INTRODUCTION

The Park of the Red Rocks, located in the foothills about twelve miles west of Denver, is one of the several park areas maintained by the City and County of Denver for the enjoyment of their citizens, other Coloradoans, and visitors to the State of Colorado. The principal attraction of the Park is its widely known Amphitheater, in which many of the greatest artists of the country perform during the summer season. During vacation periods, daytime visitors numbering in the thousands are attracted to the area to admire the scenery within the Park as well as that of the surrounding country. Because the numerous striking views of the rock formations change in mood and color throughout the day and evening, they are a reward for repeated trips to the Park; but even more enjoyment and self-satisfaction can be attained if the basic reasons for the unusual landscape features are understood. Thus, it is for those whose curiosity and interest extend somewhat beyond the demands of casual sightseeing that this sketch of the geology of the Park of the Red Rocks has been prepared.

As a matter of historic background, let us review briefly the names of some of the men who first viewed the area that is now known as the Park of the Red Rocks. In the summer of 1869, F. V. Hayden and his party were authorized by the Secretary of Interior to make a geological reconnaissance journey along the east front of the Rocky Mountains from Cheyenne, Wyoming, to Santa Fe, New Mexico, a distance of over 500 miles. In his report of July 6, 1869, Hayden officially published a record of the general landscape features and formations of the Park of the Red Rocks area. Several years later (1873) A. R. Marvin re-visited the locality and presented in the Annual Report of the U. S. Geological Survey a more detailed account of the formations and structures of the region. Accompanying Marvin was the famous field artist, W. H. Holmes, whose sketch of the Park area is shown below.

Sketch of Park of Red Rocks area made by W. H. Holmes in 1873. Looking north across the town of Morrison (b). Locality (a) in the early days was designated as Bear Station. Today this point is shown on maps as Mount Morrison. The prominent ridge to the right of the middle part of the sketch is the famous Dakota hogback. To the left middle, the uptilted edges of the red rocks of the Park are shown.

Since Marvin's time, many geologists have studied the geology of the Park and adjacent area and have contributed to the better understanding of the age, relationship, correlation, and structure of the formations.
GEOLOGIC TIME

Perhaps the most difficult geologic concept for many persons to understand is geologic time. Such expressions as the "eternal mountains" are true only in the sense of the span of time relating to the history of the human race. In this respect, mountains are "eternal"; but geologic time is so vast that one must think of centuries of historical time as being only moments in the geologic time scale. When the average person refers to an event as Recent he is thinking in terms of a few days, weeks, or months; but when the geologist refers to a geologic event as Recent, he is thinking in terms of the last few hundred thousand years.

The history of the earth as been unraveled primarily from the character, distribution, and relationship of the rocks at or near the earth's surface. Every layer of rock is a page of geologic history. There still remain, many of these pages to be discovered, deciphered, and placed in proper order within the fascinating book of "Earth Science."

The sequence of chapters, subchapters, and paragraphs of geologic time is shown in Figure 2. The Paleozoic, Mesozoic, and Cenozoic represent three "Eras" (chapters) of geologic time. These Eras can be subdivided further into time units referred to as "Periods" (subchapters) such as Cambrian, Ordovician, and Silurian. Time units smaller than the Period are designated as "Epochs" (paragraphs). The time interval represented by these units can be estimated only approximately in terms of years.

Thousands of men, whose interests have been in the various fields of natural science, have established the geologic time scale as now accepted by most geologists the world over. The question is frequently asked, "How was this scale established?" The answer is, "By studying the materials which compose the rocks, by unraveling the vertical and horizontal relationships of the rocks, by identifying and classifying the fossils contained within the rocks, and by deciphering the structures expressed by the rocks." The rocks are the basis for nearly all geologic knowledge.

As far as is known, there is no single place in the world where the complete geologic history of the earth is represented by a continuous sequence of rock layers. Consequently, the present time scale even though incomplete, had to be compiled by correlating and piecing together increments of time as represented by the strata and their fossils.

Throughout geologic history, the surface of the earth has changed its characteristics many times. The outlines of the continents have shifted because of periodic invasion and retreat of widespread seas; complex river systems have been modified or have disappeared completely; glaciers repeatedly have covered large portions of the continents; and mountain ranges have been uplifted, only to be reduced subsequently by erosion to relatively flat plains. Furthermore, various animal and plant groups have been introduced only to become extinct at a later date because of their failure to adjust to new environmental surroundings.

The surface of the earth now has features different from those which will prevail in the geologic future. It is being constantly subjected to the destructive and constructive processes of time. We are living on a restless planet—a tiny particle in our spacious and mysterious universe.

Figure 2. A Summary of the Geologic Time Scale. Geologic time is subdivided into Eras (Paleozoic, Mesozoic, Cenozoic), Periods (Cambrian, Ordovician, etc.), and Epochs (Eocene, Oligocene, etc.). These subdivisions are based primarily on the types of fossils occurring in the strata, the evolution of life groups, and the episodes of mountain building.
<table>
<thead>
<tr>
<th>Era</th>
<th>Epochs</th>
<th>Events</th>
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<tr>
<td>CENOZOIC</td>
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<td>First evidence of man</td>
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<td></td>
<td>Mammals common for first time</td>
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<td>57,000,000 years</td>
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<td>Extinction of most reptiles</td>
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<td>ROCKY MOUNTAINS UPLIFTED (LARAMIDE REVOLUTION)</td>
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<td>Reptiles first common</td>
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<td>487,000,000 years</td>
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<td>PALEOZOIC</td>
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<td>Age of rocks exposed in Park of Red Rocks area</td>
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<td></td>
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<td>Low-order life types</td>
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<td></td>
<td></td>
<td>PRE-CAMBRIAN</td>
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</tbody>
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Figure 2.
COMMENTS ON THE ORIGIN OF THE PARK

To present a thorough and complete treatment of the origin of the landscapes, geologic structures, and formations of the Park of the Red Rocks is beyond the objective of this summary. The following text is given solely for the purpose of familiarizing the reader with a few of the broad concepts involved in the complicated processes that account for the development of the Park features as they are observed today.

In order to understand these concepts, adequately, one must first realize that, during the millions of years of geologic time, the rocks of the earth's crust have been folded, tilted, and broken repeatedly as a result of gradual or of sudden and violent movements. This crustal instability is exemplified by the uplifting and lowering of the land with respect to the sea at many places along our present coast lines, by the numerous earthquakes recorded yearly in various parts of the world, and by the presence of volcanoes on or bordering the continents.

During the Paleozoic, Mesozoic, and Cenozoic Eras (see Figure 2), shallow seas advanced and retreated across North America many times. With each advance and retreat, deposits totaling thousands of feet in thickness, were left behind as conglomerates, sandstones, shales, and limestones. Periodically, these deposits were subjected to tremendous lateral and vertical forces which folded, broke, and elevated the strata into high complex mountain ranges. Accompanying these uplifts, large masses of molten rock intruded the deposits or poured out as extensive lava sheets. It may be difficult to conceive of the idea that some of the greatest mountain ranges of the geologic past were worn by erosion, through millions of years, to relatively flat plains across which widespread seas deposited many types of sediments. Such was the history, in part, of the present Rocky Mountain region of which the Park of the Red Rocks is an integral part.

The schematic drawings in Figure 3 illustrate three of the many stages through which the development of the Park of the Red Rocks passed during geologic time. These drawings are simplified and must be considered as involving only a small portion of the Front Range area of Colorado.

The oldest rocks in the Park are those of the pre-Cambrian, commonly referred to as the "basement" or "basement complex." The history of these rocks is extremely vague. In many areas throughout Colorado, formations of various ages were deposited on pre-Cambrian rocks. In the Park of the Red Rocks, the Fountain formation of Pennsylvanian age (see Figure 2) rests on them. Later in geologic time, and following the deposition of the Fountain, the Lyons, Lykins, Ralston, and Morrison formations were successively laid down by ancient seas and rivers in the order named.

During the Cretaceous Period (see Figure 2) a shallow sea encroached over a large part of western North America, including the area now occupied by the Rocky Mountains, and gave rise to the Dakota, Benton, Timpas, and many other widespread formations. These formations were deposited in a nearly horizontal position as shown in Stage I of Figure 3. At, or near, the close of Cretaceous time, western North America became involved in a major mountain-building episode commonly termed the "Laramide Revolution." During this time the formations deposited by former seas, rivers, and lakes were highly arched (Stage II, Figure 3) and broken. Molten rock intrusions and volcanoes accompanied the disturbance. Many of the formations on the high part of the uplift were removed by erosion. A mountain system was born. Later, during early and middle Cenozoic time (see Figure 2), these rugged highlands were subjected to millions of years of erosion
which eventually reduced them to relatively flat surfaces or plains. All but the roots of these mountains was destroyed. In late Cenozoic time these relatively flat surfaces were elevated into a broad regional arch upon which the present landscape features of the Rocky Mountains were etched out by streams, rivers, winds, and glaciers (Stage III, Figure 3). The rocks in the Park represent a part of the east flank of this arch. A detailed cross section of the formations on this flank is shown in Figure 5.
Stage I. The Fountain formation (2) of Pennsylvanian age was probably the first deposit laid down on the pre-Cambrian rocks (1) in the Park area. Next, the Lyons (3), Lykins (4), Ralston (5), Morrison (6), Dakota (7), Benton (8), Timpas (9), and younger formations (not shown) were laid down in the order named.

Stage II. At, or near, the close of the Cretaceous Period (see Figure 2), the formations were uplifted (warped) into a broad arch and many of them on the top of the arch were removed by erosion. The arching was accompanied by complex faulting and large intrusions of molten rock (not shown in the sketch). High, rugged mountains developed during this stage. Following the uplift, the region was eventually lowered by erosion to a relatively flat surface.

Stage III. During late Cenozoic time, the flat surface mentioned above was gently arched upward, and on it the present Rocky Mountain landscapes were etched out by streams, rivers, winds, and glaciers. As shown in the sketch, the formations of the Park of the Red Rocks represent a part of the east flank of this arch.
Deposits the younger than Timpas than Benton (8).

Dakota (7) - Morrison & Ralston (5, 6)
Lykins (4)
Lyons (3)
Fountain (2)

Pre-Cambrian (1)

STAGE I

STAGE II

Old erosional surface
Present erosional surface
PARK OF THE RED ROCKS

STAGE III

Figure 3.
Figure 4. A Columnar Section Showing the Sequence of Formations in the Park of the Red Rocks Area. The oldest rocks in the section are those of the pre-Cambrian gneisses and granites (1). The youngest completely exposed formation is the Timpas limestone (9). Formation younger and overlying the Timpas are not plotted. Geologic periods, names, and formational thickness are given to the left of the section and a brief description of each formation to the right of the section. Strata producing the major landscape features of the Park are bracketed in the lower part of the Fountain. The number within each formation corresponds to those shown on all other figures in this text.
Pre-Cambrian

Pennsylvaniaian

Triassic

Jurassic

Cretaceous

Mount Vernon drainage in these strata

Strata exposed at Amphitheater

Banded gneiss with numerous quartz veinlets.

Light gray, thin-bedded limestone; forms small ridge.

Dark gray-black, thin-bedded shale; limy in middle part.

Gray-white sandstone at top and bottom with intervening sandy shale; conglomerate at base.

Light gray claystone, sandstone and thin limy beds; dinosaur remains.

Light gray claystone, yellow silstone and sandstone; local beds of gypsum.

Red shale, siltstone with two thin limestones (Glenon & Falcon) in lower part.

Light gray, soft, cross-bedded sandstone.

Red sandstone and conglomerate with few thin beds of red siltstone and sandy claystone.

Figure 4.
Figure 5. An East-West Geologic Cross Section Through the Park of the Red Rocks Area (1.30 miles in length). Refer to Figure 7 for orientation. This sketch illustrates the sequence of the eastward dipping formations. Numbers above the base line of the section correspond to those on Figure 4. Note how the Dakota formation produces a "hogback" as a result of erosion of the softer overlying Benton and underlying Morrison formations.
TYPES OF ROCKS IN THE PARK AREA

Rocks are systematically classified on the basis of (1) conditions under which the rock formed; (2) minerals within the rock; and (3) size, shape, and arrangement of the mineral constituents composing the rock.

Rocks fall into three major groups—metamorphic, igneous, and sedimentary. In the following paragraphs these groups are briefly discussed, and photographs of specimens typifying each group are given for the purpose of identifying the various rock types characterizing the formations of the Park area.

Metamorphic Rocks

Rocks within the earth’s crust commonly undergo changes in composition, texture, and structure as a result of high temperatures, pressures, and chemical activity. These rocks are called “metamorphics.” Two types representing this group are

Gneiss—a coarse-grained rock, the minerals of which are arranged more or less in bands or layers varying in thickness from a fraction of an inch up to two inches or more (Figure 6A).

Schist—a fine-grained rock exhibiting flaky or cleavable characteristics. Schists (Figure 6B) do not show the conspicuous banding as do the gneisses.

Igneous Rocks

Igneous rocks result from the cooling of molten material that at one time existed below the surface of the earth. An example of one of the many varieties of igneous rocks is given below.

Granite—a coarse-grained rock consisting essentially of the minerals quartz and feldspar. The feldspar is generally light pink and shows pronounced reflecting surfaces (cleavage) (Figure 6C).

Sedimentary Rocks

Sedimentary rocks are formed from deposits of silt, clay, sand, and other materials deposited in seas, rivers, lakes, and above water as, for example, in dunes and beaches. Many rocks of this group are composed of minerals precipitated from sea water. Several of the more common types of sedimentary rocks are listed and briefly defined below.

Conglomerate—a rock composed essentially of large rounded pebbles; a consolidated gravel (Figure 6D).

Sandstone—a rock consisting generally of several varieties of sand grains cemented together. Quartz is a prominent mineral in most sandstones (Figure 6E).

Siltstone—a rock composed of various types of minute mineral grains of which quartz and clay are most common. (Figure 6F).

Shale—a rock consisting of microscopic particles of clay size and which commonly shows paper-thin banding (Figure 6G).

Limestone—a rock composed essentially of calcium carbonate (lime) and shows extreme variation in texture, purity, and color (Figure 6H).
Figure 6. Photographs of Hand Specimens of the Major Types of Rocks Outcropping in the Park of the Red Rocks Area.

A. Gneiss—This rock type is classified as a metamorphic. It comprises the major portion of the pre-Cambrian, which is well exposed just west of the Park and in Bear Creek Canyon. The banding is due to differences in texture and mineral composition. (One-half size)

B. Schist—This rock exhibits a distinct cleavage and wrinkling and is classified as a metamorphic. It lacks the distinct banding shown by gneisses. (One-half size)

C. Granite—A coarse-grained rock that has cooled from a molten condition and is classified as igneous. (Natural size)

D. Conglomerate—A sedimentary rock consisting of rounded pebbles of various sizes and types. The degree of cementation of the constituents varies considerably. (Natural size)

E. Sandstone—A medium-to fine-grained sedimentary rock of variable hardness, color, and composition. (Natural size)

F. Siltstone—A very fine-grained sedimentary rock whose particle size is between that of a sandstone and shale. (Natural size)

G. Shale—A very fine-grained, relatively soft, sedimentary rock made up essentially of clay minerals. Shales have a tendency to split easily. (Natural size)

H. Limestone—A sedimentary rock containing large amounts of the mineral calcite (CaCO₃). The crystalline texture and percentage of impurities of limestones are extremely variable. (Natural size)
FORMATIONS OF THE PARK AREA

Eight prominent, easily recognizable formations crop out in the Park of the Red Rocks area. These same formations are exposed either totally or partly for many miles along the Front Range of Colorado. Erosion of their uptilted edges has produced fantastic and weird relief features that cannot be slighted even by the most casual observer. The superposition of formations in the Park of the Red Rocks area is shown in Figure 4 and in the following paragraphs the major characteristics of these formations are discussed briefly, beginning with the oldest (pre-Cambrian).

Pre-Cambrian

Rocks of the pre-Cambrian (see Figures 9, 10) are very old, probably exceeding a billion years. Formed as a result of tremendous heats, enormous pressures, and drastic chemical changes, these rocks compose the core of the Front Range of the Rocky Mountains of Colorado as well as of many other major mountain ranges of North America and of the world. Most of these rocks are represented by gneisses and schists into which many veins of quartz and granite have been injected. The pre-Cambrian rocks are hard and resistant to erosion, thus producing the rough, steep slope immediately west of the Amphitheater in the Park. Many varieties of pre-Cambrian rocks crop out in road cuts in Bear Creek Canyon southwest of the Park and in ravines west of the Amphitheater.

Pennsylvanian

Fountain Formation (Figures 11 and 12)

The Fountain formation represents the oldest sedimentary deposits in the Park. It consists of 1060 feet of red and pink, soft to hard, coarse-grained sandstones and consolidated gravels (conglomerate). Thin layers of red, sandy shales occur throughout the formation. The red discoloration of the formation results from its iron content. The variation of hardness of the weathered, dipping Fountain sandstones is the primary cause of the scenic landscape features of the Park.

The Fountain formation of the Park area has failed to yield fossils of either plants or animals and is interpreted as having been deposited by flowing streams and rivers that existed in an ancient semidry climate. Yet, during Pennsylvanian time, in many areas in the eastern part of the United States, widespread swamps afforded conditions favorable for the development of commercial coal deposits mined there today.

The Fountain also produces the famous "Flat Irons" south of Boulder and, in part, the "Garden of the Gods" near Colorado Springs.

Permalian

Lyons Formation (Figures 13, 14, and 15)

The Lyons is not so prominent a scenic formation in the Park as is the underlying Fountain. It consists of 120 feet of soft, light gray sandstone showing conspicuous cross-bedding, a feature produced as a result of consolidation of ancient sand dunes and off-shore sandbar deposits. To date, fossils have not been found in this formation.

Permo-Triassic

Lykins Formation (Figure 16)

This formation is composed of 407 feet of essentially red shale and siltstone. In the lower part, two thin, minor ridge-forming limestones (see Figures 4 and 9) are present. For many years the upper one was mined for the processing of lime, but it is no longer of commercial importance.
The Lykins crops out extensively along the Front Range and constitutes a part of the “Red Bed” deposits which extend northward into Wyoming and southward into New Mexico. Fossils have not been found in these strata within the Park area. The formation, being soft and non-resistant to erosion, is responsible for the valley along the south-flowing Mount Vernon Creek, east of the Park and paralleling Highway 93.

**Jurassic**

*Ralston Formation*

The Ralston formation, consisting of 64 feet of soft, light gray claystone, yellow siltstone, thin sandstone, and minor amounts of gypsum, is exposed only locally along Highway 93 east of the Park.

*Morrison Formation (Figures 17 and 18)*

The Morrison formation is particularly noteworthy because it contains numerous, bone fragments of extinct reptiles (Dinosaurs).

The formation consists of 277 feet of alternating light gray claystone, sandstone, and thin limy beds. It is excellently exposed on the west side of the Dakota ridge east of the Park and on Highway 74. The formation accumulated on ancient river flood plains and in large fresh-water lakes that existed under a warm, moist climate. Many of the uranium deposits of the Colorado Plateau region occur in this formation.

**Cretaceous**

*Dakota Formation (Figures 19 and 20)*

The Dakota formation, 278 feet thick, produces the prominent skyline ridge east of the Park. This ridge consists of an upper and lower, hard sandstone separated by a soft, dark gray, sandy shale. The eastward dipping sandstones are more resistant to erosion than the underlying (Morrison) and overlying (Benton) formations, a condition which permits the development of the ridge or “hogback.”

In western Colorado, the Dakota occurs at the surface at many localities. In the eastern part of the State, it has served as an excellent underground reservoir for water, gas, and oil. South of Morrison, traces of uranium have been found near the base of the top sandstone.

*Benton Formation (Figures 21 and 22)*

This formation consists essentially of 480 feet of soft, gray-black shale containing occasional thin layers of decomposed volcanic ash (bentonite) and limestone. It characteristically supports a variety of prairie grasses, as can be observed by looking southward from the top of the grade on the West Alameda Parkway (Highway 74).

The Benton is the first deposit in the area that accumulated under true ocean conditions.

*Timpas Formation (Figures 23 and 24)*

The Timpas, consisting of 35 feet of light gray, well-bedded limestone, forms a minor ridge just east of the Dakota hogback. Locally, it contains many fossils and was deposited under shallow ocean conditions.

*Post Timpas Formations*

Overlying the Timpas limestone are several formations that are not discussed in this summary. From oldest to youngest, these are as follows: Apishapa, Pierre, Fox Hills, Laramie, Arapahoe-Denver, and Green Mountain. The youngest deposits in the area are represented by unconsolidated gravels occurring along drainages and on the high, flat terraces.
Figure 7. Vertical Airphotograph of the Park of the Red Rocks. This photograph shows the road system and the location of the more prominent features of the Park area. Pre-Cambrian rocks forming the higher mountains west of the Park (1). Fountain formation producing the conspicuous relief features of the Park (2). Lyons formation (3). Limestone bed (Glennon) in lower part of Lykins formation (4b). Rals-ton formation (5). Morrison formation (6). Dakota formation (7). Benton forma-tion (8). Timpas limestone (9). Formations younger than the Timpas (10.) Boulder terrace deposits (d). Amphitheater (k). Parking lots (o). The Pueblo Coffee Shop (p). Middle entrance road to Park (v, y). North entrance road to Park (w). South entrance road to Park (x). Secondary unpaved road (z). Bear Creek (C). Town of Morrison (E). Mount Vernon Creek (F). Highway 93 (G). Highway 74 (H). Morrison Water Gap (M). Highway 8 (N). Tunnel to Amphitheater (T). The heavy black line (W-E) represents the line of cross section shown in Figure 5. Photograph by U.S. Air Force.
Figure 8. Vertical Airphotograph of the Park of the Red Rocks Showing Locations of
Ground Photographs in Figures 9, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 23, 25,
26 and 27. Location 28 is a high-angle oblique airphotograph shown in Figure 28.
The long pointed end of the triangle indicates in the direction in which the text
photographs were taken.—Photograph by U. S. Air Force.
Figure 9. Looking westward from the West Alameda Parkway (Highway 74) road cut toward the northern portion of the Park. Hard pre-Cambrian granites and gneisses (1) are responsible for the high relief of the skyline. Red sandstones of the Fountain formation (2). Light gray, local ridge-forming Lyons sandstone (3). Thin limestone (Falcon member) in the lower part of the Lykins formation (4c). Minor ridge-forming limestone (Glennon member) of the Lykins formation (4b). Soft red shales of the upper part of the Lykins formation (4a). Trees in the lower right of the photograph are along Mount Vernon Creek. All the formations, with the exception of the pre-Cambrian rocks, dip toward the observer at an angle of 25-30 degrees. The variation in the ground relief in this view is due mainly to erosion of the dipping formations of varying hardness. See Figure 8 for ground location.

Figure 10. Pre-Cambrian granite and gneiss in a road cut in Bear Creek Canyon. Many varieties of pre-Cambrian rocks, which form the core of the Front Range of Colorado, may be observed in this canyon. These are the rocks on which the Fountain deposits were laid down some 225,000,000 years ago. (see Stage I, Figure 3). Granite vein (b). Banded gneiss (a and c). These rocks are perhaps as much as 1 billion years old and have been subjected many times to drastic mountain building episodes.
Figure 11. Looking northwestward, this picture shows the relationship of the pre-Cambrian rocks (1) to the overlying eastward-dipping red sandstones of the Fountain formation (2). Outwash gravels from higher elevations to the left of the picture underlie the grass-covered surface in the foreground (d) and are responsible for some of the flatter areas within the Park.

The Fountain formation (2) during past geologic times projected up and over the skyline slope of the pre-Cambrian (1) but, since, has been eroded down dip and eastward to its present position. (see Stage III, Figure 3). See Figure 8 for ground location.

Figure 12. Hard, red sandstones and thin beds of soft, sandy shales of the eastward-dipping Fountain formation (2). The shale beds, being less resistant to erosion than the sandstones, give rise to weird layered appearances of the outcrops. Pre-Cambrian rocks (1) are shown to the extreme left. See Figure 8 for ground location.
Figure 13. An outcrop of the Lyons sandstone (3), light in color and producing a local north-south ridge in the northern part of the Park. The sandstone is relatively soft and does not resist erosion as well as does some of the Fountain deposits which underlie it. Poorly exposed Fountain (2). Red shales in the lowest part of the Lykins formation (4d). Note the eastward dip of the Lyons and the vegetation it supports. See Figure 8 for ground location.

Figure 14. Looking southeastward from the north entrance road of the Park. At this locality, the Lyons sandstone (3) forms a minor cliff. The sandstone is massive to cross-bedded and is similar to beach and bar deposits now accumulating along present coast lines. The hard, ridge-forming sandstone of the Dakota formation (7) appears in the right background. See Figure 8 for ground location.
Figure 15. An outcrop of the Lyons sandstone (3) just west of the business district of the town of Morrison and along Highway 8. Pre-Cambrian (1). Fountain formation (2). See Figure 8 for ground location.

Figure 16. An outcrop of the Lyons (3) and Lykins (4) formations in a road cut just west of the business district of the town of Morrison and along Highway 8. The contact (s) separating these two formations is sharp and clearly shown. The Lyons is a white sandstone and the Lykins is a bright red shale and siltstone containing several thin beds of gypsum (t, u). See Figure 8 for ground location.
Figure 17. Looking eastward from the northern area of the Park toward the road gap (upper right) on West Alameda Parkway (Highway 74). Sandstones of the Dakota formation (7). Soft shales and sandstones of the Morrison formation (6). Valley-forming red shales of the upper part of Lykins formation (4a). Glennon limestone member in the lower part of the Lykins (4b). Falcon limestone (4c) in the lower part of the Lykins (4d). Lyons sandstone (3). These formations dip away (eastward) from the observer. The Dakota (7) is the youngest formation shown in the photograph and the Lyons (3) is the oldest. See Figure 8 for ground location.

Figure 18. A typical outcrop of the Morrison formation at spot locality (6) in Figure 17. Note the excellent bedding of these deposits. Soft shale (e). Impure limestone (f). Hard sandstone (g). Locally, this formation contains numerous bone fragments of extinct reptiles (Dinosaurs). Several fragments may be observed in sandstone (g). See Figure 8 for ground location.
Figure 19. Looking northward from the central part of the Park. The Dakota sandstone (7) is responsible for the skyline hogback, which extends many miles along the Front Range of Colorado. This formation contains water, gas, and oil in many areas throughout the State. The Morrison formation (6) forms the west face of the hogback. Soft red, sandy shales of the Lykins formation (4). Uppermost part of Fountain (2). Lyons sandstone (3). Gravels of relatively recent age cover the rounded ridges in the left and middle foreground. See Figure 8 for ground location.

Figure 20. A close-up view showing the alternating thin beds of fine-grained sandstone and sandy shale in the middle part of the Dakota formation. This exposure is in the West Alameda Parkway road cut (See Figure 17, spot locality 7) east of the Park. See Figure 8 for ground location.
Figure 21. Looking southward along the east side of the Dakota hogback from the West Alameda Parkway road cut (Highway 74). Brush-covered dip slope of the Dakota formation (7). Soft, black shales of the Benton formation (8). Minor ridge forming Timpas limestone (9). Formations younger than the Timpas (10). Water gap (M) through which Bear Creek flows, just east of the town of Morrison. See Figure 8 for ground location.

Figure 22. Thin-bedded shales of the Benton formation. Note the dip of 45 degrees to the right (east). Black shale (h). Thin limestone bed (i). Bentonite (decomposed volcanic ash) layer (j).
Figure 23. Thin-bedded, eastward-dipping white limestones of the Timpas formation (9). Thin shale layers frequently occur between the thicker beds of limestones. See Figure 8 for ground location.

Figure 24. A detail view of the Timpas limestone shown in Figure 23. This formation contains many large fossil shells as well as millions of fossils which can be observed only under a microscope.
Figure 23.

Figure 24.
Figure 26. A view of “The Pueblo” (p) and Amphitheater (k). Mount Morrison, elevation 7878 feet (m). Fountain formation (2). See Figure 8 for ground location.

Figure 27. The south elevated walk (n) leading to the Amphitheater. Fountain formation (2). See Figure 8 for ground location.
Figure 28. A High-angle Airphotograph of the Amphitheatre Area Looking Westward. Pre-Cambrian rocks (1). Fountain formation (2). Amphitheater (k). "The Pueblo" (p). South elevated walk (n). Parking lots (o). See Figure 8 for location.
—Photograph by U.S. Air Force.
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