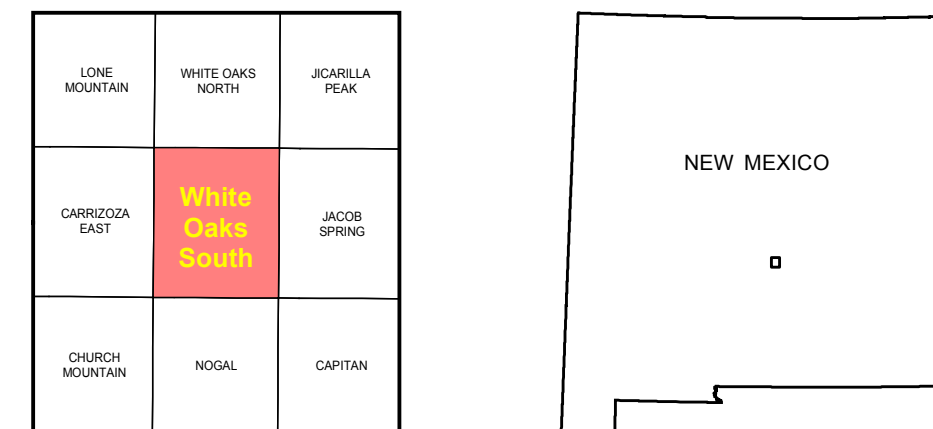


Base map from U.S. Geological Survey 1972, from photographs taken 1971, field checked in 1973.  
 1967 Meter Universal Transverse Mercator grid, zone 13, shown in red



QUADRANGLE LOCATION

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 (OFCMA), due to high demand for current geologic map data in those 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 supersede this preliminary open-file geologic map.

**DRAFT**



New Mexico Bureau of Geology and Mineral Resources  
 New Mexico Tech  
 801 Leroy Place  
 Socorro, New Mexico  
 87801-4796  
 (575) 835-5490  
<http://geoinf.nmt.edu>

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 New Mexico Tech  
 801 Leroy Place  
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 87801-4796  
 (575) 835-5490  
<http://geoinf.nmt.edu>

This and other STATEMAP quadrangles are (or soon will be) available for free download in both PDF and ArcGIS formats at:  
<http://geoinf.nmt.edu/publications/maps/geologic/ofgm/home.html>

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 Open-file Geologic Map 216

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Geologic map of the White Oaks South quadrangle, Lincoln County, New Mexico.

June 2011

by  
 Geoffrey Rawling, and Daniel Koning

New Mexico Bureau of Geology and Mineral Resources  
 801 Leroy Place, Socorro, NM, 87801

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 derived 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. 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 associated with recent development may not be shown.

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.

The map has not been reviewed according to New Mexico Bureau of Geology and Mineral Resources standards. The contents of the report and map should not be considered final and complete until reviewed and published by the New Mexico Bureau of Geology and Mineral Resources. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the State of New Mexico, or the U.S. Government.

Artificial fill for stock tanks

Anthropogenic Deposits

Quaternary and Tertiary Surficial Deposits

**QHa Alluvium (Holocene to Historic)** – Unlithified gravel and poorly to moderately sorted clay, silt, and sand in active stream channels and ephemeral arroyos. Generally incised into Qvf and terrace deposits. Only mapped where extensive; unit is otherwise lumped with Qvf. Thickness: 0 to 4 (?) meters.

**Qse Sheetflood and eolian deposits (Holocene)** – Gray to pale brown clay, silt, and very fine- to fine-grained sand that fills depressions formed on top of slump blocks in the Crevasse Canyon Formation north of Carrizo Peak. Thickness: 0 to 2 (?) meters.

**Qvf Valley fill (uppermost Pleistocene to Holocene)** – Unlithified valley fill composed of generally poorly sorted clay, silt, and sand, with abundant angular to subrounded cobbles of local bedrock. Gravels are subrounded, poorly sorted, and commonly imbricated. Matrix material is mostly pale brown to grayish brown. Unit grades into minor alluvial and colluvial fans on toes of hillslopes and locally includes small gravelly terrace deposits on the valley floor composed of sandy pebbles through boulders. Soil development is weak, with carbonate morphology less than stage II and no argillic horizon. Anthropogenic disturbance is common in developed areas. Generally incised by active drainages, floored by sand and cobble to boulder gravel of QHa. Thickness: 0 to 6 (?) meters

**Qdet Debris flow, colluvium, and talus deposits (upper Pleistocene to Holocene)** – Poorly sorted, commonly matrix-supported, pebble through boulder gravel in a matrix of sand or clayey-silty sand. Gravel clasts are angular to subrounded and vary in composition with locality. Matrix is very fine- to very coarse-grained, angular to subrounded, and contains variable amounts of silt and clay. Unit is generally heavily vegetated and poorly exposed on this quadrangle other than surface boulders; description is modified from Koning (2010). Thickness: 0 to 10 (?) meters.

**Org Rock glaciers (upper Pleistocene)** – Tongue-shaped lobes of cobbles and boulders in canyons containing abundant talus. They occur at elevations of 7440 to 8500 ft on the northern, western and southeastern sides of Carrizo Peak. The upstream ends of the lobes grade into talus. Their fronts are near the angle of repose (near 30 degrees) and are 15-35 m in height. The sides of the lobes are separated from the canyon walls by small gullies 3-15 m deep. A single longitudinal ridge parallels each side of the lobe and usually curves to form a transverse ridge at the front of the lobe. The area between the two longitudinal ridges is depressed, with irregular topography (less than 6 m of surficial relief). The gravel of the rock glacier consists of angular to subangular, blocky, and slabby clasts of Carrizo trachyte with oxidized and lichen-covered surfaces. A dark brown soil 10-20 cm thick covers isolated parts of the rock glacier surface; it contains decomposed organic material and fills gravel interstices. They are probably Wisconsin in age and are not currently active (description modified from Blagbrough, 1984).

**Qaf Alluvial fan deposits (middle to upper Pleistocene)** – Alluvial fans composed of poorly sorted sandy gravel. Gravel includes pebbles, cobbles, and boulders. Locally includes debris flows deposits where channel-fills consist of abundant matrix- to clast-supported gravels. Fans head in short, steep tributary canyons and interfinger with and/or spread out onto valley bottom deposits. Stabilized by vegetation and apparently no longer active, and locally incised by drainages floored with QHa. Thickness: 0 to 10 (?) meters.

**Qbt Bajada and fan toe deposits (middle to upper Pleistocene)** – Low gradient, coalesced fan deposits at the base of large alluvial fans shed from Carrizo Peak and Vera Cruz Mountain. Contacts identified on aerial photographs. Similar in texture and composition to adjacent alluvial fans. Thickness: 0 to 10 (?) meters.

**Qls Landslide deposits (lower to middle Pleistocene (?))** – North of Tucson Mountain, deposits consist of back-rotated toeba blocks and irregular slumps and rubble piles of Gallup Sandstone that have collapsed onto underlying shale. Southeast of Carrizo Peak deposits form heavily vegetated hummocky topography and probably consist of a mix of Tertiary gravels (Tg) and underlying mudstones and sandstones of the Crevasse Canyon Formation (Kcc). Deposits north of Carrizo Peak near Coal Dump Spring are composed of angular pebbles, cobbles and boulders of trachyte of Carrizo Peak (Tict). Landslides developed on Crevasse Canyon formation north of Carrizo Peak form hummocky topography with depressions filled with unit Qse. Thickness: 0 to 40 (?) meters.

**Tg Pediment gravel deposits (Miocene (?) to Pliocene)** – Sandy gravel that overlies broad, relatively smooth, high-level surfaces that slope away from Carrizo Peak. Gravel consists of pebbles, cobbles, and boulders of trachyte of Carrizo Peak. Gravel is very poorly sorted and mostly subrounded, although spallation of larger gravel sizes has created subangular to angular pebbles. Sand is light yellowish brown, very fine- to very coarse-grained, subangular, poorly sorted, and arkosic. Unit is moderately consolidated. Extensive downslope colluvium makes base of unit hard to define where not exposed in roadcuts. Thickness: 0 to 20 (?) meters.

Cenozoic Igneous Rocks

**Tbbat Basalt, basaltic andesite, and trachyandesite (Oligocene)** – Aphanitic-porphyrific and very-fine grained phanitic-porphyrific igneous rocks forming dikes and sills (?) in the White Oaks area. Gray, dark gray, and brownish-gray rocks with 5 – 50% plagioclase phenocrysts, and 1 – 15 % phenocrysts of biotite, pyroxene and/or hornblende, in matrix of mafic minerals and feldspar. Thickness: dikes are < 1 to 5 meters wide, thickness of possible sill is – 10 meters.

**Tdd Diabase/diorite and associated rocks, undivided (Oligocene)** – Very fine-grained phanitic and phanitic-porphyrific mafic igneous rocks forming dikes, sills, and less commonly, irregular intrusive masses. Generally light to dark gray on fresh surfaces and brown to black on weathered surfaces. Rocks often have a "salt and pepper" appearance due to fine-grained equigranular white feldspar and black to brown augite (?). Phenocrysts include augite, hornblende, and tabular intermediate (?) plagioclase. A common, distinctive texture consists of tabular plagioclase phenocrysts up to 4 cm in diameter aligned with the dike margins. Thickness: dikes are < 1 to 5 meters wide.

**Ted Diorite of Champ Hill (Oligocene)** – Distinctive dark gray to grayish-brown fine-grained phanitic diorite with 10-35% phenocrysts of augite up to several centimeters across. Rock forms a prominent sill and dike southeast of Carrizo Peak. Named for Champ Hill, a stock composed of this rock in the Angus quadrangle to the southeast. Thickness: Dike is 10 to 20 meters wide, thickness of sill is unknown but is at least 70 meters.

**Trt Rhyolite/trachyte and associated rocks (Oligocene)** – White to light gray to pale orange, aphanitic and generally aphyric or sparsely porphyritic igneous rocks forming dikes, sills and irregular igneous masses. Most are texturally and compositionally similar to and probably cogenetic with the intrusions forming Carrizo, Patos and Capitan Mountains. Where present, phenocryst assemblages are dominated by quartz and feldspar, totaling less than 5%. Flow-banding and vesicles are common, as are Liesegang bands, local chloritization and other evidence of hydrothermal alteration. Thickness: dikes are < 1 to 5 meters wide; base and top of larger masses and sills are not exposed, probably many tens to hundreds of meters.

**Tict Trachyte of Carrizo Peak (Oligocene)** – Cream colored porphyritic felsic intrusive rock underlying Carrizo Peak. It is composed of a fine-grained groundmass of subequal amounts of subhedral potassium feldspar and sodic plagioclase with 5 – 7% biotite and 1 – 3 % phenocrysts of microcline/orthoclase with lesser albite and quartz. The center of the pluton is noticeably coarse grained than the margins, but the zonation appears less regular than that mapped by Perl and Cepeda (1991). Rock type and pluton have been variously described as microgranite (Kelley and Thompson 1964), a quartz monzonite core surrounded by a rhyolite margin (Perl and Cepeda 1991), and a zoned quartz syenite to alkali feldspar granite (Allen and Foord 1991). Dips of adjacent sedimentary strata are generally steep and radial away from the intrusion, implying that it is a laccolith. Thickness: top eroded, base not exposed, > 1000 meters.

**Tipt Trachyte of Patos Mountain (Oligocene)** – Homogeneous, very light gray, fine-grained porphyritic intrusive rock underlying Patos Mountain. Rock contains 1% phenocrysts of potassium feldspar (including sanidine) and quartz and up to 1% phenocrysts of hornblende, biotite and magnetite (?). The rock type has variously been described as a syenite, a monzonite, and a rhyolite (Allen and Foord 1991 and references therein). The intrusion is probably a laccolith. Thickness: top eroded, base not exposed, > 1000 meters.

**Tcp Capitan granite (Oligocene)** – cross-section only, presumed to underlie Tucson Mountain. Thickness: > 1000 meters.

Cenozoic Sedimentary Rocks

**Tcm Cub Mountain Formation (Eocene)** – White to tan sandstones, dark red sandy mudstones, and greenish and purplish-red silty mudstones. Only the mudstones are exposed in the quadrangle, in scattered poor outcrops and subcrop in Benado Canyon. Sandy and silty mudstones are thick-bedded to massive, bioturbated, and micaceous. Thickness: base and top not exposed, probably > 1000 m. ~140 meters are exposed in the Nogal quadrangle to the south (Rawling 2011b).

**Kcc Crevasse Canyon Formation (upper Cretaceous)** – Floodplain and swamp deposits of light brownish-gray, yellowish-gray, or olive-colored to light gray, laminated fissile shale, siltstone, and mudstone. These rocks are interbedded with fluvial channel-fill deposits composed of yellow to olive to buff sandstone which increase in abundance upsection. Organic-rich shale and coal beds are common in the lower part of the formation. Iron-oxide concretions and/or possible klinker are common in the fine-grained deposits and are diagnostic of this unit. Most sandstones are fine- to medium-grained, subangular to subrounded, and immature; however 3-5 meter-thick sandstone ledges in the saddle between Carrizo Canyon and White Oaks Canyon are composed of cleaner sandstone more similar in appearance to the underlying Gallup Sandstone. North of Carrizo Peak the unit is covered by a veneer or lag of gravel composed of clasts of Tict, and is mapped as Qgl/Kcc. Thickness: ~ 250 meters based on mapping in the Capitan and Nogal quadrangles to the south (Rawling 2011b); this estimate may be high due to abundant intrusions and unpaired faults.

Mesozoic Sedimentary Rocks

**Kgs Gallup Sandstone (upper Cretaceous)** – Pale lavender to pale gray to pale yellow to tan, medium- to very thick-bedded, cross-bedded to massive, clean quartz sandstone with minor grey fissile shale intervals. Sandstones are fine- to medium-grained, locally coarse- to very coarse-grained, noncalcareous, and composed of moderately sorted subangular to subrounded quartz grains with 1-2% chert grains. Five major sandstone beds are present, separated by recessively weathering sandstones and minor shales that are poorly exposed. These beds are well-enough exposed to be mapped separately in the White Oaks area (Kgs<sub>a</sub>) along with a grey shale bed (Kgs<sub>b</sub>). Elsewhere, sandstone ledges were mapped on cliff faces and steep slopes with a line (-m-). A distinctive sandstone or siltstone bed with abundant oyster shells marks the top of the unit, and oyster and gastropod fossils are common locally. In general the unit is resistant and forms prominent cliffs and ridges. Thickness: ~ 90 meters.

**Kth Tres Hermanos Formation (upper Cretaceous)** – Light gray to light brownish-gray, very fine- to fine-grained sandstone in thin to thick, tabular beds. Sandstone is well-sorted and quartzose. Ripplemarks are preserved on top of some beds. Local paleo-burrows, trace fossils, and fragmented shells were observed. Parts of mapped unit may be sandstones within the D-Cross Tongue of the Mancos shales that are stratigraphically above the Tres Hermanos Formation. Thickness: ~ 20 meters.

**Km Mancos Shale (middle to upper Cretaceous)** – Black, dark grey, and purplish gray, very thin-bedded to laminated, fissile, noncalcareous shale. Black to dark gray to olive thin-bedded fine- to very fine-grained sandstone and siltstone beds less than 0.5 meters thick are abundant in the White Oaks area. Generally only exposed in stream cuts and manmade excavations. Exposures in the White Oaks area are identified as the D-Cross Tongue. Thickness: ~ 215 meters, including the Tres Hermanos sandstone interval, based on mapping to the south in the Capitan and Nogal quadrangles (Rawling 2011b).

**Kd Dakota Sandstone (lower to middle Cretaceous)** – Cross-section only. Thickness: ~ 100 meters based on mapping to the south in the Capitan and Nogal quadrangles (Rawling 2011b).

**TrJu – Triassic and Jurassic (?) rocks, undivided** – Cross-section only. Jurassic rocks may not be present. Thickness: ~ 75 meters, based on mapping to the south in the Capitan and Nogal quadrangles (Rawling 2011b).

Paleozoic Sedimentary Rocks

**Psa San Andres Formation (middle to upper Permian)** – Cross-section only. Thickness: ~ 305 meters, based on mapping to the south in the Rudoso area (Rawling 2011a).

**Pyu Yeso Formation and older rocks, undivided (middle Permian and older)** – Cross-section only.

