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Geologic map of the Hillsboro Quadrangle, Sierra, and Grant counties, NM

By: Hedlund, David Carl

#339

U.S. GEOLOGICAL SURVEY
Reston, Va. 22092

Memorandum

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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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

Description of Map Units

By

D. C. Hedlund

Open-file report 75-108

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

By D. C. Hedlund

DESCRIPTION OF MAP UNITS

Qa ALLUVIUM (HOLOCENE)--Poorly sorted gravel, sand, and silt deposits; gravel contains boulders and cobbles of Tertiary volcanic rocks and minor amounts of Paleozoic and Precambrian rocks. Thickness more than 10 ft (3 m)

Qtg TERRACE GRAVEL (HOLOCENE)--Chiefly subrounded cobbles and gravel consisting of Tertiary volcanic rocks. Terraces most extensive along Tierra Blanca and Trujillo Creeks. Thickness about 10 ft (3 m)

Qf FAN DEPOSITS (HOLOCENE)--Torrential fan deposits containing chiefly subangular to angular poorly sorted volcanic debris commonly derived from weathering of the Santa Fe Formation. Unit is most extensive along the west side of New Mexico Highway 27 and along the margins of the Rio Grande depression, where the thickness is more than 10 ft (3 m)

Qt TALUS DEPOSITS (HOLOCENE)--Poorly sorted unconsolidated locally derived angular boulders, rubble, and soil. Thickness several feet (about 1 m)

Ql LANDSLIDE DEPOSITS (HOLOCENE)--Blocks of Sugarlump Tuff resting on poorly consolidated breccias of the Rubio Peak Formation

Qg PEDIMENT GRAVEL DEPOSITS (HOLOCENE OR PLEISTOCENE)--Poorly sorted unconsolidated cobbles, rubble, and silt derived from Tertiary volcanic rocks. Stratified, dipping 5°-7° east. Commonly exposed along arroyos marginal to the Rio Grande depression, where the thickness is more than 20 ft (6 m)

Tsf SANTA FE FORMATION (PLIOCENE)--Light-brown coarsely stratified fanglomerate composed of latite and andesite fragments in a matrix of comminuted lava and phenocryst fragments of coarse sand size. Locally contains interbeds of sorted gravel and cobbles. The lower more strongly indurated fanglomerate beds have abundant secondary chalcedonic quartz cement. Dip is 5°-10° east. Maximum thickness about 800 ft (245 m)

Tsfb Basaltic andesite (alkali basalt)--Bluish-gray locally highly vesicular lava flows with reddened base. Porphyritic; pilotaxitic groundmass and about 15 percent phenocrysts of labradorite (An_{55}), oxyhornblende, and clinopyroxene. Reverse and oscillatory-zoned labradorite phenocrysts have thin marginal overgrowths of andesine (An_{30-35}). Flows overlie and are interbedded with uppermost fanglomerate deposits of the Santa Fe Formation. Thickness 70-120 ft (20-35 m)

RAZORBACK(?) FORMATION OF JICHA, 1954 (OLIGOCENE)

Tra Basaltic andesite--Black to dark-gray scoriaceous lava locally containing calcite-filled amygdules and irregular glass-lined vugs more than 1 cm across. Pilotaxitic groundmass contains feldspar microlites with interstitial ferric oxides and clinopyroxene. Phenocrysts are commonly oxyhornblende (6 percent), clinopyroxene (1 percent), and sodic andesine (An_{30-36}) (more than 1 percent). Thickness 0-200 ft (0-60 m)

Tram Tuff of McClede Spring--Light-brown phenocryst-poor ash-flow tuff containing abundant weakly compacted slightly devitrified ash shards and sparse pumice lapilli. Tuff contains fragmented phenocrysts of sanidine and bipyramidal quartz (more than 1 percent). Thickness about 50 ft (15 m) near McClede Springs

Tpl POLLACK QUARTZ LATITE (OLIGOCENE)--Medium-gray to light-purplish-gray quartz latite and latite lava with locally autobrecciated tops and reddened base. Flows are aphanitic to weakly porphyritic, the aphanitic flows commonly having a slabby weathering habit. Pilotaxitic to felted groundmass consists of feldspar microlites with interstitial

ferric oxides and clinopyroxene. Flows commonly contain phenocrysts of oscillatory-normal zoned calcic oligoclase-sodic andesine (An_{28-35}) (7-10 percent), embayed and partly resorbed quartz (0-4 percent), oxyhornblende (3-4 percent), and reddish-brown partially oxidized biotite (0-2 percent). Maximum thickness about 1,500 ft (460 m)

Tpla Andesite--Brownish-gray lava consisting of about 1 percent phenocrysts of zoned andesine (An_{38-40}) in a pilotaxitic groundmass with accessory clinopyroxene, ferric oxides, and biotite. Flow overlies pale-red altered latite flows (Tpl) along South Percha Creek (secs. 16 and 21, T. 16 S., R. 8 W.) where the thickness is several hundred feet (about 100 m)

Tpls Air-fall tuff--White to very light gray nonwelded tuff with vitric pumice lapilli as much as 1.8 cm across; minor amounts of vitric shards. Locally contains as much as 10 percent angular lithic fragments of latite. Tuff is commonly interbedded with latite (Tpl), where thickness is as much as 340 ft (105 m)

Tplb Latite breccia--Sedimentary breccias containing numerous fragments of medium-gray latite (Tpl). Breccias weakly indurated and contain thin interbeds of tuffaceous sandstone. Latite fragments as much as 0.8 m across. Maximum thickness about 250 ft (76 m)

Tmp MIMBRES PEAK RHYOLITE (OLIGOCENE)--Light-gray to very light gray aphanitic to weakly porphyritic rhyolitic lava flows and extrusive domes containing 2-3 percent sanidine and bipyramidal quartz phenocrysts. Strong flow lamination; spherulites locally concentrated along former vitric laminae; flow laminae are commonly contorted and have steep dips marginally to the extrusive domes. Flows commonly transgressive over a post-Kneeling Nun erosion surface; some are locally interlayered with the Pollack Quartz Latite. The rhyolite domes are generally alined along a north-south axis through the central part of the quadrangle and may have been extruded along major faults. Maximum thickness about 1,000 ft (300 m)

Tmpv Rhyolite vitrophyre--Dark-grayish-black to brownish-gray rock containing abundant black fiamme with strong eutaxitic texture but very sparse shard material. The glass has abundant perlitic fractures and an index of 1.508 ± 0.003. Highly fragmented phenocrysts are present in the following amounts: sanidine (0.7-4 percent), oligoclase (An_{28-30}) (0.3-1.6 percent), and bipyramidal quartz (0.4-1.0 percent). Accessory minerals are orthopyroxene, biotite, oxyhornblende, and ferric oxides. Vitrophyre at contact of Sugarlump Tuff and Mimbres Peak Rhyolite may represent a fused tuff. Maximum thickness about 200 ft (60 m) near Deer Hill and Sherman Mountain

Tr Rhyolite plugs and dikes

Rhyolite plug of the Thompson Cone--Light-gray to light-brownish-gray. Commonly porphyritic with as much as 15 percent phenocrysts of sanidine and bipyramidal quartz; accessory biotite and ferric oxides. Plug has radially distributed rhyolite dikes around it

Dikes--White to yellowish-gray porphyritic rock; 0-22 percent sanidine and bipyramidal quartz phenocrysts in a felted groundmass. Accessory minerals are biotite, ferric oxides, and sphene. Locally the dikes contain disseminated pyrite or ferric oxides pseudomorphic after pyrite. Most dikes are localized along joints or faults. Thickness as much as 150 ft (45 m)

Trs Rhyolite sill of Seven Brothers Mountain--Light-gray to very light gray, aphanitic to weakly porphyritic. Contains about 5 percent phenocrysts of sanidine and bipyramidal quartz in a felted to spherulitic groundmass. Sill is localized at the base of the Percha Shale. Maximum thickness 200 ft (61 m)

Tkn KNEELING NUN TUFF (OLIGOCENE)--Pale-red to pale-pinkish-gray densely welded ash-flow tuff with strong eutaxitic texture; locally contains collapsed blocks of pumice as much as 15 cm long. Crystal-rich tuff contains 26-38 percent fragmented phenocrysts of zoned oligoclase (An_{20-28}), sanidine, partly resorbed quartz, and as much as 3 percent alined biotite plates. Accessory minerals are sphene, pale-green clinopyroxene,

ferric oxides, apatite, and calcite. A sample of biotite near Lucky Bill Canyon, about 40 miles west of Hillsboro, has a K-Ar age of 33.4±1.0 m.y., as determined by McDowell (1971). Maximum thickness about 1,500 ft (460 m) but thins to the east near Sibley Mountain where the thickness is only 300 ft (90 m)

Tknt Air-fall tuff--Very light gray to yellowish-gray nonwelded ash containing about 6 percent phenocrysts of oligoclase (An_{20-26}), sanidine, and quartz, and as much as 10 percent latitic lithic fragments. Thickness of discontinuous unit in the upper part of the formation along Berenda Creek is as much as 400 feet (120 m)

Tls LAKE BEDS (OLIGOCENE)--Siltstone, mudstone, sandstone, and conglomerate. Brownish- to olive-gray weekly fissile mudstone gradational into siltstone that locally contains plant fossils identified as early Miocene to early Pliocene (R. W. Brown, in Kuellmer, 1954). The sandstone is light brownish gray, weakly indurated, coarse grained, and has limonitic stains. An interbed of conglomerate consisting of rounded basalt cobbles is present near the base and is 2.4 ft (70 cm) thick. Beds are tilted 45°-55° eastward along the south side of Percha Creek in sec. 13, T. 16 S., R. 8 W. Maximum thickness about 250 ft (75 m)

Tst SUGARLUMP TUFF (OLIGOCENE)--Very light gray, greenish-gray, light-yellowish-gray, and grayish-yellow-green air-fall tuff and tuffaceous sandstone. The air-fall tuff contains 80-90 percent pumice lapilli that show various stages of alteration to yellowish-green clay minerals. Pumice lapilli are not generally collapsed. Fragments of pale-red to purple latite comprise as much as 15 percent of the tuff. Unit commonly contains 5-8 percent fragmented phenocrysts of oligoclase (An_{28-30}), sanidine, and quartz, with accessory biotite, clay minerals, and apatite. Formation probably accumulated in an elongate basin oriented N. 15° W. within the central part of the quadrangle. Aggregate thickness along the north side of Tierra Blanca Creek near Deer Hill is

425 ft (130 m), and includes 3 interbeds of tuffaceous sandstone with an aggregate thickness of 73 ft (22 m)

Tstw Ash-flow tuff--A discontinuous ash-flow sheet at the base of the formation. Pale-red to pale-purplish-gray densely welded devitrified tuff; local black fiamme at the base. Groundmass consists of vitric to weakly devitrified compressed ash shards containing 3-6 percent fragmented phenocrysts of oligoclase (An_{23-25}), sanidine, quartz, and accessory biotite. Upper 20 ft (6 m) of ash flow is comprised of about 10 percent latite clasts and is light gray to pale yellowish green; lowest 25 ft (8 m) contains very sparse lithic fragments

Trn RHYOLITE OF NORTH PERCHA CREEK (OLIGOCENE)--Very light gray rhyolite to quartz latite; greenish-gray alteration in places. Massive with strong fluxion layering. Aphanitic to porphyritic, containing as much as 55 percent phenocrysts set in a very finely devitrified groundmass. The phenocrysts are sanidine with a satiny chatoyancy (12-26 percent), albite (An_{8-10}) (14-21 percent), rounded and embayed quartz (5-12 percent), and biotite (more than 1 percent). Accessory minerals are sphene, allanite, apatite, ferric oxides, and calcite. Porphyritic flows are locally overlain by aphanitic rhyolite and vitrophyre. Small remnant flow or plug at the head of Sawpit Canyon is slightly mineralized with pyrite. A sill of rhyolite is present in the Abo Formation near the head of Middle Percha Creek. Aggregate thickness of flows about 800 ft (245 m) in the drainage area of North Percha Creek

IGNEOUS ROCKS (UPPER CRETACEOUS)

Copper Flat stock

Kqmc Quartz monzonite--Light-pinkish-gray to light-gray rock with hypidiomorphic-granular to porphyritic to fine-grained pegmatitic texture. Contains euhedral orthoclase laths as long as 2.3 cm (50-70 percent), subhedral oligoclase (An_{23-28}) as grains less than 5 mm across (12-15 percent), quartz (6-23 percent), biotite (0.5-6.5 percent), and as

much as 8 percent pale-green hornblende. Accessory minerals in nonmineralized parts of the stock are sphene, zircon, apatite, epidote, and calcite. Within the mineralized parts the biotite shows various stages of alteration to chlorite, white mica, and ferric oxides; the plagioclase is partly altered to white mica; and magnetite is locally abundant as disseminations and clusters about the biotite. Quartz veins are also pervasive in the central part of the stock and are accompanied by pyrite, chalcopyrite, bornite, and molybdenite disseminations and fracture fillings. Minor amounts of xenolithic quartz diorite and granodiorite are locally present in the subsurface. The stock has an area of about 0.4 mi^2 (1.04 km^2) and appears to have nearly vertical walls at the contact with the andesite. A biotite concentrate from unweathered core and trench samples indicates a K-Ar age of 73.4±2.5 m.y., as determined by R. F. Marvin, H. H. Mehnert, and Violet Merritt, U.S. Geological Survey (written commun., 1974)

Kql Quartz latite dikes--Light-gray to light-pinkish-brown porphyry containing 18-35 percent phenocrysts of oligoclase (An_{24-30}), sanidine, and quartz in a matrix of alkali feldspar microlites. Some sanidine phenocrysts are as much as 1.5 cm long and display carlsbad twinning; others have marginal overgrowths of secondary alkali feldspar and display highly resorbed and pitted cores. Accessory minerals are sphene, iron oxides, epidote, calcite, sericite, and chlorite. Locally the dikes are reddened, brecciated, and mineralized with pyrite and chalcopyrite and trace amounts of gold. The dikes are chiefly radial to the quartz monzonite stock of Copper Flat where about 34 dikes have been mapped. Maximum thickness about 125 ft (38 m)

Warm Springs Canyon stock

Kqm Quartz monzonite--Light-pinkish-gray hypidiomorphic- to xenomorphic-granular medium-grained rock containing orthoclase (28 percent), oligoclase (An_{25-28}) (43 percent), quartz (22 percent), biotite (2 percent), hornblende (2 percent), epidote (2 percent), and accessory sphene, ferric oxides, and apatite. Intrusion measures about 2,000 by 4,200 ft (610 X 1,280 m) near Snake Gulch. Two small intrusions

of quartz monzonite also crop out 1/4 mi (400 m) southeast of the larger stock and contain lesser amounts of quartz (6-13 percent); these smaller bodies also display a greater degree of alteration with strong sericitization of the feldspars

Kqmd Quartz monzodiorite--Light-gray hypidiomorphic-granular medium-grained rock containing orthoclase (1-15 percent), sodic andesine (An_{30-32}) (54-76 percent), quartz (9-13 percent), hornblende (6-12 percent), biotite (2-3 percent), and accessory chlorite, ferric oxides, white mica, and apatite. Crops out as marginal facies of the quartz monzonite of Warm Springs Canyon

Kqd Quartz diorite of Tank Canyon--Medium-gray panidiomorphic-granular medium-grained rock containing orthoclase (0.5 percent), sodic andesine (An_{30-34}) (65 percent), quartz (11 percent), hornblende (17 percent), biotite (0.5 percent), and iron oxides (4 percent). Accessories are chlorite, epidote, sphene, and apatite. Crops out as irregular body along Tank Canyon and as smaller pluglike body just south of Animas Gulch

Kqds Quartz diorite of Sawpit Canyon--Medium-gray to olive-gray porphyritic medium-grained rock containing conspicuous hornblende prisms as long as 7 mm. Commonly contains zoned sodic andesine (An_{30-32}) (80 percent), brown hornblende showing various stages of chloritization (17 percent), secondary quartz (2 percent), iron oxides (1 percent), and accessory calcite, apatite, muscovite, and alkali feldspar. Poorly exposed outcrop in creek, SE 1/4 sec. 3, T. 16 S., R. 8 W., measures about 15 by 25 ft (5 X 8 m)

Kd Diorite of North Percha Creek--Medium-gray to olive-gray fine-grained weakly porphyritic rock containing scattered andesine (An_{43-45}) phenocrysts as much as 3 mm across and a few hornblende prisms as long as 7 mm. Commonly contains andesine (65-69 percent), biotite (9-14 percent), hornblende (2-6 percent), clinopyroxene (7-8 percent), iron oxides (3-5 percent), and secondary quartz (1-2 percent). Accessory minerals are apatite, white mica, and chlorite. Crops out as irregular body that extends about 6,500 ft (1,980 m) along North Percha Creek

Ka ANDESITE DIKES AND SILLS (UPPER CRETACEOUS?)--Olive-gray to medium-gray rock weathering to dark yellowish brown. Porphyritic with about 20 percent phenocrysts of sodic andesine (An_{30-35}) and oxyhornblende in a pilotaxitic groundmass. Sills commonly localized along bedding surfaces of the Percha Shale; dikes follow strong fracture and joint surfaces in Paleozoic strata and in joints in the Rubio Peak Formation; along Tank Canyon an andesite sill follows the bedding within the Bliss Sandstone. Thickness 10-75 ft (3-23 m)

RUBIO PEAK(?) FORMATION (UPPER CRETACEOUS?)

Krps Upper sandstone--Dark-greenish-gray to grayish-green weakly indurated sandstone composed largely of medium-grained angular to subangular andesite clasts. Thin-bedded to platy. Thickness as much as 35 ft (10 m)

Krp Hornblende andesite and latite--Dark-greenish-gray, medium-gray, and medium-bluish-gray aphanitic to highly porphyritic lava flows with pilotaxitic groundmass. Flows commonly contain phenocrysts of oscillatory-normal zoned andesine (An_{32-43}) (2-28 percent), oxyhornblende (0-8 percent), clinopyroxene (0-7 percent), and accessory biotite, iron oxides, and quartz. The flows are most commonly autobrecciated and locally have a green celadonite type of alteration. Minor amounts of zeolite are present within thin tuff beds that are intercalated with the andesite breccias. Thickness highly variable owing to erosion and irregular preandesite topography; maximum thickness about 1,500 ft (457 m)

Krpsl Lower sandstone--Greenish-gray medium- to coarse-grained thin-bedded rock with a platy weathering habit. Consists of reworked andesite and latite fragments which show varying degrees of sorting. Some sedimentary breccias in the middle of the section contain latite-andesite fragments as much as 2.5 cm across. Maximum thickness about 80 ft (25 m) along the east side of Decker Draw and about 300 ft (91 m) above the base of the Rubio Peak(?) Formation

Krpa Andesite--Medium-bluish-gray lava weathering pale yellowish brown. Lava has a strong spheroidal-exfoliated weathering structure locally. Highly porphyritic with as much as 38 percent phenocrysts; the modal content is as follows: zoned oscillatory-normal andesine (An_{32-38}) (12-31 percent), clinopyroxene (0-4 percent), quartz xenocrysts(?) (0-4 percent), and accessory biotite, oxyhornblende, and iron oxides. The groundmass is felted to pilotaxitic with feldspar microlites and interstitial clinopyroxene and iron oxides. Maximum thickness about 1,200 ft (366 m)

Kacf ANDESITIC ROCKS OF COPPER FLAT (UPPER CRETACEOUS)--Dark-gray, medium-gray, and greenish-gray aphanitic to porphyritic andesite and andesite breccia lava flows. Flows are locally autobrecciated. The groundmass is weakly trachytic to felted and the phenocrysts include oscillatory-normal twinned andesine (An_{32-35}) (5-30 percent), clinopyroxene (0-8 percent), and hornblende (0-5 percent); accessory minerals are apatite, iron oxides, and quartz. The andesite is intensively propylitized near the quartz monzonite of Copper Flat (Kqmc) and along mineralized faults within the andesite. The alteration minerals are calcite, chlorite, epidote, white mica, and secondary quartz. Maximum thickness about 2,732 ft (833 m) as measured in drill holes IDC-20 and -31, Copper Flat

Kacfs Sandstone--White to very light gray weakly indurated coarse-grained quartzose sandstone. Thin-bedded unit intercalated with andesite. Thickness about 30 ft (9 m)

Kb BEARTOOTH QUARTZITE (UPPER SARTEN SANDSTONE OF JICHA, 1954) (UPPER CRETACEOUS)--White to light-greenish-gray medium- to medium-coarse-grained tightly cemented locally quartzitic sandstone. Crossbedded and highly quartzose; some beds contain about 25 percent subangular to angular green chert grains. Thin interbeds of gray and white chert pebble conglomerate. Limonitic disseminations and coatings locally common. Maximum thickness about 200 ft (60 m)

Pa ABO FORMATION (LOWER PERMIAN)--Sandstone, mudstone, conglomerate, and minor limestone. Dominantly reddish-brown mudstone with interbeds of silty fine-grained reddish-brown sandstone and discontinuous nodular limestone beds. Light-brown sandstone commonly present about 300 ft (91 m) above base of formation. A discontinuous conglomerate containing abundant red and gray chert pebbles is 0-25 ft (0-8 m) above base. Maximum thickness of the highly faulted incomplete sedimentary section about 400 ft (122 m)

IPm MAGDALENA GROUP (UPPER PENNSYLVANIAN)--Limestone, shale, very minor chert- and limestone-pebble conglomerate. Limestone is medium gray, medium to thick bedded, aphanitic to finely crystalline, and contains slightly silty brownish-gray limestone beds in upper and middle parts of the section that weather to light-brown plates 1-3 cm thick. Basal olive-black shale unit 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 brachiopods 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 720 ft (220 m)

Mlv KELLY FORMATION, LAKE VALLEY LIMESTONE, AND CABALLERO FORMATION (LOWER MISSISSIPPIAN)--Limestone and marl. Total aggregate thickness is 190-217 ft (58-66 m)

Kelly Formation--Light-gray massive medium-crystalline to coarsely crystalline limestone containing white to light-gray chert nodules; crinoidal. Formation confined to northwest corner of quadrangle along North Percha Creek. Thickness 0-15 ft (0-5 m)

Lake Valley Limestone--Total thickness 170-217 ft (52-66 m)

Tierra Blanca Member--Medium-gray limestone weathering to light gray;

steplike ledge-former; medium crystalline to coarsely crystalline; abundant white to very light gray ropy chert; crinoidal. Upper 70 ft (21 m) of member is very coarsely crystalline and contains abundant white ropy chert. Approximately 15 ft (5 m) above base a thin-bedded (2-3 cm) medium-gray very finely crystalline limestone contains abundant platy chert and is about 7 ft (2 m) thick. Thickness 92 ft (28 m)

Nunn Member--Medium-dark-gray limestone weathering medium light gray; thin bedded; aphanitic to very finely crystalline; wavy or undulose bedding surfaces; abundant medium-light-gray ropy chert in lowest 10 ft (3 m). Member is commonly a slope-former and contains abundant crinoids. Thickness 45 ft (14 m)

Alamagordo Member--Massive ledge-forming limestone consisting of 17 to 20 beds, each 1-2 1/2 ft (0.3-0.8 m) thick. Dark-gray; very finely crystalline; minor amounts of black to dark-gray ropy chert in lowest 20 ft (6 m). Relatively nonfossiliferous; contains sparse disseminations of pyrite. Thickness 50 ft (15 m)

Andrecito Member--Medium-light-gray limestone and marl, thin-bedded with uneven bedding surfaces; argillaceous; poorly exposed slope-former. Contains abundant fenestelloid bryozoans. Thickness 30 ft (9 m)

Caballero Formation--Upper 18.3 m thin-bedded limestone with silty and argillaceous partings and minor black ropy chert, sparsely crinoidal. Lower 2.4 m a medium-gray to brownish-gray crossbedded very fine-to fine-grained arenaceous limestone. Formation confined to southeast corner of quadrangle near the Wilson ranch. Thickness 0-68 ft (0-21 m)

Dp PERCHA SHALE (UPPER DEVONIAN)--Total thickness about 160 ft (49 m)

Box Canyon Member--Dark-gray to olive-black shale containing thin discontinuous dark-gray silty limestone nodules. Thickness 25-30 ft (8-9 m)

Ready Pay Member--Black to olive-black highly fissile shale. Thickness about 135 ft (41 m)

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

Fusselman Dolomite--Medium-gray to dark-olive-gray dolomite; lowest 35 ft (10.7 m) weathers very light gray to light yellowish gray. Very finely crystalline to aphanitic, slightly silty; upper 40 ft (12.2 m) cherty and highly siliceous on weathered outcrop. Medium- to thick-bedded; thin discontinuous penecontemporaneous breccias locally present. Poorly fossiliferous. Thickness 85-143 ft (26-44 m)

Montoya Group--Total thickness 310-340 ft (94-104 m)

Cutter Dolomite--Medium-gray to medium-light-gray dolomite; thick bedded to massive in upper 131 ft (40 m); laminated to thin bedded in lower 65 ft (20 m). Poorly fossiliferous except for a few silicified colonial corals (Mesofavosites sp.). Thickness 195 ft (60 m)

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

Second Value Dolomite--Total thickness 70-110 ft (21-34 m). Includes 4 units, from top downward: Medium-gray thick-bedded to massive finely crystalline dolomite; thickness 35 ft (11 m). Light-gray massive dolomite containing abundant disseminated rounded and frosted quartz grains having a bluish opalescence and as much as 4 mm across; thickness 30 ft (9 m). Medium-dark-gray to black massive dolomite 15-45 ft (5-14 m) thick; locally crackled with white fracture-fillings of secondary calcite. Cable Canyon Sandstone Member, a white quartzose vitreous fine-grained massive sandstone; locally quartzitic. Crops out as fault slice 1/4 mi (0.4 km) southwest of the Gray Eagle mine along South Percha Creek. Thickness 9-20 ft (0-6 m)

OCp EL PASO LIMESTONE (LOWER ORDOVICIAN)--Limestone and very minor amounts of dolomite. Limestone is medium gray, thin to medium bedded, aphanitic to finely crystalline, and locally pelletal. Contains units of slightly silty crenulated laminae that weather brown. Cherty limestone beds with an aggregate thickness of 5-10 ft (1.5-3 m)

are common 110 ft (33.5 m) below top. Lowest 15 ft (5 m) of section contain thin beds of alternating siltstone and limestone that weather light brown. Poorly fossiliferous except for Maclurites sp. and trilobite fragments. Total thickness 460-480 ft (140-146 m)

O€b BLISS SANDSTONE (LOWER ORDOVICIAN AND UPPER CAMBRIAN)--Light-brown, dark-greenish-gray, olive-gray, and dusky-red, strongly indurated, locally quartzitic. Upper two-thirds is thin bedded; lower third is massive to thick bedded. Uppermost beds are commonly glauconitic. Massive hematitic sandstone beds with a total thickness of 8 ft (2.4 m) crop out about 10 ft (3 m) above base. Maximum thickness about 110 ft (34 m)

PRECAMBRIAN ROCKS

p€gs Granite of Seven Brothers Mountain--Light-pinkish-gray, coarsely crystalline with aplitic dikes and segregations; hypidiomorphic-granular with perthitic microcline grains as much as 2 cm across (25-32 percent), albite (33-37 percent), quartz grains as much as 8 mm across (33 percent), biotite (1-3 percent), and accessory epidote, ferric oxides, apatite, and sericite. Very weakly foliated except along faults

p€gd Granite of Dumm Canyon--Light-pinkish-gray to light-greenish-gray, medium-grained; hypidiomorphic-granular with perthitic microcline (27 percent), albite (32 percent), quartz (40 percent), biotite (1 percent), and accessory sericite and apatite. Brecciated and mineralized near the Ingersoll mine where silver-bearing base metals follow fractures that strike N. 80°-85° W.

p€g Granophyre of North Percha Creek--Light-pinkish-gray, fine- to medium-grained; allotriomorphic-granular with myrmekitic to micrographic intergrowths of quartz and microcline. Approximately equal amounts of microcline and oligoclase (An_{27}) (65-70 percent), quartz (30-35 percent), and biotite and ferric oxides (more than 1 percent). Irregular clots of blue-green hornblende locally present. Elongate

septa of amphibolite and hornblende schist within the granite are alined north-northeast and northeast

p€s Quartzofeldspathic gneiss of Tank Canyon--Pale-brownish-gray, fine- to medium-grained; contains poorly twinned and sericitized albite (70 percent) and about 30 percent quartz. The quartz is present as aggregated granules alined in the surface of foliation. Biotite and ferric oxides are accessory minerals. The gneiss contains thin layers of hornblende schist that strike N. 0°-5° E. parallel to the foliation

p€h Hornblende schist, amphibolite, chlorite schist, and phyllite--Greenish-black highly foliated rocks with abundant hornblende and chlorite crop out in 4 small fault blocks: (1) along the north side of North Percha Creek, (2) along South Percha Creek east of the Gray Eagle mine, (3) on the south side of Picket Spring Canyon, and (4) along the east side of Pierce Canyon. The North Percha Creek outcrop is characterized by greenish-black hornblende schist and gneiss that contains bluish-green hornblende, andesine (An_{35}), chlorite, epidote, and minor amounts of quartz; the schist and gneiss are strongly foliated N. 45°-70° E. The South Percha outcrop consists of fine-grained quartzofeldspathic gneiss with interlayered hornblende and quartz-chlorite schist of metasedimentary origin; relict graded bedding in the quartz-chlorite schist strikes N. 70°-85° E. The Picket Spring outcrop is characterized by grayish-green spotted chlorite schist with porphyroblasts of blue-green hornblende as much as 7 mm in length; the gneiss also contains oligoclase (An_{25}), quartz, clinozoisite, and epidote. The Pierce Canyon outcrop consists of light-pinkish-gray quartzofeldspathic gneiss that has been partly sheared to quartz-chlorite schist; the schist and gneiss are strongly foliated N. 85° E.

ECONOMIC GEOLOGY

Base metal and associated gold, silver, and manganese deposits occur in the quadrangle. The silver-bearing base metal deposits are primarily of middle Tertiary age and are localized along major north-northwest-striking faults. Fissure veins and bedding-replacement deposits are most common in the Fusselman Dolomite and El Paso Limestone; many deposits are localized in the Fusselman Dolomite just below the Percha Shale, for example, in the Kingston and Tierra Blanca districts. The mineralization is associated with a low-grade thermal metamorphism of the dolomite and limestone host rock along major faults. Talc, tremolite, and serpentine are locally common in areas of intensive mineralization. In addition to the silver-bearing base metal deposits a low-grade copper porphyry-type deposit is associated with the Laramide (73.4±2.5 m.y., R. F. Marvin, H. H. Mehnert, and Violet Merritt, U.S. Geol. Survey, written commun., 1974) quartz monzonite of the Copper Flat stock near Hillsboro (F. J. Kuellmer, 1955). Radial vein and dike systems about the Copper Flat stock are mineralized, and gold-bearing fissure veins have provided the source for both lode and gold placer deposits. Harley (1934) reported that the total gold production from the district between 1877 and 1931 totaled about 149,000 ounces (4,634 kg), of which about two-thirds of the production was from the placer deposits near the old Golddust Camp. The manganese deposits are in the Kingston district, where manganese oxides occur in about 18 small and discontinuous replacement bodies parallel to veins and faults (L. L. Farnham, 1961). The manganese oxides have formed from the weathering of rhodochrosite and alabandite which are gangue minerals associated with the silver-bearing base metal deposits in the North Kingston district. It is estimated that about 5,700 tons (5,690 metric tons) of manganese ore averaging about 30 percent manganese were extracted from the Kingston district between 1943 and 1958.

At least 74 silver-bearing base metal deposits have been examined, of which about 50 percent are localized along fissure veins within the Fusselman Dolomite. The most extensive vein system is in the Kingston district where an estimated 6 million ounces (186,600 kg) of silver was

mined between 1880 and 1893. Veins along the Bullion fault and within the Fusselman Dolomite have been mined over a length of 3,000 ft (915 m); the mines located along or near this fault include the Bullion, Superior, and Lady Franklin. Along the west side of Ladrone Gulch, fault breccia zones that strike N. 10°-20° W. are mineralized at the United States, Andy Johnson, Brush Heap, Pride of the Camp, and Black Eyed Susan mines. Most of these mines are along the fault contact of the Fusselman Dolomite with the Percha Shale and Lake Valley Limestone. The Iron King, Miners Dream, Blackie, and Tall Pine mines are located along the Iron King fault which has displaced the Magdalena Group downward on the west against the Fusselman Dolomite and Montoya Group; these mines contain appreciable rhodochrosite and rhodonite gangue and have also been exploited for manganese. The silver content of the unoxidized ore is as much as 790 ppm (6 analyses) and the chief silver mineral is argentite; the galena is argentiferous and contains as much as 1,300 ppm silver. Other ore minerals include pyrite, sphalerite, chalcopyrite, alabandite, cerargyrite, and polybasite.

Within the Tierra Blanca district the Log Cabin, Jayhawk, and Silvertail mines are located along or near the north-striking Pierce Canyon fault. All of these mines are in the upper part of the Fusselman Dolomite near the contact with the Percha Shale. Talcose shear and breccia zones within the dolomite contain argentite, pyrite, sphalerite, and galena. The Lookout mine, which is also in the Tierra Blanca district, shows silver mineralization near the contact of a rhyolite dike and sill within the Bliss Sandstone and El Paso Limestone. This mine contains the only silver tellurides, hessite and calaverite, within the district. The total silver production from the Lookout, Log Cabin, Jayhawk, and Silvertail mines is estimated to be 165,000 ounces (5,132 kg).

To the north of Kingston, the Virginia and Ingersoll mines are located along large faults and fissures within Precambrian granitic rocks. At both mines there is extensive sericitization of the granite near the fissure veins and the ores are highly pyritic. The fissure vein at the Ingersoll mine is along N. 80° E.- and N. 85° W.-striking fractures that are locally offset by

north-striking faults. The fissure vein at the Ingersoll is about 1,500 ft (457 m) long and 10-20 cm thick; the average grade of the ore is about 17.7 ounces per ton (0.55 kg/t). The veins at the Virginia and Ingersoll mines contain sphalerite, galena, chalcopyrite, argentite, polybasite, cerargyrite, and chalcocite. The galena contains as much as 700 ppm silver, and some of the sulfide concentrates from the Ingersoll mine contain 17,800 ppm silver.

Along Sawpit Canyon, 2 mi (3.2 km) north-northeast of Kingston, the Gypsy mine is localized along faults that have brought the Lake Valley Limestone into contact with the Fusselman Dolomite. About 190,000 ounces (5,909 kg) of silver has been extracted from proustite-pyrargyrite-argentite-bearing ores.

The small quartz monzonite body of Copper Flat is a relatively nonweathered subvolcanic stock that has intruded andesite and andesite breccias of Late Cretaceous age. The quartz monzonite has been dated by the K-Ar method as 73.4±2.5 m.y. The outcrop of quartz monzonite is small and measures about 0.4 square mile (1.04 km^2) and the copper mineralization is mainly confined to the central part of the intrusion (Kuellmer, 1955). Numerous fracture-fillings and disseminations of pyrite, chalcopyrite, and bornite are present in the altered central parts of the stock. Late-stage deuteric effects resulted in the pegmatization of the quartz monzonite and the generation of abundant secondary silica. Locally magnetite is abundant in the areas marginal to the central part of the stock and the magnetite commonly replaces the biotite. The sulfides are later than the magnetite and the magnetite is partly replaced by hematite. In places the quartz veins contain molybdenite but generally the molybdenum values are small, 0.009 to 0.024 percent Mo. The copper reserves, as projected to an average depth of about 700 ft (213 m) with an area of about 0.1 square mile (0.26 km^2) are an estimated 4.2 million tons (4.19 metric tons), assuming a grade of 0.5 percent copper or more.

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