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Geologic map of the San Lorenzo Quadrangle, Grant & Sierra Counties, NM

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U.S. GEOLOGICAL SURVEY
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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Geologic Map of the San Lorenzo Quadrangle, Grant and Sierra Counties, New Mexico

Description of Map Units

By

D. C. Hedlund

Open-file report 75-109
1975

GEOLOGIC MAP OF THE SAN LORENZO QUADRANGLE, GRANT AND SIERRA COUNTIES, NEW MEXICO

By D. C. Hedlund

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS (HOLOCENE)

Qa Alluvium--Poorly sorted gravel, sand, and silt deposits. Gravel contains boulders, cobbles, or fragments of Tertiary volcanic rocks and minor amounts of Paleozoic and Precambrian rock. Thickness locally more than 50 ft (15 m) along Mimbres valley

Qtg Terrace gravel--Chiefly subrounded cobbles and gravel consisting of Tertiary volcanic rocks. Terraces most extensive along both sides of the Mimbres valley, along the west side of Noonday Canyon, and along parts of Hot Springs Canyon. Also includes remnants of older terrace gravel on erosional surfaces 100-120 ft (30-36 m) above present drainage along the east side of the Mimbres River. Thickness more than 10 ft (3 m)

Qf Fan deposits--Torrential fan deposits containing chiefly subangular to angular poorly sorted fragments of Tertiary volcanic rock and Paleozoic to Precambrian rock fragments. Thickness as much as 300 ft (91 m) along west side of Mimbres valley

Qt Talus deposits--Poorly sorted unconsolidated locally derived rock fragments. Thickness more than 10 ft (3 m)

Qfo FAN DEPOSITS (HOLOCENE OR PLEISTOCENE)--Torrential fan deposits containing chiefly angular poorly sorted fragments of Tertiary volcanic rock and Paleozoic to Precambrian rock fragments. Dissected older fan aprons chiefly derived from the weathering of the Gila Conglomerate. Fan debris is locally deposited on the older olivine basalt that caps the Gila Conglomerate. Maximum thickness about 150 ft (46 m)

Tg GILA CONGLOMERATE (PLIOCENE AND MIOCENE?)--Light-brown coarsely stratified poorly sorted fanglomerate composed of latite and andesite fragments in a matrix of comminuted lava and phenocryst fragments of coarse sand size. Upper part is weakly indurated and contains gravel, whereas the lower part is more strongly indurated and is predominantly fanglomerate. Olivine basalt overlies uppermost gravel and fanglomerate beds. Maximum thickness of clastic units about 800 ft (244 m)

Tgb Olivine basalt--Dark-gray sugary-textured vesicular lava flows containing locally abundant calcite amygdule fillings. Green olivine phenocrysts as much as 1 cm across are locally common. Pilotaxitic groundmass composed of andesine (An_{43-45}) microlites with interstitial grains of olivine, pinkish-pale-brown augite, and magnetite. Some andesine microlites are intergrown with augite to form an incipient subophitic texture. Large phenocrysts of olivine (Fo_{90}) have thin marginal films of iddingsite. A whole-rock K-Ar age (W. E. Elston and others, 1973) of the olivine basalt at the top of the Gila Conglomerate near Mimbres indicates an isotopic age of 6.29 ± 0.41 m.y. Maximum thickness about 700 ft (213 m)

Tbs BEAR SPRINGS BASALT OF ELSTON, 1957 (MIOCENE?)--Dark-brownish-gray to medium-gray basaltic andesite; locally reddened and rubbly base. In places flows have thin discontinuous interbeds of bouldery conglomerate and flow breccias. Calcite-lined vesicles are locally common. Groundmass is sugary textured pilotaxitic, with feldspar microlites having interstitial granules of clinopyroxene and magnetite. Phenocryst content is variable but the flows have as much as much as 17 percent phenocrysts of labradorite (An_{53-55}) and as much as 8 percent oxyhornblende. Some of the oxyhornblende phenocrysts have cores of pale-green clinopyroxene. Maximum thickness about 800 ft (244 m)

Tra RAZORBACK FORMATION OF ELSTON, 1957 (OLIGOCENE)--Dark-gray to black to purplish-gray aphanitic to porphyritic andesite to latite lava flows. Aphanitic flows display a slabby weathering habit. As much as 15 percent phenocrysts of andesine and minor amounts of highly oxidized hornblende

and pale-green clinopyroxene. Xenocrysts(?) of highly resorbed quartz and accessory bronze-colored biotite are characteristic of the latite flows that overlie andesite. Thickness about 1,000 ft (305 m) along the west side of the Mimbres valley near the village of San Juan at Sherman

Trac Sandstone and pebble conglomerate--Pale-red to light-brown, thin-bedded, coarse-grained to conglomeratic, crossbedding common. Contains fragments of nonwelded tuff as much as 4 cm across. Underlies andesite (Tra) of the Razorback Formation in secs. 6, 31, and 36 along the west side of the Mimbres valley and may be correlative with the Piloncillo Sediments of Elston (1957). Maximum thickness about 150 ft (46 m)

Tran Air-fall tuff--Very light gray; light-greenish-gray argillic alteration of the weakly compacted but alined pumice lapilli. Lithic fragments of latite locally abundant. Very minor amounts of sanidine and bipyramidal quartz phenocrysts. Commonly has a greenish-gray tuffaceous sandstone at the base, which is about 15 ft (5 m) thick. Maximum thickness about 50 ft (15 m)

Tras Tuffaceous sandstone--White to very light gray, thin-bedded to laminated. Commonly contains rounded clasts of ash-flow tuff as much as 3 mm across. Locally grades into air-fall tuff. Maximum thickness about 150 ft (46 m)

Trat Ash-flow tuff--Pale-red moderately welded devitrified tuff composed of a very finely devitrified groundmass containing about 10 percent phenocrysts of sanidine, oligoclase, and smoky quartz, and accessory biotite and ferric oxides. Maximum thickness about 200 ft (61 m)

Tpl POLLACK QUARTZ LATITE OF JICHA, 1954 (OLIGOCENE)--Medium-gray to pale-reddish-purple to light-brown aphanitic to porphyritic quartz latite, and latite flow breccias. Pilotaxitic groundmass contains as much as 20 percent zoned andesine (An_{35-38}) phenocrysts, 3 percent oxyhornblende,

and accessory biotite, ferric oxides, clinopyroxene, apatite, and secondary quartz. Latitic flows nearly contemporaneous with the Mimbres Peak Rhyolite (Tmp); in the southeast corner of the quadrangle latite flow breccias underlie the rhyolite but to the north in the vicinity of East Canyon the latite flows overlie the rhyolite. Maximum thickness about 2,000 ft (610 m) near Hillsboro Peak

Tmp MIMBRES PEAK RHYOLITE (OLIGOCENE)--Light-gray to pale-red rhyolite with commonly contorted flow laminae. Spherulitic to felted groundmass is composed of about 5 percent phenocrysts of sanidine and quartz; accessory minerals include biotite, apatite, ferric oxides, and secondary calcite. Rhyolite flows rest unconformably on Kneeling Nun and Sugarlump Tuffs and breccias of the Pollack Quartz Latite. Maximum thickness about 1,000 ft (305 m)

Tmpt Rhyolite tuff--Pinkish-gray nonwelded to welded discontinuous beds of air-fall tuff. Ash shards are commonly nondeformed and weakly devitrified. Generally phenocryst-poor with about 1 percent oligoclase, sanidine, bipyramidal quartz,and oxyhornblende phenocrysts. Accessory minerals are sphene, biotite, and ferric oxides. Most tuff beds are intercalated within the rhyolite flows (Tmp) except along Cold Spring Canyon where the tuff at the base of the rhyolite is about 70 ft (21 m) thick. Elsewhere the tuff beds are generally less than 50 ft (15 m) thick

Tmpv Rhyolite vitrophyre--Dark-grayish-black to brownish-gray rhyolite containing abundant black fiamme with strong eutaxitic texture. The fiamme contain abundant perlitic fractures. Highly fragmented phenocrysts of sanidine, oligoclase (An_{28-30}), and bipyramidal quartz comprise about 5 percent of the flow. Accessory minerals are clinopyroxene, biotite, oxyhornblende, and ferric oxides. Vitrophyre south of Maverick Mountain and along Hot Springs Canyon may represent a fused tuff. Maximum thickness about 50 ft (15 m)

Tr Rhyolite plug and dikes of Thompson Cone--Light-gray to light-brownish-gray porphyritic rhyolite containing about 15 percent phenocrysts of sanidine and bipyramidal quartz, and accessory biotite and ferric oxides. Dikes near the head of Donahue Canyon are as much as 150 ft (46 m) thick and have a radial distribution about the rhyolite plug of Thompson cone

Trs Rhyolite sills--Light-gray to very light gray aphanitic to porphyritic rhyolite. Contain about 5 percent phenocrysts of sanidine and bipyramidal quartz set in a felted to spherulitic groundmass. Sills commonly localized at the base of the Percha Shale near the heads of Trujillo and Tierra Blanca Canyons. Sills as much as 200 ft (61 m) thick

Tvs VOLCANICLASTIC ROCKS OF ANCHETA CANYON (OLIGOCENE)--Moderate-orange-pink tuffaceous sandstone and conglomerate. Coarse- to medium-grained sandstone is moderately to weakly indurated and contains about 50 percent ash shards, 30 percent angular clasts of sanidine and plagioclase, 4 percent angular quartz fragments, and about 10 percent reworked lava fragments; accessory minerals include sphene, biotite, and ferric oxides. Maximum thickness of tuffaceous sandstone about 140 ft (43 m) along Ancheta Canyon. Along Mud Springs Canyon the tuffaceous sandstone is underlain by a bouldery conglomerate that grades upward into a pebble conglomerate. Abundant rounded to subrounded boulders and cobbles of andesite are set in a tuffaceous sandstone matrix. Maximum thickness of conglomerate is about 10 ft (3 m) in the NE 1/4 sec. 6 along Mud Spring Canyon

Tri LEUCO-QUARTZ LATITE AND RHYOLITE PORPHYRY STOCKS AND PLUGS (OLIGOCENE)--Very light gray porphyritic leucocratic quartz latite and rhyolite intrusions that display strong flow layering. About 40 percent felted groundmass and conspicuous chatoyant sanidine phenocrysts (14-24 percent) that display carlsbad twinning. Other phenocrysts include albite-

oligoclase (An_{8-12}) (16-27 percent), rounded and embayed bipyramidal quartz (3-14 percent), and minor amounts of biotite and oxyhornblende. Accessory minerals are sphene, zircon, apatite, ferric oxides, sericite, and calcite. Many of the stocks and plugs are alined along or near extensions of the Grandview fault. Ten different intrusions have been mapped and others are too small to show on the map. At most places the rhyolitic bodies have intruded the lower part of the Kneeling Nun Tuff (Tkn)

Trir Rhyolite porphyry of Rabb Park--Very light gray leucocratic intrusion that displays strong flow layering that strikes dominantly east-northeast. Porphyritic with about 45 percent felted groundmass; also locally holocrystalline. Contains 35 to 58 percent fragmented phenocrysts of sanidine which display a satiny chatoyancy, 11-16 percent phenocrysts of sodic oligoclase (An_{10-12}), and about 1 percent quartz. The holocrystalline rhyolite contains as much as 30 percent quartz; accessory minerals are biotite, sphene, zircon and ferric oxides

Tkn KNEELING NUN TUFF (OLIGOCENE)--Pale-red, medium-light-gray, and pinkish-gray ash-flow tuff; densely welded, strongly eutaxitic with compaction foliation that has dips as much as 65 degrees. Contains as much as 40 percent fragmented phenocrysts as large as 4 mm across. Phenocryst content is as follows: oligoclase (An_{20-28}) (18 percent), sanidine (13 percent), quartz (5-6 percent), and alined biotite plates (2 percent). Accessory minerals are sphene, magnetite, oxyhornblende, clinopyroxene, calcite, apatite, and zircon. Interflow breccia zones are especially common at the head of Valentine and Rosencran Canyons. The strong compaction foliation is arched along a north-south axis just west of Maverick Mountain. This arching is possibly the expression of a buried elongate ridge of older rock or may represent the axis of eruption of the ash flow. A sample of biotite from the Kneeling Nun Tuff near Lucky Bill Canyon about 20 miles west of San Lorenzo has a K-Ar age of 33.4±1.0 m.y., as determined by F. W. McDowell (1971). Maximum thickness of

the ash-flow is about 1,500 ft (457 m) at the head of Middle Percha Creek and east of Cross-O Mountain

Tknt Air-fall tuff and tuffaceous sandstone--Light-brown thin-bedded moderately indurated tuff that contains less than 10 percent phenocrysts. Lithic fragments are locally abundant and the rounding of the latite clasts suggest sedimentary transport. Noncollapsed pumice lapilli in parts of the tuff are altered to greenish-gray clay minerals. Maximum thickness about 150 ft (46 m) at Trail Canyon

Tknb Andesite breccia--Dark-gray to black bouldery breccias of sedimentary origin intercalated with ash-flow tuff. Andesite and basaltic andesite fragments are subrounded to angular and measure as much as 1.5 m across near the head of Valentine Canyon. Inter-ash-flow breccias also contain fragments of diorite, rhyolite, and leuco-quartz latite that are typical of some of the Rabb Park and Iron Creek intrusions. Some of the large andesite boulders have mantles of rhyolitic tuffaceous material and apophyses of ash-flow tuff locally extend into the breccias. The inter-ash-flow breccias have a maximum thickness of about 70 ft (21 m)

Tst SUGARLUMP TUFF (OLIGOCENE)--White to pinkish-gray nonwelded air-fall tuff and tuffaceous sandstone. Poorly welded and slightly devitrified with abundant pumice lapilli. Contains about 5 percent phenocrysts of sanidine, oligoclase, and quartz; accessory oxyhornblende, biotite, and ferric oxides. Maximum thickness about 150 ft (46 m) near City of Rocks and along Shepherd Canyon

Trr RHYOLITE OF ROSENCRAN CANYON (OLIGOCENE)--Very light gray aphanitic rhyolite with strong flow layering. Felted to spherulitic groundmass contains generally less than 10 percent phenocrysts of sanidine, albite, and bipyramidal quartz; accessory biotite, sphene, and apatite. Maximum thickness about 800 ft (244 m)

Trrt AIR-FALL TUFF AND TUFFACEOUS SANDSTONE OF ROSENCRAN CANYON (OLIGOCENE)--Very light gray thin-bedded tuff with abundant pumice lapilli alined parallel to the bedding. Contains about 10 percent phenocrysts of sanidine, plagioclase, quartz, and biotite. Base of tuff is incompletely exposed and partially overlies basaltic andesite breccias. Minimum thickness about 400 ft (122 m)

Trn RHYOLITE OF NORTH PERCHA CREEK (OLIGOCENE)--Very light gray to light-pinkish-gray rhyolite to quartz latite. Massive with strong flow layering; aphanitic to porphyritic flows contain phenocrysts of sanidine as long as 1.5 cm. Porphyritic flows are locally overlain by an aphanitic rhyolite that has a black vitric base. Commonly the microcrystalline to spherulitic groundmass composes 40-45 percent of the rhyolite, chatoyant sanidine (26 percent), albite (An_{10}) (21 percent), quartz (9 percent), and biotite (1 percent). Accessory minerals are sphene, allanite, apatite, and ferric oxides. Noncontiguous but correlative flows crop out southeast and southwest of Cross-O Mountain. Maximum thickness about 1,500 ft (457 m)

Trsl RHYOLITE SILL OF LAMPBRIGHT DRAW (OLIGOCENE?)--Very light gray rhyolite porphyry with locally abundant disseminated moderate-yellowish-green alteration. Contains about 7 percent phenocrysts of embayed bipyramidal quartz and less than 1 percent phenocrysts of sanidine; accessory garnet. Sparse amounts of pyrite present along microfractures; associated alteration products include white mica, calcite, and chlorite. Xenoliths of Percha Shale are locally present along margins of the sill. About 300 ft (91 m) thick; the upper contact was exhumed after erosion of the overlying shale and limestone cover

Trdl RHYOLITE DOME OF LAMPBRIGHT DRAW (OLIGOCENE?)--Very light gray rhyolite with strong flow layering. Aphanitic to weakly porphyritic with about 5 percent phenocrysts of sanidine and quartz. Extrusive contacts with limestone of the Magdalena Group and andesite of the Rubio Peak Formation. About 500 ft (152 m) thick

IGNEOUS ROCKS (UPPER CRETACEOUS?)

Kql Quartz latite porphyry dike--Medium-light-gray coarsely crystalline quartz latite with phenocrysts as much as 5 mm across. Phenocrysts of oligoclase (An_{26}) (25 percent), sanidine (3 percent), quartz (11 percent), biotite (10 percent), and hornblende (6 percent) are set in a felted groundmass. Accessory minerals are sphene, calcite, apatite, and ferric oxides. Euhedral biotite plates are large and numerous. Dike strikes west-northwest in secs. 25, 26, and 36 about 1 3/4 mi (2.8 km) southwest of San Lorenzo. Dike measures about 8,600 ft (2.6 km) long and is about 1,000 ft (305 m) wide

Ka Andesite dikes, sills, and plugs--Brownish-gray and olive- to medium-gray andesite that weathers to dark yellowish brown. Porphyritic with as much as 30 percent phenocrysts of sodic andesine (An_{30-35}) and oxyhornblende in a felted to pilotaxitic groundmass. Sills commonly localized along bedding surfaces of the Percha Shale, whereas the dikes follow fracture and joint surfaces in Paleozoic strata. Sills and dikes are most numerous in the southwest corner of the quadrangle

RUBIO PEAK(?) FORMATION (UPPER CRETACEOUS?)

Krp Andesite, andesite breccia, and hornblende latite--Dark-greenish-gray to olive-gray andesite flows are commonly autobrecciated and locally intruded by thin rhyolite sills and dikes. Flows have very thin and minor amounts of interbedded zeolitized tuff. Porphyritic flows contain as much as 30 percent phenocrysts of oscillatory-normal zoned andesine (An_{32-43}), oxyhornblende (0-8 percent), clinopyroxene (0-7 percent), and dusky-brown biotite (0-1 percent). Locally near faults the andesite is saussuritized with the groundmass replaced by white mica, chlorite, calcite, epidote, thulite, and ferric oxides. The andesite breccias have not been isotopically dated but must have a minimum age of 33.4 m.y. (Oligocene) because they underlie the Kneeling Nun Tuff. Maximum thickness about 1,000 ft (305 m)

Krpa Andesite--Brownish-gray nonbrecciated lava flows contain about 15 percent phenocrysts of zoned andesine (An_{43-54}) set in a pilotaxitic groundmass. Accessories are clinopyroxene, oxyhornblende, ferric oxides, and apatite. Flows locally rest on Beartooth Quartzite (Kb) and are correlative with the andesites of the Rubio Peak Formation as mapped by R. M. Hernon, W. R. Jones, and S. L. Moore (1964) in the Santa Rita quadrangle. Maximum thickness about 150 ft (46 m)

Kb BEARTOOTH QUARTZITE (UPPER SARTEN SANDSTONE OF JICHA, 1954) (UPPER CRETACEOUS)--Very light gray to light-brown sandstone and very minor thin interbeds of black shale. Sandstone is thin to medium bedded, quartzose, and commonly crossbedded with foreset laminae dipping predominantly to the south-southwest. Sandstone is commonly quartzitic on weathered outcrop and locally has abundant brown limonitic spots and manganese oxides along joint surfaces. Maximum thickness about 140 ft (43 m)

Pa ABO FORMATION (LOWER PERMIAN)--Grayish-red to dusky-red silty mudstone with locally abundant limestone nodules. Thin interbeds of pale-red tightly cemented siltstone are common. Light-brown sandstone with thin interbeds of gray chert-pebble conglomerate are present about 300 ft (91 m) above the base. Grayish-red and gray chert-pebble conglomerate beds with an aggregate thickness of 5.5 ft (1.7 m) crop out about 10-25 ft (3-7.6 m) above the base. The highly faulted and incomplete section has a thickness of about 400 ft (122 m) near Emory Pass, but thins appreciably west of the Mimbres valley where it is only 0-100 ft (0-30 m) thick

IPM MAGDALENA GROUP (UPPER PENNSYLVANIAN)--Limestone and shale, very minor chert- and limestone-pebble conglomerate. Medium-gray limestone is medium to thick bedded, aphanitic to finely crystalline, and contains slightly silty brownish-gray limestone units in the upper and middle parts of the section that weather to light-brown plates 1-3 cm thick. Basal olive-black shale is 15-35 ft (5-10 m) thick; thin limestone

beds in the upper part of the shale contain abundant brachiopoda, especially Schizophoria resupinoides (Cox) and Derbyia sp.; other brachiopoda include Neospirifer latus, Dictyoclostus sp., Antiquatonia hermosanus (Girty), Echinaria semipunctata, Composita subtilita (Hall), Linoproductus sp., and Orthotetid indet. Gastropoda include Donaldina sp. and Taosia sp. Fusulinids are especially abundant in the middle part of the group and include Bradyina sp., Climacammina sp., and Triticites Galloway (Needham). Average thickness of the group is about 720 ft (220 m)

Mlv LAKE VALLEY LIMESTONE (LOWER MISSISSIPPIAN)--Limestone and marl. Total aggregate thickness ranges from 217 ft (66 m) along the east margin of the quadrangle to about 330 ft (100 m) at the west margin

Tierra Blanca Member--Medium-gray limestone weathers to light gray; steplike ledge-former; medium to thick bedded; medium to coarsely crystalline; abundant white to very light gray ropy and nodular chert; crinoidal. Thickness 92-105 ft (28-31 m)

Nunn Member--Medium-dark-gray limestone and marl; slope-former; thin bedded with silty limestone partings; aphanitic to very finely crystalline; moderate amounts of black to dark-gray chert in upper 30 ft (9 m); contains abundant crinoids. Thickness 45-160 ft (14-49 m); thickens to the west

Alamagordo Member--Medium-gray limestone; massive ledge-former; beds 0.5-0.8 m thick; very finely crystalline to aphanitic; minor amounts of black to dark-gray chert nodules in lowest 10 ft (3 m); relatively nonfossiliferous. Thickness 25-50 ft (8-15 m); thins to the west

Andrecito Member--Medium-light-gray limestone and marl; slope-former; thin bedded with uneven bedding surfaces; medium-coarse crystallinity; contains abundant fenestelloid bryozoa and crinoid columnals. Thickness 30-40 ft (9-12 m); thickens to the west

Dp PERCHA SHALE (UPPER DEVONIAN)--Shale and silty shale with limestone nodules. Total thickness ranges from 160-280 ft (49-85 m) with pronounced thickening of the Box Canyon Member to the west

Box Canyon Member--Medium-gray shale and minor siltstone; moderately fissile; abundant silty limestone nodules in lowest 80 ft (24 m). Thin limy siltstone beds as much as 20 cm thick are common ledge-formers. Thickness 30-150 ft (9-46 m); thickens to west

Ready Pay Member--Black to olive-black shale; highly fissile and without limestone nodules. Thickness 110-130 ft (33-40 m)

SOfm FUSSELMAN DOLOMITE (MIDDLE SILURIAN) AND MONTOYA GROUP (LOWER ORDOVICIAN)

Fusselman Dolomite--Medium-gray to light-olive-gray dolomite; lowest 35 ft (11 m) weathers very light gray; medium to thick bedded; very finely crystalline to aphanitic; slightly cherty in upper 55 ft (17 m) and siliceous outcrops weather brown. Poorly fossiliferous. Thickness 90 ft (27 m)

Montoya Group--Total thickness 398 ft (121 m)

Cutter Dolomite--Dolomite, medium-gray, weathering light olive gray; thin to medium bedded with thin-bedded slope-forming beds in lowest 42 ft (13 m); very finely crystalline. Poorly fossiliferous except for a few silicified colonial corals (Mesofavosites sp.) about 30 ft (9 m) above base. Thickness 126 ft (38 m)

Aleman Formation--Laminated light-gray chert layers 1-3 cm thick alternating with medium-gray dolomite beds 2-3 cm thick. Chert laminae are more continuous downward in section. Thickness 70 ft (21 m)

Second Value Dolomite--Total thickness 202 ft (62 m). Includes, from top downward: medium-light-gray to brownish-gray dolomite; medium-bedded cliff-former; sugary textured; abundant white to very light gray chert nodules in beds 42 ft (13 m) above base; poorly fossiliferous except for Rhynchotrema sp. in lower part of unit; thickness 64 ft (19 m). Medium-light-gray arenaceous dolomite and dolomitic sandstone; weathers to brownish silicified crusts; contains abundant poorly sorted rounded and

frosted quartz grains as much as 4 mm across that have a bluish opalescence; thickness 25 ft (8 m). Medium-light-gray dolomite; medium-bedded slope-former; finely crystalline to aphanitic; thickness 15 ft (5 m). Medium-light-gray dolomite, thick- to medium-bedded, sugary-textured; nodular and ropy chert common; thin sedimentary breccia at base 0.5 ft (0.2 m) thick; thickness 98 ft (30 m)

Oep EL PASO LIMESTONE (LOWER ORDOVICIAN)--Medium-light-gray to medium-dark-gray limestone, thin- to medium-bedded, aphanitic to finely crystalline; contains units of slightly silty crenulated limestone laminae that weather light brown. Cherty limestone beds with an aggregate thickness of 32 ft (9.8 m) are common 28 ft (8.4 m) below top. Lowest 10 ft (3 m) of section contain thin beds of alternating siltstone and limestone that weather light brown. Poorly fossiliferous except for Maclurites sp. about 65 ft (19.8 m) below top; also contains brown-weathering silty algal-like segregations. Total thickness about 515 ft (157 m)

O€b BLISS SANDSTONE (LOWER ORDOVICIAN AND UPPER CAMBRIAN)--Light-brown, dark-greenish-gray, olive-gray, and dusky-red well-indurated to quartzitic sandstone. Upper two-thirds of formation tends to be thin to medium bedded whereas the lower third is massive to thick bedded. Outcrop characterized by two conspicuous sandstone ledge-forming beds; one 18 ft (5.5 m) above the base of the formation and the other 64 ft (19.5 m) above the base. A massive hematitic sandstone bed 6 ft (1.8 m) thick crops out about 44 ft (13.4 m) above the base. A greenish-gray glauconitic sandstone bed 3 ft (0.9 m) thick is locally present at the top of the formation. Scolithus casts are common in thin-bedded sandstone 40 ft (12.2 m) above the base; fucoidal markings are present 60 ft (18.3 m) above the base. Thickness of formation about 120-130 ft (37-40 m)

PRECAMBRIAN ROCKS

p€gs Granite of Seven Brothers Mountain--Light-pinkish-gray; coarsely crystalline with aplitic dikes and segregations; hypidiomorphic-granular. Contains perthitic microcline grains as much as 2 cm across (25-32 percent), albite (33-37 percent), quartz (33 percent), and biotite (1-3 percent); accessory epidote, apatite, sericite and ferric oxides. Very weakly foliated

p€g Granophyre of North Percha Creek--Light-pinkish-gray; fine to medium crystallinity; allotriomorphic-granular; commonly contains myrmekitic to micrographic intergrowths of quartz and microcline. Contains approximately equal amounts of microcline and oligoclase (An_{27}), 30-35 percent quartz, and less than 1 percent biotite and ferric oxides. Irregular clots of blue-green hornblende are locally present. Elongate dikelike bodies of amphibolite within the granite are alined north-northeast and may represent metadiabase dikes

p€s Quartzofeldspathic gneiss and leuco-granite of Upper Silver Creek Canyon--Light-gray to medium-light-gray gneiss that is strongly foliated N. 47°-60° E. Contains thin layers of hornblende schist that are alined parallel to the foliation. The gneiss is intruded by granophyre at the west end of the outcrop

p€h Hornblende and chlorite schist of Mimbres valley--Greenish-black highly foliated schist and gneiss with a strong foliation that strikes N. 75°-80° E. Contains ragged blue-green hornblende, chlorite, quartz, andesine, and epidote. Locally highly chloritic with stretched pebbles that display strong lineation plunging 15° N. 80° W.

ECONOMIC GEOLOGY

Silver-bearing base metal deposits of Middle Tertiary age (about 33 m.y.) are localized along strong faults that strike N. 10°-20° W. through the Swartz (Carpenter) mining district. Both fissure veins and bedding replacement bodies are also closely associated with a zone of thermal metamorphism that extends for at least 6 mi (9.7 km) along the strike of the faulted Paleozoic carbonate rocks. This thermal metamorphism was nearly concurrent with the mineralization and both can be attributed to the intrusion of rhyolite and quartz latite plugs, dikes, and sills into the Paleozoic strata. Tremolite and talc are found along the periphery of the thermal aureole, but diopside, epidote, grossular garnet, and magnetite are present in areas of higher grade metamorphism.

The chief producing mines of this district have been the McGee, Royal John, Acklin, Patsy, Columbia, Grandview, and Mineral Mountain (R. S. Hill, 1946; J. H. Soule, 1950). The past production from the district has totaled an estimated 60,000 long tons (60,960 t) of ore averaging about 8 percent zinc, 4 percent lead, 0.5 percent copper, and about 4 ounces of silver per ton (113 g/t). The largest production has come from bedding replacement bodies in the upper part of the El Paso Limestone. Cherty limestone beds in the El Paso Limestone that are 20-70 ft (6-21 m) below the contact with the overlying Montoya Group have been especially favorable host rocks at the Royal John mine. It is estimated that about 33,000 long tons (33,528 t) of base metal ores have been shipped from the Royal John properties.

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