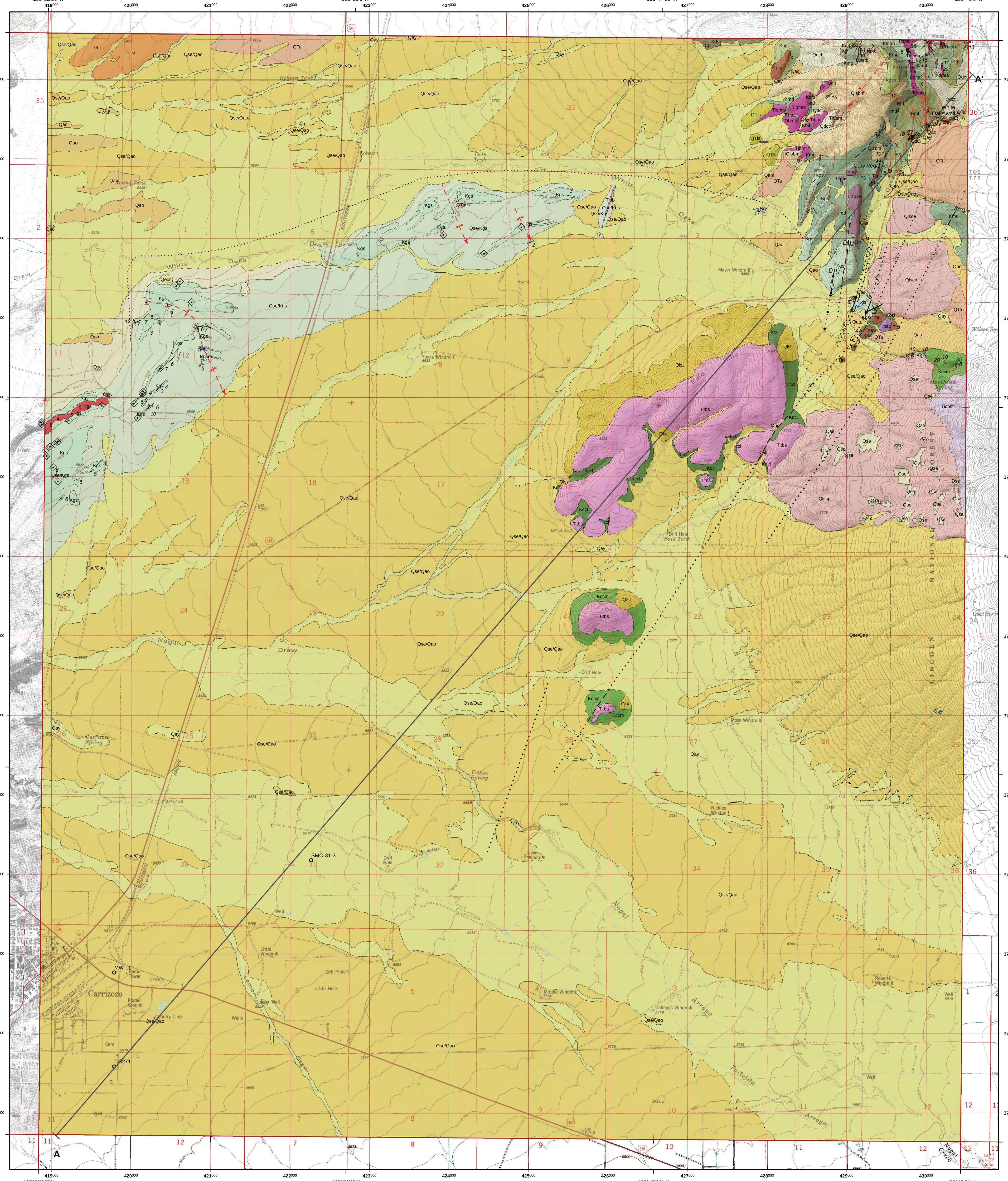
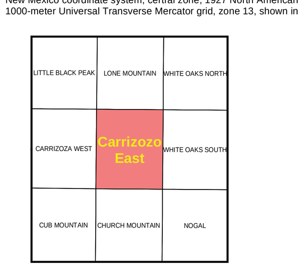
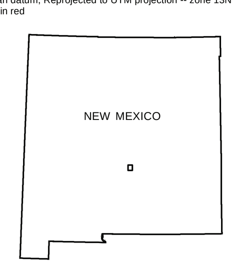
NEW MEXICO BUREAU OF GEOLOGY AND MINERAL RESOURCES A DIVISION OF NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY




QUADRANGLE LOCATION



1:24,000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

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 scientific peer 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

Geologic map of the Carrizozo East quadrangle, Lincoln County, New Mexico

June 2010

by
Daniel Koning[1] and Kirt Kempter[2]

[1] New Mexico Bureau of Geology and Mineral Resources, 801 Leroy Place, Socorro, NM 87801
[2] 2623 Via Caballero del Norte, Santa Fe, NM 87505

New Mexico Bureau of Geology and Mineral Resources
Open-file Map Series
OFGM 211

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

[505] 835-5490
http://geoinfo.nmt.edu

COMMENTS TO MAP USERS

DESCRIPTION OF MAP UNITS

We arrange map units in the Carrizozo East quadrangle into three categories: 1) Quaternary, 2) igneous intrusions, and 3) Cretaceous fluvial and marine strata. Quaternary units on this quadrangle are grouped into the following three categories: 1) sheetflood and eolian deposits, 2) debris flow and hillslope deposits, and 3) alluvial deposits.

SHEETFLOOD AND EOLIAN DEPOSITS

Qse Sheetflood and eolian deposits (uppermost Pleistocene to upper Holocene) – ... Locally at depth, color changes to brownish yellow (10YR 6/6). Internally massive, but at base of tall slopes there may be thin to medium, lenticular beds of sandy pebbles. Minor, variable medium-upper to very coarse-upper sand and very fine to very coarse pebbles of sandstone and calcium carbonate (felsic igneous clasts are common in eastern half of quadrangle). Grains are subrounded to subangular, moderately to moderately well sorted, and composed of quartz, 15-20% feldspar, and 7-15% lithic and mafic grains. Pebbles are subangular to angular. Upper 0.5-1.0 dm is loose; below, sediment is harder and marked by ped development. Typically there is a pebble lag on the surface (10-20% surface coverage by pebbles). At base of tall slopes there may be Unit appears to have somewhat higher amounts of feldspar and lithic grains than found in Gallup Sandstone. Unit includes minor coppice dunes, generally < 1 m-tall. Sand in dunes is very pale brown (10YR 7/4), fine-lower to medium-lower (mostly fine-upper), subrounded to subangular, well-sorted, and composed of quartz, ~15% feldsar, and 8% lithics and mafics. Unit grades laterally into unit Qay and defining the contact between the two is difficult. Unit is less than 1 m-thick, but may be thicker at the base of steep slopes.

Qse/Kgs Sheetflood and eolian deposits overlying Gallup Sandstone – Sheetflood and eolian deposits, as described in unit Qse, which overlie Gallup Sandstone. Generally less than 1 m-thick.

Qse/Qao Sheetflood and eolian deposits overlying older alluvium – Sheetflood and eolian deposits, as described in unit Qse, which overlie older alluvium. Generally less than 50 cm-thick.

Qse/Qlscp Sheetflood and eolian deposits overlying Carrizo Peak landslide deposits – Sheetflood and eolian deposits, as described in unit Qse, which overlie Carrizo Peak landslides. Generally less than 1 m-thick.

Qecr Coppice dunes on a sand ramp (upper Holocene) – Coppice dunes on an eolian sand ramp; dunes are up to 2 m-tall, commonly centered around junipers. Sand color of reddish yellow to brownish yellow (7.5-10YR 6/6) to very pale brown (10YR 7/4). Sand is mostly fine-upper grain size, with lesser fine-lower or medium-lower grain sizes, and subrounded to subangular, well-sorted, and composed of quartz, ~5% feldspar, and 5-10% gray lithic grains and black mafic grains. Loose. Eolian sand ramp thickness is estimated at 1-6 m.

DEBRIS FLOW AND HILLSLOPE DEPOSITS

Qdct Debris flow deposits, colluvium, and talus (upper Pleistocene to Holocene) – Poorly sorted and well-graded, commonly matrix-supported pebbles through boulders in a sandy or clayey-silty sand matrix. Gravel are angular to subrounded; gravel composition varies with source lithology of a given drainage. Matrix is light yellowish brown (10YR 6/4), very fine- to very coarse-grained sand that isporly sorted and subangular to subrounded. Variable clay and silt (1-15% of sediment volume, estimated). Moderately consolidated. 1-12 m-thick.

Qlsbm Landslide deposit on slopes of Baxter Mountain (middle to late Pleistocene) – Cobbles and boulders (and minor pebbles) composed of quartzitic Gallup Sandstone and pebbles to cobbles of Mancos Shale and/or Baxter Mountain melatrachyte in a matrix of disarticulated (ground-up) Mancos Shale. No bedding. Sandstone clasts are very poorly sorted and angular to subrounded. Shale clasts are angular. Matrix is light yellowish brown (2.5Y 6/3) sand with an estimated 10-15% clay. Sand is very fine- to very coarse-grained, and poorly sorted. Medium- to very coarse-grained sand is comprised of angular to subrounded pieces of Mancos Shale. Very fine- to fine-grained sand is composed of subrounded to subangular quartz, grains of Mancos Shale, and minor feldspar. 1-15(?) m-thick.

Qlst Landslides on slopes capped by trachyte sills (upper Pleistocene to Holocene) – Slump blocks within the D-cross Tongue of Mancos Shale or the Crevasse Canyon Formation, locally capped by fractured, transported trachyte sill. 2-10(?) m-thick.

Qlscp Landslide deposits on slopes of Carrizo Peak (lower to middle Pleistocene) – Very poorly sorted pebbles, cobbles, and boulders, composed of Carrizo Peak trachyte-syenite complex, in a sandy matrix. Clasts are well-graded, subrounded (mostly) to subangular, and monolithic. There is a single, 2 m-thick tabular zone where syenite-trachyte clasts are mixed with yellow, clayey-silty very fine-grained sandstone (from Crevasse Canyon Formation?). Matrix is very fine- to very coarse-grained sand that is well-graded, subangular to subrounded, and composed of igneous syenite-trachyte fragments with ~5% gypsum and/or calcite. Moderately consolidated. Greater than 30 m-thick.

QTls Outlier landslide remnants west of Baxter Mountain (upper Pliocene to middle Pleistocene?) – Jumbled boulders of Gallup Sandstone (metamorphosed to quartzite) in a finer-grained matrix. No intact bedding. No exposure. Up to 20 m-thick.

ALLUVIAL DEPOSITS

Qay Younger alluvium (Holocene) – Very fine- to fine-grained sand, with minor medium- to very coarse-grained sand and scattered (commonly 3-15%) pebbles. Unit generally is inset below the top of adjoining Qao deposits and has a relatively weak soil. Colors of grayish brown to brown (10YR 5/2-3), light brownish gray to pale brown (10YR 6/2-3), or grayish brown to light olive brown (2.5Y 5/2-3). Sediment becomes redder near the base of the deposit (brown to strong brown, 7.5YR 5/4-6). Variable clay-silt mixed with sand, typically 1-10% fines (estimated volume) but ranging up to 40%. Typically massive, with varying degrees of bioturbation. Sand is moderately to poorly sorted and subrounded to subangular. Medium- to very coarse-grained sand is generally lithic grains (igneous detritus, sandstone, hornfels, or shale – depending on source area) whereas very fine- to fine-grained sand is composed of quartz, feldspar, and lithic grains. 1-10% very thin to medium (mostly thin), lenticular beds of medium to very coarse sand and gravel. Gravel is generally pebbles with minor, variable amounts of cobbles. Clasts are subrounded to subangular (locally rounded), poorly sorted, and locally imbricated. Clast composition varies with source area. In White Oaks Draw, gravel consist of felsic igneous clasts, sandstone, hornfels, and shale. In Nogal Arroyo, clasts are predominately intermediate igneous types, with minor sandstone. Generally, there is a cumulic soil developed throughout the sediment. Ped development is moderate to strong, medium to very coarse, subangular blocky to prismatic; peds are generally hard in a dry state. Clay illuviation is marked by faint to very faint clay films on ped faces and faint clay bridges. Calcium carbonate accumulation is characterized by a stage I to I+ carbonate morphology. Minor gypsum accumulation below a meter depth. Locally, a sandier subunit (<1 m-thick) is found at the top of this unit, disconformably overlying older Qay strata; containing minor pebbles (10-20%), this upper unit exhibits very thin to thin, lenticular bedding or horizontal-planar laminations. In White Oaks Canyon, gravel beds are common in this unit (clast-supported pebbles and cobbles with lesser boulders), fining-upward into the finer-grained deposits described above. Weakly to moderately consolidated, mostly moderately consolidated. Unit includes minor modern and historical alluvium that are generally in narrow, incised arrows. Typical thickness of 1-3 m.

Qao Older alluvium (middle to late Pleistocene) – Deposit of variable texture that underlies higher geomorphic surfaces and typically has a strong calcic horizon on or near its surface. Typically a sandy gravel near topographic highs along the eastern border of the quadrangle, but within a few kilometers the sediment grades laterally eastward into interbedded sand (mostly fine sand), slity-clayey fine sand, silt, and clay, with 1-5% intercalated pebble-cobble beds. Gravel is locally scattered withyin finer sediment. Colors of pale brown to very pale brown (10YR 6-7/3) or pale yellow (2.5Y 7/3) or light yellowish brown (2.5Y-10YR 6/4). Non-gravelly sediment is generally in very thin to medium, tabular beds. Gravel beds are very thin to medium and lenticular. Deposit is commonly gypsiferous (1-15% gypsum filaments comprised of sand-size gypsum grains). Gravel are subrounded to angular, poorly sorted, and composed of various igneous clasts, with sandstone and hornfels common in the northeast corner of the quad. Sand is generally subrounded to subangular and moderately to poorly sorted. Medium- to very coarse-grained sand is composed of lithic grains; very fine- to fine-grained sand is composed of quartz, feldspar, and minor lithic grains. A soil with a strong calcic soil horizon (stage II+ to III carbonate morphology) has formed on the surface of this unit; this calcic horizon has moderate to strong, very fine to coarse, subangular blocky peds that are slightly hard to very hard. Except where removed by erosion, a strong brown to reddish yellow (7.5YR 5-6/6) Bw or illuviated clay (Bw) soil horizon overlies the calcic soil. Stratigraphic relations 0.5-1.0 km southeast of Fetters Spring indicate significant erosion followed deposition of this unit and the strong calcic soil found on the unit's surface formed after this erosion event. Weakly to moderately consolidated. Sandy-pebbly channel-fills transmit groundwater in this unit, which discharges at two localities on the quadrangle: Carrizozo spring and Fetters spring – both of which are marked by relatively low discharges.

Unit Qao underlies a geomorphic surface that is 1-10 m lower than the surface on unit QTa. However, we cannot state with confidence that Qao is a distinct deposit; in other words, mapped Qao may be equivalent to an eroded QTa. An exposure of QTa (data point C-497 on map) and an exposure of Qao (data point C-361 on map) exhibit similar sediment characteristics. At exposure C-497, 1.5 – 2.0 m of sediment underlies the surface associated with Qao, and this sediment is inset into QTa. However, this relatively thin, inset sediment was not observed at exposure C-361. Because of this uncertainty, we do not know the thickness of Qao. Combined thicknesses of Qao-QTa are discussed under unit Qao-QTa.

Qao-QTa Combined unit of Qao and QTa (upper Pliocene to upper Pleistocene) – Used in cross-section A- A' only. Because of uncertainty associated with the base of Qao, this combined unit is used in cross-section AA'. Three wells and an alluvium isopach map (obtained from a local landowner, Stirling Spencer, who in turn received it from a coal mining company) were used to estimate the base of this unit in the cross-section. The isopach map was constructed from coal prospect borings and indicates a westward-trending paleovalley associated with Nogal Draw. Unit Qao-QTa is about 30 m-thick in this paleovalley and about 15-20 m-thick on either side. The unit thins south of Nogal Draw. Near Carrizozo, well data suggest a bedrock high near the north part of town (Qao-QTa thicknesses of 5-7 m at the Cimarron Mining Corporation site) and deeper alluvium to the south (26 m at well T-3271).

QTa Alluvium underlying high-level surfaces in the northeastern quadrangle (upper Pliocene to middle Pleistocene) – Sandy pebbles-boulders (mostly cobbles to boulders) that are poorly to non-bedded; generally interpreted as debris flow deposits. Gravel are subrounded (mostly) to subangular, very poorly sorted, and composed of Carrizo Peak syenite-trachyte; maximum observed boulder length is about 2 m. Sand is light yellowish brown to pale yellow (2.5Y 6/3-7/4) or light gray to very pale brown (10YR 7/2-3), very fine- to very coarse-grained, angular to subangular (mostly) to subrounded, and poorly sorted. Medium to very coarse sand is composed of trachyte-syenite grains, and very fine to fine sand is composed of trachyte-syenite grains, quartz, and feldspar.

Along White Oaks Canyon, lower 2-3 m of deposit is mostly imbricated sandy gravel. Bedding is generally vague, thin-medium, and lenticular; locally cross-stratified (2 m-thick foresets). Gravel consists of well-graded pebbles-boulders of diverse lithologic types. Clasts are subrounded to subangular and include Carrizo Peak syenite-trachyte, other igneous rock types (mostly felsic), hornfels, and sandstone. Sand is light gray to very pale brown (10YR 7/2-3), fine- to very coarse-grained (mostly coarse- to very coarse-grained), poorly sorted, and includes a well-graded mixture of quartz, feldspar, and lithic grains. Moderately consolidated. 12 m-thick.

Ta High-level gravel in northwest corner of quadrangle (Pliocene?) – Gravel consisting of very fine to very coarse pebbles, cobbles, and ~15% boulders. Clasts are subrounded (mostly) to subangular and poorly sorted. Gravel are composed of trachyte-syenite, minor sandstone and hornfels, and 1-3% limestone. Exposure does not permit observations of bedding. All clasts have thick calcium carbonate coats and there is evidence of a stage IV calcic horizon on the surface of this unit. At least 6 m-thick.

Igneous intrusions

Baxter Mountain melatrachyte

The Baxter Mountain melatrachyte is a distinctive, darker igneous rock that intruded around Baxter Mountain. The largest intrusion is a stock in the vicinity of the South Homestake Shaft. A multitude of dikes emanate south from this stock as far as White Oaks Draw. On the southwest slopes of Baxter Mountain, this igneous rock occurs as both sills and dikes. This rock cross-cuts other syenite-trachyte igneous rocks and appears to be the youngest intrusive rock in the quadrangle. We assign a tentative late Oligocene age to this intrusion. Various degrees of hydrothermal alteration occurred in this rock on the east side of Baxter Mountain. Fluids evidently preferred to flow through this rock than the lower-permeability Mancos Shale. This fluid flow likely occurred shortly after the emplacement on the intrusion and is associated with mineralization. Most of the prospect pits, adits, and shafts in the northeast quadrangle are associated with this unit.

Tibmt Baxter Mountain melatrachyte (upper(?) Oligocene) – Light gray to very light yellowish gray, porphyritic trachyte with significant amounts of mafic phenocrysts. Phenocryst assemblage includes: 7-15% mafic minerals, 0.2-6.0 mm long and euhedral to subhedral, and 12-15% potassium feldspar phenocrysts, 0.5-6.0 mm-long and euhedral to subhedral. Mafic minerals are mostly augite and hornblende, with minor and variable amounts of biotite. Hornblende phenocrysts may be up to 20 mm in length. Mafic minerals locally "plucked" or dissolved, leaving casts. Groundmass is 0.1-0.2 mm in size and consists of feldspar with 25% mafic minerals. Unit correlates to melatrachyte of Grainger (1974).

Tibmtd Baxter Mountain melatrachyte dike (upper(?) Oligocene) – Light gray to very light yellowish gray, porphyritic trachyte with significant amounts of mafic phenocrysts. Phenocryst assemblage includes: 7-13% mafic minerals, 0.2-5.0 mm long (locally as much as 22 mm-long) and euhedral (mostly) to subhedral, and 10-20% potassium feldspar phenocrysts, 0.3-6.0 mm-long and subhedral (mostly) to euhedral. Mafic minerals are mostly augite and hornblende, with minor and variable amounts of biotite. Hornblende phenocrysts may be up to 20 mm in length. Groundmass is 0.1 (mostly) to 0.5 mm and composed of potassium feldspar with ~10% mafics. Unit correlates to melatrachyte of Grainger (1974). Locally, megacrysts of hornblende or potassium feldspar are present (up to 30 mm). Dikes are up to 4 m-wide. Mapped as a line only.

Tibmts Baxter Mountain melatrachyte sill (upper(?) Oligocene) – Similar to unit Tibmt, but in a sill form.

Tibmta Altered Baxter Mountain melatrachyte (upper(?) Oligocene) – Yellowish to reddish orange, porphyritic trachyte that has been notably hydrothermally altered. Phenocryst assemblage includes: 8-20% mafic minerals, 0.1-8.0 mm long and euhedral to subhedral, and 0-20% potassium feldspar phenocrysts, 1-5 mm-long and subhedral. Mafic minerals are mostly augite and hornblende, with minor and variable amounts of biotite. Hornblende phenocrysts may be up to 20 mm in length. Unit correlates to melatrachyte of Grainger (1974).

Tibmtad Altered Baxter Mountain melatrachyte dike (upper(?) Oligocene) – As in unit Tibmta, but occurring in sub-vertical dikes 1 to 4 m-wide. Unit locally mineralized and was the focus of past mining activity. Locally silicified. Phenocrysts consist of: 1) 5-20% 1-10 mm-long potassium feldspar (mostly 0.5-3.0 mm) that is locally replaced by bluish-gray minerals; 2) 10-15% pyroxene and hornblende that are commonly dissolved and replaced by a rusty, fine-grained substance (goethite or limonite). Mafic casts are typically 0.5-6.0 mm. Hornblende casts are as much as 20 mm-long. Matrix is about 0.1-0.5 mm grain-size and composed of potassium feldspar with 3-5% mafic minerals. Locally trace to 1% biotite. Unit correlates to melatrachyte of Grainger (1974). Dikes are up to 4 m-wide. Mapped as a line only.

Tibmtas Altered Baxter Mountain melatrachyte sill (upper(?) Oligocene) – Altered Baxter Mountain melatrachyte in a sill. Pinkish white, weathering to very pale brown. Similar to unit Tbmtad; locally, some of the mafic grains are biotite. Unit correlates to melatrachyte of Grainger (1974).

Andesite

A single stock(?) of andesite was identified near the mouth of White Mountain Canyon. This stock appears to cross-cut a sill of trachyte and is thus younger than the trachyte. We suspect this andesite is a less-alkalic derivative of the Baxter Mountain melatrachyte.

Tiap Porphyritic andesite (lower to upper Oligocene) – Gray color, weathering to an orangish gray. Matrix is mostly 0.1-0.3 mm (grain size) and composed of feldspar laths with 1-20% hornblende, pyroxene, and biotite. Phenocrysts comprise 3-10% of rock surface area and consist of 0.2-10 mm-long pyroxene, hornblende, and +/- biotite. Unit correlates to andesite of Grainger (1974).

Tibap Baxter Mountain porphyritic andesite (upper Eocene?) – Bluish gray, weathering to a brown varnish. Groundmass is composed of 0.2-0.5 mm plagioclase with 20-25% anhedral mafic minerals. Phenocrysts include: 1) 20-25% plagioclase (0.5-5.0 mm-long and subhedral); 2) 15% of an unknown, granular, greenish mineral forming subhedral phenocrysts; and 3) 3-5% augite (1-8 mm-long and euhedral to subhedral). Unit appears to have intruded into a trachyte sill (Tits).

Tiapd Porphyritic andesite dike (lower to upper Oligocene) – Porphyritic andesite, as described in unit Tiap, but in a dike form.

Tiaps Porphyritic andesite sill (lower to upper Oligocene) – Porphyritic andesite, as described in unit Tiap, but in a sill form.

Syenite-trachyte stocks, sills and dikes

Portions of two large stocks of trachyte are found in the northeastern part of the quadrangle. To the south is the Carrizo Peak syenite-trachyte complex. Finer-grained trachyte is found in the map area, but to the east this trachyte appears to grade into a syenite. Various sills and dikes of trachyte that are mapped in White Oaks Canyon are probably associated with the Carrizo Peak syenite-trachyte complex. These trachytes are invariably cross-cut by the Baxter Mountain melatrachyte and thus pre-date that unit. North of Baxter Mountain is a distinctive prophyritic syenite-trachyte that occurs as a stock in the north-central part of the main White Oaks mining area. We informally refer to this as the White Oaks syenite-trachyte complex. This intrusion has larger alkali feldspar phenocrysts than the Carrizo Peak syenite-trachyte complex. On the northwest slopes of Baxter Mountain, north-striking dikes of the White Oaks syenite-trachyte complex extend south onto this quadrangle. Here, a dike of Baxter Mountain melatrachyte cross-cuts the trachyte-syenite and thus the trachyte-syenite is older. Felsic tuffs have returned ages of 28-29 Ma in the Sierra Blanca volcanic complex. Felsic intrusions in the Gallinas Mountains (trachyte, syenite, and rhyolite) have been dated by the K/Ar method at 29.9 Ma (Perhac, 1970). Thus, a 28-29 Ma age is reasonable for the syenite and trachyte intrusions on this quadrangle.

Carrizo Peak igneous complex

Ticpst Carrizo Peak syenite-trachyte complex (lower to upper(?) Oligocene) – Porphyritic syenite-trachyte complex that composes Carrizo Peak, a landmark located about 1 km east of the eastern quadrangle boundary. Rock is very light gray weathering to pale yellow. Groundmass is potassium feldspar (0.1-0.4 mm grain size). 0.5-3% phenocrysts composed of subhedral potassium feldspar 0.5-5.0 mm-long; phenocrysts have been locally altered. Trachyte predominates on this quadrangle, which is inferred to laterally grade eastward into syenite at the core of the complex.

Titd Trachyte dike (lower to upper(?) Oligocene) – Trachyte dike that is non- to variably (but minor) altered. Non-altered rock is white and composed of feldspar (probably potassium feldspar). 0.1-0.3 mm grain size. 3-4% mafic minerals (probably pyroxene and hornblende) that includes some biotite. Rock has a foliated or sheared fabric. Within sheared areas are grayer or oranger zones containing north-south elongated vugs, many of which are filled by quartz. Generally less than 8 m-wide.

Tits Trachyte sill (lower to upper(?) Oligocene) – Slightly to non-porphyritic trachyte sill that is non- to variably (but minor) altered. Non-altered rock is white to orangish white to very pale brown, weathering to various orange and tan shades. Groundmass is composed of feldspar (probably potassium feldspar) of 0.1-0.5 mm grain size. 0-4% mafic minerals (probably pyroxene and hornblende) that includes some biotite. <2% phenocrysts, which include potassium feldspar (up to 4 mm-long and subhedral) and mafic grains (0.3-3.0 mm-long hornblende or pyroxene). Locally FeO stains on fracture faces.

Titbs Trachyte sill at Bald Hills (lower to upper(?) Oligocene – Slightly porphyritic trachyte sill that caps the Bald Hills. Groundmass is aphanitic (<0.2 mm grain size) and white, light tan, or light gray. Rock weathers to light gray, light brownish gray, or pinkish gray. 1-3% phenocrysts that are 0.2-8.0 mm (mostly 0.2-4.0 mm), anhedral to euhedral, and composed of hornblende and/or biotite. Similar rock caps the two conical hills northwest of Moss Windmill (1-2 km south of Bald Hills). The northern of these two conical hills has 10-15% phenocrysts that are 0.1-2.0 mm, anhedral, and are altered to a reddish brown, unknown mineral; the original mineral was likely biotite based on alteration rims of trace observed biotite. Base is not exposed and thickness is highly uncertain; our best estimate is 40-60 m-thick.

Titps Porphyritc trachyte sill (lower to upper(?) Oligocene) – Porphyritic trachyte. Very pale brown to yellow color, weathering to light gray. Phenocryst assemblage: 15-25% potassium feldspar phenocrysts (euhedral to subhedral) that range from 0.5-10 mm. Matrix consists of potassium feldspar (subhedral) that is 0.1-0.5 mm-long.

Titad Altered trachyte dike (lower to upper(?) Oligocene) – Trachyte dike that has been altered. White to light gray to very pale brown to pinkish gray, weathering to a creamy orange to yellow color. Grain size is 0.1-0.5 mm. Rock composed of potassium feldspar laths that are not aligned, in addition to 10% original mafic minerals (pyroxene or hornblende) that have ...

... (2.5Y-10YR 6-7/4) to pale yellow (2.5Y 8/2-4) sandstone, weathering to yellowish brown (10YR 5/6), very pale brown (10YR 6/4), or light gray (2.5Y-10YR 7/2). Locally strongly varnished. Medium to thick, tabular beds that are internally massive; subordinate planar-horizontal, laminated to very thin beds; local bioturbation. Sand grains are mostly fine-upper to medium-lower (locally minor very fine-grained sand, but very fine-grained sand is not typical), subangular to subrounded, ... mafic and lithic grains; locally as much as 20% feldspar and 20% lithic + mafic grains. Glauconitic and locally calcareous ... in calcareous, yellow to light yellowish brown, fine-lower to coarse-lower sandstone beds. Minor interbeds of a ... sand is fine-grained, subrounded, well-sorted, and has 3-5% dark gray-black lithic grains and ~5% feldspar. In a very few ... in coarse- to very coarse-grained, subrounded sandstone (composed of quartz with 10% lithic grains). Lowest sandstone ... (laminated to very thinly bedded), with foresets up to 40 cm-thick; sand is bright white, weathering to pale yellow (2.5Y ... and composed of quartz with 1% dark gray lithic grains and black mafic grains. Upper 6 m of the lower tongue is ledge- ...

... of 60-90 m. A total thickness of 150 m was used for this unit in the cross-section.

Pag Grayburg Formation, Artesia Group (upper Permian) – In the Little Black Peak quadrangle to the northwest, where it was called the Bernal Formation, this unit is red to buff, calcareous sandstone, siltstone, and shale; 60-90 m-thick (Smith and Budding, 1959).

Psa San Andres Formation, undifferentiated (lower to upper Permian) – Interbedded limestone, sandstone, dolomite, anhydrite, and gypsum beds. Near the base is a 6-12 m-thick sandstone (Weber, 1964). ~180 m-thick to the north of this quadrangle (Smith and Budding, 1959).

Py Yeso Formation (lower Permian) – Yellow and red siltstone, limestone, and gypsum. A thickness of 630 m is given in the Three Rivers quadrangle to the south (Koning, 2009).

Pa Abo Formation (lower Permian) – Reddish color; consists of overbank deposits of mudstone and clayey fine-grained sandstone that are intercalated with coarse channel-fills of sandstone and pebbly sandstone. Thickness not known in map area and unit may not even be present.

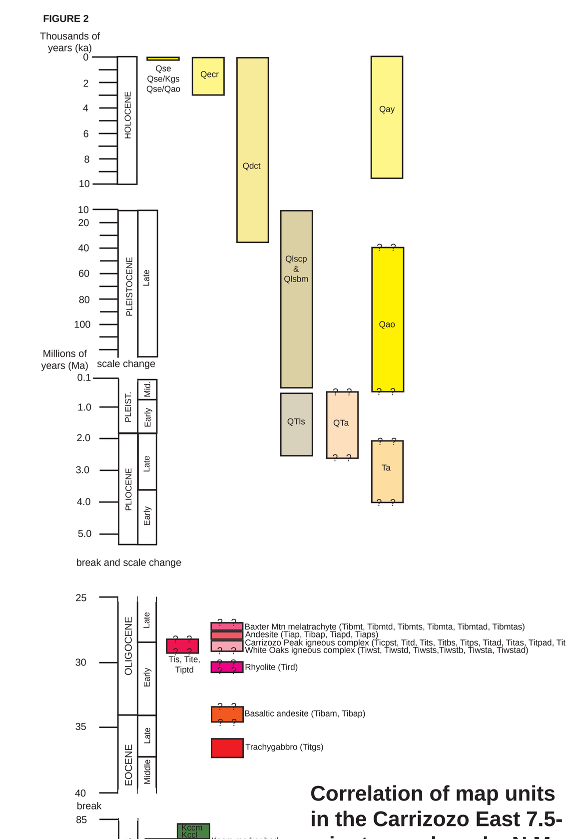
ACKNOWLEDGMENTS

We wish to thank Stirling Spencer, Gary Vega, Warren Malkerson, Rick Virden, Odis McClellan, David Dotson, Jake Stafford, and Paul Pino for allowing access to their land. Stirling Spencer shared an isopach map for alluvium as well as insights relating to the association of vegetation and surficial sediments.

REFERENCES

Birkeland, P.W., Machette, M.N., and Haller, K.M., 1991, Soils as a tool for applied Quaternary geology: Utah Geological and Mineral Survey, a division of the Utah Department of Natural Resources, Miscellaneous Publication 91-3, 63 p.
Birkeland, P.W., 1999, Soils and geomorphology: New York, Oxford University Press, 430 p.
Compton, R.R., 1985, Geology in the field: New York, John Wiley & Sons, Inc., 398 p.
Gile, L.H., Peterson, F.F., and Grossman, R.B., 1966, Morphological and genetic sequences of carbonate accumulation in desert soils: Soil Science, v. 101, p. 347-360.
Ingram, R.L., 1954, Terminology for the thickness of stratification and parting units in sedimentary rocks: Geological Society of America Bulletin, v. 65, p. 937-938, table 2.
Dowe, C.E., McMillan, N.J., McLemore, V.T., and Hutt, a., 2002, Eocene magmas of the Sacramento Mountain, NM – subduction or rifting?: New Mexico Geology, v. 24, p. 59-60.
Grainger, J.R., 1974, Geology of the White Oaks Mining District, Lincoln County, New Mexico [M.S. thesis]: Albuquerque, University of New Mexico, 69 p.
Haines, R.A., 1968, The geology of the White Oaks-Patos Mountain area, Lincoln County, New Mexico [M.S. thesis]: Albuquerque, University of New Mexico.
Koning, D.J., 2009, Preliminary geologic map of the Three Rivers 7.5-minute quadrangle, Otero County, New Mexico: New Mexico Bureau of Geology, open-file geologic map, scale 1:24000.
McLemore, V.T., 2002, The Three Rivers Petroglyph site, Otero County, New Mexico [non peer-reviewed mini-paper]: New Mexico Geological Society, 53rd Annual Field Conference Guidebook, p. 26-27.
Perhac, R.M., 1970, Geology and mineral deposits of the Gallinas Mountains, Lincoln and Torrence Counties, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 95, 51 p.
Munsell Color, 1994 edition, Munsell soil color charts: New Windsor, N.Y., Kollmorgen Corp., Macbeth Division.
Smith, C.T., 1964, Reconnaissance geology of the Little Black Peak Quadrangle, Lincoln and Socorro Counties, New Mexico: New Mexico Institute of Mining and Technology, State Bureau of Mines and Mineral Resources, Circular 75.
Smith C.T., and Budding, A.J., 1959, Reconnaissance geologic map of the Little Black Peak quadrangle, east half: New Mexico Institute of Mining and Technology, State Bureau of Mines and Mineral Resources Geologic Map 11.
Soil Survey Staff, 1992, Keys to Soil Taxonomy: U.S. Department of Agriculture, SMSS Technical Monograph no. 19, 5th edition, 541 p.
Sprankle, D.G., 1983, Soil survey of Lincoln County area, New Mexico: U.S. Department of Agriculture, Soil Conservation Service, 217 p.
Udden, J.A., 1914, The mechanical composition of clastic sediments: Bulletin of the Geological Society of America, v. 25, p. 655-744.
Varney, P. 1981, New Mexico's Best Ghost Towns: Flagstaff, Arizona, Northland Press, 190 p.
Weber, R.H., 1964, Geology of the Carrizozo quadrangle, New Mexico: New Mexico Geological Society, 15th Field Conference Guidebook, p. 100-109.
Wentworth, C.K., 1922, A scale of grade and class terms for clastic sediments: Journal of Geology, v. 30, p. 377-392.

FIGURE 2



Correlation of map units in the Carrizozo East 7.5-minute quadrangle, N.M.

Carrizozo East
Section line A-A'