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NMBGMR Open-file Map Series OFGM 85
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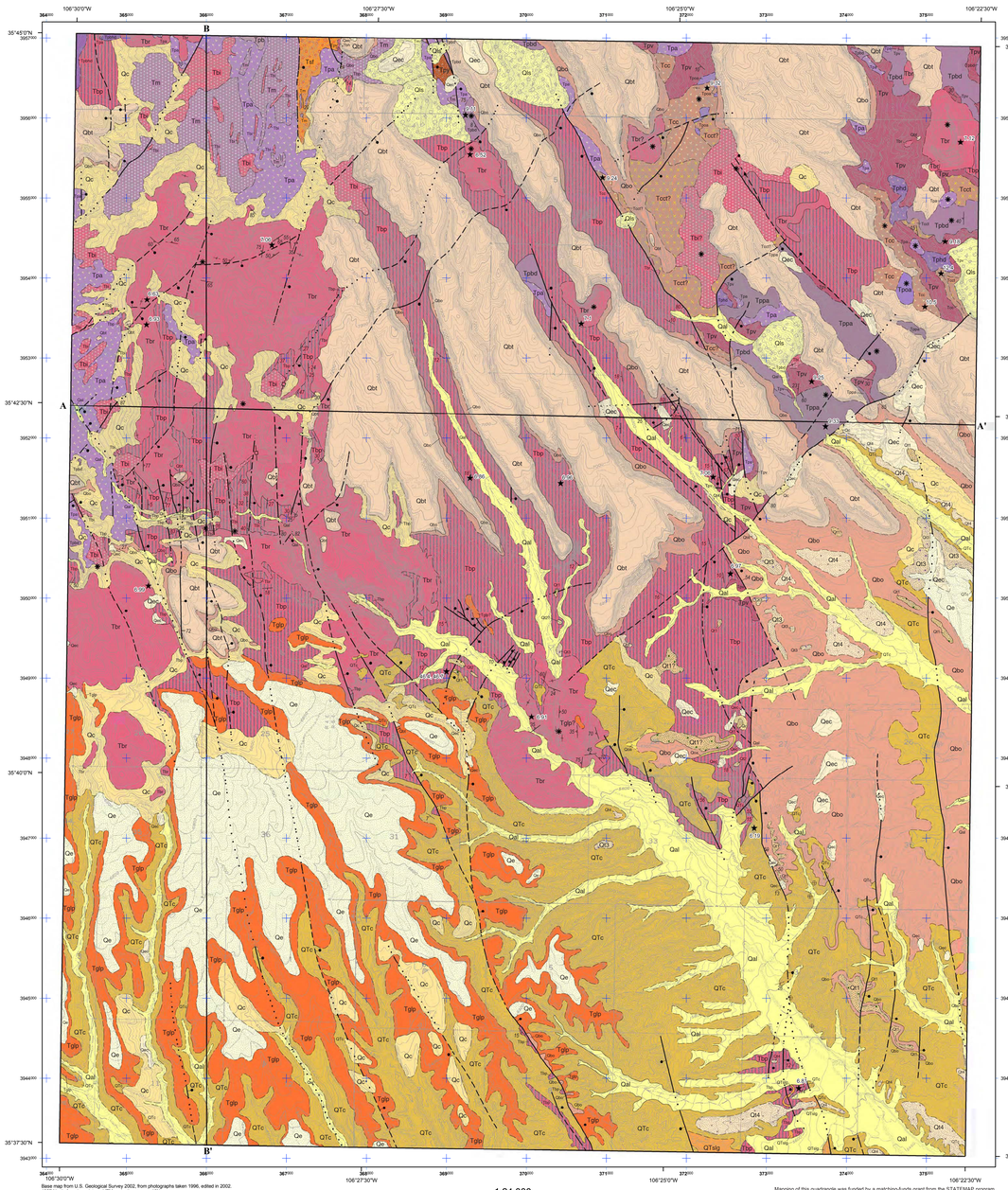
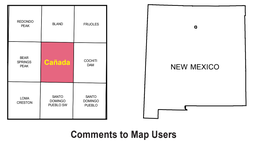


Base from U.S. Geological Survey 2002, from photographs taken 1996, edited in 2002.
North American datum, UTM projection, zone 13N.
1000-meter Universal Transverse Mercator grid, zone 13, shown in blue.

Digital cartography by S. D. Lynch, M. M. Mansell, and D. J. McCraw



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1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

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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STATEMAP quadrangles are available for free downloads at:
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Geologic map of the Cañada quadrangle, Sandoval County, New Mexico

May 2005

by

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New Mexico Bureau of Geology and Mineral Resources
Open-file Geologic Map 85

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map may be based on any of the following: reconnaissance field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation.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

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New Mexico Bureau of Geology and Mineral Resources — New Mexico Tech — Earth Science for the 21st Century

NEW MEXICO STATEMAP

Description of Map Units

Quaternary

Qal **Alluvium deposited by active streams (Upper Pleistocene? to Holocene)** - Poorly sorted gravelly sand and sandy gravel deposited in channels and minor floodplain areas of ephemeral streams and arroyos. Beds of eolian fine sand up to 0.5 m thick are locally present, and colluvium is present near valley margins. Total thickness is unknown but may be as much as 10-30 m.

Qc **Colluvium (Upper Pleistocene to Holocene)** - Hillslope and talus deposits from local sources. In the southern half of the quadrangle, colluvium is loose gravel primarily eroded from the gravel of Lookout Park. Most hillslopes contain a few centimeters to a meter thickness of colluvium, but unit Qc is mapped only where the thickness and distribution of colluvium prohibits confident mapping of other units. As thick as 20 m locally.

Qls **Landslides (Upper Pleistocene to Holocene)** - Poorly sorted debris that has moved down steep slopes chaotically or as a series of blocks.

Qe **Eolian sand and silt (Upper Pleistocene to Holocene)** - Massive fine sand and coarse silt forming a 0.5-3 m thick deposit, primarily on top of the ancient geomorphic surface that is underlain by the gravel of Lookout Park.

Terrace gravel (Pleistocene) - Fill and strath piedmont-stream terraces formed along tributaries to the Rio Grande, primarily associated with Peralta, Bland, and Cochiti Canyons. Gravel is composed of variably altered andesitic and rhyolitic clasts and, in Peralta Canyon, Bandelier Tuff fragments.

Qt4 **Terrace gravel (Upper Pleistocene)** - Fill-terrace gravel with an upper surface approximately 18-20 m above grade along Peralta and Cochiti Canyons. Gravel is typically no more than 3 m. On the Santo Domingo Pueblo quadrangle, *Qt4* grades to a terrace along the Rio Grande that is overlain by *ca.* 60 ka El Cajete pumice (Smith and Kuhle, 1997a). Dethier and McCoy (1993) estimate an age of 95 ±15 ka for fill terraces at a similar elevation above grade in the Española Basin.

Qt3 **Terrace gravel (Middle Pleistocene)** - Fill-terrace gravel 5-10 m thick, with an upper surface approximately 30-35 m above grade. Terraces probably correlate to similarly numbered terrace deposits along the Rio Grande in the Santo Domingo Pueblo quadrangle (Smith and Kuhle, 1998). The Rio Grande terraces likely correlate to those for which Dethier and McCoy (1993) estimate an age of 170 ±40 ka.

Qt2 **Terrace gravel (Middle Pleistocene)** - Fill-terrace gravel, 5-10 m thick, located approximately 50-70 m above grade. The correlative terraces along the Rio Grande on the Santo Domingo Pueblo quadrangle are less than 550 ka (Smith and Kuhle, 1998) and are tentatively correlated to Española Basin terraces for which Dethier and McCoy (1993) estimate an age of 310 ±70 ka. *Qt2* is probably correlative with the Cañada terrace of Aby (1997).

Qt1 **Terrace gravel (Middle Pleistocene)** - Fill-terrace gravel, generally 3-5 m thick, but locally as much as 20 m thick, marking former courses of Peralta and Cochiti Canyons. This gravel deposit commonly forms inverted ridges rather than being inset along modern drainages and, therefore, is technically not a terrace deposit, but is mapped as a terrace deposit to be consistent with designation of presumed correlative gravel. Terrace gravel in a similar landscape position on the Santo Domingo Pueblo Southwest quadrangle contains the 620 ka Lava Creek B ash (Smith and Kuhle, 1997b).

Qec **El Cajete Member Pumice (Valles Rhyolite, Upper Pleistocene)** - Discontinuous sheetwash and fluvially reworked rhyolite pumice-fall deposit, typically less than 5 m thick. Also includes poorly to moderately sorted primary deposits that occur along the Pajarito fault zone and in Bland Canyon. Pumice clasts are white to tan, vesicular, and typically less than 7 cm in diameter. They contain less than 2% phenocrysts of quartz, sanidine, biotite, and rare clinopyroxene and hornblende. Erupted approximately 60 ka from the El Cajete crater in southern moat of Valles caldera. Quarried in many locations. Maximum thickness about 10 m.

Qoa **Older alluvium (Lower Pleistocene?)** - Alluvial gravel and sand locally underlying Bandelier Tuff north of Peralta Canyon. Delineates paleodrainages incised into the Peralta Tuff Member of the Bearhead Rhyolite, Cochiti Formation, and gravel of Lookout Park, and later filled by the BandelierTuff. Thickness is typically 1-3 m.

Qbt **Bandelier Tuff, Tshierge Member and Tsankawi Pumice Bed (Lower Pleistocene)** - White to tan to orange, non-welded to welded, rhyolite ash-flow tuff containing abundant (~15%) phenocrysts of quartz and sanidine, with quartz more abundant than sanidine, and trace clinopyroxene. Quartz phenocrysts are large (up to 3 mm) and euhedral. Sanidine is clear and commonly displays a blue iridescence. Locally contains abundant lithic clasts but typically lithics<poor (less than 2%). Compound cooling unit consisting of at least three flow units. Typically non-welded to slightly welded, but is densely welded locally. Basal pumice-fall deposit (Tsankawi Pumice Bed) occurs locally (less than 2 m thick). Forms conspicuous orange cliffs. Erupted ~1.22 Ma during Valles caldera formation. Maximum thickness ~150m.

Qbo **Bandelier Tuff, Otowi Member and Guaje Pumice Bed (Lower Pleistocene)** - White to tan non-welded rhyolite ash-flow tuff containing abundant (~10-15%) phenocrysts of euhedral quartz (3 mm) and sanidine, with more quartz than sanidine, and trace mafic phenocrysts. Commonly contains abundant (3-10%) mafic lithic clasts. Basal pumice-fall deposit (Guaje Pumice Bed) occurs locally (less than 2 m thick). Typically forms slopes, and tent-rock formation is also common. Erupted ~1.61 Ma during the Toledo caldera formation. Maximum thickness ~100 m.

Quaternary and Tertiary

QTslg **Sierra Ladrones Formation (Upper Miocene to Lower Pleistocene)** - Gravel deposited by axial river (ancestral Rio Grande). Restricted to outcrops in the southeastern corner of the quadrangle, but also found as clasts in Peralta Tuff at Tent Rocks, and in fault gouge along Pajarito fault on west side of Bland Canyon. Contains about 35-40% quartzite, 20% granitic and metamorphic rocks and the remainder mostly volcanic rocks. Clasts of Oligocene Pedernal Chert comprise 1 to 5% of most outcrops. In the adjacent Santo Domingo Pueblo SW quadrangle, axial gravel is interbedded with beds of Peralta Tuff Member of the Bearhead Rhyolite (Smith and Kuhle, 1997b) that yield 40Ar/39Ar ages of 6.81 ±0.02, 6.81 ±0.01, and 6.88 ±0.01 Ma (W. McIntosh, *personal communication, Feb. 1997*). At Tent Rocks, rhyolitic hydromagmatic deposits dated at 6.90 ±0.06 Ma (McIntosh and Quade, 1995; Smith, 2000), and clearly from a lower stratigraphic position than the samples providing the three ages above, contain accessory clasts derived from axial gravel deposits. Tephra, apparently reworked from the lower Bandelier Tuff, and dated at 1.62 ±0.01 Ma (W. McIntosh, *personal communication, Feb. 1997*) is present approximately 20 m below the top of the Sierra Ladrones Formation in the Santa Fe River valley immediately upstream of Cochiti Dam in the Santo Domingo Pueblo quadrangle (Smith and Kuhle, 1997a). These dates limit the age of the Sierra Ladrones Formation outcrops in the Santo Domingo from late Miocene to early Pleistocene, although outcrops on this quadrangle are all of late Miocene age.

QTc **Cochiti Formation (Upper Miocene to Lower Pleistocene)** - Volcanic sand and gravel in poorly sorted, tabular beds. Clasts consist of Keres Group volcanic rocks with a distinct upward increase in the abundance of devitrified and altered rhyolite at the expense of vitric rhyolite. Gradationally overlies the upper Miocene Peralta Tuff Member of the Bearhead Rhyolite (Smith and Lavine, 1996; Smith, 2000). The basal contact at Tent Rocks is located about 10 m above a 6.79 ±0.05 Ma pyroclastic deposit (McIntosh and Quade, 1995). A 6.16 ±0.07 Ma (W. McIntosh, personal communication, Oct. 1997) rhyolitic tephra is present in lower beds of the formation at Tent Rocks. East of Tent Rocks, the lower Pleistocene Bandelier Tuff (*Qbo*) is present within the uppermost Cochiti Formation. In the Cochiti Dam quadrangle, the upper Cochiti Formation contains primary and reworked tephra-fall beds dated at 1.87 ±0.01 Ma and 1.84 ±0.02 Ma by $^{40}Ar/^{39}Ar$ (W. McIntosh, *personal communication, Feb. 1997*) and correlated, by visual comparison, to the San Diego Canyon A and B ignimbrites. The Cochiti Formation is interbedded with unit *QTslg* near the southeastern corner of the quadrangle.

Tertiary

Tglp **Gravel of Lookout Park (Upper Pliocene)** - Cobble to boulder gravel resting on a broad pediment surface cut primarily on Cochiti Formation in the southwestern part of the quadrangle. The gravel is composed mostly of Keres Group andesite and rhyolite clasts, and is 5-15 m thick. Gravel is inset below basalt of Santa Ana Mesa dated at 2.41 ±0.03 Ma, on the Santo Domingo Pueblo Southwest quadrangle (Smith and Kuhle, 1997b), and underlies lower Bandelier Tuff (1.61 Ma), indicating deposition during a short period of the late Pliocene. Remnants of a stage IV calcic soil horizon are present at the surface in some places. This older soil was stripped and then the gravel was largely buried in eolian sand and silt (*Qe*) in which a new soil has formed with a stage II-stage III calcic horizon evident in various places.

Keres Group

Tbr **Bearhead rhyolite (Upper Miocene)** - Lava domes and flows of white to pale pink to light gray rhyolite and volcanic breccias. Contains 1-3% phenocrysts of quartz, sanidine, biotite, ±minor plagioclase. Commonly strongly flow banded with vitrophyre near margins. Domes distributed along N-S and NE-SW striking faults. Erupted between 6.52-7.06 Ma (Justet, 1999). Maximum thickness is ~370 meters observed near the type locality of Bearhead Peak.

Tbl **Bearhead rhyolite (Upper Miocene)** - White to light gray rhyolite dikes, plugs and stocks. Contain 1-3% phenocrysts of quartz, sanidine, biotite, ±minor plagioclase. Commonly displays intense, vertically oriented platy cleavage. Vitrophyre typical near margins. Present along and at the intersection of N-S and NE-SE striking faults.

Tbp **Bearhead rhyolite, Peralta tuff member (Upper Miocene)** - White to tan to pale pink, pyroclastic-fall, flow, and surge deposits interbedded with gray to tan sandy gravel. Pyroclastic deposits consist of pumice and ash of crystal-poor rhyolite containing less than 3% phenocrysts of quartz, sanidine, biotite, and plagioclase. Typically contains abundant (10%) lithic clasts of dominantly andesite and rhyolite lava with lesser amounts of dacite and basalt lava. Sedimentary layers contain exclusively volcanic clasts, which are predominantly glassy and devitrified rhyolite, with variable amounts of intermediate-composition rocks from the older Paliza Canyon formation. Sedimentary strata are thickest near the base of the unit in Bland Canyon, and are restricted to the Bearhead basin (Smith, 2001) between Peralta and Bland Canyons. The stratigraphy of the Peralta Tuff is described by Smith (2001). Forms tent rocks locally. Erupted between about 6.2-7.0 Ma (Smith, 2001). Thickness in the map area is about 500 m.

Tpbd **Paliza Canyon formation (Miocene)** - Biotite dacite. Domes, flows, and minor intrusives of gray to pink porphyritic dacite containing ~1-5% phenocrysts of plagioclase, biotite, ±clinopyroxene, ±hornblende, ±quartz. Typically massive but is flow banded or flow brecciated locally. Maximum observed thickness is about 150 m.

Tphd **Paliza Canyon formation (Miocene)** - Hornblende dacite. Domes, flows, and minor intrusives of gray to pink porphyritic dacite containing ~1-5% phenocrysts of plagioclase, hornblende, minor clinopyroxene, ±biotite. May contain clots of plagioclase and mafic minerals. Flows massive to banded, may contain flow breccia. Outcrop in NW corner of quadrangle is coarsely porphyritic with plagioclase and hornblende phenocrysts up to 1 cm. Maximum observed thickness about 60 m.

Tppa **Paliza Canyon formation (Miocene)** - Porphyritic andesite. Domes and flows of coarse, gray to black porphyritic andesite. Contains large phenocrysts of plagioclase and abundant phenocrysts of clinopyroxene and hypersthene in a glassy almost intersertal groundmass of plagioclase, clinopyroxene, hypersthene, and opaque minerals. Plagioclase may be complexly zoned, and may contain clots up to 20 cm in diameter. Flows may be sheeted or contain flow breccia. K-Ar age west of Rancho Canada 9.33 ±0.19 Ma (Goff et al., 1990). Maximum observed thickness about 150 m.

Tpa **Paliza Canyon formation (Miocene)** - Flows, domes, and minor intrusives of gray to dark pink to black porphyritic andesite. Also includes associated volcanic breccias, which are especially thick in upper Cochiti Canyon (Lavine, 1995). Contains 1-5% phenocrysts of plagioclase, clinopyroxene, and lesser amounts of hypersthene. Maximum observed thickness about 140 m. Commonly flow banded.

Tpoa **Paliza Canyon formation (Miocene)** - Olivine andesite. Domes and flows of black to gray andesite and minor red cinder deposits. Contains plagioclase, clinopyroxene, hypersthene and iddingsitized olivine in intersertal to glassy groundmass. May contain sparse plagioclase-pyroxene clots. May contain apatite microphenocrysts. Flows massive with vesicular flow tops. Flows rarely sheeted.

Tpv **Paliza Canyon formation (Miocene)** - Volcaniclastic deposits. Coarse-grained volcaniclastic breccia, conglomerate, and sandstone interbedded with thin Paliza Canyon formation lava flows and flow breccias of basalt and basaltic andesite composition. Primarily debris-flow and fluvial deposits consisting of reworked flow-breccia blocks and tephra. Locally includes primary and slightly reworked gray, andesitic tephra and white rhyodacitic and dacitic tephra. Outcrops in Cochiti and Sanchez Canyons include monolithologic breccias with sparse radially-jointed blocks that may be block-and-ash-flow deposits. Stratigraphy, volcanology, and sedimentology of these deposits described by Lavine (1995)

Tm **Paliza Canyon formation (Miocene)** - Monzonite dikes and stocks. Characterized in detail by Stein (1983). Contains phenocrysts and locally glomerocrysts of plagioclase and augite set in a fine-grained phaneritic to aphanitic groundmass of plagioclase, orthoclase, quartz, and augite. Fine-grained or aphanitic locally. Light to very dark gray to dark green to black, pervasively hydrothermally altered. Present along Colle Canyon in footwall of major NE-striking fault. Intruded by *Tbl*. Dikes range between 1 cm to 30 m wide, trend northerly, and are vertical.

Tpb **Paliza Canyon formation (Miocene)** - Olivine basalt. Contains sparse phenocrysts of plagioclase, augite, and olivine. Exposed in Colle Canyon at northern quadrangle margin. Intruded by *Tm*.

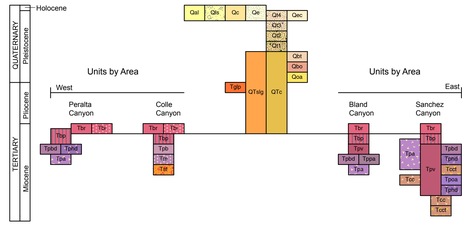
Tcc **Canovas Canyon rhyolite (Miocene)** - Domes, flows, and intrusions. White to gray to pink, flow-banded devitrified rhyolite and rhyodacite. Contains phenocrysts of quartz, plagioclase, biotite, ±sanidine, ±hornblende. May contain flow breccia, perlite, and rare obsidian at margins of intrusions. Tcc underlies or intrudes intermediate-composition rocks of lower Keres Group. K-Ar ages of four domes and flows range from 9.24 ±1.50 Ma to 12.4 ±2.0 Ma (Goff et al., 1990). Maximum observed thickness about 110 m.

Tcct **Canovas Canyon rhyolite (Miocene)** - tuff. White to pink ash-fall and ash-flow tuffs. Consists of at least four mappable units. Lowermost unit consists of pink lithic-rich ash-fall tuff containing abundant lithic fragments of pink flow-banded rhyolite. Other units consist of thin beds of white, fine-grained ash and pumice. Maximum observed thickness about 20 m.

Santa Fe Group

Tsf **Sandstone (Miocene)** - White, silicified and metamorphosed fine-grained, well-sorted, sandstone. Consists of ~90% quartz with minor feldspar and lithic fragments. Mostly massive but locally includes faint horizontal and cross bedding. Based on grain size, composition, and lack of associated mudstone, the sandstone is tentatively correlated to middle Miocene eolian sandstones, such as the Zia sandstone, in the Albuquerque basin, and the Ojo Caliente sandstone Member of the Tesuque formation, in the Espanola basin. Stein (1983) and Smith (2001) interpret as roof pendants within stocks of unit *Tm*. Maximum thickness is 100 m.

Correlation of Map Units

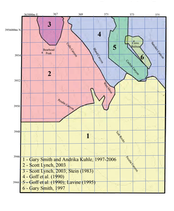


Hoodoos eroded in the Peralta Tuff member of the Bearhead Rhyolite (foreground) and gravel of the Cochiti formation (skyline) provide the geologic framework of the Kasha Katuwe Tent Rocks National Monument. Photo by Gary Smith.

Explanation of Map Symbols

- 7.12 — Age (Ma)
- Volcanic vent
- Horizontal bedding
- Strike and dip of bedding
- Strike of vertical joints
- Strike and dip of flow foliation
- Strike of vertical flow foliation
- Contact, dashed where approximate, solid where certain, dotted where concealed, dip shown where measured
- Fault, dashed where approximate, solid where certain, dotted where concealed Ball on downthrown side, dip shown where measured
- A — A' Line of cross section

Index to Geologic Mapping



Geologic Overview

The Cañada quadrangle is located at the boundary between the southern Jemez volcanic field and northern Santo Domingo Basin, and on the western edge of the Rio Grande rift. The Santo Domingo Basin is an accommodation zone within the rift that is filled primarily with Santa Fe Group sediments (Smith and Kuhle, 1998). The Jemez volcanic field is at the intersection between the rift and the northeast-trending Jemez lineament. These structures are characteristically expressed in the Jemez Mountains as northerly and northeasterly trending normal faults. Miocene to Pleistocene lavas and pyroclastics ranging in composition from basalt to rhyolite make up the volcanic field, and its development culminated with the formation of the Valles caldera and associated 1.22 Ma eruption of the Bandelier tuff. The southeastern margin of the Valles caldera is about 10-15 km northwest of the Cañada quadrangle.

In the southern Jemez volcanic field, the Bandelier tuff erupted over a rugged terrain of volcanic rocks known as the Keres Group (Bailey et al., 1969). The group was refined by Gardner *et al.* (1986) and consists of Canovas Canyon rhyolite, Paliza Canyon formation, and Bearhead rhyolite. Paliza Canyon Formation dominates Keres Group, and consists of voluminous andesitic to dacitic, with some basaltic, lavas and associated volcaniclastic breccias (Gardner *et al.*, 1986). Canovas Canyon rhyolite flows and tuffs typically underlie Paliza Canyon andesites and dacites, but are intercalated locally. Most of the Canovas Canyon and Paliza Canyon volcanic rocks were erupted 8-10 Ma (Gardner *et al.*, 1986; Goff *et al.*, 1990; Lavine *et al.*, 1996, Chamberlin *et al.*, 1999). Overlying the Paliza Canyon formation is the Bearhead Rhyolite, which consists of rhyolite intrusions, lava flows and domes, and the associated pyroclastic and sedimentary strata of the Peralta Tuff Member. Bearhead rhyolite erupted between 6-7 Ma (Gardner *et al.*, 1986).

The northern 2/3 of the Cañada quadrangle is Keres Group rocks and Bandelier Tuff, and the southern 1/3 is primarily volcaniclastic basin-fill sediments and pediment gravels of the Santa Fe Group. The Keres Group rocks form prominent highlands along the northwestern and northeastern sides of the quadrangle, with Bandelier Tuff capping the mesas in between. Keres Group rocks are also present in the deeply incised canyons between the mesas of Bandelier Tuff.

A 12.4 Ma Canovas Canyon Rhyolite flow (*Tccr*) and an underlying tuff (*Tcct*) are exposed in Sanchez Canyon and are the oldest volcanic units in the Cañada quadrangle. The flow is overlain by intercalated Paliza Canyon Formation andesite and dacite flows, domes, and volcaniclastic deposits. The lower part of this sequence is intercalated with Canovas Canyon rhyolite domes, flows, and tuffs as young as 9.2 Ma (Gardner and Goff, 1984). There is no compositional progression in this sequence of rocks (Goff *et al.*, 1990). The sequence is overlain by Peralta Tuff, which is overlain by a Bearhead Rhyolite dome.

In the western part of the quadrangle, Paliza Canyon Formation andesite flows (*Tpa*) and intrusive rocks (*Tm*) are the oldest volcanic units exposed. Paliza Canyon Formation biotite dacite flows (*Tpbd*) overlie andesite flows (*Tpa*) along the western quadrangle margin. A Paliza Canyon Formation hornblende dacite flow (*Tphd*) is present beneath Peralta Tuff (*Tbp*) and apparently above andesite flows (*Tpa*). It is a single exposure in the northwest corner of the quadrangle and its stratigraphic relationship with the biotite dacite (*Tpbd*) is unknown.

Bearhead Rhyolite is stratigraphically above Paliza Canyon Formation in the Canada quadrangle. The Peralta tuff member (*Tbp*) is typically overlain and intruded by Bearhead Rhyolite domes, flows, and intrusions (*Tbr/Tbl*), but in Peralta Canyon they are intercalated or the Peralta Tuff buries the lava. Bandelier Tuff (*Qbo/Qbt*) overlies Bearhead Rhyolite and Keres Group.

The Cochiti Formation (*QTc*) gradationally overlies the Peralta Tuff Member in the southern part of Canada quadrangle and is interbedded with the Sierra Ladrones Formation (*QTslg*) near the southeastern corner. Bandelier Tuff (*Qbo*) is present within the uppermost Cochiti Formation east of Tent Rocks.

The Jemez volcanic field is at the intersection of the north-trending Rio Grande Rift and the northeast-trending Jemez lineament. High-angle normal faults trending north, north-northwest and northeast are numerous in the Canada quadrangle. Most of these faults dip between 65°-80° to the east or southeast. A notable exception is the major Medio Dia fault, which is down to the west. They are well exposed in the Keres Group volcanics, commonly with fault gouge, breccias, slicks, alteration zones, and in some places quartz veins. The displacement in Keres Group rocks is greater than 170 meters where the Peralta fault enters Peralta Canyon and juxtaposes Peralta Tuff against Paliza Canyon andesite (*Tpa*). The Bland fault juxtaposes hypabyssal Keres Group rocks in the footwall against Peralta Tuff in the hanging wall. Several faults also offset upper Pliocene pediment gravels (*Tglp*) in the northern part of the quadrangle by as much as 70 m, and a few displace the 1.22 Ma Bandelier tuff (*Qbt*) in the northern part by typically less than 30 m.

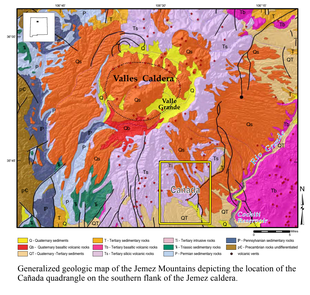
The Pajarito fault zone is a major north to northeast trending structure in the Jemez Mountains. In the Canada quadrangle it has a record of movement in the middle Pleistocene. Between Bland and Cochiti Canyons it displaces the Bandelier Tuff by 80 meters. In Bland Canyon it also cuts middle Pleistocene terrace gravel (*Qt3*), which is in fault contact with Peralta Tuff. Goff *et al.* (1990) estimate a maximum displacement of 300 m in the Keres Group rocks along the Pajarito fault between Bland and Cochiti Canyons.

Many of the Keres Group magmas intruded and erupted along faults in the southern Jemez volcanic field (Gardner *et al.* 1986). In the Canada quadrangle, several Bearhead Rhyolite stocks and domes are found at the intersection between N-S trending and NE-SW trending faults. In the northwest corner of the quadrangle, Bearhead Rhyolite vents are aligned along N-S trending faults, which are intruded by rhyolite dikes. The intermediate and rhyolitic dikes in the Cochiti mining district very commonly trend N-S and NE-SW.

The Bearhead basin accommodates the 500 m thick, west-tilted section of Peralta Tuff between Peralta and Medio Dia Canyons (Smith, 1999). The fault zone of Peralta Canyon forms the western stepped margin of the basin, with the Peralta fault forming its far western edge. The Peralta Tuff thins against the western margin, and is abruptly truncated by the Peralta fault. The down to the west Medio Dia fault zone forms the eastern margin of the Bearhead basin. The southeastern margin of the basin is partly uplifted in the footwall of the Pajarito fault. This uplift, along with possibly greater displacement along the Peralta fault zone than the Medio Dia fault zone, accounts for the westward tilt of the Bearhead basin. The basin is about 8 km wide near its southern end. It tapers to the north between northeast trending faults and the northwest trending Medio Dia fault. It is about 2.5 km wide near the northern quadrangle boundary, where northeast trending, down to the southeast faults form its northern margin. The thick section of Peralta Tuff Member and overlying Cochiti Formation is absent east and west of the Bearhead basin, indicating deposition during basin subsidence (Smith, 1999).

North of Bearhead Peak there is mostly hypabyssal rocks of the Cochiti mining district. The area is in the footwall of a NE-trending fault zone, including the major Bland fault (Stein, 1983). Uplift and erosion of these blocks has exposed the feeder system of the Keres Group volcanic rocks, a depth of exposure seen nowhere else in the Jemez volcanic field. The rocks are primarily dikes and stocks of the Paliza Canyon formation that are intruded by Bearhead Rhyolite dikes and stocks. The dikes commonly are near vertical and strike north to northeast, coincident with fault orientations in the area.

The rocks in the Cochiti mining district are hydrothermally altered and intensely fractured. Faults and fractures in the district are commonly filled with N-S and NE-SW trending, gold and silver bearing epithermal quartz veins up to 1 meter wide. The rocks are variably chlorized, silicified, and argillized. WoldeGabriel and Goff (1989) dated hydrothermal illite and determined this alteration occurred between 5.9-6.5 Ma and may thus be associated with Bearhead Rhyolite magmatism.



Generalized geologic map of the Jemez Mountains depicting the location of the Cañada quadrangle on the southern flank of the Jemez caldera.

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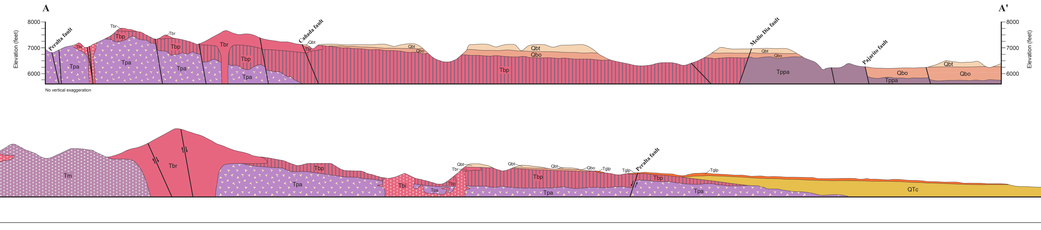
Geologic Cross Sections