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located in basin areas underlain by thick accumulations of Tertiary rocks and valley fill. They can be interpreted in terms of the thickness of the low-density rocks and the configuration of the basins in which they occur. The local anomalies associated with density contrasts within the pre-Tertiary rocks are generally of smaller amplitude, but significant local anomalies associated with bedrock features have been observed.

A knowledge of the broad regional variations in Bouguer anomaly values is of great use in the study of the large-scale variations in the thickness and composition of the crust. It is also helpful in isolating the local gravity anomalies superimposed on the regional variations. In the Basin and Range province the preparation of a contour map to illustrate the regional gravity anomalies is complicated by numerous local anomalies of large amplitude. The anomaly value for an individual gravity station may not be even approximately representative of the anomaly values over an area of even a few square miles, particularly if the station is near the margin of a basin underlain by several thousand feet of low density Cenozoic rocks. To prepare an anomaly map that will show the regional gravity anomalies some method of averaging values or selecting stations must be used. The map in figure 130.1 was prepared by contouring the anomaly values for representative stations located in the ranges.

The regional Bouguer anomaly values range from about −60 milligals to −240 milligals, and show an inverse correlation with the regional topography. The highest anomaly values are at the southwest edge of the map. Here the anomaly values rise abruptly where the regional elevation decreases toward the Pacific Ocean. Over the western Mojave Desert, where the surface relief is small, the regional gravity relief is small. North of the western Mojave Desert the anomaly values decrease as the surface rises to a high over the Sierra Nevada and White Mountains. Relatively high anomaly values occur in topographically low areas around Death Valley and the Colorado River. Northward from these areas the general level of the surface rises and the anomaly values decrease. In east-central Nevada the surface is higher, and the Bouguer anomaly values are lower than in any other part of the State.

Along the west-central border of Nevada the anomaly values decrease as the surface rises toward the Sierra Nevada. In northwestern Nevada the main gravity feature is a high, which is in the topographic low containing the Smoke Creek and Black Rock Deserts, Desert Valley, the lower Humboldt River valley, and the Carson Sink. Northwest of this area the anomaly values decrease over a topographic highland. A strip in which gravity is low and the surface is high extends northward from the Ely area to the Idaho-Nevada State line. East of this low trend there is a gravity high in the Lake Bonneville basin. East of the Lake Bonneville basin the anomaly values are lower over the Wasatch Range.

The correlation between low Bouguer anomaly values and high regional topography clearly shows that there is a relative mass deficiency under the regional highlands. Although the gravity data do not indicate the nature of the mass deficiency, which can occur anywhere within the crust or in the upper mantle, the correlation with topography suggests that some form of regional isostatic compensation exists.

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USGS 400-B
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131. MESOZOIC AGE OF ROOF PENDANTS IN WEST-CENTRAL NEVADA

By James G. Moore, Menlo Park, Calif.

Work done in cooperation with the Nevada Bureau of Mines

In an area of roughly 3,000 square miles in the western Great Basin, lying mainly in Lyon, Douglas, and Ormsby Counties, Nev. (fig. 131.1), about 430 square miles are underlain by Cretaceous(?) intrusive rocks, largely granitic, related to the Sierra Nevada batholith, and about 180 square miles by partly metamorphosed rocks older than the batholith. The metamorphic rocks occur in irregular roof pendants and septa, which have

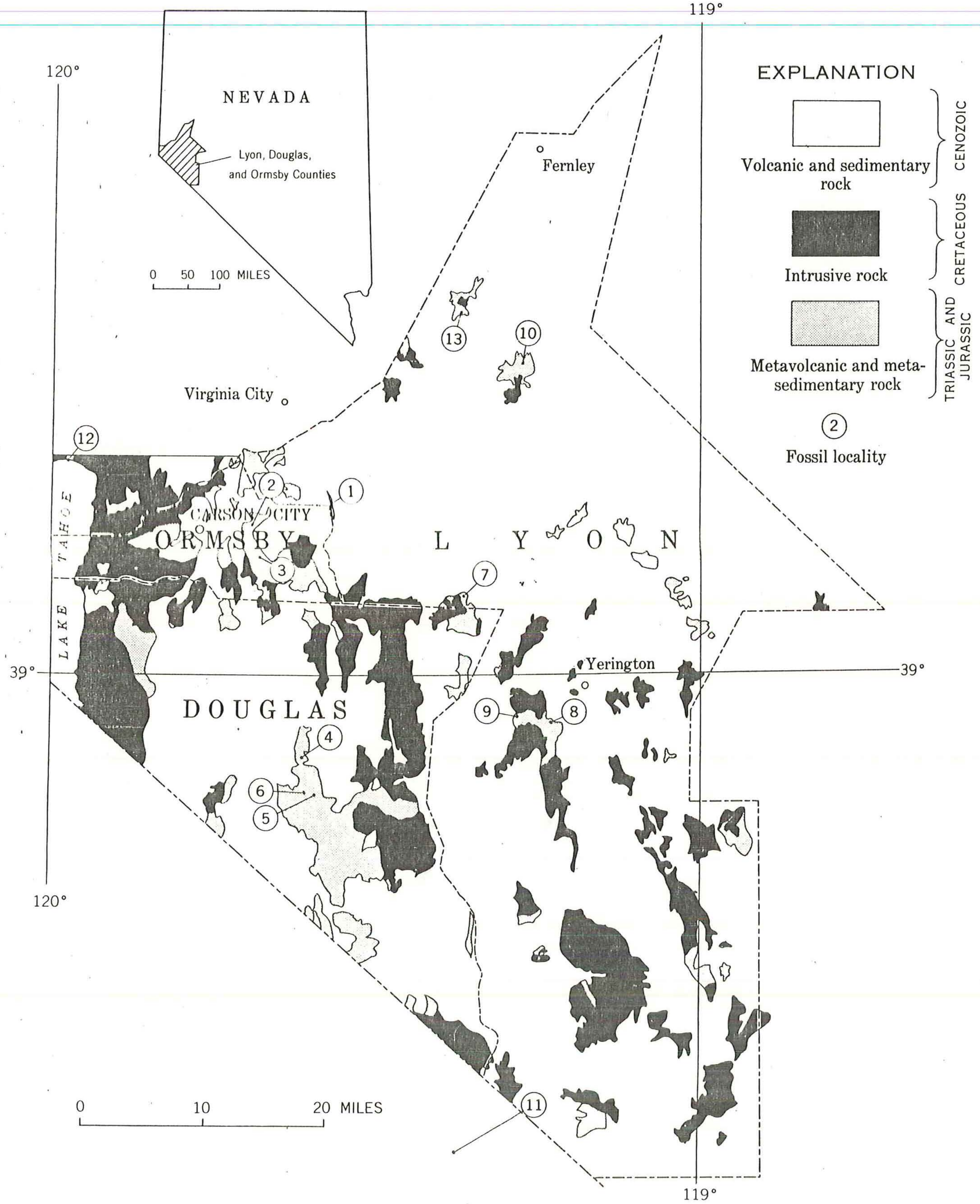

FIGURE 131.1.—Generalized geologic map of Lyon, Douglas, and Ormsby Counties, Nev.

been deformed, intruded, and recrystallized by the granitic rocks. The rest of the area is underlain by Cenozoic volcanic and sedimentary deposits. The area is considered to be within the borders of the batholith, because granitic rocks are more than twice as abundant as the older rocks.

In the prebatholithic sequence, metavolcanic rocks are somewhat more abundant than metasedimentary rocks, which were themselves largely derived from volcanic detritus. The metavolcanic rocks are dominantly meta-andesite and meta-dacite, mostly in the form of volcanic breccia, but also include much metabasalt and metarhyolite. The metavolcanic rocks are interbedded with marine sedimentary rocks and are at least in part of submarine origin. The rarity of pillow lava, however, and the association of volcanic rocks with gypsum deposits, suggest that part of the volcanic rock was formed in a terrestrial or near-shore environment.

The metasedimentary rocks originally consisted mainly of shale, siltstone (commonly tuffaceous), and limestone, but these are interbedded with sandstone, graywacke, dolomite, gypsum, and small amounts of chert. Intercalated with them, also, are conglomerate and sedimentary breccia that may have originated as submarine mud flows.

In general the metasedimentary rocks underlie the metavolcanic rocks. This is so in the area north of Carson City, in the Sweetwater Range, and in the Virginia City quadrangle, which lies just north of the tri-county area (Thompson, 1956, p. 48). But at Yerington the metasedimentary rocks mostly overlie the metavolcanic rocks (Knopf, 1918, p. 13), and in all areas much of the sedimentary rock contains volcanic material. In many places, however, the stratigraphy and structure of these rocks are not well understood and the relations of the sedimentary and volcanic units are uncertain.

Fossils have been collected from the metasedimentary rocks at 13 localities in the tri-county area (table 131.1

TABLE 131.1.—*Mesozoic fossils from Lyon, Douglas, and Ormsby Counties and adjacent areas*

No. on fig. 131.1	Mountain range	Locality	Fossils	Age	Reference
1a	Pine Nut____	Eldorado Canyon, 4 miles southeast of Dayton. Bottom of canyon on east side of creek, sec. 6, T. 15 N., R. 22 E.	*Monotis subcircularis* Gabb.	Late Triassic (late Norian).	Gianella, 1936, p. 37. Identified by S.W. Muller.
1b	_____do______	____do________________________	Arietitid ammonites___	Early Jurassic, probably Sinemurian (late early Early Jurassic).	This report. Identified by N. J. Silberling.
2	_____do______	Brunswick site. Ridge crest 500 feet west of bridge across Carson River at site of Brunswick. Two miles east of New Empire.	Spherical and crescentic cavities suggest the globose ammonite *Arcestes*.	If these are not inorganic they indicate a Late Triassic age.	Do.
3	____do	Sand Canyon, a southern tributary of Brunswick Canyon. West side of road at the boundary between secs. 19 and 30, T. 15 N., R. 21 E.	*Monotis subcircularis* Gabb.	Late Late Triassic (middle or late Norian).	Do.
4	_____do______	South of Pine Nut Creek in sec. 15, T. 12 N., R. 21 E.	*Spiriferina*___________	Early Mesozoic, probably Late Triassic.	Collected and identified by E. R. Larson, written communication, 1958.
5	_____do______	Southwest of ridge crest ½ mile west of Alpine Mill on Pine Nut Creek: NE¼NE¼ sec. 35, T. 12 N., R. 21 E.	*Monotis subcircularis* Gabb. *Hetarastridium* sp. *Placites* sp. *Rhabdoceras* sp. *Sandlingites*? sp. *Halorites*? sp. Choristoceratid.	Late Late Triassic (middle or late Norian).	This report. Identified by N. J. Silberling.

TABLE 131.1.—*Mesozoic fossils from Lyon, Douglas, and Ormsby Counties and adjacent areas*—Continued

No. on fig. 131.1	Mountain range	Locality	Fossils	Age	Reference
6	do	One and one-half miles west of Albine Mill on Pine Nut Creek NW¼NW¼ sec. 35, T. 12 N., R. 21 E.	*Pinna* sp. Indeterminate pectenoid. Indeterminate gastropods. Fragments of large concentrically ribbed pelecypod.	The large pelecypods with concentric ribbing indicate a Mesozoic age.	This report. Identified by N. J. Silberling.
7	Buckskin	Northeast part of Buckskin Range, near intersection of Churchill Canyon and road from Lincoln Flat: NW¼NE¼ sec. 12, T. 14 N., R. 23 E.	"*Pecten*" aff. "*P.*" *valoniensis.* *Pteria* sp. Nuculid? pelecypods.	Early Mesozoic	Do.
8a	Singatse	Yerington district; on the south side of road near Malachite mine. Near SE¼SE¼ sec. 31, T. 13 N., R. 25 E.	*Daonella* sp. *Halobia.*	Triassic	Knopf, 1918, p. 13. Identified by T. W. Stanton.
8b	do	do	*Halobia* sp.	Late Triassic	This report. Identified by N. J. Silberling.
9	do	Ludwig mine	Not specified	Triassic	Jones, 1912, p. 400.
10	Churchill Butte.	Northeast side of butte in SE¼ sec. 3, T. 17 N., R. 24 E.	*Arietites*	Early Jurassic	Collected and identified by V. P. Gianella, written communication, 1958.
11	Sweetwater	Lobdel Lake district	Ammonite either a *Caloceras*? or a *Arnioceras*?	do	Halsey,[1] 1953, p. 28. Identified by S. W. Muller.
12	Sierra Nevada.	Beach pebble at northern end of Lake Tahoe.	Ammonoid cephalopod	Mesozoic	Larson and Gianella, 1951.
13	Virginia Range.	North-central sec. 23, T. 18 N., R. 23 E. Churchill Butte 15-minute quadrangle.	Arietitid ammonite	Early Jurassic	Collected by V. P. Gianella and D.I. Axelrod, 1959. Identified by N. J. Silberling.

[1] Halsey, J. H., 1953, Geology of parts of the Bridgeport, Calif., and Wellington, Nev., quadrangles. University of California Ph. D. thesis, 498 pages. Halsey also mentions (p. 27) that poorly preserved ammonites and *Halobia* probably of Triassic age have been collected "in the hills surrounding Topaz Lake and in Risue Canyon." Both localities are on the west side of the Sweetwater Range.

and fig. 131.1). During the course of recent reconnaissance mapping, 5 new fossil localities were found, and enlarged collections were made from 2 previously known localities. In addition, this note lists the fossils in 4 collections by others of which no descriptions had previously been published. All 13 collections consist of Mesozoic fossils; in 5 of them, the fossils are Triassic (mostly Late Triassic) and in 3 they are Early Jurassic. No Paleozoic rocks have been recognized in the mapped area, though the extensive faulting and folding of the prebatholithic rocks should have caused them to be exposed if they were present.

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132. IDENTIFICATION OF THE DUNDERBERG SHALE OF LATE CAMBRIAN AGE IN THE EASTERN GREAT BASIN

By Allison R. Palmer, Washington, D.C.

Previous to 1958 the Dunderberg shale, or a supposedly equivalent unit, had been identified at many places in the eastern half of the Great Basin where it had been regarded as an important regional stratigraphic marker (Palmer, 1956). Bentley (1958) has described what he called the "Dunderberg shale" as occurring at many localities in western Utah, and has shown that it is a shaly westward extension of the Worm Creek quartzite member of the St. Charles formation of the northern Wasatch Range. He has also shown that the trilobite fauna of the "Dunderberg shale" in western Utah is entirely that of the *Elvinia* zone. It has now been established, however, by detailed examination of the Dunderberg shale at its type locality in the Eureka district, Nevada, that trilobites of the *Elvinia* zone are confined to limestones in the upper 50 feet of the formation. The lower 200 feet, which includes most of the shale in the formation, contains abundant representatives of the *Dunderbergia* zone (Palmer, 1960). Bentley's "Dunderberg shale," therefore, is younger than almost all of the Dunderberg shale at its type locality.

In the Eureka district the contact of the Dunderberg shale with the underlying Hamburg dolomite is a zone of shearing (Nolan, Merriam, and Williams, 1956, p. 18), but until recently only a few feet of beds was believed to be missing. New evidence now indicates that as much as 200 to 300 feet of the lower part of the Dunderberg shale may be faulted out at Eureka. An essentially unfaulted exposure of Dunderberg shale, 600 feet thick, has now been recognized near Cherry Creek, about 65 miles northeast of Eureka. In this section the upper 350 feet of beds contains trilobites of both the *Elvinia* and *Dunderbergia* zones, similar to those found at Eureka. The lower 250 feet contains different trilobites, belonging to the *Aphelaspis* zone. Below these beds, and above another shaly unit containing *Eldoradia*, there is about 1,000 feet of thick-bedded limestone which has not been named. As *Eldoradia* is found in the upper beds of the Secret Canyon shale, which lies just beneath the Hamburg dolomite at Eureka, the unnamed limestone near Cherry Creek should probably be correlated with the Hamburg dolomite. The estimated thickness of 1,000 feet for the Hamburg dolomite (Nolan, Merriam, and Williams, 1956, p. 17) is approximately the same as that of the unnamed limestone unit, and the thickness of the *Dunderbergia* zone is also about the same in the two areas. There is thus no indication of significant stratigraphic thinning between Cherry Creek and Eureka and it seems likely that the absence of the lower part of the Dunderberg at Eureka is due to faulting.

The Hicks formation, exposed in the Deep Creek Range about 55 miles east of Cherry Creek, consists of units of interbedded shale and thin-bedded limestone alternating with units of medium- to thick-bedded dolomite (fig. 132.1). A 30-foot unit of interbedded limestone and shale at the top of the formation contains trilobites of the *Elvinia* zone. This unit was identified by Bentley as the "Dunderberg shale" and separated from the underlying Hicks formation. A shaly unit in the middle of the Hicks formation, separated from Bentley's "Dunderberg shale" by 120 feet of dolomite, contains trilobites of the *Dunderbergia* zone in its upper part and trilobites of the *Aphelaspis* zone in its lower part. This unit correlates with the lower part of the Dunderberg shale as exposed near Cherry Creek. Therefore, the unit that has been called the "Dunderberg shale" by Bentley and by those who have studied it at many localities in western Utah is not equivalent to the whole of the Dunderberg shale exposed near Eureka and Cherry Creek, Nev.

The stratigraphic evidence presented above indicates that the name "Dunderberg shale" should no longer be used for a thin unit of interbedded limestones and shales occurring in western Utah and containing *Elvinia* zone trilobites. This unit is better named the Corset Spring shale. Bentley has pointed out correctly that the Corset Spring shale, which occurs in the Snake Range just west of the Nevada-Utah line, is equivalent to his "Dunderberg shale" (Bentley, 1958, p. 21).