

Geologic Map of the Silver City Quadrangle, Grant County, New Mexico.

By

**Robert S. Hildebrand, Charles A. Ferguson, and
Steve Skotnicki**

May 2008

**New Mexico Bureau of Geology and Mineral Resources
*Open-file Digital Geologic Map OF-GM 164***

Scale 1:24,000

This work was supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program (STATEMAP) under USGS Cooperative Agreement 06HQPA0003 and the New Mexico Bureau of Geology and Mineral Resources.



**New Mexico Bureau of Geology and Mineral Resources
801 Leroy Place, Socorro, New Mexico, 87801-4796**

The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government or the State of New Mexico.

Geology of the Silver City 1:24,000 Map Area

By Robert S. Hildebrand, Charles A. Ferguson, and Steve Skotnicki

Qy Younger alluvium (Recent to late Pleistocene) - Alluvium in active channels, flood plains, and terraces incised less than 3m.

Qc Colluvium and talus (Recent to late Pleistocene) - Slope deposits, mostly shown in areas where bedrock relationships are uncertain.

Qm Terraced alluvium (Late Pleistocene) - Alluvium in terraces incised between 3-10m. This unit appears to be correlative with sand and gravel deposits in pedimented plains and meadows north of Silver City along Silva and Little Walnut creeks.

Qo Older alluvium (Early to Late Pleistocene) - Older alluvium in high-standing terraces, and piedmont deposits

Tgy Conglomerate (Miocene to Pliocene) - Conglomerate, pebbly sandstone, and sandstone. Clasts in the conglomerate distinguish this unit from the volcanoclastic sandstone and conglomerate (Tvc). On LS Mesa in the northwest corner of the map, clasts of the Bear Mountain intrusive complex, which intrudes Tvc, are abundant. Northwest of Silver City, this unit contains abundant quartz-phyric felsic volcanic clasts, which are notably absent in the older Tvc unit. The Tgy conglomerate also contains clasts of the phenocryst-poor rhyolite (Tri) which it unconformably overlies and which intrudes the volcanoclastic conglomerate (0 to >150m thick).

Tt Nonwelded lithic tuff (Cenozoic) - Nonwelded lithic-rich ash-flow tuff containing clasts of quartz feldspar phenocryst-rich, welded ash-flow tuff (0-30m thick)

Ta Andesite lava (Cenozoic) - Andesitic lava containing 20-35% 1-4mm plagioclase and 2-4% 1-2mm altered mafics (0-120m thick).

Ttw Welded ash-flow tuff (Cenozoic). Contains subhedral to euhedral quartz, sanadine, and biotite, in a tan to light pink and gray aphanitic matrix. Each mineral comprises up to about 5% of the rock. Altogether, the rock is relatively crystal-rich, containing between 15 and 20% phenocrysts. Biotite is slightly altered and has a silvery sheen. Quartz is clear. Both quartz and biotite are between 1-3 mm across. Clear crystals of sanadine range up to 5 mm. On weathered surfaces quartz and sanadine appear as slightly darker spots. Eutaxitic foliation is visible locally, but most exposures are not ideal. Large rounded boulders of this unit up to 2 meters across are contained within **Tgy** immediately adjacent to the contact. They are so numerous that they resemble bedrock, but eutaxitic foliation in these clasts is random.

Tb Bear Mountain intrusive complex (Cenozoic) - Dacitic porphyry containing 10-15% 1-3mm euhedral plagioclase (An 28-34), up to 2% <2mm biotite, and sparse magnetite phenocrysts. The groundmass is cryptoperthitic and contains abundant miarolitic cavities according to Petersen (1979). Mostly sheets and laccoliths. Similar rocks (**Tb'**), but rhyodacitic in composition and slightly older than the **Tb** occur at Mt. Stewart and in the extreme northwestern part of the map area.

Tri Phenocryst-poor rhyolite (Cenozoic) - Very phenocryst-poor, light-colored felsite porphyry dikes, sills, and intrusions, characteristically strongly lineated and containing sparse, euhedral biotite up to 5mm.

Tvc Volcanoclastic sandstone and conglomerate (Cenozoic) - Red sandy matrix conglomerate and sandstone. In the north-central part of the map, the unit consists of monotonous, very thick-bedded to massive clast-supported conglomerate, and clasts are dominated by andesitic lava (TKa) and K-feldspar porphyritic monzonite (TKe). Elsewhere the unit is dominantly a thin- to medium-bedded conglomerate and pebbly sandstone with cross-stratified sandstone and sparse siltstone and mudstone beds. Intervals of

felsic pumiceous sandstone are locally important. In the northwest, the unit is dominated by sandstone with subordinate mudstone and includes several phenocryst-poor andesitic lavas (0 to >150m thick).

Tvt Ash-flow tuffs within volcaniclastic rocks (Cenozoic) – A series of at least two and as many as four nonwelded to poorly welded felsic ash-flow tuffs ranging from 0-5m thick within the volcaniclastic sandstone and conglomerate unit. The tuffs are typically pumice-rich and the lower ones contain biotite phenocrysts up to 4mm. Other phenocrysts include biotite, sanidine, plagioclase and quartz.

Tao Older andesitic lavas within volcaniclastic rocks (Cenozoic) – Phenocryst-poor andesitic lavas intercalated with Tvc.

TKe Eighty Mountain intrusion (Cretaceous to Early Cenozoic) – K-feldspar porphyritic monzonitic intrusion containing 5-10% hornblende and biotite.

TKm Mafic intrusion (Cretaceous to Early Cenozoic) – A highly variably textured complex of mafic intrusions in the vicinity of Pinos Altos Mountain. Varieties include hornblende-porphyritic andesitic porphyry similar to the **TKh** unit, plagioclase-porphyritic gabbroic bodies, and medium-grained equigranular diorite to monzodiorite with 20-30% hornblende and biotite.

TKh Hornblende porphyry dikes and sills (Cretaceous to Early Cenozoic) – Dark, fine-grained crystalline matrix andesitic porphyry dikes and sills with abundant 4-15mm hornblende phenocrysts. This unit is also labeled **Th** due to space limitations. Hundreds of dominantly NNE-trending dikes and sills of **TKh** intrude **Kc** north and northeast of Silver City. We have not mapped these in detail as the area is mainly covered by housing developments. Those interested in the pre-development outcrop pattern of the intrusions in that area are referred to Cunningham (1974).

TKmz Fine-grained monzonite (Cretaceous to Early Cenozoic) – Two small intrusions of fine-grained monzonite containing 10-30% mafics (biotite and hornblende). Locally the intrusions contain sparse phenocrysts of K-feldspar and hornblende up to 1cm.

TKa Andesite (Cretaceous to Early Cenozoic) – Andesitic lava containing up to 30% phenocrysts of plagioclase (1-5mm) and altered mafics (up to 4mm). On the slopes of Pinos Altos Mt in the northeast corner of the map area, the unit is intimately associated with mafic intrusions (**TKm**). In these areas, the andesite lava is distinguished from intrusive rocks with certainty only in areas where auto-brecciated texture is present (0-200m thick).

TKsc Quartz pebble conglomerate (Cretaceous) – Pebble conglomerate containing well-rounded quartz pebbles and rounded to sub-angular argillite and arkosic sandstone pebbles in a dark, argillaceous sandy matrix. The unit is poorly-preserved, its outcrop pattern based entirely on float, where it occurs along the unconformity between the Colorado Formation (**Kc**) and the volcaniclastic conglomerate (**Tcv**) in the center of section 20, T14W, R17S. The unit is probably correlative with the **Ksc** map unit of Skotnicki and Ferguson (2007) in the easterly adjacent Bayard 7.5' quadrangle.

Kc Colorado Formation (Cretaceous) – Arkosic lithic sandstone, siltstone, and shale with sparse oyster-rich skeletal packstone beds up to 20cm thick. Sandstone beds, typically cross-stratified, range up to 10m thick and constitute approximately 20% of the formation. Dinosaur tracks occur within some thin-bedded siltstone units (0 to >300m thick).

Kb Beartooth Quartzite (Cretaceous) – A complex succession of quartz sandstone, siltstone, silty shale, and pebble conglomerate. The unit typically consists of a basal silty shale up to 10m thick overlain by quartz sandstone interbedded with subordinate siltstone and shale. Pebble to granule conglomerate and pebbly quartz sandstone, if present, occur near the base, but nowhere, apparently at the base of the unit. Pebble conglomerate and sandstone beds are commonly cross-stratified in tabular-planar to wedge-planar sets and rarely troughs. Clasts within the conglomerates are sedimentary rock, presumably from the underlying Paleozoic section. A gradational upper contact with the Colorado Formation is defined at the top of the highest quartz sandstone (10-40m thick).

MP Lake Valley and Oswaldo Limestone (Mississippian - Pennsylvanian) – Medium- to thick-bedded limestone, typically cherty with sparse interbeds up to 5m thick of dark shale and rare, fine-grained, cross-stratified, pink quartz sandstone. Limestone consists mostly of skeletal packstone and grainstone with abundant crinoid columnals, and locally abundant fusulinids. Red chert characterizes the middle portion of this unit throughout the map area (200-240m)

Dp Percha Shale (Devonian) – Dark green gray shale with sparse silty laminae near the base. The upper 10-15m contains sparse lenticular micritic limestone beds that is locally differentiated as a separate unit (the Box Member). The main unit, known as the Ready Pay Member constitutes most of the formation in this area (120m thick)

Stratigraphic nomenclature of Silurian and Ordovician units follow that of Clemons (1991) which is slightly modified from Hayes (1975) based on recommendations from the American Commission on Stratigraphic Nomenclature (1961) and the North American Commission on Stratigraphic Nomenclature (1983).

OS Cutter Member of the Montoya Formation and Fusselman Formation (Ordovician and Silurian) – A pair of mostly massive micritic carbonate units with sparse skeletal remains. The lower unit (Cutter) contains large heads of colonial tabulate and rugose coral, and locally includes a basal skeletal packstone containing abundant large brachiopods. The upper unit (Fusselman) is thinner, typically darker, and commonly vuggy with a widespread skeletal wackestone containing large pentamerid brachiopods whose identification yields an Early to Middle Silurian age (Harbour, 1972). The units are combined because the contact is very difficult to pick consistently, especially on the east-facing dip-slopes of the Silver City Range ().

Oa Aleman Member of the Montoya Formation (Ordovician) – Thin-bedded light brown micritic dolostone with abundant (30-50%) bed-parallel ribbon chert (10-20m).

Ome Upham Member of the Montoya Formation and McKelligan and Jose members of the El Paso Formation (Ordovician) – A three part map unit spanning the Montoya and El Paso formation boundary. The formations, easily distinguished in areas of structural simplicity and good exposure are very difficult to consistently map on the heavily vegetated east-facing dip slope of the Silver City Range. Both formations include a basal unit containing abundant quartz sand. The oldest unit, the Jose Member, thin and poorly represented in the Silver City (0-5m thick), is a low-angle cross-stratified sandy dolostone that grades up into the McKelligan Member () which is dominated by thick, amalgamated sequences of algal laminated massive carbonate (mostly limestone) that displays teepee structures, intraclastic breccia and conglomerate, and well-developed columnar stromatolites. Chert is rare to absent in the Jose and McKelligan members. The McKelligan is unconformably overlain by the Upham Member of the Montoya Formation (25-30m thick), characterized in its basal portion by abundant granule to medium-grained well-rounded quartz sand in chaotic intraclastic breccia and conglomeratic carbonate, chiefly dolostone. Dolostone of the Upham Member is chiefly cherty skeletal packstone and grainstone. The upper contact of the Upham Member is a pronounced unconformity that is commonly strongly silicified and hematite stained (combined thickness of 60-80m).

Oeh Hitt Canyon Member, El Paso Formation (Ordovician) – Thin- to medium-bedded, tabular-planar sets of strongly bioturbated gray and tan carbonate. Carbonates are typically dolomitic, variably cherty skeletal wackestone and packstone, and the gray and tan color variation defines a characteristic “chicken-wire” texture giving the unit a mottled appearance (75-90m).

Cb Bliss Formation (Cambrian) – Quartz sandstone, dolomitic quartz sandstone, and rare dolostone. The lowermost part consists of medium-bedded, low-angle cross-stratified quartz sandstone with abundant *Skolithos* traces. The remainder of the formation consists of thin- to medium-bedded, wedge-planar and trough cross-stratified sandstone with at least two prominent intervals containing oolitic ironstone. Glauconite-rich intervals are also present as are thin dolostone units. The top of the unit, which is

gradational with the overlying El Paso Formation is defined as the top of the youngest quartz sandstone (40-65m thick)

American Commission on Stratigraphic Nomenclature, 1961, Code of stratigraphic nomenclature: AAPG Bulletin, v. 45, p. 645-665.

Proterozoic Rocks

YXgp Granite porphyry (Middle Proterozoic?). Contains about 10% subhedral light gray phenocrysts of K-feldspar and sparse smaller quartz, both 2-4 mm wide and locally slightly larger, in a finely granular orange-tan matrix of quartz and feldspar. Subhedral K-feldspar (exhibiting Carlsbad twinning) is locally light tan and stands out in contrast to the darker orange matrix. In other areas, K-feldspar is nearly the same color as the matrix and is difficult to see. In these areas quartz appears as darker gray spots on weathered surfaces. Biotite is less than 1% of the rock and occurs as small anhedral clumps less than 2 mm wide. In most areas, however, biotite is almost completely weathered and nearly unrecognizable. Nearly all exposures exhibit the same texture, though locally the matrix is slightly coarser grained. Weathers into a distinctive light rusty orange color and typically breaks and weathers into angular fragments, compared to the more rounded outcrops of map unit **Xg**. The mineralogy of both **YXgp** and **Xg** are very similar, suggesting they may be related.

Xg Granite (Early Proterozoic?). Medium- to marginally coarse-grained and equigranular. This characteristically light orange-colored granite is almost everywhere texturally similar. It is composed of relatively equant crystals of K-feldspar, plagioclase, and quartz. Plagioclase appears altered (serritized?). Biotite is almost completely altered to hematite and most outcrops appear leucocratic. As such, it is difficult to estimate the original percentage of the mineral. The exposures farthest south are the most strongly foliated, with foliation defined by quartz crystals strung out into long lenses, and aligned mica. In hand lens, these quartz lenses appear to be recrystallized into individual crystals. Feldspars are broken and elongated. A little farther north foliation is weaker and defined only by aligned biotite. Foliation fades out northward. Rare fine-grained granite dikes cut the granite. Of the three observed, all are near-vertical and trend approximately N110°E. One occurred in the south and was also foliated.

Xa Amphibolite. Mostly medium-grained. Composed of interlocking crystals of dark amphibole and light gray plagioclase and minor quartz. Exposures are commonly dark grayish green. This unit is both foliated and non-foliated.

Xq Quartz-muscovite schist. This unit characteristically contains quartz and coarse-grained muscovite. It is mostly strongly foliated and forms resistant ridges. In many areas muscovite is a minor component and the rock can be classified as a quartzite. The quartzite is most muscovite-free and lightest gray in a band about 20 meters wide immediately adjacent to the granite along the southern contact of the unit. It is possible that this band represents an original stratigraphic horizon that acted as a barrier to granite intrusion.

Xs Quartz-biotite schist. This rock is composed mostly of fine-grained quartz, and less abundant fine-grained biotite ± muscovite. The rock is characteristically light tan with a wispy, locally undulating foliation. The rock is mostly forms slopes that are covered with dark brown soil, so exposures are poor. Although most exposures contain biotite as the dominant mica, muscovite is abundant locally, and in some areas the rock can be difficult to distinguish from the quartz-muscovite schist (**Xq**). In a few eastern outcrops, the rock contains red garnet between 2-6 mm in diameter. The protolith for this rock was probably fine-grained silty sandstone.

References

Clemons, R. E., 1991, Petrography and depositional environments of the Lower Ordovician El Paso Formation: New Mexico Bureau of Mines and Mineral Resources Bulletin 125, 66 pp.

Cunningham, J. E., 1974, Geologic map and sections of Silver City quadrangle, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Geologic Map 30.

Harbour, R. L., 1972, Geology of the northern Franklin Mountains, Texas and New Mexico: USGS Bulletin 1298, 129 pp.

Hayes, P. T., 1975, Cambrian and Ordovician rocks of southern Arizona and New Mexico and westernmost Texas: USGS Professional Paper 873, 98 pp., 1 sheet

North American Commission on Stratigraphic Nomenclature, 1983, North American stratigraphic code: AAPG Bulletin, v. 67, p. 841-875.

Petersen, H. W., 1979, Structural and petrological relationships of the Bear Mountain intrusive, Silver City Range, Grant County, New Mexico: unpublished M.S. thesis, University of Houston, 112 pp., 3 plates.