THE CASTLE ROCK CONGLOMERATE AND ASSOCIATED PLACER GOLD DEPOSITS

26606

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CONTENTS

Introduction	Page 1
Topography and Drainage	2
Stratigraphy	3
Structure	8
Petrography of Castle Rock Conglomerate	9
Microscopic Study of the Pebbles and Boulders of the Castle Rock Conglomerate and of Certain Rocks of the Front Range Area.	17
Placer Gold in the Cherry Creek and Running Creek Drainage Basins	24
Location and Richness	24
The Source of the Gold	28
Dawson lava	28
Sawson arkose	29
Castle Rock conglomerate	31
Resume	33
Acknowledgements	35
Illustrations	
Structure contour map	In pocket
Geological map	In pocket

INTRODUCTION

One of the most baffling problems in connection with the geology of the mineral deposits of Colorado is the question of the source of the placer gold of the Cherry Creek and Running Creek drainage basins in the Castle Rock and Denver quadrangles. These streams do not head in the Front Range, nor have any signs of mineralization been reported in the vicinity of the above mentioned creeks. Inasmuch as intermittent attempts have been made to recover gold on a commercial basis from the placer sands ever since 1858 (1) , and the possibility of the existence of placer ground of commercial importance in the area is admitted, it was deemed advisable to make a careful study of the occurrence with the view of determining definitely the source of the gold.

In the early stages of the investigation it became apparent that the placer gold was generally related to the Castle Rock conglomerate, therefore it became necessary to extend the investigation to include a stratigraphic study of this formation in order to properly trace the succession of events involved in the development of the modern placers.

Some of the principal papers discussing the Castle Rock conglomerate are listed as follows:

Hayden, F. V. Third annual preliminary field report of the United States Geological Survey of Colorado and New Mexico pp. 39-40, 1869.

Resume of the geology along the eastern base of the Front of Colorado Range; U.S. Geol. & Geog. Survey Terr. Eight Ann. Rept for 1874, pp. 36-46, 1876.

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(1) F. Hall, History of Colorado, Vol. 3, p. 333, 1891.

duplicate

Cannon, G. L. Jr. Notes on the Geology of Palmer Lake, Colo. Colo. Sci. Soc. Proc., Vol. 4, pp. 224-234, 1892.
Emmons, S. F., Cross, Whitman and Eldridge, G. H. Geology of the Denver Basin in Colorado, U. S. Geol. Survey, Mono. 27, 1896.
Lee, W. T. The areal geology of the Castle Rock region, Colorado, Am. Geologist, Vol. 29, pp. 96-109, 1902.
Darton, N. H. Age of the Monument Creek formation; Am. Jour. Sci. 4th Ser. Vol. 20, pp. 178-180, 1905.
Richardson, G. B. The Monument Creek group; Geol. Soc. America Bull., Vol. 23, pp. 257-276, 1912.
Castle Rock folio, Colorado, No. 198, U. S. Geol. Survey.

LOCATION The area involved in the problem under discussion covers a large part of the Castle Rock quadrangle in Douglas, Elbert, and El Paso Counties, Colorado, especially the area in which the Castle Rock conglomerate constitutes the surface rock.

TOPOGRAPHY AND DRAINAGE -- Topographically, the greatest part of the Castle Rock quadrangle is located in the plains area which is underlain for the most part by the soft Dawson arkose of Eocene age, and the relatively well indurated Castle Rock conglomerate of Oligocene age. A few patches of Dawson lava form the table lands and buttes near the Castlewood reservoir and in the southern part of the quadrangle the Castle Rock conglomerate, on account of its hardness, occupies a somewhat higher elevation by comparison with the topography of the soft Dawson arkose.

In general, the plains area represents a submaturely dissected plateau, with numerous mesas capped by resistant Castle Rock conglomerate and rhyolite lava of Dawson age. It slopes gently toward the northeast from an elevation of 7500 feet in the southern part of the quadrangle to an elevation of

6300 feet in its northeastern portion. The relief in the plains area is greatest in the west central portion of the quadrangle where numerous mesas capped by Dawson lava or Castle Rock conglomerate rise from 400 to 600 feet above the surrounding country.

The area is drained by a number of small northward flowing streams tributary to the Platte River. The largest of these in passing from east to west are: Kiowa Creek in the southeastern portion of the quadrangle, Running Creek, located a few miles west of Kiowa Creek, Cherry Creek and West Cherry Creek, which drain the central part of the quadrangle, and Plum and West Plum Creeks in the western portion. The valleys are relatively broad in soft Dawson arkose, but are narrow where they pass through the more resistant Castle Rock conglomerate and in the lava flows of the Dawson formation. The principal streams usually carry a small amount of water because the average annual rainfall over the plains of the quadrangle does not exceed sixteen inches per annum.

STRATIGRAPHY

Richardson (1) gives the following stratigraphical table for the Castle Rock quadrangle.

G. B. Richardson op. cit.

After Richardson 1915

System	Series		
Tertiary	Oligocene		Castle Rock Conglom. 300'
	Eocene		Dawson arkose 2000' maximum
Cretaceous	Upper Cretaceous		Laramie formation 600' to 2000'
		Montana group very thick	Fox Hills ss and Pierre shale
		Colo-rado group	Niobrara 400' and Benton 600'
			Dakota Sandstone 60'
	Lower Cretaceous		Purgatoire 200'
Cretaceous or Jurassic	L. Cretaceous or Up. Jurassic		Morrison form 300'
Jurassic	Up. Jurassic		
	Permian		Lykinsform 225'
Carboniferous	Pennsylv.		Fountain form 2000'
	Mississipian		Millsap. ls. 100'
Ordovician	L. Ordovician		Manitou ls. (thin)
Cambrian	Up. Cambrian		Sawatch ss. 350' maximum
Pre-Cambrian			Pikes Peak Granite

Inasmuch as the present study is concerned only with the Castle Rock conglomerate and the immediately underlying Dawson formation, no description of the older formations of the area is given.

The greater part of the area in the Castle Rock quadrangle is underlain by the Dawson arkose of Eocene age. However, the central and east central portions are occupied by the Castle Rock conglomerate of lower Oligocene age and by a few outcrops of Eocene lava and tuff, whereas the extreme west central portion of the quadrangle shows the outcrops of the Pikes Peak granite of Pre-Cambrian age and of the Paleozoic and Mesozoic limestones, shales and sandstones in the vicinity of the Perry Park. Numerous isolated patches of Eocene lava and some conglomerates are scattered over the area south and west of the main body of the Castle Rock conglomerate.

The Castle Rock conglomerate occupies a narrow, nearly continuous area stretching from Newlin Gulch to a few miles east and south of the town of Elbert. A few erosion remnants of Castle Rock conglomerate are to be found one mile and a half northeast of Sedalia and from ten to fifteen miles southwest of Elbert. The outcrops of Dawson and few patches of Quaternary deposits surround on all sides both the Castle Rock conglomerate and the Eocene rhyolite.

At the present time the thickness of the Castle Rock conglomerate varies from a thin veneer of residual pebbles and boulders up to 300 feet. Unquestionably its initial thickness and its extent was much greater than at the present time, a fact which is well sustained by the preservation of numerous small outliers of conglomerate scattered over a large area.

A complete section of the Castle Rock conglomerate is not exposed, nevertheless, a detailed study of the outcrops shows that the conglomerate is very variable in its character. This formation is composed essentially of coarse arkosic sandstone but includes locally large mass of conglomerate in the lower portion. Above this zone lies coarse arkosic sandstone usually streaked with lenses of conglomerate. An exposure at Castle Rock near the town of this name shows sixty feet of indurated conglomeratic arkose, which at the base is a coarse conglomerate. This coarse conglomerate is easily distinguishable from the underlying fine textured Dawson arkose. Richardson states that in many places the Castle Rock conglomerate rests on an uneven eroded surface of the Dawson arkose. A field examination by the writer of some of the above mentioned localities points to no noticeable angular unconformity between the Castle Rock and the upper part of the Dawson formation, though the presence of a disconformity is indicated at a few localities.

In the mesa west of the Castlewood reservoir the Castle Rock conglomerate rests upon the rhyolite flow of the Dawson formation. Two miles farther west, several feet of Dawson arkose intervenes between the lava and the Castle Rock conglomerate. At all other localities in the area the Castle Rock conglomerate rests upon a horizon in the Dawson stratigraphically below the lava flow. It is apparent that from 35 to 50 feet of the upper Dawson was removed over a considerable area prior to the deposition of the Castle Rock conglomerate.

The fact that pebbles and boulders of the Dawson rhyolite are the most abundant of all types in the Castle Rock conglomerate is significant in this connection. Indeed it is probable that a large proportion of the arkose material of the formation represent reworked Dawson material. Perhaps further detailed geological and field study of the upper part of the Dawson formation would assist in determining the relations of this formation to the Castle Rock conglomerate which unquestionably is of lower Oligocene age as indicated by the presence of Titanotherium bones.

The Castle Rock conglomerate lies nearly flat except in the west near the base of the mountains where the beds are naturally at high and low angles. Along the base of the mountains in the southwest corner of the quadrangle the Dawson arkose is concealed by Quaternary deposits.

The Dawson arkose has a maximum thickness of about 2000 feet. It is composed of varicolored and varitextured arkosic conglomerate, sandstone, shale, clay and of some carbonaceous material. Arkose predominates in the Dawson formation. It is mainly of medium to coarse texture. Beds and occasional thin lenses of conglomerate occur throughout the formation but are more common in its lower portions. The color of the Dawson arkose is predominately white.

According to Richardson (1) there are two marked unconformities in the Dawson arkose. He states:

"An unconformity in the Dawson arkose of more than usual prominence is exposed near the top of a number of the buttes that are capped by rhyolite in the vicinity of Larkspur and Greenland ... Another unconformity is shown by the uneven surface below the rhyolite on the west side of Dawson Butte."

A field examination supports rather the view that these unconformities are intraformational disconformities rather than true unconformities. Structure contours drawn on the Dawson-Castle Rock contact and upon the Dawson lava by the writer indicates that both surfaces are nearly identical in structure, (see Fig. 1).

The volcanic material in the Dawson formation is composed of rhyolite and of tuff. This material appears in numerous buttes and knolls over a large area situated south and west of the main body of conglomerate. These separated masses are probably the remnants of a formerly continuous sheet of lava and associated debris.

The volcanic rocks are interstratified with the upper part of the Dawson arkose and usually do not exceed 20 feet in thickness.

STRUCTURE

Structurally, the Castle Rock quadrangle belongs to the Denver Basin area. In the area under discussion all the pre-Oligocene sedimentary formations lie nearly flat except to the

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G. B. Richardson op. cit.

west near the base of the mountains where the beds are tilted to the eastward at a high angle except where faulting occurs as near the foot of the mountains in the southeastern portion of the quadrangle.

Structure contours drawn on the Dawson-Castle Rock contact and on the lava bed of Dawson age indicate that both surfaces dip northward at a low angle. (See Fig. 1)

The change in the direction of the drainage systems in the quadrangle in post-Oligocene time suggests the possibility that the area underlain by the Castle Rock conglomerate has been tilted or raised in comparison to the area to the north and west.

PETROGRAPHY OF CASTLE ROCK CONGLOMERATE

Pebbles and boulders constitute a prominent part of the Castle Rock conglomerate at many localities. These range in size from a fraction of an inch to nearly four feet in diameter and are well rounded. The pebbles and boulders are imbedded in a medium to fine grained, well indurated matrix composed of angular to subangular fragments of quartz and partly altered feldspar. The study of the cementing material shows that it is composed of an isotropic colorless aggregate of hallosite with an index of refraction equal to about 1.473 in the natural state, together with a small amount of quartz and kaolinite. However, some samples show a predominance of siliceous cementing material over hallosite.

The relatively great thickness of the conglomerate, together with ripple marks and crossbedding, the large size of the rounded pebbles, and the absence of marked alteration in the feldspars strongly suggest that the Castle Rock conglomerate was deposited by torrential streams in a semiarid region.

In general the problem of the source of the material in the Castle Rock formation can be attacked from several angles. The field study of ripple marks, cross bedding, the change in lithology, the size and shape of the imbedded pebbles should give some clue in determining the direction of flow of an ancient stream. However the lithological correlation between the sedimentary material now in place and the older igneous and sedimentary rocks of the source area is one of the best criteria in a complex problem of this character.

The field study of the Castle Rock conglomerate shows that ripple marks, cross bedding, size and shape of pebbles cannot be of value in the elucidation of our problem because the data obtained are too indefinite. The detailed lithological study of the conglomerate was made at three widely separated points as follows: 1, near Castlewood Reservoir; 2, in the bluff at the west edge of the town of Elbert; 3, on the hill in SW$\frac{1}{4}$ of Section 18, T8S; R65W. At these points the conglomerate is well indurated and very coarse, the pebbles ranging in size from a few inches to four feet in diameter.

Both the megascopic and microscopic study of the pebbles comprising the Castle Rock conglomerate and of certain areas of petrographically similar metamorphic rocks of the

Front Range (see map of the Front Range) points to the area situated west of Denver as the source of much of the Castle Rock conglomerate. The most common pebbles and boulders in the formation are of the rhyolite lava of the upper Dawson. In addition to these are fragments of pegmatites, coarse grained granites, porphyries, schists, gneisses and quartzites from the Front Range area west of Denver. This conclusion is especially well sustained by the recognition of the identity in character and composition of the peculiar pre-Cambrian quartzite formation at Coal Creek and some of the quartzite pebbles found in the Castle Rock conglomerate. Moreover, certain pebbles of augite syenite in the conglomerate appear to have been derived from a small restricted area of this rock along Turkey Creek about 8 miles south and 3 miles east of the town of Golden, near the head of its north fork.

The Coal Creek quartzite occupies a small area, not over ten square miles, along Coal Creek, approximately eighteen miles northwest of Denver. (1) (2)

The quartzite is in contact with gneiss, granite, and schist at various points. The megascopical study of the fine grained dark green and yellowish quartzite obtained from the Coal Creek area and from the Castle Rock formation indicates their similarity. Under the microscope some of the thin sections made of quartzite obtained from these far distant localities manifest their complete identity. They are chiefly composed of medium grained anhedral quartz and of a small amount of subhedral magnetite. Quartz grains show strong parallel arrangement and

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(1) Koerner & Ball "Quartzite Area of Coal Creek" Thesis Colo. School of Mines, 1906.

(2) Dr. T. S. Lovering, Personal Communication.

some crushing phenomena. Numerous long radiating needles of sillimanite are disseminated throughout.

The results of the study of the conglomerate pebbles from the three above mentioned localities are given in tabular form below:

PEBBLES FROM CASTLE ROCK CONGLOMERATE

Locality: Bluff at the west edge of the town of Elbert.

Kind of rock	Probable source locality	Probable source formation	Remarks
Silicified Wood	Local	Dawson	
Quartzite		Dakota	
Quartzite	West of Denver	Pre-Cambrian	
Quartzite	" " "	Pre-Cambrian	
Ferruginous quartzite			
Quartzite sandstone			
Rhyolite	Local	Dawson	
Ferruginous conglomeratic ss.			
Pegmatitic quartz		Pre-Cambrian	
Quartzite	Coal Creek	Pre-Cambrian	Fine grained, yellowish-green.
Quartzite	Coal Creek	Pre-Cambrian	Fine grained, grayish green.
Sandstone			
Conglomeratic ss.			
Schist	West of Denver	Idaho Springs	
Pegmatite		Pre-Cambrian	
Quartzite	West of Denver	Pre-Cambrian	
Gneiss		Idaho Springs	
Syenite	Turkey Creek	Pre-Cambrian	
Porphyry			
Rhyolite			
Porphyry			
Pegmatite		Pre-Cambrian	
Granite	S.W. of Denver	Pikes Peak	
Granite			

PEBBLES FROM CASTLE ROCK CONGLOMERATE

Locality: Bluff at the west edge of the town of Elbert. (con.)

Kind of rock.	Probable source locality.	Probable source formation.	Remarks
Gneiss	West of Denver.	Pre-Cambrian	
Muscovite gneiss	West of Denver	Idaho Springs	
Muscovite granite		Pre-Cambrian	
Granite	S.W. of Denver	Pikes Peak	
Diorite		Pre-Cambrian	Fine grained
Granite pegmatite		Pre-Cambrian	
Ferruginous quartzitic ss.		Pre-Cambrian	
Pegmatite Gneiss	West & N.W of Denver	Pre-Cambrian	
Granite	West of Denver	Pre-Cambrian	Decomposed

PEBBLES FROM CASTLE ROCK CONGLOMERATE

Locality: Hill in SW$\frac{1}{4}$ of Sec. 18, T8S, R65W.

Kind of rock.	Probable source locality.	Probable source formation.	Remarks.
Aplitic granite	S.W. of Denver	Pikes Peak	
Granite	west of Denver	Pre-Cambrian	Gneissoid
Granite		Pre-Cambrian	
Granite		Pre-Cambrian	
Granite	West of Denver	Silver Plume	
Granite	S.W. of Denver	Pikes Peak	
Granite	West of Denver	Early Silver Plume	
Pegmatitic granite		Pre-Cambrian	
Biotite granite	West of Denver	Pre-Cambrian	
Muscovite granite	West of Denver	Pre-Cambrian	
Granite	West of Denver	Pre-Cambrian	
Hornblende gneiss	West of Denver	Pre-Cambrian	
Ferruginous sandstone		Fountain	
Quartzite	Coal Creek	Pre-Cambrian	Fine grained, greenish-yellow.

PEBBLES FROM CASTLE ROCK CONGLOMERATE

Locality: Hill in SW$\frac{1}{4}$ of Sec. 18, T8S, R65W. (con.)

Kind of rock	Probable source	Probable source formation	Remarks
Conglomeratic ferruginous ss.			
Ferruginous quartzite	West of Denver	Pre-Cambrian	
Quartzite	Coal Creek	Pre-Cambrian	Fine, greenish gray showing strong metamorphism.
Gneiss	West of Denver	Idaho Springs	
Schist	West of Denver	Idaho Springs	
Pegmatitic quartz	Coal Creek	Pre-Cambrian	
Rhyolite	Local	Dawson	
Sandstone		Dakota	
Granite	S.W. of Denver	Pikes Peak	
Granite		Pre-Cambrian	Fine grained.
Granite Gneiss	West of Denver	Pre-Cambrian	
Muscovite granite	West of Denver	Pre-Cambrian	Coarse grained.
Muscovite granite	West of Denver	Pre-Cambrian	Fine grained.
Ferruginous conglomerate			
Andesite porphyry	West of Denver	Eocene?	
Granite	West of Denver?	Pre-Cambrian	Fine grained.
Granite	West of Denver	Pre-Cambrian	Coarse grained.
Granite		Pre-Cambrian	Medium grained
Biotite granite		Pre-Cambrian	Gneissoid

PEBBLES FROM CASTLE ROCK CONGLOMERATE

Locality: West side of Castlewood Reservoir

Kind of rock	Probable source locality	Probable source formation	Remarks
Rhyolite	Local	Dawson	
Aplitic granite	Pikes Peak	Pre-Cambrian	
Granite	West of Denver	Silver Plume	Coarse grained
Ferruginous sandstone		Fountain	
Rhyolite	Local	Dawson	
Muscovite granite	West of Denver	Pre-Cambrian	
Gneiss	West of Denver	Pre-Cambrian	
Rhyolite porphyry	West of Denver	Eocene?	
Quartzite	Coal Creek	Pre-Cambrian	Fine, dark greenish gray.
Quartzite		Pre-Cambrian	Fine grained
Graphic granite		Pre-Cambrian	Ferruginous
Pegmatitic granite		Pre-Cambrian	
Biotite granite		Pre-Cambrian	
Biotite granite	S.W. of Denver	Pikes Peak gr.	
Biotite gneiss	West of Denver	Idaho Springs	
Granite		Pre-Cambrian	
Sandstone		Lyons	Fine grained, of light red color.
Rhyolite porphyry			
Rhyolite	Local	Dawson	
Rhyolite	Local	Dawson	
Rhyolite porphyry			
Pegmatitic quartz		Pre-Cambrian	
Silicified wood		Dawson	
Biotite gneiss		Pre-Cambrian	
Quartzite		Pre-Cambrian	Ferruginous
Quartzite gneiss		Pre-Cambrian	

PEBBLES FROM CASTLE ROCK CONGLOMERATE

Locality: West side of Castlewood Reservoir (con.)

Kind of rock.	Probable source locality.	Probable source formation.	Remarks.
Pegmatitic granite		Pre-Cambrian	
Aplitic granite		Pre-Cambrian	
Gneiss	West of Denver	Pre-Cambrian	
Ferruginous quartzite	West of Denver	Pre-Cambrian	
Granite	West of Denver	Pre-Cambrian	
Biotite granite	West of Denver	Pre-Cambrian	
Quartzitic ss.			
Rhyolite	Local	Dawson	
Rhyolite	Local	Dawson	
Rhyolite	Local	Dawson	
Rhyolite	Local	Dawson	
Gneiss		Pre-Cambrian	
Syenite			
Andesite porphyry	West of Denver		
Andesite	West of Denver		
Andesite porphyry	West of Denver		
Augite syenite porphyry	Turkey Creek	Pre-Cambrian	
Augite syenite	Turkey Creek	Pre-Cambrian	
Rhyolite			
Quartzitic conglomerate	Local	Dawson	
Rhyolite porphyry	Local	Dawson	
Quartz vein in granite			

The above given tables show a close similarity between the conglomerate pebbles and the rocks of various types outcropping in the Front Range west of Denver (see Map). A relatively small number of pebbles of Pikes Peak granite which are fairly resistant to mechanical and chemical weathering occur in the Castle Rock formation. These may have been derived from the area of this rock north of the Platte River.

The relation of the source rock to the Castle Rock conglomerate indicates that the drainage during lower Oligocene time when the Castle Rock conglomerate was being deposited was toward the southeast. This conclusion has an important bearing on the history of the Platte and Arkansas Rivers because it indicates that during lower Oligocene time the drainage system of the large part of the Castle Rock quadrangle belonged to the Arkansas River system rather than to the Platte as at present.

The Range was probably higher along the mineral Belt between Boulder County and Leadville in early Oligocene time than in the area to the north and south. Perhaps the uplift was related to the igneous activity and mineralization which affected the area in Eocene time.

MICROSCOPIC STUDY OF THE PEBBLES AND BOULDERS OF THE CASTLE ROCK CONGLOMERATE AND OF CERTAIN ROCKS OF THE FRONT RANGE AREA

Thin Section #1 from Castlewood Reservoir

With hand lens:--Of porphyritic texture, contains a few small phenocrysts of biotite and magnetite. Ground mass is aphanetic. The speciman shows a very well developed flow structure.

Under microscope:--Shows porphyritic texture, with numerous small inclusions of magnetite disseminated thruout the ground mass (poicilitic texture). Phenocrysts are composed of a few relatively large euhedral crystals of sanidine, few euhedral large crystals of biotite and few anhedral grains of quartz. The ground mass is cryptocrystalline with numerous small inclusions of magnetite disseminated throughout.

Name:--Rhyolite.

Thin Section #2 from Castlewood Reservoir

Under hand lens:--Medium grained holocrystalline rock of dull light brick red color composed of feldspars (orthoclase) and some plagioclase and magnetite.

Under microscope:--Holocrystalline rock composed of anhedral grains of orthoclase and oligoclase, and few subhedral grains of magnetite. Albite and Carlsbad twinning are absent. Feldspars are partly altered to limonite and some kaolin .

Name:--

Thin Section #3 from Castlewood Reservoir

Under hand lens: shows a well marked porphyritic structure. Phenocrysts are mainly composed of euhedral and subhedral elongated feldspar crystals and subhedral magnetite. Groundmass is aphanitic.

Under microscope: porphyritic texture with a felsitic ground mass. The phenocrysts are composed of elongated euhedral crystals of oligoclasse, orthoclase, and of subhedral magnetite. Both feldspars show evidence of orientation. Oligoclase is the predominant mineral in the phenocrysts showing both albite and carlsbad twinning and is partly altered to sericite and limonite. Magnetite phenocrysts show a subhedral outline and are partly altered to limonite. The felsitic poicilitic ground mass is composed of euhedral and subhedral small crystals of feldspars. Small grains of magnetite are disseminated throughout the ground mass. A few grains of apatite are present as inclusions in feldspars.

Name: -- Andesite porphyry.

Thin Section #4 from Castlewood Reservoir

Under hand lens: -- Porphyritic rock with dense aphanitic of light brick red color groundmass. Phenocrysts are composed of dull, subhedral and rounded crystals of feldspars, of some biotite and a badly altered ferromagnesian mineral.

Under microscope:--Groundmass is felsitic and poicilitic. Composed of subhedral crystals of orthoelase and plagioclase. Small grains of magnetite are disseminated throughout the groundmass. A few phenocrysts are of suhedral plagioclase badly altered to limonite and sericite.

Name:--Latite porphyry.

Thin Section #5 from Castewood Reservoir

Under hand lens:--Porphyritic rock of dark reddish brown color with a dense aphanetic groundmass. Half of the bulk is occuppied by the white gray subhedral and euhedral crystals of feldspar of elongated and tabular habits. Few irregular grains of biotite are present as the phenocrysts.

Under microscope:--A porphyritic rock with felsitic and poecilitic groundmass. Phenocrysts occupy nearly half of the bulk and are mainly composed of euhedral elongated crystals of oligoclase which show both albite and carlsbad twinning and subhedral and euhedral crystals of magnetite and biotite. Some magnetite and limonite are secondary after biotite. The groundmass is composed of dense anhedral crystals of plagioclase and orthoclase. Smaller irregular grains of magnetite are disseminated throughout the groundmass.

Name:--Andesite porphyry.

Thin Section #6 from Castlewood Reservoir

Under hand lens:--Holocrystalline medium grained gray rock with gneissic structure. Composed of practically fresh orthoclase,and plagioclase, and carries a large amount of ferromagnesians. Shows some presence of limonite.

Under microscope:--Holocrystalline porphyritic rock with micrograniti c groundmass. The groundmass is composed mostly of subhedral and anhedral crystals oforthoclase and of albite-oligoclase. Orthoclase grains are usually clear. Albite-oligoclase shows good carlsbad and albite twinning. Both minerals show certain flow conditions because the grains have certain directions of elongation. Albite-oligoclase givesa negative biaxial figure and greatly predominates over orthoclase. Phenocrysts are composed of subhedral, somewhat elongated crystals of albite-oligoclase, orthoclase augite isotropic leucite with index of refraction 1.513, secondary hornblende, magnetite. The large, somewhat elongated euhedral and subhedral grains of augite greatly predominate in numbers in the phenocrysts. Augits is slightly pleochroic and partly altered to strongly pleochroic hornblende, magnetite, to some biotite and limonite. The euhedral and subhedral grains of magnetite are imbedded in augite. Grains of apatite are disseminated throughout the microgranitic ground mass.

Name:--Augite leucite syenite porphyry.

Thin Section #7 from Castlewood Reservoir

Under hand lens:--Holocrystalline greyish black medium grained to fine rock carrying a large amount of augite and some magnetite. Two thirds of the bulk is made of albite crystals. Rock shows some alteration to limonite and kaolin.

Under microscope:--Holocrystalline, poecilitic, medium to fine grained, rock. Some areas show porphyritic structure with a microgranitic ground mass. Many crystals, especially the ferromagnesian are somewhat elongated and show a certain orientation. Nearly 2/3 of the bulk is made up of the subhedral and anhedral somewhat elongated crystals of feldspar. The indices of refraction of feldspars, ranging from 1.530 to 1.540, strongly suggest that the bulk of it is composed to albite-oligoclase. A few grains with the indices of less than 1.530 indicate the presence of a small amount of orthoclase. Some of the albite-oligoclase crystals manifest albite and carlsbad twinning, are often turbid from alteration to limonite, kaolin and carry a large amount of minute inclusions probably of gas. Feldspars carry a large amount of small and relatively large crystals of apatite.

One third of the bulk is made up of subhedral and unhedral crystals of yellowish green augite which manifests both long and short prismatic habits. Augite is pleochroic and shows some alteration to hornblende. Augite carries as inclusions a large amount of subhedral and euhedral grains of magnetite. The euhedral and subhedral grains of magnetite are also fresh disseminated throughout feldspars.

In a few spots the isotropic colorless nonpleochroic grains, of an index of refraction less than that of the Canadian basin can be observed. This isotropic mineral probably is "Leucite" as in thin section #6.

In general, the thin section #7 is somewhat similar to the thin section #6.

Name:--Augite syenite.

Thin Section #8 from Castlewood Reservoir

Under hand lens:--Clastic rock of gray to dark gray color composed of well rounded grains of dense aphanetic material and of feldspars. The grains are well cemented together with the fine grained sacharoidal quartz (quartzite).

Under microscope:--The greatest bulk is occuppied with the well rounded large grains of porphyritic rock composed of small anhedral grains of quartz. The groundmass is cryptocrystalline ~~of the large grains~~ made up of small irregular indistinct particles of quartz and feldspars. The interspace between the large grains is occuppied with the rounded, relatively uniform medium sized grains of quartz. Quartz grains show certain elongation. Some fine grained quartz shows crushing phenomena.

Name:--Quartzite conglomerate.

Thin Section #9 from Sec. 18, T. 8 S., R. 65 W. (Defective)

Under hand lens:--Holocrystalline, medium grained, gray to pinkish gray. Shows certain parallel arrangement of the ferromagneian minerals. Composed of the following minerals: Quartz, biotite, feldspars, some limonite. Quartz predominates.

Under microscope:--Holocrystalline, medium grained rock of poecilitic texture composed of subhedral and anhedral grains of quartz of subhedral and euhedral crystals of biotite, of anhedral magnetite, and of feldspars. The feldspars are subordinate in amount to quartz. Quartz contains small grains of magnetite, apatite and feldspars. Feldspars are chiefly composed of microcline and of small amount of albite and orthoclase.

Name:--Gneissoid biotite granite.

Thin Section #10 from Castlewood Reservoir

Under hand lens:--Porphyritic with an aphanitic groundmass of brownish red color. Phenocrysts are composed of small subhedral grains of feldspars and muscovite.

Under microscope:--Porphyritic with cryptocrystalline to fine crystalline groundmass. The phenocrysts are composed of euhedral and subhedral crystals of clear sanidine, quartz, albite-oligoclase, and biotite. Albite-oligoclase shows carlsbad and albite twinnings. The ground mass is dark colored and acidic in character with an index of refraction less than 1.525.

Name:--Rhyolite porphyry.

Thin Section #11 from Ebert Bluff

Under hand lens:--Holocrystalline, porphyritic with a fine granitic groundmass of grayish black color. Phenocrysts are mainly composed of hornblende, some orthoclase and plagioclase faldspars. Some alteration to limonite is noticeable.

Under microscope:--Holocrystalline, porphyritic with a granitic to micrograritic groundmass, of poecilitic texture. Some areas show a somewhat parallel arrangement and elongation of the phenocryst.

The phenocrysts are composed of euhedral and subhedral crystals of highly pleochroic hornblende of oligoclase, orthoclase, and of magnetite. Hornblende is partly altered to biotite and magnetite and carries some apatite and magnetite as inclusions. The ferromagnesians make one third of the bulk. Oligoclase shows good albite and carlsbad twinnings, carries some apatite and magnetite as inclusions and is slightly altered to limonite and sericite. The granitic and microgranitic groundmass is mainly composed of orthoclase, oligoclase and hornblende.

Name:--Hornblende syenite porphyry.

Thin Section #12 from Castlewood Reservoir

Under hand lens:--A quartz vein carrying some black soft manganese-like substance in holocrystalline, reddish partly altered rock.

Under microscope:--Quartz vein composed of two generations of anhedral fine grained and very fine grained quartz. The country rock is holocrystalline composed of euhedral and subhedral grains of quartz, microcline, albite, and some orthoclase. Albite is turbid, gives a very poor interference figure and shows certain alteration to sericite.

Name:--Quartz vein in granite.

Thin Section #13 from SW$\frac{1}{4}$ sec. 18, T. 8 S., R. 65 W.

Under hand lens:--Medium grained,grayish quartzitic rock composed of quartz grains partly stained yellow by limonite.

Under microscope:--Even, medium grained,clastic rock composed of ahhedral grains of quartz. Quartz grains give a wavy extinction and a very indefinite interference figure. Some quartz grains manifest crushing phenomena. Subhedral and anhedral grains of magnetite are included poecilitically in quartz or occupy the intergrain spaces. Few grains of zircon and few neeld-like crystals of sillimanite can be seen.

Name:--Quartzite.

Thin Section #14 from Coal Creek, 18 miles NW of Denver

Under hand lens:--Fine grained quartzite of dark bottle green color, carrying a small amount of minute dark minerals. Probably magnetite. Shows some marked minute stratification.

Under microscope:--Clastic rock composed of small anhedral grains of lenticular and partly crushed quartz of very small amount of anhedral magnetite and some chlorite. Quartz grains carry many minute inclusions of magnetite and of air. Alteration to limonite can be noted.

Name:--(Lenticular) Quartzite.

Thin Section #15 from Castle Rock Conglomerate

Under hand lens:--Hard, dense, fine grained rock of dark greenish gray color composed of quartz grains. Small amount of minute ferromagnesian minerals and of iron oxides.

Under microscope:--A clastic rock mainly composed of medium grained and fine grained anhedral crystals of quartz and of some elongated subhedral grains of magnetite. Quartz carry numerous minute inclusions of magnetite gas and of needle-like crystals of sillimanite

Thin Section #19 from Bear Creek

Under hand lens:--Medium grained to fine grained gray, clastic rock composed of quartz, some biotite, and feldspars.

Under microscope:--Medium grained to fine grained, clastic rock composed of anhedral grains of quartz, of anhedral grains of plagioclase feldspars, some biotite and a little magnetite. Crushing phenomena and bending are noticeable. Plagioclase feldspars belong to a more acid variety. Quartz grains rather predominate over the feldspars.

Name:--Feldspathic quartzite (quartzitic ss).

Thin Section #16 from Coal Creek

Under hand lens:--Fine grained clastic rock of light bottle green color. Composed of quartz.

Under microscope:--Composed of anhedral, medium grained and fine grained quartz carrying fine particles of magnetite. Quartz grainsshow strong parallel arrangement. Small amount of subhedral grains of magnetite and of slightly pleochroic chlorite probably pennine is present.

Name:--Quartzite.

Thin Section #17 from Coal Creek

Under microscope:--Clastic rock composed of medium grained anhedral quartz, small amount of subhedral magnetite and (andalusite?). Quartz grains show strong parallel arrangement. Numerous radiating needles of sillimanite, also few grains of topaz.

Name:-- Quartzite

PLACER GOLD IN THE CHERRY CREEK AND RUNNING CREEK DRAINAGE BASINS

LOCATION AND RICHNESS The occurrence of the placer gold in the area situated north and northeast of the Castle Rock conglomerate and its economic evaluation is a problem of long standing. One of the first discoveries of gold in Colorado was made in 1858 (1) in Russelville Gulch, a few miles west of the town of Castle Rock. Later on the placer mining was carried along Newlin Gulch, Gold Creek, and Rock Gulch, all in this general area. Emmons (2) in his report states:

> "Within the past year (1895) public attention has been directed to the so-called placer deposits of Newlin Gulch. Tunnels have been driven into these ancient drift deposits at various points on either side of the gulch for a distance of two or three miles." ....

Along the above mentioned creeks gold is usually found along the streams which are now cutting through the old stream terraces and bars of the ancient Quaternary streams and the Dawson arkose of Eocene age.

Beginning in 1930 a revival of prospecting for gold has occurred along Newlin Gulch and in the area south of the town of Elizabeth. Quite recently (1932) the manager of one of the placer workings situated a few miles southwest of Elizabeth along Gold Creek claims to have proven the presence of a gold bearing area of large dimensions by drilling numerous shallow test pits. The writer has examined the mining operations now in progress along Newlin Gulch and a large area south and southwest

(1) Fr. Hall op. cit.
(2) S. F. Emmons op. cit.

of Elizabeth, especially along the Gold creek, Russelville Creek and a few intermittent streams situated south of the Gold Creek. Also samples of sand have been taken from the beds of several creeks now draining the Castle Rock quadrangle and examined for gold, both by panning and by the use of a Wilfley table.

This examination strongly suggests that gold found at the present time along the Newlin Gulch is concentrated only in the post-Dawson beds. Sands from the bed of Cherry Creek, near the middle of the east half of Section 17; T9S; R66W; and the SW$\frac{1}{4}$ of Section 16, T9S, R65W; Kiowa Creek, near the town of Elbert, Running Creek in SW$\frac{1}{4}$; Sec. 36; T9S; R65W; and from a little creek situated $\frac{1}{2}$ mile west of Cherry Creek in SW$\frac{1}{4}$; Section 18; T9S; R65W, yielded no gold except one of the Cherry Creek samples which showed a few small colors. The panning of the Quaternary
Section13;T8S;R65;
and Recent deposits on Mr. Chirnside's ranch near Elizabeth and farther south as well as a certain mining activity which goes on at the present time along Russellville Gulch, Gold Creek and Gold Run Creek, mainly in the area situated in T8S; R65W show a good color of gold to the pan and certain concentration of fine gold at many places. Gold thus obtained is usually fine ranging from 4 millimeters in diameter to the very fine, so called flour gold. Many larger gold particles are well rounded showing evidence of being transported over a long distance.

In general a poor water supply and the properties of fine gold under the present methods of concentration make the problem of extraction of gold from the placers a complex one.

Until recently no actual exploration and operation on a large scale, as far as the writer knows, has been undertaken in the region under discussion.

The localities from which the samples were taken and the data obtained are given in the following table.

TABLE I

Where one ton is taken as equal 2000 pounds, one yard equals 1.5 tons; and one ml. of gold is taken as equivalent to 0.0665¢

Source	Results Obtained: By Panning & Wilfley Table	Results Obtained: By Assaying
Gravel just above bed rock of Dawson formation at the mouth of tunnel, west side of Newlin Gulch, Sec. 36; T6S; R67W.	3 small colors. Small to medium amount of Black sand.	
Gravel terrace, about 3 feet above Dawson formation. Mine tunnel situated on the west side of Newlin Gulch, Sec.36; T6S; R67W.	7 relatively large platy colors. Medium amount of Black sand.	
Stratified gravel above the Castle Rock conglomerate west of Bridge over creek, NW$\frac{1}{4}$; Section 5, T9S, R65W.	No colors	
Sand from the bottom of Cherry Creek. Middle of E$\frac{1}{2}$ of Section 17; T9S; R65W	No colors Very small amount of Black sand	
Sand from the bottom of creek $\frac{1}{2}$ mile west of Cherry Creek; SW$\frac{1}{4}$ of Section 18, T9S, R65W.	No colors Small amount of Black sand.	
Sand from the bottom of Kiowa Creek at the town of Elbert.	No colors Very small amount of Black sand.	
Sand from the bottom of Running Creek; SW$\frac{1}{4}$ of Section 36; T9S, R65W	No colors Relatively small amount of Black sand	
Sand from the bottom of Cherry Creek, SE$\frac{1}{4}$ of Section 16, T9S; R65W	One color relatively large and elongated. Good amount of Black sand.	$1.01 per cu.yd.

TABLE I (Continued)

Source	Results Obtained By Panning & WilfleyTable	By Assaying
Stream gravel just above Dawson arkose, SE$\frac{1}{4}$ of Section 36, West side of Newlin Gulch		14¢ per cu-yd
Gravel Bed above the contact with Dawson from the tunnel near the concentrating machine south of the old tunnel. Section 36, T6S, R67W.	No colors Small amount of black sand	

(1) Assaying by Mr. Horn of the Colorado School of Mines Experimental Plant.

THE SOURCE OF THE GOLD   There are several possible sources of the placer gold of the Castle Rock quadrangle, namely: Dawson lava, Dawson arkose, and Castle Rock formations.

LAVA

The volcanic rocks or their mineralized portions, if any, whose remnants now occupy the knolls and small mesas widely scattered over the area south and southwest of the Castle Rock conglomerate might be a source of gold. A somewhat hasty examination of the volcanic rocks failed to disclose the presence of mineralized areas and the samples of volcanic rock taken from numerous localities, after being powdered for panning and assaying, gave negative results.

TABLE II

Source	Results Obtained By crushing and panning	By assaying (1)
Lava cap, mesa three miles north of the town of Castle Rock, SE¼ of Section 22, T7S, R57W.	No colors Small amount of Black sand	No gold
Lava from quarry situated in Section 19; T8S; R66W.	No colors Relatively small amount of Black sand	No gold
Lava Hill situated in Section 27, T8S; R65W.	No colors Very small amount of Black sand.	No gold
Lava from a small quarry near the road in NE¼ of Section 31, T8S, R66W.	No colors Small amount of black sand	No gold
Lava from the edge of the mesa near the road in NE¼ of Section 34, T8S, R66W.	No colors Small amount of Black sand.	No gold

(1) Assays by Mr. Horn of the Colorado School of Mines Experimental Plant.

DAWSON ARKOSE

The possibility of the Dawson arkose being the source of gold has also been considered. The Dawson formation underlies the Castle Rock conglomerate and outcrops over a large area which surrounds the conglomerate. The panning and assay of the several samples taken from the Dawson arkose gave negative results with the exception of a sample taken from the upper part of the Dawson situated in NW$\frac{1}{4}$, Section 6, T7S, R66W. A careful repeat sample obtained, after scraping off a surface layer about six inches thick, gave negative results, thus supporting the conclusion that the Dawson arkose cannot be reasonably considered as the source rock for the gold found in the Quaternary and Recent deposits of the Castle Rock quadrangle.

The details as to the location of the points at which the samples of the Dawson arkose have been taken and the final results obtained therefrom are given in the accompanying table:

TABLE III

Source Dawson Arkose	Result Obtained By Wilfley table and panning	By assaying
Coarse sandstone, upper part of formation. NW$\frac{1}{4}$; Section 6, T7S, R66W.	No colors. Small amount of Black sand	No gold
Upper portion of the Dawson arkose from a tunnel 3/8 mile west of a mine situated at the Newlin Gulch. Castle Rock conglomerate caps the hill.	No colors. Relatively small amount of Black sand	
Dawson arkose just beneath stream gravel from a tunnel in west bank of Newlin Gulch. Section 36, T6S, R67W.	No colors.	
Dawson arkose taken from a point 200 feet below the lava cap on the west side of the lava mesa, 1$\frac{1}{2}$ miles west of the town of Castle Rock near stone quarry.	No colors. Many clay particles. Very little black sand.	
Dawson arkose just above lava in the NE$\frac{1}{4}$ of Section 30, T8S, R66W.	No colors. Considerable Black sand.	
Dawson arkose taken from a point 150 feet below the Castle Rock conglomerate at the butte near the town of Castle Rock.	No colors. Relatively small amount of Black sand.	

CASTLE ROCK CONGLOMERATE

Emmons (1) in his report on the "Geology of Denver Basin" states:

"South and west of the heads of Newlin Gulch and adjoining gulches these undisturbed beds extend in an apparently unbroken mesa as far as the eye can reach. Tests made of the disintegrated material on the top of the mesa show a small but fairly uniform content of gold in the beds."

The recent field examination by the writer unquestionably proves that Emmons was referring to the outcrops of the Castle Rock conglomerate near Newlin Gulch. A few samples taken from the Castle Rock conglomerate show the presence of gold in the center of Section 6 in T7S, R66W and in a fine sand west of the bridge in NW$\frac{1}{4}$, Section 5, T9S, R65W. The results of the analysis for gold of few samples taken from the Castle Rock conglomerate is given as follows:

TABLE IV

Source	Results Obtained By crushing, panning and Wilfley table	By assaying
Sandstone in Castle Rock conglomerate, center of Section 6, T7S, R66W. Several samples taken at 25 feet intervals.		33¢ per cu. yd.
Fine grained Castle Rock conglomerate west of bridge, NW$\frac{1}{4}$, Section 5, T9S, R65W.	One color.	
Loose sand from a bench of weathered Castle Rock conglomerate near Castlewood Reservoir	No colors.	

(1) S. F. Emmons op. cit.

Numerous samples of gold taken from the Quaternary deposits, from the sandy bottoms of the creeks draining the area under discussion, from the Castle Rock conglomerate, and from the Dawson arkose and Dawson lava suggest the Castle Rock conglomerate as a main intermediate source for the gold found in the Castle Rock quadrangle. The localization of the source rock for the main part of the material comprising the Castle Rock conglomerate and the absence of gold in the Dawson arkose and the lava of the upper Dawson indicates that the post basal Eocene and pre-Oligocene gold veins and dikes of the Boulder-Leadville mineral belt served as a source of gold of the Castle Rock conglomerate as well as of many of the pebbles in this formation. The concentration of gold in the conglomerate was accomplished by the Oligocene torrential streams carrying gold both in mechanical and colloidal suspension.

The possibility of transportation in colloidal suspension is suggested by the predominance of fine gold (flour gold), both in the Castle Rock conglomerate and in the Quaternary deposits.

Waldemar Lindgren (1) points out that:

"Gold is easily brought into the colloid states and as such it may be transported in solution of colloid silica." He also states that:

"Gold has undoubtedly been transported in the form of chloride though its migration in colloidal suspension derived by solution processes from native gold is probably much more common than has been suspected."

(1) Lindgren, Waldemar Mineral Deposits 1928 p. 267.

Freise (1) also discusses the possibility of concentration of gold in some gold placers by solution and redeposition.

RESUMÉ

Both the megascopic and microscopic study of the pebbles comprising the Castle Rock conglomerate and a similar study of certain areas of petrographically significant metamorphic and igneous rocks of the Front Range leads to the following conclusions:

1. The area situated west of Denver is the source rock for much of the material of the Castle Rock conglomerate. This premise is especially well sustained by the identity in character and composition of the peculiar pre-Cambrian quartzite formation in Coal Creek and some of the quartzite pebbles found in the Castle Rock conglomerate, also by the presence of augite syenite pebbles in the Castle Rock formation, whereas its primary distribution is restricted to small areas situated along Turkey Creek of the Front Range.

2. The occurrence of the source rock indicates that the drainage during lower Oligocene time, when the Castle Rock conglomerate was being deposited in the Castle Rock quadrangle, was directed toward the southeast. This conclusion has an important bearing on the history of the Platte and Arkansas rivers because it indicates that during lower Oligocene time the drainage system of the larger part of the Castle Rock quadrangle was a part of the Arkansas River

(1) W. F. Freise Econ. Geol. p. 421, No. 4, 1931

system.

3. A determination of the gold content of the Castle Rock conglomerate, of the Dawson formation, and of the Dawson lava found in Castle Rock quadrangle indicates some presence of gold in Castle Rock quadrangle and its absence in lava and arkose of Eocene age.

4. The source of the pebbles in the Castle Rock formation indicates that the gold was derived from the gold veins of the Boulder-Leadville mineral Belt, also that the age of the gold is definitely post basal Eocene and pre Oligocene.

5. The minuteness of much of the gold particles and the well rounded outlines of many larger gold particles found in the conglomerate and the Quaternary and Recent deposits, indicates considerable transportation in mechanical and colloidal suspension, harmonizing with the conclusion in regard to the age and source. A more detailed microscopical and chemical study of gold in the laboratory is desirable.

6. The minuteness and relatively wide distribution of gold in small quantity throughout the Castle Rock (Oligocene) conglomerate coupled with the somewhat large extent of Quaternary and Recent deposits partly derived from the erosion of conglomerate, do not favor greatly the concentration of rich gold deposits. However, it is possible that a more detailed geological and magnetometer investigation of the placer ground might bring to light the presence of buried stream channels in the Castle Rock conglomerate and the Quaternary gravels carrying a greater quantity of gold, and thus give a

strong impulse to the revival of mining for gold in the Castle Rock quadrangle.

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JESS HORN LATER WAS EMPLOYED AT CLIMAX AS FOREMAN OF THE MOLYBDENITE PACKING PLANT. HE DIED OF A HEART ATTACK AROUND 1960. R. MEYERTONS