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GEOLOGY OF OURAY AND ENVIRONS

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INTRODUCTION

Within the widened valley in which Ouray is situated, a great variety of geology is magnificently displayed. One may stand on the main street and in turning 360 degrees see rocks ranging in age from Precambrian to Recent. Within a radius of two miles of town, one may see clearly displayed features of geologic interest such as angular unconformities, erosional unconformities of mature relief, overturned beds, monoclinal folds, faults, a deeply dissected laccolith, dikes, sills, a variety of glacial features, landslides, talus piles, post-glacial gorges and waterfalls, pyrometasomatic deposits, bedded replacement deposits in an ancient sink-hole structure, and probably two ages of fissure veins.

The Ouray geologic scene consists of several separate and different facades: (1) the western facade, (2) the northern facade, (3) the eastern facade, (4) the southeastern facade, and (5) the southern facade.

Western Facade

The western view from Ouray consists of the great canyon side, west of Canyon and Uncompahgre Creeks, which is dominated by the bold Pennsylvanian Hermosa ledges for 1,500 feet above the valley bottom (fig. 1). The upper part of the cliffs immediately west of town is formed of the reddish-brown Cutler beds (fig. 2). Back of the cliffs the slopes consist of formations ranging from the Triassic Dolores to the Dakota sandstone in ledges immediately beneath the cliffs of the laccolithic quartz monzonite. All the sedimentary rocks in the vicinity of Ouray strike N. 45° - 80° E. and dip northward. Surmounting the early Tertiary quartz monzonite is an outlier of San Juan tuff (Two Sisters) which rests unconformably upon the intrusive. Southward along the facade the lower beds are upthrown several hundred feet across the Ouray fault, and in that area two quartz monzonite sills follow Dolores and lower beds of the Jurassic. The upper part of the southern end of the facade near the head of Angel Creek is composed of San Juan tuff, which builds up through towering cliffs for a thickness of 2,500-3,000 feet.

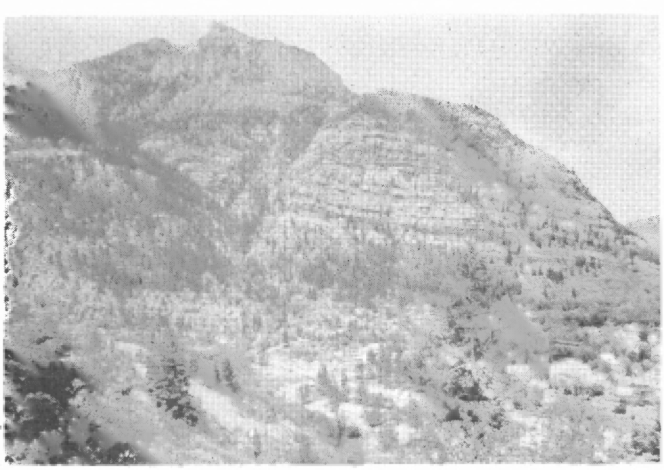

Figure. 2. View of the western facade. Oak Creek Canyon runs up to the left toward snow-capped Whitehouse Mountain at extreme upper left. Base of the Cutler formation just above the thick ledges of the main facade.

Table 1 Bedded formations of the Ouray area (Modified from Burbank, 1941).

	Age	Formation	Thickness	Character
Tertiary	Miocene (?)	San Juan tuff	1,800 - 3,000	Chiefly latitic volcanic debris. Near the base is well-stratified tuff, in part conglomeratic. Tuff-breccia in upper part.
Tertiary	Oligocene (?)	Telluride conglomerate	0 - 50	Mostly a coarse conglomerate containing pebbles and boulders of granite, schist, quartzite, porphyritic igneous rocks, and Paleozoic and Mesozoic sedimentary rocks.
Mesozoic	Upper Cretaceous	Mancos shale	0 - 1,200	Dark-gray marine shale with thin beds of limestone.
Mesozoic	Upper Cretaceous	Dakota (?) sandstone and quartzite	135 - 150	Gray or rusty-brown quartzose sandstone with shale partings, and locally carbonaceous shale in middle and upper part.
Mesozoic	Upper Jurassic	Brushy Basin shale member of Morrison formation	350 - 400	Mostly variegated shale, with green colors predominating except where altered; also red and brown shale and yellowish to gray sandstone.
Mesozoic	Upper Jurassic	Junction Creek sandstone member of Morrison formation	250 - 300	White or gray sandstone interbedded with red-brown and green shale, and thin limestone. Basal sandstone, 25-30 feet thick, locally altered to quartzite, and constituting the lower quartzite of miners.
Mesozoic	Upper Jurassic	Wanakah member of Morrison formation	85 - 125	Divisible into three units; the basal unit a dark bituminous shaly

			limestone overlain by limestone breccia derived from disintegration of gypsum-limestone complex; constituties Pony Express beds of miners (Todilto). The middle unit a sandstone, soft and friable, with clayey layers near top; mostly even-bedded; constitutes Upper La Plata sandstone of local use (Bilk Creek?). Upper unit chiefly green and brown shale, with green sandstone locally at base; thin beds and lenses of limestone; widespread layers of chert beds near top. All above Pony Express beds may be Summerville equivalent.
	Entrada sandstone	45 - 80	Very massive friable white sandstone, distinctly crossbedded in upper part; cliff-forming; more even-bedded in lower part, with layers of coarse and fine grains.
Upper Triassic	Chinle (Dolores) formation	40 - 100	Fine-grained bright-red sandstone, sandy marl, and shale. Contains beds of limestone pebbles or pebble-conglomerate. Locally quartzose pebble beds near base.
Permian	Cutler formation	0 - 2,100	A series of bright-red sandstone, pinkish grit, and conglomerate, alternating with sandy shale and earthy reddish limestone.
Pennsylvanian	Hermosa formation	1,400 - 1,600	Near base greenish sandstone and dark marine shale with thin interbedded fossiliferous limestone. The middle and upper parts contain thick beds of arkosic grit with interbeds of shale and limestone.
	Molas formation	40 - 60	Red calcareous shale and sandstone with pebbles of quartzite and chert, and interbedded conglomeratic layers containing many chert pebbles; Also pebbles of underlying Mississippian limestone.
Paleozoic Mississippian	Leadville limestone	180 - 230	Lower part predominantly dark blue-gray or brownish-gray limestone, with sandy layers near base. Upper part mostly coarser-textured clastic limestone with interbeds of reddish shale. Locally, thin-bedded cherty and ferruginous limestone at top.
Upper Devonian	Ouray limestone (dolomite)	65 - 70	Mostly gray, buff, white, fine-grained dolomite or dolomitic limestone; layers of pinkish clastic limestone with Upper Devonian fossils locally.
	Elbert formation	35 - 50	Thin-bedded buff dolomitic limestone, with interbedded sandstone and calcareous shale.
Precambrian	Uncompahgre formation	5,000 - 8,000	Massive to thin-bedded quartzite with minor slate partings; in wide bands alternating with slate or shale bands; quartzite is white, pink, and brownish to dark-gray; slate and schist is rusty-brown or black.

Northeastern Facade

The northern facade is dominated by Cascade Mountain (fig. 3). The stratigraphic sequence is similar to that on the west rising through the colorful Hermosa and Cutler beds in the cliffy section on up to the Dakota through tree-covered higher slopes. The view differs from the western one owing principally to the greater apparent dip and the convergence of higher with lower beds eastward along the prominent face (fig. 4). From high vantage points south or west of town an angular truncation of tilted Cutler beds by Dolores beds can be seen, and along the eastern part of the face (east of Cascade Creek falls) the Cutler is overlapped, with Dolores there resting upon Hermosa beds. Well up the tree-covered upper slopes, just above the yellowish Centar mine dump, there is a

Figure 3. View of the northern facade and Cascade Mountain. Cascade Creek Canyon cuts diagonally up the face to the right. White ridge at left is the "Blowout" or the Ouray stock.

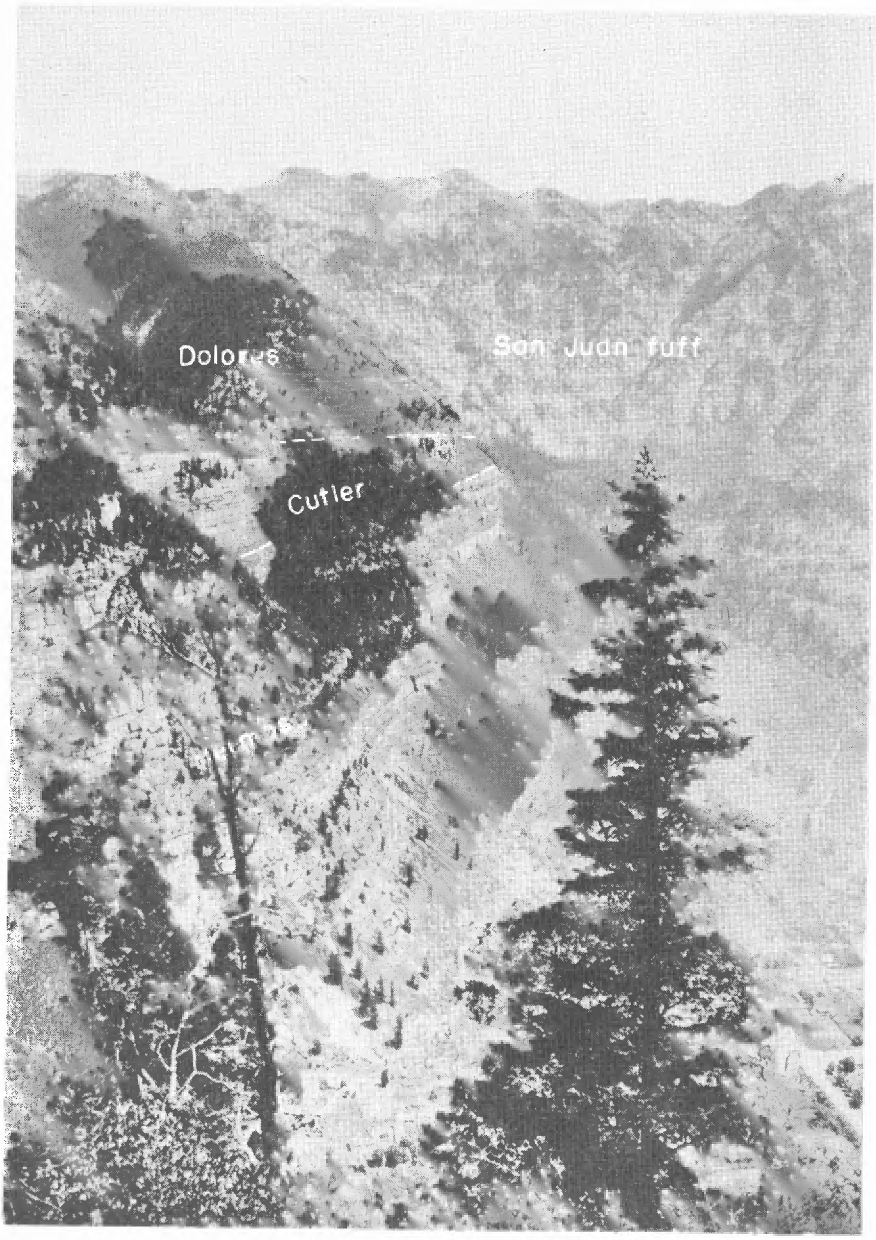

Figure 4. View east along the northern facade toward The Amphitheater.

small cliff formed principally of Dakota sandstone and quartz monzonite porphyry. The remainder of the slopes and cliffs forming the backbone of Cascade Mountain is composed of San Juan tuff, some 1,500-2,000 feet thick. All the formations in the northern facade decline northward the Hermosa and Cutler more sharply in the pre-Dolores monocline, and about 1½ miles north of Ouray the Cutler-Hermosa contact descends to the floor of the valley.

The central part of the northern facade is indented by two small canyons between which is the yellowish-stained "Blowout". This is the Ouray stock (fig. 5), the feeder to the laccolith remnants on both sides of Uncompahgre Canyon. Most of the central part of the laccolith has been cut away by erosion of the canyon; its outer parts, expecially to the northeast, were either eroded in early Tertiary time (pre-San Juan tuff) or are covered by the tuff. The bright colors of the rocks in and around the Ouray stock are due to weathered pyrite deposited by hydrothermal alteration, and to metamorphism around and in the stock. Two greenish-gray latite dikes may be seen in the Hermosa cliffs, the eastern one passing into a sill leading along the unconformity at the base of the Dolores formation.

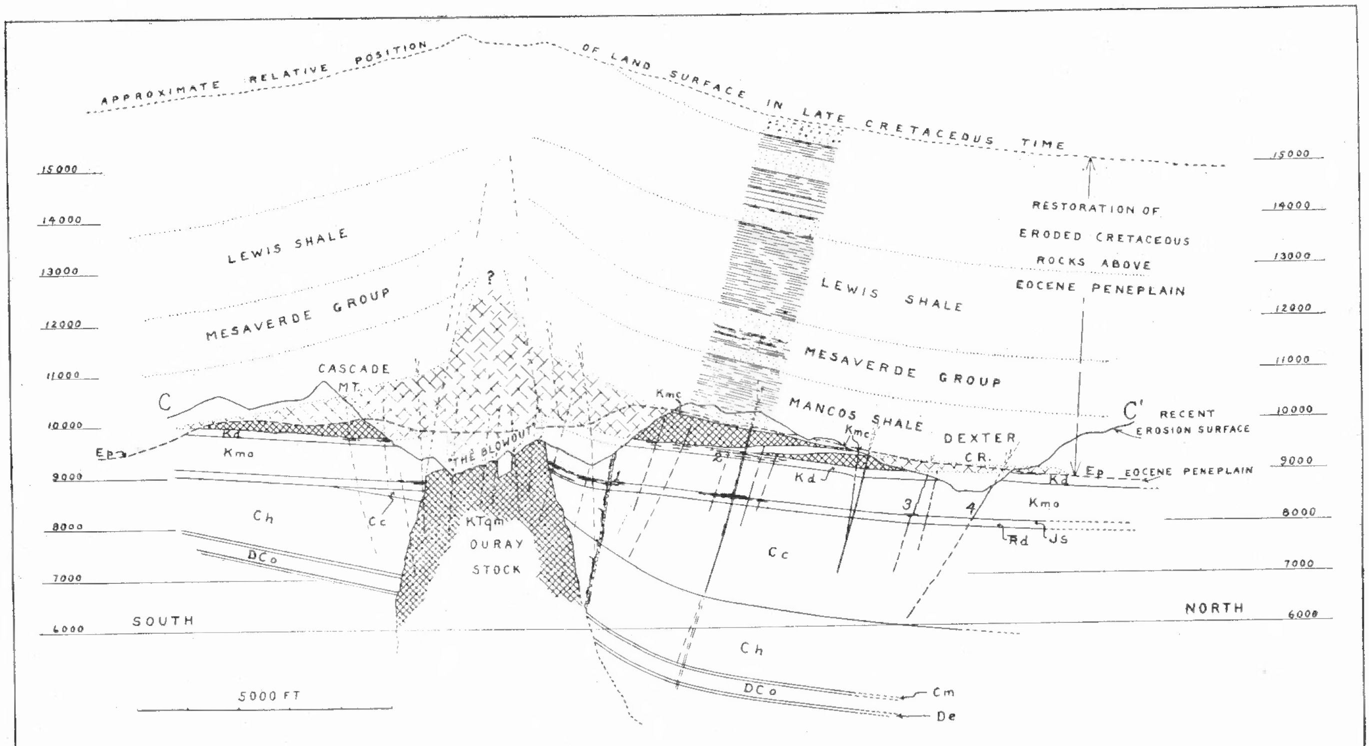

Fig. 5. —Restoration of geologic conditions in late Upper Cretaceous time, showing the probable relation of the Ouray stock and its associated mineral deposits to the Upper Cretaceous formations and the land surface in late Upper Cretaceous or early Eocene time. Elevations give the present position of land with reference to sea-level. Ep, surface of Eocene peneplain. Rs, recent erosion surface. De, Elbert formation; DCo, Ouray limestone; Cm, Molas formation; Ch, Hermosa formation; Cc, Cutler formation; TRd, Dolores formation; Js, Jurassic sandstone; Kmo, Morrison formation; Kd, Dakota (?) sandstone; Kmc, Mancos shale; KTgm, late Upper Cretaceous or early Eocene intrusions of quartz monzonite porphyry. See geologic map Plate I, section C-C', for position of section.

Figures show relative position of certain mines with respect to the Ouray stock: 1. Wanakah and Bright Diamond mines; 2. American Nettie mine; 3. Bachelor mine; 4. Calliope mine.

(From Burbank, 1930)

Eastern Facade

The view from Ouray is into The Amphitheater, which is banked around by cliffs of San Juan tuff whose exposed thickness (top eroded and base covered) is some 3,200 feet. The highest point on the rim of the Amphitheater is nearly 12,400 feet, thus rising about 4,600 feet above Ouray (fig. 6). High on the wall of The Amphitheater, at about 11,500 feet, is a narrow dark outcrop band which may be either a sill or a flow. The tree-covered lower slopes which form the foreground to the view of The Amphitheater are composed of landslide, beneath most of which may lie weak beds of Molas shale that probably facilitated the sliding. Of equal or greater geologic interest than the slide, however, is the fact that the site of The Amphitheater was a valley of considerable relief prior to the burial of the area by the San Juan tuff. Thus, on the ridge north of The Amphitheater, the base of the tuff resting on eroded quartz monzonite is at an altitude of 10,400 feet and south of The Amphitheater it rests on Precambrian quartzite at about 10,000 feet. Although the

Figure 6. View of The Amphitheater. U. S. Highway 550 in foreground. Tree-covered landslide in middle and north of Portland Creek, which descends from the south side of The Amphitheater.

base of the tuff is covered in the center of The Amphitheater, it would probably be about 9,000 feet altitude at its lowest point. The minimum exposed relief of the ancient valley is, therefore, about 1,000 feet. Whether the buried valley trended northerly or westerly is not certain.

Southeastern Facade

This view is of a rounded bold ridge south of the Amphitheater. In the foreground is a low ridge of Ouray limestone that rises only a few hundred feet above town. Back of this is a bold somber ridge that is viewed more or less end-on. The lower part is a bold shield consisting mostly of Precambrian quartzite of the Uncompahgre formation; the upper part is San Juan tuff. From the proper vantage point the geologic impression that is gained is one of a Precambrian knob rising in the overlying San Juan tuff. To the right and forming the distant backdrop for the view up Uncompahgre Canyon is the pyramid-shaped Mount Abrams, but this is beyond the Ouray area.

Southern Facade

The southern view is toward the northern end of Hayden Mountain, which is a high ridge between Uncompahgre Canyon to the east and Canyon Creek to the west The view from town is across two geological steps (fig. 7), the first formed by the immediate rise of hills south of town composed of Devonian and Mississippian Ouray limestone. If the view is from Lookout Point, 1.4 miles

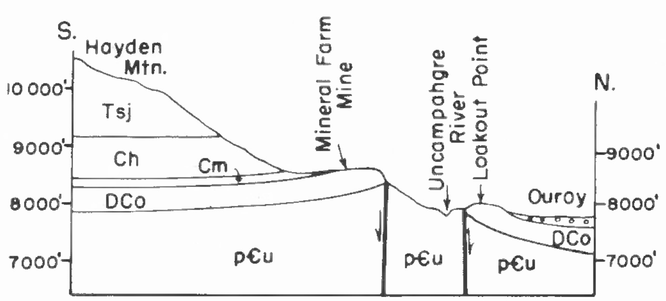

Figure 7. Structure section southward from Ouray.

south of town by the switchback road, then it is from the top of the first step. From this vantage point the second step is more prominent and forms a bold rim rising about ½ mile to the south across the narrow Uncompahgre River gorge. The riser of the second step is largely quartzite that strikes westerly and dips very steeply toward the observer. The cap to the step is formed by a thin interval of Devonian Elbert sandstone and siltstone overlain by massive Ouray limestone. The step is inclined west-northwesterly at about 15° and on its back slope, out of view, lie weak beds of the Pennsylvanian Molas formation, along which erosion has cut the second step or high bench at the base of Hayden Mountain. One may drive to this bench by a side road about two miles south of Ouray along the road up Canyon Creek. The lower slope of Hayden Mountain consists of Pennsylvanian Hermosa beds and the more precipitous upper part is Telluride conglomerate and San Juan tuff.

Perhaps the most striking features of the geology of the southern facade are those along the Ouray fault, which extends from the south side of The Amphitheater about N. 70°W. past Box Canyon and up the western facade into the head of Oak Creek (fig. 1). The fault is nearly vertical and the maximum downthrow on the north side is several hundred feet near the middle. Southeastward along U. S. Highway 550 from Lookout Point the Ouray limestone of the northern, downthrown side stands above the Precambrian quartzite on the south, upthrown side. This situation makes it appear that the limestone is more resistant to erosion than the quartzite, and this may be true especially for the thin-bedded and shattered and sheared quartzite beds near the fault.

At Box Canyon soft Molas and Hermosa beds lie on the north side of the fault while Precambrian diabase (dike) and quartzite lie on the south side; the contrast in resistance of the two blocks is so great as to cause a bold scarp and waterfall. The abrupt descent here, and in the step down from the Ouray limestone ridge at Lookout Point to the valley floor of the town, is largely the result of "plunging" by the Wisconsin glacier as it encountered the soft, nonresistant beds of the Molas that underlie most of Ouray.

COAL RESOURCES OF THE DURANGO AREA, COLORADO AND NEW MEXICO

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INTRODUCTION

Coal is one of the largest assured sources of energy in both Colorado and New Mexico. Although coal is developed only locally at the present time there may be extensive developments in the future to meet the demands of industry both within and beyond the limits of the two states.