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Geologic Map and Sections of Bishop Cap-Organ Mountains Area, New Mexico

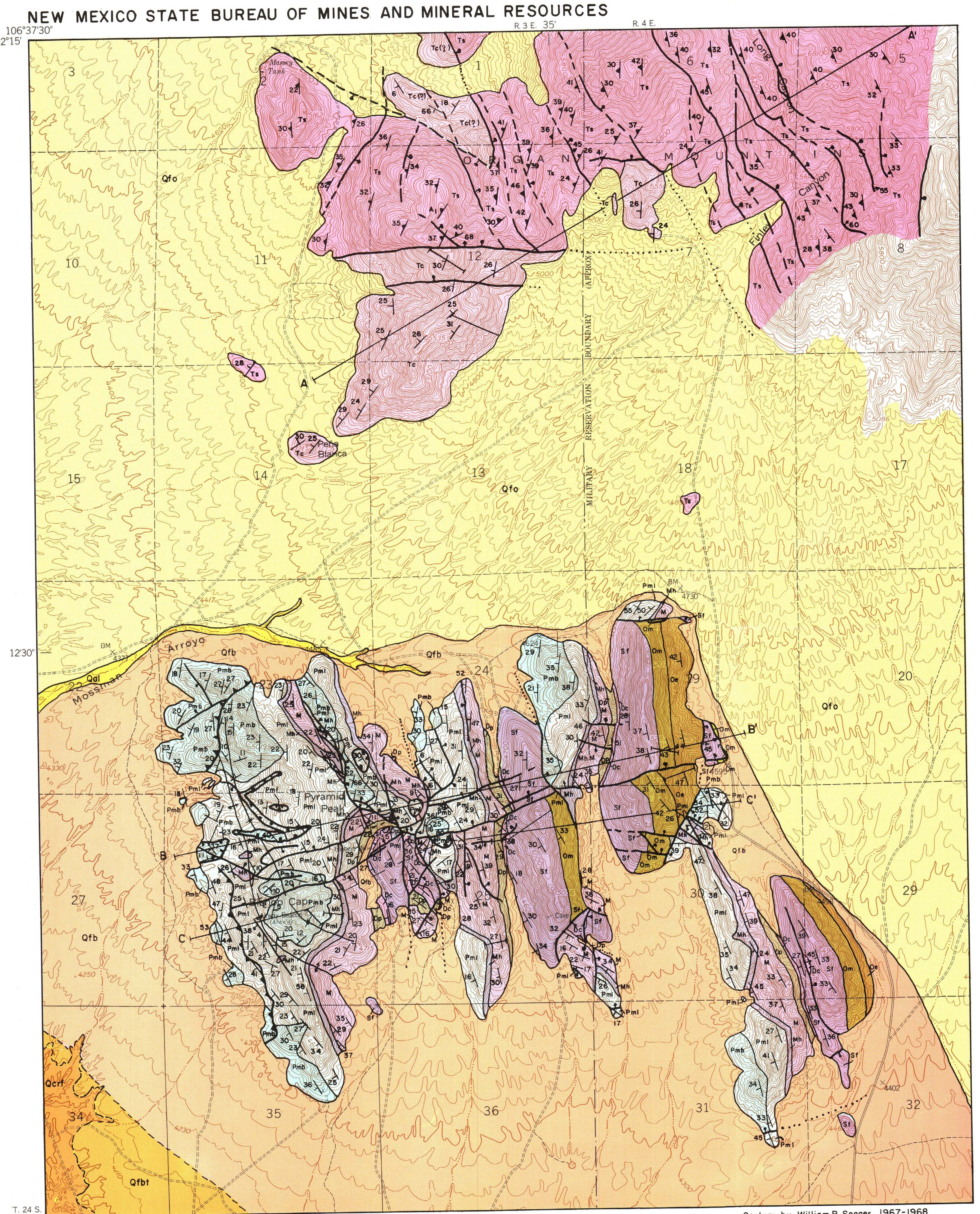
by W. R. Seager

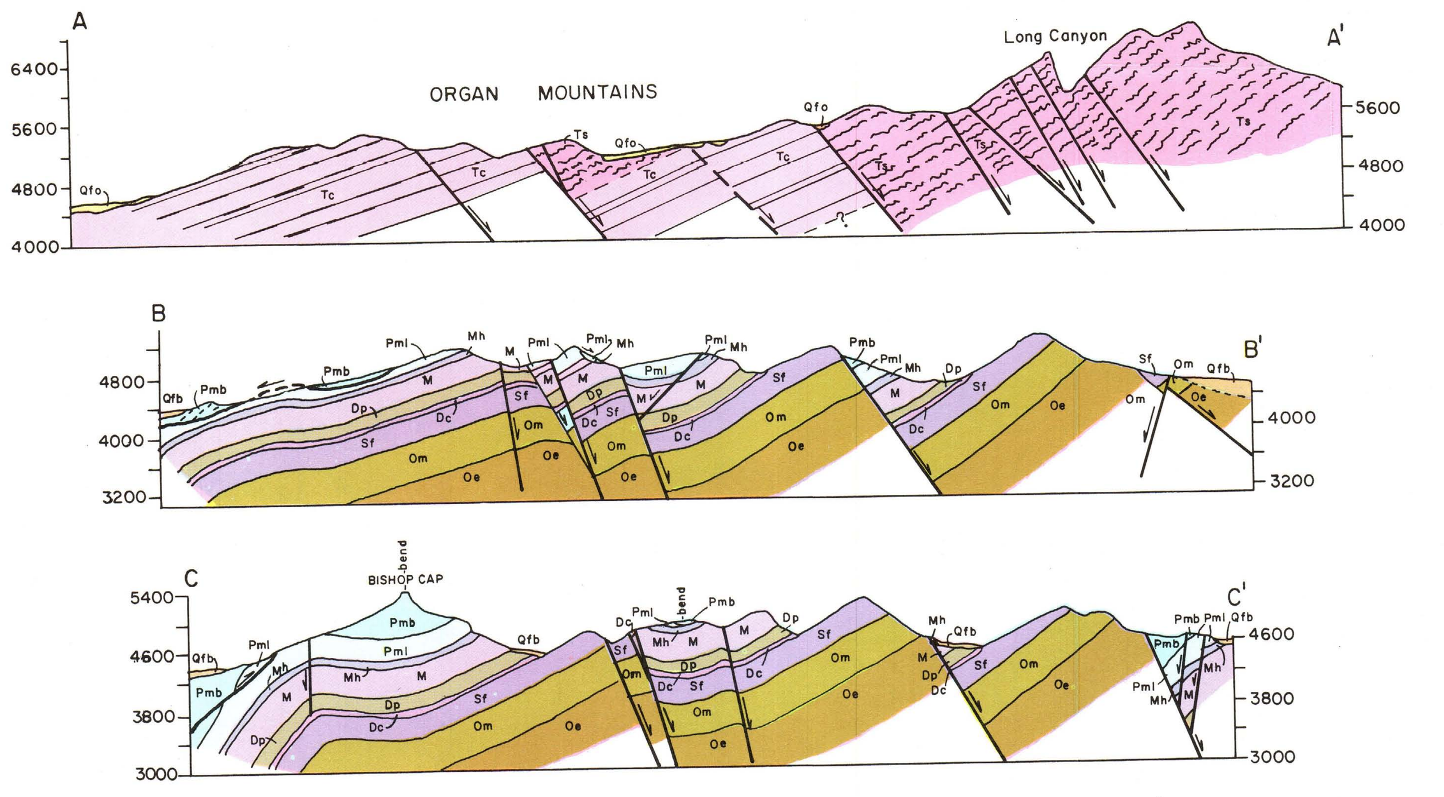
GEOLOGIC MAP 29 New Mexico Bureau of Mines & Mineral Resources 1973

A DIVISION OF

NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY

W. R. Seager BISHOP CAP-ORGAN MTS. AREA New Mexico Bureau Mines Geologic Map 29





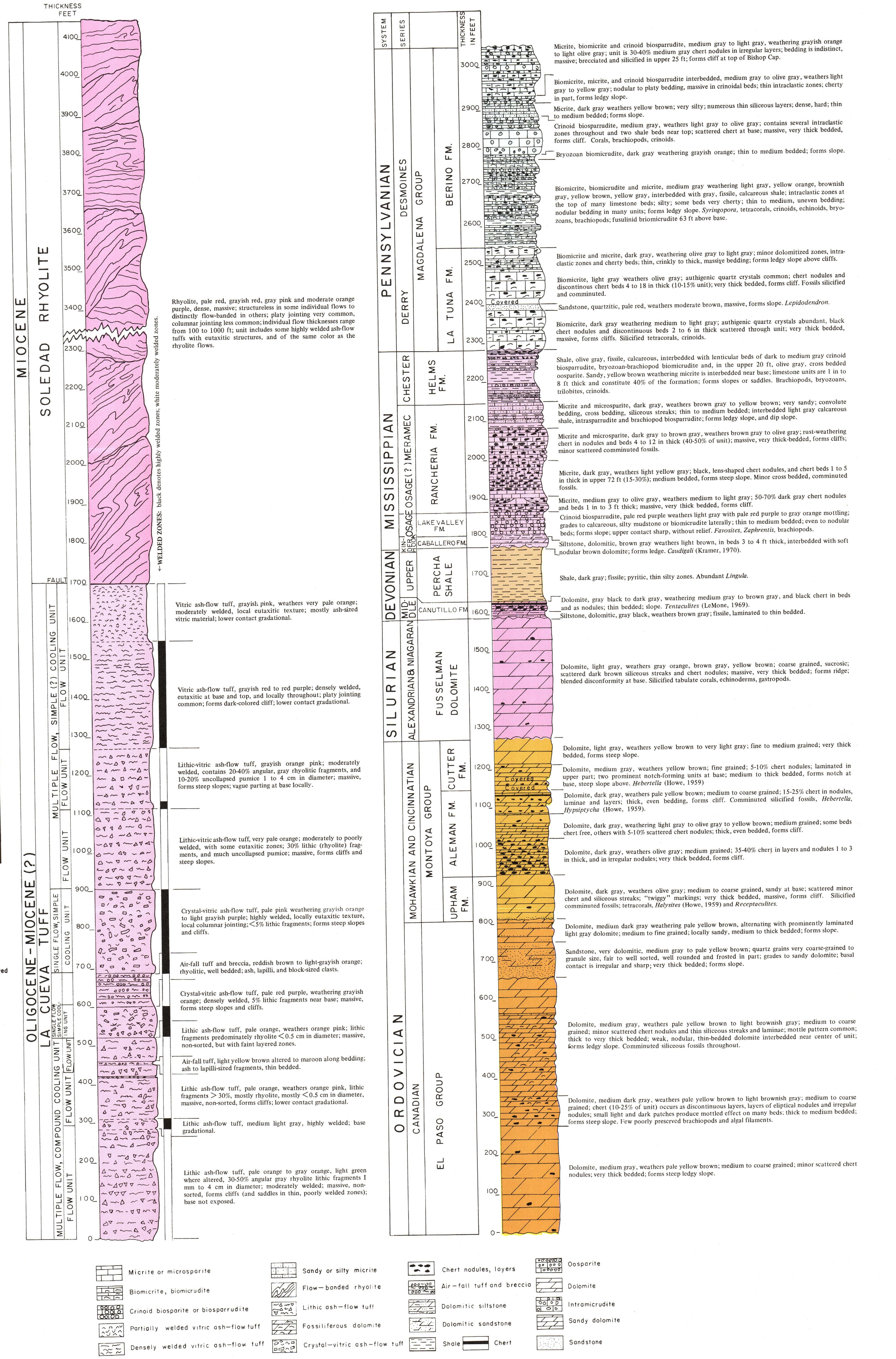
EXPLANATION

- Qal — Holocene arroyo alluvium
- Qfo — Alluvial fan deposits, derived from Organ Mts.
- Qfb / Qfbt — Alluvial fan (Qfb) and toe slope deposits (Qfbt), derived from Bishop Cap
- Qcrf — Camp Rice Formation
- Ts — Soledad Rhyolite
- Tc — La Cueva Tuff
- Pmb — Berino Formation
- Pml — La Tuna Formation
- Mh — Helms Formation
- M — Rancheria, Lake Valley, and Caballero Formations
- Dp — Percha Shale
- Dc — Canutillo Formation
- Sf — Fusselman Dolomite
- Om — Montoya Group
- Oe — El Paso Group

Stratigraphic contact
Normal fault, dumbell on downthrown side; dashed where inferred, dotted where concealed
Thrust fault, barbs on upper plate; younger rocks on older
Gravity glide fault, blocks on upper plate; younger rocks on older
Anticlinal axis
Synclinal axis
Strike and dip of beds
Flat beds
Strike and dip of flow banding in Soledad Rhyolite
Line of measured section

GEOLOGIC MAP OF BISHOP CAP - ORGAN MOUNTAINS AREA, DOÑA ANA COUNTY, NEW MEXICO

by William R. Seager, 1973



—text by William R. Seager and W. Vernon Kramer

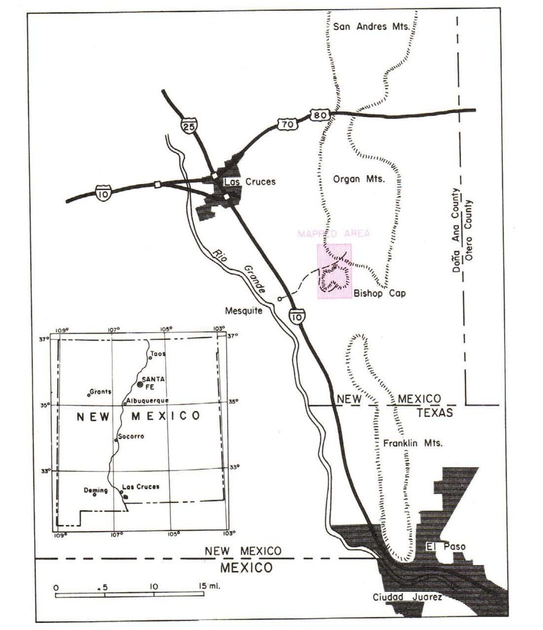


Figure 1—Location map.

INTRODUCTION

The Bishop Cap and southwestern Organ Mountain area is located about 15 air miles southeast of Las Cruces, in south-central Doña Ana County (fig. 1). The map covers all of the northwest quarter and part of the southwest quarter of the Bishop Cap 7½-minute topographic quadrangle. The eastern half of the quadrangle, which includes the southeastern Organ Mountains, is occupied by the Fort Bliss gunnery and bombing range, therefore inaccessible.

The Bishop Cap hills are situated within the broad gap between the Organ Mountains, to the north, and the Franklin Mountains to the south. The Organ Mountains consist of several closely spaced north-trending hogbacks connected in their central parts by a narrow east-trending ridge. Maximum elevation is 5,419 feet at Bishop Cap, a prominent miter-shaped peak on the western edge of the hills. Local relief ranges from a few hundred to about 1,000 feet. A narrow gap, formed on alluvial fans sloping southward from the Organs, separates the Bishop Cap hills from the Organs. Elevations in the Organs range up to about 6,800 feet in the map area; local relief exceeds 1,300 feet in many areas. Topography is very rugged; vertical walls 500 to 700 feet high are present on some mountain slopes and in Long Canyon. Vegetation consists of juniper, cacti, sotol, grasses, yucca, and, in the lower elevations of the Organs and throughout Bishop Cap hills, creosote, ocotillo, mesquite and cacti. The region is unpopulated and used mainly for recreation. Fluorite was mined occasionally in the past. Access to the area is provided by a passable jeep or pickup trail that connects with the I-10 and I-25 interchange at Mesquite, south of Las Cruces.

A number of earlier workers in the Bishop Cap area were primarily interested in the fluorspar deposits and local stratigraphy. Ladoo (1927), Johnston (1928), Sur (1946) and Rothrock *and others* (1946), reported on some of the fluorspar deposits. Dunham (1935) in his report on the Organ Mountains gave a brief account of the stratigraphy and mineralization in the Bishop Cap hills; he named the La Cueva Tuff, Soledad Rhyolite, and other formations. Kottlowski (1953) referred to the stratigraphy of the area and, in 1957, described dolomitic formations in the Bishop Cap hills. His reconnaissance map of the Las Cruces quadrangle (1960a) includes the present map area, as does the map of Harbour (1960). Kottlowski refers to the Bishop Cap section also in papers published in 1960b, 1960c, and 1963. Anderson (1955) noted the presence of some uranium minerals in the Bishop Cap fluorite; Williams *and others* (1964) and Williams (1966) briefly described barite and fluorite from the area. Kramer's (1970 masters thesis unpublished) includes a map of the Bishop Cap hills and a discussion of the stratigraphy and mineral deposits.

STRATIGRAPHY

Thicknesses, lithology, and fossil content of all rock units are described in the composite columnar section. The total section exposed is about 7,200 feet, more than half consisting of volcanics of middle to late Cenozoic age; the remainder consists predominantly of shelf and basin marine carbonates of Paleozoic age.

Paleozoic Rocks

About 3,075 feet of Paleozoic rocks, ranging in age from Ordovician to Pennsylvanian, are exposed in the Bishop Cap hills. Units not exposed are Precambrian rocks, the lower part of the El Paso Group, the upper part of the Magdalena Group, and the Hueco Limestone. Ordovician and Silurian rocks consist primarily of massive cliff-forming marine shelf dolomite; because of their susceptibility to brecciation these rocks are important hosts for barite-fluorite mineralization. The Montoya Group in the Bishop Cap hills has been described in some detail by Howe (1959). LeMone (1969) summarized Ordovician and Silurian strata in the south-central New Mexico area. Devonian rocks, disconformably overlying Silurian rocks, are primarily black pyrite-bearing shales locally containing a prolific *Lingula* fauna, although chert beds and minor carbonates are present at the base of the section. Kramer (1970) suggests the impermeable Devonian shales blocked the rise of ore-bearing fluids thus locally concentrating mineralization in older formations.

Mississippian rocks are included in the Helms, Rancheria, Lake Valley, and Caballero Formations. Thin, crinoidal Lake Valley strata, locally containing bioherms, appear to be separated from overlying Rancheria beds by an abrupt lithology change probably representing a disconformity (Laudon and Bowsher, 1949). The rhythmically layered, black, sparsely fossiliferous micrite and chert beds of the Rancheria may reflect starved basin conditions (Armstrong, 1965) and probably rather deep water. Shallowing conditions are evidenced by oolitic and bioclastic strata at the top of the Rancheria and in the Helms Formation. The transitional nature of the two formations is indicated by mutual intertonguing. Locally the shaly Helms Formation apparently ponded rising ore fluids because upper Rancheria beds are altered and mineralized in several places.

Pennsylvanian rocks consist primarily of a sequence of shallow water stable shelf limestone disconformably overlying the Helms. A single tongue of coarse-grained quartzitic to arkosic sandstone 8 to 20 feet thick, containing *Lepidodendron,* occurs near the center of the La Tuna Formation. Cyclical repetition of biomicrite, intrasparite and crinoidal biosparrudite is characteristic of the Berino Formation together with several shaly tongues containing petrified wood.

Cenozoic Rocks

Cenozoic rocks include 1) thick Tertiary rhyolitic volcanic section exposed in the Organ Mountains, and 2) widespread Pleistocene to Holocene alluvial deposits in the lowlands between and surrounding the Organs and Bishop Cap hills. The Orejon Andesite (Dunham, 1935), which forms the base of the volcanic sequence in the Organs, is not exposed in the map area; nor is the Organ batholith within which the spectacular spires farther north are carved. The exposed volcanics are subdivided (Dunham 1935) into the older La Cueva Tuff which overlies the Orejon, and younger Soledad Rhyolite. The nature of the contact between them was not determined inasmuch as the two formations are separated by faults at most localities. Poor exposures obscure one apparently unfaulted contact in NW ¼ sec. 7, R. 4 E., T. 24 S. The La Cueva Tuff is at least 1,650 feet thick at the southwestern corner of the range but the base and top of the formation are not exposed. This remarkable thickness compares with a complete thickness of only 200 feet reported by Dunham (1935) at the type locality, La Cueva rock, east of Las Cruces on the western side of the Organs. The bulk of the formation consists of thick homogeneous ash-flow tuff units, lithic rich, that contain laterally persistent blended discontinuities and welded zones imparting a crude stratification to the unit when viewed from a distance. The uniform character of much of the deposits together with the discontinuities and welded zones suggests that the sequence comprises multiple flows that cooled as compound cooling units. Other thick ash-flows interstratified in the sequence are interpreted as single or multiple flows with a simple cooling history. The dark red-brown, resistant La Cueva tuff unit that caps the peak in the center of sec. 16, T. 24 S., R. 3 E. appears from a distance identical to Soledad Rhyolite flows, thus distinctive from the rest of the La Cueva Tuff. Close inspection, however, reveals that the unit is a densely welded ash-flow tuff characterized by platy jointing and, locally, eutaxitic banding. Furthermore, the unit is gradational with less welded, lighter colored zones above and below. Similar ash-flow tuffs, difficult to distinguish from Soledad Rhyolite flows on the basis of color or weathering characteristics, occur locally within the Soledad.

Excellent exposures of the Soledad Rhyolite occur in the Finlay Canyon-Long Canyon area. In that area the formation is at least 2,000 feet thick, and perhaps much thicker. Individual flows may be with or without distinct flow-banding but platy jointing is characteristic of nearly all. They commonly exceed several hundred feet in thickness and form steep canyon walls or vertical cliff faces. At least four different varieties of rhyolite were distinguished on the basis of texture, structural features and color. Although contacts were not observed these varieties probably represent different flows. However, complex faulting, great thicknesses, and the lenticular nature of the units precluded piecing together a reliable succession of flows. Foliation in the flows dip 30-40° to the west in general conformity with the rest of the southern Organ Mountains. Consequently, none of the rhyolite appears to be intrusive, and the source of the thick succession of lavas remains unknown.

No absolute age dates of the La Cueva Tuff have been made but a single K-Ar date (feldspar) from the Soledad reveals an age of 24.9±1.0 m.y. (F. E. Kottlowski, letter, 1970). If the date is accurate the Soledad may be the youngest rhyolite flow in Doña Ana County, considerably younger than the Bell Top Formation (35 m.y.). The Soledad may be approximately coeval with rhyolitic air-fall tuffs in the upper Thurman Formation (Seager and Hawley, in press), or may be equivalent, in part, to undated rhyolite flows in the Doña Ana Mountains. The date indicates the Soledad is younger than the Organ Mountain batholith (27 m.y., Kottlowski, Weber, Willard, 1969), although Dunham (1935) interpreted the Soledad as being older. Mutual contacts between the Soledad and Organ Mountain batholith are lacking throughout the range (Dunham, 1935, pl. II); the batholith is in intrusive contact with rocks only as young as Orejon Andesite. Pending more conclusive evidence, the Soledad is probably younger than the batholith.

Pleistocene and Holocene deposits include weakly indurated to unconsolidated deposits surrounding the mountain uplifts. The Camp Rice Formation (early to middle Pleistocene) comprises about 300 feet of weakly indurated fluvial sand and gravel deposited by an ancestral Rio Grande. In the Las Cruces area it has been described in detail by Hawley *and others* (1969, 1970), and in the El Paso area by Strain (1966, 1969a, 1969b). Middle Pleistocene to Holocene deposits of undetermined thicknesses are primarily a complex of fans, stream, and basin-floor deposits that probably include Camp Rice fanglomerates, Jornada II, Isaacks Ranch, Organ and historical alluvium (L. H. Gile, personal communication, January 1972; Gile, Hawley and Grossman, 1971). These deposits are derived entirely from the Organ Mountains and Bishop Cap hills and have been subdivided on the geologic map according to their source.

STRUCTURE

The major structural features of the Bishop Cap hills are five westward tilted fault blocks formed by north-northwest-trending high-angle normal faults (section B-B′ and C-C′ and fig. 2). Faulting was responsible for the fivefold repetition of sequences in the Paleozoic section in east-west dimension. Stratigraphic separation ranges from about 400 to 1600 feet. The arcuate east to northwest-trending Blue Star fault (fig. 2) transects each of the fault blocks near the center of the hills but apparently is offset by, and thus older than, the north-trending faults. Barite-fluorite mineralization is localized along this fault, especially where it transects the Fusselman and intersects certain north-trending fractures. Large-scale folded strata are limited to a monoclinal-like flexure and an adjoining shallow syncline preserved in the westernmost fault block beneath, and west of, Bishop Cap (section C-C′). The monoclinal fold dips westward beneath alluvial fan gravels, as do volcanic strata on the western side of the Organ range. Whether these uplifts are terminated by faulting along their western margin, or by overlap of fans onto homoclinally dipping strata, is not known.

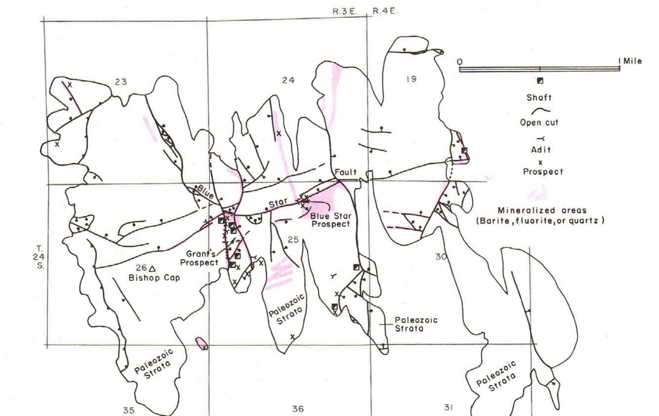


Figure 2—Mineralized areas and fault pattern, Bishop Cap hills area.

Half a mile north of Bishop Cap, are remnants (about 160 acres) of a gravity-slide block involving a plate of La Tuna and Berino formations (fig. 3 and section B-B′). The probable source of the slide plate is the structurally high crest of the fault block half a mile east of the slide remnants. Other smaller toreva-type rock slides are scattered throughout the hills.

East-west-trending down-to-the-north faults of large displacement apparently separate the southwestern Organ Mountains from the Bishop Cap hills. One such fault is exposed at the northeastern corner of the Bishop Cap hills and others are inferred in the alluvium-covered gap between the uplifts. On the other hand, the Bishop Cap hills appear to be separated from the south-central and southeastern Organ Mountains by numerous northwest-trending down-to-the-east normal faults. These are well-exposed in the Organs where they result in repetition of La Cueva and Soledad rock units (section A-A′). Southeastward these faults project into the broad, alluvium-filled valley east of the Bishop Cap hills and may account for repetition of Paleozoic rock units between the eastern Bishop Cap hills and southeastern Organ Mountains.

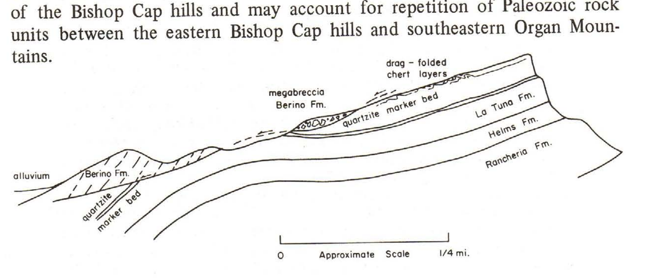


Figure 3—Diagrammatic cross section illustrating gravity-slide block north of Bishop Cap.

ECONOMIC GEOLOGY

Fluorite deposits in the Bishop Cap hills were discovered and prospected in the early to mid 1900's; approximately 120 tons of fluorite were produced. Mineralization is predominantly fluorite but barite is also associated with most deposits. The hydrothermal deposits occur exclusively in Paleozoic limestone and dolomite.

Two types of mineral deposition occur: 1) open-space filling with minor replacement in or near faults or other fractures, 2) replacement along favorable bedding zones. Deposition in fractures is the more important type; the more widespread but lower grade deposition, controlled by bedding, is of minor significance. All fluorite produced has been mined from fault zones. The most prominent mineralization parallels the Blue Star fault and its minor adjacent faults (fig. 2). Almost all fault zones in or near the Blue Star fault are mineralized at outcrops. Recurrent movements have taken place along many faults as evidenced by exposures of post-mineralization slickensides. The largest known fluorite deposits occur where the Blue Star or subsidiary faults transect the Fusselman Dolomite.

The major north-northwest-trending faults that produced the hills have only minor associated mineralization. An important exception is the two north-northwest-trending faults bordering the area of Grants prospect. Both are mineralized along their course, and especially at their intersection with the Blue Star fault.

Mineralization

Mineralized areas are readily identified by silicification. Rugose quartz zones are common near faults, especially faulted areas in the Fusselman Dolomite; but varieties of cryptocrystalline quartz, such as jasper and chalcedony with some opal, make up much of the vein material. The silicified zones in limestone and dolomite crop out as prominent ridges or areas of boulder debris. Most silicified outcrops that were prospected by pits show that the silicification extended only to shallow depths, usually pinching out within 20 feet of the surface.

Fluorite commonly crops out in fracture and fault zones as massive, crystalline pods. Minor fluorite deposits within fault zones often widen in areas where shale, apparently acting as a dam to rising fluids, overlies the limestones and dolomites. These shale units include the Percha, Helms, and several shale beds within the Berino Formation. Although fluorite locally occurs alone, barite is almost always accompanied by fluorite. Barite fills voids and cements breccia but rarely replaces the host rock. The same formations are hosts for both barite and fluorite.

Calcite, ferruginous calcite (including siderite) and manganiferous calcite are common in mineralized areas. Pyrite occurs in many of the fluorite veins.

(text continued on reverse)