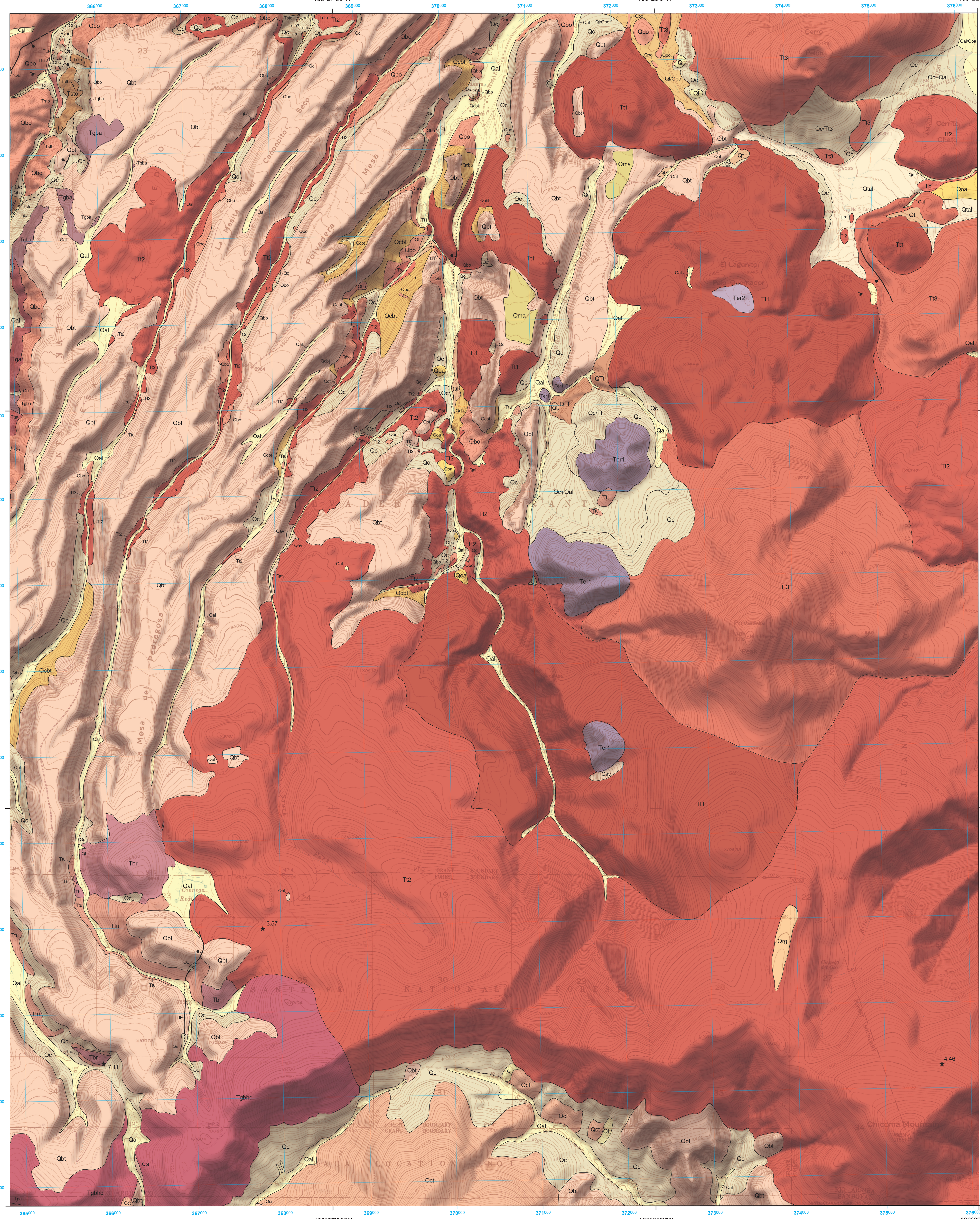
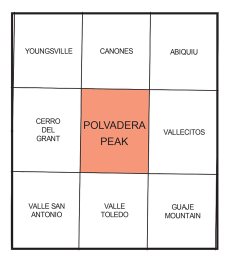
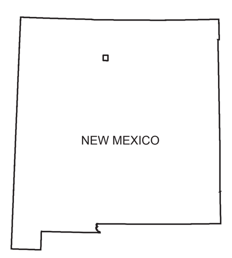
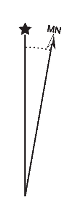


Base map from U.S. Geological Survey 1970, from photographs taken 1965, field checked in 1970, edited in 1993.
1927 North American datum, UTM projection -- zone 13N
1000-meter Universal Transverse Mercator grid, zone 13, shown in blue



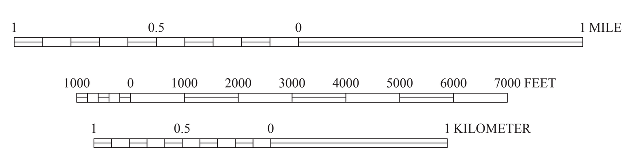


QUADRANGLE LOCATION



Magnetic Declination
May 2004
10° 19' East
At Map Center

1:24,000



CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

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

[575] 835-5490

This and other STATEMAP quadrangles are available for free download in both PDF and ArcGIS formats at:

http://geoinfo.nmt.edu

New Mexico Bureau of Geology and Mineral Resources
Open-file Geologic Map 96

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, (L. Greer Price, *Director and State Geologist*, Dr. J. Michael Timmons, *Geologic Mapping Program Manager*).

Geologic map of thePolvadera Peak quadrangle, Rio Arriba and Sandovol Counties, New Mexico.

May 2004

by
Kirt Kempter [1], Shari A. Kelley [2], and Linda Fluk [3]

[1] *2623 Via Caballero del Norte, Santa Fe, NM, 87505*
[2] *New Mexico Bureau of Geology and Mineral Resources, 801 Leroy Pl., Socorro, NM 87801*
[3] *160 County Rd. 113, Santa Fe, NM 87506*

Map Symbols

Gelogic contact– solid where exposed or known, dashed where approximately known, queried where uncertain.

Normal fault–bar-and-ball on downthrown side. Solid where exposed, dashed were approximately known, dotted where concealed.

50 Strike and dip of bedding.

7.11 Radiometric date in Ma.

A ⊢⊣ A' Location of geologic cross section.

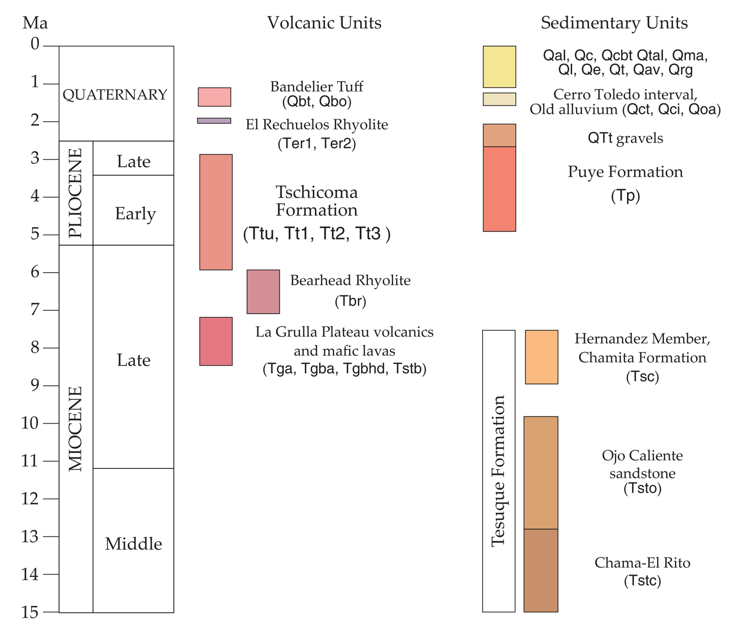
COMMENTS TO MAP USERS

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.

Correlation Diagram



Map Unit Descriptions

Quaternary

Qal — **Alluvium—**Late Pleistocene to Holocene. Alluvial deposits in modern drainage bottoms. Deposits include conglomerates, sands, and silts. Holocene terrace deposits less than 1 meter above drainage bottoms are included. Alluvium in canyons in the western portion of the quadrangle is dominated by weathering products of the Bandelier Tuff (primarily **Qbt**), while alluvium in eastern canyons is dominated by fluvial clasts of Tschicoma dacite. Obsidian fragments common. Maximum thickness can exceed 4 meters.

Qc/Qcbt — **Colluvium—**Late Pleistocene to Holocene. Poorly sorted talus, debris, and colluvium in wedge-shaped deposits on hill slopes. Numerous hill slopes beneath mesas of Tshirege Member, Bandelier Tuff (**Qbt**), are covered by **Qbt** colluvium (obscuring the underlying bed rock), and have been mapped as **Qcbt**. Thickness can locally exceed 5 meters.

Qt — **Terraces—**Late Pleistocene to Holocene. Alluvial deposits near the margins of modern streams or older perched floodplain deposits. Most are fill terrace deposits of sand, silt and gravel < 10 m above modern drainages. Maximum thickness is <5 meters.

Qtal — **Undifferentiated terraces and alluvium in modern stream drainages—**Obsidian fragments common. Late Pleistocene to Holocene.

Qe — **Eolian deposits—**Late Pleistocene to Holocene. Poorly bedded fine-grained sand and silt preserved sporadically on terraces and mesa tops. Although no sedimentary structures could be identified, these deposits appear to be primarily eolian in origin, capping older alluvial deposits. Less than 1 meter in thickness.

Ql — **Landslides—**Pleistocene to Holocene. Unsorted, chaotic debris emplaced during a single detachment event from a steep slope or cliff. Fan-shaped deposits occur where debris spread out on valley floor. Thickness highly variable.

Qav — **Rock avalanche deposits—**Late Pleistocene to Holocene. Chaotic, angular debris emplaced during a single detachment event from a steep slope or cliff, generally lacking a sedimentary matrix. Mapped only in a few locations. Thickness can exceed 10 meters.

Qma — **Mesa alluvium—**Late Pleistocene to Holocene. Poorly sorted sand and debris composed primarily of reworked Upper Bandelier Tuff (**Qbt**). Obsidian fragments common. Though common as isolated patches on **Qbt** mesa tops, these deposits were only mapped in a few localities. Maximum thickness is less than 2 meters.

Qrg — **Rock glacier—**Quaternary. Debris field of large, tabular Tschicoma dacite blocks along a flat ridge between Polvadera Peak and Tschicoma Peak. The deposit was possibly mobilized via interstitial ice and/or thawing alpine permafrost, providing a buoyant substrate facilitating slow creep on nearly flat topography.

Qoa — **Old Alluvium—**Quaternary. Older alluvial deposits of gravel, sand, and silt that were deposited after the eruption of the Tshirege Member, Bandelier Tuff. Dominant clast lithology is Tschicoma Formation dacite, with subordinate amounts of rhyolite lava and rare Tshirege Member, Bandelier Tuff. In Polvadera Canyon, a remnant of a paleocanyon filled by this unit is exposed along the western edge of the modern canyon. Aggradation of this paleocanyon may have occurred when the downcutting of the river encountered a mound of Tschicoma dacite (at the confluence of Polvadera Creek and the West Fork Polvadera Creek), impeding erosion and backfilling the canyon with sediment. The modern canyon then incised slightly to the east of this paleodrainage, preserving alluvial deposits along the canyon's western margin. Maximum thickness is approximately 30 meters.

Qbt — **Upper Bandelier Tuff, Tshirege Member.—**Early Quaternary. White to orange non-welded to welded ash-flow tuff containing abundant phenocrysts of quartz and sanidine. Basal Tsankawi Pumice, though seldom exposed, is typically 1 meter thick and well stratified. Overlying ash-flow tuff beds consist of multiple flow units in a compound cooling unit with thin surge beds (less than 0.5 meters thick) locally exposed. Though mostly lithic poor (2-3% lithic fragments), one of the lower flow units contains > 5% of lithic fragments, appearing similar to facies of the Otowi Member, Bandelier Tuff. Erupted at approximately 1.25 Ma during the formation of the Valles caldera (Phillips et al., 2007). Maximum thickness is approximately 250 meters.

Qct/Qci — **Cerro Toledo Formation—**Quaternary. Rhyolitic lavas erupted within the Toledo embayment along the southern boundary of the quadrangle and poorly exposed fluvial sediments deposited between eruptions of the Bandelier Tuff (Gardner et al., 2010). The rhyolite lavas are typically white to gray to pink and crystal poor, with sparse phenocrysts of quartz and sanidine. Qci represents the Indian Point rhyolite (Goff et al., 2011), a sparsely porphyritic rhyolite lava with ~3% phenocrysts of quartz and sanidine. Lithophysal, flow banded and obsidian phases are common in **Qct** lavas. Sedimentary facies are preserved in the South and West Forks of Polvadera Canyon, overlying either Tschicoma dacite or Otowi Member of the Bandelier Tuff. These fluvial facies are poorly consolidated, typically manifested as colluvial rounded cobbles of mixed lithologies (primarily Tschicoma dacite) at the surface. Fluvial cobbles of Otowi Member, Bandelier Tuff, were not recognized, so mapping of this unit was based on stratigraphic position and extrapolation. Maximum thickness is approximately 5 meters.

Qbo — **Bandelier Tuff, Otowi Member—**Quaternary. White to beige to orange non-welded to welded ash-flow tuff containing abundant phenocrysts of quartz and sanidine and sparse mafic phenocrysts. Moderate to abundant lithic fragments (5-12%), primarily of andesitic or mafic lavas. Though not as evident as the overlying Tshirege Member, this unit represents a compound cooling unit of multiple flows. One of the lower flow units is lithic poor (< 5%), resembling facies of the Tshirege Member. Where poorly welded this unit is also poorly exposed, often obscured by colluvium of overlying Tshirege Member. Thus, there is likely much more of this unit than indicated on the map. No exposures of the basal Guaje Pumice were observed in the quadrangle. Erupted at approximately 1.61 Ma during the formation of the Toledo Caldera (Spell et al., 1996). Maximum thickness (exposed in Cañones Canyon) is approximately 200 meters.

QTt — **Terrace gravels and conglomerates of uncertain age—**Late Tertiary – Early Quaternary. Isolated exposures of older alluvium preserved adjacent to large Tschicoma flow boundaries. May be equivalent to the Puye Formation (Griggs, 1964; Gardner et al., 1986). Mostly coarse boulder conglomerate of Tschicoma dacite with minor amounts of andesite and rhyolite. No clasts of Bandelier Tuff. Maximum thickness is approximately 30 meters.

Tertiary

Ter1/Ter2 — **El Rechuelos Rhyolite—**Late Tertiary. Ter1 is represented by three eruptive centers of white to pink rhyolite with subordinate amounts of dark, glassy, and sometimes sugary-textured obsidian, emplaced along an arcuate fracture along the western margin of Polvadera Peak at ~ 2 Ma (Goff et al., 1989). Another rhyolite eruptive center, mapped as Ter2, is located approximately 2.5 miles north of Polvadera Peak, and is defined by a small crater termed El Lagunito de Palo Quemador. Geochemical analyses of this rhyolite suggest that it may be more closely related to older Tschicoma-related volcanism (Loeffler, 1984). Rhyolite fragments are typically pumiceous with < 5% phenocrysts of plagioclase, quartz, biotite and hornblende. The three remaining eruptive centers occur along a north-south fracture west of Polvadera Peak. Two large centers occur at the head of Cañada del Ojitos and consist of intrusive and extrusive dome facies with sparse phenocrysts of plagioclase and biotite. The margins of both of these domes include autobrecciated and vesicular horizons with minor obsidian facies. The northernmost of these two domes has apparent landslide scarps on its NW flank, which may explain the two small satellite exposures of this unit in the Cañada del Ojitos valley floor. Lastly, at approximately 1.2 miles SW of Polvadera Peak is a small rhyolite center with abundant obsidian facies, though poorly exposed. Maximum thickness is approximately 150 meters.

Tp — **Puye Formation—**Pliocene to Early Pleistocene. Poorly exposed alluvial sediments composed almost entirely of Tschicoma lava clasts. Mapped only in the West Fork of Polvadera Canyon where overlain by the Otowi Member of the Bandelier Tuff. May also include older terrace deposits (QTt) mapped adjacent to Tschicoma domes in the northeast quadrant of the quadrangle. Boulder conglomerates common, although pebble conglomerates, sandstones, and siltstones also present. Maximum thickness is approximately 25 meters.

Ttu, Tt1, Tt2, Tt3 — **Tschicoma Formation—**Late Miocene to Pliocene. Light gray to dark gray coarsely porphyritic lavas, primarily of dacitic composition but also including andesites and rhyodacites. This episode of volcanism includes thick, superimposed flows and high-aspect ratio domes. No pyroclastic facies of this unit were observed in the quadrangle (but do occur on the Vallecitos quadrangle to the east). The first and third highest peaks in the Jemez Mountains, Tschicoma Peak and Polvadera Peak, are dacitic domes of this unit located within the quadrangle. Age dates for this unit in the northeastern Jemez Mountains range from ~ 6 to 3 Ma with most domes/flows emplaced between 5 to 3 Ma. These domes and flows were subdivided into three general age relationships based on field relationships, age data, and geomorphology of the dome flows:
1) an older sequence of domes and flows (Tt1), including plagioclase-dominated flows with both hydrous (biotite + hornblende) and non hydrous mineralogy. Age dates from these flows imply ages greater than 4.5 Ma, including a dome immediately southwest of Polvadera Peak. In the NE quadrant these older flows and domes are mostly dacitic to rhyodacitic, with abundant phenocrysts of plagioclase, biotite and hornblende with minor amounts of pyroxene.
2) Tt2 represents dacite and rhyodacite lavas (undivided) that formed Chicoma (or Tschicoma) Peak, including the northern rim rocks of the Toledo embayment and flows that extend to the north end of the quadrangle. These massive to sheeted, coarsely porphyritic lavas have abundant phenocrysts of plagioclase, and variable quantities of phenocrysts of biotite, hornblende, and rare clinopyroxene. The younger lavas may contain of sanidine and quartz and 2 to 25 cm, elliptically-shaped inclusions of mafic composition; $^{40}Ar/^{39}Ar$ dates are 4.29 to 4.46 Ma (Kempter et al., 2007). This unit also includes porphyritic lavas that commonly contain cognate clots of more mafic magmas (vesicular basaltic andesite) ranging in size from 2 to 25 cm.
3) The youngest lavas and domes (Tt3) formed Polvadera Peak and Cerro Pelon, both porphyritic dacites with plagioclase the dominant phenocyrst. Cerro Pelon contains both clinopyroxene and orthopyroxene, with minor biotite and hornblende.
Undifferentiated Tschicoma dacite lavas are represented by the symbol Ttu. Maximum thickness of Tschicoma lavas exceeds 600 meters.

Tbr — **Miocene Bearhead Rhyolite—**Rhyolite domes and intrusions exposed at three vent sources in the southwestern corner of the quadrangle. They include flow banded, vitrophyric lava with vesicular horizons with phenocrysts of plagioclase and minor biotite. Ages for this group of rhyolites range from 5.8 – 7.5 Ma (Kempter et al., 2007; Loeffler et al., 1988). These lavas were previously mapped as El Rechuelos rhyolite, but age considerations and similar exposures along the northern rim of the Valles Caldera (Goff et al., 2006) suggest these lavas correlate with the widespread pulse of Bearhead volcanic activity recognized in the southern Jemez Mountains (Justet and Spell, 2001; Justet, 2003).

Tgbhd — **Dacite lava of La Grulla Plateau—**Light gray porphyritic dacite with phenocrysts of plagioclase, biotite, and hornblende. Overlies more mafic rocks (**Tgba**) in the walls of Cañones Canyon. Maximum thickness is approximately 80 meters.

Tgba/Tga — **Lavas of La Grulla Plateau—**Miocene. Older basaltic andesite lavas (Tgba) capped by younger andesite lavas (Tga) along Cañones Canyon in the western margin of the quadrangle. The basaltic andesites are dark gray, fine grained, with phenocrysts of plagioclase, clinopyroxene, orthopyroxene and olivine. This unit thins and thickens dramatically, clearly filling in paleotopography at the time of its eruption. The base of the unit is typically hidden by colluvium, although where exposed, the lava overlies fluvial deposits of the Hernandez Member of the Chamita Formation. Presumably, these lavas underlie the thick Tschicoma dacite sequence in the quadrangle. The andesitc lavas are more coarsely porphyritic and are much more extensive on the adjoining Cerro del Grant quadrangle to the west. Maximum thickness is approximately 100 meters.

Tsc — **Santa Fe Group, Chamita Formation—**Poorly exposed fluvial sandstones with rounded cobbles (2 to 12 cm across) of volcanic origin overlying the eolian sandstones along the eastern rim of Cañones Canyon, possibly representing the Hernandez Member of the Chamita Formation as mapped by Koning and Aby (2005). These gravels contain cobbles of andesite with lesser amounts of rhyolite and basaltic andesite, possibly originating from the San Juan or Latir volcanic fields. Maximum thickness exceeds 200 meters.

Tsto/Tstb — **Santa Fe Group, Tesuque Formation, Ojo Caliente Sandstone Member—**Miocene. Buff to tan, cross-bedded eolian sandstones exposed in Cañones Canyon and Chihuahueños Creek in the northwestern corner of the quadrangle. These eolian sandstones are composed primarily of quartz and clearly indicate a prevailing wind from the west. In Cañones Canyon some exposures of the Ojo Caliente Member are consolidated, outcropping as subdued cliffs. Most of the unit, however, is poorly consolidated, forming buff-colored sand and silt on the canyon slope. At the base of the eolian sequence in Cañones Canyon are isolated exposures of thin basalt flows (Tstb), presumably intercalated with the sedimentary sequence. These lavas may correlate with the Lobato basalt in the northeastern Jemez Mountains.

Tstc — **Santa Fe Group, Tesuque Formation, Chama-El Rito Member—**Miocene. Rare exposures of fluvial sandstone and siltstones including sand grains of quartz, feldspar and iron oxides. Underlies Ojo Caliente Member along the northern boundary of the quadrangle in Chihuahueños Canyon. Maximum thickness of 10 meters.

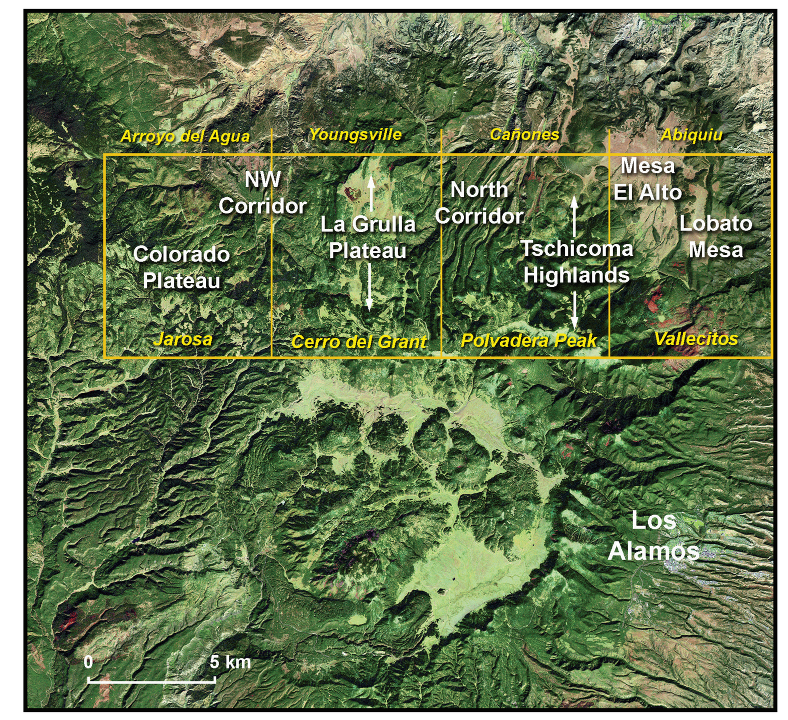


Figure 1—Satellite image of the Valles Caldera and the northern Jemez Mountains showing the location of the four 7.5-minute topograhic quadrangles north of the Valles Caldera. Geographically important divisions include the Colorado Plateau, La Grulla Plateau, Tschicoma Highlands, Mesa El Alto, and Lobato Mesa. The Bandelier Tuff was emplaced along two relatively lowland corridors, one to the NW onto the Colorado Plateau, and one to the north, between La Grulla Plateau and the Tschicoma highlands.

Figure 2—Unusual debris field of tabular Tschicoma dacite blocks along a flat ridge between Polvadera Peak and Tschicoma Peak. The deposit has been mapped as a Quaternary rock glacier (**Qrg**), and possibly mobilized via interstitial ice and/or thawing alpine permafrost, providing a buoyant substrate facilitating slow creep on nearly flat topography.

Figure 3—Cañoncito Seco heading into the Cañones quadrangle showing layered Upper Bandelier Tuff (Tshirege member, **Qbt**) above massive, moderately to densely welded Lower Bandelier Tuff (Otowi member, **Qbo**). In general the Otowi member is more welded than the Tshirege Tuff in the northern Jemez Mountains. Note onlap of Tshirege Tuff on basalts of Polvadera Mesa down canyon.

Figure 4—Shari Kelley providing scale for Bandelier Tuff deposits. The Otowi Member tuff is gray, reaching her head level. Two meters of overlying Tsankawi tephra are then overlain by pyroclastic flow deposits of the Tshirege Member tuff.