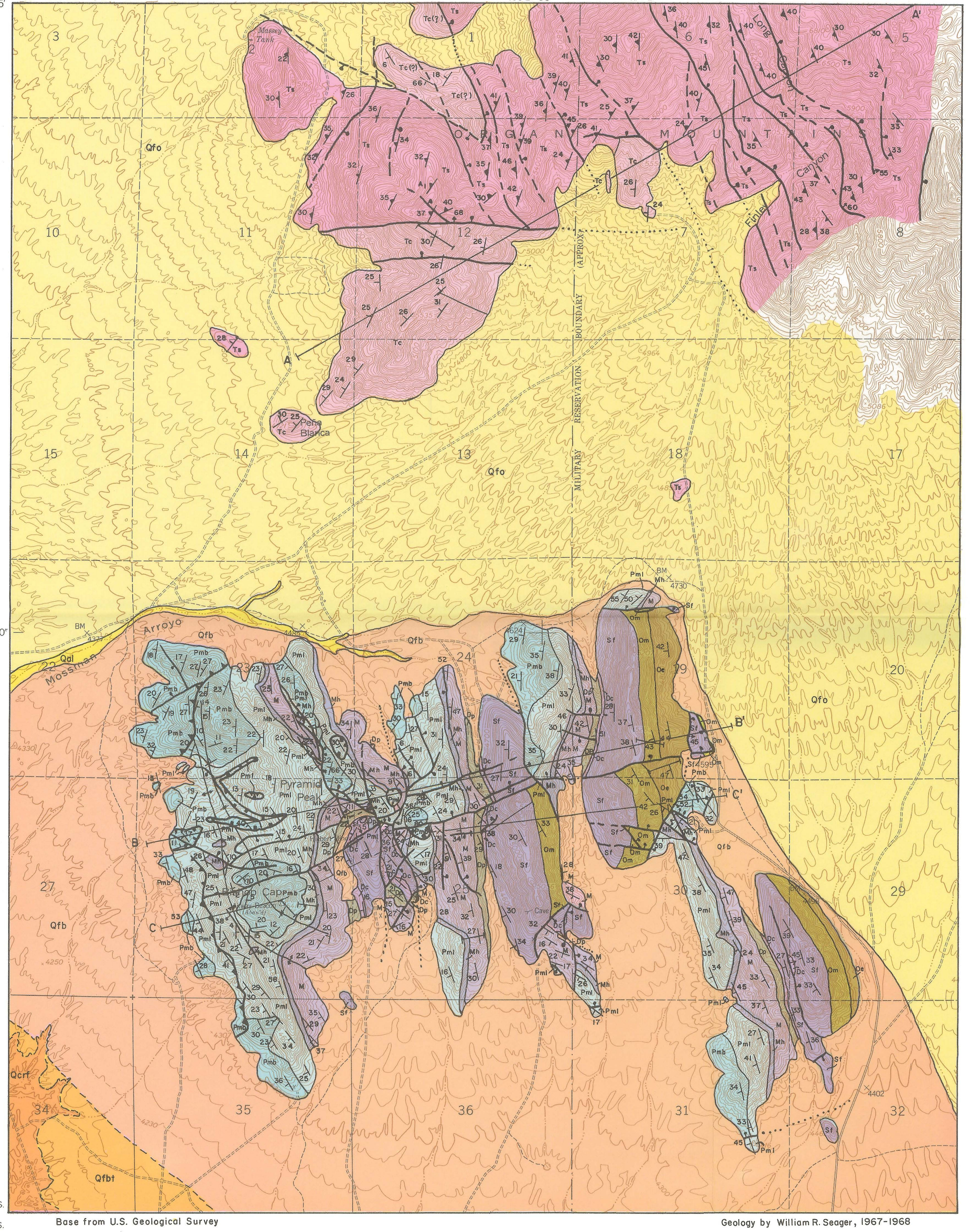
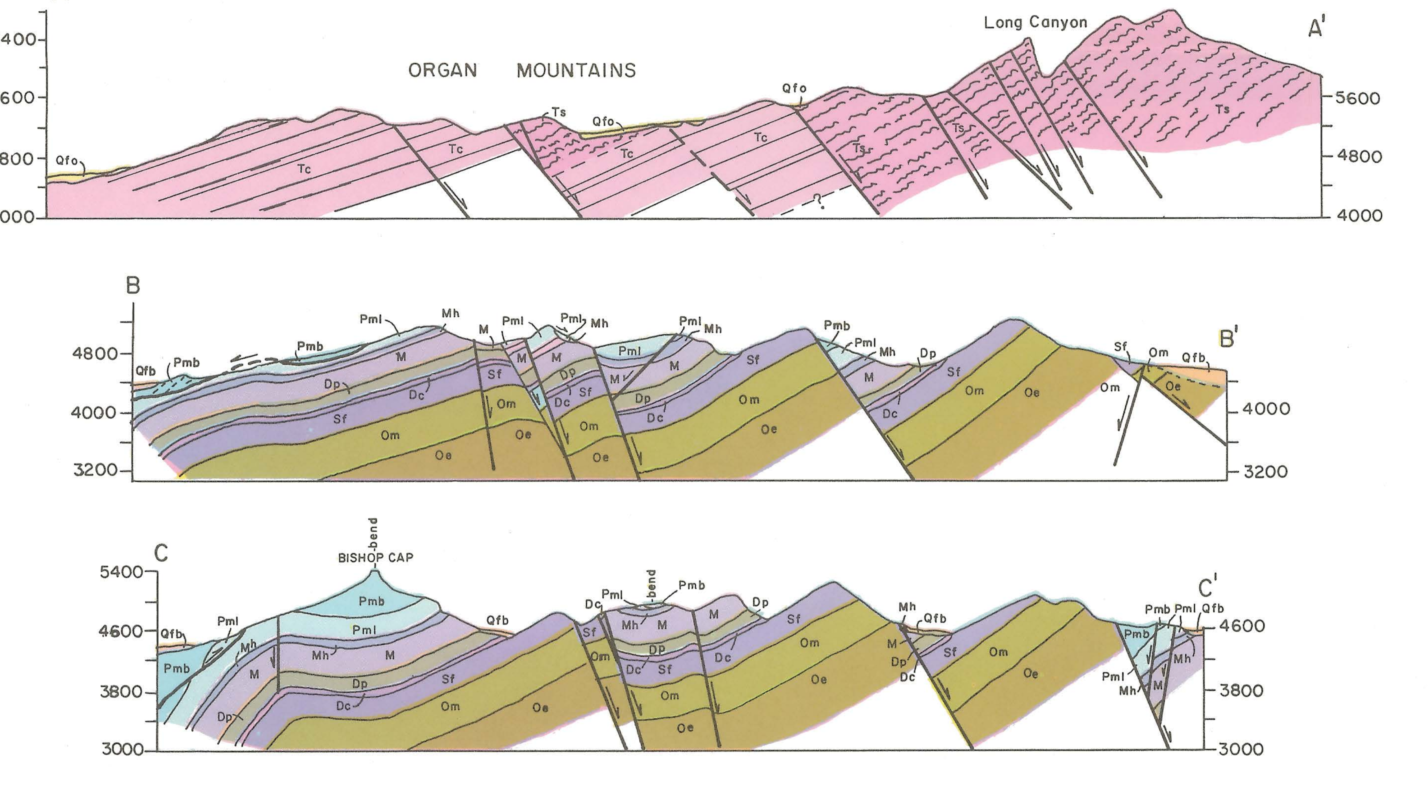




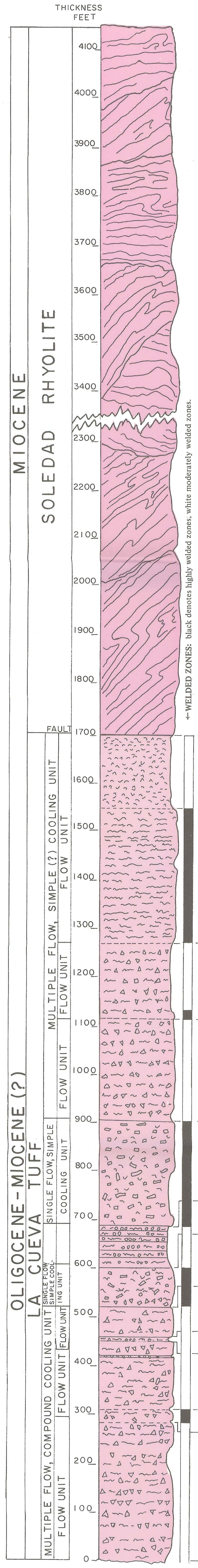
EXPLANATION

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, dumbbell 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



Rhyolite, pale red, grayish red, gray pink and moderate orange purple, dense, massive; structureless in some individual flows to distinctly flow-banded in others; platy jointing very common, columnar jointing less common; individual flow thicknesses range from 100 to 1000 ft; unit includes some highly welded ash-flow tuffs with eutaxitic structures, and of the same color as the rhyolite flows.

Vitric ash-flow tuff, grayish pink, weathers very pale orange; moderately welded, local eutaxitic texture; mostly ash-sized vitric material; lower contact gradational.

Vitric ash-flow tuff, grayish red to red purple; densely welded, eutaxitic at base and top, and locally throughout; platy jointing common; forms dark-colored cliff; lower contact gradational.

Lithic-vitric ash-flow tuff, grayish orange pink; moderately welded, contains 20-40% angular, gray rhyolitic fragments, and 10-20% uncollapsed pumice 1 to 4 cm in diameter; massive, forms steep slopes; vague parting at base locally.

Lithic-vitric ash-flow tuff, very pale orange; moderately to poorly welded, with some eutaxitic zones; 30% lithic (rhyolite) fragments, and much uncollapsed pumice; massive, forms cliffs and steep slopes.

Crystal-vitric ash-flow tuff, pale pink weathering grayish orange to light grayish purple; highly welded, locally eutaxitic texture, local columnar jointing; <5% lithic fragments; forms steep slopes and cliffs.

Air-fall tuff and breccia, reddish brown to light-grayish orange; rhyolitic, well bedded; ash, lapilli, and block-sized clasts.

Crystal-vitric ash-flow tuff, pale red purple, weathering grayish orange; densely welded, 5% lithic fragments near base; massive, forms steep slopes and cliffs.

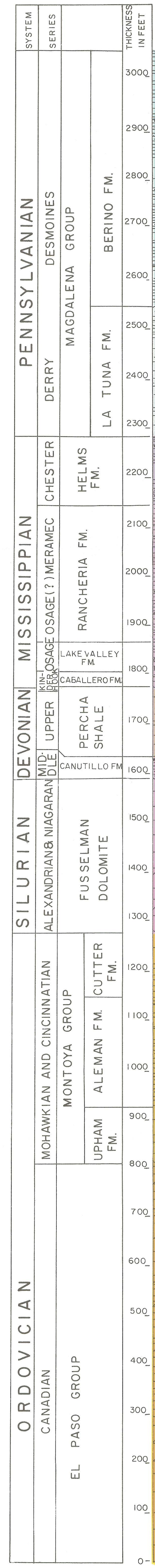
Lithic ash-flow tuff, pale orange, weathers orange pink; lithic fragments predominately rhyolite <0.5 cm in diameter; massive, non-sorted, but with faint layered zones.

Air-fall tuff, light yellow brown altered to maroon along bedding; ash to lapilli-sized fragments, thin bedded.

Lithic ash-flow tuff, pale orange, weathers orange pink, lithic fragments >30%, mostly rhyolite, mostly <0.5 cm in diameter, massive, non-sorted, forms cliffs; lower contact gradational.

Lithic ash-flow tuff, medium light gray, highly welded; base gradational.

Lithic ash-flow tuff, pale orange to gray orange, light green where altered, 30-50% angular gray rhyolite lithic fragments 1 mm to 4 cm in diameter; moderately welded; massive, non-sorted, forms cliffs (and saddles in thin, poorly welded zones); base not exposed.



Micrite, biomicrite and crinoid biosparrudite, medium gray to light gray, weathering grayish orange to light olive gray; unit is 30-40% medium gray chert nodules in irregular layers; bedding is indistinct, massive; brecciated and silicified in upper 25 ft; forms cliff at top of Bishop Cap.

Biomicrite, micrite, and crinoid biosparrudite interbedded, medium gray to olive gray, weathers light gray to yellow gray; nodular to platy bedding, massive in crinoidal beds; thin intraclastic zones; cherty in part, forms ledgy slope.

Micrite, dark gray weathers yellow brown; very silty; numerous thin siliceous layers; dense, hard; thin to medium bedded; forms slope.

Crinoid biosparrudite, medium gray, weathers light gray to olive gray; contains several intraclastic zones throughout and two shale beds near top; scattered chert at base; massive, very thick bedded, forms cliff. Corals, brachiopods, crinoids.

Bryozoan biomicrudite, dark gray weathering grayish orange; thin to medium bedded; forms slope.

Biomicrite, biomicrudite and micrite, medium gray weathering light gray, yellow orange, brownish gray, yellow brown, yellow gray, interbedded with gray, fissile, calcareous shale; intraclastic zones at the top of many limestone beds; silty; some beds very cherty; thin to medium, uneven bedding; nodular bedding in many units; forms ledgy slope. *Syringopora,* tetracorals, crinoids, echinoids, bryozoans, brachiopods; fusulinid briomicrudite 63 ft above base.

Biomicrite and micrite, dark gray, weathering olive gray to light gray; minor dolomitized zones, intraclastic zones and cherty beds; thin, crinkly to thick, massive bedding; forms ledgy slope above cliffs.

Biomicrite, light gray weathers olive gray; authigenic quartz crystals common; chert nodules and discontinous chert beds 4 to 18 in thick (10-15% unit); very thick bedded, forms cliff. Fossils silicified and comminuted.

Sandstone, quartzitic, pale red, weathers moderate brown, massive, forms slope. *Lepidodendron.*

Biomicrite, dark gray weathering medium to light gray; authigenic quartz crystals abundant, black chert nodules and discontinuous beds 2 to 6 in thick scattered through unit; very thick bedded, massive, forms cliffs. Silicified tetracorals, crinoids.

Shale, olive gray, fissile, calcareous, interbedded with lenticular beds of dark to medium gray crinoid biosparrudite, bryozoan-brachiopod biomicrudite and, in the upper 20 ft, olive gray, cross bedded oosparite. Sandy, yellow brown weathering micrite is interbedded near base; limestone units are 1 in to 8 ft thick and constitute 40% of the formation; forms slopes or saddles. Brachiopods, bryozoans, trilobites, crinoids.

Micrite and microsparite, dark gray, weathers brown gray to yellow brown; very sandy; convolute bedding, cross bedding, siliceous streaks; thin to medium bedded; interbedded light gray calcareous shale, intrasparrudite and brachiopod biosparrudite; forms ledgy slope, and dip slope.

Micrite and microsparite, dark gray to brown gray, weathers brown gray to olive gray; rust-weathering chert in nodules and beds 4 to 12 in thick (40-50% of unit); massive, very thick-bedded, forms cliffs; minor scattered comminuted fossils.

Micrite, dark gray, weathers light yellow gray; black, lens-shaped chert nodules, and chert beds 1 to 5 in thick in upper 72 ft (15-30%); medium bedded, forms steep slope. Minor cross bedded, comminuted fossils.

Micrite, medium gray to olive gray, weathers medium to light gray; 50-70% dark gray chert nodules and beds 1 in to 3 ft thick; massive, very thick bedded, forms cliff.

Crinoid biosparrudite, pale red purple weathers light gray with pale red purple to gray orange mottling; grades to calcareous, silty mudstone or biomicrudite laterally; thin to medium bedded; even to nodular beds; forms slope; upper contact sharp, without relief. *Favosites, Zaphrentis,* brachiopods.

Siltstone, dolomitic, brown gray weathers light brown, in beds 3 to 4 ft thick, interbedded with soft nodular brown dolomite; forms ledge. *Caudigali* (Kramer, 1970).

Shale, dark gray; fissile; pyritic, thin silty zones. Abundant *Lingula.*

Dolomite, gray black to dark gray, weathering medium gray to brown gray, and black chert in beds and as nodules; thin bedded; slope. *Tentaculites* (LeMone, 1969).

Siltstone, dolomitic, gray black, weathers brown gray; fissile, laminated to thin bedded.

Dolomite, light gray, weathers gray orange, brown gray, yellow brown; coarse grained, sucrosic; scattered dark brown siliceous streaks and chert nodules; massive, very thick bedded; forms ridge; blended disconformity at base. Silicified tabulate corals, echinoderms, gastropods.

Dolomite, light gray, weathers yellow brown to very light gray; fine to medium grained; very thick bedded, forms steep slope.

Dolomite, medium gray, weathers yellow brown; fine grained; 5-10% chert nodules; laminated in upper part; two prominent notch-forming units at base; medium to thick bedded, forms notch at base, steep slope above. *Hebertella* (Howe, 1959)

Dolomite, dark gray, weathers pale yellow brown; medium to coarse grained; 15-25% chert in nodules, laminae and layers; thick, even bedding, forms cliff. Comminuted silicified fossils, *Hebertella, Hypsiptycha* (Howe, 1959).

Dolomite, dark gray, weathering light gray to olive gray to yellow brown; medium grained; some beds chert free, others with 5-10% scattered chert nodules; thick, even bedded, forms cliff.

Dolomite, dark gray, weathers olive gray; medium grained; 35-40% chert in layers and nodules 1 to 3 in thick, and in irregular nodules; very thick bedded, forms cliff.

Dolomite, dark gray, weathers olive gray; medium to coarse grained, sandy at base; scattered minor chert and siliceous streaks; "twiggy" markings; very thick bedded, massive, forms cliff. Silicified comminuted fossils; tetracorals, *Halysites* (Howe, 1959) and *Receptaculites.*

Dolomite, medium dark gray weathering pale yellow brown, alternating with prominently laminated light gray dolomite; medium to fine grained; locally sandy, medium to thick bedded; forms slope.

Sandstone, very dolomitic, medium gray to pale yellow brown; quartz grains very coarse-grained to granule size, fair to well sorted, well rounded and frosted in part; grades to sandy dolomite; basal contact is irregular and sharp; very thick bedded; forms slope.

Dolomite, medium gray, weathers pale yellow brown to light brownish gray; medium to coarse grained; minor scattered chert nodules and thin siliceous streaks and laminae; mottle pattern common; thick to very thick bedded; weak, nodular, thin-bedded dolomite interbedded near center of unit; forms ledgy slope. Comminuted siliceous fossils throughout.

Dolomite, medium dark gray, weathers pale yellow brown to light brownish gray; medium to coarse grained; chert (10-25% of unit) occurs as discontinuous layers, layers of eliptical nodules and irregular nodules; small light and dark patches produce mottled effect on many beds; thick to medium bedded; forms steep slope. Few poorly preserved brachiopods and algal filaments.

Dolomite, medium gray, weathers pale yellow brown; medium to coarse grained; minor scattered chert nodules; very thick bedded; forms steep ledgy slope.

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

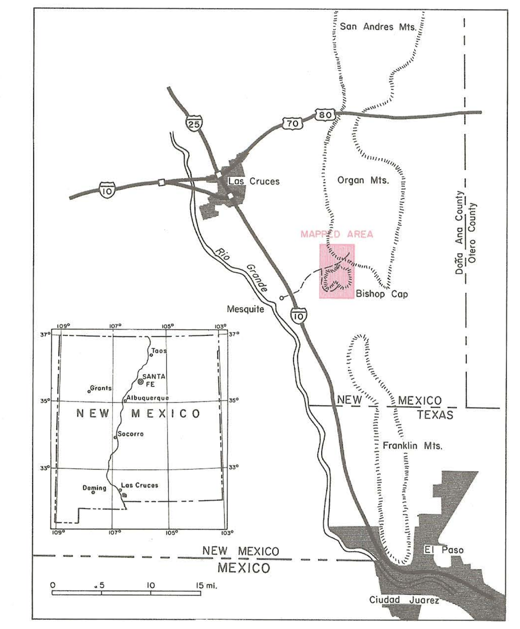


Figure 1–Location map.

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.

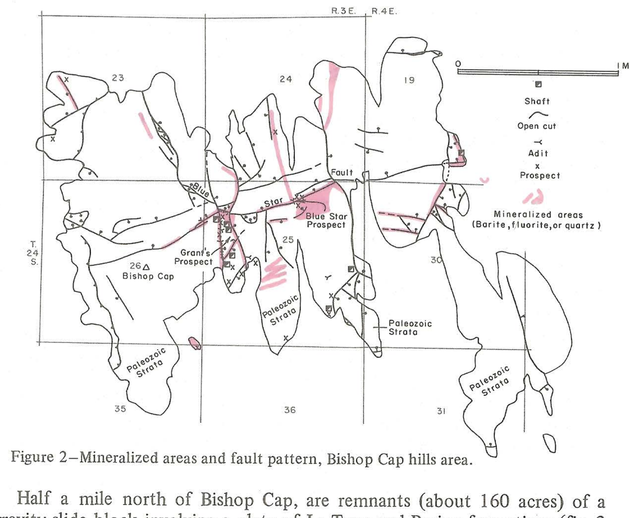


Figure 2–Mineralized areas and fault pattern, Bishop Cap hills area.

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.

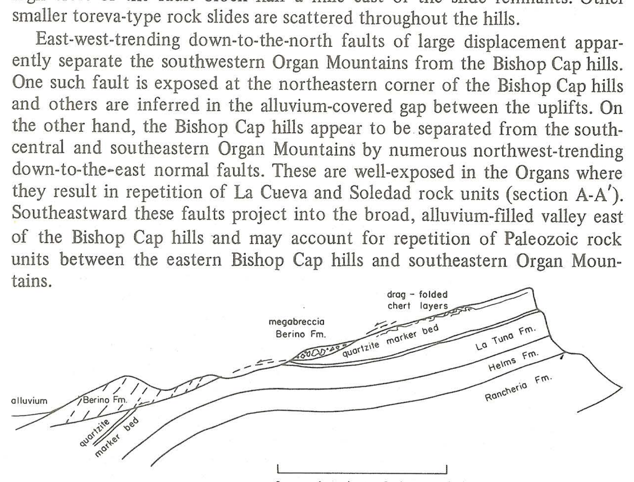


Figure 3–Diagrammatic cross section illustrating gravity-slide block north of Bishop Cap.

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)

Chalcopyrite and galena are rare and occur only in fault zone breccias. Several mineralized zones are moderately radioactive, especially veins in the Rancheria and Fusselman formations. The radioactive minerals were not identified.

The order of mineral deposition is well illustrated in several zoned veins. Studies of veins and thin sections of vein material indicate the paragenesis shown in fig. 4.

Figure 4 Paragenesis of minerals in the Bishop Cap hills.

Grant's Prospect

Grant's prospect is located in the NW ¼ section 25, T. 24 S., R. 3 E. (fig. 2). Barite-fluorite-quartz mineralization has been explored by several tunnels, shallow pits and numerous pits within fault zones. The prospect includes several separated deposits located within a fault block bounded on the east and west by north-northwest-trending faults and on the north by the Blue Star fault. Mineralization occurs along all three faults and in several lesser fractures within the Fusselman Dolomite in the center of the block. At the north end of the block fluorite occurs in the La Tuna Formation where the Blue Star fault brings the La Tuna against the Percha Shale. Intense fracturing, silicification, and relatively large amounts of fluorite in this area apparently result from the convergence of the three major faults, and the presence of favorable host rocks. The fault which bounds this block on the west is the longest continuously mineralized vein in the Bishop Cap hills. Rothrock (1946) reported that fluorite occurs in this fault for more than 1,200 feet, with an average vein thickness of three to four feet. Fluorite and quartz occur along the footwall in the Fusselman; ferruginous and manganiferous calcite occur near the center of the vein; and quartz, barite and fluorite occur in the Canutillo Formation comprising the hanging wall. The vein pinches and swells along strike and downdip. Open-space filling was the predominant type of deposition.

Most of the fluorite produced in the Bishop Cap hills has come from this prospect. A study by the United States Bureau of Mines (Sur, 1946) concluded that the fluorite deposits on Grant's prospect were too low in grade and too small in size to be economic. However, these veins have not been cored. Possibly economic deposits of fluorite are present, especially within the intensely faulted zones of the prospect. The claims are owned by J. F. Grant of Las Cruces (1969).

Blue Star Prospect

The Blue Star prospect (NW ¼, NE ¼, sec. 24, T. 24 S., R. 3 E; fig. 2) has been partially explored by two short tunnels and several shallow pits. About 12 tons of fluorite have been mined from this prospect (Williams, 1966). Core drilling was done by the Rangaire Corporation during the winter of 1969-70.

The prospect is on the Blue Star fault. Most of the mineral deposition is open-space filling in the fault zone, but wallrock replacement is common. Large pods of fluorite and barite-fluorite crop out in the largest vein but the mineralization probably is shallow as suggested by core data. Core recovered from one vein shows barite, fluorite, calcite, some pyrite and a few tiny cubes of galena at about 45 feet from the surface; at 50 feet, calcite predominates. The drill cores show that the vein is 15 feet thick near the surface but thins to less than four feet at a depth of 45 feet. The vein is less than 100 feet in length and dips about 55° N. The purple fluorite here is moderately radioactive.

Numerous mineralized minor faults branch about 30° southwest from the Blue Star fault. A second zone of mineralized minor faults, about 400 feet south of the prospect, generally parallels the Blue Star fault. Almost all the mineralized minor fault zones crop out on the dip slope of the Fusselman Dolomite (fig. 2). None appear to constitute a workable deposit.

In summary, apparently small amounts of fluorite and barite mineralization are widespread in fault zones within the Fusselman, and beneath shale units in the Bishop Cap hills. Silicification is the most important alteration that accompanied mineralization. About 120 tons of fluorite have been shipped from the area, mostly in 1944. Limited testing along some of the most favorable areas has failed to locate economic deposits, but commercial deposits of fluorite and barite may be present in the Bishop Cap hills.

REFERENCES

Anderson, E. C., 1955, *Occurrences of uranium ores in New Mexico:* New Mexico State Bur. Mines Min. Res. Circ. 29, p. 19.

Armstrong, A. K., 1965, *The stratigraphy and facies of the Mississippian strata of southwestern New Mexico,* in New Mexico Geol. Soc. Guidebook Sixteenth Ann. Field Conf., Southwestern New Mexico II: p. 132-140.

Dunham, K. C., 1935, *The geology of the Organ Mountains, Doña Ana County, New Mexico:* New Mexico State Bur. Mines Min. Res. Bull. 11, 272 p.

Gile, L. H., Hawley, J. W., Grossman, R. B., 1971, *The identification, occurrence and genesis of soils in an arid region of southern New Mexico,* in Soil Conservation Service Soil Survey Inv., Unpub. Training Bull., Desert Soil-Geomorphology Project: 177 p.

Harbour, R. L., 1960, *Las Cruces to Vinton Canyon and Anthony Gap, Pennsylvanian localities in the northern Franklin Mountains and the southern San Andres Mountains with emphasis on Pennsylvanian Stratigraphy,* in Roswell Geol. Soc. Guidebook, Road log for the first day: p. 12.

Hawley, J. W., ed., 1970, *Cenozoic stratigraphy of the Rio Grande Valley, Doña Ana County, New Mexico,* in El Paso Geol. Soc. Guidebook, Fourth Ann. Field Conf.: 49 p.

Hawley, J. W., Kottlowski, F. E., Strain, W. S., Seager, W. R., King, W. E., and LeMone, D. V., 1969, *The Santa Fe Group in the south-central New Mexico border region:* New Mexico State Bur. Mines Min. Res. Circ. 104, Border Stratigraphy Symposium p. 52-76.

Howe, H. V., 1959, *Montoya Group stratigraphy (Ordovician) of Trans-Pecos, Texas:* Amer. Assoc. Petrol. Geol. Bull., v. 43, p. 2284-2332.

Johnston, W. D., Jr., 1928, *Fluorspar in New Mexico:* New Mexico State Bur. Mines Min. Res. Bull. 4, 272 p.

Kottlowski, F. E., 1953, *Road log from El Paso to Las Cruces,* in New Mexico Geol. Soc. Guidebook, 4th Field Conf.: p. 18-28.

1957 *High-purity dolomite deposits of south-central New Mexico:* New Mexico State Bur. Mines Min. Res. Circ. 47, p. 25-28.

———, 1960a, *Reconnaissance geologic map of Las Cruces thirty minute quadrangle:* New Mexico State Bur. Mines Min. Res. Geol. Map 14.

———, 1960b, *Depositional features of the Pennsylvanian of south-central New Mexico,* in Roswell Geol. Soc. Guidebook, Northern Franklin Mountains and Southern San Andres Mountains with emphasis on Pennsylvanian stratigraphy: p. 12-16.

———, 1960c, *Summary of Pennsylvanian sections of southwestern New Mexico and southeastern Arizona:* New Mexico State Bur. Mines Min. Res. Bull. 66, p. 72-74.

———, 1963, *Paleozoic and Mesozoic strata of southwestern and south-central New Mexico:* New Mexico State Bur. Mines Min. Res. Bull. 79, 100 p.

———, Weber, R. H., and Willard, M. E., 1969, *Tertiary intrusive-volcanic-mineralization episodes in the New Mexico region* (abs.): Geol. Soc. America 1969 Ann. Mtg., p. 278.

Kramer, W. V., 1970, *Geology of the Bishop Cap hills, Doña Ana County, New Mexico:* Unpub. M.S. thesis, Univ. Texas El Paso, 76 p.

Ladoo, R. B., 1927, *Fluorspar–its mining, milling, and utilization, with a chapter on cryolite:* U. S. Bur. Mines. Bull. 244, p. 121-122.

Laudon, L. R. and Bowsher, A. L., 1949, *Mississippian formations of southwestern New Mexico:* Geol. Soc. America Bull., v. 64, no. 4, p. 381-389.

LeMone, D., 1969, *Lower Paleozoic rocks of the El Paso area,* in New Mexico Geol. Soc. Guidebook Twentieth Field Conf., The Border Region: p. 68-79.

Rothrock, H. E., Johnson, C. H., Hahn, A. D., 1946, *Fluorspar resources of New Mexico:* New Mexico State Bur. Mines Min. Res. Bull. 21, p. 61-62.

Seager, W. R., Hawley, J. W., *Geology of the Rincon and northeastern Hatch quadrangles, Doña Ana County, New Mexico:* New Mexico State Bur. Mines Min. Res. Bull., in press.

Sur, F. J., 1946, *Exploration of Bishop Cap fluorspar project, Doña Ana County, New Mexico:* U. S. Bur. Mines Rept. Inv. 3946, 9 p.

Strain, W. S., 1966, *Blancan mammalian fauna and Pleistocene formations, Hudspeth County, Texas:* Texas Memorial Museum Bull. 10, 55 p.

———, 1969a, *Late Cenozoic strata of the El Paso area:* New Mexico State Bur. Mines Min. Res. Circ. 104, Border Stratigraphy Symposium, p. 122-123.

———, 1969b, *Late Cenozoic strata of the El Paso-Juarez area:* New Mexico Geol. Soc. Guidebook Twentieth Ann. Field Conf., The Border Region: p. 155-157.

Williams, F. E., 1966, *Fluorspar deposits of New Mexico:* U. S. Bur. Mines Info. Circ. 8307, p. 27-29.

Williams, F. E., Fillo, P. V., Bloom, P. A., 1964, *Barite deposits of New Mexico:* New Mexico State Bur. Mines Min. Res. Circ. 76, p. 12-13.