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SUMMARY OF THE GEOLOGY OF THE RICO REGION, COLORADO'

By

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The Rico Mountains are an elliptical group of 12,000-foot peaks on the southwest edge of the San Juan Mountains, close to the vague boundary between the San Juans and the Colorado Plateau. The principal tectonic feature of the Rico Mountains is the Rico dome, in which the sedimentary rocks are bowed up sharply from their gentle southwesterly regional dip (see fig. 1); at the center of the dome are a monzonite stock and an upfaulted core of Precambrian rocks, and the doming is accentuated by the inflationary effects of numerous sills and laccoliths, some as much as several hundred feet thick. The dome and mountains are bisected by the valley of the Dolores River, which flows southward through the area, producing a relief of more than 3,000 feet and exposing a sedimentary sequence of some 11,000 feet of rocks from Precambrian quartzite to the Cretaceous Mancos Shale (table 1). Nestled in this valley in the midst of the Rico Mountains, at an elevation of 8,800 feet, is the town of Rico, which was established as a silver mining camp in 1879. The principal mineral production of the district has been ores of silver, zinc, lead, gold, and copper, produced mostly from veins and irregular replacement deposits in limestones of the Ouray, Leadville, and Hermosa Formations. Uranium-vanadium ores have been mined from deposits in the Entrada Sandstone east of Rico, and in recent years sulfuric acid was made at Rico from pyrite, for shipment by truck to nearby uranium mills; but in 1966 the Colorado Game, Fish and Parks Department took note of acid being inadvertently dispatched downriver without benefit of containers, and the acid plant was shut down. As of 1962 the total mineral production from the Rico district was nearly $45 million.

The Rico region was mapped by Whitman Cross and his associates in 1897-1908, in conjunction with their study of the Rico mining district and their mapping for the Rico and Engineer Mountain 15' folios (Cross and Spencer, 1900; Ransome, 1901; Cross and Ransome, 1905; Cross, 1910). This early work resulted in published geologic maps of the entire region at 1:62,500, and a 1:23,600 geologic map of about 34 square miles centered on Rico. In 1967 E. T. McKnight of the U.S. Geological Survey completed a detailed study of the heart of the district, an area of about 10 square miles. His study included preparation of a geologic map at 1:9,600 based on both surface and mine mapping. During 1964-67 I remapped the Rico and Hermosa Peak 71/2' quadrangles at 1:24,000, making full use of Cross' and McKnight's large-scale mapping.

The general stratigraphy and structure of the region were well discerned by Cross and Spencer, and it is no surprise (and a tribute to Cross) that the current mapping at 1:24,000 has produced no radical changes from the earlier mapping at 1:23,600. McKnight's more detailed work in the center of the district has resulted in some revision of both stratigraphic and structural interpretations, but has not affected the basic concept of the Rico dome as developed by Cross. General aspects to be summarized here are refinement of the older mapping in terms of currently used Jurassic units, some observations on the validity of the Rico Formation, and clarification of the relative ages of the igneous rocks.

[1] Publication authorized by the Director, U.S. Geological Survey

JURASSIC UNITS

Cross and Spencer divided the thick Jurassic continental succession between the Dolores Formation and the Dakota Sandstone into two formations, the La Plata Formation or La Plata Sandstone, and the McElmo Formation. Colorado Plateau geologists have long since revised this stratigraphy elsewhere in the San Juan basin, and the only major revision of Cross' mapping during the recent quadrangle mapping has been to carry out the same revision of the La Plata and McElmo in the Rico region. The units now used in the Rico region, and their correspondence to the La Plata and McElmo, are shown below (table 2). The lithologic descriptions and thicknesses are taken directly from sections measured by Spencer (Cross and Spencer, 1900, p. 73-77) : the McElmo Formation on the north side of the West Dolores River, 81/2 miles west-northwest of Rico, and the La Plata Formation in the cliff exposure at Section Point, 4 miles east-northeast of Rico.

The Wanakah Formation cannot be effectively separated from the Entrada Sandstone in most of the Rico region west of the Dolores River because of the lack of good exposures, and it follows that any attempt to map the members of the Wanakah is even more futile. However, east of the Dolores River the exposures are better, and mapping is further facilitated by the presence of the Pony Express Limestone Member. Occurring as it does in the midst of a rather monotonous succession of continental elastics, this beautifully distinctive medium-gray thin-bedded limestone can be walked out almost continuously from Section Point, where the unit is 2 feet thick and sandy, to the east edge of the Hermosa Peak quadrangle, where it is 15 feet thick. The Pony Express pinches out westward along a northerly trending line that before erosion would have passed a short distance west of Section Point. The limestone is exposed on the west side of Bar-

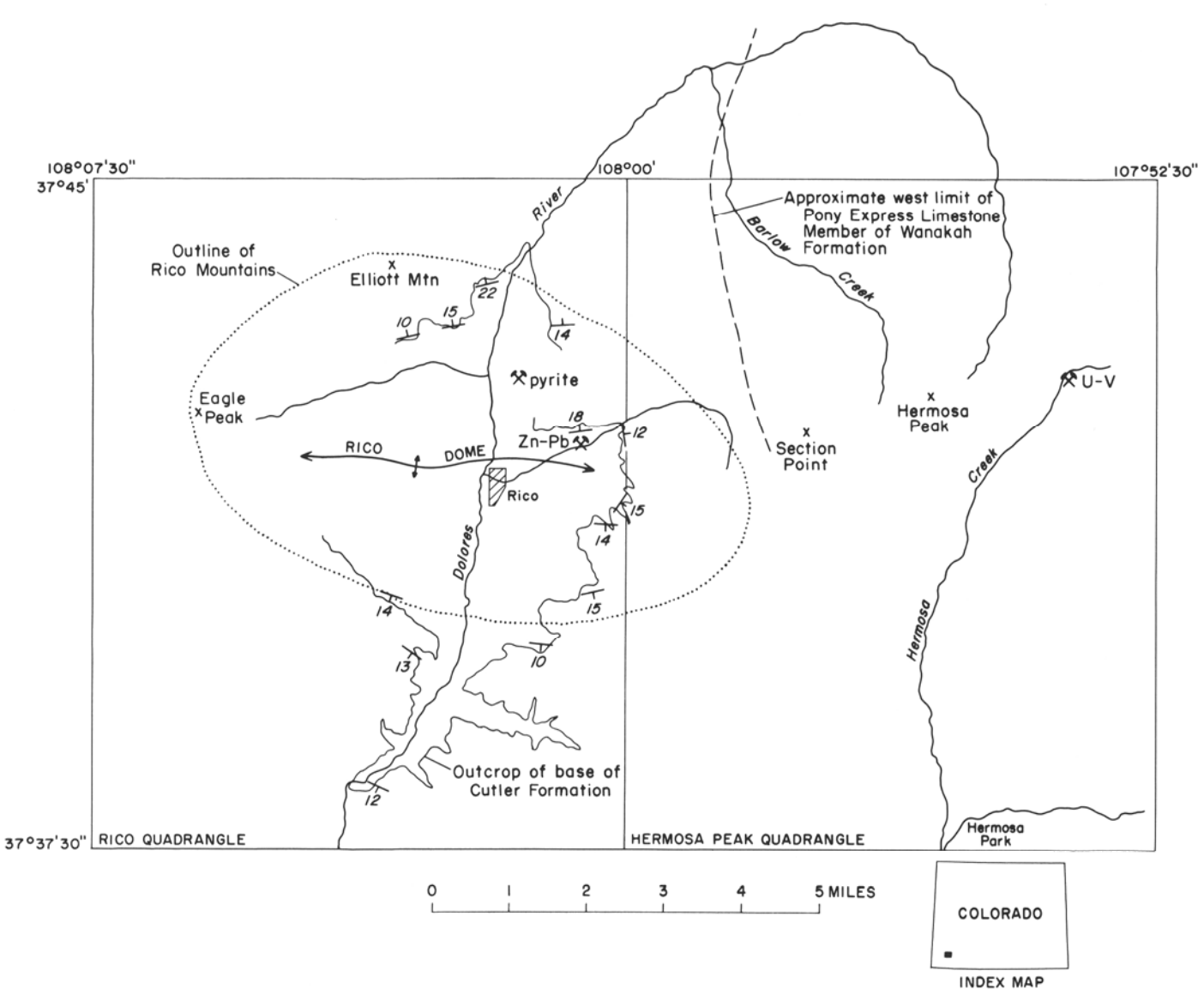

FIGURE 1.
Location Map of the Rico Region, Colorado

low Creek about a mile south of the junction with the Dolores River (Bromfield, 1967, p. 13), but is absent in the roadcut just north of the junction. Because of the better exposures east of the Dolores River, and the presence of the Pony Express as a distinct marker bed, the Entrada and Wanakah have been mapped separately in the Hermosa Peak quadrangle but not in the Rico quadrangle except along its north edge, where they are fairly well exposed.

The Salt Wash Sandstone Member as mapped in most of the Rico quadrangle includes at its base a medium-grained massive sandstone considered to be an equivalent of the Junction Creek Sandstone. This unit varies in thickness from 56 feet, north of the West Dolores River 61/2 miles northwest of Rico, to about 40 feet west of Elliott Mountain, to 70 feet west of Eagle Peak, and probably thickens southward but is not measurable elsewhere in the Rico quadrangle. The unit may be present in the Hermosa Peak quadrangle but this part of the section is not sufficiently well exposed to permit identification of a possible Junction Creek equivalent.

RICO FORMATION

Geologists working in the Paleozoic section of southwestern Colorado are generally aware of the controversy regarding the Rico Formation. The problem has been discussed by Baars (1962) and will not be reviewed here except to summarize it for readers not familiar with the area. The formation was proposed by Spencer (Cross and Spencer, 1900, p. 59-66) as a transitional unit between the underlying gray, limestone-rich marine beds of the

TABLE 1. MESOZOIC AND OLDER SEDIMENTARY AND METAMORPHIC ROCKS IN THE RICO REGION, COLORADO

AGE	FORMATION	DOMINANT LITHOLOGY	APPROXIMATE MAXIMUM EXPOSED THICKNESS (ft)
Late Cretaceous	Mancos Shale	Dark-gray shale.	3,000
Late and Early (?) Cretaceous	Dakota Sandstone	Light-gray and tan sandstone, minor black shale.	300
	Unconformity		
Late Jurassic	Morrison Formation	Brushy Basin Shale Member: light-green and brown shale.	500
		Salt Wash Sandstone Member: light-gray and brownish-gray sandstone with greenish clay galls; Junction Creek Sandstone equivalent at base in western part of area.	300
Late Jurassic	Wanakah Formation	Limy siltstone above, fine-grained sandstone below; Pony Express Limestone Member at base in eastern part of area.	200
Late Jurassic	Entrada Sandstone	Light-brown or gray massive sandstone; locally contains coarse frosted quartz grains near base.	80
	Unconformity		
Late Triassic	Dolores Formation	Light-reddish-brown very fine-grained sandstone and siltstone; thin beds of gray limestone pebble conglomerate.	1,000
	Unconformity		
Early Permian	Cutler Formation	Interbedded reddish-brown siltstone and purplish-brown coarse-grained arkose and conglomerate.	2,100
Middle Pennsylvanian	Rico Formation	Sandstone and arkose, in part conglomeratic, and subordinate shale and shaly limestone; various shades of greenish- reddish-, and brownish-gray. (Included in upper member of Hermosa Formation in eastern part of region.)	325
Middle Pennsylvanian	Hermosa Formation	Upper member: greenish-gray to brownish-red arkose, sandstone, shale, conglomerate, and minor limestone.	830
		Middle member: gray massive limestone beds separated by gray or brownish-red sandstone and shale.	650
		Lower member: greenish-gray sandstone, siltstone, and arkose; minor shale and limestone.	880
Middle Pennsylvanian	Quartzite of Larsen tunnel area	Gray to brown coarse-grained quartzite.	80
	Unconformity		
Lower Mississippian	Leadville Limestone	Light-gray crystalline limestone and dolomite	170
Devonian	Ouray Limestone	Crystalline limestone; in subsurface only.	
	Unconformity		
Precambrian	Uncompahgre Quartzite	Light-gray well-indurated quartzite.	1,000(?)
Precambrian		Metadiorite.	?
Precambrian		Greenstone.	?
		Total	11,415

TABLE 2. JURASSIC UNITS CURRENTLY USED IN RICO REGION, COLORADO

OLD NAMES*	LITHOLOGY*	THICKNESS* (ft)	CURRENT NAMES	
McElmo Formation	Green shale with a few bands of sandstone.	35	Brushy Basin Shale Member	Morrison Formation
	Conglomerate with white impure chert.	15		
	Alternating dull-red and green shales with thin sandstone.	275		
La Plata Formation	Sandstone, rusty brown or gray, in banks separated by thin layers of crumbling, sandy shale; a few of the lower sandstone layers are calcareous.	73	Salt Wash Sandstone Member	
	Red sandy shale.	8		
	White saccharoidal sandstone.	4		
	Sandy shales, crumbling very readily, containing a few thin layers of sandstone, most abundant in the upper part, * * * color of whole series is reddish.	60	Marl Member and Bilk Creek Sandstone Member	Wanakah Formation
	Dark, calcareous sandstone, containing considerable calcite near the middle.	3-4	Pony Express Limestone Member	
	Massive sandstone of the usual La Plata character.	104	Entrada Sandstone	

* From Cross and Spencer (1900, p. 73-77).

Hermosa Formation (Pennsylvanian) and the overlying continental red beds, at that time considered as Dolores (Triassic) but shortly thereafter separated from the Dolores and named the Cutler Formation (Permian). As originally defined in the Rico area, the Rico Formation consisted of "sandstones and conglomerates with intercalated shales and sandy fossiliferous limestones." It was considered a distinct unit because it seemed lithologically to belong with the overlying red beds, yet unlike them, it was fossiliferous, and at least some of its fossils were common to the Hermosa Formation. But even at that time there was no clearly significant lithologic definition of the base of the Rico, and the upper contact was "entirely artificial, being based on the highest known occurrence of the Rico fossils" (Cross and Spencer, 1900, p. 60). Cross and Spencer were able to locate what they regarded as the upper contact of the Rico in a few places, but in most of the area they mapped the contact on the basis of an assumed thickness of 325 feet, representing an arbitrary thickness slightly greater than the greatest known thickness between the base and the uppermost fossils. Farther east, on the south face of Engineer Mountain, Cross later discovered a Rico-type fossil-bearing limestone in the midst of typical Cutler redbeds, but retained the Rico Formation nevertheless (Cross, 1910, p. 6).

The Rico Formation has been retained in the mapping of the Rico 71/2' quadrangle, not because of any conviction of its stratigraphic significance but because McKnight was able to trace its upper as well as its lower contact, and therefore found it useful as a map unit in interpreting and depicting the structure. In the stream valleys east of Rico the formation disappears beneath the Cutler Formation, dipping eastward around the east flank of the Rico dome. Six miles to the southeast, where the same strata come to the surface again in the Hermosa Park area, the Rico has lost its character; good criteria for locating either the top or the base of the formation are lacking, and the Rico has not been mapped separately but has been included with the upper member of the Hermosa. There is no argument as to whether the same sequence of beds is present here, but the distinguishing characteristics of the Rico, questionable at best, are obscured if indeed they are present at all; it is, in short, difficult enough to find one artificial contact, let alone two, so the Rico here simply is not a mappable lithologic unit.

IGNEOUS ROCKS

Three rock types constitute the bulk of the intrusive igneous rocks in the Rico Mountains. The most widespread is a porphyritic hornblende latite, the typical porphyry of the Rico area, that forms sills, laccoliths, and dikes throughout the Rico Mountains and is seen in rockslides along the highway a few miles south of Rico. The second type is an augite monzonite that cuts the latite and forms a stock in the center of the Rico dome. The third type, a quartz-bearing biotite trachyte, is exposed in sills on the east side of the Rico Mountains and is the predominant igneous rock a few miles to the east. All three types postdate the Mancos Shale. The monzonite is post-latite, but good evidence of the age relations between latite and trachyte, and of the exact geologic age of the intrusives, has thus far been lacking.

At least one answer has come out of recent mapping

in the Hermosa Peak area, and others are within sight. Hermosa Peak, a 12,500-foot crag lying between the laccolithic Rico Mountains and the more rugged peaks of the San Juan volcanic field, consists of typical porphyritic hornblende latite intruded in the Dakota and Mancos Formations; Cross depicted it in the Engineer Mountain folio as a laccolith, but two of the three exposures of the contact show it to be sharply discordant and vertical. Partly surrounding Hermosa Peak is a sill of the biotite trachyte; Cross suspected that the trachyte was younger but could find no evidence. Positive proof has now been found in the form of several trachyte dikes, with slightly chilled borders, that cut cleanly across the latite in Hermosa Peak; the trachyte is identical to that of the larger masses to the north and east, and weathers to a light-colored trench or gap that can be seen from a mile or more away.

The geologic ages of the three igneous rocks are known only as post-Mancos and pre-Pleistocene. The hornblende latite is thought to be early Tertiary in age, but the ubiquity of alteration effects suggests that it may be as old as latest Cretaceous. None of the three rocks has yet been dated radiometrically, but specimens of all three have been found that appear to be fresh enough for reliable dating. Work is in progress on these rocks, and it is hoped that they will provide K-Ar ages, now highly desirable as bench marks for the intrusive sequence in the western San Juans.

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