UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Geologic map and sections of the Steeple Rock quadrangle, Grant and Hidalgo Counies, New Mexico

By

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This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards nor with the North American stratigraphic code.

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ILLUSTRATIONS

TABLES

DESCRIPTION OF MAP UNITS

Qa **Alluvium (Holocene)**--Poorly sorted gravel, sand, and silt containing fragments of Tertiary volcanic rock. Thickness generally less than 10 ft (3 m)

Qf **Fan deposits (Holocene and (or) Pleistocene)**--Sheet-flood fan deposits contain chiefly subangular to angular, poorly sorted fragments of Tertiary volcanic rock. Thickness commonly less than 80 ft (25 m) thick

Qfo **Older fan deposits (Pleistocene)**--Sheet-flood fan deposits and some residual lag deposits with chiefly angular fragments of Tertiary volcanic rock. Lag deposits are derived from the underlying weathered Gila Conglomerate. Thickness locally exceeds 200 ft (60 m)

QTg **Gila Conglomerate (Pleistocene, Pliocene, and Miocene)**--Lower part consists of coarse-grained rhyolitic fanglomerate with abundant very light gray, angular, rhyolite fragments up to 30 cm across. Upper part consists of light-brown to tan, poorly sorted sandstone and conglomerate. Contact between two units is gradational. Maximum exposed thickness about 300 ft (90 m)

RHYOLITE OF MULE MOUNTAINS (MIOCENE)

Trm **Rhyolite flows**--Very light gray to white, flow-laminated, aphanitic to slightly porphyritic rhyolite; basal part of some flows consists of black vitrophyre. Maximum thickness about 200 ft (60 m). Flows probably erupted from small plugs at Deer Peak and along Alexander Canyon. Unit correlates with Mule Mountain Rhyolite of Rhodes and Smith (1973) and Rhyolite of Mule Creek (Ratté and Brooks, 1989)

Trvm **Vitrophyre**--Black to dark-gray, perlitic, vitrophyre units at base of rhyolite flows; locally spherulitic at contact with rhyolite. Variable thickness but locally as much as 100 ft (30 m). Whole rock potassium-argon age of 18.6 m.y. is reported from obsidian nodules in outcrops along the north side of New Mexico-Arizona State Highway 78 (Weber and Bassett, 1963). Marvin and others (1987) report an age of 17.7±1.9 m.y. for the Rhyolite of Mule Creek

Ttm **Air-fall tuff and tuffaceous sandstone**--Very light gray, light-pinkish-gray, light-greenish-gray, thin-bedded to laminated, air-fall tuff with thin interbeds of tuffaceous sandstone. Locally contains abundant non-compressed pumice fragments that are slightly altered to light greenish gray. Angular, reddish-brown, latitic lithic fragments are locally abundant at base. Phenocrysts constitute less than 5 percent of the air-fall tuff. Thickness ranges from 0 to 100 ft (0-30 m)

Tr **Rhyolite dikes and plugs**--Very light gray, aphanitic to slightly porphyritic, flow-laminated, high-silica, rhyolite dikes. Many dikes are coextensive with northwest-striking faults and joints. Marginal breccia zones along some rhyolite dikes are locally mineralized, e.g. at the Jumbo and Alabama mines. Other rhyolite dikes are sericitized, especially those along the southwest side of Vanderbilt Peak. Dikes contain generally less than 10 percent phenocrysts of sanidine and bipyramidal quartz. Maximum thickness about 100 ft (30 m). Potassium-argon age probably between 17 and 21 m.y.

Tri **Rhyolite plugs**--Very light gray to pinkish-gray and light-gray, aphanitic to slightly porphyritic rhyolite with highly contorted and well developed flow laminae. Plugs form a series of northwest-trending elongate intrusions at Telephone Ridge, Raeburn Windmill, Pinon Mountain, Vanderbilt Peak, and near Hext Place. Some of the more elongate plugs represent expanded rhyolite dikes. The Telephone Ridge intrusion is an altered (silicic and alunitic) rhyolite dike-tuff complex that locally contains thin (<10 ft) brown-weathering tuff lenses. These tuff beds are discontinuous, show abrupt terminations, and represent intermittent hot-ash eruptions that accompanied the intrusion of rhyolite. The Telephone Ridge intrusion may be a sill or laccolithic body. The rhyolite is generally phenocryst-poor with only about 10 to 15 percent phenocrysts of sanidine, quartz, plagioclase, and biotite. A chemical analysis of a highly potassic rhyolite plug 0.5 mi south of Vanderbilt Peak shows the presence of 77.0 percent SiO_2, 0.70 percent Na_2O, and 7.98 percent K_2O (sample SR-42-83, table 1) (Analysts: A.J. Bartel, J. Taggart, and K. Stewart; U.S. Geological Survey, 1983)

Tqmd **Quartz monzonite porphyry dike (Miocene)**--Medium-light-gray porphyry with 20 to 30 percent oligoclase (An_{28}) phenocrysts as much as 1.5 cm across in a felted groundmass. Biotite and hornblende comprise about 5 percent of rock and zircon is a common accessory mineral. A fission-track age of 21.4±1.6 m.y. is reported for zircon (C.H. Thorman, written commun., 1979); dike is probably coeval with other silicic dikes in the area. Quartz monzonite dike has a maximum thickness of about 100 ft (30 m) and can be traced for about 5 mi (8 km)

Tlpc **Lava flows of Crookson Peak (Oligocene)**--Dominantly grayish-red dacitic lavas that locally weather dusky-red and form rubbly to platy outcrop debris. Flows form a prominent southwest-facing erosional scarp defined by the Apache Box, Crookson Peak, Juniper Peak, and Kemp Peak to the southeast. Dacitic flows commonly contain 10 to 20 percent oligoclase-sodic andesine (An_{28-33}) phenocrysts that locally show a glomeroporphyritic texture. The groundmass is felted to pilotaxitic with disseminated iron oxides and accessory clinopyroxene granules. Maximum thickness about 1,000 ft (305 m)

BASALTIC AND ANDESITIC ROCKS OF DARK THUNDER CANYON AND INTERLAYERED SILICIC TUFFS (OLIGOCENE)

Tbd **Basaltic flow member**--Dark-gray, medium-olive-gray, and brownish-gray; massive to vesicular and amygdaloidal lava flows of dominantly basaltic composition (SiO_2=46.9 percent). Unit also consists of some porphyritic basaltic andesite flows that contain as much as 30 percent andesine (An_{36-45}) laths 1 cm long. The groundmass is pilotaxitic to felted, contains abundant magnetite-ilmenite granules, and accessory amounts of clinopyroxene and oxyhornblende. Unit is repeated by faulting and the amygdaloidal flows at Black Hill are considered a faulted part of the Dark Thunder sequence. Maximum thickness about 2,600 ft (800 m)

Ttc **Ash-flow tuff of Croom Ranch**--Very light gray, partially welded, devitrified, crystal-poor, ash-flow tuff; the highly recrystallized groundmass consists of poorly compressed ash shards. Phenocrysts include 1 to 3 percent sanidine, 3 to 7 percent bipyramidal quartz, and traces of biotite, plagioclase, and oxyhornblende. Thickness ranges from 0 to 100 ft (0-30 m)

Tld **Dacite porphyry of Walker Canyon**--Very small outcrop of dacite along east margin of quadrangle. A light-brownish-gray, flow-laminated, aphyric to slightly porphyritic lava flow containing up to 5 percent sodic andesine (An_{30-33}) phenocrysts and accessory oxyhornblende and iron oxides. Thickness ranges from 0 to 160 ft (0-50 m)

Tdt **Ash-flow tuff**--Yellowish-gray, pinkish-gray to light-gray, nonwelded but well-indurated, ash-flow tuff that forms the upper part of a paired sequence with the Bloodgood Canyon Tuff. Ash-flow contains 4 to 7 percent phenocrysts of sanidine and quartz; accessory minerals are biotite and sphene. Thickness ranges from 0 to 50 ft (0-15 m)

Tts **Air-fall tuff**--Very light gray, devitrified, partially welded, air-fall tuff that occurs at the base of the basaltic andesite flows near the Goldenrod and East Camp mines. Tuff is crystal-poor containing about 3 percent bipyramidal quartz and 1 percent sanidine phenocrysts; accessories are biotite and oxyhornblende. Discontinuous unit 0 to 50 ft (0-15 m) thick

Ttsd **Sandstone member**--Yellowish-gray, light-greenish-gray, grayish-green, thin-bedded to laminated, medium coarse- to coarse-grained sandstone that occurs near the base of the basaltic andesite in the vicinity of the Thanksgiving mine. Angular sand-size clasts of andesite and dacite are cemented by celadonite and iron oxides. Highly discontinuous and faulted beds as much as 100 ft (30 m) thick

Tbg **Bloodgood Canyon Tuff (Oligocene)**--Light-brownish-gray, densely welded, devitrified ash-flow tuff contains about 10 percent crystal fragments up to 3 mm across. Crystals include 8 percent sanidine and 2 percent bipyramidal quartz. Accessory minerals are sphene, biotite, and iron oxides. $^{40}Ar/^{39}Ar$ age of 28.05±0.04 Ma (W.C. McIntosh, written commun., 1989) is considered to be most accurate. Maximum thickness about 200 ft (60 m)

Tdc **Davis Canyon Tuff (Oligocene)**--Light-brownish-gray, densely welded, crystal-poor, devitrified, ash-flow tuff with distinctive very light gray, "stringy" compressed pumice lapilli up to 7 mm across. Concretionary bodies up to 20 cm in diameter occur along the upper surface of the ash flow. Tuff contains 1 to 2 percent phenocrysts of plagioclase, sanidine, and quartz; accessories include oxybiotite and sphene. $^{40}Ar/^{39}Ar$ age of 29.0±0.11 Ma (W.C. McIntosh, written commun., 1989) is considered to be most accurate. Tuff occurs as discontinuous sheet 0 to 150 ft (0-45 m) thick beneath Bloodgood Canyon Tuff near Davenport Canyon

Tds **Volcaniclastic rocks (Oligocene)**--Light-greenish-gray to light-brownish-gray, thin-bedded, coarse-grained sandstone that commonly grades downward into a bouldery conglomerate consisting of dacitic boulders and cobbles. Discontinuous unit ranges from 0 to 200 ft (0-60 m) in thickness

DACITE OF SUMMIT MOUNTAIN (OLIGOCENE)

Tdps **Dacite porphyry flows**--Grayish-red-purple, pale-purplish-gray, pale-red, porphyritic dacite flows with intercalated ash-flow tuffs and sandstone. Dacitic flows contain 15 to 40 percent phenocrysts as much as 4 mm across. Phenocrysts include 10-35 percent andesine (An_{38-45}), 1-5 percent oxyhornblende, and 1-3 percent biotite; accessory minerals are clinopyroxene, calcite, white mica, quartz, and iron oxides. Moderately developed propylitic alteration along faults. Chemical analyses of unaltered dacite porphyry from Laura Canyon indicate 59.7 percent SiO_2, 3.6 percent Na_2O, and 3.3 percent K_2O (sample SRX-122-78, table 1), and from near Vanderbilt Peak 66.0 percent SiO_2, 3.4 percent Na_2O, and 4.0 percent K_2O (sample SR-41-83, table 1). Unit is repeated by faulting but may be as much as 2,000 ft (610 m) thick

Tdpd **Porphyritic dacite**--Pale-red, highly porphyritic dacite flow just east of New Seep Windmill contains about 35 percent andesine (An_{35-38}) phenocrysts up to 6 mm across. Groundmass has distinctive devitrified spherulitic texture with relict perlitic fractures. Dacite contains as much as 5 to 6 percent oxyhornblende and 2 percent biotite phenocrysts. Maximum thickness about 200 ft (60 m)

Tlps **Sandstone member**--Light-greenish-gray, dusky-red, very light gray to light-brown, thin-bedded to laminated, medium-grained sandstone. Locally highly crossbedded as near the Carnation mine. Angular sand-size clasts of dacite and andesite are most common and the matrix is commonly of celadonite. Some outcrops, as near the Center mine, are silicified and sericitized. Some units are repeated by faulting and therefore the correlation of various sandstone units is uncertain. Thickness generally less than 100 ft (30 m)

Tdr **Aphyric dacite flow member**--Medium-gray, aphyric, flow-laminated, platy weathering dacitic lava flows with locally reddened flow tops. Unit locally contains sparse, stubby, highly zoned oligoclase (An_{25-28}) phenocrysts about 0.5 mm across in a felted groundmass. Accessory oxyhornblende and clinopyroxene

Tcb **Caballo Blanco Tuff (Oligocene)**--White to light-brownish-gray to light-pinkish-gray, densely welded, devitrified, ash-flow tuff that displays evidence of intensive gas phase alteration. Tuff contains about 20 percent crystal fragments including 8 percent sanidine, 6 percent oligoclase (An_{12-14}), and 8 percent bipyramidal quartz; accessories are biotite and iron oxides. Discontinuous outcrop pattern probably reflects deposition on an irregular topography; maximum thickness about 170 ft (52 m). $^{40}Ar/^{39}Ar$ age of 31.71±0.12 Ma (McIntosh, Sutter, Chapin, and Kedzie, 1990)

Td **Ash-flow tuff of Davenport Canyon (Oligocene)**--Light-brownish-gray to medium-light-gray, densely welded, devitrified, ash-flow tuff containing about 25 to 28 percent crystal fragments including 25 percent andesine (An_{40-42}) distinctive, vitreous, dark-green clinopyroxene. Accessory minerals are oxyhornblende, biotite, quartz, and iron oxides. Thickness ranges from 0 to 160 ft (0-50 m)

Tstd **Sandstone Member (Oligocene)**--At base of ash-flow tuff (Td), a medium light-brownish-gray, thin-bedded, medium- to coarse-grained sandstone unit is as much as 50 ft (15 m) thick

Ttd **Air-fall tuff (Oligocene)**--Light-yellowish-gray, laminated air-fall tuff with as much as 10 percent biotite and accessory amounts of sanidine and quartz. Thickness 0 to 20 ft (0-6 m)

Tmt **Ash-flow tuff (Oligocene)**--Light-gray to pinkish-gray, moderately welded, devitrified, crystal-poor ash-flow tuff containing abundant reddish-brown aphyric lava fragments at base. Discontinuous unit 0 to 50 ft (0-15 m) thick

Tahi **Andesite porphyry plug of Horse Camp Peak (Oligocene)**--Medium light-gray to pale-red-purple, porphyritic andesite plug containing about 15 percent phenocrysts up to 5 mm across in a very finely felted groundmass. Phenocrysts are 10 to 15 percent olgioclase (An_{20-23}) and 2 percent biotite with as much as 2 percent iron ore granules dispersed through the groundmass. Plug has a weakly developed columnar jointing

Trsr **Rhyolite of Steeple Rock (Oligocene)**--Light-gray, pale-red, light-brownish-gray, flow-laminated, devitrified, locally spherulitic, rhyolitic lava flow or dome. Secondary chalcedonic quartz fills elongate vugs along contorted flow laminae. Phenocrysts are 2 percent sanidine, and 1 to 2 percent biotite. Accessories are quartz, oxyhornblende, and iron oxides. Thickness ranges from 0 to 400 ft (0-120 m). A biotite concentrate yielded a K-Ar age of 33.1±1.1 m.y. (R.F. Marvin, H.H. Mehnert, and V.M. Merritt, written commun., 1979). A concealed vent for the flows may be present near the Old Man Hext Windmill

Tdm **Aphyric dacite flows (Oligocene)**--Medium-gray, flow-laminated, phenocryst-poor, dacitic lava flows with locally reddened flow tops. Secondary quartz veinlets and vug-fillings locally common. Unit thins appreciably to the northeast

Tqd **Diorite plug (Oligocene)**--Very light gray to light-brownish-gray, fine-grained, hypidiomorphic-granular diorite that typically weathers to spheroidal boulders. Contains about 85 percent andesine (An_{42}) laths 1 to 2 mm long, 10 percent biotite, 1 to 2 percent hornblende, 3 to 4 percent iron oxides, including abundant magnetite, and accessory calcite and apatite. Small plug in S1/2 sec. 31, T. 17 S., R. 20 W.

TUFF SEQUENCE OF MUD SPRINGS AND INTERLAYERED VOLCANIC AND VOLCANICLASTIC ROCKS (OLIGOCENE)

Ttm-12 **Ash-flow tuff**--Pale-yellowish-gray, poorly welded but indurated tuff contains about 5 percent phenocrysts of sanidine and plagioclase. Some yellowish-green argillic alteration of the poorly compressed pumice lapilli. Locally abundant lithic fragments of dacite near the base. Thickness 0 to 80 ft (0-25 m)

Trss **Volcaniclastic rocks of Steeple Rock**--Grayish-green, celadonitic, tuffaceous sandstone with minor thin beds of air-fall tuff. Thin- to medium-bedded, medium- to coarse-grained, clastic rocks consist of angular, sand-size, andesite fragments. Some of the poorly compressed pumice in the air-fall tuff units are altered to dark-green celadonite. Thickness ranges from 0 to 200 ft (0-60 m)

Tdi **Rhyodacite of Carlisle Canyon**--Light-brownish-gray to pale-red, contorted and steeply dipping flow-laminated rhyodacite dome containing about 35 percent phenocrysts 2-3 mm across in a devitrified-spherulitic groundmass. Phenocrysts are 25 percent oligoclase (An_{27-30}), 1 percent sanidine, 2 percent quartz, and 3 to 5 percent biotite. Accessory minerals are iron oxides, oxyhornblende, and apatite. Thickness ranges from 0 to 400 ft (0-125 m)

Ttm-11 **Ash-flow tuff**--Pale-orange-gray, poorly welded, devitrified, lithic-rich, crystal-poor tuff. Contains about 1 to 2 percent distinctive bronzy biotite. Thickness ranges from 0 to 280 ft (0-85 m)

Tam **Andesite of Mount Royal**--Medium-gray to purplish-gray andesite porphyry contains about 20 percent andesine (An_{38-42}) phenocrysts up to 7 mm across. Fractures in some flows locally contain abundant radiating aggregates of natrolite. Thick series of lava flows that intertongue to the southeast with ash-flow tuff members in the Mud Springs Peaks area. Thickness about 800 ft (250 m)

Ttm-10 **Ash-flow and air-fall tuff**--From top to bottom the following unmapped units can be recognized:
(1) **Ash-flow tuff**--Purplish-gray to pale-red-purple, densely welded, devitrified tuff with locally abundant lithophysae up to 3 cm across. Rock typically contains 10-12 percent sanidine, 4 percent oligoclase (An_{28-30}), and 13 percent quartz phenocryst fragments up to 4 mm across. Accessory minerals are biotite and iron oxides. Unit is about 10 ft (3 m) thick and locally has a white, nonwelded, basal unit up to 6 ft (1.8 m) thick
(2) **Ash-flow tuff**--Purplish- to brownish-gray, nonwelded tuff containing about 50 percent angular dacitic lithic fragments and about 20 percent white to very light gray compressed pumice fragments up to 2 cm across. Unit thickness about 50 ft (15 m)

(3) **Air-fall tuff**--Medium-light-gray, bedded air-fall tuff with interbeds of coarse-grained tuffaceous sandstone. Contains non-collapsed pumice fragments. The sandstone beds are coarse grained, thin bedded, and consist of angular andesite clasts. Unit about 20 ft (6 m) thick

Ttm-9 **Ash-flow and air-fall tuff**--Member is divisible into two parts: (1) Upper part consists of pale-red to light-gray, densely welded ash-flow tuff with a white-weathering cap rock. Tuff contains 15 to 20 percent crystal fragments of which 15 percent are sodic andesine (An_{33-35}) and 2 percent are biotite; accessories are quartz, sanidine, and iron oxides. Thickness about 120 ft (36 m) (2) Lower part consists of very light gray, poorly welded, bedded, air-fall tuff that contains as much as 15 percent lithic fragments of rhyolite and dacite a few centimeters across. Maximum thickness about 40 ft (12 m)

Ttm-8 **Ash-flow tuff**--Very light gray, densely welded, devitrified tuff contains 15 to 20 percent phenocrysts. Base of ash-flow contains abundant dacitic lithic fragments. Phenocrysts consist of 10 to 12 percent calcic oligoclasse (An_{28-30}), 1 to 4 percent bluish chatoyant sanidine, 0 to 4 percent quartz, and 1 to 2 percent biotite. Accessory minerals are oxyhornblende and iron oxides. A biotite sample from the same unit in the adjacent Steeple Rock 2SE quadrangle yielded a K-Ar age of 33.8±1.1 m.y. (R.F. Marvin, H.H. Mehnert, and V.M. Merritt, written commun., 1979). Thickness ranges from 0 to 100 ft (0-30 m)

Ttm-7 **Air-fall tuff and tuffaceous sandstone**--An upper air-fall tuff is light brownish gray, lithic rich, nonwelded, and contains thin interbeds of light-brown, thin-bedded, tuffaceous sandstone. The lower air-fall tuff contains abundant andesite lithic fragments up to 3 cm across and blocks of welded tuff 30 to 40 cm across. Interlayered andesite porphyry flows (Tam) are locally present. Total aggregate thickness ranges from 0 to 240 ft (0-73 m)

Tcsr **Sandstone**--Light-brown to brown, thin-bedded, medium- to coarse-grained, poorly sorted sandstone. Thickness ranges from 0 to 15 ft (0-5 m)

Ttm-6 **Ash-flow tuff**--White, densely welded, devitrified, crystal-poor tuff contains about 2 to 3 percent sanidine phenocrysts and traces of biotite. The groundmass is recrystallized suggesting some gas phase alteration. Thickness ranges from 0 to 230 ft (0-70 m)

Ttm-5 **Ash-flow tuff**--Light-gray, light-brownish-gray, purplish-gray, and brown-weathering ash-flow tuff. Persistent ridge-former which comprises most of the Mud Springs Peaks. Tuff contains 10 to 12 percent oligoclase (An_{28-30}) crystals; accessory minerals are sanidine, biotite, and iron oxides. Upper half of unit is very light brownish gray, densely welded, devitrified, and commonly forms a cap rock to the lower slabby-weathering purplish-gray tuff. Lower half is purplish gray, rubbly, dark weathering, and contains about 10 percent lithic fragments of andesite. Total aggregate thickness ranges from 0 to 240 ft (0-75 m). A biotite concentrate has yielded a K-Ar age of 32.0±1.1 m.y. (R.F. Marvin, H.H. Mehnert, and V.M. Merritt, written commun., 1979)

Ttm-4 **Ash-flow tuff**--Light-brownish-gray, densely welded, devitrified, slabby-weathering ash-flow tuff. Upper part has abundant rhyolitic lithic fragments as much as 2 cm across. Thickness ranges from 0 to 190 ft (0-60 m)

Ttm-3 **Rhyolitic breccia**--Very light gray, massive, poorly stratified, sedimentary breccia consisting of abundant, closely packed, angular, rhyolite fragments as large as 30 cm across. Thin andesite flows and andesitic autobreccias occur within the unit along the distal western end of the outcrop. Aggregate thickness ranges from 0 to 160 ft (0-50 m)

Ttm-2 **Ash-flow tuff**--Yellowish-gray, lithic-rich, nonwelded tuff about 30 ft (9 m) thick is underlain by a light-brownish-gray to purplish-gray, massive, densely welded, devitrified, ash-flow tuff with compressed yellowish-gray pumice lapilli. Locally an unmapped, discontinuous, light-brown, thin-bedded sandstone overlies the nonwelded tuff. The welded ash-flow tuff is as much as 160 ft (50 m) thick

Tcs **Sandstone**--Greenish-gray, thin-bedded, medium coarse-grained, celadonitic sandstone that locally grades upward into light-brown, medium-bedded, tuffaceous sedimentary breccia. Thickness ranges from 0 to 115 ft (0-35 m)

Ttm-1 **Ash-flow tuff**--Pale-red, welded, devitrified, ash-flow tuff contains about 5 percent crystals of sodic oligoclase (An_{25-27}) and sanidine, and about 10 percent dacitic lithic fragments. Abundant very light gray, poorly compressed pumice lapilli at the base but tuff is more welded in upper part. Thickness ranges from 0 to 250 ft (0-75 m)

ANDESITE OF MUD SPRINGS PEAKS (OLIGOCENE)

Tapm **Andesite porphyry**--Medium-gray, porphyritic andesite flows containing about 25 percent phenocrysts of zoned andesine (An_{40-45}) set in a pilotaxitic groundmass. Accessory minerals are clinopyroxene, oxyhornblende, and iron oxides. Maximum thickness about 1,200 ft (365 m)

Tapb **Andesitic sedimentary breccia**--Reddish-brown, massive to thick-bedded, poorly sorted, coarse, laharic breccias containing angular andesite fragments up to 20 cm across. Outcrop weathers to spire and pinnacle forms. Unit interlenses with the andesite porphyry (Tapm) and fills a highly irregular topography on andesite flows (Tbm below). Thickness varies from 0 to 250 ft (0-75 m)

Tmd **Dacite porphyry dikes**--Light-brownish-gray to grayish-red porphyritic dikes containing about 15 to 20 percent phenocrysts of plagioclase 1 to 2 mm across. Accessory ferric oxides and oxyhornblende dispersed through felted groundmass. Dikes less than 10 ft (3 m) thick

Tbms **Andesite porphyry sill**--Medium-gray, porphyritic sill in sandstone beds of the Virden Formation of Elston (1960) (TKs). Sill is thin, less than 10 ft (6 m) exposed

Tasm **Sandstone**--Very light gray to yellowish- and greenish-gray, thin-bedded to laminated, medium- to coarse-grained, micaceous sandstone. Thickness 0 to 180 ft (0-55 m)

Tbm **Andesite**--Dark-gray to greenish-gray, aphanitic to slightly porphyritic, amygdaloidal to vesicular flows with minor celadonitic alteration and some secondary calcite vug-fillings. Flows typically contain 5 to 10 percent phenocrysts of andesine (An_{42-45}) in a pilotaxitic groundmass; accessory clinopyroxene, oxyhornblende, and iron oxides. Thickness is 150 ft (45 m)

VIRDEN FORMATION OF ELSTON (1960) (PALEOCENE AND (OR) UPPER CRETACEOUS)

TKsb **Arkosic sedimentary breccia**--Moderate-reddish-orange, thick-bedded, coarse-grained, poorly sorted, arkosic sandstone and sedimentary breccia containing abundant angular blocks of Precambrian granite up to 2.5 ft (0.8 m) across. The granite fragments are lithologically similar to the granite outcrops along the Mud Springs Ranch road in the Canador Peak quadrangle to the south. The formation of the arkose is indicative of the beginning of Laramide block faulting in this region. Maximum thickness of the arkose is about 20 ft (5 m)

TKs **Sandstone, siltstone, pebble conglomerate, and minor black shale**--Dominantly fluviatile-deltaic sediments consisting of alternating beds of pale-yellowish-brown sandstone and siltstone with intercalated basalt- and granite-cobble conglomerate in the upper part. Black, opalized fossil wood is common in parts of the unit and the wood fragments are indicative of a late Montana to early Lance age (Morrison, 1965). Angular, sand-size andesite clasts occur within sandstone beds of the upper sequence and typically weather a dark purplish gray. Sandstone beds in lower part of section are quartzose but contain as much as 10 percent interstitial white clay and clay galls are locally abundant. Total aggregate thickness about 1,700 ft (520 m)

Table 1.--Chemical analyses of Miocene and Oligocene volcanic rocks from the Steeple Rock quadrangle

[N = Not determined; * Total iron reported as Fe_2O_3; (LOI) = loss on ignition--900 °C. Analyses by X-ray spectroscopy by N. Skinner (1979) and single solution methods by A.J. Bartel, K. Stewart, and J. Taggart (1983)]

Rock type--	Rhyolite	Dacite Porphyry	Dacite Porphyry
Field No.--	SR-42-83	SR-41-83	SRX-122-78
Lab No.----	D-251858	D-251857	W-203841
sp. gr.----	N	N	2.57
SiO_2-----	77.0	66.0	59.7
Al_2O_3----	11.2	14.9	16.7
Fe_2O_3----	*.74	*3.49	4.9
FeO------	N	N	.90
MgO------	.13	1.46	3.1
CaO------	.15	2.71	3.6
Na_2O-----	.70	3.42	3.6
K_2O------	7.98	4.05	3.3
TiO_2-----	.08	.57	.61
P_2O_5-----	<.05	.20	.21
MnO------	<.02	.05	.10
H_2O^+-----	N	N	2.7
H_2O^------	N	N	1.0
CO_2------	N	N	.66
(LOI)----	.84	1.71	N
Total----	99	98	100

SAMPLE LOCATIONS

Sample SR-42-83 (D-251858): Rhyolite plug
Location - About 0.5 mi south of Vanderbilt Peak; SE1/4NE1/4 sec. 10, T. 17 S., R. 21 W., Steeple Rock quadrangle.

Sample SR-41-83 (D-251857): Dacite porphyry of Summit Mountain
Location - East side of Vanderbilt Peak; NE1/4NE1/4 sec. 10, T. 17 S., R. 21 W., Steeple Rock quadrangle.

Sample SRX-122-78 (W-203841): Dacite porphyry of Summit Mountain
Location - Near Laura Canyon; NW1/4SE1/4 sec. 11, T. 17 S., R. 21 W., Steeple Rock quadrangle.

Table 2.--Mines, prospects, and mineral occurrences in the Steeple Rock quadrangle, New Mexico

[Leaders (--) indicate no data. 1 troy ounce = 31.1 grams]

Map No.	Name	Location Sec.	T.S.	R.W.	Description	Development	References
					Precious- and base-metal deposits		
1	Mount Royal	SE1/4 23	17	21	Base-metal ores along fault breccia of the Steeple Rock fault.	Shaft reported to be 350 ft (107 m) deep.	Gillerman, 1964, p. 196
2	Imperial	SE1/4, NE1/4, 23	17	21	Silver- and gold-bearing base-metal ores along silicified breccias of the Steeple Rock fault. Estimated ore values cited by Gillerman as an average of 0.08 oz of gold and 8 oz of silver per ton.	Shaft, open-cut, prospect pits. Shaft reported to be 300 ft (91 m) deep.	Gillerman, 1964, p. 195, 196
3	Jim Crow	SE1/4, SW1/4, 14	17	21	Mineralized and silicified breccias along fault that strikes N. 45° W. One of the chief producers in the area of Mount Royal. Total value of production was probably about $95,000 from 360,000 tons of ore. The ratio of gold to silver was 1:58 by weight. One semiquantitative spectrographic analysis of ore showed 70 ppm Ag, 1,000 ppm Cu, 100 ppm Mo, 1,000 ppm Pb, and 1,500 ppm Zn.	Five shafts in cluster and trench. Deepest shaft 307 ft (93 m).	Gillerman, 1964, p. 195, 196
4	Alabama	NW1/4 14	17	21	Silicified fault parallel and adjacent to rhyolite dike. Abundant manganese oxides in ore in addition to chalcopyrite, pyrite, and galena. One semiquantitative spectrographic analysis of the ore from the mine dump showed 700 ppm Ag, 20 ppm Au, 700 ppm Cu, 1,000 ppm Pb, and 1,000 ppm Zn.	Shaft and prospect pits along footwall side of rhyolite dike. Shaft 300 ft (91 m).	Gillerman, 1964, p. 195
5	New Years Gift	10	17	21	Silicified fault parallel and adjacent to rhyolite dike.	Shaft reported to be 250 ft (76 m) deep.	Gillerman, 1964, p. 196
6	Laura	SW1/4 2	17	21	Highly silicified fault with vuggy quartz vein containing pyrite, chalcopyrite, and galena.	Shaft reported 300 ft (91 m) deep in 1914 but later extended to 700 ft (213 m) in 1942. Reopened and operated in 1978.	Gillerman, 1964, p. 196
7	Summit	36	16	21	Silicified breccia zone strikes N. 40° W. and is as much as 9 m wide. Vein is contiguous with rhyolite dike to the southwest. Abundant pyrite, chalcopyrite, galena, and sphalerite as vug and breccia fillings.	Two tunnels--Apex and Summit. Operated in 1978-79 by the Royal Mining Co. when a crosscut tunnel was further enlarged.	Gillerman, 1964, p. 193

Table 2.--Mines, prospects, and mineral occurrences in the Steeple Rock quadrangle, New Mexico--Continued

Map No.	Name	Location Sec.	T.S.	R.W.	Description	Development	References
					Base- and precious-metal deposits--Continued		
8	Carlisle	1	17	21	Silicified breccia zone along the Carlisle fault which strikes west-northwest. The juncture with the northwest-striking Apache fault has produced breccia pipes that are highly mineralized. The ore occurs in pods and irregular masses between breccia fragments. Best estimates suggest about 3 million oz of silver and 135,000 oz of gold have been mined from the Carlisle workings. About 7 percent base metal sulfides including chalcopyrite, pyrite, galena, and sphalerite.	Shaft and winze to 716 ft (218 m). More than 10,000 ft (3,048 m) of workings that are now largely inaccessible.	R. L. Griggs and H. C. Wagner, 1966, p. 29; Gillerman, 1964, p. 186-188; P. L. Russell, 1947, p. 5-10; R. Powers, 1976, p. 74; B. P. Biggerstaff, 1974, p. 71-73
9	Center and Pennsylvania mines	1	17	21	Silicified fault breccias and quartz vein along the N. 75° W.-striking Carlisle fault. Vug and breccia fillings of pyrite, galena, sphalerite, chalcopyrite, pyrite, acanthite, and native gold. Two semiquantitative spectrographic analyses of ore mined in 1979 showed 70, 150 ppm Ag; 100, 700 ppm Cd; 5,000, 10,000 ppm Cu; 5,000, 30,000 ppm Pb; and 10,000, 70,000 ppm Zn. Gangue minerals are amethystine quartz, barite, fluorite, quartz, epidote, and manganese oxides. Total past production is unknown, but the Center-Pennsylvania mines probably ranked second to the Carlisle mine in total production from the Steeple Rock district. According to Gillerman (1964), production at the Pennsylvania is estimated at 1,500 to 2,000 tons of gold-silver ore with no figures available for the Center mine.	Shaft at Center mine is at least 380 ft (116 m) deep and connected with the Pennsylvania shaft at the 120 ft (37 m) level. Operated most recently by the Royal Mining Co. in 1973 and in 1977-78 by Dresser Industries.	R. L. Griggs and H. C. Wagner, 1966, p. 25-27; B. P. Biggerstaff, 1974, p. 68, 69; Gillerman, 1964, p. 188, 189
10	Ontario	7	17	20	Vein along eastward extension of the Carlisle fault. Vein strikes due east and dips 70° S.	Inclined shaft 160 ft (49 m) deep.	Gillerman, 1964, p. 189
11	Blue Goose	7	17	20	Silicified and brecciated vein along Blue Goose fault is slightly mineralized. Fault strikes N. 55° W. and dips 70° SW.	Three shafts	--
12	Goldenrod	7	17	20	Silicified and brecciated vein along Blue Goose fault.	Shaft	Gillerman, 1964, p. 182
13	Carnation	6	17	20	Vein strikes N. 55° W. along East Camp fault and fracture system. Minor base-metal sulfides are present.	Shaft, open cut, and prospect pits.	Gillerman, 1964, p. 192

Table 2.--Mines, prospects, and mineral occurrences in the Steeple Rock quadrangle, New Mexico--Continued

Map No.	Name	Location Sec.	T.S.	R.W.	Description	Development	References
					Precious- and base-metal deposits--Continued		
14	Golden Nugget or Nugget	8	17	20	Silicified and brecciated vein along the East Camp fault contains minor amounts of base-metal sulfides as crustiform vug fillings.	Three shafts, 20, 116, and 150 ft deep and 800 ft (243 m) of workings.	Gillerman, 1964, p. 192
15	East Camp	8	17	20	Vein along silicified and brecciated part of East Camp fault. Gold as disseminated particles in quartz. Acanthite, carargyrite, pyrite, galena, chalcopyrite, pyromorphite(?), and copper carbonates as fracture and vug fillings. Part of mineralized fault with veins extending for at least 9,600 ft (2,926 m) along the East Camp fault. Total past production figures not available, but from July 1943 to September 1944 production was 21,452 s.t. of ore that averaged 8 percent combined zinc, lead, and copper with 2.0 oz of silver and 0.1 oz of gold per ton.	Two shafts, one at least 600 ft (183 m) deep.	R. L. Griggs and H. C. Wagner, 1966, p. 28; P. L. Russell, 1947, p. 12; B. P. Biggerstaff, 1974, p. 69-71; Gillerman, 1964, p. 189-192
16	MacDonald Tunnel	8	17	20	Silicified and brecciated vein strikes N. 50-60° W. along the East Camp fault.	Tunnel extends 460 ft (140 m) northwest along vein. An old shaft extends downward 300 ft (91 m) from above the portal to intercept the tunnel. MacDonald No. 2 shaft was sunk to a depth of 635 ft (194 m) in 1939 and 1940.	Gillerman, 1964, p. 192
17	Davenport	8	17	20	Vein strikes N. 50-60° W. along the East Camp fault. Vein is up to 3 m wide and contains vug and fracture fillings of acanthite, cerargyrite, native silver, pyrite, chalcopyrite, galena, sphalerite, and gold disseminations in quartz. Ore is reported to average 8 to 12 oz of silver per ton and 0.1 to 0.2 oz of gold.	Shaft 320 ft (94 m) deep; chiefly worked in early 1900's and 1930's.	Gillerman, 1964, p. 189-192; B. P. Biggerstaff, 1974, p. 69, 70
18	Thanksgiving and other small prospects on the Gold Bug claims	9	17	20	Silicified and brecciated veins along the East Camp fault contain pods of near-surface, silver-enriched ore.	Two shafts and prospect pits of shallow depth.	Gillerman, 1964, p. 192
19	Bluebird	9	17	20	Vein along N. 60° W.-striking Bluebell fault. Near-surface, silver-enriched base-metal ore.	Shaft adjacent to Bluebell Windmill; about 300 ft (91 m) deep.	Gillerman, 1964, p. 192, 193

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