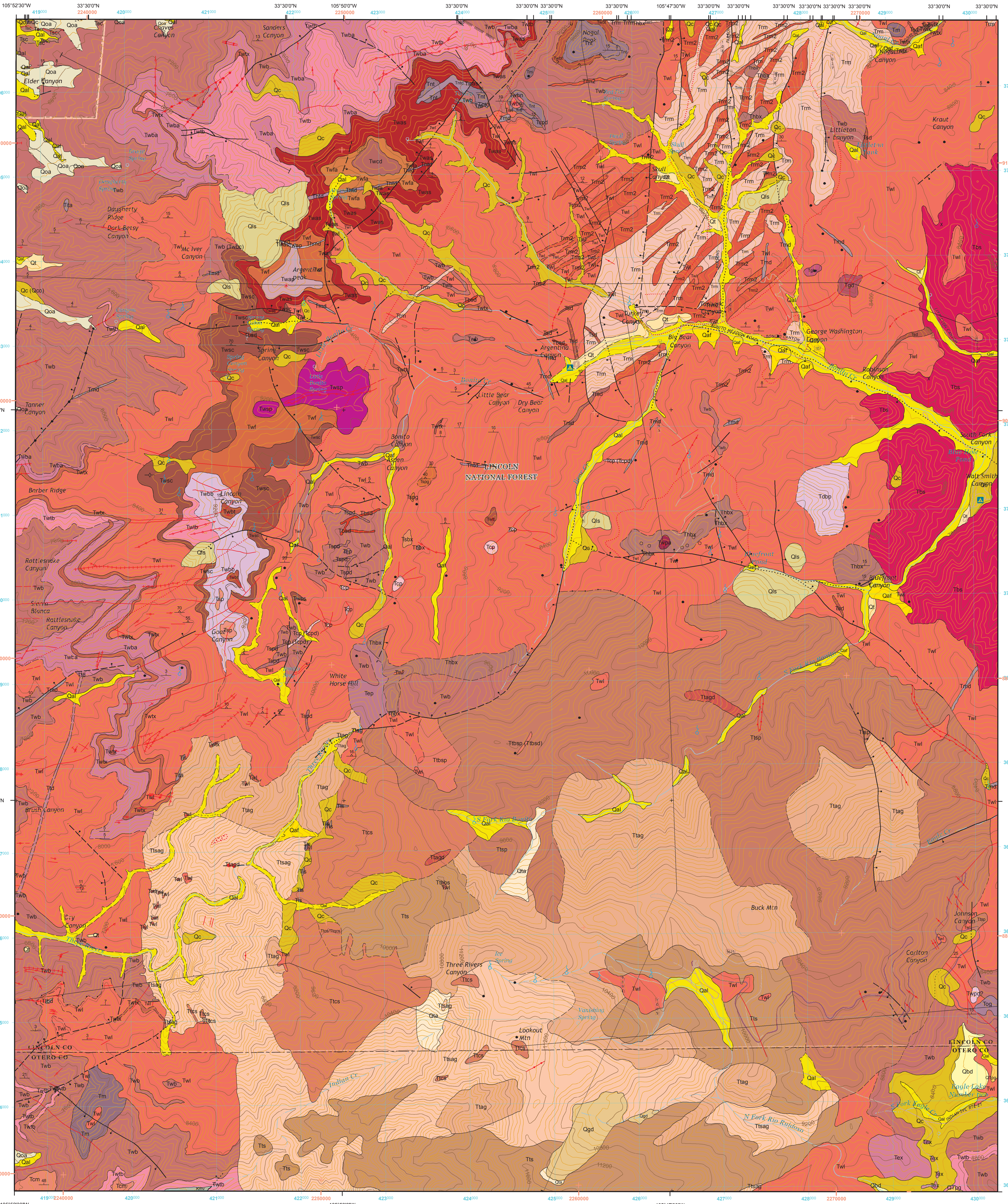
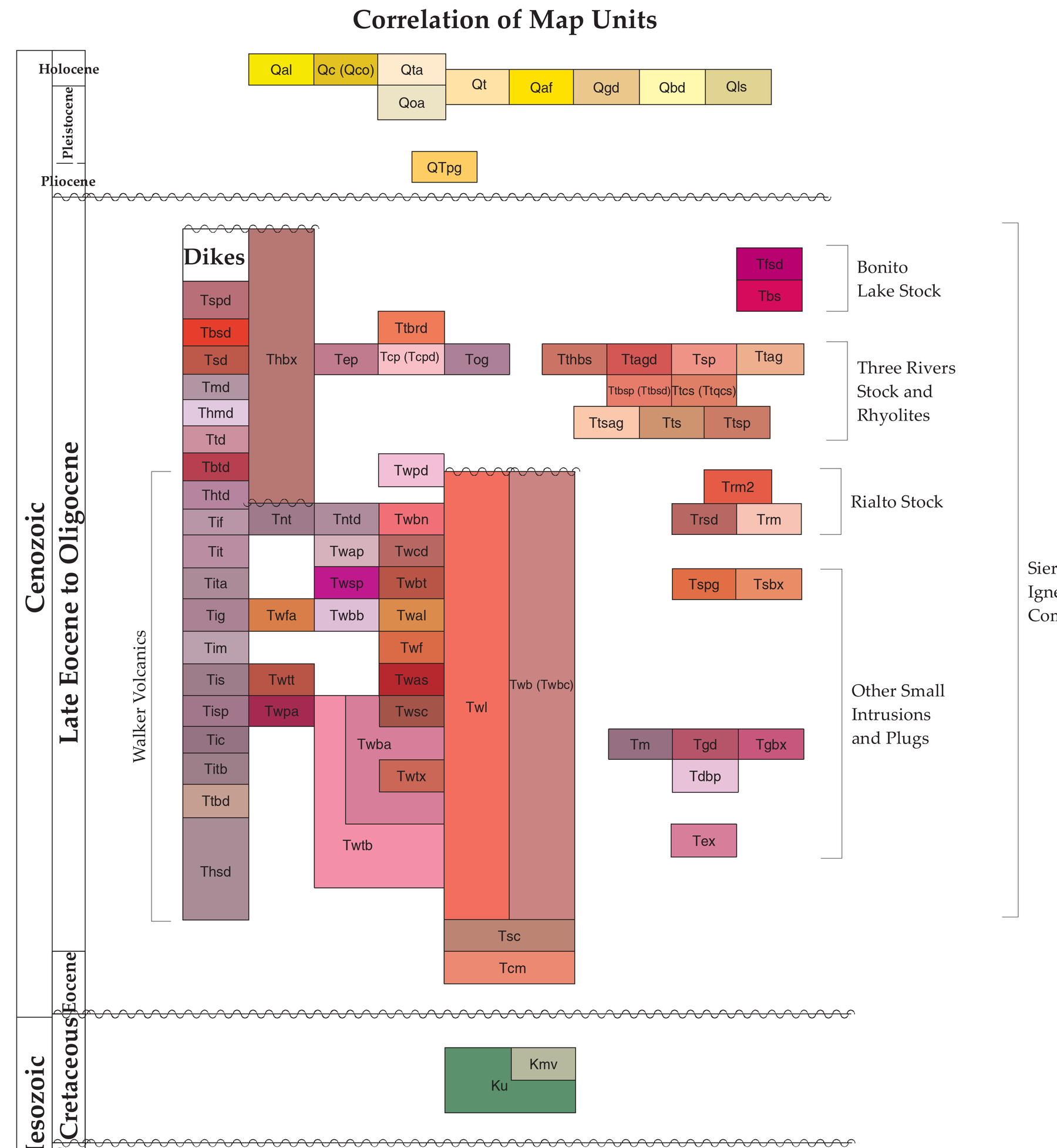
NMBGMR Open-File Geologic Map 134
Last Modified October 2019



Correlation of Map Units



Explanation of Map

- 01.01.01 Contact—Identity and existence are certain. Location is accurate.
- 01.01.03 Contact—Identity and existence are certain. Location is approximate.
- 01.01.04 Contact—Identity or existence are questionable. Location is approximate.
- 01.01.07 Contact—Identity and existence are certain. Location is concealed.
- 01.01.19 Gradational contact—Identity and existence are certain. Location is approximate.
- 01.01.38 Contact—Identity and existence are probable. Location is approximate.
- 01.02.01 Key bed—Identity and existence are certain. Location is accurate.
- 01.02.03 Key bed—Identity and existence are certain. Location is approximate.
- 01.03.01 Dike (1st option)—Identity and existence are certain. Location is accurate.
- 01.03.02 Dike (1st option)—Identity and existence are certain. Location is approximate.
- 01.03.03 Dike (2nd option)—Identity and existence are certain. Location is accurate.
- 01.03.04 Dike (2nd option)—Identity and existence are certain. Location is approximate.
- 01.03.05 Dike (3rd option)—Identity and existence are certain. Location is accurate.
- 01.03.06 Dike (3rd option)—Identity and existence are certain. Location is approximate.
- 01.03.09 Dike (5th option)—Identity and existence are certain. Location is accurate.
- 01.03.10 Dike (5th option)—Identity and existence are certain. Location is approximate.
- 01.03.11 Dike (6th option)—Identity and existence are certain. Location is accurate.
- 01.03.12 Dike (6th option)—Identity and existence are certain. Location is approximate.
- 02.01.01 Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence are certain. Location is accurate.
- 02.01.03 Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence are certain. Location is approximate.
- 02.01.04 Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity or existence are questionable. Location is approximate.
- 02.01.07 Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence are certain. Location is concealed.
- 02.02.01 Normal fault—Identity and existence are certain. Location is accurate. Ball and bar on downthrown block.
- 02.02.03 Normal fault—Identity and existence are certain. Location is approximate. Ball and bar on downthrown block.
- 02.02.04 Normal fault—Identity or existence are questionable. Location is approximate. Ball and bar on downthrown block.
- 02.02.07 Normal fault—Identity and existence are certain. Location is concealed. Ball and bar on downthrown block.
- 02.02.38 Normal fault—Identity and existence are probable. Location is approximate. Ball and bar on downthrown block.
- 02.07.01 Oblique-slip fault, right-lateral offset—Identity and existence are certain. Location is accurate. Arrows show relative motion; ball and bar on downthrown block.
- 02.07.07 Oblique-slip fault, right-lateral offset—Identity and existence are certain. Location is concealed. Arrows show relative motion; ball and bar on downthrown block.
- 19.01.01 Vein, veinlet, or mineralized stringer—Identity and existence are certain. Location is accurate.
- 19.01.03 Vein, veinlet, or mineralized stringer—Identity and existence are certain. Location is
- 19.01.23 Metamorphic facies boundary—Showing approximate boundary between diagnostic mineral assemblages
- 02.11.12 Lineation on fault surface—Showing bearing and plunge.
- 06.02 Inclined bedding—Showing strike and dip.
- 08.02.03 Inclined flow banding, lamination, layering, or foliation in igneous rock—Showing strike and dip.
- 08.02.04 Vertical flow banding, lamination, layering, or foliation in igneous rock—Showing strike.
- 18.55 Small cone, vent, cinder cone, or spatter cone
- 19.03.01 Prospect (pit or small open cut)
- 19.3.25 Drill hole for mineral
- 30.3.12 Spring, as shown on topographic maps or on general-purpose or smaller scale maps
- 31.22 Field station
- 31.21 Sample locality—Showing sample number.
- 19.01.17 Zone of mineralized or altered rock—Showing low level of mineralization.
- 31.10 Cross section line and label

Description of Map Units

01-00-00-00-00—Heading 02—Quaternary—Quaternary—Quaternary

01-01-00-00-00—Unit—Qal—Alluvium—Deposits of sand, gravel and silt in main valley bottoms; locally includes stream terraces, alluvial fans, and canyon wall colluvium; valley floor alluvium is typically finer-grained, silt- and sand-dominated deposits with interbedded gravel beds, whereas low terrace deposits are predominantly sand and gravel. Qal is mostly Holocene in age; maximum thickness of various alluvium deposits is uncertain but may exceed 15 m (Canary yellow – PC916).

01-02-00-00-00—Unit—Qc (Qco)—Colluvium—Poorly sorted slope-wash and-mass wasting deposits from local sources; mapped only where extensive or where covering critical relations; thickness can locally exceed 15 m (Sand – PC940).

01-03-00-00-00—Unit—Qta—Talus deposits—Angular rock-debris deposits at the heads of high cliffs in southern map area; composed mostly of syenitic blocks (Moore et al., 1988) (Sand – PC940).

01-04-00-00-00—Unit—Qt—Terrace deposits—Deposits of pebble to boulder size gravel with a sandy matrix underlying terrace surfaces located approximately 5 to 15 m above local base level; mapped only in upper Salazar Canyon; deposits are only a few meters thick (French grey 20% - PC1069).

01-05-00-00-00—Unit—Qls—Landslides—Poorly sorted debris that has moved chaotically down steep slopes; slumps or block slides partially, to completely intact, that have moved down slope; slumps and block slides usually display some rotation relative to their failure plane; ages vary from Holocene to mid- to late-Pleistocene; thicknesses vary considerably depending on the size and nature of the landslide (Beige – PC997).

01-06-00-00-00—Unit—Qaf—Alluvial fans—Typically fan-shaped deposits of coarse to fine gravel and sand, silt, and clay within and at the mouths of valleys; associated with present drainages and usually not incised; grades into alluvial deposits along main channels; probably Holocene to middle Pleistocene in age; maximum exposed thickness about 15 m (Deco yellow – PC1011).

01-07-00-00-00—Unit—Qgd—Glacial deposits—Bull Lake and Pinedale age glacial deposits at the head of the north fork Rio Ruidoso on high slopes in southern map area (Moore et al., 1988) (Warm grey 50% - PC1054).

01-08-00-00-00—Unit—Qbd—Glacial boulder deposits—Glacial outwash debris in southeastern quadrangle composed of unsorted boulders, cobbles and pebbles of crystalline rocks eroded from the Three Rivers Stock (Moore et al., 1988) (French grey 70% - PC1074).

01-09-00-00-00—Unit—Qoa—Older alluvium—Older deposits of alluvium now undergoing erosion in the mouths of some streams in northwest part of quadrangle; maximum thickness about 15 m (Light peach – PC927).

02-00-00-00-00—Heading 02—Plio-Pleistocene—Plio-Pleistocene—Plio-Pleistocene

02-01-00-00-00—Unit—QTpg—Palomas Gravel—Fans of course syenite-rich gravel deposited in the southeastern map area (Moore et al., 1988) (Cool grey 20% - PC1060).

03-00-00-00-00—Heading 02—Oligocene to Upper Eocene—Oligocene to Upper Eocene—Oligocene to Upper Eocene

03-01-01-00-00—Unit—Thbx—Mineralized hydrothermal breccia—White to pale gray to orange to blue breccia zones and pipes with secondary mineralization caused by severe hydrothermal alteration in and around the three major stocks; most are probably associated with hydrothermal explosions; most need substantially more investigation. The Blue Front Canyon deposit on SW margin of Bonito Lake stock consists of a 200-m-high faulted pipe of banded quartz-alunite-corundum rock within Walker lavas (Twl); Great Western Mine deposit on north edge of Three Rivers stock consists of three aligned silicified breccia pipes >1 km in length of quartz with minor Fe-oxides and pyrite; Elk Point deposit on NW edge of Three Rivers stock consists of similar silicified breccia zone about 1.5 km long; Parsons deposit in southern Rialto stock contains large blocks and fragments of intrusive rocks in a silicified pipe cut by a later dike; unnamed deposit in Rialto stock east of Nogal Pass consists of two pipes of brecciated, silicified intrusive rocks; age of breccia formation is assumed to post-date emplacement of stocks; thickness and dimensions of each deposit are highly variable (Vermillion – PC921).

03-02-00-00-00—Heading 03—Bonito Lake Stock and Associated Dikes—Bonito Lake Stock and Associated Dikes—Bonito Lake Stock and Associated Dikes

03-02-01-00-00—Unit—Tfsd—Fine-grained syenodiorite dikes—Fine-grained syenodiorite dikes

03-02-02-00-00—Unit—Tbs—Bonito Lake syenite to syenodiorite—Gray to salt-and-pepper, medium- to coarse-grained, hypidiomorphic granular syenite in northeast map area; contains plagioclase, Kspar, minor quartz (≤2%), biotite, hornblende and clinopyroxene (Thompson, 1972; Black, 1978; Constantopoulos, 2007); accessories consist of apatite, sphene, zircon, ilmenite and magnetite; alteration minerals consist of epidote, chlorite, sericite and Fe-oxides; margins of intrusive body are generally dioritic containing more plagioclase and mafic minerals than core syenite; commonly contains aplite dikes about 0.1 to 0.5 m wide consisting of fine-grained quartz, potassium feldspar, minor biotite and rare magnetite; interstitial quartz often has graphic texture with Kspar. K-Ar date on biotite is 26.6 ± 1.4 Ma (Thompson, 1972); maximum exposed thickness about 425 m (Pink – PC929).

03-03-00-00-00—Heading 03—Three Rivers Stock and Associated Dikes, Plugs and Flows—Three Rivers Stock and Associated Dikes, Plugs and Flows—Three Rivers Stock and Associated Dikes, Plugs and Flows

03-03-01-00-00—Unit—Ttbrd—Biotite rhyolite dikes—Two northeast- to east-trending dikes that cut "nordmarkite" (Ttsp) and Walker Group lavas (Twl) on the east margin of the quadrangle; part of the NE-trending rhyolite dike swarm further to the east mentioned by Segerstrom et al. (1979, p. 14); dikes are 1 to 3 m wide; consist of white, nearly aphyric, mildly altered rhyolite with sparse phenocrysts of Kspar and biotite in a silicified (or devitrified) groundmass with tiny quartz, Kspar, sericite and smudgy opaque oxides; Kspar phenocrysts are zoned. Preliminary Ar40/39 age on biotite from northern dike is 25.4 ± 0.8 Ma (too thin to color).

03-03-02-00-00—Unit—Tog—Oak Grove rhyolite—Flow of white to gray, aphyric rhyolite on east edge of the quadrangle just west of Oak Grove campground; contains microphenocrysts of quartz in flow-banded groundmass that is devitrified and spherulitic; lava displays flow-banding with extreme folding; may be contemporaneous with rhyolite dikes above although no biotite is visible; overlies Walker Group breccia (Twb); age unknown; maximum exposed thickness about 20 m (Mulberry – PC995).

03-03-03-00-00—Unit—Tcp/Tcpd—Cone Peak rhyolite—Several small plugs and many thin dikes (Tcpd) of gray to white, slightly porphyritic rhyolite containing phenocrysts of small quartz, Kspar, biotite and sparse plagioclase; groundmass and phenocrysts usually altered and silicified (Black, 1977). Intrusions occur around NW margin of Three Rivers stock and do not cut the stock. Intrusions cut Walker Group lavas and breccias (Twl and Twb). Age unknown; thickness at Cone Peak is about 40 m (Mulberry – PC995).

03-03-04-00-00—Unit—Tep—Elk Point rhyolite—Plug of gray, flow-banded, porphyritic rhyolite containing large phenocrysts of Kspar in devitrified to silicified groundmass having smaller crystals of Kspar, quartz, plagioclase, biotite, hornblende, opaque oxides, and rare tiny apatite; plug previously identified as rhyolite by Segerstrom et al. (1979). "Fresh" rhyolite found only at the NW corner of the plug where considerable intrusion breccia is visible; rhyolite is progressively silicified and brecciated further to the south and SE until the original rhyolite texture and mineralogy is lost; cuts Walker Group lavas and breccias (Twl and Twb); in fault contact with Three Rivers stock; age unknown; maximum exposed thickness roughly 200 m in Little Bear Canyon (Mulberry – PC995).

03-03-05-00-00—Unit—Ttagd—Alkali granite dikes—Fine- to coarse-grained, pale pink to pale tan to salt-and-pepper dikes from 0.5 to 80 m wide; contain Kspar, quartz, minor plagioclase, minor biotite, arfvedsonite, trace sphene, apatite, zircon and opaque minerals. Thin dike on east edge of quadrangle cuts Walker Group lava and breccia (Twl and Twb); other dikes within interior of stock are much thicker and cut various syenite units; ages of various dikes unknown (Carmine red – PC926).

03-03-06-00-00—Unit—Tsp—Syenite Porphyry Plugs—Two small plugs on ridge crest just north of Three Rivers stock in general vicinity of UTM 421000/3700000; consist of gray syenite with sparse phenocrysts of Kspar, biotite and clinopyroxene in fine-grained devitrified to altered groundmass of Kspar, minor plagioclase and biotite; alteration consists of chlorite, sericite, silica, minor Fe-oxides and epidote; cuts Walker Group lavas and breccias (Twl and Twb); cut by dikes of Tspd and Tbsd; ages unknown but appear to be associated with Three Rivers stock based on mineralogy and proximity; maximum exposed thickness ≤45 m (Blush pink – PC928).

03-03-07-00-00—Unit—Ttag—Alkali granite—Fine- to medium-grained, equigranular to slightly porphyritic, pale gray to salt-and-pepper granite composed of Kspar, quartz, and minor plagioclase; commonly contains interstitial and graphic intergrowths of quartz-alkali feldspar. Mafic minerals consist of biotite ± arfvedsonite ± aegirine. Accessory minerals consist of apatite, magnetite, ilmenite, sphene and zircon. Some areas contain sparse larger crystals of alkali feldspar. Some zones contain essentially no mafic minerals. Alteration phases consist of epidote, sericite, chlorite and Fe-oxides. This unit forms several, relatively small to large intrusive bodies throughout the stock. According to Giles and Thompson (1972), Segerstrom et al. (1979 and Moore et al. (1988), anomalous molybdenum concentrations (as MoS2) are associated with this unit but we found no veinlets, veins, pods, or streaks of molybdenite during our mapping. Rb-Sr age (whole rock) from unknown site is 26.7 ± 1.2 Ma (Moore et al., 1991); preliminary Ar40/39 date on arfvedsonite from body at top of eastern chair lift, Ski Apache is 27 ± 2 Ma. Maximum exposed thickness is ≥700 m (Carmine red – PC926).

03-03-08-00-00—Unit—Tthbs—Hornblende-biotite syenite plug—Tiny, ≤50-m-diameter plug of white to light gray, slightly porphyritic syenite; rock is very fresh, containing larger crystals of Kspar and smaller hornblende and biotite in a groundmass of tiny plagioclase, opaque oxides, some quartz, and clinopyroxene; also contains rare tiny zircon and apatite; intrudes syenite; SE edge of plug abuts very small stoped block of hydrothermally altered Walker Group trachyandesite or trachybasalt (Twl); age unknown; thickness unknown (Magenta – PC930).

03-03-09-00-00—Unit—Ttbsp/Ttbsd—Biotite syenite porphyry—Small intrusion and nearby dike (Ttbsd) of pinkish-gray, sparsely porphyritic syenite; contains large Kspar phenocrysts with microcline twinning in fine-grained, granular groundmass having small Kspar, biotite, a bit of plagioclase and quartz, opaque oxides, and rare tiny apatite and zircon. Intrudes Walker Group lavas, Twl (as roof pendant) and Ttsp ("nordmarkite"); in fault contact with Twl and Twb; age unknown; maximum exposed thickness about 270 m (Magenta – PC930).

03-03-10-00-00—Unit—Ttcs/Ttqcs—Coarse-grained syenite—Light gray, very coarse-grained, hypidiomorphic granular syenite consisting primarily of "hash" of large Kspar (anorthoclase) surrounded by small interstial Kspar and quartz (some with graphic texture), aegirine, arfvedsonite, opaque oxides, tiny apatite, rare rutile and zircon; no apparent plagioclase; a zone of more quartz-rich syenite (Ttqcs) is found on the east margin of the unit; sporadically contains ≤10 cm enclaves of fine-grained igneous (?) rock; intruded by thin porphyritic dikes of fine-grained, equigranular alkali granite (?) containing Kspar and clinopyroxene phenocrysts and unidentified blue and purple minerals; various units not dated; maximum exposed thickness about 650 m (Process red – PC994).

03-03-11-00-00—Unit—Ttsag—Quartz syenite to alkali granite—Highly variable, but voluminous unit of medium-grained, light gray to bluish gray, equigranular to porphyritic, quartz syenite to granite; syenite is dominant; contains Kspar (often large and distinctly blue-gray) partly rimmed by other feldspar; blue-gray phenocrysts are most plentiful at higher elevations and western margin in the unit; plagioclase sparse to absent; quartz sparse to ≥10 modal percent; quartz is interstitial and may have graphic texture; contains minor arfvedsonite, aegirine, and/or biotite; some specimens contain augite; accessory minerals are opaque oxides, apatite, sphene, and zircon; may contain minor muscovite; alteration minerals consist of epidote, chlorite, calcite and Fe-oxides. K-Ar date on biotite is 28.1 ± 1.7 Ma (Moore et al., 1988); preliminary Ar40/39 date on Kspar from west contact in Three Rivers canyon is 28.24 ± 0.19 Ma; maximum exposed thickness is ≥850 m (Pink – PC929).

03-03-12-00-00—Unit—Tts—Syenite and syenite porphyry—Medium- to coarse-grained, light gray to very pale pink, hypidiomorphic granular syenite usually containing abundant large crystals of potassium feldspar and interstitial quartz; graphic texture common; plagioclase sparse to absent; contains minor biotite and arfvedsonite; accessories consist of apatite, sphene, zircon, magnetite and ilmenite; alteration minerals are quartz, chlorite, sericite, minor epidote and Fe-oxides; contains sporadic ≤8 cm enclaves of fine-grained igneous rock. K-Ar age on anorthoclase is 25.8 ± 1.1 Ma (Giles and Thompson, 1972), a date we consider much too young. Cuts unit Ttsp; maximum exposed thickness about 600 m (Deco pink – PC1014).

03-03-13-00-00—Unit—Ttsp—Quartz syenite porphyry—Very distinctive unit of coarse-grained, brownish gray to rose, quartz syenite (nordmarkite, Williams et al., 1954; Giles and Thompson, 1972) with abundant, large crystals of pinkish Kspar in a granular matrix of Kspar, minor quartz and plagioclase, arfvedsonite, aegirine ± biotite. Kspar phenocrysts may be rimmed by sanidine and plagioclase. Accessory minerals are apatite, zircon, ilmenite and magnetite. Alteration minerals are sericite, chlorite, epidote, and Fe-oxides. Near contacts with country rocks or in the apparent roof zone, the phenocryst content of the syenite may exceed 70%. Contains sporadic ≤10 cm enclaves of fine-grained igneous rock; K-Ar date on arfvedsonite is 29.9 ± 1.8 Ma (Allen and Foord; 1991; Moore et al., 1991); preliminary Ar40/39 age on large Kspar from east of Buck Mountain is 28.95 ± 0.18 Ma; maximum exposed thickness ≥730 m (Blush pink – PC928).

03-04-00-00-00—Heading 03—Rialto Stock and Associated Dikes—Rialto Stock and Associated Dikes—Rialto Stock and Associated Dikes

03-04-01-00-00—Unit—Trm2—Monzonite to quartz diorite—Secondary intrusive phase of Rialto stock consists of white to gray, weakly porphyritic, fine-grained quartz diorite having phenocrysts of plagioclase in groundmass of plagioclase, minor Kspar, euhedral biotite, hornblende, and small quartz (≤10%). Accessory phases are fine-grained magnetite, ilmenite and apatite. Occurs as extensive swarm of NE-trending dikes and possible sills that intrude stage 1 Rialto syenite and Walker Group metavolcanic rocks (Twl and Twb). Hydrothermal and supergene alteration processes have resulted in pervasive bleaching and limonite-staining with generally strong alteration ranging from phyllic (quartz ± sericite ± pyrite) to locally argillic. Mineralization occurs as ubiquitous fine-grained pyrite (oxidized) and small veins of lead, zinc and molybdenum sulfides (Thompson, 1973) that currently appear as narrow hematite-goethite gossans. Age of unit is yet to be determined; maximum exposed thickness about 280 m (Deco pink – PC1014).

03-04-02-00-00—Unit—Trsd—Quartz syenite dike—Broad, NE-trending dike of salt-and-pepper, slightly pink, medium-grained, hypidiomorphic granular, quartz syenite containing plagioclase, Kspar, quartz, biotite, hornblende, a bit of clinopyroxene and opaque oxides with trace zircon, sphene, and apatite; alteration very minor; occurs on prominent ridge south of Bonito Creek and west of Big Bear Creek; dike is up to 20 m wide; cuts hydrothermally altered Walker Group lavas (Twl and Twb); age unknown (Parma violet – PC1008).

03-04-03-00-00—Unit—Trm—Syenite—Broad, NE-trending dike of salt-and-pepper, slightly pink, medium-grained, hypidiomorphic granular, quartz syenite containing plagioclase, Kspar, quartz, biotite, hornblende, a bit of clinopyroxene and opaque oxides with trace zircon, sphene, and apatite; alteration very minor; occurs on prominent ridge south of Bonito Creek and west of Big Bear Creek; dike is up to 20 m wide; cuts hydrothermally altered Walker Group lavas (Twl and Twb); age unknown (Parma violet – PC1008).

03-05-00-00-00—Heading 03—Other Small Intrusions and Plugs—Other Small Intrusions and Plugs—Other Small Intrusions and Plugs

03-05-01-00-00—Unit—Tspg/Tsbx—Syenite plugs—Three small plugs on ridge between Aspen and Little Bear canyons. The northern plug consists of pale pinkish gray, medium-grained, hypidiomorphic granular syenite containing Kspar, plagioclase, biotite, hornblende and opaque oxides; alteration consists of epidote, actinolite (?) and Fe-oxides. The central plug consists of gray syenite porphyry with large Kspar in granular matrix of plagioclase, clinopyroxene, biotite and opaque oxides; alteration is epidote, chlorite and Fe-oxides. The southern plug (Tsbx) consists of gray, silicified, fine- to medium-grained syentite breccia containing clasts of mafic volcanic rocks up to 10 cm long in matrix of altered Kspar, plagioclase, clinopyroxene, biotite and smudgy opaque oxides; alteration is silica, chlorite and epidote (?). The plugs probably represent the top of a small syenite stock; intrude hydrothermally altered Walker Group lavas (Twl); maximum exposed thickness about 35 m; ages unknown (Burnt ochre – PC943).

03-05-01-00-00—Unit—Tspg/Tsbx—Syenite plugs—Three small plugs on ridge between Aspen and Little Bear canyons. The northern plug consists of pale pinkish gray, medium-grained, hypidiomorphic granular syenite containing Kspar, plagioclase, biotite, hornblende and opaque oxides; alteration consists of epidote, actinolite (?) and Fe-oxides. The central plug consists of gray syenite porphyry with large Kspar in granular matrix of plagioclase, clinopyroxene, biotite and opaque oxides; alteration is epidote, chlorite and Fe-oxides. The southern plug (Tsbx) consists of gray, silicified, fine- to medium-grained syentite breccia containing clasts of mafic volcanic rocks up to 10 cm long in matrix of altered Kspar, plagioclase, clinopyroxene, biotite and smudgy opaque oxides; alteration is silica, chlorite and epidote (?). The plugs probably represent the top of a small syenite stock; intrude hydrothermally altered Walker Group lavas (Twl); maximum exposed thickness about 35 m; ages unknown (Burnt ochre – PC943).

03-05-02-00-00—Unit—Tm—Monzonite to diorite plugs—Greenish gray, fine- to medium-grained monzonite to diorite plugs containing abundant plagioclase and sparse to very sparse Kspar; mafic minerals are clinopyroxene and lesser amounts of hornblende and biotite; most specimens show alteration to clay, chlorite, calcite, and quartz ± epidote. Tiny knob west of Nogal Peak cuts Walker Group breccias (Twb) and contains small vugs of amethystine quartz. Small plug in Nogal Canyon intrudes altered Walker lavas (Twl); exposed thickness about 100 m. Lenticular intrusion in SW map area identified by Moore et al. (1988) is overlain by trachybasalt lava and cut by two syenite porphyry dikes (Tspd); exposed thickness about 220 m. Ages of various features are unknown (Dark green – PC908).

03-05-03-00-00—Unit—Tgd/Tgbx—Grizzly Peak diorite—Plug-like body and associated radiating dikes (Tmd) of greenish-gray, medium- to course-grained, hypidiomorphic granular diorite consisting almost entirely of plagioclase and clinopyroxene; has a small amount of tiny interstitial quartz and Kspar (?); unit is thoroughly altered to chlorite, epidote, sericite, secondary quartz, minor calcite, and smudgy magnetite; cut by small veinlets of epidote and quartz. A small, poorly exposed zone of diorite intrusion breccia (Tgbx) occurs on the slope west of the plug. Unit intrudes hydrothermally altered Walker lavas (Twl). Age unknown; maximum exposed thickness of Grizzly Peak is ≤100 m (Copenhagen blue – PC906).

03-05-03-01-00—Unit—Tgd/Tgbx—Grizzly Peak diorite—Plug-like body and associated radiating dikes (Tmd) of greenish-gray, medium- to course-grained, hypidiomorphic granular diorite consisting almost entirely of plagioclase and clinopyroxene; has a small amount of tiny interstitial quartz and Kspar (?); unit is thoroughly altered to chlorite, epidote, sericite, secondary quartz, minor calcite, and smudgy magnetite; cut by small veinlets of epidote and quartz. A small, poorly exposed zone of diorite intrusion breccia (Tgbx) occurs on the slope west of the plug. Unit intrudes hydrothermally altered Walker lavas (Twl). Age unknown; maximum exposed thickness of Grizzly Peak is ≤100 m (Copenhagen blue – PC906).

03-05-04-00-00—Unit—Tdbp—Dark Betty diorite porphyry—Small, circular intrusion on south side of upper Dark Betty Canyon containing conspicuous phenocrysts and phenocryst clots of white plagioclase ≤1.5 cm long in greenish gray, fine-grained groundmass of plagioclase, clinopyroxene, opaque oxides and rare olivine. Texture of plagioclase phenocrysts closely resembles texture in unit Twtx described below and may be source of some Twtx lavas. Alteration consists of chlorite, epidote, silica and calcite. Intrudes hydrothermally altered Walker lavas (Twl); a highly silicified zone occurs on the SE margin of the intrusion; exposed thickness is about 310 m; age unknown (Indigo blue – PC901).

03-05-05-00-00—Unit—Tex—Feldspathoidal gabbro porphyry—Plug of very dark gray to splotchy black and white, feldspathoidal gabbro (essexite; Williams et al., 1954; Moore et al., 1988) in southeast corner of map; contains large (≤3 cm) phenocrysts of pinkish potassium feldspar and white plagioclase in a highly altered, medium-grained groundmass of nepheline, clinopyroxene, olivine, biotite and smudgy magnetite; alteration phases consist of epidote, chlorite, sericite, calcite, quartz and Fe-oxides. Intrudes Walker Group lavas and breccias (Twl and Twb); K-Ar date on "fresh" gabbro is 32.8 ± 1.2 Ma (Moore et al., 1988); preliminary Ar40/39 date on hydrothermally altered gabbro is 30.5 ± 0.5 Ma, presumably affected by the adjacent Three Rivers stock. Maximum exposed thickness is 185 m (Lilac – PC956).

03-06-00-00-00—Heading 03—Dikes—Dikes—All generic dikes

03-06-01-00-00—Unit—Tbsd—Syenite porphyry dikes—Gray, fine- to medium-grained syenite containing sparse phenocrysts of potassium feldspar, plagioclase, biotite, clinopyroxene ± hornblende; a few dikes of this type have hornblende as dominant mafic phase; some dikes more than 10 m wide; intrudes Twl, Twb and Tsp; those in the south map area may be associated with the Three Rivers stock; ages of various dikes unknown.

03-06-01-00-00—Unit—Thsd—Syenite porphyry dikes—Gray, fine- to medium-grained syenite containing sparse phenocrysts of potassium feldspar, plagioclase, biotite, clinopyroxene ± hornblende; a few dikes of this type have hornblende as dominant mafic phase; some dikes more than 10 m wide; intrudes Twl, Twb and Tsp; those in the south map area may be associated with the Three Rivers stock; ages of various dikes unknown.

03-06-01-00-00—Unit—Tspd—Syenite porphyry dikes—Gray, fine- to medium-grained syenite containing sparse phenocrysts of potassium feldspar, plagioclase, biotite, clinopyroxene ± hornblende; a few dikes of this type have hornblende as dominant mafic phase; some dikes more than 10 m wide; intrudes Twl, Twb and Tsp; those in the south map area may be associated with the Three Rivers stock; ages of various dikes unknown.

03-06-02-00-00—Unit—Tsd—Syenite dikes—Light gray, medium to course-grained dikes containing alkali feldspar, plagioclase, clinopyroxene, hornblende, biotite and sparse quartz; dikes are 1 to 50 m wide; ages unknown.

03-06-03-00-00—Unit—Thmd—Monzonite to diorite dikes—Gray to greenish gray, medium- to course-grained dikes containing plagioclase, clinopyroxene ± hornblende ± biotite; dikes are generally 1 to 6 m wide; rare dikes are more than 25 m wide; ages unknown.

03-06-03-00-00—Unit—Tmd—Monzonite to diorite dikes—Gray to greenish gray, medium- to course-grained dikes containing plagioclase, clinopyroxene ± hornblende ± biotite; dikes are generally 1 to 6 m wide; rare dikes are more than 25 m wide; ages unknown.

03-06-04-00-00—Unit—Ttd—Porphyritic hornblende trachydacite dikes—An unusual bluish gray, fine-grained porphyritic dike with NNE trend can be traced as fins or as float for a distance of several kilometers through units Twb and Twl on SW side of quadrangle; contains phenocrysts of plagioclase and hornblende in a groundmass of plagioclase, clinopyroxene, magnetite, apatite and hornblende; dike has variable width of 5 to 50 m. Another dike of porphyritic hornblende trachydacite trends ENE in the vicinity of Argentina Spring.

03-06-05-00-00—Unit—Tbtd—Biotite and hornblende trachydacite to alkali rhyolite dikes—Gray to tan, slightly porphyritic dikes containing sparse phenocrysts of Kspar, plagioclase ± biotite ± hornblende ± quartz; dikes typically 1 to 6 m wide; ages unknown.

03-06-05-00-00—Unit—Thtd—Biotite and hornblende trachydacite to alkali rhyolite dikes—Gray to tan, slightly porphyritic dikes containing sparse phenocrysts of Kspar, plagioclase ± biotite ± hornblende ± quartz; dikes typically 1 to 6 m wide; ages unknown.

03-06-06-00-00—Unit—Ttbd—Clinopyroxene-phyric trachybasalt dikes—Greenish black, fine-grained, porphyritic basalt with conspicuous clinopyroxene ≤2 cm in diameter in intersertal groundmass of plagioclase, olivine, clinopyroxene and magnetite; olivine has iddingsite rims; plagioclase is slightly aligned; clinopyroxene is zoned and contains olivine inclusions; alteration consists of quartz, calcite, Fe-oxides, chlorite, and epidote; dikes generally ≤3 m wide; ages of dikes unknown.

03-06-07-00-00—Unit—Tif—Felsite—White, fine-grained, aphyric, felsic dikes, 1 to 5 m wide; ages unknown.

03-06-08-00-00—Unit—Tit—Trachyte—Light to dark gray porphyritic dikes with 15 to 25% plagioclase laths 10 to 20 mm long set in an equigranular to fine-grained matrix of dark green pyroxene and feldspar. The plagioclase laths are often distinctively aligned parallel to the margins of the dikes. Dikes are generally 1 to 4 m wide; ages of dikes unknown.

03-06-09-00-00—Unit—Tita—Porphyritic trachyandesite—Dikes and small sills of light gray to purple gray porphyry with 5 to 15% of 1 to 10 mm diameter plagioclase phenocrysts, dark green pyroxene, black hornblende, opaque oxides ± potassium feldspar; some dikes may grade into more equigranular textures (Tig). Dikes often contain syenitic and sedimentary xenoliths; dikes in center and east of quadrangle are altered to silica, calcite, clay, chlorite and epidote; dikes generally 1 to 12 m wide; ages of dikes unknown.

03-06-10-00-00—Unit—Tig—Alkali gabbro to syenogabbro—Salt-and-pepper, fine- to medium-grained, equigranular dikes and small sills containing plagioclase and pyroxene phenocrysts; may grade into more porphyritic dikes (Tita); generally 2 to 6 m wide; ages of dikes unknown.

03-06-11-00-00—Unit—Tim—Megacrystal trachyte porphyry—Greenish gray porphyritic dikes and sills with megacrysts of embayed hornblende and/or green pyroxene that are up to 2 to 4 cm across; groundmass contains hornblende ± biotite; may contain xenoliths of pink coarse-grained syenite; dikes may be up to 20 m across; ages of dikes unknown.

03-06-12-00-00—Unit—Tisp—Syenite—Pink, medium-grained, equigranular dikes and sill composed of potassium feldspar, green pyroxene, occasional biotite and sparse quartz; some contain large Kspar (Tisp). Dikes may be up to 20 m across; ages of dikes unknown.

03-06-12-00-00—Unit—Tis—Syenite—Pink, medium-grained, equigranular dikes and sill composed of potassium feldspar, green pyroxene, occasional biotite and sparse quartz; some contain large Kspar (Tisp). Dikes may be up to 20 m across; ages of dikes unknown.

03-06-13-00-00—Unit—Tic—Mafic clot syenite—White sparsely porphyritic dikes with about ±7 % conspicuous clots of altered mafic minerals; dike rock contains phenocrysts of Kspar and plagioclase in matrix of plagioclase, clinopyroxene and biotite; cuts Tita dikes; ages unknown.

03-06-14-00-00—Unit—Titb—Trachybasalt—Black to gray dikes containing phenocrysts of plagioclase in groundmass of plagioclase, olivine, clinopyroxene ± phlogopite; dikes may be up to 10 m in width; ages of dikes unknown.

04-00-00-00-00—Heading 02—Oligocene to Upper Eocene—Oligocene to Upper Eocene—Oligocene to Upper Eocene

04-01-00-00-00—Heading 03—Sierra Blanca Volcanics—Sierra Blanca Volcanics—Sierra Blanca Volcanics

04-01-01-00-00—Unit—Tnt/Tntd—Nogal Peak Trachyte—White to pale pinkish gray, slightly porphyritic to aphyric lavas with intercalated flow and flow breccia; at Nogal Peak lavas consist of five flows having a total thickness of 300 m (Thompson, 1972, 1973; see Fig. 6); flows contain phenocrysts of plagioclase in a trachytic matrix of fine plagioclase, clinopyroxene, biotite, hornblende, sparse sanidine and devitrified glass with accessory apatite and magnetite. Alteration minerals include epidote, chlorite, sericite, quartz and Fe-oxides. Some flows include fragments of trachyandesite from underlying units. The contact with the underlying Walker Volcanic Breccia (our name, Twb) appears to be conformable. West and southwest of Nogal Peak, the unit consists of a single flow of gray, slightly porphyritic, medium- to fine-grained lava containing phenocrysts of plagioclase in a trachytic matrix of plagioclase, clinopyroxene, Kspar, biotite (?) and hornblende (?); mafic phases are completely altered to sericite, chlorite, clays, silica, calcite, smudgy opaque oxides and minor limonite. This flow is intruded by dikes (Tntd) of similar mineralogy but coarser texture; maximum exposed thickness of flow is ≤35 m. Rocks of this formation generally overlie Walker Volcanic Breccia (Twb) but flow at Hill 9500 underlies basalt (Twbn). Various flows and dike are not dated but a K-Ar age of 31.8 ± 1.3 Ma (Thompson, 1972) has been obtained on glass from the Church Mountain latite, which occupies a similar stratigraphic position as Nogal Peak Trachyte (Tnt = Peach – PC939; Tntd = Orange – PC918).

04-01-01-01-00—Unit—Tnt/Tntd—Nogal Peak Trachyte—White to pale pinkish gray, slightly porphyritic to aphyric lavas with intercalated flow and flow breccia; at Nogal Peak lavas consist of five flows having a total thickness of 300 m (Thompson, 1972, 1973; see Fig. 6); flows contain phenocrysts of plagioclase in a trachytic matrix of fine plagioclase, clinopyroxene, biotite, hornblende, sparse sanidine and devitrified glass with accessory apatite and magnetite. Alteration minerals include epidote, chlorite, sericite, quartz and Fe-oxides. Some flows include fragments of trachyandesite from underlying units. The contact with the underlying Walker Volcanic Breccia (our name, Twb) appears to be conformable. West and southwest of Nogal Peak, the unit consists of a single flow of gray, slightly porphyritic, medium- to fine-grained lava containing phenocrysts of plagioclase in a trachytic matrix of plagioclase, clinopyroxene, Kspar, biotite (?) and hornblende (?); mafic phases are completely altered to sericite, chlorite, clays, silica, calcite, smudgy opaque oxides and minor limonite. This flow is intruded by dikes (Tntd) of similar mineralogy but coarser texture; maximum exposed thickness of flow is ≤35 m. Rocks of this formation generally overlie Walker Volcanic Breccia (Twb) but flow at Hill 9500 underlies basalt (Twbn). Various flows and dike are not dated but a K-Ar age of 31.8 ± 1.3 Ma (Thompson, 1972) has been obtained on glass from the Church Mountain latite, which occupies a similar stratigraphic position as Nogal Peak Trachyte (Tnt = Peach – PC939; Tntd = Orange – PC918).

04-02-00-00-00—Heading 03—Walker Volcanic—Walker Volcanic Breccia —Walker Volcanic Breccia

04-02-01-00-00—Unit—Twl—Lava-rich unit, undivided—Aphyric to porphyritic lavas consisting of tephrite, alkali basalt, trachybasalt, basaltic trachyandesite, trachyandesite, phonolite and minor trachyte (Moore et al., 1988). The sequence generally becomes more trachytic higher in the section and the proportion of interbedded breccia is ≤40%. Individual flows of distinctive texture and/or mineralogy can be broken out in the winding cliffs of the escarpments along the west and north edges of the quadrangle. Elsewhere, pervasive hydrothermal alteration and poor exposure prevent effective separation of individual flows. Lava at base of unit in western Three Rivers Canyon is tephrite or trachybasalt containing phenocrysts of clinopyroxene in greenish black groundmass of plagioclase, altered olivine, magnetite and devitrified glass; alteration minerals are chlorite, calcite and Fe-oxides. Alteration minerals are epidote, chlorite and clay. Bluish gray lava and flow-breccia sequence in lower Blue Front canyon contains phenocrysts of plagioclase in a highly devitrified groundmass of plagioclase, clinopyroxene and altered phlogopite (?). Light gray slightly porphyritic trachyandesite or trachyte flows midway up the north slope of Brush Canyon contains phenocrysts of hornblende and plagioclase in groundmass of plagioclase, clinopyroxene, magnetite, and hornblende. Unit also occurs as roof pendants and hornfelsed septa above and between the stocks described above. Near contacts, the volcanic rocks are altered to cordierite- and/or andalusite-bearing, pyroxene hornfels with scattered occurrences of dumortierite and topaz (Giles and Thompson, 1972). Thickness of individual flows is rarely greater than 20 m. Unit is ≥500 m thick on west side of quadrangle, 400 m thick in NE corner of quadrangle, and 475 m thick east of South Fork Rio Bonito. None of the flows of map unit Twl have been dated due to hydrothermal alteration (Jade green – PC1021).

04-02-02-00-00—Unit—Twpd—Porphyritic trachydacite east of Highway 532—Gray, porphyritic, slightly trachytic lava containing phenocrysts of Kspar, plagioclase, biotite, opaque oxides and minor quartz in groundmass of tiny plagioclase, clinopyroxene and silicified glass; alteration consists of silica, sericite, chlorite, and smudgy opaque oxides; overlies Walker lavas and breccias (Twl and Twb); occupies same stratigraphic position as Oak Grove rhyolite (Tog) and could conceivably be associated with Three Rivers stock; age unknown; thickness about 20 m (Yellow ochre – PC942).

04-02-03-00-00—Unit—Twbn—Alkali basalt of Hill 9500—Dark greenish gray to black lava and minor scoria deposits capping hill SSW of Nogal Peak; contains small but conspicuous phenocrysts of clinopyroxene and plagioclase in groundmass of plagioclase, clinopyroxene, iddingsitized olivine, opaque oxides and altered glass; alteration consists of clay, sericite, silica, calcite and chlorite; overlies flow of Nogal Peak Trachyte (Tnt); cut by biotite syenite dike (Tbsd); age unknown; thickness about 15 m (Copenhagen blue – PC906).

04-02-04-00-00—Unit—Twcd—Porphyritic trachydacite north of Argentina Spring—Gray, coarse porphyritic lava containing large phenocrysts of plagioclase and Kspar (?) in trachytic matrix of plagioclase, clinopyroxene, opaque oxides and devitrified glass; alteration consists of silica, clay, sericite and chlorite; overlies Twfa; age unknown; thickness about 50 m (Yellow orange – PC1002).

04-02-05-00-00—Unit—Twfa—Fine-grained trachydacite north of Argentina Spring—Dark gray to black, aphanitic, trachytic lavas containing a few very small phenocrysts of plagioclase and biotite in an altered groundmass of plagioclase, clinopyroxene, opaque oxides and tiny Kspar (?); alteration consists of silica, sericite, Fe-oxides and chlorite; underlies Twcd and overlies Twas; age unknown; maximum thickness about 60 m (Lime peel – PC1005).

04-02-06-00-00—Unit—Twap—Basaltic trachyandesite of Argentina Peak—Dark gray to reddish black, medium-grained lavas containing a few small phenocrysts of plagioclase in an altered, felty groundmass of plagioclase, clinopyroxene, olivine, and magnetite; alteration consists of hematite, limonite, silica, sericite and chlorite; southern part of unit contains probable vent area; overlies Twf and Twas; age unknown; thickness about 60 m (Grass green – PC909).

04-02-07-00-00—Unit—Twsp/Twspd—Aphyric trachyandesite of Spring Point—Eroded plug, associated flows and east-trending dike (Twspd) of dark gray to black trachyandesite; contains very rare phenocrysts of plagioclase in very fine-grained altered groundmass of plagioclase, magnetite, clinopyroxene, and rare biotite; alteration consists of silica, sericite, chlorite and a little hematite; overlies Twf; age unknown; maximum exposed thickness about 50 m (Parrot green – PC1006).

04-02-08-00-00—Unit—Twbt—Basaltic trachyandesite of Hill 9395—Dark gray to black, sparsely porphyritic, fine-grained lavas containing phenocrysts of plagioclase in completely altered groundmass of tiny plagioclase, clinopyroxene, olivine and opaque oxides; contains sparse gabbroic xenoliths; alteration consists of silica, sericite, chlorite, Fe-oxides and epidote; Hill 9395 is probable vent area; hill to south capped by Twbt is eroded flow; overlies Twbb; age unknown; maximum thickness about 20 m (Aquamarine – PC905).

04-02-09-00-00—Unit—Twbb/Twal—Basaltic trachyandesite flows, agglutinate and breccia—Lumped unit of gray thin driblet flows and dark red agglutinate, spatter, scoria, breccia and tuff representing multiple eruptive events; most specimens contain plagioclase, clinopyroxene and olivine; upper material is probably associated with lavas of Hill 9395; contains thin bed (±3 m) of white accretionary lapilli tuff layers (Twal) in ravine east of Trail 25; several layers contain balls ≤0.5 cm in diameter of opalized mud with a few tiny feldspar and magnetite crystals; unit Twbb underlies lavas of Twbt and is cut by various dikes and plugs; overlies units Twf, Twsc and Twtb; ages of various deposits unknown; maximum thickness about 100 m (Twbb = Burnt ochre – PC943; Twal = Poppy red – PC922).

04-02-09-01-00—Unit—Twbb/Twal—Basaltic trachyandesite flows, agglutinate and breccia—Lumped unit of gray thin driblet flows and dark red agglutinate, spatter, scoria, breccia and tuff representing multiple eruptive events; most specimens contain plagioclase, clinopyroxene and olivine; upper material is probably associated with lavas of Hill 9395; contains thin bed (±3 m) of white accretionary lapilli tuff layers (Twal) in ravine east of Trail 25; several layers contain balls ≤0.5 cm in diameter of opalized mud with a few tiny feldspar and magnetite crystals; unit Twbb underlies lavas of Twbt and is cut by various dikes and plugs; overlies units Twf, Twsc and Twtb; ages of various deposits unknown; maximum thickness about 100 m (Twbb = Burnt ochre – PC943; Twal = Poppy red – PC922).

04-02-10-00-00—Unit—Twf—Aphyric trachybasalt south of Argentina Spring—Multiple flows of dark gray to greenish gray aphyric basalt with sparse phenocrysts of plagioclase and clinopyroxene in altered groundmass of plagioclase, clinopyroxene, opaque oxides and olivine; alteration consists of silica, Fe-oxides, sericite, chlorite and epidote (?); unit extends south to Spring Point area; underlies Twbb, Twsp and Twap; overlies Twas and Twsc; ages of various flows unknown; maximum exposed thickness about 130 m (Peacock – PC1027).

04-02-11-00-00—Unit—Twas—Argentina Spring tuff—Black to gray to pale tan, slightly welded to densely welded, lithic-rich, biotite rhyolite ash flow tuff (ignimbrite); contains flattened welded pumice (fiamme) with maximum aspect ratio of ≥25:1; bottom of unit resembles reomorphic tuff (Branney et al., 2008); small abundant phenocrysts consist of sanidine, plagioclase, biotite, opaque oxides, ≤2 % quartz and tiny altered hornblende (?) in banded eutaxitic groundmass; some bands contain spherulites; pumice, spherulites and bands contain deuteric tridymite and fine alkali feldspar; alteration consists of silica, sericite and Fe-oxides; lithic fragments consist of white chert to fine-grained sandstone and a variety of light to dark-colored volcanic rocks; also contains flattened mafic clots; upper layers of unit conceivably represent another tuff (Bucky Pasture tuff) in Godfrey Hills to west; source of tuff is unclear; underlies Twf, Twap, Twfa, and Tnt; interbedded in Twb; overlies Twsc and Twl; age unknown; maximum thickness is roughly 100 m (Poppy red – PC922).

04-02-12-00-00—Unit—Twsc—Spring Canyon trachydacite—(formerly trachyandesite of Spring Canyon, Thompson, 1972, 1973)—Thick, cliff-forming lava of aphyric, flow-banded trachydacite; contains very sparse small phenocrysts of plagioclase in felty groundmass of tiny plagioclase, clinopyroxene, biotite and magnetite; some specimens are spotted with clots of tiny plagioclase; biotite is difficult to find at many locations; alteration consists of mica, sericite, silica and Fe-oxides; vent area for unit is just east of Hill 9350; overlies various Walker lavas and breccias (Twl and Twb); underlies Twas, Twf and Twbb; age unknown; maximum exposed thickness near vent is 110 m (Goldenrod – PC1034).

04-02-13-00-00—Unit—Twtt—Porphyritic trachydacite tuff east of Little Bear Canyon—Possible eroded vent of brownish gray, porphyritic, fragmental tuff; caps small hill on ridge north of Cone Peak; contains phenocrysts of plagioclase, Kspar (?), magnetite, very altered biotite and hornblende, and rare quartz; lithics consist of mafic volcanic rocks. Tuff is quite altered containing silica, sericite, chlorite, smudgy opaque oxides, other Fe-oxides and sparse epidote; overlies Walker lavas and minor interbedded breccias (Twl); age unknown; thickness about 30 m (Sunburst yellow – PC917).

04-02-14-00-00—Unit—Twpa—Porphyritic trachyandesite—Circular, vent-like body of dark gray, massive to scoriaceous trachyandesite with 0.5 cm long phenocrysts of plagioclase in groundmass of plagioclase, clinopyroxene and altered glass; surrounded by hydrothermal breccia at Great Western Mine; alteration consists of clay, silica, Fe-oxides, and chlorite; maximum exposed thickness about 40 m; age unknown (Apple green – PC912).

04-02-15-00-00—Unit—Twtx—Plagioclase porphyritic trachybasalt to basaltic trachyandesite—Distinctive group of related lavas distributed throughout north and west quadrangle; consists of dark gray to gray porphyritic lavas that contain large jackstraw plagioclase and plagioclase clots; typical specimens contain 15-20% elongate plagioclase laths up to 2 cm long in a groundmass of plagioclase, clinopyroxene, altered olivine, opaque oxides and glass. Lava in lower Nogal Canyon (NE corner of quadrangle) contains additional groundmass phlogopite (?); alteration consists of silica, calcite, sericite, chlorite, epidote, and Fe-oxides. Between upper Barber Ridge and Brush Canyon areas, Twtx consists of two superimposed lava flows separated by layer of Twba; stratigraphic relations elsewhere are uncertain, although the unit probably occurs in the central part of the Walker lava package (Twl); ages of various flows unknown; maximum thickness is roughly 25 m (Violet – PC932).

04-02-16-00-00—Unit—Twba—Porphyritic trachyandesite—Black to gray to blue-gray flows and flow breccias of porphyritic trachyandesite containing phenocrysts of plagioclase ± Kspar in groundmass of plagioclase, clinopyroxene ± hornblende ± biotite and devitrified glass; generally displays argillic to weak propylitic alteration; overlies Twb in northwest slopes of quadrangle; interbedded with both Twtx and Twtb; various flows not dated; maximum exposed thickness about 245 m (True blue – PC903).

04-02-17-00-00—Unit—Twtb—Trachybasalt and tephrite—Dark gray, fine-grained trachybasalt to tephrite lavas that form conspicuous thin (≤20 m) shelves within unit Twb described below and forms a package of flows (often with spotted texture) and interbedded breccias in the northwest part of the quadrangle; flows interbedded in Twb are equivalent to unit Tvtf of Moore et al., (1988); usually contains small phenocrysts of clinopyroxene ± iddingsitized olivine; groundmass consists of plagioclase, augite, magnetite, apatite, olivine ± biotite ± nepheline; generally displays argillic to weak propylitic alteration; overlies Cub Mountain Formation (Tcm) in the SE corner of quadrangle; individual flows not dated; maximum exposed thickness about 260 m (Imperial violet – PC1007).

04-02-18-00-00—Unit—Twb/Twbc—Breccia-rich unit, undivided—Purple gray to reddish brown volcanic breccia consisting of flow breccia, debris flows, mudflows, minor pyroclastic deposits, minor lava flows and subordinate vent breccia; clasts consist primarily of aphyric to porphyritic tephrite, trachybasalt and trachyandesite (unit Tsb of Thompson, 1972, 1973). Typical breccia fragments are 5 to 20 cm in diameter although some are more than 1 m across; breccia fragments generally constitute more than 50% of the rock; most fragments are rimmed with earthy red hematite. The breccia matrix is fine-grained containing alteration products of Fe-oxides, clay, zeolites, calcite and chlorite ± epidote. An analysis of a large clinopyroxene-porphyritic clast from a thick monolithologic breccia in lowermost Spring Canyon area (west end of cross section A-A') is basaltic trachyandesite. Base of unit is not exposed throughout most of Nogal Peak quadrangle. Maximum thickness is at least 550 m. Another breccia-rich horizon occurs beneath the Nogal Peak trachyte near the northern edge of the quadrangle. This horizon consists of roughly 150 m of purple gray to reddish gray volcanic breccia with 25% interlayered lava flows of alkali basalt to trachyte composition and is equivalent to a roof pendant of volcanic breccia overlying the NW portion of the Rialto Stock. Some areas of breccia particularly rich in agglutinate, scoria and spatter are mapped separately (Twbc). Age of the lower breccia is unknown but is estimated to be between 38 and 32 Ma (Thompson, 1972; Moore et al., 1991) (Twb = French grey 50% - PC1072; Twbc = Terra cotta – PC944).

05-00-00-00-00—Heading 02—Late Eocene—Late Eocene—Late Eocene

05-01-00-00-00—Unit—Tsc—Sanders Canyon Formation—Gray to purple gray volcaniclastic sediments consisting of sandstone, mudstone and minor conglomerate (Cather, 1991); provenance of most volcanic detritus is thought to be derived from intermediate composition volcanic sources to the southwest; contains some interfingering lenses of Sierra Blanca derived pebbles and cobbles near the top of unit; contact with overlying Walker breccia (Twb) is gradational; contact with underlying Cub Mountain Formation (Tcm) is also somewhat gradational; type reference section for Sanders Canyon Formation (Tcm) occurs in vicinity of Chavez Canyon in northwest map area; age is thought to be Eocene; thickness in reference section is 150 m (Burnt ochre – PC943).

06-00-00-00-00—Heading 02—Eocene—Eocene—Eocene

06-01-00-00-00—Unit—Tcm—Cub Mountain Formation—Sediments composed of interlayered, white to yellowish brown arkosic sandstone and red, maroon, and greenish gray mudstone, siltstone and fine-grained sandstone (Bodine, 1956; Moore et al., 1988). Unit contains thin lenses of chert, quartzite-pebble conglomerate and silicified wood. Unconformably overlain by units Tsc, Twb, and Twtb. Age is thought to be Eocene (Cather, 1991). Exposed thickness in map area is roughly 65 m (Goldenrod – PC1034).

07-00-00-00-00—Heading 02—Cretaceous—Cretaceous—Cretaceous

07-01-00-00-00—Unit—Kmv—Mesa Verde Group—Interbedded, light gray, yellowish gray, and reddish gray, massive to medium-bedded, fine- to medium-grained sandstone of continental margin or overbank river deposit origin (Moore et al, 1988); medium-dark gray carbonaceous siltstone; and a few coal beds in carbonaceous siltstone; exposed only in extreme SW corner of quadrangle where thickness is roughly 30 m (True green – PC910).

07-02-00-00-00—Unit—Ku—Cretaceous rocks, undivided (cross sections only)—Undivided stack of sedimentary rocks consisting of Mesa Verde Group (Upper Cretaceous), Mancos Shale (middle to upper Cretaceous), and Dakota sandstone (lower to middle Cretaceous); see Rawling, 2004b for distinguishing characteristics of each unit. Most of this stack is not exposed on Nogal Peak quadrangle. Aggregate thickness is about 680 m (Rawling, 2004b) (True green – PC910).

08-00-00-00-00—Heading 02—Triassic—Triassic—Triassic

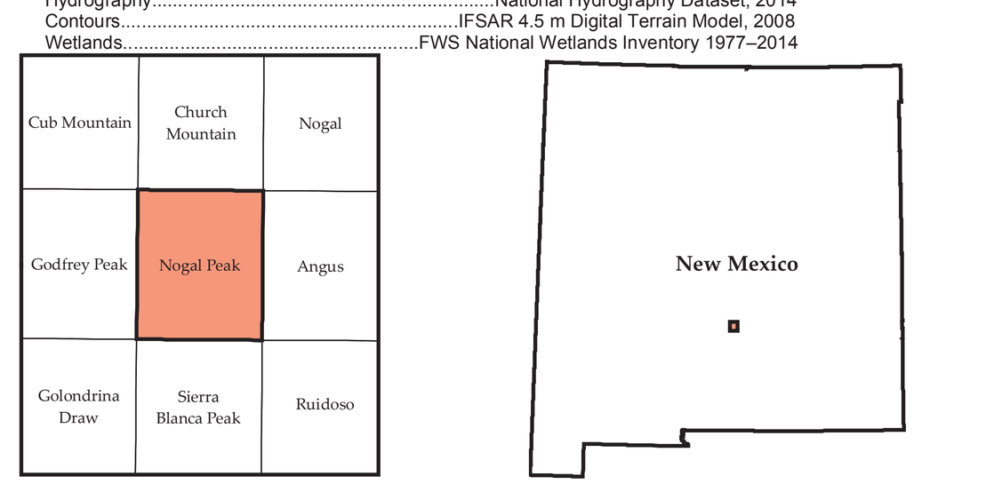
08-01-00-00-00—Unit—TRsr—Santa Rosa Formation (cross section B-B' only)—Gray to bluish gray limestone and dolomite; unit is not exposed on Nogal Peak quadrangle; estimated thickness ≤45 m; see Rawling, 2004b for distinguishing characteristics (Cool gray 70% - PC1065).

09-00-00-00-00—Heading 02—Permian—Permian—Permian

09-01-00-00-00—Unit—Pu—Permian rocks, undivided (cross section B-B' only)—Undivided stack of sedimentary rocks consisting of Grayburg Formation (upper Permian), San Andres Formation (middle to upper Permian), and Yeso Formation (middle Permian); this stack is not exposed on Nogal Peak quadrangle; estimated thickness ≤925 m; see Rawling, 2004b for distinguishing characteristics (Light aqua – PC992).

Base map from U.S. Geological Survey 2017.
North American Datum of 1927 (NAD27)
Projection and 1,000-meter grid: Universal Transverse Mercator, Zone 13S, shown in blue.
10,000-foot ticks: New Mexico Coordinate System of 1983 (central zone), shown in red.

Roads ... U.S. Census Bureau, 2015–2016
Names ... GNIS, 2016
Hydrography ... National Hydrography Dataset, 2014
Contours ... IFSAR 4.5 m Digital Terrain Model, 2008
Wetlands ... FWS National Wetlands Inventory 1977–2014



Quadrangle Location

Magnetic Declination
June, 2009
8° 54' East
At Map Center

1:24,000

1 0.5 0 1 Mile
1000 0 1000 2000 3000 4000 5000 6000 7000 Feet
1 0.5 0 1 Kilometer

Contour Interval 80 Feet
National Geodetic Vertical Datum 1929

New Mexico Bureau of Geology and Mineral Resources
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Open-File Geologic Map 134

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Geologic Map of the Nogal Peak 7.5-Minute Quadrangle, Lincoln & Otero Counties, New Mexico

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by

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This draft geologic map is preliminary and will undergo revision. It was produced from either scans of hand-drafted originals or from digitally drafted original maps and figures using a wide variety of software, and is currently in cartographic production. It is being distributed in this draft form as part of the bureau's Open-file map series (OFGM), due to high demand for current geologic map data in these areas where STATEMAP quadrangles are located, and it is the bureau's policy to disseminate geologic data to the public as soon as possible.

After this map has undergone review, editing, and final cartographic production adhering to bureau map standards, it will be released in our Geologic Map (GM) series. This final version will receive a new GM number and will supercede this preliminary open-file geologic map.

DRAFT

Comments to Map Users

A geologic map displays information on the distribution, nature, orientation, and age relationships of rock and deposits and the occurrence of structural features. Geologic and fault contacts are irregular surfaces that form boundaries between different types or ages of units. Data depicted on this geologic quadrangle map may be based on any of the following: reconnaissance field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation. Locations of contacts are not surveyed, but are plotted by interpretation of the position of a given contact onto a topographic base map; therefore, the accuracy of contact locations depends on the scale of mapping and the interpretation of the geologist(s). Any enlargement of this map could cause misunderstanding in the detail of mapping and may result in erroneous interpretations. Site-specific conditions should be verified by detailed surface mapping or subsurface exploration. Topographic and cultural changes may not be shown due to recent development.

Cross sections are constructed based upon the interpretations of the author made from geologic mapping, and available geophysical, and subsurface (drillhole) data. Cross sections should be used as an aid to understanding the general geologic framework of the map area, and not be the sole source of information for use in locating or designing wells, buildings, roads, or other man-made structures.

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