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THE PETROLOGY AND STRUCTURE OF THE BURIED PRECAMBRIAN BASEMENT OF COLORADO

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Volume I

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ABSTRACT

A study of the buried Precambrian basement of Colorado has been made as part of a regional investigation of the buried crust of the North American continent by the Advanced Research Projects Agency. Material for this study consisted of samples of basement rock from 123 out of a total of 193 wells drilled for oil and gas which penetrated the subsurface basement. Most of the collected samples were drill cuttings, but a few of the samples were cores of basement rock. In addition, 133 samples were collected from the exposed basement in central Colorado in order to correlate the petrographic characteristics of the well samples with the surface samples of similar rocks.

Based on the identification of basement rocks from well and surface samples, ten lithological terranes, named after counties, have been distinguished in the Precambrian basement of Colorado. These are informal names for location purposes only and are as follows: (1) Weld-Delta metasedimentary terrane, (2) Kit Carson-Kiowa metasedimentary terrane, (3) Saguache-Huerfano metasedimentary terrane, (4) La Plata-San Juan metasedimentary terrane, (5) Logan-Yuma granitic

terrane, (6) Pueblo-Teller granitic terrane, (7) Las Animas-Baca granitic terrane, (8) Mesa-Montezuma granitic terrane, (9) Uinta Mountain sedimentary terrane, and (10) Otero-Bent volcanic terrane.

The lithological trends of the terranes, the structural trends of the exposed Precambrian basement rocks, the pattern of gravity anomalies, and the distribution of isotopic age determinations of Precambrian rocks were all considered in an analysis of the Precambrian structure. A compilation of all available published isotopic age determinations of basement rocks in Colorado shows that there probably have been several orogenic periods with syntectonic and post-tectonic intrusive activity from as early as 1800 m.y. to 525 m.y. The basement of Colorado is believed to have formed as the result of deformation, of metamorphism, and of intrusion of successive superimposed Precambrian orogenic belts. The ages of the basement rocks appear to bear no relation to the pattern of the lithological terranes. Anticlinoria and synclinoria formed during the orogenic deformations of the basement appear to be responsible for the pattern of granitic terranes associated with positive gravity anomalies and the pattern of metasedimentary terranes associated with negative gravity anomalies. The Precambrian sedimentary terrane formed as a basin of deposition upon the surface of the older, crystalline basement, and the volcanic terrane suggest a zone of deep faulting and associated volcanism.

Except for the structural trend of the Uinta Mountains, there appears to be no distinct relationship between the present structure of the basement in Colorado and the basement lithological terranes or the Precambrian structural trends. Since the formation of the basement, there has been progressively less correlation between younger tectonic trends and the Precambrian structural trends, a fact which suggests that the Precambrian trends have had less structural influence on each succeedingly younger tectonic event.

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INTRODUCTION

Purpose and Scope of Investigation

A study of the buried Precambrian basement rocks of Colorado has been made in order to determine the areal extent and directional trends of the Principal basement lithologies. Because the area of exposed basement rocks in Colorado comprises only a small percentage of the total area of the State, most of the data for this study were obtained by examination of samples from oil and gas exploration wells which penetrated the basement. Many published papers containing general information on the exposed basement rocks of Colorado were reviewed. As a result of this investigation, a geological map of the buried basement has been prepared and an interpretation has been made of the probable structure of the basement. The possible effect of the Precambrian lithology and structure upon the later tectonic development of the basement in Colorado has also been investigated.

Acknowledgements

An investigation of the buried crust of the North American continent, of which this thesis project is a part, has been conducted under the overall coordination of Dr. William R. Muehlberger of the

Department of Geology, the University of Texas. A research-assistant salary and funds for thin sections and isotopic age determination were furnished through Dr. Muehlberger by the United States Air Force under Advanced Research Projects Agency (ARPA) contract number AF49(638)-1115 in the VELA-UNIFORM program. Additional funds for tuition and thin sections were supplied by the Colorado School of Mines Foundation, Incorporated.

The writer would like to express his sincere thanks to Dr. Robert M. Hutchinson, chairman of the doctoral advisory committee, who supervised the work on this thesis project and who gave valuable assistance by guiding and counseling the writer during all stages of the research. He would also like to thank the other members of his doctoral advisory committee, Professors John D. Haun, L. Trowbridge Grose, Niles E. Grosvenor, James G. Johnstone, and John M. George, who helped in many phases of the planning, execution, and final fruitions of the project. It is a pleasure also to thank Dr. Peter C. Badgley, former chairman of the doctoral advisory committee, for initiating the writer to this project and for guidance during the early stages of the work; and Dr. William R. Muehlberger, supervisor of the Basement Rocks Project, for helpful suggestions in the correlation of this Colorado portion of the project with surrounding areas.

Especial thanks are extended to Mr. James G. Mitchell, president of the American Stratigraphic Company, Denver, Colorado, who permitted the writer to obtain samples of basement rocks from his firm's well-samples library. Through Mr. Mitchell's generosity, more than half of the samples studied in this project, often unobtainable from any other source, were collected. Thanks are also due to all who donated samples for this project, as follows:

Amarillo Sample Cut Service
Amerada Petroleum Corporation
California Oil Company
    J. W. Rold
    M. R. Hembree
Colorado School of Mines
Continental Oil Company
El Paso Natural Gas Company
Gulf Oil and Refining Company
Humble Oil and Refining Company
Kingwood Oil Company
R. W. Lange
Midland Sample Library
Pan American Petroleum Company
    J. F. DeChadenedes
Phillips Petroleum Company
St. Helens Petroleum Company
Shell Oil Company
Texaco, Incorporated
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Previous Studies of Buried Precambrian Rocks in Colorado and Adjacent States

Although no comprehensive study of the buried Precambrian basement has previously been made for all of Colorado, several papers have been published which discuss portions of the state. The buried basement in the southwestern corner of Colorado was discussed by Fitzsimmons (1963). Two articles on eastern Colorado were prepared by the present writer (Edwards, 1963; 1964) and represent progress reports on this thesis project. On the exposed basement of Colorado, much work has been done both on a regional and on a local scale. Some of the more important regional papers are as follows: on the Front Range, Lovering and Goddard (1950), Boos and Boos (1957), Badgley (1960), Hutchinson (1960b), Hutchinson and others (1960), Tweto and Sims (1963); on the Sawatch Range, Stark and Barnes (1935); on the Gunnison Valley, Hunter (1925); and on the San Juan Mountains, Larsen and Cross (1956). Papers dealing with investigations of a more local nature are discussed in later sections of this report.

Previous studies of buried basement rocks in States adjacent to Colorado include those of Landes (1927), Walters (1946) and Farquhar (1957) for Kansas; Flawn (1956) for Texas and southeastern New Mexico; Ham, Denison, and Merritt (1964) for southern Oklahoma; and Fitzsimmons (1963) for the Four Corners area of Arizona, New Mexico, and Utah, as well as Colorado. Since 1958, the Basement Rocks Committee of the Kansas Geological Society has tabulated over 2400 wells known to have encountered basement rocks in that state, has published several reports on projects involving the Precambrian basement, and is currently engaged in research on others. In order to obtain an integrated picture of the basement of the North American Continent, the ARPA Basement Rocks Project under the direction of Dr. W. R. Muehlberger is coordinating studies for all of the United States plus portions of Canada and of Mexico. In 1964, a symposium on "Relation of Basement to Sedimentary Basins" was held in Toronto, Canada, under the sponsorship of the American Association of Petroleum Geologists. Several papers presented at this symposium which have some bearing on the study of the basement in Colorado have been published in the July 1965 Bulletin of the A.A.P.G. (Flawn, 1965; Stockwell, 1965; Rudman, Summerson, and Hinze, 1965; Ham, Denison, and Merritt, 1965; Prucha, Graham, and Nickelsen, 1965; and Hoppin and Palmquist, 1965).

Present Structural Framework of Colorado

The present structural framework of Colorado may be divided into two regions, each of which has a distinctive structural development (fig. 1). One region includes that part of eastern Colorado which lies east of the Rocky Mountains. The structure of this region is characterized by broad arches and basins, the most prominent of which is the Denver basin. The western flank of this basin has a very steep dip against the uplifts of the Front Range and the Wet Mountains. The axis of the Denver basin extends north-south and lies very close to the western flank, adjacent to the mountain front. The gently dipping eastern flank of this strongly asymmetric basin extends into eastern Colorado and western Kansas, where it terminates against the northeast-trending Las Animas arch, and against the Chadron and Cambridge arches in western Nebraska. The Hartville uplift forms the northern boundary of the Denver basin in eastern Wyoming. In southeastern Colorado, the southern termination of the Denver basin is against the Apishapa uplift which extends to the southeast as a subsurface continuation of the Wet Mountains uplift.

The Sierra Grande arch in Colorado is the northern end of an arch which extends southwesterly into New Mexico. Between this arch and the Sangre de Cristo Range to the west is the Raton basin, which also continues southward into New Mexico. East of the combined axes of the Sierra Grande and Las Animas arches lies the western end of the Hugoton embayment of southwestern Kansas and northwestern Oklahoma.

The second structural region includes central and western Colorado, where the structure is considerably more complex than that of eastern Colorado and consists of a number of mountainous uplifts with intervening basins. The Front Range, largest of these uplifts, is divided in northernmost Colorado into the Laramie and Medicine Bow Ranges, which are separated by the southern end of the Laramie basin. West of the Medicine Bow Range and separated from it by the North and Middle Park basin lies the Sierra Madre-Park Range uplift. Southeastward, the Park Range trends into the Gore and Tenmile Ranges. Still farther to the southeast across the basin of South Park, the Wet Mountains uplift

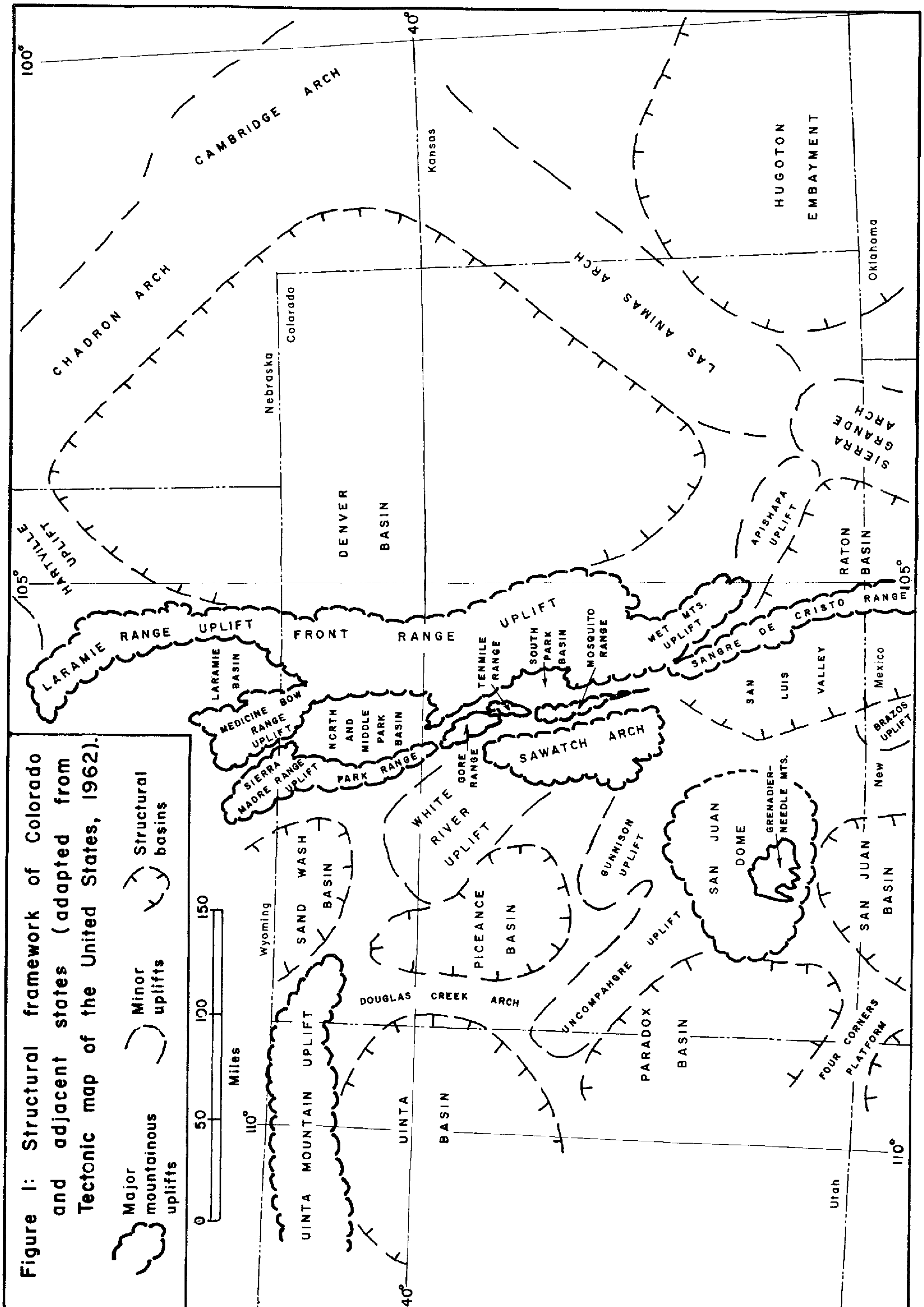


Figure 1: Structural framework of Colorado and adjacent states (adapted from Tectonic map of the United States, 1962).

lies along this same structural trend.

A third northwest-southeast-trending series of uplifts extends from the eastern end of the east-west Uinta Mountains uplift as the White River uplift, the Sawatch arch (including the Mosquito Range which constitutes its eastern flank), and the Sangre de Cristo Range. This last range is actually the remnant of a marginal thrust belt of Tertiary age (Karig, 1963b), and has a structural origin different from that of the other ranges in Colorado. Between the Park Range and the Uinta Mountain and White River uplifts lies the Sand Wash basin.

The Piceance basin separates the Uinta-White River-Sawatch structural trend from a fourth line of uplifts, which trends to the southeast as the Uncompahgre uplift (with the subsidiary Gunnison uplift on its northeast flank) and the San Juan dome. This line of uplifts extends beneath the Tertiary volcanics of the San Juan Mountains and is terminated in southern Colorado by the graben of the San Luis Valley. Kelley (1955, p. 23), Baltz (1965), and Peterson and others (1965) show this structural trend to continue into New Mexico as the Archuleta and Brazos uplifts. Between the Uncompahgre and Uinta Mountain uplifts is a small, north-south-trending feature known as the Douglas Creek arch, which separates the Piceance basin from the Uinta basin of Utah. To the southwest of the Uncompahgre-San Juan line of uplifts lie the Paradox basin in Colorado and Utah and the San Juan basin in Colorado and New Mexico. These two basins are separated by the Four-Corners platform, which extends southwesterly from the Grenadier-Needle Mountains area of exposed Precambrian rocks in the San Juan dome.

Distribution of Exposed Precambrian Rocks

Precambrian rocks are not exposed east of the Front Range, the Wet Mountains, and the Sangre de Cristo Range in eastern Colorado. In central and western Colorado, however, basement rocks are exposed within the uplifts of the Front, Laramie, Medicine Bow, Park, Gore, Tenmile, Sawatch, and Mosquito Ranges, in the Wet and Uinta Mountains, in the Grenadier-Needle Mountains area of the San Juan dome, and in the Gunnison Valley along the Gunnison uplift (pl. 1). Smaller exposures are present across the less well-developed uplifts which have not been as deeply denuded of their sedimentary cover. Such exposures are in the vicinity of Unaweep Canyon on the Uncompahgre uplift, around Glenwood Canyon on the White River uplift, and in northern Saguache County across the buried southeastern end of the Gunnison uplift. Small basement exposures also are present in up-faulted basement blocks near Parshall and Hot Sulphur Springs in Grand County, at the southern end of the North and Middle Park basin.

Location of Wells

Within the State of Colorado as of December 1965, a total of 193 wells has been reported as encountering either Precambrian basement rocks or igneous rocks. These wells are listed in Appendix I of Volume 2, pages 1 to 19. The principal source of this information has been the well-completion cards published by the Petroleum Information Corporation of Denver, Colorado. These wells drilled in search of oil and gas were located in the most interesting or promising areas for that purpose. Consequently, the well control on the basement rocks is not uniformly distributed. For large areas of the buried basement there are no data whatsoever.

In southeastern Colorado, the basement tests are located across the crests or along the structually higher flanks of the Sierra Grande uplift, the Apishapa Uplift, and the Las Animas arch. In the northeastern part of the State, however, most of the wells drilled to the basement occur on the gently sloping eastern flank of the Denver basin. The locations of these wells were determined by stratigraphic and structural investigations of overlying sedimentary formations, predominantly Cretaceous. The holes were extended to the basement in order to test the deeper Mesozoic and Paleozoic formations for possible hydrocarbon traps. Only three wells have been drilled to the basement near the axis of the Denver basin.

The structural framework of the basement in central and western Colorado is much more complex because of repeated phases of tectonic activity since late Paleozoic time, but here, also, the structure is the prime factor in the location of the basement test wells. Most of these wells lie on the flanks of the large basins where the sedimentary formations have been upturned against the uplifts. Some wells occur on relatively minor structures within the basins, and still others occur on anomalous structural features probably caused by Tertiary igneous intrusions.

PREPARATION AND PRESENTATION OF DATA

Collection of Samples

Samples were collected from 123 of the 193 wells which have been reported as having been drilled into Precambrian rock or igneous rock. Seventy-two of these wells are in eastern Colorado and the remaining fifty-one are in the central and western parts of the State (pl. 1). Igneous and metamorphic rocks were identified in samples from 100 wells. These rock types include plutonic granites, quartz monzonite, and granodiorite; granitic and porphyroblastic augen genisses; metasomatic gneisses; metasedimentary gneisses, schists, quartzites, and amphibolites. Five of the wells had samples of shallow intrusive and tuffaceous rocks considered to be of Precambrian age. Samples from four wells were of late Precambrian sediments, and another well was drilled into a sediment or regolith of late Precambrian age or possibly of Cambrian age. One well sample appeared to be a sediment altered by contact metamorphism and is of unknown age, quite possibly Pennsylvanian. Finally, twelve of the wells encountered shallow intrusive rocks or hornfelses considered here to be of Tertiary age.

Samples were not located for the remaining 69 of the 192 reported basement wells. For most of these, the samples have either been discarded of lost. In others, the depth of penetration into the basement was only a few feet and was insufficient for chips of the basement rock to be recovered in the cuttings from the well. Sills, dikes and stocks of Tertiary intrusions were encountered in still others of these wells. In some of the older wells it is doubtful if the basement was actually encountered as was reported. Samples were not collected from wells drilled after June, 1964.

Most of the samples from the wells were in the form of cuttings, and identification as to the rock type was based entirely upon the petrographic examination. In a few wells, however, the basement was cored and the petrographic analysis of samples from these wells could be supported by a megascopic examination of the textures in the core. The entire project was handicapped by the fact that the rocks from the basement test wells could not be observed in their actual field relationships. Samples of exposed basement rocks were collected from areas in the southern Front Range, the Sawatch Range, and the Gunnison Valley. These rocks were considered to be representative of the basement rocks of Colorado and a petrographic and petrologic study of them helped greatly in the interpretation of the textures and field occurrences of buried rocks having similar lithologies.

Method of Study

A total of 280 thin sections were prepared from the samples collected from the 123 basement test wells. Upon completion of this project these thin sections will be placed on permanent file at the Crustal Studies Laboratory, Department of Geology, The University of Texas, Austin, Texas. Index numbers of the thin sections of well samples from the buried basement of Colorado are designated with the prefix "CL". The number of thin sections per well ranged from one to a maximum of eight. Each thin section was examined by petrographic microscope. The component minerals were identified, a visual estimate was made of the percentage of each mineral, and the fabric of the rock was determined. These petrographic descriptions are given in Appendix II of Volume 2, pages 20 to 196. If the rock was determined to be of metamorphic origin, an interpretation based upon the data obtained in the petrographic examination was made as to the nature of the original rock. For about 10 percent of the total number of thin sections, petrographic methods using the universal stage were employed as a means of checking the determinations of the variety of plagioclase, amphibole, or pyroxene. The predominant rock type for each well was plotted on a base map of the State of Colorado (pl. 1), and the resulting pattern of lithological trends was outlined.

One hundred and thirty-three thin sections were made from the collected samples of the exposed Precambrian basement. Descriptions of these thin sections are to be found in Appendix III of Volume 2, pages 197 to 274. These thin sections are on permanent deposit in the Petrological Reference Collection of the Department of Geological Engineering, Colorado School of Mines, Golden, Colorado, and are indexed with the prefix number of PRC-27.

All available published isotopic age determinations of basement rocks in Colorado (table 18 and plate 2) were studied in the interpretation of the structure of the basement. In addition, age determinations on samples from 10 wells were given the writer by Dr. W. R. Muehlberger. These determinations were made by the U. S. Geological Survey, Isotope Geology Branch (S. S. Goldich, Chief), in co-operation with the A.R.P.A. project.

An Airy-Heiskanen isostatic anomaly gravity map of Colorado prepared by Qureshy (1958, 1960) was used in support of delineation of the lithological terranes and also in the interpretation of the basement structure.

Terminology and Definitions

Most of the petrographic and petrologic terminology in this report is that used by Williams, Turner, and Gilbert (1954). However, for the few samples of sedimentary rocks encountered in this study the terms "sandstone", "shale", and "limestone", with modifying adjectives are used in preference to the terminology for sedimentary rocks used in the above book.

In the naming of the metamorphic rocks examined during the course of this study, the least abundant mineral in the rock appears first in the name, followed by the minerals in order of increasing abundance. For example, a gneiss containing 10 percent microcline, 20 percent biotite, 30 percent quartz, and 40 percent plagioclase is named a microcline-biotite-quartz-plagioclase gneiss.

> Amphibolite: "A crystalloblastic rock consisting mainly of amphibole and plagioclase." (A.G.I., 1960).

These two minerals must occur in approximately equal amounts and each must make up at least 40 percent of the rock. Rocks which diverge from these criteria are called either plagioclase-hornblende gneiss or hornblende-plagioclase gneiss.

> Basement (complex): "A series of rocks generally with complex structure beneath the dominantly sedimentary rocks. In many places they are igneous and metamorphic rocks of either Early or Late Precambrian, but in some places may be much younger, as Paleozoic, Mesozoic, or even Cenozoic." (A.G.I., 1960).

In this paper, the Precambrian sedimentary rocks of the Uinta Mountain Group are included as basement. The Tertiary stocks and batholiths, such as those in the Sawatch Range, have not been included.

> Gneiss: "A coarse-grained rock in which bands rich in granular minerals alternate with bands in which schistose minerals predominate." (A.G.I., 1960).

In the thin sections made from drill cuttings, from which megascopic textures could not be determined, a rock which contains less than 30 percent micaceous minerals is considered a gneiss. These micaceous minerals must also occur in discrete bands and patches or as individual grains.

Granite: Used in the strict sense, granite is a genetic term and refers to plutonic igneous rocks which contain between 10 and 30 percent quartz, 50 and 90 percent feldspar, and the remainder composed of ferromagnesian minerals and accessory minerals (Williams, Turner, and Gilbert, 1954). At least two-thirds of the feldspar must be potash feldspar, either orthoclase or microcline.

Granitic: This adjective, when used in the broad sense as for granitic terrane, granitic gneisses, or granitic rocks, is a descriptive term and refers to acidic igneous and metamorphic rocks which range in composition from diorites and granodiorites to syenites and granites.

> Granitization: "A term used in somewhat different connotations by different authors, but in general, referring to the production of a granitic rock from sediments by an unspecified process. Some would limit the term to the production of granite in place, without the formation of a 'notable' amount of liquids; others would include all granitic rocks formed from sediments by any process, regardless of the amount of liquid formed or any evidence of movement. The precise mechanism, frequency, and magnitude of the process are still in dispute." (A.G.I., 1960).

In this paper "granitization" is used as a general term meaning the changing of a pre-existing rock into a rock of more granitic composition by some unspecified process.

Metasediments: Although Stokes and Varnes (1955) consider this term as referring to partly metamorphosed sediments, in this paper it refers to well-foliated metamorphic rocks, such as gneisses, schists, quartzites, and amphibolites, which have been formed by the metamorphism of sedimentary rocks. Some metamorphosed volcanic rocks are also included.

> Metasomatism: "The process of practically simultaneous capillary solution and deposition by which a new mineral of partly or wholly differing chemical composition may grow in the body of an old mineral or mineral aggregate (Lindgren). The agents involved are chemically active liquids or gases operating in small, usually submicroscopic, openings. Replacement may occur among free grains or aggregates resulting, perhaps, in change of volume, or

within rigid rocks where the replacing mineral occupies exactly the space formerly filled by the earlier mineral or rock. The changes may take place within a closed system, without affecting the bulk composition of the mass, or may require introduction and removal of certain substances, with corresponding change not only in the mineralogy, but in the bulk chemical composition of the rocks affected. In the study of metamorphic rocks, volume-for-volume replacement with introduction and removal of material is the usual meaning. The process is widespread and important, not only in metamorphic rocks as they are usually defined, but also in many ore deposits and to a varying degree, in almost all kinds of earth material." (Stokes and Varnes, 1955).

Quartzite: The definition used here is that of Rice (1941) which reads, in part:

"...The term quartzite has been used for a metamorphic rock produced by a recrystallization of a quartz sandstone under heat and pressure..."

Schist: "A medium- or coarse-grained metamorphic rock with sub-parallel orientation of the micaceous minerals which dominate its composition." (A.G.I., 1960).

In the thin sections of drill cuttings in this study, a schist was considered to contain greater than 30 percent micaceous minerals. These minerals occurred throughout the rock in an interconnecting network of grains.

Terrane: "The area or surface over which a particular rock or group of rocks is prevalent." (A.G.I., 1960).

Therefore, a metasedimentary terrane is one in which metasedimentary rocks such as schists, gneisses, quartzites, and amphibolites predominate, but in which granitic igneous rocks and granitic gneisses may also be found. A granitic terrane is one in which granitic rocks (used in the broad sense) predominate, but in which some metasedimentary rocks also occur. Sedimentary rocks characterize a sedimentary terrane and volcanic rocks characterize a volcanic terrane.

> Trend: "The direction or bearing of the outcrop of a bed, vein, fault, ore body, contact, or linear structure. Also the direction or bearing of larger features such as folds, mountains, or ridges." (Stokes and Varnes, 1955).

In this paper, "trend" refers to the predominant direction or bearing of some linear or elongate geological feature. "Structural trend" refers to a feature which is structural in nature, whereas "lithological trend" refers to a feature defined on the basis of lithology.

Criteria for Distinguishing Granitic Igneous Rocks from Granitic Gneisses

The granitic rocks examined in thin section for this study were classified either as granitic igneous rocks or as granitic gneisses. The criteria for distinguishing between these two groups of rocks were primarily petrographic as most of the thin sections were of drill cuttings and the larger scale rock textures could not be observed. However, by the comparison of textures in the thin sections of well samples with similar textures found in thin sections of samples collected from the exposed Precambrian basement, it is believed that the interpretation as to the origin of the buried samples is correct.

Granitic igneous rocks were determined on the basis of the mineral paragenesis which indicated these particular rocks crystallized from a silicate melt. The plagioclase grains were euhedral to subhedral in outline and commonly exhibited pericline and Carlsbad twins in addition to the usual albite twins. Very distinct compositional zoning in the plagioclase grains was also common. Biotite grains were of a size range comparable to the feldspar and quartz grains in the rock and occurred in single grains with subhedral to anhedral outlines. Graphic textures of quartz in microcline or orthoclase were present in a few rocks. Figures 22, 23, and 25 illustrate examples of what are thought to be typical granitic igneous rocks in the Precambrian basement of Colorado.

Granitic gneisses, on the other hand, lacked these typical features of igneous rocks. Metamorphism of granitic igneous rocks could have obliterated the original igneous textures. Plagioclase grains were xenoblastic or had a modified idioblastic shape; that is, an originally idioblastic (or euhedral) grain had been subtly rounded or corroded. Twinning of the plagioclase grains was primarily of the albite type with some of the larger grains also exhibiting Carlsbad twins. The albite twin lamellae were often very indistinct. Pericline twins were observed only rarely. Zoning of plagioclase was very weak if at all present. Biotite grains were often considerably smaller in size than the quartz and feldspar grains and occurred in clusters of weakly oriented grains. Xenoblastic augen of microcline introduced by alkali-silicate metasomatism may also be present. Figure 20 illustrates a typical granitic orthogneiss.

Some of the granitic gneisses were identified as metasedimentary gneisses which had been strongly metasomatized by alkali-silicate solutions. The resulting fabric was more granoblastic, with irregularly shaped inequigranular grains of microcline and quartz emplaced within the original paragneiss host rock. The original grains of plagioclase and biotite had been severely altered to sericite and hematite, and small, rounded blebs of quartz had formed within many of the other mineral grains. Figure 10 is of a typical metasomatic granitic gneiss.

Lastly, some granitic gneisses have been produced by cataclasis, in which the original rock, whether an igneous granite or a granitic gneiss, had been subjected to deformation which destroyed the original fabric. Figure 21 illustrates a slightly cataclastic granitic gneiss and figure 24 is of a more extreme example of cataclasis.

PETROGRAPHY AND PETROLOGY OF THE BURIED PRECAMBRIAN BASEMENT

As a result of petrographic study of samples from 123 wells in Precambrian rocks and from published information on the exposed basement, 10 lithologic terranes have been delineated for the State of Colorado. These terranes are as follows: the Weld-Delta metasedimentary terrane, the Kit Carson-Kiowa metasedimentary terrane, the Saguache-Huerfano metasedimentary terrane, the La Plata-San Juan metasedimentary terrane, the Logan-Yuma granitic terrane, the Pueblo-Teller granitic terrane, the Las Animas-Baca granitic terrane, the Mesa-Montezuma granitic terrane, the Uinta Mountain sedimentary terrane, and the Otero-Bent volcanic terrane (see Plate 1). These terranes have been named after counties within which the basement rocks are adjudged as typical of the terrane. However, the Uinta Mountain sedimentary terrane was named after the Precambrian sedimentary rocks of the Uinta Mountain Group, which are typically exposed in the Uinta Mountains of Utah and Colorado. For most of the other terranes, the county names were those which have Precambrian rock from the subsurface only, but in some instances, counties which have large areas of exposed basement rocks considered to be typical of the terrane were used in the terrane name. The names of the terranes are to be considered as being informal and are introduced here only for the purpose of facilitating the discussion of each terrane and for location within the State of Colorado.

In addition to the well samples from the buried Precambrian basement, suites of exposed basement rocks were studied from the Front Range, Sawatch Range, Mosquito Range, and Gunnison Valley areas. Most of these surface samples were collected from the exposed basement of the Weld-Delta metasedimentary terrane, but others were from the Pueblo-Teller granitic terrane, the Mesa-Montezuma granitic terrane, and from the complex granitized area where these three terranes and the Saguache-Huerfano metasedimentary terrane all converge.

Table 1 is a summary of the principal lithologies which occur within each of the basement terranes. It will be noticed that granitic igneous rocks and granitic gneisses occur within the metasedimentary terranes, often in considerable amounts. Similarly, metasedimentary gneisses and schists are found within the granitic terranes.

Weld-Delta Metasedimentary Terrane

The Weld-Delta metasedimentary terrane is the largest of the basement lithological terranes in Colorado and extends throughout most of the northern and western parts of the State (pl. 1) except for the far northwestern corner which is occupied by the Uinta Mountain metasedimentary terrane. The terrane is bounded on the east by the Logan-Yuma granitic terrane and on the south by the Pueblo-Teller granitic terrane and the Mesa-Montezuma granitic terrane. To the north it passes into Wyoming and to the west it continues into Utah. Samples of basement rocks were obtained from 24 wells in this terrane. Five of the wells are located in Jackson County, 4 each are in Routt and Weld Counties, 2 each are in Garfield, Grand, and Montrose Counties, and 1 well each is in Adams, Delta, Larimer, Mesa, and Rio Blanco Counties. Other counties included in this terrane are all or parts of Arapahoe, Boulder, Clear Creek, Denver, Douglas, Eagle, Gilpin, Gunnison, Jefferson, Morgan, Park, Pitkin, and Summit.

The definition of this terrane is based on the predominance in this part of the state of metasedimentary rocks and granitized metasediments (table 1). Some granitic gneisses and granitic igneous rocks are also present. Basement rocks of the terrane are extensively exposed in the northern Front Range, Park Range, Gore Range, Sawatch Range, and in the Gunnison Valley. Small exposures occur near Hot Sulphur Springs and Parshall in central Grand County, in several canyons which cut the White River uplift in eastern Garfield County, and in canyons at the northern end of the Uncompahgre uplift in Mesa County. Rocks similar to these of the exposed basement were identified in the samples from the 24 wells in the terrane. Four additional wells were drilled into igneous rocks which are here considered to be Tertiary intrusive rocks.

Summary of the exposed basement rocks.

The basement rocks identified in the well samples from the Weld-Delta metasedimentary terrane are very similar to the rocks exposed in

TABLE 1: SUMMARY OF TERRANE LITHOLOGIES

Terrane	Generalized Lithologies (listed in order of decreasing apparent importance)
Weld-Delta metasedimentary terrane	Quartzo-feldspathic, pelitic, calcareous, and basic paragneisses; granitized paragneisses, granitic igneous rocks, and orthogneisses.
Kit Carson-Kiowa metasedimentary terrane	Quartzo-feldspathic and pelitic schists and paragneisses, orthogneisses, augen gneisses, and basic paragneisses.
Saguache-Huerfano metasedimentary terrane	Quartzo-feldspathic, pelitic, calcareous, and basic paragneisses, granitized paragneisses, and granitic igneous rocks.
La Plata-San Juan metasedimentary terrane	Quartzite, slate, basic paragneisses, and granitic igneous rocks
Logan-Yuma granitic terrane	Orthogneisses, augen gneisses, granitized paragneisses, and granitic igneous rocks.
Pueblo-Teller granitic terrane	Orthogneisses, augen gneisses, granitic igneous rocks, granitized paragneisses, and quartzo-feldspathic, pelitic, calcareous and basic paragneisses.
Las Animas-Baca granitic terrane	Granitic igneous rocks, orthogneisses, and cataclastic orthogneisses.
Mesa-Montezuma granitic terrane	Orthogneisses, granitized paragneisses, granitic igneous rocks, and calcareous, quartzo-feldspathic, pelitic, and basic paragneisses.
Uinta Mountain sedimentary terrane	Quartzites, sandy, silty, and limy shales, sandy and argillaceous limestones, and conglomerate (?).
Otero-Bent volcanic terrane	Rhyolitic, latitic, and dacitic tuffs, latites, andesites, and olivine basalts.

the Front Range, which have been described in detail by Lovering and Goddard (1950), Boos and Boos (1957), Wahlstrom and Kim (1959), Hutchinson and others (1960), Moench, Harrison, and Sims (1962), and Wells, Sheridan, and Albee (1964). In general, two separate series of metamorphic rocks have been identified and have been termed the Idaho Springs Formation and the Swandyke Hornblende Gneiss.

Lovering and Goddard (1950), who have published the most extensive work on the basement rocks of the Front Range, considered the Idaho Springs Formation to be the older of the two series. They describe it as being composed primarily of quartz-biotite schists and quartz-biotite-sillimanite schists with lesser amounts of quartzite, quartz schist, quartz gneiss, and lime silicate gneiss. Migmatized or metasomatized gneisses also occur on a large scale and the entire assemblage has been intruded by many large and small granitic plutons (Lovering and Goddard, 1950; Boos and Boos, 1957; Hutchinson, 1960b; Hutchinson and others, 1960), which possess the characteristics of concordant, transitional catazonal-mesozonal intrusions (Buddington, 1959; Badgley, 1960).

Samples of the Idaho Springs Formation were collected along the route of the field trip described by Sheridan, Sims, and Harrison (1960) for the Idaho Springs-Central City area (fig. 2). In addition, a suite of thin sections of the bedrock in the damsite foundations of the Public Service Company of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit, south of Georgetown, Clear Creek County, was donated to this project by Dr. L. W. LeRoy of the Colorado School of Mines. Most of the rocks from these two suites (table 2) were found to be biotite-quartz-plagioclase gneisses which contained varying amounts of microcline (fig. 3). Sillimanite is present in some of the more schistose rocks which lack microcline (fig. 4). Some lime-silicate gneisses are exposed near Black Hawk, Gilpin County. The parent rocks for this assemblage are considered to have been argillaceous to quartzo-feldspathic sediments and some impure limestones. A few layers of amphibolite within this sequence represent basic volcanic flows or sills which were deposited with or were intruded into the sediments prior to the metamorphism.

The Swandyke Hornblende Gneiss was described by Lovering and Goddard (1950, p. 20) as being composed of hornblende schists and gneisses with interbedded quartz-biotite schists. This series was believed by Lovering and Goddard (1950, p. 20) to have been basic intrusive and extrusive rocks stratigraphically younger than the bulk of the Idaho Springs Formation, but had been metamorphosed to the same degree as the rocks of the Idaho Springs Formation. Harrison and Wells (1959, p. 17) consider the Swandyke Hornblende Gneiss (referred to by them as quartz diorite and associated hornblendite) to represent basic sills and dikes which were intruded into the Idaho Springs Formation prior to the metamorphism of the sequence.

Suites of samples were collected both from the type area at Swandyke, Summit County, and from the smaller area of occurrence shown on the map of Lovering and Goddard (1950) east of Central City, Gilpin

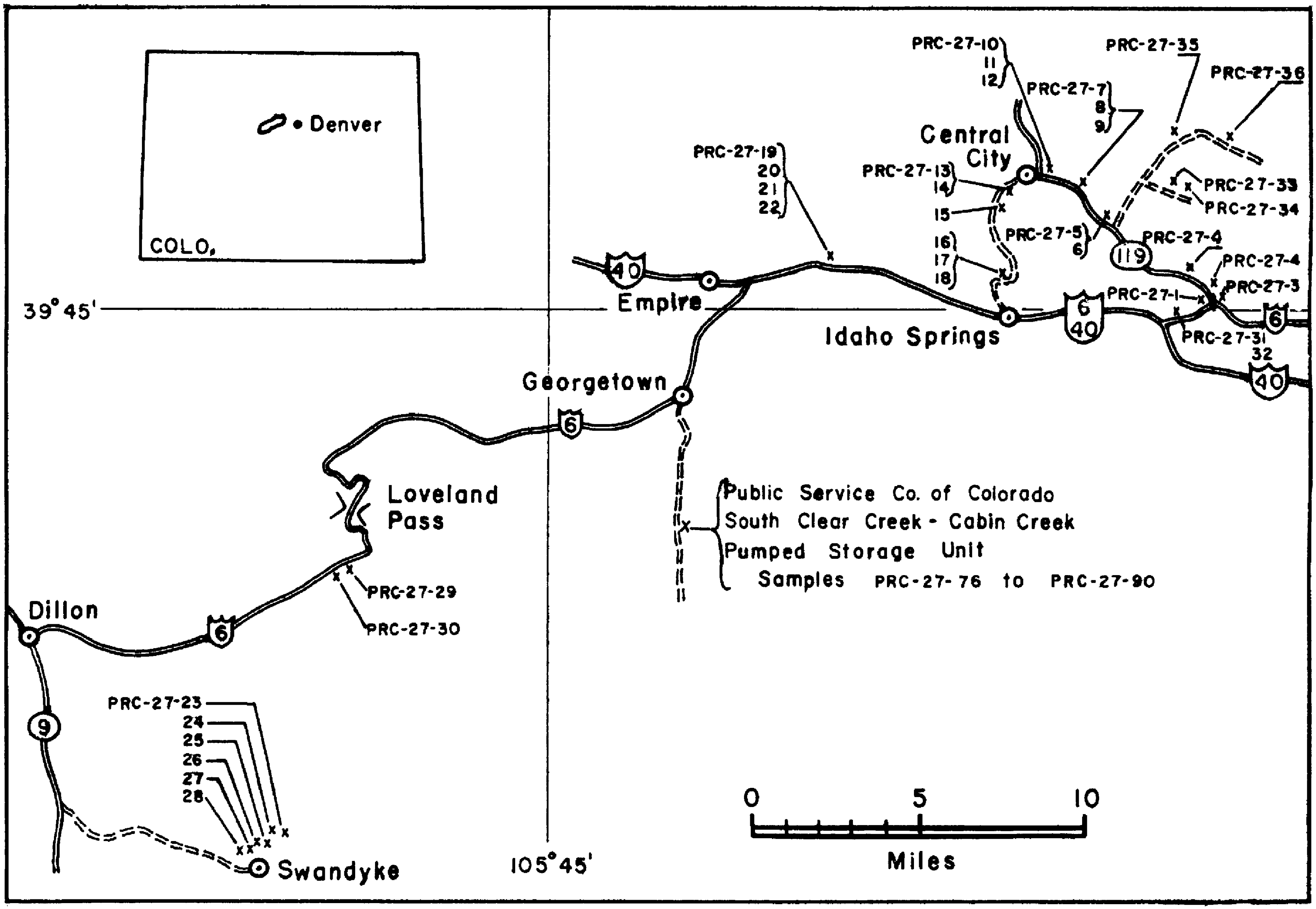


Figure 2: Locations of samples collected from the exposed basement, Idaho Springs, Swandyke, and Georgetown areas, Weld - Delta metasedimentary terrane.

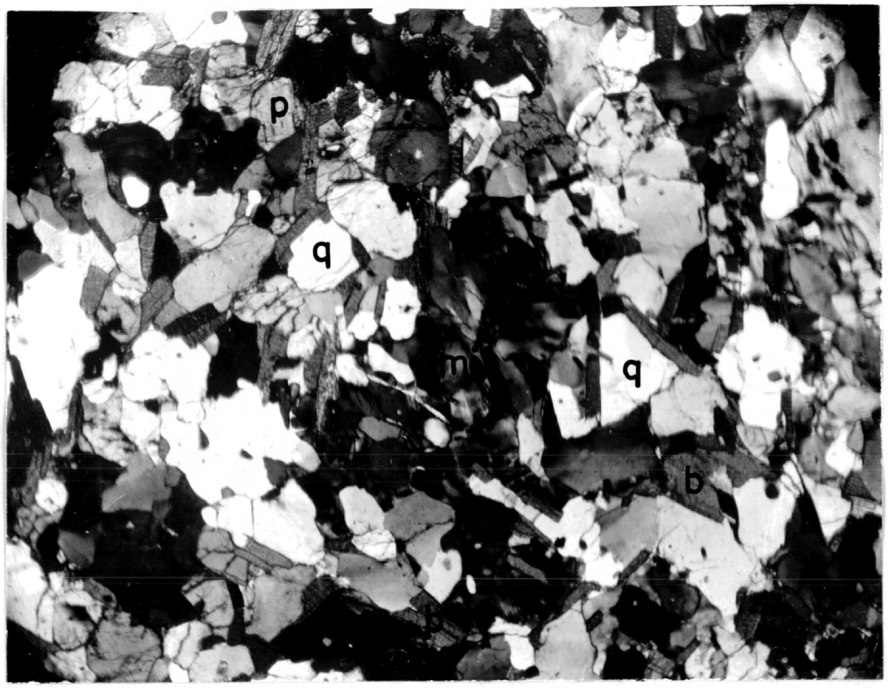


Figure 3: Photomicrograph of a biotite-plagioclase-microcline-quartz gneiss from the Idaho Springs Formation, sample PRC-27-7. b-biotite, p-plagioclase, mi-microcline, q-quartz. Crossed nicols, X25.

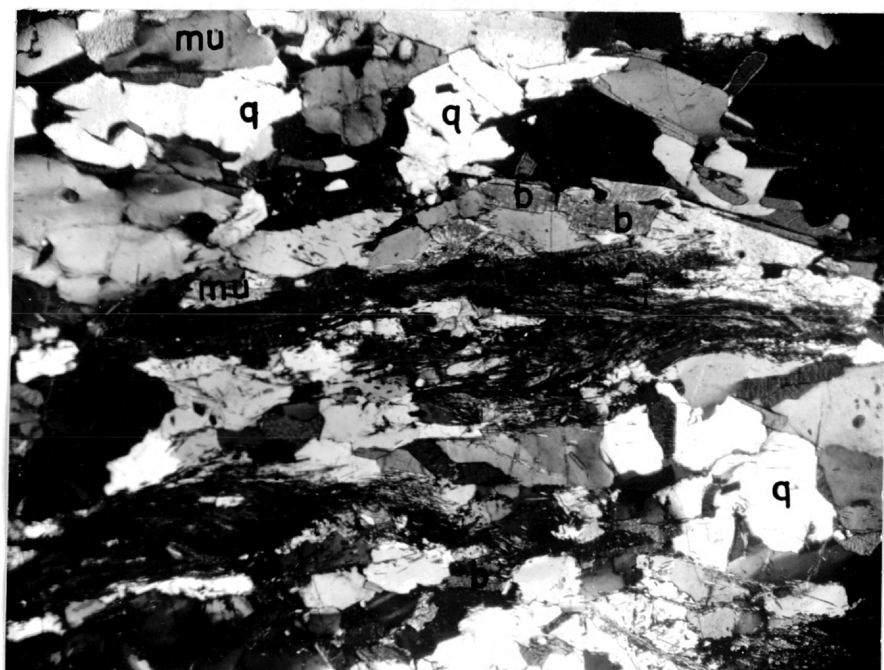


Figure 4: Photomicrograph of a muscovite-sillimanite-biotite-quartz gneiss from Idaho Springs Formation, sample PRC-27-8. mu-muscovite, si-sillimanite, b-biotite, q-quartz. Crossed nicols, X25.

County (fig. 2). In these suites, most of the rocks are amphibolites and plagioclase-hornblende gneisses (table 3, fig. 5). Diopside is common in many of the amphibolites but quartz makes up only a few percent. A few biotite-quartz-plagioclase gneisses, similar to the gneisses of the Idaho Springs Formation, are present within the Swandyke Hornblende Gneiss and probably represent argillaceous to quartzo-feldspathic sediments.

The degree of metamorphism in these two series is about the same as that of most of the metamorphic rocks of the exposed basement in Colorado, which are in the almandine-amphibolite facies of Turner and Verhoogen (1960, p. 544-553). Braddock (1965), however, mentions an occurrence of rocks in the Front Range west of Fort Collins which are within the greenschist facies and represent a lower grade of metamorphism.

The sequence of quartzites exposed in Coal Creek Canyon, Boulder and Jefferson Counties, was considered by Lovering and Goddard (1950, p. 23) and Boos and Boos (1957, p. 2713) to be younger than the Idaho Springs Formation. However, on the evidence of a definite interlayering of the two lithologies and of similar degrees of deformation and metamorphism, Wells, Sheridan, and Albee (1964) determined the Coal Creek Quartzite and the Idaho Springs Formation to be essentially contemporaneous deposits.

The more recent works on the Precambrian metasedimentary rocks of the Front Range (Wahlstrom and Kim 1959; Moench, Harrison, and Sims,

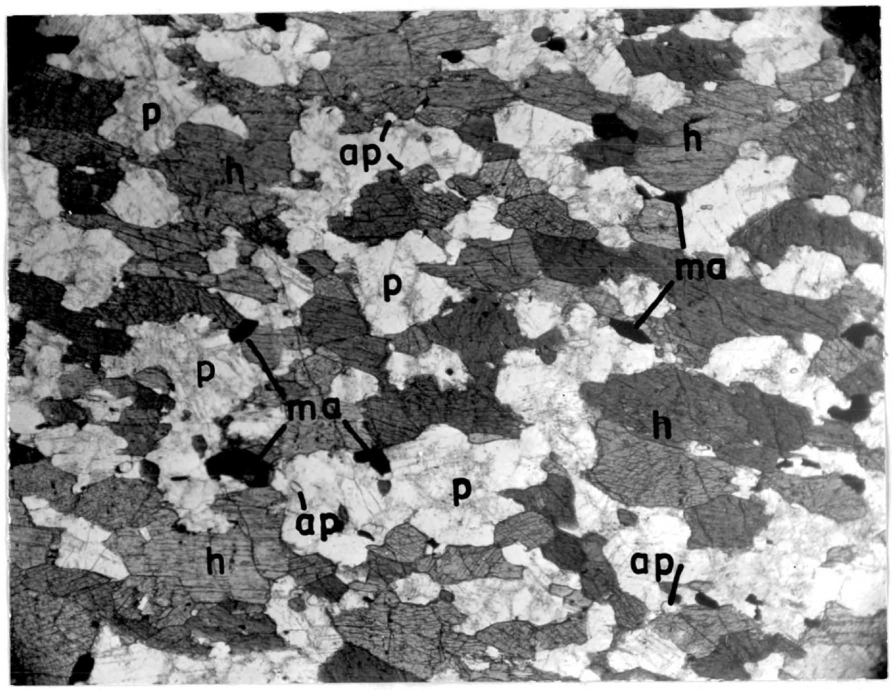


Figure 5: Photomicrograph of an amphibolite from the Swandyke Hornblende Gneiss, sample PRC-27-26. ap-apatite, ma-magnetite, h-hornblende, p-plagioclase. Uncrossed nicols, X25.

1962; Wells, Sheridan, and Albee, 1964) no longer refer to the names "Idaho Springs Formation" and "Swandyke Hornblende Gneiss" but instead name the rock units on a mineralogical basis. According to Wahlstrom and Kim (1959, p. 1219):

> "The Idaho Springs formation is not a formation in the ordinary sense. As generally used, the term refers to a laterally extensive assemblage of foliated rocks of complex but fairly distinctive lithology and fabric formed by the high-grade regional metamorphism of a thick sequence of clastic, relatively noncalcareous sedimentary rocks. Similarly, the Swandyke hornblende gneiss is the result of the metamorphism of a succession of interlayered calcareous and quartzo-feldspathic sedimentary rocks and is exemplified by the extensive hornblende schists and gneisses in the southwestern portion of the Front Range. There is no basis for the assumption that rocks that have been classified as Idaho Springs Formation or Swandyke hornblende gneiss in one part of the Front Range were metamorphosed at the same time or involved original materials of the same geologic age as rocks similarly classified in other portions of the Front Range. The Precambrian core of the Front Range has had a complicated history, and indiscriminate classification of the foliated metamorphic rocks into two or three general catagories does not serve a useful purpose in the interpretation of the geologic history. However, metasedimentary rocks that have fabrics and mineralogy similar to those in the rock assemblages near Idaho Springs can be classified as the Idaho Springs type of metasedimentary rock; metamorphosed rocks similar to those near Swandyke can be referred to as the Swandyke type of rock."

Suites of samples of the exposed Precambrian basement of Colorado were also collected from the complex area in the southern Front Range and the Sawatch Range where the Weld-Delta, Pueblo-Teller, Saguache-Huerfano, and Mesa-Montezuma terranes all converge. East of the Sawatch Range, the basement rocks of the Mosquito Range and the southern Front Range are primarily granitic (Stark and Barnes, 1935, p. 473; map of Tweto and Sims, 1963) and are included in the Pueblo-Teller granitic terrane. The suites from the Sawatch Range and the Gunnison Valley (fig. 6, table 4) show that the basement rocks are similar to the Idaho Springs and Swandyke formations, as is suggested by the descriptions given for the basement rocks of these areas by Stark and Barnes (1935) and Hunter (1925). Granitization or alkali-silicate metasomatism of the metasedimentary gneisses was observed in many of the samples from the Sawatch Range. The rocks exposed in the Gunnison Valley, however, are generally more quartzose than those of the Idaho Springs Formation, and some quartzitic layers exhibit what appears to be relict cross-bedding (fig. 7). Most amphibolitic gneisses also occur. Quartzo-feldspathic sediments and some intercalated volcanic rocks were parent rocks of these metasediments in the southern part of the Weld-Delta metasedimentary terrane.

Petrography of the buried basement rocks.

Samples from 10 of the wells in the Weld-Delta metasedimentary terrane are of gneissose to schistose metasedimentary rocks (table 5). The Shell Oil Corp. #1 Colorado National Bank, Weld County (CL-158), encountered quartzite as the basement rock. From 80 to 100 percent of the rock is composed of severely strained, fractured, and granulated quartz grains (fig. 8). However, several of the samples contained as much as 10 percent each of chlorite and of sericite, and the rock could be considered as a sericite-chlorite-quartz gneiss. One of the rock fragments contained a large fractured grain of microcline. The ori-

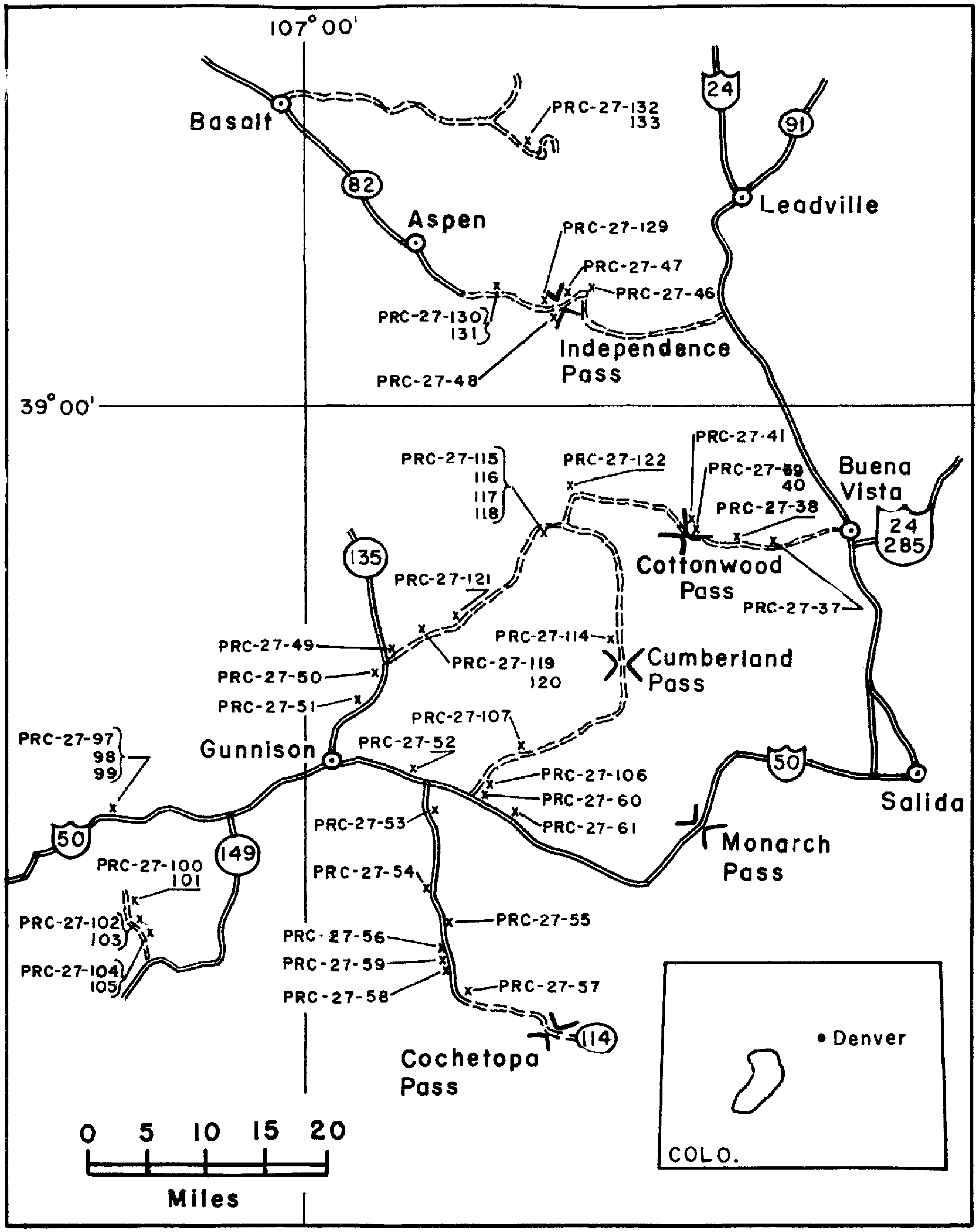


Figure 6: Locations of samples collected from the exposed basement, Sawatch Range, Gunnison Valley, and Cochetopa Canyon areas, Weld — Delta metasedimentary terrane and Mesa — Montezuma granitic terrane.

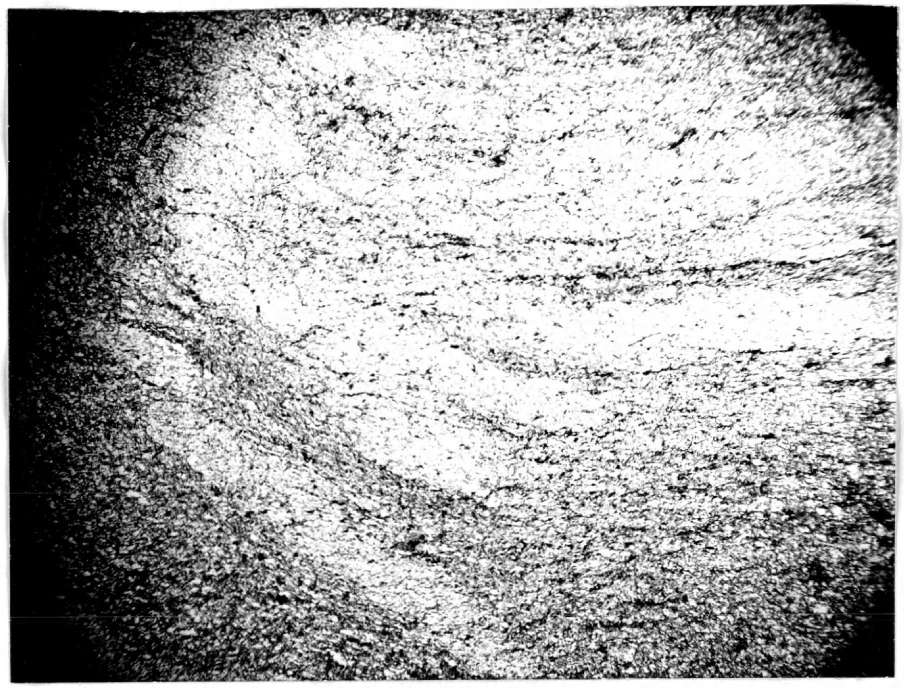


Figure 7: Photomicrograph of muscovite-biotite-quartz gneiss at Almont, sample PRC-27-49, illustrating relict cross-bedding. Uncrossed nicols, X9.

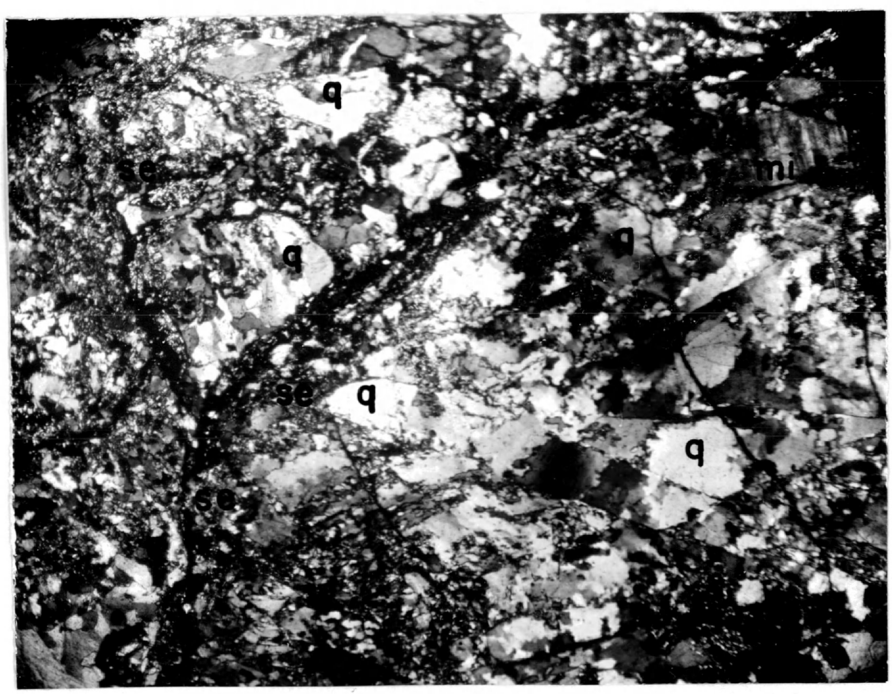


Figure 8: Photomicrograph of quartzite from well CL-158. q-quartz, mi-microcline, se-sericite. Crossed nicols, X25.

ginal rock probably was a quartzose sandstone which contained very little interstitial clay. A few quartzo-feldspathic to arkosic beds may have been present also.

Cores of the basement from the California Oil Co. #1 Meyers, Larimer County (CL-68), are of a biotite-plagioclase-quartz gneiss which had been intruded by dikes of aluminous granite or pegmatite. In the gneiss, plagioclase makes up from 30 to 60 percent and has been severely to completely altered to sericite. Biotite comprises between 5 and 19 percent and has been severely altered to muscovite and hematite. From 25 to 60 percent of the rock is composed of strongly strained and fractured, lens-shaped xenoblastic grains of quartz. The granitic intrusive rock ranges in composition from microcline granite to quartz monzonite and contains large, shredlike grains of muscovite, which comprise from 1 to 15 percent. Plagioclase makes up between a trace and 25 percent and microcline makes up between 25 and 79 percent. Both minerals occur in strongly altered anhedral grains, in which the twinning has been obscured. Quartz comprises from 15 to 58 percent and occurs in strongly strained and sutured grains, some of which contain minute needles of rutile. The original rocks are considered to have been argillaceous to quartzo-feldspathic sediments.

The samples from the U. S. Army Corps of Engineers #1 Rocky Mountain Arsenal, Adams County (CL-175), are from a section of core of the basement rock and are identified as microcline-biotite-quartz-plagioclase gneiss and biotite-quartz-hornblende-plagioclase gneiss. In the microcline-bearing gneiss, biotite makes up five percent and is present both as large, altered xenoblastic grains and as small, unaltered idioblastic grains, many of which occur within the larger biotite grains. Five percent of the rock is also composed of xenoblastic grains of microcline, which show indistinct twinning. Quartz makes up 25 percent and xenoblastic grains of plagioclase, the composition of oligoclase, make up 64 percent. In the hornblende-bearing gneiss, biotite also comprises 5 percent, but hornblende makes up 20 percent and occurs in corroded xenoblastic grains. Quartz makes up 15 percent and plagioclase (oligoclase) makes up 60 percent. The parent rocks are considered to have been quartzo-feldspathic and calcareous argillaceous sediments.

A biotite-quartz-plagioclase schist, in which biotite makes up from 20 to 24 percent, was encountered in the Amerada Petroleum Co. #1 Government-Thompson, Jackson County (CL-180). Moderately to strongly strained and sutured grains of quartz make up between 25 and 35 percent. Plagioclase grains, which have been severely to completely altered to sericite, comprise from 40 to 54 percent of the rock. The original rocks were probably argillaceous sediments.

In the O. D. Robinson #1 Robert Kagie, Routt County (CL-146), the basement rock is a microcline-sillimanite-plagioclase-biotite-quartz schist. Microcline comprises from 0 to 35 percent and sillimanite, in clusters of minute needlelike grains, makes up from 10 to 15 percent. Plagioclase, the composition of oligoclase, makes up between 7 and 15 percent of the rock and occurs in severely to completely altered xenoblastic grains. From 15 to 30 percent is composed of xenoblastic grains of biotite and 30 to 48 percent is made up of severely strained and sutured grains of quartz. Alumina-rich argillaceous and quartzo-feldspathic sediments were very likely the parent rocks of this schist.

The Pacific Natural Gas #26-35 Pagoda Unit, Routt Co. (CL-207), was drilled into basement rocks identified as magnetite-bearing quartz-plagioclase-hornblende gneiss. Xenoblastic grains of magnetite are associated with hornblende and make up 10 percent of the rock. Quartz comprises 15 percent. Plagioclase, ranging in composition from andesine to labradorite, occurs in moderately to severely altered xenoblastic grains, which make up 33 percent. Forty percent is composed of xenoblastic grains of hornblende. The parent rocks were probably calcareous and quartzose sediments. Also identified in the samples from this well was a quartz-plagioclase gneiss, which may have been originally a granodioritic igneous intrusive. Quartz in this rock comprises 45 percent and occurs in moderately to severely strained xenoblastic grains. Plagioclase (oligoclase), in which albite and pericline twins are present, is moderately altered to sericite and makes up 50 percent. Only a trace of hornblende is present and the grains occur within quartz. Biotite makes up 2 percent of the rock and 3 percent is composed of microcline. A trace of garnet is also present.

Samples of biotite-quartz-plagioclase gneiss were recovered from the Forest Oil Corp. #1 Government, Garfield County (CL-38). Xenoblastic grains of biotite make up about 15 percent and have been moderately altered to chlorite. Plagioclase, the composition of oligoclase, occurs in strongly altered xenoblastic grains, which comprise from 20 to 32 percent. Between 50 and 60 percent of the samples is composed of xenoblastic grains of quartz, which are strongly strained, sutured, and granulated. Traces of both sillimanite and tourmaline also occur in the rock. The original rocks were most likely argillaceous quartzo-feldspathic sediments.

The muscovite-biotite-plagioclase-quartz gneiss in samples from the Cushman and Pilcher #1 Hawkins, Delta County (CL-22), was probably produced by the metamorphism of quartzo-feldspathic sediments. Muscovite comprises 5 percent of the rock and biotite makes up 10 percent. Twenty percent of the rock is composed of plagioclase, which was not identified as to the variety. The grains are strongly altered to sericite and albite twins are obscured. Quartz, in moderately to strongly strained and sutured grains, makes up 65 percent.

The R. E. Wear #1 Fee, Montrose County (CL-106), encountered microcline-biotite-quartz-plagioclase gneiss as the basement rock (fig. 9). Microcline is present in small xenoblastic grains, which make up from 0 to 25 percent of the samples. Biotite ranges in amount from 15 to 20 percent and quartz makes up from 15 to 30 percent. Plagioclase, ranging in composition from oligoclase to andesine, occurs in slightly altered xenoblastic grains, which comprise between 30 and 45 percent. Albite and pericline twins were observed. Magnetite

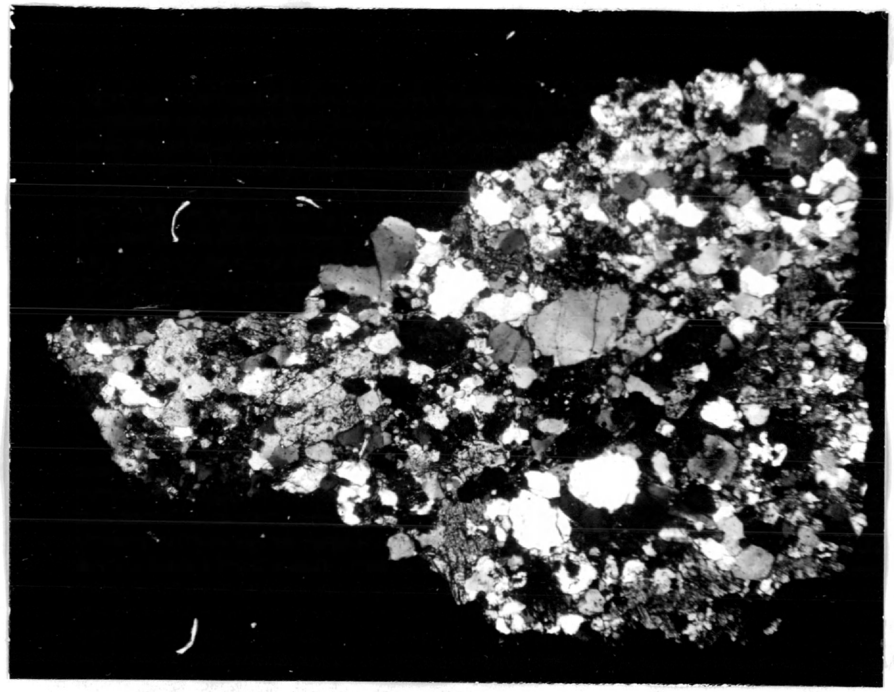


Figure 9: Photomicrograph of microcline-biotite-quartz-plagioclase gneiss from well CL-106, showing relict sedimentary texture of rounded quartz grains. Crossed nicols, X25.

grains make up 5 percent of the rock and masses of leucoxene make up from a trace to 9 percent. The parent rocks of this gneiss were probably argillaceous quartzo-feldspathic sediments.

In the Texaco, Inc. #1 J. L. Stivers, Montrose County (CL-208), samples of the basement rock are a very fine-grained epidote-muscovite-biotite-quartz-feldspar gneiss. Minerals in the rock range in size from a maximum of 0.5 mm for quartz grains down to microcrystalline for all of the minerals. Epidote makes up 5 percent, muscovite makes up between 0 and 10 percent, and biotite makes up 10 percent. Xenoblastic grains of quartz comprise 20 percent and occur both in bands or veinlets of larger grains and in the microcrystalline matrix with feldspar. Feldspar, which occurs in grains too small to be identified as to the variety, makes up from 51 to 55 percent of the rock. The original rocks must have also been argillaceous quartzo-feldspathic sediments.

Granitic gneisses, which have been interpreted as metasomatized or granitized metasedimentary rocks, were found in seven of the wells in the Weld-Delta metasedimentary terrane. The samples from the British-American Producing Co. #1 Wise, Weld County (CL-156), are identified as biotite-quartz-plagioclase gneiss. Between 2 and 5 percent of the rock is composed of microcline, which occurs both as small, interstitial grains and as large xenoblastic porphyroblasts. Biotite makes up from 1 to 10 percent and has been moderately altered to chlorite. Quartz grains are moderately to severely strained and sutured and make up from 25 to 30 percent. Plagioclase, the composition of oligoclase, occurs in strongly altered xenoblastic grains, which comprise between 60 and 67 percent of the samples. The original rocks were probably quartzo-feldspathic sediments, which have been metasomatized by alkali-rich solutions.

Basement rocks in samples from the Shell Oil Corp. #1 Klingensmith, Weld County (CL-160), include biotite-microcline-quartz-plagioclase gneiss and quartz-hornblende-plagioclase gneiss. In the biotite-microcline-quartz-plagioclase gneiss, biotite makes up from 5 to 10 percent and is the only ferromagnesian mineral present. Quartz is moderately to strongly strained and comprises 20 to 35 percent of the rock. Between 10 and 55 percent is composed of xenoblastic grains of microcline. Plagioclase (oligoclase) makes up from 15 to 60 percent and occurs in slightly to strongly altered xenoblastic grains. However, in the quartz-hornblende-plagioclase gneiss, the plagioclase is andesine and occurs in strongly altered xenoblastic grains, which comprise between 47 and 50 percent. The major ferromagnesian mineral is hornblende, which occurs in corroded xenoblastic grains and makes up 30 to 35 percent. However, 2 percent of biotite is also present. About 15 percent of the rock is composed of slightly to moderately strained grains of quartz. The original rocks must have been argillaceous and calcareous to quartzo-feldspathic sediments, which were subjected to alkali-silicate metasomatism. This particular well is located very near the boundary with the Logan-Yuma granitic terrane.

The Continental Oil Co. #A-6 Pollack, Jackson County (CL-54), supplied samples of a biotite-plagioclase-microcline-quartz gneiss. Biotite (including chlorite) makes up 15 percent and severely altered xenoblastic grains of plagioclase, ranging in composition from oligoclase to andesine, also make up 15 percent. Twenty percent of the rock is composed of microcline, which occurs in xenoblastic grains. Moderately strained xenoblastic grains of quartz make up 50 percent. The parent rocks appear to have been argillaceous quartzo-feldspathic sediments.

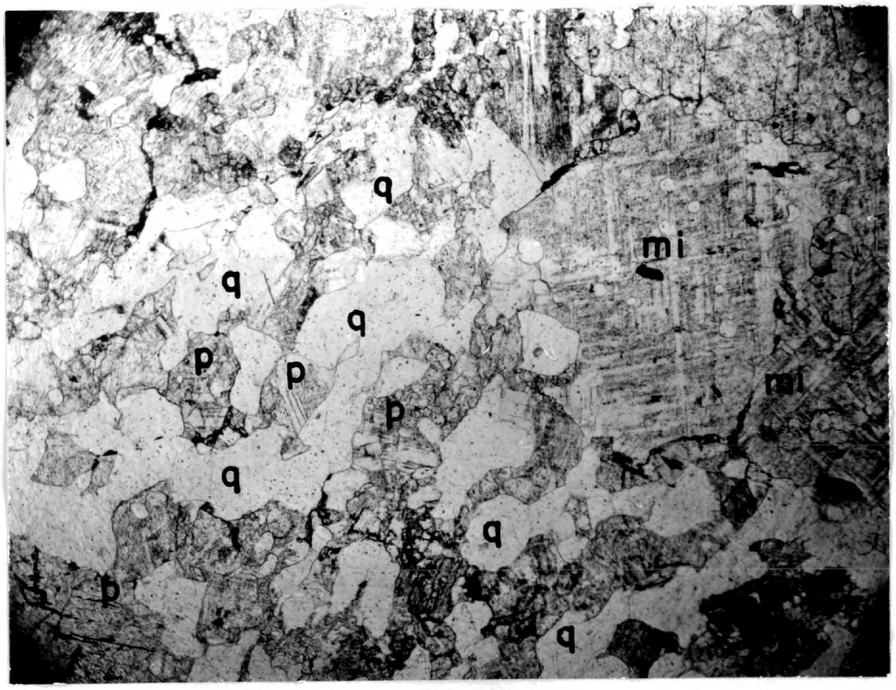
Samples from the British-American Producing Co. #1-C Lazy-U-Ranch, Grand County (CL-43), are of a muscovite-plagioclase-microcline-quartz gneiss. Shredlike grains of muscovite comprise five percent of the rock. Twenty-five percent is composed of plagioclase (oligoclase), which occurs in severely altered xenoblastic grains and shows albite and Carlsbad twins. Xenoblastic grains of microcline make up 35 percent and quartz, also in xenoblastic grains, makes up 35 percent. Quartzo-feldspathic sediments are considered to be the original rocks for this gneiss.

In the samples from the DeBarard Cattle Co. #1 State, Grand County (CL-44), the basement rocks are of two varieties: a biotite-quartz-microcline-hornblende-plagioclase gneiss, believed to have been originally basic volcanic rocks, and a biotite-quartz-plagioclase gneiss, which probably was a quartz dioritic to granodioritic magma. The volcanics were intruded and metasomatized by this magma. In the biotite-quartz-microcline-hornblende-plagioclase gneiss, biotite and quartz each make up 5 percent and microcline makes up 10 percent. Idioblastic to xenoblastic grains of hornblende comprise 30 percent of the rock. Forty-eight percent is composed of plagioclase, the composition of andesine, which occurs in idioblastic to xenoblastic grains. The biotite-quartz-plagioclase gneiss is composed 10 percent of biotite (including chlorite), 20 percent of quartz, and 62 percent of plagioclase (oligoclase). The plagioclase has been severely altered to sericite and the quartz has been strongly strained.

The Pan-American Petroleum Co. #1 Jones, Routt County (CL-198), encountered a muscovite-biotite-plagioclase-quartz-microcline gneiss (fig. 10, A and B). Muscovite occurs in shredlike xenoblastic grains associated with biotite and makes up five percent of the rock. Biotite comprises seven percent and is severely to completely altered to chlorite. Twenty-five percent is composed of plagioclase, the composition of oligoclase, which occurs in severely altered xenoblastic grains. Quartz is present in strongly strained and fractured grains and makes up 30 percent. Xenoblastic grains of microcline also make up 30 percent of the rock. The parent rocks were quartzo-feldspathic sediments, which have been metasomatized by alkali-silicate solutions.

The basement rock in samples from the Humble Oil and Refining Co. #1 Government-Crosho Lake, Rio Blanco County (CL-202), is a biotite-quartz-plagioclase-microcline gneiss similar to the gneiss of well CL-198. For this rock, also, the original rocks are considered to have been quartzo-feldspathic sediments, which were subjected to alkali-silicate metasomatism. Biotite, which has been completely altered to muscovite, chlorite, and hematite, makes up 9 percent of the rock and quartz, which occurs in granulated grains, makes up 25 percent. Plagioclase (oligoclase) occurs in severely altered xenoblastic grains, which comprise 30 percent of the rock. Thirty-five percent is composed of xenoblastic grains of microcline. Small grains of microline and quartz occur together in interstitial bands.

The granitic gneisses encountered in five of the wells in this terrane are believed to represent orthogneisses. These are: the Amerada Petroleum Co. #1 Morris, Jackson County (CL-52); the William J. Hewitt #1 Government (Hewitt), Jackson County (CL-55); the Texaco, Inc. #1 King Mountain Unit-Government, Routt County (CL-148); the Kerr-McGee and Phillips Petroleum Co. #1 Unit, Garfield County (CL-42); and the Amerada Petroleum Co. #1 Unit, Mesa County (CL-90). The samples from these wells are in the range of quartz-plagioclase-microcline gneiss and probably represent metamorphosed plutonic igneous rocks ranging from granites to granodiorites. Muscovite ranges in amounts from 0 to 5 percent and biotite, in some rocks altered to chlorite, ranges from 0 to 15 percent. Quartz, in moderately to severely strained, sutured, and granulated grains, makes up between 15 and 40 percent. Xenoblastic grains of microcline, which occurs as large porphyroblasts in some of the samples, comprise from 10 to 45 percent. Between 20 and 55 percent is composed of plagioclase, which ranges in composition from albite to andesine but in most of the rocks is oligoclase. The grains have been



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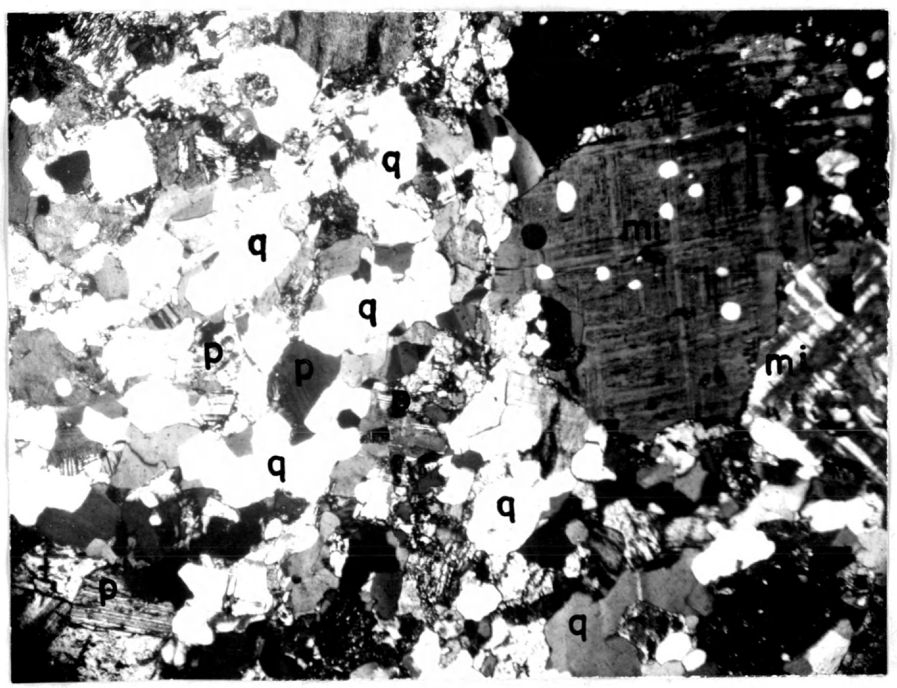


B

Figure 10: Photomicrograph of muscovite-biotite-plagioclase-quartz-microcline gneiss from well CL-198, showing a large porphyroblast of microcline with included blebs of quartz, and bands of quartz grains which represent the original sedimentary bedding. p-plagioclase, q-quartz, mi-microcline.

A: Uncrossed nicols, X25

B: Crossed micols, X25

slightly to strongly altered to sericite and exhibit albite, pericline, and Carlsbad twins. The samples in well CL-90 showed evidence of cataclasis, as the grains of quartz and of the feldspars were severely strained and fractured and the albite twin lamallae in the feldspars were distorted.

A plutonic igneous rock identified as a granodiorite was recovered in samples from the Hiawatha Oil and Gas Co. #1-25 Government-Fuller, Jackson County (CL-56). Subhedral to anhedral grains of biotite make up 5 percent of this rock and strongly strained anhedral grains of quartz, which contain minute needles of rutile, make up 15 percent. Plagioclase, which ranges in composition from oligoclase to andesine, occurs in slightly altered subhedral to anhedral grains and makes up 65 percent of the rock.

The rock obtained in cores from the California Oil Co. #1 U. P. Ferch, Weld County (CL-157), is of problematical origin. It could be either a severely weathered biotite-plagioclase-quartz gneiss of the Precambrian basement, or argillaceous shales and sandstones, which have been subjected to contact metamorphism. Quartz makes up from 20 to 83 percent of the rock and occurs in slightly strained grains. In some of the samples from this well the quartz grains appear to make up subrounded pebbles, which are surrounded by thin films of sericite and hematite. A few grains of chert are also present. Sericite comprises between 10 and 45 percent and occurs as masses, which fill the interstitial spaces between quartz grains. From 0 to 25 percent is composed of biotite which occurs in large, severely altered shredlike grains. In one of the samples biotite also occurs as small idioblastic grains, which have grown within masses of sericite and within the larger fragmental grains of biotite (fig. 11). Hematite makes up about 5 percent and is associated with sericite and altered biotite. If the so-called "basement rock" from this well represents shale and sandstone, the age could be as young as Pennsylvanian, because clastic sediments of Pennsylvanian age lie on the Precambrian basement in this area (Taylor, 1958). The later growth of the idioblastic biotite may be due to contact metamorphism associated with a possible nearby intrusive, but no evidence of such an intrusive was encountered in the well samples. It is interesting to note that the location of this well is on the northeasterly extended trend of the Tertiary intrusives associated with the Colorado mineral belt. The Airy-Heiskanen gravity map of Colorado (Qureshy, 1958, 1960) indicates that the gravity low associated with the areas of Tertiary intrusive activity in central Colorado extends northeastward beyond the Front Range and beneath the Denver basin as far as Weld County (fig. 35). The easternmost exposure of Tertiary intrusives along this trend is in the foothills of the Front Range west of Lyons, Boulder County, where a latite-rhyolite porphyry sill has intruded the Fountain Formation (map of Lovering and Goddard, 1950). No detailed study of the contact metamorphism at this locality has been made but Wagner (1940) and Hunter (1947) mention darkening of the shales and bleaching of the arkosic conglomerates in the Fountain For-

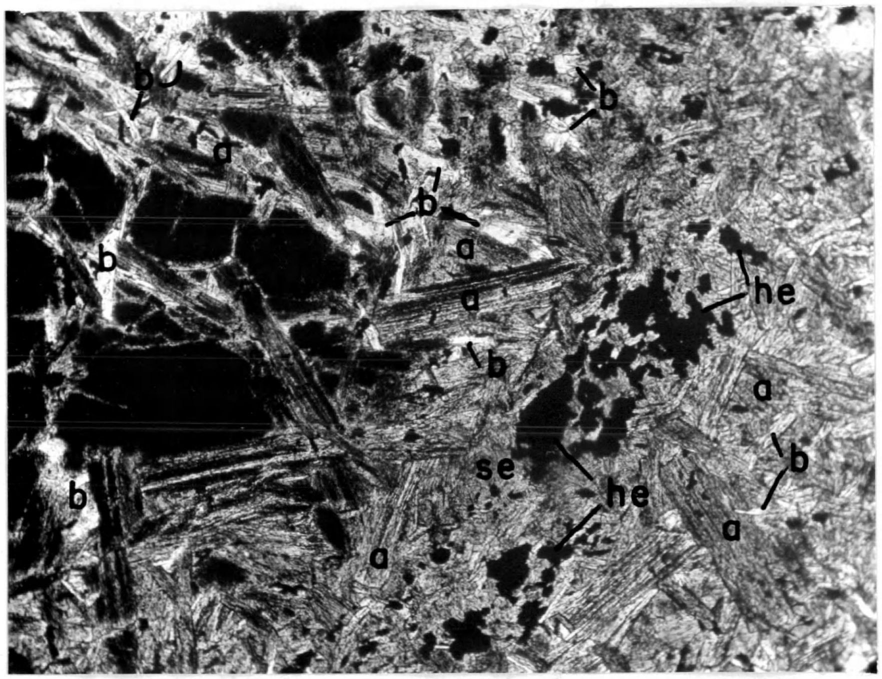


Figure 11: Photomicrograph of the basement rock from well CL-157, showing small idioblastic grains of biotite (b) within large altered xenoblastic grains of biotite (a) and masses of sericite (se). he-hematite. The rock may be a shale altered by contact metamorphism. Uncrossed nicols, X75.

mation immediately adjacent to the sill.

Fine-grained porphyritic igneous rocks considered to be Tertiary intrusives were encountered in the following wells: Broderick and Gordon #1 Government, Routt County (CL-141); Gardner Bros. #1 Chura, Routt County, (CL-143); Champlin Refining Co. #1 Black, Eagle County (CL-31); and Superior Oil Co. #1 Unit, Pitkin County (CL-203). Samples from well CL-141 were identified as ranging from a biotite-bearing andesite to latite, in which the plagioclase grains have been severely altered to sericite and calcite. Rock from well CL-143 ranges in composition from quartz latite porphyry to rhyolite porphyry. Fenneman and Gale (1906, p. 32), and George and Crawford (1909, p. 216) describe Tertiary intrusive rocks in Routt County which are similar to the rocks in these two wells. Well CL-31 in Eagle County also encountered a shallow intrusive rock, which ranged from quartz latite porphyry to rhyolite porphyry. Gableman (1949) describes stocks and dikes of quartz monzonite (quartz latite) porphyry about 10 miles to the southeast of this well. Quartz latite porphyry was recovered from well CL-205 in Pitkin County. This well lies just northwest of the Tertiary intrusives of the Elk Mountains, Ruby Range, and West Elk Mountains, which were described by Cross (1894b) as ranging in composition from diorites to quartz monzonites.

Kit Carson-Kiowa Metasedimentary Terrane

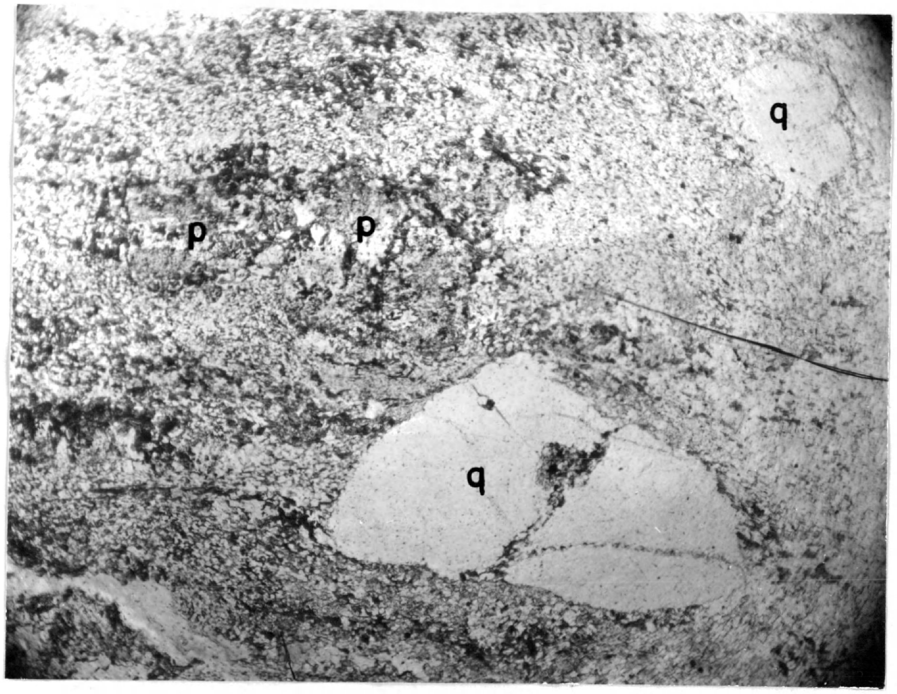
The Kit Carson-Kiowa metasedimentary terrane is bounded on the north and northwest by the Logan-Yuma granitic terrane, on the southwest by the Pueblo-Teller granitic terrane, and on the south by the Las Animas-Baca granitic terrane (pl. 1). To the east, the terrane extends into Kansas. Samples of basement rocks were collected from 11 wells in this terrane. Three wells each are in Kit Carson and Yuma Counties, 2 are in Kiowa County, and 1 well each is in Otero, Prowers, and Washington Counties. Other counties within the borders of this terrane are all or parts of Bent, Cheyenne, Crowley, and Lincoln.

No Precambrian rocks are exposed at the surface in the Kit Carson-Kiowa metasedimentary terrane. Samples from nine wells which encountered metasedimentary rocks provided the basis for the definition of the terrane. These rocks are predominately well-foliated quartzose schists (tables 1 and 6) and are considered to represent metamorphosed argillaceous and quartzose sediments with some metamorphosed volcanics. Samples from several of the wells contain tourmaline grains in amounts ranging from only a trace to as much as five percent. The remaining two wells of the eleven in the terrane encountered granitic gneisses, which resemble those of the Logan-Yuma granitic terrane.

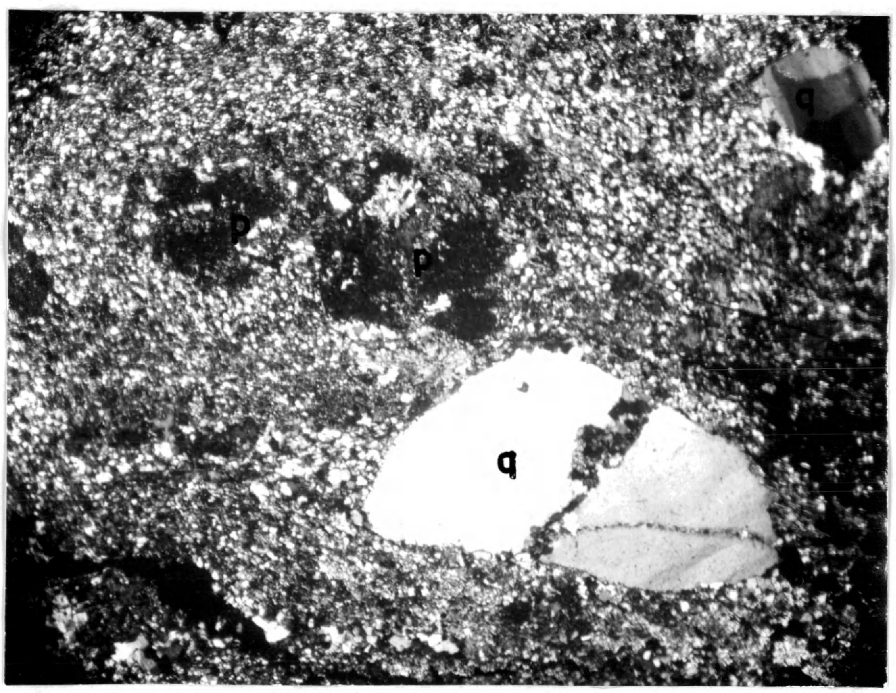
The Indian Territory Illuminating Oil #1 Vorce, Washington County (CL-153), encountered a plagioclase-muscovite-biotite-quartz schist, which has been severely altered by weathering. The plagioclase has no observable twinning and has been severely altered to sericite. The biotite has a distinct preferred orientation and has been severely altered to muscovite and hematite. Quartz occurs in moderately to severely strained grains with sutured and granulated borders. Traces of sillimanite and tourmaline are also present. The original rock was probably an argillaceous sediment.

Samples from the Indian Territory Illuminating Oil #1 Strangeways, Yuma County (CL-167), range from a biotite-muscovite-sericite-quartz gneiss to quartzite. The rock is very fine-grained, which suggests that the original rock was an alumina-rich, slightly argillaceous siltstone or fine-grained sandstone. Similar rocks were encountered in the Seaboard Oil Co. and British-American Producing Co. #1 Morrow, Kit Carson County (CL-64). In this well the rock is a muscovite-biotite-quartz-sericite schist. Sericite makes up 45 percent of the sample and 10 percent is quartz. The fine-grained texture of this rock also suggests that the original rock was an argillaceous siltstone.

The rock in the samples from the Deep Rock Oil Co. #1 Edmondson, Kit Carson County (CL-61), is a plagioclase-biotite-orthoclase-quartz schist. The rock can be best described as having been originally a volcanic flow or tuff of rhyolitic composition (fig. 12, A and B). Plagioclase occurs in large idioblastic crystals, which before metamorphism were probably phenocrysts. The grains have been strongly altered to sericite and the albite twinning is very indistinct. Some quartz occurs in large, moderately strained grains, but most of the quartz in the rock is present as microcrystalline grains and occurs associated with orthoclase in the groundmass. Biotite occurs as later growths of microcrystalline grains scattered throughout the groundmass



A



B

Figure 12: Photomicrograph of plagioclase-biotite-orthoclase-quartz schist (metarhyolite) from well CL-61.

A: Showing gneissic banding due to minute grains of biotite. Uncrossed nicols, X25.

B: Showing large grains of quartz (q) and of severely altered plagioclase (p) which were originally phenocrysts.

and also within the plagioclase phenocrysts. Some microcline and muscovite is also present in the groundmass.

A tourmaline-bearing chlorite-sericite-quartz schist (fig. 13) came from the basement in the Gulf Oil Corp. #1 U. P. Risser, Kiowa County (CL-57). Quartz occurs in clusters and bands of strongly strained grains with sutured borders and comprises between 45 and 60 percent of the samples. Sericite (including muscovite) makes up between 25 and 40 percent of the rock. Chlorite makes up about 10 percent. Small grains of magnetite occur in distinct bands and masses associated with sericite. Tourmaline is present in small idioblastic needles in amounts ranging from 2 to 5 percent. The original rocks were probably boron-rich argillaceous sediments. The tourmaline crystals have a linear preferred orientation and thus appear to have been formed during the metamorphism and development of the foliation, rather than having been formed due to introduction of boron by contact metasomatism. The tourmaline crystals in that case would occur in radiating clusters.

Samples from the Superior Oil Co. #1 State, Kiowa County (CL-59), are of a sericite-quartz gneiss or quartzite. Eighty-five percent of the rock is composed of small, severely strained grains of quartz. Sericite makes up the remaining 15 percent. A trace of tourmaline in idioblastic crystals is also present. The original rock was very likely an alumina-rich, slightly argillaceous siltstone or sandstone.

The Phillips Petroleum Co. #1 Stwalley, Prowers County (CL-119), encountered a severely altered muscovite-microcline-quartz-plagioclase

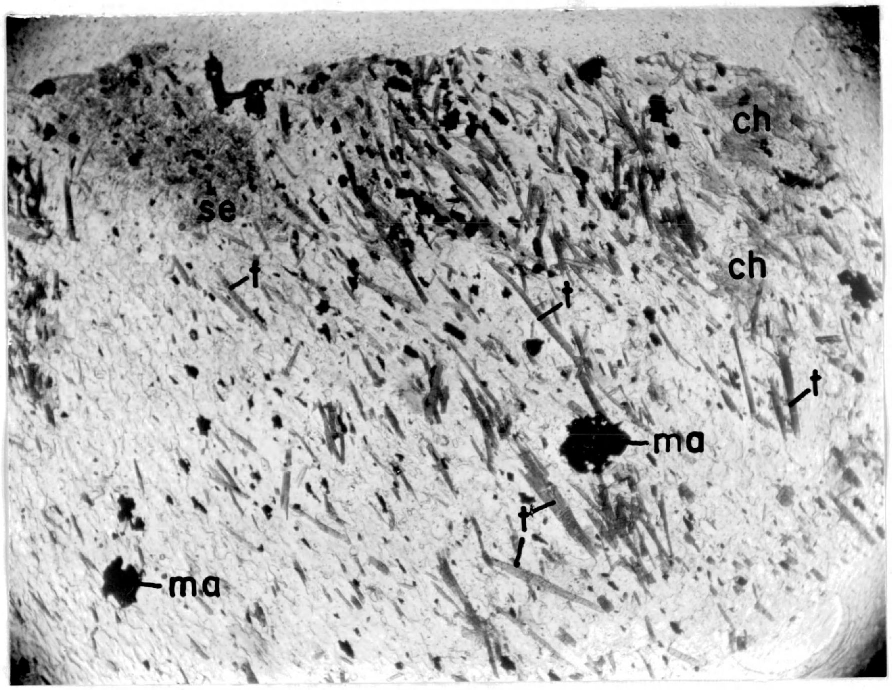


Figure 13: Photomicrograph of tourmaline-bearing chlorite-sericite-quartz schist from well CL-57. t-tourmaline, ch-chlorite, ma-magnetite, se-sericite. Matrix is predominantly quartz with sericite. Uncrossed nicols, X25.

gneiss. Plagioclase, which originally made up 45 percent of the rock, has been severely to completely altered until only 5 percent remains, the other 40 percent having been altered to masses of sericite. Quartz, in moderately strained grains, comprises 30 percent and xenoblastic grains of microcline make up 15 percent. Muscovite and biotite grains with weak preferred orientation are also present. The original rock was probably a quartzo-feldspathic sediment.

In the far southwestern end of the Kit Carson-Kiowa metasedimentary terrane, the Pure Oil Co. #1 Craighead, Otero County (CL-110), encountered a garnet-bearing tremolite-hornblende-plagioclase gneiss. Plagioclase, the composition of andesine, comprises 51 percent of the rock and occurs in large, moderately altered idioblastic to xenoblastic grains. Albite, pericline, and Carlsbad twins were observed. Hornblende is present in small idioblastic grains, which have a preferred orientation and which make up 30 percent of the sample. Seven percent is composed of colorless tremolite, which occurs in idioblastic grains. Garnet makes up five percent of the rock and is present in pale pink xenoblastic grains. The original rock was probably a basaltic volcanic flow.

The Texaco, Inc. #1 Blach, Yuma County (CL-174), supplied samples of non-metamorphosed hematitic quartzite to hematitic argillaceous siltstone. Quartz occurs in subangular to subrounded fragments, which are made up of severely strained xenoblastic grains, and comprises 45 to 95 percent of the rock. Hematite appears to make up from 5 to 40 percent. Sericite is present in amounts from a trace up to 15 percent and biotite makes up from a trace to 5 percent. A few minute grains of tourmaline, probably of detrital origin, also are present. The original rock was probably a hematite-rich argillaceous siltstone, or possibly only an iron-rich regolith lying upon the Precambrian surface and buried by the lower Paleozoic formations.

A muscovite-biotite-plagioclase-quartz-microcline gneiss, very similar to the granitic gneisses of the Logan-Yuma granitic terrane, was obtained from the Continental Oil Co. #1 Lowe, Kit Carson County (CL-210). Microcline in large, xenoblastic grains makes up 30 percent, and quartz in moderately strained xenoblastic grains also makes up 30 percent. Plagioclase, the composition of oligoclase, comprises 25 percent and occurs in xenoblastic grains, which have been moderately to strongly altered to sericite. Ten percent of the rock is composed of idioblastic to xenoblastic grains of biotite, which have a preferred orientation, and 5 percent is made up of muscovite. The original rock was probably a quartz monzonite.

Cores of basement rock were obtained from the California Oil Co. #1 Lloyd Mumm, Yuma County (CL-206), and are of a biotite-quartz-plagioclase gneiss with large porphyroblastic augen of microcline. Biotite makes up between 15 and 20 percent and has a distinct preferred orientation. Twenty-five to 35 percent of the rock is composed of quartz in strongly-strained xenoblastic grains with sutured borders. The plagioclase is oligoclase and occurs in weakly zoned idioblastic to xenoblastic grains, which have been slightly to strongly altered to sericite. Albite and Carlsbad twins are present. Plagioclase makes up 48 to 58 percent of the rock. Microcline occurs in xenoblastic grains, which are present in the rock in amounts ranging from a trace to 10 percent. Most of the microcline grains occur clustered into large, irregularly-shaped augen, but a few small grains occur outside the augen interstitially to quartz and plagioclase. Biotite grains are not present within the augen but lie in clusters of grains banked around the borders of the augen. This rock may have been originally a plutonic rock the composition of granodiorite, which at some later time was metamorphosed to a granitic gneiss and which was also subjected to alkali-silicate metasomatism. It is very similar in appearance to the augen gneiss of well CL-88 of the adjacent Logan-Yuma granitic terrane (fig. 37 A and B) and to the augen gneisses which are exposed in the Pueblo-Teller granitic terrane (fig. 36).

The mineral assemblages of the metasedimentary rocks indicate that the grade of metamorphism is the quartz-albite-muscovite-chlorite subfacies of the greenschist facies for pelitic schists, and may be as high as the quartz-albite-epidote-biotite subfacies (Turner and Verhoogen, 1960). Thus the metamorphic facies of these rocks is of a lower grade than that for the metamorphic rocks of the exposed basement in Colorado, which are mostly of the almandine-amphibolite facies. Well samples of granitic gneisses in the terrane and metasediments from the southern end of the terrane in Prowers County (CL-119) and in Otero

County (CL-110), which lie near the contact with the Pueblo-Baca granitic terrane, are within the almandine-amphibolite facies.

Saguache-Huerfano Metasedimentary Terrane

The Saguache-Huerfano metasedimentary terrane (pl. 1) is bordered on the northeast by the Pueblo-Teller granitic terrane and on the southeast by the Las Animas-Baca granitic terrane. The Mesa-Montezuma granitic terrane lies to the west. To the north, the boundary between the Saguache-Huerfano and Weld-Delta terranes lies in the granitized area between the Pueblo-Teller and Mesa-Montezuma granitic terranes. To the south, the terrane extends into the State of New Mexico. Samples of basement rock were obtained from 10 wells in this terrane. Four of the wells are located in Huerfano County, 2 are in Las Animas County, and 1 well each is in Alamosa, Fremont, Pueblo, and Saguache Counties. All or parts of Conejos, Costilla, Custer, and Rio Grande Counties are also included within this terrane.

The terrane is based upon the identification of metasedimentary rocks in samples from nine of the wells and upon published reports of the predominance of metasedimentary rocks in the exposed basement of the Wet Mountains and the Sangre de Cristo Range (table 1). Plutonic igneous rocks were found in samples from the tenth well of the terrane and also occur in the areas of exposed basement rocks. One additional well, located in Huerfano County, was drilled into a dike or sill of Tertiary age.

Summary of the exposed basement rocks

The exposed basement rocks in the Wet Mountains are similar in appearance, and probably are similar in origin, to the Idaho Springs formation of the Front Range. Boyer (1962, p. 1053) described the rocks in the southern Wet Mountains as consisting of a thick series of metasediments, with granitic intrusions and associated lit-par-lit gneisses, migmatites, and other composite rocks. Much of this granitization was believed to have been the result of emanations from the San Isabel Batholith, which is composed of two varieties of granite: a coarse-grained, porphyritic phase and, less commonly, a medium-grained phase (Boyer, 1962, p. 1056). Smaller granitic plutons and gneissic granites are also present in the area.

Farther to the northwest in the Wet Mountains, Christman and others, (1959, p. 493-494) differentiated the basement into twenty major and minor rock types, which were placed into three groups according to their relative age and assumed origin. These groups from oldest to youngest are: (1) metasedimentary gneisses, which include hornblende-plagioclase gneiss, biotite-quartz-plagioclase gneiss, hornblende-pyroxene-plagioclase gneiss, garnetiferous gneisses and quartzites, sillimanitic gneiss, and pyroxene-scapolite gneiss; (2) granitic gneisses of unknown origin, or migmatite, alaskitic granite gneiss, the names of which are not intended to imply the mode of origin; and (3) igneous and other rocks including metamorphosed gabbroic and ultramafic rocks, pegmatite, breccia, albite syenite altered rock, and dike rock (Christman and others, 1959, p. 494).

Very little detailed work has been done on the Precambrian rocks of the Sangre de Cristo Range, which crop out on the western side of the range. Burbank and Goddard (1937, p. 938-939) report that the basement rocks are predominately metamorphic gneisses and schists with local bodies of granitic rocks. The exposed basement of the range in southern Saguache County is composed of metasedimentary rocks and granitic gneisses, which were originally granitic intrustions (Clement, 1952; Karig, 1963b).

The small exposures of Precambrian basement south of the Bonanza mining district, Saguache County, are composed of granitic rocks with some schists and gneisses, which have been intruded by granites and aplite dikes (Burbank, 1932, p. 6; Larsen and Cross, 1956, p. 22). These basement rocks in the Kerber Creek area occur in overthrust sheets, which apparently came from the south or southwest (Burbank, 1932, p. 39; Burbank and Goddard, 1937, p. 970). Exposures of basement rocks along Saguache Creek west of the town of Saguache are also of granites with some schists (Larsen and Cross, 1956, p. 22).

Samples of the exposed basement rocks from the Saguache-Huerfano metasedimentary terrane (table 7) were collected in Phantom Canyon south of the mass of augen gneisses in the Pueblo-Teller granitic terrane, in the southern end of the Sawatch Range along U. S. Routes 50 and 285 (Monarch Pass and Poncha Pass areas), along Colo. Rte. 114 west of the town of Saguache, and along the Ute Trail road northeast of Salida (fig. 14). The Phantom Canyon samples are primarily of biotite-microcline-plagioclase-quartz gneiss and contain from 1 to 25 percent muscovite (fig. 15). The original rocks were probably aluminous shales to arkoses. One sample from this area was of a sillimanite-bearing quartzite (fig. 16).

The samples, which were collected from the Monarch Pass and Poncha Pass areas and from the area west of the town of Saguache, are of plagioclase-quartz-microcline gneiss, biotite-quartz-microcline-plagioclase gneiss, and quartz-plagioclase-hornblende gneiss. The rocks were originally argillaceous to quartzo-feldspathic sediments and possibly some volcanics, which have been extensively granitized by alkali silicate metasomatism. Similar rocks in the Quartz Creek area of Gunnison County have been described by Staatz and Trites (1955).

Northeast of Salida, the rocks which crop out along the Ute Trail road, are plagioclase-hornblende gneisses. The hornblende grains have relict ophitic textures (fig. 17), which indicates the original rocks were gabbroic or diabasic intrusions. Cross (1895) suggested that these gneisses may have been possibly of volcanic origin.

Petrography of the buried basement rocks

The rocks identified in well samples from this terrane are primarily foliated schists and gneisses (table 8). Some occurrences of metasomatized gneiss and of plutonic granite, similar to those exposed in the southern Wet Mountains, are present in samples from the eastern

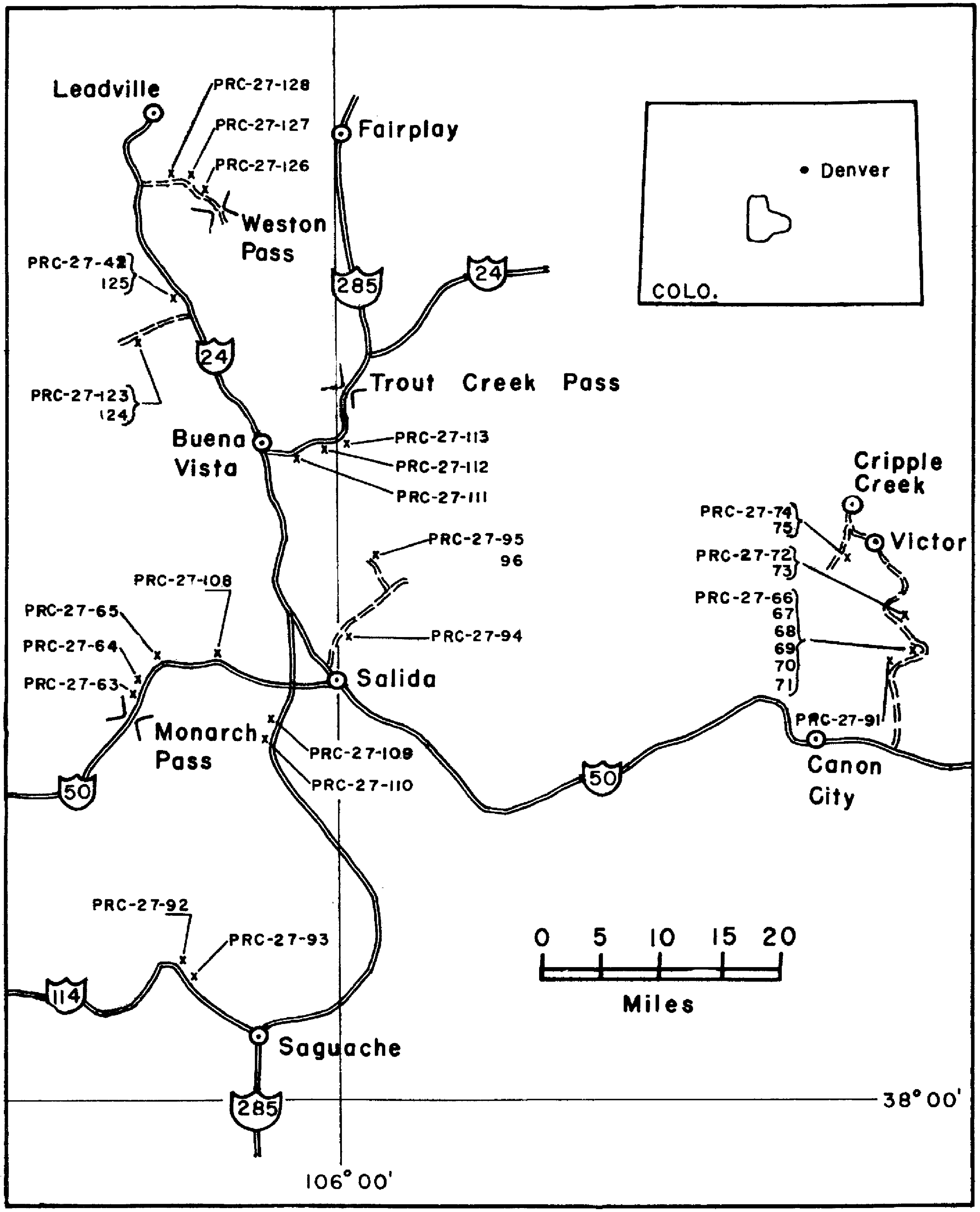


Figure 14: Locations of samples collected from the exposed basement, Phantom Canyon, Cripple Creek, Sawatch Range, Saguache Creek, and Salida areas, Pueblo-Teller granitic terrane and Saguache - Huerfano metasedimentary terrane.

Figure 15: Photomicrograph of biotite-microcline-plagioclase-quartz gneiss from Phantom Canyon, sample PRC-27-71. mu-muscovite, b-biotite, mi-microcline, p-plagioclase, q-quartz. Crossed nicols, X25.

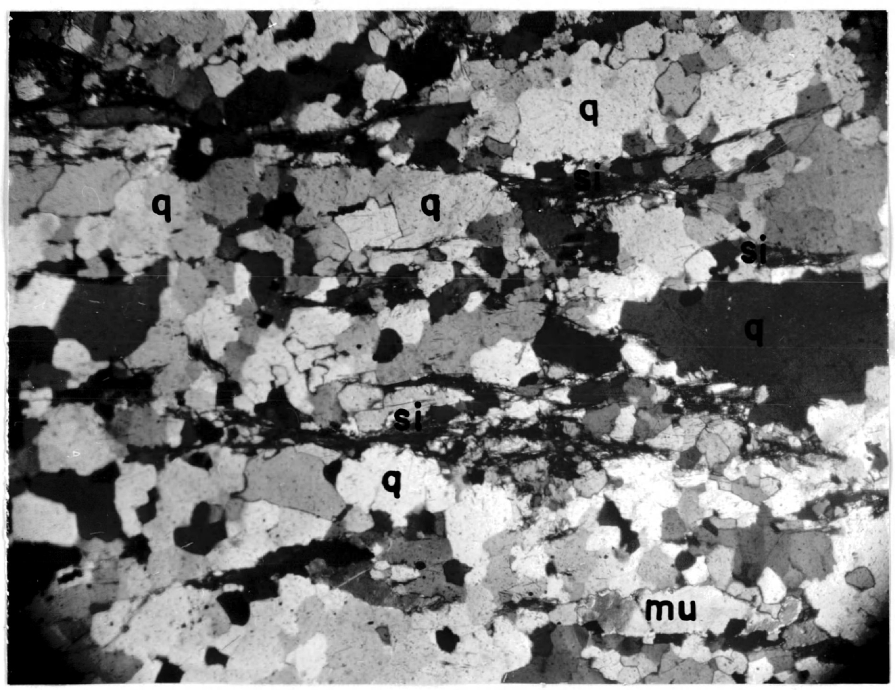


Figure 16: Photomicrograph of sillimanite-bearing quartzite from Phantom Canyon, sample PRC-27-91. mu-muscovite, si-sillimanite, q-quartz. Crossed nicols, X25.

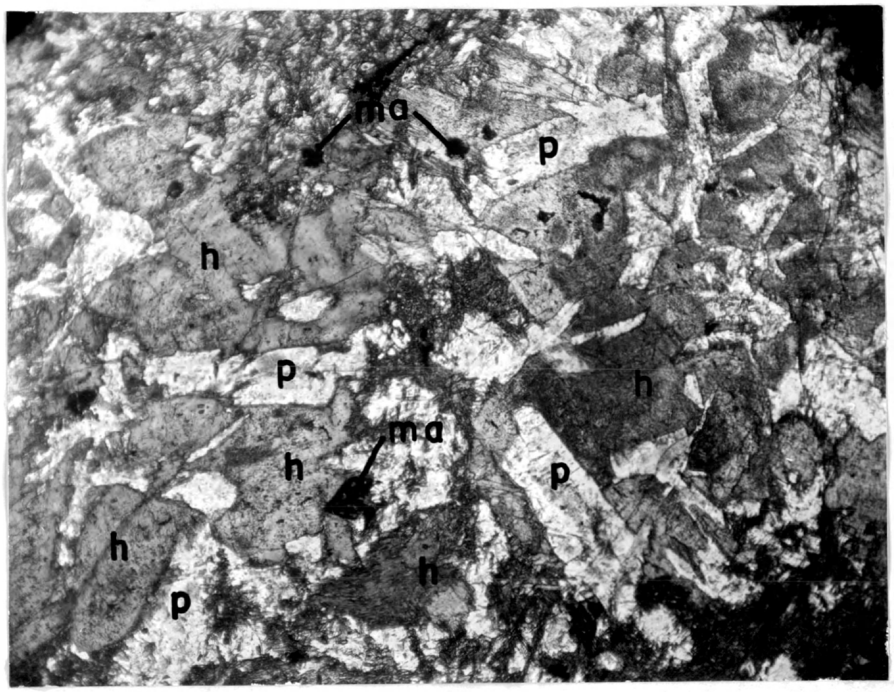


Figure 17: Photomicrograph of plagioclase-hornblende schist from Ute Trail road, sample PRC-27-94 showing relict ophitic texture. p-plagioclase, h-hornblende, ma-magnetite. Uncrossed nicols, X25.

part of the terrane.

Samples of biotite-microcline-quartz-plagioclase gneiss to quartz-microcline-biotite-plagioclase schist occur in the Skelly Oil Co. #1 Weiland (CL-76) and the Skelly Oil Co. #1 Pressey (CL-50), both in Las Animas County. Quartz in moderately to strongly strained and sutured grains comprises from 10 to 20 percent of the rock and xenoblastic grains of microcline make up 5 to 69 percent. Biotite makes up 10 percent of the rock from well CL-76, but in the more schistose sample from well CL-50, the amount of biotite ranges from 15 to 30 percent. Plagioclase, ranging in composition from albite to predominantly oligoclase, makes up from only a trace to 60 percent. The more strongly altered samples from well CL-76 contained from 20 to 25 percent of calcite. The original rocks were probably argillaceous quartzo-feldspathic sediments.

Altered plagioclase-biotite-microcline-quartz gneiss and biotite-quartz schist occur as the basement rock in samples from the Skelly Oil Co. #1 Niebuhr, Huerfano County (CL-49). Plagioclase, completely altered to masses of sericite, makes up only ten percent of the rock. Between 10 and 40 percent is composed of biotite, which has been moderately altered to muscovite and hematite. Microcline comprises from 10 to 30 percent and quartz makes up between 50 to 60 percent. Fragments of calcareous arkose or "granite wash" also are present in the samples from this well. Argillaceous quartzo-feldspathic sediments were most likely the parent rocks of these metasediments.

The Skelly Oil Co. #1 Shafer, Huerfano County (CL-51) supplied samples of both hornblende-biotite-quartz-plagioclase gneiss and biotite-quartz-plagioclase-microcline gneiss. Corroded idioblastic to xenoblastic grains of hornblende make up 10 percent of the hornblende-biotite-quartz-plagioclase gneiss, and idioblastic to xenoblastic grains of biotite comprise 15 percent of the rock. Twenty-five percent is composed of quartz and the remaining 50 percent is made up of plagioclase, the composition of oligoclase, in moderately sericitized xenoblastic grains. In the biotite-quartz-plagioclase-microcline gneiss, xenoblastic grains of microcline make up 35 percent, slightly altered xenoblastic grains of plagioclase (oligoclase) 30 percent, strained and sutured grains of quartz 25 percent, and idioblastic to xenoblastic grains of biotite 10 percent. Both gneisses are probably the result of the metamorphism of a calcareous and argillaceous sequence of sediments.

Basement rock in samples from the Kinney-Coastal and Texas Producing Co. #1 Pino (Escondido), Huerfano County (CL-47), consists of hornblende-quartz-microcline-plagioclase gneiss and biotite-plagioclase-hornblende schist. Hornblende in the gneiss makes up only 15 percent and occurs in corroded xenoblastic grains. Quartz comprises 20 percent of the rock and microcline is 30 percent. The plagioclase ranges from oligoclase to andesine and makes up 32 percent. The grains show indistinct albite and pericline twins and also weak compositional zoning. In the schist, hornblende occurs in corroded idioblastic to xenoblastic grains and makes up 60 percent of the rock. Plagioclase, the composition of oligoclase, makes up 25 percent, shows weak zoning, and has albite twins. Biotite comprises 10 percent, microcline 3 percent, and quartz only 2 percent. The original rocks were probably calcareous quartzo-feldspathic sediments, which have had alkali-silicate solutions introduced metasomatically, as the microcline grains often enclose small grains of hornblende and biotite.

In Pueblo County, the Pure Oil Co. #1 E. K. Warren (CL-132) encountered microcline-quartz-plagioclase gneiss and magnetite-bearing hornblende-quartz-plagioclase gneiss. Hornblende in the samples ranges from 0 to 12 percent of the rock and biotite ranges from a trace to 5 percent. Strongly strained, sutured, and granulated grains of quartz comprise from 15 to 40 percent of the samples. From 25 to 55 percent is composed of plagioclase, the composition of oligoclase, which shows albite and pericline twins and which is slightly to moderately altered to sericite. Microcline ranges from 25 to 30 percent in the microcline-quartz-plagioclase gneiss and is not present in the hornblende-quartz-plagioclase gneiss. The parent rocks were most likely argillaceous and calcareous quartzo-feldspathic sediments.

Samples from the Delhi-Taylor #1-16 State, Fremont County (CL-189), are of a sillimanite-muscovite-biotite-plagioclase-quartz gneiss. Sillimanite occurs in minute needles associated with biotite, quartz, and muscovite, and comprises from 2 to 5 percent of the rocks. Muscovite makes up 3 to 15 percent and biotite is between 10 and 15 percent. Between 5 and 30 percent is composed of plagioclase (oligoclase), which has been severely altered to sericite. From 45 to 55 percent of the rock is quartz in strongly strained grains. Up to five percent microcline, in xenoblastic grains which exhibit Carlsbad twins, occurs in the samples. Alumina-rich argillaceous sediments were probably the parent rocks for these metasediments.

The Amerada Petroleum Co. #1-F State, Alamosa County (CL-1) encountered hornblende-biotite-quartz-plagioclase gneiss and garnet-bearing biotite-quartz-plagioclase schist. Hornblende in the gneiss ranges from 5 to 10 percent and biotite makes up from 10 to 15 percent. Both minerals occur in xenoblastic grains. Slightly to strongly strained xenoblastic grains of quartz comprise 15 percent. Between 49 and 56 percent of the rock is composed of plagioclase, the composition of oligoclase, which occurs in slightly altered xenoblastic grains. Albite and pericline twins are present. In the garnet-bearing schist, the garnet occurs as fractured, pink xenoblastic grains, which make up five percent. The percentage of biotite ranges from 13 to 30 and that of quartz from 5 to 45. Plagioclase, the composition of oligoclase, comprises between 35 and 60 percent. The original rocks were calcareous and argillaceous quartzo-feldspathic sediments.

Samples from the Tennessee Gas Transmission Co. #1 State "B", Saguache County (CL-199), are of a muscovite-biotite-microcline-quartz-plagioclase gneiss with minor amounts of hornblende-biotite-plagioclase schist. Muscovite in the gneiss makes up from 3 to 5 percent, biotite and magnetite each make up from 5 to 7 percent, and microcline makes up from 0 to 15 percent. Quartz comprises 25 percent and plagioclase makes up from 45 to 58 percent. Plagioclase is the composition of oligoclase and occurs in slightly altered xenoblastic grains. In the hornblende-biotite-plagioclase-schist, plagioclase (oligoclase) in unaltered grains, which show albite twinning only rarely, makes up 35 percent of the rock. Idioblastic to xenoblastic grains of biotite comprises 35 percent and 25 percent is of xenoblastic grains of hornblende. Five percent of the rock is composed of small grains of sphene. The parent rocks were probably calcareous and argillaceous quartzo-feldspathic sediments also.

A plutonic rock the composition of granite was encountered in samples from the Skelly Oil Co. #1 Busch, Huerfano County (CL-48). Fifteen percent of the rock is composed of zoned subhedral to anhedral grains of plagioclase, which ranges in composition from albite to oligoclase. The grains have been strongly altered to sericite. Quartz makes up 25 percent and 60 percent is composed of anhedral grains of microcline. This well is located within the salient of the Saguache-Huerfano metasedimentary terrane, which extends between the Pueblo-Teller and Las Animas-Baca granitic terranes. These samples of granite may be related to the plutonic intrusions of these two flanking terranes.

Well CL-205 in Huerfano County, the Kingwood Oil Co. #1-A U. S. Alamo dome, was drilled into a fine-grained igneous rock identified as a latite or quartz latite. The color of the rock is very light gray to white and the texture is fine grained, felsophyric. Quartz makes up 10 percent, orthoclase 30 percent, and plagioclase, the composition of oligoclase makes up 55 percent. About five percent of the rock is composed of calcite. Hills(1900, p. 4; 1901, p. 4) describes dikes of similar rocks associated with the Tertiary intrusives in the Raton basin. Creely and Saterdal (1956, p. 73) believe that the igneous rocks encountered in wells on the Alamo dome structure in Huerfano County are associated with the nearby Black Hills intrusive of Tertiary age.

La Plata-San Juan Metasedimentary Terrane

The La Plata-San Juan metasedimentary terrane exists as two lobes of an elongate belt lying within the Mesa-Montezuma granitic terrane (pl. 1). Outcrops of the metavolcanics of the Irving Greenstone and of the quartzites, slates, and conglomerates of the Needle Mountains Group are exposed in the large mass of the Grenadier-Needle Mountains area and also in several small exposures within the Tertiary volcanic mass on the San Juan dome. The definition of this terrane is based on the association of these two series of rocks in the Grenadier-Needle Mountains area and also on the subsurface occurrence of similar rocks in the two wells which are adjudged to be within the terrane (table 1).

Most of San Juan County and parts of Archuleta, Dolores, Hinsdale, La Plata, Montrose, Ouray, and San Miguel Counties occur in this terrane. One well in southeastern La Plata County encountered rocks similar in lithology to the Irving Greenstone. No surface evidence of the terrane is present west of the San Juan dome, nor is there subsurface evidence in the central parts of Dolores, Montrose, or San Miguel Counties. However, the occurrence of quartzite in a well located at the extreme western end of Montrose County is considered to represent the subsurface continuation of the terrane lithology to the west. The outline of the terrane in this area is based on gravity and magnetic anomalies in southeastern Utah (Case and Joesting, 1961b).

Summary of the exposed basement rocks

The Irving Greenstone (Howe, 1904) is exposed in the southeastern part of the Grenadier-Needle Mountains area of the San Juan dome and consists primarily of amphibolites and hornblendic gneisses. Indistinct igneous textures preserved as relicts indicate that these rocks were originally basic volcanic flows (Larsen and Cross, 1956, p. 22). Some schists and quartzites also occur within the formation. Associated with the Irving Greenstone are what appear to have been dikes and irregularly-shaped granitic intrusions, both of which have been altered by the metamorphism that produced the greenstone from the original volcanics and sediments (Larsen and Cross, 1956, p. 23). The thickness of the formation was estimated by Cross, Howe, Irving, and Emmons (1905, p. 2) to be at least 10,000 feet.

The Needle Mountains Group (Cross, Howe, Irving, and Emmons, 1905, p. 3) occurs in a narrow arc-shaped band across the northern and eastern parts of the Grenadier-Needle Mountains area of exposed Precambrian rocks. This series of metasediments is made up of two members: the lower one being the Vallecito Conglomerate (Cross, Howe, Irving, and Emmons, 1905, p. 3) which is made up of quartzite pebbles and contains some fragments of the Irving Greenstone, and the upper member being the Uncompahgre Formation (Cross, Howe, and Ransome, 1905, p. 3) composed of interbedded quartzites and slates. The thickness of the Vallecito Conglomerate is at least 3000 feet, and that of the Uncompahgre Formation is at least 8500 feet. In neither case are the tops or bottoms of the members exposed (Larsen and Cross, 1956, p. 24).

The degree of metamorphism of the rocks in both the Irving Greenstone and the Needle Mountains Group is about the same (Larsen and Cross, 1956, p. 240), and is considerably less than that of the "ancient schists and gneisses" of the same region, which are here included within the Mesa-Montezuma granitic terrane. Hinds (1936, p. 72) considers that the surface of contact between the Irving Greenstone and the Needle Mountains Group was originally depositional in nature, but has subsequently been obscured by shearing.

Petrography of the buried basement rocks

Only two wells encountered rocks which are believed to be associated with this terrane (table 9). These are the Shell Oil Co. #2 Wray Mesa Unit, Montrose County (CL-181), and the Stanolind Oil and Gas Co. #6-B Ute Indian, La Plata County (CL-83). The rock in the samples from well CL-181 is a quartzite, 80 percent of which is made up of moderately strained, subrounded grains of quartz (fig. 18). Overgrowths of quartz are in optical continuity with the parent grains and grain borders are intricately sutured. Microcline makes up 7 percent of the rock and 6 percent is plagioclase, which ranges in composition from albite to oligoclase. Sericite makes up 5 percent of the rock. The parent rock was quartzose sandstone.

Rocks occurring in the samples from well CL-83 include quartz-biotite-hornblende-plagioclase gneiss, biotite-plagioclase-hornblende gneiss, amphibolite, and quartz-microcline gneiss. In the hornblende-plagioclase gneisses, quartz ranges in percentage from only a trace to 15 percent and occurs in moderately strained grains. Biotite makes up from 0 to 10 percent and is associated with hornblende, which comprises from 25 to 50 percent of the rocks and which occurs in corroded idioblastic to xenoblastic grains. Plagioclase, ranging in composition from oligoclase to andesine, makes up between 35 and 52 percent and is present in idioblastic to xenoblastic grains which show albite and Carlsbad twins. The grains have been moderately to severely altered to sericite. Some small elongate laths are enclosed within hornblende grains as a relict of ophitic texture, which suggests that these hornblende-plagioclase gneisses were originally basaltic flows (fig. 19). These metavolcanic rocks have been intruded by a granitic magma, which was the parent of the quartz-microcline gneiss in the samples from this well. In this granitic rock, quartz occurs in strongly strained xenoblastic grains, some in micrographic intergrowths with microcline, and

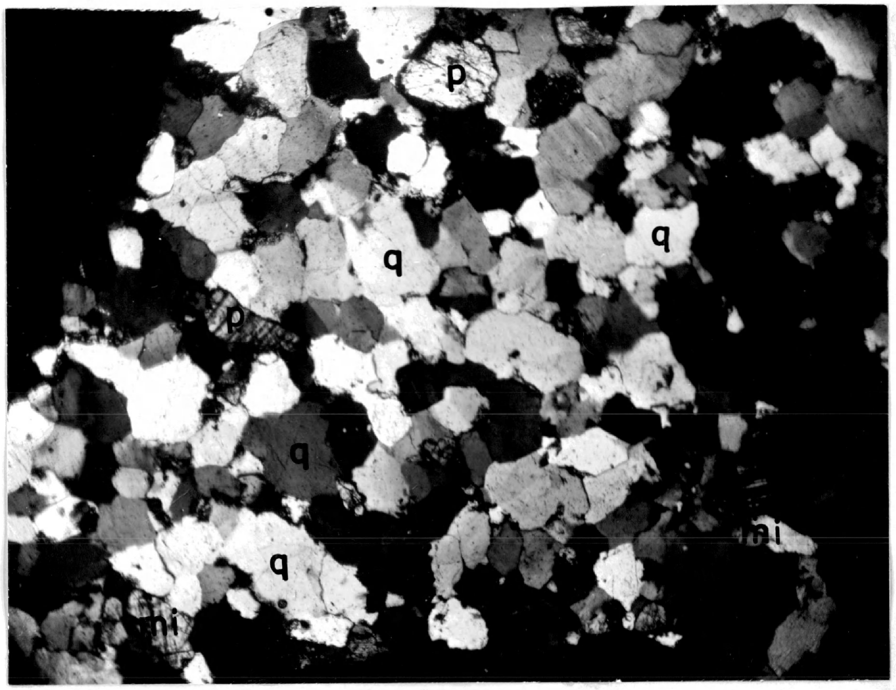


Figure 18: Photomicrograph of quartzite from well CL-181. p-plagioclase, mi-microcline, q-quartz. Crossed nicols, X25.

Figure 19: Photomicrograph of plagioclase-hornblende gneiss from well CL-83, showing relict ophitic texture. Uncrossed nicols, X25.

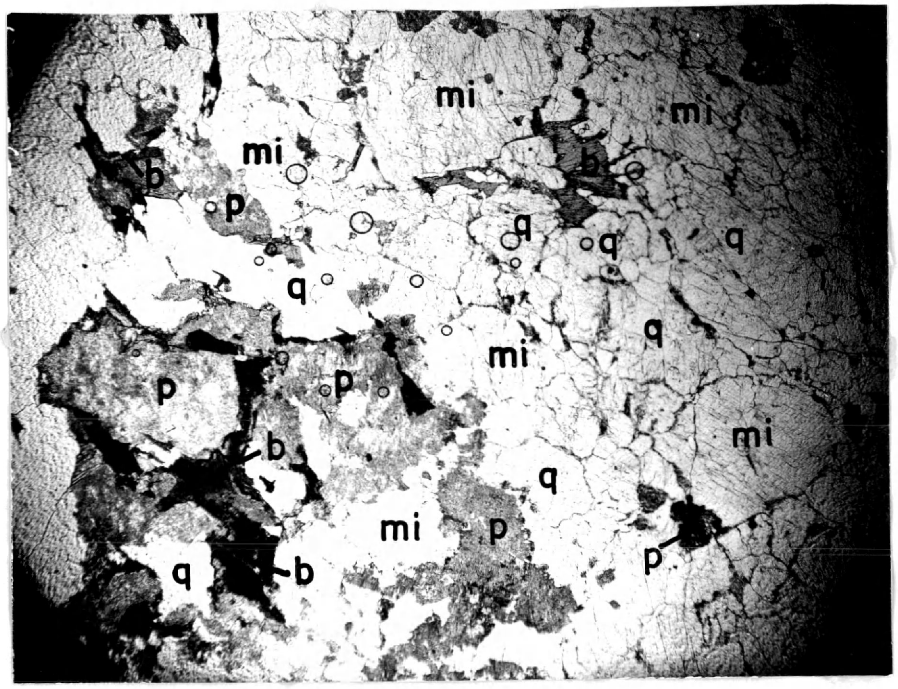
makes up 20 percent. Seventy-four percent of the rock is composed of microcline. A trace of plagioclase, the composition of oligoclase, is present and one percent of the rock is chlorite.

Logan-Yuma Granitic Terrane

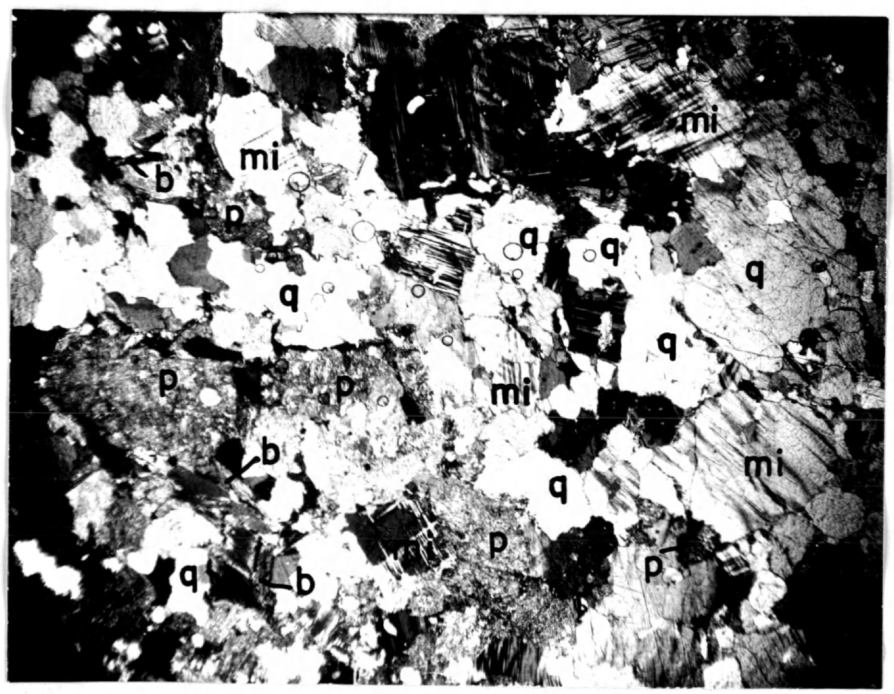
The Logan-Yuma granitic terrane lies in the northeastern corner of Colorado and includes Logan, Sedgewick, Phillips, Washington, Morgan, eastern Weld, and northwestern Yuma Counties (pl. 1). On the west it is bounded by the Weld-Delta metasedimentary terrane and on the southeast by the Kit Carson-Kiowa metasedimentary terrane. To the north and east the terrane passes into the State of Nebraska. Samples of basement rock were collected from 17 wells. Five wells each are in Logan and Yuma Counties, 2 each are in Morgan and Washington Counties, and 1 each is in Phillips, Sedgwick, and eastern Weld Counties. Southwest of Morgan and Washington Counties the presence of the terrane has not been established, as there are no wells in this part of the Denver basin which have been drilled to basement.

No surface exposures of Precambrian rocks are present within this terrane. The well samples of basement rock upon which the definition of the terrane is based are predominantly coarse-grained gneisses and augen gneisses, which appear to have been originally igneous rocks (tables 1 and 10). A few samples are of igneous rock, broadly termed "granitic" but actually ranging in composition between quartz monzonite and granodiorite. A belt of slightly cataclastic granitized metasediments occurs along the southeastern border of the terrane adjacent to the Kit Carson-Kiowa metasedimentary terrane, and several other occurrences of metasedimentary rocks are present in northern Logan County.

The following wells encountered coarse-grained granitic gneisses or augen gneisses: Shell Oil Co. #1-4728 Federal, Weld County (CL-159); Patrick Doheny #1 Mittelstadt, Logan County (CL-86); Shell Oil Co. #16-A C. F. Green, Logan County (CL-88); Shell Oil Co. #2-B State, Logan County (CL-89); Superior Oil Co. #45-32 Weiss, Morgan County (CL-108); Continental Oil Co. and others #1 Sprague Bros., Sedgwick County (CL-212); Amerada Petroleum Co. #1 Heyen, Washington County (CL-150); and Shell Oil Co. #1 Olsen, Yuma County (CL-173). Samples from these wells were all generally of quartz-microcline-plagioclase gneiss with biotite occurring in amounts ranging from 0 to 15 percent. Muscovite is present in many of the samples in amounts ranging from a trace to 5 percent. A few samples contain from a trace to 10 percent of hornblende. Plagioclase ranges from 5 percent to a maximum of 68 percent, is between oligoclase and andesine in composition, and usually occurs in xenoblastic grains, which are strongly altered to sericite. Some elongate grains have the appearance of having been originally idioblastic in outline. Microcline is present in large to small xenoblastic grains in amounts between a trace and 73 percent. In well CL-88 in Logan County, many grains of microcline were observed clustered together into irregularly-shaped augen (fig. 20, A and B). Quartz makes up between 15 and 40 percent of the rock in the samples studied. The grains are slightly to strongly strained and grain borders are



A



B

Figure 20: Photomicrograph of augen gneiss from well CL-88. Auge in upper right half is composed principally of microcline (mi) and quartz (q) with some small grains of biotite (b) and plagioclase (p). Gneiss in lower left half contains sericitized plagioclase, biotite, quartz, and some microcline.

A: Uncrossed micols, X9.

B: Crossed nicols, X9.

slightly to intricately sutured or crenulated. Samples from well CL-212 in Sedgwick County show the effects of cataclasis, in which all grains are fractured and broken. Quartz in particular shows severe strain (fig. 21).

Samples from the Anderson-Pritchard Oil Corp. #1 Blanchard, Morgan County (CL-107), are of an igneous rock identified as quartz monzonite. Plagioclase makes up 30 percent and occurs in euhedral to anhedral grains, which exhibit albite and Carlsbad twins. Alteration to sericite is moderate to severe. Microcline makes up 45 percent of the sample and quartz, which is moderately to strongly strained and fractured, comprises 15 percent. Biotite in euhedral to anhedral grains makes up 10 percent and has a slight preferred orientation.

The Texota Oil Co. #1 Hansen, Phillips County (CL-183), encountered igneous rock, which is identified as granodiorite (fig. 22). Plagioclase, ranging in composition from oligoclase to andesine, comprises 50 percent of the sample and occurs in euhedral to anhedral grains, which are moderately to strongly altered to sericite. Albite, pericline, and Carlsbad twins were observed. Quartz makes up 20 percent and anhedral grains of biotite, with a weak preferred orientation, make up 15 percent. Microcline makes up only 10 percent. About five percent of the sample is sphene, which occurs in euhedral to anhedral grains.

Occurrences of metasomatized or granitized metasedimentary rocks were found in northern Logan County and also across northwestern Yuma

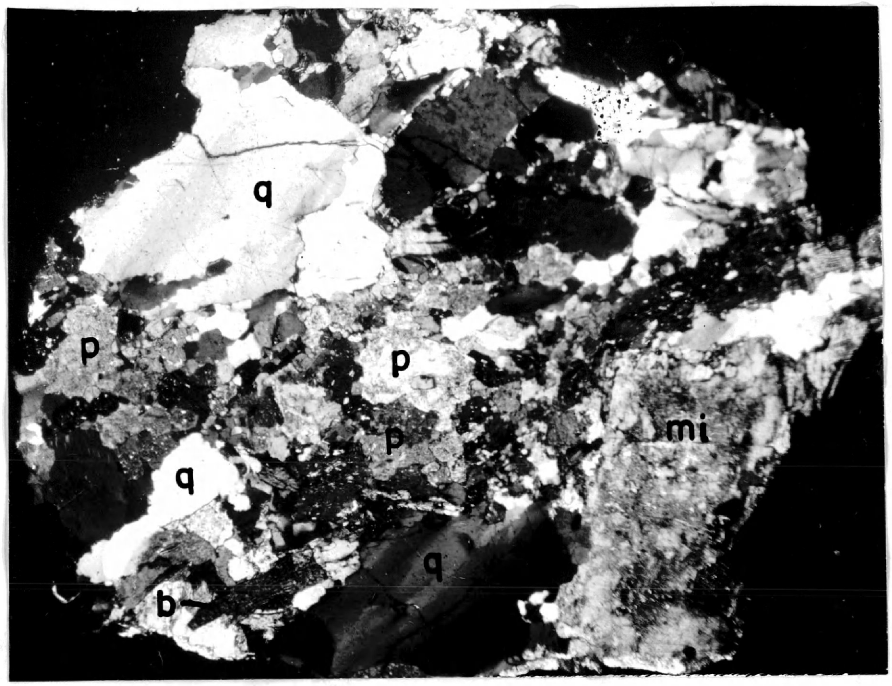


Figure 21: Photomicrograph of cataclastic granitic gneiss from well CL-212. b-biotite, mi-microcline, q-quartz, p-plagioclase. Crossed nicols, X25.

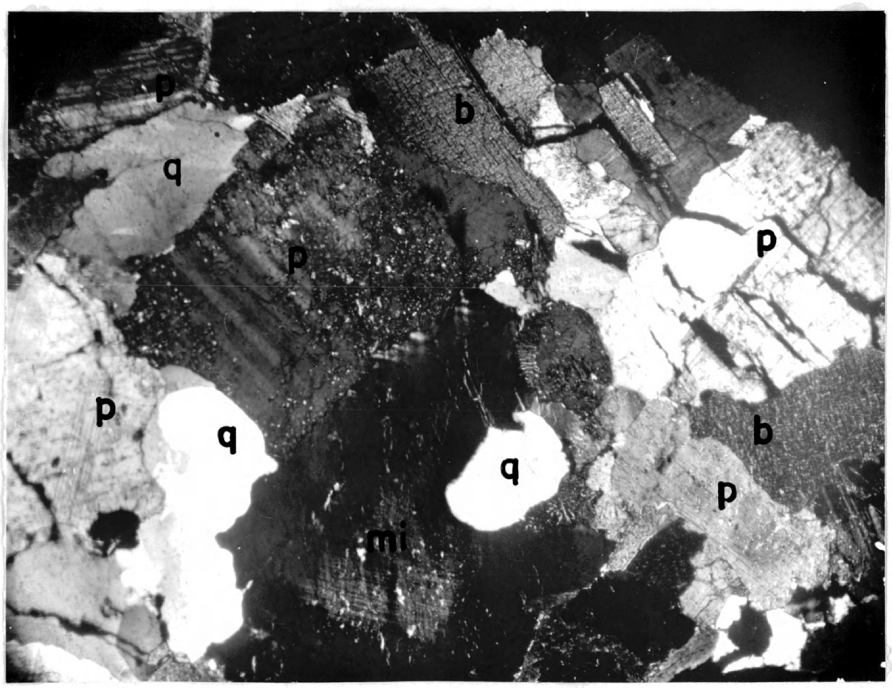


Figure 22: Photomicrograph of granodiorite from well CL-183. mi-microcline, b-biotite, q-quartz, p-plagioclase. Crossed nicols, X25.

County. The basement rocks are mostly fine-grained biotite-microcline-quartz-plagioclase gneisses, in which the grains have a distinct gneissic banding. Other rocks in these areas are amphibolite and hornblende-quartz-microcline-plagioclase gneiss. The original rocks are thought to have been calcareous, argillaceous, and quartzo-feldspathic sediments, which have been granitized by the addition of alkali-silicate solutions.

The wells which encountered rocks of the above in the Logan-Yuma granitic terrane are: British-American Producing Co. #4 Segelke, Logan County (CL-84); British-American Producing Co. #18 Yenter "B", Logan County (CL-85); Canada-Southern Oil Co. #1 Doyle Nieman, Yuma County (CL-162); Ohio Oil Co. #1 Brophy, Yuma County (CL-171); Lion Oil Co. #1 Chrismer, Yuma County (CL-170); Carter Oil Co. and Mountain States Drilling Co. #1 Henik, Yuma County (CL-164); and Skiles Oil Co. #1 Brower, Washington County, (CL-155). In addition to these wells, well CL-89 in Logan County, which was drilled into granitic gneisses, also encountered some granitized metasediments in the basement. The amphibolite from well CL-84 in Yuma County contains no microcline, but the quartz-plagioclase gneiss from this same well has about five percent microcline. Microcline in samples from other wells in the metasomatized metasediments ranges between 15 and 60 percent of the rock. Some of this microcline appears to have been introduced interstitially. Plagioclase makes up between 15 and 50 percent and is predominantly oligoclase. Some samples have plagioclase, ranging in composition from oligoclase to andesine. Albite and pericline twins are present and the grains are slightly to strongly altered to sericite. Quartz makes up from 20 to 30 percent of the samples and occurs in moderately to strongly strained grains. Biotite is present in most of the samples in amounts from 2 to 10 percent, and the grains have a strong preferred orientation. In the amphibolite from well CL-84, hornblende comprises 30 percent. Only one other well (CL-164) has samples containing hornblende, and in this rock it is only five percent.

Pueblo-Teller Granitic Terrane

The Pueblo-Teller granitic terrane lies in the central part of Colorado at the southern end of the Front Range and extends as far west as the Sawatch Range (pl. 1). To the north and west lies the Weld-Delta metasedimentary terrane, and to the southwest is the Saguache-Huerfano metasedimentary terrane. The Kit Carson-Kiowa metasedimentary terrane borders this terrane on the east. Samples were collected from 11 wells within the terrane, 6 of which are located in Pueblo County, 1 in Otero County, and 4 in Park County west of the Front Range.

This terrane is characterized primarily by granitic gneisses and augen gneisses of probably igneous origin, and granitic igneous rocks, although rocks of metasedimentary origin are present in the exposed basement and in the well samples (table 1). Large areas of granitic igneous rocks and granitic gneisses are exposed in the Front Range in Douglas, El Paso, Fremont, Jefferson, Park, and Teller Counties. These rocks also occur in the Mosquito Range in Lake and Chaffee Counties and in the northern end of the Wet Mountains in Fremont County. A narrow neck containing granitized metasedimentary rocks lies between the opposing ends of the Saguache-Huerfano and Kit Carson-Kiowa terranes and connects the Pueblo-Teller granitic terrane with the Las Animas-Baca granitic terrane to the southeast. Although there are no wells northeast of Pueblo County to prove the presence of this terrane in that direction, it is believed that the terrane connects with the Logan-Yuma granitic terrane across the Denver basin.

Summary of the exposed basement rocks

The large intrusive mass of the Pikes Peak batholith is present in the eastern half of the exposed part of the Pueblo-Teller granitic terrane and has been studied in detail by Hutchinson (1960b), Johnson (1961), Scott (1963), and Peterson (1964). Only the northern, western, and southern parts of the batholith are exposed in the Front Range, and the eastern part, which is buried beneath sedimentary rocks in the southern end of the Denver basin, has not been encountered by wells. The batholith has the characteristics of a rudely concentrically-zoned, mesozonal intrusive (Buddington, 1959; Hutchinson, 1960b) and is composed primarily of alaskite, leucogranite, granite, quartz monzonite, and granodiorite (Hutchinson, 1960b).

On the north this batholith is bordered by the metasediments of the Weld-Delta metasedimentary terrane. On the west, separated from the Pikes Peak batholith by a narrow belt of metasediments, lies the Kenosha batholith. This syntectonic, catazonal intrusion (Trimble, 1961, p. 64) is here considered to lie within the Weld-Delta metasedimentary terrane. Bordering the Pikes Peak batholith on the south and west is an extensive development of porphyroblastic augen gneisses, which have been regarded by many workers (Cross, 1894a; Mathews, 1900; Stark and others, 1949; Lovering and Goddard, 1950; Bhutta, 1954; Boos and Boos, 1957; Timroth, 1958; and Shappirio, 1963) as a coarse-grained variant or border facies of the Pikes Peak granite. However, Hutchinson (1960c, 1963) has demonstrated by both structural and temporal relationships that the augen gneisses are considerably older than the Pikes Peak granite. These augen gneisses are also present in the southern part of South Park (Stark and others, 1949) and in the hills east of the Arkansas River from northeast of Salida (Bhutta, 1954) to east of Buena Vista (Hutchinson and others, 1960; De Voto, 1961). North of Buena Vista the augen gneisses grade into the gneissic granites typically exposed near Granite, Chaffee County (Hutchinson and others, 1960). Large masses of coarse-grained igneous rocks and granitic gneisses exposed in the northern Wet Mountains and Arkansas Canyon areas of Fremont County (Merewether, 1955; Chronic, 1960) are included within this terrane.

Samples of the augen gneisses were collected from the Phantom Canyon and Cripple Creek areas south of the Pikes Peak batholith, from the Ute Trail road northeast of Salida, and along Trout Creek (U. S. Rte. 285) east of Buena Vista (fig. 14). The rocks from the Phantom Canyon, Cripple Creek, and Trout Creek areas are essentially biotite-plagioclase-quartz-microcline gneisses (table 11). The microcline has been metasomatically introduced and occurs only in lens-shaped augen composed of many small xenoblastic grains. According to Hutchinson and others (1964, p. 333), these microcline augen

> "appear to have grown by a growth mechanism of mutual exclusion in which microcline augen in a nonequilibrating stress environment were recurrently broken down to polycenters of crystallization all the while expelling ferromagnesian minerals which ended up rimming the microcline augen."

The original rocks may have been a sedimentary sequence of arkosic sandstones and shales. In Cripple Creek Canyon, south of the town of Cripple Creek, schistose rocks are exposed, surrounded by the more prevalent augen gneisses. The development of the coarse-grained augen gneisses may have been favored by the originally coarse-grained texture of the sediments, but certainly has been due in part also to recrystallization and addition of material during the severe metamorphism and metasomatism.

Granitic rocks exposed between Buena Vista and Leadville (fig. 14) are biotite-quartz-microcline-plagioclase gneisses and biotite-quartz-plagioclase gneisses and gneissoid granites (table 11). The original composition must have been from quartz monzonite to granodiorite, but some microcline has probably been introduced by alkali-silicate metasomatism. Metamorphosed granites and quartz monzonites are present in

Lake County, on the west side of Weston Pass. Some amphibolites, probably representing basic volcanic rocks also occur here. The border between the Pueblo-Teller and Weld-Delta terranes lies just to the north.

The augen gneisses northeast of Salida were collected along Turret road, just west of the junction with the Ute Trail road (fig. 14). In the outcrop, these rocks grade from schistose metasediments into augen gneisses within a few tens of feet. In thin section, these rocks are definitely of sedimentary origin, and the microcline and quartz, which make up the augen, have been introduced (table 11). The augen are S-shaped, indicating deformational stress during metasomatism and development of the augen. This locality is on the border between the Pueblo-Teller granitic terrane and the Saguache-Huerfano metasedimentary terrane to the south.

Petrography of the buried basement rocks

Five of the wells in Pueblo County encountered rocks identified as granitic gneiss (table 12). These are: the Continental Oil Co. #1 Paige (CL-123), the Continental Oil Co. #1 Young (CL-125), the Pan-American Petroleum Co. #1 Ingram (CL-129), the Skelly Oil Co. #1 M. E. Lutin (CL-196), and the Phillips Petroleum Co. #1 Sample Nose-Government (CL-130). Also included within this group is the Vaughey and Vaughey #1 W. S. Sidney (CL-111) in Otero County. All of the samples from these wells are variations of biotite-quartz-microcline-plagioclase gneiss. Biotite in the rocks ranges in amounts from a trace to 33 percent, but is mostly about 1 or 2 percent. The grains have been strongly altered to chlorite and have a preferred orientation. Quartz makes up from 3 to 49 percent of the samples and occurs in strongly to severely strained grains. Minute needlelike crystallites of rutile are present in quartz grains in most of the samples from Pueblo County. Microcline in large to small grains occurs in most of the samples and ranges from 2 to 65 percent. The larger grains often show Carlsbad twins. Between 10 and 50 percent of the rocks is composed of plagioclase, which ranges in composition from oligoclase to sodic andesine. Plagioclase occurs in both large and small xenoblastic grains, which have been moderately to completely altered to sericite. The original rocks may have been plutonic igneous rocks, which ranged in composition from quartz monzonite to granodiorite, or they may represent strongly metamorphosed arkosic sediments, as the texture seen in thin sections of these granitic gneisses is very similar to the texture of the augen gneisses in the exposed basement of the Pueblo-Teller granitic terrane.

Granitized or metasomatized metasediments were identified in samples from the Phillips Petroleum Co. #1-A Johnson, Pueblo County (CL-131), which lies in the narrow neck connecting the Pueblo-Teller and Las Animas-Baca granitic terranes. The rock is a biotite-quartz-plagioclase-microcline gneiss. Biotite, strongly altered to chlorite, ranges from a trace to 15 percent of the rock, and quartz, in moderately strained xenoblastic grains, makes up between 25 and 30 percent.

Moderately altered grains of plagioclase, the composition of oligoclase, comprise from 10 to 45 percent. Xenoblastic grains of microcline make up between 15 and 58 percent of the samples. The smaller grains occur interstitially and may have been introduced by alkali-silicate metasomatism.

The four wells in Park County are all located within a few miles north and east of Hartsel, and about five miles west of the exposed Precambrian basement of the Front Range. Many small exposures of basement rocks, partially buried by Paleozoic, Mesozoic, and Cenozoic sediments and by Tertiary volcanic rocks, are present to the south in South Park (Stark and others, 1949).

Samples from the McDannald Oil Co. #1 State, Park County (CL-113), encountered a series of metasedimentary rocks, which are identified as plagioclase-hornblende gneiss, plagioclase-quartz-biotite schist, quartz-plagioclase gneiss, and muscovite-plagioclase-quartz gneiss. In the plagioclase-hornblende gneiss, plagioclase, the composition of andesine, makes up between 15 and 40 percent of the rock and occurs in strongly to severely altered xenoblastic grains. Hornblende, in corroded idioblastic to xenoblastic grains, comprises from 50 to 63 percent and magnetite makes up from 5 to 10 percent. The plagioclase-quartz-biotite-schist contains severely altered grains of plagioclase (andesine), which comprise 25 percent. Strongly strained and sutured quartz grains make up 35 percent and elongate xenoblastic grains of biotite make up 38 percent. Forty-five percent of the quartz-plagioclase gneiss is composed of slightly to strongly strained and sutured quartz grains and 48 percent is made up of plagioclase, which ranges in composition from oligoclase to andesine and which occurs in moderately to strongly altered xenoblastic grains. Finally, the muscovite-plagioclase-quartz gneiss contains 15 percent muscovite, 30 percent slightly to strongly altered xenoblastic grains of plagioclase, and 55 percent strongly strained and sutured grains of quartz. The parent rocks for this series of schists and gneisses must have been calcareous and argillaceous sediments with interbedded basic volcanic rocks.

The Shell Oil Corp. #1 Federal, Park County (CL-114), was drilled into rocks identified as chlorite-plagioclase-amphibole-sericite schist and biotite-microcline-quartz-plagioclase gneiss. The schist contains 5 percent each of leucoxene and of microcline, and 10 percent chlorite. Plagioclase also makes up 10 percent of the rock and occurs in small lathlike grains which have been strongly altered to sericite. Amphibole, of the variety tremolite-actinolite, makes up 20 percent. Fifty percent of the rock is composed of sericite, which occurs in masses of microcrystalline grains. In the gneiss, biotite, which has been strongly altered to muscovite, comprises 10 percent and broken and granulated xenoblastic grains of microcline make up 15 percent. Twenty-five percent is composed of quartz, which occurs in strongly strained, sutured, and granulated grains. Xenoblastic grains of plagioclase, which range in composition from oligoclase to andesine, have been severely to completely altered to sericite and make up 40 percent of the rock. Masses of sericite make up 8 percent. These samples were drill cuttings which came from a 140-foot interval in the basement. Therefore, the exact relationship between the two rocks is not known. The parent rocks may have been a sequence of sedimentary rocks and basic volcanic rocks, which were intruded and metamorphosed by a granitic magma.

The basement rocks from the Shell Oil Corp. #1-4343 State, Park County (CL-116), consist of muscovite-biotite-quartz gneiss and biotite-plagioclase-quartz gneiss. In the muscovite-biotite-quartz gneiss, muscovite ranges in amount from 2 to 5 percent and biotite ranges from 10 to 20 percent. Quartz, which occurs in moderately to severely strained and sutured xenoblastic grains, makes up about 80 percent of the rock. In the biotite-plagioclase-quartz gneiss, only a trace of muscovite is present, but biotite comprises 15 percent. Plagioclase (oligoclase) makes up 35 percent and is moderately altered to sericite. Fifty percent of the rock is composed of moderately strained and sutured xenoblastic grains of quartz. The parent rocks were argillaceous to quartzose sediments.

The only well in the Park County area which did not encounter metasediments as the basement rock is the Shell Oil Corp. #1 A. T. McDannald, Park County (CL-115). Samples from this well are identified as a biotite-microcline-quartz-plagioclase augen gneiss and may represent severely metamorphosed and metasomatized arkosic sediments. Biotite occurs in idioblastic to xenoblastic grains, which make up 15 percent of the gneissic groundmass. Quartz makes up from 20 to 30 percent and is present in strongly strained and sutured grains. Plagioclase in the gneissic groundmass ranges in composition from oligoclase to andesine and occurs in moderately to severely altered xenoblastic grains, which make up 45 percent of the groundmass. In the granitic augen portion of the rock, the plagioclase is oligoclase and comprises between 45 and 70 percent. The grains range from idioblastic to xenoblastic in form and are very slightly to moderately altered to sericite. Microcline occurs only in the granitic augen and makes up from 10 to 20 percent.

Las Animas-Baca Granitic Terrane

The Las Animas-Baca granitic terrane is present in southeastern Colorado and includes all of Baca County, most of Las Animas County except for the far western portion, and the southern half of Bent and Prowers Counties (pl. 1). Some of Otero County is also included. The terrane is bordered on the north by the Kit Carson-Kiowa metasedimentary terrane. To the west lies the Saguache-Huerfano metasedimentary terrane, and to the south and east the terrane continues into the States of New Mexico, Oklahoma, and Kansas. Samples of basement rocks were obtained from 16 wells within the terrane. Eight of these wells are located in Las Animas County, 4 are in Baca County, 3 are in Bent County and 1 is in Prowers County. In addition, two other wells encountered shallow intrusive rocks and hornfelses of probably Tertiary age.

No surface exposures of the Precambrian basement rocks occur within the Las Animas-Baca granitic terrane. The basement rocks encountered in the wells are predominantly granitic igneous rocks (tables 1 and 13), some of which show the effects of cataclasis. Samples of granitic gneiss from this terrane were found only in wells in Las Animas County. A narrow neck of granitized metasediments and granitic gneisses, lying between the Kit Carson-Kiowa and Saguache-Huerfano metasedimentary terranes, connects this terrane with the Pueblo-Teller granitic terrane.

Samples containing plutonic igneous rocks with well-developed igneous textures (fig. 23) were obtained from the Boswell and Frates #1 Government, Las Animas County (CL-71); the Stanolind Oil and Gas Co. #1 C. F. and I., Las Animas County (CL-77); the Moran Bros. #1 Cramer, Baca County (CL-177); and the Clayton Oil Co. #1 Etchart, Bent County (CL-12). These rocks range in composition from quartz monzonite to granodiorite and contain distinctly zoned euhedral to subhedral grains of plagioclase. The composition of the plagioclase ranges from oligoclase to andesine, and the grains comprise between 23 and 65 percent of the samples. Microcline makes up from 9 to 50 percent and occurs in anhedral grains. Between 20 and 30 percent of the rock is composed of moderately strained anhedral grains of quartz. Biotite grains, moderately altered to chlorite, occur in amounts ranging from a trace to 10 percent.

Other plutonic igneous rocks in the terrane which have less well developed igneous textures occurred in the following wells: the R. W. Lange #1 Marquez, Las Animas County (CL-193); the Sullivan and Pauley #1 Waldroup, Las Animas County (CL-80); the Skelly Oil Co. #1

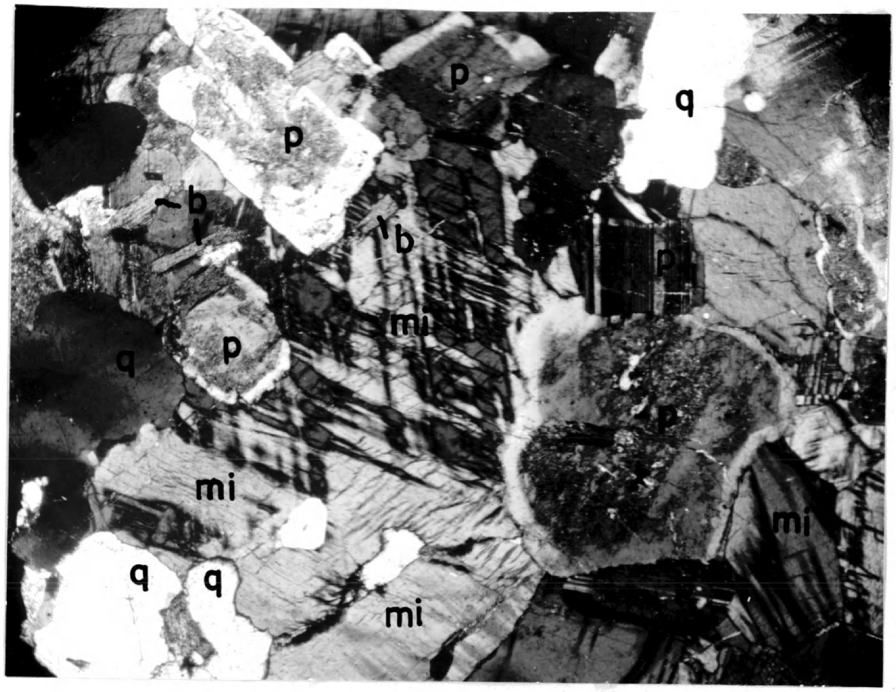


Figure 23: Photomicrograph of granite from well CL-71, showing zoned euhedral grains of plagioclase. b-biotite, q-quartz, p-plagioclase, mi-microcline. Crossed nicols, X25.

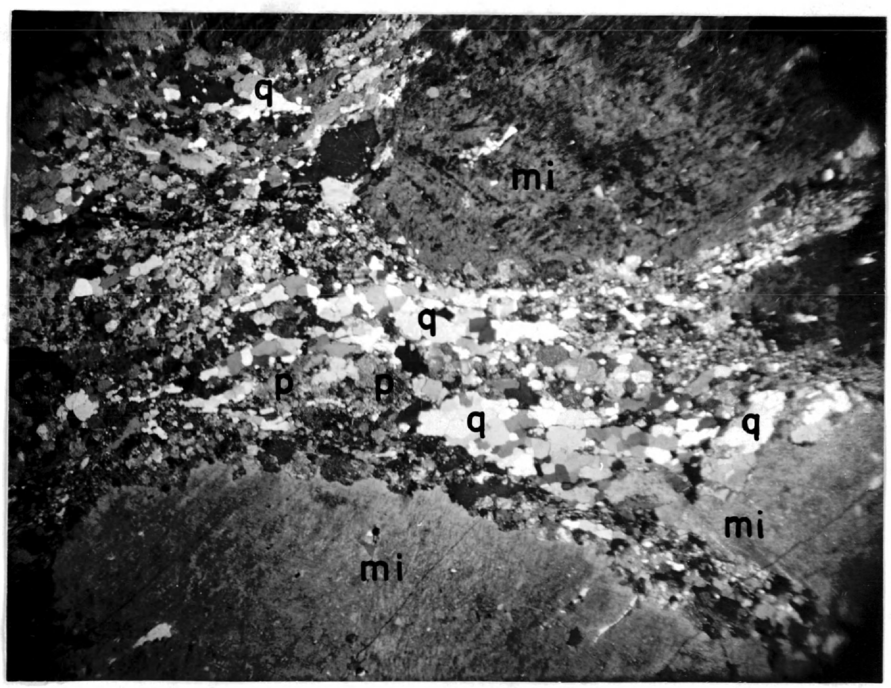


Figure 24: Photomicrograph of cataclastic granitic gneiss from well CL-69. p-plagioclase, q-quartz, mi-microcline. Crossed nicols, X9.

McEndree, Baca County (CL-176); the Moran Bros. #1 Singer, Baca County (CL-178); the Frankfort Oil Co. #1-C Cimmaron, Baca County (CL-186); the Seaboard Oil Co. #1 Government, Bent County (CL-13); and the Amerada Petroleum Co. #1 C. L. Dillon, Bent County (CL-11). These rocks range in composition from granite to quartz monzonite, and some are slightly to moderately cataclastic. Microcline occurs as anhedral grains, some with Carlsbad twins, which make up from 0 to 74 percent of the rocks. Between 5 and 45 percent is composed of plagioclase predominantly the composition of oligoclase. The grains occur in zoned euhedral to unzoned subhedral form and have been slightly to severely altered to sericite. Quartz makes up from 15 to 30 percent and is present in moderately to severely strained anhedral grains, some of which contain minute needles of rutile. Biotite occurs in amounts ranging from a trace to 10 percent. A trace of hornblende occurs in one sample from well CL-176.

The basement rock in a core from well CL-193 in Las Animas County is a porphyritic quartz monzonite with large phenocrysts of microcline, which poikilitically enclose small grains of plagioclase, quartz, biotite, and magnetite. Plagioclase grains are euhedral to subhedral in form and are distinctly zoned. Biotite makes up only 2 to 3 percent. The rock is coarse-grained and has a light-gray color.

Granitic gneisses in the Las Animas-Baca granitic terrane are variations of biotite-quartz-microcline-plagioclase gneiss but show the effects of both cataclassis and some alkali metasomatism. Wells in this group are all in Las Animas County and are the Skelly Oil Co. #1 Jolly-Government (CL-75), the Johnson and Sullivan #1 A. T. McCarty (CL-204), the Baker and Taylor Drilling #1 R. S. LeSage (CL-69), and the Parker Gun Club #1 Adams (CL-73). Biotite makes up from a trace to 10 percent of the samples. Quartz occurs in moderately to strongly strained and fractured grains, which comprise between 25 and 50 percent of the rocks. Quartz grains in well CL-204 contain minute needles of rutile. Microcline, ranging from large xenoblastic grains to small interstitial grains, makes up from 20 to 60 percent of the samples. Between 5 and 40 percent is composed of plagioclase, the composition of oligoclase. The plagioclase grains are xenoblastic and are moderately to strongly altered to sericite. Some grains show albite, pericline, and Carlsbad twins. These granitic gneisses were originally igneous rocks, which ranged in composition from granite to quartz monzonite.

The gneiss in well CL-69 appears to be a strongly sheared or granulated microcline granite or quartz monzonite and was probably deformed only by cataclasis (fig. 24). Large unbroken but rounded grains of microcline are surrounded by a fine-grained matrix composed of quartz, plagioclase, and microcline. Biotite, about two percent has been completely altered to chlorite. The quartz grains have an elongate shape with sutured borders and occur in elongate aggregates or bands throughout the rock as if original large grains had been crushed and granulated into a lens-shaped aggregates of smaller grains.

The samples from the Charles A. Wallace #1 Witte, Prowers County (CL-121), contain fragments of amphibolite and of quartz monzonite. The basement rock at this locality is believed to represent basic volcanic rocks, which have been intruded by a quartz monzonitic magma. The plagioclase in the amphibolite ranges in composition from andesine to labradorite, and the grains make up from 37 to 45 percent of the rock. Hornblende comprises between 40 to 45 percent. Between 5 and 10 percent is composed of epidote, and biotite makes up from a trace to 10 percent. In the quartz monzonite intrusive, plagioclase occurs in euhedral to anhedral grains, which make up about 35 percent and which range in composition from oligoclase to andesine. The grains have been moderately to severely altered to sericite. Moderately to strongly strained anhedral grains of quartz comprise 30 percent of the rock, and microcline, occurring in anhedral grains, makes up 25 percent. Muscovite occurs in amounts ranging from 5 to 10 percent and biotite is from a trace to 2 percent. This well is very close to well CL-119 in the Kit Carson-Kiowa metasedimentary terrane, and the border between the two terranes is considered to pass between these two wells.

The two wells in the Las Animas-Baca granitic terrane which were drilled into shallow intrusives and hornsfelses of probable Tertiary age are the R. W. Lange #1 Government, Las Animas County (CL-72), and the Ohio Oil Co. #1 Eldridge, Prowers County (CL-118). Both wells are located near the surface exposures of Tertiary intrusives, shown on the Geologic Map of Colorado (1935) and on the map of Merewether (1955).

Well CL-72 encountered a dike of quartz latite porphyry and also hornfelsic rocks produced by contact metamorphism near the dike. This dike is part of the extensive system associated with the Spanish Peaks intrusives in western Huerfano County. On the well completion card issued by Petroleum Information Corporation, this well was reported to have encountered the Precambrian basement beneath the hornfelses at an elevation of 511 feet below sea level and to have penetrated 40 feet into the Precambrian. Unfortunately, samples of this basement were not available for study from this well. Well CL-118 was drilled just north of the Two Buttes intrusive in southern Prowers County and encountered a dike of biotite lamprophyre with euhedral phenocrysts of biotite, similar to the rock of the two Buttes intrusive described by Sanders (1934, p. 868). Cross (1906) named the rock from this locality "Prowersose".

Mesa-Montezuma Granitic Terrane

The Mesa-Montezuma granitic terrane lies in the southwestern part of Colorado and extends into the States of Utah, Arizona, and New Mexico on the south and west (pl. 1). To the east is the Saguache-Huerfano metasedimentary terrane, and to the north is the Weld-Delta metasedimentary terrane. Crossing this terrane in a narrow band from northwest to southeast is the La Plata-San Juan metasedimentary terrane. Samples of basement rocks from 11 wells in this terrane were available for study. Four of the wells are located in Montezuma County, 3 are in Montrose County, 2 are in San Miguel County and 1 each is in Archuleta and Mesa Counties. All or parts of Conejos, Dolores, Gunnison, Hinsdale, La Plata, Mineral, Ouray, Rio Grande, and Saguache Counties are included in this terrane, although no wells which encountered undoubted Precambrian rocks of this terrane are present within these counties.

The definition of this terrane is based on the occurrence of granitic igneous rocks, granitic gneisses, and granitized metasediments as the major part of the exposed basement and in the 11 wells of this terrane (table 1). Extensive exposures of basement rocks are present in the Gunnison Valley along the northeastern border of the terrane, in the Uncompahgre Plateau on the northwest, and in the region of the Needle and Grenadier Mountains in the center of the terrane. Around this later exposed mass within the San Juan dome many small scattered occurrences of basement rocks are present, chiefly near the towns of Rico, Ouray, and Lake City, and also in the valleys of the Conejos and Piedra Rivers. One additional well in Dolores County supplied samples of a porphyry which gave a lead-alpha age of latest Precambrian to Cambrian. Tertiary intrusive rocks and hornfelses were encountered in five other wells.

Summary of the exposed basement rocks

The most comprehensive work on the basement rocks in southwestern Colorado is that of Larsen and Cross (1956) on the San Juan region.

They state (Larsen and Cross, 1956, p. 17) that the greater part of the exposed Precambrian basement is of schistose and gneissose rocks. However, their map included not only the area called here the Mesa-Montezuma granitic terrane, but also, in the Gunnison Valley area, a large part of the Weld-Delta metasedimentary terrane. In addition, the present writer considers the Irving Greenstone and the quartzites, slates, and conglomerates of the Needle Mountains Group, both of which are exposed in the Grenadier-Needle Mountains area of the San Juan dome, to be in a separate terrane named the La Plata-San Juan metasedimentary terrane. Many closely-spaced intrusive bodies of granitic rock are present within the Grenadier-Needle Mountains area, and intrude both the older schists and gneisses and the younger metasediments of the Needle Mountains Group(Larsen and Cross, 1956, p. 26).

In the Uncompahgre Plateau, Dane (1935), Cater (1955), and Shoemaker (1956) report that the exposures of the Precambrian basement south of and including those in Coach Creek and Unaweep Canyon, are principally of granitic rocks. Although no detailed studies have been made in this area, Shoemaker (1956) mentions an older and a younger granite, as well as strongly granitized gneisses. The basement rocks which are exposed in the canyons on the northern and northeastern flanks of the Uncompahgre uplift are for the most part metasediments (Shoemaker, 1956), and are here placed in the Weld-Delta metasedimentary terrane.

The basement rocks in the Gunnison Valley, considered here to be in the southern part of the Weld-Delta metasedimentary terrane, are predominantly schists and gneisses with some small granitic plutons (Hunter, 1925; Larsen and Cross, 1956; Hansen, 1964). In the upper ends of several of the tributary valleys on the south side of the valley, granitic rocks are present, and lie in the Mesa-Montezuma granitic terrane. A large area of these granitic rocks floors the valley of Cebolla Creek around Powerhorn in southern Gunnison County (Larsen and Cross, 1956, p. 33). Another is at the head of Cochetopa Canyon in northwestern Saguache County, where granites and porphyroblastic augen gneisses are exposed just south of the gneisses of the Weld-Delta metasedimentary terrane.

Samples of exposed basement rocks in the Meza-Montezuma granitic terrane were collected only from the locality at the head of Cochetopa Canyon (fig. 6). Three samples of granitic gneiss, generally the composition of biotite-quartz-plagioclase-microcline gneiss, were identified (table 14). Two of the samples were originally of granitic rock, which had probably been subjected to syntectonic deformation during the period of intrusion. Some metasomatism also has taken place. The third sample, of the porphyroblastic augen gneiss, appeared to have been originally an arkosic sedimentary rock. The later growth of the microcline augen was promoted by alkali-silicate metasomatism.

Petrography of the buried basement rocks

Four of the 11 basement wells in the Mesa-Montezuma granitic terrane (table 15) were drilled into granitic gneisses which have the appearance of having been originally plutonic igneous rocks. Samples from both the Wirt Franklin #1 Sullenberger, Archuleta County (CL-3), and the Gulf Oil Corp. #1 Fulks, Montezuma County (CL-100), are identified as biotite-quartz-plagioclase-microcline gneiss. However, the samples from well CL-3 are cuttings in which the fragments are too small for the fabric to be determined. Biotite in the samples from these wells ranges in amount from a trace to 9 percent and quartz, in moderately to strongly strained and sutured xenoblastic grains, makes up between 10 and 25 percent. From 15 to 30 percent of the rocks is composed of plagioclase, the composition of oligoclase, which occurs in slightly to strongly altered xenoblastic grains. The grains exhibit albite, pericline, and Carlsbad twins. Some of the plagioclase grains from well CL-100 have idioblastic form. Microcline comprises from 35 to 70 percent of the samples and occurs in xenoblastic grains. The original rocks were very likely granites or quartz monzonites.

The Kerr-McGee #1 Placerville, San Miguel County (CL-200), encountered a hornblende-biotite-microcline-quartz-plagioclase gneiss. Corroded xenoblastic grains of hornblende comprise from a trace to 5 percent of the rock and are associated with xenoblastic grains of biotite, which also makes up about 5 percent. Between 3 and 15 percent is composed of xenoblastic grains of microcline. Quartz, in strongly to severely strained, granulated, and sutured grains makes up between 8 and 15 percent. Plagioclase, ranging in composition from oligoclase to andesine, occurs in moderately to severely sericitized xenoblastic grains which comprise from 63 to 75 percent of the rock. Both albite and Carlsbad twins are observed in plagioclase. The parent rock of this gneiss was probably a granodiorite.

In the samples from the St. Helens' Petroleum Co. #1 Sanburg, Montrose County (CL-105), a biotite-quartz-orthoclase-plagioclase porphyroblastic gneiss was identified. Between 5 and 15 percent of the rock is composed of biotite, which is slightly to moderately altered to chlorite. Quartz makes up between 15 and 25 percent and occurs in moderately to strongly strained xenoblastic grains. Plagioclase, which ranges in composition from oligoclase to andesine and exhibits albite, pericline, and Carlsbad twins, comprises from 34 to 77 percent of the rock. Orthoclase occurs in large xenoblastic porphyroblasts which make up from 0 to 25 percent of the rock.

Six of the wells in the Mesa-Montezuma granitic terrane encountered plutonic igneous rocks. Three of these, the California Oil Co. #1 Ute Tribal (CL-98), the Continental Oil Co. #1 Ute Mountain (CL-99), and the Pan-American Petroleum Co. #1 Ute Mountain (CL-101), all in Montezuma County, supplied samples of a granite with a well-developed micrographic texture (fig. 25). Plagioclase, ranging from albite to oligoclase, makes up from 1 to 5 percent and occurs in strongly altered euhedral to subhedral grains, which show albite, pericline and Carlsbad twins. Quartz comprises from 10 to 15 percent and occurs in slightly to strongly strained euhedral to anhedral grains, which are graphically

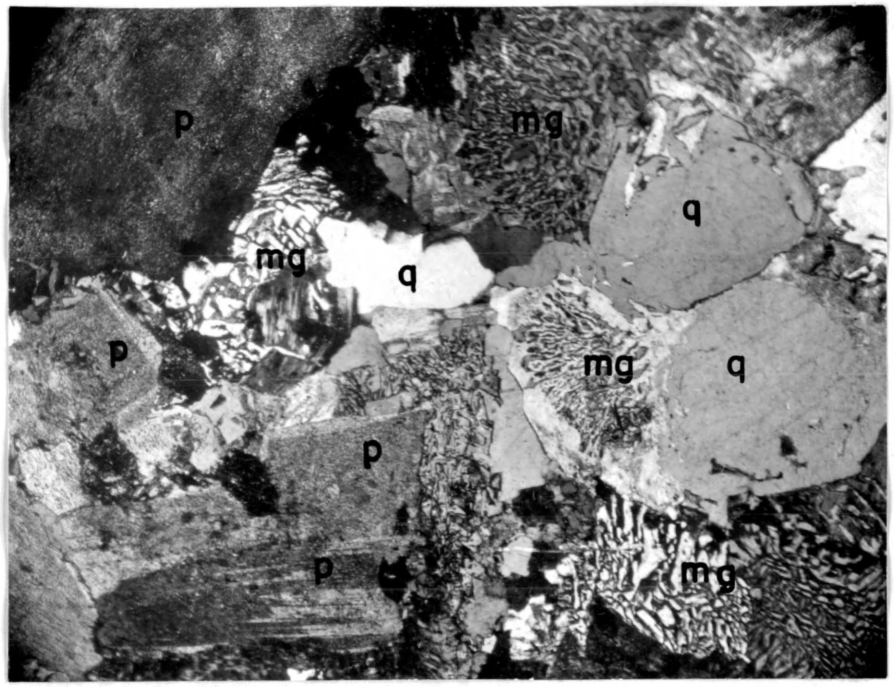


Figure 25: Photomicrograph of micrographic granite from well CL-98. p-plagioclase, q-quartz, mg-micrographic quartz and microcline. Crossed nicols, X25.

intergrown with microcline at grain contacts. Euhedral to subhedral grains of microcline, which have been strongly altered to sericite make up from 5 to 20 percent of the rock. Carlsbad twins are observed in the microcline. Between 60 and 75 percent of the rock is composed of anhedral grains of micrographic quartz and microcline. Carlsbad twins are apparent in these grains also. Chlorite makes up only one percent and a trace of muscovite is present.

The Penrose and Tatum #1 Orme, Montrose County (CL-103), was drilled into a plutonic igneous rock identified as either a microcline granite or syenite to a monzonite. Quartz is present in amounts of only 2 to 3 percent. Biotite makes up from 2 to 15 percent. Between 5 and 37 percent of the rock is composed of plagioclase (oligoclase) which occurs in subhedral to anhedral grains slightly altered to sericite. Microcline comprises from 45 to 90 percent. The size of the fragments from this well is too small for the fabric of the rock to be determined accurately.

Two wells, the Shell Oil Corp. #1 Wray Mesa Unit, Montrose County (CL-182), and the Pure Oil Co. #1 Unit (Gateway), Mesa County (CL-94), encountered quartz monzonite to granodiorite. In well CL-182, biotite is no longer present but has been altered to muscovite, which makes up five percent of the basement rock. Subhedral to anhedral grains of orthoclase, which show Carlsbad twins, comprise from 15 to 20 percent, and anhedral grains of moderately strained quartz make up 20 to 30 percent. Strongly altered euhedral to subhedral grains of plagioclase, which range in composition from oligoclase to andesine, comprise from 40 to 55 percent of the rock. In well CL-94, from 10 to 15 percent of the rock is made up of biotite, and from 2 to 32 percent is made up of microcline. One fragment of an anhedral phenocryst of microcline contained 90 percent microcline. Quartz makes up from 15 to 30 percent of the rock and occurs in strongly strained and sutured anhedral grains. Plagioclase, ranging in composition from oligoclase to andesine, makes up between 40 and 50 percent and is present in slightly to moderately altered euhedral to anhedral grains, which exhibit albite, pericline, and Carlsbad twins.

Metasedimentary rocks, which have been subjected to alkali-silicate metasomatism, are present in the Mesa-Montezuma granitic terrane in samples from the Fred Turner #1 F. H. Buss, San Miguel County (CL-149). The basement rock from this well is a biotite-microcline-quartz-plagioclase gneiss, which contains five percent of biotite. Fifteen percent of the sample is composed of microcline, which occurs in xenoblastic grains with Carlsbad twins. Quartz makes up 25 percent and is present in moderately to strongly strained xenoblastic grains. Forty-nine percent of the rock is composed of plagioclase (oligoclase) in xenoblastic grains. The parent rocks were quartzo-feldspathic to arkosic sediments.

A shallow intrusive latite porphyry, dated as late Precambrian, was encountered in the Smith Drilling Co. #1 Groundhog Unit, Dolores County (CL-29). Between 25 and 40 percent of the porphyry is phenocrysts, of which plagioclase, the composition of oligoclase, makes up from 45 to 80 percent, and strongly altered euhedral crystals of hornblende make up between 10 and 50 percent. Of the groundmass, from 5 to 10 percent is hornblende in subhedral to anhedral grains and 30 to 40 percent is orthoclase. Quartz makes up only 2 to 5 percent. Sphene and magnetite are present both in groundmass and as phenocrysts.

Wells which encountered Tertiary intrusive rocks or hornfelsic rocks believed to be associated with intrusives are the Cameron Drilling #1 Ed Bramwell, Archuleta County (CL-2), the Francis Harvey #1 Government, Archuleta County (CL-4), the Western Natural Gas #1 MacIntosh, Montezuma County (CL-97), the Western Natural Gas #1-A Glade, Dolores County (CL-30), and the Intex Oil Co. #1 D. Halls, Ouray County (CL-201). The rock in samples from well CL-2 is a plagioclase-chlorite-sericite hornfels. No evidence of an intrusive rock was seen in the samples from this well. Samples of a chlorite-diopside-feldspar hornfels were collected from well CL-97, but fragments of a latite intrusive are also present. Quartz latite porphyry is the rock in samples from both well CL-4 and well CL-201. The samples from well CL-30 are of a dacite. These rocks are all similar to the descriptions by Larsen and Cross (1956) of Tertiary intrusives exposed in the San Juan Mountain region.

Uinta Mountain Sedimentary Terrane

The Uinta Mountain sedimentary terrane is present in Moffat, Rio Blanco, and Routt Counties in the northwestern corner of Colorado (pl. 1). The terrane is defined primarily on the basis of the quartzites and shales of the Uinta Mountain Group, which are exposed in the Uinta Mountains of Colorado and Utah (table 1). Small exposures of these rocks also occur east of the main mass at Cross Mountain (Kanizay, 1956) and at Juniper Mountain (Abrassart and Clough, 1955) in south-central Moffat County. Samples from three wells in this terrane (table 16) are of rocks similar to those which have been described in the exposed areas by Hansen (1965), Abrassart and Clough (1955) and Kanizay (1956). Two of these wells are located in central Routt County and one is in Moffat County, near the Juniper Mountain structure. Samples from a fourth well in Rio Blanco County are of a sandy limestone to calcareous sandstone and possibly may not represent the Precambrian sedimentary rocks of this terrane. Sandstones and shales of the Precambrian Uinta Mountain Group have been reported on the well completion cards issued by the Petroleum Information Corporation, Denver, Colorado, for three additional wells in southern Moffat County. However, samples of the basement rocks from these wells were not available for this study.

Summary of the exposed basement rocks

Two different series of Precambrian rocks are present in the Uinta Mountains of Utah and Colorado (Van Hise, 1909; Hinds, 1936; Forrester, 1937; and Hansen, 1965). The Red Creek Quartzite is a highly metamorphosed sequence of quartzites, quartz-mica schists, plagioclase-quartz gneisses, diorite gneisses, and amphibolites, whereas the Uinta Mountain Group consists of dark red, medium- to coarse-grained sandstones and quartzites with lesser amounts of shale and conglomerate (Hansen, 1965). Ritzma (1959, 1960) suggested that the Red Creek Quartzite was produced by the metamorphism of the Precambrian Uinta Mountain sediments during Tertiary time. However, Hansen(1965) reported an isotopic age of greater than 2 billion years for the Red Creek Quartzite. The present writer considers the Red Creek Quartzite to be representative of the Precambrian metasediments in the Weld-Delta metasedimentary terrane, which extend beneath the younger Precambrian sedimentary rocks of the Uinta Mountain sedimentary terrane (see Plate 3).

Hansen (1955, p. 27) determined the thickness of the Uinta Mountain Group, in a continuous section across cold Spring Mountain on the Utah-Colorado State line, to be approximately 20,000 feet. As neither the top nor bottom of the sequence is exposed, Ritzma (1959, p. 19) believes the total thickness of the Uinta Mountain Group may approach 24,000 feet.

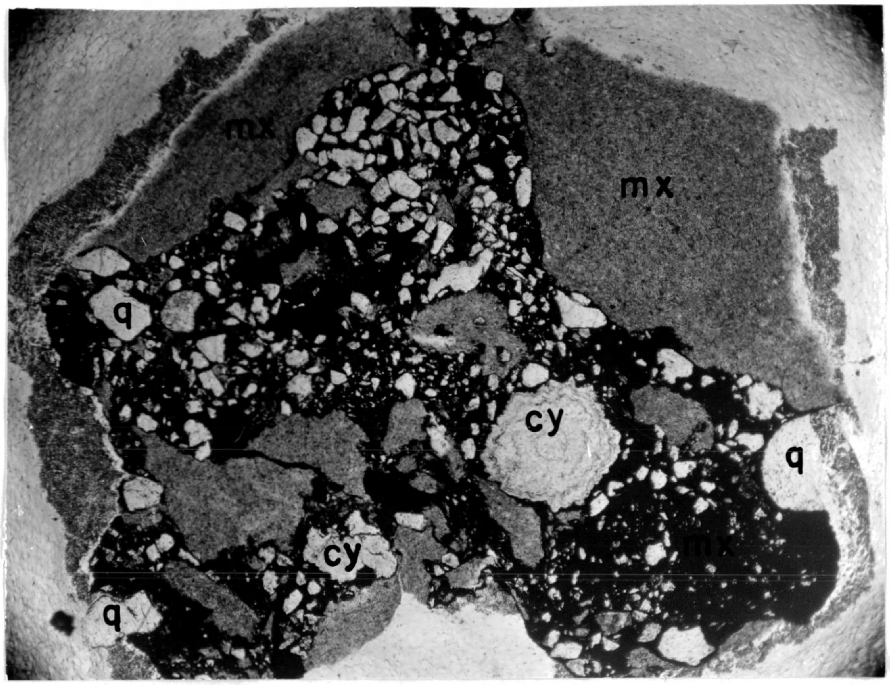
From a study of the sedimentary features of the Uinta Mountain Group, Curtis (1962, p. 15) considers that these rocks do not extend more than a few miles to the north or south of the present Uinta Mountain structural axis, nor very far to the east of the exposures at Juniper Mountain. According to Ritzma (1959, p. 18), geophysical data indicate that these rocks continue at least 15 miles east of Juniper Mountain. Sediments of the Uinta Mountain Group are not present in the Park

Range to the east, nor in the exposed Precambrian of the White River and Uncompahgre uplifts to the south. Crittenden (1955, p. 22) suggests that these sedimentary rocks extend only a few miles north of the Wyoming State line.

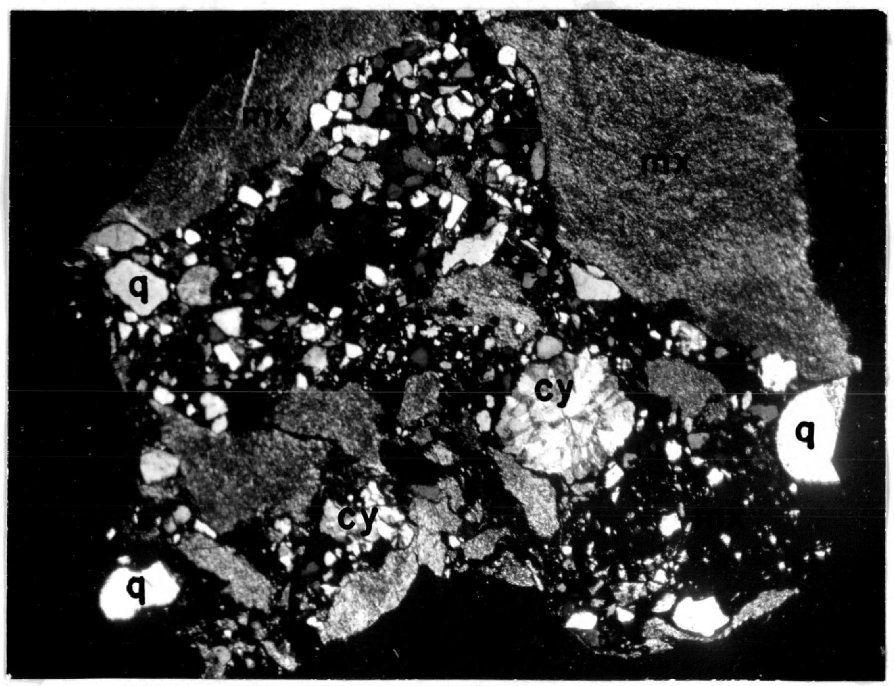
Petrography of the buried basement rocks

The only well in the Uinta Mountain sedimentary terrane which encountered red-colored rocks typical of the Uinta Mountain Group is the Amerada Petroleum Co. #1 Unit, Moffat County (CL-95). The samples were identified as shale with some sandy to silty limestone. Between 60 and 75 percent of the shale is composed of sericitic clay and from 20 to 30 percent is made up of angular to subrounded grains of quartz (fig. 26, A and B). One sample of arkosic shale contains only 5 percent quartz but microcline grains comprise 18 percent. Fifteen percent of this rock is composed of minute flakes of chlorite which occur in the matrix with sericite. The limestone samples contain from 50 to 88 percent of calcite. Some of this calcite occurs in the form of oolites or recrystallized fragments, which may be of organic origin. Between 15 and 40 percent of quartz is also present. Sericite makes up only as much as 10 percent and hematite, which gives most of the samples the distinctive red color, ranges in amount from 0 to 5 percent. This well is located about six miles to the southeast of the exposed rocks of the Uinta Mountain Group at Juniper Mountain.

The Texaco, Inc. #1 Colvert, Routt County (CL-147), encountered



A



B

Figure 26: Photomicrograph of a fragment of sandy shale from well CL-95. q-quartz, cy-chalcedony, mx-matrix of sericite with some calcite and hematite.

A: Uncrossed nicols, X25

B: Crossed nicols, X25.

basement rocks which consist of a pale green sandy to silty shale and a light gray quartzite. Of the shale, 68 percent is composed of sericitic clay, 20 percent is of subangular to subrounded grains of quartz, and 5 percent is of subangular grains of microcline. Small, shredlike flakes of biotite and muscovite each make up two percent. Ninety-eight percent of the quartzite (fig. 27) is composed of subrounded to rounded quartz grains. Optically continuous overgrowths of quartz on these grains have cemented the rock into a compact quartzitic sandstone. All grains have been moderately to severely strained and grain borders are slightly sutured. Voids, probably indicating the loss of quartz grains during the preparation of the thin sections, make up the remaining two percent of the rock. Traces of microcline, biotite, muscovite, sphene, hematite, pyrite, and calcite are also present.

A variety of rocks are represented in the samples from the Texaco, Inc. #1 Peavy, Routt County (CL-211). Calcareous to shaly arkoses and sandstones are predominant. Subangular to subrounded grains of quartz, some of which occur in severely strained aggregates, make up from 35 to 80 percent, sericitic clay makes up from 25 to 45 percent, and calcite makes up 20 percent. Fragments of quartzite containing between 40 and 86 percent quartz in severely strained and sutured grains and from a trace to 10 percent of plagioclase also occur. Calcite cement is present surrounding the quartzite fragments. A third kind of rock observed in the samples is a severely altered biotite-quartz-plagioclase gneiss. The plagioclase, now completely altered to sericite and calcite, makes

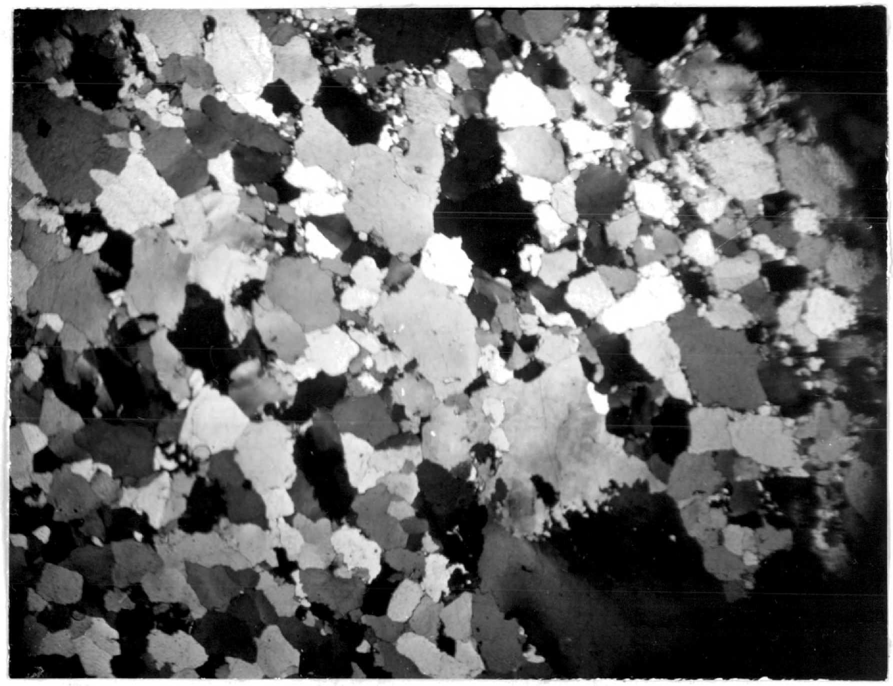


Figure 27: Photomicrograph of quartzite from well CL-147. Crossed nicols, X9.

of this rock may also be due to a change in the facies of the Uinta Mountain Group from the region of outcrop southward to the location of this well.

Otero-Bent Volcanic Terrane

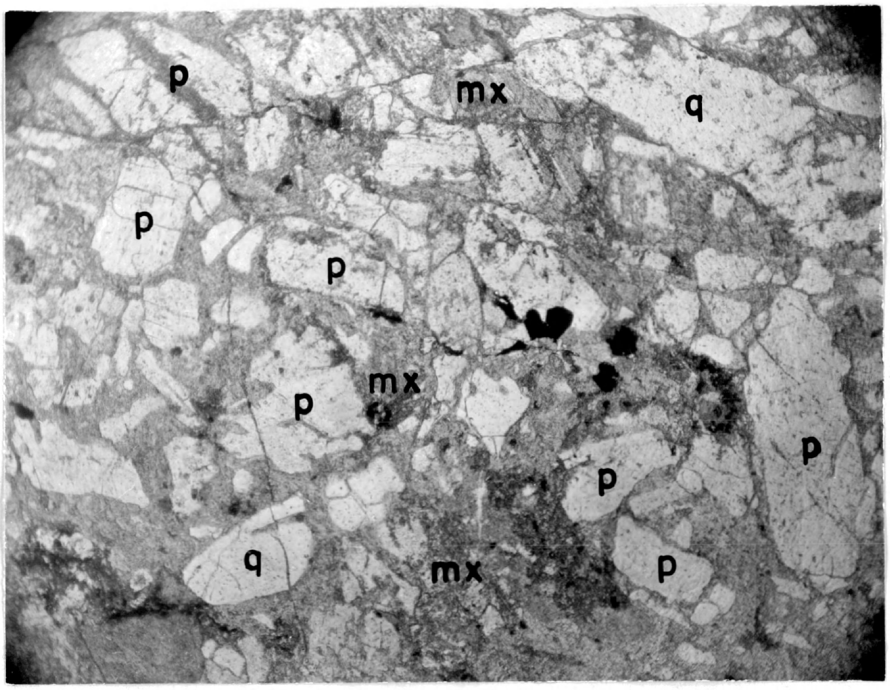
The Otero-Bent volcanic terrane is a small, elongate terrane which lies entirely within the Las Animas-Baca granitic terrane (pl. 1), although the northern limit does come close to the boundary between the Las Animas-Baca and Kit Carson-Kiowa terranes. No outcrops of basement rocks are present in this terrane. Therefore, the definition of the terrane is based solely upon four wells which encountered rocks identified as tuffaceous volcanics and shallow-seated intrusives (tables 1 and 17). One well occurs in each of the four southeastern Colorado counties of Baca, Bent, Las Animas, and Otero. The basement rocks from these wells have not been metamorphosed, but they are considered to be of Precambrian age because they lie beneath lower Paleozoic sedimentary rocks. None of the wells penetrated through the volcanics into any underlying gneissic or granitic basement rocks, such as those which occur in the surrounding Las Animas-Baca granitic terrane.

The samples from the Carter Oil Co. #1 Exploration, Otero County (CL-109), contain fragments of andesite and of rhyolitic to latitic crystal vitric tuff. Plagioclase, ranging in composition from oligoclase to andesine, occurs as lathlike subhedral grains and makes up 75 percent of the andesite. The alteration products of sericite, leucoxene, and chlorite make up 15 percent, and 10 percent is composed of subhedral grains of magnetite. Devitrified glass comprises 50 percent of the tuff, and sericite makes up from 15 to 30 percent. Small lathlike grains of plagioclase and microcrystalline grains of orthoclase are each present in amounts up to 10 percent. Chlorite occurs in anhedral masses throughout the rock.

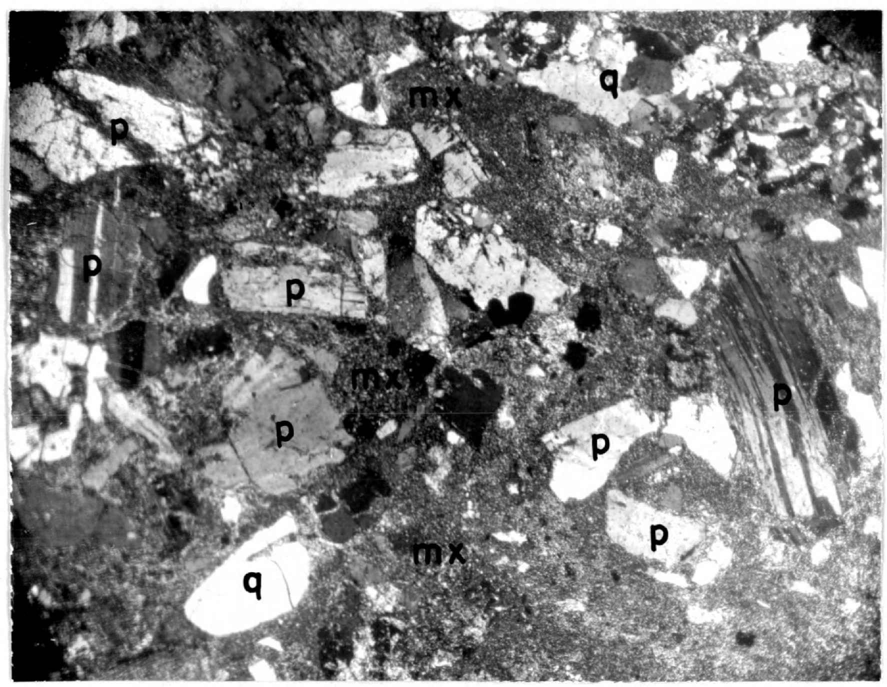
A dacitic crystal vitric tuff is present in samples from the Texaco, Inc. #1 Government-Davis, Las Animas County (CL-191) (fig. 28, A and B). Devitrified glass in these samples ranges from 10 to 43 percent. Plagioclase, the composition of oligoclase, occurs as fractured and bent fragments of euhedral and subhedral crystals and comprises 30 percent of the rock. Fractured and corroded grains of quartz make up from 5 to 10 percent, and euhedral to subhedral grains of biotite make up from 2 to 3 percent. Sericite makes up between 15 and 30 percent of the rock, and chlorite is about 5 percent. Both sericite and chlorite occur as alteration products in the groundmass of devitrified glass.

The samples obtained from the Marland #1 Mesa-Bergunthal, Baca County (CL-10), were of latite porphyry (fig. 29) which is either a shallow intrusive rock or a non-tuffaceous extrusive flow. Plagioclase occurs as zoned euhedral phenocrysts of andesine to labradorite, which exhibit albite, pericline, and Carlsbad twins. Hornblende phenocrysts are corroded, but the phenocrysts of biotite are euhedral to subhedral in form. From 95 to 100 percent of the phenocrysts are plagioclase, and the remaining 5 percent is divided about equally between biotite and up about 55 percent of the rock. Xenoblastic grains of quartz comprise 25 percent and biotite and leucoxene each make up 10 percent. Finally, a few fragments of biotite-plagioclase-hornblende schist were also found in the samples from this well. Ten percent of this schist is composed of biotite. Plagioclase, identified as andesine, makes up 15 percent and hornblende, in idioblastic to xenoblastic grains, makes up 65 percent. Leucoxene and magnetite each comprise five percent. No quartz was observed in this rock. This sample may represent a conglomerate within the Uinta Mountain Group which contains pebbles of the older metasedimentary rocks from the Weld-Delta metasedimentary terrane. The boundary of the Uinta Mountain sedimentary terrane is believed to pass near this well.

The Buford Oil Co. #1 Government, Rio Blanco County (CL-133), supplied samples of a sandy crystalline limestone or calcareous arkose. Calcite comprises from 40 to 80 percent of the rock and quartz, in subangular to subrounded grains, makes up from 15 to 60 percent. The quartz grains occur either as individual grains within a matrix of calcite, or an an aggregate of grains with interstitial calcite cement. Between 5 and 10 percent of the detrital grains is composed of subangular to subrounded grains of microcline. Because the samples from this well are characterized by the abundance of calcite and are thus unlike other rocks of this terrane, it is quite possible that the samples may not represent the Precambrian sediments of the Uinta Mountain Group upon which the terrane is based. However, the more calcareous nature



A



B

Figure 28: Photomicrograph of dacitic crystal vitric tuff from well CL-191, showing fragments of quartz (q) and plagioclase (p) in a matrix of devitrified glass (mx)

A: Uncrossed nicols, X25

B: Crossed nicols, X25.

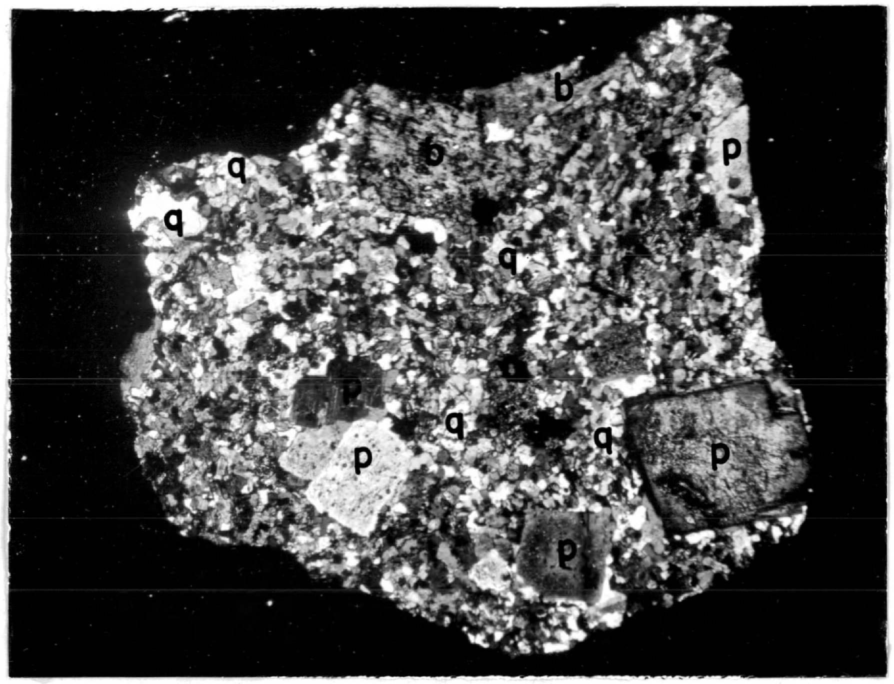


Figure 29: Photomicrograph of latite porphyry from well CL-10, showing zoned euhedral phenocrysts of plagioclase. b-biotite, q-quartz, p-plagioclase. Crossed nicols, X25.

hornblende. In the groundmass, microcline makes up between 32 and 50 percent, subhedral grains of plagioclase (oligoclase) range from 20 to 30 percent, and quartz is about 10 percent. Hornblende comprises between 5 and 15 percent, and biotite makes up 10 percent.

The rock in the samples from the Texaco, Inc. #1 M. E. Jones, Bent County (CL-179), is an altered olivine basalt. Twenty-five percent of the samples is subhedral to anhedral phenocrysts of augite, which have been slightly to severely altered to tremolite-actinolite. Of the groundmass, from 40 to 45 percent is lathlike euhedral to subhedral grains of plagioclase, the composition of andesine. Serpentine, as an alteration product of olivine, makes up from 15 to 35 percent. Anhedral grains of tremolite-actinolite comprise between 15 and 23 percent. Chlorite also occurs in amounts ranging from 5 to 10 percent.

Petrology of the Basement Terranes

The modal compositions of all samples studied in thin sections, which are given in Appendices II and III, Volume 2, have been plotted on triangular mineralogical composition diagrams (figs. 30, 31, 32, 33, and 34) for each terrane. These diagrams illustrate the comparative compositions of the rocks of the terranes in terms of the relative volume percentages of: (1) Quartz, (2) total Feldspar (plagioclase, microcline, and orthoclase, and also all sericite), and (3) All Other Minerals (chiefly biotite and hornblende, but also including muscovite, chlorite, diopside, augite, tremolite-actinolite, epidote, apatite,

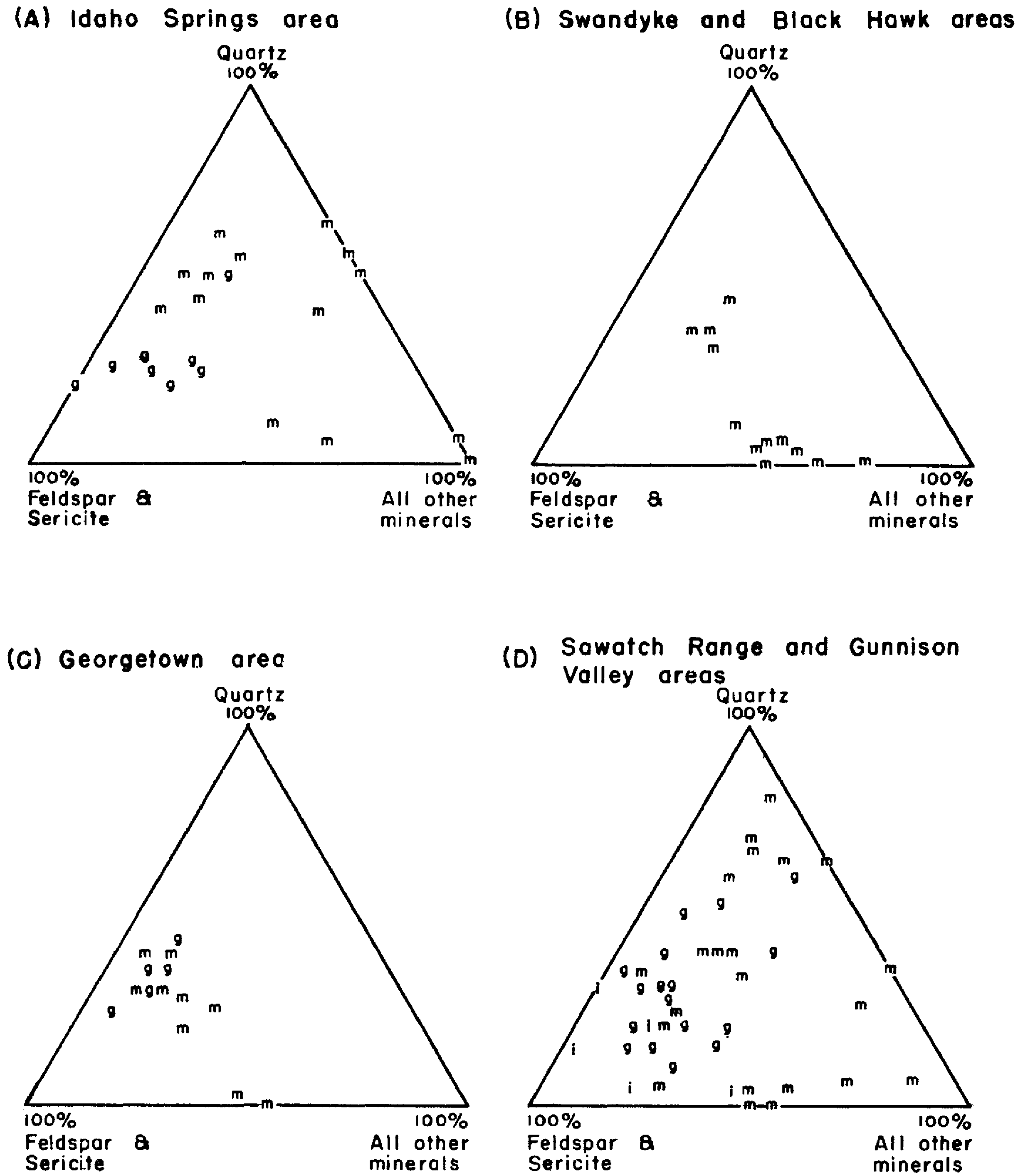


Figure 30: Mineralogical composition diagrams of samples collected from the exposed basement of the Weld – Delta metasedimentary terrane. I = granitic igneous rock, g = granitic gneiss, m = metasedimentary rock.

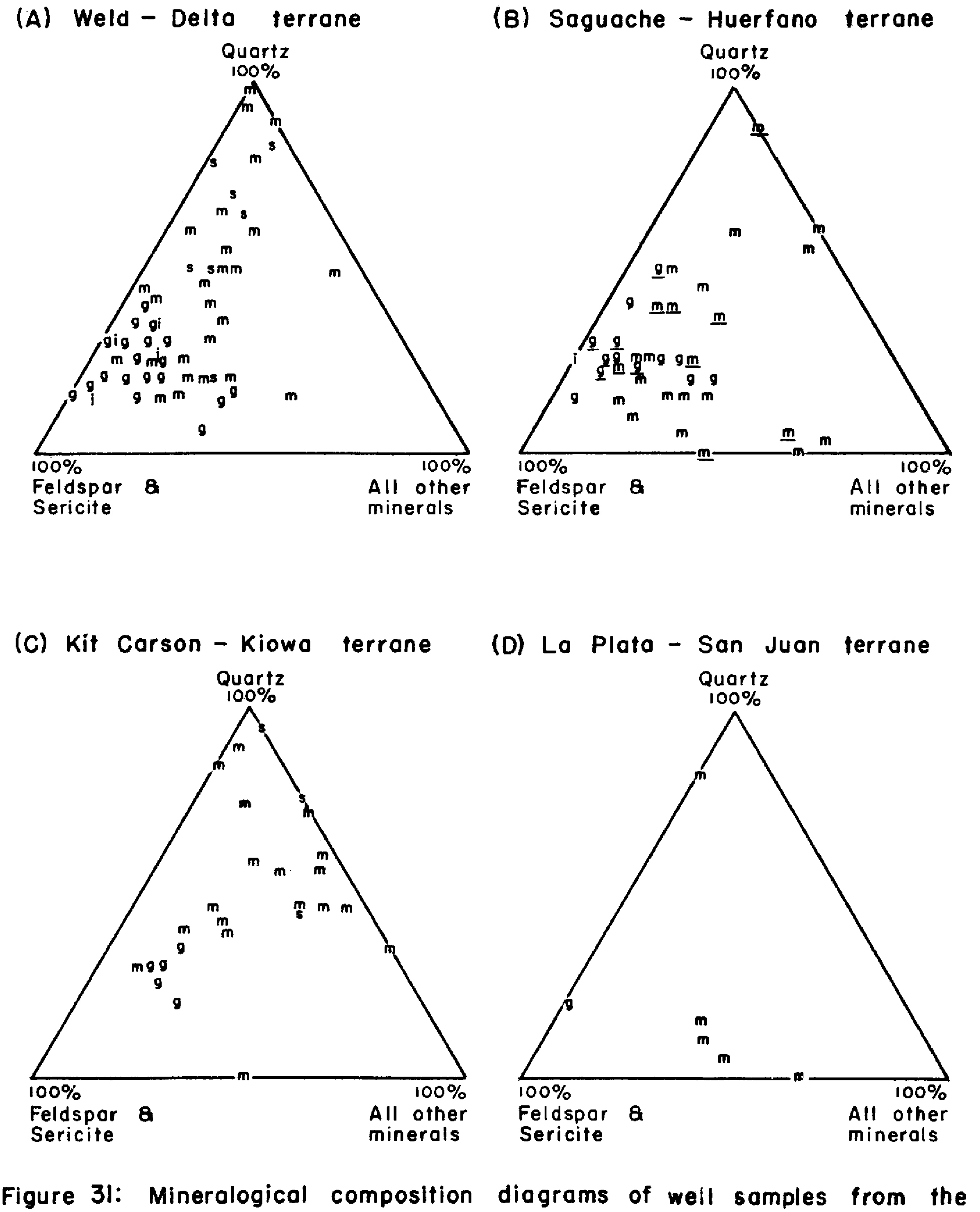


Figure 31: Mineralogical composition diagrams of well samples from the buried basement of the four metasedimentary terranes. i = granitic igneous rock, g = granitic gneiss, m = metasedimentary rock, s = sedimentary rock. Samples of exposed basement from the Saguache - Huerfano terrane are underlined.

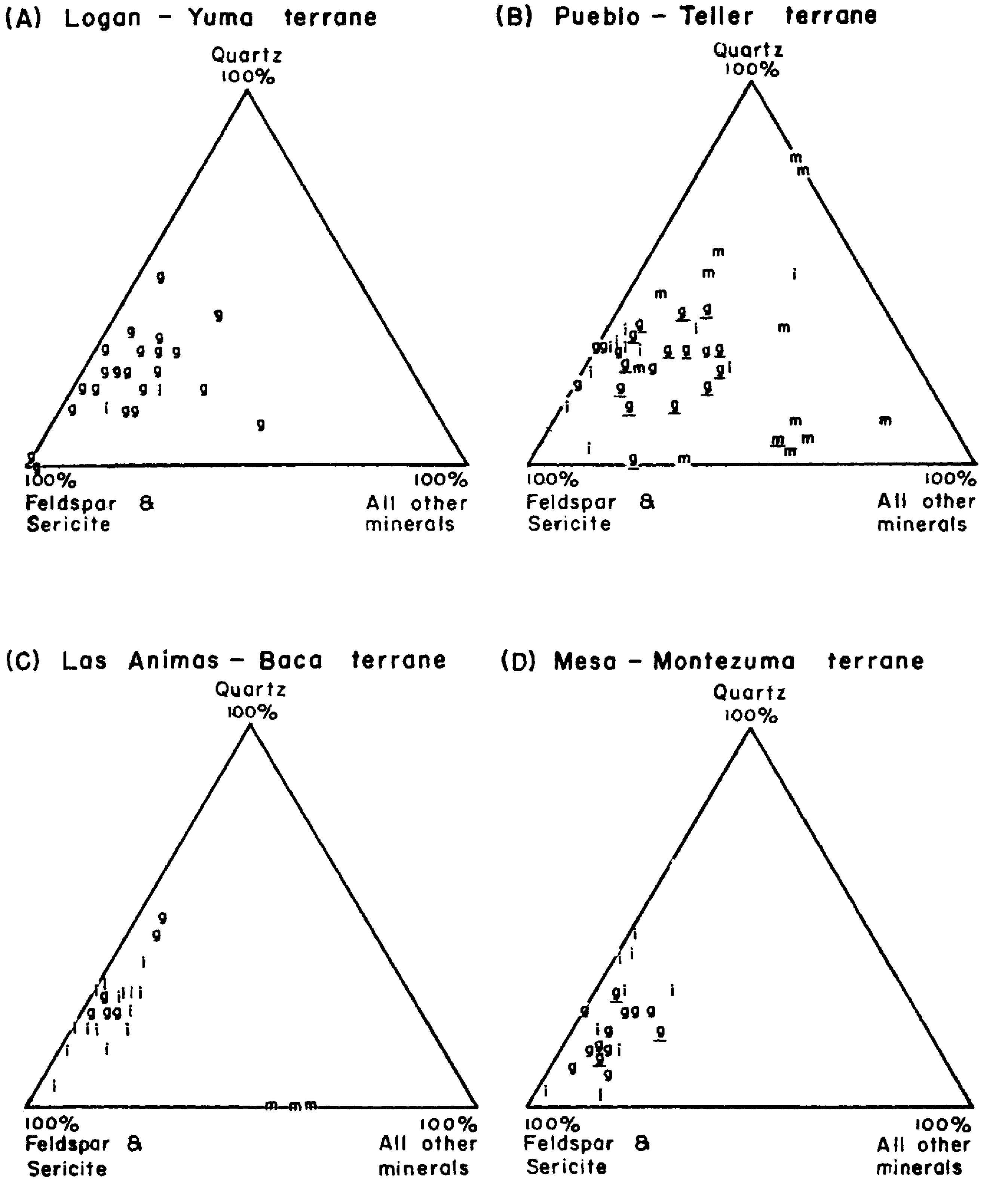


Figure 32: Mineralogical composition diagrams of well samples from the buried basement of the four granitic terranes. i = granitic igneous rock, g = granitic gneiss, m = metasedimentary rock. Samples of exposed basement from the Pueblo - Teller and Mesa - Montezuma terranes are underlined.

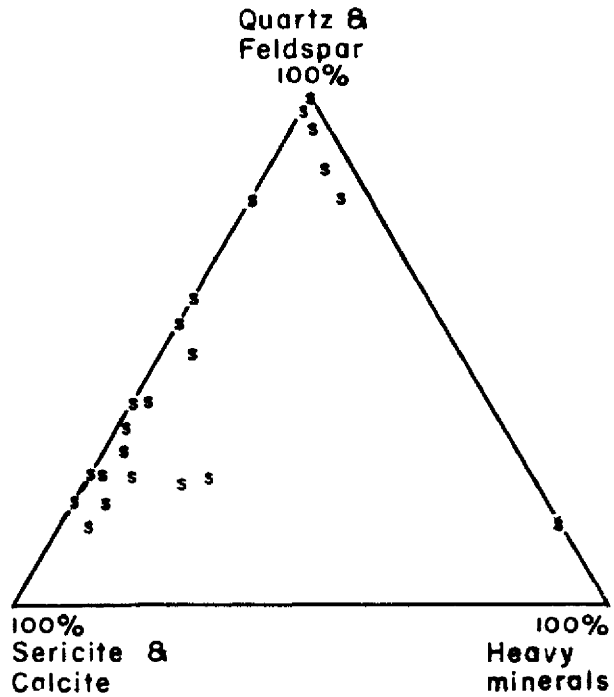


Figure 33: Mineralogical composition diagram of well samples from the buried basement of the Uinta Mountain sedimentary terrane. s = sedimentary rock.

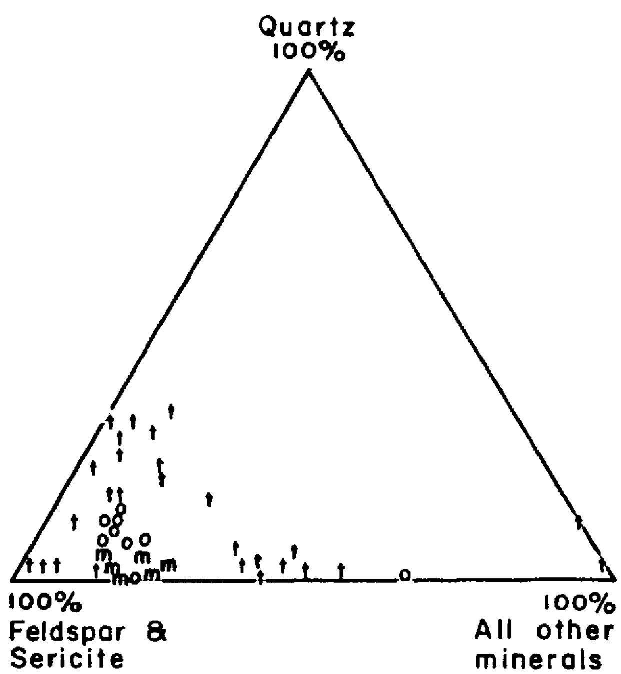


Figure 34: Mineralogical composition diagram of well samples of Precambrian volcanic and intrusive rocks (o = Otero - Bent volcanic terrane, m = Mesa - Montezuma granitic terrane) and Tertiary intrusive rocks (t).

zircon, sphene, leucoxene, tourmaline, sillimanite, garnet, rutile, fluorite, magnetite, hematite, pyrite, calcite, and serpentine). On the diagram for the Uinta Mountain sedimentary terrane (fig. 33), the three end members of the diagram are: (1) detrital Quartz and Feldspar grains, (2) Sericite and Calcite matrix or cement, and (3) Heavy Mineral grains.

On the diagrams for the metasedimentary terranes (figs. 30 A, B, C, and D; and 31 A, B, C, and D), the distribution pattern of the samples of metasedimentary rocks (m) suggests the composition of the original sediments. The biotite-quartz-plagioclase gneisses occur generally between the Quartz and Feldspar end points and have less than 50 percent of the ferromagnesian (plus accessory) minerals, indicating quartzofeldspathic to argillaceous parent sediments. Plagioclase-hornblende schists and amphibolites, which are low in quartz, lie near the Feldspar-Other Minerals line. These rocks have been formed either from lime-bearing argillaceous sediments or from basic volcanic rocks. Quartzites and quartzitic gneisses lie near the Quartz end member and are the metamorphic products of quartz-rich sediments.

Granitic rocks, including both igneous (i) and gneissic (g) varieties, fall within a rather restricted area not far from the Quartz-Feldspar line and near the Feldspar end (figs. 30 A, C, and D; 31 A, B, C, and D; and 32 A, B, C, and D). This reflects the granitic composition of 50 to 90 percent feldspar, 10 to 30 percent quartz, and the remainder composed of ferromagnesian and accessory minerals. However, granitic gneisses produced by the alkali-silicate metasomatism of metasedimentary rocks have a greater variety in their composition and may occur throughout the diagram, depending upon the degree of granitization.

Precambrian sedimentary rocks (fig. 33) are composed primarily of detrital quartz and feldspar in a matrix of sericite and calcite. Heavy minerals are a minor constituent except for one sample, which was of a plagioclase-hornblende schist fragment and which properly should not be included on the diagram. The composition of the samples ranges from 100 percent detrital grains in the quartzites to about 20 percent detrital grains in the sandy shales. The samples from well CL-133, of which the reported Precambrian age may be questioned, occur distributed among the other samples and are not characterized by a distinctive compositional grouping on the diagram. The crystalline calcite matrix of the samples from this well is the primary feature which distinguishes them from the other samples in the terrane, and may be the result of a facies change from quartzose and argillaceous sediments in the Uinta Mountains to more calcareous sediments farther south, where this well is located. Stratigraphic relationships of the shales and sandstones in the Uinta Mountain Group indicate that the source area of the sediments lay to the northeast of the depositional basin (Hansen, 1955, p. 27).

Samples of volcanic and shallow intrusive rocks are illustrated on the compositional diagram of figure 34. The Precambrian volcanic rocks of the Otero-Bent volcanic terrane (o), except for the sample of olivine basalt, show a fairly restricted composition relative to total feldspar. The rocks of this terrane are lower in quartz content than the granitic rocks of the other terranes. The Precambrian shallow intrusive from the Mesa-Montezuma granitic terrane (m) is also of the same general composition as the rocks of the Otero-Bent volcanic terrane.

For comparison, the Tertiary intrusive rocks encountered in the well samples (t) have also been plotted on this diagram. These rocks show a greater variety of composition ranging from greater in percentage of quartz, through greater total feldspar percentage, to greater in percentage of all other minerals. Tertiary hornsfelsic rocks fall near the mid-point of the Feldspar-Other Minerals line and near the Other Minerals end point of the Quartz-Other Minerals line.

TABLE 2: EXPOSED BASEMENT ROCKS OF THE WELD-DELTA METASEDIMENTARY TERRANE

Idaho Springs, Central City, and Georgetown areas

SAMPLE NUMBER	BASEMENT ROCK LITHOLOGY	PROBABLE ORIGINAL ROCK
PRC-27-1	Biotite-plagioclase-microcline-quartz gneiss	Quartzo feldspathic to arkosic sediments
2	Biotite-quartz-hornblende-plagioclase gneiss to amphibolite	Basic volcanic flows or sills
3	Hornblende-biotite-plagioclase-quartz gneiss	Calcareous to argillaceous quartzo-feldspathic sediments
4	Muscovite-sillimanite-biotite-quartz schist	Alumina-rich argillaceous sediments
5	Tremolite-quartz-epidote-plagioclase-hornblende gneiss to amphibolite	Basic volcanic flows or sills
6	Biotite-plagioclase-quartz gneiss	Argillaceous quartzo-feldspathic sediments
7	Biotite-plagioclase-microcline-quartz gneiss	Argillaceous quartzo-feldspathic sediments, slightly metasomatized
8	Muscovite-sillimanite-biotite-quartz gneiss	Alumina-rich argillaceous sediments
9	Biotite-plagioclase-quartz gneiss	Argillaceous quartzo-feldspathic sediments
10	Diopside-garnet-quartz skarn	Argillaceous calcareous sediments
11	Quartz-hornblende-diopside-epidote skarn	Argillaceous calcareous sediments
12	Hornblende-diopside-epidote skarn	Argillaceous calcareous sediments
13	Microcline-biotite-quartz-plagioclase gneiss	Granodiorite

SAMPLE NUMBER	BASEMENT ROCK LITHOLOGY	PROBABLE ORIGINAL ROCK
PRC-27-14	Biotite-quartz-plagioclase gneiss	Granodiorite
15	Biotite-quartz-plagioclase-microcline gneiss	Argillaceous quartzo-feldspathic sediments, metasomatized
16	Biotite-plagioclase-quartz gneiss	Alumina-rich argillaceous sediments
17	Plagioclase-sillimanite-biotite-quartz schist	Alumina-rich argillaceous sediments
18	Muscovite-sillimanite-biotite-plagioclase-quartz migmatite schist	Alumina-rich argillaceous sediments, metasomatized
19	Biotite-microcline-quartz-plagioclase migmatite gneiss	Argillaceous quartzo-feldspathic sediments, metasomatized
20	Quartz-plagioclase-microcline gneiss	Quartz monzonite
21	Biotite-plagioclase-quartz-microcline migmatite gneiss	Argillaceous quartzo-feldspathic sediments, metasomatized
22	Plagioclase-biotite-quartz-microcline migmatite gneiss	Argillaceous to quartzo-feldspathic sediments, metasomatized
76	Hornblende-biotite-quartz-plagioclase gneiss	Calcareous and argillaceous quartzo-feldspathic sediments
77	Amphibolite	Calcareous argillaceous sediments or basic volcanic flows, metasomatized
78	Hornblende-biotite-quartz-plagioclase gneiss	Calcareous and argillaceous quartzo-feldspathic sediments
79	Amphibolite	Basic volcanic flows

SAMPLE NUMBER	BASEMENT ROCK LITHOLOGY	PROBABLE ORIGINAL ROCK
PRC-27-80	Biotite-quartz-plagioclase gneiss	Argillaceous quartzo-feldspathic sediments
81	Altered biotite-quartz-plagioclase schistose gneiss	Argillaceous quartzo-feldspathic sediments
82	Altered biotite-quartz-plagioclase gneiss	Argillaceous quartzo-feldspathic sediments
83	Biotite-hornblende-quartz-plagioclase schistose gneiss	Calcareous quartzo-feldspathic sediments
84	Biotite-hornblende-quartz-plagioclase schistose gneiss	Calcareous quartzo-feldspathic sediments
85	Microcline-biotite-quartz-plagioclase gneiss	Argillaceous quartzo-feldspathic sediments
86	Muscovite-biotite-plagioclase-microcline-quartz gneiss	Quartzo-feldspathic sediments, metasomatized
87	Microcline-biotite-quartz-plagioclase gneiss	Quartzo-feldspathic sediments, metasomatized
88	Biotite-quartz-microcline-plagioclase gneiss	Quartzo-feldspathic sediments, metasomatized
89	Biotite-plagioclase-microcline-quartz gneiss	Argillaceous quartzo-feldspathic sediments, metasomatized
90	Biotite-microcline-quartz-plagioclase gneiss	Argillaceous quartzo-feldspathic sediments, metasomatized

TABLE 3: EXPOSED BASEMENT ROCKS OF THE WELD-DELTA METASEDIMENTARY TERRANE

Swandyke, Floyd Hill, and Black Hawk areas

SAMPLE NUMBER	BASEMENT ROCK LITHOLOGY	PROBABLE ORIGINAL ROCK
PRC-27-23	Quartz-diopside-hornblende-plagioclase gneiss to amphibolite	Basic volcanic flows or sills
24	Biotite-hornblende-quartz-plagioclase gneiss	Calcareous argillaceous sediments
25	Biotite-quartz-plagioclase gneiss	Argillaceous to quartzo-feldspathic sediments
26	Amphibolite	Basic volcanic flows or sills
27	Amphibolite	Basic volcanic flows or sills
28	Amphibolite	Basic volcanic flows or sills
29	Garnet-bearing biotite-quartz-plagioclase gneiss	Argillaceous to quartzo-feldspathic sediments
30	Garnet-bearing sillimanite-biotite-plagioclase-quartz gneiss	Alumina-rich argillaceous to quartzo-feldspathic sediments, metasomatized
31	Diopside-plagioclase-hornblende gneiss	Basic volcanic flows or sills
32	Biotite-quartz-hornblende-plagioclase gneiss to amphibolite	Basic volcanic flows or sills
33	Diopside-hornblende-plagioclase gneiss to amphibolite	Basic volcanic flows or sills
34	Biotite-plagioclase-quartz gneiss	Argillaceous to quartzo-feldspathic sediments
35	Amphibolite	Basic volcanic flows or sills

SAMPLE NUMBER	BASEMENT ROCK LITHOLOGY	PROBABLE ORIGINAL ROCK
PRC-27-36	Diopside-plagioclase-hornblende gneiss to amphibolite	Basic volcanic flows or sills

TABLE 4: EXPOSED BASEMENT ROCKS OF THE WELD-DELTA METASEDIMENTARY TERRANE

Sawatch Range and Gunnison Valley areas

SAMPLE NUMBER	BASEMENT ROCK LITHOLOGY	PROBABLE ORIGINAL ROCK
PRC-27-46	Garnet-bearing biotite-quartz-plagioclase gneiss	Argillaceous quartzo-feldspathic sediments
47	Sillimanite-biotite-plagioclase-microcline quartz gneiss	Alumina-rich argillaceous sediments, metasomatized
48	Quartz monzonite	-
129	Biotite-quartz-plagioclase-microcline gneiss	Quartz monzonite
130	Microcline-biotite-quartz-plagioclase gneiss	Quartz monzonite
131	Microcline-plagioclase-quartz gneiss	Quartzo-feldspathic sediments, metasomatized
132	Muscovite-biotite-plagioclase-quartz-microcline gneiss	Argillaceous quartzo-feldspathic sediments metasomatized
133	Biotite-microcline-quartz-plagioclase gneiss	Quartz monzonite
37	Biotite-microcline-quartz-plagioclase gneiss	Argillaceous quartzo-feldspathic sediments metasomatized
38	Quartz-biotite-plagioclase schist	Argillaceous to quartzo-feldspathic sediments
39	Plagioclase-muscovite-quartz gneiss	Aluminous argillaceous quartzo-feldspathic sediments, metasomatized
40	Muscovite-biotite-plagioclase-quartz gneiss	Argillaceous quartzo-feldspathic sediments
41	Amphibolite	Gabbro

SAMPLE NUMBER	BASEMENT ROCK LITHOLOGY	PROBABLE ORIGINAL ROCK
PRC-27-114	Biotite-orthoclase-quartz-plagioclase gneiss	Quartzo-feldspathic sediments
122	Quartz-biotite-plagioclase gneiss	Quartz diorite
115	Plagioclase-hornblende-quartz-calcite gneiss	Argillaceous and quartzose calcareous sediments
116	Quartz-plagioclase-hornblende schist	Calcareous and quartzose argillaceous sediments
117	Hornblende-plagioclase-quartz gneiss	Calcareous and argillaceous quartzose sediments
118	Biotite-microcline-plagioclase-quartz gneiss	Quartz monzonite
121	Muscovite-biotite-microcline-plagioclase-quartz gneiss	Quartz monzonite
119	Muscovite-biotite-plagioclase-quartz-microcline gneiss	Quartzo-feldspathic sediments, metasomatized
120	Plagioclase-biotite-muscovite-quartz schist	Argillaceous to quartzo-feldspathic sediments
49	Muscovite-biotite-quartz gneiss to quartzite	Argillaceous quartzose sediments
50	Biotite-muscovite-microcline-plagioclase-quartz gneiss	Aluminous argillaceous quartzo-feldspathic sediments
51	Diorite and muscovite-biotite-plagioclase-quartz schist	Argillaceous to quartzo-feldspathic sediments, intruded and metasomatized by dioritic magma
97	Hornblende-biotite-quartz-microcline-plagioclase gneiss	Argillaceous quartzo-feldspathic sediments

SAMPLE NUMBER	BASEMENT ROCK LITHOLOGY	PROBABLE ORIGINAL ROCK
PRC-27-98	Hornblende-quartz-biotite-microcline-plagioclase gneiss	Calcareous argillaceous quartzo-feldspathic sediments, metasomatized
99	Amphibolite	Basic volcanic flows or sills
100	Epidote-bearing microcline-biotite-plagioclase quartz gneiss	Argillaceous quartzo-feldspathic sediments
101	Muscovite-biotite-plagioclase-microcline-quartz gneiss	Argillaceous quartzo feldspathic sediments
102	Biotite-quartz-plagioclase-microcline gneiss	Granite to quartz monzonite, metasomatized
103	Biotite-quartz-plagioclase-microcline gneiss	Quartz monzonite, metasomatized
104	Leucogabbro	-
105	Calcite-quartz-hornblende gneiss	Quartzose to argillaceous calcareous sediments
52	Biotite-sericite-quartz-gneiss to quartzite	Argillaceous quartzose sediments
53	Quartz-plagioclase actinolite gneiss	Basic volcanic flows or sills
54	Quartz latite to rhyolite porphyry or tuff	-
55	Amphibolite	Gabbro
59	Muscovite-plagioclase-biotite-quartz gneiss	Argillaceous quartzose sediments
60	Plagioclase-quartz-microcline gneiss	Granite to quartz monzonite, metasomatized
106	Muscovite-plagioclase-biotite-microcline-quartz gneiss	Argillaceous quartzose sediments
107	Amphibolite	Basic volcanic flows

SAMPLE NUMBER	BASEMENT ROCK LITHOLOGY	PROBABLE ORIGINAL ROCK
PRC-27-61	Biotite-plagioclase-quartz-microcline gneiss	Quartz monzonite
62	Granite aplite	-

TABLE 5: BURIED BASEMENT ROCKS OF THE WELD-DELTA METASEDIMENTARY TERRANE

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY ()= no. of thin sections	PROBABLE ORIGINAL ROCK
Weld CL-158	Shell Oil Co. #1Colorado National Bank	(4) Quartzite and sericite-chlorite-quartz gneiss	Quartzose sandstones
Larimer CL-68	California Oil Co. #1 Meyers	(8) Biotite-plagioclase-quartz gneiss and muscovite-bearing microcline granite to quartz monzonite	Argillaceous to quartzo-feldspathic sediments and igneous intrusive
Adams CL-175	U.S. Army Corps of Engineers #1 Rocky Mountain Arsenal	(2) Microcline-biotite-quartz-plagioclase gneiss and biotite-quartz-hornblende-plagioclase gneiss	Quartzo-feldspathic and calcareous argillaceous sediments
Jackson CL-180	Amerada Petroleum Co. #1 Government-Thompson	(2) Biotite-quartz-plagioclase schist	Argillaceous sediments
Routt CL-146	O.D. Robinson #1 Robert Kagie	(3) Microcline-sillimanite-plagioclase-biotite-quartz schist	Alumina-rich argillaceous and quartzo-feldspathic sediments
Routt CL-207	Pacific Natural Gas Expl. and Southern Union Prod. #26-35 Pagoda Unit	(2) Magnetite-bearing quartz-plagioclase-hornblende gneiss and quartz-plagioclase gneiss	Calcareous and quartzose sediments and granodiorite intrusions
Garfield CL-38	Forest Oil Corp. #1 Government	(3) Biotite-plagioclase-quartz gneiss	Argillaceous quartzo-feldspathic sediments
Delta CL-22	Cushman and Pilcher #1 Hawkins (Government)	(1) Muscovite-biotite-plagioclase-quartz gneiss	Quartzo-feldspathic sediments
Montrose CL-106	R.E. Wear #1 Fee	(3) Microcline-biotite-quartz-plagioclase gneiss	Argillaceous quartzo-feldspathic sediments
Montrose CL-208	Texaco, Inc. #1 J.L. Stivers	(2) Epidote-muscovite-biotite-quartz feldspar gneiss	Argillaceous quartzo-feldspathic sediments

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY ()= no. of thin sections	PROBABLE ORIGINAL ROCK
Weld CL-156	British-American Producing Co. #1 Wise	(2) Biotite-quartz-plagioclase gneiss	Quartzo-feldspathic sediments, metasomatized
Weld CL-160	Shell Oil Co. #1 Klingensmith	(4) Biotite-microcline-quartz-plagioclase gneiss and quartz-hornblende-plagioclase gneiss	Argillaceous and calcareous quartzo-feldspathic sediments, metasomatized
Jackson CL-54	Continental Oil Co. #A-6 Pollack	(1) Biotite-plagioclase-microcline-quartz gneiss	Argillaceous quartzo-feldspathic sediments, metasomatized
Grand CL-43	British-American Producing Co. #1-C Lazy-U-Ranch	(1) Muscovite-plagioclase-microcline-quartz gneiss	Quartzo-feldspathic sediments, metasomatized
Grand CL-44	DeBarard Cattle Co. #1 State	(2) Biotite-quartz-microcline-hornblende-plagioclase gneiss and biotite-quartz-plagioclase gneiss	Basic volcanic flows or sills, metasomatized by quartz diorite intrusion
Routt CL-198	Pan-American Petroleum Co. #1 Jones	(1) Muscovite-biotite-plagioclase-quartz-microcline gneiss	Quartzo-feldspathic sediments, metasomatized
Rio Blanco CL-202	Humble Oil and Refining Co. #1 Government-Crosho Lake	(1) Biotite-quartz-plagioclase-microcline gneiss	Quartzo-feldspathic sediments, metasomatized
Jackson CL-52	Amerada Petroleum Co. #1 Morris	(1) Quartz-plagioclase-microcline gneiss	Quartz monzonite
Jackson CL-55	William J. Hewitt #1 Government (Hewitt)	(2) Hornblende-biotite-quartz-plagioclase-microcline gneiss	Quartz monzonite

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY ()= no. of thin sections	PROBABLE ORIGINAL ROCK
Routt CL-148	Texaco, Inc. #1 King Mountain Unit-Government (Sampson-Government)	(1) Quartz-plagioclase-microcline gneiss	Granite to quartz monzonite
Garfield CL-42	Kerr-McGee and Phillips Petroleum Co. #1 Unit	(2) Biotite-quartz-microcline-plagioclase gneiss	Quartz monzonite to granodiorite
Mesa CL-90	Amerada Petroleum Co. #1 Unit	(3) Muscovite-microcline-quartz-plagioclase gneiss	Quartz monzonite to granodiorite
Jackson CL-56	Hiawatha Oil and Gas Co. #1-25 Government-Fuller	(1) Granodiorite	-
Weld CL-157	California Oil Co. #1 U.P. Ferch	(5) Argillaceous shales and sandstones - some are hornfelsic	-
Routt CL-141	Broderick and Gordon #1 Government	(2) Biotite-bearing andesite to latite (Tertiary intrusive)	-
Routt CL-143	Gardner Bros. #1 Chura	(1) Quartz latite porphyry to rhyolite porphyry (Tertiary intrusive)	-
Eagle CL-31	Champlin Refining Co. #1 Black	(3) Quartz latite porphyry to rhyolite porphyry (Tertiary intrusive)	-
Pitkin CL-203	Superior Oil Co. #1 Unit	(3) Quartz latite porphyry (Tertiary intrusive)	-

TABLE 6: BURIED BASEMENT ROCKS OF THE KIT CARSON-KIOWA METASEDIMENTARY TERRANE

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY ()= no. of thin sections	PROBABLE ORIGINAL ROCK
Washington CL-153	Indian Territory Illuminating Oil #1 Vorce	(3) Plagioclase-muscovite-biotite-quartz schist	Argillaceous sediments
Yuma CL-167	Indian Territory Illuminating Oil #1 Strangeways	(3) Biotite-muscovite-sericite-quartz gneiss to quartzite	Argillaceous to quartzose sediments
Kit Carson CL-64	Seaboard Oil Co. British-American Producing Co. #1 Morrow	(1) Muscovite-biotite-quartz-sericite schist	Argillaceous sediments
Kit Carson CL-61	Deep Rock Oil Co. #1 Edmondson	(3) Plagioclase-biotite-orthoclase-quartz schist	Rhyolitic lava flow or tuff
Kiowa CL-57	Gulf Oil Corp. #1 U.P. Risser	(4) Tourmaline-bearing chlorite-sericite-quartz schist	Argillaceous sediments
Kiowa CL-59	Superior Oil Co. #1 State	(1) Sericite-quartz gneiss to quartzite	Argillaceous to quartzose sediments
Prowers CL-119	Phillips Petroleum Co. #1 Stwalley	(1) Altered muscovite-microcline-quartz-plagioclase gneiss	Argillaceous quartzo-feldspathic sediments
Otero CL-110	Pure Oil Co. #1 Craighead	(1) Garnet-bearing tremolite-hornblende-plagioclase gneiss	Basaltic flow or basic volcanic rock
Yuma CL-174	Texaco, Inc. #1 Blach	(3) Hematitic quartzite to hematite-bearing siltstone	Possibly an iron-rich regolith or an iron-rich argillaceous sediment

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY ()= no. of thin sections	PROBABLE ORIGINAL ROCK
Kit Carson CL-210	Continental Oil Co. #1 Lowe	(1) Muscovite-biotite-plagioclase-quartz-microcline gneiss	Quartz monzonite
Yuma CL-206	California Oil Co. #1 Lloyd Mumm	(6) Microcline-biotite-quartz-plagioclase augen gneiss	Granodiorite, metasomatized

TABLE 7: EXPOSED BASEMENT ROCKS OF THE SAGUACHE-HUERFANO METASEDIMENTARY TERRANE

Phantom Canyon, Sawatch Range, Saguache Creek, and Salida areas

SAMPLE NUMBER	BASEMENT ROCK LITHOLOGY	PROBABLE ORIGINAL ROCK
PRC-27-66	Biotite-microcline-quartz-plagioclase gneiss	Argillaceous quartzo-feldspathic sediments, metasomatized.
67	Plagioclase-muscovite-microcline-quartz gneiss	Aluminous argillaceous to quartzo-feldspathic sediments
68	Biotite-microcline-plagioclase-quartz gneiss	Argillaceous quartzo-feldspathic to arkosic sediments
69	Biotite-plagioclase-microcline-quartz gneiss	Arkosic sediments
70	Muscovite-biotite-quartz-microcline-plagioclase gneiss	Arkosic sediments
71	Muscovite-biotite-quartz-microcline-plagioclase gneiss	Arkosic sediments
91	Quartzite to sillimanite-quartz gneiss	Alumina-rich quartzose sediments
63	Biotite-quartz-microcline-plagioclase gneiss	Argillaceous quartzo-feldspathic sediments, metasomatized
64	Biotite-quartz-plagioclase-microcline gneiss	Argillaceous quartzo-feldspathic sediments, metasomatized
65	Biotite-quartz-microcline gneiss	Granite
108	Biotite-muscovite-quartz-plagioclase gneiss	Aluminous argillaceous to quartzo-feldspathic sediments

SAMPLE NUMBER	BASEMENT ROCK LITHOLOGY	PROBABLE ORIGINAL ROCK
PRC-27-109	Biotite-quartz-plagioclase-microcline gneiss	Quartzo-feldspathic to arkosic sediments, metasomatized
110	Quartz-plagioclase-hornblende gneiss	Basic volcanic flows or sills
92	Amphibolite	Basic volcanic flows or sills
93	Plagioclase-biotite-microcline-quartz gneiss	Quartzo-feldspathic to argillaceous sediments, metasomatized
94	Plagioclase-hornblende gneiss	Gabbro

TABLE 8: BURIED BASEMENT ROCKS OF THE SAGUACHE-HUERFANO METASEDIMENTARY TERRANE

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY () = no. of thin sections	PROBABLE ORIGINAL ROCK
Las Animas CL-76	Skelly Oil Co. #1 Weiland	(2) Biotite-microcline-quartz-plagioclase gneiss	Argillaceous quartzo-feldspathic sediments, metasomatized
Las Animas CL-50	Skelly Oil Co. #1 Pressey	(3) Quartz-microcline-biotite-plagioclase gneiss to schist	Argillaceous quartzo-feldspathic sediments
Huerfano CL-49	Skelly Oil Co. #1 Niebuhr	(2) Plagioclase-biotite-microcline-quartz gneiss, biotite-quartz schist, and calcareous arkose (granite wash)	Argillaceous quartzo-feldspathic sediments
Huerfano CL-51	Skelly Oil Co. #1 Shafer	(2) Biotite-quartz-plagioclase-microcline gneiss and hornblende-biotite-quartz-plagioclase gneiss	Calcareous and argillaceous quartzo-feldspathic sediments, metasomatized
Huerfano CL-47	Kinney-Coastal and Texas Producing Co. #1 Pino (Escondido)	(1) Hornblende-quartz-microcline-plagioclase gneiss and biotite-plagioclase-hornblende schist	Calcareous and quartzo-feldspath-sediments, metasomatized
Pueblo CL-132	Pure Oil Co. #1 E. K. Warren	(3) Magnetite-bearing hornblende-quartz-plagioclase gneiss and microcline-quartz-plagioclase gneiss	Argillaceous and calcareous quartzo-feldspathic sediments metasomatized
Fremont CL-189	Delhi-Taylor Oil Corp. #1-16 State	(2) Sillimanite-muscovite-biotite-plagioclase-quartz gneiss to schist	Alumina-rich argillaceous sediments
Alamosa CL-1	Amerada Petroleum Co. #1-F State	(4) Hornblende-biotite-quartz-plagioclase gneiss and garnet-bearing biotite-quartz-plagioclase gneiss	Calcareous and argillaceous quartzo-feldspathic sediments
Saguache CL-199	Tennessee Gas Trans. #1 State "B"	(3) Muscovite-biotite-microcline-quartz-plagioclase gneiss and hornblende-biotite-plagioclase schist	Calcareous and argillaceous quartzo-feldspathic sediments

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY ()= no. of thin sections	PROBABLE ORIGINAL ROCK
Huerfano CL-48	Skelly Oil Co. #1 Busch	(1) Granite	-
Huerfano CL-205	Kingwood Oil Co. #1-A U. S. Alamo Dome	(1) Latite to quartz latite (Tertiary intrusive)	-

TABLE 9: BURIED BASEMENT ROCKS OF THE LA PLATA-SAN JUAN METASEDIMENTARY TERRANE

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY ()= no. of thin sections	PROBABLE ORIGINAL ROCK
Montrose CL-181	Shell Oil Corp. #2 Wray Mesa Unit	(1) Quartzite	Quartzose sediments
La Plata CL-83	Stanolind Oil and Gas Co. #6-B Ute Indian	(6) Quartz-biotite-hornblende-plagioclase gneiss, biotite-plagioclase-hornblende gneiss, amphibolite, and quartz-microcline gneiss	Basaltic flows and basic volcanic rocks intruded by granitic magma

TABLE 10: BURIED BASEMENT ROCKS OF THE LOGAN-YUMA GRANITIC TERRANE

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY ()= no. of thin sections	PROBABLE ORIGINAL ROCK
Weld CL-159	Shell Oil Co. #1-4728 Federal	(2) Muscovite-plagioclase-quartz-microcline gneiss	Granite to quartz monzonite
Logan CL-86	Patrick Doheny #1 Mittelstadt	(2) Hornblende-biotite-quartz-microcline-plagioclase gneiss	Quartz monzonite to granodiorite
Logan CL-88	Shell Oil Co. #16-A C. F. Green	(5) Biotite-quartz-microcline-plagioclase augen gneiss	Quartz monzonite to granodiorite, metasomatized
Logan CL-89	Shell Oil Co. #2-B State	(3) Microcline-biotite-quartz-plagioclase gneiss	Quartz monzonite to granodiorite, intruded into quartzo-feldspathic sediments
Morgan CL-108	Superior Oil Co. #45-32 Weiss	(1) Muscovite-microcline-quartz-plagioclase gneiss	Granodiorite
Sedgwick CL-212	Continental Oil Co. and others #1 Sprague Bros.	(2) Muscovite-biotite-microcline-quartz-plagioclase gneiss	Quartz monzonite
Washington CL-150	Amerada Petroleum Co. #1 Heyen	(1) Biotite-quartz-microcline-plagioclase gneiss	Quartz monzonite to granodiorite
Yuma CL-173	Shell Oil Co. #1 Olsen	(1) Biotite-quartz-microcline-plagioclase gneiss	Granite to quartz monzonite
Morgan CL-107	Anderson-Pritchard Oil Corp. #1 Blanchard	(1) Quartz monzonite	-

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY ()= no. of thin sections	PROBABLE ORIGINAL ROCK
Phillips CL-183	Texota Oil Co. #1 Hansen	(1) Granodiorite	-
Logan CL-84	British-American Producing Co. #4 Segelke	(1) Amphibolite and microcline-quartz-plagioclase gneiss	Calcareous and quartzo-feld-sediments, metasomatized
Logan CL-85	British-American Producing Co. #18 Yenter "B"	(2) Biotite-plagioclase-quartz-microcline gneiss	Quartzo-feldspathic sediments, metasomatized
Yuma CL-162	Canada-Southern Oil Co. #1 Doyle Neiman	(1) Biotite-plagioclase-quartz-microcline gneiss	Quartzo-feldspathic sediments, metasomatized
Yuma CL-171	Ohio Oil Co. #1 Brophy	(1) Biotite-microcline-quartz-plagioclase gneiss	Quartzo-feldspathic sediments, metasomatized
Yuma CL-170	Lion Oil Co. #1 Chrismer	(1) Biotite-microcline-quartz-plagioclase gneiss	Quartzo-feldspathic sediments, metasomatized
Yuma CL-164	Carter Oil Co. and Mountain States Drill-ing #1 Henik	(1) Hornblende-quartz-microcline-plagioclase gneiss	Calcareous quartzo-feldspathic sediments, metasomatized
Washington CL-155	Skiles Oil Co. #1 Brower	(1) Biotite-quartz-microcline-plagioclase gneiss	Quartzo-feldspathic sediments, metasomatized

TABLE II: EXPOSED BASEMENT ROCKS OF THE PUEBLO-TELLER GRANITIC TERRANE

Phantom Canyon, Cripple Creek, and Sawatch areas

SAMPLE NUMBER	BASEMENT ROCK LITHOLOGY	PROBABLE ORIGINAL ROCK
PRC-27-72	Biotite-quartz-plagioclase-microcline augen gneiss	Arkosic sediments, metasomatized
73	Biotite-microcline-plagioclase-quartz augen gneiss	Arkosic sediments, metasomatized
74	Biotite-plagioclase-microcline-quartz augen gneiss	Arkosic sediments, metasomatized
75	Biotite-plagioclase-quartz-microcline augen gneiss	Arkosic sediments, metasomatized
95	Plagioclase-biotite-microcline augen gneiss	Argillaceous to quartzo-feldspathic sediments, metasomatized
96	Muscovite-biotite-quartz-plagioclase gneiss	Argillaceous quartzo-feldspathic sediments, metasomatized
111	Biotite-quartz-plagioclase-microcline gneiss	Granodiorite, metasomatized
112	Biotite-quartz-plagioclase-microcline gneiss	Granodiorite, metasomatized
113	Muscovite-biotite-microcline-plagioclase quartz gneiss	Granodiorite, metasomatized
125	Biotite-quartz-microcline-plagioclase gneiss	Quartz monzonite, metasomatized
42	Plagioclase-quartz-microcline gneiss	Quartz monzonite, metasomatized
123	Biotite-quartz-plagioclase gneiss	Granodiorite, slightly metasomatized
124	Biotite-quartz-plagioclase gneiss	Granodiorite, slightly metasomatized

SAMPLE NUMBER	BASEMENT ROCK LITHOLOGY	PROBABLE ORIGINAL ROCK
PRC-27-126	Biotite-plagioclase-quartz-microcline gneiss	Granite to quartz monzonite
127	Quartz-biotite-hornblende-plagioclase gneiss	Basic volcanic flows, metasomatized
128	Plagioclase-quartz-microcline gneiss	Granite

TABLE 12: BURIED BASEMENT ROCKS OF THE PUEBLO-TELLER GRANITIC TERRANE

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY ()= no. of thin sections	PROBABLE ORIGINAL ROCK
Pueblo CL-123	Continental Oil Co. #1 Paige	(1) Strongly altered biotite-quartz-plagioclase gneiss	Granodiorite
Pueblo CL-125	Continental Oil Co. #1 Young	(3) Biotite-quartz-microcline-plagioclase gneiss	Quartz monzonite
Pueblo CL-129	Pan-American Petroleum Co. #1 Ingram	(3) Biotite-quartz-plagioclase-microcline gneiss	Quartz monzonite
Pueblo CL-196	Skelly Oil Co. #1 M. E. Lutin	(2) Plagioclase-quartz-microcline gneiss	Quartz monzonite
Pueblo CL-130	Phillips Petroleum Co. #1 Sample Nose-Government	(1) Microcline-quartz-plagioclase gneiss	Granodiorite
Otero CL-111	Vaughey and Vaughey #1 W. S. Sidney	(1) Plagioclase-quartz-microcline gneiss	Granite
Pueblo CL-131	Phillips Petroleum Co. #1-A Johnson	(3) Biotite-quartz-plagioclase-microcline gneiss	Quartzo-feldspathic sediments, metasomatized
Park CL-113	McDannald Oil Co. #1 State	(4) Plagioclase-hornblende gneiss, plagioclase-quartz-biotite schist, quartz-plagioclase gneiss, and muscovite-plagioclase-quartz gneiss	Calcareous and argillaceous sediments, and basic volcanic rocks

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY ()= no. of thin sections	PROBABLE ORIGINAL ROCK
Park CL-114	Shell Oil Corp. #1 Federal	(2) Chlorite-plagioclase-amphibole-sericite schist and biotite-microcline-quartz-plagioclase gneiss	Basic volcanic rocks, metasomatized
Park CL-116	Shell Oil Corp. #1-4343 State	(3) Muscovite-biotite-quartz gneiss and biotite-plagioclase-quartz gneiss	Argillaceous to quartzose sediments
Park CL-115	Shell Oil Corp. #1 A. T. McDannald	(2) Biotite-microcline-quartz-plagioclase augen gneiss	Arkosic sediments, metasomatized

TABLE 13: BURIED BASEMENT ROCKS OF THE LAS ANIMAS-BACA GRANITIC TERRANE

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY ()= no. of thin sections	PROBABLE ORIGINAL ROCK
Las Animas CL-71	Boswell and Frates #1 Government	(6) Quartz monzonite (Granite to granodiorite)	-
Las Animas CL-77	Stanolind Oil and Gas Co. #1 C. F. and I.	(3) Quartz monzonite	-
Baca CL-177	Moran Bros. #1 Cramer	(3) Quartz monzonite (Granite to granodiorite)	-
Bent CL-12	Clayton Oil Co. #1 Etchart	(1) Granodiorite	-
Las Animas CL-193	R. W. Lange #1 Marquez	(2) Porphyritic quartz monzonite	-
Las Animas CL-80	Sullivan and Pauley #1 Waldroup	(2) Quartz monzonite	-
Baca CL-176	Skelly Oil Co. #1 McEndree	(2) Quartz monzonite	-
Baca CL-178	Moran Bros. #1 Singer	(1) Granite	-
Baca CL-186	Frankfort Oil Co. #1-C Cimmarron	(2) Cataclastic granite	Granite
Bent CL-13	Seaboard Oil Co. #1 Government	(1) Quartz monzonite	-

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY () = no. of thin sections	PROBABLE ORIGINAL ROCK
Bent CL-11	Amerada Petroleum Co. #1 C. L. Dillon	(1) Quartz monzonite	-
Las Animas CL-75	Skelly Oil Co. #1 Jolly-Government	(2) Biotite-plagioclase-quartz-microcline gneiss	Granite to quartz monzonite
Las Animas CL-204	Johnson and Sullivan #1 A. T. McCarty	(2) Plagioclase-microcline-quartz gneiss	Granite
Las Animas CL-69	Baker and Taylor Drilling #1 R. S. LeSage	(3) Quartz-plagioclase-microcline gneiss	Granite to quartz monzonite
Las Animas CL-73	Parker Gun Club #1 Adams	(1) Biotite-quartz-microcline-plagioclase gneiss	Quartz monzonite
Prowers CL-121	Charles A. Wallace #1 Witte	(3) Quartz monzonite and amphibolite	Basaltic flow or basic volcanic rock (and igneous intrusive)
Las Animas CL-72	R. W. Lange #1 Government	(3) Quartz latite porphyry (Tertiary intrusive), muscovite hornfels, and diopside-actinolite hornfels	Quartz latite intrusion into calcareous and argillaceous sediments
Prowers CL-118	Ohio Oil Co. #1 Eldridge	(1) Plagioclase-bearing biotite lamprophyre (Tertiary intrusive)	-

TABLE 14: EXPOSED BASEMENT ROCKS OF THE MESA-MONTEZUMA GRANITIC TERRANE

Upper Cochetopa canyon area

SAMPLE NUMBER	BASEMENT ROCK LITHOLOGY	PROBABLE ORIGINAL ROCK
PRC-27-56	Biotite-plagioclase-quartz-microcline gneiss	Granite, metasomatized
57	Biotite-quartz-plagioclase-microcline porphyroblastic gneiss	Arkosic sediments, metasomatized into augen gneiss
58	Quartz-plagioclase-microcline gneiss	Granite

TABLE 15: BURIED BASEMENT ROCKS OF THE MESA-MONTEZUMA GRANITIC TERRANE

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY () = no. of thin sections	PROBABLE ORIGINAL ROCK
Archuleta CL-3	Wirt Franklin #1 Sullenberger	(2) Biotite-quartz-plagioclase-microcline gneiss	Granite
Montezuma CL-100	Gulf Oil Corp. #1 Fulks	(3) Biotite-quartz-plagioclase-microcline gneiss	Granite to quartz monzonite
San Miguel CL-200	Kerr-McGee Oil Co. #1 Placerville	(3) Hornblende-biotite-microcline-quartz-plagioclase gneiss	Granodiorite
Montrose CL-105	St. Helen's Petroleum Co. #1 C.B. and L.H. Sandburg (#1 Bostwick Park Unit)	(2) Biotite-quartz-orthoclase-plagioclase porphyroblastic gneiss	Quartz monzonite to granodiorite
Montezuma CL-98	California Oil Co. #1 Ute Tribal	(3) Micrographic granite	-
Montezuma CL-99	Continental Oil Co. #1 Ute Mountain	(1) Micrographic granite	-
Montezuma CL-101	Pan-American Petroleum Co. #1 Ute Mountain	(1) Micrographic granite	-
Montrose CL-103	Penrose and Tatum #1 Orme	(2) Microcline granite or syenite to monzonite	-
Montrose CL-182	Shell Oil Corp. #1 Wray Mesa Unit	(2) Quartz monzonite to granodiorite	-

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY () = no. of thin sections	PROBABLE ORIGINAL ROCK
Mesa CL-94	Pure Oil Co. #1 Unit (Gateway)	(3) Porphyritic quartz monzonite to granodiorite	-
San Miguel CL-149	Fred Turner #1 F. H. Buss	(1) Biotite-microcline-quartz-plagioclase gneiss	Quartzo-feldspathic to arkosic sediments, metasomatized
Dolores CL-29	Smith Drilling Co. #1 Groundhog Unit	(6) Latite porphyry (Precambrian?)	-
Archuleta CL-2	Cameron Drilling #1 Ed Bramwell	(2) Plagioclase-chlorite-sericite hornfels (Tertiary intrusive)	Calcareous and argillaceous sediments
Archuleta CL-4	Francis Harvey #1 Government (Quartz Creek)	(1) Quartz latite porphyry (Tertiary intrusive)	-
Montezuma CL-97	Western Natural Gas, Byrd, Frost and English #1 MacIntosh	(5) Chlorite-diopside-feldspar hornfels and latite (Tertiary intrusive)	Calcareous and argillaceous sediments (and igneous intrusive)
Dolores CL-30	Western Natural Gas, Byrd, Frost, and English #1-A Glade (J. A. Uhl-Government)	(2) Dacite (Tertiary intrusive)	-
Ouray CL-201	Intex Oil Co. South Penn Oil Co. #1 D. Halls	(3) Quartz latite porphyry (Tertiary intrusive)	-

TABLE 16: BURIED BASEMENT ROCKS OF THE UINTA MOUNTAIN SEDIMENTARY TERRANE

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY () = no. of thin sections	PROBABLE ORIGINAL ROCK
Moffat CL-95	Amerada Petroleum Co. #1 Unit	(4) Sandy to silty shale and sandy to silty limestone	-
Routt CL-147	Texaco, Inc. #1 Colvert	(3) Sandy to silty shale and quartzite	-
Routt CL-211	Texaco, Inc. #1 Peavy	(4) Calcareous to shaly arkose and sandstone, quartzite, biotite-calcite-quartz-sericite gneiss, and biotite-plagioclase-hornblende schist	Quartzose and quartzo-feldspathic sediments, and basic volcanic rocks
Rio Blanco CL-133	Buford Oil Co. #1 Government	(3) Sandy crystalline limestone to calcareous sandstone	-

TABLE 17: BURIED BASEMENT ROCKS OF THE OTERO-BENT VOLCANIC TERRANE

COUNTY AND WELL NUMBER	NAME OF WELL	BASEMENT ROCK LITHOLOGY () = no. of thin sections	PROBABLE ORIGINAL ROCK
Otero CL-109	Carter Oil Co. #1 Exploration (Colorado Strat Hole)	(2) Rhyolitic to latitic crystal vitric tuff and andesite	-
Las Animas CL-191	Texaco, Inc. #1 Government-Davis	(2) Dacitic crystal vitric tuff	-
Baca CL-10	Marland #1 Mesa-Bergunthal	(3) Latite porphyry	-
Bent CL-179	Texaco, Inc. #1 M. E. Jones	(2) Altered olivine basalt	-

PRECAMBRIAN STRUCTURE OF THE BASEMENT IN COLORADO

Lithological Trends

Three apparent directions of lithological trends are shown by the distribution pattern of the 10 basement terranes in Colorado (pl. 1 and pl. 3). The most pronounced of these trend directions is northeast-southwest and is best illustrated in eastern Colorado by the Kit Carson-Kiowa metasedimentary terrane and the Logan-Yuma and Pueblo-Teller granitic terranes. Although not enough of the Mesa-Montezuma granitic terrane is present in Colorado to exhibit any particular trend direction, it does lie on the southwestern extension of the lithological trend of the Logan-Yuma and Pueblo-Teller granitic terranes.

Less apparent is a lithological trend in a northwest-southeast direction. It is best shown by the La Plata-San Juan metasedimentary terrane, which changes from a north-northwest to a west-northwest direction as the terrane is traced from New Mexico across Colorado and into Utah. A west-northwest trend is also shown by the outline of the Otero-Bent volcanic terrane. The Weld-Delta metasedimentary terrane appears to bifurcate and have two trend directions. The predominant trend is to the northeast, but this direction may change to east-west where the terrane is overlain by the Uinta Mountain sedimentary terrane. The other trend direction of the Weld-Delta terrane is to the southeast and extends between the Pueblo-Teller and Mesa-Montezuma granitic terranes to connect with the Saguache-Huerfano metasedimentary terrane. The northwest-southeast lithological trend is the dominant direction for the Saguache-Huerfano terrane, but this terrane also appears to bifurcate, with a less apparent trend to the northeast passing between the Pueblo-Teller and Las Animas-Baca granitic terranes.

The third lithological trend direction, east-west, is present primarily in the pattern of the Uinta Mountain sedimentary terrane. An apparent east-west trend is also shown by the Las Animas-Baca granitic terrane. However, as with the Mesa-Montezuma granitic terrane, not enough of this terrane is present in Colorado to determine any particular trend direction, and the complete picture must wait until the results of this study are combined with studies in adjacent states.

Isotopic Age Determinations

The isotopic ages determined from the basement rocks of Colorado appear to have no distinct pattern in relation to the pattern of the lithological terranes (pl. 2). These ages have been determined from rocks from many localities in the Precambrian basement of Colorado (table 18), but most of them are from the Weld-Delta metasedimentary terrane. Some of the age determinations have been made in order to test and compare different methods of age determination on a variety of minerals and, therefore, not all of the ages which have been published will be reliable indicators of the age of the rocks. For examples, the maximum age obtained from the Precambrian basement of Colorado is 3180 m.y. (Pb^{206}-U^{238}), determined on biotite-xenotime from a granite in Unaweep Canyon, Mesa County. The minimum age is 200 m.y. (Pb^{208}-U^{232}) on apatite from this same granite (Gheith, 1958). Concordant ages usually are obtained from a particular rock or locality by using the K-Ar method on biotite; the Rb-Sr method on biotite, feldspar, or whole rock; and the Pb^{206}-U^{238}, Pb^{207}-U^{235}, and Pb^{206}-Pb^{207} methods on zircon, apatite, monazite, or uranium minerals (Knopf, 1957; Aldrich and others, 1960; Goldich and others, 1961). The Pb^{208}-Th^{232} and lead-alpha methods have been judged unreliable (Rankama, 1954, p. 384; Tilton and others, 1957, p. 369-370; Knopf, 1957, p. 230). Of the other three lead-isotope methods, the Pb^{206}-Pb^{207} has been considered to be the most reliable (Knopf, 1957, p. 230).

The majority of isotopic age determinations which are here considered from the above to be reliable are shown on Plate 2 and range from a maximum of 1810 m.y. to a minimum of 600 m.y. According to Goldich and others (1961, p. 168) these ages would range from late Middle Precambrian through the Late Precambrian and possibly to the beginning of Cambrian time. The present writer, in order to have a more convenient scale, has further divided the Late Precambrian (1700 to 600 m.y. of Goldich and others, 1961) into early Late Precambrian (1700 to 1300 m.y.), middle Late Precambrian (1300 to 1000 m.y.), and late Late Precambrian (1000 to 600 m.y.). It is felt that the terms "Huronian" and "Keweenawan", used by Goldich and others (1961) for comparable time spans in Minnesota, is unjustified for use in the Precambrian of Colorado.

In the Weld-Delta metasedimentary terrane, published ages determined on exposed basement rocks range from 1460 to 980 m.y. for the K-Ar method, from 1650 to 1275 m.y. for the Rb-Sr method, and from 1730 to 915 m.y. for lead-isotope methods. Two isotopic ages were determined on well samples from this terrane in connection with this project. The age of the metasedimentary gneiss from well CL-175 in Adams County (pl. 2, no. 1) was found to be 1390 m.y. by K-Ar and 1320 m.y. by Rb-Sr. These define one event near 1350 m.y. The granitic gneiss from well CL-42 in Garfield County (pl. 2, no. 15) gave an age of 1690 m.y. by Rb-Sr. An attempt was made to determine the age of the granitized metasediment from well CL-202 in Rio Blanco County (pl. 2, no. 43), but the Rb-Sr ration was unfavorable for dating (W. R. Muehlberger, personal communication).

No isotopic ages have been determined on basement rocks of the Kit Carson-Kiowa metasedimentary terrane. However, to the east in the State of Kansas, an age of 1081 m.y. (K-Ar) has been reported on a well sample of hematitic biotite schist from Wallace County (Cole, Merriam, and Hambleton, 1964, p. 5). If this age is representative of the time of metamorphism of the terrane (middle Late Precambrian), it corresponds with some of the younger dates obtained in the Weld-Delta metasedimentary terrane. Some K-Ar dates within this range have been obtained from the Pikes Peak batholith and associated intrusions in the exposed basement of the Pueblo-Teller granitic terrane (Hutchinson, 1959a; 1959b; 1960b; 1960c; 1963).

Age determinations of the exposed basement rocks in the Saguache-Huerfano metasedimentary terrane have been made only on rocks from the Wet Mountains area. Lead-alpha ages of 1220 to 1080 m.y. were reported on metasedimentary gneisses in the central Wet Mountains (pl. 2, no. 50) by Jaffe and others (1959). Boyer (1962, p. 1058) has given a lead-alpha age of 1430 m.y. for the San Isabel granite of the southern Wet Mountains (pl. 2, no. 51). Alkalic stocks and dikes in the McKinley Mountain area (pl. 2, no. 48 and 49) have been dated by Jaffe and others (1959) as between 590 and 755 m.y. (lead-alpha), which represents latest Late Precambrian or possibly Early Cambrian time. One isotopic age of 1260 m.y. (K-Ar) was determined on samples from well CL-1 in Alamosa County (pl. 2, no. 47) for this study of the basement rocks of Colorado.

The age of the La Plata-San Juan metasedimentary terrane relative to that of the surrounding Mesa-Montezuma granitic terrane is not known. No radiometric age determinations have been made on rocks from this terrane, either from surface exposures or from subsurface well samples. On the basis of the lesser degree of metamorphism, Cross, Howe, Irving, and Emmons (1905, p. 3), Hinds (1936, p. 63), and Larsen and Cross (1956, p. 22) all considered the Irving Greenstone and the Needle Mountains Group to be younger than the surrounding "ancient schists and gneisses". The gneissic granite intrusions in the Grenadier-Needle Mountains area are older than the rocks of this terrane, but other granitic masses are younger, as they intrude the greenstones and the slates and quartzites (Cross, Howe, Irving, and Emmons, 1905, p. 7;

Larsen and Cross, 1956, p. 26). Hinds (1936, p. 120) and Ross (1963, p. 107-108) consider these quartzites to be older than those of the Grand Canyon Series in Arizona and the Uinta Mountain Group in Utah and Colorado, both of Late Precambrian age. Speculation as to the age of the Needle Mountains Group could be settled by isotopic ages determined on a few properly-selected samples.

The only isotopic ages for the Logan-Yuma granitic terrane are three which were determined on well samples for this project. The oldest, 1510 m.y. (Rb-Sr), was determined on the augen gneiss from well CL-88 in Logan County (pl. 2, no. 52). The granitic gneiss from well CL-173 in Yuma County (pl. 2, no. 54) gave an age of 1360 m.y. (Rb-Sr), and the granitized metasedimentary gneiss and granitic gneiss from well CL-89 in Logan County (pl. 2, no. 53) was dated at 1250 m.y. (Rb-Sr).

Isotopic ages from the exposed basement of the Pueblo-Teller granitic terrane (table 18) range from a maximum of 1540 m.y. (K-Ar) to a minimum of 870 m.y. (K-Ar). Some Rb-Sr and lead-isotope dates are also available which agree closely with the K-Ar dates from the same rocks. The older dates, which range between 1600 and 1300 m.y., are from the granitic gneisses and augen gneisses of the terrane. Younger ages, between 1100 and 900 m.y., are from the Pikes Peak batholith or from smaller batholiths and stocks spatially associated with it (Hutchinson, 1963). The ages between 1600 and 1300 m.y. represent orogenic periods when deep-seated syntectonic catazonal intrusions and metasomatic activity were taking place and formed the early Late Precambrian basement framework. Ages between 1100 and 900 m.y. represent a later, post-tectonic period when mesozonal intrusions were emplaced within the stabilized early Late Precambrian basement. Ages were determined on samples from two wells in the buried part of the terrane. The granitic gneiss from well CL-129 in Pueblo County (pl. 2, no. 71) was dated at 1300 m.y. (Rb-Sr) and the granitized metasedimentary gneiss from well CL-131 (pl. 2, no. 72), located in the branch of this terrane which extends toward the Las Animas-Baca granitic terrane, gave an age of 1600 m.y. (Rb-Sr).

Only one isotopic age determined on samples from well CL-177 in Baca County (pl. 2, no. 75), has been made for the Las Animas-Baca granitic terrane. The quartz monzonite from this well was dated as 1280 m.y. (Rb-Sr) and is comparable with the middle Late Precambrian ages obtained from other terranes.

No isotopic ages have been determined on well samples from the Mesa-Montezuma granitic terrane in connection with this project. However, an age determination on samples from well CL-99 in Montezuma County (pl. 2, no. 79) has been published (Fitzsimmons, 1963, p. 19) and the micrographic granite at this location gave an age of 1810 m.y. (Rb-Sr). Two ages given to the writer by the California Oil Company were determined on samples from well CL-149 in San Miguel County (pl. 2, no. 81) and from well CL-29 in Dolores County (pl. 2, no. 76). The granitized gneiss in well CL-149 was determined to have an age of 1380 m.y. (K-Ar) and the latite porphyry from well CL-29 gave a lead-alpha date of 550 ± 110 m.y. Exposed basement rocks in Unaweep Canyon in Mesa County (pl. 2, no. 78) have yielded ages of around 1350 m.y. for both the K-Ar and Rb-Sr methods. Lead-isotope methods on rocks at this same locality gave ages which ranged from 3180 to 1050 m.y., but the more reliable Pb^{206}-Pb^{207} method gave ages which were restricted between 1640 and 1800 m.y. Granites and granitic gneisses from the Cochetopa Canyon area (pl. 2, no. 80) gave Rb-Sr ages of 1650 and 1356 m.y. (Wetherill and Bickford, 1965). A lead-alpha age of 583 m.y. was obtained from alkalic intrusive rocks of the Iron Hill complex in Gunnison County (pl. 2, no. 77) (Jaffe and others, 1959).

Neither the rocks from the subsurface well samples nor from the surface exposures of the Uinta Mountain sedimentary terrane have been dated by isotope methods. Ages ranging from 2320 m.y. (K-Ar) to 1520 m.y. (Rb-Sr) have been reported on the older, strongly-metamorphosed metasediments of the Red Creek Quartzite in Utah (Hansen, 1965, p. 31). The sediments of the Uinta Mountain Group have been considered to be broadly analogous to the Late Precambrian sediments of the Belt Series to the north in Idaho and Montana and with the Grand Canyon Series in Arizona (Ross, 1963, p. 105).

No isotopic ages have been determined on rocks from the Otero-Bent volcanic terrane. The basement in this area is overlain by the Arbuckle Dolomite of Early Ordovician age (Maher, 1953, p. 2480; MacLachlan, 1961, p. 47-48). Although some of the rocks of this terrane may be shallow intrusives, others have textures which are undeniably tuffaceous and must have been deposited subaerially. Therefore, the rocks cannot represent intraformational sheets intruded along the unconformity between the Arbuckle Dolomite and the Precambrian basement, and their age must be at least as great as Late Cambrian. Ham, Denison, and Merritt (1964, p. 26-27) report ages of 525 to 500 m.y. (Rb-Sr, and lead isotope) for rhyolite and granitic rocks of a volcanic terrane in southwestern Oklahoma. The general structural trend of this volcanic terrane in Oklahoma is to the northwest (Flawn, 1956; Ham, Denison, and Merritt, 1964), and is directly in line with the location of the Otero-Bent volcanic terrane in Colorado. Lead-alpha ages only a little older than the Oklahoma ages have been obtained from rocks which occur in the exposed Precambrian basement of the Wet Mountains, Custer County, Colorado, which lie further along the northwestern extension of the Oklahoma structural trend, and at Iron Hill, Gunnison County, Colorado (pl. 2, nos. 48,49, and 77). Five zircon samples from an albite syenite in the Wet Mountains gave an average age of 595 m.y. and other zircon samples from the Wet Mountains gave ages which range from a high of 755 m.y. to 590 m.y. (Jaffe and others, 1959). A syenite from the Iron Hill area yielded ages ranging between 583 and 525 m.y. (Jaffe and others, 1959). In both of these localities, the syenites are post-tectonic and are associated with carbonatites (Olson and Wallace, 1956; Parker and Hildebrand, 1963). The older Precambrian gneisses of the Wet Mountains, into which the younger alkalic rocks have been intruded, have been dated by the lead-alpha method (Jaffe and others, 1959) and range between 1220 and 1080 million years (table 18).

On the other hand, the Otero-Bent volcanic terrane lies to the north of a series of volcanic rocks in the subsurface Panhandle volcanic terrane of northern Texas (Flawn, 1956). Age determinations on two rhyolites and a granite from this terrane were made by Wasserburg and others (1962, p. 4032-4033) and range from 1290 to 1180 m.y. (Rb-Sr). This is about the same age as the plutonic igneous rocks in the Las Animas-Baca granitic terrane which surrounds the Otero-Bent terrane and probably forms the basement beneath it. Until the age of these volcanic rocks in the Otero-Bent volcanic terrane has been determined, the exact structural and temporal relationships with the basement rocks of the Las Animas-Baca granitic terrane will not be known.

Wetherill and Bickford (1965), on the basis of isotopic age studies of samples collected throughout central Colorado, considered the basement to have formed during a widespread period of igneous and metamorphic activity which occurred about 1650 million years age (Rb-Sr), and younger ages were believed to have been caused by a redistribution of radiogenic strontium during later metamorphic events. Giffin and Kulp (1960), in a similar study using the K-Ar method, believed the period of formation of the basement in Colorado to be about 1500 million years ago, with a later metamorphic event around 1000 m.y. which resulted in a loss of radiogenic argon from the basement in the Pikes Peak area. However, Hutchinson (1959a, 1959b, 1960b, and 1963) and Peterman, Hedge, and Braddock (1965) determined from studies of the local geological and intrusive relationships in the Front Range that the oldest ages of 1650 to 1300 m.y. are obtained from the gneissoid plutons and augen gneisses, which are products of a catazonal environment, and that ages younger than 1300 m.y. are associated with mesozonal plutons. These relationships hold for both granitic and metasedimentary terranes as Hutchinson's work in the Pikes Peak region of the southern Front Range lies in the Pueblo-Teller granitic terrane and the work of Peterman, Hedge, and Braddock was in the northern Front Range, which lies within the Weld-Delta metasedimentary terrane.

The range of isotopic age determinations from the basement rocks of Colorado (table 18) indicates that there have probably been several orogenic periods with syntectonic and post-tectonic intrusive activity from as early as 1800 m.y. to 525 m.y. These dates have been obtained from many different sources, which used different values for the decay constants in the calculations. Five age ranges appear to have existed in Precambrian time. These occurred about 1650, 1430 - 1380, 1350 - 1300, 1250 - 1200, and 1050 - 980 million years ago. Insufficient evidence is at hand to indicate whether or not these represent five periods of orogeny. Other less-apparent periods of igneous intrusive activity also occurred.

Structural Trends

Structural trends of the basement rocks in Colorado, illustrated by the foliation directions in the exposed basement (pl. 1), have a very complex pattern, which is the result of the complex history of orogenies.

However, there does appear to be a preferred orientation of these structural trends in a northeasterly direction. In orogenic regions throughout the world the predominant trends of bedding, fold structures, schistosity and intrusive activity are all generally parallel to the gross lithological trends and reflect the structural control of orogenic belts. The Cordilleran region of British Columbia, in western Canada, has been the site of at least six major orogenies since Late Precambrian time (White, 1959), and each successive deformation has modified, but not obliterated, the older structural patterns. The overall pattern of the region follows the trend of the orogenic belt. The Tasman geosyncline of eastern Auatralia was repeatedly deformed throughout Paleozoic time and was finally stabilized in the Permian (Playford and Johnstone, 1959, p. 398). The result is a complex region of sedimentary, igneous, and metamorphic rocks, all of which still exhibit the overall structural trend of the Tasman geosyncline (Tectonic Map of Australia, 1960). The Precambrian rocks of the Grenville province in the Canadian shield have been involved in several orogenic events and have a much greater complexity of structural trends than rocks of the older Superior province, which appear to have undergone only one or possibly two orogenies (Stockwell, 1965). According to Engel (1963), the crust in the central part of the Superior province was stabilized during the first orogeny and has been preserved, whereas the thinner crust around the margins of this province was not stabilized until it had been subjected to several more orogenic periods. Thus if an orogenic region has been involved in several periods of deformation and intrusion during its history, the structural trends of many local areas may not coincide with the overall lithological trends, but throughout the region as a whole, there will be a preferred structural trend which will be parallel to the major lithological trends. Such appears to be the case in the Precambrian basement of Colorado.

Weld-Delta Metasedimentary Terrane

In general, the foliation of the Precambrian rocks exposed throughout most of the Weld-Delta metasedimentary terrane parallels the predominant northeasterly trend of the terrane (pl. 1). However, south of the Late Precambrian shear zone now occupied by the Colorado mineral belt, the predominant direction of foliation in this terrane is to the northwest (Badgley, 1960, p. 165; and maps of Lovering and Goddard, 1950; Oriel, 1954; Boos and Boos, 1957; and Tweto and Sims, 1963). Along the eastern border of the Front Range in Larimer County, the foliation in the Precambrian gneisses trends east-west to west-northwest (Hudson, 1958; Conner, 1962; Swann, 1962; and Wohlford, 1962). In the vicinity of Coal Creek, Jefferson County, the foliation strikes to the northeast (Wells, Sheridan, and Albee, 1964). Farther south in Jefferson County, near Golden, Chapman (1948) and Gableman (1948) indicate an east-west strike to the metamorphic rocks. Near the contact of the metasediments with the Pikes Peak batholith in western Douglas County, on the border between the Weld-Delta metasedimentary terrane and the

Pueblo-Teller granitic terrane to the south, the strike of the metasediments is northwest to west-northwest (Hutchinson, 1960b; Scott, 1963).

The Precambrian rocks of the Front Range to the east and south of Middle Park have been described by Tweto (1957, p. 20) as follows:

> "They are predominantly gneiss and schist of the Idaho Springs formation and small bodies of granitic rocks of various types. Along the east side of the Park, in the Front and Never Summer Ranges, the crystalline rocks are largely schist and gneiss with a general easterly strike, except for an irregular body of granite east of Granby (Lovering and Goddard, 1950, pl. 1). Along the south side of the Park, from Fraser to the Williams Range thrust fault, the metamorphic rocks predominate and have a general northeasterly trend of folds and foliation. To the north near the Colorado River, the metamorphic rocks give way to granite which is the chief rock in the isolated masses of Precambrian rocks north of Parshall and in klippen of the Williams Range thrust fault north of Kremmling. The Precambrian rocks of the Park Range are poorly known. In the Rabbit Ears region they are complex mixtures of granitic and metamorphic rocks. Farther south, in the Gore Range, the metamorphic rocks become predominant, although they enclose many small bodies of granitic and dioritic rocks, mostly with gradational contacts."

Hanshaw (1958) mentions that the foliation in the Precambrian rocks on the west side of the Gore Range strikes northeast, northwest, and also east-west, but adds that the northeasterly direction is the most pronounced.

As Tweto (1957) has mentioned, the Precambrian rocks of the Park Range are poorly known. In the Sierra Madre Range, the northern extension of the Park Range in Wyoming, Spencer (1904, p. 18) states that igneous rocks, which are present in large masses near the Colorado-Wyoming State line, are more prevalent than are the metasediments which occur across the northern part of the range. The strike of these metasedimentary rocks is east-west (Spencer, 1904, p. 17).

The metasedimentary gneisses of the Northgate district in northern Jackson County strike east-west to northeast (Steven, 1960, p. 354). These rocks occur in a belt of exposed basement which extends between the Medicine Bow Range on the east and Park Range on the west.

Although several large masses of Precambrian granitic rock are present in the Sawatch Range, the map of Tweto and Sims (1963) indicates that foliated metamorphic rocks predominate. North of Independence Pass in Eagle, Lake, and Pitkin Counties, the strike of the foliation is shown as being mainly from east-west to northeast, whereas south of this pass the foliation strikes mainly to the north-northwest. Northwest strikes are also predominant for the Precambrian rocks exposed in Glenwood Canyon, eastern Garfield County (Bass and Northrop, 1963, p. 4; Harper, 1964). The general trend of the foliation in the metasedimentary rocks in the eastern part of the Gunnison Valley is northwest to west-northwest (Staatz and Trites, 1955, p. 4). Northeast strikes are also present but are not common (Hunter, 1925, p. 83-85). The exposures in the western part of the Gunnison Valley, primarily in Montrose County, strike from north-south to north-northeast (Larsen and Cross, 1956, p. 239). North of Unaweep Canyon in the Uncompahgre uplift, schists and gneisses predominate and strike to the east and northeast (Dane, 1935, p. 22).

Kit Carson-Kiowa Metasedimentary Terrane

No exposed basement rocks are present in the Kit Carson metasedimentary terrane, and therefore, no structural trends can be observed. The post-Precambrian Las Animas arch, which has a northeasterly trend, is the only structural feature within the terrane (fig. 1). To the west is the southern end of the Denver basin where no wells have penetrated to the Precambrian basement. To the east, according to the map of Merriam, Cole, and Hambleton (1961), most of western Kansas is underlain by granitic basement rock with a few isolated outliers of quartzite and schist. However, there are only a few wells to the basement in western Kansas, and the data upon which this map was based came mostly from the rock descriptions on sample logs, drillers' logs, and from a petrographic study of the Kansas Precambrian basement by Farquhar (1957). The apparent association of the Las Animas arch and the metasedimentary rocks of this terrane may be due only to the fact that most of the basement test wells were drilled on or near the crest of the arch.

Saguache-Huerfano Metasedimentary Terrane

In the McKinley Mountain area of the northwestern Wet Mountains the general trend of foliation is east-west to east-northeast (Christman and others, 1959). This same direction is predominant in the southern Wet Mountains (Boyer, 1962, pl. 4). In the southern end of the Front Range, Boos and Boos (1957) show the strike of the schistose rocks south of the Pueblo-Teller granitic terrane to be also to the east-northeast. This direction of structural trends is nearly at right angles to the proposed location of the boundary between the Saguache-Huerfano and Pueblo-Teller terranes in Fremont and Pueblo Counties (pl. 1).

Burbank and Goddard (1937, p. 938) report that the strike of the metasediments in the Sangre de Cristo Range is primarily to the northeast. Karig (1963b) found that the foliation trends of hornblendite and hornblende-biotite gneiss ranged from N35°E to east-west in the Venable Peak-Crestone Peak area of the Sangre de Cristo Range; however, in gneissic granite and in contact zones between granite and gneisses, the foliation had strikes between N40°W and north-south.

West of Saguache, the foliation in the small exposures of basement rock along Saguache Creek (Colo. Rte. 114) were found to strike to the northeast.

<u>La Plata-San Juan Metasedimentary Terrane</u>

The outcrop pattern of the Irving Greenstone and the Needle Mountains Group in the Grenadier-Needle Mountains area of the San Juan Mountains (see map of Larsen and Cross, 1956) suggests that there is a structural relationship between these two series of rocks. The strike of the Irving Greenstone is north-south in its area of outcrop in the San Juan dome, and that of the quartzites and slates of the Needle Mountains Group is also north-south where they are adjacent to the greenstone (Larsen and Cross, 1956). The two series are now observed in fault contact although Hinds (1936, p. 72) considers that this contact was originally an unconformity. Toward the north and west, the strike of the Needle Mountains Group swings in an arc through northwest to east-west at the extreme western end of the outcrop belt. This series occurs in a strongly folded and faulted synclinal trough (map of Cross, Howe, Irving and Emmons, 1905) within the Mesa-Montezuma granitic terrane.

Small exposures of rocks of the Needle Mountains Group are present to the north and west of the mass of exposed Precambrian basement in the San Juan dome (Larsen and Cross, 1956). South of Ouray, the quartzites and slates of the Uncompahgre Formation strike northeast to east-northeast and dip to the northwest (map of Cross, Howe, and Ransome, 1905). About six miles to the west in T43N, R8W, sec 8 (NMPM) is another small outcrop, striking N65°W, and associated with rhyolite believed to be also of Precambrian age (Cross and Purington, 1899, p. 2). A third exposure is present just east of the town of Rico, in Dolores County. The quartzites at this locality are in up-faulted blocks within the Rico dome, and have a strike of north-south to north-northeast with an eastward dip (Cross and Ransome, 1905, p. 2).

These occurrences of the Needle Mountains Group throughout a wide area north and west of the exposed rocks in the San Juan dome suggest that the La Plata-San Juan metasedimentary terrane continues in the subsurface toward the northwest. However, no evidence of rocks from this terrane was found to the west in well CL-29 in Dolores County, wells CL-149 and CL-200 in San Miguel County, or well CL-103 in Montrose County. Both wells CL-30 in Dolores County and CL-201 in Ouray County encountered Tertiary intrusives, and may not have penetrated deep enough to reach the basement. The samples from well CL-149 in San Miguel County were of granitized metasedimentary rock which is considered to be in the Mesa-Montezuma granitic terrane. It is possible, however, that this rock may represent the continuation of the La Plata-San Juan terrane across this area. Quartzites similar to those of the Needle Mountains Group do not occur again west of Rico until they appear in the samples from well CL-181 in western Montrose County.

Metasediments of the Needle Mountain Group are present on the east side of San Juan dome in T40N, R5W, sec 12 (NMPM) and in T39N, R4W, sec 35 (NMPM) and T38N, R4W, sec 2 (NMPM), all in Hinsdale County, but no rocks similar to those of this terrane are present to the northeast in the Precambrian mass along the southeast side of the Lake City caldera (Larsen and Cross, 1956). The exposure of basement rocks in the Piedra River Valley, T36N, R3W, sec 8 (NMPM), Archuleta County, shown by Larsen and Cross (1956) to be of the Needle Mountains Group, is actually a mass of baked Paleozoic and Mesozoic formations associated with an intrusive porphyry of probable Tertiary age. Two exposures of Precambrian basement rock downstream from this locality in the Piedra River are of coarse-grained granitic gneiss and are considered to be in the Mesa-Montezuma granitic terrane.

The samples from well CL-83 contain hornblendic gneisses and amphibolites which are similar to the description of the Irving Greenstone by Larsen and Cross (1956, p. 23). This well lies about 25 miles south of the outcrop belt of Irving Greenstone in the Grenadier-Needle Mountains area, and is in line with the extended north-south strike of these rocks.

Foster and Stipp(1961) show quartzitic rocks of Precambrian age in the Tusas Mountain and Burned Mountain areas of Rio Arriba County, New Mexico. These rocks are similar in stratigraphy to the Needle Mountains Group and the structural trend is to the northwest (Barker, 1958, p. 65-66), or in the direction of the exposed rocks of the Needle Mountains Group in Colorado.

Logan-Yuma Granitic Terrane

Nothing is known of the internal structural trends of the Logan-Yuma granitic terrane as no outcrops of basement rocks are present within the terrane or adjacent to it in the flanking metasedimentary terranes.

Pueblo-Teller Granitic Terrane

Generally speaking, the Precambrian rocks exposed in the Front Range east of South Park are metasediments north of the South Platte River as far as the Kenosha batholith, whereas granitic augen gneisses and granites occur to the south of the river (D. L. Sawatsky, personal communication). The basement rocks exposed in the Wilkerson Pass-

Badger Mountain area in the Front Range east of South Park are sillimanitic schists and gneisses which strike northwest and dip to the northeast (Hutchinson and others, 1960, p. 157). The four wells which encountered the basement in South Park lie to the west along the westward extension of this band of metasediments. Three of the four wells were drilled into the metasediments, but the fourth (CL-115), which lies farthest to the west, was drilled into the granitic gneisses. Granitic gneisses are also exposed to the south in South dome and have been described by Timroth (1958).

Northeast of Salida, Bhutta (1954, p. 111) reports northeasterly strikes to the rocks exposed in the Ute Creek area, but he adds that the strike changes to the northwest both to the north and to the south of this area. De Voto (1961) has mapped northeast strikes in the foliation of the augen gneisses west of Trout Creek Pass, but Hutchinson and others (1960, p. 157) state that to the west the strike changes through north-south to northwest. Chronic (1960) and Shappirio (1963) both indicate the general trend of foliation and of pegmatite dikes to be to the northeast in the "Pikes Peak granite" (augen gneiss) of the Parksdale-Royal Gorge area.

Las Animas-Baca Granitic Terrane

Nothing is known of the direction of structural trends in the Las Animas-Baca granitic terrane as there are no exposures of the Precambrian basement either within the terrane or close by in the surrounding terranes. The prevalence of well-developed igneous textures in many of the samples from this terrane suggests a considerable number of plutonic intrusions in contrast to the dominance of granitic gneisses in the Logan-Yuma granitic terrane and in the buried portion of the Pueblo-Teller granitic terrane in Pueblo County.

Mesa-Montezuma Granitic Terrane

The border drawn between the Mesa-Montezuma granitic terrane and the Saguache-Huerfano metasedimentary terrane to the east is, for the most part, conjectural. Very little is known of the basement in this region as it is covered by the Tertiary volcanic rocks of the San Juan Mountains and by the alluvial gravels of the San Luis Valley. No wells have been drilled to the Precambrian and the only gravity surveys done in the area are those of Karig (1963a) and Gaca (1965) which indicate a series of north-northwest trending, en-echelon horst and graben structures of Tertiary age. Exposures of basement rocks to the south in Conejos County and to the north in Saguache County do, however, help to delineate the terrane boundary in these areas. Along the Conejos River in western Conejos County, outcrops of basement rock exposed from beneath the Tertiary volcanic cover are present in two locations (map of Larsen and Cross, 1956). The downstream exposure, in T33N, R6E, sec 26 (NMPM), consists of a series of foliated metasedimentary schists and gneisses and granitized or metasomatized gneisses. These rocks strike N20°W and dip about 75° to the southwest. Seven miles to the northwest, a second outcrop occurs in T33N, R5E, sec 2 and 3 (NMPM). At this location the rock is a massive, coarse-grained porphyroblastic granitic gneiss which has a foliation striking N50°E and dipping 70° to the southeast. The boundary between the Mesa-Montezuma granitic terrane and the Saguache-Huerfano metasedimentary terrane is believed to pass between these two small exposures of basement rocks and extend northward.

In northern Saguache County, the small exposures of Precambrian rocks south of Bonanza and west of Saguache are of granitized metasediments, which strike to the northeast. The rocks in these localities are considered to be in the Saguache-Huerfano metasedimentary terrane, or in the region of the strongly granitized paragneisses between the Mesa-Montezuma and Pueblo-Baca granitic terranes. The metasediments north of the granitic gneisses in Cochetopa Canyon also have northeasterly strikes.

Farther to the northwest, in the exposed belt of Precambrian metasedimentary rocks in eastern and southern Gunnison County, the general direction of strike is to the northwest (Staatz and Trites, 1955). Foliation trends in the schists and gneisses northwest of Vernal Mesa, in Montrose County near the western end of the exposed Precambrian of the Gunnison River region, are from north-south to north-northeast (Larsen and Cross, 1956, p. 239). In this area, a mass of granite is exposed (Hunter 1925, p. 47-49), which Shoemaker (1956) considers to be very similar to the granites in the Unaweep Canyon area farther west. North of Unaweep Canyon in Mesa County, the foliation in the metasediments strikes to the east and northeast (Dane, 1935, p. 22).

Within the large Precambrian mass of the San Juan dome, Larsen and Cross (1956, p. 239), referring to the Needle Mountains Folio of Cross, Howe, Irving, and Emmons, (1905) and the Engineer Mountain Folio of Cross and Hole (1910), state that the belt of "ancient schists and gneisses" exposed along the canyon of the Animas River has foliation trends ranging from north-south through northeast to east-west. The strike of the foliation in the Irving Greenstone and in the quartzites and slates of the Needle Mountains Group will not be considered here as these two series of rocks are placed within the La Plata-San Juan metasedimentary terrane. The foliation in a small outcrop of "ancient schists and gneisses" exposed north of Rico, in Dolores County, strikes in an east-west direction (Larsen and Cross, 1956, p. 239).

Uinta Mountain Sedimentary Terrane

The Uinta Mountain sedimentary terrane formed as a rapidly subsiding east-trending trough in Late Precambrian time (Hansen, 1965, p. 167) and was filled with the poorly sorted clastic sediments of the Uinta Mountain Group. This trough may possibly have been an eastward extension of the Late Precambrian Beltian geosyncline which lay to the west (Ross, 1963, p. 105). In a discussion of the geologic history of the region, Hansen (1965, p. 167-171) states that the trough was uplifted at the end of the Precambrian and although some deposition took place the region was primarily a positive landmass for most of Early Paleozoic time. By Mississippian time the region was the site of extensive marine deposition. Tectonic activity during Pennsylvanian and Permian time, which produced the Ancestral Rocky Mountains to the south and east, does not seem to have affected the Uinta Mountain terrane. Instead, the region was at the edge of the unstable shelf of the Cordilleran geosyncline throughout the Late Paleozoic and Mesozoic and was the site of marine deposition. Deformation during the Laramide orogeny of Late Cretaceous to Early Tertiary time produced the present structure of the Uinta Mountains. This is an elongate east-west-trending anticlinal fold broken on the northern and southern flanks by great longitudinal reverse faults and lesser normal faults (Forrester, 1937; Hansen, 1965, p. 137-138). In Colorado only the eastern end of the Uinta mountain anticline is present and has the form of a large dome. The general trend of bedding in the exposed rocks of the Uinta Mountain group is west-northwest at the Utah State line, changing to east-west at the easternmost exposures (Hansen, 1965, p. 138). In a few places along the northern flank the underlying metasedimentary gneisses and quartzites of the Red Creek Quartzite are exposed and are unconformably overlain by the Uinta Mountain Group.

Otero-Bent Volcanic Terrane

The Otero-Bent volcanic terrane is nowhere exposed at the surface in Colorado, and therefore, no structural trends can be observed in the rocks. The terrane lies across the northern end of the Sierra Grande arch (fig. 1) on the upthrown side of the Ute Pass-Freezeout Creek fault. This fault is shown by Anderman (1961) to have an alignment of west-northwest in Otero and Bent Counties, but changes to a more north-south direction in Baca County and passes southward into Oklahoma.

The basement rocks of this terrane are shallow-seated intrusives or extrusives and tuffs which are indicative of volcanic and pyroclastic activity. This suggests that the Ute Pass-Freezeout Creek fault may have been present during the Precambrian.

Gravity Data

The distribution of the basement lithological terranes in Colorado has a vague correlation with the pattern of positive and negative gravity areas shown by Qureshy (1958, 1960) on the Airy-Heiskanen isostatic anomaly map of Colorado (fig. 35). The best correspondence of the basement rock lithologies to the regional gravity pattern is in eastern Colorado, where post-Precambrian tectonism has been, at most, gentle warping which produced broad arches and basins. A prominent gravity high, which has no corresponding post-Precambrian structural feature in the basement (fig. 1), extends southeastward from Logan and Sedgwick Counties in the northeastern corner of the state to Douglas and Jefferson Counties, where it connects with the gravity high associated with the Front Range uplift. This gravity high lies almost in

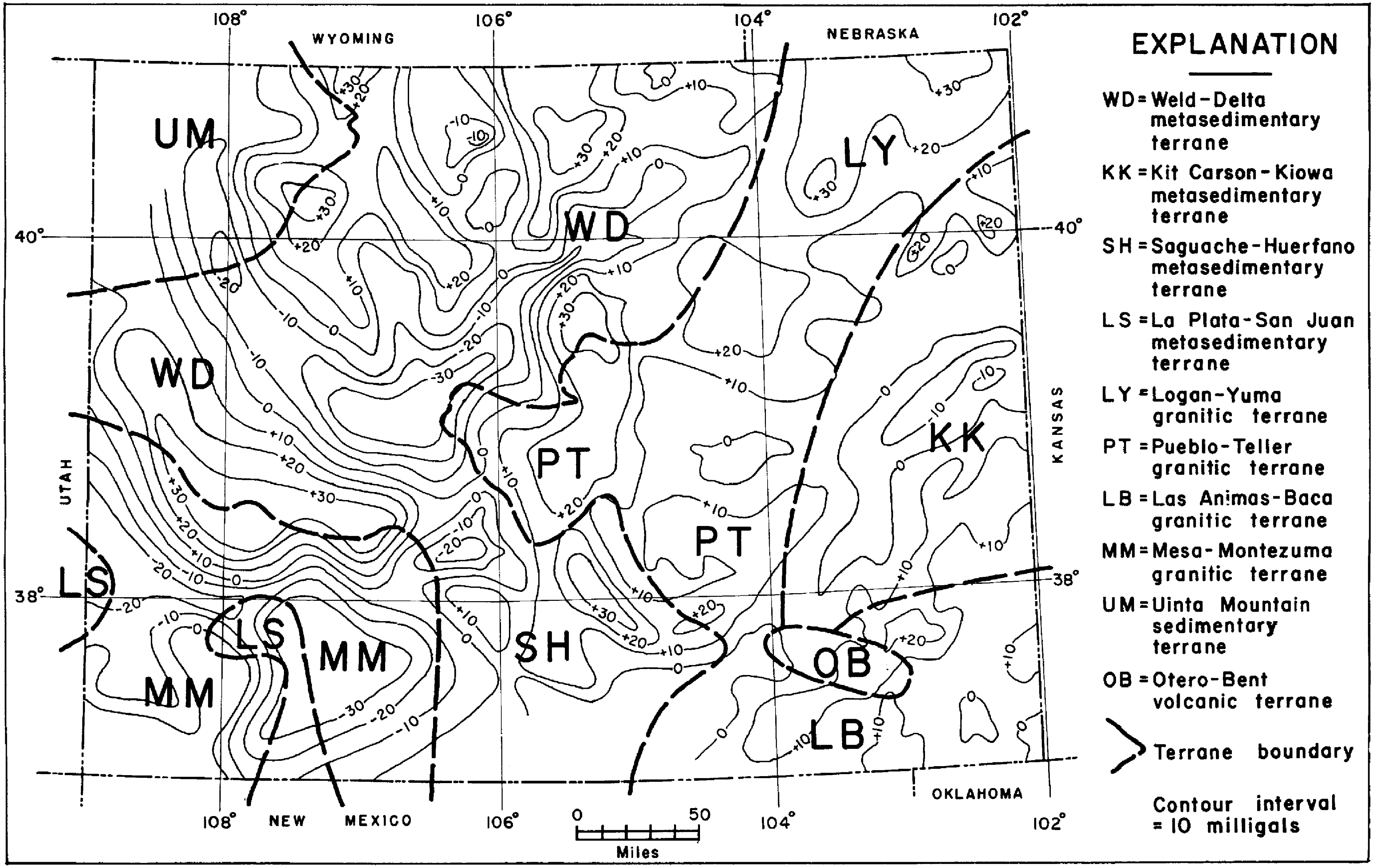


Figure 35: Airy - Heiskanen isostatic anomaly map of Colorado (from Qureshy, 1958), with basement terranes added.

the same position as the combined trends of the Logan-Yuma and Pueblo-Teller granitic terranes. To the southeast, an elongate gravity low corresponds to the location of the Kit Carson-Kiowa metasedimentary terrane. A branch of this gravity low extends due west into the Pueblo-Teller granitic terrane. There are no well samples from the basement to indicate any lithological reason for this, but it may represent a tongue of the metasedimentary terrane which possibly could separate the Logan-Yuma granitic terrane from the Pueblo-Teller granitic terrane. The northeastern end of the Weld-Delta metasedimentary terrane, east of the Front Range, is also associated with a gravity low. However, this may be due in part to the presence of the northeast-trending belt of Tertiary intrusions in the Colorado mineral belt (fig. 38).

In the central and western parts of Colorado, tectonic activity in Pennsylvanian time and in Cretaceous-Tertiary time produced mountainous uplifts and intervening basins (Eardley, 1962) (figs. 41 and 42) and any gravity pattern which might be related to the Precambrian structure in this area has been masked or obliterated. Case and Joesting (1961a), however, describe aeromagnetic and gravity anomalies in western Colorado and eastern Utah, which suggest northeast-trending structures in the basement. The large northwest-trending gravity anomalies in western Colorado (fig. 35) coincide generally with the positions of the late Paleozoic uplifts and basins of the Ancestral Rocky Mountains (fig. 41) (Qureshy, 1962, p. 2466). These uplifts persisted for a long period of geologic time from Pennsylvanian, possibly from Late

Mississippian, to Early Cretaceous time (Eardley, 1962, p. 251). The positive gravity anomalies associated with the uplifts are considered to indicate a thinner crust where the dense, underlying mantle has risen (Qureshy, 1958, p. 25) as the crust was gradually uplifted and eroded. These Late Paleozoic uplifts, for which structural and stratigraphic evidence may still be seen, provide a clue to the Precambrian structure in eastern Colorado where only lithologic patterns and gravity data are available. Qureshy (1958, 1962) believes that the gravity highs in eastern Colorado represent upwarps of the crust and that the gravity lows are downwarps. These upwarps appear to correspond to the positions of the granitic terranes, whereas the downwarps are associated with the metasedimentary terranes.

Jackson, Stewart, and Pakiser (1963), in a determination of crustal structure in eastern Colorado by seismic refraction methods, regarded the dip of the base of the crust as being essentially horizontal with no indication of crustal warping as suggested by Qureshy. However, the direction of their seismic profile, which extended from Nee Granda Reservoir in Kiowa County to southwestern Nebraska, crossed the Kit Carson-Kiowa and Logan-Yuma terranes at an oblique angle to the lithologic and gravity trends. It is possible that in this direction any change in the dip of the crust would be too gradual to detect.

In southeastern Colorado, the correlation of the lithological terranes with the gravity pattern is also disrupted by post-Precambrian tectonism. Gravity highs are associated with the northwest-trending

Wet Mountains and Apishapa uplifts (figs. 1 and 35), and with the northeast-trending Sierra Grande and Las Animas arches. Gravity lows correspond to the Raton basin and the Hugoton embayment.

Structure of the Basement

The basement of Colorado was formed during several periods of deformation and intrusion of a Precambrian orogenic belt (Badgley, 1960, p. 166) throughout early and middle Late Precambrian time. Although there are local divergences in trend, the gross structural trend of the basement rocks in Colorado is northeast-southwest (pl. 1) (Oriel, 1954; Badgley, 1960, p. 165) and indicates that the trend of the orogenic belt was northeast-southwest (King, 1959, p. 99). The grade of metamorphism in the paragneisses (almandine-amphibolite facies) and the intrusive relationships of the plutons which have yielded the oldest isotopic ages (1800 to 1300 m.y.) show that the crustal level now exposed at the basement surface was, at the time of the oldest deformation, the catazone or low mesozone. Mesozonal plutons emplaced within this basement framework have middle Late Precambrian ages (1300 to 1000 m.y.) and indicate a time when the basement had stabilized and represented a higher crustal level. According to the depth zone concept (Buddington, 1959, p. 676-677), the catazone or low mesozone represents a region approximately 7 to 9 miles below the surface, and the mesozone, approximately 5 to 8 miles. However, as these zones are more properly intensity zones, a greater rate of increase in temperature with depth would result in these zones occurring at shallower levels in the crust.

Isotopic age determinations presently available from the basement rocks of Colorado do not seem to show any definite pattern in their distribution (pl. 2) and suggest that the orogenies in which the basement was formed took place on a scale larger than the State of Colorado. The Precambrian basement province which includes Colorado has a northeasterly trend across the North American Continent (fig. 39). No pattern of distribution within Colorado is apparent for the younger mesozonal intrusions, either. However, the majority of age determinations around 1000 m.y. are associated spatially with the Pikes Peak batholith and several of its satellite stocks. These plutons appear to represent the last period of large-scale Precambrian intrusive activity. A few other age determinations of this same range, which occur elsewhere in the basement of Colorado, may represent small plutons intruded during the same period as the Pikes Peak batholith. Later Precambrian intrusive activity was restricted to small, epizonal alkalic stocks, which were emplaced in very latest Precambrian time, possibly early Cambrian time.

As a result of the deformation and intrusion which occurred throughout early Late Precambrian time, the basement of Colorado was deformed into anticlinoria and synclinoria (pl. 3). These are now expressed at the basement surface as the granitic and metasedimentary terranes. The northeast-southwest trends of the basement terranes, shown by the Kit Carson-Kiowa metasedimentary terrane and the Logan-Yuma and Pueblo-Teller granitic terranes in eastern Colorado, is related to the overall tectonic trend of the early late Precambrian orogenic belt (fig. 39). In central and western Colorado, the basement terranes trend in a more northwesterly direction and appear to cut across the predominant direction of structural trends in the basement (pl. 1). This may be due to the fact that tectonic activity from Late Paleozoic to Triassic time exposed parts of the basement in central and western Colorado to deep erosion, and thus may have altered the old Precambrian lithological pattern. Also, there are fewer wells in western Colorado than in the eastern part of the State, and therefore, there is less control on the positions of the terrane boundaries.

Catazonal plutons, orthogneisses, and augen gneisses are characteristic of the anticlinorial granitic terranes, but some paragneisses may also occur. Some of these rocks may have been part of an older pre-orogenic basement framework of Early to Middle Precambrian age and have been metasomatized, somewhat remobilized, and deformed into granitic gneisses of the catazone during the orogenic periods of early Late Precambrian time. Downward folding of the basement into synclinoria has preserved the paragneisses, which are characteristic of the metasedimentary terranes. Rocks of a lower metamorphic grade than that of most of the basement of Colorado occur within the Kit Carson-Kiowa and Weld-Delta metasedimentary terranes. Within the metasedimentary terranes, granitic gneisses and augen gneisses may occur as minor uplifts or intrusions near the border of the granitic terranes. The large number of low-mesozonal and catazonal plutons exposed within the present mountain uplifts of the Front Range, Sawatch Range, and Wet Mountains of the Weld-Delta metasedimentary terrane may be due to the fact that the basement rocks of these ranges have been subjected to deep erosion during the periods of uplift in Late Paleozoic and Cenozoic time, which has exposed the lowermost regions of the synclinorial metasedimentary terrane (pl. 3).

The Airy-Heiskanen isostatic anomaly map of Colorado (Qureshy, 1958, 1960) appears to support this structural picture of anticlinoria and synclinoria, particularly in eastern Colorado where post-Precambrian tectonism has been negligible (fig. 35). A gravity high would be associated with areas where the crust had been folded and thrusted upward, whereas a gravity low would be associated with a downfolded and thickened crust. The gravity anomalies in eastern Colorado are believed by Qureshy (1958, p. 27; 1962, p. 2466) to be very ancient features, perhaps as old as Precambrian.

From geological contact relationships, De Voto (1961, p. 25) determined the augen gneiss along Trout Creek, east of Buena Vista, Chaffee County, to be younger than the enclosing metasedimentary gneisses, as the augen gneiss, although in general conformity with the country rocks, locally transects the foliation of the metasediments. De Voto (1961, p. 30) suggests that this augen gneiss represents a high-catazonal to low mesozonal pluton which was the product of selective fusion at great depth. In this particular augen gneiss (De Voto, 1961, p. 29) and in the augen gneisses at Cripple Creek, Teller County (Hutchinson and others, 1964), the augen are made up of small xenoblastic microcline grains with minor amounts of quartz and plagioclase. Biotite grains have been excluded from the augen during their growth which suggests that the development of the microcline-rich augen occurred after the formation of the host rock. The formation of the granitic gneisses is considered to have occurred in the manner described by Eskola (1949) and Buddington (1959, p. 717) for the formation of gneiss domes by remobilization and introduction of fluids. Buddington (1959, p. 714) includes augen gneisses, prophyroblastic granites, granitic gneisses of replacement (metasomatic) origin, and migmatites with the catazonal environment. According to Williams, Turner, and Gilbert (1954, p. 247):

> "...in the deep levels of the crust igneous and metamorphic processes presumably merge to such a degree that distinction between the two is no longer justified."

The Pikes Peak granite has been intruded into the augen gneiss country rock as a mesozonal pluton (Hutchinson, 1960b), and therefore, the magma must have originated at a deeper level in the crust. De Voto (1961, p. 30) considered the augen gneisses to have been formed in the catazone, and age determinations show them to be of early Late Precambrian age. Johnson (1961, p. 70-71), using ideas developed by Hutchinson (1956, 1960a) for the origin of the Enchanted Rock batholith in

Texas, proposed a mode of origin for the Pikes Peak batholith, in which the older metasediments (formed in the early Late Precambrian orogenies) were selectively fused at great depth (in middle Late Precambrian time) and generated a granitic magma. In the time between the early Late Precambrian orogenies and the middle Late Precambrian intrusion of the Pikes Peak granite, the basement framework had become stabilized and the environment changed from the catazone to the mesozone.

A broad positive gravity anomaly extends southwestward from the northeastern corner of Colorado, where the Logan-Yuma granitic terrane has been designated, to the Front Range (fig. 35), where large areas of granitic augen gneisses in the southern Front Range and well samples of granitic gneisses from the buried basement of the Pueblo-Teller granitic terrane in Pueblo County closely resemble the granitic gneisses and augen gneisses found in the basement of the Logan-Yuma granitic terrane (figs. 36 and 37). From the evidence of the northeast-southwest-trending gravity anomaly, the similarity of the terrane lithologies, and the prevailing northeasterly direction of foliation trends in the Precambrian basement of Colorado (Oriel, 1954; King, 1959, p. 99; Badgley, 1960, p. 165), the writer believes that these two terranes connect across the Denver Basin and together form one elongate granitic terrane (pl. 1 and pl. 3). However, there are no wells to the subsurface basement from the southern Front Range and Pueblo County on the southwest to Morgan and Washington Counties on the northeast, and therefore, there are no samples of basement rocks from within this large area to either prove

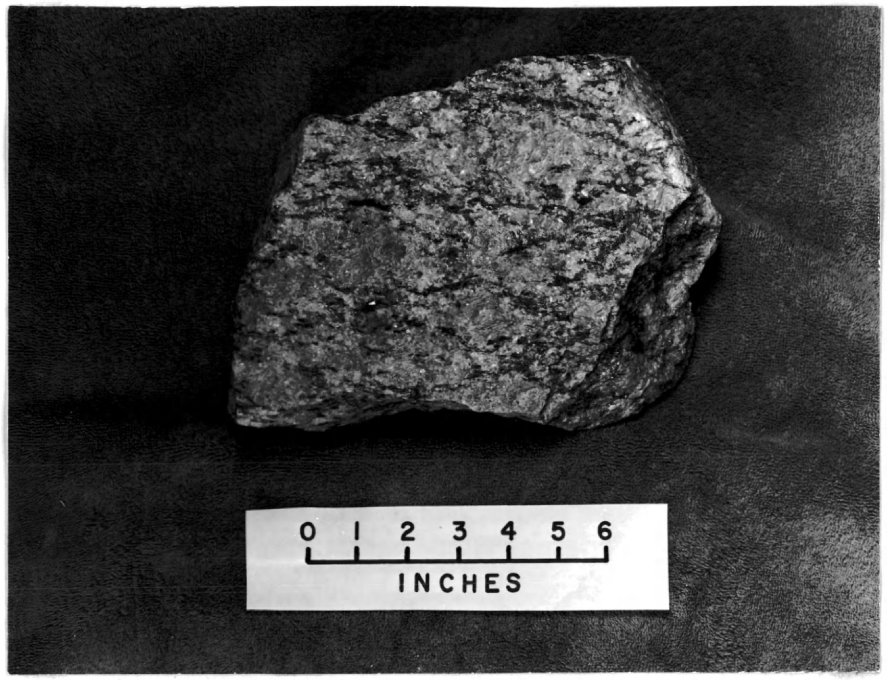


Figure 36: Biotite-plagioclase-microcline-quartz augen gneiss from Cripple Creek, Teller County. Sample PRC-27-74. Large gray areas devoid of dark minerals are porphyroblastic augen of microcline.

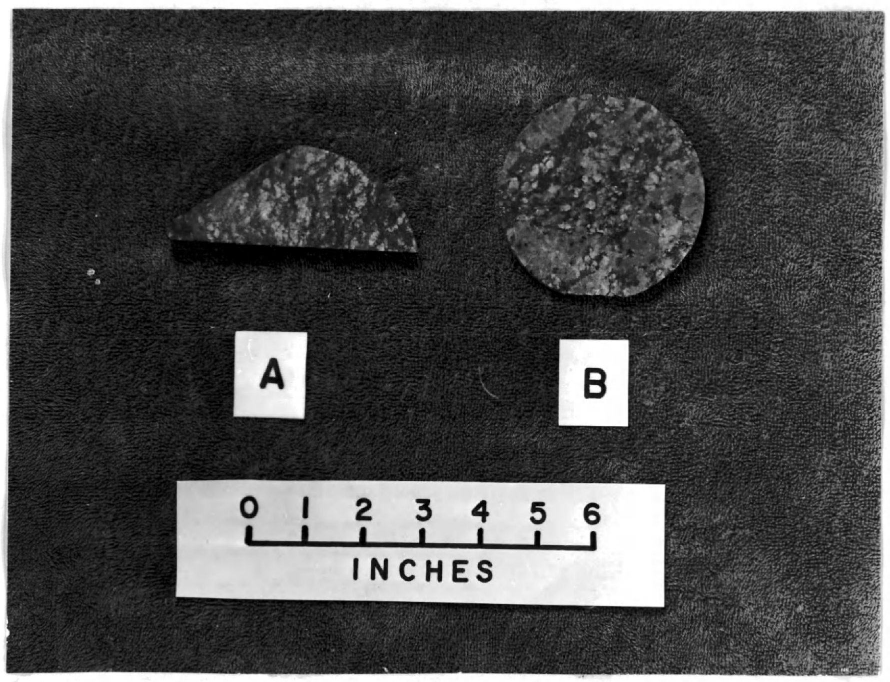


Figure 37: Biotite-microcline-quartz-plagioclase augen gneisses from the subsurface of northeastern Colorado. Large gray areas devoid of dark minerals are porphyroblastic augen of microcline.

A: Well CL-88, Logan County, Logan-Yuma granitic terrane

B: Well CL-206, Yuma County, Kit Carson-Kiowa metasedimentary terrane, but near boundary with Logan-Yuma granitic terrane.

or disprove this belief. This anticlinorial axis is also considered to extend to the southwest, through the region of granitized gneisses between the Weld-Delta and Saguache-Huerfano metasedimentary terranes, and include the Mesa-Montezuma granitic terrane (pl. 3).

In the Weld-Delta metasedimentary terrane, the granitic igneous rocks, granitic gneisses, and granitized metasediments encountered in wells CL-42, CL-43, CL-44, CL-52, CL-54, CL-55, CL-56, CL-90, CL-148, and CL-202 (pl. 1) occur within an elongate area which has a lithologic trend parallel to that of the terrane. Tweto (1957, p. 20) and the maps of Oriel (1954) and of Tweto and Sims (1963) show large areas of granitic rocks in the southern Park Range and in Grand County near Parshall and Hot Sulphur Springs. Harper (1964) states that at least half of the exposed Precambrian rocks of Glenwood Canyon in the White River uplift are of granitic rocks, which occur as plutons and dikes. These areas are also within this elongate trend of granitic rocks. At the northeastern end are the large plutonic masses of the Sherman granite, the Laramie anorthosite, and associated plutonic igneous rocks exposed in the Laramie Range. On the southwestern end are granitic gneisses and granites exposed in the northern end of the Uncompahgre uplift. This belt of granitic rocks could possibly be designated as a separate terrane, but the writer feels that there is not enough information from either the published papers on the exposed basement or from the well samples of the subsurface basement to justify this at the present time.

Downwarping of the crust in northwestern Colorado into an east-west elongated depositional basin is shown by the late Late Precambrian Uinta Mountain sedimentary terrane. The former north-south extent of these sedimentary rocks, however, is unknown. The west-northwest trend of the outline of the Otero-Bent volcanic terrane is the result of Late Paleozoic tectonism, but it is believed that these volcanic rocks were erupted along a west-northwest-striking fault or deep crustal fracture. Age determinations made on volcanic and shallow intrusive rocks similar to those of this terrane lie along a west-northwest alignment from southwestern Oklahoma to the Wet Mountains and Gunnison Valley of south-central Colorado and range from very latest Precambrian to Early Cambrian time. Although the rocks of the Otero-Bent volcanic terrane have not been dated, they lie directly on this alignment from Oklahoma to southern Colorado. It is not known whether or not the Otero-Bent and Uinta Mountain terranes are approximately contemporaneous, but apparently both terranes formed very late in Precambrian time upon the surface of a stabilized basement.

TABLE 18: ISOTOPIC AGE DETERMINATIONS OF PRECAMBRIAN ROCKS IN COLORADO

Compiled from all available isotopic ages published as of November 1965. Ten determinations made on well samples for this project are included. From discussions of the various methods of age determination in Rankama (1954), Knopf (1957), Tilton and others (1957), Aldrich and others (1960), and Goldich and others (1961), the ages considered to be the most reliable are underlined and are located on Plate 2.

Key to decay constants for K-Ar and Rb-Sr methods (see Source of Data column):

K-Ar:
(1) $\lambda\beta = 4.72 \times 10^{-10} yr^{-1}$, $\lambda\epsilon = .585 \times 10^{-10} yr^{-1}$
(2) $\lambda\beta = 4.72 \times 10^{-10} yr^{-1}$, $\lambda\epsilon = .589 \times 10^{-10} yr^{-1}$
(3) $\lambda\beta = 4.76 \times 10^{-10} yr^{-1}$, $\lambda\epsilon = .589 \times 10^{-10} yr^{-1}$
(4) $\lambda\beta = 4.72 \times 10^{-10} yr^{-1}$, $\lambda\epsilon = .557 \times 10^{-10} yr^{-1}$
(5) $\lambda\beta = 5.30 \times 10^{-10} yr^{-1}$, $\lambda\epsilon = .585 \times 10^{-10} yr^{-1}$
(6) $\lambda\beta = 5.08 \times 10^{-10} yr^{-1}$, $\lambda\epsilon = .508 \times 10^{-10} yr^{-1}$

Rb-Sr:
(7) $\lambda = 1.47 \times 10^{-11} yr^{-1}$
(8) $\lambda = 1.39 \times 10^{-11} yr^{-1}$
(9) $\lambda = 1.385 \times 10^{-11} yr^{-1}$
(10) $\lambda = 1.13 \times 10^{-11} yr^{-1}$
(11) $\lambda = 1.11 \times 10^{-11} yr^{-1}$

TERRANE AND NUMBER	COUNTY, LOCATION AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years)							SOURCE OF DATA
			K-Ar	Rb-Sr	Pb^{206}/U^{238}	Pb^{207}/U^{235}	Pb^{206}/Pb^{207}	Pb^{208}/Th^{232}	Lead-alpha	
WD 1	Adams County (C1-175) U.S. Army Corps of Engineers #1 Rocky Mountain Arsenal 26-2S-67W Microcline-biotite-quartz plagioclase gneiss	Biotite	1390	1320						This study (W.R. Muehlberger, personal comm.) (1, 7)
WD 2	Boulder County Granite pluton of Boulder Creek granite Location not given, but probably Central City area (see Moench, Harrison and Sims, 1962)	Zircon			as low as 1050		1730 (4 sples.)		as low as 1050	U.S. Geol. Survey (1964)

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years)							SOURCE OF DATA
			K-Ar	Rb-Sr	$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$	$\frac{Pb^{206}}{Pb^{207}}$	$\frac{Pb^{208}}{Th^{232}}$	Lead-alpha	
WD 3	Boulder County Silver Plume type of granite dike. Location not given (see no. 2 above)	Zircon			1050		1410		1050	U.S. Geol. Survey (1964)
WD 4	Boulder County 9400 ft. east of Eldora stock. Medium-grained amphibolite.	Hornblende	1375							Hart (1964) (5)
WD 5	Boulder County 14,000 ft. east of Eldora stock. Medium-grained homogeneous quartz-feldspar-biotite gneiss	Coarse Biotite	1172	1275						Hart (1964) (5, 8)
WD 6	Boulder County 22,500 ft. east of Eldora stock. Feldspar-quartz-biotite-muscovite pegmatite.	Coarse biotite muscovite feldspar	1168 1150 916	1291 1353						Hart (1964) (5, 8) " "
WD 7	Chaffee or Gunnison County Monarch Pass biotite gneiss	Biotite	1330							Giffin and Kulp (1960) (2)
WD 8	Clear Creek County quarry west of Silver Plume Silver Plume granite	Biotite	1210							Giffin and Kulp (1960) (2)

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years) K-Ar	Rb-Sr	$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$	$\frac{Pb^{206}}{Pb^{207}}$	$\frac{Pb^{208}}{Th^{232}}$	Lead-alpha	SOURCE OF DATA
WD 9	Clear Creek County quarry ½ mile west of Silver Plume granite	Biotite	1230 1210	1350 1360						Aldrich and others (1958) (1, 8)
WD 10	Clear Creek County at Silver Plume dike of Silver Plume granite	Biotite	1220							Giffin and Kulp (1960) (2)
WD 11	Clear Creek County (?) Silver Plume granite Location not given				930					Ahrens (1949) (Source of age not cited)
WD 12	Clear Creek County Loveland Pass Biotite granite	Biotite	1050							Giffin and Kulp (1960) (2)
WD 13	Eagle County U.S. Rte. 24, 200 meters south of road to Red Cliff Granitic gneiss	Whole rock		1650						Wetherill and Bickford (1965) (8)
WD 14	Eagle County U.S. Rte. 24 between Red Cliff and Pando Granite dike	Whole rock		1650						Wetherill and Bickford (1965) (8)
WD 15	Garfield County (CL-42) Kerr-McGee and Phillips #1 Unit 8-8S-102W Biotite-quartz-microcline-plagioclase gneiss	Whole rock		1690						This study. (W. R. Muehlberger personal comm.) (7)

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years)							SOURCE OF DATA
			K-Ar	Rb-Sr	$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$	$\frac{Pb^{206}}{Pb^{207}}$	$\frac{Pb^{208}}{Th^{232}}$	Lead-alpha	
WD 16	Gilpin County Lillian Mine, Central City Syenite	Zircon							1250	Gottfried, Jaffe, and Senftle (1959)
		Uraninite			1340	1345	1380	1210		"
WD 17	Gilpin County near Rollinsville Biotite pegmatite	Biotite	1240							Giffin and Kulp (1960) (2)
WD 18	Gilpin County near Rollinsville Biotite granite	Biotite	1340							Giffin and Kulp (1960) (2)
WD 19	Grand County near Fraser Biotite pegmatite	Biotite	1380							Giffin and Kulp (1960) (2)
WD 20	Gunnison County Colo. Rte. 306, 19.3 mi east of Almont Augen gneiss	Whole rock		1650						Wetherill and Bickford (1965) (8)
WD 21	Gunnison County Colo. Rte. 306, 7.1 mi. NE of Almont Slightly foliated granite	Whole rock		1650						Wetherill and Bickford (1965) (8)
				1397						"
WD 22	Gunnison County 12.3 mi. NE of Parlin between Ohio City and Pitkin Granite	Whole rock		1650						Wetherill and Bickford (1965) (8)

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years) K-Ar	Rb-Sr	$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$	$\frac{Pb^{206}}{Pb^{207}}$	$\frac{Pb^{208}}{Th^{232}}$	Lead-alpha	SOURCE OF DATA
WD	Gunnison County	Microlite	815	1290						Gheith (1958) (4, 8)
23	Brown Derby Mine near	Zircon			935	1100	1425			"
	Ohio City	Lepidolite		1475						"
	Pegmatite	"	1415							"
		Lepidolite	1395	1410	isotopic					"
		"	1360	1390	Pb-U					"
			1345	1560	ranged from					"
			1315	1370	915 to 1590					"
				1480						"
		Feldspar	875							"
		"	900							"
		Muscovite	1200	1390						"
	Altered Granite	Zircon			935	1100	1430			"
		Lepidolite		1460						"
	(Age of 1375 m.y. considered most probable at this locality by Gheith, 1958)	Monozite			1590	1420	1170	995		"
	Rock not specified	Lepidolite		1330						Herzog and others (1960) (source of ages not cited)
		Lepidolite		1350						"
		"		1375						"
		"		1395						"
		"		1410						"
		"		1415						"
		"		1570						"
				800						Ahrens (1949) (11)
				900						"

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years) K-Ar	Rb-Sr	$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$	$\frac{Pb^{206}}{Pb^{207}}$	$\frac{Pb^{208}}{Th^{232}}$	Lead-alpha	SOURCE OF DATA
WD 24	Gunnison County Quartz Creek, one mile west of Brown Derby Mine, Rock not specified (Age of 1350 m.y. considered most probable at this locality by Gheith, 1958)	Zircon			925	1130	1540	530		Gheith (1958)
WD 25	Gunnison County "Indian Head" rock between Parlin and Ohio City Granite	Whole Rock		1650						Wetherill and Bickford (1965) (8)
WD 26	Gunnison County U.S. Route 50 between Doylesville and Parlin (5 mi. south of Brown Derby Mine) Pegmatite	Microlite & Muscovite	1240	1400	isotopic Pb-U 1760 m.y.					Gheith (1958) (4,8)
		Mica	1325	1310						"
		Zircon					1700			"
		Monazite			1590	1420	1170	995		"
		Microlite			915	1055	1350			"
		Columbite-tantalite			1520	1470	1390			"
		Microcline	830	1290						Davis and others (1956) (6, 10)
		Lepidolite	1300	1410						Aldrich and others (1958) (1,8)
	Granite	Biotite	1380	1310						"
		Biotite	1300	1310						Gheith (1958) (4,8)
		Feldspar	970	1495						"
		Zircon			925	1130	1700	530		"
		Zircon			925	1130	1540	530		"
		Zircon			930	1130	1500	515		"
					(1500 m.y. age by isotopic Pb-U preferred by Gheith, 1958)					
	Granite	Whole Rock		1650						Wetherill and Bickford (1965) (8)
		"		1275						"

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years)							SOURCE OF DATA
			K-Ar	Rb-Sr	$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$	$\frac{Pb^{206}}{Pb^{207}}$	$\frac{Pb^{208}}{Th^{232}}$	Lead-alpha	
WD 26	Gunnison County U.S. Rte. 50, 5.7 mi east of Parlin Granite	Whole Rock		1650						Wetherill and Bickford (1965) (8)
WD 27	Gunnison County U.S. Rte. 50, 2.0 mi east of Parlin Granite	Whole rock		1650						Wetherill and Bickford (1965) (8)
WD 28	Gunnison County U.S. Rte. 50, 5.2 mi west of Monarch Pass Granodiorite	Whole Rock		1650						Wetherill and Bickford (1965) (8)
WD 29	Gunnison County U.S. Rte. 50, 6.9 mi west of Gunnison	Whole rock		1650						Wetherill and Bickford (1965) (8)
WD 30	Gunnison County Gunnison Canyon between Cimarron and Sapinero Biotite gneiss	Biotite	1130							Giffin and Kulp (1960) (2)
WD 31	Jackson County near Northgate Granite	Biotite	1180							Giffin and Kulp (1960) (2)
		Biotite	1160							"
WD 32	Jefferson County Gneiss from shear zone Location not given	Biotite	1200							Giffin and Kulp (1960) (2)

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years)							SOURCE OF DATA
			K-Ar	Rb-Sr	$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$	$\frac{Pb^{206}}{Pb^{207}}$	$\frac{Pb^{208}}{Th^{232}}$	Lead-alpha	
WD 33	Jefferson County near Golden Biotite granite	Biotite	1390							Giffin and Kulp (1960) (2)
WD 34	Jefferson County near Golden Biotite pegmatite	Biotite	1460							Giffin and Kulp (1960) (2)
WD 35	Jefferson County 1 mile east of Conifer Doublehead pluton Quartz monzonite	Biotite	1240							Hutchinson (1959a) (3)
WD 36	Lake County St Kevin Mining district St Kevin granite	7 whole rock samples		1350						Hedge and Walthall (1963) (7)
WD 37	Lake County Colo. Rte. 82, 0.7 mi west of Independence Pass Granite	Whole rock		1650						Wetherill and Bickford (1965) (8)
WD 38	Lake County 0.7 mi south of intersection of U.S. Rte. 24 and Colo. Rte. 82	Whole rock		1650						Wetherill and Bickford (1965) (8)
WD 39	Larimer County Between Livermore and Virginia Dale Sherman Granite	8 whole rock samples		1330						Peterman, Hedge, and Braddock (1965) (7)

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years)							SOURCE OF DATA
			K-Ar	Rb-Sr	$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$	$\frac{Pb^{206}}{Pb^{207}}$	$\frac{Pb^{208}}{Th^{232}}$	Lead-alpha	
WD 39	Log Cabin granite	6 whole rock samples		1330						Peterman, Hedge and Braddock (1965) (7)
WD 40	Larimer County Big Thompson Canyon area west of Loveland Quartz diorite	Whole rock		1650						Peterman, Hedge and Braddock (1965) (7)
	Orthogneiss	Whole rock		1650						"
	Low grade Metasedimentary rocks	Whole rock		1350						"
WD 41	Montrose County Black Canyon of Gunnison National Monument Biotite gneiss	Biotite	980							Giffin and Kulp (1960) (2)
WD 42	Park County 3 miles south of Jefferson Kenosha batholith Quartz monzonite	Biotite	1300							Hutchinson (1959a) (3)
WD 43	Rio Blanco County (CL-202) Humble Oil & Refining Co. #1 Crosho Lake-Gov't 13-2N-87W Biotite-quartz-plagioclase-microcline gneiss	Whole rock	Rb-Sr ratios unfavorable for dating							This study (W.R. Muehlberger, personal comm.)

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years)							SOURCE OF DATA
			K-Ar	Rb-Sr	$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$	$\frac{Pb^{206}}{Pb^{207}}$	$\frac{Pb^{208}}{Th^{232}}$	Lead-alpha	
WD 44	Routt County Park Range, near Slavonia Granitic porphyry	Zircon							739	Jaffe and others (1959)
WD 45	Saguache County U.S. Rte. 50, 15 mi east of Parlin Gneissic granite	Whole rock		1650						Wetherill and Bickford (1965) (8)
WD 46	Routt County Park Range	Zircon							1430	Jaffe and others (1959)
	Location not given	Zircon							1420	"
Not on Plate 2	Boulder County Location not given Boulder Creek granite	16 Zircon samples							900	Phair and Gottfried (1958)
Not on Plate 2	Boulder County Location not given	Zircon						600		Phair and Gottfried (1958)
	Silver Plume type of pegmatite, comagmatic with Log Cabin granite	Zircon							700	"
Not on Plate 2	Boulder County Location not given dikes of Silver Plume Granite cutting Boulder creek granite	Zircon							610	Phair and Gottfried (1958)
Not on Plate 2	Boulder County Location not given Granodioritic variety of Silver Plume Granite								900	Phair and Gottfried (1958)

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years)							SOURCE OF DATA
			K-Ar	Rb-Sr	$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$	$\frac{Pb^{206}}{Pb^{207}}$	$\frac{Pb^{208}}{Th^{232}}$	Lead-alpha	
Not on Plate 2	Other isotopic ages near Eldora, Boulder County, given by Hart (1964) may possibly show the effects of the Tertiary Eldora stock and were not included.									
SH 47	Alamosa County (CL-1) Amerada Petroleum Co. #1-F State 16-39N-10E (NMPM) Biotite-quartz-plagioclase gneiss	Biotite	1260							This study (W.R. Muehlberger, personal comm.) (1)
SH 48	Custer County Wet Mountains Location not given (probably McKinley Mountain area) granite	Zircon							755	Jaffe and others (1959)
SH 49	Custer County Wet Mountains McKinley Mountain area Albite syenite	Zircon (fresh)							595 avg. of 5	Jaffe and others (1959)
		"							580	"
		"							601	"
		Zircon (metamict)							590	"
		"							644	"
		"							605	"
		"							655	"

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years)							SOURCE OF DATA
			K-Ar	Rb-Sr	$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$	$\frac{Pb^{206}}{Pb^{207}}$	$\frac{Pb^{208}}{Th^{232}}$	Lead-alpha	
SH 50	Custer County Wet Mountains Location not given (probably McKinley Mountain area) granite gneiss	Zircon (metamict) " "							1220 1130 1080	Jaffe and others (1959) " "
SH 51	Huerfano County Southern Wet Mountains San Isabel granite	Zircon							1430	Boyer (1962)
LY 52	Logan County (CL-88) Shell Oil Co. #16-A Green 30-9N-53W Biotite-quartz-microcline-plagioclase augen gneiss	Feldspar		1510						This study. (W.R. Muehlberger, personal comm.) (7)
LY 53	Logan County (CL-89) Shell Oil Co. #2-B State 16-8N-53W Microcline-biotite-quartz-plagioclase gneiss	Biotite		1250						This study (W.R. Muehlberger personal comm.) (7)
LY 54	Yuma County (CL-173) Shell Oil Co. #1 Olsen 21-4N-48W Biotite-quartz-microcline-plagioclase gneiss	Whole rock		1360						This study. (W.R. Muehlberger personal comm.) (7)

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years) K-Ar	Rb-Sr	Pb^{206}/U^{238}	Pb^{207}/U^{235}	Pb^{206}/Pb^{207}	Pb^{208}/Th^{232}	Lead-alpha	SOURCE OF DATA
PT 55	Chaffee County 5 miles west of Trout Creek Pass "Granite" (augen gneiss)	Biotite	1430							Giffin and Kulp (1960) (2)
PT 56	Douglas County Devils Head Pegmatite	Samarskite			Lead-isotope ages are 1080, 1160, and 1220 m.y. depending on the isotope. 1080 age preferred.					Johnson (1961) from data in Hillebrand (1888), Holmes (1931) and Lovering and Goddard (1950)
PT 57	El Paso County top of Pikes Peak Pikes Peak Granite	Biotite	1060	1080						Aldrich and others (1958) (1, 8)
		Biotite	980							Giffin and Kulp (1960) (2)
PT 58	El Paso County Location not given Pikes Peak Granite	mineral not given			1050					Ahrens, 1949 (source not cited)
PT 59	El Paso County Gold Camp Road, 1 mile east of Rosemont Mt. Rosa Granite	Biotite	1020							Giffin and Kulp (1960) (2)
PT 60	El Paso County U.S. Route 24, 2 miles east of Manitou Springs Pikes Peak granite	Zircon			625	710				Aldrich and others (1958)
		Zircon			624	707				Davis and others (1960)
		Zircon			624	707	980	313		Gheith (1958)
		Zircon							707	Phair and Gottfried (1958)
		Zircon							675	Jaffe and others (1959)

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years)							SOURCE OF DATA
			K-Ar	Rb-Sr	Pb^{206}/U^{238}	Pb^{207}/U^{235}	Pb^{206}/Pb^{207}	Pb^{208}/Th^{232}	Lead-alpha	
PT 60	(Con't)	Mica	1030	1020						Davis and others (1956) (6, 10)
		Mica	980							Aldrich and others (1958) (1, 8)
PT 61	El Paso County Pikes Peak toll road	Biotite	1010							Giffin and Kulp (1960) (2)
	Pikes Peak granite	Biotite	1030							"
PT 62	Fremont County Royal Gorge Granite	Biotite	1540							Giffin and Kulp (1960) (2)
PT 63	Fremont County East end of Arkansas Canyon Biotite granite	Biotite	1470							Giffin and Kulp (1960) (2)
PT 64	Fremont County Arkansas Canyon	Biotite	1290							Giffin and Kulp (1960) (2)
	Biotite gneiss	Biotite	1300							"
PT 65	Jefferson County near South Platte. Outer zone, Pikes Peak batholith Granite	Biotite	1080							Hutchinson (1959b) (3)
PT 66	Jefferson County near South Platte. Intermediate zone, Pikes Peak batholith, Granodiorite	Biotite	1050							Hutchinson (1959b) (3)

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years)							SOURCE OF DATA
			K-Ar	Rb-Sr	$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$	$\frac{Pb^{206}}{Pb^{207}}$	$\frac{Pb^{208}}{Th^{232}}$	Lead-alpha	
PT 67	Jefferson County Wellington Lake Septum of hornblende grano-diorite in outer granitic zone.	Biotite	1050							Hutchinson (1959a) (3)
PT 68	Park County Tarryall Mountains 4 miles north of Tarryall Porphyritic aplite facies of Pikes Peak batholith	Biotite	995							Hutchinson (1963) (3)
PT 69	Park County Redskin Gulch stock, 3 miles southeast of Tarryall. Granite	Biotite	870							Hutchinson (1963) (3)
PT 70	Park County Lake George stock 2 miles north of Lake George Alkaline syenite	Biotite	995							Hutchinson (1963) (3)
PT 71	Pueblo County (CL-129) Pan American Pet. #1 Ingram 4-29S-67W Biotite-quartz-plagioclase microcline gneiss	Microcline		1300						This study. (W.R. Muehlberger personal comm.) (7)

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years)							SOURCE OF DATA
			K-Ar	Rb-Sr	Pb^{206}/U^{238}	Pb^{207}/U^{235}	Pb^{206}/Pb^{207}	Pb^{208}/Th^{232}	Lead-alpha	
PT 72	Pueblo County (CL-131) Phillips Pet. Co. #1-A Johnson 25-24S-61W Biotite-quartz-plagioclase-microcline gneiss	Whole rock		1600						This study. (W. R. Muehlberger personal comm.) (7)
PT 73	Teller County 2 miles south of Cripple Creek Cripple Creek granite	Biotite	1080							Hutchinson (1963) (3)
PT 74	Teller County Cripple Creek Canyon 5 mi. south of Cripple Creek Biotite-plagioclase-microcline-quartz augen gneiss	Biotite	1320							Hutchinson (1963) (3)
LB 75	Baca County (CL-177) Moran Bros. #1 Cramer 12-33S-50W Quartz monzonite	Whole rock		1280						This study. (W.R. Muehlberger personal comm.) (7)
MM 76	Dolores County (CL-29) Smith Drilling Co. #1 Groundhog Unit 13-40N-13W (NMPM) Latite porphyry	Zircon							550	California Oil Co.
MM 77	Gunnison County Iron Hill, near Powderhorn	Zircon							525	Jaffe and others (1959)
	Syenite	Zircon							550	"

TERRANE AND NUMBER	COUNTY, LOCATION, AND ROCK SAMPLED	MINERAL TESTED	AVERAGE AGE (in millions of years) K-Ar	Rb-Sr	$\frac{Pb^{206}}{U^{238}}$	$\frac{Pb^{207}}{U^{235}}$	$\frac{Pb^{206}}{Pb^{207}}$	$\frac{Pb^{208}}{Th^{232}}$	Lead-alpha	SOURCE OF DATA
MM 78	Mesa County	Apatite			1050		1810	200		Gheith (1958) (4,8)
	Quarry near east end of	"			1050	1380	1810			"
	Unaweep Canyon	"					1650			"
	(Shoemaker, 1956)	Biotite	1350							"
	Uncompahgre granite	"	1350				1700			"
		"	1330	1350						"
		Biotite-xenotime			3180	2065	1640	1100		"
		Biotite-xenotime	1360	1370						Aldrich and others (1956) (6, 10)
		Xenotime					1650			Gheith (1958)
		K-feldspar	1030							Davis and others (1955) (6)
MM 79	Montezuma County (CL-99) Continental Oil Co. #1 Ute Mountain 7-32N-19W (NMPM) Micrographic granite	Feldspar		1810						Fitzsimmons (1963) (also from W.R. Muehlberger personal comm.) (7)
MM 80	Saguache County Colo. Rte. 114, 15.0 mi. south of U.S. Rte. 50 Granite	Whole rock		1650						Wetherill and Bickford (1965) (8)
		"		1356						"
MM 81	San Miguel County (CL-149) Fred Turner #1 Buss 26-44N-13W (NMPM) Biotite-microcline-quartz-plagioclase gneiss	Biotite	1380							California Oil Co. (personal comm.) (1)

POST-PRECAMBRIAN IGNEOUS AND METAMORPHIC ACTIVITY IN COLORADO

As far as this paper is concerned, the primary interest in post-Precambrian igneous and metamorphic activity in Colorado is in the possible formation and existence of basement rocks which are not Precambrian in age. The term "basement", as defined by the American Geological Institute (A.G.I., 1960, p. 25), refers to the complex of igneous and metamorphic rocks beneath the sedimentary strata. Usually the term is understood to mean Precambrian rocks, but there may also be Paleozoic, Mesozoic, and Cenozoic basement rocks. Metasedimentary and plutonic rocks in Colorado similar to those of the exposed Precambrian basement and unconformably overlain by Paleozoic, Mesozoic, and Cenozoic sedimentary (or volcanic) rocks have been assumed to be of Precambrian age. Usually this assumption is valid, but unless there is some confirmation either by field relationships, where the youngest age of the basement is indicated by the age of the overlying strata, or by isotopic age determinations made on the basement rocks, there is always the possibility that these rocks may be younger than Precambrian.

Igneous rocks of the alkalic intrusive complexes at Iron Hill, Gunnison County, and at McKinley Mountain, Custer County (fig. 38), have been dated by the lead-alpha method (Jaffe and others, 1959) and fall approximately on the time boundary between the Precambrian and Cambrian. The shallow intrusive latite porphyry from well CL-29 in Dolores County yielded an age of 550 ± 110 m.y., which indicates that it could be placed within the Cambrian Period. The tuffaceous and shallow intrusive rocks of the Otero-Bent volcanic terrane (fig. 42) are known to be older than the overlying Arbuckle Dolomite of Ordovician age, but whether or not they are as old as Precambrian remains to be seen.

Three small subcircular inliers which contain blocks of Silurian and older sedimentary rocks along with much material of probable volcanic origin occur within the exposed Precambrian basement of the Laramie Range in southern Wyoming and northern Colorado (fig. 38) (Chronic and Ferris, 1961; 1963; Chronic, McCallum, and Ferris, 1965). These inliers are believed to be diatremes or volcanic pipes, certainly of post-Silurian age, which indicate a previously unknown period of volcanism of possible Late Paleozoic age in the Rocky Mountains (Chronic, McCallum, and Ferris, 1965).

Barnes (1954) determined from detailed field and petrographic studies that a coarse-grained porphyritic granite exposed at the southern end of the Grenadier-Needle Mountains mass in the Animas River Valley north of Durango, La Plata County (fig. 38), intruded the overlying

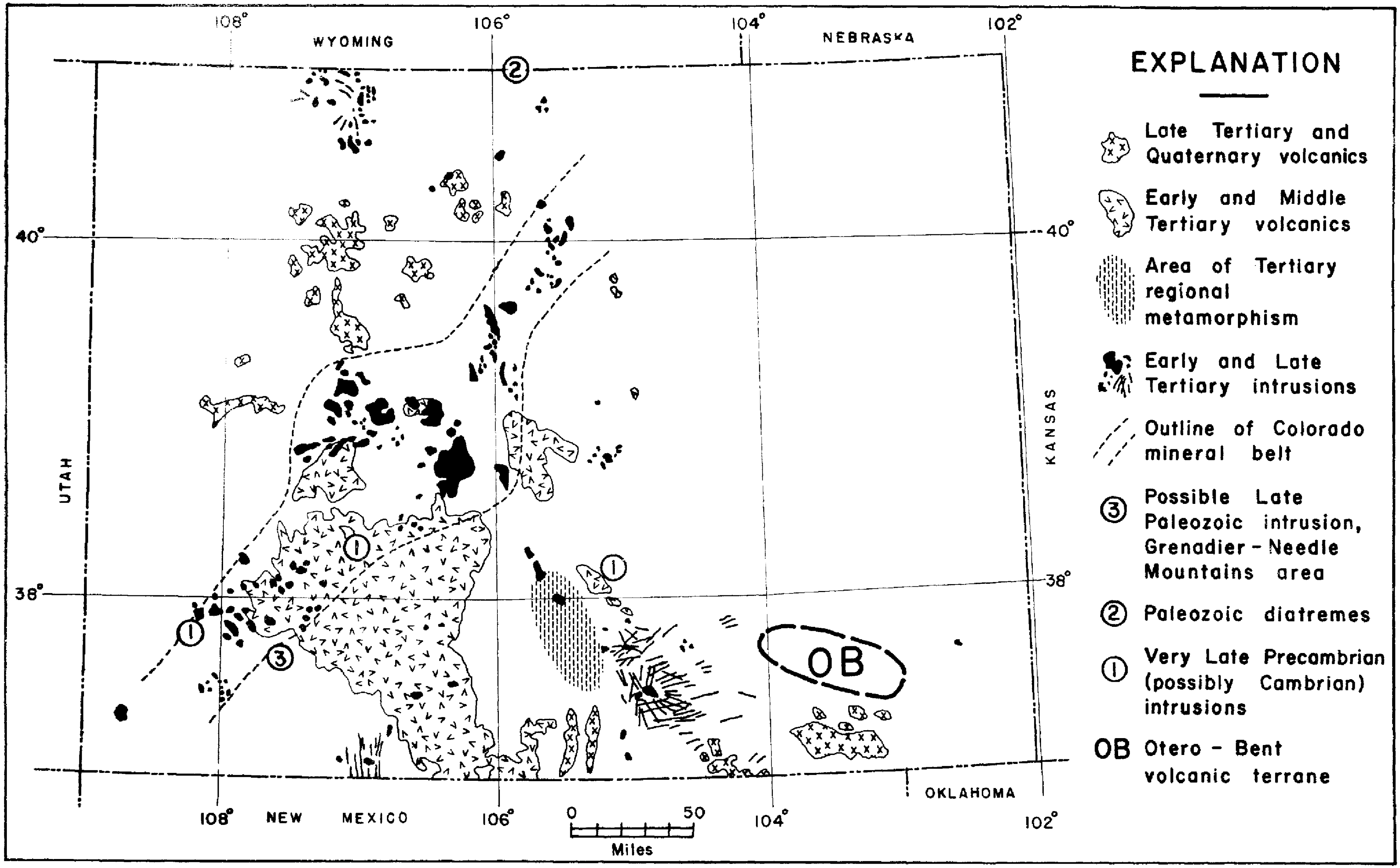


Figure 38: Location map of post-Precambrian igneous and metamorphic activity in Colorado (from Geological Map of Colorado, 1935, and other references mentioned in text). Very Late Precambrian intrusions and Otero-Bent volcanic terrane included.

Ignacio Quartzite with attendant contact metamorphism, and also contained xenoliths of the quartzite. He also concluded from a study of the Paleozoic stratigraphy in the area (Barnes, 1954) that the age of the Ignacio Quartzite was Devonian and not Cambrian as considered previously by Cross and Hole (1910, p. 4). This would place the age of the granite intrusive as younger than Devonian. Hinds (1936, p. 70), however, had also examined the quartzite-granite contact in this same area and considered it to be an unconformity, as he reported arkosic debris from the subjacent granite present in the overlying sandstone. It would be interesting to have an isotopic age determination made on samples of the granite from this locality. Other than the diatremes of possible Late Paleozoic age in the Laramie Range of Wyoming and Colorado (Chronic, McCallum, and Ferris, 1965) no direct evidence of any other occurrences of igneous activity is known to exist in Colorado from latest Precambrian (or earliest Cambrian) time to the Late Cretaceous-Early Tertiary period of extensive intrusion and volcanism.

Concerning igneous activity which may have accompanied the formation of the Late Paleozoic Ancestral Rocky Mountains, Burbank (1933, p. 281) writes:

> "There is but slight evidence that volcanism and igneous intrusion accompanied this diastrophism, although the Pennsylvanian and Permian conglomerates in the Sangre de Cristo Range and as far north as Minturn in central Colorado contain igneous rocks of kinds not commonly recognized as pre-Cambrian; but their sources are undetermined. However, igneous activity must have been comparatively feeble and any ore deposits that may have been formed were likely to have been destroyed during the epoch of erosion that reduced the highland areas to a mature

topography before the beginning of the Mesozoic."

Harms (1964, p. 96), in a study of the structural history of the Front Range, states that there is no evidence of any igneous activity associated with the late Paleozoic tectonism. However, the above-mentioned diatremes within the exposed basement of the Laramie Range may represent volcanic activity associated with the development of the Ancestral Rocky Mountains.

Occurrences of bentonitic layers in the Chinle Formation of Triassic age (Oriel and Craig, 1960, p. 48; Cadigan, 1963) and in the Mowry (Haun, 1959) and Pierre Shales of Cretaceous age are evidence of igneous activity in western North America during Mesozoic time, but none of which originated in Colorado.

The most widespread period of igneous activity in Colorado since Precambrian time began during the Cretaceous-Tertiary Laramide deformation. Numerous intrusions occurred across the State along a northeast-trending belt from Montezuma County to Boulder County (fig. 38). A less well-developed line of intrusions extends from the area of the Spanish Peaks in southern Colorado north-northwest to the Elkhead Mountains. Where these two trends cross, the Tertiary batholiths of the Sawatch Range occur. Extensive vulcanism throughout Tertiary time took place in the region of the San Juan Mountains. Other tuffaceous and volcanic flow rocks of early through late Tertiary age occur throughout southern, central, and western Colorado. In addition, volcanic ash debris is a component of many late Cretaceous and Tertiary sediments.

Volcanic rocks of Quaternary age are present in the southern San Juan Mountains and in the San Luis Valley (Geologic Map of Colorado, 1935). An occurrence of volcanism in Recent time near Dotsero, Eagle County, has been described by Landon (1933) and Giegengack (1962), and consists of a basaltic flow with associated volcanic ash and cinders.

Metamorphic activity since Precambrian time has most likely been confined to contact effects adjacent to many of these Tertiary and Quaternary intrusions. Karig (1963b, 1964), however, describes occurrences of regionally-metamorphosed rocks along the west side of the Sangre de Cristo Range in Saguache and Alamosa Counties (fig. 38). The metamorphism is considered to be of Tertiary age and has affected rocks both of Permo-Pennsylvanian and of Precambrian age. The maximum grade of metamorphism observed by Karig was in the greenschist facies, characterized by the development of chloritoid-bearing and andalusite-bearing phyllites and schists. Metamorphism of the Precambrian gneisses resulted mainly in the development of chlorite, muscovite, and epidote.

If these Tertiary metamorphic rocks, or the coarse-grained igneous intrusions of Tertiary age such as these which are found in the Front Range, the Sawatch Range, or the Elk Mountains, were encountered in drill cuttings, they could conceivably be mistaken for Precambrian basement rocks. The Tertiary batholiths in the Sawatch Range have intruded the Precambrian basement, and if it were not for the associated dikes which extend into overlying post-Precambrian sedimentary rocks, these intrusions would probably be considered as Precambrian. Isotopic ages on these Tertiary batholiths and stocks range from 35 to 75 m.y., with the majority being around 65 m.y. (Eckelmann and Kulp, 1957; Pearson and others, 1962).

TECTONIC HISTORY OF COLORADO

The tectonic history of the region which includes the State of Colorado has been discussed by Eardley (1962) in connection with the tectonic history of the North American continent, and also by Haun and Kent (1965) for the Rocky Mountain region. A brief summary will be given here in which consideration will be given to the possible influence of Precambrian basement lithology and structure upon the post-Precambrian tectonic development of Colorado.

The Precambrian basement provinces of North America, which have been defined by isotopic age methods, have overall trends to the northeast (fig. 39) (Gastil, 1960; Engel, 1963; Tilton and Hart, 1963). These provinces formed as marginal orogenic belts during the evolution of the continent and, at the culmination of each successive orogenic period, became a stabilized part of the growing continent (Engel, 1963). The prevailing trend of the early Late Precambrian orogenic belt which produced the basement of Colorado was to the northeast (King, 1959, p. 99), and younger Precambrian igneous activity in Colorado was in the form of post-tectonic mesozonal intrusions emplaced within the con-

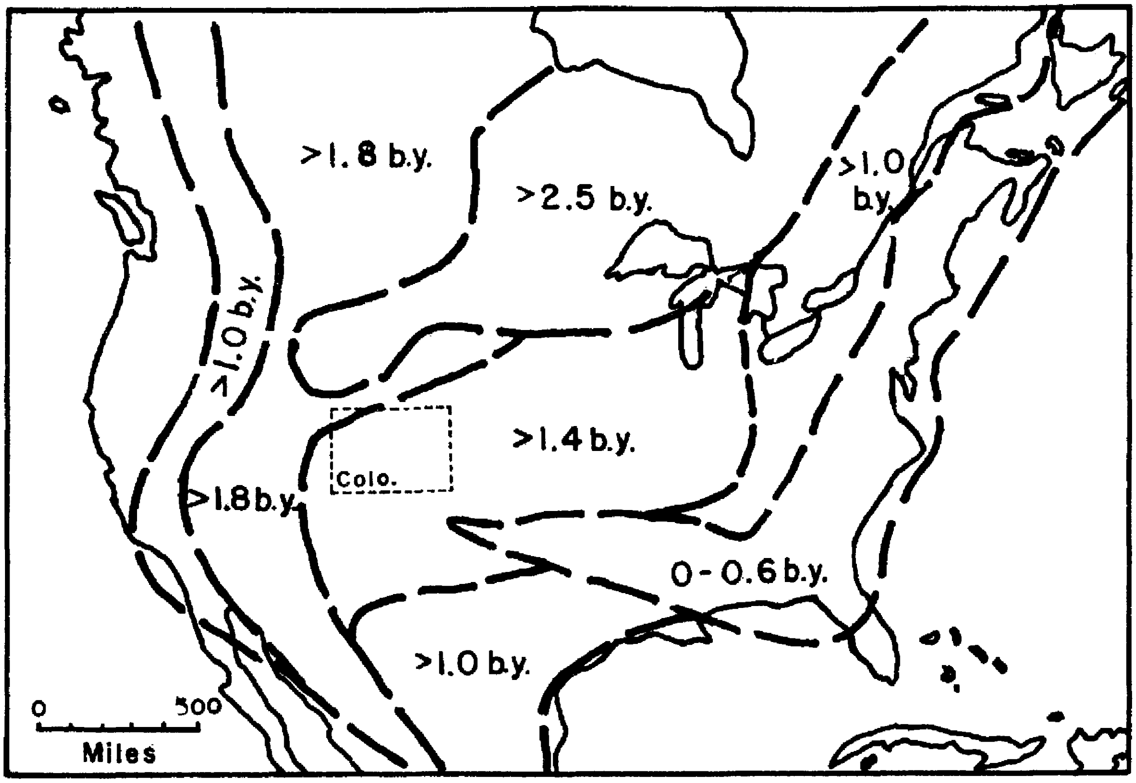


Figure 39: Precambrian provinces of North America as determined by isotopic ages (adapted from Engel, 1963).

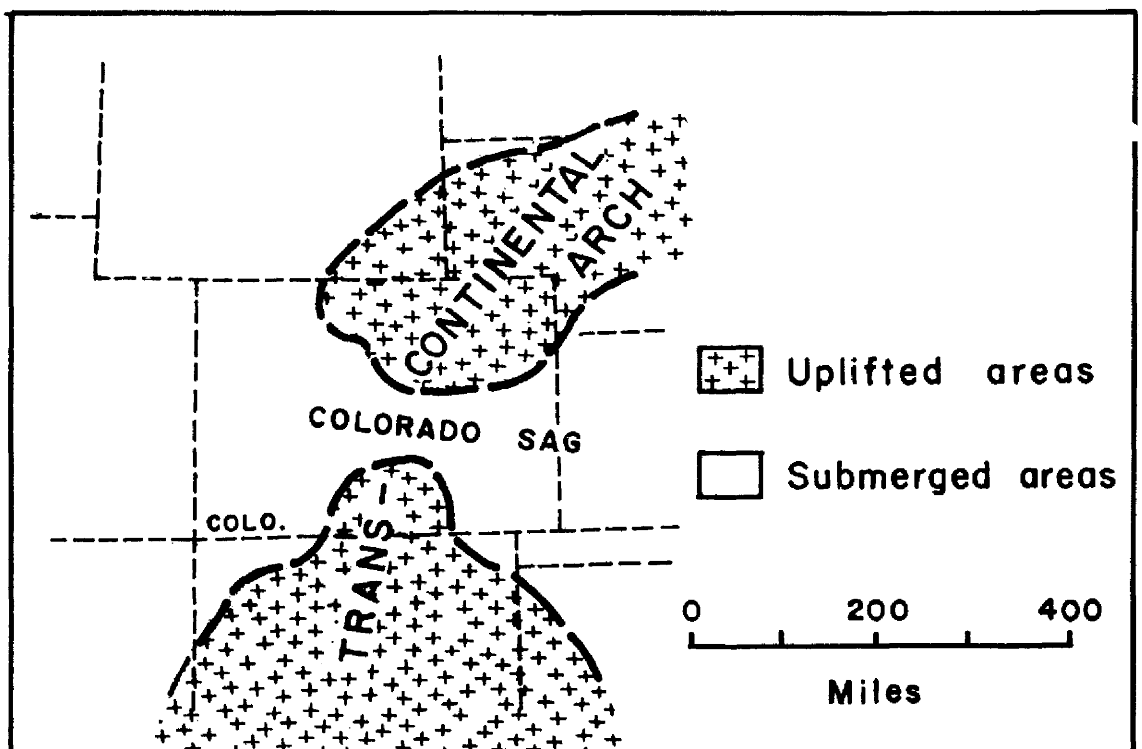


Figure 40: Paleogeography of Colorado and adjacent areas at the end of the Cambrian Period (adapted from Haun and Kent, 1965).

solidated and stabilized basement framework. Following the formation of the basement in early to middle Late Precambrian time, extensive shearing has continued to occur along a northeast-trending zone across central Colorado, which is now the site of the Colorado mineral belt (Tweto and Sims, 1963). In late Late Precambrian time, downwarping or subsidence of the crust in northwestern Colorado produced the depositional basin for the Uinta Mountain sedimentary terrane. Deep fracturing or faulting of the crust in a west-northwest direction also occurred in late Late Precambrian time from Oklahoma to southern Colorado and was accompanied by volcanic eruptions and shallow-seated intrusive activity.

The early late Precambrian northeasterly structural trend of the basement continued from Late Precambrian time into Paleozoic time as the crustal upwarp of the Transcontinental arch (fig. 40) (Eardley, 1962; Haun and Kent, 1965) and was an important structural influence on Early and Middle Paleozoic sedimentation in Colorado. The structural downwarp across the Transcontinental arch known as the Colorado sag (Eardley, 1962; Haun and Kent, 1965) may have been related to the west-northwest-trending zone of volcanism and possible faulting of very latest Precambrian time. The basement of Colorado appears to have remained stable throughout the Early Paleozoic, with the only expression of tectonic activity being epeirogenic uplift and subsidence.

In Late Mississippian or Early Pennsylvanian time the northeasterly trend of structural elements in Colorado, which had persisted since the Precambrian, was replaced by a northwesterly trend which has been the most persistent structural trend in Colorado ever since. There are no distinct pre-existing structural features of Precambrian age which can be singled out as examples of basement control for this trend, but in southern and western Colorado several of the lithological terranes have an apparent northwesterly alignment (pl. 1) which may indicate warping or perhaps even faulting in a northwesterly direction. The most intense period of Late Paleozoic tectonic activity occurred during the Middle Pennsylvanian (fig. 41) (Mallory, 1960, p. 25), but pulsational uplift and downwarping influenced sedimentation in the region as late as the Jurassic (Oriel and Craig, 1960, p. 56). Tweto and Sims (1963, p. 1006-1008) cite evidence which shows that the Late Precambrian northeasterly shear zone across central Colorado continued as a local control of sedimentation throughout Late Paleozoic and Mesozoic time.

Regional subsidence of the basement in Early Cretaceous time resulted in a north-south oriented seaway across Colorado (Haun and Weimer, 1960, p. 58; Eardley, 1962). In the Late Cretaceous, transgressive and regressive shorelines in Colorado had a northwest orientation (Weimer, 1960, p. 14-17), and indicated pulsational uplift along northwesterly alignments. Laramide deformation of Late Cretaceous to Early Tertiary time resulted in an overall north-south trend for tectonic elements in central Colorado. However, these are seen in detail to consist of many northwest-trending en-echelon units (fig. 42).

Three regional structural trends have been determined by Warner (1957) for Laramide deformation in Colorado. These are: a major north-

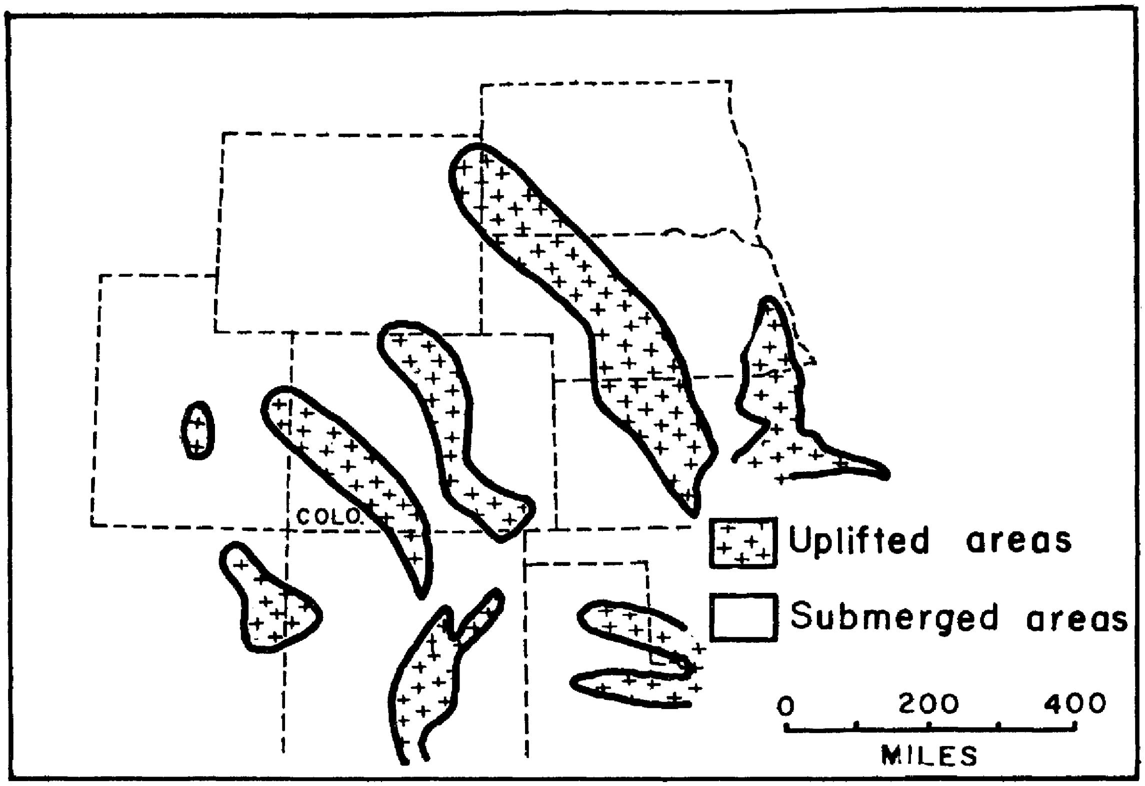


Figure 41: Paleogeography of Colorado and adjacent areas during the Pennsylvanian Period (from Eardley, 1962).

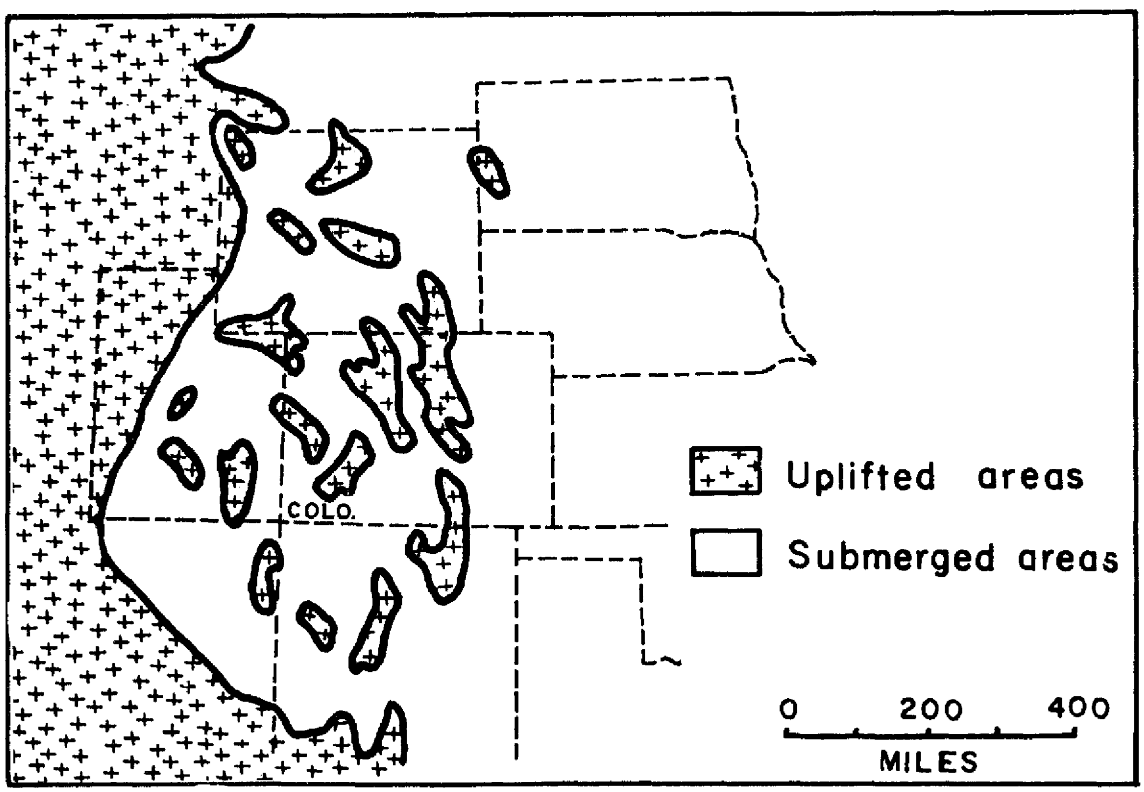


Figure 42: Paleogeography of Colorado and adjacent areas during the Late Cretaceous and Early Tertiary Periods (from Eardley, 1962).

south belt of uplifts characterized by folding, faulting, and thrusting; a zone of uplifts extending northwesterly from southeastern Colorado to the Uinta Mountains; and a poorly-defined zone of uplifts extending northeasterly from the Four Corners region, characterized by extensive Early Tertiary intrusive activity. This last trend may possibly have been controlled by the northeast-trending regional structure of the Precambrian basement (Warner, 1957; Tweto and Sims, 1963). The northwesterly trend probably is directly related to the Late Paleozoic tectonism which produced the Ancestral Rocky Mountains (Burbank, 1933) and the east-west trend of the Uinta Mountains appears to bear a direct relationship to the late Late Precambrian depositional trough.

Post-Laramide tectonism in Colorado has been characterized by regional uplift, normal faulting, and igneous activity (Haun and Kent, 1965, p. 1794). Doming associated with extensive volcanism occurred in Early and Middle Tertiary time in the San Juan Mountains (Larsen and Cross, 1956). Normal faulting in Middle Tertiary time, and possibly continuing into Recent time, has resulted in the San Luis Valley and associated smaller graben structures which extend northward from New Mexico as far as the Arkansas Valley between the Sawatch and Mosquito Ranges (Karig, 1963b, p. 105). Early Tertiary intrusive activity is oriented in a northeasterly direction as is illustrated by the intrusions of the Colorado mineral belt. Volcanic rocks of Early to Middle Tertiary age lie south of this zone and extend from the San Juan Mountains to the Thirty Nine Mile volcanic field in the southern Front Range (fig. 38).

An extensive system of stocks, plugs, dikes, and sills of Early to Middle Tertiary age associated with the Spanish Peaks intrusives lie in a north-northwest-aligned zone east of the Sangre de Cristo Range and San Luis Valley. Volcanism and intrusive activity of Late Tertiary to Quaternary age has occurred throughout northern, central, and southern Colorado in a poorly-defined north-northeast-trending zone (fig. 38) which may bear some relation to the rifting of the San Luis Valley region.

In considering the possible control of the basement lithological terranes upon the present structure, the broad eastern flank of the Denver basin coincides generally with the trend of the Logan-Yuma and Pueblo-Teller granitic terranes. Most of the mountain uplifts of Colorado and crustal flexures, such as the troughs of the Denver, Raton, and Piceance basins, the crests of the Apishapa uplift and Las Animas arch, and the northeastern flanks of the Uncompahgre uplift and the Paradox and San Juan basins, occur mainly within metasedimentary terranes. Chamberlin (1945) considered that the basement uplifts in Montana and Wyoming were controlled by the lithology of the basement rocks. The cores of these uplifts were described by him as rigid granitic batholiths surrounded by a schistose basement framework. These schists presumeably had less strength to resist deformation and the marginal faults and flexures were concentrated in them. These analogies break down, however, when the present basement structure of the Weld-Delta, Saguache-Huerfano, Las Animas-Baca, and Mesa-Montezuma terranes are considered as a whole (compare Figure 1 with Plate 1 and Plate 3). There seems to be no distinct association of the present basement structure in Colorado with the lithology of the Precambrian basement terranes.

Badgley (1960, p. 165, 168) considers that the directions of Laramide faulting and jointing in the exposed Precambrian basement of Colorado, due to a stress oriented N80°E, have been strongly influenced by the Precambrian tectonic framework. Tweto and Sims (1963, p. 993) state that many of the faults and shears in the exposed basement have been inherited from Precambrian time, and that some of these features which were previously regarded to be of Laramide origin are actually Precambrian. Undoubtedly, many of the old Precambrian joints, faults, and shears were rejuvenated as a response to crustal stresses during the Cretaceous-Tertiary Laramide deformation. However, Houston (1965) proposes caution in determining whether or not Precambrian structures have influenced the Laramide tectonic pattern. He states that the effects of Laramide deformation must be subtracted from the regional structure so that the pre-Laramide positions of the faults, joints, and foliation directions can be related. Prucha, Graham, and Nickelsen (1965) and Hoppin and Palmquist (1965) believe that foliation trends and differences in basement lithologies have had little to do with the development of Laramide structure in Wyoming.

From this brief review of the tectonic history of Colorado, it appears that with the passage of time since the Precambrian, the basement structural trends of Precambrian age have had progressively less influence upon the development of post-Precambrian structure. This may be due to the fact that since its origin in the Precambrian, the basement now exposed at the Earth's surface has become progressively further removed from the deep-lying zones where tectonic activity originates. Also, each new period of tectonism adds new structural features and masks older ones until they can no longer be identified, although it is possible that they may still continue to exert some small degree of control on the pattern of deformation.

SUMMARY OF CONCLUSIONS

As a result of this investigation, the pattern of basement lithologies identified in samples from 123 wells in Colorado has outlined 10 lithological terranes. Four of these terranes, the Weld-Delta metasedimentary terrane, the Kit Carson-Kiowa metasedimentary terrane, the Saguache-Huerfano metasedimentary terrane, and the La Plata-San Juan metasedimentary terrane, are characterized by a predominance of paragneisses. Four terranes, the Logan-Yuma granitic terrane, the Pueblo-Teller granitic terrane, the Las Animas-Baca granitic terrane, and the Mesa-Montezuma granitic terrane, are charaterized by a predominance of granitic rocks and orthogneisses. With reference to the remaining two terranes, the Uinta Mountain sedimentary terrane is made up of Precambrian sedimentary rocks, and the Otero-Bent volcanic terrane is composed of volcanic rocks.

Foliation trends in the exposed Precambrian rocks and the distribution of isotopic age determinations have no distinct relationship to the pattern of lithological terranes. This fact may be due to the lack of sufficient data at the present time from well samples and from isotopic age determinations. However, the pattern of positive and negative gravity anomalies, particularly in eastern Colorado where post-Precambrian tectonic activity has been slight, does appear to bear a direct relationship to the pattern of granitic and metasedimentary terranes.

It is concluded that the Precambrian basement framework of Colorado was formed during several orogenic periods which involved deformation, metamorphism, and syntectonic and post-tectonic intrusive activity. These resulted in a complex pattern of foliation trends marked by over-all structural trend of northeast-southwest, which reflects the tectonic control of the orogenic belt. Isotopic age determinations range from as early as 1800 m.y. to as late as 525 m.y., but there appear to have been at least five periods of large-scale igneous activity. These occurred throughout the basement of Colorado about 1650, 1430-1380, 1350-1300, 1250-1200, and 1050-980 million years ago. The last of these major periods of intrusive activity occurred primarily in the Pikes Peak region of the southern Front Range and appears to be more restricted in distribution than the older periods of intrusion. This particular period is characterized by post-tectonic mesozonal plutons, which were emplaced within a stabilized basement framework of older rocks typical of the catazone.

The granitic and metasedimentary terranes represent anticlinoria of upfolded and upthrusted granitic rocks and synclinoria of downfolded metasedimentary rocks formed during the periods of orogenic deformation and intrusion of the basement. The anticlinoria of granitic rocks correspond to positive gravity anomalies which suggest an upfolded basement and a shallower-than-average depth to the mantle. The synclinoria of metasedimentary rocks correspond to negative gravity anomalies where a downfolded and thickened basement has resulted in a greater-than-average depth to the mantle.

The Otero-Bent volcanic terrane, in southeastern Colorado, is made up of tuffaceous volcanic rocks and shallow-seated intrusives perhaps indicating a zone of deep crustal fracturing. Although the rocks of this terrane have not been dated, they are similar to and are believed to be contemporaneous with late Late Precambrian (650 to 550 m.y.) shallow-seated intrusives and volcanic rocks which occur in south-central Colorado and in southwestern Oklahoma. The Uinta Mountain sedimentary terrane, in northwestern Colorado, occupies a very Late Precambrian east-west-trending structural downwarp of the older, crystalline basement into which the clastic sediments of the Uinta Mountain Group were deposited.

Since the stabilization of the early Late Precambrian orogenic belt in middle Late Precambrian time, the structural influence of the basement upon the later tectonic development of Colorado has decreased with the passage of time. Epeirogenic uplift of the basement in the northeast-trending Transcontinental arch extended from the Late Precambrian into the Early Paleozoic. Successive periods of tectonic activity in Late Paleozoic, Cretaceous-Tertiary, and Tertiary times have been progressively freer from influence of Precambrian structure and have impressed their own patterns of deformation upon the basement.

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THE PETROLOGY AND STRUCTURE OF

THE BURIED PRECAMBRIAN BASEMENT OF COLORADO

By

Jonathan Edwards, Jr.

Volume 2

Appendices

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APPENDIX I: TABULAR DATA OF WELLS TO THE BASEMENT IN COLORADO

Compiled from the well completion cards published by Petroleum Information Corporation, Denver, Colorado.

Wells are listed by county, and within each county by Township, Range, and Section. NSL = no samples located for the well. Samples from wells drilled after June 1964 were not included in this study.

COUNTY AND LOCATION	OPERATOR AND LEASE	WELL NUMBER	DATE	SURFACE ELEV. (msl)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT (ft)	ELEV. OF BASEMENT (msl)	AGE OF OVERLYING FORMATION	DESCRIPTION ON PAGE (Vol. 2)
Adams 26-2S-67W	U. S. Army Corps of Engineers #1 Rocky Mountain Arsenal	CL-175 AD-1	1961	5202 (KB)	12045	11974	-6772	Ordovician?	21
Alamosa 16-39N-10E (NMPM)	Amerada Petroleum Co. #1-F State	CL-1 AL-1	1959	7569 (KB)	6072	5408	2161	Tertiary	22
Archuleta 9-32N-1E (NMPM)	Cameron Drilling Co. #1 Ed Bramwell	CL-2 AH-1	1957	7252 (Gr)	2476	2450	4802	Triassic	24
Archuleta 18-34N-1W (NMPM)	J.E. Mavor, et.al. #1 Snook Heirs	CL-6 AH-5	1953	7160	1331	1303	5857	Triassic	NSL
Archuleta 28-35N-2W (NMPM)	Wirt Franklin #1 Sullenberger	CL-3 AH-2	-	7580 (KB)	1550 ?	1668	5912	-	25
Archuleta 4-36N-2E (NMPM)	Francis Harvey #1 Government (#1 Quartz Creek)	CL-4 AH-3	1953	8771 (Gr)	1221	Tertiary 920	Intrusive 7851	-	26
Archuleta 24-36N-2W (NMPM)	Plains Prod. #1 Macht	CL-8 AH-7	-	7612 (KB)	2022	2021	5591	Ignacio	NSL

COUNTY AND LOCATION	OPERATOR AND LEASE	WELL NUMBER	DATE	SURFACE ELEV. (msl)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT (ft)	ELEV. OF BASEMENT (msl)	AGE OF OVERLYING FORMATION	DESCRIPTION ON PAGE (Vol. 2)
Baca 32-28S-48W	Skelly Oil Co. #1 McEndree	CL-176 BA-3	1961	4620 (KB)	5601	5563	-943	Ordovician	29
Baca 8-30S-50W	Marland #1 Mesa-Bergunthal	CL-10 BA-2	1928	4934 (KB)	2088	2067	3002	Ordovician	27
Baca 34-32S-49W	J.E. Campbell #1 -	CL-185 BA-6	-	-	-	278	-	-	NSL
Baca 12-33S-50W	Moran Bros. #1 Cramer	CL-177 BA-4	1961	4972 (KB)	3307	3238	1734	Ordovician	31
Baca 22-34S-48W	Frankfort Oil Co. #1-C Cimarron	CL-186 BA-7	1960	4350 (KB)	6075	6048	1518	Ordovician	33
Baca 3-35S-50W	Moran Bros. #1 Singer	CL-178 BA-5	1961	4510	4591	4560	-50	Ordovician	32
Bent 15-26S-52W	Clayton Oil Co. #1 Etchart	CL-12 BE-2	1959	4194 (KB)	4450	4430	-236	Ordovician	35
Bent 14-26S-53W	Seaboard Oil Co. #1 Government	CL-13 BE-3	1957	4364 (KB)	6461	6429	-2065	Ordovician	35
Bent 27-27S-49W	Marland #1 Pipe Springs	CL-187 BE-6	1930	4827	6084	5920	-1093	Pennsylvanian	NSL
Bent 35-27S-52W	Texaco, Inc. #1 M.E. Jones	CL-179 BE-5	1961	4423 (KB)	4397	4380	43	Ordovician	36
Bent 17-27S-51W	Amerada Petroleum Co. #1 C.L. Dillon	CL-11 BE-1	1956	4316 (DF)	4532	4530	-214	Ordovician	34
Cheyenne 19-13S-46W	Continental Oil Co. #1 Continental-UPRR	CL-209 CY-2	1963	4438 (KB)	6145	6136	-1698	Cambrian	NSL

COUNTY AND LOCATION	OPERATOR AND LEASE	WELL NUMBER	DATE	SURFACE ELEV. (msl)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT (ft)	ELEV. OF BASEMENT (msl)	AGE OF OVERLYING FORMATION	DESCRIPTION ON PAGE (Vol. 2)
Cheyenne 13-13S-49W	Gulf Oil Corp. #1 U.P. Larsen	CL-15 CY-1	1938	4518 (KB)	6360	6340	-1822	-	NSL
Custer 26-21S-69W	Donnelly #1 Hodge	CL-188 CU-1	1940	-	1662	1300	-	-	NSL
Delta 21-13S-93W	Murfin and Sutton #1 Ferrier	CL-26 DE-10	1957	6928 (KB)	4889	4870	2058	Jurassic	NSL
Delta 35-13S-95W	Cushman and Pilcher #1 Hawkins	CL-22 DE-6	1956	5473 (Gr)	2606	2590	2883	Jurassic	37
Delta 22-14S-94W	Williamson Oil and Gas #1-B Government (Thos. F. Strook)	CL-27 DE-11	1956	5369 (DF)	1948	1940	3429	-	NSL
Delta 25-14S-94W	James M. Cline #1 Fee	CL-21 DE-5	1952	5390 (Gr)	730	-	-	-	NSL
Delta 36-14S-94W	James M. Cline #1 Federal-Cline	CL-20 DE-4	1952	5290 (bar)	1904	1090	4200	-	NSL
Delta 14-14S-95W	Mid-Colorado #1 Mower	CL-25 DE-9	1924	5000 (DF)	-	1835	3165	-	NSL
Delta 26-14S-95W	Dodge Drilling and Development #1 Jeffries	CL-23 DE-7	-	5336	1025	-	-	-	NSL
Delta 12-15S-93W	W. S. Meader #1 Hotchkiss	CL-24 DE-8	1953	5447	1102	1060	4387	-	NSL
Delta 5-15S-94W	Black Canyon Oil and Gas Co. #1 -	CL-18 DE-2	1936	5000	565	-	-	-	NSL

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Delta 5-15S-94W	W. D. Broadhead #1 Spaulding Bros.	CL-19 DE-3	1947	-	685	-	-	-	NSL
Delta 6-15S-94W	G. A. Billstrom #1 -	CL-17 DE-1	1936	5000	500	495	4505	-	NSL
Delta 16-15S-95W	Williamson Oil and Gas #1 Peters	CL-28 DE-12	1956	4834 (KB)	2025	2025	2809	Jurassic	NSL
Dolores 13-40N-13W (NMPM)	Ray Smith #1 Chester Brown (Smith Drilling #1 Groundhog Unit)	CL-29 DO-1	1957	8078 (KB)	4436	3934	4144	Pennsylvanian	38
Dolores 26-41N-17W (NMPM)	Western Natural Gas., P.B. English, Byrd, and Frost #1-A Glade (J.A. Uhl-Government)	CL-30 DO-2	1948	8300	7680	Tertiary 7590	intrusive 710	-	43
Eagle 4-5S-84W	Champlin Refining Co. #1 Black	CL-31 EA-1	1949	6800 (Gr)	6321	Tertiary 6090	intrusive 710	-	44
El Paso 17-17S-67W	Colorado Petroleum #1 Hart	CL-32 EP-1	1946	6200 (Gr)	3504	1070	5130	-	NSL
El Paso 19-17S-67W	Red Creek Oil Co. #1 State	CL-33 EP-2	1926	6190	2675	-	-	-	NSL
Fremont 33-16S-70W	Lorado #1 Freek	CL-34 FR-1	1947	-	422	-	-	-	NSL
Fremont 4-17S-70W	Lorado #2 Freek	CL-35 FR-2	1948	-	1430	-	-	-	NSL

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Fremont 16-18S-69W	Delhi-Taylor Oil Corp. #1-16 State	CL-189 FR-5	1961	5698 (DF)	3930	3810	1888	Ordovician	46
Fremont 13-18S-72W	Parkdale Oil and Gas #1 -	CL-37 FR-4	1944	-	930	-	-	-	NSL
Garfield 2-7S-104W	Forest Oil Corp. #1 Government (Gulf Oil Corp. #4 South Canyon-Government)	CL-38 GA-1	1953 1959	5879 (KB)	5745	5406	473	Permian	47
Garfield 8-8S-102W	Kerr-McGee Oil Ind. Inc. #1 Unit	CL-42 GA-3	1948	5107 (Gr)	4241	4150	957	Triassic	49
Grand 3-2N-77W	British-American Prod. #1-C Lazy-U-Ranch	CL-43 GR-1	1953	8268 (KB)	4629	4587	3781	-	50
Grand 27-4N-81W	DeBarard Cattle Co. #1 State	CL-44 GR-2	1952	6920 (Gr)	4705	4195	2725	-	51
Huerfano 30-26S-63W	Skelly Oil Co. #1 Busch (#3)	CL-48 HN-2	1947	6105 (RT)	1229	1200	4905	Pennsylvanian	53
Huerfano 6-26S-64W	Skelly Oil Co. #1 Niebuhr (#5)	CL-49 HN-3	1948	5842 (RT)	914	898	4944	Pennsylvanian	54
Huerfano 32-26S-64W	Skelly Oil Co. #1 Shafer (#4)	CL-51 HN-4	1947	6026 (RT)	851	834	5192	Pennsylvanian	55
Huerfano 33-26S-67W	Sideman-White #1-X Martinez	CL-190 HN-5	1940	-	2600	2237	-	-	NSL
Huerfano 24-26S-68W	Kinney-Coastal and Texas Prod. Co. #1 Pino (Escondido)	CL-47 HN-1	1928	6450 (KB)	2200	2175	4275	Pennsylvanian?	52

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Huerfano 34-27S-68W	Kingwood Oil Co. #1-A U.S. Alamo Dome	CL-205 HN-6	1960	7122 (KB)	2858	Tertiary 2730	intrusive 4392	-	56
Huerfano 27-27S-69W	Pan American Petroleum Corp. #1 Sylvia Phoffenhouser	-	1959	7349 (KB)	3482	3410?	3939	Pennsylvanian	NSL
Huerfano 4-29S-69W	S.W. Pressey #2 Ojo	-	1934	-	400	Tertiary	intrusive	-	NSL
Jackson 8-6N-79W	Amerada Petroleum Co. #1 Government-Thompson	CL-180 JA-6	1961	8498 (Gr)	2934	2910	5588	Triassic	60
Jackson 14-6N-79W	Amerada Petroleum Co. #1 Morris	CL-52 JA-1	1958	8544 (Gr)	7623	7612	932	Jurassic	57
Jackson 21-6N-79W	William J. Hewitt #1 Government (Hewitt)	CL-55 JA-4	1956	8954 (Gr)	2755	2732	6222	Jurassic	58
Jackson 25-7N-81W	Hiawatha Oil and Gas #1 Government-Fuller (#1-25)	CL-56 JA-5	1953	8400 (Gr)	8244	8180	220	Triassic	59
Jackson 34-9N-78W	Continental Oil Co. #3-A Hoye (Gulf Oil Corp. #1 Busch Draw-Gov't)	CL-53 JA-2	1953 1961	8283	6358	6334	1949	Jurassic	NSL
Jackson 2-9N-79W	Continental Oil Co. #A-6 Pollack	CL-54 JA-3	1952	8213 (Gr)	6180	6170	2043	Jurassic	57
Kiowa 1-17S-50W	Gulf Oil Corp. #1 U.P. Risser	CL-57 KI-1	1937	4467 (DF)	6175	6150	-1683	Cambrian	61
Kiowa 16-18S-46W	Superior Oil Co. #1 State	CL-59 KI-3	1952	3953 (DF)	5588	5550	-1597	Ordovician	63

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Kiowa 23-19S-49W	Superior Oil Co. #65-23 Weisenberger	CL-60 KI-4	1954	4147 (KB)	6030	6025	-1878	Ordovician	NSL
Kiowa 11-20S-49W	Continental Oil Co. #1 McClave	-	1952	4043 (Gr)	5914	5914	-1871	Cambrian	NSL
Kit Carson 31-6S-42W	Seaboard Oil Co. British-American Prod. Co. #1 Morrow	CL-64 KC-4	1956	3952 (KB)	5869	5865	-1913	Cambrian	65
Kit Carson 33-6S-44W	Deep Rock Oil Corp. #1 Edmondson	CL-61 KC-1	1953	3884 (Gr)	5972	5946	-2062	Cambrian	63
Kit Carson 6-6S-46W	Plains Exploration #1 Vannida	-	1965	4212 (KB)	6105	6079	-1867	Cambrian	Not included
Kit Carson 6-7S-46W	McDannald Oil Co. #1 Willey	CL-63 KC-3	1952	4171 (Gr)	6134	6134	-1963	Ordovician	NSL
Kit Carson 20-10S-47W	Honolulu Oil Corp. #1 McConnell	CL-62 KC-5	1958	4617 (DF)	6602	6600	-1983	Cambrian	NSL
Kit Carson 1-11S-46W	Continental Oil Co. #1 Lowe	CL-210 KC-5	1964	4481 (KB)	6255	6232	-1751	Cambrian	66
La Plata 17-33N-7W (NMPM)	Stanolind Oil and Gas Co. #6-B Ute Indian	CL-83 LP-3	1956	6513 (KB)	13127	13047	-6534	Cambrian	66
Larimer 2-4N-70W	Deininger et al. #1 Kistler	CL-67 LR-1	1933	-	399	380	-	-	NSL
Larimer 19-8N-68W	California Oil Co. #1 Meyers (Trigood Oil Co. #1 C.E. Meyers)	CL-68 LR-2	1953	5136 (DF)	7352	7302	-2166	Pennsylvanian	70

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Las Animas 19-26S-62W	Skelly Oil Co. #1 Weiland	CL-76 LA-8	1947	5929 (RT)	1495	1480	4449	Pennsylvanian	84
Las Animas 24-26S-63W	Skelly Oil Co. #1 Pressey	CL-50 LA-13	1947	6099 (RT)	1371	1280	4819	Pennsylvanian	88
Las Animas 30-27S-61W	Skelly Oil Co. #1 Jolly-Government	CL-75 LA-7	1947	5632 (RT)	1941	1916	3716	Pennsylvanian	82
Las Animas 12-28S-52W	Texaco Inc. #1 Government-Davis	CL-191 LA-14	1960	4583 (KB)	2630	2595	1988	Ordovician	89
Las Animas 16-28S-62W	R.W. Lange #1 State	CL-192 LA-15	1958	5649 (KB)	1989	1900 (1884)	3749	Pennsylvanian	NSL
Las Animas 23-29S-56W	Phillips, Reiter, and Foster #1 Haskins	CL-74 LA-6	1928	4648	2570	1175?	3473	Ordovician	NSL
Las Animas 10-29S-62W	R.W. Lange #1 Government	CL-72 LA-4	1958	5659 (KB)	6210 Tertiary intrusive? Hornfels at 2057	6170	-511	Pennsylvanian	80
Las Animas 9-29S-63W	R.W. Lange #1 Marquez	CL-193 LA-16	1959	6227 (KB)	7119	6956	-729	Pennsylvanian	91
Las Animas 26-29S-65W	Huerfano Oil & Gas Co. #1 Stewart	CL-194 LA-17	-	6310	2103	2083?	4227	-	NSL
Las Animas 15-32S-56W	Sullivan and Pauley #1 Dougherty	CL-78 LA-10	1956	5601 (KB)	3270	3223	2378	Ordovician	NSL
Las Animas 7-33S-57W	Sullivan and Pauley #1 Waldroup	CL-80 LA-12	1956	5818 (KB)	2895	2886	2932	Pennsylvanian	87

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Las Animas 2-33S-60W	Baker and Taylor #1 Le Sage (Jay Taylor #1 R.S. Le Sage)	CL-69 LA-1	1953	5653	2495	2488	3165	Pennsylvanian	74
Las Animas 16-33S-63W	S.D. Johnson and Bruce Sullivan #1 A.T. McCarty	CL-204 LA-18	1954	6164 (DF)	5438	5434	-730	Pennsylvanian	92
Las Animas 32-34S-56W	Parker Gun Club #1 Adams	CL-73 LA-5	-	6125	3870	3870?	2255	-	82
Las Animas 29-34S-59W	Taylor and Sullivan #1 Catherine Mock (Baker and Taylor #1 Mock)	CL-70 LA-2	1954	5791 (Gr)	3450	3360	2431	Pennsylvanian	NSL
Las Animas 4-34S-62W	Sullivan and Pauley #1 Sandoval	CL-79 LA-11	1956	6260 (KB)	5043	5026	1234	Pennsylvanian	NSL
Las Animas 31-34S-63W	Stanolind Oil and Gas Co. #1 C.F. & I.	CL-77 LA-9	1948	7087 (RB)	6918	6918?	169	Pennsylvanian	85
Las Animas 2-35S-52W	Boswell and Frates #1 Government	CL-71 LA-3	1956	4746 (KB)	2755	2330	2416	Cambrian	76
Logan 1-7N-52W	Shawnee Oil Co. #1 Rodman-State	CL-87 LO-4	1956	4154 (KB)	7455	7445	-3291	Pennsylvanian	NSL
Logan 16-8N-53W	Shell Oil Co. #2-B State	CL-89 LO-6	1954	4184 (KB)	7755	7666	-3482	Pennsylvanian	100
Logan 3-8N-54W	British-American Prod. Co. #18 Yenter "B"	CL-85 LO-2	1953	4397 (KB)	8043	8028	-3631	Pennsylvanian	94

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Logan 30-9N-53W	Shell Oil Co. #16-A C.F. Green	CL-88 LO-5	1952	4193 (DF)	7802	7744	-3551	Pennsylvanian	97
Logan 23-10N-53W	Patrick Doheny #1 Mittelstadt	CL-86 LO-3	1956	4166 (KB)	7667	7630	-3464	Pennsylvanian	95
Logan 26-11N-53W	British-American Prod. Co. #4 Segelke	CL-84 LO-1	1957	4624 (KB)	8120	8098	-3474	Pennsylvanian	93
Mesa 23-1S-1W (UPM)	D & R G W	CL-93 ME-4	1929	4583	1924	-	-	-	NSL
Mesa 26-1S-1W (UPM)	Grand Junction #1 Fee (City Cemetery)	CL-91 ME-2	-	4583 (Gr)	1213	1214	3369	-	NSL
Mesa 35-2S-2E (UPM)	Joe Dinger #1 Fee (Claybank)	CL-92 ME-3	1948	4970 (Gr)	3648	2114	2856	-	NSL
Mesa 14-9S-101W	Amerada Petroleum Co. #1 Unit	CL-90 ME-1	1949	5184 (DF)	4223	4193	991	Triassic	102
Mesa 15-15S-104W	Pure Oil Co. #1 Unit (Gateway)	CL-94 ME-5	1948	4689 (Gr)	7939	4841	-152	Pennsylvanian	104
Moffat 14-4N-90W	Miami Oil Prod. #1 O'Brian	-	1964	7528 (KB)	7822	7360	168	Cambrian	Not included
Moffat 15-4N-101W	Richfield Oil of Montana #1 Fee	CL-96 MO-2	1948	6917	4055	3771	3146	-	NSL
Moffat 35-4N-102W	Pure Oil Co. #1 Unit	CL-195 MO-3	1962	6171 (DF)	8058	5390	780	Cambrian	NSL

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Moffat 9-5N-94W	Amerada Petroleum Co. #1 Unit	CL-95 MO-1	1956	6216 (Gr)	5404	5392	824	Cambrian	106
Moffat 13-12N-89W	Quintana Prod. #1 Ula Rose	-	1955	6853 (DF)	3214	Tertiary 3197	intrusive	-	NSL
Moffat 14-12N-89W	Quintana Prod. #1 Government	-	1954	6805 (KB)	3045	Tertiary 2975	intrusive	-	NSL
Montezuma 7-32N-19W (NMPM)	Continental Oil Co. #1 Ute Mountain	CL-99 MZ-4	1954	4919 (Gr)	7227	7208	-2289	Devonian	114
Montezuma 24-32N-20W (NMPM)	Pan American Petroleum Corp. #1 Ute Mountain	CL-101 MZ-6	1957	4865 (KB)	7272	7267	-2402	Cambrian	116
Montezuma 22-33N-19W (NMPM)	California Oil Co. #1 Ute Tribal	CL-98 MZ-3	1957	5122 (KB)	8020	8000	-2878	Devonian	112
Montezuma 25-36N-18W (NMPM)	Western Natural Gas, Byrd, Frost & English #1 MacIntosh	CL-97 MZ-2	1948	6027 (DF)	4965	Tertiary 4610	intrusive	-	109
Montezuma 27-37N-17W (NMPM)	Gulf Oil Corp. #1 Fulks	CL-100 MZ-5	1955	6741 (DF)	8787	8639	-1898	Devonian?	114
Montrose 18-45N-10W (NMPM)	Penrose and Tatum #1 Orme	CL-103 MT-2	1953	8900 (est)	1753	1695	7205	-	117
Montrose 21-47N-19W (NMPM)	Shell Oil Co. #1 Wray Mesa Unit	CL-182 MT-7	1961	6336 (DF)	11268	11215	-4879	Mississippian	122

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Montrose 32-47N-19W (NMPM)	Shell Oil Co. #2 Wray Mesa Unit	CL-181 MT-6	1961	6982 (DF)	11593	11562	-4580	Cambrian	121
Montrose 15-49N-8W (NMPM)	St. Helens Petroleum Corp. #1 C.B. & L.H. Sanburg (#1 Bostwick Park Unit)	CL-105 MT-4	1956	6998 (Gr)	2418	2404	4594	-	118
Montrose 9-49N-10W (NMPM)	Texaco Inc. #1 J.L. Stivers	CL-208 MT-8	1963	5653 (KB)	1423	1407	4246	Triassic	123
Montrose 21-50N-7W (NMPM)	L.A. Messmer #1 Allyn	CL-102 MT-1	1955	8302 (gr)	821	821	7481	-	NSL
Montrose 27-50N-10W (NMPM)	R.E. Wear #1 Fee	CL-106 MT-5	1946	5490	2020	1635	3855	Jurassic	119
Morgan 32-3N-55W	Superior Oil Co. #45-32 Weiss	CL-108 MG-2	1955	4444 (Gr)	8452	8435	-3991	Pennsylvanian	125
Morgan 11-6N-55W	Anderson-Pritchard #1 Blanchard	CL-107 MG-1	1954	4359 (Gr)	8915	8186	-3827	Pennsylvanian	124
Otero 5-23S-59W	Pan American Petroleum Co. #1 Arnold Harriman Inc.	-	1965	4449 (KB)	6722	6707	-2258	Ordovician	Not included
Otero 3-24S-59W	Vaughey and Vaughey #1 W.S. Sidney	CL-111 OT-3	1957	4603 (KB)	6574	6567	-1964	Ordovician	127
Otero 24-25S-56W	Pure Oil Co. #1-A Craighead	CL-110 OT-2	1957	4404 (DF)	6877	6863	-2459	Ordovician	127

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Otero 30-26S-57W	Carter Oil Co. #1 Exploration (Colo. Strat. Hole)	CL-109 OT-1	1940	4685 (DF)	4235	4169	516	Ordovician	125
Ouray 35-45N-8W (NMPM)	Intex Oil, South Penn Oil #1 D. Halls	CL-201 OU-1	1959	7199 (DF)	2413	Tertiary 2350	intrusive	-	128
Park 28-11S-73W	McDannald Oil Co. #1 Fee	CL-122 PA-1	1950	-	2087	-	-	well spudded in Precambrian	NSL
Park 32-11S-75W	Shell Oil Co. #1 A.T. McDannald	CL-115 PA-4	1956	8915 (KB)	3560	3474	5441	Permian	135
Park 36-11S-75W	Shell Oil Co. #1-4343 State	CL-116 PA-5	1956	8986 (KB)	5349	5258	3728	Jurassic	137
Park 4-12S-74W	Shell Oil Co. #1 Federal	CL-114 PA-3	1956	8906 (KB)	571	433	8473	-	133
Park 20-12S-74W	McDannald Oil Co. #1 State	CL-113 PA-2	1949	8850	6182	5750	3100	Pennsylvanian	130
Phillips 30-8N-43W	Texota Oil Co. #1 Hansen	CL-183 PH-1	1961	3700 (KB)	5919	5906	-2206	Cambrian	138
Pitkin 9-10S-89W	Superior Oil Co. #1 Unit	CL-203 PI-1	1947	9158 (KB)	4453	Tertiary 4210	intrusive	-	138
Prowers 4-24S-43W	Phillips Petroleum Co. #1 Stwalley	CL-119 PR-2	1956	3569 (DF)	6427	6410	-2841	Cambrian	141
Prowers 12-24S-44W	Charles A. Wallace #1 Witte	CL-121 PR-4	1952	3649 (RT)	6575	6546	-2897	Ordovician	142

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Prowers 25-27S-46W	Ohio Oil Co. #1 Eldridge	CL-118 PR-1	1947	3761 (DF)	Tertiary 6475	intrusive 6467	-2706	Cambrian	141
Pueblo 6-18S-64W	Continental Oil Co. #1 Paige	CL-123 PB-2	1946	5248 (Gr)	6932	6929	-1681	-	145
Pueblo 34-18S-66W	British-American Prod. Co. #1 Colo. Sch. Mines	CL-122 PB-1	1955	5662 (DF)	4258	4236	1426	Ordovician	NSL
Pueblo 4-18S-67W	Continental Oil Co. #1-C State	CL-124 PB-3	1946	5970 (Gr)	1938	1780	4190	-	NSL
Pueblo 11-19S-65W	Continental Oil Co. #1 Young	CL-125 PB-4	1942	5038	6112	6070	-1042	Mississippian	145
Pueblo 36-20S-66W	Midwest Refining Co. #1 Overland	CL-128 PB-7	1919	4750	3945	3945	805	-	NSL
Pueblo 4-20S-67W	Pan American Petroleum Corp. #1 Ingram	CL-129 PB-8	1954	5157	4497	4445	712	Pennsylvanian	147
Pueblo 30-21S-65W	Skelly Oil Co. #1 M.E. Lutin	CL-196 PB-12	1959	5291 (DF)	3709	3696	1595	Pennsylvanian	153
Pueblo 13-23S-68W	Pure Oil Co. #1 E.K. Warren	CL-132 PB-11	1950	6524 (Gr)	4262	4200	2324	Pennsylvanian	151
Pueblo 25-24S-61W	Phillips Petroleum Co. #1-A Johnson	CL-131 PB-10	1956	4716 (DF)	5174	5128	-412	Pennsylvanian	150
Pueblo 17-24S-64W	Phillips Petroleum Co. #1 Cedarwood	CL-197 PB-13	1956	5669 (DF)	2592	2580	3089	Pennsylvanian ?	NSL
Pueblo 21-24S-65W	K. D. Oil #1 Little	CL-126 PB-5	1956	5750 (Gr)	2858	2820	2930	Permian	NSL

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Pueblo 9-25S-64W	Phillips Petroleum Co. #1 Sample Nose-Gov't (#1 J. Brann)	CL-130 PB-9	1956	5673 (DF)	2308	2283	3390	Pennsylvanian	149
Rio Blanco 16-1N-91W	Buford Oil Co. #1 Government	CL-133 RB-1	1941	8974	4527	4478	4496	Cambrian	154
Rio Blanco 13-2N-87W	Humble Oil & Refining Co. #1 Crosho Lake-Gov't	CL-202 RB-7	1962	11072 (KB)	9096	9070	2002	Cambrian	156
Rio Blanco 28-3N-88W	Rio Oil Co. #1 Government	CL-137 RB-5	-	8900	8000	Tertiary intrusive 793		-	NSL
Routt 2-1S-85W	Texaco Inc. #1 King Mountain Unit-Government (#1 Sampson-Government)	CL-148 RT-10	1961	8915 (DF)	4013	3814	5101	Pennsylvanian	162
Routt 23-3N-85W	Daube Oil Co. #1 Horace E. Pastorius	CL-142 RT-4	1958	8417 (Gr)	2172	2172	6245	Triassic	NSL
Routt 29-4N-87W	O.D. Robinson #1 Robert Kagie	CL-146 RT-8	1953	9800 (Gr)	4795	4792	5008	Pennsylvanian	158
Routt 35-4N-89W	Pacific Nat. Gas Expl., Southern Union Prod. #26-35 Pagoda Unit	CL-207 RT-12	1962	8366 (KB)	7052	7040	1326	Pennsylvanian	163
Routt 27-5N-85W	Arrowhead Exploration Co. #1 Barber	CL-139 RT-1	1959	7027 (DF)	687	660	6367	Cretaceous	NSL
Routt 14-6N-85W	W.E. Atkinson #1 State	CL-140 RT-2	1950	7195 (Gr)	2015	2005	5190	Triassic	NSL
Routt 7-6N-86W	Texaco, Inc. #1 Colvert	CL-147 RT-9	1949	6664	5627	5600	1064	-	160

COUNTY AND LOCATION	OPERATOR AND LEASE	WELL NUMBER	DATE	SURFACE ELEV. (msl)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT (ft)	ELEV. OF BASEMENT (msl)	AGE OF OVERLYING FORMATION	DESCRIPTION ON PAGE (Vol. 2)
Routt 33-7N-85W	E.L. Moore & L.E. Craig #1-X Irwin	CL-144 RT-6	1941	-	3018	2990	-	-	NSL
Routt 34-7N-85W	G.L. Reasor #1 Boden	CL-145 RT-7	1952	6700 (Gr)	2488	2485	4215	Triassic	NSL
Routt 4-7N-86W	Gardner Bros. #1 Chura	CL-143 RT-5	-	7252 (DF)	2078	Tertiary 2064	intrusive	-	157
Routt 18-7N-86W	Broderick and Gordon #1 Government	CL-141 RT-3	-	7400	3269	3198	4202	-	156
Routt 13-7N-87W	Pan American Petroleum Corp. #1 Jones	CL-198 RT-11	1962	7545 (KB)	5764	5738	1807	Pennsylvanian	162
Routt 27-8N-86W	Texaco, Inc. #1 Peavy	CL-211 RT-13	1964	7062 (Gr)	3284	3258	3804	Pennsylvanian	164
Saguache 14-41N-7E (NMPM)	Tennessee Gas Trans. Co. #1 State "B"	CL-199 SG-1	1959	7674 (DF)	10346	10333	-2659	-	168
San Miguel 11-43N-11W (NMPM)	Kerr-McGee Oil Ind., Inc. #1 Placerville	CL-200 SM-2	1960	7429 (Gr)	6244	6150	1279	Pennsylvanian	170
San Miguel 26-44N-13W (NMPM)	Fred Turner #1 Buss	CL-149 SM-1	1952	6487 (DF)	8790	8000	-1513	Pennsylvanian	170
Sedgwick 18-10N-47W	Continental Oil Co., Stuarco Oil Co., California Oil Co., and Midwest Oil Co. #1 Sprague Bros.	CL-212 SD-1	1964	4064 (KB)	6647	6630	-2566	Pennsylvanian	172

COUNTY AND LOCATION	OPERATOR AND LEASE	WELL NUMBER	DATE	SURFACE ELEV. (msl)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT (ft)	ELEV. OF BASEMENT (msl)	AGE OF OVERLYING FORMATION	DESCRIPTION ON PAGE (Vol. 2)
Washington 28-1S-49W	Indian Territory Illuminating Oil, and Carter Oil Co. #1 Vorce	CL-153 WA-4	1936	4732	7005	6937	-2205	-	174
Washington 7-2S-52W	Amerada Petroleum Co. #1 Heyen	CL-150 WA-1	1952	4818 (Gr)	7998	7990	-3172	Pennsylvanian	174
Washington 11-38-51W	Chicago Corporation, Republic Natural Gas #1 A.E. Scheetz	-	1952	4617 (Gr)	7396	7390	-2764	Cambrian	NSL
Washington 34-1N-49W	Skiles Oil Corp. #1 Brower	CL-155 WA-6	1952	4290 (KB)	6872	6828	-2538	-	176
Washington 35-3N-50W	Carter Oil Co. #1 Glade Stansfield	CL-151 WA-2	1952	4308 (Gr)	7100	6970	-2662	Pennsylvanian	NSL
Weld 12-8N-60W	Shell Oil Co. #1 Colorado National Bank	GL-158 WL-3	1957	4986 (KB)	9955	9896	-4910	Pennsylvanian	180
Weld 19-8N-61W	British-American Prod. Co. #1 Wise	CL-156 WL-1	1956	5015 (KB)	10284	10228	-5213	Pennsylvanian	176
Weld 27-8N-66W	California Oil Co. #1 U.P.R.R. Ferch	CL-157 WL-2	1956	5035 (Gr)	10667	10615	-5580	Pennsylvanian	177
Weld 18-10N-56W	Shell Oil Co. #1-4728 Federal	CL-159 WL-4	1957	4592 (DF)	8859	8807	-4215	Pennsylvanian	182
Weld 1-11N-59W	Shell Oil Co. #1 Klingensmith	CL-160 WL-5	1956	5237 (KB)	9938	9909	-4672	Permian	183
Yuma 19-1S-47W	Texaco, Inc. #1 Blach	CL-174 YU-14	1953	4208 (KB)	6551	6538	-2330	Cambrian	191

COUNTY AND LOCATION	OPERATOR AND LEASE	WELL NUMBER	DATE	SURFACE ELEV. (msl)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT (ft)	ELEV. OF BASEMENT (msl)	AGE OF OVERLYING FORMATION	DESCRIPTION ON PAGE (Vol. 2)
Yuma 21-2S-43W	Indian Territory Illuminating Oil #1 Strangeways	CL-167 YU-7	1936	3597	5595	5560	-1963	Cambrian	187
Yuma 1-3S-48W	California Oil Co. #1 Lloyd Mumm	CL-206 YU-16	1962	4253 (KB)	6532	6520	-2267	Cambrian	193
Yuma 30-5S-46W	Plains Exploration #1 Lippelmann	-	1965	4177 (KB)	6250	6247	-2070	Cambrian	Not included
Yuma 21-5S-47W	McDannald Oil Co. #1 Young	-	1950	4270 (Gr)	6395	-	-	Cambrian	NSL
Yuma 25-5S-47W	Plains Exploration #1 Gulley	-	1965	4206 (KB)	6300	6292	-2086	Cambrian	Not included
Yuma 30-5S-48W	M.J. Lebsack #1-A Watmore	CL-169 YU-9	1956	4433 (KB)	6604	-	-	Cambrian	NSL
Yuma 8-1N-48W	Carter Oil Co., and Mountain States Drill-ing #1 Henik-State	CL-164 YU-4	1951	4188 (Gr)	6768	6765	-2577	-	187
Yuma 2-2N-48W	Lion Oil Co. #1 Chrismer	CL-170 YU-10	1951	4103 (KB)	6779	6743	-2640	Pennsylvanian	189
Yuma 1-4N-43W	Shell Oil Co. #1 Kinnie	CL-172 YU-12	1956	3643 (KB)	5768	5766	-2123	Mississippian	NSL
Yuma 21-4N-45W	Brown #1 Pyle	CL-161 YU-1	1951	3830 (KB)	6137	-	-	-	NSL
Yuma 31-4N-46W	Ohio Oil Co. #1 Brophy	CL-171 YU-11	1951	3957 (KB)	6380	6366	-2409	Pennsylvanian	190

COUNTY AND LOCATION	OPERATOR AND LEASE	WELL NUMBER	DATE	SURFACE ELEV. (msl)	TOTAL DEPTH (ft)	DEPTH TO BASEMENT (ft)	ELEV. OF BASEMENT (msl)	AGE OF OVERLYING FORMATION	DESCRIPTION ON PAGE (Vol. 2)
Yuma 21-4N-48W	Shell Oil Co. #1 Olson	CL-173 YU-13	1956	4072 (KB)	6683	6675	-2603	Cambrian	191
Yuma 10-5N-46W	Canada Southern Oils, Inc. #1 Doyle Neiman	CL-162 YU-2	1953	3898 (KB)	6342	6340	-2442	Pennsylvanian	186

APPENDIX II: DETAILED PETROGRAPHIC DESCRIPTIONS OF WELL SAMPLES FROM THE BURIED BASEMENT OF COLORADO

Wells listed by county, and within each county by the index number assigned to each well.

Thin sections are on permanent file at the Crustal Studies Laboratory, Department of Geology, The University of Texas, Austin, Texas.

U.S. Army	Adams County	CL-175
Corps of Engineers	2S-67W, sec 26	AD-1-1
#1 Rocky Mountain Arsenal		Core chip
		11976-85 ft.

Plagioclase 64% Oligoclase; xenoblastic grains 1.5 to 0.1 mm.; slightly altered to sericite; indistinct albite and pericline twins; poikiloblastically enclose quartz, microcline, biotite, and epidote.
Quartz 25% Xenoblastic grains 1.0 to 0.05 mm.; moderately strained and fractured; sutured borders
Biotite 5% Idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-green to very dark green; strongly altered to sericite and hematite; small idioblastic crystals have formed within larger altered grains; preferred orientation.
Microcline 5% Xenoblastic grains 1.0 to 0.05 mm.; polysynthetic twins faint or absent; occur interstitially.
Magnetite 1% Xenoblastic grains 1.0 to 0.05 mm.
Leucoxene Tr.
Epidote Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Microcline-biotite-quartz-plagioclase gneiss.

U.S. Army	Adams County	CL-175
Corps of Engineers	2S-67W, sec 26	AD-1-2
#1 Rocky Mountain Arsenal		Core chip
		11976-85 ft.

Plagioclase 60% Oligoclase; xenoblastic grains 1.0 to 0.2 mm.; slightly altered to sericite; indistinct albite and pericline twins; poikiloblastically enclose quartz, biotite, apatite and hornblende; myrmekitic.
Hornblende 20% Corroded xenoblastic grains 1.0 to 0.01 mm.; pleochroic from yellowish-green to deep bluish-green; poikiloblastically enclose quartz and apatite.
Quartz 15% Xenoblastic grains 0.5 to 0.05 mm.; slightly strained and fractured.
Biotite 5% Elongate idioblastic to xenoblastic grains 3.5 to 0.1 mm.; pleochroic from pale greenish-yellow to dark greenish-brown; weak preferred orientation.
Microcline Tr. Xenoblastic grains 0.3 to 0.05 mm.; polysynthetic twins faint or absent; occur interstitially.

Epidote Tr.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, nematoblastic to lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-quartz-hornblende-plagioclase gneiss.

Amerada Petroleum Co.	Alamosa County	CL-1
#1-F State	39N-10E, sec 16	AL-1-1
	(NMPM)	Core chip
		5868-69 ft.

Plagioclase 56% Oligoclase; xenoblastic grains 1.5 to 0.1 mm.; slightly altered to sericite; albite and pericline twins; poikiloblastically enclose quartz, biotite, sphene, apatite, and zircon.
Quartz 15% Xenoblastic grains 0.5 to 0.05 mm.; slightly to strongly strained and fractured; sutured borders.
Biotite 10% Idioblastic to xenoblastic grains 2.0 to 0.05 mm.; pleochroic from pale yellow to dark brown; preferred orientation.
Hornblende 5% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from yellowish-green to deep bluish-green; poikiloblastically enclose apatite; associated with biotite, magnetite, and sphene.
Sphene 5% Xenoblastic grains 0.3 to 0.05 mm.; often surrounds magnetite.
Magnetite 5% Xenoblastic grains 0.5 to 0.05 mm.
Microcline 2% Xenoblastic grains 1.0 to 0.05 mm.
Apatite 2%
Zircon Tr.
Allanite Tr.

Fabric: Gneissose, lepidoblastic to nematoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Hornblende-biotite-quartz-plagioclase gneiss.

Amerada Petroleum Co.	Alamosa County	CL-1
#1-F State	39N-10E, sec 16	AL-1-2
	(NMPM)	Core chip
		5870-71 ft.

Plagioclase 49% Oligoclase; xenoblastic grains 1.0 to 0.2 mm.; slightly altered to sericite; albite and pericline twins; poikiloblastically enclose quartz, biotite, sphene, apatite, and zircon.
Quartz 15% Xenoblastic grains 0.5 to 0.05 mm.; slightly to strongly strained and fractured.
Biotite 15% Idioblastic to xenoblastic grains 1.0 to 0.5 mm.; pleochroic from pale yellow to dark brown; preferred orientation.
Hornblende 10% Xenoblastic grains 1.5 to 0.5 mm.; pleochroic from yellowish-green to deep bluish-green; poikiloblastically enclose apatite; associated with biotite, magnetite, and sphene.
Sphene 5% Xenoblastic grains 0.3 to 0.05 mm.; often surrounds magnetite.
Apatite 3%
Magnetite 3%
Microcline Tr.
Zircon Tr.
Leucoxene Tr.

Fabric: Gneissose to schistose, lepidoblastic to nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Hornblende-biotite-quartz-plagioclase gneiss

Amerada Petroleum Co.	Alamosa County	CL-1
#1-F State	39N-10E, sec 16	AL-1-3
	(NMPM)	Core chip
		5992-93 ft.

Plagioclase 60% Oligoclase; xenoblastic grains 0.5 to 0.1 mm.; slightly altered to sericite; albite and pericline twins.
Biotite 30% Elongate idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-brown to dark greenish-brown or dark brown; preferred orientation.
Quartz 5% Xenoblastic grains 0.2 to 0.05 mm.; slightly strained.
Garnet 4% Xenoblastic porphyroblasts 2.0 to 0.1 mm.; isotropic; pale pink color; poikiloblastically enclose quartz, biotite and magnetite; fractured.
Magnetite 1%
Apatite Tr.

Fabric: Schistose, lepidoblastic, porphyroblastic, fine-grained.
Probable rock: Garnet-bearing quartz-biotite-plagioclase schist.

Amerada Petroleum Co.	Alamosa County	CL-1
#1-F State	39N-10E, sec 16	AL-1-4
	(NMPM)	Core chip
		5996-97 ft.

Quartz 45% Xenoblastic grains 0.3 to 0.05 mm.; slightly to strongly strained.
Plagioclase 35% Oligoclase; xenoblastic grains 0.3 to 0.05 mm.; slightly altered to sericite; albite and pericline twins.
Biotite 13% Elongate idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellowish-brown to dark greenish-brown or dark brown; preferred orientation.
Garnet 5% Xenoblastic grains 1.0 to 0.05 mm.; isotropic; pale pink color; poikiloblastically enclose quartz, biotite, and magnetite; fractured.
Magnetite 2%
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, fine-grained.
Probable rock: Garnet-bearing biotite-plagioclase-quartz gneiss.

Cameron Drilling	Archuleta County	CL-2
#1 Ed Bramwell	32N-1E, sec 9	AH-1-1
	(NMPM)	Cuttings
		2460-70 ft.

Sericite 52% Aggregates of microcrystalline grains; alteration product of plagioclase.
Chlorite 30% Irregularly-shaped xenoblastic grains and masses 0.2 mm. to microcrystalline.
Plagioclase 10% Oligoclase to andesine; idioblastic to xenoblastic crystals 0.2 to 0.01 mm.; moderately to severely altered to sericite; albite twins indistinct.
Leucoxene 5% Xenoblastic grains and masses 0.2 mm. to microcrystalline.
Calcite 2% Idioblastic to xenoblastic grains 1.0 to 0.01 mm.; alteration product; occur in clusters and veinlets.
Quartz 1% Xenoblastic grains 0.2 to 0.01 mm.
Apatite Tr.
Hematite Tr.

Fabric: Metamorphic, hornfelsic, non-porphyroblastic, fine-grained.
Probable rock: Plagioclase-chlorite-sericite hornfels.

Cameron Drilling	Archuleta County	CL-2
#1 Ed Bramwell	32N-1E, sec 9	AH-1-2
	(NMPM)	Cuttings
		2476 ft.

Sericite 40% Aggregates of microcrystalline grains; alteration product of plagioclase.
Chlorite 34% Irregularly-shaped xenoblastic grains and masses 0.2 mm. to microcrystalline.
Plagioclase 15% Variety undetermined; idioblastic to xenoblastic crystals 0.2 to 0.1 mm.; moderately to severely altered to sericite; albite twins indistinct.
Leucoxene 5% Xenoblastic grains and masses 0.3 mm. to microcrystalline.
Calcite 5% Idioblastic to xenoblastic grains 1.0 to 0.01 mm.; alteration product; occur in clusters and veinlets.
Quartz 1% Xenoblastic grains 0.2 to 0.01 mm.
Apatite Tr.
Hematite Tr.

Fabric: Metamorphic, hornfelsic, non-porphyroblastic, fine-grained.
Probable rock: Plagioclase-chlorite-sericite hornfels.

Wirt Franklin	Archuleta County	CL-3
#1 Sullenberger	35N-2W, sec 28	AH-2-1
	(NMPM)	Cuttings
		1550 ft.

Microline 45% Xenoblastic grains 1.5 to 0.2 mm.; microperthitic.
Plagioclase 30% Oligoclase; xenoblastic grains 1.0 to 0.5 mm.; slightly altered to sericite; albite twins indistinct; intergrown with microcline.
Quartz 25% Xenoblastic grains 0.75 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured.
Biotite Tr. Elongate idioblastic to xenoblastic grains 0.01 mm. to microcrystalline; pleochroic from pale yellowish-green to brownish-green; interstitial to microcline and plagioclase.
Muscovite Tr. Shredlike xenoblastic grains 0.1 to 0.01 mm.
Chlorite Tr.
Hematite Tr.

Fabric: Granoblastic, porphyroblastic, fine-grained.

Probable rock: Quartz-plagioclase-microcline gneiss.
(Thin section contains only 4 small fragments, see AH-2-1a)

Wirt Franklin	Archuleta County	CL-3
#1 Sullenberger	35N-2W, sec 28	AH-2-1a
	(NMPM)	Cuttings
		1550 ft.

Microcline 70% Xenoblastic grains 2.0 to 0.05 mm.; Carlsbad twins; perthitic to microperthitic; poikiloblastically enclose quartz, plagioclase, and biotite.
Plagioclase 15% Oligoclase; xenoblastic grains 2.5 to 0.1 mm.; slightly to strongly altered to sericite; albite, pericline, and Carlsbad twins; some grains strained and fractured.
Quartz 10% Xenoblastic grains 1.0 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders.
Biotite 5% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from yellowish-green to dark green; moderately to strongly altered to chlorite.
Hornblende Tr.
Epidote Tr.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic, porphyroblastic, medium-grained.
Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

Francis Harvey	Archuleta County	CL-4
#1 Government	36N-2E, sec 4	AH-3-1
(#1 Quartz Creek)	(NMPM)	Cuttings
		1200-05 ft.
		(T.D.)

Phenocrysts: 40% of thin section.

Plagioclase 85% Albite to oligoclase; euhedral to subhedral crystals 2.0 to 0.5 mm.; slightly altered to sericite; albite and pericline twins.
Biotite 10% Euhedral to anhedral crystals 1.0 to 0.2 mm.; pleochroic from very pale yellow to deep reddish-brown, slightly to strongly altered to chlorite.

Hornblende 5% Corroded anhedral grains 1.5 to 0.05 mm.; pleochroic from pale yellowish-green to dark green.

Groundmass: 60% of thin section.

Orthoclase 44% Anhedral grains 0.5 to 0.01 mm.; also occurs with quartz in micrographic intergrowths.
Plagioclase 25% Albite to oligoclase; subhedral grains 0.3 to 0.1 mm.; slightly altered to sericite; albite twins.
Quartz 25% Anhedral grains 0.3 to 0.01 mm.; slightly strained; also in micrographic intergrowths.
Chlorite 5% Irregularly-shaped anhedral masses 1.0 to 0.01 mm.; alteration product of hornblende and biotite.
Tremolite-Actinolite 1% Fibrous clusters of needlelike euhedral crystals 1.5 to 0.01 mm.
Magnetite Tr. Anhedral grains 0.2 to 0.01 mm.; associated with altered biotite and hornblende.
Pyrite Tr. Anhedral grains 0.3 to 0.01 mm.; associated with tremolite-actinolite.

Fabric: Holocrystalline, inequigranular-porphyritic, micrographic, fine-grained.
Probable rock: Quartz latite porphyry.

Marland	Baca County	CL-10
#1 Mesa-Bergunthal	30S-50W, sec 8	BA-2-1
		Cuttings
		2042-50 ft.

Phenocrysts: 30% of thin section.

Plagioclase 100% Andesine to labradorite; zoned euhedral crystals 2.0 to 0.3 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; poikilitically enclose quartz, biotite, hornblende, and magnetite.

Groundmass: 70% of thin section.

Microcline 49% Anhedral grains 0.1 to 0.01 mm.; faint polysynthetic twins.
Plagioclase 25% Oligoclase; subhedral to anhedral grains 0.3 to 0.05 mm.; moderately altered to sericite.
Quartz 10% Anhedral grains 0.2 to 0.01 mm.; slightly strained.
Biotite 10% Subhedral to anhedral grains 0.2 to 0.01 mm.; pleochroic from pale greenish-yellow to very dark brownish-green.
Hornblende 5% Anhedral grains 0.5 to 0.05 mm.; pleochroic from pale

green to bluish-green
Magnetite 1% Euhedral crystals 0.3 to 0.05 mm.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric, fine-grained.
Probable rock: Latite porphyry.

Marland	Baca County	CL-10
#1 Mesa-Bergunthal	30S-50W, sec 8	BA-2-2
		Cuttings
		2082-84 ft.

Phenocrysts: 35% of thin section.

Plagioclase 95% Andesine to labradorite; zoned euhedral crystals 2.0 to 0.2 mm.; slightly to moderately altered to sericite; albite and Carlsbad twins.
Biotite 3% Euhedral to subhedral crystals 1.0 to 0.2 mm.; pleochroic from pale greenish-yellow to dark greenish-brown; poikilitically encloses quartz, microcline, magnetite, and leucoxene.
Hornblende 2% Corroded anhedral grains 1.0 to 0.2 mm.; pleochroic from pale green to bluish-green; poikilitically encloses quartz, magnetite, and apatite.

Groundmass: 65% of thin section.

Microcline 50% Anhedral grains 0.1 to 0.01 mm.; faint polysynthetic twins.
Plagioclase 20% Oligoclase; subhedral grains 2.0 to 0.05 mm.; moderately altered to sericite.
Quartz 10% Anhedral grains 2.0 to 0.01 mm.; slightly strained.
Biotite 10% Anhedral grains 0.2 to 0.01 mm.
Hornblende 10% Anhedral grains 0.2 to 0.01 mm.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Leucoxene Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric, fine-grained.
Probable rock: Latite porphyry.

Marland	Baca County	CL-10
#1 Mesa-Bergunthal	30S-50W, sec 8	BA-2-3
		Cuttings
		2084-88 ft.

Phenocrysts: 35% of thin section

Plagioclase 95% Labradorite; zoned euhedral crystals 2.5 to 0.2 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; poikilitically encloses quartz, hornblende, and magnetite.
Hornblende 3% Corroded anhedral grains 1.0 to 0.2 mm.; pleochroic from pale green to bluish-green.
Biotite 2% Subhedral grains 1.0 to 0.2 mm.; pleochroic from pale greenish-yellow to dark greenish-brown; poikilitically enclose quartz, microcline, magnetite, and leucoxene.

Groundmass: 65% of thin section.

Microcline 32% Anhedral grains 0.1 to 0.01 mm.; faint polysynthetic twins.
Plagioclase 30% Oligoclase; subhedral grains 0.2 to 0.05 mm.; moderately altered to sericite.
Hornblende 15% Anhedral grains 0.2 to 0.01 mm.
Quartz 10% Anhedral grains 0.2 to 0.01 mm.; slightly strained.
Biotite 10% Subhedral to anhedral grains 0.2 to 0.01 mm.
Magnetite 3% Euhedral crystals 0.2 to 0.01 mm.
Apatite Tr.
Zircon Tr.
Leucoxene Tr.
Calcite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric, fine-grained.
Probable rock: Latite porphyry

Skelly Oil Co.	Baca County	CL-176
#1 McEndree	28S-48W, sec 32	BA-3-1
		Cuttings
		5580-90 ft.

Plagioclase 45% Albite to oligoclase; subhedral grains 3.0 to 0.3 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins.
Microcline 30% Anhedral grains 2.5 to 0.1 mm.; poikilitically en-

close quartz, biotite, and magnetite; microperthitic.
Quartz 20% Anhedral grains 2.0 to 0.01 mm.; moderately to severely strained and fractured; sutured and granulated borders.
Biotite 5% Anhedral grains 0.5 to 0.1 mm.; pleochroic from pale brown to dark brown; strongly to severely altered to chlorite (pennine).
Hornblende Tr. Xenoblastic grains 0.2 to 0.1 mm.; pleochroic from yellowish-green to bluish-green; associated with biotite and magnetite.
Sphene Tr.
Leucoxene Tr.
Epidote Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained, slightly cataclastic.
Probable rock: Quartz monzonite

Skelly Oil Co.	Baca County	CL-176
#1 McEndree	28S-48W, sec 32	BA-3-2
		Cuttings
		5580-5600 ft.

Microcline 50% Anhedral grains 4.5 to 0.1 mm.; microperthitic; Carlsbad twins; poikilitically enclose quartz, plagioclase, and biotite.
Plagioclase 30% Albite to oligoclase; euhedral to subhedral grains 2.0 to 0.2 mm.; strongly to severely altered to sericite; albite, pericline, and Carlsbad twins.
Quartz 20% Anhedral grains 2.0 to 0.1 mm.; moderately to severely strained and fractured; some grain borders sutured and granulated.
Biotite Tr. Subhedral grains 0.5 to 0.1 mm.; pleochroic from pale yellowish-green to dark brownish-green; moderately to strongly altered to chlorite.
Epidote Tr. Anhedral grains 0.2 to 0.05 mm.; associated with altered biotite and plagioclase.
Sphene Tr. Euhedral to subhedral grains 1.0 to 0.3 mm.; severely altered to leucoxene; associated with magnetite.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Quartz monzonite

Moran Bros.	Baca County	CL-177
#1 Cramer	33S-50W, sec 12	BA-4-1
		Cuttings
		3240-50 ft.

Microcline 35% Subhedral to anhedral grains 4.5 to 0.1 mm.; microperthitic; Carlsbad twins; poikilitically enclose quartz and plagioclase.
Plagioclase 30% Albite to oligoclase; zoned subhedral grains 3.0 to 0.1 mm.; moderately to severely altered to sericite; albite and Carlsbad twins; albite rims.
Quartz 30% Anhedral grains 4.5 to 0.05 mm.; moderately to strongly strained and fractured; poikilitically enclose microcline, biotite, and sphene.
Biotite 5% Subhedral to anhedral grains 1.5 to 0.05 mm.; pleochroic from pale greenish-yellow to very dark greenish-brown; strongly to severely altered to chlorite (pennine); poikilitically enclose leucoxene, apatite, and zircon.
Leucoxene Tr. Microcrystalline grains in masses 0.5 to 0.05 mm. alteration product of euhedral crystals of sphene.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Quartz monzonite

Moran Bros.	Baca County	CL-177
#1 Cramer	33S-50W, sec 12	BA-4-2
		Cuttings
		3250-60 ft.

Microcline 45% Subhedral to anhedral grains 4.0 to 0.1 mm.; microperthitic; Carlsbad twins; poikilitically enclose quartz; slightly altered to sericite.
Quartz 30% Anhedral grains 4.0 to 0.05 mm.; moderately strained and fractured; subhedral where in contact with microcline.
Plagioclase 25% Oligoclase; euhedral to subhedral grains 4.0 to 0.75 mm.; moderately to severely altered to sericite; albite and Carlsbad twins; albite rims.
Biotite Tr. Elongate subhedral grains 0.5 to 0.1 mm.; pleochroic from pale greenish-yellow to very dark greenish-brown; slightly to severely altered to chlorite (pennine).

Sphene Tr. Subhedral to anhedral grains 0.5 mm. to microcrystalline; severely altered to leucoxene.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Microcline granite.

Moran Bros.	Baca County	CL-177
#1 Cramer	33S-50W, sec 12	BA-4-3
		Cuttings
		3270-80 ft.

Plagioclase 55% Oligoclase to andesine; euhedral to subhedral grains 4.0 to 0.2 mm.; moderately to severely altered to sericite; albite and pericline twins; albite rims.
Quartz 28% Anhedral grains 4.0 to 0.05 mm.; moderately strained and fractured; subhedral where in contact with microcline.
Microcline 15% Subhedral to anhedral grains 5.0 to 0.1 mm.; microperthitic; Carlsbad twins; poikilitically enclose quartz; slightly altered to sericite.
Biotite 2% Subhedral grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark greenish-brown; slightly to severely altered to chlorite (pennine).
Sphene Tr. Euhedral to subhedral grains 0.75 mm. to microcrystalline; severely altered to leucoxene.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Granodiorite

Moran Bros.	Baca County	CL-178
#1 Singer	35S-50W, sec 3	BA-5-1
		Cuttings
		4580-90 ft.

Microcline 74% Anhedral grains 2.5 to 0.5 mm.; microperthitic; poikilitically enclose quartz.

Quartz 15% Anhedral grains 1.5 to 0.1 mm.; moderately strained and fractured.
Plagioclase 10% Oligoclase; subhedral grains 2.0 to 0.3 mm.; slightly altered to sericite; albite and Carlsbad twins; narrow rims of albite.
Biotite 1% Subhedral grains 0.3 to 0.05 mm.; pleochroic from pale brown to dark brown.
Chlorite Tr. Anhedral masses 0.5 to 0.01 mm.; alteration product of biotite.
Epidote Tr.
Sphene Tr.
Leucoxene Tr.
Apatite Tr.
Magnetite Tr.
Pyrite Tr.

Fabric: Sample is composed primarily of individual mineral grains, so true grain size and fabric cannot be determined. Appears to be holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Granite

Frankfort Oil Co.	Baca County	CL-186
#1-C Cimarron	34S-48W, sec 22	BA-7-1
		Cuttings
		6050-60 ft.

Microcline 63% Subhedral to anhedral grains 4.0 to 0.05 mm.; Carlsbad twins; microperthitic; poikilitically enclose quartz, plagioclase, and zircon; smaller grains occur interstitally.
Quartz 30% Anhedral grains 1.0 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured and granulated.
Plagioclase 5% Albite to oligoclase; anhedral grains 0.2 to 0.05 mm.; moderately to strongly altered to sericite; myrmekitic; albite twins absent; occur interstitially.
Biotite 2% Elongate subhedral to anhedral grains 1.0 to 0.01 mm.; pleochroic from pale yellowish-green to brownish-green; severely to completely altered to chlorite, muscovite, and hematite.
Sphene Tr. Anhedral grains 0.05 mm. to microcrystalline; associated with altered biotite.
Zircon Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, fine- to medium-grained. Cataclastic.
Probable rock: Cataclastic granite

Frankfort Oil Co.	Baca County	CL-186
#1-C Cimarron	34S-48W, sec 22	BA-7-2
		Cuttings
		6069 ft.

Microcline 55% Subhedral to anhedral grains 2.0 to 0.05 mm.; Carlsbad twins; microperthitic.
Quartz 30% Anhedral grains 0.5 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured and granulated.
Biotite 10% Elongate subhedral to anhedral grains 0.5 to 0.01 mm.; pleochroic from pale yellowish-green to dark green; severely to completely altered to chlorite, muscovite, and hematite.
Plagioclase 5% Albite to oligoclase; anhedral grains 1.0 to 0.05 mm.; strongly altered to sericite; myrmekitic, albite twins absent; occur interstitially.
Leucoxene Tr. Masses of microcrystalline grains; associated with altered biotite.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, fine- to medium-grained. Cataclastic.
Probable rock: Cataclastic granite

Amerada Petroleum Co.	Bent County	CL-11
#1 C. L. Dillon	27S-51W, sec 17	BE-1-1
		Cuttings
		4531 ft.

Plagioclase 35% Oligoclase; subhedral to anhedral grains 4.5 to 0.1 mm.; strongly to severely altered to sericite; albite and Carlsbad twins; weakly zoned; albite rims; poikilitically enclose quartz, biotite, and magnetite.
Microcline 33% Anhedral grains 5.5 to 1.5 mm.; microperthitic; poikilitically enclose plagioclase and quartz.
Quartz 20% Anhedral grains 2.5 to 0.05 mm.; moderately strained and fractured; sutured borders; contain microcrystalline needles of rutile.
Biotite 5% Subhedral to anhedral grains 1.0 to 0.1 mm.; completely altered to chlorite.
Muscovite 5% Anhedral grains 1.5 to 0.05 mm.; associated with biotite and also formed from sericite.
Magnetite 2%
Sphene Tr.
Apatite Tr.
Zircon Tr.

Pyrite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Quartz monzonite.

Clayton Oil Co.	Bent County	CL-12
#1 Etchart	26S-52W, sec 15	BE-2-1
		Cuttings
		4440 ft.

Plagioclase 65% Oligoclase; zoned euhedral to subhedral grains 3.5 to 0.1 mm.; moderately to severely altered to sericite; albite, pericline, and Carlsbad twins; albite rims.
Quartz 20% Anhedral grains 1.5 to 0.05 mm.; moderately strained and fractured.
Microcline 10% Anhedral grains 3.5 to 0.2 mm.; microperthitic; poikilitically enclose quartz, biotite, magnetite, and leucoxene.
Biotite 5% Subhedral grains 1.5 to 0.1 mm.; pleochroic from pale yellow to dark brown; slightly altered to chlorite; poikilitically enclose apatite.
Leucoxene Tr. Microcrystalline grains in anhedral masses 1.0 to 0.05 mm. associated with magnetite.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Granodiorite

Seaboard Oil Co.	Bent County	CL-13
#1 Government	26S-53W, sec 14	BE-3-1
		Cuttings
		6430-40 ft.

Plagioclase 40% Oligoclase; zoned euhedral to subhedral crystals 6.0 to 0.2 mm.; moderately to strongly altered to sericite; albite and Carlsbad twins; narrow rims of albite; poikilitically enclose chlorite, magnetite and apatite.
Microcline 35% Anhedral grains 4.0 to 1.0 mm.; microperthitic; Carlsbad twins; poikilitically enclose quartz and plagioclase.
Quartz 15% Anhedral grains 2.0 to 0.1 mm.; slightly to moderately strained and fractured.

Biotite 10% Subhedral grains 2.0 to 0.1 mm.; pleochroic from pale yellowish-brown to dark brown; partly altered to chlorite; poikilitically enclose apatite, sphene, and magnetite.
Muscovite Tr. Shredlike anhedral grains 0.3 to 0.05 mm.; associated with biotite.
Sphene Tr. Euhedral to anhedral grains 1.0 to 0.01 mm.; severely to completely altered to leucoxene.
Apatite Tr.
Magnetite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium- to coarse-grained.
Probable rock: Quartz monzonite.

Texaco, Inc.	Bent County	CL-179
#1 M.E. Jones	27S-52W, sec 35	BE-5-1
		Cuttings
		4380-90 ft.

Phenocrysts: 15% of thin section

Augite 100% Subhedral to anhedral grains 2.0 to 0.5 mm.; severely fractured and altered to tremolite-actinolite.

Groundmass: 85% of thin section.

Plagioclase 40% Andesine; euhedral to subhedral lathlike grains 0.5 to 0.1 mm.; slightly altered to sericite; albite and pericline twins; fractured.
Tremolite-Actinolite 23% Elongate anhedral grains 1.0 to 0.01 mm.; pleochroic from pale yellowish-green to pale bluish-green; minute grains occur in fibrous clusters.
Serpentine 15% Antigorite; fibrous masses of elongate grains 0.05 mm. to microcrystalline; pale green; alteration product of olivine.
Chlorite 10%
Augite 5% Anhedral grains 0.2 to 0.1 mm.
Magnetite 5% Subhedral grains 0.2 to 0.05 mm.
Epidote 2% Strongly-fractured anhedral grains 0.3 to 0.1 mm.
Leucoxene Tr. Opaque anhedral masses 1.0 to 0.01 mm.; associated with magnetite.
Calcite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, subophitic, fine-grained.

Probable rock: Altered olivine basalt

Texaco, Inc.	Bent County	CL-179
#1 M. E. Jones	27S-52W, sec 35	BE-5-2
		Cuttings
		4390-97 ft.

Phenocrysts: 25% of thin section

Augite 100% Subhedral to anhedral grains 2.0 to 0.5 mm.; severely fractured; slightly altered to tremolite-actinolite.

Groundmass: 75% of thin section

Plagioclase 45% Andesine; euhedral to subhedral lathlike crystals 1.0 to 0.1 mm.; slightly altered to sericite; albite, pericline, and Carlsbad twins; fractured and slightly bent.
Serpentine 35% Antigorite; fibrous masses of elongate grains 0.05 mm. to microcrystalline; pale green; alteration product of olivine.
Tremolite-Actinolite 15% Elongate anhedral grains 1.0 to 0.01 mm.; pleochroic from pale yellowish-green to pale bluish-green; minute grains occur in fibrous clusters.
Chlorite 5% Pennine; shredlike anhedral grains 0.2 to 0.01 mm.; associated with serpentine.
Quartz Tr. Anhedral grains 0.1 to 0.01 mm.
Epidote Tr.
Leucoxene Tr. Opaque anhedral grains 1.0 to 0.01 mm.; associated with magnetite.
Magnetite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, subophitic, fine-grained.
Probable rock: Altered olivine basalt.

Cushman and Pilcher	Delta County	CL-22
#1 Hawkins	13S-95W, sec 35	DE-6-1
(#1 Government)		Cuttings
		2590-2602 ft.

Quartz 65% Xenoblastic grains 2.0 to 0.01 mm.; moderately to strongly strained and fractured; sutured grain borders.
Plagioclase 20% Xenoblastic grains 1.0 to 0.1 mm.; strongly altered

to sericite; albite twin lamellae obscured.
Biotite 10% Zenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark brownish-green; preferred orientation.
Muscovite 5% Shredlike xenoblastic grains 0.5 to 0.1 mm.; associated with biotite.
Sphene Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Muscovite-biotite-plagioclase-quartz gneiss.

Smith Drilling	Dolores County	CL-29
#1 Groundhog Unit	40N-13W, sec 13	DO-1-1
(Ray Smith	(NMPM)	Cuttings
#1 Chester Brown)		3980-90 ft.

Phenocrysts: 30% of thin section

Hornblende 50% Euhedral to subhedral crystals 1.5 to 0.2 mm.; pleochroic from pale yellowish-green to pale bluish-green; moderately altered to chlorite (pennine).
Plagioclase 45% Oligoclase; euhedral to subhedral crystals 3.0 to 0.3 mm.; slightly altered to sericite; albite, pericline, and Carlsbad twins; weak zoning.
Magnetite 3% Subhedral to anhedral grains 0.2 to 0.1 mm.
Muscovite 1% Subhedral grains 1.0 to 0.2 mm.
Sphene 1% Euhedral to subhedral crystals 0.5 to 0.1 mm.
Apatite Tr. Euhedral crystals 0.2 to 0.1 mm.

Groundmass: 70% of thin section

Orthoclase 57% Anhedral grains 0.05 mm. to microcrystalline.
Plagioclase 35% Subhedral grains 0.2 mm. to microcrystalline; slightly altered to sericite; albite twins.
Hornblende 5% Subhedral to anhedral grains 0.2 to 0.05 mm.
Magnetite 2%
Sphene 1%
Epidote Tr. Anhedral grains 0.5 to 0.05 mm.; associated with hornblende.
Muscovite Tr.
Apatite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric,

fine-grained.
Probable rock: Latite porphyry

Smith Drilling	Dolores County	CL-29
#1 Groundhog Unit	40N-13W, sec 13	DO-1-2
(Ray Smith	(NMPM)	Cuttings
#1 Chester Brown		3990-95 ft.

Phenocrysts: 25% of thin section.

Plagioclase 50% Oligoclase; euhedral to subhedral crystals 2.0 to 0.2 mm.; slightly altered to sericite; albite, pericline, and Carlsbad twins; albite rims.
Hornblende 42% Euhedral to subhedral crystals 1.0 to 0.2 mm.; pleochroic from pale-yellowish-green to pale bluish-green; moderately to strongly altered to chlorite (pennine).
Muscovite 5% Subhedral grains 0.3 to 0.1 mm.
Magnetite 2% Subhedral to anhedral grains 0.2 to 0.1 mm.
Sphene 1% Euhedral to subhedral crystals 0.2 to 0.1 mm.

Groundmass: 75% of thin section

Orthoclase 50% Anhedral grains 0.05 mm. to microcrystalline.
Plagioclase 37% Subhedral grains 0.2 mm. to microcrystalline; slightly altered to sericite; albite twins.
Hornblende 10% Subhedral to anhedral grains 0.2 to 0.05 mm.
Magnetite 2%
Sphene 1%
Epidote Tr. Anhedral grains 0.3 to 0.05 mm.; associated with hornblende.
Muscovite Tr.
Apatite Tr.
Zircon Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric, fine-grained.
Probable rock: Latite porphyry.

Smith Drilling	Dolores County	CL-29
#1 Groundhog Unit	40N-13W, sec 13	DO-1-3
(Ray Smith	(NMPM)	Cuttings
#1 Chester Brown)		4045-55 ft.

Phenocrysts: 35% of thin section

Plagioclase 55% Oligoclase; euhedral to subhedral crystals 2.5 to 0.3 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins.
Hornblende 41% Euhedral to subhedral crystals 1.0 to 0.3 mm.; pleochroic from colorless or pale yellowish-green to pale bluish-green; strongly altered to chlorite (pennine) and epidote.
Magnetite 2% Subhedral to anhedral grains 0.2 to 0.1 mm.
Sphene 2% Subhedral to anhedral grains 0.2 to 0.1 mm.
Muscovite Tr. Shredlike anhedral grains 0.5 to 0.1 mm.
Apatite Tr. Euhedral crystals 0.2 to 0.1 mm.

Groundmass: 65% of thin section

Orthoclase 50% Anhedral grains 0.05 mm. to microcrystalline.
Plagioclase 35% Subhedral grains 0.2 mm. to microcrystalline; slightly altered to sericite; albite twins.
Hornblende 5% Subhedral to anhedral grains 0.2 to 0.05 mm.
Epidote 3% Anhedral grains 0.3 to 0.05 mm.; associated with phenocrysts of hornblende and plagioclase.
Quartz 2% Anhedral grains 0.3 to 0.01 mm.; moderately strained.
Sphene 2%
Magnetite 2%
Calcite 1%
Muscovite Tr.
Apatite Tr.
Zircon Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric, fine-grained.
Probable rock: Latite porphyry.

Smith Drilling	Dolores County	CL-29
#1 Groundhog Unit	40N-13W, sec 13	DO-1-4
(Ray Smith	(NMPM)	Cuttings
#1 Chester Brown)		4080-90 ft.

Phenocrysts: 30% of thin section

Plagioclase 81% Oligoclase; euhedral to subhedral crystals 3.5 to 0.2 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins.
Hornblende 15% Subhedral to anhedral grains 1.5 to 0.2 mm.; pleochroic from colorless or pale yellowish-green to pale bluish-

green; strongly altered to chlorite (pennine).
Magnetite 3% Subhedral to anhedral grains 0.2 to 0.1 mm.
Sphene 1% Subhedral to anhedral grains 0.2 to 0.1 mm.
Muscovite Tr. Shredlike anhedral grains 0.5 to 0.1 mm.

Groundmass: 70% of thin section

Orthoclase 47% Anhedral grains 0.05 mm. to microcrystalline.
Plagioclase 35% Subhedral grains 0.2 mm. to microcrystalline; slightly altered to sericite; albite twins.
Hornblende 10% Subhedral to anhedral grains 0.2 to 0.05 mm.
Magnetite 3%
Quartz 2% Anhedral grains 0.2 to 0.01 mm.; slightly to moderately strained.
Epidote 2% Anhedral grains 0.3 to 0.05 mm.; associated with phenocrysts of hornblende and plagioclase.
Sphene 1%
Muscovite Tr.
Apatite Tr.
Zircon Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric, fine-grained.
Probable rock: Latite porphyry

Smith Drilling	Dolores County	CL-29
#1 Groundhog Unit	40N-13W, sec 13	DO-1-5
(Ray Smith	(NMPM)	Cuttings
#1 Chester Brown)		4200-10 ft.

Phenocrysts: 35% of thin section.

Plagioclase 80% Oligoclase; euhedral to subhedral crystals 3.0 to 0.2 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins.
Hornblende 16% Euhedral to subhedral grains 2.0 to 0.3 mm.; pleochroic from pale yellowish-green to pale bluish-green; severely altered to chlorite.
Magnetite 3% Subhedral to anhedral grains 0.2 to 0.1 mm.
Sphene 1% Subhedral to anhedral grains 0.2 to 0.1 mm.
Muscovite Tr. Shredlike anhedral grains 0.5 to 0.2 mm.

Groundmass: 65% of thin section.

Orthoclase 45% Anhedral grains 0.05 mm. to microcrystalline.

Plagioclase 30% Subhedral grains 0.2 mm. to microcrystalline.
Magnetite 8% Subhedral to anhedral grains 0.1 to 0.01 mm.; often associated with altered hornblende phenocrysts.
Hornblende 7% Subhedral to anhedral grains 0.2 to 0.05 mm.
Quartz 5% Anhedral grains 0.2 to 0.01 mm.; slightly strained; some borders sutured.
Muscovite 2%
Sphene 2%
Epidote 1%
Apatite Tr.
Zircon Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric, fine-grained.
Probable rock: Latite porphyry

Smith Drilling	Dolores County	CL-29
#1 Groundhog Unit	40N-13W, sec 13	DO-1-6
(Ray Smith	(NMPM)	Cuttings
#1 Chester Brown)		4425-30 ft.

Phenocrysts: 40% of thin section.

Plagioclase 85% Oligoclase; euhedral to subhedral crystals 4.0 to 0.3 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins.
Hornblende 10% Subhedral to anhedral grains 1.0 to 0.2 mm.; pleochroic from colorless or pale yellowish-green to pale bluish-green; slightly to severely altered to chlorite.
Magnetite 3% Subhedral to anhedral grains 0.2 to 0.1 mm.
Sphene 2% Subhedral to anhedral grains 0.2 to 0.1 mm.
Apatite Tr. Euhedral crystals 0.3 to 0.1 mm.

Groundmass: 60% of thin section.

Orthoclase 43% Anhedral grains 0.05 mm. to microcrystalline.
Plagioclase 40% Subhedral grains 0.05 mm. to microcrystalline.
Hornblende 5% Subhedral to anhedral grains 0.2 to 0.05 mm.
Quartz 5% Anhedral grains 0.2 to 0.05 mm.; slightly strained; some borders sutured.
Magnetite 3%
Epidote 2%
Sphene 2%
Muscovite Tr.
Apatite Tr.

Zircon Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric, fine-grained.
Probable rock: Latite porphyry.

Western Natural Gas	Dolores County	CL-30
Byrd, Frost, and English	41N-17W, sec 26	DO-2-1
#1-A Glade	(NMPM)	Cuttings
(J. A. Uhl-Government)		7610-20 ft.

Plagioclase 60% Oligoclase to andesine; lathlike euhedral to subhedral grains 1.0 to 0.05 mm.; moderately altered to sericite; albite and Carlsbad twins.
Tremolite-actinolite 10% Elongate subhedral grains 0.5 to 0.05 mm.; colorless; alteration product of diopside.
Magnetite 10% Euhedral to anhedral grains 0.1 to 0.01 mm.
Diopside 5% Corroded euhedral to subhedral grains 1.0 to 0.05 mm.; fractured; associated with tremolite-actinolite.
Quartz 5% Anhedral grains 0.3 to 0.01 mm.; unstrained; interstitial to plagioclase laths.
Chlorite 5% Pennine; anhedral masses 1.0 to 0.05 mm.
Biotite 3% Elongate subhedral grains 0.5 to 0.01 mm.; pleochroic from light brown to dark reddish-brown.
Hornblende 2% Subhedral to anhedral grains 0.2 to 0.05 mm.; pleochroic from very pale brown to dark greenish-brown.
Apatite Tr.

Fabric: Holocrystalline, inequigranular-seriate, fine-grained.
Probable rock: Dacite

Western Natural Gas	Dolores County	CL-30
Byrd, Frost, and English	41N-17W, sec 26	DO-2-2
#1-A Glade	(NMPM)	Cuttings
(J. A. Uhl-Government)		7660-70 ft.

Plagioclase 60% Oligoclase to andesine; lathlike euhedral to subhedral grains 1.5 to 0.05 mm.; moderately altered to sericite; albite and Carlsbad twins.
Tremolite-actinolite 10% Elongate subhedral grains 0.3 to 0.05 mm.; pleochroic from colorless to pale brown; alteration product of diopside.

Magnetite 10% Euhedral to anhedral grains 0.1 to 0.01 mm.
Diopside 5% Corroded euhedral to subhedral grains 0.5 to 0.1 mm.; fractured; associated with tremolite-actinolite.
Biotite 5% Elongate subhedral grains 0.3 to 0.05 mm.; pleochroic from light brown to dark reddish-brown.
Quartz 5% Anhedral grains 0.2 to 0.01 mm.; unstrained; interstitial to plagioclase laths.
Chlorite 5% Anhedral masses 1.0 to 0.05 mm.
Hornblende Tr.
Apatite Tr.
Pyrite Tr.

Fabric: Holocrystalline, intergranular, fine-grained.
Probable rock: Dacite

Champlin Refining Co.	Eagle County	CL-31
#1 Black	5S-84W, sec 4	EA-1-1
		Cuttings
		6100-10 ft.

Phenocrysts: 30% of thin section

Plagioclase 95% Oligoclase; euhedral to subhedral crystals 1.5 to 0.2 mm.; moderately to strongly altered to sericite and calcite; albite twins obscured.
Biotite 4% Subhedral grains 0.5 to 0.05 mm.; severely altered to chlorite.
Wollastonite 1% Corroded subhedral to anhedral grains and in fibrous aggregates 0.3 to 0.1 mm.

Groundmass: 70% of thin section

Microcrystalline grains 90% Probably composed of anhedral grains of orthoclase and quartz; some subhedral laths of plagioclase 0.05 to 0.01 mm.
Chlorite 5% Anhedral masses 2.0 to 0.01 mm.; alteration product of biotite.
Calcite 3% Anhedral grains and masses 0.1 mm. to microcrystalline; alteration product.
Leucoxene 1% Anhedral masses of microcrystalline grains.
Apatite 1% Euhedral to subhedral grains 0.2 to 0.05 mm.
Zircon Tr.
Magnetite Tr.
Pyrite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, felsophyric to orthophyric, fine-grained.
Probable rock: Latite porphyry

Champlin Refining Co.	Eagle County	CL-31
#1 Black	5S-84W, sec 4	EA-1-2
		Cuttings
		6200-10 ft.

Phenocrysts: 65% of thin section.

Plagioclase 45% Oligoclase; euhedral to subhedral crystals 1.5 to 0.3 mm.; moderately to severely altered to sericite; albite twins obscured.
Micrographic granite 45% Anhedral grains 2.0 to 1.0 mm.; micrographic intergrowths of orthoclase and quartz.
Biotite 10% Euhedral to subhedral grains 1.0 to 0.2 mm.; severely to completely altered to chlorite.
Wollastonite Tr. Elongate subhedral grains and fibrous aggregates 0.5 to 0.1 mm.
Groundmass: 35% of thin section

Orthoclase 40% Anhedral grains 0.05 to 0.01 mm.; moderately altered to sericite.
Quartz 25% Anhedral grains 0.05 to 0.01 mm.; unstrained.
Plagioclase 15% Lathlike subhedral grains 0.1 to 0.01 mm.; moderately altered to sericite.
Chlorite 10% Anhedral masses 0.2 to 0.01 mm.; alteration product of biotite.
Epidote 5% Anhedral grains 0.1 to 0.01 mm.; associated with chlorite as an alteration product of biotite.
Calcite 3% Anhedral grains and masses 1.5 mm. to microcrystalline; alteration product.
Apatite 2%
Sphene Tr.
Leucoxene Tr.
Pyrite Tr.

Fabric: Holocrystalline; inequigranular-porphyritic, micrographic, felsophyric to orthophyric, fine-grained.
Probable rock: Quartz latite porphyry to rhyolite porphyry.

Champlin Refining Co.	Eagle County	CL-31
#1 Black	5S-84W, sec 4	EA-1-3
		Cuttings
		6300-10 ft.

Plagioclase 30% Oligoclase; euhedral to subhedral grains 1.0 to 0.1 mm.; slightly to moderately altered to sericite; albite and pericline twins.
Orthoclase 25% Anhedral grains 1.0 to 0.01 mm.; interstitial to quartz and plagioclase.
Quartz 15% Anhedral grains 0.5 to 0.01 mm.; unstrained grains.
Epidote 15% Anhedral grains 0.1 to 0.05 mm.; occur in aggregates as an alteration product of feldspars.
Chlorite 10% Anhedral masses 1.0 to 0.01 mm.; alteration product of biotite.
Sericite 5% Anhedral masses 0.3 mm. to microcrystalline; alteration product of feldspars.
Sphene Tr.
Apatite Tr.
Magnetite Tr.

Fabric: Holocrystalline, inequigranular-seriate, felsophyric to orthophyric, fine-grained.
Probable rock: Quartz latite

Delhi-Taylor Oil Corp.	Fremont County	CL-189
#1-16 State	18S-69W, sec 16	FR-5-1
		Cuttings
		3925-30 ft.

Quartz 45% Xenoblastic grains 1.5 to 0.01 mm.; strongly strained and fractured; sutured borders.
Plagioclase 30% Oligoclase; xenoblastic grains 0.5 to 0.1 mm.; severely altered to sericite; albite twins obscured.
Biotite 10% Idioblastic to xenoblastic grains 0.3 to 0.05 mm.; pleochroic from pale yellow to greenish-brown or from light brown to very dark brown; preferred orientation.
Microcline 5% Xenoblastic grains 1.0 to 0.05 mm.; slightly altered to sericite; Carlsbad twins; poikiloblastically enclose quartz, plagioclase and biotite.
Magnetite 5% Idioblastic to xenoblastic grains 0.1 to 0.01 mm.
Muscovite 3% Shredlike xenoblastic grains 1.0 to 0.1 mm.; associated with biotite.
Sillimanite 2% Microcrystalline idioblastic grains in clusters 0.5 to 0.01 mm.; associated with biotite, quartz and muscovite;

preferred orientation.
Leucoxene Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Microcline-biotite-plagioclase-quartz gneiss

Delhi-Taylor Oil Corp.	Fremont County	CL-189
#1-16 State	18S-69W, sec 16	FR-5-2
		Cuttings
		3930 ft.

Quartz 55% Xenoblastic grains 0.5 to 0.05 mm.; strongly strained and fractured; sutured borders.
Biotite 15% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellow to dark brown; preferred orientation.
Muscovite 15% Shredlike xenoblastic grains 1.5 to 0.5 mm.; associated with biotite.
Plagioclase 5% Oligoclase (?); xenoblastic grains 0.3 to 0.1 mm.; severely to completely altered to sericite; albite twins obscured.
Sillimanite 5% Microcrystalline idioblastic grains in clusters 0.3 to 0.01 mm.; associated with quartz, biotite, and muscovite; preferred orientation.
Magnetite 5% Idioblastic to xenoblastic grains 0.3 to 0.01 mm.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Calcite Tr.

Fabric: Gneissose to schistose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Sillimanite-plagioclase-muscovite-biotite-quartz gneiss.

Forest Oil Corp.	Garfield County	CL-38
#1 Government	7S-104W, sec 2	GA-1-1
(Gulf Oil Corp.		Cuttings
#4 South Canyon-Government)		5550 ft.

Quartz 50% Xenoblastic grains 0.5 to 0.01 mm.; strongly strained and fractured; grain borders sutured and granulated.
Plagioclase 32% Oligoclase; xenoblastic grains 0.3 to 0.1 mm.;

severely altered to sericite; albite twins obscured.
Biotite 15% Shredlike xenoblastic grains 0.5 to 0.1 mm.; pleochroic from yellowish-brown to dark greenish-brown; moderately to strongly altered to chlorite and muscovite; preferred orientation.
Calcite 2% Xenoblastic grains 0.3 to 0.01 mm.
Muscovite 1% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.
Sillimanite Tr. Elongate idioblastic crystals 0.01 mm. to microcrystalline; enclosed within some quartz grains.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-quartz gneiss.

Forest Oil Corp.	Garfield County	CL-38
#1 Government	7S-104W, sec 2	GA-1-2
(Gulf Oil Corp.		Cuttings
#4 South Canyon-Government)		5650-60 ft.

Quartz 55% Xenoblastic grains 0.5 to 0.01 mm.; strongly strained and fractured; sutured borders.
Plagioclase 29% Oligoclase; xenoblastic grains 0.3 to 0.05 mm.; strongly altered to sericite; albite twins obscured.
Biotite 15% Shredlike xenoblastic grains 0.5 to 0.05 mm.; pleochroic from yellowish-green to dark brownish-green or from very pale brown to reddish-brown; slightly to moderately altered to chlorite; preferred orientation.
Muscovite 1% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.
Tourmaline Tr. Broken idioblastic to xenoblastic grains 0.1 to 0.05 mm.; pleochroic from pale gray to dark bluish-gray.
Sphene Tr.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-quartz gneiss.

Forest Oil Corp.	Garfield County	CL-38
#1 Government	7S-104W, sec 2	GA-1-3
(Gulf Oil Corp.		Cuttings
#4 South Canyon-Government)		5650-60 ft.

Quartz 60% Xenoblastic grains 0.5 to 0.01 mm.; strongly strained and fractured; grain borders sutured and granulated.
Plagioclase 20% Oligoclase; xenoblastic grains 0.2 to 0.05 mm.; slightly to strongly altered to sericite; albite twins rare.
Biotite 17% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellow to dark reddish-brown or from pale yellowish-green to brownish-green; preferred orientation.
Muscovite 3% Shredlike xenoblastic grains 0.5 to 0.05 mm.
Sillimanite Tr. Microcrystalline idioblastic grains in fibrous clusters 0.2 to 0.01 mm.; enclosed within quartz and associated with biotite.
Sphene Tr.
Leucoxene Tr.
Zircon Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-quartz gneiss.

Kerr-McGee and	Garfield County	CL-42
Phillips Petroleum Co.	8S-102W, sec 8	GA-3-1
#1 Unit		Cuttings
		4300-10 ft.

Microcline 39% Xenoblastic grains 4.5 to 0.5 mm.; indistinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz, plagioclase and biotite.
Plagioclase 30% Oligoclase; xenoblastic grains 2.5 to 0.2 mm.; slightly to moderately altered to sericite; albite, pericline and Carlsbad twins.
Quartz 15% Xenoblastic grains 3.0 to 0.05 mm.; strongly strained and fractured; grain borders sutured and slightly granulated.
Biotite 15% Elongate xenoblastic grains 1.5 to 0.1 mm.; pleochroic from pale yellowish-brown to dark brown; preferred orientation.
Muscovite 1% Shredlike xenoblastic grains 0.5 to 0.1 mm.; associated with biotite.
Epidote Tr.
Apatite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

Kerr-McGee and Phillips Petroleum Co. #1 Unit	Garfield County 8S-102W, sec 8	CL-42 GA-3-2 Cuttings 4315-25 ft.

Plagioclase 55% Oligoclase; xenoblastic grains 3.0 to 0.2 mm.; slightly altered to sericite; albite and pericline twins; myrmekitic.
Quartz 20% Xenoblastic grains 2.0 to 0.05 mm.; strongly strained and fractured; grain borders sutured.
Biotite 15% Elongate xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale greenish-brown to very dark greenish-brown; slightly altered to chlorite; preferred orientation.
Microcline 10% Xenoblastic grains 2.0 to 0.5 mm.; indistinct polysynthetic twins; microperthitic.
Muscovite Tr. Xenoblastic grains 0.1 to 0.05 mm.; associated with biotite.
Sphene Tr.
Apatite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Microcline-biotite-quartz-plagioclase gneiss.

British-American Producing Co. #1-C Lazy-U-Ranch	Grand County 2N-77W, sec 3	CL-43 GR-1-1 Cuttings 4620-30 ft.

Quartz 35% Xenoblastic grains 1.0 to 0.01 mm.; occur in aggregates up to 3.0 mm.; slightly to moderately strained; fractured; grain borders sutured.
Microcline 35% Xenoblastic grains 1.0 to 0.1 mm.; microperthitic; slightly altered to sericite.
Plagioclase 25% Oligoclase; xenoblastic grains 2.0 to 0.05 mm.; severely altered to sericite; fractured; albite and Carlsbad twins.
Muscovite 5% Shredlike xenoblastic grains 1.0 to 0.05 mm.; some grains formed from sericite.

Leucoxene Tr.

Fabric: Granoblastic, in part cataclastic, fine-grained.
Probable rock: Muscovite-plagioclase-microcline-quartz gneiss.

DeBarard Cattle Co.	Grand County	CL-44
#1 State	4N-81W, sec 27	GR-2-1
		Cuttings
		4400-05 ft.

Plagioclase 50% Andesine; idioblastic to xenoblastic grains 1.5 to 0.1 mm.; slightly to severely altered to sericite; albite twins.
Hornblende 30% Idioblastic to xenoblastic grains 1.5 to 0.05 mm.; pleochroic from yellowish-green to bluish-green; poikiloblastically enclose plagioclase, sphene and apatite.
Microcline 10% Xenoblastic grains 1.5 to 0.1 mm.; poikiloblastically enclose apatite and hornblende.
Quartz 5% Xenoblastic grains 1.0 to 0.1 mm.; strongly strained and fractured.
Biotite 5% Idioblastic to xenoblastic grains 1.0 to 0.1 mm.; pleochroic from pale yellowish-brown to dark brownish-green.
Apatite Tr.
Sphene Tr. Idioblastic to xenoblastic grains 0.3 to 0.05 mm.; severely altered to leucoxene.
Epidote Tr. Xenoblastic grains 0.3 to 0.05 mm.; alteration product of hornblende.
Chlorite Tr.

Fabric: Gneissose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-quartz-microcline-hornblende-plagioclase gneiss. (Amphibolite which has been subjected to alkali-silicate metasomatism.)

DeBarard Cattle Co.	Grand County	CL-44
#1 State	4N-81W, sec 27	GR-2-2
		Cuttings
		4680-85 ft.

Plagioclase 62% Oligoclase; idioblastic to xenoblastic grains 1.5 to 0.1 mm.; severely altered to sericite; albite and Carlsbad twins.
Quartz 20% Xenoblastic grains 1.5 to 0.1 mm.; strongly strained and fractured.

Biotite 5% Idioblastic to xenoblastic grains 1.0 to 0.1 mm.; pleochroic from pale yellow to dark brown; moderately to strongly altered to chlorite.
Chlorite 5% Pennine; xenoblastic grains 1.0 to 0.05 mm.
Epidote 5% Xenoblastic grains 0.5 to 0.1 mm.; associated with biotite.
Muscovite 2% Elongate xenoblastic grains 0.1 to 0.05 mm.; associated with altered biotite and epidote.
Magnetite 1%
Hornblende Tr. Subrounded xenoblastic grains 0.2 to 0.1 mm.; pleochroic from yellowish-green to bluish-green.
Sphene Tr. Xenoblastic grains 0.2 to 0.05 mm.
Apatite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-quartz-plagioclase gneiss.

Kinney-Coastal and Texas Producting Co. #1 Pino (Escondido)	Huerfano County 26S-68W, sec 24	CL-47 HN-1-1 Cuttings 2080-2145 ft.

Variety #1, fragments make up 60% of thin section.

Plagioclase 32% Oligoclase to andesine; xenoblastic grains 0.5 to 0.05 mm.; slightly to moderately altered to sericite; very indistinct albite and pericline twins; some weak zoning.
Microcline 30% Xenoblastic grains 0.3 to 0.01 mm.; faint polysynthetic twins.
Quartz 20% Xenoblastic grains 0.1 to 0.01 mm.; slightly strained.
Hornblende 15% Corroded xenoblastic grains 0.3 to 0.01 mm.; pleochroic from yellowish-green to deep green or bluish-green.
Sphene 2% Xenoblastic grains 0.1 to 0.01 mm.
Leucoxene 1%
Biotite Tr. Xenoblastic grains 0.2 to 0.05 mm.; severely to completely altered to chlorite.
Muscovite Tr. Shredlike xenoblastic grains 0.1 to 0.05 mm.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Gneissose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Hornblende-quartz-microcline-plagioclase gneiss.

Variety #2, fragments make up 40% of thin section.

Hornblende 60% Corroded idioblastic to xenoblastic grains 1.5 to 0.1 mm.; pleochroic from yellowish-green to bluish-green; poikiloblastically enclose quartz and apatite; preferred orientation.
Plagioclase 25% Oligoclase; xenoblastic grains 0.3 to 0.05 mm.; slightly to moderately altered to sericite; weak zoning; albite twins.
Biotite 10% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from light brown to dark brown; weak preferred orientation.
Microcline 3% Xenoblastic grains 1.0 to 0.05 mm.; faint polysynthetic twins; poikiloblastically enclose hornblende and biotite.
Quartz 2% Xenoblastic grains 0.3 to 0.05 mm.; slightly to moderately strained.
Leucoxene Tr.
Apatite Tr.
Magnetite Tr.

Fabric: Schistose, nematoblastic to lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-hornblende schist.
(Rock of both varieties has been subjected to alkali-silicate metasomatism.)

Skelly Oil Co.	Huerfano County	CL-48
#1 Busch	26S-63W, sec 30	HN-2-1
		Cuttings
		1210-15 ft.

Microcline 60% Anhedral grains 1.5 to 0.1 mm.; microperthitic; poikilitically enclose quartz and plagioclase.
Quartz 25% Anhedral grains 2.5 to 0.05 mm.; moderately to strongly strained and fractured.
Plagioclase 15% Albite to oligoclase; zoned subhedral to anhedral grains 0.5 to 0.05 mm.; strongly altered to sericite; albite twins obscured; albite rims; myrmekitic.
Apatite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, fine-grained, slight cataclastic.
Probable rock: Granite

Skelly Oil Co.	Huerfano County	CL-48
#1 Niebuhr	26S-64W, sec 6	HN-3-1
		Cuttings
		900-05 ft.

Variety #1, fragments make up 70% of thin section.

Quartz 50% Xenoblastic grains 1.5 to 0.05 mm.; moderately to severely strained and fractured; sutured borders; contain microcrystalline needles of rutile.
Microcline 30% Idioblastic to xenoblastic grains 1.5 to 0.01 mm.; microperthitic; poikiloblastically enclose quartz.
Biotite 10% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale greenish-brown to dark green; moderately to strongly altered to muscovite and hematite; weak preferred orientation.
Sericite 10% Microcrystalline grains in xenoblastic masses 0.75 to 0.2 mm.; alteration product of plagioclase.
Hematite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Altered plagioclase-biotite-microcline-quartz gneiss.

Variety #2, fragments make up 20% of thin section.

Quartz 50% Subrounded grains 2.0 to 0.1 mm.; moderately strained and fractured; some grains contain microcrystalline needles of rutile.
Calcite 30% Xenoblastic grains 0.5 mm. to microcrystalline; occurs interstitially as a cement.
Microcline 20% Subangular to subrounded grains 1.0 to 0.5 mm.; slightly altered to sericite.
Hematite Tr.

Fabric: Sedimentary, detrital, subangular to subrounded grains, fine-grained.
Probable rock: Calcite-cemented arkose (Granite wash)

Variety #3, fragments make up 10% of thin section.

Quartz 60% Xenoblastic grains 0.2 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders.
Biotite 40% Idioblastic to xenoblastic grains 0.2 to 0.01 mm.; pleochroic from pale greenish-brown to dark brownish-green; slightly to moderately altered to muscovite and hematite; preferred orientation.
Apatite Tr.
Hematite Tr.

Fabric: Schistose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-quartz schist

Skelly Oil Co.	Huerfano County	CL-49
#1 Niebuhr	26S-64W, sec 6	HN-3-2
		Cuttings
		905-10 ft.

Variety #1, fragments make up 80% of thin section.

Quartz 60% Xenoblastic grains 0.5 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated.
Biotite 15% Xenoblastic grains 0.3 to 0.05 mm.; pleochroic from pale greenish-brown to very dark green; moderately altered to muscovite and hematite; preferred orientation.
Microcline 10% Xenoblastic grains 1.5 to 0.05 mm.; faint polysynthetic twins; poikiloblastically enclose quartz and altered plagioclase.
Sericite 10% Microcrystalline grains in xenoblastic masses 0.3 to 0.01 mm.; alteration product of plagioclase.
Calcite 5% Xenoblastic grains and masses 0.5 mm. to microcrystalline; occur interstitially as an alteration product.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Altered microcline-plagioclase-biotite-quartz gneiss.

Variety #2, fragments make up 20% of thin section.

Quartz 45% Subangular to subrounded grains 2.0 to 0.05 mm.; moderately to strongly strained; poikiloblastically enclose altered plagioclase.
Calcite 35% Microcrystalline grains; matrix of rock.
Microcline 20% Subangular to subrounded grains 1.5 to 0.01 mm.; distinct polysynthetic twins; poikiloblastically enclose altered plagioclase.
Magnetite Tr.
Hematite Tr.

Fabric: Sedimentary, crystalline and detrital, subangular to subrounded grains, fine-grained.
Probable rock: Calcite cemented arkose (Granite wash)

Skelly Oil Co.	Huerfano County	CL-51
#1 Shafer	26S-64W, sec 32	HN-4-1
		Cuttings
		830-35 ft.

Microcline 35% Xenoblastic grains 1.0 to 0.1 mm.; faintly microperthitic; poikiloblastically enclose quartz, biotite, and plagioclase.
Plagioclase 30% Oligoclase; xenoblastic grains 1.0 to 0.1 mm.; slightly altered to sericite; albite twins indistinct; myrmekitic.
Quartz 25% Xenoblastic grains 1.5 to 0.05 mm.; moderately strained and fractured; sutured borders.
Biotite 10% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleo-

chroic from pale greenish-yellow to very dark greenish-brown; preferred orientation.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

Skelly Oil Co.	Huerfano County	CL-51
#1 Shafer	26S-64W, sec 32	HN-4-2
		Cuttings
		850-51 ft.

Plagioclase 50% Oligoclase; xenoblastic grains 1.5 to 0.3 mm.; slightly to moderately altered to sericite; albite twins; poikiloblastically enclose quartz and biotite.
Quartz 25% Xenoblastic grains 2.0 to 0.1 mm.; moderately to strongly strained and fractured.
Biotite 15% Idioblastic to xenoblastic grains 1.0 to 0.1 mm.; pleochroic from pale yellowish-brown to dark brownish-green; weak preferred orientation.
Hornblende 10% Corroded idioblastic to xenoblastic crystals 1.5 to 0.2 mm.; pleochroic from yellowish-green to deep green or bluish-green; fractured; poikiloblastically enclose apatite; moderately altered to biotite and calcite.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Calcite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic and nematoblastic, non-porphyroblastic, medium-grained.
Probable rock: Hornblende-biotite-quartz-plagioclase gneiss.

Kingwood Oil Co.	Huerfano County	CL-205
#1-A U.S. Alamo Dome	27S-68W, sec 34	HN-6-1
		Core chip
		2839-55 ft.

Plagioclase 55% Oligoclase; euhedral to subhedral grains 0.2 to 0.01 mm.; moderately to strongly altered to sericite; albite and Carlsbad twins.

Orthoclase 30% Anhedral grains 0.1 to 0.01 mm.; moderately altered to sericite.
Quartz 10% Anhedral grains 0.1 to 0.01 mm.; slightly strained.
Calcite 5% Irregularly-shaped anhedral masses 0.5 to 0.01 mm.
Muscovite Tr. Shredlike subhedral to anhedral grains 0.1 to 0.01 mm.

Fabric: Holocrystalline, aphanitic-granular, non-porphyritic, felsophyric, fine-grained.
Probable rock: Latite to quartz latite.

Amerada Petroleum Co.	Jackson County	CL-52
#1 Morris	6N-79W, sec 14	JA-1-1
		Cuttings
		7620 ft.

Microcline 45% Xenoblastic grains 7.0 to 0.2 mm.; microperthitic; poikiloblastically enclose quartz, plagioclase, and biotite; some grains occur as large porphyroblasts.
Plagioclase 35% Oligoclase; xenoblastic grains 3.0 to 0.2 mm.; strongly to severely altered to sericite; albite twins obscured.
Quartz 17% Xenoblastic grains 3.0 to 0.05 mm.; moderately to strongly strained and fractured; some grain borders sutured and granulated.
Biotite 2% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale brownish-green to dark brownish-green.
Muscovite 1% Shredlike idioblastic to xenoblastic grains 0.3 to 0.05 mm.; associated with biotite and altered plagioclase.
Apatite Tr.
Leucoxene Tr.
Calcite Tr.

Fabric: Granoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Quartz-plagioclase-microcline gneiss.

Continental Oil Co.	Jackson County	CL-54
#A-6 Pollack	9N-79W, sec 2	JA-3-1
		Cuttings
		6165-70 ft.

Quartz 50% Xenoblastic grains 1.0 to 0.05 mm.; slightly to moderately strained; grain borders sutured.
Microcline 20% Xenoblastic grains 1.0 to 0.05 mm.; distinct polysynthetic twins; no microperthite.
Plagioclase 15% Oligoclase to andesine; xenoblastic grains 0.5 to

0.05 mm.; moderately to severely altered to sericite; albite twins.
Biotite 10% Elongate xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale brown to dark brownish-green; preferred orientation.
Chlorite 5% Pennine; elongate xenoblastic grains 0.2 to 0.05 mm.; alteration product of biotite.
Epidote Tr. Xenoblastic grains 0.1 to 0.05 mm.; associated with altered biotite.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-microcline-quartz gneiss.

William J. Hewitt	Jackson County	CL-55
#1 Government	6N-79W, sec 21	JA-4-1
(Hewitt)		Cuttings
		2735-40 ft.

Microcline 40% Xenoblastic grains 3.0 to 0.1 mm.; microperthitic; poikiloblastically enclose plagioclase, quartz, and biotite.
Plagioclase 30% Oligoclase to andesine; xenoblastic grains 2.5 to 0.1 mm.; slightly to moderately altered to sericite; albite and Carlsbad twins.
Quartz 20% Xenoblastic grains 1.5 to 0.05 mm.; strongly strained and fractured; grain borders sutured and granulated.
Biotite 10% Elongate xenoblastic grains 1.5 to 0.01 mm.; pleochroic from pale yellowish-green to very dark brownish-green; slightly altered to chlorite; poikiloblastically enclose apatite and zircon.
Hornblende Tr. One xenoblastic grain 0.2 mm.; pleochroic from yellowish-green to dark green; partly altered to biotite.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.
Calcite Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, medium-grained; in part cataclastic.
Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

William J. Hewitt #1 Government (Hewitt)	Jackson County 6N-79W, sec 21	CL-55 JA-4-2 Cuttings 2750-55 ft.

Microcline 40% Xenoblastic grains 2.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase, quartz and biotite.
Quartz 25% Xenoblastic grains 1.0 to 0.01 mm.; strongly strained and fractured; grain borders sutured and granulated.
Plagioclase 20% Oligoclase to andesine; xenoblastic grains 1.5 to 0.1 mm.; moderately to strongly altered to sericite; albite and pericline twins; myrmekitic.
Biotite 10% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale greenish-yellow to very dark green; slightly altered to chlorite; preferred orientation.
Hornblende 5% Xenoblastic grains 1.0 to 0.2 mm.; pleochroic from yellowish-green to dark green or bluish-green; partly altered to biotite.
Epidote Tr. Xenoblastic grains 1.0 to 0.05 mm.; fractured; associated with biotite and hornblende.
Apatite Tr.
Magnetite Tr.
Calcite Tr.

Fabric: Gneissose, lepidoblastic to nematoblastic, non-porphyroblastic, medium-grained.
Probable rock: Hornblende-biotite-plagioclase-quartz-microcline gneiss.

Hiawatha Oil and Gas Co. #1-25 Government- Fuller	Jackson County 7N-81W, sec 25	CL-56 JA-5-1 Cuttings 8220-30 ft.

Plagioclase 65% Oligoclase to andesine; subhedral to anhedral grains 3.0 to 0.5 mm.; slightly to moderately altered to sericite; albite and Carlsbad twins.
Microcline 15% Anhedral grains 5.0 to 1.0 mm.; microperthitic; poikilically enclose quartz and plagioclase.
Quartz 15% Anhedral grains 2.0 to 0.1 mm.; strongly strained and fractured; grain borders sutured; contain microcrystalline needles of rutile
Biotite 5% Subhedral to anhedral grains 1.5 to 0.1 mm.; pleochroic from very pale yellowish-brown to brownish-green.
Hornblende Tr. Anhedral grains 1.0 to 0.2 mm.; pleochroic from yellow-

ish-green to bluish-green.
Epidote Tr.
Calcite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Granodiorite.

Amerada Petroleum Co.	Jackson County	CL-180
#1 Government-Thompson	6N-79W, sec 8	JA-6-1
		Cuttings
		2920-25 ft.

Plagioclase 54% Variety not determined; xenoblastic grains 0.5 to 0.1 mm.; severely to almost completely altered to sericite; albite twins obscured.
Quartz 25% Xenoblastic grains 0.5 to 0.01 mm.; moderately to strongly strained and fractured; borders intricately sutured and granulated.
Biotite 20% Elongate idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale brown to deep brown or from pale greenish-yellow to dark greenish-brown; preferred orientation.
Leucoxene 1%
Apatite Tr.
Hematite Tr.

Fabric: Schistose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-quartz-plagioclase schist.

Amerada Petroleum Co.	Jackson County	CL-180
#1 Government-Thompson	6N-79W, sec 8	JA-6-2
		Cuttings
		2910-20 ft.

Plagioclase 40% Oligoclase (?); xenoblastic grains 0.3 to 0.05 mm.; severely altered to sericite; albite twins obscured.
Quartz 35% Xenoblastic grains 0.2 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders.
Biotite 24% Elongate idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale brown to deep brown or from pale greenish-yellow to dark greenish-brown; preferred orientation.
Calcite 1% Masses of xenoblastic grains 0.5 to 0.01 mm.

Leucoxene Tr.
Apatite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Schistose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-quartz-plagioclase schist.

Gulf Oil Corp	Kiowa County	CL-57
#1 U.P. Risser	17S-50W, sec 1	KI-1-1
		Cuttings
		6158-60 ft.

Quartz 45% Xenoblastic grains 1.0 to 0.01 mm.; slightly to strongly strained; sutured borders; larger grains occur in bands and aggregates.
Muscovite 35% Shredlike xenoblastic grains 0.3 to 0.01 mm.; occur in bands and masses; preferred orientation.
Chlorite 10% Shredlike xenoblastic grains 0.5 to 0.01 mm.
Sericite 5% Microcrystalline xenoblastic grains; associated with muscovite and magnetite.
Magnetite 3% Idioblastic to xenoblastic grains 0.5 to 0.01 mm.; smaller grains occur in distinct bands.
Tourmaline 2% Elongate idioblastic grains 0.3 to 0.01 mm.; pleochroic from pale purplish-gray to dark bluish-gray; preferred orientation.
Biotite Tr. Elongate xenoblastic grains 0.2 to 0.05 mm.; severely altered to chlorite and sericite.
Sphene Tr.

Fabric: Schistose, lepidoblastic to nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Tourmaline-bearing chlorite-muscovite-quartz schist.

Gulf Oil Corp.	Kiowa County	CL-57
#1 U.P. Risser	17S-50W, sec 1	KI-1-2
		Cuttings
		6160 ft.

Quartz 58% Xenoblastic grains 0.3 to 0.01 mm.; slightly to strongly strained; sutured borders; larger grains occur in bands and aggregates.
Sericite 20% Microcrystalline xenoblastic grains; occur in masses; associated with muscovite and magnetite.

Chlorite 10% Shredlike xenoblastic grains 0.5 to 0.01 mm.
Muscovite 5% Shredlike xenoblastic grains 0.1 to 0.01 mm.; preferred orientation.
Tourmaline 5% Elongate idioblastic grains 0.3 to 0.01 mm.; pleochroic from pale purplish-gray to dark bluish-gray; preferred orientation.
Magnetite 2% Idioblastic to xenoblastic grains 0.3 to 0.01 mm.
Biotite Tr.
Hematite Tr.

Fabric: Schistose, lepidoblastic to nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Tourmaline-bearing chlorite-sericite-quartz schist.

Gulf Oil Corp.	Kiowa County	CL-57
#1 U.P. Risser	17S-50W, sec 1	KI-1-3
		Cuttings
		6155-58 ft.

Quartz 60% Xenoblastic grains 0.5 to 0.01 mm.; slightly to moderately strained and fractured; sutured borders; grains occur in clusters.
Muscovite 30% Shredlike xenoblastic grains 0.3 to 0.05 mm.; preferred orientation.
Magnetite 5% Idioblastic to xenoblastic grains 0.2 to 0.01 mm.
Sericite 3% Microcrystalline xenoblastic grains; occur with muscovite.
Tourmaline 2% Elongate idioblastic grains 0.5 to 0.05 mm.; pleochroic from pale purplish-gray to dark bluish-gray; preferred orientation.
Chlorite Tr. Shredlike xenoblastic grains 0.2 to 0.05 mm.
Sphene Tr.
Apatite Tr.
Hematite Tr.

Fabric: Schistose, lepidoblastic to nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Tourmaline-bearing muscovite-quartz schist.

Gulf Oil Corp.	Kiowa County	CL-57
#1 U.P. Risser	17S-50W, sec 1	KI-1-4
		Cuttings
		6155-75 ft.

Quartz 56% Xenoblastic grains 0.3 to 0.01 mm.; slightly to strongly strained and fractured; sutured borders; grains occur in clusters.

Sericite 15% Microcrystalline xenoblastic grains in bands and masses; often associated with muscovite and magnetite.
Muscovite 12% Shredlike xenoblastic grains 0.3 to 0.05 mm.; preferred orientation.
Chlorite 10% Shredlike xenoblastic grains 0.5 to 0.05 mm.
Magnetite 5% Idioblastic to xenoblastic grains 0.2 to 0.01 mm.
Tourmaline 2% Elongate idioblastic grains 0.3 to 0.05 mm.; pleochroic from pale purplish-gray to dark bluish-gray; preferred orientation.
Sphene Tr.
Apatite Tr.
Hematite Tr.

Fabric: Schistose, lepidoblastic to nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Tourmaline-bearing chlorite-muscovite-sericite-quartz schist.

Superior Oil Co.	Kiowa County	CL-59
#1 State	18S-46W, sec 16	KI-3-1
		Cuttings
		5588 ft.

Quartz 85% Xenoblastic grains 1.0 to 0.01 mm.; slightly to severely strained; sutured and granulated borders; larger grains occur in aggregates.
Sericite 15% Microcrystalline xenoblastic grains.
Muscovite Tr. Shredlike xenoblastic grains 0.2 to 0.01 mm.; associated with sericite; preferred orientation.
Tourmaline Tr. Elongate idioblastic crystals 0.2 to 0.05 mm.; pleochroic from pale purplish-gray to dark bluish-gray.
Epidote Tr.
Sphene Tr.
Chlorite Tr. Pennine; xenoblastic masses 0.2 to 0.01 mm.; associated with quartz and hematite in a ghost crystal outline of hornblende.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Tourmaline-bearing sericite-quartz gneiss to quartzite.

Deep Rock Oil Co.	Kit Carson County	CL-61
#1 Edmondson	6S-44W, sec 33	KC-1-1
		Core chip
		5951-56 ft.

Quartz 42% Xenoblastic grains 0.5 mm. to microcrystalline; moderately strained.
Orthoclase (?) 20% Microcrystalline xenoblastic grains.
Biotite 15% Microcrystalline idioblastic grains; pleochroic from pale green to very dark green; preferred orientation.
Plagioclase 10% Oligoclase; idioblastic to xenoblastic grains 1.0 to 0.1 mm; moderately to strongly altered to sericite; albite twins indistinct.
Microcline 5% Xenoblastic grains 0.5 to 0.1 mm.; faint polysynthetic twins.
Muscovite 5% Microcrystalline xenoblastic grains.
Calcite 3% Idioblastic to xenoblastic grains 1.0 mm. to microcrystalline.
Chlorite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Schistose, lepidoblastic, porphyroblastic, fine-grained.
Probable rock: Microcline-plagioclase-biotite-orthoclase-quartz schist. (Probably was originally a rhyolitic flow of tuff.)

Deep Rock Oil Co.	Kit Carson County	CL-61
#1 Edmondson	6S-44W, sec 33	KC-1-2
		2 Core chips
		5961-66 ft.

Quartz 45% Xenoblastic grains 0.5 mm. to microcrystalline; moderately strained; sutured borders.
Orthoclase (?) 25% Microcrystalline xenoblastic grains.
Biotite 15% Idioblastic grains 0.1 mm. to microcrystalline; pleochroic from pale green to very dark green; preferred orientation.
Plagioclase 10% Oligoclase; xenoblastic grains 1.0 to 0.1 mm.; moderately to strongly altered to sericite; albite twins indistinct or absent.
Muscovite 4% Xenoblastic grains 0.1 mm. to microcrystalline.
Microcline 1% Indistinct xenoblastic grains 0.2 to 0.01 mm.; faint polysynthetic twins.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Schistose, lepidoblastic, porphyroblastic, fine-grained.
Probable rock: Plagioclase-biotite-orthoclase-quartz schist. (Probably was originally a rhyolitic flow or tuff.)

Deep Rock Oil Co.
#1 Edmondson

Kit Carson County
6S-44W, sec 33

CL-61
KC-1-3
3 Core chips
5966-71 ft.

Quartz 40% Xenoblastic grains 2.0 to 0.01 mm.; moderately strained; sutured borders.
Orthoclase (?) 20% Xenoblastic grains 0.01 mm. to microcrystalline.
Biotite 20% Idioblastic grains 0.1 mm. to microcrystalline; pleochroic from yellowish-green to very dark green; preferred orientation.
Plagioclase 15% Albite to oligoclase; idioblastic crystals 2.0 to 0.2 mm.; strongly altered to sericite; albite twins very indistinct.
Muscovite 5% Xenoblastic grains 0.2 mm. to microcrystalline.
Microcline Tr. Indistinct xenoblastic grains 0.2 to 0.05 mm.; faint polysynthetic twins.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.

Fabric: Schistose, lepidoblastic, porphyroblastic, fine-grained.
Probable rock: Plagioclase-biotite-orthoclase-quartz schist.
(Probably was originally a rhyolitic flow or tuff.)

Seaboard Oil Co. and
British-American
Producing Co.
#1 Morrow

Kit Carson County
6S-42W, sec 31

CL-64
KC-4-1
Core chip
5865-69 ft.

Sericite 45% Microcrystalline xenoblastic grains; occur in distinct bands and also interstitial to quartz grains.
Quartz 40% Xenoblastic grains 0.5 to 0.01 mm.; moderately to strongly strained and fractured; grain borders sutured.
Biotite 10% Xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale yellowish-green to dark brownish-green; weak preferred orientation.
Muscovite 5% Shredlike xenoblastic grains 1.0 to 0.01 mm.; associated with biotite and sericite.
Leucoxene Tr.
Magnetite Tr.
Pyrite Tr.
Calcite Tr.

Fabric: Schistose, lepidoblastic, non-porphyroblastic, fine-grained.

Probable rock: Muscovite-biotite-quartz-sericite schist.

Continental Oil Co.	Kit Carson County	CL-210
#1 Lowe	11S-46W, sec 1	KC-5-1
		Cuttings
		6250-55 ft.

Microcline 30% Xenoblastic grains 3.5 to 0.05 mm.; microperthitic; poikiloblastically enclose quartz, plagioclase, and biotite.
Quartz 30% Xenoblastic grains 2.0 to 0.05 mm.; moderately strained and fractured; some sutured grain borders.
Plagioclase 25% Oligoclase; xenoblastic grains 1.5 to 0.1 mm.; moderately to strongly altered to sericite; albite twins; myrmekitic.
Biotite 10% Elongate idioblastic to xenoblastic grains 1.0 to 0.1 mm.; pleochroic from pale greenish-yellow to very dark brownish-green; slightly altered to chlorite; preferred orientation.
Muscovite 5% Shredlike xenoblastic grains 1.0 to 0.05 mm.; preferred orientation.
Sphene Tr. Xenoblastic masses 0.1 mm. to microcrystalline; moderately altered to leucoxene.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Muscovite-biotite-plagioclase-quartz-microcline gneiss.

Stanolind Oil and Gas Co.	La Plata County	CL-83
#6-B Ute Indian	33N-7W, sec 17	LP-3-1
	(NMPM)	Cuttings
		13050-55 ft.

Microcline 74% Xenoblastic grains 2.0 to 0.05 mm.; distinct polysynthetic twins; microperthitic; slightly altered to sericite.
Quartz 20% Xenoblastic grains 0.5 to 0.01 mm.; strongly to severely strained and fractured; sutured borders; some grains occur in aggregates; some occur in micrographic intergrowths with microcline.
Sericite 5% Microcrystalline xenoblastic grains in masses 0.5 to 0.05 mm.; alteration product of plagioclase and microcline.
Chlorite 1% Shredlike xenoblastic grains 0.3 to 0.05 mm.; alteration

product of biotite.
Plagioclase Tr. Oligoclase (one grain); xenoblastic; 0.3 mm.; albite twins.

Fabric: Granoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Quartz-microcline gneiss.

Stanolind and Gas Co. #6-B Ute Indian	La Plata County 33N-7W, sec 17 (NMPM)	CL-83 LP-3-2 Cuttings 13080-82 ft.

Plagioclase 50% Oligoclase; xenoblastic grains 1.5 to 0.01 mm.; strongly to severely altered to sericite; albite and Carlsbad twins; poikiloblastically enclose many small blebs of quartz.
Hornblende 35% Corroded xenoblastic grains 2.0 to 0.05 mm.; ragged grain borders; pleochoric from yellowish-green to dark green or bluish-green; poikiloblastically enclose quartz, apatite, and magnetite.
Biotite 7% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale greenish-brown to dark greenish-brown; occur in clusters associated with hornblende; moderately altered to chlorite.
Quartz 5% Xenoblastic grains 0.5 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders.
Apatite 2%
Magnetite 1%
Sphene Tr.
Epidote Tr.
Pyrite Tr.

Fabric: Gneissose, nematoblastic, non-porphyroblastic, medium-grained.
Probable rock: Quartz-biotite-hornblende-plagioclase gneiss to amphibolite.

Stanolind Oil and Gas Co. #6-B Ute Indian	La Plata County 33N-7W, sec 17 (NMPM)	CL-83 LP-3-3 Cuttings 13100-03

Plagioclase 52% Oligoclase; idioblastic to xenoblastic grains 2.0 to 0.1 mm.; moderately to strongly altered to sericite; albite and Carlsbad twins; albite rims; poikiloblastically enclose quartz, hornblende, and biotite.

Hornblende 25% Corroded xenoblastic grains 1.5 to 0.05 mm.; ragged grain borders; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose quartz, apatite, and magnetite.
Biotite 10% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale greenish-brown to very dark greenish-brown; occur in clusters associated with hornblende.
Quartz 10% Xenoblastic grains 1.0 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders.
Apatite 2%
Magnetite 1% Idioblastic grains 0.3 to 0.05 mm.; associated with biotite and hornblende; some skeletal grains may be ilmenite.
Sphene Tr.
Epidote Tr.
Pyrite Tr.

Fabric: Gneissose, nematoblastic, non-porphyroblastic, medium-grained.
Probable rock: Quartz-biotite-hornblende-plagioclase gneiss.

Stanolind Oil and Gas Co. #6-B Ute Indian	La Plata County 33N-7W, sec 17 (NMPM)	CL-83 LP-3-3a Cuttings 13100-03 ft.

Plagioclase 50% Oligoclase; idioblastic to xenoblastic grains 1.5 to 0.2 mm.; moderately to strongly altered to sericite; albite and Carlsbad twins; unmixing rims of albite.
Hornblende 25% Corroded idioblastic to xenoblastic grains 1.5 to 0.05 mm.; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose quartz, apatite, and magnetite.
Quartz 15% Xenoblastic grains 0.5 to 0.01 mm.; moderately strained and fractured.
Biotite 7% Idioblastic to xenoblastic grains 0.05 to 0.01 mm.; pleochroic from pale greenish-brown to very dark greenish-brown; poikiloblastically enclose apatite and magnetite; associated with hornblende.
Apatite 2%
Magnetite 1% Idioblastic to xenoblastic grains 0.3 to 0.01 mm.; associated with biotite and hornblende; some skeletal grains may be ilmenite.
Epidote Tr. Xenoblastic grains 0.1 to 0.01 mm.; associated with plagioclase and hornblende.
Sphene Tr.
Pyrite Tr.

Fabric: Gneissose, nematoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-quartz-hornblende-plagioclase gneiss.

Stanolind Oil and Gas Co. #6-B Ute Indian	La Plata County 33N-7W, sec 17 (NMPM)	CL-83 LP-3-4 Cuttings 13110-13 ft.

Hornblende 50% Corroded xenoblastic grains 1.0 to 0.05 mm.; ragged grain borders; pleochroic from pale yellowish-green to dark green or bluish-green; poikiloblastically enclose plagioclase laths and biotite.
Plagioclase 35% Andesine; elongate idioblastic to xenoblastic grains 0.5 to 0.05 mm.; moderately to severely altered to sericite; albite twins.
Biotite 15% Xenoblastic grains 0.3 to 0.05 mm.; pleochroic from very pale brown to dark greenish-brown; associated with hornblende.
Quartz Tr. Xenoblastic grains 0.1 to 0.01 mm.; slightly to moderately strained; grains occur interstitially to hornblende and plagioclase.
Epidote Tr.
Apatite Tr.
Pyrite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained. (Relict ophitic texture of plagioclase laths in hornblende)
Probable rock: Biotite-plagioclase-hornblende gneiss to amphibolite.

Stanolind Oil and Gas Co. #6-B Ute Indian	La Plata County 33N-7W, sec 17 (NMPM)	CL-83 LP-3-5 Cuttings 13120-22 ft.

Plagioclase 50% Oligoclase; idioblastic to xenoblastic grains 2.5 to 0.05 mm.; moderately to strongly altered to sericite; albite and Carlsbad twins; poikiloblastically enclose quartz and hornblende.
Hornblende 40% Corroded xenoblastic grains 2.5 to 0.05 mm.; ragged grain borders; pleochroic from pale yellowish-green to dark green or bluish-green; poikiloblastically enclose apatite and sphene.
Quartz 5% Xenoblastic grains 1.0 to 0.01 mm.; moderately strained and fractured; sutured borders.
Epidote 2% Xenoblastic grains 1.0 to 0.05 mm.; associated with plagio-

clase and hornblende.
Apatite 2%
Calcite 1%
Chlorite Tr. Pennine; xenoblastic grains 0.3 to 0.05 mm.; alteration product of biotite.
Sphene Tr.
Magnetite Tr.
Pyrite Tr.

Fabric: Gneissose, nematoblastic, non-porphyroblastic, medium-grained.
Probable rock: Amphibolite

California Oil Co.	Larimer County	CL-68
#1 Meyers	8N-68W, sec 19	LR-2-1
(Trigood Oil Co.		3 Core chips
#1 C.E. Meyers		7310-20 ft.

Quartz 50% Xenoblastic grains 2.0 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders; poikiloblastically enclose biotite; grains occur in lens-shaped aggregates.
Sericite 30% Microcrystalline grains in xenoblastic masses 1.0 to 0.1 mm.; formed from the complete alteration of plagioclase; some grains occur within fractures in quartz.
Biotite 19% Elongate xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale brown to dark reddish-brown; moderately altered to muscovite and hematite; preferred orientation.
Magnetite 1% Xenoblastic grains 0.2 to 0.05 mm.; associated with biotite.
Muscovite Tr. Shredlike xenoblastic grains 0.3 to 0.01 mm.; associated with biotite.
Zircon Tr.
Hematite Tr.

Fabric: Gneissose to schistose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-plagioclase (?)-quartz gneiss.

California Oil Co.	Larimer County	CL-68
#1 Meyers	8N-68W, sec 19	LR-2-2
(Trigood Oil Co.		2 Core chips
#1 C. E. Meyers)		7330-40 ft.

Microcline 58% Anhedral grains 15.0 to 5.0 mm.; indistinct polysyn-

thetic twins; strongly altered to sericite; perthitic; poikilitically enclose quartz.
Quartz 30% Anhedral grains 8.0 to 0.05 mm.; moderately strained and fractured; sutured borders; grains contain microcrystalline needles of rutile.
Sericite 10% Microcrystalline grains in xenoblastic masses 3.0 to 0.1 mm.; formed from the complete alteration of plagioclase; some grains occur within fractures in quartz.
Muscovite 2% Shredlike subhedral to anhedral grains 1.5 to 0.05 mm.

Fabric: Holocrystalline, hypidiomorphic-granular, coarse-grained.
Probable rock: Muscovite-bearing microcline granite.

California Oil Co.	Larimer County	CL-68
#1 Meyers	8N-68W, sec 19	LR-2-3
(Trigood Oil Co.		Core Chip
#1 C. E. Meyers)		7346.5 ft.

Microcline 40% Anhedral grains 9.0 to 3.0 mm.; indistinct polysynthetic twins; strongly altered to sericite; microperthitic; poikilitically enclose quartz.
Quartz 25% Anhedral grains 6.0 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured and slightly granulated; grains contain microcrystalline needles of rutile; some grains graphically intergrown with microcline.
Plagioclase 20% Oligoclase (?); anhedral grains 5.5 to 0.1 mm.; severely altered to sericite; albite twins obscured; poikilitically enclose quartz and epidote.
Muscovite 15% Shredlike subhedral to anhedral grains 9.0 to 0.05 mm.
Epidote Tr.
Sphene Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, coarse-grained.
Probable rock: Muscovite-bearing microcline granite.

California Oil Co.	Larimer County	CL-68
#1 Meyers	8N-68W, sec 19	LR-2-4
(Trigood Oil Co.		Core chip
#1 C. E. Meyers)		7347.5 ft.

Quartz 45% Xenoblastic grains 2.0 to 0.01 mm.; moderately to severely

strained and fractured; grain borders sutured and granulated; grains occur in lens-shaped aggregates.
Plagioclase 35% (Variety undetermined); xenoblastic grains 1.5 to 0.05 mm.; severely to completely altered to sericite.
Biotite 15% Elongate xenoblastic grains 1.0 to 0.1 mm.; pleochroic from pale yellow to greenish-brown; strongly altered to muscovite and hematite; preferred orientation.
Microcline 4% Xenoblastic grains 1.5 to 0.1 mm.; indistinct polysynthetic twins; moderately altered to sericite.
Muscovite 1% Shredlike xenoblastic grains 1.0 to 0.05 mm.; associated with biotite.
Apatite Tr.
Zircon Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-plagioclase-quartz gneiss.

California Oil Co.	Larimer County	CL-68
#1 Meyers	8N-68W, sec 19	LR-2-5
(Trigood Oil Co.		2 Core chips
#1 C. E. Meyers)		7348.5 ft.

Quartz 79% Anhedral grains 5.0 to 0.05 mm.; moderately to strongly strained and fractured; sutured and granulated borders; grains contain microcrystalline needles of rutile.
Microcline 20% Anhedral grains 6.0 mm.; indistinct polysynthetic twins; slightly altered to sericite; microperthitic; poikilitically enclose quartz.
Muscovite 1% Shredlike anhedral grains 1.5 to 0.5 mm.
Plagioclase Tr. Oligoclase (?); one subhedral grain 1.0 mm.; moderately altered to sericite; albite twins indistinct.

Fabric: Holocrystalline, hypidiomorphic-granular, medium- to coarse-grained.
Probable rock: Muscovite-bearing microcline granite.

California Oil Co.	Larimer County	CL-68
#1 Meyers	8N-68W, sec 19	LR-2-6
(Trigood Oil Co.		Core Chip
#1 C. E. Meyers)		7349.5 ft.

Quartz 35% Anhedral grains 10.0 to 0.05 mm.; strongly strained and

fractured; grain borders sutured and granulated.
Microcline 30% Anhedral grains 4.0 to 1.0 mm.; indistinct polysynthetic twins; slightly altered to sericite; microperthitic.
Plagioclase 25% (Variety undetermined); anhedral grains 10.0 to 1.0 mm.; severely altered to sericite; albite twins obscured; poikilitically enclose quartz.
Muscovite 5% Shredlike anhedral grains 0.2 to 0.05 mm.
Biotite 5% Subhedral to anhedral grains 1.0 to 0.05 mm.; pleochroic from pale greenish-yellow to dark green; severely altered to muscovite and hematite.
Sphene Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, coarse-grained.
Probable rock: Quartz monzonite

California Oil Co.	Larimer County	CL-68
#1 Meyers	8N-68W, sec 19	LR-2-7
(Trigood Oil Co.		Core chip
#1 C. E. Meyers)		7350.5 ft.

Plagioclase 60% Oligoclase; xenoblastic grains 4.0 to 1.0 mm.; severely altered to sericite; albite twins obscured.
Quartz 25% Xenoblastic grains 4.0 to 0.05 mm.; strongly strained and fractured; grain borders sutured and granulated.
Biotite 15% Xenoblastic grains 2.5 to 0.1 mm.; pleochroic from pale yellow to yellowish-green; preferred orientation.
Muscovite Tr. Shredlike xenoblastic grains 0.1 to 0.01 mm.; associated with plagioclase.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-quartz-plagioclase gneiss

California Oil Co.	Larimer County	CL-68
#1 Meyers	8N-68W, sec 19	LR-2-8
(Trigood Oil Co.		2 Core chips
#1 C. E. Meyers)		7351.5 ft.

Quartz 60% Xenoblastic grains 7.0 to 0.05 mm.; strongly strained and fractured; grain borders sutured and granulated.
Plagioclase 35% Oligoclase; xenoblastic grains 4.5 to 0.5 mm.; severely to completely altered to sericite; albite twins obscured.
Biotite 5% Xenoblastic grains 2.0 to 0.2 mm.; pleochroic from pale yellowish-green to yellowish-green; severely altered to muscovite and hematite; preferred orientation.
Zircon Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-plagioclase-quartz gneiss.

Baker and Taylor Drilling	Las Animas County	CL-69
#1 R. S. LeSage	33S-60W, sec 2	LA-1-1
		3 Core chips
		2488-95 ft.

Plagioclase 38% Albite to oligoclase; xenoblastic grains 1.0 to 0.05 mm.; strongly altered to sericite; indistinct albite twins; myrmekitic.
Microcline 35% Xenoblastic grains 3.5 to 0.05 mm.; microperthitic; poikiloblastically enclose quartz, biotite and plagioclase; smaller grains occur interstitially.
Quartz 25% Xenoblastic grains 1.0 to 0.05 mm.; slightly to moderately strained ~~and fractured~~; sutured borders; grains are elongated and occur in bands.
Biotite 2% Elongate xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellowish-green to dark brownish-green; severely altered to chlorite; preferred orientation.
Muscovite Tr. Xenoblastic grains 0.2 to 0.01 mm.
Epidote Tr.
Leucoxene Tr.
Magnetite Tr.
Hematite Tr.
Calcite Tr.

Fabric: Gneissose, cataclastic, slightly lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Quartz-microcline-plagioclase gneiss

Baker and Taylor Drilling	Las Animas County	CL-69
#1 R. S. LeSage	33S-60W, sec 2	LA-1-2
		Core chip
		2488-95 ft.

Microcline 48% Xenoblastic grains 11.5 to 0.05 mm.; microperthitic; poikiloblastically enclose quartz, plagioclase, muscovite and magnetite; smaller grains occur interstitially.
Quartz 30% Xenoblastic grains 1.0 to 0.05 mm.; slightly to moderately strained and fractured; sutured borders; grains occur in bands.
Plagioclase 20% Albite to oligoclase; idioblastic to xenoblastic grains 1.0 to 0.05 mm.; strongly altered to sericite; weakly zoned; indistinct albite and Carlsbad twins; myrmekitic.
Biotite 2% Elongate xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale greenish-yellow to dark brownish-green; severely to completely altered to chlorite; preferred orientation.
Muscovite Tr. Xenoblastic grains 0.5 to 0.01 mm.; associated with biotite.
Sphene Tr.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Gneissose, cataclastic, slightly lepidoblastic, non-porphyroblastic, coarse-grained.
Probable rock: <u>Plagioclase-quartz-microcline gneiss</u>.

Baker and Taylor Drilling	Las Animas County	CL-69
#1 R. S. LeSage	33S-60W, sec 2	LA-1-3
		Core chip
		2488-95 ft.

Microcline 38% Xenoblastic grains 5.5 to 0.05 mm.; microperthitic; poikiloblastically enclose quartz, plagioclase, and biotite; smaller grains occur interstitially.
Plagioclase 35% Albite to oligoclase; xenoblastic grains 2.5 to 0.05 mm.; strongly altered to sericite; indistinct albite and Carlsbad twins; myrmekitic.
Quartz 25% Xenoblastic grains 1.0 to 0.01 mm.; slightly to moderately strained and fractured; sutured borders; grains occur in bands.
Biotite 2% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellowish-green to dark brownish-green; severely to completely altered to chlorite; preferred orientation.

Muscovite Tr. Xenoblastic grains 0.3 to 0.01 mm.; associated with biotite.
Epidote Tr.
Sphene Tr.
Leucoxene Tr.
Apatite Tr.
Magnetite Tr.
Hematite Tr.
Calcite Tr.

Fabric: Gneissose, cataclastic, slightly lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Quartz-plagioclase-microcline gneiss.

Boswell and Frates	Las Animas County	CL-71
#1 Government	35S-52W, sec 2	LA-3-1
		Cuttings
		2515-20 ft.

Microcline 50% Anhedral grains 4.5 to 0.2 mm.; microperthitic; poikilitically enclose plagioclase, quartz, biotite, and apatite.
Plagioclase 25% Oligoclase; euhedral to subhedral grains 1.5 to 0.2 mm.; moderately to strongly altered to sericite; weakly zoned; albite and Carlsbad twins; albite rims.
Quartz 20% Anhedral grains 3.5 to 0.05 mm.; moderately to strongly strained and fractured; poikilitically enclose biotite and plagioclase.
Biotite 5% Subhedral to anhedral grains 1.0 to 0.1 mm.; pleochroic from light brownish-green to very dark brownish-green; moderately altered to chlorite.
Sericite Tr. Microcrystalline grains; occur in veinlets.
Muscovite Tr. Shredlike anhedral grains 0.1 to 0.01 mm.; associated with biotite.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Granite.

Boswell and Frates | Las Animas County | CL-71
#1 Government | 35S-52W, sec 2 | LA-3-2
Cuttings
2535-40 ft.

Plagioclase 60% Oligoclase; subhedral to anhedral grains 5.0 to 0.2 mm.; slightly to strongly altered to sericite; albite, pericline, and Carlsbad twins; twins bent and distorted; albite rims.
Quartz 30% Anhedral grains 5.0 to 0.05 mm.; slightly to strongly strained and fractured; some granulation.
Microcline 9% Anhedral grains 2.5 to 0.2 mm.; microperthitic; poikilitically enclose quartz.
Sericite 1% Microcrystalline grains; occur in veinlets.
Biotite Tr.
Sphene Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Granodiorite

Boxwell and Frates | Las Animas County | CL-71
#1 Government | 35S-52W, sec 2 | LA-3-3
Cuttings
2605-10 ft.

Microcline 35% Anhedral grains 1.5 to 0.3 mm.; microperthitic; poikilitically enclose quartz, plagioclase, and biotite.
Plagioclase 30% Oligoclase; euhedral to subhedral grains 1.5 to 0.2 mm.; moderately to strongly altered to sericite; albite and Carlsbad twins; weakly zoned; albite rims.
Quartz 25% Anhedral grains 4.5 to 0.05 mm.; moderately to strongly strained and fractured; some grain borders sutured and granulated; poikilitically enclose biotite.
Biotite 10% Subhedral to anhedral grains 0.5 to 0.05 mm.; pleochroic from pale greenish-brown to dark greenish-brown; moderately altered to chlorite.
Muscovite Tr. Shredlike anhedral grains 0.1 to 0.01 mm.; associated with biotite.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.

Probable rock: Quartz monzonite.

Boswell and Frates #1 Government	Las Animas County 35S-52W, sec 2	CL-71 LA-3-4 Cuttings 2650-55 ft.

Microcline 40% Anhedral grains 3.0 to 0.2 mm.; microperthitic; poikilitically enclose quartz, plagioclase and biotite; Carlsbad twins.
Quartz 30% Anhedral grains 3.0 to 0.05 mm.; strongly to severely strained and fractured; grain borders sutured and granulated; poikilitically enclose biotite and plagioclase.
Plagioclase 23% Oligoclase; zoned subhedral grains 2.5 to 0.2 mm.; moderately to strongly altered to sericite; albite, pericline, and Carlsbad twins; albite rims; myrmekitic.
Biotite 7% Subhedral to anhedral grains 0.5 to 0.05 mm.; pleochroic from pale greenish-brown to dark greenish-brown; moderately to strongly altered to chlorite.
Muscovite Tr. Shredlike anhedral grains 0.3 to 0.05 mm.; associated with biotite and plagioclase.
Sphene Tr.
Apatite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained, slightly cataclastic.
Probable rock: Quartz monzonite

Boswell and Frates #1 Government	Las Animas County 35S-52W, sec 2	CL-71 LA-3-5 Cuttings 2700-05 ft.

Microcline 35% Anhedral grains 2.0 to 0.2 mm.; microperthitic; poikilitically enclose quartz, plagioclase, and biotite; Carlsbad twins.
Plagioclase 30% Oligoclase; zoned euhedral to subhedral grains 1.0 to 0.1 mm.; moderately to strongly altered to sericite; albite and Carlsbad twins; albite rims; myrmekitic.
Quartz 25% Anhedral grains 2.5 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured and granulated.

Biotite 10% Subhedral to anhedral grains 0.5 to 0.05 mm.; pleochroic from pale yellow to dark greenish-brown; moderately altered to chlorite.
Muscovite Tr. Shredlike anhedral grains 0.2 to 0.05 mm.; associated with biotite.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained, slightly cataclastic.
Probable rock: Quartz monzonite.

Boswell and Frates	Las Animas County	CL-71
#1 Government	35S-52W, sec 2	LA-3-6
		Cuttings
		2750-55 ft.

Microcline 35% Anhedral grains 2.5 to 0.2 mm.; microperthitic; poikilitically enclose quartz, plagioclase, and biotite; Carlsbad twins.
Quartz 30% Anhedral grains 3.0 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured and granulated; poikilitically enclose biotite.
Plagioclase 25% Oligoclase; zoned euhedral to subhedral grains 2.0 to 0.1 mm.; moderately to severely altered to sericite; albite and Carlsbad twins; albite rims; myrmekitic.
Biotite 10% Subhedral to anhedral grains 1.0 to 0.05 mm.; pleochroic from pale yellow to dark greenish-brown; slightly altered to chlorite or to muscovite and hematite.
Muscovite Tr. Shredlike anhedral grains 0.3 to 0.05 mm.; associated with biotite.
Apatite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained, slightly cataclastic.
Probable rock: Quartz monzonite

R. W. Lange
#1 Government

Las Animas County
29S-62W, sec 10

CL-72
LA-4-1
Cuttings
4010-20 ft.

Variety #1, fragments make up 95% of thin section.

Phenocrysts: 35% of thin section.

Plagioclase 100% Oligoclase; fragments of euhedral and subhedral crystals 0.75 to 0.1 mm.; slightly altered to sericite; albite, pericline, and Carlsbad twins; poikilitically enclose biotite and apatite.

Groundmass: 65% of thin section.

Quartz 50% Anhedral grains 0.5 mm. to microcrystalline; larger grains in veinlets.
Orthoclase (?) 35% Microcrystalline anhedral grains.
Biotite 10% Anhedral grains 0.01 mm. to microcrystalline; pleochroic from pale green to brownish-green.
Tremolite-Actinolite 3% Anhedral grains and radiating aggregates 0.3 to 0.05 mm.; pleochroic from yellowish-green to dark bluish-green.
Calcite 1% Anhedral masses 0.2 mm. to microcrystalline.
Chlorite 1% Pennine; anhedral grains and masses 0.2 mm. to microcrystalline.
Epidote Tr. Anhedral grains 0.1 mm. to microcrystalline; aggregates associated with tremolite-actinolite.
Apatite Tr.
Magnetite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric, fine-grained.
Probable rock: Quartz latite porphyry

Variety #2, fragments make up 5% of thin section.

Muscovite 94% Tabular subhedral grains 0.05 mm. to microcrystalline; pleochroic from colorless to bluish-green; no preferred orientation.
Pyrite 3% Anhedral grains 0.3 mm. to microcrystalline; irregularly-shaped aggregates.
Quartz 2% Anhedral grains 0.1 mm. to microcrystalline; occur in clusters of unstrained grains; sutured borders; some orthoclase may be present.
Epidote 1% Microcrystalline elongate subhedral grains.

Fabric: Metamorphic, hornfelsic, non-porphyroblastic, fine-grained.
Probable rock: Muscovite hornfels.

R. W. Lange	Las Animas County	CL-72
#1 Government	29S-62W, sec 10	LA-4-2
		Cuttings
		5500-10 ft.

Actinolite 55% Subhedral crystals 1.0 to 0.01 mm.; pleochroic from yellowish-green to bluish-green.
Diopside 40% Subhedral to anhedral grains 1.0 to 0.01 mm.
Calcite 3% Subhedral to anhedral grains 0.5 to 0.01 mm.; associated with diopside and garnet.
Garnet 2% Anhedral grains 1.0 to 0.05 mm.; pale pink color; faintly anisotropic.
Plagioclase Tr. Oligoclase; anhedral grains 0.2 to 0.05 mm.; albite twins; unaltered.
Epidote Tr. Anhedral masses and grains 0.3 mm. to microcrystalline.
Magnetite Tr.

Fabric: Metamorphic, hornfelsic, non-porphyroblastic, fine-grained.
Probable rock: Diopside-actinolite hornfels.

R. W. Lange	Las Animas County	CL-72
#1 Government	29S-62W, sec 10	LA-4-3
		Cuttings
		6140-50 ft.

Actinolite 50% Subhedral grains 0.2 mm.; to microcrystalline; occur in massed bands and aggregates; pleochroic from yellowish-green to bluish-green.
Diopside 25% Subhedral to anhedral grains 1.5 to 0.01 mm.; faintly pleochroic from colorless to very pale green.
Sericite 10% Microcrystalline grains in bands and masses.
Epidote 10% Anhedral grains and indistinct masses 0.5 mm. to microcrystalline.
Cordierite (?) 5% Anhedral grains 0.2 to 0.01 mm.
Biotite Tr. Subhedral to anhedral grains 0.01 mm. to microcrystalline; pleochroic from pale brown to dark brown.
Magnetite Tr.

Fabric: Metamorphic, hornfelsic, non-porphyroblastic, fine-grained.
Probable rock: Cordierite-epidote-sericite-diopside-actinolite hornfels.

Parker Gun Club
#1 Adams

Las Animas County
34S-56W, sec 32

CL-73
LA-5-1
Core chip
3866-68 ft.

Plagioclase 35% Oligoclase; xenoblastic grains 6.0 to 0.05 mm.; moderately to strongly altered to sericite; albite, pericline, and Carlsbad twins; myrmekitic; poikiloblastically enclose biotite.
Microcline 33% Xenoblastic grains 5.0 to 0.05 mm.; microperthitic; poikiloblastically enclose quartz, plagioclase, and biotite; indistinct polysynthetic twins.
Quartz 25% Xenoblastic grains 1.0 to 0.05 mm.; slightly to moderately strained and fractured.
Biotite 7% Xenoblastic grains 1.0 to 0.1 mm.; pleochroic from pale greenish-yellow to dark brownish-green; severely altered to chlorite and replaced by calcite.
Calcite Tr. Xenoblastic grains and masses 0.1 mm. to microcrystalline; associated with biotite.
Leucoxene Tr. Xenoblastic masses of microcrystalline grains; associated with biotite.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-microcline-plagioclase gneiss.

Skelly Oil Co.
#1 Jolly-Government

Las Animas County
27S-61W, sec 30

CL-75
LA-7-1
Cuttings
1925-30 ft.

Microcline 60% Xenoblastic grains 3.0 to 0.1 mm.; microperthitic; Carlsbad twins; poikiloblastically enclose quartz and plagioclase; small grains occur interstitially to larger grains of microcline, quartz, and plagioclase.
Quartz 25% Xenoblastic grains 1.5 to 0.05 mm.; slightly to moderately strained and fractured; sutured borders; poikiloblastically enclose biotite; grains occur in aggregates.
Plagioclase 10% Oligoclase; xenoblastic grains 1.5 to 0.05 mm.; strongly to severely altered to sericite; albite twins indistinct; myrmekitic.
Biotite 5% Xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale

greenish-yellow to dark brownish-green; associated with magnetite and leucoxene.
Epidote Tr. Xenoblastic grains 0.3 to 0.01 mm.; associated with biotite.
Leucoxene Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic, non-porphyroblastic, medium-grained, cataclastic.
Probable rock: Biotite-plagioclase-quartz-microcline gneiss.

Skelly Oil Co.	Las Animas County	CL-75
#1 Jolly-Government	27S-61W, sec 30	LA-7-2
		Cuttings
		1935-40 ft.

Plagioclase 40% Oligoclase to andesine; xenoblastic grains 2.5 to 0.05 mm.; slightly to strongly altered to sericite; weakly zoned; albite twins; some twin lamellae distorted; poikiloblastically enclose quartz, microcline, and biotite; albite rims; myremekitic.
Quartz 30% Xenoblastic grains 1.5 to 0.01 mm.; slightly to moderately strained and fractured; sutured borders; grains occur in aggregates and interstitially to larger grains of quartz, plagioclase, and microcline.
Microcline 20% Xenoblastic grains 2.0 to 0.05 mm.; microperthitic; poikiloblastically enclose plagioclase, quartz, biotite, and magnetite; smaller grains occur interstitially to larger grains of quartz, plagioclase, and microcline.
Biotite 10% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale greenish-yellow to dark brownish-green; associated with leucoxene; moderately altered to chlorite.
Epidote Tr.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium-grained, cataclastic.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Skelly Oil Co.	Las Animas County	CL-76
#1 Weiland	26S-62W, sec 19	LA-8-1
		Cuttings
		1485-90 ft.

Plagioclase 40% Albite to oligoclase; xenoblastic grains 1.5 to 0.05 mm.; alternate twin lamellae strongly altered to sericite; indistinct albite, pericline, and Carlsbad twins; some grains weakly zoned.
Quartz 20% Xenoblastic grains 0.5 to 0.01 mm.; moderately strained and fractured; sutured borders.
Calcite 20% Microcrystalline grains in xenoblastic masses 1.0 to 0.05 mm.; alteration product.
Microcline 10% Xenoblastic grains 0.5 to 0.01 mm.; poikiloblastically enclose quartz, biotite, and plagioclase; smaller grains occur interstitially.
Biotite 10% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellowish-green to very dark brownish-green; partly replaced by hematite; preferred orientation.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Altered biotite-microcline-quartz-plagioclase gneiss.

Skelly Oil Co.	Las Animas County	CL-76
#1 Weiland	26S-62W, sec 19	LA-8-2
		Cuttings
		1490-95 ft.

Plagioclase 35% Albite to oligoclase; xenoblastic grains 0.5 to 0.05 mm.; moderately to strongly altered to sericite; albite, pericline, and Carlsbad twins; myrmekitic.
Calcite 25% Microcrystalline grains in xenoblastic masses 1.5 to 0.1 mm.; alteration product.
Quartz 20% Xenoblastic grains 1.5 to 0.05 mm.; slightly to moderately strained and fractured; sutured borders.
Microcline 10% Xenoblastic grains 0.1 to 0.05 mm.; poikiloblastically enclose quartz and plagioclase; smaller grains occur interstitially.
Biotite 10% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellow to dark brown or from pale green to dark brownish-green; preferred orientation.

Hornblende Tr. Idioblastic to xenoblastic grains 0.5 to 0.1 mm.; pleochroic from pale green to bluish-green; poikiloblastically enclose biotite, quartz and apatite.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Altered biotite-microcline-quartz-plagioclase gneiss.

Stanolind Oil and Gas Co. #1 C.F. & I.	Las Animas County 34S-63W, sec 31	CL-77 LA-9-1 Cuttings 6660-70 ft.

Microcline 35% Subhedral to anhedral grains 2.5 to 0.3 mm.; microperthitic; Carlsbad twins; poikilitically encloses quartz, plagioclase, and biotite.
Plagioclase 30% Oligoclase; zoned subhedral to anhedral grains 1.5 to 0.2 mm.; moderately to strongly altered to sericite; albite, pericline and Carlsbad twins; albite rims; myrmekitic.
Quartz 29% Anhedral grains 4.5 to 0.05 mm.; slightly to moderately strained and fractured; sutured borders; poikilitically enclose biotite, plagioclase, sphene, and magnetite.
Biotite 5% Subhedral to anhedral grains 1.5 to 0.1 mm.; pleochroic from pale brown to dark greenish-brown; strongly to severely altered to chlorite and hematite.
Sphene 1% Euhedral to anhedral crystals 0.3 to 0.1 mm.; some grains completely altered to leucoxene.
Epidote Tr.
Apatite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Quartz monzonite.

Stanolind Oil and Gas Co. #1 C. F. & I.	Las Animas County 34S-63W, sec 31	CL-77 LA-9-2 Cuttings 6750-60 ft.

Microcline 35% Subhedral to anhedral grains 2.0 to 0.2 mm.; microperthitic; Carlsbad twins; poikilitically enclose quartz, plagioclase and biotite.

Quartz 30% Anhedral grains 5.5 to 0.1 mm.; slightly to moderately strained and fractured; sutured borders; poikilitically enclose plagioclase, biotite, and magnetite.

Plagioclase 25% Oligoclase; zoned euhedral to subhedral grains 2.0 to 0.1 mm.; moderately to strongly altered to sericite; albite, pericline, and Carlsbad twins.

Biotite 10% Subhedral to anhedral grains 1.0 to 0.05 mm.; pleochroic from pale brown to dark greenish-brown; severely altered to chlorite.

Muscovite Tr. Anhedral grains 0.2 to 0.05 mm.; associated with biotite.

Sphene Tr.

Leucoxene Tr.

Epidote Tr.

Apatite Tr.

Magnetite Tr.

Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.

Probable rock: Quartz monzonite.

Stanolind Oil and Gas Co. #1 C. F. & I.	Las Animas County 34S-63W, sec 31	CL-77 LA-9-3 Cuttings 6900-10 ft.

Microcline 35% Subhedral grains 3.5 to 0.2 mm.; microperthitic; Carlsbad twins; poikilitically enclose plagioclase, quartz, biotite, and magnetite.

Quartz 30% Anhedral grains 3.5 to 0.05 mm.; slightly to moderately strained and fractured; poikilitically enclose plagioclase, biotite and magnetite.

Plagioclase 25% Oligoclase; zoned euhedral to subhedral grains 2.0 to 0.2 mm.; moderately to strongly altered to sericite; albite, pericline, and Carlsbad twins; albite rims.

Biotite 10% Subhedral to anhedral grains 0.5 to 0.1 mm.; pleochroic from pale brown to dark greenish-brown; moderately to severely altered to chlorite.

Sphene Tr. Subhedral to anhedral grains 0.5 to 0.01 mm.; severely altered to leucoxene and hematite.

Epidote Tr.

Apatite Tr.

Magnetite Tr.

Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium grained.
Probable rock: Quartz monzonite.

Sullivan and Pauley	Las Animas County	CL-80
#1 Waldroup	33S-57W, sec 7	LA-12-1
		Cuttings
		2890-95 ft.

Plagioclase 42% Oligoclase; euhedral to subhedral grains 4.5 to 0.1 mm.; moderately to severely altered to sericite; albite twins obscured; myrmekitic; albite rims.
Quartz 30% Anhedral grains 3.5 to 0.05 mm.; slightly to moderately strained and fractured; poikilitically enclose microcline, sphene, apatite, and magnetite; also contain microcrystalline needles of rutile.
Microcline 20% Anhedral grains 2.5 to 0.1 mm.; microperthitic; poikilitically enclose plagioclase, quartz, biotite, and magnetite.
Biotite 5% Subhedral to anhedral grains 1.0 to 0.05 mm.; pleochroic from pale yellow to dark brownish-green; severely altered to chlorite.
Leucoxene 2% Microcrystalline grains in masses; alteration product of euhedral crystals of sphene 0.75 to 0.1 mm.
Magnetite 1%
Apatite Tr.
Zircon Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Quartz monzonite.

Sullivan and Pauley	Las Animas County	CL-80
#1 Waldroup	33S-57W, sec 7	LA-12-2
		Cuttings
		2895 ft.

Microcline 45% Anhedral grains 5.5 to 0.1 mm.; microperthitic; poikilitically enclose plagioclase, quartz, sphene, and magnetite.
Plagioclase 32% Oligoclase; subhedral to anhedral grains 2.5 to 0.2 mm.; severely altered to sericite; albite twins obscured; myrmekitic; albite rims.
Quartz 20% Anhedral grains 3.5 to 0.2 mm.; slightly strained and fractured; poikilitically enclose biotite, plagioclase, and magnetite.

Leucoxene 2% Microcrystalline grains in masses; alteration product of euhedral crystals of sphene 0.5 to 0.1 mm.
Magnetite 1%
Biotite Tr.
Apatite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Quartz monzonite.

Skelly Oil Co.	Las Animas County	CL-150
#1 Pressey	26S-63W, sec 24	LA-13-1
		Cuttings
		1285-90 ft.

Microcline 69% Xenoblastic grains 1.0 to 0.05 mm.; poikiloblastically enclose quartz and biotite.
Biotite 20% Idioblastic to xenoblastic grains 0.5 to 0.1 mm.; pleochroic from pale yellowish-green to dark brownish-green or from light brown to reddish-brown; preferred orientation.
Quartz 10% Xenoblastic grains 1.0 to 0.05 mm.; moderately to strongly strained and fractured.
Calcite 1% Xenoblastic grains and masses 1.0 to 0.05 mm.; prominent twinning; alteration product or replacement mineral.
Plagioclase Tr. Xenoblastic grains 0.3 to 0.05 mm.; adjacent to microcline; strongly myrmekitic; moderately altered to sericite.
Epidote Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Quartz-biotite-microcline gneiss.

Skelly Oil Co.	Las Animas County	CL-50
#1 Pressey	26S-63W, sec 24	LA-13-2
		Cuttings
		1300-05 ft.

Plagioclase 60% Oligoclase; xenoblastic grains 1.0 to 0.1 mm.; slightly to strongly altered to sericite; myrmekitic; fractured; albite twins indistinct.
Quartz 15% Xenoblastic grains 0.5 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured.

Biotite 15% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from light brown to dark reddish-brown; preferred orientation.
Microcline 10% Xenoblastic grains 0.5 to 0.1 mm.; poikiloblastically enclose quartz and biotite.
Apatite Tr.
Calcite Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Microcline-biotite-quartz-plagioclase gneiss.

Skelly Oil Co.	Las Animas County	CL-50
#1 Pressey	26S-63W, sec 24	LA-13-3
		Cuttings
		1330-35 ft.

Plagioclase 50% Oligoclase; xenoblastic grains 1.0 to 0.2 mm.; slightly to moderately altered to sericite; albite and pericline twins; poikiloblastically encloses quartz, biotite, and apatite; myrmekitic.
Biotite 30% Idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-brown to dark brown; preferred orientation.
Quartz 15% Xenoblastic grains 1.0 to 0.05 mm.; slightly to strongly strained and fractured; sutured borders.
Microcline 5% Xenoblastic grains 3.0 to 0.05 mm.; microperthitic.
Garnet (?) Tr. Idioblastic grain 0.5 mm.; colorless; isotropic.
Calcite Tr. Xenoblastic grains and masses 0.5 to 0.1 mm.; prominent twinning; vein and fracture filling.
Sphene Tr.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Schistose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Microcline-quartz-biotite-plagioclase schist.

Texaco, Inc.	Las Animas County	CL-191
#1 Government-Davis	28S-52W, sec 12	LA-14-1
		Cuttings
		2610-20 ft.

Plagioclase 32% Oligoclase; fragments of euhedral and subhedral crystals 1.5 to 0.1 mm.; slightly altered to sericite; albite twins, some bent due to deformation of grains.
Sericite 25% Microcrystalline grains; alteration product.
Glass 25% Devitrified; submicroscopic.
Quartz 10% Fractured and corroded anhedral grains 1.0 to 0.1 mm.; strongly strained and fractured.
Chlorite 5% Anhedral masses 0.3 mm. to microcrystalline.
Biotite 3% Euhedral to subhedral grains 0.05 mm. to microcrystalline; pleochroic from pale green to dark brownish green; associated with magnetite.
Apatite Tr.
Zircon Tr.
Leucoxene Tr.
Calcite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Pyroclastic, merocrystalline, fine-grained.
Probable rock: Dacitic crystal vitric tuff.

Texaco, Inc.	Las Animas County	CL-191
#1 Government-Davis	28S-52W, sec 12	LA-14-2
		Cuttings
		2620-30 ft.

Glass 43% Devitrified; submicroscopic.
Plagioclase 30% Albite to oligoclase; fragments of euhedral to subhedral grains 1.5 to 0.1 mm.; slightly altered to sericite; albite twins, some bent due to deformation of grains.
Sericite 15% Microcrystalline grains; alteration product.
Quartz 5% Fractured and corroded anhedral grains 1.0 to 0.01 mm.; moderately strained and fractured; some grains occur in small veinlets; sutured borders.
Chlorite 5% Anhedral masses 0.2 mm. to microcrystalline.
Biotite 2% Euhedral to subhedral grains 0.05 mm. to microcrystalline; pleochroic from pale green to dark brownish-green; associated with altered magnetite.
Apatite Tr.
Zircon Tr.
Leucoxene Tr.
Hematite Tr.

Fabric: Pyroclastic, merocrystalline, fine-grained.
Probable rock: Dacitic crystal vitric tuff.

R. W. Lange	Las Animas County	CL-193
#1 Marquez	29S-63W, sec 9	LA-16-1
		Core chip
		7118-19 ft.

Microcline 82% Anhedral phenocryst 25.0 to 6.5 mm.; microperthitic; Carlsbad twins; poikilitically enclose plagioclase, quartz, biotite, and magnetite.
Plagioclase 10% Albite to oligoclase; zoned euhedral to subhedral crystals 3.5 to 0.2 mm.; moderately to severely altered to sericite; albite twins; myrmekitic; albite rims.
Quartz 5% Anhedral grains 5.0 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured and granulated; contain microcrystalline needles of rutile.
Biotite 2% Subhedral to anhedral grains 0.5 to 0.1 mm.; pleochroic from pale greenish-yellow to dark brown; moderately altered to chlorite.
Sphene 1% Euhedral to anhedral grains 0.5 to 0.05 mm.; pleochroic from pale brown to reddish-brown; often associated with magnetite.
Epidote Tr. Anhedral grains 0.2 to 0.05 mm.; brown color like sphene but has anomalous interference colors.
Magnetite Tr.
Apatite Tr.
Zircon Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, medium- to coarse-grained.
Probable rock: Microcline phenocryst (from rock of thin section LA-16-2).

R. W. Lange	Las Animas County	CL-193
#1 Marquez	29S-63W, sec 9	LA-16-2
		Core chip
		7118-19 ft.

Plagioclase 45% Oligoclase; zoned euhedral to subhedral crystals 12.0 to 0.1 mm.; moderately to severely altered to sericite; albite, pericline and Carlsbad twins; albite rims; myrmekitic.
Quartz 38% Anhedral grains 10.0 to 0.01 mm.; strongly strained and fractured; grain borders sutured and granulated; contain microcrystalline needles of rutile.
Microcline 10% Anhedral grains 7.5 to 0.2 mm.; microperthitic; poikilitically enclose quartz, plagioclase, biotite, magnetite, and sphene.
Biotite 3% Subhedral to anhedral grains 1.0 to 0.1 mm.; pleochroic

from pale yellowish-green to dark brown; strongly altered to chlorite (pennine).
Sphene 2% Subhedral to anhedral grains 0.5 to 0.1 mm.; pleochroic from pale brown to reddish-brown.
Epidote 1% Anhedral grains 0.5 to 0.05 mm.; brown color like sphene but has anomalous interference colors.
Magnetite 1%
Muscovite Tr.
Allanite Tr.
Apatite Tr.
Zircon Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, coarse-grained.
Probable rock: Granodiorite.

Probable rock of both thin sections LA-16-1 and LA-16-2: Porphritic quartz monzonite.

Johnson and Sullivan	Las Animas County	CL-204
#1 A. T. McCarty	33S-63W, sec 16	LA-18-1
		Cuttings
		5425-30 ft.

Quartz 45% Xenoblastic grains 1.0 to 0.01 mm.; moderately to strongly strained and fractured; grain borders sutured and granulated; contain microcrystalline needles of rutile; poikiloblastically enclose plagioclase.
Microcline 35% Xenoblastic grains 2.0 to 0.05 mm.; microperthitic; poikiloblastically enclose plagioclase and quartz.
Plagioclase 14% Oligoclase to andesine; xenoblastic grains 0.5 to 0.05 mm.; strongly to severely altered to sericite; albite twins obscured.
Calcite 5% Xenoblastic grains and masses 0.5 mm. to microcrystalline; occurs intergranularly.
Chlorite 1% Xenoblastic grains 0.1 to 0.05 mm.; alteration product of biotite.
Leucoxene Tr.
Apatite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic, non-porphyroblastic, medium-grained, cataclastic.
Probable rock: Plagioclase-microcline-quartz gneiss.
(Based on examination of 3 small fragments)

Johnson and Sullivan	Las Animas County	CL-204
#1 A. T. McCarty	33S-63W, sec 16	LA-18-1a
		Cuttings
		5425-30 ft.

Quartz 50% Xenoblastic grains 2.0 to 0.05 mm.; moderately to strongly strained and fractured; grains have sutured borders; contains rutile.
Microcline 40% Xenoblastic grains 2.5 to 0.1 mm.; slightly to moderately altered to sericite; distinct to faint polysynthetic twins.
Plagioclase 5% Oligoclase; xenoblastic grains 1.5 to 0.2 mm.; moderately to severely altered to sericite; albite twins very indistinct.
Muscovite 2% Shredlike xenoblastic grains 0.5 to 0.05 mm.
Calcite 2% Xenoblastic grains 1.5 to 0.05 mm.; intergranular to other minerals.
Magnetite 1%
Biotite Tr. Idioblastic to xenoblastic grains 0.1 to 0.05 mm.; pleochroic from pale yellowish-green to dark green; associated with muscovite.
Leucoxene Tr.
Zircon Tr.

Fabric: Granoblastic, non-porphyroblastic, medium-grained, somewhat cataclastic.
Probable rock: Plagioclase-microcline-quartz gneiss.
(Fragments with clastic fabric may be of granite wash)

British-American	Logan County	CL-84
Producing Co.	11N-53W, sec 26	LO-1-1
#4 Segelke		Cuttings
		8110-20 ft.

Variety #1, fragments make up 75% of thin section.

Plagioclase 42% Oligoclase to andesine; xenoblastic grains 1.0 to 0.2 mm.; slightly to severely altered to sericite; albite and pericline twins; poikiloblastically enclose quartz, hornblende and biotite.
Hornblende 30% Corroded xenoblastic grains 0.5 to 0.05 mm.; ragged grain borders; pleochroic from yellowish-green to dark green or bluish-green; preferred orientation.
Biotite 15% Elongate xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark brown; associated with hornblende; preferred orientation.

Quartz 10% Xenoblastic grains 0.5 to 0.05 mm.; moderately strained; occur interstitially to plagioclase, hornblende, and biotite.
Magnetite 3% Idioblastic to xenoblastic grains 0.3 to 0.05 mm.
Pyrite Tr.

Fabric: Gneissose, nematoblastic to lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Amphibolite

Variety #2, fragments make up 25% of thin section.

Plagioclase 78% Oligoclase; xenoblastic grains 5.0 to 0.1 mm.; strongly altered to sericite; albite twins poikiloblastically enclose blebs of quartz.
Quartz 15% Xenoblastic grains 3.0 to 0.05 mm.; moderately strained; sutured borders.
Microcline 5% Xenoblastic grains 3.0 mm.; microperthitic; poikiloblastically enclose plagioclase and quartz.
Biotite 2% Xenoblastic grains 0.3 to 0.1 mm.; pleochroic from pale greenish-brown to very dark brownish-green; weak preferred orientation.

Fabric: Granoblastic, non-porphyroblastic, medium-grained.
Probable rock: Microcline-quartz-plagioclase gneiss.

British-American Producing Co. #18 Yenter "B"	Logan County 8N-54W, sec 3	CL-85 LO 2-1 Cuttings 8030-40 ft.

Microcline 45% Xenoblastic grains 1.0 to 0.01 mm.; distinct polysynthetic twins; slightly microperthitic; grains have mortar texture with smaller grains interstitial to larger grains.
Quartz 30% Xenoblastic grains 1.0 to 0.01 mm.; moderately strained and fractured; grain borders sutured and slightly granulated.
Plagioclase 15% Oligoclase; xenoblastic grains 1.0 to 0.05 mm.; slightly to moderately altered to sericite; albite and pericline twins.
Biotite 10% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellowish-green to dark green; moderately altered to chlorite; preferred orientation.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Calcite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-quartz-microcline gneiss.

British- American Producing Co. #18 Yenter "B"	Logan County 8N-54W, sec 3	CL-85 LO-2-2 Cuttings 8040-43 ft.

Plagioclase 35% Oligoclase; xenoblastic grains 2.0 to 0.1 mm.; slightly altered to sericite; albite and pericline twins; myrmekitic.
Quartz 30% Xenoblastic grains 1.5 to 0.01 mm.; moderately strained and fractured; grain borders slightly sutured; grains occur in elongate aggregates.
Microcline 25% Xenoblastic grains 1.0 to 0.01 mm.; distinct polysynthetic twins; smaller grains occur interstitially to larger grains.
Biotite 10% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellowish-green to dark green; moderately altered to chlorite; preferred orientation.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Patrick Doheny #1 Mittelstadt	Logan County 10N-53W, sec 23	CL-86 LO-3-1 Cuttings 7640-45 ft.

Microcline 45% Xenoblastic grains 6.0 to 0.2 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose quartz, biotite, apatite, zircon, and magnetite.
Plagioclase 25% Oligoclase; xenoblastic grains 3.0 to 0.1 mm.; moderately to severely altered to sericite; albite twins indistinct.

Quartz 15% Xenoblastic grains 1.5 to 0.05 mm.; moderately to strongly strained and fractured; some grain borders slightly sutured.
Biotite 10% Xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale yellow to brownish-green; poikiloblastically enclose apatite and zircon; weak preferred orientation; moderately altered to chlorite.
Hornblende 5% Corroded xenoblastic grains 2.0 to 0.2 mm.; twinned; pleochroic from pale yellowish-green to dark green or bluish-green; moderately altered to biotite; preferred orientation.
Apatite Tr.
Zircon Tr.
Pyrite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Hornblende-biotite-quartz-plagioclase-microcline gneiss.

Patrick Doheny	Logan County	CL-86
#1 Mittelstadt	10N-53W, sec 23	LO-3-2
		Cuttings
		7645-50 ft.

Plagioclase 48% Oligoclase; xenoblastic grains 2.5 to 0.1 mm.; moderately to severely altered to sericite; albite twins obscured; myrmekitic.
Quartz 20% Xenoblastic grains 1.0 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders.
Microcline 15% Xenoblastic grains 2.5 to 0.2 mm.; distinct polysynthetic twins; Carlsbad twins; slightly microperthitic.
Biotite 10% Xenoblastic grains 1.0 to 0.1 mm.; pleochroic from pale yellow to brownish-green; poikiloblastically enclose apatite and zircon; slightly altered to chlorite.
Hornblende 5% Corroded xenoblastic grains 1.0 to 0.05 mm.; twinned; pleochroic from pale yellowish-green to dark green or bluish-green; moderately altered to biotite.
Sphene 2% Corroded idioblastic to xenoblastic grains 2.0 to 0.05 mm.; slightly pleochroic from pale brown to light reddish-brown; fractured.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, medium-grained.
Probable rock: Hornblende-biotite-microcline-quartz-plagioclase-gneiss.

Shell Oil Co.
#16-A C. F. Green

Logan County
9N-53W, sec 30

CL-88
LO-5-1
2 Core chips
7786 ft.

Chip #1 (larger):

Microcline 90% One xenoblastic grain 14.5 mm.; microperthitic; poikiloblastically enclose quartz, plagioclase, and muscovite; smaller xenoblastic grains 0.2 to 0.05 mm.; occur interstitially to other minerals.
Plagioclase 8% Oligoclase; xenoblastic grains 2.0 to 0.05 mm.; strongly to severely altered to sericite; smaller grains occur interstitially with microcline; albite twins obscured.
Quartz 2% Xenoblastic grains 1.0 to 0.05 mm.; slightly to moderately strained and fractured; sutured borders.
Chlorite Tr. Irregularly-shaped xenoblastic grains 0.5 to 0.01 mm.; alteration product of biotite.
Muscovite Tr.
Hematite Tr.

Fabric: Granoblastic, porphyroblastic, coarse-grained, slightly cataclastic.
Probable rock: Microcline augen (for rock see chip #2)

Chip #2 (smaller):

Quartz 50% Xenoblastic grains 1.5 to 0.01 mm.; slightly to moderately strained and fractured; grain borders sutured.
Plagioclase 35% Oligoclase; xenoblastic grains 1.5 to 0.05 mm.; strongly to severely altered to sericite; albite twins obscured; myrmekitic.
Microcline 10% Xenoblastic grains 0.5 to 0.01 mm.; poikiloblastically enclose quartz and plagioclase.
Biotite 5% Shredlike xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale greenish-yellow to greenish-brown; moderately altered to chlorite; preferred orientation.
Sphene Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained, slightly cataclastic.
Probable rock: Biotite-microcline-plagioclase-quartz augen gneiss. (Identification based on both chips).

Shell Oil Co.	Logan County	CL-88
#16-A C. F. Green	9N-53W, sec 30	LO-5-2
		2 Core chips
		7792 ft.

Chip #1 (larger):

Plagioclase 68% Oligoclase; xenoblastic grains 5.5 to 0.1 mm.; strongly altered to sericite; albite and pericline twins obscured; smaller grains occur interstitially to larger grains of quartz and plagioclase.
Quartz 30% Xenoblastic grains 3.5 to 0.05 mm.; slightly to moderately strained and fractured; grain borders slightly sutured.
Biotite 2% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellow to brownish-green; severely altered to chlorite; preferred orientation.
Muscovite Tr.
Apatite Tr.
Zircon Tr.
Hematite Tr.

Fabric: Granoblastic, non-porphyroblastic, medium-grained, slightly cataclastic.

Chip #2 (smaller):

Plagioclase 99% Oligoclase; xenoblastic grains 5.5 to 0.1 mm.; moderately altered to sericite; albite twins.
Chlorite 1% Pennine; shredlike xenoblastic masses 0.2 to 0.05 mm.; alteration product of biotite.
Muscovite Tr.
Hematite Tr.

Fabric: Not determined.
Probable rock: Quartz-plagioclase gneiss (identification based on both chips)

Shell Oil Co.	Logan County	CL-88
#16-A C. F. Green	9N-53W, sec 30	LO-5-3
		Core chip
		7802 ft.

Quartz 40% Xenoblastic grains 3.5 to 0.05 mm.; slightly to moderately strained and fractured; sutured borders; smaller grains occur interstitially to larger grains.

Plagioclase 35% Oligoclase; xenoblastic grains 2.5 to 0.1 mm.; moderately to severely altered to sericite; albite and pericline twins; smaller grains occur interstitially to larger grains.
Biotite 15% Elongate idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellow to greenish-brown; strongly altered to chlorite (pennine); preferred orientation.
Magnetite 8% Xenoblastic grains 0.5 to 0.05 mm.; occur in aggregates 8.0 to 3.5 mm.
Microcline 2% Xenoblastic grains 0.3 to 0.05 mm.; occur interstitially to larger grains of quartz and plagioclase.
Muscovite Tr.
Sphene Tr.
Leucoxene Tr.
Epidote Tr.
Apatite Tr.
Zircon Tr.
Calcite Tr.
Hematite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium-grained, slightly cataclastic.
Probable rock: Magnetite-bearing biotite-plagioclase-quartz gneiss.

Shell Oil Co.	Logan County	CL-88
#16-A C. F. Green	9N-53W, sec 30	LO-5-4
		Core chip
		7787-7802 ft.

Plagioclase 40% Oligoclase; xenoblastic grains 3.0 to 0.1 mm.; severely to completely altered to sericite; albite twins obscured; myrmekitic.
Microcline 25% Xenoblastic grains 2.5 to 0.1 mm.; microperthitic; poikiloblastically enclose plagioclase, quartz, apatite, and biotite; many grains clustered together into augen; smaller grains occur interstitially to larger grains of plagioclase, microcline, and quartz.
Quartz 25% Xenoblastic grains 1.0 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders; contain a few microcrystalline needles of rutile.
Biotite 5% Elongate idioblastic to xenoblastic grains 1.5 to 0.1 mm.; pleochroic from pale yellowish-brown to dark greenish-brown; slightly altered to chlorite; preferred orientation.
Chlorite 2% Pennine; shredlike xenoblastic grains 0.75 to 0.1 mm.; alteration product of biotite.
Apatite 2%
Magnetite 1%

Sphene Tr.
Leucoxene Tr.
Hematite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, medium-grained.
Probable rock: <u>Biotite-quartz-microcline-plagioclase augen gneiss</u>.

Shell Oil Co.	Logan County	CL-88
#16-A C. F. Green	9N-53W, sec 30	LO-5-5
		Core chip
		7787-7802 ft.

Plagioclase 40% Oligoclase; xenoblastic grains 3.5 to 0.1 mm.; severely altered to sericite; albite twins obscured; myrmekitic; poikiloblastically enclose quartz.
Quartz 30% Xenoblastic grains 4.0 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders; contain a few microcrystalline needles of rutile.
Biotite 15% Elongate idioblastic to xenoblastic grains 1.5 to 0.1 mm.; pleochroic from pale greenish-brown to very dark greenish-brown; slightly to strongly altered to chlorite; preferred orientation.
Microcline 11% Xenoblastic grains 1.5 to 0.1 mm.; faintly microperthitic; poikiloblastically enclose plagioclase, quartz, apatite, biotite, and magnetite; many grains clustered together into augen; small grains occur interstitially to quartz and plagioclase.
Apatite 2%
Magnetite 2%
Sphene Tr.
Leucoxene Tr.
Zircon Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic to granoblastic, porphyroblastic, medium-grained.
Probable rock: <u>Microcline-biotite-quartz-plagioclase augen gneiss</u>.

Shell Oil Co.	Logan County	CL-89
#2-B State	8N-53W, sec 16	LO-6-1
		Cuttings
		7695-7700 ft.

Plagioclase 50% Oligoclase to andesine; xenoblastic grains 3.0 to 0.1 mm.; slightly to strongly altered to sericite; albite twins indistinct.
Quartz 25% Xenoblastic grains 3.0 to 0.05 mm.; moderately to strongly strained and fractured; grain borders slightly sutured.
Microcline 15% Xenoblastic grains 4.5 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase and quartz.
Biotite 10% Xenoblastic grains 1.5 to 0.1 mm.; pleochroic from pale yellow to very dark greenish-brown, brown to dark brown in basal sections; slightly to moderately altered to chlorite (pennine).
Hornblende Tr. Xenoblastic grains 0.1 to 0.05 mm.; associated with biotite.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Calcite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, medium-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Shell Oil Co.	Logan County	CL-89
#2-B State	8N-53W, sec 16	LO-6-2
		Cuttings
		7700-05 ft.

Plagioclase 53% Oligoclase to andesine; xenoblastic grains 6.0 to 0.1 mm.; severely to completely altered to sericite; albite and pericline twins; obscured in some grains.
Quartz 25% Xenoblastic grains 2.5 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders.
Biotite 15% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from very pale brown to greenish-brown; moderately to strongly altered to chlorite (pennine).
Microcline 5% Xenoblastic grains 1.0 to 0.1 mm.; distinct polysynthetic twins; poikiloblastically enclose plagioclase.
Magnetite 2% Idioblastic to xenoblastic grains 0.1 to 0.01 mm.; associated with chlorite in altered biotite and with sericite in altered plagioclase.
Epidote Tr.
Leucoxene Tr.
Zircon Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Microcline-biotite-quartz-plagioclase gneiss.

Shell Oil Co.	Logan County	CL-89
#2-B State	8N-53W, sec 16	LO-6-3
		Cuttings
		7715-20 ft.

Plagioclase 50% Oligoclase; xenoblastic grains 1.0 to 0.1 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose small blebs of quartz.
Quartz 20% Xenoblastic grains 3.0 to 0.01 mm.; slightly to moderately strained and fractured; grain borders sutured.
Biotite 15% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from very pale yellowish-green to dark brownish-green; slightly altered to chlorite; poikiloblastically enclose quartz, epidote, apatite, and zircon; preferred orientation.
Hornblende 10% Corroded xenoblastic grains 0.5 to 0.05 mm.; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose quartz, sphene, magnetite, and apatite; weak preferred orientation.
Magnetite 5% Idioblastic to xenoblastic grains 0.2 to 0.01 mm.
Epidote Tr.
Sphene Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic to nematoblastic, in part granoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Hornblende-biotite-quartz-plagioclase gneiss.

Amerada Petroleum Co.	Mesa County	CL-90
#1 Unit	9S-101W, sec 14	ME-1-1
		Cuttings
		4210-15 ft.

Plagioclase 45% Oligoclase; idioblastic to xenoblastic grains 2.0 to 0.01 mm.; slightly altered to sericite; strongly strained, fractured, and granulated; albite twins bent and distorted.
Quartz 40% Xenoblastic grains 1.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders intricately sutured and granulated; occur in lens-shaped aggregates.

Microcline 10% Xenoblastic grains 1.5 to 0.01 mm.; weak polysynthetic twins; microperthitic; granulated.
Muscovite 5% Shredlike xenoblastic grains 1.0 to 0.01 mm.
Biotite Tr. Rounded xenoblastic grains 0.01 mm.; pleochroic from pale brown to brown.
Leucoxene Tr.
Apatite Tr.
Hematite Tr.

Fabric: Gneissose, cataclastic, medium-grained.
Probable rock: Muscovite-microcline-quartz plagioclase gneiss.

Amerada Petroleum Co.	Mesa County	CL-90
#1 Unit	9S-101W, sec 14	ME-1-2
		Cuttings
		4215-20 ft.

Microcline 40% Xenoblastic grains 2.5 to 0.01 mm.; distinct to weak polysynthetic twins; microperthitic; granulated.
Quartz 30% Xenoblastic grains 1.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders intricately sutured and granulated.
Plagioclase 25% Albite to oligoclase; xenoblastic grains 2.5 to 0.01 mm.; slightly altered to sericite; strongly strained, fractured and granulated; albite twins bent and distorted.
Muscovite 5% Shredlike xenoblastic grains 1.0 to 0.05 mm.
Chlorite Tr. Irregularly-shaped xenoblastic grains 0.1 to 0.01 mm.; alteration product of biotite.
Leucoxene Tr.
Apatite Tr.
Hematite Tr.

Fabric: Gneissose, cataclastic, medium-grained.
Probable rock: Muscovite-plagioclase-quartz-microcline gneiss.

Amerada Petroleum Co.	Mesa County	CL-90
#1 Unit	9S-101W, sec 14	ME-1-3
		Cuttings
		4220-24 ft.

Quartz 35% Xenoblastic grains 2.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders intricately sutured and granulated.

Plagioclase 30% Albite to oligoclase; xenoblastic grains 1.5 to 0.1 mm.; slightly altered to sericite; strongly strained, fractured and granulated; albite twins bent and distorted; some pericline twins.
Microcline 25% Xenoblastic grains 1.0 to 0.01 mm.; distinct to weak polysynthetic twins; microperthitic texture; granulated.
Muscovite 10% Shredlike xenoblastic grains 1.5 to 0.01 mm.; bent and distorted.
Chlorite Tr. Irregularly-shaped xenoblastic grains 0.05 to 0.01 mm.; alteration product of biotite.
Leucoxene Tr.
Apatite Tr.

Fabric: Gneissose, cataclastic, medium-grained.
Probable rock: Muscovite-microcline-plagioclase-quartz gneiss.

Pure Oil Co.	Mesa County	CL-94
#1 Unit (Gateway)	15S-104W, sec 15	ME-5-1
		Core chip
		7846-48.5 ft.

Plagioclase 40% Oligoclase; subhedral to anhedral grains 5.0 to 0.1 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; poikilitically enclose quartz.
Microcline 32% Anhedral grains 11.0 to 0.5 mm.; distinct polysynthetic twins; microperthitic; Carlsbad twins; poikilitically enclose quartz, plagioclase, biotite, and magnetite.
Quartz 15% Anhedral grains 5.0 to 0.05 mm.; moderately to strongly strained and fractured; grain borders slightly sutured; poikilitically enclose biotite, plagioclase, and apatite.
Biotite 10% Anhedral grains 2.0 to 0.05 mm.; pleochroic from pale yellow to dark greenish-brown; strongly altered to chlorite, muscovite, and hematite; weak preferred orientation.
Epidote 1% Anhedral grains 0.2 to 0.01 mm.; associated with biotite.
Apatite 1%
Magnetite 1%
Muscovite Tr.
Sphene Tr.
Zircon Tr.
Calcite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, coarse-grained. Slightly gneissic.
Probable rock: Porphyritic quartz monzonite.

Pure Oil Co.	Mesa County	CL-94
#1 Unit (Gateway)	15S-104W, sec 15	ME-5-2
		Core chip
		7892-97 ft.

Microcline 90% Anhedral grains 18.0 to 13.0 mm.; distinct polysynthetic twins; microperthitic; Carlsbad twins; poikilitically enclose plagioclase, quartz, biotite, and magnetite.
Plagioclase 5% Oligoclase; euhedral to anhedral grains 3.0 to 0.1 mm.; slightly to moderately altered to sericite; albite, Carlsbad, and pericline twins; albite rims; weakly zoned; myrmekitic.
Quartz 3% Anhedral grains 3.0 to 0.05 mm.; slightly to moderately strained and fractured; some grains are in micrographic intergrowths with microcline.
Biotite 2% Anhedral grains 1.5 to 0.1 mm.; pleochroic from pale yellow to greenish-brown; moderately altered to chlorite.
Muscovite Tr.
Epidote Tr.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, coarse-grained.
Probable rock: Microcline phenocryst (from quartz monzonite)

Pure Oil Co.	Mesa County	CL-94
#1 Unit (Gateway)	15S-104W, sec 15	ME-5-3
		Core chip
		7935-39 ft.

Plagioclase 50% Oligoclase to andesine; euhedral to anhedral grains 7.0 to 0.1 mm.; slightly altered to sericite; albite, pericline, and Carlsbad twins; distinctly zoned.
Quartz 30% Anhedral grains 5.0 to 0.05 mm.; moderately to strongly strained and fractured; grain borders slightly sutured.
Biotite 15% Anhedral grains 3.0 to 0.1 mm.; pleochroic from pale yellow to greenish-brown; slightly altered to chlorite; weak preferred orientation.
Sphene 3% Euhedral to anhedral grains 3.0 to 1.0 mm.; pleochroic from pale brown to light reddish-brown.
Microcline 2% Anhedral grains 4.0 to 0.5 mm.; distinct polysynthetic twins; microperthitic.
Epidote Tr.
Apatite Tr.

Zircon Tr.
Magnetite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium- to coarse-grained, slightly gneissic.
Probable rock: Granodiorite.

Amerada Petroleum Co.	Moffat County	CL-95
#1 Unit	5N-94W, sec 9	MO-1-1
		Cuttings
		5400-05 ft.

Sericite (clay) 73% Microcrystalline grains; matrix of rock; partly altered to muscovite.
Quartz 25% Angular to subrounded grains 0.3 to 0.01 mm.; moderately to strongly strained.
Hematite 2% Microcrystalline grains; occur scattered in the matrix but quite dense in patches.
Zircon Tr.
Magnetite Tr.

Fabric: Sedimentary, detrital, poorly-sorted, angular to subrounded grains, fine-grained.
Probable rock: Sandy or silty shale (Identification based on examination of 3 small fragments.)

Amerada Petroleum Co.	Moffat County	CL-95
#1 Unit	5N-94W, sec 9	MO-1-1a
		Cuttings
		5400-05 ft.

Variety #1, fragments make up 80% of thin section.

Calcite 64% Microcrystalline xenoblastic grains; some occur in circular, oval, and elongate masses 0.5 to 0.05 mm. which may be of organic origin.
Quartz 35% Subangular to subrounded grains 0.3 mm. to microcrystalline; slightly to moderately strained.
Hematite 1% Microcrystalline grains; occur scattered but quite dense in patches.
Zircon Tr.
Magnetite Tr.

Fabric: Sedimentary, crystalline and detrital, fine-grained.
Probable rock: Sandy limestone.

Variety #2, fragments make up 15% of thin section.

Sericite (clay) 73% Microcrystalline grains; matrix of rock; partly altered to muscovite.
Quartz 25% Angular to subrounded grains 0.5 to 0.01 mm.; slightly to moderately strained.
Hematite 2% Microcrystalline grains; occur scattered in the matrix but quite dense in patches.
Magnetite Tr.
Leucoxene Tr.

Fabric: Sedimentary, detrital, poorly-sorted, angular to subrounded grains, fine-grained.
Probable rock: Sandy or silty shale.

Variety #3, fragments make up 5% of thin section.

Sericite (clay) 60% Microcrystalline grains; matrix of rock; partly altered to muscovite.
Microcline 18% Angular grains 0.1 to 0.01 mm.; distinct polysynthetic twins.
Chlorite 15% Irregular masses 0.2 mm. to microcrystalline; occur in matrix.
Quartz 5% Subangular grains 0.1 mm. to microcrystalline; slightly to moderately strained.
Leucoxene 2%
Tourmaline Tr. Fractured subhedral grains 0.1 to 0.01 mm.; pleochroic from very pale gray to dark purplish-gray.
Zircon Tr.
Apatite Tr.
Magnetite Tr.

Fabric: Sedimentary, detrital, poorly-sorted, angular to subangular grains, fine-grained.
Probable rock: Sandy shale (arkosic)

Amerada Petroleum Co.	Moffat County	CL-95
#1 Unit	5N-94W, sec 9	MO-1-2
		Cuttings
		5395-5400 ft.

Variety #1, fragments make up 60% of thin section.

Sericite (clay) 75% Microcrystalline grains; matrix of rock; partly altered to muscovite.
Quartz 20% Angular to subrounded grains 0.2 mm. to microcrystalline; slightly to moderately strained.
Hematite 5% Microcrystalline grains; occur scattered in the matrix but quite dense in places.
Zircon Tr.

Fabric: Sedimentary, detrital, poorly-sorted, angular to subrounded grains, fine-grained.
Probable rock: Sandy or silty shale.

Variety #2, fragments make up 20% of thin section

Calcite 50% Microcrystalline xenoblastic grains; some occur in circular, oval, and elongate masses 0.5 to 0.05 mm. which may be of organic origin.
Quartz 40% Angular to subrounded grains 0.1 mm. to microcrystalline; slightly strained.
Sericite 10% Microcrystalline grains.
Chlorite Tr.
Hematite Tr.

Fabric: Sedimentary, crystalline and detrital, poorly sorted, angular to subrounded grains, fine-grained.
Probable rock: Sandy or silty limestone.

Variety #3, fragments make up 20% of thin section.

Calcite 80% Microcrystalline xenoblastic grains; occur in fine laminae as bedding; may be some cross-bedding.
Quartz 15% Angular to subangular grains 0.05 mm. to microcrystalline.
Muscovite 4% Microcrystalline grains.
Hematite 1% Microcrystalline grains in bands with calcite.
Tourmaline Tr. Elongate fractured subhedral grains 0.1 to 0.01 mm.; pleochroic from colorless to pale green.

Fabric: Sedimentary, detrital, poorly-sorted, fine-grained.
Probable rock: Clastic hematitic limestone.

Amerada Petroleum Co.	Moffat County	CL-95
#1 Unit	5N-94W, sec 9	MO-1-3
		Cuttings
		5390-95 ft.

Sericite (clay) 62% Microcrystalline grains; matrix of rock; partly altered to muscovite.
Quartz 30% Angular to subrounded grains 0.5 mm. to microcrystalline; slightly to moderately strained; some grains have formed from chalcedony and have undulatory extinction and relict concentric banding.
Calcite 5% Microcrystalline xenoblastic grains in irregularly-shaped masses; also in circular, oval, and elongate masses 0.5 to 0.05 mm. which may be of organic origin.
Hematite 3% Microcrystalline grains; occur scattered but quite dense in patches.
Leucoxene Tr
Tourmaline Tr. Subrounded grains 0.1 to 0.01 mm.; reddish-brown; non-pleochroic; cross-fractures.
Magnetite Tr.

Fabric: Sedimentary, detrital, poorly-sorted, angular to subrounded grains, fine-grained.
Probable rock: Sandy to silty shale.

Western Natural Gas	Montezuma County	CL-97
Byrd, Frost, and English	36N-18W, sec 25	MZ-2-1
#1 MacIntosh	(NMPM)	Cuttings
		4640-50 ft.

Feldspar 50% Variety undetermined; xenoblastic grains 0.2 mm. to microcrystalline; moderately altered to sericite; extinction wavy; twins absent or indistinct.
Diopside 34% Idioblastic to xenoblastic grains 0.2 mm. to microcrystalline; pleochroic from pale yellowish-green to pale green; moderately altered to uralite.
Muscovite 5% Shredlike xenoblastic grains 4.5 to 0.1 mm.; poikiloblastically enclose diopside.
Chlorite 5% Irregularly shaped xenoblastic grains 1.0 mm. to microcrystalline; alteration product.
Pyrite 3% Idioblastic to xenoblastic grains 0.5 to 0.01 mm.; occur in discontinuous bands.
Gypsum 2% Xenoblastic grains 4.0 to 0.2 mm.; occur in veinlets; faint cleavage and twinning.
Sericite 1% Xenoblastic masses and grains 1.0 mm. to microcrystalline; alteration product.
Anhydrite Tr. Rectangular idioblastic grains 0.2 mm.; faint cleavage; associated with gypsum.
Magnetite Tr.
Apatite Tr.

Sphene Tr.
Calcite Tr.

Fabric: Metamorphic, hornfelsic, porphyroblastic, fine-grained.
Probable rock: Chlorite-diopside feldspar hornfels. (Porphyroblasts of muscovite.)

Western Natural Gas	Montezuma County	CL-97
Byrd, Frost, and English	36N-18W, sec 25	MZ-2-2
#1 MacIntosh	(NMPM)	Cuttings
		4730-40 ft.

Phenocrysts: 65% of thin section.

Plagioclase 100% Oligoclase; euhedral to subhedral crystals 1.0 to 0.2 mm.; moderately to strongly altered to sericite; albite and Carlsbad twins.

Groundmass: 35% of thin section

Orthoclase 45% Anhedral grains 0.05 mm. to microcrystalline.
Plagioclase 30% Albite to oligoclase; subhedral grains 0.2 to 0.05 mm.; moderately altered to sericite; albite twins.
Sericite 15% Anhedral masses and grains 0.3 mm. to microcrystalline; associated with altered phenocrysts of plagioclase.
Quartz 5% Anhedral grains 0.01 mm. to microcrystalline.
Chlorite 2% Shredlike anhedral grains 0.5 to 0.01 mm.; alteration product.
Pyrite 2%
Sphene 1%
Apatite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric, fine-grained.
Probable rock: Latite porphyry.

Western Natural Gas	Montezuma County	CL-97
Byrd, Frost, and English	36N-18W, sec 25	MZ-2-3
#1 MacIntosh	(NMPM)	Cuttings
		4810-20 ft.

Plagioclase 81% Oligoclase; euhedral to subhedral crystals 1.0 to 0.05 mm.; slightly to strongly altered to sericite; albite

and pericline twins; weak zoning.
Orthoclase 6% Anhedral grains 0.1 mm. to microcrystalline.
Sericite 7% Anhedral masses and grains 0.2 mm. to microcrystalline.
Chlorite 3% Anhedral grains 0.2 to 0.05 mm.
Diopside 2% Corroded anhedral grains 0.5 to 0.05 mm.; pleochroic from pale yellowish-green to pale green.
Quartz 1% Anhedral grains 0.1 mm. to microcrystalline.
Apatite Tr.

Fabric: Holocrystalline, inequigranular-seriate, fine-grained.
Probable rock: Latite

Western Natural Gas	Montezuma County	CL-97
Byrd, Frost, and English	36N-18W, sec 25	MZ-2-3a
#1 MacIntosh		Cuttings
		4810-20 ft.

Plagioclase 77% Oligoclase; euhedral to subhedral crystals 1.5 to 0.05 mm.; slightly to moderately altered to sericite; albite, Carlsbad, and pericline twins.
Orthoclase 10% Anhedral grains 0.1 mm. to microcrystalline; occur interstitially to plagioclase grains.
Sericite 5% Anhedral grains and masses 0.2 mm. to microcrystalline.
Chlorite 5% Anhedral grains 0.3 to 0.01 mm.; pleochroic from pale yellowish-green to pale green; some grains twinned.
Diopside 2% Corroded subhedral to anhedral grains 2.0 to 0.05 mm.; pleochroic from pale yellowish-green to pale green; some grains twinned.
Quartz 1% Anhedral grains 0.05 mm. to microcrystalline; micrographically intergrown with orthoclase.
Apatite Tr.
Zircon Tr.
Sphene Tr.
Hornblende Tr.

Fabric: Holocrystalline, inequigranular-seriate, fine- to medium-grained.
Probable rock: Latite.

Western Natural Gas Byrd, Frost, and English #1 MacIntosh	Montezuma County 36N-18W, sec 25 (NMPM)	Cl-97 MZ-2-4 Cuttings 4910-20 ft.

Plagioclase 72% Albite to oligoclase; euhedral to subhedral crystals 1.0 to 0.1 mm.; slightly to strongly altered to sericite; albite and pericline twins; weak zoning.
Orthcclase 15% Anhedral grains 0.2 to 0.01 mm.
Diopside 10% Corroded subhedral to anhedral grains 0.5 to 0.05 mm.; pleochroic from pale yellowish-green to pale green; twinned.
Magnetite 2%
Sphene 1%
Apatite Tr.
Calcite Tr.

Fabric: Holocrystalline, inequigranular-seriate, fine-grained.
Probable rock: Latite.

California Oil Co. #1 Ute Tribal	Montezuma County 33N-19W, sec 22 (NMPM)	CL-98 MZ-3-1 Cuttings 8010-11 ft.

Micrographic granite 75% Anhedral grains 1.5 to 0.5 mm.; micrographic intergrowths of quartz and microcline; Carlsbad twins.
Quartz 15% Subhedral grains 2.5 to 0.2 mm.; moderately to strongly strained and fractured; graphic intergrowths at contacts with microcline;
Microcline 5% Euhedral to subhedral grains 1.5 to 0.1 mm.; strongly altered to sericite; polysynthetic twins obscured; Carlsbad twins; microperthitic; poikilitically enclose plagioclase.
Plagioclase 3% Albite to oligoclase; euhedral to subhedral grains 1.0 to 0.1 mm.; slightly to moderately altered to sericite; albite and Carlsbad twins.
Chlorite 1% Irregular anhedral masses 0.5 to 0.05 mm.; alteration product of biotite.
Magnetite 1%
Sphene Tr.
Leucoxene Tr.
Zircon Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, micrographic, fine- to medium-grained.

Probable rock: Micrographic granite.

California Oil Co.	Montezuma County	CL-98
#1 Ute Tribal	33N-19W, sec 22	MZ-3-2
		3 Core chips
		8011 ft.

Micrographic granite 72% Anhedral grains 4.0 to 0.5 mm.; micrographic intergrowths of quartz and microcline; Carlsbad twins.
Quartz 15% Subhedral to anhedral grains 2.0 to 0.05 mm.; slightly to moderately strained and fractured; graphic intergrowths at contacts with microcline.
Microcline 10% Euhedral to subhedral grains 3.5 to 0.3 mm.; strongly altered to sericite; polysynthetic twins obscured; Carlsbad twins; microperthitic.
Plagioclase 1% Oligoclase; euhedral to anhedral grains 1.0 to 0.1 mm.; slightly to severely altered to sericite; albite twins indistinct.
Chlorite 1% Irregular anhedral masses 0.5 to 0.05 mm.; alteration product of biotite.
Leucoxene 1%
Muscovite Tr.
Sphene Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, micrographic, fine- to medium-grained.
Probable rock: Micrographic granite.

California Oil Co.	Montezuma County	CL-98
#1 Ute Tribal	33N-19W, sec 22	MZ-3-3
	(NMPM)	Core chip
		8014-15 ft.

Micrographic granite 75% Anhedral grains 3.0 to 0.5 mm.; micrographic intergrowths of quartz and microcline; Carlsbad twins.
Quartz 15% Euhedral to anhedral grains 2.0 to 0.1 mm.; slightly to strongly strained and fractured; graphic intergrowths at contacts with microcline.
Microcline 5% Euhedral to subhedral grains 3.0 to 0.3 mm.; strongly altered to sericite; polysynthetic twins obscured; Carlsbad

twins; microperthitic; poikilitically enclose plagioclase.
Plagioclase 3% Albite to oligoclase; euhedral to subhedral grains 4.5 to 0.2 mm.; moderately to strongly altered to sericite; albite, Carlsbad, and pericline twins.
Chlorite 1%
Magnetite 1%
Leucoxene Tr.
Zircon Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, micrographic, medium-grained.
Probable rock: Micrographic granite.

Continental Oil Co.	Montezuma County	CL-99
#1 Ute Mountain	32N-19W, sec 7	MZ-4-1
	(NMPM)	Core chip
		7222-27 ft.

Micrographic granite 75% Anhedral grains 3.5 to 0.5 mm.; micrographic intergrowths of quartz and microcline.
Quartz 10% Euhedral to anhedral grains 2.5 to 0.2 mm.; slightly to moderately strained and fractured; graphic intergrowths at contacts with microcline.
Microcline 10% Euhedral to subhedral grains 2.5 to 0.5 mm.; strongly altered to sericite; polysynthetic twins obscured; microperthitic.
Plagioclase 2% Albite to oligoclase; euhedral to subhedral grains 3.0 to 0.3 mm.; moderately to strongly altered to sericite; albite and Carlsbad twins obscured.
Leucoxene 2%
Magnetite 1%
Muscovite Tr.
Zircon Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, micrographic, medium-grained.
Probable rock: Micrographic granite.

Gulf Oil Corp.	Montezuma County	CL-100
#1 Fulks	37N-17W, sec 27	MZ-5-1
	(NMPM)	Cuttings
		8660-64 ft.

Microcline 57% Xenoblastic grains 1.5 to 0.05 mm.; poikiloblastically enclose plagioclase and quartz.
Quartz 20% Xenoblastic grains 2.0 to 0.01 mm.; slightly to strongly strained and fractured; sutured borders.
Plagioclase 15% Oligoclase; xenoblastic grains 1.5 to 0.1 mm.; moderately to strongly altered to sericite; albite twins indistinct; myrmekitic.
Biotite 7% Xenoblastic grains 1.5 to 0.01 mm.; pleochroic from yellowish-green to very dark green; moderately altered to chlorite; weak preferred orientation.
Magnetite 1% Idioblastic to xenoblastic grains 0.2 to 0.05 mm.; associated with biotite.
Muscovite Tr. Shredlike xenoblastic grains 0.3 to 0.01 mm.; associated with biotite.
Sphene Tr.
Leucoxene Tr.
Zircon Tr.
Apatite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-plagioclase-quartz-microcline gneiss.

Gulf Oil Corp.	Montezuma County	CL-100
#1 Fulks	37N-17W, sec 27	MZ-5-2
	(NMPM)	Cuttings
		8714-20 ft.

Microcline 40% Xenoblastic grains 2.0 to 0.05 mm.; poikiloblastically enclose plagioclase, biotite, and some small blebs of quartz.
Plagioclase 25% Oligoclase; idioblastic to xenoblastic grains 2.0 to 0.1 mm.; moderately to strongly altered to sericite; albite twins indistinct; myrmekitic.
Quartz 25% Xenoblastic grains 1.5 to 0.01 mm.; slightly to moderately strained and fractured; some grain borders slightly sutured.
Biotite 9% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from yellowish-green to very dark green or brownish-green; moderately altered to chlorite.
Leucoxene 1%
Muscovite Tr. Shredlike xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

Gulf Oil Co.	Montezuma County	CL-100
#1 Fulks	37N-17W, sec 27	MZ-5-3
	(NMPM)	Cuttings
		8764-70 ft.

Microcline 35% Xenoblastic grains 2.5 to 0.05 mm.; poikiloblastically enclose plagioclase and quartz.
Plagioclase 30% Oligoclase; idioblastic to xenoblastic grains 2.0 to 0.05 mm.; moderately to strongly altered to sericite; albite and Carlsbad twins indistinct; myrmekitic.
Quartz 25% Xenoblastic grains 1.5 to 0.01 mm.; slightly to moderately strained and fractured; grain borders sutured.
Chlorite 8% Xenoblastic grains 0.5 to 0.05 mm.; alteration product of biotite.
Biotite 1% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from yellowish-green to very dark green; moderately to severely altered to chlorite or muscovite.
Calcite 1% Xenoblastic grains and masses 0.2 to 0.05 mm.; associated with altered biotite, magnetite, and hematite.
Muscovite Tr. Elongate xenoblastic grains 0.3 to 0.05 mm.; associated with biotite.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

Pan American	Montezuma County	CL-101
Petroleum Co.	32N-20W, sec 24	MZ-6-1
#1 Ute Mountain	(NMPM)	Cuttings
		7272 ft.

Micrographic granite 60% Anhedral grains 5.0 to 1.0 mm.; micrographic intergrowths of quartz and microcline; Carlsbad twins.
Microcline 20% Subhedral grains 3.0 to 0.5 mm.; strongly altered to

sericite; polysynthetic twins obscured; Carlsbad twins; microperthitic.
Quartz 14% Euhedral to anhedral grains 2.0 to 0.2 mm.; slightly strained and fractured; graphic intergrowths at contacts with microcline.
Plagioclase 5% Oligoclase; euhedral to anhedral grains 1.5 to 0.3 mm.; strongly altered to sericite; albite, Carlsbad, and pericline twins.
Leucoxene 1%
Muscovite Tr.
Magnetite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, micrographic, medium-grained.
Probable rock: Micrographic granite.

Penrose and Tatum #1 Orme	Montrose County 45N-10W, sec 18 (NMPM)	CL-103 MT-2-1 Cuttings 1715-20 ft.

Microcline 90% Anhedral grains 3.0 to 0.5 mm.; distinct polysynthetic twins; microperthitic; poikilitically enclose plagioclase and quartz.
Plagioclase 5% Oligoclase; anhedral grains 0.5 to 0.1 mm.; slightly altered to sericite; albite twins.
Quartz 3% Anhedral grains 0.2 to 0.05 mm.; slightly strained.
Biotite 2% Shredlike anhedral grains 0.3 to 0.01 mm.; pleochroic from pale yellowish-green to green.
Magnetite Tr.

Fabric: Not determined
Probable rock: Microcline granite (Identification based on only four small fragments)

Penrose and Tatum #1 Orme	Montrose County 45N-10W, sec 18 (NMPM)	CL-103 MT-2-2 Cuttings 1740-46 ft.

Microcline 45% Anhedral grains 2.0 to 0.5 mm.; distinct polysynthetic twins; microperthitic; poikilitically enclose plagioclase and quartz.

Plagioclase 37% Oligoclase; subhedral to anhedral grains 2.0 to 0.5 mm.; slightly to moderately altered to sericite; albite and Carlsbad twins.
Biotite 15% Euhedral to anhedral grains 1.5 to 0.1 mm.; pleochroic from pale greenish-brown to dark greenish-brown, or from pale green to dark green; moderately to strongly altered to chlorite.
Quartz 2% Anhedral grains 0.5 to 0.05 mm.; moderately strained.
Muscovite 1%
Sphene Tr.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Monzonite to syenite.

St. Helen's Petroleum Co.	Montrose County	CL-105
#1 C. B. and L. H. Sanburg	49N-8W, sec 15	MT-4-1
(#1 Bostwick Park Unit)	(NMPM)	Cuttings
		2407 ft.

Plagioclase 34% Oligoclase to andesine; idioblastic to xenoblastic grains 2.0 to 0.5 mm.; moderately to strongly altered to sericite; albite and Carlsbad twins.
Orthoclase 25% Xenoblastic grains 6.0 to 5.0 mm.; no polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose quartz.
Quartz 25% Xenoblastic grains 1.5 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured and slightly granulated.
Biotite 15% Idioblastic to xenoblastic grains 2.0 to 0.05 mm.; pleochroic from pale greenish-yellow to dark brownish-green; moderately altered to chlorite and hematite; preferred orientation.
Magnetite 1% Idioblastic to xenoblastic grains 0.3 to 0.05 mm.; associated with biotite.
Sphene Tr.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-orthoclase-plagioclase porphyroblastic gneiss.

St. Helen's Petroleum Co.
#1 C. B. and L. H. Sanburg
(#1 Bostwick Park Unit)

Montrose County
49N-8W, sec 15
(NMPM)

CL-105
MT-4-2
Cuttings
2415 ft.

Plagioclase 77% Oligoclase to andesine; xenoblastic grains 4.0 to 0.5 mm.; moderately to strongly altered to sericite; zoned; albite, pericline, and Carlsbad twins; poikiloblastically enclose biotite and magnetite.
Quartz 15% Xenoblastic grains 1.5 to 0.05 mm.; moderately to severely strained and fractured; grain borders sutured and slightly granulated.
Biotite 5% Xenoblastic grains 1.0 to 0.1 mm.; pleochroic from pale greenish-yellow to dark green; slightly altered to chlorite; weak preferred orientation.
Calcite 2% Xenoblastic grains 0.5 mm. to microcrystalline; occur in veinlets.
Magnetite 1%
Epidote Tr.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-quartz-plagioclase gneiss.

R. E. Wear
#1 Fee

Montrose County
50N-10W, sec 27
(NMPM)

CL-106
MT-5-1
Cuttings
1635-40 ft.

Plagioclase 39% Oligoclase to andesine; xenoblastic grains 0.5 to 0.05 mm.; slightly altered to sericite; albite twins.
Microcline 25% Xenoblastic grains 0.3 to 0.01 mm.; distinct polysynthetic twins; poikiloblastically enclose quartz.
Quartz 15% Xenoblastic grains 0.5 to 0.01 mm.; moderately to strongly strained and fractured; grain borders sutured and granulated.
Biotite 15% Shredlike xenoblastic grains 0.5 to 0.01 mm.; pleochroic from greenish-yellow to dark brownish-green; preferred orientation.
Magnetite 5% Idioblastic to xenoblastic grains 0.1 to 0.01 mm.; grains scattered throughout the rock.
Muscovite 1%
Epidote Tr.

Leucoxene Tr.
Apatite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-quartz-microcline-plagioclase gneiss.

R. E. Wear	Montrose County	CL-106
#1 Fee	50N-10W, sec 27	MT-5-2
	(NMPM)	Cuttings
		1640-45 ft.

Plagioclase 30% Oligoclase to andesine; xenoblastic grains 0.3 to 0.01 mm.; slightly altered to sericite; albite and pericline twins.
Quartz 20% Xenoblastic grains 0.3 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders; some grains poikiloblastically enclose plagioclase.
Biotite 20% Shredlike xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale yellowish-brown to dark greenish-brown; preferred orientation.
Microcline 15% Xenoblastic grains 0.2 to 0.01 mm.; distinct polysynthetic twins.
Leucoxene 9% Xenoblastic masses of microcrystalline grains.
Magnetite 5% Idioblastic to xenoblastic grains 0.5 to 0.01 mm.; grains scattered throughout the rock.
Hornblende 1% Strongly corroded xenoblastic grains 0.5 to 0.01 mm.
Epidote Tr.
Muscovite Tr.
Apatite Tr.

Fabric: Gneissose to schistose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Microcline-biotite-quartz-plagioclase gneiss.

R. E. Wear	Montrose County	CL-106
#1 Fee	50N-10W, sec 27	MT-5-3
	(NMPM)	Cuttings
		1645-50 ft.

Plagioclase 45% Oligoclase to andesine; xenoblastic grains 0.5 to 0.01 mm.; moderately altered to sericite; albite twins indistinct.
Quartz 30% Xenoblastic grains 0.5 to 0.01 mm.; moderately to strongly strained and fractured; grain borders sutured.

Biotite 20% Shredlike xenoblastic grains 0.3 to 0.01 mm.; pleochroic from pale yellowish-brown to dark brownish-green; preferred orientation.
Magnetite 5% Idioblastic to xenoblastic grains 0.1 to 0.01 mm.; grains scattered throughout the rock.
Muscovite Tr.
Epidote Tr.
Apatite Tr.

Fabric: Gneissose to schistose, lepidoblastic, non-porphyroblastic fine-grained.
Probable rock: Biotite-quartz-plagioclase gneiss.

Shell Oil Corp.	Montrose County	CL-181
#2 Wray Mesa Unit	47N-19W, sec 32	MT-6-1
	(NMPM)	Cuttings
		11580-90 ft.

Quartz 80% Subrounded grains 1.0 to 0.01 mm.; moderately to strongly strained and fractured; overgrowths in optical continuity with parent grains; grain borders intricately sutured.
Microcline 7% Subangular to subrounded grains 0.75 to 0.1 mm.
Plagioclase 6% Albite to oligoclase; subangular to subrounded grains 0.5 to 0.1 mm.; slightly to moderately altered to sericite; albite twins indistinct.
Sericite 5% Microcrystalline grains; occur intergranularly to other minerals; also in masses as an alteration product.
Chert 2% Subrounded grains of cryptocrystalline material 1.0 to 0.1 mm.
Biotite Tr. Xenoblastic grains 0.01 mm.; contained within quartz grains.
Muscovite Tr. Shredlike xenoblastic grains 0.05 mm. to microcrystalline; occur intergranularly.
Chlorite Tr. Microcrystalline shredlike grains; occur intergranularly.
Leucoxene Tr.
Magnetite Tr.

Fabric: Sedimentary, detrital, well-sorted, fine-grained; to metamorphic, granoblastic, non-porphyroblastic, fine-grained.
Probable rock: Quartzite.

Shell Oil Corp.	Montrose County	CL-182
#1 Wray Mesa Unit	47N-19W, sec 21	MT-7-1
	(NMPM)	Core chip
		11266 ft.

Plagioclase 40% Oligoclase to andesine; euhedral to subhedral grains 6.5 to 0.1 mm.; strongly altered to sericite; albite and Carlsbad twins; weakly zoned.
Quartz 30% Anhedral grains 5.5 to 0.05 mm.; moderately strained and fractured; grain borders slightly sutured; poikilitically enclose plagioclase; micrographic intergrowths at some contacts with orthoclase.
Orthoclase 20% Subhedral to anhedral grains 10.5 to 0.1 mm.; no polysynthetic twins; Carlsbad twins; microperthitic; poikilitically enclose quartz and plagioclase.
Muscovite 5% Subhedral to anhedral grains 1.5 to 0.05 mm.; alteration product of original biotite grains.
Sericite 3% Masses and veinlets of microcrystalline grains; also associated with muscovite in altered biotite.
Leucoxene 1% Anhedral grains and masses 0.5 mm. to microcrystalline; alteration product of sphene.
Calcite 1% Euhedral to anhedral grains and masses 0.2 to 0.05 mm.; alteration product of plagioclase.
Chlorite Tr.
Sphene Tr.
Apatite Tr.
Pyrite Tr.

Fabric: Holocrystalline, inequigranular-seriate, coarse-grained.
Probable rock: Quartz monzonite.

Shell Oil Corp.	Montrose County	CL-182
#1 Wray Mesa Unit	47N-19W, sec 21	MT-7-2
	(NMPM)	Core chip
		11266 ft.

Plagioclase 55% Oligoclase to andesine; euhedral to subhedral grains 11.0 to 0.1 mm.; strongly altered to sericite; albite, pericline, and Carlsbad twins; albite rims.
Quartz 20% Anhedral grains 8.0 to 0.1 mm.; moderately to strongly strained and fractured; sutured borders; micrographic intergrowths at some contacts with orthoclase; poikilitically enclose plagioclase.
Orthoclase 15% Subhedral to anhedral grains 11.0 to 0.05 mm.; no polysynthetic twins; Carlsbad twins; microperthitic; poikiliti-

cally enclose quartz and plagioclase.
Muscovite 5% Subhedral to anhedral grains 2.0 to 0.05 mm.; alteration product of original biotite grains.
Sericite 3% Masses and veinlets of microcrystalline grains; also associated with muscovite in altered biotite.
Leucoxene 1% Anhedral grains and masses 1.0 mm. to microcrystalline; alteration product of sphene.
Calcite 1% Euhedral to anhedral grains and masses 1.0 to 0.05 mm.; alteration product of plagioclase.
Pyrite Tr.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Holocrystalline, inequigranular-seriate, coarse-grained.
Probable rock: Granodiorite to quartz monzonite.

Texaco, Inc.	Montrose County	CL-208
#1 J. L. Stivers	49N-10W, sec 9	MT-8-1
	(NMPM)	Cuttings
		1400-10 ft.

Feldspar 55% Variety not determined; xenoblastic grains 0.05 mm. to microcrystalline; slightly altered to sericite; no twinning apparent.
Quartz 20% Xenoblastic grains 0.5 mm. to microcrystalline; larger elongate grains occur in bands or veinlets; moderately strained; sutured borders; smaller grains occur in microcrystalline aggregate with feldspar.
Biotite 10% Shredlike xenoblastic grains 0.3 mm. to microcrystalline; pleochroic from pale greenish-yellow to dark greenish-brown; preferred orientation.
Epidote 8% Xenoblastic grains 0.05 mm. to microcrystalline; associated with biotite.
Leucoxene 5%
Magnetite 2%

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, very fine-grained.
Probable rock: Epidote-biotite-quartz-feldspar gneiss.

Texaco, Inc. #1 J. L. Stivers	Montrose County 49N-10W, sec 9 (NMPM)	CL-208 MT-8-2 Cuttings 1410-20 ft.

Feldspar 51% Variety not determined; xenoblastic grains 0.05 mm. to microcrystalline; slightly altered to sericite; no twinning apparent.
Quartz 20% Xenoblastic grains 0.1 mm. to microcrystalline; slightly strained; sutured borders; occur in microcrystalline aggregate with feldspar.
Muscovite 10% Shredlike xenoblastic grains 0.1 mm. to microcrystalline.
Biotite 10% Shredlike xenoblastic grains 0.2 mm. to microcrystalline; pleochroic from pale greenish-yellow to dark greenish-brown; preferred orientation.
Epidote 5% Xenoblastic grains 0.05 mm. to microcrystalline; associated with biotite.
Leucoxene 3%
Magnetite 1%

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, very fine-grained.
Probable rock: Biotite-muscovite-quartz-feldspar gneiss.

Anderson-Pritchard Oil Corp. #1 Blanchard	Morgan County 6N-55W, sec 11	CL-107 MG-1-1 Cuttings 8194 ft.

Microcline 45% Anhedral grains 3.0 to 0.2 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikilitically enclose quartz, plagioclase, biotite and apatite.
Plagioclase 30% Oligoclase; euhedral to anhedral grains 4.0 to 0.1 mm.; moderately to severely altered to sericite; albite and Carlsbad twins; zoned.
Quartz 15% Anhedral grains 2.0 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured and granulated.
Biotite 10% Euhedral to anhedral grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-green to dark brownish-green; slightly to moderately altered to chlorite; weak preferred orientation.
Muscovite Tr. Shredlike anhedral grains 0.2 to 0.05 mm.; associated with biotite.
Epidote Tr. Anhedral grains 0.5 to 0.01 mm.; associated with biotite.
Sphene Tr.
Apatite Tr.

Magnetite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Quartz monzonite.

Superior Oil Co.	Morgan County	CL-108
#45-32 Weiss	3N-55W, sec 32	MG-2-1
		Cuttings
		8450 ft.

Plagioclase 60% Oligoclase; idioblastic to xenoblastic grains 3.0 to 0.1 mm.; moderately to strongly altered to sericite; albite and pericline twins; weakly zoned; myrmekitic.
Quartz 25% Xenoblastic grains 2.0 to 0.01 mm.; strongly strained and fractured; grain borders sutured and granulated.
Microcline 10% Xenoblastic grains 1.5 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase.
Muscovite 5% Shredlike xenoblastic grains 0.5 to 0.01 mm.
Biotite Tr. Xenoblastic grains 0.1 to 0.05 mm.; associated with muscovite.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Muscovite-microcline-quartz-plagioclase gneiss.

Carter Oil Co.	Otero County	CL-109
#1 Exploration	26S-57W, sec 30	OT-1-1
(Colo. Strat. Hole)		Cuttings
		4215-20 ft.

Variety #1, fragments make up 60% of thin section.

Glass 50% Opaque yellow to brown masses 0.2 mm. to submicroscopic; devitrified.
Sericite 30% Microcrystalline grains; alteration product.
Orthoclase 10% Microcrystalline anhedral grains.
Quartz 5% Anhedral grains and fragments 0.5 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders.
Chlorite 5% Anhedral masses 0.5 mm. to microcrystalline; alteration product.
Zircon Tr.
Magnetite Tr.

Hematite Tr.

Fabric: Pyroclastic, merocrystalline, fine-grained.
Probable rock: Rhyolitic crystal vitric tuff.

Variety #2, fragments make up 40% of thin section.

Plagioclase 75% Oligoclase to andesine; lathlike subhedral grains 0.5 to 0.01 mm.; moderately altered to sericite; indistinct albite twins.
Magnetite 10% Subhedral grains 0.01 mm. to microcrystalline.
Sericite 5% Microcrystalline grains; alteration product of plagioclase.
Leucoxene 5% Opaque anhedral masses 0.1 to less than 0.01 mm.
Chlorite 5% Irregularly-shaped anhedral grains 0.5 to 0.01 mm.; alteration product.
Calcite Tr. Anhedral masses 0.3 to 0.1 mm.

Fabric: Holocrystalline, aphanitic-granular, non-porphyritic, trachytic, fine-grained.
Probable rock: Andesite.

Carter Oil Co.	Otero County	CL-109
#1 Exploration	26S-57W, sec 30	OT-1-2
(Colo. Strat. Hole)		Cuttings
		4185-4220 ft.
		(mostly 4205-20 ft.)

Glass 52% Opaque yellow to green masses 1.0 mm. to submicroscopic; devitrified.
Sericite 15% Microcrystalline grains; alteration product.
Orthoclase 12% Microcrystalline anhedral grains.
Plagioclase 10% Oligoclase to andesine; lathlike subhedral grains 1.0 to 0.01 mm.; severely altered to sericite; albite twins obscured.
Quartz 5% Anhedral grains 1.0 mm. to microcrystalline; slightly strained, sutured borders.
Chlorite 5% Anhedral masses 1.0 mm. to microcrystalline; alteration product.
Calcite 1% Euhedral to anhedral grains and masses 1.0 to 0.05 mm.
Magnetite Tr.
Leucoxene Tr.

Fabric: Pyroclastic, merocrystalline, fine-grained.
Probable rock: Latitic crystal vitric tuff.

Pure Oil Co. #1 Craighead	Otero County 25S-56W, sec 24	CL-110 OT-2-1 Cuttings 6877 ft.

Plagioclase 51% Andesine; idioblastic to xenoblastic grains 3.5 to 0.1 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins.
Hornblende 30% Idioblastic to xenoblastic grains 1.0 to 0.01 mm.; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose quartz and apatite; preferred orientation.
Tremolite 7% Elongate idioblastic to xenoblastic grains 0.5 to 0.01 mm.; colorless; associated with hornblende; preferred orientation.
Garnet 5% Xenoblastic grains 0.5 to 0.05 mm.; isotropic; pale pink color; strongly fractured.
Biotite 3% Elongate idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale greenish-brown to dark greenish-brown; moderately altered to chlorite; preferred orientation.
Magnetite 2% Xenoblastic grains 0.5 to 0.01 mm.
Apatite 2%
Quartz Tr. Xenoblastic grains 0.2 to 0.05 mm.; slightly to moderately strained; occur interstitially to plagioclase and hornblende.
Epidote Tr.
Tourmaline Tr.
Pyrite Tr.

Fabric: Gneissose, nematoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Garnet-bearing tremolite-hornblende-plagioclase gneiss.

Vaughey and Vaughey #1 W. S. Sidney	Otero County 24S-59W, sec 3	CL-111 OT-3-1 Cuttings 6573 ft.

Microcline 57% Xenoblastic grains 3.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase and quartz.
Quartz 30% Xenoblastic grains 3.5 to 0.05 mm.; moderately to strongly strained and fractured; grain borders slightly sutured.
Plagioclase 10% Oligoclase; xenoblastic grains 4.5 to 0.1 mm.; slightly to strongly altered to sericite; albite and pericline twins; albite rims.

Magnetite 2%
Calcite 1%
Biotite Tr.
Muscovite Tr.

Fabric: Granoblastic, non-porphyroblastic, medium-grained.
Probable rock: Plagioclase-quartz-microcline gneiss.

Intex Oil Co.	Ouray County	CL-201
South Penn Oil Co.	45N-8W, sec 35	OU-1-1
#1 D. Halls	(NMPM)	Cuttings
		2365-70 ft.

Phenocrysts: 35% of thin section.

Plagioclase 60% Oligoclase; euhedral grains 2.5 to 0.2 mm.; moderately to severely altered to sericite; albite, Carlsbad, and pericline twins.
Quartz 25% Corroded euhedral grains 1.5 to 0.2 mm.; unstrained; thin reaction rims with the groundmass.
Chlorite 6% Pennine; anhedral masses 2.0 to 0.1 mm.; alteration product of original biotite or hornblende phenocrysts.
Epidote 3% Anhedral aggregates of radiating needlelike grains 0.2 to 0.05 mm.; associated with chlorite.
Magnetite 3% Euhedral grains 0.2 to 0.05 mm.
Sericite 2% Anhedral masses 0.2 mm. to microcrystalline; associated with chlorite.
Sphene 1% Euhedral to anhedral grains 0.2 to 0.05 mm.; slightly altered to leucoxene.
Pyrite Tr.

Groundmass: 65% of thin section.

Orthoclase 75% Anhedral grains 0.05 mm. to microcrystalline; slightly altered to sericite;
Quartz 25% Anhedral grains 0.05 mm. to microcrystalline; occur with orthoclase.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric, fine-grained.
Probable rock: Quartz latite porphyry.

Intex Oil Co.	Ouray County	CL-201
South Penn Oil Co.	45N-8W, sec 35	OU-1-2
#1 D. Halls	(NMPM)	Cuttings
		2370-75 ft.

Phenocrysts: 40% of thin section.

Plagioclase 40% Oligoclase; euhedral grains 2.5 to 0.3 mm.; moderately to severely altered to sericite; albite, Carlsbad, and pericline twins.
Chlorite 25% Pennine; anhedral masses 2.0 to 0.1 mm.; alteration product of original biotite or hornblende phenocrysts.
Quartz 15% Corroded euhedral grains 1.0 to 0.1 mm.; unstrained; thin reaction rims with groundmass.
Magnetite 8% Euhedral to anhedral grains 1.0 to 0.05 mm.
Epidote 5% Anhedral aggregates of radiating needlelike grains 0.3 to 0.01 mm.; associated with chlorite.
Sericite 5% Anhedral masses 0.5 mm. to microcrystalline; associated with chlorite.
Sphene 2% Euhedral to anhedral grains 0.3 to 0.05 mm.; slightly altered to leucoxene.
Pyrite Tr.

Groundmass: 60% of thin section.

Orthoclase 80% Anhedral grains 0.05 mm. to microcrystalline; slightly altered to sericite.
Quartz 20% Anhedral grains 0.05 mm. to microcrystalline; occur with orthoclase.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric, fine-grained.
Probable rock: Quartz latite porphyry.

Intex Oil Co.	Ouray County	CL-201
South Penn Oil Co.	45N-8W, sec 35	OU-1-3
#1 D. Halls	(NMPM)	Cuttings
		2374-82 ft.

Phenocrysts: 35% of thin section.

Plagioclase 70% Oligoclase; euhedral grains 2.0 to 0.3 mm.; moderately to severely altered to sericite; indistinct albite, pericline, and Carlsbad twins.
Chlorite 10% Pennine; anhedral masses 1.0 to 0.1 mm.; alteration product of original biotite or hornblende phenocrysts.
Epidote 7% Anhedral aggregates of radiating needlelike grains 0.2 to 0.01 mm.; associated with chlorite.
Quartz 5% Corroded euhedral grains 1.0 to 0.1 mm.; unstrained; thin reaction rims with groundmass.
Magnetite 5% Euhedral to anhedral grains 0.2 to 0.05 mm.
Sericite 2% Anhedral masses 0.2 mm. to microcrystalline; associated with chlorite.
Apatite 1%
Sphene Tr.
Pyrite Tr.

Groundmass: 65% of thin section.

Orthoclase 80% Anhedral grains 0.05 mm. to microcrystalline; slightly altered to sericite.
Quartz 20% Anhedral grains 0.05 mm. to microcrystalline; occur with orthoclase.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric, fine-grained.
Probable rock: Quartz latite porphyry.

McDannald Oil Co.	Park County	CL-113
#1 State	12S-74W, sec 20	PA-2-1
		Cuttings
		5760-70 ft.

Variety #1, fragments make up 50% of thin section.

Hornblende 57% Corroded idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; poikiloblastically enclose quartz, magnetite, and apatite; preferred orientation.
Plagioclase 40% Andesine; xenoblastic grains 0.5 to 0.1 mm.; moderately to strongly altered to sericite; indistinct albite and pericline twins.

Quartz 2% Xenoblastic grains 0.1 to 0.01 mm.; slightly strained.
Magnetite 1%
Apatite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Plagioclase-hornblende gneiss.

Variety #2, fragments make up 50% of thin section.

Plagioclase 48% Oligoclase to andesine; xenoblastic grains 4.0 to 0.1 mm.; moderately to strongly altered to sericite; albite and pericline twins.
Quartz 45% Xenoblastic grains 1.0 to 0.05 mm.; slightly to strongly strained and fractured; grain borders sutured; many grains occur in aggregates.
Calcite 5% Xenoblastic grains 0.5 mm. to microcrystalline; occur in fractures and veinlets.
Biotite 2% Xenoblastic grains 0.2 to 0.05 mm.; pleochroic from pale yellowish-green to very dark brownish-green; severely altered to chlorite, muscovite and hematite.
Sphene Tr.
Hematite Tr.

Fabric: Granoblastic, in part cataclastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Quartz-plagioclase gneiss.

McDannald Oil Co.	Park County	CL-113
#1 State	12S-74W, sec 20	PA-2-2
		Cuttings
		5800-10 ft.

Hornblende 50% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; ragged terminations; poikiloblastically enclose quartz, magnetite, and apatite; preferred orientation.
Plagioclase 35% Andesine; xenoblastic grains 0.5 to 0.05 mm.; strongly altered to sericite; albite twins obscured.
Magnetite 10% Xenoblastic grains 0.5 to 0.05 mm.
Quartz 5% Xenoblastic grains 0.3 to 0.01 mm.; slightly strained.
Biotite Tr.
Apatite Tr.
Hematite Tr.
Pyrite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Plagioclase-hornblende gneiss.

McDannald Oil Co.	Park County	CL-113
#1 State	12S-74W, sec 20	PA-2-3
		Cuttings
		6050-60 ft.

Hornblende 50% Xenoblastic grains 2.0 to 0.05 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; ragged terminations; poikiloblastically enclose quartz, magnetite, and apatite; preferred orientation.
Plagioclase 35% Andesine; xenoblastic grains 0.5 to 0.01 mm.; strongly to severely altered to sericite; albite and pericline twins obscured.
Quartz 10% Xenoblastic grains 0.3 to 0.01 mm.; slightly strained.
Magnetite 5% Xenoblastic grains 0.3 to 0.01 mm.
Biotite Tr.
Apatite Tr.
Pyrite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Plagioclase-hornblende gneiss.

McDannald Oil Co.	Park County	CL-113
#1 State	12S-74W, sec 20	PA-2-4
		Cuttings
		6170-80 ft.

Variety #1, fragments make up 65% of thin section.

Biotite 38% Elongate xenoblastic grains 2.0 to 0.01 mm.; pleochroic from pale brown to reddish-brown; slightly altered to chlorite (pennine); preferred orientation.
Quartz 35% Xenoblastic grains 1.0 to 0.01 mm.; strongly strained and fractured; sutured borders.
Plagioclase 25% Andesine; xenoblastic grains 0.5 to 0.05 mm.; moderately to severely altered to sericite; albite and pericline twins obscured.
Magnetite 2% Xenoblastic grains 0.2 to 0.01 mm.
Sphene Tr.
Apatite Tr.

Zircon Tr.
Hematite Tr.

Fabric: Schistose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Plagioclase-quartz-biotite schist.

Variety #2, fragments make up 25% of thin section.

Hornblende 63% Xenoblastic grains 2.0 to 0.01 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; ragged terminations; poikiloblastically enclose quartz, magnetite, and apatite; preferred orientation.
Plagioclase 15% Andesine; xenoblastic grains 0.2 to 0.05 mm.; severely altered to sericite; albite twins indistinct.
Quartz 10% Xenoblastic grains 0.1 to 0.01 mm.; slightly strained.
Magnetite 9% Xenoblastic grains 0.2 to 0.01 mm.
Biotite 2% Elongate xenoblastic grains 0.3 to 0.05 mm.; pleochroic from very pale yellow to reddish-brown; alteration product of hornblende; preferred orientation.
Sphene 1%
Hematite Tr.
Pyrite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Quartz-plagioclase-hornblende schist.

Variety #3, fragments make up 10% of thin section.

Quartz 55% Xenoblastic grains 1.0 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured.
Plagioclase 30% Oligoclase; xenoblastic grains 0.5 to 0.05 mm.; slightly to strongly altered to sericite; albite twins.
Muscovite 15% Elongate xenoblastic grains 0.3 to 0.05 mm.;
Biotite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Muscovite-plagioclase-quartz gneiss.

Shell Oil Co.	Park County	CL-114
#1 Federal	12S-74W, sec 4	PA-3-1
		Cuttings
		433-571 ft.

Sample was separated megascopically into gneissic and granitic fractions. PA-3-1 is gneissic fraction.

Sericite 50% Masses of microcrystalline grains and aggregates; alteration product; also occur in veinlets.
Tremoline-Actinolite 20% Elongate idioblastic to xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale yellowish-green to bluish-green; twinned.
Plagioclase 10% Lathlike xenoblastic grains 0.75 to 0.01 mm.; strongly altered to sericite; albite twins indistinct; associated with sericite masses.
Chlorite 10% Pennine; shredlike xenoblastic grains 0.3 to 0.01 mm.; alteration product of tremolite-actinolite.
Microcline 5% Xenoblastic grains 0.1 to 0.01 mm.
Leucoxene 5% Masses of xenoblastic grains 0.2 mm. to microcrystalline; alteration product of sphene.
Epidote Tr.
Apatite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Chlorite-plagioclase-amphibole-sericite schist. (see description for thin section PA-3-2)

Shell Oil Co.	Park County	CL-114
#1 Federal	12S-74W, sec 4	PA-3-2
		Cuttings
		433-571 ft.

Sample was separated megascopically into gneissic and granitic fractions. PA-3-2 is granitic fraction.

Plagioclase 40% Oligoclase to andesine; xenoblastic grains 1.5 to 0.05 mm.; severely to almost completely altered to sericite; albite twins obscured.
Quartz 25% Xenoblastic grains 1.0 to 0.01 mm.; strongly strained and fractured; borders strongly sutured and granulated.
Microcline 15% Xenoblastic grains 1.0 to 0.01 mm.; indistinct polysynthetic twins; microperthitic; grains broken and granulated.
Sericite 8% Microcrystalline grains in masses and veinlets; alteration product.
Muscovite 7% Elongate xenoblastic grains 0.3 to 0.05 mm.; alteration product of biotite; preferred orientation.
Biotite 3% Elongate idioblastic to xenoblastic grains 0.75 to 0.05

mm.; pleochroic from pale greenish-yellow to dark greenish-brown; preferred orientation; strongly altered to muscovite.
Calcite 2% Xenoblastic grains 0.2 to 0.05 mm.; occur in masses and veinlets.
Leucoxene Tr.
Hematite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

PA-3-1 and PA-3-2: Migmatitic rock with amphibolitic schist layers and biotite-microcline-quartz-plagioclase gneiss layers.

Shell Oil Co.	Park County	CL-115
#1 A. T. McDannald	11S-75W, sec 32	PA-4-1
		Cuttings
		3474-3560 ft.

Sample was separated megascopically into gneissic and granitic fractions. PA-4-1 is gneissic fraction.

Plagioclase 45% Oligoclase to andesine; xenoblastic grains 5.0 to 0.5 mm.; moderately to severely altered to sericite; albite and pericline twins, some are bent.
Quartz 30% Xenoblastic grains 1.0 to 0.1 mm.; strongly strained and fractured; sutured borders.
Biotite 15% Idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellow to dark brown; preferred orientation; grains banked around large grains of plagioclase.
Calcite 5% Xenoblastic grains 1.5 to 0.1 mm.; occur in aggregates.
Magnetite 3% Xenoblastic grains 1.5 to 0.05 mm.; associated with biotite.
Sphene 2% Xenoblastic grains and aggregates 0.1 to 0.05 mm.; moderately to severely altered to leucoxene.
Apatite Tr.
Chlorite Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: (See description for thin section PA-4-2)

Shell Oil Co.
#1 A. T. McDannald

Park County
11S-75W, sec 32

CL-115
PA-4-2
Cuttings
3474-3560 ft.

Sample was separated megascopically into gneissic and granitic fractions. PA-4-2 is granitic fraction.

Variety #1, fragments make up 75% of thin section.

Plagioclase 45% Oligoclase; idioblastic to xenoblastic grains 6.0 to 0.3 mm.; moderately altered to sericite; albite twins bent and distorted; grains bent and fractured.
Quartz 30% Xenoblastic grains 5.0 to 0.05 mm.; severely strained and fractured; borders intricately sutured and granulated.
Microcline 20% Xenoblastic grains 2.5 to 2.0 mm.; microperthitic; poikiloblastically encloses plagioclase and apatite.
Muscovite 5% Shredlike xenoblastic grains 1.0 to 0.05 mm.; bent and distorted.
Apatite Tr.
Hematite Tr.

Fabric: Granoblastic, in part cataclastic, porphyroblastic, coarse-grained.

Variety #2, fragments make up 25% of thin section.

Plagioclase 70% Oligoclase; lathlike idioblastic to xenoblastic grains 1.0 to 0.01 mm.; albite twins; preferred orientation; may be slightly granulated.
Quartz 20% Xenoblastic grains 2.5 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders.
Microcline 10% Xenoblastic grains 2.5 to 1.5 mm.; poikiloblastically enclose plagioclase.
Muscovite Tr. Shredlike xenoblastic grains 0.2 to 0.05 mm.
Rutile (?) Tr. Radiating clusters of needle-like idioblastic crystals 0.1 to 0.01 mm.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock of both thin sections PA-4-1 and PA-4-2 (both varieties):
Biotite-microcline-quartz-plagioclase augen gneiss

Shell Oil Co. Park County CL-116
#1-4343 State 11S-75W, sec 36 PA-5-1
Cuttings
5260-65 ft.

Quartz 80% Xenoblastic grains 0.2 to 0.05 mm.; moderately strained and fractured; sutured borders.
Biotite 10% Elongate idioblastic to xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale green or pale brown to dark brown; preferred orientation.
Muscovite 5% Elongate idioblastic to xenoblastic grains 1.0 to 0.05 mm.; preferred orientation.
Calcite 5% Xenoblastic grains 0.5 mm. to microcrystalline; occur in aggregates and in fractures.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Muscovite-biotite-quartz gneiss.

Shell Oil Co. Park County CL-116
#1-4343 State 11S-75W, sec 36 PA-5-2
Cuttings
5300-05 ft.

Quartz 78% Xenoblastic grains 1.0 to 0.01 mm.; moderately to severely strained and fractured; grain borders sutured and granulated.
Biotite 20% Elongate idioblastic to xenoblastic grains 1.5 to 0.01 mm.; pleochroic from pale yellowish-brown to dark greenish-brown or dark brown; preferred orientation.
Muscovite 2% Shredlike xenoblastic grains 0.5 to 0.05 mm.; associated with biotite; preferred orientation.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-quartz gneiss

Shell Oil Co. Park County CL-116
#1-4343 State 11S-75W, sec 36 PA-5-3
Cuttings
5340-45 ft.

Quartz 50% Xenoblastic grains 1.5 to 0.01 mm.; slightly to moderately strained and fractured; grain borders sutured.
Plagioclase 35% Oligoclase; xenoblastic grains 0.5 to 0.05 mm.; moder-

ately altered to sericite; albite twins indistinct.
Biotite 15% Elongate idioblastic to xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale green to dark greenish-brown or from pale yellow to brown; preferred orientation.
Muscovite Tr.
Calcite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-quartz gneiss.

Texota Oil Co.	Phillips County	CL-183
#1 Hansen	8N-43W, sec 30	PH-1-1
		Cuttings
		5919 ft.

Plagioclase 50% Oligoclase to andesine; euhedral to anhedral grains 3.0 to 0.2 mm.; moderately to strongly altered to sericite; albite, pericline, and Carlsbad twins; myrmekitic.
Quartz 20% Anhedral grains 1.5 to 0.05 mm.; strongly strained and fractured; grain borders sutured.
Biotite 15% Anhedral grains 2.0 to 0.1 mm.; pleochroic from pale yellowish-green to very dark brownish-green; slightly altered to chlorite; poikilitically enclose plagioclase, quartz, magnetite, epidote, apatite, and zircon; weak preferred orientation.
Microcline 10% Anhedral grains 3.5 to 0.5 mm.; distinct polysynthetic twins; microperthitic; poikilitically enclose plagioclase, quartz, and biotite.
Sphene 5% Euhedral to anhedral grains 1.5 to 0.01 mm.; pleochroic from pale brown to light reddish-brown; moderately altered to leucoxene.
Epidote Tr. Euhedral to anhedral grains 0.5 to 0.01 mm.; associated with biotite.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Granodiorite.

Superior Oil Co.	Pitkin County	CL-203
#1 Unit	10S-89W, sec 9	PI-1-1
		Cuttings
		4300-10 ft.

Phenocrysts: 10% of thin section.

Plagioclase 60% Oligoclase; euhedral to subhedral grains 1.5 to 0.5 mm.; slightly altered to sericite; albite, pericline, and Carlsbad twins.
Quartz 35% Euhedral to anhedral grains 1.0 to 0.5 mm.; slightly strained.
Orthoclase 5% Anhedral grains 1.0 to 0.5 mm.; no polysynthetic twins; microperthitic; slightly altered to sericite.

Groundmass: 90% of thin section.

Plagioclase 40% Oligoclase; subhedral to anhedral grains 0.2 to 0.05 mm.; slightly altered to sericite; albite and pericline twins.
Quartz 30% Anhedral grains 0.2 to 0.01 mm.; slightly strained.
Orthoclase 25% Anhedral grains 0.3 to 0.01 mm.; occur interstitially to quartz and plagioclase.
Sphene 3% Anhedral grains 0.2 to 0.05 mm.; slightly altered to leucoxene.
Biotite 2% Shredlike anhedral grains 0.2 to 0.01 mm.; pleochroic from very pale brown to reddish-brown.
Muscovite Tr.
Leucoxene Tr.
Apatite Tr.
Magnetite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, felsophyric, fine-grained.
Probable rock: Quartz latite porphyry

Superior Oil Co.	Pitkin County	CL-203
#1 Unit	10S-89W, sec 9	PI-1-2
		Cuttings
		4350-60 ft.

Phenocrysts: 15% of thin section.

Plagioclase 70% Oligoclase; euhedral to subhedral grains 1.0 to 0.5 mm.; slightly altered to sericite; albite, pericline, and Carlsbad twins.
Orthoclase 25% Subhedral to anhedral grains 1.5 to 0.5 mm.; no polysynthetic twins; microperthitic; slightly altered to sericite.
Quartz 5% Subhedral to anhedral grains 1.0 to 0.5 mm.; slightly strained.

Groundmass: 85% of thin section.

Plagioclase 40% Oligoclase; subhedral to anhedral grains 0.3 to 0.05 mm.; slightly altered to sericite; albite and pericline twins.
Quartz 34% Anhedral grains 0.2 to 0.01 mm.; slightly strained.
Orthoclase 25% Anhedral grains 0.2 to 0.01 mm.; occur interstitially to quartz and plagioclase.
Calcite 1%
Muscovite Tr.
Sphene Tr.
Leucoxene Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, felsophyric, fine-grained.
Probable rock: Quartz latite porphyry

Superior Oil Co.	Pitkin County	CL-203
#1 Unit	10S-89W, sec 9	PI-1-3
		Cuttings
		4400-10 ft.

Phenocrysts: 15% of thin section.

Orthoclase 50% Subhedral to anhedral grains 1.5 to 0.5 mm.; no polysynthetic twins; microperthitic; slightly altered to sericite.
Plagioclase 40% Oligoclase; euhedral to subhedral grains 2.0 to 0.5 mm.; alightly altered to sericite; albite, pericline, and Carlsbad twins.
Quartz 10% Euhedral to subhedral grains 2.0 to 0.5 mm.; slightly strained and fractured.

Groundmass: 85% of thin section.

Plagioclase 45% Oligoclase; subhedral to anhedral grains 0.3 to 0.05 mm.; slightly altered to sericite; albite and pericline twins.
Quartz 30% Anhedral grains 0.3 to 0.01 mm.; slightly strained.
Orthoclase 21% Anhedral grains 0.2 to 0.01 mm.; occur interstitially with quartz and plagioclase.
Calcite 2%
Biotite 1%
Muscovite 1%
Sphene Tr.
Beryl (?) Tr.
Magnetite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, felsophyric, fine-grained.
Probable rock: Quartz latite porphyry.

Ohio Oil Co.	Prowers County	CL-118
#1 Eldridge	27-46W, sec 25	PR-1-1
		Cuttings
		6471 ft.

Phenocrysts: 10% of thin section.

Biotite 74% Tabular euhedral crystals 1.0 to 0.2 mm.; pleochroic from light brown to dark brown; poikilitically enclose diopside.
Augite 20% Euhedral to subhedral crystals 1.0 to 0.2 mm.; fractured.
Apatite 4% Subhedral grains 0.3 to 0.2 mm.
Talc (?) 1% Masses 1.0 to 0.5 mm. formed as alteration product of olivine; some magnetite included.
Magnetite 1% Euhedral to anhedral crystals 1.0 to 0.1 mm.

Groundmass: 90% of thin section

Plagioclase 50% Variety undetermined; subhedral to anhedral lathlike grains 0.3 to microcrystalline; moderately to strongly altered to sericite; albite twins indistinct.
Biotite 20% Elongate euhedral to subhedral crystals 0.1 mm. to microcrystalline.
Calcite 10% Anhedral masses 0.3 to 0.05 mm.
Magnetite 10% Euhedral crystals 0.01 mm. to microcrystalline.
Apatite 5%
Crystallites 5% Bundles of radiating microcrystalline needles; probably rutile or apatite.
Quartz Tr. Anhedral grains 0.5 to 0.1 mm.; moderately strained; sutured borders; occurs in veinlet.

Fabric: Holocrystalline, inequigranular-porphyritic, lamprophyric, fine-grained.
Probable rock: Plagioclase-bearing biotite lamprophyre. (Kersantite)

Phillips Petroleum Co.	Prowers County	CL-119
#1 Stwalley	24S-43W, sec 4	PR-2-1
		Core chip
		6417-27 ft.

Sericite 40% Microcrystalline grains in xenoblastic masses 1.0 to 0.1 mm.; alteration product of plagioclase.
Quartz 30% Xenoblastic grains 0.75 to 0.01 mm.; slightly to moderately strained and fractured; sutured borders.
Microcline 15% Idioblastic to xenoblastic grains 0.3 to 0.05 mm.; indistinct polysynthetic twins.
Plagioclase 5% Variety not determined; xenoblastic grains 0.3 to 0.05 mm.; strongly to severely altered to sericite; albite twins absent or indistinct.
Muscovite 5% Shredlike xenoblastic grains 1.0 to 0.05 mm.; associated with biotite as an alteration product.
Biotite 3% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellow to greenish-brown; weak preferred orientation.
Magnetite 2%
Epidote Tr.
Leucoxene Tr.
Apatite Tr.
Hematite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Altered muscovite-microcline-quartz-plagioclase gneiss.

Charles A. Wallace	Prowers County	CL-121
#1 Witte	24S-44W, sec 12	PR-4-1
		Cuttings
		6570-75 ft.

Variety #1, fragments make up 90% of thin section.

Plagioclase 38% Oligoclase to andesine; zoned euhedral to subhedral crystals 1.5 to 0.2 mm.; moderately altered to sericite; albite, pericline, and Carlsbad twins; myrmekitic.
Quartz 30% Anhedral grains 1.5 to 0.05 mm.; moderately strained and fractured.
Microcline 25% Anhedral grains 1.0 to 0.1 mm.; microperthitic; poikilitically enclose quartz and plagioclase.
Muscovite 5% Anhedral grains 1.0 to 0.1 mm.
Biotite 2% Subhedral to anhedral grains 0.5 to 0.05 mm.; pleochroic from pale brown to dark greenish-brown; strongly to severely altered to chlorite.
Sphene Tr.
Leucoxene Tr.
Apatite Tr.

Magnetite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, fine-grained.
Probable rock: Quartz monzonite.

Variety #2, fragments make up 10% of thin section.

Hornblende 40% Idioblastic to xenoblastic grains 1.0 to 0.3 mm.; pleochroic from pale yellowish-green to bluish-green; poikiloblastically enclose apatite, biotite, magnetite, and sphene.
Plagioclase 37% Andesine to labradorite; xenoblastic grains 1.5 to 0.1 mm.; severely altered to sericite; albite twins obscured.
Biotite 10% Idioblastic to xenoblastic grains 1.0 to 0.2 mm.; pleochroic from pale yellow to greenish-brown; severely to completely altered to chlorite.
Epidote 5% Xenoblastic grains 0.5 to 0.05 mm.; associated with hornblende and altered biotite.
Magnetite 5% Xenoblastic grains 0.5 to 0.01 mm.
Apatite 3%
Sphene Tr. Xenoblastic grains 0.05 to 0.01 mm.; associated with magnetite.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-hornblende gneiss (Amphibolite).

Charles A. Wallace	Prowers County	CL-121
#1 Witte	24S-44W, sec 12	PR-4-2
		Cuttings
		6510-20 ft.

Plagioclase 45% Andesine to labradorite; zoned idioblastic to xenoblastic grains 2.0 to 0.2 mm.; severely altered to sericite; albite and Carlsbad twins.
Hornblende 40% Corroded idioblastic to xenoblastic grains 3.5 to 0.3 mm.; pleochroic from pale yellowish-green to brownish-green or bluish-green; poikiloblastically enclose plagioclase, biotite, apatite, and magnetite; some grains twinned.
Epidote 7% Xenoblastic grains 1.0 to 0.01 mm.; associated with hornblende and plagioclase.
Apatite 4%
Biotite 3% Idioblastic to xenoblastic grains 1.0 to 0.3 mm.; pleochroic from pale brown to dark greenish-brown; formed from hornblende; strongly altered to chlorite.
Magnetite 1%
Sphene Tr.

Calcite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, medium-grained.
Probable rock: Hornblende-plagioclase gneiss (amphibolite).

Charles A. Wallace	Prowers County	CL-121
#1 Witte	24S-44W, sec 12	PR-4-3
		Cuttings
		6540-45 ft.

Variety #1, fragments make up 80% of thin section.

Hornblende 45% Corroded idioblastic to xenoblastic grains 3.5 to 0.2 mm.; pleochroic from pale yellowish-green to brownish-green or bluish-green; poikiloblastically enclose plagioclase, biotite, apatite, and magnetite; some grains twinned.
Plagioclase 40% Andesine to labradorite; xenoblastic grains 3.5 to 0.1 mm.; severely to completely altered to sericite; albite twins obscured.
Epidote 10% Xenoblastic grains 0.5 to 0.01 mm.; associated with hornblende and plagioclase.
Apatite 3%
Magnetite 2%
Chlorite Tr. Idioblastic to xenoblastic grains 1.0 to 0.1 mm.; alteration product of biotite.
Quartz Tr. Xenoblastic grains 0.1 to 0.05 mm.
Sphene Tr.

Fabric: Schistose, nematoblastic, nonporphyroblastic, medium-grained.
Probable rock: Plagioclase-hornblende gneiss (amphibolite).

Variety #2, fragments make up 20% of thin section.

Plagioclase 35% Oligoclase to andesine; zoned subhedral to anhedral grains 1.0 to 0.2 mm.; moderately to strongly altered to sericite; albite, pericline, and Carlsbad twins; myrmekitic.
Quartz 30% Anhedral grains 1.0 to 0.1 mm.; slightly to strongly strained and fractured; sutured borders.
Microcline 25% Anhedral grains 1.0 to 0.1 mm.; poikilitically enclose quartz and plagioclase.
Muscovite 10% Shredlike anhedral grains 1.5 to 0.05 mm.
Biotite Tr. Anhedral grains 0.2 to 0.05 mm.; pleochroic from pale brown to dark green; severely altered to chlorite.
Apatite Tr.
Hematite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, fine-grained.
Probable rock: Quartz monzonite.

Continental Oil Co.	Pueblo County	CL-123
#1 Paige	18S-64W, sec 6	PB-2-1
		Core chip
		6929-32 ft.

Sericite 45% Masses of microcrystalline grains 11.0 to 0.01 mm.; alteration product of original idioblastic to xenoblastic grains of plagioclase.
Quartz 35% Elongate xenoblastic grains 3.5 to 0.1 mm.; severely strained and fractured; sutured grain borders; contain minute crystallites of rutile.
Calcite 11% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; occur in masses and veinlets as an alteration product.
Muscovite 5% Shredlike xenoblastic grains 1.5 to 0.05 mm.; alteration product of biotite; preferred orientation.
Chlorite 3% Xenoblastic grains 1.0 to 0.01 mm.; alteration product of biotite; associated with muscovite.
Hematite 1%
Biotite Tr. Xenoblastic grains 0.75 to 0.05 mm.; pleochroic from pale brownish-green to dark brownish-green; preferred orientation; strongly altered.
Sphene Tr. Xenoblastic grains 0.05 to 0.01 mm.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, coarse-grained.
Probable rock: Strongly altered biotite-quartz-plagioclase gneiss.

Continental Oil Co.	Pueblo County	CL-125
#1 Young	19S-65W, sec 11	PB-4-1
		Cuttings
		6070-75 ft.

Plagioclase 40% Oligoclase; xenoblastic grains 1.0 to 0.1 mm.; severely altered to sericite; albite twins obscured or absent.
Biotite 33% Elongate idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale brown to greenish-brown; strongly altered to chlorite; preferred orientation.

Quartz 25% Xenoblastic grains 0.5 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders; some grains contain microcrystalline needles of rutile.
Microcline 2% Xenoblastic grains 1.0 to 0.3 mm.; distinct polysynthetic twins.
Leucoxene Tr.
Apatite Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Quartz-biotite-plagioclase gneiss.

Continental Oil Co.	Pueblo County	CL-125
#1 Young	19S-65W, sec 11	PB-4-2
		Cuttings
		6080-85 ft.

Microcline 41% Xenoblastic grains 4.5 to 0.5 mm.; distinct polysynthetic twins; perthitic; poikiloblastically enclose quartz, biotite, and zircon.
Quartz 35% Xenoblastic grains 2.5 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured; contain microcrystalline needles of rutile.
Plagioclase 20% Oligoclase; xenoblastic grains 2.0 to 0.2 mm.; severely to completely altered to sericite.
Calcite 3% Xenoblastic grains 1.0 mm. to microcrystalline; occurs in aggregates and veinlets.
Biotite 1% Xenoblastic grains 1.0 to 0.1 mm.; pleochroic from pale greenish-yellow to greenish-brown; severely to completely altered to chlorite.
Epidote Tr.
Zircon Tr.

Fabric: Granoblastic, porphyroblastic, medium-grained.
Probable rock: Plagioclase-quartz-microcline gneiss

Continental Oil Co.	Pueblo County	CL-125
#1 Young	19S-65W, sec 11	PB-4-3
		Cuttings
		6090-95 ft.

Plagioclase 35% Oligoclase; xenoblastic grains 4.0 to 0.2 mm.; severely to completely altered to sericite.

Quartz 30% Xenoblastic grains 1.0 to 0.05 mm.; moderately strained and fractured; sutured borders; contain microcrystalline needles of rutile.
Microcline 15% Xenoblastic grains 4.0 to 0.2 mm.; distinct polysynthetic twins; perthitic; poikiloblastically enclose quartz.
Biotite 10% Xenoblastic grains 2.5 to 0.05 mm.; pleochroic from pale greenish-yellow to dark greenish-brown; moderately altered to chlorite; preferred orientation.
Sericite 10% Xenoblastic masses 0.5 mm. to microcrystalline; associated with plagioclase.
Epidote Tr.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, medium-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Pan American	Pueblo County	CL-129
Petroleum Co.	20S-67W, sec 4	PB-8-1
#1 Ingram		3 Core chips
		4494-95 ft.

Microcline 44% Xenoblastic grains 10.0 to 0.5 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose quartz and plagioclase.
Plagioclase 42% Oligoclase to andesine; idioblastic to xenoblastic grains 7.0 to 1.0 mm.; severely to completely altered to sericite; albite and pericline twins obscured.
Magnetite 10% Xenoblastic masses and grains 6.0 to 0.05 mm.; occur interstitially to microcline and plagioclase.
Quartz 3% Xenoblastic grains 1.5 to 0.05 mm.; moderately to strongly strained and fractured; contain microcrystalline needles of rutile.
Muscovite 1% Xenoblastic grains 1.0 to 0.1 mm.; associated with magnetite.
Biotite Tr. Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellow to brown; strongly altered to chlorite.
Epidote Tr.
Zircon Tr.
Hematite Tr.

Fabric: Granoblastic, porphyroblastic, coarse-grained.
Probable rock: Magnetite-bearing plagioclase-microcline gneiss.

Pan American Petroleum Co. #1 Ingram	Pueblo County 20S-67W, sec 4	CL-129 PB-8-2 2 Core chips 4495-96 ft.

Microcline 44% Xenoblastic grains 4.5 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz, plagioclase, and biotite.
Quartz 30% Xenoblastic grains 1.0 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders; contain microcrystalline needles of rutile.
Plagioclase 20% Oligoclase to andesine; xenoblastic grains 2.0 to 0.1 mm.; severely to completely altered to sericite.
Biotite 5% Elongate xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellow to dark greenish-brown; severely to completely altered to chlorite (pennine); preferred orientation.
Muscovite 1% Shredlike xenoblastic grains 1.0 to 0.05 mm.; associated with biotite; preferred orientation.
Epidote Tr.
Leucoxene Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-plagioclase-quartz-microcline gneiss.

Pan American Petroleum Co. #1 Ingram	Pueblo County 20S-67W, sec 4	CL-129 PB-8-3 3 Core chips 4496-97 ft.

Quartz 49% Xenoblastic grains 1.5 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders; contain microcrystalline needles of rutile.
Biotite 30% Elongate idioblastic to xenoblastic grains 2.5 to 0.05 mm.; pleochroic from pale yellow to brown; moderately altered to chlorite and sericite; preferred orientation.
Plagioclase 15% Variety not determined; xenoblastic grains 6.0 to 1.0 mm.; severely to completely altered to sericite; albite twins ob-

scured.
Magnetite 5% Idioblastic to xenoblastic grains 1.5 to 0.05 mm.; associated with biotite.
Muscovite 1% Shredlike xenoblastic grains 0.5 to 0.05 mm.; associated with biotite; preferred orientation.
Epidote Tr.
Zircon Tr.
Hematite Tr.
Calcite Tr.

Fabric: Schistose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Magnetite-bearing plagioclase-biotite-quartz gneiss.

Phillips Petroleum Co.	Pueblo County	CL-130
#1 Sample Nose-Government	25S-64W, sec 9	PB-9-1
(#1 J. Brann)		Core chip
		2290-93 ft.

Plagioclase 50% Oligoclase; xenoblastic grains 6.0 to 0.05 mm.; moderately to severely altered to sericite; indistinct albite twins; myrmekitic; poikiloblastically enclose quartz; smaller grains occur interstitially.
Quartz 30% Xenoblastic grains 9.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated; poikiloblastically enclose plagioclase and microcline; contain microcrystalline needles of rutile.
Microcline 15% Xenoblastic grains 3.5 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase; smaller grains occur interstitially and in aggregates.
Magnetite 3% Xenoblastic grains 0.1 to 0.01 mm.
Biotite 2% Xenoblastic grains 0.5 to 0.1 mm.; pleochroic from pale yellow to brown; slightly altered to chlorite; weak preferred orientation.
Muscovite Tr. Xenoblastic grains 1.0 to 0.05 mm.; associated with biotite.
Sphene Tr.
Zircon Tr.
Hematite Tr.

Fabric: Granoblastic, porphyroblastic, medium- to coarse-grained, slightly cataclastic.
Probable rock: Microcline-quartz-plagioclase gneiss.

Phillips Petroleum Co.	Pueblo County	CL-131
#1-A Johnson	24S-61W, sec 25	PB-10-1
		2 Core chips
		5136-38 ft.

Plagioclase 45% Oligoclase; xenoblastic grains 1.5 to 0.05 mm.; slightly to moderately altered to sericite; albite and pericline twins indistinct; poikiloblastically enclose quartz and apatite; myrmekitic.
Quartz 25% Xenoblastic grains 1.5 to 0.01 mm.; moderately strained and fractured; sutured borders.
Microcline 15% Xenoblastic grains 2.5 to 0.01 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz and plagioclase; smaller grains occur interstitially.
Biotite 15% Idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale greenish-yellow to very dark brownish-green; strongly altered to chlorite.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Phillips Petroleum Co.	Pueblo County	CL-131
#1-A Johnson	24S-61W, sec 25	PB-10-2
		2 Core chips
		5140-42 ft.

Microcline 40% Xenoblastic grains 3.0 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz and plagioclase smaller grains occur interstitially.
Plagioclase 30% Oligoclase; xenoblastic grains 6.0 to 0.1 mm.; moderately altered to sericite; albite and pericline twins; albite rims; myrmekitic.
Quartz 30% Xenoblastic grains 1.5 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders.
Biotite Tr. Xenoblastic grains 0.3 to 0.05 mm.; pleochroic from pale greenish-yellow to dark brownish-green; strongly altered to chlorite; weak preferred orientation.
Sphene Tr.
Apatite Tr.

Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Quartz-plagioclase-microcline gneiss.

Phillips Petroleum Co.	Pueblo County	CL-131
#1-A Johnson	24S-61W, sec 25	PB-10-3
		Core chip
		5142-44 ft.

Microcline 58% Xenoblastic grains 1.5 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz; smaller grains occur interstitially.
Quartz 30% Xenoblastic grains 3.5 to 0.05 mm.; moderately strained and fractured; grain borders sutured.
Plagioclase 10% Oligoclase; xenoblastic grains 3.0 to 0.2 mm.; slightly altered to sericite; albite and Carlsbad twins; albite rims; myrmekitic.
Biotite 2% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellowish-green to dark brownish-green; moderately altered to chlorite.
Garnet Tr. Xenoblastic grains 0.5 to 0.2 mm.; isotropic; pale pink color; fractured.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic, non-porphyroblastic, medium-grained.
Probable rock: Plagioclase-quartz-microcline gneiss.

Pure Oil Co.	Pueblo County	CL-132
#1 E. K. Warren	23S-68W, sec 13	PB-11-1
		2 Core chips
		3884-87 ft.

Plagioclase 55% Oligoclase to andesine; xenoblastic grains 1.5 to 0.05 mm.; slightly altered to sericite; albite and pericline twins.
Quartz 25% Xenoblastic grains 2.0 to 0.01 mm.; strongly strained and fractured; grain borders sutured and granulated.

Hornblende 12% Corroded xenoblastic grains 0.5 to 0.01 mm.; ragged terminations; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose quartz, sphene and magnetite.
Magnetite 6% Xenoblastic grains 0.5 to 0.05 mm.
Sphene 2% Xenoblastic grains 0.1 to 0.01 mm.; associated with magnetite; slightly altered to leucoxene.
Biotite Tr. Xenoblastic grains 0.1 to 0.05 mm.; pleochroic from pale greenish-yellow to greenish-brown; associated with hornblende; moderately altered to chlorite.
Epidote Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, nematoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Magnetite-bearing hornblende-quartz-plagioclase gneiss.

Pure Oil Co.	Pueblo County	CL-132
#1 E. K. Warren	23S-68W, sec 13	PB-11-2
		Core chip
		4147-49 ft.

Plagioclase 55% Oligoclase; xenoblastic grains 3.0 to 0.05 mm.; slightly to moderately altered to sericite; albite and pericline twins; myrmekitic.
Microcline 25% Xenoblastic grains 3.0 to 0.01 mm.; distinct polysynthetic twins; some grains faintly microperthitic; smaller grains occur interstitially.
Quartz 15% Xenoblastic grains 1.5 to 0.01 mm.; strongly strained and fractured; grain borders sutured and granulated; smaller grains occur interstitially with microcline.
Biotite 5% Xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale yellow to dark brown; slightly altered to chlorite; weak preferred orientation.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic, non-porphyroblastic, medium-grained.
Probable rock: Quartz-microcline-plagioclase gneiss.

Pure Oil Co.	Pueblo County	CL-132
#1 E. K. Warren	23S-68W, sec 13	PB-11-2a
		2 Core chips
		4147-49 ft.

Quartz 40% Xenoblastic grains 3.0 to 0.01 mm.; moderately to strongly strained and fractured; grain borders sutured and granulated.
Microcline 30% Xenoblastic grains 3.5 to 0.01 mm.; microperthitic; poikiloblastically enclose quartz, plagioclase, and biotite; smaller grains occur interstitially with quartz.
Plagioclase 25% Oligoclase; xenoblastic grains 2.0 to 0.1 mm.; slightly to moderately altered to sericite; albite and pericline twins; myrmekitic.
Epidote 2% Xenoblastic grains 0.3 to 0.05 mm.; associated with hornblende and biotite.
Hornblende 1% Corroded xenoblastic grains 0.3 to 0.01 mm.; pleochroic from yellowish-green to green.
Biotite 1% Idioblastic to xenoblastic grains 0.3 to 0.05 mm.; pleochroic from pale greenish-yellow to dark greenish-brown; moderately altered to chlorite.
Magnetite 1%
Zircon Tr.
Apatite Tr.
Hematite Tr.

Fabric: Granoblastic, porphyroblastic, medium-grained.
Probable rock: Plagioclase-microcline-quartz gneiss.

Skelly Oil Co.	Pueblo County	CL-196
#1 M. E. Lutin	21S-65W, sec 30	PB-12-1
		Cuttings
		3690-99 ft.

Microcline 59% Xenoblastic grains 2.5 to 0.01 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz and plagioclase.
Plagioclase 25% Oligoclase; xenoblastic grains 0.3 to 0.01 mm.; strongly to severely altered to sericite; indistinct albite twins; myrmekitic; albite rims.
Quartz 15% Xenoblastic grains 0.3 to 0.01 mm.; moderately to severely strained and fractured; grain borders sutured and granulated.
Biotite 1% Xenoblastic grains 0.2 to 0.05 mm.; pleochroic from pale brownish-green to dark brownish-green; severely altered to chlorite.

Leucoxene Tr.
Calcite Tr.
Apatite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic, porphyroblastic, fine- to medium-grained, cataclastic.
Probable rock: Quartz-plagioclase-microcline gneiss.

Skelly Oil Co.	Pueblo County	CL-196
#1 M. E. Lutin	21S-65W, sec 30	PB-12-2
		Cuttings
		3699 ft.

Microcline 65% Xenoblastic grains 0.75 to 0.01 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz and plagioclase.
Quartz 23% Xenoblastic grains 1.0 to 0.01 mm.; moderately to severely strained and fractured; grain borders sutured and granulated.
Plagioclase 10% Oligoclase (?); xenoblastic grains 0.5 to 0.05 mm.; slightly to moderately altered to sericite; albite twins indistinct or obscured; myrmekitic; albite rims.
Biotite 1% Xenoblastic grains 0.3 to 0.05 mm.; pleochroic from pale yellow to brownish-green; strongly altered to chlorite.
Magnetite 1%
Leucoxene Tr.
Zircon Tr.
Hematite Tr.

Fabric: Granoblastic, non-porphyroblastic, fine-grained, cataclastic.
Probable rock: Plagioclase-quartz-microcline gneiss.

Buford Oil Co.	Rio Blanco County	CL-133
#1 Government	1N-91W, sec 16	RB-1-1
		Cuttings
		4500-09 ft.

Calcite 75% Xenoblastic grains 0.2 to 0.01 mm.
Quartz 15% Subangular to subrounded grains 0.3 to 0.01 mm.; slightly to strongly strained; occur in bands and as individual grains surrounded by calcite.
Microcline 10% Subangular grains 0.15 to 0.01 mm.; distinct polysyn-

thetic twins; occur with quartz.
Tourmaline Tr. Rounded grains 0.1 mm.; pleochroic from very pale gray to dark bluish-gray.
Pyrite Tr.
Hematite Tr.

Fabric: Sedimentary, crystalline and detrital, fine-grained.
Probable rock: Sandy crystalline limestone.

Buford Oil Co.	Rio Blanco County	CL-133
#1 Government	1N-91W, sec 16	RB-1-2
		Cuttings
		4512-27 ft.

Calcite 80% Xenoblastic grains 0.3 to 0.01 mm.; faint outlines of oolites 0.75 mm.
Quartz 15% Subangular to subrounded grains 0.75 to 0.01 mm.; slightly to strongly strained; individual grains surrounded by calcite.
Microcline 5% Subangular to subrounded grains 0.15 to 0.01 mm.; distinct polysynthetic twins.
Plagioclase Tr.
Pyrite Tr.

Fabric: Sedimentary, crystalline and detrital, fine-grained.
Probable rock: Sandy crystalline limestone.

Buford Oil Co.	Rio Blanco County	CL-133
#1 Government	1N-91W, sec 16	RB-1-3
		Cuttings
		- - -

Quartz 60% Subrounded grains 1.0 to 0.05 mm.; slightly to moderately strained.
Calcite 40% Anhedral grains 0.2 to 0.05 mm.; fill interstices between quartz grains.
Apatite Tr. Euhedral crystals 0.01 mm.; included within quartz.

Fabric: Sedimentary, detrital and crystalline, fine-grained.
Probable rock: Calcite-cemented sandstone, or sandy crystalline limestone.

Humble Oil and Refining Co. #1 Government-Crosho Lake	Rio Blanco County 2N-87W, sec 13	CL-202 RB-7-1 Core Chip 9081-9106 ft.

Microcline 35% Xenoblastic grains 3.0 to 0.01 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz and plagioclase; smaller grains occur in bands.
Plagioclase 30% Oligoclase; xenoblastic grains 3.0 to 0.01 mm.; strongly to severely altered to sericite; albite and Carlsbad twins obscured.
Quartz 25% Xenoblastic grains 0.5 to 0.01 mm.; slightly strained and fractured; grain borders slightly sutured; grains occur in elongate aggregates; smaller grains occur in bands with microcline.
Biotite 9% Shredlike xenoblastic grains 0.5 to 0.05 mm.; completely altered to muscovite, sericite, chlorite, and hematite.
Magnetite 1% Xenoblastic grains 1.0 to 0.01 mm.; moderately altered to hematite.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.

Fabric: Granoblastic, non-porphyroblastic, cataclastic, fine-grained.
Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

Broderick and Gordon #1 Government	Routt County 7N-86W, sec 18	CL-141 RT-3-1 Cuttings 3240-50 ft.

Plagioclase 43% Andesine; euhedral to subhedral lathlike grains 0.3 to 0.05 mm.; slightly to moderately altered to sericite and calcite; albite twins; preferred flow orientation.
Calcite 30% Irregularly-shaped anhedral grains and masses 0.3 mm. to microcrystalline; some occur in veinlets.
Orthoclase 15% Anhedral grains 0.05 mm. to microcrystalline; interstitial to plagioclase laths.
Biotite 5% Subhedral to anhedral grains 0.2 to 0.05 mm.; pleochroic from pale reddish-brown to dark reddish-brown.
Leucoxene 5% Opaque anhedral masses and grains 0.1 mm. to microcrystalline.
Quartz 2% Anhedral grains 0.3 to 0.01 mm.; severely strained; may have been tridymite.
Sericite Tr. Microcrystalline grains in zoned masses 0.5 mm.; altera-

tion product of original plagioclase phenocrysts.
Apatite Tr.
Magnetite Tr.
Pyrite Tr.

Fabric: Holocrystalline, aphanitic-granular, felsophyric, fine-grained.
Probable rock: Biotite-bearing andesite.

Broderick and Gordon #1 Government	Routt County 7N-86W, sec 18	CL-141 RT-3-2 Cuttings 3243 ft.

Calcite 40% Subhedral to anhedral grains and irregularly-shaped masses 1.5 mm. to microcrystalline; some occur in veinlets.
Orthoclase 25% Anhedral grains 0.05 mm. to microcrystalline; interstitial to plagioclase laths.
Plagioclase 20% Andesine; euhedral to subhedral lathlike grains 0.3 to 0.01 mm. slightly to strongly altered to sericite and calcite; albite twins indistinct; weak preferred flow orientation.
Quartz 5% Anhedral grains 2.5 to 0.01 mm.; slightly to severely strained; may have been tridymite; some large grains contain microcrystalline needles of rutile.
Sericite 5% Microcrystalline grains in angular zoned masses 1.0 to 0.2 mm.; alteration product of original plagioclase phenocrysts.
Leucoxene 5% Opaque anhedral masses and grains 0.1 mm. to microcrystalline.
Biotite Tr. Subhedral to anhedral grains 0.05 mm. to microcrystalline; pleochroic from pale reddish-brown to dark reddish-brown.
Apatite Tr.
Magnetite Tr.
Pyrite Tr.

Fabric: Holocrystalline, aphanitic-granular, felsophyric, fine-grained.
Probable rock: Biotite-bearing andesite to latite.

Gardner Bros. #1 Chura	Routt County 7N-86W, sec 4	CL-143 RT-5-1 Core chip 2064-78 ft.

Phenocrysts: 15% of thin section.

Plagioclase 50% Oligoclase to andesine; euhedral to subhedral crystals 2.0 to 0.1 mm.; strongly to completely altered to sericite and calcite; twinning obscured.
Quartz 30% Corroded subhedral to anhedral grains 1.0 to 0.01 mm.; thin reaction rims with groundmass; some grains enclose microcrystalline needles of rutile.
Biotite 20% Euhedral to subhedral crystals 1.0 to 0.1 mm.; pleochroic from pale yellow to dark reddish-brown.

Groundmass: 85% of thin section.

Orthoclase 55% Anhedral grains 0.05 mm. to microcrystalline.
Plagioclase 25% Albite to oligoclase; euhedral to subhedral crystals 0.1 to 0.01 mm.; moderately altered to sericite; albite twins obscured.
Quartz 20% Anhedral grains 0.1 mm. to microcrystalline.
Biotite Tr. Subhedral grains 0.1 to 0.01 mm.; pleochroic from pale yellowish-green to dark brownish-green.
Zircon Tr.
Magnetite Tr.
Leucoxene Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, orthophyric, fine-grained.
Probable rock: Quartz-latite porphyry to rhyolite porphyry.

O. D. Robinson	Routt County	CL-146
#1 Robert Kagie	4N-87W, sec 29	RT-8-1
		Cuttings
		4780-90 ft.

Microcline 35% Xenoblastic grains 3.0 to 1.0 mm.; microperthitic; poikiloblastically encloses quartz, plagioclase and sillimanite.
Quartz 30% Xenoblastic grains 0.5 to 0.01 mm.; moderately to severely strained and fractured; grain borders sutured and granulated.
Biotite 15% Elongate shredlike xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale greenish-yellow to brownish-green or from pale brown to dark reddish-brown; preferred orientation.
Plagioclase 10% Oligoclase; xenoblastic grains 2.0 to 0.05 mm.; strongly to completely altered to sericite; albite twins absent.
Sillimanite 10% Microcrystalline needlelike idioblastic grains in fibrous clusters 0.2 to 0.01 mm.; contained within quartz, bio-

tite and microcline; preferred orientation.
Muscovite Tr. Idioblastic to xenoblastic grains 0.3 to 0.01 mm.; associated with microcline.
Garnet Tr. Xenoblastic grains 0.3 to 0.01 mm.; isotropic; fractured; pale pink color.
Zircon Tr.
Leucoxene Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic to nematoblastic, porphyroblastic, fine- to medium-grained.
Probable rock: Sillimanite-plagioclase-biotite-quartz-microcline gneiss.

O. D. Robinson	Routt County	CL-146
#1 Robert Kagie	4N-87W, sec 29	RT-8-2
		Cuttings
		4770-80 ft.

Quartz 48% Xenoblastic grains 0.5 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated.
Biotite 30% Elongate shredlike xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale greenish-yellow to brownish-green or from pale brown to dark reddish-brown; slightly altered to chlorite; preferred orientation.
Sillimanite 15% Microcrystalline needlelike idioblastic grains in fibrous clusters 1.5 to 0.01 mm.; contained within quartz and biotite; preferred orientation.
Plagioclase 7% Oligoclase; xenoblastic grains 0.5 to 0.05 mm.; strongly to completely altered to sericite; albite twins obscured.
Leucoxene Tr.
Zircon Tr.
Pyrite Tr.

Fabric: Schistose, lepidoblastic to nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Plagioclase-sillimanite-biotite-quartz schist.

O. D. Robinson	Routt County	CL-146
#1 Robert Kagie	4N-87W, sec 29	RT-8-3
		Cuttings
		4780-95 ft.

Quartz 40% Xenoblastic grains 1.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated.
Biotite 25% Elongate shredlike xenoblstic grains 1.0 to 0.05 mm.; pleochroic from pale greenish-yellow to brownish-green or from pale brown to dark reddish-brown; slightly altered to chlorite; preferred orientation.
Plagioclase 15% Oligoclase; xenoblastic grains 1.5 to 0.05 mm.; strongly to completely altered to sericite and calcite; albite twins obscured.
Sillimanite 15% Microcrystalline needlelike idioblastic grains in fibrous clusters 3.5 to 0.01 mm.; contained within quartz and biotite; preferred orientation.
Microcline 5% Xenoblastic grains 3.5 to 0.3 mm.; microperthitic.
Muscovite Xenoblastic grains 0.3 to 0.01 mm.; associated with microcline.
Sphene Tr.
Leucoxene Tr.
Zircon Tr.

Fabric: Schistose, lepidoblastic to nematoblastic, non-porphyroblastic, fine- to medium grained.
Probable rock: Microcline-sillimanite-plagioclase-biotite-quartz schist.

Texaco, Inc.	Routt County	CL-147
#1 Colvert	6N-86W, sec 7	RT-9-1
		Core chip
		5600 ft.

Sericite (clay) 68% Microcrystalline grains; matrix of rock; partly altered to muscovite.
Quartz 20% Subangular to subrounded grains 0.5 to 0.01 mm.; moderately to strongly strained.
Microcline 5% Subangular grains 0.5 to 0.01 mm.; distinct polysynthetic twins.
Biotite 2% Irregularly-shaped grains 0.2 to 0.01 mm.; pleochroic from pale yellowish-green to dark brownish-green.
Muscovite 2% Shredlike grains 0.01 mm.
Chlorite 1% Microcrystalline grains in matrix.
Pyrite 1% Idioblastic crystals 0.01 mm.
Leucoxene 1%
Apatite Tr.
Zircon Tr.

Fabric: Sedimentary, detrital, poorly-sorted, subangular to subrounded grains, fine-grained.
Probable rock: Sandy or silty shale.

Texaco, Inc.	Routt County	CL-147
#1 Colvert	6N-86W, sec 7	RT-9-2
		Core chip
		5614-15 ft.

Quartz 97% Subrounded to rounded grains 4.0 to 0.01 mm.; moderately to severely strained and fractured; grain borders sutured; some granulated; overgrowths in optical continuity with parent grain.
Microcline Tr. Subrounded grains 1.0 to 0.2 mm.; faint polysynthetic twins.
Biotite Tr. Shredlike to subrounded grains 0.1 to 0.01 mm.; occur intergranularly and enclosed within quartz.
Muscovite Tr. Elongate shredlike grains 0.1 to 0.01 mm.
Sphene Tr.
Zircon Tr.
Hematite Tr.
Pyrite Tr.
Voids 3% Some may be due to loss of grains during preparation of thin section.

Fabric: Sedimentary, detrital, well-sorted, subrounded to rounded grains, medium-grained, cataclastic (may be slightly metamorphic).
Probable rock: Quartzite.

Texaco, Inc.	Routt County	CL-147
#1 Colvert	6N-86W, sec 7	RT-9-3
		Core chip
		5623-27 ft.

Quartz 98% Subrounded to rounded grains 3.0 to 0.01 mm.; moderately to severely strained and fractured; grain borders sutured and granulated; overgrowths in optical continuity with parent grain.
Calcite 1% Angular to subangular xenoblastic grains 0.5 to 0.05 mm.; occur in discontinuous bands and scattered throughout rock.
Microcline Tr. Subrounded grains 1.0 to 0.01 mm.; faint polysynthetic twins.
Biotite Tr. Shredlike to subrounded grains 0.05 to 0.01 mm.; occur intergranularly and enclosed within quartz.
Muscovite Tr. Elongate shredlike grains 0.1 to 0.01 mm.
Sphene Tr.
Hematite Tr.
Voids 1% Some may be due to loss of grains during preparation of thin section.

Fabric: Sedimentary, detrital, well-sorted subrounded to rounded grains, medium-grained, cataclastic (May be slightly metamorphic).
Probable rock: Quartzite.

Texaco, Inc.	Routt County	CL-148
#1 King Mountain Unit-Government	1S-85W, sec 2	RT-10-1
(#1 Sampson-Government)		Core chip
		4006-13 ft.

Microcline 45% Xenoblastic grains 7.0 to 0.1 mm.; distinct to faint polysynthetic twins; microperthitic; poikiloblastically enclose quartz, plagioclase, apatite and chlorite.
Plagioclase 37% Albite to oligoclase; xenoblastic grains 3.5 to 0.1 mm.; severely altered to sericite; albite and pericline twins; myrmekitic.
Quartz 15% Xenoblastic grains 2.0 to 0.05 mm.; severely strained and fractured; grain borders sutured and granulated; some grains occur in aggregates.
Sericite 3% Microcrystalline grains in aggregates 1.0 to 0.2 mm.; alteration product of original biotite grains.
Chlorite Tr. Irregularly-shaped masses 0.5 to 0.01 mm.; associated with sericite in altered biotite.
Epidote Tr. Aggregates of xenoblastic grains 0.01 mm.; associated with sericite in altered biotite and with magnetite.
Leucoxene Tr.
Magnetite Tr.
Apatite Tr.
Zircon Tr.
Hematite Tr.

Fabric: Granoblastic, non-porphyroblastic, coarse-grained.
Probable rock: Quartz-plagioclase-microcline gneiss.

Pan American	Routt County	CL-198
Petroleum Corp.	7N-87W, sec 13	RT-11-1
#1 Jones		Core chip
		5757-64 ft.

Microcline 30% Xenoblastic grains 3.5 to 0.05 mm.; distinct to faint polysynthetic twins; microperthitic; poikiloblastically enclose quartz, plagioclase, apatite, muscovite, and altered biotite.
Quartz 30% Xenoblastic grains 1.0 to 0.05 mm.; strongly strained and

fractured; sutured borders; grains occur in aggregates and bands.
Plagioclase 25% Oligoclase; xenoblastic grains 1.5 to 0.2 mm.; severely altered to sericite; albite twins obscured.
Biotite 7% Elongate shredlike xenoblastic grains 0.5 to 0.1 mm.; severely to completely altered to sericite, muscovite, and hematite; preferred orientation.
Muscovite 5% Elongate shredlike xenoblastic grains 0.5 to 0.05 mm.; associated with altered biotite; preferred orientation.
Leucoxene 1%
Magnetite 1%
Hematite 1%
Epidote Tr.
Apatite Tr.
Zircon Tr.
Calcite Tr.

Fabric: Granoblastic, non-porphyroblastic, medium-grained.
Probable rock: Muscovite-biotite-plagioclase-quartz-microcline gneiss.

Pacific Natural Gas Expl.	Routt County	CL-207
Southern Union Prod.	4N-89W, sec 35	RT-12-1
#26-35 Pagoda Unit		Cuttings
		7042-46 ft.

Hornblende 40% Xenoblastic grains 1.0 to 0.1 mm.; pleochroic from pale greenish-yellow to brownish-green or green; poikiloblastically enclose apatite.
Plagioclase 33% Andesine to labradorite; xenoblastic grains 1.0 to 0.2 mm.; moderately to severely altered to sericite; weakly zoned; albite and pericline twins.
Quartz 15% Xenoblastic grains 0.5 to 0.1 mm.; moderately strained and fractured.
Magnetite 10% Xenoblastic grains 0.3 to 0.05 mm.; associated with hornblende.
Apatite 2%
Biotite Tr. Xenoblastic grains 0.2 to 0.01 mm.; pleochroic from pale brown to greenish-brown; associated with hornblende.
Garnet Tr. Xenoblastic grains 0.3 to 0.05 mm.; isotropic; fractured; very pale pink color.
Sphene Tr.
Leucoxene Tr.
Zircon Tr.
Hematite Tr.

Fabric: Gneissose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Magnetite-bearing quartz-plagioclase-hornblende gneiss.

Pacific Natural Gas Expl.	Routt County	CL-207
Southern Union Prod.	4N-89W, sec 35	RT-12-2
#26-35 Pagoda Unit		Cuttings
		7045-52 ft.

Plagioclase 50% Oligoclase; xenoblastic grains 2.5 to 1.0 mm.; moderately altered to sericite; albite twins; and also andesine to labradorite; xenoblastic grains 1.0 to 0.5 mm.; strongly to severely altered to sericite; albite and pericline twins.
Quartz 45% Xenoblastic grains 2.0 to 0.05 mm.; moderately to severely strained and fractured; grain borders sutured and granulated; enclose subrounded grains of plagioclase and hornblende.
Microcline 3% Xenoblastic grains 1.5 mm.; microperthitic.
Biotite 2% Shredlike xenoblastic grains 0.3 to 0.01 mm.; pleochroic from pale yellow to reddish-brown; faint preferred orientation.
Hornblende Tr. Rounded xenoblastic grains 0.05 mm.; enclosed within quartz.
Garnet Tr. Subrounded xenoblastic grains 0.2 to 0.1 mm.; isotropic; fractured; very pale pink color.
Muscovite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic, non-porphyroblastic, medium-grained.
Probable rock: Quartz-plagioclase gneiss.

Texaco, Inc.	Routt County	CL-211
#1 Peavy	8N-86W, sec 27	RT-13-1
		Cuttings
		3260-65 ft.

Variety #1, fragments make up 40% of thin section.

Sericite 35% Xenoblastic masses 0.05 mm. to microcrystalline; alteration product of biotite and of original plagioclase.
Quartz 25% Xenoblastic grains 0.1 to 0.01 mm.; moderately to strongly strained; sutured borders.
Calcite 20% Xenoblastic grains 0.5 mm. to microcrystalline; replacement mineral.
Biotite 10% Xenoblastic grains 0.3 to 0.01 mm.; pleochroic from pale

yellow to dark green; preferred orientation.
Leucoxene 10% Xenoblastic masses 0.1 to 0.01 mm. composed of microcrystalline grains.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-calcite-quartz-sericite gneiss (altered biotite-quartz-plagioclase gneiss.)

Variety #2, fragments make up 35% of thin section.

Quartz 35% Subangular to subrounded grains 0.75 to 0.01 mm.; slightly to severely strained; some grains composed of highly sutured aggregates.
Sericite 25% Microcrystalline grains composing the matrix of the rock.
Calcite 20% Xenoblastic grains 0.5 mm. to microcrystalline occur interstitially to quartz and feldspar grains as matrix; also occur in veinlets.
Microcline 8% Subrounded grains 0.2 to 0.05 mm.; distinct polysynthetic twins.
Plagioclase 7% Subrounded grains 0.5 to 0.05 mm.; severely to completely altered to sericite.
Leucoxene 2%
Hematite 2%
Biotite 1%

Fabric: Sedimentary, detrital and crystalline, fine-grained.
Probable rock: Calcareous silty arkose.

Variety #3, fragments make up 15% of thin section.

Calcite 58% Masses of microcrystalline grains 5.0 to 0.05 mm.; may be cementing material.
Quartz 40% Xenoblastic grains 0.05 mm. to microcrystalline; severely strained and fractured; grain borders sutured and granulated.
Hematite 2%

Fabric: Granoblastic, non-porphyroblastic, very fine-grained.
Probable rock: Quartzite. (may possibly be a metamorphic rock fragment in a sedimentary rock.)

Variety #4, fragments make up 10% of thin section.

Hornblende 65% Idioblastic to xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale green to dark green or bluish-green.
Plagioclase 15% Andesine; xenoblastic grains 0.2 to 0.05 mm.; slightly altered to sericite; albite twins very indistinct.

Biotite 10% Idioblastic to xenoblastic grains 0.1 to 0.01 mm.; pleochroic from pale yellow to dark brownish-green; associated with hornblende; preferred orientation.
Leucoxene 5% Xenoblastic masses of microcrystalline grains; associated with magnetite.
Magnetite 5% Xenoblastic grains 0.05 to 0.01 mm.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-hornblende schist.

Texaco, Inc.	Routt County	CL-211
#1 Peavy	8N-86W, sec 27	RT-13-2
		Cuttings
		3265-70 ft.

Variety #1, fragments make up 65% of thin section.

Quartz 80% Xenoblastic grains 0.1 to 0.01 mm.; strongly to severely strained; grain borders sutured and granulated.
Plagioclase 10% Variety not determined; xenoblastic grains 0.05 to 0.01 mm.; severely to completely altered to sericite.
Biotite 5% Shredlike xenoblastic grains 0.2 to 0.01 mm.; pleochroic from pale greenish-yellow to dark brownish-green; moderately altered to chlorite (pennine).
Calcite 5% Masses and veinlets of microcrystalline grains.
Muscovite Tr.
Hematite Tr.

Fabric: Granoblastic, non-porphyroblastic, very fine-grained.
Probable rock: Biotite-plagioclase-quartz gneiss or quartzite.

Variety #2, fragments make up 35% of thin section.

Quartz 50% Subangular to subrounded grains 0.5 to 0.01 mm.; slightly to moderately strained.
Sericite 45% Microcrystalline grains composing the matrix of the rock.
Plagioclase 5% Subrounded grains 0.3 to 0.05 mm.; severely to completely altered to sericite.

Fabric: Sedimentary, detrital, fine-grained.
Probable rock: Shaly arkose.

Texaco, Inc.
#1 Peavy

Routt County
8N-86W, sec 27

CL-211
RT-13-3
Cuttings
3275-80 ft.

Quartz 80% Xenoblastic grains 0.5 to 0.01 mm.; strongly to severely strained; grain borders sutured and granulated.
Sphene 10% Elongate xenoblastic grains 0.1 to 0.01 mm.
Muscovite 5% Shredlike xenoblastic grains 0.05 to 0.01 mm.
Calcite 5% Xenoblastic grains 0.1 mm. to microcrystalline; occur in masses and veinlets.
Plagioclase Tr. Variety not determined; xenoblastic grains 0.2 to 0.05 mm.; faint albite twins.

Fabric: Granoblastic, non-porphyroblastic, very fine-grained.
Probable rock: Quartzite.

Texaco, Inc.
#1 Peavy

Routt County
8N-86W, sec 27

CL-211
RT-13-4
Cuttings
3280-84 ft.

Variety #1, fragments make up 70% of thin section.

Quartz 86% Xenoblastic grains 0.5 to 0.01 mm.; moderately to strongly strained, sutured and granulated.
Sphene 5% Elongate xenoblastic grains 0.05 to 0.01 mm.
Calcite 5% Xenoblastic grains 0.05 mm. to microcrystalline; occur in masses and veinlets.
Muscovite 2% Shredlike xenoblastic grains 0.05 to 0.01 mm.
Hematite 2%
Plagioclase Tr. Oligoclase; xenoblastic grains 0.5 to 0.05 mm.; albite twins indistinct.

Fabric: Granoblastic, non-porphyroblastic, fine-grained.
Probable rock: Quartzite.

Variety #2, fragments make up 30% of thin section.

Quartz 80% Xenoblastic grains 0.1 to 0.01 mm.; moderately strained, sutured and granulated; make up subangular fragments of quartzite 2.5 to 0.05 mm.
Calcite 20% Xenoblastic grains 0.2 mm. to microcrystalline; comprises the matrix.
Hematite Tr.

Fabric: Sedimentary, detrital, fine-grained.
Probable rock: Calcareous quartzose sandstone.

Tennessee Gas Trans.	Saguache County	CL-199
#1 State "B"	41N-7E, sec 14	SG-1-1
	(NMPM)	Cuttings
		10140-50 ft.

Plagioclase 50% Oligoclase; xenoblastic grains 0.5 to 0.1 mm.; slightly altered to sericite; albite twins; some grains have albite rims.
Quartz 25% Xenoblastic grains 0.5 to 0.05 mm.; slightly strained; slightly sutured borders.
Microcline 10% Xenoblastic grains 0.5 to 0.05 mm.; distinct polysynthetic twins.
Muscovite 5% Shredlike xenoblastic grains 0.5 to 0.05 mm.
Biotite 5% Elongate idioblastic to xenoblastic grains 1.0 to 0.1 mm.; pleochroic from pale greenish-brown to dark greenish-brown; preferred orientation.
Magnetite 5% Idioblastic to xenoblastic grains 0.2 to 0.05 mm.
Apatite Tr. Xenoblastic grains 0.1 to 0.05 mm.
Chlorite Tr. Elongate xenoblastic grains 0.2 to 0.05 mm.; alteration product of biotite.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-muscovite-microcline-quartz-plagioclase gneiss.

Tennessee Gas Trans.	Saguache County	CL-199
#1 State "B"	41N-7E, sec 14	SG-1-2
	(NMPM)	Cuttings
		10300-10 ft.

Variety #1, fragments make up 90% of thin section.

Plagioclase 45% Oligoclase; xenoblastic grains 0.5 to 0.1 mm.; slightly altered to sericite; albite twins; some grains have albitic rims.
Quartz 25% Xenoblastic grains 0.3 to 0.05 mm.; slightly strained; slightly sutured borders.
Microcline 15% Xenoblastic grains 0.3 to 0.1 mm.; distinct polysynthetic twins; poikiloblastically enclose quartz.
Magnetite 7% Idioblastic to xenoblastic grains 0.2 to 0.01 mm.
Biotite 5% Elongate idioblastic to xenoblastic grains 0.5 to 0.05 mm.;

pleochroic from pale greenish-yellow to very dark greenish-brown; preferred orientation.
Muscovite 3% Shredlike xenoblastic grains 0.3 to 0.05 mm.
Apatite Tr. Xenoblastic grains 0.1 to 0.05 mm.
Chlorite Tr. Elongate xenoblastic grains 0.1 to 0.05 mm.; alteration product of biotite.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-magnetite-microcline-quartz-plagioclase gneiss.

Variety #2, fragments make up 10% of thin section.

Plagioclase 35% Oligoclase; xenoblastic grains 0.75 to 0.1 mm.; no alteration to sericite; albite twins rare.
Biotite 35% Elongate idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellow to brown.
Hornblende 25% Xenoblastic grains 2.5 to 0.1 mm.; poikiloblastically enclose plagioclase, biotite, and apatite; pleochroic from yellowish-green to bluish-green.
Sphene 5% Fractured and corroded xenoblastic grains 0.2 to 0.05 mm.
Epidote Tr. Xenoblastic grains 0.3 to 0.1 mm.; associated with biotite.
Apatite Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Schistose, lepidoblastic to nematoblastic, non-porphyroblastic, medium-grained.
Probable rock: Hornblende-biotite-plagioclase schist.

Tennessee Gas Trans.	Saguache County	CL-199
#1 State "B"	41N-7E, sec 14	SG-1-3
	(NMPM)	Cuttings
		10320-30 ft.

Plagioclase 58% Oligoclase; xenoblastic grains 1.5 to 0.2 mm.; slightly altered to sericite; albite twins; some grains have narrow rims of albite.
Quartz 25% Xenoblastic grains 0.5 to 0.05 mm.; slightly strained; slightly sutured borders.
Biotite 7% Elongate idioblastic to xenoblastic grains 0.3 to 0.01 mm.; pleochroic from pale greenish-yellow to dark brownish-green; preferred orientation.
Muscovite 5% Shredlike xenoblastic grains 1.0 to 0.05 mm.
Magnetite 5% Idioblastic to xenoblastic grains 0.3 to 0.01 mm.

Microcline Tr. Xenoblastic grains 0.2 to 0.05 mm.
Apatite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Muscovite-biotite-quartz-plagioclase gneiss.

Fred Turner	San Miguel County	CL-149
#1 F. H. Buss	44N-13W, sec 26	SM-1-1
	(NMPM)	Core chip
		8449-8790 ft.

Plagioclase 49% Oligoclase; xenoblastic grains 2.5 to 0.2 mm.; albite twins indistinct; myrmekitic; poikiloblastically enclose biotite.
Quartz 25% Xenoblastic grains 2.5 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured.
Microcline 15% Xenoblastic grains 4.5 to 0.05 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose plagioclase, quartz, biotite, and magnetite.
Biotite 5% Shredlike xenoblastic grains 0.5 to 0.05 mm.; pleochroic from very pale yellow to dark brownish-green; moderately altered to chlorite; preferred orientation.
Epidote 3% Xenoblastic grains 0.5 to 0.01 mm.; associated with biotite and hornblende.
Magnetite 2% Idioblastic to xenoblastic grains 0.3 to 0.05 mm. associated with biotite and hornblende.
Sphene 1% Xenoblastic grains 0.3 to 0.05 mm.; associated with magnetite; slightly altered to leucoxene.
Hornblende Tr. Xenoblastic grains 0.5 to 0.01 mm.; pleochroic from yellowish-green to dark green or bluish-green.
Apatite Tr.
Zircon Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Kerr-McGee	San Miguel County	CL-200
#1 Placerville	43N-11W, sec 11	SM-2-1
	(NMPM)	Cuttings
		6175-80 ft.

Plagioclase 75% Oligoclase to andesine; xenoblastic grains 2.5 to

0.1 mm.; moderately to strongly altered to sericite; albite and Carlsbad twins; weakly zoned; poikiloblastically enclose quartz, hornblende, and biotite.

Quartz 8% Xenoblastic grains 1.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated.

Biotite 7% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark greenish-brown; dark green in basal section; associated with hornblende.

Hornblende 5% Xenoblastic grains 1.5 to 0.05 mm.; pleochroic from yellowish-green to dark green or bluish-green.

Microcline 3% Xenoblastic grains 1.0 to 0.3 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase and quartz.

Epidote 2% Xenoblastic grains 0.2 to 0.05 mm.; associated with hornblende and plagioclase.

Sphene Tr.

Apatite Tr.

Magnetite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic and nematoblastic, medium-grained.

Probable rock: Hornblende-biotite-quartz-plagioclase gneiss.

Kerr-McGee #1 Placerville	San Miguel County 43N-11W, sec 11 (NMPM)	CL-200 SM-2-2 Cuttings 6200-05 ft.

Plagioclase 63% Oligoclase to andesine; xenoblastic grains 3.0 to 0.05 mm.; moderately to severely altered to sericite; albite twins; weakly zoned; poikiloblastically enclose quartz, microcline, and biotite.

Microcline 15% Xenoblastic grains 1.5 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase and quartz.

Quartz 15% Xenoblastic grains 2.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated.

Biotite 5% Xenoblastic grains 2.0 to 0.05 mm.; pleochroic from pale yellowish-green to very dark brownish-green; dark green in basal sections.

Epidote 1%

Magnetite 1%

Hornblende Tr.

Sphene Tr.

Apatite Tr.

Fluorite Tr. Xenoblastic grains 0.05 to 0.01 mm.; isotropic; interstitial to quartz and plagioclase.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-quartz-microcline-plagioclase gneiss.

Kerr-McGee	San Miguel County	CL-200
#1 Placerville	43N-11W, sec 11	SM-2-3
	(NMPM)	Cuttings
		6240-45 ft.

Plagioclase 70% Oligoclase to andesine; xenoblastic grains 4.0 to 0.05 mm.; moderately to strongly altered to sericite; albite and Carlsbad twins; weakly zoned; poikiloblastically enclose quartz and biotite.
Quartz 15% Xenoblastic grains 1.5 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated; contain microcrystalline needles of rutile.
Microcline 5% Xenoblastic grains 3.5 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase and quartz.
Biotite 5% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from greenish-yellow to very dark greenish-brown; moderately altered to chlorite.
Hornblende 3% Corroded xenoblastic grains 1.0 to 0.05 mm.; pleochroic from yellowish-green to dark green; associated with biotite.
Sphene 2%
Leucoxene Tr.
Epidote Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic and nematoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Continental Oil Co.	Sedgwick County	CL-212
and others	10N-47W, sec 18	SD-1-1
#1 Sprague Bros.		Cuttings
		6640-46 ft.

Plagioclase 35% Oligoclase; xenoblastic grains 1.0 to 0.05 mm.; moderately to strongly altered to sericite; albite twins; myrmekitic.
Quartz 30% Xenoblastic grains 1.5 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated.
Microcline 25% Xenoblastic grains 1.5 to 0.1 mm.; polysynthetic twins indistinct; microperthitic; poikiloblastically enclose plagioclase.
Biotite 10% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellow to brown; severely altered to chlorite (pennine); preferred orientation.
Muscovite Tr.
Leucoxene Tr.
Apatite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, cataclastic, fine-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Continental Oil Co., and others #1 Sprague Bros.	Sedgwick County 10N-47W, sec 18	CL-212 SD-1-2 Cuttings 6647 ft.

Plagioclase 30% Oligoclase; xenoblastic grains 2.0 to 0.05 mm.; moderately to strongly altered to sericite; albite twins obscured; weakly zoned; myrmekitic.
Quartz 30% Xenoblastic grains 2.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated.
Microcline 25% Xenoblastic grains 1.5 to 0.1 mm.; polysynthetic twins indistinct; poikiloblastically enclose plagioclase, some quartz present in micrographic intergrowths.
Biotite 10% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellow to brown; strongly altered to chlorite (pennine); preferred orientation.
Muscovite 5% Shredlike xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Leucoxene Tr.
Apatite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, cataclastic, medium-grained.
Probable rock: Muscovite-biotite-microcline-quartz-plagioclase gneiss.

Amerada Petroleum Co.	Washington County	CL-150
#1 Heyen	2S-52W, sec 7	WA-1-1
		2 Core chips
		7998 ft.

Plagioclase 50% Oligoclase; xenoblastic grains 4.5 to 0.1 mm.; strongly to severely altered to sericite; albite twins obscured.
Microcline 15% Xenoblastic grains 3.0 to 0.2 mm.; moderately altered to sericite; poikiloblastically enclose quartz, muscovite and chlorite.
Quartz 15% Xenoblastic grains 0.5 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured.
Calcite 15% Xenoblastic grains 0.2 mm. to microcrystalline; occur in masses and bands.
Sericite 3% Xenoblastic masses of microcrystalline grains 0.3 to 0.05 mm.; alteration product of plagioclase and biotite; associated with calcite.
Magnetite 2%
Muscovite Tr.
Chlorite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic; non-porphyroblastic, medium-grained.
Probable rock: Altered biotite-quartz-microcline-plagioclase gneiss.

Indian Territory	Washington County	CL-153
Illuminating Oil	1S-49W, sec 28	WA-4-1
#1 Vorce		Cuttings
		6970-80 ft.

Biotite 40% Shredlike xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-brown to dark brownish green; severely altered to sericite, muscovite, and hematite; preferred orientation.
Quartz 35% Xenoblastic grains 0.5 to 0.01 mm.; severely strained and fractured; grain borders sutured and granulated.
Muscovite 15% Shredlike xenoblastic grains 1.0 to 0.01 mm.; associated with biotite; preferred orientation.
Hematite 10% Microcrystalline grains associated with altered biotite.
Leucoxene Tr.
Sillimanite Tr.
Sericite Tr.
Calcite Tr.

Fabric: Schistose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Muscovite-quartz-biotite schist (severely weathered).

Indian Territory	Washington County	CL-153
Illuminating Oil	1S-49W, sec 28	WA-4-2
#1 Vorce		Cuttings
		6980-90 ft.

Quartz 45% Xenoblastic grains 0.3 to 0.01 mm.; moderately to severely strained and fractured; grain borders sutured and granulated.
Biotite 25% Xenoblastic grains 0.5 to 0.01 mm.; pleochroic from greenish-brown to dark greenish-brown; severely altered to sericite, muscovite, and hematite; preferred orientation.
Muscovite 15% Shredlike xenoblastic grains 0.5 to 0.01 mm.; associated with biotite; preferred orientation.
Plagioclase 10% Variety not determined; xenoblastic grains 0.5 to 0.05 mm.; strongly to severely altered to sericite; no twinning apparent.
Calcite 5% Xenoblastic grains 0.5 mm. to microcrystalline.
Tourmaline Tr. One xenoblastic grain 0.2 mm.; pleochroic from very pale purplish-gray to very dark bluish-gray.

Fabric: Schistose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Plagioclase-muscovite-biotite-quartz schist.

Indian Territory	Washington County	CL-153
Illuminating Oil	1S-49W, sec 28	WA-4-3
#1 Vorce		Cuttings
		6990-7000 ft.

Quartz 57% Xenoblastic grains 0.5 to 0.01 mm.; slightly to strongly strained and fractured; grain borders sutured and granulated.
Muscovite 20% Shredlike xenoblastic grains 1.5 to 0.01 mm.; preferred orientation.
Biotite 15% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellow to dark brownish-green or from pale yellowish-green to dark green; preferred orientation.
Plagioclase 5% Oligoclase; xenoblastic grains 0.3 to 0.05 mm.; moderately to strongly altered to sericite; albite twins not apparent.
Calcite 3% Xenoblastic grains 0.3 mm. to microcrystalline.
Apatite Tr.
Zircon Tr.
Hematite Tr.

Fabric: Schistose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Plagioclase-biotite-muscovite-quartz schist.

Skiles Oil Co. | Washington County | CL-155
#1 Brower | 1N-49W, sec 34 | WA-6-1
Cuttings
6868 ft.

Plagioclase 45% Oligoclase to andesine; xenoblastic grains 0.5 to 0.01 mm.; strongly altered to sericite; albite twins obscured.
Microcline 30% Xenoblastic grains 1.5 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase and quartz.
Quartz 20% Xenoblastic grains 0.3 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated.
Biotite 4% Xenoblastic grains 0.1 to 0.05 mm.; pleochroic from pale greenish-brown to dark greenish-brown; severely to completely altered to chlorite, sericite, and hematite; preferred orientation.
Muscovite 1%
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic, porphyroblastic, cataclastic, fine-grained.
Probable rock: Biotite-quartz-microcline-plagioclase gneiss.

British-American Producting Co. | Weld County | CL-156
#1 Wise | 8N-61W, sec 19 | WL-1-1
Cuttings
10240-50 ft.

Plagioclase 67% Oligoclase; xenoblastic grains 3.0 to 0.1 mm.; strongly altered to sericite; albite and pericline twins; poikiloblastically enclose quartz, microcline, and biotite.
Quartz 30% Xenoblastic grains 1.5 to 0.01 mm.; moderately to severely strained and fractured; grain borders sutured.
Microcline 2% Xenoblastic grains 4.5 to 0.05 mm.; distinct polysynthetic twins; microperthitic; smaller grains occur interstitially.
Biotite 1% Xenoblastic grains 0.3 to 0.05 mm.; pleochroic from greenish-brown to dark greenish-brown; strongly altered to chlorite.
Apatite Tr.
Hematite Tr
Calcite Tr.

Fabric: Granoblastic, porphyroblastic, medium-grained.
Probable rock: Quartz-plagioclase gneiss.

British-American Producting Co. #1 Wise	Weld County 8N-61W, sec 19	CL-156 WL-1-2 Cuttings 10260-70 ft.

Plagioclase 60% Oligoclase; xenoblastic grains 5.0 to 0.05 mm.; strongly altered to sericite; albite and pericline twins; poikiloblastically enclose quartz, microcline, and biotite.
Quartz 25% Xenoblastic grains 1.0 to 0.01 mm.; moderately to severely strained and fractured; grain borders sutured.
Biotite 10% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale greenish-yellow to dark greenish-brown or from pale brown to dark brown; moderately altered to chlorite; preferred orientation.
Microcline 5% Xenoblastic grains 1.0 to 0.05 mm.; poikiloblastically enclose quartz; smaller grains occur interstitially.
Magnetite Tr.
Hematite Tr.
Calcite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-quartz-plagioclase gneiss.

California Oil Co. #1 U.P.R.R. Ferch	Weld County 8N-66W, sec 27	CL-157 WL-2-1 3 Core chips 10619-29 ft.

Quartz 83% Angular to subangular xenoblastic grains 0.5 to 0.05 mm.; slightly to moderately strained and fractured; mosaic texture; some grain borders sutured and granulated; contain microcrystalline needles of rutile; grains make up large subrounded fragments of quartzite 5.0 to 0.3 mm.; surrounded by sericite.
Sericite 10% Filaments and masses of microcrystalline grains; partly altered to muscovite.
Biotite 4% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from very pale brownish-green to dark green; larger shredlike grains severely altered to muscovite and hematite; smaller idioblastic grains cross-cut larger grains; no preferred orientation.
Muscovite 2% Idioblastic to xenoblastic grains 0.3 to 0.05 mm.; associated with sericite and biotite.
Hematite 1%
Sphene Tr.

Leucoxene Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Sedimentary, detrital, moderately sorted, fine-grained.
Probable rock: Quartz conglomerate (composed of quartzite fragments.)

California Oil Co.	Weld County	CL-157
#1 U.P.R.R. Ferch	8N-66W, sec 27	WL-2-2
		Core chip
		10624-29 ft.

Sericite 45% Masses of microcrystalline grains; partly altered to muscovite; surrounds clusters and individual grains of quartz.
Biotite 25% Idioblastic to xenoblastic grains 1.0 to 0.01 mm.; pleochroic from very pale green to dark brownish-green; larger shredlike grains severely altered to muscovite and hematite; smaller idioblastic grains cross-cut larger grains; no preferred orientation.
Quartz 20% Angular to subangular xenoblastic grains 0.5 to 0.01 mm.; slightly strained and fractured; mosaic texture; some grain borders sutured and granulated; contain microcrystalline needles of rutile; grains occur in subrounded clusters 10.0 to 0.2 mm. surrounded by sericite; some chert also occurs.
Muscovite 5% Shredlike xenoblastic grains 0.1 to 0.01 mm.; associated with sericite and biotite; crumpled grains 2.0 mm. also occur.
Hematite 5% Microcrystalline grains.
Epidote Tr. Iron-rich zoisite; xenoblastic grains 2.0 to 0.1 mm.; severely fractured and altered to hematite.
Magnetite Tr.
Zircon Tr.

Fabric: Sedimentary, detrital, poorly-sorted, angular to subrounded grains; medium grained; to metamorphic, hornfelsic, non-porphyroblastic, medium grained.
Probable rock: Muscovite-quartz-biotite-sericite hornfels.(?)

California Oil Co.	Weld County	CL-157
#1 U.P.R.R. Ferch	8N-66W, sec 27	WL-2-3
		Core chip
		10629-34 ft.

Quartz 50% Angular to subangular xenoblastic grains 0.3 to 0.01 mm.; slightly to strongly strained and fractured; mosaic texture; some grain borders are sutured and granulated; grains occur in elongate subangular clusters and bands surrounded by sericite.
Sericite 40% Masses of microcrystalline grains; matrix of rock; partly altered to muscovite.
Hematite 5% Microcrystalline grains.
Leucoxene 3%
Magnetite 2%
Sphene Tr.
Zircon Tr.

Fabric: Sedimentary, detrital, poorly-sorted, angular to subangular grains, fine-grained.
Probable rock: Siltstone.

California Oil Co.	Weld County	CL-157
#1 U.P.R.R. Ferch	8N-66W, sec 27	WL-2-4
		Core chip
		10634-39 ft.

Quartz 70% Angular to subangular xenoblastic grains 0.4 to 0.05 mm.; slightly to strongly strained and fractured; mosaic texture; some grain borders sutured and granulated; grains occur in elongate subangular clusters separated by thin bands and clusters of sericite.
Sericite 20% Masses of microcrystalline grains; some filaments separate individual quartz grains.
Biotite 5% Shredlike xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale green to dark green; larger grains severely altered to muscovite and hematite; preferred orientation.
Magnetite 3%
Hematite 2%
Muscovite Tr.
Sphene Tr.
Leucoxene Tr.
Zircon Tr.

Fabric: Sedimentary, detrital, poorly-sorted, angular to subangular grains, fine-grained.
Probable rock: Siltstone.

California Oil Co. #1 U.P.R.R. Ferch	Weld County 8N-66W, sec 27	CL-157 WL-2-5 Core chip 10639-43 ft.

Quartz 65% Angular to subangular xenoblastic grains 0.3 to 0.05 mm.; slightly to strongly strained and fractured; mosaic texture; some grain borders sutured; grains occur in elongate subangular clusters separated by thin bands and clusters of sericite.
Sericite 20% Masses of microcrystalline grains; some filaments separate individual quartz grains; partly altered to muscovite.
Biotite 10% Shredlike xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale green to dark brownish-green; larger grains severely altered to muscovite and hematite; preferred orientation.
Magnetite 3%
Hematite 2%
Sphene Tr.
Leucoxene Tr.
Zircon Tr.
Muscovite Tr.

Fabric: Sedimentary, detrital, poorly-sorted, angular to subangular grains, fine-grained.
Probable rock: Siltstone.

Shell Oil Co. #1 Colorado National Bank	Weld County 8N-60W, sec 12	CL-158 WL-3-1 Cuttings 9920-25 ft.

Quartz 98% Xenoblastic grains 1.0 mm. to microcrystalline; severely strained, fractured, and granulated; grain borders intricately sutured.
Sericite 2% Xenoblastic microcrystalline grains.
Microcline Tr. Xenoblastic grains 0.5 to 0.01 mm.; polysynthetic twins distorted; severely fractured.
Hematite Tr.

Fabric: Granoblastic, non-porphyroblastic, cataclastic, fine-grained.
Probable rock: Quartzite.

Shell Oil Corp.	Weld County	CL-158
#1 Colorado	8N-60W, sec 12	WL-3-2
National Bank		Cuttings
		9925-30 ft.

Quartz 94% Xenoblastic grains 1.5 mm. to microcrystalline; severely strained, fractured, and granulated; grain borders intricately sutured.
Sericite 5% Xenoblastic masses 1.0 mm. to microcrystalline.
Chlorite 1% Shredlike xenoblastic grains 1.0 to 0.01 mm.
Hematite Tr.

Fabric: Granoblastic, non-porphyroblastic, cataclastic, fine-grained.
Probable rock: Quartzite.

Shell Oil Corp.	Weld County	CL-158
#1 Colorado	8N-60W, sec 12	WL-3-3
National Bank		Cuttings
		9930-35 ft.

Quartz 80% Xenoblastic grains 1.5 mm. to microcrystalline; severely strained, fractured, and granulated; grain borders intricately sutured.
Chlorite 10% Shredlike xenoblastic grains 0.5 to 0.01 mm.; preferred orientation.
Sericite 10% Xenoblastic masses 1.0 mm. to microcrystalline.
Hematite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-prophyroblastic, cataclastic, fine-grained.
Probable rock: Quartzite to sericite-chlorite-quartz gneiss.

Shell Oil Corp.	Weld County	CL-158
#1 Colorado	8N-60W, sec 12	WL-3-4
National Bank		Cuttings
		9935-40 ft.

Variety #1, fragments make up 60% of thin section.

Quartz 90% Xenoblastic grains 0.5 mm. to microcrystalline; severely strained, fractured, and granulated; grain borders intricately sutured.
Chlorite 10% Shredlike xenoblastic grains 0.3 to 0.01 mm.; preferred

orientation.
Sericite Tr.
Muscovite Tr.
Hematite Tr.

Fabric: Granoblastic, non-porphyroblastic, cataclastic, fine-grained.
Probable rock: Quartzite.

Variety #2, fragments make up 40% of thin section.

Microcline 50% Xenoblastic grains 3.0 to 0.05 mm.; polysynthetic twins indistinct; Carlsbad twins; microperthitic; strongly fractured.
Quartz 42% Xenoblastic grains 1.5 mm. to microcrystalline; severely strained, fractured and granulated; grain borders intricately sutured.
Chlorite 5% Shredlike xenoblastic grains 0.3 to 0.01 mm.; preferred orientation.
Sericite 2% Xenoblastic masses 0.5 mm. to microcrystalline.
Hematite 1%
Biotite Tr.
Magnetite Tr.

Fabric: Granoblastic, porphyroblastic, cataclastic, fine- to medium-grained.
Probable rock: Chlorite-quartz-microcline gneiss.

Shell Oil Corp.	Weld County	CL-159
#1-4728 Federal	10N-56W, sec 18	WL-4-1
		Cuttings
		8813 ft.

Microcline 40% Xenoblastic grains 5.0 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz and plagioclase; some grains strained and fractured; smaller grains occur interstitially.
Quartz 35% Xenoblastic grains 1.5 to 0.01 mm.; moderately to strongly strained and fractured; grain borders sutured and granulated.
Plagioclase 15% Oligoclase; xenoblastic grains 2.0 to 0.05 mm.; strongly altered to sericite; albite twins obscured or absent; poikiloblastically enclose quartz.
Muscovite 5% Shredlike xenoblastic grains 1.5 to 0.01 mm.
Sericite 4% Xenoblastic grains 1.0 mm. to microcrystalline.
Biotite 1%
Calcite Tr.

Fabric: Granoblastic, porphyroblastic, cataclastic, medium-grained.
Probable rock: Muscovite-plagioclase-quartz-microcline gneiss.

Shell Oil Corp.	Weld County	CL-159
#1-4728 Federal	10N-56W, sec 8	WL-4-2
		Cuttings
		8830-35 ft.

Microcline 73% Xenoblastic grains 4.5 to 0.05 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose quartz, plagioclase and muscovite.
Quartz 20% Xenoblastic grains 1.0 to 0.01 mm.; moderately to strongly strained and fractured; grain borders sutured.
Plagioclase 5% Oligoclase; xenoblastic grains 0.5 to 0.05 mm.; strongly altered to sericite; albite twins obscured or absent.
Muscovite 2% Shredlike xenoblastic grains 1.0 to 0.01 mm.
Sericite Tr.

Fabric: Granoblastic, porphyroblastic, medium-grained.
Probable rock: Plagioclase-quartz-microcline gneiss.

Shell Oil Corp.	Weld County	CL-160
#1 Klingensmith	11N-59W, sec 1	WL-5-1
		Cuttings
		9901 ft.

Microcline 55% Xenoblastic grains 4.0 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz and plagioclase.
Quartz 20% Xenoblastic grains 1.0 to 0.05 mm.; moderately to strongly strained and fractured.
Plagioclase 15% Oligoclase; xenoblastic grains 3.0 to 0.1 mm.; slightly to strongly altered to sericite; albite twins; albite rims; myrmekitic.
Biotite 10% Elongate idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellow to dark brown or greenish-brown; slightly altered to chlorite; preferred orientation.
Zircon Tr.
Hematite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, medium-grained.
Probable rock: Biotite-plagioclase-quartz-microcline gneiss.

Shell Oil Corp. Weld County CL-160
#1 Klingensmith 11N-59W, sec 1 WL-5-2
Cuttings
9905-10 ft.

Plagioclase 45% Oligoclase; xenoblastic grains 2.0 to 0.3 mm.; slightly to moderately altered to sericite; albite and pericline twins; poikiloblastically enclose quartz and biotite.
Quartz 30% Xenoblastic grains 1.0 to 0.05 mm.; moderately to strongly strained and fractured.
Microcline 15% Xenoblastic grains 1.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz.
Biotite 10% Elongate idioblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellow to reddish-brown or dark greenish-brown; moderately altered to chlorite; preferred orientation.
Muscovite Tr.
Zircon Tr.
Magnetite Tr.
Calcite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Shell Oil Corp. Weld County CL-160
#1 Klingensmith 11N-59W, sec 1 WL-5-3
Cuttings
9915-20 ft.

Variety #1, fragments make up 65% of thin section.

Plagioclase 50% Oligoclase; xenoblastic grains 4.0 to 0.1 mm.; slightly to strongly altered to sericite; albite and pericline twins; poikiloblastically enclose quartz and biotite; myrmekitic.
Quartz 35% Xenoblastic grains 2.5 to 0.01 mm.; moderately to strongly strained and fractured; grain borders sutured.
Biotite 10% Elongate idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellow to reddish-brown or greenish-brown; slightly altered to chlorite; preferred orientation.
Microcline 5% Xenoblastic grains 0.5 to 0.05 mm.; distinct polysynthetic twins; poikiloblastically enclose quartz and plagioclase.
Pyrite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium-grained.

Probable rock: Microcline-biotite-quartz-plagioclase gneiss.

Variety #2, fragments make up 35% of thin section.

Plagioclase 50% Andesine; xenoblastic grains 0.5 to 0.1 mm.; moderately to strongly altered to sericite; albite and pericline twins.
Hornblende 30% Xenoblastic grains 0.5 to 0.05 mm.; ragged terminations; pleochroic from pale yellowish-green to dark green or bluish-green; poikiloblastically enclose quartz and apatite; preferred orientation.
Quartz 13% Xenoblastic grains 0.3 to 0.05 mm.; slightly to moderately strained.
Sphene 3% Xenoblastic grains 0.1 to 0.05 mm.; associated with hornblende and magnetite.
Magnetite 2% Idioblastic to xenoblastic grains 0.2 to 0.05 mm.
Biotite 2% Xenoblastic grains 0.2 to 0.01 mm.; pleochroic from very pale yellow to dark greenish-brown; moderately to strongly altered to chlorite; preferred orientation.
Apatite Tr.
Pyrite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Quartz-hornblende-plagioclase gneiss.

Shell Oil Corp.	Weld County	CL-160
#1 Klingensmith	4N-59W, sec 1	WL-5-4
		Cuttings
		9920-25 ft.

Variety #1, fragments make up 60% of thin section:

Plagioclase 47% Andesine; xenoblastic grains 0.5 to 0.1 mm.; moderately to strongly altered to sericite; albite and pericline twins.
Hornblende 35% Corroded xenoblastic grains 1.0 to 0.05 mm.; ragged terminations; pleochroic from pale yellowish-green to dark green or bluish-green; poikiloblastically enclose quartz and apatite; preferred orientation.
Quartz 15% Xenoblastic grains 0.3 to 0.05 mm.; slightly to moderately strained.
Biotite 2% Xenoblastic grains 0.3 to 0.01 mm.; severely to completely altered to chlorite; preferred orientation.
Magnetite 1%
Sphene Tr.
Apatite Tr.
Zircon Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Quartz-hornblende-plagioclase gneiss.

Variety #2, fragments make up 40% of thin section.

Plagioclase 60% Oligoclase; xenoblastic grains 1.5 to 0.05 mm.; slightly to strongly altered to sericite; albite twins; poikiloblastically enclose biotite and quartz; myrmekitic.
Quartz 20% Xenoblastic grains 1.5 to 0.05 mm.; moderately to severely strained and fractured.
Microcline 10% Xenoblastic grains 1.5 to 0.2 mm.; distinct polysynthetic twins; microperthitic.
Biotite 5% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellow to reddish-brown; strongly altered to chlorite; weak preferred orientation.
Sericite 5% Xenoblastic masses 0.5 mm. to microcrystalline.

Fabric: Granoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Canada Southern Oil Co.	Yuma County	CL-162
#1 Doyle Neiman	5N-46W, sec 10	YU-2-1
		Cuttings
		6340 ft.

Microcline 60% Xenoblastic grains 1.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz, plagioclase, and magnetite.
Quartz 20% Xenoblastic grains 0.5 to 0.05 mm.; moderately to strongly strained and fractured.
Plagioclase 15% Oligoclase; xenoblastic grains 0.5 to 0.05 mm.; slightly to strongly altered to sericite; albite twins; albite rims; myrmekitic.
Biotite 5% Xenoblastic grains 0.3 to 0.05 mm.; pleochroic from pale greenish-yellow to dark brownish-green; slightly altered to chlorite; weak preferred orientation.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-quartz-microcline gneiss.

Carter Oil Co.	Yuma County	CL-164
Mountain States Drilling	1N-48W, sec 8	YU-4-1
#1 Henik-State		Cuttings
		6760-65 ft.

Plagioclase 38% Oligoclase to andesine; xenoblastic grains 1.5 to 0.1 mm.; strongly to severely altered to sericite; albite and pericline twins; poikiloblastically enclose quartz.
Microcline 30% Xenoblastic grains 1.5 to 0.1 mm.; distinct polysynthetic twins; poikiloblastically enclose quartz and plagioclase.
Quartz 25% Xenoblastic grains 2.5 to 0.05 mm.; strongly strained and fractured; grain borders sutured and granulated; contain microcrystalline needles of rutile.
Hornblende 5% Corroded xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; poikiloblastically enclose quartz and apatite; preferred orientation.
Epidote 2% Xenoblastic grains 0.5 to 0.05 mm.; strongly fractured; associated with hornblende and plagioclase.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Hematite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Hornblende-quartz-microcline-plagioclase gneiss.

Indian Territory	Yuma County	CL-167
Illuminating Oil	2S-43W, sec 21	YU-7-1
#1 Strangeways		Cuttings
		5560-70 ft.

Quartz 90% Xenoblastic grains 1.0 mm. to microcrystalline; slightly to moderately strained and fractured; some large grains occur in bands or aggregates; intricately sutured borders.
Sericite 8% Microcrystalline shredlike xenoblastic grains; preferred orientation.
Muscovite 1% Shredlike xenoblastic grains 0.3 mm. to microcrystalline.
Biotite 1% Shredlike xenoblastic grains 0.05 mm. to microcrystalline; pleochroic from pale greenish-yellow to very dark brownish-green; occur in lens-shaped aggregates; weak preferred orientation.
Microcline Tr. Xenoblastic grains 0.3 mm. to microcrystalline.
Leucoxene Tr.

Epidote Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, very fine-grained.
Probable rock: Sericite-quartz gneiss to quartzite.

Indian Territory	Yuma County	CL-167
Illuminating Oil	2S-43W, sec 21	YU-7-2
#1 Strangeways		Cuttings
		5590-95 ft.

Quartz 75% Xenoblastic grains 0.2 mm. to microcrystalline; slightly strained; some grains occur in aggregates.
Sericite 13% Microcrystalline shredlike xenoblastic grains; weak preferred orientation.
Muscovite 5% Shredlike xenoblastic grains 0.2 to 0.01 mm.
Biotite 5% Shredlike xenoblastic grains 0.1 mm. to microcrystalline; pleochroic from pale yellow to brown or from pale green to dark greenish-brown; occur in lens-shaped aggregates; weak preferred orientation.
Calcite 2% Xenoblastic grains and masses 0.2 mm. to microcrystalline.
Plagioclase Tr. Oligoclase; xenoblastic grains 0.2 mm. to microcrystalline; albite twins.
Tourmaline Tr. Fractured xenoblastic grains 0.01 mm. to microcrystalline; pleochroic from pale purplish-gray to very dark bluish-gray.
Leucoxene Tr.
Magnetite Tr.
Hematite Tr.
Pyrite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, very fine-grained.
Probable rock: Biotite-muscovite-sericite-quartz gneiss to quartzite.

Indian Territory	Yuma County	CL-167
Illuminating Oil	2S-43W, sec 21	YU-7-3
#1 Strangeways		Cuttings
		5565-80 ft.

Variety #1, fragments make up 85% of thin section.

Quartz 45% Xenoblastic grains 0.1 mm. to microcrystalline; slightly strained.
Biotite 20% Idioblastic to xenoblastic grains 0.05 mm. to microcrystalline; pleochroic from pale yellowish-green to dark green and from pale yellow to bluish-green; preferred orientation.
Sericite 15% Microcrystalline xenoblastic grains; alteration product.
Muscovite 15% Shredlike xenoblastic grains 0.2 mm. to microcrystalline.
Leucoxene 5% Opaque xenoblastic masses 0.01 mm. to microcrystalline.

Fabric: Schistose, lepidoblastic, non-porphyroblastic, very fine-grained.
Probable rock: Muscovite-sericite-biotite-quartz schist.

Variety #2, fragments make up 15% of thin section.

Quartz 72% Xenoblastic grains 5.0 to 0.01 mm.; strongly strained and fractured; grain borders sutured and granulated.
Biotite 20% Idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from yellowish-green to deep green.
Muscovite 5% Xenoblastic grains 0.1 to 0.01 mm.; associated with biotite.
Magnetite 2% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Sericite 1% Microcrystalline grains and masses; alteration product of plagioclase.
Leucoxene Tr.
Pyrite Tr.

Fabric: Granoblastic to cataclastic, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Muscovite-biotite-quartz gneiss.

Lion Oil Co.	Yuma County	CL-170
#1 Chrismer	2N-48W, sec 2	YU-10-1
		Cuttings
		6785-88 ft.

Plagioclase 50% Oligoclase to andesine; xenoblastic grains 1.0 to 0.05 mm.; slightly to strongly altered to sericite; albite, pericline, and Carlsbad twins; albite rims; myrmekitic.
Quartz 25% Xenoblastic grains 2.0 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders; contain microcrystalline needles of rutile.
Microcline 15% Xenoblastic grains 3.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz and plagioclase.

Biotite 10% Shredlike xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellowish-green to dark green; moderately altered to chlorite; preferred orientation.
Epidote Tr. Xenoblastic grains 0.5 to 0.05 mm.; fractured; associated with biotite.
Sphene Tr. Xenoblastic grains 0.1 to 0.05 mm.; associated with magnetite.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.
Pyrite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Ohio Oil Co.	Yuma County	CL-171
#1 Brophy	4N-46W, sec 31	YU-11-1
		Cuttings
		6365-70 ft.

Plagioclase 35% Oligoclase to andesine; xenoblastic grains 1.0 to 0.05 mm.; strongly to severely altered to sericite; albite twins indistinct.
Quartz 32% Elongate xenoblastic grains 0.5 to 0.01 mm.; moderately to strongly strained and fractured; grain borders sutured and slightly granulated.
Microcline 20% Xenoblastic grains 1.0 to 0.05 mm.; distinct polysynthetic twins; poikiloblastically enclose plagioclase and quartz.
Biotite 10% Elongate xenoblastic grains 0.2 to 0.01 mm.; pleochroic from pale brownish-green to dark brownish-green; strongly to severely altered to chlorite (pennine); preferred orientation.
Sphene 2% Xenoblastic grains 0.1 to 0.01 mm.; moderately to strongly altered to leucoxene.
Epidote 1% Xenoblastic grains 0.2 to 0.01 mm.; fractured; associated with biotite.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.
Pyrite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, cataclastic, fine-grained.

Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Shell Oil Co.	Yuma County	CL-173
#1 Olsen	4N-48W, sec 21	YU-13-1
		Cuttings
		6675-80 ft.

Microcline 40% Xenoblastic grains 4.0 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz and plagioclase.
Plagioclase 30% Oligoclase; xenoblastic grains 2.0 to 0.1 mm.; moderately altered to sericite; albite, pericline, and Carlsbad twins; albite rims; myrmekitic.
Quartz 25% Xenoblastic grains 2.0 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders.
Biotite 5% Xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale brown to dark brown; moderately altered to chlorite; preferred orientation.
Muscovite Tr.
Zircon Tr.
Hematite Tr.
Pyrite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

Texaco, Inc.	Yuma County	CL-174
#1 Blach	1S-47W, sec 19	YU-14-1
		Core chip
		6545-46 ft.

Quartz 95% Subangular to subrounded fragments 4.0 to 0.5 mm. composed of xenoblastic grains 0.5 to 0.01 mm.; strongly to severely strained; grain borders intricately sutured and granulated; some fragments composed of cryptocrystalline silica.
Hematite 5% Xenoblastic masses 0.1 mm. to microcrystalline; occur interstitially to quartzite fragments.
Sericite Tr.
Leucoxene Tr.
Pyrite Tr.

Fabric: Sedimentary, detrital, fine-grained.

Probable rock: Hematitic quartz sandstone.

Texaco, Inc.	Yuma County	CL-174
#1 Blach	1S-47W, sec 19	YU-14-2
		2 Core chips
		6550-51 ft.

Quartz 73% Subangular to subrounded fragments 1.0 to 0.1 mm. composed of xenoblastic grains 0.3 to 0.01 mm.; strongly to severely strained; grain borders intricately sutured.
Hematite 20% Xenoblastic masses 0.1 mm. to microcrystalline; occur in bands or layers and interstitially to quartzite fragments.
Biotite 5% Shredlike xenoblastic grains and fragments 0.05 to 0.01 mm.; pleochroic from pale green to dark green; severely altered to chlorite, muscovite, and hematite.
Sericite 2%
Leucoxene Tr.
Calcite Tr.

Fabric: Sedimentary, detrital, very fine-grained.
Probable rock: Hematite-bearing siltstone.

Texaco, Inc.	Yuma County	CL-174
#1 Blach	1S-47W, sec 19	YU-14-3
		Core chip
		6547-48 ft.

Quartz 45% Subangular to subrounded fragments 1.0 to 0.05 mm. composed of xenoblastic grains 0.3 to 0.01 mm.; moderately to severely strained; grain borders intricately sutured.
Hematite 40% Xenoblastic masses 0.2 mm. to microcrystalline; occur in bands or layers and interstitially to quartzite fragments.
Sericite 15% Microcrystalline grains associated with hematite-rich layers.
Biotite Tr. Shredlike xenoblastic grains and fragments 0.2 to 0.01 mm.; pleochroic from pale green to dark green; severely altered to muscovite and hematite.
Tourmaline Tr. Idioblastic to xenoblastic grains 0.1 to 0.01 mm.; pleochroic from colorless to greenish-gray; fractured.

Fabric: Sedimentary, detrital, fine-grained.
Probable rock: Hematite-bearing siltstone.

California Oil Co.	Yuma County	CL-206
#1 Lloyd Mumm	3S-48W, sec 1	YU-16-1
		Core chip
		6525 ft.

Plagioclase 48% Oligoclase; weakly-zoned idioblastic to xenoblastic grains 5.0 to 0.3 mm.; slightly to strongly altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose quartz and biotite; myrmekitic.
Quartz 25% Xenoblastic grains 6.0 to 0.01 mm.; strongly strained and fractured; grain borders sutured and granulated.
Biotite 15% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellow to dark greenish-brown; poikiloblastically enclose apatite and zircon; preferred orientation.
Microcline 10% Xenoblastic grains 4.5 to 0.5 mm.; poikiloblastically encloses quartz, plagioclase, and biotite; grains make up augen of microcline.
Muscovite 2% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Microcline-biotite-quartz-plagioclase augen gneiss.

California Oil Co.	Yuma County	CL-206
#1 Lloyd Mumm	3S-48W, sec 1	YU-16-2
		Core chip
		6525 ft.

Plagioclase 57% Oligoclase; weakly zoned idioblastic to xenoblastic grains 5.5 to 0.2 mm.; slightly to strongly altered to sericite; albite, pericline and Carlsbad twins; poikiloblastically enclose quartz and biotite.
Quartz 20% Xenoblastic grains 5.5 to 0.05 mm.; strongly strained and fractured; grain borders sutured and granulated.
Biotite 20% Idioblastic to xenoblastic grains 3.0 to 0.1 mm.; pleochroic from pale yellow to dark greenish-brown; poikiloblastically enclose apatite and zircon; preferred orientation.
Muscovite 3% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Leucoxene Tr.

Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-plagioclase gneiss.

California Oil Co.	Yuma County	CL-206
#1 Lloyd Mumm	3S-48W, sec 1	YU-16-3
		Core chip
		6525 ft.

Plagioclase 48% Oligoclase; weakly zoned idioblastic to xenoblastic grains 6.5 to 0.3 mm.; slightly to strongly altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose quartz and biotite.
Quartz 35% Xenoblastic grains 5.0 to 0.01 mm.; strongly strained and fractured; grain borders sutured and granulated.
Biotite 15% Idioblastic to xenoblastic grains 2.0 to 0.1 mm.; pleochroic from pale yellow to dark greenish-brown; poikiloblastically enclose apatite, zircon, and sphene; slightly altered to chlorite; preferred orientation.
Muscovite 2% Idioblastic to xenoblastic grains 0.3 to 0.05 mm.; associated with biotite.
Microcline Tr. Xenoblastic grains 0.3 to 0.1 mm.; associated with large grains of plagioclase.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-plagioclase gneiss.

California Oil Co.	Yuma County	CL-206
#1 Lloyd Mumm	3S-48W, sec 1	YU-16-4
		Core chip
		6525 ft.

Plagioclase 58% Oligoclase; weakly zoned idioblastic to xenoblastic grains 6.0 to 0.2 mm.; slightly to strongly altered to sericite;

albite, pericline and Carlsbad twins; poikiloblastically enclose quartz and biotite; myrmekitic.
Quartz 30% Xenoblastic grains 5.5 to 0.05 mm.; strongly to severely strained and fractured; grain borders sutured and granulated.
Biotite 10% Idioblastic to xenoblastic grains 2.5 to 0.1 mm.; pleochroic from pale greenish-yellow to dark greenish-brown; poikiloblastically enclose apatite and zircon; preferred orientation.
Muscovite 2% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Microcline Tr. Xenoblastic grains 0.5 to 0.05 mm.; associated with large grains of plagioclase; also occurs interstitially.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-plagioclase gneiss.

California Oil Co.	Yuma County	CL-206
#1 Lloyd Mumm	3S-48W, sec 1	YU-16-5
		Core chip
		6525 ft.

Plagioclase 58% Oligoclase; weakly zoned idioblastic to xenoblastic grains 7.0 to 0.2 mm.; slightly to strongly altered to sericite; albite and Carlsbad twins; poikiloblastically enclose quartz, biotite, and sphene.
Quartz 30% Xenoblastic grains 5.0 to 0.05 mm.; strongly strained and fractured; grain borders sutured and granulated.
Biotite 10% Idioblastic to xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale greenish-yellow to dark brownish-green; poikiloblastically enclose apatite, zircon, and sphene; preferred orientation.
Muscovite 2% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Microcline Tr. Xenoblastic grains 0.2 to 0.05 mm.; associated with plagioclase.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-plagioclase gneiss.

California Oil Co.	Yuma County	CL-206
#1 Lloyd Mumm	3S-48W, sec 1	YU-16-6
		Core chip
		6525 ft.

Plagioclase 58% Oligoclase; weakly zoned idioblastic to xenoblastic grains 6.5 to 0.3 mm.; slightly to strongly altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose quartz and biotite.
Quartz 30% Xenoblastic grains 6.0 to 0.05 mm.; strongly strained and fractured; grain borders sutured and granulated.
Biotite 10% Idioblastic to xenoblastic grains 2.5 to 0.05 mm.; pleochroic from pale greenish-yellow to dark brownish-green; slightly altered to chlorite; poikiloblastically enclose apatite, zircon, and sphene; preferred orientation.
Muscovite 2% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-plagioclase gneiss.

APPENDIX III: DETAILED PETROGRAPHIC DESCRIPTIONS OF SAMPLES COLLECTED FROM THE EXPOSED BASEMENT OF COLORACO

Samples listed in numerical order from PRC-27-1 to PRC-27-133.

Thin sections are on permanent file in the Petrologic Reference Collection, Department of Geological Engineering, Colorado School of Mines, Golden, Colorado.

Colo. Rte. 119 at intersection U.S. Rte. 6 | Gilpin County 3S-72W, sec 36 | PRC-27-1 (IS-1)

Quartz 40% Xenoblastic grains 4.0 to 0.05 mm.; strongly to severely strained and fractured; grain borders sutured and slightly granulated.
Microcline 35% Xenoblastic grains 3.0 to 0.2 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase, quartz, and biotite.
Plagioclase 15% Oligoclase; xenoblastic grains 1.5 to 0.1 mm.; slightly to moderately altered to sericite; albite twins; albite rims; myrmekitic.
Biotite 5% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-green to dark brownish green; preferred orientation.
Magnetite 4% Xenoblastic grains 0.5 to 0.05 mm.
Sphene 1%
Muscovite Tr.
Epidote Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-plagioclase-microcline-quartz gneiss.

Colo. Rte. 119 at intersection U.S. Rte. 6 | Gilpin County 3S-72W, sec 36 | PRC-27-2 (IS-2)

Plagioclase 40% Oligoclase to andesine; xenoblastic grains 3.0 to 0.05 mm.; slightly to moderately altered to sericite; albite and pericline twins; poikiloblastically enclose quartz, hornblende, biotite, and magnetite; large grains occur with quartz in felsic layers.
Hornblende 35% Corroded xenoblastic grains 2.0 to 0.05 mm.; ragged terminations; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose plagioclase, biotite, magnetite, and apatite; preferred orientation.
Quartz 10% Xenoblastic grains 1.0 to 0.01 mm.; slightly to moderately strained.
Biotite 10% Elongate idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark brown; associated with hornblende; preferred orientation.
Magnetite 5% Xenoblastic grains 1.0 to 0.01 mm.
Apatite Tr.

Zircon Tr.
Pyrite Tr.

Fabric: Schistose, nematoblastic to lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-quartz-hornblende-plagioclase gneiss to amphibolite.

Colo. Rte. 119 — Gilpin County — PRC-27-3
0.5 mi north of intersection of U.S. Rte. 6 — 3S-72W, sec 25 — (IS-3)

Quartz 50% Xenoblastic grains 8.0 to 0.05 mm.; moderately strained and fractured; larger grains occur as elongate lenses; poikiloblastically enclose biotite.
Plagioclase 35% Oligoclase to andesine; xenoblastic grains 2.5 to 0.1 mm.; slightly to strongly altered to sericite; albite and pericline twins; poikiloblastically enclose biotite and quartz.
Biotite 10% Idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark brown; preferred orientation.
Hornblende 5% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from yellowish-green to dark green or bluish-green; associated with biotite; preferred orientation.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic to nematoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Hornblende-biotite-plagioclase-quartz gneiss.

Colo. Rte. 119 — Gilpin County — PRC-27-4
5 mi. SE of Black Hawk — 3S-72W, sec 26 — (IS-4)

Quartz 55% Xenoblastic grains 2.0 to 0.01 mm.; slightly to moderately strained and fractured; poikiloblastically enclose biotite and sillimanite.
Biotite 25% Idioblastic to xenoblastic grains 3.0 to 0.01 mm.; pleochroic from pale yellowish-brown to dark brown; moderately altered to chlorite (pennine); preferred orientation.

Sillimanite 14% Elongate idioblastic grains 0.2 mm. to microcrystalline; occur in aggregates up to 6.0 mm.; associated with biotite and quartz; preferred orientation.
Muscovite 5% Idioblastic to xenoblastic grains 2.0 to 0.05 mm.; associated with biotite.
Magnetite 1%
Zircon Tr.
Hematite Tr.
Pyrite Tr.

Fabric: Schistose, lepidoblastic to nematoblastic, porphyroblastic, medium-grained.
Probable rock: Muscovite-sillimanite-biotite-quartz schist.

Colo. Rte. 119 3 mi SE of Black Hawk	Gilpin County 3S-72W, sec 16	PRC-27-5 (IS-5a)

Hornblende 45% Idioblastic to xenoblastic grains 1.5 to 0.05 mm.; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose plagioclase; preferred orientation.
Plagioclase 30% Andesine to labradorite; xenoblastic grains 0.5 to 0.05 mm.; slightly to completely altered to sericite; albite and pericline twins; zoned.
Epidote 15% Xenoblastic grains 3.0 to 0.05 mm.; poikiloblastically enclose hornblende, tremolite, sericite, and calcite; occur in altered bands.
Quartz 5% Xenoblastic grains 1.0 to 0.05 mm.; moderately to strongly strained.
Tremolite 5% Corroded xenoblastic grains 1.5 to 0.1 mm.; pleochroic from very pale green to pale bluish-green; alteration product of hornblende; associated with epidote; preferred orientation.
Sphene Tr.
Magnetite Tr.
Pyrite Tr.
Calcite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Tremolite-quartz-epidote-plagioclase-hornblende gneiss to amphibolite.

Colo. Rte. 119 | Gilpin County | PRC-27-6
3 mi. SE of Black Hawk | 3S-72W, sec 16 | (IS-5b)

Quartz 50% Xenoblastic grains 1.5 to 0.05 mm.; moderately to strongly strained and fractured.
Plagioclase 40% Andesine; xenoblastic grains 1.0 to 0.1 mm.; slightly altered to sericite; albite and pericline twins; poikiloblastically enclose quartz.
Biotite 7% Elongate idioblastic to xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark brown; moderately altered to chlorite; preferred orientation.
Muscovite 2% Shredlike xenoblastic grains 1.5 to 0.05 mm.
Garnet 1% Xenoblastic grains 1.5 to 0.01 mm.; pale pink color; isotropic; fractured; poikiloblastically enclose quartz.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Pyrite Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-plagioclase-quartz gneiss.

Colo. Rte. 119 | Gilpin County | PRC-27-7
1 mi. east of Black Hawk | 3S-72W, sec 8 | (IS-6)

Quartz 43% Xenoblastic grains 1.0 to 0.01 mm.; moderately to strongly strained and fractured.
Microcline 25% Xenoblastic grains 2.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase, quartz, biotite, muscovite and magnetite.
Plagioclase 15% Oligoclase; xenoblastic grains 1.0 to 0.05 mm.; unaltered; albite and pericline twins indistinct.
Biotite 15% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellow to dark brown; preferred orientation.
Muscovite 2% Shredlike xenoblastic grains 1.0 to 0.05 mm.; associated with biotite.
Sillimanite Tr.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-microcline-quartz gneiss.

Colo. Rte. 119 — Gilpin County — PRC-27-8
1 mi. east of Black Hawk — 3S-72W, sec 8 — (IS-7a)

Quartz 63% Xenoblastic grains 1.5 to 0.01 mm.; moderately to severely strained and fractured; grain borders intricately sutured and granulated.
Biotite 15% Xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale yellowish-brown to very dark brown; preferred orientation.
Sillimanite 15% Elongate idioblastic grains 0.3 mm. to microcrystalline; occur in aggregates up to 5.0 mm.; associated with quartz and muscovite; preferred orientation.
Muscovite 5% Idioblastic to xenoblastic grains 1.5 to 0.01 mm.; associated with biotite.
Microcline 1%
Magnetite 1%
Sphene Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose to schistose, lepidoblastic and nematoblastic, porphyroblastic, fine-grained.
Probable rock: Muscovite-sillimanite-biotite-quartz gneiss.

Colo. Rte. 119 — Gilpin County — PRC-27-9
1 mi. east of Black Hawk — 3S-72W, sec 8 — (IS-8)

Quartz 60% Xenoblastic grains 1.5 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders.
Plagioclase 25% Oligoclase; xenoblastic grains 1.0 to 0.2 mm.; unaltered; albite and pericline twins.
Biotite 10% Elongate xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale yellow to very dark brown; preferred orientation.
Microcline 3% Xenoblastic grains 1.0 to 0.1 mm.; distinct polysynthetic twins.
Magnetite 2% Xenoblastic grains 0.5 to 0.01 mm.
Muscovite Tr.
Sphene Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-quartz gneiss.

Intersection Colo. Rtes. 119 and 279 at Black Hawk	Gilpin County 3S-72W, sec 7	PRC-27-10 (IS-9)

Quartz 50% Xenoblastic grains 19.0 to 0.05 mm.; moderately to strongly strained and fractured; poikiloblastically enclose diopside, hornblende, apatite, garnet, and calcite; larger grains occur as very elongate lenses.
Garnet 35% Aggregates of xenoblastic grains 20.0 to 0.1 mm.; pale pink color; isotropic; fractured; poikiloblastically enclose hornblende, diopside, epidote, quartz and apatite.
Diopside 10% Idioblastic grains 1.5 to 0.05 mm.; very pale gray to green color; fractured.
Hornblende 4% Corroded idioblastic to xenoblastic grains 1.5 to 0.1 mm.; pleochroic from pale yellowish-green to bluish-green; associated with diopside.
Epidote 1% Xenoblastic grains 1.5 to 0.05 mm.; associated with diopside in garnet.
Apatite Tr.
Zircon Tr.
Calcite Tr.

Fabric: Granoblastic, porphyroblastic, medium- to coarse-grained; coarsely banded.
Probable rock: Diopside-garnet-quartz skarn.

Intersection Colo. Rtes. 119 and 279 at Black Hawk	Gilpin County 3S-72W, sec 7	PRC-27-11 (IS-10)

Epidote 46% Xenoblastic grains 25.0 to 0.01 mm.; poikiloblastically enclose diopside, calcite, garnet, sphene, hornblende, and quartz.
Diopside 35% Idioblastic to xenoblastic grains 3.5 to 0.05 mm.; very pale green color; fractured.
Hornblende 5% Corroded xenoblastic grains 1.5 to 0.01 mm.; pleochroic from yellowish-green to dark green or bluish-green; associated with diopside.
Quartz 5% Xenoblastic grains 1.0 to 0.01 mm.; strongly strained and fractured.
Sphene 5% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.
Garnet 4% Xenoblastic grains 2.0 to 0.1 mm.; pink color; isotropic; fractured.
Apatite Tr.
Calcite Tr.

Fabric: Granoblastic, porphyroblastic, medium- to coarse-grained; coarsely banded.
Probable rock: Quartz-hornblende-diopside-epidote skarn.

Intersection Colo. Rtes. 119 and 279 at Black Hawk	Gilpin County 3S-72W, sec 7	PRC-27-12 (IS-11)

Epidote 70% Xenoblastic grains 7.0 to 0.01 mm.; poikiloblastically enclose diopside, hornblende, and sphene.
Diopside 15% Idioblastic to xenoblastic grains 4.5 to 0.05 mm.; very pale green color; fractured.
Hornblende 10% Idioblastic to xenoblastic grains 1.0 to 0.01 mm.; pleochroic from yellowish-green to dark green or bluish-green; smaller grains associated with diopside.
Sphene 5% Idioblastic to xenoblastic grains 1.0 to 0.01 mm.
Apatite Tr.
Calcite Tr.
Pyrite Tr.

Fabric: Granoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Hornblende-diopside-epidote skarn.

Colo. Rte. 279 0.5 mi. south of Central City	Gilpin County 3S-73W, sec 13	PRC-27-13 (IS-12-1)

Plagioclase 45% Oligoclase; idioblastic to xenoblastic grains 6.0 to 0.2 mm.; moderately to strongly altered to sericite; albite, pericline, and Carlsbad twins; zoned; poikiloblastically enclose biotite, magnetite, and small blebs of quartz.
Quartz 24% Xenoblastic grains 6.0 to 0.01 mm.; strongly strained and fractured; sutured borders; poikiloblastically enclose magnetite and apatite.
Biotite 20% Xenoblastic grains 3.0 to 0.1 mm.; pleochroic from pale yellowish-brown to very dark greenish-brown; poikiloblastically enclose apatite; small intergrowths of quartz.
Microcline 5% Xenoblastic grains 3.0 to 0.1 mm.; distinct to indistinct polysynthetic twins; faintly microperthitic; poikiloblastically enclose magnetite and small blebs of quartz.
Sphene 3% Xenoblastic grains 1.5 to 0.05 mm.; associated with biotite; strongly to severely altered to leucoxene.
Magnetite 2% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; asso-

ciated with biotite and sphene.
Apatite 1%
Epidote Tr.
Hornblende Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Microcline-biotite-quartz-plagioclase gneiss.

Colo. Rte. 279 0.5 mi south of Central City	Gilpin County 3S-73W, sec 13	PRC-27-14 (IS-12-2)

Plagioclase 55% Oligoclase; idioblastic to xenoblastic grains 5.0 to 0.2 mm.; moderately to strongly altered to sericite; albite, pericline, and Carlsbad twins; zoned; poikiloblastically enclose biotite, magnetite, apatite, and small blebs of quartz; myrmekitic.
Quartz 20% Xenoblastic grains 5.5 to 0.01 mm.; strongly to severely strained and fractured; poikiloblastically enclose plagioclase and apatite.
Biotite 15% Xenoblastic grains 3.0 to 0.05 mm.; pleochroic from pale yellow to dark brownish-green; poikiloblastically enclose apatite and magnetite.
Microcline 4% Xenoblastic grains 2.0 to 0.5 mm.; indistinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase and small blebs of quartz.
Sphene 3% Xenoblastic grains 1.0 to 0.05 mm.; associated with biotite; strongly to severely altered to leucoxene.
Apatite 2%
Magnetite 1%
Epidote Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-plagioclase gneiss.

Colo. Rte. 279 1 mi. SW of Central City	Gilpin County 3S-73W, sec 14	PRC-27-15 (IS-13)

Microcline 38% Xenoblastic grains 10.0 to 0.05 mm.; microperthitic; poikiloblastically enclose quartz, plagioclase, biotite, and

apatite.
Plagioclase 30% Oligoclase; xenoblastic grains 4.5 to 0.1 mm.; slightly altered to sericite; albite and pericline twins; poikiloblastically enclose biotite; myrmekitic.
Quartz 25% Xenoblastic grains 3.0 to 0.05 mm.; strongly to severely strained and fractured; sutured borders; poikiloblastically enclose biotite.
Biotite 5% Xenoblastic grains 1.0 to 0.01 mm.; pleochroic from light yellowish-brown to very dark brownish-green; small intergrowths of quartz; preferred orientation.
Hornblende 1%
Sphene 1%
Epidote Tr.
Allanite Tr.
Apatite Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: <u>Biotite-quartz-plagioclase-microcline gneiss</u>.

Colo. Rte. 279 1.5 mi. north of Idaho Springs	Clear Creek County 3S-73W, sec 25	PRC-27-16 (IS-14)

Quartz 54% Xenoblastic grains 1.0 to 0.01 mm.; severely strained and fractured; grain borders intricately sutured and slightly granulated.
Plagioclase 25% Oligoclase; xenoblastic grains 2.0 to 0.1 mm.; slightly to moderately altered to sericite; albite and pericline twins; myrmekitic.
Biotite 15% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from light yellowish-brown to very dark brown; preferred orientation.
Sillimanite 3% Elongate idioblastic grains 0.2 mm. to microcrystalline; occur in elongate aggregates; associated with biotite and quartz; preferred orientation.
Muscovite 2% Elongate idioblastic to xenoblastic grains 1.0 to 0.5 mm.; associated with biotite and sillimanite; preferred orientation.
Microcline 1%
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-quartz gneiss.

Colo. Rte. 279 1.5 mi. north of Idaho Springs	Clear Creek County 3S-73W, sec 26	PRC-27-17a&b (IS-15, 2 thin sections)

Quartz 40% Xenoblastic grains 6.0 to 0.01 mm.; severely strained and fractured; sutured borders.
Biotite 30% Elongate xenoblastic grains 2.5 to 0.01 mm.; pleochroic from light yellowish-brown to very dark brown; preferred orientation.
Sillimanite 15% Elongate idioblastic grains 0.2 mm. to microcrystalline; occur in layers; associated with biotite; preferred orientation.
Sericite 15% Xenoblastic masses of microcrystalline grains 6.0 to 0.05 mm.; alteration product of original plagioclase grains; also associated with biotite and sillimanite.
Muscovite Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Schistose, lepidoblastic to nematoblastic, porphyroblastic, fine- to medium-grained.
Probable rock: Plagioclase-sillimanite-biotite-quartz schist.

Colo. Rte. 279 1.5 mi. north of Idaho Springs	Clear Creek County 3S-73W, sec 26	PRC-27-18 (IS-16)

Quartz 50% Xenoblastic grains 6.0 to 0.01 mm.; severely strained and fractured; grain borders intricately sutured and slightly granulated; larger grains occur in felsic layer.
Plagioclase 30% Oligoclase; xenoblastic grains 8.0 to 0.05 mm.; strongly to completely altered to sericite; albite twins indistinct; poikiloblastically enclose quartz, biotite, muscovite, and apatite; large grains occur with quartz in felsic layer; myrmekitic.
Biotite 10% Elongate xenoblastic grains 1.5 to 0.01 mm.; pleochroic from light yellowish-brown to very dark brown; preferred orientation.
Sillimanite 5% Elongate idioblastic grains 0.1 mm. to microcrystal-

line; associated with biotite; preferred orientation.
Muscovite 5% Xenoblastic grains 1.5 to 0.05 mm.; associated with biotite and sillimanite.
Microcline Tr.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Hematite Tr.

Fabric: Granoblastic to schistose, lepidoblastic, non-porphyroblastic, fine- to coarse-grained; coarsely banded.
Probable rock: Muscovite-sillimanite-biotite-plagioclase-quartz migmatite schist.

U.S. Rtes. 6 and 40	Clear Creek County	PRC-27-19
1 mi. east of Lawson	3S-74W, sec 24	(IS-18)

Plagioclase 45% Oligoclase to andesine; idioblastic to xenoblastic grains 4.0 to 0.1 mm.; moderately to strongly altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose quartz, biotite, and magnetite; myrmekitic.
Quartz 27% Xenoblastic grains 5.0 to 0.05 mm.; strongly to severely strained and fractured; sutured borders; contain microcrystalline needles of rutile.
Microcline 15% Xenoblastic grains 3.0 to 0.2 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase, biotite, and quartz.
Biotite 10% Xenoblastic grains 2.0 to 0.05 mm.; pleochroic from pale yellow to very dark brown; slightly altered to chlorite; weak preferred orientation.
Muscovite 2% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Magnetite 1%
Sphene Tr.
Zircon Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-microcline-quartz-plagioclase migmatite gneiss.

U.S. Rtes. 6 and 40	Clear Creek County	PRC-27-20
1 mi. east of Lawson	3S-74W, sec 24	(IS-19)

Microcline 45% Idioblastic to xenoblastic grains 6.0 to 0.2 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz and plagioclase.
Plagioclase 35% Oligoclase to andesine; xenoblastic grains 4.0 to 0.1 mm.; strongly altered to sericite; albite, pericline and Carlsbad twins indistinct; myrmekitic.
Quartz 20% Xenoblastic grains 6.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and slightly granulated; contain microcrystalline needles of rutile.
Muscovite Tr.
Biotite Tr.
Sphene Tr.

Fabric: Granoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Quartz-plagioclase-microcline gneiss.

U.S. Rtes 6 and 40	Clear Creek County	PRC-27-21
1 mi. east of Lawson	3S-74W, sec 24	(IS-20)

Microcline 40% Idioblastic to xenoblastic grains 3.0 to 0.2 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose plagioclase, biotite and quartz.
Quartz 25% Xenoblastic grains 9.0 to 0.01 mm.; severely strained and fractured; grain borders sutured and slightly granulated; contain microcrystalline needles of rutile.
Plagioclase 20% Oligoclase to andesine; xenoblastic grains 8.0 to 0.1 mm.; strongly altered to sericite; albite and Carlsbad twins indistinct; poikiloblastically enclose quartz, biotite and magnetite.
Biotite 10% Xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale yellow to very dark brown; slightly altered to chlorite; weak preferred orientation.
Muscovite 3% Idioblastic to xenoblastic grains 1.0 to 0.05 mm.; associated with biotite.
Magnetite 2%
Sphene Tr.
Zircon Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-plagioclase-quartz-microcline migmatite gneiss.

U.S. Rtes. 6 and 40	Clear Creek County	PRC-27-22
1 mi. east of Lawson	3S-74W, sec 24	(IS-21)

Microcline 35% Xenoblastic grains 2.5 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz and plagioclase.
Quartz 25% Xenoblastic grains 7.0 to 0.01 mm.; severely strained and fractured; grain borders sutured and granulated; contain microcrystalline needles of rutile.
Biotite 20% Elongate idioblastic to xenoblastic grains 4.0 to 0.05 mm.; pleochroic from light yellowish-brown to very dark brown; preferred orientation.
Plagioclase 15% Oligoclase to andesine; xenoblastic grains 5.0 to 0.05 mm.; slightly to moderately altered to sericite; albite and pericline twins; poikiloblastically enclose quartz and biotite; myrmekitic.
Muscovite 3% Xenoblastic grains 0.3 to 0.05 mm.; associated with biotite.
Magnetite 2% Xenoblastic grains 1.5 to 0.05 mm.; associated with biotite.
Sphene Tr.
Zircon Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium-grained; coarsely-banded.
Probable rock: Plagioclase-biotite-quartz-microcline migmatite gneiss.

Swandyke	Summit County	PRC-27-23
	6S-76W, sec 17	(Sg-1)

Plagioclase 50% Andesine to labradorite; xenoblastic grains 1.5 to 0.2 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins.
Hornblende 30% Idioblastic to xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale yellowish-green to dark green; poikiloblastically enclose plagioclase, diopside, and apatite; preferred orientation.
Diopside 10% Corroded xenoblastic grains 0.5 to 0.1 mm.; very pale green color; fractured; associated with hornblende.
Quartz 10% Xenoblastic grains 9.0 to 0.05 mm.; strongly strained and fractured; sutured borders; occur in felsic layer.
Microcline Tr.
Sphene Tr.
Apatite Tr.

Magnetite Tr.
Pyrite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Quartz-diopside-hornblende-plagioclase gneiss to amphibolite.

Swandyke	Summit County 6S-76W, sec 18	PRC-27-24 (Sg-2)

Plagioclase 44% Andesine; xenoblastic grains 1.0 to 0.05 mm.; slightly altered to sericite; albite and pericline twins.
Quartz 30% Xenoblastic grains 3.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders intricately sutured and granulated; larger grains very elongate.
Hornblende 10% Corroded xenoblastic grains 1.0 to 0.01 mm.; pleochroic from yellowish-green to dark green; poikiloblastically enclose quartz and biotite; preferred orientation.
Biotite 5% Shredlike xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale yellowish-brown to very dark brown; slightly altered to chlorite; associated with hornblende; preferred orientation.
Magnetite 5% Xenoblastic grains 0.5 to 0.01 mm.; associated with hornblende and biotite.
Sphene 5% Xenoblastic grains 0.5 to 0.01 mm.; moderately altered to leucoxene.
Epidote 1%
Apatite Tr.

Fabric: Gneissose, nematoblastic to lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-hornblende-quartz-plagioclase gneiss.

Swandyke	Summit County 6S-76W, sec 18	PRC-27-25 (Sg-3)

Plagioclase 43% Oligoclase to andesine; xenoblastic grains 1.5 to 0.05 mm.; slightly altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose quartz and biotite.
Quartz 35% Xenoblastic grains 4.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders intricately sutured and granulated; large grains very elongate.
Biotite 20% Elongate xenoblastic grains 1.0 to 0.01 mm.; pleochroic

from pale greenish-yellow to very dark greenish-brown; slightly altered to chlorite; preferred orientation.
Apatite 1%
Magnetite 1%
Sphene Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-quartz-plagioclase gneiss.

Mountain slope 1.0 mi. west of Swandyke	Summit County 6S-76W, sec 18	PRC-27-26 (Sg-4)

Plagioclase 47% Andesine to labradorite; xenoblastic grains 1.0 to 0.1 mm.; moderately to severely altered to sericite; albite and pericline twins; zoned.
Hornblende 45% Xenoblastic grains 1.5 to 0.05 mm.; ragged terminations; pleochroic from yellowish-green to dark green or bluish-green; preferred orientation.
Magnetite 3% Idioblastic to xenoblastic grains 0.5 to 0.01 mm.
Quartz 3% Xenoblastic grains 3.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders intricately sutured and granulated; larger grains occur in veinlets.
Apatite 1%
Pyrite 1%
Biotite Tr.
Epidote Tr.
Calcite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Amphibolite.

Mountain slope 1.5 mi. west of Swandyke	Summit County 6S-76W, sec 18	PRC-27-27 (Sg-5)

Plagioclase 42% Andesine; xenoblastic grains 0.5 to 0.05 mm.; moderately to severely altered to sericite; albite and pericline twins indistinct.
Hornblende 35% Xenoblastic grains 1.5 to 0.05 mm.; ragged terminations; pleochroic from yellowish-green to dark green or bluish-

green; twinned; preferred orientation.
Sphene 8% Xenoblastic grains 0.3 to 0.01 mm.; associated with hornblende and magnetite.
Quartz 5% Xenoblastic grains 0.5 to 0.01 mm.; strongly strained and fractured; sutured borders.
Biotite 5% Elongate xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; twinned; preferred orientation.
Magnetite 5% Xenoblastic grains 0.5 to 0.01 mm.
Epidote Tr.
Apatite Tr.
Pyrite Tr.
Calcite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Amphibolite.

Mountain slope 1.5 mi. west of Swandyke	Summit County 6S-77W, sec 13	PRC-27-28 (Sg-6)

Plagioclase 47% Andesine; xenoblastic grains 1.0 to 0.1 mm.; slightly to completely altered to sericite; albite and pericline twins.
Hornblende 45% Idioblastic to xenoblastic grains 3.0 to 0.05 mm.; pleochroic from yellowish-green to dark green or bluish-green; twinned; preferred orientation.
Biotite 3% Elongate idioblastic grains 0.5 to 0.01 mm.; pleochroic from pale greenish-yellow to very dark greenish-brown; moderately to strongly altered to chlorite (pennine); preferred orientation.
Quartz 3% Xenoblastic grains 0.2 to 0.05 mm.; moderately to strongly strained.
Apatite 1%
Magnetite 1%

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Amphibolite.

U.S. Rte. 6
2.0 mi. SSW of
Loveland Pass

Summit County
5S-76W, sec 10

PRC-27-29a&b
(Sg-7, 2 thin sections)

Plagioclase 46% Oligoclase; xenoblastic grains 1.5 to 0.1 mm.; slightly to moderately altered to sericite; albite and pericline twins; poikiloblastically enclose quartz and biotite.
Quartz 35% Xenoblastic grains 0.5 to 0.01 mm.; moderately to strongly strained; sutured borders.
Biotite 15% Elongate idioblastic to xenoblastic grains 2.0 to 0.05 mm.; pleochroic from brown to dark brown; slightly altered to chlorite; preferred orientation.
Garnet 2% Xenoblastic grains 4.0 to 0.05 mm.; pale pink color; isotropic; fractured; poikiloblastically enclose quartz, biotite, and pyrite.
Apatite 1%
Pyrite 1%
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, fine- to medium-grained.
Probable rock: Garnet-bearing biotite-quartz-plagioclase gneiss.

U.S. Rte. 6
1.5 mi. SSW of
Loveland Pass

Summit County
5S-76W, sec 3

PRC-27-30
(Sg-8a)

Quartz 43% Xenoblastic grains 3.0 to 0.01 mm.; strongly to severely strained and fractured; sutured borders.
Plagioclase 35% Oligoclase; xenoblastic grains 2.0 to 0.1 mm.; moderately to strongly altered to sericite; albite, pericline, and Carlsbad twins.
Biotite 13% Idioblastic to xenoblastic grains 4.5 to 0.01 mm.; pleochroic from pale brown to very dark brown; slightly altered to chlorite; poikiloblastically enclose zircon; preferred orientation.
Sillimanite 5% Elongate idioblastic grains 0.2 mm. to microcrystalline; associated with biotite and quartz; preferred orientation.
Garnet 3% Xenoblastic grains 3.0 to 0.05 mm.; pale pink color; isotropic; fractured.
Magnetite 1%
Zircon Tr.
Calcite Tr.

Fabric: Gneissose, lepidoblastic to nematoblastic; porphyroblastic, medium-grained.
Probable rock: Garnet-bearing sillimanite-biotite-plagioclase-quartz gneiss.

Floyd Hill U.S. Rte. 6 0.5 mi. east of intersection, U.S. Rte. 40	Clear Creek County 3S-72W, sec 34	PRC-27-31 (Sg-10b)

Hornblende 53% Idioblastic to xenoblastic grains 3.0 to 0.05 mm.; pleochroic from yellowish-green to dark green and bluish-green; twinned; poikiloblastically enclose plagioclase, sphene, and apatite; preferred orientation.
Plagioclase 25% Andesine to labradorite; xenoblastic grains 1.0 to 0.1 mm.; slightly to severely altered to sericite; albite and pericline twins; zoned.
Diopside 15% Corroded xenoblastic grains 2.0 to 0.05 mm.; very pale green color; fractured; associated with hornblende.
Epidote 5% Xenoblastic grains 0.5 to 0.05 mm.; associated with hornblende and altered plagioclase.
Sphene 2%
Quartz Tr.
Apatite Tr.
Pyrite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, medium-grained.
Probable rock: Diopside-plagioclase-hornblende gneiss.

Floyd Hill U.S. Rte. 6 0.5 mi. east of intersection, U.S. Rte. 40	Clear Creek County 3S-72W, sec 34	PRC-27-32 (Sg-10c)

Plagioclase 45% Oligoclase to andesine; xenoblastic grains 2.5 to 0.1 mm.; slightly to strongly altered to sericite; albite, pericline, and Carlsbad twins; zoned.
Hornblende 40% Xenoblastic grains 2.0 to 0.05 mm.; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose biotite, apatite, and magnetite; preferred orientation.
Quartz 5% Xenoblastic grains 9.0 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders; larger grains occur

in felsic layers with plagioclase.
Biotite 5% Elongate idioblastic to xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale greenish-yellow to dark greenish-brown; moderately altered to chlorite; preferred orientation.
Magnetite 5% Xenoblastic grains 1.5 to 0.01 mm.
Sphene Tr.
Apatite Tr.
Pyrite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-hornblende-plagioclase gneiss to amphibolite.

County road 3.5 mi. east of Black Hawk	Gilpin County 3S-72W, sec 11	PRC-27-33 (Sg-11b)

Plagioclase 47% Andesine; xenoblastic grains 0.5 to 0.05 mm.; most grains unaltered; some grains near a fracture are completely altered to sericite; albite and pericline twins; zoned.
Hornblende 40% Xenoblastic grains 1.0 to 0.01 mm.; ragged terminations; pleochroic from yellowish-green to dark green to bluish-green; preferred orientation.
Diopside 8% Corroded xenoblastic grains 0.2 to 0.05 mm.; very pale green color; fractured; associated with hornblende.
Epidote 5% Xenoblastic grains 0.3 to 0.01 mm.; occur in fracture with altered hornblende and plagioclase.
Sphene Tr.
Apatite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Diopside-hornblende-plagioclase gneiss to amphibolite.

County Road 3.5 mi. east of Black Hawk	Gilpin County 3S-72W, sec 10	PRC-27-34 (Sg-11c)

Quartz 50% Xenoblastic grains 1.0 to 0.01 mm.; moderately strained and fractured.
Plagioclase 40% Oligoclase; xenoblastic grains 1.0 to 0.05 mm.; slightly altered to sericite; albite and pericline twins.
Biotite 10% Shredlike xenoblastic grains 1.0 to 0.01 mm.; pleochroic

from pale greenish-yellow to very dark brownish-green.
Garnet Tr.
Epidote Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-quartz gneiss.

County road 4 mi. east of Black Hawk	Gilpin County 3S-72W, sec 2	PRC-27-35 (Sg-12)

Hornblende 58% Xenoblastic grains 1.5 to 0.01 mm.; ragged terminations; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose plagioclase and apatite.
Plagioclase 40% Andesine to labradorite; xenoblastic grains 2.0 to 0.05 mm.; slightly to severely altered to sericite; albite, pericline, and Carlsbad twins; zoned.
Quartz 2% Xenoblastic grains 0.1 to 0.05 mm.; strongly strained.
Apatite Tr.
Zircon Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Amphibolite.

Golden Gate Canyon Road 5.5 mi. east of Black Hawk	Jefferson County, 3S-72W, sec 1	PRC-27-36 (Sg-13)

Hornblende 40% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose sphene, plagioclase, and apatite; preferred orientation.
Plagioclase 35% Andesine to labradorite; xenoblastic grains 1.0 to 0.1 mm.; slightly to severely altered to sericite; albite and pericline twins; zoned.
Diopside 15% Corroded xenoblastic grains 0.5 to 0.05 mm.; very pale green color; fractured; associated with hornblende.
Epidote 5% Xenoblastic grains 0.3 to 0.05 mm.; associated with hornblende.
Sphene 4% Xenoblastic grains 0.1 to 0.01 mm.

Quartz 1%
Apatite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Diopside-plagioclase-hornblende gneiss to amphibolite.

Colo. Rte. 306 9 mi. west of Buena Vista	Chaffee County 14S-80W, sec 23	PRC-27-37 (SG-1)

Plagioclaste 40% Andesine; xenoblastic grains 5.0 to 0.05 mm.; strongly to severely altered to sericite; albite, pericline and Carlsbad twins; poikiloblastically enclose biotite, muscovite, magnetite, and sphene; myrmekitic.
Quartz 20% Xenoblastic grains 4.5 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated.
Microcline 15% Xenoblastic grains 8.0 to 0.05 mm.; distinct polysynthetic twins; perthitic; poikiloblastically enclose quartz and plagioclase.
Biotite 13% Elongate xenoblastic grains 2.0 to 0.05 mm.; pleochroic from light yellowish-brown to very dark brown; moderately to strongly altered to chlorite; preferred orientation.
Magnetite 4% Xenoblastic grains 3.0 to 0.05 mm.; associated with biotite.
Epidote 3% Xenoblastic grains 3.0 to 0.05 mm.; includes allanite; associated with biotite.
Muscovite 2% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Sphene 2%
Apatite 1%
Pyrite Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Colo. Rte. 306 13 mi. west of Buena Vista	Chaffee County 14S-80W, sec 19	PRC-27-38 (SG-2)

Plagioclase 66% Oligoclase to andesine; xenoblastic grains 3.0 to 0.05 mm.; slightly to moderately altered to sericite; indistinct albite twins; poikiloblastically enclose biotite and small blebs of quartz; myrmekitic.

Biotite 25% Elongate idioblastic to xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale yellowish-green to brownish-green; slightly to moderately altered to chlorite; preferred orientation.

Quartz 5% Xenoblastic grains 3.5 to 0.01 mm.; strongly strained and fractured; sutured borders.

Microcline 2%

Sillimanite 1%

Epidote 1%

Garnet Tr.

Magnetite Tr.

Fabric: Schistose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.

Probable rock: Quartz-biotite-plagioclase schist.

Colo. Rte. 306 at Cottonwood Pass	Chaffee County 14S-81W, sec 14	PRC-27-39 (SG-3a)

Quartz 60% Xenoblastic grains 3.5 to 0.01 mm.; moderately to strongly strained and fractured; poikiloblastically enclose plagioclase.

Muscovite 27% Idioblastic to shredlike xenoblastic grains 3.0 to 0.01 mm.; poikiloblastically enclose plagioclase and quartz; small intergrowths of quartz.

Plagioclase 10% Variety undetermined; xenoblastic grains 2.5 to 0.01 mm.; strongly altered to sericite; albite twins obscured; poikiloblastically enclose quartz and muscovite; myrmekitic.

Biotite 2% Xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale yellowish-green to brownish-green; severely to completely altered to chlorite.

Magnetite 1%

Sphene Tr.

Apatite Tr.

Fabric: Gneissose, to schistose, lepidoblastic, porphyroblastic, medium-grained.

Probable rock: Plagioclase-muscovite-quartz gneiss.

Colo. Rte. 306 at Cottonwood Pass	Chaffee County 14S-81W, sec 14	PRC-27-40 (SG-3b)

Quartz 81% Xenoblastic grains 3.0 to 0.05 mm.; slightly to moderately strained.
Plagioclase 5% Oligoclase; xenoblastic grains 1.0 to 0.05 mm.; moderately to strongly altered to sericite; indistinct albite twins; poikiloblastically enclose quartz, biotite, and muscovite; myrmekitic.
Biotite 5% Xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale yellow to greenish-brown; poikiloblastically enclose quartz, muscovite, magnetite and apatite; preferred orientation.
Muscovite 5% Idioblastic to shredlike xenoblastic grains 1.5 to 0.05 mm.
Magnetite 3% Idioblastic to xenoblastic grains 0.2 to 0.01 mm.
Sillimanite 1%
Hornblende Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Muscovite-biotite-plagioclase-quartz gneiss.

Colo. Rte. 306 0.5 mi. NW of Cottonwood Pass	Gunnison County 14S-81W, sec 14	PRC-27-41 (SG-4)

Plagioclase 50% Andesine to labradorite; lathlike idioblastic grains 14.0 to 0.2 mm.; moderately to severely altered to sericite; albite, pericline, and Carlsbad twins.
Hornblende 45% Idioblastic to xenoblastic grains 3.0 to 0.05 mm. in xenoblastic aggregates up to 15.0 mm.; pleochroic from yellowish-green to dark green or bluish-green; relict ophitic texture; poikiloblastically enclose quartz, magnetite, and biotite.
Magnetite 3% Xenoblastic grains 4.0 to 0.01 mm.; associated with hornblende.
Epidote 2% Xenoblastic grains 0.5 to 0.05 mm.; associated with hornblende.
Quartz Tr.
Biotite Tr.
Sphene Tr.
Apatite Tr.

Fabric: Granoblastic, nematoblastic, non-foliate, non-porphyroblastic, coarse-grained; relict ophitic texture.
Probable rock: Amphibolite.

U.S. Rte. 24	Chaffee County	PRC-27-42
0.5 mi. south of Granite	12S-79W, sec 6	(SG-5)

Microcline 45% Xenoblastic grains 4.5 to 0.2 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase, quartz and biotite.
Quartz 34% Xenoblastic grains 10.0 to 0.01 mm.; severely strained and fractured; grain borders sutured and granulated; contain microcrystalline needles of rutile.
Plagioclase 15% Oligoclase; xenoblastic grains 5.0 to 0.05 mm.; strongly to severely altered to sericite; albite and Carlsbad twins obscured; poikiloblastically enclose biotite, muscovite and magnetite.
Biotite 4% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark greenish-brown; moderately altered to chlorite; preferred orientation.
Muscovite 1%
Magnetite 1%
Epidote Tr.
Apatite Tr.
Zircon Tr.

Fabric: Granoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Plagioclase-quartz-microcline gneiss.

Colo. Rte. 82	Lake County	PRC-27-43
0.5 mi. east of	11S-80W, sec 19	(SG-6)
Twin Lakes Village		

Microcline 50% Euhedral grains 30.0 to 0.5 mm.; indistinct polysynthetic twins; graphic intergrowths of quartz; microperthitic; poikilitically enclose plagioclase, biotite, sphene, and magnetite; occur as phenocrysts.
Plagioclase 25% Oligoclase to andesine; euhedral grains 6.0 to 0.1 mm.; slightly to strongly altered to sericite; albite, pericline, and Carlsbad twins; strongly zoned; myrmekitic.
Quartz 12% Anhedral grains 7.0 to 0.05 mm.; slightly to moderately strained and fractured.
Biotite 5% Euhedral to anhedral grains 3.0 to 0.05 mm.; pleochroic from light yellowish-brown to very dark brown; moderately altered to chlorite.
Hornblende 3% Euhedral to anhedral grains 1.5 to 0.1 mm.; twinned; pleochroic from yellowish-green to bluish-green and yellowish-brown to brown; associated with some grains of biotite.
Epidote 2% Anhedral grains 1.5 to 0.05 mm.; associated with biotite

and hornblende.
Magnetite 2% Euhedral grains 1.5 to 0.05 mm.
Sphene 1%
Apatite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, medium- to coarse-grained.
Probable rock: Porphyritic quartz monzonite.

Colo. Rte. 82	Lake County	PRC-27-45
5 mi. west of	11S-81W, sec 30	(SG-8)
Twin Lakes Village		

Orthoclase 35% Euhedral to anhedral grains 25.0 to 0.05 mm.; no polysynthetic twins; graphic intergrowths of quartz; microperthitic; poikilitically enclose plagioclase, hornblende, sphene, and magnetite; occur as phenocrysts.
Plagioclase 45% Oligoclase to andesine; euhedral to subhedral grains 4.0 to 0.1 mm.; slightly altered to sericite; albite, pericline, and Carlsbad twins; strongly zoned; some large grains composed of aggregates of many small grains; myrmekitic.
Quartz 10% Anhedral grains 5.5 to 0.05 mm.; slightly to moderately strained and fractured.
Hornblende 5% Euhedral to anhedral grains 4.5 to 0.1 mm.; twinned; pleochroic from yellowish-green to dark green.
Biotite 2% Anhedral grains 3.0 to 0.05 mm.; pleochroic from light yellowish-brown to very dark brown; small grains associated with hornblende.
Magnetite 2% Anhedral grains 1.5 to 0.05 mm.
Sphene 1%
Apatite Tr.
Zircon Tr.

Fabric: Holocrystalline, inequigranular-porphyritic; medium- to coarse-grained.
Probable rock: Porphyritic quartz monzonite.

Colo. Rte. 82	Lake County	PRC-27-46
1.0 mi. east of	11S-82W, sec 10	(SG-9)
Independence Pass		

Plagioclase 55% Andesine; xenoblastic grains 3.5 to 0.1 mm.; slightly to moderately altered to sericite; albite, pericline, and

Carlsbad twins; poikiloblastically enclose biotite and quartz.
Quartz 25% Xenoblastic grains 7.0 to 0.05 mm.; slightly to strongly strained and fractured; poikiloblastically enclose plagioclase and biotite.
Biotite 15% Idioblastic to xenoblastic grains 2.0 to 0.05 mm.; pleochroic from light yellowish-brown to very dark brown; preferred orientation.
Garnet 5% Xenoblastic grains 5.0 to 0.05 mm.; pale pink color; isotropic; fractured; poikiloblastically enclose biotite, quartz, and apatite; occur in aggregates.
Muscovite Tr.
Sphene Tr.
Apatite Tr.
Pyrite Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Garnet-bearing biotite-quartz-plagioclase gneiss.

Colo. Rte. 82	Lake County	PRC-27-47
1 mi. east of	11S-82W, sec 10	(SG-10)
Independence Pass		

Quartz 40% Xenoblastic grains 3.0 to 0.05 mm.; moderately to strongly strained and fractured; poikiloblastically enclose biotite and magnetite.
Microcline 34% Xenoblastic grains 3.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz, plagioclase, biotite, and sphene.
Plagioclase 15% Oligoclase to andesine; xenoblastic grains 1.5 to 0.1 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose biotite.
Biotite 5% Idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark brown; preferred orientation.
Sillimanite 5% Elongate idioblastic grains 0.5 mm. to microcrystalline; occur in bands; preferred orientation.
Magnetite 1%
Sphene Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, nematoblastic, medium-grained.
Probable rock: Sillimanite-biotite-plagioclase-microcline-quartz gneiss.

Colo. Rte. 82
0.5 mi. SW of
Independence Pass

Pitkin County
11S-82W, sec 9

PRC-27-48
(SG-11)

Microcline 38% Anhedral grains 14.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikilitically enclose plagioclase, quartz, biotite and magnetite.
Plagioclase 25% Andesine; euhedral to anhedral grains 9.0 to 0.1 mm.; slightly altered to sericite; albite, pericline, and Carlsbad twins; zoned; poikilitically enclose biotite and magnetite; myrmekitic.
Quartz 20% Anhedral grains 10.0 to 0.05 mm.; moderately strained and fractured; sutured borders.
Biotite 15% Anhedral grains 2.0 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark brown; poikilitically enclose apatite; weak preferred orientation.
Apatite 1%
Magnetite 1%
Sphene Tr.
Zircon Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, medium- to coarse-grained, slightly gneissic.
Probable rock: Quartz monzonite.

Colo. Rte. 135
at intersection
Colo. Rte. 306
at Almont

Gunnison County
51N-1E, sec 22

PRC-27-49
(SG-12)

Quartz 75% Xenoblastic grains 0.5 to 0.01 mm.; strongly strained; sutured borders.
Biotite 15% Elongate xenoblastic grains 0.2 to 0.01 mm.; pleochroic from pale yellow to very dark brown; preferred orientation.
Muscovite 10% Shredlike xenoblastic grains 0.2 to 0.01 mm.; associated with biotite.
Zircon Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Muscovite-biotite-quartz gneiss to quartzite.

Colo. Rte. 135 1.5 mi. SW of Almont	Gunnison County 51N-1E, sec 27	PRC-27-50 (SG-13)

Quartz 40% Xenoblastic grains 6.0 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders; larger grains occur as elongate lenses in veins.
Plagioclase 25% Oligoclase to andesine; xenoblastic grains 0.2 to 0.05 mm.; unaltered; albite twins.
Microcline 13% Xenoblastic grains 0.2 to 0.05 mm.; distinct polysynthetic twins.
Muscovite 12% Shredlike xenoblastic grains 2.0 to 0.05 mm.; poikiloblastically enclose quartz and biotite; preferred orientation.
Biotite 10% Xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale yellowish-brown to very dark brown; preferred orientation.
Sphene Tr.
Zircon Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-muscovite-microcline-plagioclase-quartz gneiss.

Colo. Rte. 135 7 mi. NE of Gunnison	Gunnison County 51N-1E, sec 33	PRC-27-51a&b (SG-14, 2 thin sections)

Igneous fraction:

Plagioclase 75% Euhedral grains 4.5 to 0.2 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; strongly zoned; poikilitically enclose biotite and muscovite.
Biotite 20% Shredlike anhedral grains 3.0 to 0.01 mm.; pleochroic from pale yellowish-brown to very dark brown; slightly altered to chlorite.
Quartz 4% Anhedral grains 0.5 to 0.05 mm.; strongly to severely strained; occur interstitially to plagioclase grains.
Muscovite 1% Anhedral grains 0.5 to 0.01 mm.; associated with biotite.
Zircon Tr.
Magnetite Tr.

Fabric: Holocrystalline, hypidiomorphic-granular, medium-grained.
Probable rock: Diorite.

Metamorphic fraction:

Quartz 40% Xenoblastic grains 0.5 to 0.01 mm.; strongly strained; poikiloblastically enclose biotite.
Plagioclase 25% Andesine; idioblastic to xenoblastic grains 1.0 to 0.1 mm.; slightly altered to sericite; albite and pericline twins indistinct; larger zoned idioblastic grains have been introduced by solutions from adjacent diorite; poikiloblastically enclose biotite.
Biotite 25% Xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale yellowish-brown to very dark brown; preferred orientation.
Muscovite 10% Idioblastic to shredlike xenoblastic grains 1.0 to 0.01 mm.; associated with biotite; preferred orientation.
Sphene Tr.

Fabric: Schistose, lepidoblastic, porphyroblastic, fine-grained.
Probable rock: Muscovite-biotite-plagioclase-quartz schist.

U.S. Rte. 50 1 mi. west of intersection Colo. Rte. 114	Gunnison County 49N-2E, sec 7	PRC-27-52 (SG-15)

Quartz 60% Xenoblastic grains 0.5 to 0.01 mm.; moderately to strongly strained; grain borders intricately sutured and granulated; larger grains occur in distinct layers.
Sericite 25% Microcrystalline grains in distinct layers with smaller grains of quartz.
Biotite 15% Xenoblastic grains 0.05 mm. to microcrystalline; occur with sericite.
Plagioclase Tr.
Tourmaline Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, very fine-grained; relict cross-bedding.
Probable rock: Biotite-sericite-quartz-gneiss to quartzite.

Colo. Rte. 114 3 mi. south of U.S. Rte. 50	Gunnison County 49N-2E, sec 28	PRC-27-53 (SG-16)

Actinolite 77% Idioblastic to xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale yellowish-green to green or bluish-green.
Plagioclase 10% Variety not determined; xenoblastic grains 0.5 to

0.01 mm.; moderately to strongly altered to sericite; albite twins indistinct; larger grains occur in veins with quartz.
Quartz 5% Xenoblastic grains 0.5 to 0.01 mm.; strongly strained and fractured; occur in veins.
Magnetite 5% Xenoblastic grains 0.1 to 0.01 mm.
Epidote 3% Xenoblastic grains 0.5 to 0.05 mm.; occur in veins with quartz and plagioclase.
Biotite Tr.
Chlorite Tr.
Apatite Tr.
Calcite Tr.

Fabric: Granoblastic, nematoblastic, non-foliate, non-porphyroblastic, very fine-grained.
Probable rock: Quartz-plagioclase-actinolite gneiss.

Colo. Rte. 114	Gunnison County	PRC-27-54
7 mi. south of	48N-2E, sec 16	(SG-17)
U.S. Rte. 50		

Phenocrysts: 25% of thin section

Plagioclase 90% Oligoclase; euhedral to subhedral grains 4.0 to 0.1 mm.; slightly altered to sericite; albite and Carlsbad twins; strained and fractured; some grains have subrounded outlines.
Quartz 10% Anhedral grains 1.0 to 0.1 mm.; strongly to severely strained, fractured, and granulated; some grains have subrounded outlines.

Groundmass: 75% of thin section:

Orthoclase 80% Microcrystalline anhedral grains.
Quartz 15% Anhedral grains 0.1 mm. to microcrystalline; severely strained; larger grains occur in small veinlets.
Biotite 5% Anhedral grains 0.05 mm. to microcrystalline; pleochroic from light brown to dark brown; moderately altered to chlorite.
Apatite Tr.
Magnetite Tr.
Calcite Tr.

Fabric: Holocrystalline, inequigranular-porphyritic, fine-grained; has been metamorphosed.
Probable rock: Quartz latite to rhyolite porphyry or tuff.

Colo. Rte. 114 Saguache County PRC-27-55
11.5 mi. south of 48N-2E, sec 32 (SG-18)
U.S. Rte. 50

Hornblende 50% Xenoblastic grains 1.0 to 0.01 mm.; ragged terminations; pleochroic from yellowish-green to dark green or bluish-green.
Plagioclase 40% Andesine; elongate xenoblastic grains 8.0 to 0.05 mm.; strongly altered to sericite; indistinct albite and Carlsbad twins; poikiloblastically enclose hornblende, biotite and quartz.
Biotite 5% Xenoblastic grains 0.2 to 0.01 mm.; pleochroic from pale yellowish-brown to dark brown; associated with hornblende.
Sphene 3% Masses of xenoblastic grains 0.5 to 0.01 mm.; associated with hornblende.
Quartz 2% Xenoblastic grains 0.2 to 0.01 mm.
Epidote Tr.
Apatite Tr.
Magnetite Tr.

Fabric: Granoblastic, nematoblastic, non-foliate, non-porphyroblastic, fine- to coarse-grained.
Probable rock: Amphibolite.

Colo. Rte. 114 Saguache County PRC-27-56
12.5 mi. south of 47N-2E, sec 8 (SG-19)
U.S. Rte. 50

Microcline 62% Xenoblastic grains 6.0 to 0.05 mm.; distinct polysynthetic twins; perthitic; poikiloblastically enclose plagioclase and small grains of microcline.
Quartz 15% Xenoblastic grains 1.0 to 0.01 mm.; strongly to severely strained and fractured; sutured borders.
Plagioclase 15% Oligoclase; xenoblastic grains 2.0 to 0.05 mm.; moderately altered to sericite; albite and Carlsbad twins; myrmekitic.
Biotite 5% Xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale yellow to brownish-green; weak preferred orientation.
Sphene 2% Idioblastic to xenoblastic grains 1.5 to 0.05 mm.; severely to completely altered to leucoxene; associated with biotite.
Magnetite 1%
Muscovite Tr.
Apatite Tr.
Zircon Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, fine- to coarse-grained.
Probable rock: Biotite-plagioclase-quartz-microcline gneiss.

Colo. Rte. 114 16 mi. south of U.S. Rte. 50	Saguache County 47N-2E, sec 28	PRC-27-57 (SG-20)

Microcline 35% Xenoblastic grains 18.0 to 0.1 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; micrographic intergrowths of quartz; poikiloblastically enclose plagioclase, quartz, biotite, sphene, and magnetite.
Plagioclase 25% Oligoclase; idioblastic to xenoblastic grains 8.0 to 0.05 mm.; moderately to strongly altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose biotite, sphene, epidote, magnetite, and zircon; myrmekitic.
Quartz 20% Xenoblastic grains 2.0 to 0.01 mm.; severely strained and fractured; grain borders sutured and granulated.
Biotite 13% Xenoblastic grains 3.0 to 0.05 mm.; pleochroic from pale greenish-yellow to brownish-green; slightly altered to chlorite; preferred orientation.
Epidote 5% Xenoblastic grains 1.5 to 0.05 mm.; associated with biotite.
Sphene 1%
Magnetite 1%
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-plagioclase-microcline porphyroblastic gneiss.

Colo. Rte. 114 14 mi. south of U. S. Rte. 50	Saguache County 47N-2E, sec 17	PRC-27-58 (SG-21)

Microcline 40% Xenoblastic grains 3.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz, biotite, and plagioclase.
Plagioclase 25% Oligoclase to andesine; xenoblastic grains 3.0 to 0.1 mm.; slightly altered to sericite; albite and pericline twins; poikiloblastically enclose quartz and microcline; myrme-

kitic.
Quartz 30% Xenoblastic grains 4.5 to 0.01 mm.; strongly strained and fractured; sutured borders.
Biotite 4% Xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale yellow to dark greenish-brown; preferred orientation.
Muscovite 1%
Sphene Tr.
Apatite Tr.
Magnetite Tr.
Calcite Tr.

Fabric: Granoblastic, non-porphyroblastic, medium-grained.
Probable rock: Quartz-plagioclase-microcline gneiss.

Colo. Rte. 114 13 mi. south of U.S. Rte. 50	Saguache County 47N-2E, sec 17	PRC-27-59 (SG-22)

Quartz 65% Xenoblastic grains 0.3 to 0.01 mm.; strongly strained.
Biotite 15% Shredlike xenoblastic grains 0.2 to 0.01 mm.; pleochroic from pale yellowish-brown to dark brown; weak preferred orientation.
Plagioclase 10% Variety not determined; xenoblastic grains 0.1 to 0.01 mm.; slightly altered to sericite; albite twins indistinct.
Muscovite 10% Shredlike xenoblastic grains 0.3 to 0.01 mm.
Sphene Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Muscovite-plagioclase-biotite-quartz gneiss.

U.S. Rte. 50 1 mi. SE of Parlin	Gunnison County 49N-2E, sec 23	PRC-27-60 (SG-23)

Microcline 46% Xenoblastic grains 5.5 to 0.1 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose quartz, plagioclase and biotite.
Quartz 35% Xenoblastic grains 2.5 to 0.01 mm.; severely strained and fractured; grain borders intricately sutured and granulated.
Plagioclase 15% Oligoclase; xenoblastic grains 1.5 to 0.05 mm.; slightly to moderately altered to sericite; albite twins indis-

tinct; myrmekitic.
Biotite 2% Xenoblastic grains 0.5 to 0.05 mm.; severely to completely altered to chlorite (pennine).
Sphene 1%
Magnetite 1%
Muscovite Tr.

Fabric: Granoblastic, porphyroblastic, cataclastic, medium-grained.
Probable rock: Plagioclase-quartz-microcline gneiss.

U.S. Rte. 50 4 mi. SE of Parlin	Gunnison County 49N-3E, sec 29	PRC-27-61a&b (SG-24, 2 thin sections)

Microcline 35% Idioblastic to xenoblastic grains 20.0 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase, quartz, biotite, and small grains of microcline.
Quartz 30% Xenoblastic grains 3.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated.
Plagioclase 25% Oligoclase; idioblastic to xenoblastic grains 7.0 to 0.05 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; myrmekitic.
Biotite 9% Xenoblastic grains 4.0 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark brown; poikiloblastically enclose apatite, magnetite, and quartz.
Magnetite 1%
Muscovite Tr.
Sphene Tr.
Apatite Tr.
Zircon Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-plagioclase-quartz-microcline gneiss.

U.S. Rte. 50 4 mi. SE of Parlin	Gunnison County 49N-3E, sec 29	PRC-27-62 (SG-24a)

Microcline 65% Anhedral grains 3.0 to 0.05 mm.; distinct polysynthetic twins; micrographic intergrowths with quartz.
Quartz 30% Anhedral grains 2.0 to 0.01 mm.; moderately to severely

strained and fractured; sutured borders.
Plagioclase 5% Variety not determined; anhedral grains 0.2 to 0.05 mm.; moderately altered to sericite.
Biotite Tr.
Muscovite Tr.
Apatite Tr.
Magnetite Tr.

Fabric: Holocrystalline, allotrimorphic-granular, fine-grained.
Probable rock: Granite aplite.

U.S. Rte. 50	Gunnison County	PRC-27-63
4.5 mi. south of	48N-5E, sec 1	(SG-26)
Monarch Pass		

Plagioclase 35% Oligoclase; idioblastic to xenoblastic grains 2.5 to 0.05 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; albite rims; poikiloblastically enclose quartz and magnetite; myrmekitic.
Microcline 33% Idioblastic to xenoblastic grains 3.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose microcline, and quartz.
Quartz 25% Xenoblastic grains 3.0 to 0.05 mm.; strongly strained and fractured; sutured borders.
Biotite 5% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellcwish-brown to very dark brown; weak preferred orientation.
Muscovite 1%
Magnetite 1%
Sphene Tr.
Apatite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-quartz-microcline-plagioclase gneiss.

U.S. Rte. 50	Gunnison County	PRC-27-64
3.5 mi. south	49N-6E, sec 31	(SG-27)
of Monarch Pass		

Microcline 35% Idioblastic to xenoblastic grains 3.0 to 0.5 mm.; distinct polysynthetic twins; poikiloblastically enclose plagioclase and quartz.
Plagioclase 35% Oligoclase; idioblastic to xenoblastic grains 2.0 to

0.1 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose quartz and biotite; myrmekitic.
Quartz 22% Xenoblastic grains 2.5 to 0.05 mm.; strongly strained and fractured; sutured borders.
Biotite 5% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark brown; slightly altered to chlorite; preferred orientation.
Magnetite 2% Xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Muscovite 1%
Apatite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

U.S. Rte. 50 13 mi. west of Poncha Springs	Chaffee County 50N-6E, sec 33	PRC-27-65 (SG-28)

Microcline 43% Idioblastic to xenoblastic grains 9.0 to 0.1 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose plagioclase, quartz and biotite.
Quartz 30% Xenoblastic grains 4.0 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders.
Plagioclase 25% Andesine; xenoblastic grains 5.0 to 0.1 mm.; moderately to strongly altered to sericite; albite and pericline twins; poikiloblastically enclose quartz, biotite, muscovite, and magnetite; myrmekitic.
Biotite 2% Xenoblastic grains 1.5 to 0.05 mm.; completely altered to chlorite (pennine); weak preferred orientation.
Muscovite Tr.
Sphene Tr.
Apatite Tr.
Magnetite Tr.

Fabric: Granoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Plagioclase-quartz-microcline gneiss.

Phantom Canyon Road (Eight Mile Creek) 12 mi. NE of Canon City	Fremont County 17S-69W, sec 22	PRC-27-66 (Ph-1)

Plagioclase 40% Oligoclase; xenoblastic grains 1.5 to 0.1 mm.; slightly to moderately altered to sericite; albite and pericline twins; mymekitic.
Quartz 30% Xenoblastic grains 2.5 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders.
Microcline 22% Xenoblastic grains 13.0 to 0.05 mm.; distinct polysynthetic twins; microperthitic; micrographic intergrowths with quartz; poikiloblastically enclose plagioclase, quartz, biotite, muscovite, magnetite, and small grains of microcline.
Biotite 5% Xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale greenish-yellow to very dark greenish-brown; slightly to moderately altered to muscovite; preferred orientation.
Muscovite 2% Idioblastic to shredlike xenoblastic grains 1.0 to 0.05 mm.; associated with biotite.
Magnetite 1%
Sphene Tr.
Apatite Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, medium-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Phantom Canyon Road (Eight Mile Creek) 12 mi. NE of Canon City	Fremont County 17S-69W, sec 22	PRC-27-67 a&b (Ph-2, 2 thin sections).

Quartz 37% Xenoblastic grains 2.0 to 0.01 mm.; slightly to strongly strained and fractured.
Microcline 30% Xenoblastic grains 4.0 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz, muscovite, and plagioclase.
Muscovite 25% Elongate idioblastic to xenoblastic grains 2.5 to 0.01 mm.; occur in bands; preferred orientation.
Plagioclase 5% Oligoclase; xenoblastic grains 1.0 to 0.05 mm.; slightly altered to sericite; albite twins.
Biotite 2% Elongate xenoblastic grains 2.0 to 0.1 mm.; associated with muscovite; preferred orientation.
Magnetite 1%
Apatite Tr.
Hematite Tr.

Fabric: Schistose, lepidoblastic, porphyroblastic, medium-grained.
Probable rock: Plagioclase-muscovite-microcline-quartz gneiss.

Phantom Canyon Road | Fremont County | PRC-27-68
(Eight Mile Creek) | 17S-69W, sec 22 | (Ph-5)
12 mi. NE of Canon City

Quartz 40% Xenoblastic grains 3.0 to 0.01 mm.; moderately to strongly strained and fractured.
Plagioclase 33% Oligoclase; 1.0 to 0.05 mm.; slightly to moderately altered to sericite; albite, pericline and Carlsbad twins.
Microcline 15% Xenoblastic grains 1.0 to 0.05 mm.; distinct polysynthetic twins.
Biotite 10% Elongate xenoblastic grains 1.0 to 0.05 mm.; pleochroic from light yellowish-brown to very dark greenish-brown; preferred orientation.
Muscovite 1%
Garnet 1%
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-microcline-plagioclase-quartz gneiss.

Phantom Canyon Road | Fremont County | PRC-27-69
(Eight Mile Creek) | 17S-69W, sec 22 | (Ph-6)
12 mi. NE of Canon City

Quartz 40% Xenoblastic grains 2.0 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders.
Microcline 36% Xenoblastic grains 1.0 to 0.05 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic.
Plagioclase 10% Oligoclase; xenoblastic grains 1.5 to 0.1 mm.; slightly altered to sericite; albite twins.
Biotite 10% Elongate xenoblastic grains 1.0 to 0.05 mm.; pleochroic from light yellowish-brown to dark greenish-brown; preferred orientation.
Muscovite 3% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; associated with biotite; preferred orientation.
Magnetite 1%
Garnet Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Biotite-plagioclase-microcline-quartz gneiss.

Phantom Canyon Road (Eight Mile Creek) 12 mi. NE of Canon City | Fremont County 17S-69W, sec 22 | PRC-27-70 (Ph-7)

Plagioclase 30% Oligoclase, xenoblastic grains 0.5 to 0.1 mm.; moderately to strongly altered to sericite; albite twins.
Microcline 30% Xenoblastic grains 1.5 to 0.1 mm.; distinct polysynthetic twins.
Quartz 25% Xenoblastic grains 0.5 to 0.05 mm.; moderately strained and fractured.
Biotite 10% Elongate xenoblastic grains 1.5 to 0.05 mm.; pleochroic from light yellowish-brown to very dark brown; moderately to strongly altered to muscovite and hematite; preferred orientation.
Muscovite 5% Shredlike xenoblastic grains 2.5 to 0.05 mm.; associated with biotite.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Muscovite-biotite-quartz-microcline-plagioclase gneiss.

Phantom Canyon Road (Eight Mile Creek) 12 mi. NE of Canon City | Fremont County 17S-69W, sec 22 | PRC-27-71 (Ph-8)

Plagioclase 35% Oligoclase; xenoblastic grains 1.0 to 0.1 mm.; slightly to moderately altered to sericite; albite and pericline twins.
Microcline 30% Xenoblastic grains 1.0 to 0.1 mm.; distinct polysynthetic twins.
Quartz 25% Xenoblastic grains 0.5 to 0.05 mm.; moderately to strongly strained and fractured.
Biotite 5% Elongate xenoblastic grains 1.0 to 0.05 mm.; pleochroic from light yellowish-brown to very dark brown; slightly altered to muscovite and hematite; preferred orientation.
Muscovite 5% Shredlike xenoblastic grains 3.0 to 0.05 mm.; associated with biotite; preferred orientation.
Zircon Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Muscovite-biotite-quartz-microcline-plagioclase gneiss.

Phantom Canyon Road (Eight Mile Creek) 14 mi. NE of Canon City	Fremont County 17S-69W, sec 9	PRC-27-72 (Ph-9a)

Microcline 50% Idioblastic to xenoblastic grains 9.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase, biotite, magnetite, and small blebs of quartz; grains occur in augen of lens-shaped aggregates up to 30.0 mm.
Plagioclase 20% Oligoclase to andesine; xenoblastic grains 2.5 to 0.1 mm.; slightly to strongly altered to sericite; albite, pericline, and Carlsbad twins; albite rims; poikiloblastically enclose biotite; myrmekitic.
Quartz 15% Xenoblastic grains 5.0 to 0.05 mm.; strongly strained and fractured; grain borders sutured and slightly granulated; poikiloblastically enclose plagioclase, microcline, biotite, and magnetite.
Biotite 10% Elongate idioblastic to xenoblastic grains 3.0 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark brown; preferred orientation.
Sphene 2% Idioblastic to xenoblastic grains 2.0 to 0.05 mm.; strongly altered to leucoxene; associated with biotite and magnetite.
Magnetite 2% Xenoblastic grains 1.0 to 0.05 mm.
Apatite 1%
Zircon Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-plagioclase-microcline augen gneiss.

Phantom Canyon Road (Eight Mile Creek) 14 mi. NE of Canon City	Fremont County 17S-69W, sec 9	PRC-27-73 (Ph-9a)

Quartz 40% Xenoblastic grains 5.0 to 0.05 mm.; strongly strained and fractured; grain borders sutured and slightly granulated; poikiloblastically enclose plagioclase, microcline, and biotite.
Plagioclase 25% Oligoclase to andesine; xenoblastic grains 5.5 to 0.1 mm.; slightly to strongly altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose microcline and biotite; myrmekitic.
Microcline 20% Xenoblastic grains 3.5 to 0.2 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose plagioclase, quartz, biotite, and magnetite; grains occur in aggregates.

Biotite 10% Elongate idioblastic to xenoblastic grains 3.0 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark brown; slightly altered to chlorite; preferred orientation.
Sphene 3% Idioblastic to xenoblastic grains 4.0 to 0.05 mm.; strongly to severely altered to leucoxene; associated with biotite and magnetite.
Apatite 1%
Magnetite 1%
Muscovite Tr.
Zircon Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic; medium- to coarse-grained.
Probable rock: Biotite-microcline-plagioclase-quartz augen gneiss.

Cripple Creek Canyon 5 mi. south of Cripple Creek	Teller County 16S-70W, sec 3	PRC-27-74 (Cc-1a)

Quartz 40% Xenoblastic grains 6.0 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders; poikiloblastically enclose microcline, plagioclase, and biotite.
Microcline 25% Xenoblastic grains 5.0 to 0.1 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose plagioclase, quartz, biotite, and magnetite; grains occur in aggregates.
Plagioclase 20% Oligoclase; idioblastic to xenoblastic grains 3.0 to 0.1 mm.; slightly to strongly altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose quartz, biotite, magnetite and apatite; myrmekitic.
Biotite 10% Elongate idioblastic to xenoblastic grains 2.5 to 0.05 mm.; pleochroic from pale yellow to very dark brown; preferred orientation.
Sphene 3% Idioblastic to xenoblastic grains 1.5 to 0.05 mm.; strongly altered to leucoxene; pleochroic from pale brown to reddish-brown; associated with magnetite and biotite.
Apatite 1%
Magnetite 1%
Zircon Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-plagioclase-microcline-quartz augen gneiss.

Cripple Creek Canyon 5 mi. south of Cripple Creek	Teller County 16S-70W, sec 3	PRC-27-75 (Cc-1b)

Microcline 55% Idioblastic to xenoblastic grains 22.0 to 0.1 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose plagioclase, biotite, magnetite, and small blebs of quartz; grains occur in augen of lens-shaped aggregates up to 25.0 mm.
Quartz 20% Xenoblastic grains 4.5 to 0.05 mm.; moderately to strongly strained and fractured.
Plagioclase 15% Oligoclase; xenoblastic grains 3.0 to 0.1 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose quartz, microcline, and biotite; myrmekitic.
Biotite 5% Elongate idioblastic to xenoblastic grains 3.5 to 0.05 mm.; pleochroic from pale yellow to very dark brown; preferred orientation.
Sphene 3% Idioblastic to xenoblastic grains 3.0 to 0.05 mm.; strongly altered to leucoxene; pleochroic from light brown to reddish-brown; associated with magnetite and biotite.
Apatite 1%
Magnetite 1%
Zircon Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-plagioclase-quartz-microcline augen gneiss.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit	Clear Creek County 4S-74W, sec 31 & 32	PRC-27-76 drill hole #1 depth: 38 ft.

Plagioclase 55% Oligoclase to andesine; xenoblastic grains 2.0 to 0.1 mm.; slightly to moderately altered to sericite; albite and pericline twins;
Quartz 30% Xenoblastic grains 2.5 to 0.01 mm.; strongly strained, fractured and granulated; sutured borders.
Biotite 10% Shredlike xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale yellowish-brown to very dark brown or reddish-brown.
Hornblende 5% Severely corroded xenoblastic grains 1.5 to 0.01 mm.; pleochroic from pale yellowish-green to dark green and bluish-green; associated with and altered to biotite.
Epidote Tr.

Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained, cataclastic.
Probable rock: Hornblende-biotite-quartz-plagioclase gneiss.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit	Clear Creek County 4S-74W, sec 31 & 32	PRC-27-77 drill hole #1 depth: 43 ft.

Plagioclase 45% Andesine (?); xenoblastic grains 0.5 to 0.1 mm.; severely to completely altered to sericite; albite twins obscured.
Hornblende 45% Xenoblastic grains 1.0 to 0.1 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; grain terminations ragged; poikiloblastically enclose plagioclase, sphene, chlorite, apatite and quartz.
Chlorite 6% Pennine; shredlike xenoblastic grains 0.5 to 0.05 mm.; alteration product of biotite; preferred orientation.
Sphene 3% Xenoblastic grains 0.2 to 0.05 mm.
Microcline 1% Xenoblastic grains 0.5 to 0.05 mm.; distinct polysynthetic twins; occur interstitially in small clusters.
Quartz Tr. Xenoblastic grains 0.1 to 0.01 mm.
Epidote Tr.
Apatite Tr.
Pyrite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Amphibolite.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit	Clear Creek County 4S-74W, sec 31 & 32	PRC-27-78 drill hole #1 depth: 105 ft.

Plagioclase 45% Oligoclase to andesine; xenoblastic grains 2.0 to 0.1 mm.; slightly to strongly altered to sericite; albite and pericline twins; poikiloblastically enclose quartz, biotite, and hornblende; myrmekitic.
Quartz 40% Xenoblastic grains 6.0 to 0.01 mm.; moderately to strongly

strained and fractured; grain borders sutured and granulated.
Biotite 7% Xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale yellow to reddish-brown; associated with hornblende as an alteration product.
Hornblende 5% Corroded xenoblastic grains 2.5 to 0.05 mm.; pleochroic from pale yellowish-green to dark green or bluish-green.
Microcline 3% Xenoblastic grains 1.0 to 0.05 mm.; distinct polysynthetic twins; grains occur in clusters.
Sphene Tr.
Epidote Tr.
Apatite Tr.
Zircon Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic fine-grained.
Probable rock: Hornblende-biotite-quartz-plagioclase gneiss.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit	Clear Creek County 4S-74W, sec 31 & 32	PRC-27-79 drill hole #2 depth: 21 ft.

Plagioclase 50% Andesine (?); xenoblastic grains 2.0 to 0.1 mm.; completely altered to sericite; albite twins obscured.
Hornblende 45% Xenoblastic grains 2.0 to 0.05 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; poikiloblastically enclose apatite, biotite, epidote, and quartz.
Quartz 2% Xenoblastic grains 1.0 to 0.05 mm.; moderately strained and fractured; occur interstitially.
Apatite 1% Idioblastic to xenoblastic grains 0.1 to 0.05 mm.; associated with hornblende.
Biotite 1% Elongate xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellow to reddish-brown; alteration product of hornblende.
Epidote 1% Xenoblastic grains 0.5 to 0.05 mm.; associated with biotite and hornblende.
Calcite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Amphibolite.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit
Clear Creek County 4S-74W, sec 31 & 32
PRC-27-80 drill hole #2 depth: 85 ft.

Plagioclase 55% Oligoclase to andesine; idioblastic to xenoblastic grains 2.0 to 0.2 mm.; moderately to strongly altered to sericite; albite, Carlsbad, and pericline twins; poikiloblastically enclose quartz and biotite.
Quartz 30% Xenoblastic grains 4.0 to 0.01 mm.; strongly strained and fractured; grain borders sutured and granulated.
Biotite 14% Elongate xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellow to dark brown; slightly to moderately altered to chlorite and sericite; preferred orientation.
Calcite 1% Xenoblastic grains 0.5 to 0.01 mm.; occur in clusters and veinlets as a replacement mineral.
Muscovite Tr.
Epidote Tr.
Apatite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-quartz-plagioclase gneiss.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit
Clear Creek County 4S-74W, sec 31 & 32
PRC-27-81 drill hole #2 depth: 115 ft.

Plagioclase 50% Andesine(?); xenoblastic grains 1.0 to 0.1 mm.; severely altered to sericite; albite twins obscured.
Quartz 28% Xenoblastic grains 1.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated.
Biotite 20% Shredlike xenoblastic grains 0.3 to 0.05 mm.; pleochroic from pale yellow to dark greenish-brown; severely to completely altered to chlorite, muscovite, and sericite; preferred orientation.
Calcite 2% Xenoblastic grains 1.0 mm. to microcrystalline; occur in clusters and veinlets as a replacement mineral.
Apatite Tr.

Fabric: Gneissose to schistose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Altered-biotite-quartz-plagioclase schistose gneiss.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit
Clear Creek County
4S-74W, sec 31 & 32
PRC-27-82
drill hole #2
depth: 124 ft.

Plagioclase 53% Variety undetermined; xenoblastic grains 1.0 to 0.05 mm.; severely altered to sericite; albite twins obscured.
Quartz 40% Elongate xenoblastic grains 2.5 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated.
Biotite 5% Shredlike anhedral grains 0.3 to 0.05 mm.; severely to completely altered to sericite and muscovite; preferred orientation.
Calcite 2% Xenoblastic grains 1.0 mm. to microcrystalline; occur in clusters and veinlets as a replacement mineral.
Leucoxene Tr.
Apatite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Altered biotite-quartz-plagioclase gneiss.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit
Clear Creek County
4S-74W, sec 31 & 32
PRC-27-83
drill hole #3
depth: 52 ft.

Plagioclase 55% Oligoclase to andesine; xenoblastic grains 1.5 to 0.1 mm.; slightly to strongly altered to sericite; albite and pericline twins.
Quartz 20% Xenoblastic grains 4.5 to 0.05 mm.; strongly strained and fractured; grain borders sutured; poikiloblastically enclose plagioclase.
Hornblende 20% Corroded xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; partly altered to biotite; poikiloblastically enclose biotite, quartz and apatite.
Biotite 5% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-brown to dark reddish-brown; slightly altered to chlorite; assoicated with hornblende.
Epidote Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose to schistose, nematoblastic to lepidoblastic, non-

porphyroblastic, fine-grained.
Probable rock: Biotite-hornblende-quartz-plagioclase schistose gneiss.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit	Clear Creek County 4S-74W, sec 31 & 32	PRC-27-84 drill hole #3 depth: 91 ft.

Plagioclase 45% Oligoclase to andesine; xenoblastic grains 3.0 to 0.1 mm.; slightly to moderately altered to sericite; albite and pericline twins.
Quartz 25% Xenoblastic grains 3.5 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured.
Hornblende 20% Corroded xenoblastic grains 2.5 to 0.05 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; partly altered to biotite; poikiloblastically enclose biotite, quartz, and apatite.
Biotite 10% Xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale yellowish-brown to dark reddish-brown; slightly altered to chorite; associated with hornblende.
Epidote Tr.
Apatite Tr.
Magnetite Tr.
Pyrite Tr.

Fabric: Gneissose to schistose, nematoblastic to lepidoblastic, nonporphyroblastic, fine-grained.
Probable rock: Biotite-hornblende-quartz-plagioclase schistose gneiss.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit	Clear Creek County 4S-74W, sec 31 & 32	PRC-27-85 drill hole #10 depth: 73 ft.

Plagioclase 53% Oligoclase; xenoblastic grains 1.5 to 0.1 mm.; strongly to severely altered to sericite; albite, pericline and Carlsbad twins.
Quartz 30% Xenoblastic grains 5.0 to 0.05 mm.; strongly strained and fractured; grain borders sutured and granulated.
Biotite 10% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale greenish-yellow to very dark green; severely altered to chlorite, muscovite, hematite and sericite; weak preferred orientation.
Microcline 5% Xenoblastic grains 0.5 to 0.1 mm.; distinct polysynthe-

tic twins; occur interstitially to larger grains of quartz and plagioclase, and also in small aggregates of grains.
Muscovite 2% Xenoblastic grains 0.1 to 0.05 mm.; associated with biotite.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Microcline-biotite-quartz-plagioclase gneiss.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit	Clear Creek County 4S-74W, sec 31 & 32	PRC-27-86 drill hole #10 depth: 82 ft.

Quartz 35% Xenoblastic grains 6.5 to 0.1 mm.; strongly strained and fractured; grain borders sutured.
Microcline 30% Xenoblastic grains 5.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz, plagioclase and muscovite.
Plagioclase 25% Oligoclase to andesine; xenoblastic grains 1.0 to 0.1 mm.; severely altered to sericite; albite twins obscured; albite rims on some grains.
Biotite 6% Xenoblastic grains 0.5 to 0.05 mm.; severely to completely altered to sericite and muscovite; preferred orientation.
Muscovite 4% Xenoblastic grains 0.3 to 0.05 mm.; associated with biotite.
Leucoxene Tr.
Apatite Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Muscovite-biotite-plagioclase-microcline-quartz gneiss.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit	Clear Creek County 4S-74W, sec 31 & 32	PRC-27-87 drill hole #10 depth: 90 ft.

Plagioclase 45% Oligoclase to andesine; xenoblastic grains 1.5 to 0.1 mm.; severely altered to sericite; albite twins obscured.
Quartz 35% Xenoblastic grains 5.0 to 0.05 mm.; strongly strained and

fractured; grain borders sutured.
Biotite 13% Xenoblastic grains 0.5 to 0.01 mm.; severely to completely altered to muscovite, hematite, and sericite; preferred orientation.
Microcline 5% Xenoblastic grains 0.75 to 0.1 mm.; distinct polysynthetic twins; occur in aggregates of grains.
Muscovite 2% Xenoblastic grains 0.2 to 0.05 mm.; associated with biotite.
Sphene Tr.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Microcline-biotite-quartz-plagioclase gneiss.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit	Clear Creek County 4S-74W, sec 31 & 32	PRC-27-88 drill hole #10 depth: 106 ft.

Plagioclase 38% Oligoclase to andesine; xenoblastic grains 3.5 to 0.2 mm.; moderately to strongly altered to sericite; albite, pericline and Carlsbad twins.
Microcline 30% Xenoblastic grains 15.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic, poikiloblastically enclose quartz, plagioclase, microcline, and muscovite.
Quartz 25% Xenoblastic grains 7.0 to 0.01 mm.; moderately to strongly strained and fractured; grain borders sutured.
Biotite 5% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale yellowish-brown to dark brown; strongly altered to chlorite.
Muscovite 2% Shredlike xenoblastic grains 1.0 to 0.05 mm.; associated with microcline and altered biotite.
Epidote Tr.
Zircon Tr.
Rutile Tr. Minute needlelike crystallites included within chlorite.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, fine- to coarse-grained.
Probable rock: Biotite-quartz-microcline-plagioclase gneiss.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit	Clear Creek County 4S-74W, sec 31 & 32	PRC-27-89 drill hole #13 depth: 85 ft.

Quartz 42% Elongate xenoblastic grains 7.0 to 0.05 mm.; strongly strained and fractured; grain borders sutured and granulated; poikiloblastically enclose microcline, plagioclase and biotite.
Microcline 25% Xenoblastic grains 1.5 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase; grains occur in lenslike aggregates.
Plagioclase 20% Oligoclase; xenoblastic grains 2.0 to 0.05 mm.; slightly to moderately altered to sericite; albite and pericline twins; myrmekitic.
Biotite 10% Xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale greenish-yellow to dark brown.
Magnetite 2% Xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Muscovite 1% Xenoblastic grains 0.3 to 0.05 mm.; associated with biotite.
Epidote Tr.
Apatite Tr.
Zircon Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic, fine-grained.
Probable rock: Biotite-plagioclase-microcline-quartz gneiss.

Public Service Co. of Colorado, South Clear Creek-Cabin Creek Pumped Storage Unit	Clear Creek County 4S-74W, sec 31 & 32	PRC-27-90 drill hole #13 depth: 102 ft.

Plagioclase 47% Oligoclase; xenoblastic grains 1.0 to 0.1 mm.; strongly fractured and altered to sericite; albite twins obscured.
Quartz 30% Xenoblastic grains 1.5 to 0.01 mm.; strongly strained and fractured; grain borders sutured.
Microcline 10% Xenoblastic grains 0.5 to 0.05 mm.; distinct polysynthetic twins; occur in small aggregates of grains.
Biotite 10% Xenoblastic grains 0.5 to 0.05 mm.; pleochroic from pale greenish-yellow to very dark greenish-brown; moderately altered to sericite;
Magnetite 3% Xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Leucoxene Tr. Xenoblastic grains 0.2 mm. to microcrystalline; associated

with magnetite and altered biotite.
Muscovite Tr.
Apatite Tr.
Zircon Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

Phantom Canyon Road (Eight Mile Creek) 10.0 mi. NE of Canon City	Fremont County 17S-69W, sec 28	PRC-27-91

Quartz 89% Elongate xenoblastic grains 1.5 to 0.01 mm.; moderately to severely strained and fractured; grain borders sutured and granulated.
Sillimanite 5% Needlelike idioblastic grains 0.2 mm. to microcrystalline; occur in fibrous aggregates; preferred orientation.
Magnetite 3% Xenoblastic grains 0.2 to 0.01 mm.
Muscovite 2% Shredlike xenoblastic grains 0.5 to 0.05 mm.; preferred orientation.
Hematite 1%
Leucoxene Tr.
Zircon Tr.

Fabric: Granoblastic to gneissose, nematoblastic, non-porphyroblastic, cataclastic, fine-grained.
Probable rock: Quartzite to sillimanite-quartz gneiss.

Colo. Rte. 114 8 mi. west of Saguache	Saguache County 45N-6E, sec 24	PRC-27-92

Plagioclase 58% Oligoclase to andesine; xenoblastic grains 3.5 to 0.1 mm.; slightly altered to sericite; albite, pericline, and Carlsbad twins.
Hornblende 40% Xenoblastic grains 2.0 to 0.05 mm.; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose quartz and apatite; preferred orientation.
Augite 1% Corroded xenoblastic grains 2.0 to 0.05 mm.; very pale green color; associated with hornblende.
Biotite 1% Elongate xenoblastic grains 1.0 to 0.05 mm.; pleochroic from light brown to dark reddish-brown; associated with horn-

blende.
Quartz Tr.
Microcline Tr.
Apatite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, medium-grained.
Probable rock: Amphibolite.

Colo. Rte. 114 8 mi. west of Saguache	Saguache County 45N-6E, sec 24	PRC-27-93

Quartz 50% Xenoblastic grains 4.0 to 0.05 mm.; moderately to strongly strained and fractured; poikiloblastically enclose plagioclase, microcline, and biotite.
Microcline 37% Xenoblastic grains 2.5 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz, plagioclase, and biotite.
Biotite 7% Elongate xenoblastic grains 2.0 to 0.05 mm.; pleochroic from light yellow to dark brown; poikiloblastically enclose zircon; preferred orientation.
Plagioclase 5% Oligoclase; xenoblastic grains 2.0 to 0.05 mm.; slightly to moderately altered to sericite; albite and pericline twins; albite rims; myrmekitic.
Muscovite 1% Shredlike xenoblastic grains 0.2 to 0.05 mm.; associated with biotite.
Sphene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Plagioclase-biotite-microcline-quartz gneiss.

Ute Trail Road 2.5 mi. NE of Salida	Chaffee County 50N-9E, sec 20	PRC-27-94

Hornblende 55% Corroded xenoblastic grains 4.5 to 0.01 mm.; ragged terminations; pleochroic from very pale yellowish-green to dark green or bluish-green; poikiloblastically enclose plagioclase laths in relict ophitic texture.

Plagioclase 25% Andesine to labradorite; lathlike idioblastic to xenoblastic grains 1.0 to 0.01 mm.; strongly to severely altered to sericite; albite twins indistinct; Carlsbad twins; zoned.
Sericite 10% Xenoblastic masses of microcrystalline grains; alteration product of plagioclase.
Magnetite 5% Xenoblastic grains 0.5 to 0.01 mm.; distinct sieve texture.
Biotite 3% Xenoblastic grains 0.2 to 0.01 mm.; pleochroic from pale yellow to brown; alteration product of hornblende.
Epidote 2%
Pyrite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, medium-grained. Relict ophitic texture.
Probable rock: Plagioclase-hornblende gneiss.

Turret Road 6.5 mi. NNE of Salida	Chaffee County 51N-9E, sec 34	PRC-27-95

Microcline 72% Xenoblastic grains 3.5 to 0.05 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; occur in rounded aggregates.
Biotite 15% Idioblastic to shredlike xenoblastic grains 3.0 to 0.05 mm.; pleochroic from light yellow to dark greenish-brown; poikiloblastically enclose microcline, plagioclase, and sphene; preferred orientation.
Plagioclase 5% Andesine; xenoblastic grains 1.0 to 0.1 mm.; moderately to severely altered to sericite; albite and pericline twins.
Sphene 5% Xenoblastic grains 0.2 to 0.01 mm.; severely altered to leucoxene.
Epidote 2% Xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Quartz 1% Xenoblastic grains 0.1 to 0.01 mm.; moderately to strongly strained and fractured; occur interstitially.
Allanite Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, fine- to medium-grained.
Probable rock: Plagioclase-biotite-microcline augen gneiss.

Turret Road Chaffee County PRC-27-96
6.5 mi. NNE of 51N-9E, sec 34
Salida

Plagioclase 50% Oligoclase; xenoblastic grains 0.5 to 0.05 mm.; slightly altered to sericite; albite twins indistinct.
Quartz 30% Xenoblastic grains 4.0 to 0.01 mm.; strongly strained and fractured; grain borders sutured and granulated; large grains occur in lens-shaped aggregates.
Biotite 15% Elongate idioblastic to xenoblastic grains 2.0 to 0.01 mm.; pleochroic from yellowish-brown to very dark brown; preferred orientation.
Muscovite 5% Shredlike xenoblastic grains 0.5 to 0.01 mm.; associated with biotite.
Sphene Tr.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Muscovite-biotite-quartz-plagioclase gneiss.

U.S. Rte. 92 Gunnison County PRC-27-97
(old U.S. Rte. 50) 49N-4W, sec 27
2 mi. east of
Sapinero

Plagioclase 35% Oligoclase to andesine; xenoblastic grains 1.0 to 0.2 mm.; slightly altered to sericite; albite and pericline twins indistinct to absent; albite rims; myrmekitic.
Microcline 25% Xenoblastic grains 4.0 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase and quartz.
Quartz 20% Xenoblastic grains 1.5 to 0.01 mm.; strongly strained and fractured; sutured borders.
Biotite 10% Elongate xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale yellow to dark brownish-green; preferred orientation.
Hornblende 5% Corroded xenoblastic grains 1.0 to 0.05 mm.; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose quartz and biotite.
Magnetite 3% Xenoblastic grains 0.2 to 0.05 mm.
Sphene 2% Xenoblastic grains 0.2 to 0.01 mm.; associated with magnetite.
Apatite Tr.

Zircon Tr.

Fabric: Gneissose, lepidoblastic to nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Hornblende-biotite-quartz-microcline-plagioclase gneiss.

U.S. Rte. 92 (old U.S. Rte. 50) 2 mi. east of Sapinero	Gunnison County 49N-4W, sec 27	PRC-27-98

Plagioclase 37% Oligoclase to andesine; xenoblastic grains 2.0 to 0.1 mm.; moderately to severely altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose quartz and biotite; myrmekitic.
Microcline 25% Xenoblastic grains 8.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic; large grains occur in felsic layers with severely altered plagioclase grains; smaller grains occur interstitially in mafic layers.
Biotite 15% Elongate idioblastic to xenoblastic grains 1.0 to 0.5 mm.; pleochroic from light yellow to very dark brownish-green; larger grains occur in felsic layers; poikiloblastically enclose sphene and zircon; slightly altered to chlorite; preferred orientation.
Quartz 10% Xenoblastic grains 8.0 to 0.05 mm.; strongly strained and fractured; grain borders sutured and granulated.
Hornblende 5% Corroded xenoblastic grains 1.0 to 0.01 mm.; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose apatite and sphene; occur with biotite in mafic layers; preferred orientation.
Sphene 3% Xenoblastic grains 0.2 to 0.05 mm.; associated with hornblende and magnetite.
Magnetite 3% Xenoblastic grains 0.3 to 0.05 mm.
Epidote 1%
Apatite 1%
Zircon Tr.

Fabric: Gneissose, lepidoblastic to nematoblastic, porphyroblastic, layered, medium- to coarse-grained.
Probable rock: Hornblende-quartz-biotite-microcline-plagioclase gneiss.

U.S. Rte. 92 (old U.S. Rte. 50) 2 mi. east of Sapinero	Gunnison County 49N-4W, sec 27	PRC-27-99

Plagioclase 50% Andesine to labradorite; xenoblastic grains 0.5 to 0.05 mm.; slightly to severely altered to sericite and calcite; albite and pericline twins; zoned.
Hornblende 42% Idioblastic to xenoblastic grains 3.0 to 0.05 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; twinned; preferred orientation.
Epidote 5% Lathlike idioblastic to xenoblastic grains 0.3 to 0.01 mm.; associated with hornblende as an alteration product; concentrated along microshears.
Quartz 2% Xenoblastic grains 0.3 to 0.05 mm.; strongly strained and fractured; grain borders sutured; occur interstitially to plagioclase and hornblende.
Sphene 1%
Apatite Tr.
Magnetite Tr.
Hematite Tr.
Pyrite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Amphibolite.

Lake Fork Canyon 6 mi. North of Gateview	Gunnison County 48N-3W, sec 32	PRC-27-100

Quartz 33% Xenoblastic grains 4.5 to 0.01 mm.; moderately to severely strained and fractured; grain borders sutured and granulated; larger grains occur in quartzose layers and also in a small vein.
Plagioclase 20% Variety not determined; xenoblastic grains 0.5 to 0.01 mm.; slightly to moderately altered to sericite; albite twins very indistinct to absent; larger grains occur with quartz in vein.
Biotite 20% Shredlike xenoblastic grains 1.0 to 0.01 mm.; pleochroic from very pale yellow to greenish-brown; larger grains occur in vein; smaller grains absent from host rock near vein; preferred orientation.
Microcline 15% Xenoblastic grains 0.2 to 0.01 mm.; distinct polysynthetic twins.
Epidote 8% Xenoblastic grains 0.3 to 0.01 mm.; associated with bio tite; less abundant in host rock near vein.
Hornblende 2% Corroded xenoblastic grains 1.0 to 0.1 mm.; pleochroic

from pale yellowish-green to dark green or bluish-green; associated with coarse biotite in vein.
Magnetite 1% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.
Sphene 1%
Apatite Tr.

Fabric: Gneissose to schistose, lepidoblastic, non-porphyroblastic, fine- to medium-grained.
Probable rock: Epidote-bearing microcline-biotite-plagioclase-quartz gneiss.

Lake Fork Canyon 6 mi. north of Gateview — Gunnison County 48N-3W, sec 32 — PRC-27-101

Quartz 40% Xenoblastic grains 0.3 to 0.01 mm.; strongly strained and fractured; sutured borders.
Microcline 20% Xenoblastic grains 0.3 to 0.01 mm.; distinct polysynthetic twins.
Plagioclase 15% Oligoclase; xenoblastic grains 0.2 to 0.05 mm.; moderately altered to sericite; albite twins.
Biotite 10% Xenoblastic grains 0.1 to 0.01 mm.; pleochroic from pale green to brownish-green; weak preferred orientation.
Muscovite 5% Shredlike xenoblastic grains 0.3 to 0.01 mm.; associated with biotite.
Magnetite 5% Idioblastic to xenoblastic grains 0.3 to 0.01 mm.
Epidote 3% Xenoblastic grains 0.05 to 0.01 mm.; associated with biotite.
Sphene 2% Xenoblastic grains 0.1 to 0.01 mm.; strongly altered to leucoxene.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Muscovite-biotite-plagioclase-microcline-quartz gneiss.

Lake Fork Canyon 4 mi. north of Gateview — Gunnison County 47N-3W, sec 5 — PRC-27-102

Microcline 45% Xenoblastic grains 13.0 to 0.01 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose quartz, plagioclase, biotite, and magnetite; smaller grains occur in cross-cutting bands and aggregates.

Plagioclase 25% Oligoclase; xenoblastic grains 8.0 to 0.01 mm.; moderately to strongly altered to sericite; indistinct albite and Carlsbad twins, poikiloblastically enclose quartz, biotite, and sphene; weakly zoned.

Quartz 15% Xenoblastic grains 1.5 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated; smaller grains occur in bands of microcline.

Biotite 10% Idioblastic to shredlike xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale yellow to brownish-green; poikiloblastically enclose sphene, epidote, apatite, and zircon; preferred orientation.

Sphene 2% Idioblastic to xenoblastic grains 1.5 to 0.05 mm.; moderately to strongly altered to leucoxene; associated with magnetite and biotite.

Magnetite 2% Idioblastic to xenoblastic grains 1.0 to 0.05 mm.; associated with biotite.

Muscovite 1% Xenoblastic grains 0.1 to 0.05 mm.; associated with biotite.

Epidote Tr.

Apatite Tr.

Zircon Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, coarse-grained.

Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

Lake Fork Canyon 4 mi. north of Gateview	Gunnison County 47N-3W, sec 5	PRC-27-103

Microcline 35% Xenoblastic grains 12.0 to 0.01 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose quartz, plagioclase, biotite, muscovite and magnetite; smaller grains occur in bands and aggregates.

Plagioclase 30% Oligoclase; xenoblastic grains 8.0 to 0.01 mm.; moderately to strongly altered to sericite; indistinct albite and Carlsbad twins; poikiloblastically enclose quartz, biotite and sphene; weakly zoned.

Quartz 15% Xenoblastic grains 1.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated; smaller grains occur in bands with microcline.

Biotite 10% Idioblastic to shredlike xenoblastic grains 0.5 to 0.01 mm.; pleochroic from pale yellow to brownish-green; poikiloblastically enclose sphene, epidote, apatite, and zircon; preferred orientation; occur in aggregates.

Muscovite 5% Xenoblastic grains 0.2 to 0.01 mm.; associated with biotite and sericite.
Sphene 3% Idioblastic to xenoblastic grains 1.0 to 0.05 mm.; moderately altered to leucoxene; associated with magnetite and biotite.
Magnetite 2% Idioblastic to xenoblastic grains 1.5 to 0.05 mm.
Hornblende Tr. Corroded xenoblastic grains 0.3 to 0.05 mm.; pleochroic from yellowish-green to dark green.
Epidote Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, coarse-grained.
Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

Lake Fork Canyon 3 mi. north of Gateview	Gunnison County 47N-3W, sec 5	PRC-27-104

Plagioclase 49% Andesine to labradorite; lathlike euhedral to subhedral grains 3.0 to 0.1 mm.; slightly to severely altered to sericite; albite, pericline, and Carlsbad twins; zoned.
Diopside 35% Elongate subhedral to anhedral grains 5.0 to 0.05 mm.; twinned; very pale brown color; slightly to moderately altered to hornblende and biotite.
Micrographic granite 5% Anhedral grains 0.5 to 0.05 mm.; composed of intergrown quartz and orthoclase; grains occur intergranularly to plagioclase laths; quartz slightly strained; orthoclase moderately altered to sericite.
Magnetite 5% Anhedral grains 1.0 to 0.01 mm.; occur intergranularly to plagioclase laths.
Hornblende 3% Anhedral grains 1.0 to 0.01 mm.; pleochroic from yellowish-brown to dark brownish-green; associated with diopside.
Biotite 3% Anhedral grains 0.3 to 0.01 mm.; pleochroic from pale yellow to very dark reddish-brown; slightly altered to chlorite; associated with diopside.
Apatite Tr.
Pyrite Tr.

Fabric: Holocrystalline; inequigranular-seriate; subophitic to intergranular; medium-grained.
Probable rock: Leucogabbro.

Lake Fork Canyon — Gunnison County — PRC-27-105
3 mi. north of Gateview — 47N-3W, sec 17

Hornblende 50% Xenoblastic grains 0.2 to 0.01 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; preferred orientation.
Quartz 35% Xenoblastic grains 0.1 to 0.01 mm.; strongly strained; grain borders sutured.
Calcite 10% Xenoblastic grains 0.5 to 0.01 mm.; occur in a distinct layer in the rock.
Sphene 2%
Epidote 2%
Muscovite 1%
Magnetite Tr.
Pyrite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, very fine-grained.
Probable rock: Calcite-quartz-hornblende gneiss.

Quartz Creek Road — Gunnison County — PRC-27-106
2 mi. NE of Parlin — 49N-2E, sec 13

Quartz 69% Xenoblastic grains 0.5 to 0.01 mm.; moderately to strongly strained and fractured; grain borders intricately sutured and granulated.
Microcline 10% Xenoblastic grains 0.1 to 0.01 mm.; indistinct polysynthetic twins; microperthitic; occur interstitially to quartz grains.
Biotite 10% Xenoblastic grains 0.2 to 0.01 mm.; pleochroic from pale yellow to very dark greenish-brown; preferred orientation.
Plagioclase 5% Oligoclase; xenoblastic grains 0.1 to 0.01 mm.; slightly altered to sericite; albite twins; occur interstitially to quartz grains; myrmekitic.
Muscovite 5% Shredlike xenoblastic grains 1.0 to 0.01 mm. (includes sericite); weak preferred orientation.
Sphene 1%
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Muscovite-plagioclase-biotite-microcline-quartz gneiss.

Quartz Creek Road
2 mi. SE of
Ohio City

Gunnison County
50N-R3E, sec 27

PRC-27-107

Hornblende 50% Elongate idioblastic to xenoblastic grains 1.5 to 0.05 mm.; pleochroic from yellowish-green to dark green or bluish-green; occur in aggregates; no preferred orientation.
Plagioclase 45% Andesine; xenoblastic grains 0.3 to 0.05 mm.; slightly altered to sericite; albite, pericline and Carlsbad twins.
Sphene 5% Xenoblastic grains 0.05 to 0.01 mm.; slightly altered to leucoxene.
Apatite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Amphibolite.

U.S. Rte 50
8 mi. west of
Poncha Springs

Chaffee County
50N-7E, sec 32

PRC-27-108

Plagioclase 45% Oligoclase; xenoblastic grains 1.0 to 0.05 mm.; strongly to severely altered to sericite; albite twins obscured; poikiloblastically enclose quartz, muscovite, and magnetite.
Quartz 25% Xenoblastic grains 0.5 to 0.01 mm.; strongly strained and fractured; grain borders sutured and slightly granulated.
Muscovite 13% Shredlike xenoblastic grains 5.0 to 0.01 mm.; large sievelike grains enclose grains of plagioclase, quartz, biotite and magnetite; crinkled; graphic texture with quartz; preferred orientation.
Biotite 7% Xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellow to brown; severely to completely altered to chlorite; associated with muscovite; preferred orientation.
Magnetite 5% Idioblastic to xenoblastic grains 0.5 to 0.01 mm.; associated with biotite.
Microcline 3% Xenoblastic grains 0.5 to 0.1 mm.; distinct polysynthetic twins; occur interstitially to plagioclase and quartz.
Sillimanite 2% Needlelike idioblastic grains 0.2 mm. to microcrystalline; occur in aggregates and included within quartz and muscovite.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-muscovite-quartz-plagioclase gneiss.

U.S. Rte. 285 | Chaffee County | PRC-27-109
6 mi. south of Poncha Springs | 48N-8E, sec 5 |

Microcline 35% Xenoblastic grains 1.0 to 0.05 mm.; distinct polysynthetic twins; poikiloblastically enclose small blebs of quartz and biotite.
Plagioclase 25% Oligoclase; xenoblastic grains 1.0 to 0.1 mm.; slightly altered to sericite; albite twins indistinct; myrmekitic.
Quartz 25% Xenoblastic grains 1.0 to 0.05 mm.; moderately strained and fractured; grain borders slightly sutured.
Biotite 10% Elongate idioblastic to xenoblastic grains 1.5 to 0.05 mm.; pleochroic from pale greenish-yellow to brownish-green; poikiloblastically enclose sphene and zircon; preferred orientation.
Magnetite 3% Xenoblastic grains 1.0 to 0.05 mm.; associated with biotite.
Sphene 2% Xenoblastic grains 0.1 to 0.01 mm.; strongly to severely altered to leucoxene; associated with biotite and magnetite.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

U.S. Rte. 285 | Saguache County | PRC-27-110
3 mi. south of Poncha Springs | 49N-8E, sec 21 |

Hornblende 55% Idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; preferred orientation.
Plagioclase 35% Andesine to labradorite; xenoblastic grains 0.5 to 0.05 mm.; slightly altered to sericite; albite, pericline and Carlsbad twins.
Quartz 5% Xenoblastic grains 0.5 to 0.05 mm.; slightly to moderately strained; occur interstitially to plagioclase and hornblende; also occur in an indistinct, plagioclase-free layer.
Sphene 5% Xenoblastic grains 0.05 to 0.01 mm.; occur in aggregates up to 0.5 mm. slightly altered to leucoxene.
Apatite Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Quartz-plagioclase-hornblende gneiss.

U.S. Rte. 285 | Chaffee County | PRC-27-111
7 mi. south of | 14S-77W, sec 8
Trout Creek Pass

Microcline 35% Xenoblastic grains 11.0 to 0.1 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose plagioclase, quartz, biotite, sphene, and magnetite.
Plagioclase 25% Oligoclase to andesine; xenoblastic grains 5.0 to 0.2 mm.; slightly to severely altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose biotite and magnetite; zoned; myrmekitic.
Quartz 15% Xenoblastic grains 5.0 to 0.05 mm.; strongly strained and fractured; grain borders sutured and granulated.
Biotite 15% Idioblastic to xenoblastic grains 1.0 to 0.05 mm.; pleochroic from pale yellow to brown; slightly altered to chlorite; poikiloblastically enclose sphene and magnetite; preferred orientation.
Sphene 5% Xenoblastic grains 0.5 to 0.01 mm.; occur in aggregates; associated with biotite.
Magnetite 3% Idioblastic to xenoblastic grains 0.5 to 0.05 mm.; associated with biotite and sphene.
Hornblende 2% Corroded xenoblastic grains 1.5 to 0.05 mm.; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose quartz, magnetite, biotite and apatite.
Epidote Tr. Idioblastic to xenoblastic grains 0.5 to 0.05 mm.
Apatite Tr.
Calcite Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

U.S. Rte 285 | Chaffee County | PRC-27-112
5 mi. south of | 14S-77W, sec 10
Trout Creek Pass

Microcline 35% Xenoblastic grains 11.0 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase, quartz, magnetite, and small grains of microcline; grains occur in aggregates.
Plagioclase 30% Oligoclase to andesine; xenoblastic grains 6.0 to 0.1 mm.; moderately to strongly altered to sericite; albite, pericline and Carlsbad twins.
Quartz 27% Xenoblastic grains 7.0 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured.

Biotite 5% Idioblastic to xenoblastic grains 3.0 to 0.01 mm.; pleochroic from light yellowish-brown to very dark brown; poikiloblastically enclose apatite, sphene and zircon; slightly altered to chlorite; preferred orientation.
Sphene 2% Idioblastic to xenoblastic grains 0.3 to 0.01 mm.; moderately to severely altered to leucoxene; associated with biotite and magnetite.
Magnetite 1%
Muscovite Tr.
Epidote Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

U.S. Rte. 285	Chaffee County	PRC-27-113
5 mi. south of	14S-77W, sec 10	
Trout Creek Pass		

Quartz 40% Xenoblastic grains 7.0 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders; poikiloblastically enclose plagioclase, microcline, and biotite.
Plagioclase 30% Oligoclase to andesine; xenoblastic grains 3.0 to 0.1 mm.; slightly to strongly altered to sericite; albite, pericline, and Carlsbad twins; myrmekitic.
Biotite 15% Elongate idioblastic to xenoblastic grains 2.0 to 0.05 mm.; pleochroic from pale greenish-yellow to very dark brownish-green; slightly altered to chlorite; preferred orientation.
Microcline 10% Xenoblastic grains 1.0 to 0.1 mm.; distinct polysynthetic twins; occur in small aggregates and interstitially to plagioclase grains.
Muscovite 5% Xenoblastic grains 1.0 to 0.05 mm.; associated with biotite; small intergrowths of magnetite.
Sphene Tr.
Apatite Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium- to coarse-grained.
Probable rock: Muscovite-microcline-biotite-plagioclase-quartz gneiss.

Colo. Rte. 162
Cumberland Pass Road
1.5 mi. north of
Cumberland Pass

Gunnison County
15S-81W, sec 31

PRC-27-114

Plagioclase 58% Oligoclase to andesine; xenoblastic grains 3.0 to 0.05 mm.; slightly to strongly altered to sericite; indistinct albite and Carlsbad twins; weakly zoned; myrmekitic.
Quartz 30% Xenoblastic grains 4.0 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders.
Orthoclase 5% Xenoblastic grains 1.5 to 0.05 mm.; no twinning apparent; microperthitic; smaller grains occur interstitially.
Biotite 5% Elongate xenoblastic grains 1.5 to 0.01 mm.; pleochroic from light yellow to greenish-brown; moderately to strongly altered to chlorite (pennine); preferred orientation.
Sphene 2% Idioblastic to xenoblastic grains 3.0 to 0.01 mm.; moderately to severely altered to leucoxene; associated with biotite and magnetite.
Epidote Tr.
Apatite Tr.
Magnetite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Biotite-orthoclase-quartz-plagioclase gneiss.

Colo. Rte. 306
Taylor Canyon
Upstream side of
Taylor Dam

Gunnison County
14S-83W, sec 24

PRC-27-115

Calcite 42% Xenoblastic grains 1.0 mm. to microcrystalline; occur in distinct layers.
Quartz 27% Xenoblastic grains 0.3 to 0.01 mm.; strongly strained and fractured; sutured borders; occur in distinct layers.
Hornblende 15% Corroded xenoblastic grains 2.5 to 0.01 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; strained and fractured; slightly altered to chlorite (pennine); poikiloblastically enclose quartz, apatite, and sphene; associated with quartz; preferred orientation.
Plagioclase 10% Variety not determined; xenoblastic grains 0.5 to 0.01 mm.; moderately altered to sericite; albite twins absent; associated with quartz.
Biotite 3% Xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale yellow to brown; strongly to severely altered to chlorite (pennine); associated with hornblende; preferred orientation.

Sphene 2% Xenoblastic grains 0.05 to 0.01 mm.; moderately to strongly altered to leucoxene; associated with hornblende.
Microcline 1% Xenoblastic grains 0.1 to 0.01 mm.; distinct polysynthetic twins.
Epidote Tr.
Zircon Tr.
Magnetite Tr.
Pyrite Tr.

Fabric: Gneissose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Plagioclase-hornblende-quartz-calcite gneiss.

Colo. Rte. 306 Taylor Canyon Upstream side of Taylor Dam	Gunnison County 14S-83W, sec 24	PRC-27-116

Hornblende 65% Corroded xenoblastic grains 0.5 to 0.01 mm.; pleochroic from yellowish-green to dark green or bluish-green; poikiloblastically enclose quartz; preferred orientation.
Plagioclase 25% Andesine; xenoblastic grains 0.3 to 0.01 mm.; moderately to strongly altered to sericite; albite twins indistinct.
Quartz 5% Xenoblastic grains 0.1 to 0.01 mm.; moderately strained; occur interstitially to hornblende and plagioclase.
Magnetite 5% Xenoblastic grains 0.2 to 0.01 mm.; associated with hornblende.
Microcline Tr.
Sphene Tr.

Fabric: Schistose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Quartz-plagioclase-hornblende schist.

Colo. Rte. 306 Taylor Canyon Upstream side of Taylor Dam	Gunnison County 14S-83W, sec 24	PRC-27-117

Quartz 70% Xenoblastic grains 0.3 to 0.01 mm.; moderately to strongly strained and fractured.
Plagioclase 15% Variety not determined; xenoblastic grains 0.05 to 0.01 mm.; slightly to moderately altered to sericite; occur interstitially to quartz.
Hornblende 10% Corroded xenoblastic grains 0.3 to 0.01 mm.; pleo-

chroic from yellowish-green to dark green or bluish-green; preferred orientation.
Epidote 5% Xenoblastic grains 0.5 to 0.01 mm.; associated with hornblende.
Biotite Tr. Xenoblastic grains 0.05 to 0.01 mm.; pleochroic from pale yellow to greenish-brown; strongly altered to chlorite; associated with hornblende; preferred orientation.
Magnetite Tr.
Zircon Tr.

Fabric: Gneissose, nematoblastic, non-porphyroblastic, fine-grained.
Probable rock: Hornblende-plagioclase-quartz gneiss.

Colo. Rte. 306 Taylor Canyon 0.5 mi. SW of Taylor Dam	Gunnison County 14S-83W, sec 24	PRC-27-118

Quartz 30% Xenoblastic grains 3.5 to 0.01 mm.; severely strained and fractured; grain borders intricately sutured and granulated; occur in aggregates.
Plagioclase 28% Oligoclase to andesine; xenoblastic grains 8.0 to 0.05 mm.; strongly altered to sericite; albite and Carlsbad twins indistinct and distorted; poikiloblastically enclose epidote; myrmekitic.
Microcline 25% Xenoblastic grains 13.0 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase, quartz and epidote.
Biotite 10% Shredlike xenoblastic grains 4.0 to 0.05 mm.; pleochroic from light yellowish-brown to brown; strongly altered to chlorite; preferred orientation.
Sphene 3% Idioblastic to xenoblastic grains 1.0 to 0.01 mm.; strongly altered to leucoxene; associated with biotite.
Magnetite 2% Xenoblastic grains 1.5 to 0.01 mm.; associated with biotite and sphene.
Apatite 2% Elongate idioblastic to xenoblastic grains 0.3 to 0.05 mm.; fractured; associated with biotite.
Epidote Tr.
Muscovite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, cataclastic, medium- to coarse-grained.
Probable rock: Biotite-microcline-plagioclase-quartz gneiss.

Colo. Rte. 306 4 mi. NE of Almont	Gunnison County 15S-84W, sec 29	PRC-27-119

Microcline 40% Xenoblastic grains 6.0 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz, plagioclase, biotite, and muscovite.
Quartz 30% Xenoblastic grains 3.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and slightly granulated; contain microcrystalline needles of rutile.
Plagioclase 15% Oligoclase; xenoblastic grains 3.0 to 0.1 mm.; moderately to strongly altered to sericite; poikiloblastically enclose biotite and muscovite; weakly zoned; myrmekitic.
Biotite 10% Xenoblastic grains 2.5 to 0.05 mm.; pleochroic from very pale yellow to dark reddish-brown; poikiloblastically enclose zircon; slightly altered to chlorite; preferred orientation.
Muscovite 5% Idioblastic to xenoblastic grains 3.0 to 0.05 mm.; smaller grains associated with biotite.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, medium- to coarse-grained.
Probable rock: Muscovite-biotite-plagioclase-quartz-microcline gneiss.

Colo. Rte. 306 4 mi. NE of Almont	Gunnison County 15S-84W, sec 29	PRC-27-120

Quartz 40% Xenoblastic grains 3.0 to 0.01 mm.; strongly strained and fractured; grain borders sutured and slightly granulated; poikiloblastically enclose biotite.
Muscovite 25% Elongate idioblastic to xenoblastic grains 15.0 to 0.1 mm.; poikiloblastically enclose biotite and quartz; preferred orientation.
Biotite 20% Elongate idioblastic to xenoblastic grains 3.0 to 0.05 mm.; pleochroic from pale yellow to dark reddish-brown; poikiloblastically enclose zircon; occur in aggregates; preferred orientation.
Plagioclase 15% Oligoclase; xenoblastic grains 0.5 to 0.2 mm.; slightly to moderately altered to sericite; indistinct albite and pericline twins.
Sillimanite Tr.
Zircon Tr.

Fabric: Schistose, lepidoblastic, non-porphyroblastic, medium- to coarse grained.
Probable rock: Plagioclase-biotite-muscovite-quartz schist

Colo. Rte. 306 | Gunnison County | PRC-27-121
8 mi. NE of | 15S-84W, sec 24
Almont

Quartz 53% Xenoblastic grains 10.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated.
Plagioclase 20% Oligoclase; idioblastic grains 6.0 to 0.1 mm.; moderately to strongly altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose muscovite; myrmekitic.
Microcline 10% Xenoblastic grains 10.0 to 0.1 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose quartz, plagioclase, biotite, muscovite, and small grains of microcline.
Biotite 10% Idioblastic to xenoblastic grains 6.0 to 0.05 mm.; pleochroic from light yellowish-brown to dark brown or very dark greenish-brown; slightly altered to chlorite; poikiloblastically enclose apatite, magnetite, muscovite, and zircon; preferred orientation.
Muscovite 5% Idioblastic to xenoblastic grains 2.0 to 0.05 mm.; larger grains associated with biotite, smaller with plagioclase; intergrowths of magnetite; preferred orientation.
Apatite 1%
Magnetite 1%
Sphene Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, coarse-grained.
Probable rock: Muscovite-biotite-microcline-plagioclase-quartz gneiss.

Taylor Park | Gunnison County | PRC-27-122
4 mi. north of | 13S-83W, sec 28
Taylor Park Village

Plagioclase 50% Andesine; idioblastic to xenoblastic grains 6.0 to 0.2 mm.; slightly to strongly altered to sericite; albite, pericline, and Carlsbad twins; strongly zoned.
Biotite 25% Shredlike xenoblastic grains 6.0 to 0.05 mm.; pleochroic from light yellowish-brown to brown; poikiloblastically enclose apatite, magnetite and sphene.
Quartz 15% Xenoblastic grains 6.0 to 0.05 mm.; moderately to strongly strained and fractured; grain borders sutured and slightly granulated.
Sphene 3% Xenoblastic grains 1.5 to 0.01 mm.; moderately to strongly altered to leucoxene; associated with biotite.
Apatite 3% Idioblastic grains 0.3 to 0.05 mm.; associated with bio-

tite.
Magnetite 3% Xenoblastic grains 1.0 to 0.05 mm.; associated with sphene and biotite.
Muscovite 1%

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, coarse-grained.
Probable rock: Quartz-biotite-plagioclase gneiss.

Clear Creek Road 1 mi. east of Vicksburg	Chaffee County 12S-80W, sec 17	PRC-27-123

Plagioclase 42% Andesine; idioblastic to xenoblastic grains 8.0 to 0.2 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose biotite, apatite, and small blebs of introduced quartz.
Quartz 30% Xenoblastic grains 4.0 to 0.01 mm.; moderately to severely strained and fractured; grain borders sutured and slightly granulated.
Biotite 20% Shredlike xenoblastic grains 6.0 to 0.05 mm.; pleochroic from light yellowish-brown to very dark greenish-brown; poikiloblastically enclose apatite, magnetite, and epidote; weak preferred orientation.
Apatite 3% Idioblastic grains 0.3 to 0.05 mm.; associated with biotite.
Epidote 2% Xenoblastic grains 0.5 to 0.05 mm.; associated with biotite; pleochroic from very pale yellow to brown.
Magnetite 2% Xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Sphene 1%

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, coarse-grained.
Probable rock: Biotite-quartz-plagioclase gneiss.

Clear Creek Road 1 mi. east of Vicksburg	Chaffee County 12S-80W, sec 17	PRC-27-124a&b (2 thin sections)

Plagioclase 45% Andesine; xenoblastic grains 9.5 to 0.1 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose quartz, biotite, muscovite, magnetite, and smaller grains of plagioclase.
Quartz 25% Xenoblastic grains 2.0 to 0.01 mm.; strongly strained and

fractured; grain borders intricately sutured and granulated.
Biotite 20% Elongate idioblastic to xenoblastic grains 3.0 to 0.01 mm.; pleochroic from light yellowish-brown to very dark greenish-brown; poikiloblastically enclose apatite; preferred orientation.
Apatite 5% Idioblastic grains 1.0 to 0.01 mm.; associated with biotite.
Magnetite 3% Xenoblastic grains 1.0 to 0.01 mm.; associated with biotite.
Sphene 1%
Epidote 1%
Allanite Tr.
Muscovite Tr.
Zircon Tr.
Pyrite Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, cataclastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-plagioclase gneiss.

U.S. Rte. 24 1 mi. south of Granite	Chaffee County 12S-79W, sec 6	PRC-27-125

Plagioclase 30% Andesine; xenoblastic grains 7.0 to 0.01 mm.; strongly altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose quartz, biotite, epidote, magnetite, and apatite; small grains associated with biotite have intergrowths of magnetite; myrmekitic.
Microcline 20% Xenoblastic grains 14.0 to 3.0 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz, plagioclase, biotite and magnetite.
Quartz 20% Xenoblastic grains 2.5 to 0.01 mm.; strongly to severely strained and fractured; grain borders intricately sutured and granulated.
Biotite 20% Idioblastic to xenoblastic grains 4.0 to 0.05 mm.; pleochroic from light yellowish-brown to very dark greenish-brown; slightly altered to chlorite; poikiloblastically enclose apatite; preferred orientation.
Apatite 5% Idioblastic grains 1.0 to 0.05 mm.; associated with biotite.
Magnetite 3% Xenoblastic grains 1.5 to 0.05 mm.; associated with biotite.
Sphene 1%
Epidote 1%
Allanite Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, cataclastic, medium- to coarse-grained.
Probable rock: Biotite-quartz-microcline-plagioclase gneiss.

Weston Pass Road 2.5 mi. NW of Weston Pass	Lake County 10S-79W, sec 27	PRC-27-126

Microcline 39% Xenoblastic grains 15.0 to 0.3 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose biotite, plagioclase, quartz, magnetite, and muscovite.
Quartz 30% Xenoblastic grains 10.0 to 0.05 mm.; strongly strained and fractured; grain borders sutured.
Plagioclase 15% Oligoclase to andesine; xenoblastic grains 5.5 to 0.1 mm.; moderately to strongly altered to sericite; albite and Carlsbad twins; poikiloblastically enclose biotite and muscovite; myrmekitic.
Biotite 10% Xenoblastic grains 3.5 to 0.05 mm.; pleochroic from pale yellowish-brown to very dark greenish-brown; poikiloblastically enclose apatite and zircon; slightly to moderately altered to chlorite; preferred orientation.
Muscovite 2% Idioblastic to xenoblastic grains 1.5 to 0.05 mm.; associated with biotite.
Apatite 2%
Magnetite 2%
Sphene Tr.
Epidote Tr.
Zircon Tr.
Pyrite Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, coarse-grained.
Probable rock: Biotite-plagioclase-quartz-microcline gneiss.

Weston Pass Road 3 mi. NW of Weston Pass	Lake County 10S-79W, sec 21	PRC-27-127

Plagioclase 40% Andesine; idioblastic to xenoblastic grains 1.5 to 0.1 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose small blebs of quartz; myrmekitic.
Hornblende 35% Xenoblastic grains 3.0 to 0.05 mm.; pleochroic from pale yellowish-green to dark green or bluish-green; poikiloblas-

tically enclose biotite, sphene, apatite, and small blebs of quartz; preferred orientation.
Biotite 15% Idioblastic to xenoblastic grains 3.0 to 0.05 mm.; pleochroic from pale yellow to greenish-brown; poikiloblastically enclose apatite and intergrowths of quartz; associated with hornblende; preferred orientation.
Quartz 6% Xenoblastic grains 1.0 to 0.01 mm.; moderately to strongly strained; appears to have been introduced interstitially.
Sphene 2% Xenoblastic grains 1.5 to 0.01 mm.; strongly altered to leucoxene; associated with hornblende.
Microcline 1%
Magnetite 1%
Epidote Tr.
Apatite Tr.
Pyrite Tr.

Fabric: Schistose, nematoblastic to lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Quartz-biotite-hornblende-plagioclase gneiss.

Weston Pass Road 4.5 mi. NW of Weston Pass	Lake County 10S-79W, sec 19	PRC-27-128

Microcline 49% Xenoblastic grains 11.0 to 0.05 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose plagioclase, quartz, biotite, muscovite, and magnetite.
Quartz 35% Xenoblastic grains 5.0 to 0.01 mm.; strongly strained and fractured; grain borders sutured and slightly granulated; contain microcrystalline needles of rutile.
Plagioclase 10% Oligoclase to andesine; xenoblastic grains 4.5 to 0.1 mm.; strongly altered to sericite; albite and Carlsbad twins; albite rims; weakly zoned; myrmekitic.
Biotite 3% Xenoblastic grains 1.5 to 0.1 mm.; pleochroic from pale yellowish-brown to very dark greenish-brown; moderately altered to chlorite.
Muscovite 3% Xenoblastic grains 3.0 to 0.05 mm.
Leucoxene Tr.
Apatite Tr.
Zircon Tr.
Magnetite Tr.
Hematite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, porphyroblastic,

medium- to coarse-grained.
Probable rock: Plagioclase-quartz-microcline gneiss.

Colo. Rte. 82 Pitkin County PRC-27-129
1 mi. west of 11S-82W, sec 8
Independence Pass

Microcline 41% Idioblastic to xenoblastic grains 11.0 to 0.1 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose plagioclase, quartz, biotite, and magnetite.
Plagioclase 25% Andesine; xenoblastic grains 7.0 to 0.1 mm.; moderately to strongly altered to sericite; albite, pericline, and Carlsbad twins; weakly zoned; coarsely and finely myrmekitic.
Quartz 20% Xenoblastic grains 12.0 to 0.01 mm.; strongly strained and fractured; grain borders sutured; contain microcrystalline needles of rutile.
Biotite 10% Xenoblastic grains 3.0 to 0.1 mm.; pleochroic from pale yellow to dark brown; poikiloblastically enclose apatite and zircon; weak preferred orientation.
Magnetite 2% Xenoblastic grains 1.5 to 0.05 mm.; associated with biotite.
Sphene 1%
Apatite 1%
Epidote Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, coarse-grained.
Probable rock: Biotite-quartz-plagioclase-microcline gneiss.

Colo. Rte. 82 Pitkin County PRC-27-130
10 mi. SE of 11S-83W, sec 5
Aspen

Plagioclase 30% Andesine; idioblastic to xenoblastic grains 4.5 to 0.2 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose muscovite and apatite; weakly zoned; myrmekitic.
Quartz 20% Xenoblastic grains 8.0 to 0.05 mm.; strongly strained and fractured; sutured borders; contain microcrystalline needles of rutile.
Biotite 20% Xenoblastic grains 6.0 to 0.05 mm.; pleochroic from pale yellow to dark brown; weak preferred orientation.

Microcline 15% Xenoblastic grains 6.0 to 0.5 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose plagioclase, quartz, epidote, and sphene; some graphic intergrowths with quartz.
Magnetite 5% Idioblastic to xenoblastic grains 1.0 to 0.05 mm.; associated with biotite.
Sphene 3% Xenoblastic grains 3.0 to 0.1 mm.; faintly pleochroic.
Epidote 3% Xenoblastic grains 1.0 to 0.05 mm.; associated with biotite.
Muscovite 2% Xenoblastic grains 0.5 to 0.05 mm.; associated with biotite.
Apatite 2%

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, coarse-grained.
Probable rock: Microcline-biotite-quartz-plagioclase gneiss.

Colo. Rte. 82 8 mi. SE of Aspen	Pitkin County 11S-83W, sec 5	PRC-27-131

Quartz 50% Xenoblastic grains 5.0 to 0.05 mm.; moderately to strongly strained and fractured; sutured borders; contain microcrystalline needles of rutile.
Plagioclase 35% Andesine; xenoblastic grains 1.5 to 0.05 mm.; moderately to strongly altered to sericite; albite, pericline and Carlsbad twins; poikiloblastically enclose muscovite; myrmekitic.
Microcline 5% Xenoblastic grains 1.5 to 0.05 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz, plagioclase, biotite, muscovite, and magnetite.
Biotite 3% Shredlike xenoblastic grains 2.0 to 0.05 mm.; pleochroic from pale brown to very dark brown; severely to completely altered to chlorite (Pennine) and muscovite; preferred orientation.
Muscovite 2% Xenoblastic grains 1.5 to 0.05 mm.; associated with biotite; preferred orientation.
Epidote 2% Xenoblastic grains 1.0 to 0.01 mm.; occur along small fractures and also associated with biotite.
Magnetite 2% Idioblastic to xenoblastic grains 1.0 to 0.01 mm.
Sphene 1%
Sillimanite Tr.
Apatite Tr.
Zircon Tr.
Calcite Tr.

Fabric: Granoblastic to gneissose, lepidoblastic, non-porphyroblastic, medium-grained.
Probable rock: Microcline-plagioclase-quartz gneiss.

Frying Pan Creek Road 7 mi. SE of Thomasville	Pitkin County 8S-83W, sec 36	PRC-27-132

Microcline 30% Xenoblastic grains 1.0 to 0.05 mm.; distinct polysynthetic twins; Carlsbad twins; microperthitic; poikiloblastically enclose plagioclase.
Quartz 30% Xenoblastic grains 1.0 to 0.01 mm.; moderately to strongly strained and fractured; sutured borders.
Plagioclase 25% Oligoclase; xenoblastic grains 1.0 to 0.05 mm.; moderately altered to sericite; indistinct albite and Carlsbad twins; myrmekitic.
Biotite 9% Shredlike xenoblastic grains 1.0 to 0.01 mm.; pleochroic from pale greenish-yellow to dark brownish-green; slightly altered to chlorite; preferred orientation.
Muscovite 5% Shredlike xenoblastic grains 2.5 to 0.05 mm.
Magnetite 1%
Sphene Tr.
Apatite Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, non-porphyroblastic, fine-grained.
Probable rock: Muscovite-biotite-plagioclase-quartz-microcline gneiss.

Frying Pan Creek Road 7 mi. SE of Thomasville	Pitkin County 8S-83W, sec 36	PRC-27-133

Plagioclase 35% Oligoclase to andesine; idioblastic to xenoblastic grains 9.5 to 0.1 mm.; slightly to moderately altered to sericite; albite, pericline, and Carlsbad twins; poikiloblastically enclose biotite, muscovite, magnetite, and apatite; myrmekitic.
Quartz 28% Xenoblastic grains 8.0 to 0.01 mm.; strongly to severely strained and fractured; grain borders sutured and granulated; contain microcrystalline needles of rutile.
Microcline 20% Xenoblastic grains 14.5 to 0.1 mm.; distinct polysynthetic twins; microperthitic; poikiloblastically enclose quartz, plagioclase, biotite and magnetite.
Biotite 10% Idioblastic to xenoblastic grains 4.0 to 0.01 mm.; pleo-

chroic from pale yellowish-brown to very dark brown; poikiloblastically enclose apatite and zircon; slightly altered to chlorite; weak preferred orientation.

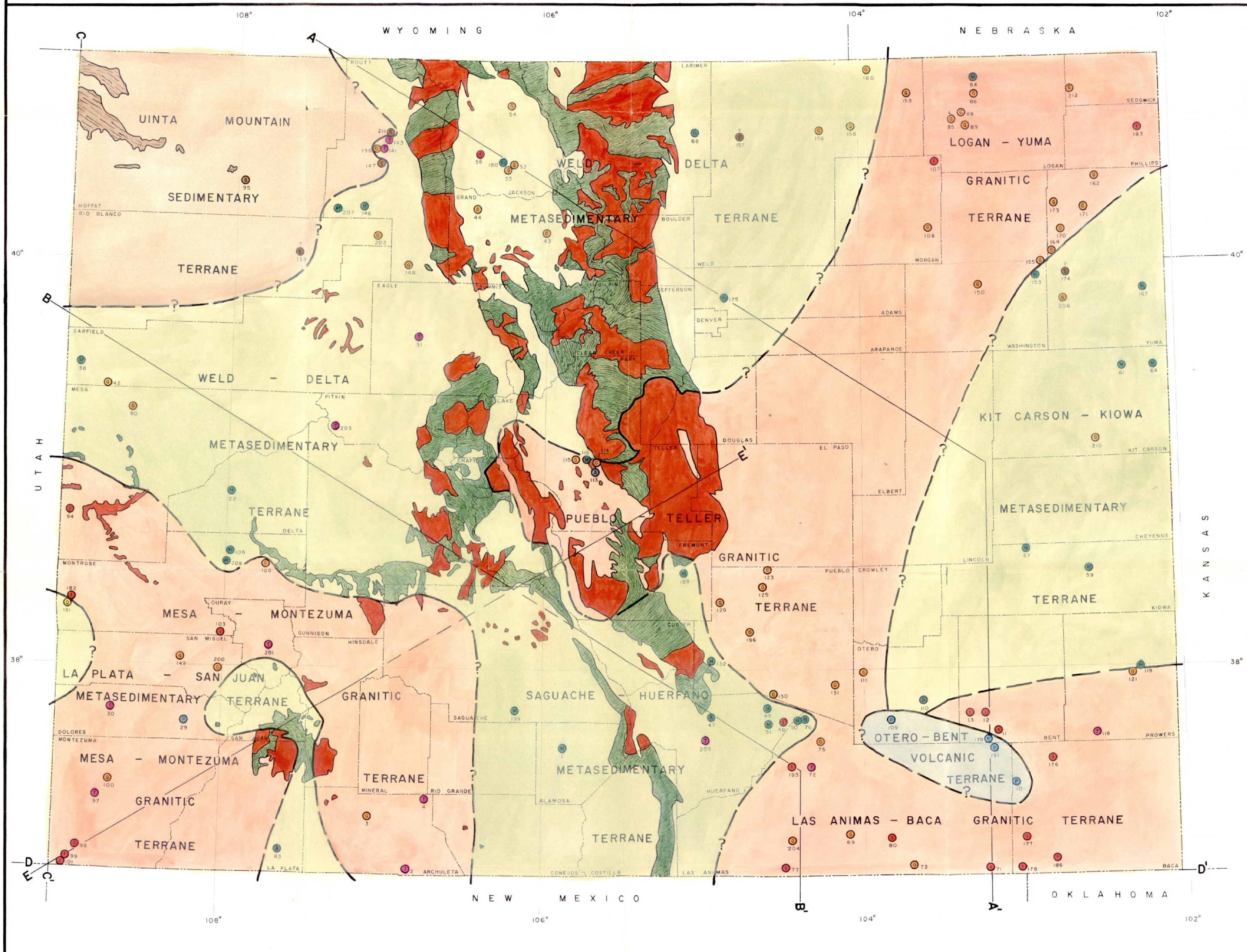
Muscovite 2%
Apatite 2%
Magnetite 2%
Epidote 1%
Sphene Tr.
Zircon Tr.

Fabric: Gneissose, lepidoblastic, porphyroblastic, coarse-grained.
Probable rock: Biotite-microcline-quartz-plagioclase gneiss.

T-1060

Plate I

PRECAMBRIAN BASEMENT TERRANES OF COLORADO



EXPLANATION

PRECAMBRIAN BASEMENT TERRANES

- Granitic terrane
- Metasedimentary terrane
- Sedimentary terrane
- Volcanic terrane

WELL SAMPLES

- Granitic igneous rock
- Granitic gneiss
- Metasediments - foliated schists and gneisses
- Quartzite
- Amphibolite
- Precambrian sedimentary rock
- Precambrian volcanic rock
- Tertiary volcanic or intrusive rock
- 183 Well reference number
- ? Questionable Precambrian basement rock

EXPOSED BASEMENT ROCKS

- Granites and granitic gneisses
- Metasedimentary rocks (Lines indicate general trend of foliation)
- Precambrian sedimentary rocks (Lines indicate general trend of bedding)

Approximate terrane boundary (Based on well data and on exposed basement rocks)

Inferred terrane boundary (Well data lacking)

A———A' Cross section line

0 10 20 30 40 50 Miles

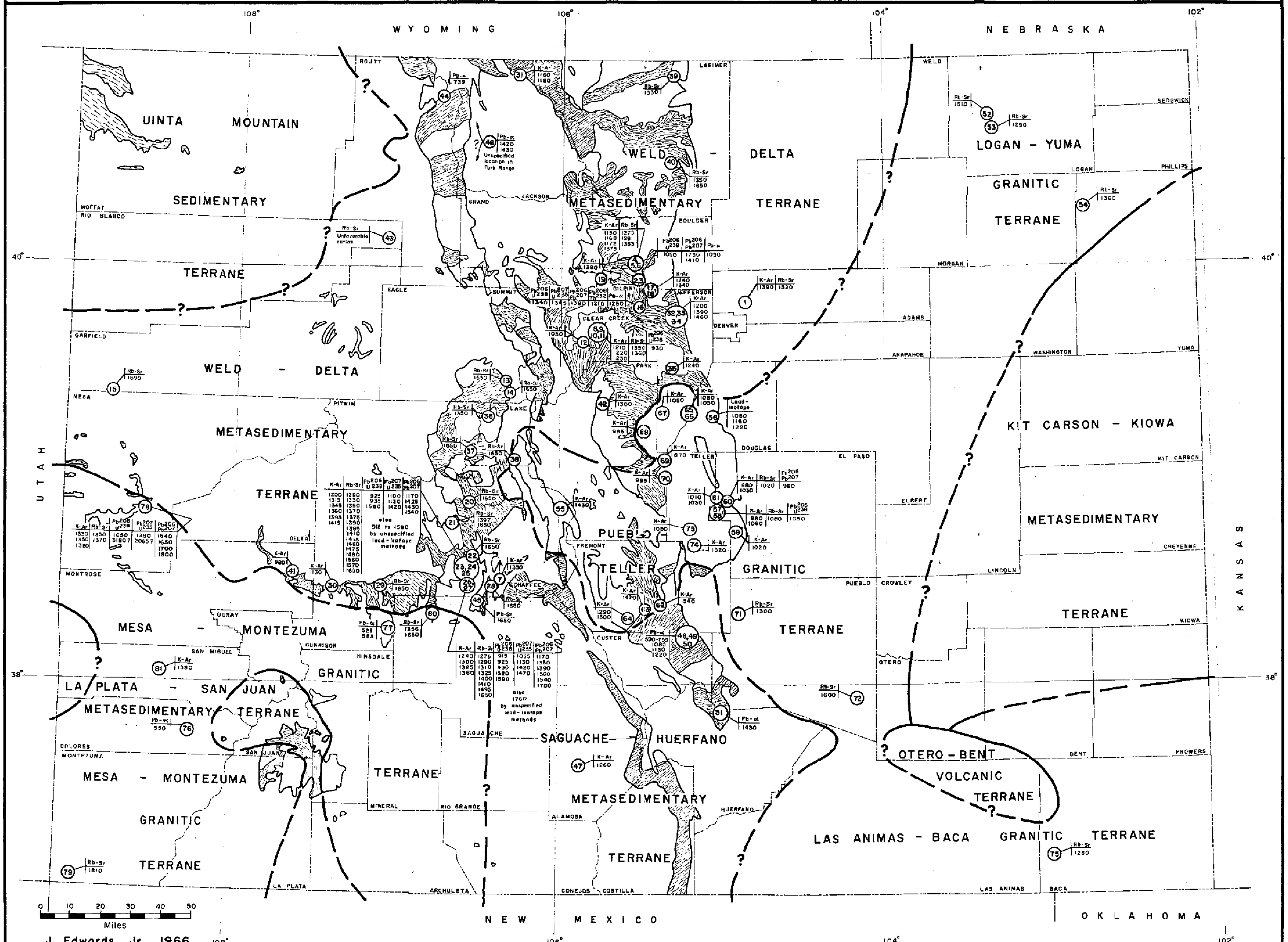
Scale 1:1,000,000

J. Edwards, Jr., 1966

Exposed basement rocks taken from:
Geologic Map of Colorado (1935)
Oriel (1954)
Merewether (1955)
Tweto and Sims (1963)

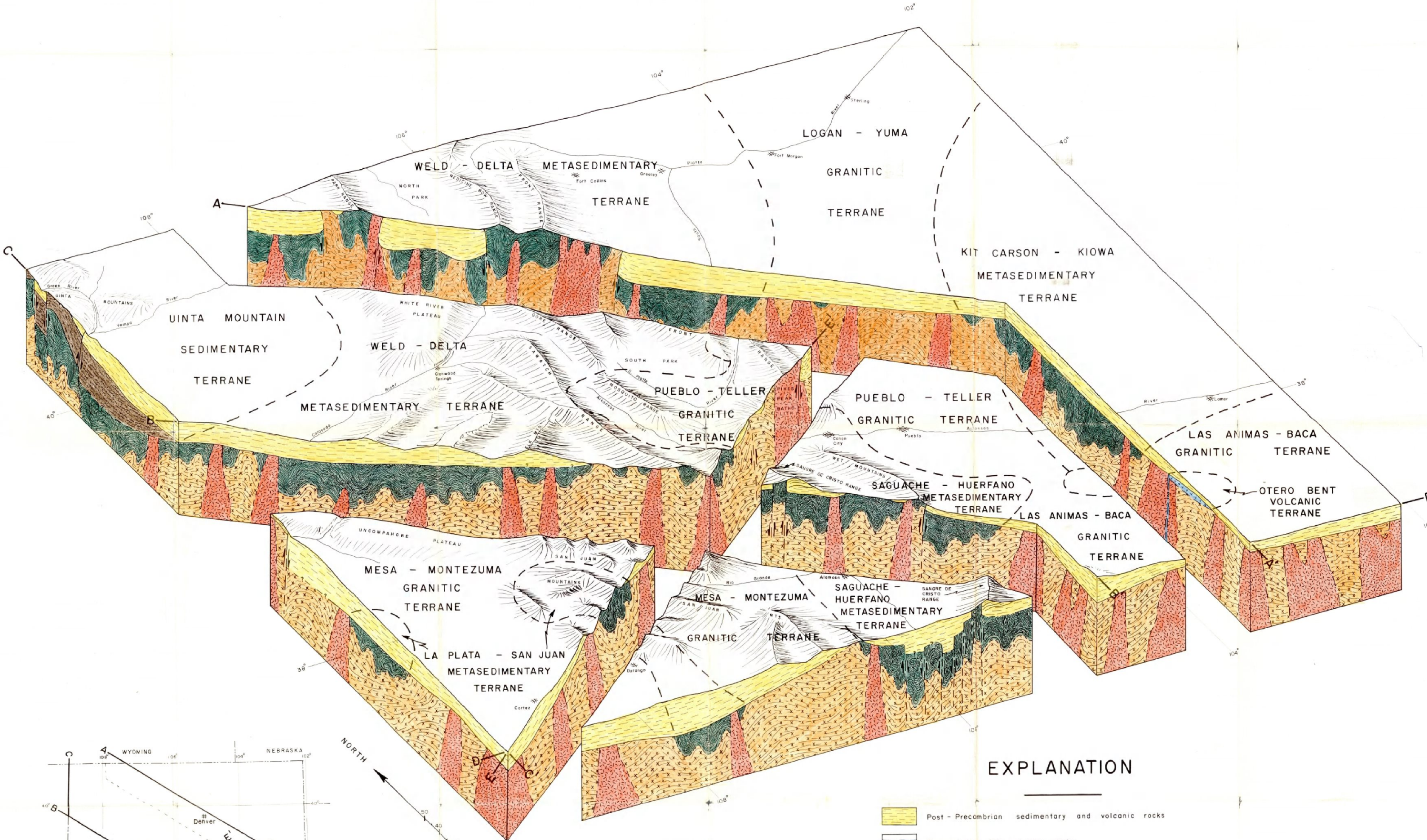
ISOTOPIC AGE DETERMINATIONS OF PRECAMBRIAN ROCKS IN COLORADO

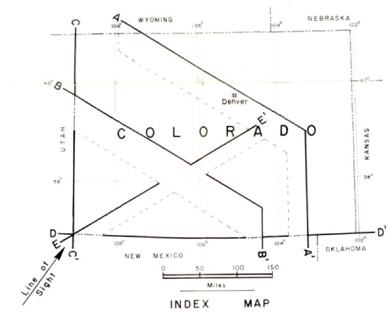
Refer to table 18 for complete tabulation of isotopic ages, rocks and minerals determined, locations, and references.



BLOCK DIAGRAM OF BURIED PRECAMBRIAN BASEMENT STRUCTURE OF COLORADO

Gross relations between Precambrian lithologies and structure are shown. Post-Precambrian structure is generalized.





INDEX MAP

Line of sight and cross section panels for block diagram are shown. Light dashes indicate limits of sections removed for viewing panels.

Horizontal scale 1:1,000,000

Vertical scale five times horizontal

J. Edwards, Jr., 1966

(Configuration of the basement surface from Am. Assoc. Petroleum Geologists Basement Rocks Committee, Basement Contour Map of the United States, preliminary copy.)

EXPLANATION

- Post-Precambrian sedimentary and volcanic rocks
- Precambrian (?) volcanic rocks
- Precambrian sedimentary rocks
- Precambrian granitic rocks (mesozonal plutons)
- Precambrian metasedimentary rocks and migmatites
- Precambrian granitic rocks (catazonal plutons, granitic orthogneisses, and some paragneisses)

(Tertiary plutons have been omitted from this diagram)