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NMBGMR Open-file Geologic Map 5
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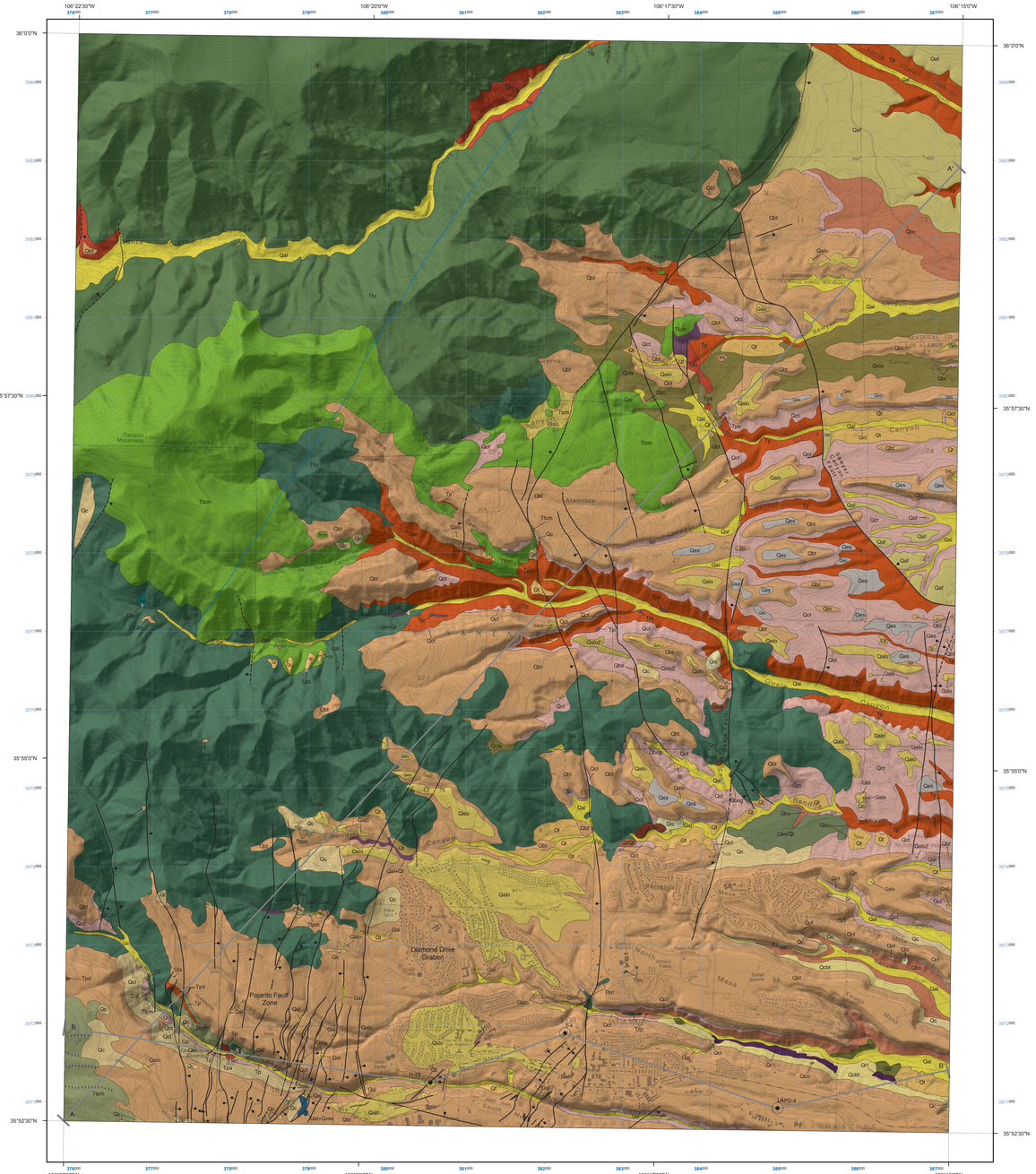

Geologic map of the Guaje Mountain quadrangle, Los Alamos and Sandoval Counties, New Mexico.

May 1998

by

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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map may be based on any of the following: reconnaissance field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation.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 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.

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 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Magnetic Declination
Month, Year
10° 19' East
At Map Center

Base map from U.S. Geological Survey 1984, reised 1993, from photographs taken 1978, edited in 1993.
1927 North American datum, UTM projection – zone 13N
1000-meter Universal Transverse Mercator grid, zone 13, shown in red

QUADRANGLE LOCATION

New Mexico Bureau of Geology and Mineral Resources
Open-file Geologic Map **55**

Mapping of this quadrangle was funded by a matching-funds grant from the STATEMAP program of the National Cooperative Geologic Mapping Act, administered by the U. S. Geological Survey, and by the New Mexico Bureau of Geology and Mineral Resources, (Dr. Peter A. Scholle, *Director and State Geologist*, Dr. J. Michael Timmons, *Geologic Mapping Program Manager*).

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http://geoinfo.nmt.edu/publications/maps/geologic/ofgm/home.html

Qal **Alluvium.** Silt, sand and gravel deposited in modern drainages; may include terrace deposits. Streams draining the Sierra de Los Valles are particularly laden with sand and gravel of the rhyodacite or dacite derived from the Tschicoma Formation; stream deposits within the Pajarito Plateau contain abundant clasts and phenocryst grains of the Bandelier Tuff. Holocene to Pleistocene in age (Phillips *et al.,* 1998; Reneau, 2000) with a maximum thickness of ~ 5 meters.

Qes **Eolian and sheet wash deposits.** Tan to brown silt-to clay- rich soil that develops primarily on Cerro Toledo interval on the east side of the map area. Soil material is transported in by the wind, but is reworked by slope wash. Holocene to Pleistocene in age with an average thickness of ~ 1 meter.

Qc **Colluvium.** Talus debris that typically form wedge-shaped deposits adjacent to cliffs (in particular the Tshirege Member of the Bandelier Tuff, *Qcbt*). Debris is unsorted to poorly-sorted, often obscuring faults and/or contacts between rock units. Although abundant, these deposits were mapped in only a few locations, particularly on north facing slopes. Holocene to Pleistocene in age with a maximum thickness of ~ 15 meters.

Qcbt

Qvec **El Cajete Pyroclastic Beds, East Fork Member, Valles Rhyolite.** White to beige pyroclastic fall deposits containing pumice, ash, crystals, and lithic fragments. The pumice contains < 10% phenocrysts of quartz sanidine, and biotite. The deposits in this area are not primary, but are reworked. 50 to 60 ka (Reneau *et al.,* 1996). < 1 m thick.

Qt **Terrace gravel.** Fluvial pebble to boulder-sized gravel composed primarily of Tschicoma Formation lava or Bandelier Tuff, deposited along the edges of modern drainages at levels as much as 30 m above the present canyon floor. Terraces are particularly well developed in Rendija Canyon (Reneau and McDonald, 1996; Reneau *et al.,* 1996). Terraces are also well preserved in eastern Pueblo Canyon, Guaje Canyon, and Sawyer Canyon. El Cajete pumice sits on a low terrace on the south side of Pueblo Canyon near the eastern edge of the map. Holocene to Pleistocene in age (Reneau, 2000) with a maximum thickness of ~ 30 meters. In Pueblo Canyon *Qt1* is the higher terrace level; Qt2 is lower. El Cajete pumice overlies *Qt2* at the eastern edge of the quadrangle.

Qt1

Qt2

Qaf **Alluvial fan deposits.** Tan silt and gravel overlying Cerro Toledo deposits or Bandelier Tuff east of the Sawyer Canyon and Pajarito fault zones in the eastern part of the map area. The gravel is derived from Puye Formation eroding from the footwall of the faults. Pleistocene in age and ~1- 3 meter thick.

Qls **Landslides.** Two types: slump or block slides that remain nearly intact after detaching from a steep slope or cliff; or unsorted, chaotic debris emplaced during a chaotic detachment event from a steep slope or cliff. The latter deposits are typically fan-shaped on the valley floor. Holocene to Pleistocene in age of highly variable thicknesses.

Qcta **Cerro Toledo deposits (see below) with younger alluvium and/or colluvium, undivided.** These deposits typically occur in valleys where the upper portions of the underlying Cerro Toledo tephras have been reworked and are mixed with younger alluvial and colluvial material. Younger material typically includes reworked vitric pumices of Bandelier Tuff *(Tsankawi or Tshirege Member*) or clasts of devitrified Bandelier Tuff. Alluvial material may also include younger terrace deposits, with rounded cobbles and boulders of Tschicoma lavas.

Qalo2 **Old alluvium.** Clasts of rounded Tschicoma Formation dacite to rhyodacite and rounded Bandelier Tuff preserved in a southeast-trending paleochannel cut into Cerro Toledo deposits in upper Cabre Canyon.

Qalo **Older alluvium.** In the town site of Los Alamos, this unit is largely composed of alternating gravel and sandstone layers of fluvial origin interbedded with beds of tephra. Some gravel lenses are dominated by pumice, but most lenses contain subequal amounts of pumice and Tschicoma Formation lava, and rare flow-banded rhyolite and obsidian granule- to pebble-sized gravel. The tephra beds are <1 m thick; the pumice is likely derived from the Cerro del Medio dome to the west of Los Alamos erupted at ~ 1.1 Ma (Spell and Harrison, 1993). The older alluvium is well exposed in a road cut just southwest of the Larry R. Walkup Aquatic Center on Canyon Road in Los Alamos. Northeast of Los Alamos, the unit is dominantly gravel, including clasts of Bandelier Tuff; pumice is absent in these deposits. The older alluvium generally sits on Bandelier Tuff. North of Los Alamos, Qalo contains abundant clasts of streaky, flow-banded rhyolite lava, black, grassy tuff, and some obsidian. Qalo was deposited as fans shortly after the eruption of the Bandelier Tuff prior to the development of the modern drainage system (Reneau. Pleistocene in age with a maximum thickness of ~ 30 meters.

Qbt **Upper Bandelier Tuff, Tshirege Member.** Beige to orange to gray, poorly-welded to densely-welded ignimbrite containing abundant phenocrysts of sanidine and quartz and trace amounts of clinopyroxene and hypersthene (Smith and Bailey, 1966). Sanidine commonly displays blue iridescence. Accidental lithic fragments typically ~ 5% except in discreet lenses and lag horizons. *Qbt* is a compound flow unit with multiple flow units as described by Broxton and Reneau (1995) and Gardner et al. (1999, 2001), and is well exposed in canyons throughout the Pajarito Plateau. Surge deposits, typically < 1 meter thick, are common at the base of the unit and overlie a stratified pumice tephra (*Tsankawi Pumice Bed*) that is typically ~ 1 meter thick. The ignimbrite was erupted from the Valles caldera at 1.25±0.01 Ma (Phillips, 2004) and filled valleys along the paleotopographically complex eastern flank of Sierra de Los Valles. The degree of welding decreases toward east and some of the upper cooling units pinch out toward the east. Maximum observed thickness is ~ 180 meters.

Qct **Cerro Toledo deposits.** Tephra, reworked tephra and epiclastic alluvium deposited between eruptions of the Tshirege and Otowi members of the Bandelier Tuff (Broxton and Reneau, 1995). Alluvial deposits include sand, silt, and conglomerates with rounded clasts of Tschicoma lavas. Aphyric obsidian common. Fanglomerate alluvial deposits in Los Alamos Canyon record a major fluvial system during this interval. Tephras originated from rhyolite dome complex eruptions in the Toledo caldera and the Toledo embayment (Smith *et al.,* 1970; Heiken *et al.,* 1986). Tephra deposits typically contain pumices with rare phenocrysts of quartz, sandine and biotite. In the northern portion of the map area crystal-rich tephras occur near the top of the interval, with abundant phenocrysts of quartz and sanidine. Radiometric ages of pumices and source domes range from 1.21 to 1.64 Ma (Izett *et al.,* 1981; Stix *et al.,* 1988; Spell *et al.,* 1996). Maximum exposed thickness is ~ 100 meters.

Qbo **Lower Bandelier Tuff, Otowi Member.** White to beige poorly-welded ignimbrite with abundant phenocrysts of quartz and sanidine (Bailey *et al.,* 1969). Abundant accidental lithic fragments of dark grey to red mafic rocks give outcrops a peppered appearance. Qbo is primarily a slope-forming unit and was erupted from the Toledo caldera at 1.61±0.01 to 1.62±0.04 Ma (Izett and Obradovich, 1994; Spell *et al.,* 1996). Otowi Member ignimbrite was deposited primarily in the southeastern portion of the quadrangle and was not deposited north of Rendija Canyon. The Guaje Pumice Bed, a stratified pumice fall and surge deposit that preceded Otowi ignimbrite deposition, is exposed in isolated outcrops in Cabra Canyon (*Qbog*) and beneath the Otowi Member in Pueblo Canyon. The Guaje Pumice Bed, which is 2 - 3 m thick also crops out the contact between the Puye Formation and Cerro Toledo deposits in Guaje Canyon. Maximum exposed thickness is ~ 50 m.

Qbog

Legend

- Volcanic vent
- Well
- Cross section line (A – A')
- Normal Fault - solid where exposed or known; dashed where approximately located; dotted where concealed; querried where uncertain. Bar and ball on downthrown side, tic showing dip.
- Lineament
- scarp
- Contacts - solid where exposed or known;

Unit Descriptions

Tp **Puye Formation.** Light to dark gray fanglomerates derived from Tschicoma lavas (Griggs, 1964; Gardner *et al.,* 1986; Waresback, 1986; Turbeville *et al.,* 1989). Silt and sand layers interbedded with cobble to boulder-sized conglomerates deposited as debris flows, lahars, and alluvial fans. Clasts are typically rounded to sub-rounded and include a wide variety of dacitic and rhyodacitic lavas. Rhyodacite of Rendija Canyon and dacite of Caballo Mountain clasts are common. Lower Puye Formation deposits that overlie Santa Fe Group sediments east of the study area include clasts of rhyodacite of Rendija Canyon, suggesting a major eastward progradation of Puye Formation following the eruption of the Rendija Canyon rhyodacite at ~ 5.0 Ma. Reneau and Dethier (1996) note that deposition of the Puye Formation was probably controlled by blockage of the Rio Grande by volcanism in the Cerros del Rio volcanic field located to the southeast of the quadrangle. Age range of exposed Puye Formation is ~ 2.4 to 5.3 Ma (WoldeGabriel *et al.,* 2001). Maximum thickness is ~ 100 meters.

Tpt

Thin beds of tephras and/or ignimbrites (*Tpt*) are interbedded with these sediments. In the middle reaches of Guaje Canyon, on the south side of the canyon, ~0.5 m layers of tephra and ignimbrite are interbedded; the entire deposit is 6 to 10 m thick. The contact relations in the middle portion of Guaje Canyon are obscure, but this deposit appears to lie between Rendija Canyon rhyodacite and Puye Formation. The tan ignimbrite contains abundant gray pumice fragments, quartz, sanidine, obsidian, and lithic fragments. A second set of exposures occurs on the south side of Guaje Canyon along the old road into the canyon. One tephra is exposed near the canyon bottom and one is near the top of the Puye Formation. The upper tephra gives a 40Ar/39Ar age of 4.01 ± 0.22 Ma. The tephras are clast-supported pumice fall < 1 m thick. Clasts range in size from 0.5-1.0 cm. Clots of large (1-3 mm), fresh, euhedral amphibole crystals are present throughout the sample. Some clots include small, uncommon felsic minerals that are impossible to identify using a binocular microscope. Other clots have rare occurrences of biotite, but, for the most part, these clots are monomineralic. Lithics include light gray clasts of glassy and stony lava. Clay is pervasive as an alteration product, but a gritty texture suggests that primary glass may still be present. Maximum thickness is ~ 6 meters.

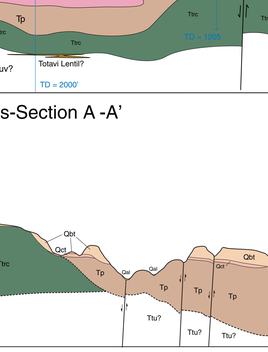
Tschicoma Formation (Pliocene)

Ttnd **"Northern dacites", Tschicoma Formation (shown only on cross-section B-B').** Crystal poor dacite with 2-5% phenocrysts of plagioclase, clinopyroxene and orthopyroxene encountered in well H-19. 40Ar/39Ar ages of 2.36±0.54 and 2.49±0.23 Ma have been determined from similar lavas in a drillhole to the south of the quadrangle (Samuels *et al.,* 2007; Broxton *et al.,* 2007).

Ttcm **Dacite of Caballo Mountain, Tshicoma Formation.** Lavender to dark gray flow-banded dacitic lavas and associated block and ash flows erupted from the vicinity of Caballo Mountain. Streaky, flow-banded lavender to red facies common. Lavas contain 10 –20% phenocrysts of plagioclase and hornblende with subordinate pyroxene, biotite and quartz. At least three separate flows occur, the youngest containing more abundant hornblende. These flows extended in two main directions: one extending SSE of Caballo Mountain, capping the north canyon wall of Guaje Canyon, and one that flowed to the ENE of Caballo Mountain, extending to just west of Pine Springs. Sample from top of Caballo Mountain has age date of 3.03 ± 0.15 Ma (Broxton *et al.,* 2007))

Tsca **Small volume tephras, ignimbrites, block and ash flows, and associated colluvial deposits.** Outcrops are limited to exposures ~ 0.5 km NNW of Pine Springs. Glassy lava fragments in the block and ash flows appear dacitic, with phenocrysts of plagioclase, amphibole, pyroxene and biotite. Stratified tephra and ignimbrite facies dip ~15° in an easterly direction. These deposits appear to be overlain by Caballo Lavas and are therefore likely to be > 3.0 Ma. Maximum thickness is ~ 30 meters.

Correlation of Map Units



Tpm **Dacite of Pajarito Mountain, Tshicoma Formation.** Light to medium gray to reddish dacite lavas and associated block and ash flows erupted from Pajarito Mountain. Phenocrysts make up 10 – 24 % of the rock and consist of plagioclase (disequilibrium textures), clinopyroxene, orthopyroxene, and trace hornblende, Fe-Ti oxides, and apatite. Contains crystal clots of clinopyroxene and orthopyroxene. At least 2 major flows are observed in Los Alamos Canyon, overlying Rendija lavas. Brecciated basal horizons typical. Age dates range from 2.91 ± 0.06 to 3.07 ± 0.07 on Pajarito Mountain (WoldeGabriel, pers. communication) with a maximum thickness of ~ 180 meters in map area.

Ttu **Tshicoma Formation Lavas, Undifferentiated.** This unit, which primarily consists of exposures on the Santa Clara Indian Reservation, represents unmapped territory since access to this region was not allowed. An unnamed center north of Santa Clara Canyon (Smith *et al.,* 1970) is the likely source for 3.79 ±0.17 to 4.39±0.13 Ma dacite (WoldeGabriel *et al.,* 2006) exposed in Santa Clara Canyon just north of the quadrangle boundary. Although the majority of the rocks exposed in the canyon are believed to be Tschicoma Formation, older and younger rocks may exist.

Ttrb **Breccia, white to gray ignimbrite and tephra.** Exposed in a landslide scar in upper Guaje Canyon, west of Guaje Reservoir. Appears to overlie *Ttr* (below). Lower portion includes large lithic fragments of sub-rounded boulders of Rendija Canyon lavas (*Ttr*). Thin ash and surge beds (< 0.5 meters) occur in the sequence. The upper portion of the deposit appears more as a brecciated lava, containing phenocrysts of plagioclase (some megacrysts), quartz, and lesser biotite and pyroxene. Age most likely comparable to the Rendija Canyon lavas with a maximum exposed thickness of ~ 60 meters.

Ttrc **rhyodacite of Rendija Canyon, Tshicoma Formation.** Light to dark gray to red rhyodacitic lavas that form the central part of Sierra de Los Valles. Phenocrysts make up 11-16% of the rock and consist of plagioclase (megacrysts up to 2 cm across), alkali feldspar (both as sanidine and anorthoclase), and quartz (resorbed); subordinate biotite, clinopyroxene, and hornblende, and trace sphene, zircon, and Fe-Ti oxides. Massive, high-aspect ratio flows with associated block and ash flows where overstepped lava flanks collapsed during flowage. Lavas outcrops can be massive and/or sheeted, and typically exhibit a knobby surface texture that spalls off 1-2 cm-size fragments (enhanced since the Cerro Grande fire). Rendija Canyon lavas north of Guaje Canyon contain moderate amounts of biotite. Maximum thickness is > 350 meters. Age dates range from 4.95 ± 0.06 to 5.03 ± 0.02 (Broxton *et al.,* 2007).

Ttr

Ttu **Small-volume ignimbrites in upper Guaje Canyon, west of the reservoir.** In ascending order, these tuffs consists of 0.75 m of brown to gray ignimbrite, 13 cm of bedded tuffs, 0.64 m of white ignimbrite, and 0.98 m of light gray to lavender tuff breccia. Phenocrysts of plagioclase and trace amounts of quartz and biotite. Maximum exposed thickness is ~ 2.5 meters. Lower ignimbrite has age date of 5.32 ± 0.02 Ma (WoldeGabriel, pers. communication).

Keres Group and Santa Fe Group **(Miocene)**

Tsp? **Miocene Peralta Tuff Member, Bearhead Rhyolite. (Shown only on cross-section BB').** Pumice-rich volcaniclastic sediments intercalated with well-bedded tephra. A pumice sample from 508-518 ft. in Well R-2 has a 40Ar/39Ar age of 6.44±0.46 Ma. Pumice from 413-423 ft. in R4 gave a poorly constrained 40Ar/39Ar age of 7.6±1.2 Ma.

Tsfc? **Miocene Chamita Formation, Santa Fe Group. (Shown only on cross-section B-B').** Well-bedded sandstone with minor gravel at depths of 420 to 494 feet in well R2.

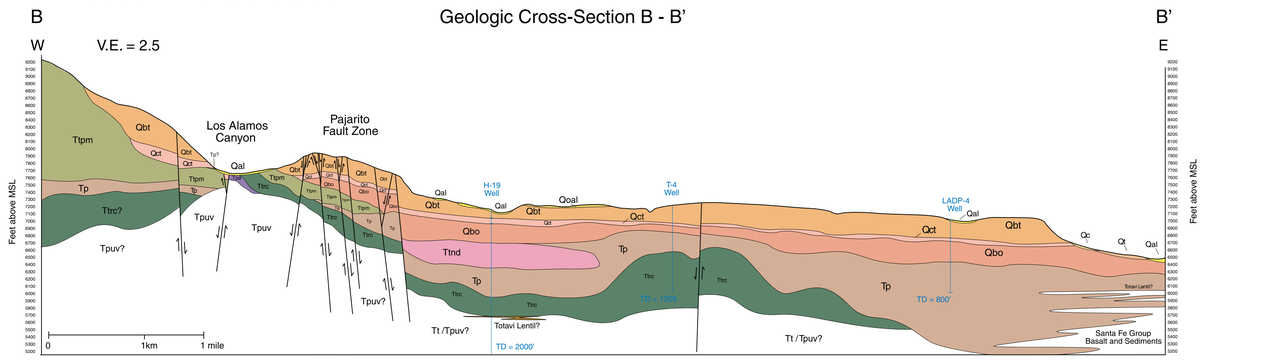
Tpuv **Undivided Miocene Paliza Canyon Formation lava flows and volcaniclastic deposits. (Shown only on cross-sections).**

Tpa **Miocene Keres Group Volcanic Rocks.** Dark gray to red (oxidized) intermediate composition lavas exposed in Santa Clara Canyon, Los Alamos Canyon, and the Pine Springs area. The andesite in Santa Clara Canyon is platy, dark gray, and porphyritic with phenocrysts of plagioclase (Woldegabriel *et al.,* 2006). The 40Ar/39Ar age for this andesite is 7.78±0.04 Ma. In Los Alamos Canyon, the porphyritic andesite lava at the reservoir outlet has 20% phenocrysts of plagioclase, clinopyroxene, and othopyroxene and an 40Ar/39Ar age date of 8.72 ± 0.05 Ma (Broxton *et al.,* 2007). This flow also has crystal clots of clinopyroxene, orthopyroxene, and plagioclase. Vesicular facies are common in the Pine Springs area, where four separate outcrops occur, representing two lava types. One appears more dacitic, with larger phenocrysts of plagioclase and lighter color, and one more andesitic, with a dark, fine-grained groundmass with smaller phenocrysts of plagioclase and pyroxene. WoldeGabriel et al. (2006) report an 40Ar/39Ar age of 11.18±0.13 Ma on an andesite in the southernmost outcrop at Pine Spring. The three northern outcrops are red (oxidized), but the southernmost outcrop is relatively unaltered. Maximum exposed thickness is ~ 40 meters.

Tpd **Miocene Polvadera Group Volcanic Rocks.** Outcrop in Guaje Canyon is a crystal-poor lava with conspicuous phenocrysts of sanidine and numerous felty crystals of amphibole, most of which are altered. Sanidine comprises <3% of the whole rock, while amphibole comprises ~3% of the whole rock. Some quartz is present, but whether these are quartz phenocrysts or silicic vug fill is unclear. Small mafic crystals are also present; these appear to be pyroxenes. A 40Ar/39Ar age of 9.58±0.13 Ma was determined for this dacite.

Ttb **Miocene Polvadera Group Volcanic Rocks.** Dark gray to black basalt with olivine and plagioclase phenocrysts correlated with the Lobato Formation. 40Ar/39Ar ages of 10.2-13.1 Ma were determined for basalt flows in the Lobato Formation just north of the quadrangle boundary (WoldeGabriel *et al.,* 2006).

Geologic Cross-Section B - B'



Geologic Cross-Section A -A'