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Geology of Santo Domingo Pueblo and Santo Domingo Pueblo SW quadrangles, Sandoval County, New Mexico

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A geologic map graphically displays information on the distribution, nature, orientation and age relationships of rock and surficial units and the occurrence of structural features. These data are derived from geologic field mapping, compilation of published and unpublished work, and photogeologic interpretation. Locations of geologic unit contacts are not surveyed; therefore, the accuracy of contact locations depends on the scale of mapping and the interpretation of the geologist. Portions of the study area may have been mapped at scales smaller than depicted on the geologic map; therefore, the user should be aware of significant variations in map detail. 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.

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Unit Descriptions

COCHITI DAM EXCAVATION AND FILL

Although the map base is a revised topographic map issued after construction of Cochiti Dam, not all of the dam fill is correctly represented and topography was not revised in the area of excavations for fill material and the conveyance channel.

df — Dam fill and engineering structures.

Diagonal hatchures — areas of deep excavation and removal of sufficient volume of material so as to prohibit accurate mapping on this topographic base. Unit *QTslg* is currently exposed in most of these areas but at elevations 200-300 feet lower than the topography represented on the topographic base.

Other excavations and recontouring have substantially modified the landscape within the area portrayed on the map base by the disturbed - ground symbol (removed here for clarity – see actual topographic map for areal extent). The magnitude of this disturbance is not so great, however, as to prohibit mapping of units and projections of contacts onto the pre - excavation topography.

QUATERNARY ALLUVIAL, EOLIAN, AND MASS - WASTING DEPOSITS

Qf — **Deposits of modern channel and floodplain of the Rio Grande (Holocene) —** Sand, mud and minor gravel, mostly within 3 m elevation of the present channel. Prominent geomorphic expression of abandoned channels (some of which are occupied by permanent ponds and marshes) and vegetated bars. These deposits are probably mostly of historic age and are largely younger than 1940 (*cf.*, Graf, 1994, *figure 10.3*). Thickness unknown.

Qoa — **Older alluvium of the Rio Grande (upper Pleistocene? and Holocene) —** Alluvial sand, gravel and silt, 10-30 m thick, underlying a low-relief surface about 3 m above the active channel of the Rio Grande. This surface has been largely modified by agricultural activity but, where unmodified, lacks the remnant channel and bar topography that is prominent on the surface of unit *Qf*. Probably intercalated with unit *Qal* near the valley margins. U.S. Army Corps of Engineers (USACE) core logs along the Rio Grande at the Cochiti Dam outlet indicate a 10-30 m thickness for this deposit.

Qal — **Alluvium deposited by Rio Grande tributaries (upper Pleistocene? and Holocene) —** Poorly sorted gravelly sand and sandy gravel deposited in channels and minor floodplain areas of tributary streams and as a broad alluvial apron along the west side of the Rio Grande valley (east edge of the Santo Domingo Pueblo SW quadrangle). Includes tributary-mouth fans where the *Santa Fe River*, an unnamed arroyo south of Peña Blanca, *Galisteo Creek*, and streams in Peralta Canyon, Cañon Santo Domingo, and Cañada de Cochiti emerge from relatively confined valleys onto the Rio Grande floodplain. Beds of eolian fine sand to 0.5 m thick are locally present. This deposit is entrenched by as much as 3 m in several localities, especially along the lower *Santa Fe River* and *Galisteo Creek*. The upper surface continues to receive deposition by lower-order tributaries, however, so this unit was not mapped as a terrace. Along the margin of the Rio Grande valley, these deposits are graded to the top of unit *Qoa* and are also likely interbedded with *Qoa*. Alluvium deposited near the confluence of Peralta Canyon and the *Rio Grande* at Cochiti Pueblo is graded to an older confluence farther east. Westward migration of the *Rio Grande* has caused a local base-level drop, regrading of the lowermost Peralta Canyon drainage, and incision of unit *Qal* by as much as 8 m at the mouth of Peralta Canyon and at the eastern edge of Cochiti Pueblo. Although giving the appearance of a terrace, the elevated surface resulting from this incision continues to receive sediment from hillslopes and lower-order tributaries and merges westward with the active depositional surface of the Peralta Canyon drainage. Total thickness is probably similar to unit *Qoa*, 10-30 m.

Qe — **Eolian sand and silt (upper Pleistocene and Holocene) —** Massive fine sand and coarse silt forming 1-5 m thick deposits in the western part of Santo Domingo Pueblo SW quadrangle. They are most notable here in high elevation positions in the landscape, especially mantling gravel of Lookout Park (*Tglp*) and the basalt flows to the southwest. On the Santo Domingo Pueblo quadrangle, this unit forms a 1-2 m thick cap on terrace gravel of units Qta_4 and Qtp_4 and thickens to as much as 3 m against terrace riser of Qta_3 where sheetwash sand and gravel are also present. Locally contains snails that have yielded AMS ^{14}C dates of 36.9 ±0.5 and 37.8 ±0.5 ka, although these samples may only contain "dead" carbon (D. Dethier, *personal communication*, August 1996). A 10-20 cm thick layer of coarse ash and fine lapilli of the El Cajete Pumice, dated at ~60 ka (Reneau, *et al.*, 1996) is present within this unit in the NE ¼ Sec. 20 T.16N. R.6E. A complicated stratigraphy resulting from eolian accumulation and localized sheetwash and gullywash erosion or deflation is suggested by buried, truncated soils and the presence of archeological material of Archaic to Pueblo IV vintage at various levels in the deposit.

Qog — **Older gravel (lower Pleistocene) —** Volcanic-clast gravel, 1-2 m thick, resting above Bandelier Tuff (Qbo) in several outcrops in the central and north-central part of the Santo Domingo Pueblo SW quadrangle. Probably represents a thin veneer of gravel deposited on top of the tuff prior to reincision of drainage following inundation of the landscape by the pyroclastic flow.

Qta and Qtp - Terrace gravel (Pleistocene) — Fill and strath terraces formed along the *Rio Grande* (axial gravel - *Qta*) and tributaries (piedmont gravel - *Qtp*). *Rio Grande* terrace gravels contain approximately 30-40% quartzite, 15-20% intermediate-composition volcanic rocks, 5-10 % rhyolite, 10-15% granitic and gneissic rocks, 5-20% basalt clasts and 0-10% clasts of the Bandelier Tuff. In the Santo Domingo Pueblo quadrangle: *Santa Fe River* terraces are underlain primarily by pebbly arkosic sand; pebbles are dominantly granitic rocks, white vein quartz, and basalt with subordinate intermediate volcanic rocks. Peralta and Santo Domingo Canyons terrace gravel is composed of variably altered andesitic and rhyolitic clasts and, in Peralta Canyon, Bandelier Tuff fragments. Dominant gravel clasts in *Galisteo Creek* terraces are hornblende-pyroxene latite, derived from the Cerrillos area, and red sandstone and petrified wood eroded from the Eocene Galisteo Formation east of the quadrangle. In the Santo Domingo Pueblo SW quadrangle: tributary-stream terrace gravel is dominated by variably altered andesitic and rhyolitic clasts, derived from the Cochiti Formation (*QTc*) ,and locally abundant quartzite pebbles (derived from *QTsl*). Terrace gravel in Borrego Canyon includes 10-25% basalt cobbles and boulders (to 1 m across) and ~1% cemented red sandstone eroded from middle Santa Fe Group strata exposed in the Loma Creston quadrangle farther west.

Qta_1 — **Qta_1 - Terrace gravel (middle Pleistocene) —** Strath-terrace gravel located approximately 80-90 m above grade. Gravel is 3-5 m thick and locally capped by a discontinuous veneer of eolian sand and silt to 1 m. Contains, near the base, a reworked pale-gray ash correlated on the basis of shard chemistry (A. Sarna-Wojcicki, *USGS, written communication*, March 1998) to Lava Creek B (660 ka; Izett, *et al.*, 1999) erupted from the Yellowstone caldera.

Qtp_1 — **Qtp_1 - Terrace gravel (middle Pleistocene) —** Fill-terrace gravel, 3-8 m thick confidently identified in Cañon Seguro and between Santo Domingo and Borrego Canyons where Lava Creek B tephra (A. Sarna-Wojcicki, *USGS, written communication*, March 1998) is found in the lower part of the fill. At the latter locality, Qtp_1 gravel progaded over Qta_1 gravel. Gravel in a similar geomorphic position, but lacking ash, is found adjacent to Borrego Canyon.

Qta_2 — **Qta_2 - Terrace gravel (middle Pleistocene) —** Strath-terrace gravel located approximately 50-70 m above grade along the *Rio Grande* and, at one locality, along the *Santa Fe River*. Axial gravel present above *Santa Cruz Arroyo* is 1-2 m thick and contains up to 20% clasts of Bandelier Tuff and 10-20% basalt. Eroded terrace remnant in Santa Fe River valley contains basalt boulders to 1.25 m across. Four kilometers to the north, in the Cochiti Dam quadrangle, an axial strath gravel of unit Qta_2 overlies a soil developed on a flood-gravel deposit. This lower gravel includes reworked biotite-rhyolite tephra dated by $^{40}Ar/^{39}Ar$ at 0.55 ±0.01 Ma (W. McIntosh, *personal communication*, February 1997) that is probably correlative to the South Mountain Rhyolite. Dethier and McCoy (1993) estimate an age of 310 ±70 ka for fill terraces at a similar elevation above grade in the Española Basin, which may be roughly correlative with the <550 ka Qta_2 strath. Dethier et al. (1988) report a varnish-cation-ratio age estimate of 350-240 ka for gravel from Qta_2 in the Cochiti Dam quadrangle.

Qtp_2 — **Qtp_2 - Terrace gravel (middle Pleistocene) —** Fill-terrace gravel, 5-10 m thick, located approximately 50-70 m above grade north of Borrego Canyon and in a discontinuous belt through the central part of the Santo Doming Pueblo SW quadrangle. Rare clasts of welded Bandelier Tuff in this latter outcrop belt are derived from source outcrops outside the present watersheds of existing drainages and, along with distribution of terrace remnants, suggest deposition by an ancestral Peralta Canyon drainage that extended southward to a confluence with Borrego Canyon or the *Rio Grande*. Geomorphic relationships in this quadrangle, and in the Cañada quadrangle farther north, indicate that this ancestral drainage was pirated by headward erosion of two tributaries to the *Rio Grande*, one of which is represented by lower Cañon Santo Domingo. The correlative terraces in the Santo Domingo Pueblo quadrangle are <550 ka and are tentatively correlated to Española Basin terraces for which Dethier and McCoy (1993) estimate an age of 310 ±70 ka. Qtp_2 is probably correlative with the Cañada terrace of Aby (1997).

Qta_3 — **Qta_3 - Terrace gravel (middle Pleistocene) —** Fill-terrace gravel with an upper surface approximately 30-35 m above grade along the *Rio Grande*, *Santa Fe River*, and Peralta Canyon. Qta_3 is at least 30 m thick along the *Rio Grande* between Cochiti Dam and Peña Blanca. The Qta_3 fill consists of three subunits, not mapped separately. From bottom to top these are: (1) A lower cobble gravel with intercalated sand lenses and minor slackwater silt and clay. This unit is best exposed in borrow pits in Peña Blanca and is at least 15 m thick. (2) A middle sand and silt with gravel lenses, approximately 12-15 m thick, which includes gypsiferous mud. (3) An upper gravel about 1-2 m thick. Hoge (1970) proposed correlation of the unit here mapped as Qta_3 with the middle Pleistocene Edith Gravel of the Albuquerque area, although we map the extent of this gravel differently than did Hoge. Dethier and McCoy (1993) estimate an age of 170 ±40 ka for fill terraces at a similar elevation above grade in the Española Basin, which may be roughly correlative with the Qta_3 fill.

Qtp_3 — **Qtp_3 - Terrace gravel (middle Pleistocene) —** Fill-terrace gravel 5-10 m thick, with an upper surface approximately 30-35 m above grade. The most prominent of these deposits are present in the lower part of the unnamed drainage north of Borrego Canyon. These deposits extend away from the modern drainage and mark the course of an ancestral Peralta Canyon, which entered the area from the north (see description for Qtp_2).

Qta_4 — **Qta_4 - Terrace gravel (upper Pleistocene) —** Fill-terrace gravel with an upper surface approximately 18-20 m above grade along the *Rio Grande*, *Santa Fe River*, *Galisteo Creek* and Peralta and Santo Domingo Canyons. Because Qta_4 is typically inset against similar gravel of Qta_3, the precise portrayal of the thickness of Qta_4 terrace fill is difficult to establish for many outcrops. In gullies south of the outlet of Cochiti Dam and in borrow pits in Peña Blanca it is apparent that this terrace deposit is at least as much as 8 m thick. At the extreme north edge of the quadrangle this terrace includes boulders of basalt and hawaiite as much as 4 m across that presumably represent floods related to outbreaks from landslide dams in White Rock Canyon. Qta_4 underlies Qe, which contains ~60 ka El Cajete Pumice (Reneau, *et al.*, 1996). Dethier and McCoy (1993) estimate an age of 95 ±15 ka for fill terraces at a similar elevation above grade in the Española Basin, which may be roughly correlative with the Qta_4 fill. Qtp_4 probably correlates to the Rio terrace of Aby (1997). Topographic maps predating the construction of Cochiti Dam suggest the presence of a slightly lower, ~15 m, terrace that was destroyed during dam construction. Photographs in USACE foundation reports for the building of Cochiti Dam illustrate a several-meter thick accumulation of pumice on the upper surface of this terrace and banked against the backslope. This deposit was most likely El Cajete Pumice. It is not clear to us if this terrace is distinct from Qta_4 or not. If it is really younger, it may correlate to the Ash terrace of Aby (1997).

Qtp_4 — **Qtp_4 - Terrace gravel (upper Pleistocene) —** Fill-terrace gravel, 3-8 m thick, with an upper surface approximately 18-20 m above grade. It is less than 3 m thick in lower Peralta Canyon but reaches typical thickness near the mouth of the *Santa Fe River*. It is most prominent along Borrego Canyon and the south side of Cañon Santo Domingo where this gravel underlies a broad surface marking a former tributary-mouth fan along the western side of the Rio Grande valley. The equivalent terraces in the Santo Domingo Pueblo quadrangle are >60 ka and are tentatively correlated to Española Basin terraces for which Dethier and McCoy (1993) estimate an age of 95 ±15 ka.

Qtp_5 — **Qtp_5 - Terrace gravel (upper Pleistocene) —** Fill-terrace gravel, 2-8 m thick, with an upper surface approximately 10 m above grade. Found discontinuously in Cañon Santo Domingo.

Qaf — **Alluvial fan gravel (middle? Pleistocene to Holocene) —** Poorly sorted, angular gravel of basalt clasts, 5 cm to 2 m across, comprising alluvial fans and thin (<1 m thick) downslope alluvial aprons adjacent to the La Bajada Mesa escarpment. Probably interbedded with unit *Qalm*. Local, 0.5-1.5 m thick, veneers of eolian sand not mapped separately.

Qpu — **Piedmont sand, undifferentiated (middle Pleistocene) —** Poorly sorted sand and minor, lenticular gravel overlying Qta_3 adjacent to the *Santa Fe River*, and averaging 2.5 m thick. Generally exhibits a capping soil with a 1+ m thick Bt horizon and a stage II to III calcic horizon. In the center of Sec21 T.16N. R.6E., this deposit is clearly disconformable on Qta_3, although it may not be substantially younger than the underlying terrace gravel. Texture and rarely preserved sedimentary structures suggest that *Qpu* is a combination of sheetwash, gullywash, and eolian sediment derived, at least in part, from erosion of the higher upland surface and the backslope above the Qta_3 terrace. Deposition of this material probably followed abandonment of the Qta_3 surface by the *Rio Grande*.

Qalm — **Alluvium of the La Majada Mesa surface (lower? to middle Pleistocene) —** Poorly sorted sand and silt with minor, lenticular gravel; texturally similar to *Qpu*. Deposits of alluvium and eolian sediment associated with an extensive geomorphic surface extending from *Galisteo Creek* to near the base of La Bajada Mesa and constructed by *Galisteo Creek*, *Santa Fe River* and, perhaps to a minor extent, the *Rio Grande*. Sediment underlying this surface rests on Sierra Ladrones Formation (Santa Fe Group) and has been extensively stripped. Where *Qalm* rests directly on *QTslp*, there is insufficient textural or compositional difference to distinguish the two units. Excavations east of Cochiti Dam reveal that at least 10-12 m of *Qalm* originally rested above *QTslg*, although much of this material was removed to provide fill for Cochiti Dam. In the walls of these excavations, *Qalm* contains numerous buried soils suggesting a complex history of alternating landscape stability and accretion. A capping stage III to IV calcic horizon is present in many places below a largely stripped Bt. Local accumulations of sand on the uppermost surface are associated with active eolian processes but were not mapped separately. Unit *Qalm* is possibly correlative with the Ridge terrace of Aby (1997) and with axial-gravel terrace Qta_1.

Qls — **Landslide deposits and colluvium (Pleistocene?) —** Rotated slide blocks of hawaiite lava and coarse colluvium accumulated on slopes below unit *Th* in the northeast corner of the Santo Domingo Pueblo quadrangle.

Qc — **Colluvium (upper Pleistocene and Holocene) —** Rock - fall talus cones and scree slopes composed of basalt blocks mantling steep hillslopes below basaltic lava flows in the southern part of the Santo Domingo Pueblo SW quadrangle. Also delineates gravelly colluvial slopes along the north side of lower Borrego Canyon.

QUATERNARY – TERTIARY ALLUVIAL DEPOSITS

Santa Fe Group

Sierra Ladrones Formation - upper Miocene to lower Pleistocene

QTslp — **Sand, mud and gravel deposited by eastern-piedmont streams —** Buff to red colored sand and mud. Pebbly lithic-arkosic sand derived from sources east and northeast of the basin. Finer-grained facies may include both eastern piedmont and axial-floodplain deposits. Most pebbly layers from north side of *Galisteo Creek* to north side of Santa Fe River valley are dominated by clasts of granite, basalt, and white vein quartz suggesting depositon by an Ancestral *Santa Fe River*. Gravel layers and lenses south of *Galisteo Creek*, and locally on the north side of that valley, contain abundant clasts of hornblende-pyroxene latite porphyry, derived from intrusive and volcanic rocks near Cerrillos, and ubiquitous, though minor, rounded cobbles of petrified wood likely eroded from the Eocene Galisteo Formation. These latter gravels have a provenance similar to that of modern *Galisteo Creek*. Presence of basalt clasts and intercalation with Bandelier Tuff in the *Galisteo Creek* drainage indicate a Pliocene - early Pleistocene age for exposed parts of this unit. Pumiceous alluvium in this valley, 1.5 mile east of Domingo, contains abundant fossil remains of *Equus* and *Gomphotherium*. Includes axial-gravel deposits (*QTslg*) where too thin to map separately.

QTsl / QTslg — **Gravel deposited by axial river (ancestral *Rio Grande*) —** Mapped as *QTsl* in the Santo Domingo Pueblo SW quadrangle, but differentiated from *QTslp* as *QTslg* where unit thickness and map scale permited in the Santo Domingo Pueblo quadrangle. 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. Interbedded with Cochiti Formation (*QTc*) and the Peralta Tuff Member of the Bearhead Rhyolite (*Tbp*). In the Santo Domingo Pueblo SW quadrangle, axial gravel is interbedded with beds of Peralta Tuff Member of the Bearhead Rhyolite that have yielded $^{40}Ar/^{39}Ar$ ages of 6.81 ±0.02, 6.81 ±0.01, and 6.88 ±0.01 Ma (W. McIntosh, *personal communication*, Feb. 1997). These upper Miocene outcrops are contiguous with those exposed in the footwall of the Sile fault, south of Sile, where an age of 6.82 ±0.04 Ma was determined (W. McIntosh, *personal communication*, Oct. 1997) for pumice within *QTslg*. To the northwest, in the Cañada quadrangle, rhyolitic hydromagmatic deposits dated at 6.90 ±0.06 Ma (McIntosh and Quade, 1995), 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 in the Santa Fe River valley immediately upstream of Cochiti Dam. These dates constrain the age of the Sierra Ladrones Formation outcrops in the map area from late Miocene to early Pleistocene. Cuttings from a Bureau of Indian Affairs water well drilled near the eastern margin of the quadrangle encountered axial gravel in the subsurface (cross-section A-A').

QTsls — **Sand deposited by axial river (ancestral *Rio Grande*) —** Sand and gravelly sand conspicuous along east side of *Rio Grande*, mostly south of Peña Blanca. Locally partially cemented by yellow-brown iron hydroxides. Trough and tabular crossbedding reveal flow toward the south and southwest. Distinct from *QTslg* by dominance of sand, rather than gravel, size grains. Approximately 200 m thick with base not exposed.

QTslm — **Lacustrine clay, silt, and sand —** Two lithofacies assemblages are recognized. Laminated and thin bedded sand, silt, and clay associated with volcanic deposits of unit *Tb* are located between Cochiti Lake and Cañada de Cochiti. These are deposits of lakes that formed in hydromagmatic craters (outcrops in Cañada de Cochiti) and upslope of hydromagmatic tuff rings and lava flows that temporarily blocked the ancestral *Rio Grande* (Smith, *et al.*, 1997; outcrops east of Cochiti Dam). Combined surface and subsurface data (USACE) indicate thickness as great as 25 m. The second lithofacies assemblage is mapped as numerous distinct beds interbedded with unit *QTsls* south of Peña Blanca and consists of massive to laminated calcareous green mudstone, marl, tuffaceous marl, reworked tuff and diatomite.

QTsll — **Lacustrine limestone, mudstone and minor sandstone —** Consists of 1 to 3 beds of vuggy limestone, travertine, and marl interbedded with green calcareous mudstone and local beds of axial-composition sand. Total thickness is 4 to 12 m; thickest outcrops form prominent east - dipping cuesta along north side of *Galisteo Creek* north of Domingo and in unnamed valley southeast of Peña Blanca. In the latter area, limestone fills channels incised through basalt (*Tb*). Gastropod and ostracode fossils locally abundant. Abundance of precipitated calcite suggests bodies of water that were at least partially spring fed. The large extent of this deposit, however, suggests an areally extensive shallow lake. These deposits might speculatively relate to disruption of surface flow and consequent water-table rise caused by impoundment of the Rio Grande valley behind lava dams of the San Felipe volcanic field located immediately southwest of the quadrangle.

QTc — **Cochiti Formation (upper Miocene to lower Pleistocene) —** Volcaniclastic sand and gravel in poorly sorted, tabular beds. Gradationally overlies the upper Miocene Peralta Tuff Member of the Bearhead Rhyolite (Smith and Lavine, 1996). Contact 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*, October 1997) rhyolitic tephra is present near the base of the formation at Tent Rocks in the Cañada quadrangle. In the Cochiti Dam quadrangle, the upper Cochiti Formation contains primary and reworked tephra-fall beds dated at 1.87 ±0.01 and 1.84 ±0.02 Ma by $^{40}Ar/^{39}Ar$ (W. McIntosh, *personal communication*, February 1997) and correlated, by visual comparison, to the San Diego Canyon A and B ignimbrites. In the Cañada quadrangle, lower Pleistocene Bandelier Tuff is present within the uppermost Cochiti Formation. The Cochiti Formation is interbedded with unit *QTslg*. Outcrops in the northern and western part of Santo Domingo Pueblo SW quadrangle are primarily gravel and pebbly sand. The formation becomes finer grained toward the central and south - central part of the quadrangle, where it is principally sand and silt with uncommon tabular gravel beds, generally less than 1.5 m thick. Clasts consist of Keres Group volcanic rocks. In the northern part of the quadrangle there is a distinct upward increase in the abundance of devitrified and altered rhyolite at the expense of vitric rhyolite; rhyolite fragments are primarily derived from the Bearhead Rhyolite. Western outcrops include pebbles of obsidian and altered pumice believed to be derived from the Canovas Canyon and Bearhead Rhyolites. At the highest stratigraphic levels near the western margin of the quadrangle, nonvolcanic quartz and feldspar comprise ~10% of the sand. Western outcrops of Cochiti Formation are derived from middle Miocene Santa Fe Group outcrops within and west of the Cañada de Cochiti fault zone. These older sedimentary strata record the intercalation of early Keres Group volcaniclastic aprons from the north with alluvium derived from the east slope of the Nacimiento Mountains farther west. The western outcrops of the Cochiti Formation record the recycling of this earlier sedimentary sequence into the subsiding Santo Domingo basin.

Tglp — **Gravel of Lookout Park (upper Pliocene) —** Cobble to boulder gravel, composed mostly of Keres Group andesite and rhyolite clasts, 5-15 m thick, disconformably overlying Cochiti Formation. Over most of the quadrangle, this gravel deposit rests on a broad pediment surface but, in outcrops in lower Borrego Canyon and south of lower Santo Domingo Canyon is slightly inset into older deposits. Is inset below basalt of Santa Ana Mesa (Tb_2) dated at 2.41 ±0.03 and underlies lower Bandelier Tuff (1.61 Ma) indicating deposition during a short period of the late Pliocene. Remants 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 in which a new soil has formed with a stage II- stage III calcic horizon evident in various places.

Volcanic Rocks

Qbo — **Bandelier Tuff, Otowi Member and Guaje Pumice (Lower Pleistocene) —** Silver gray pumice-lapilli fall deposit (1.2-1.8 m thick) overlain by as much as 15 m of erosionally truncated, white to pink nonwelded ignimbrite containing pumice bombs to 50 cm. In the Santo Domingo Pueblo SW quadrangle, Bandelier Tuff rests unconformably on gravel of Lookout Park (*Tglp*), occupying shallow channels incised into the gravel or resting on a paleosol developed in eolian sand resting on the gravel.

Tb — **Olivine basalt (Pliocene), Santo Domingo Pueblo Quadrangle —** Olivine basalt within Sierra Ladrones Formation in Peña Blanca – Cochiti Dam area. Two lava flows are present along the *Santa Fe River* downstream from Cochiti Dam but only the lower of these flows is present elsewhere. These lavas overlie and are separated by hydromagmatic tuff (unit *Tbt*) that is too thin to map separately. Probable source of lava flows was a low spatter cone or shield cone that was located near the *Santa Fe River* but was destroyed and buried during the construction of Cochiti Dam (Smith, *et al.*, 1997). Sample collected above the *Santa Fe River* provided a $^{40}Ar/^{39}Ar$ date of 2.71 ±0.04 Ma (W. McIntosh, *personal communication*, October 1996). Texturally similar basalt was recovered as cuttings from the BIA Santa Cruz Springs well (cross-section A-A') but these latter flows were likely erupted northeast of the quadrangle and overlie lava flows dated at 2.57 ±0.03 to 2.67 ±0.06 Ma (W. McIntosh, *personal communication*, October 1997).

Olivine basalt (Pliocene), Santo Domingo Pueblo SW Quadrangle – Tb / Tbv - Olivine basalt (Pliocene) — Basaltic lava flows (*Tb*) of the San Felipe volcanic field, forming the top of Santa Ana Mesa in the southwest corner of the quadrangle. Vent - proximal spatter and scoria (*Tbv*) are prominent near vents, which are marked by asterisks. Relative age relationships of the three lava flow sequences that were mapped are ambiguous on the basis of reconnaissance field observations.

Tb_3 — **Tb_3 –** Poorly exposed basalt, probably only 1 flow, with sparse olivine and plagioclase phenocrysts to 3 mm, erupted from vents south of the quadrangle.

Tb_2 / Tbv_2 — **Tb_2 / Tbv_2 –** A single, inflated basalt flow, generally 4-6 m thick but thickening toward source, erupted from the northernmost volcano on Santa Ana Mesa, which is marked by a pyroclastic cone of spatter and cinder (Tbv_2). Overlies hydromagmatic tuff (*Tbt*). Lava flow overlies and is inset against older lava of Tb_1 where it was eroded by the ancestral *Rio Grande*. Consists of ~20-25% iddingsitized olivine phenocrysts (to 3.0 mm) and glomerphenocrysts (to 5.0 mm) in a coarse grained intergranular groundmass of plagioclase, clinopyroxene and oxide minerals. $^{40}Ar/^{39}Ar$ plateau age of 2.41 ±0.03 Ma (W. McIntosh, *written communication*, April 1998).

Tb_1 / Tbv_1 — **Tb_1 / Tbv_1 –** Sequence of 1-4(?) lava flows, more than 15 m thick, erupted from a linear chain of low shield volcanoes and eroded cinder cones (Tbv_1). Eroded eastern margin is associated with scattered quartzite pebbles indicating a former course of the *Rio Grande* following the eruption of the lava flows. Consists of 10% olivine phenocrysts (1-3 mm) and 20% plagioclase phenocrysts (0.6-1 mm), including olivine+plagioclase glomerphenocrysts to 5.0 mm across, in a fine grained intergranular groundmass of plagioclase, clinopyroxene, and oxide minerals. Distinguished from Tbv_2 by greater abundance of plagioclase and lower abundance of olivine, which are also reflected geochemically by higher CaO and lower MgO. $^{40}Ar/^{39}Ar$ plateau age of 2.62 ±0.15 Ma (W. McIntosh, *written communication*, July 1998).

Tbt — **Basaltic tuff (Pliocene)—** Bedded, hydromagmatic tuffs forming tuff rings centered below Cochiti Dam between the *Rio Grande* and Cañada de Cochiti (Smith, *et al.*, 1997). Deposits dominated by ash size sideromelane tephra and comminuted basin-fill sediment. Clasts of rounded quartzite, granitic rocks, and volcanic rocks derived from underlying *QTslg* are common. Accretionary lapilli are sparsely present. Sandwave crossbedding is prominent in most outcrops, but is most well developed in the outcrops along Cañada de Cochiti. Thin, planar-bedded tuff exposed east of N.M. Highway 22, 1.5 mi. northeast of Santo Domingo Pueblo is thought to correlate to tuff exposed in Peña Blanca – Cochiti Dam area.

Th — **Hawaiite (Pliocene) —** Sparsely porphyritic hawaiite lava flow mapped along margin of the La Bajada escarpment by Aubele (1978). Texturally similar lava flows were encountered in the BIA Santa Cruz Springs well at depths below 630' (192 m). Cuttings from these flows yielded ages of 2.57 ±0.03 to 2.67 ±0.06 Ma (W. McIntosh, *personal communication*, October 1997).

Tbp — **Bearhead Rhyolite, Peralta Tuff Member (upper Miocene) —** Sparsely porphyritic (quartz+sanidine+biotite) rhyolitic tuff, lapilli tuff and gravel notably rich in glassy rhyolite. Interbedded with *QTsl* in NE corner of quadrangle and is present beneath *QTc* in the footwall of the Camada fault at the northern edge of the quadrangle; approximately 50 m of section exposed. Dated tuff layers within the quadrangle range from 6.81 ±0.02 to 6.88 ±0.01. Known thickness exceeds 500 m in the Canada quadrangle, where dates range between ~7.0 and 6.75 Ma.

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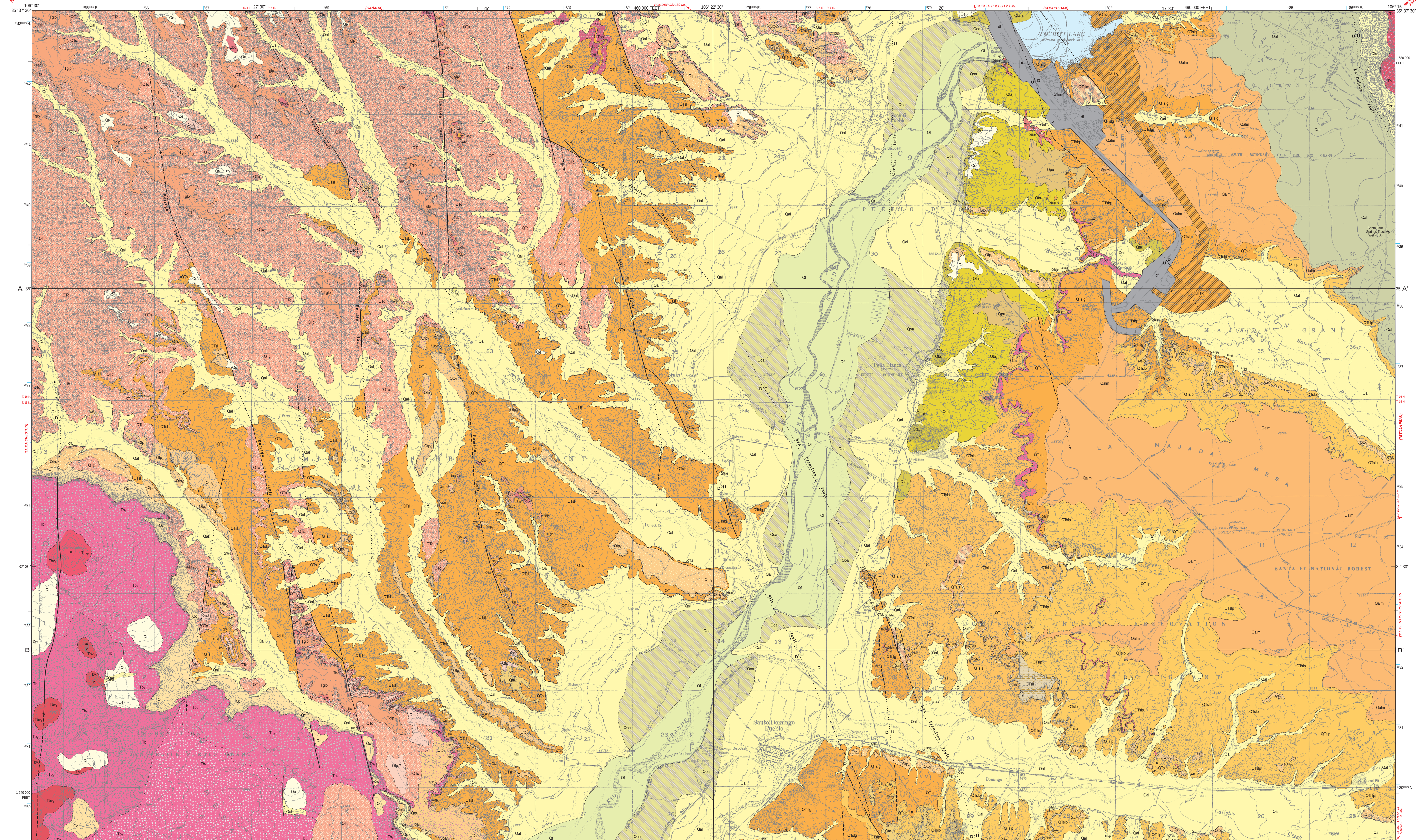
SANTO DOMINGO PUEBLO SW QUADRANGLE / SANTO DOMINGO PUEBLO QUADRANGLE
NEW MEXICO



Base from U.S. Geological Survey 1953, photorevised 1993
1927 North American datum, Projection and10,000-foot grid based on New Mexico coordinate system, cental zone (Transverse Mercator)
1000-meter Universal Transverse Mercator grid ticks, zone 13, shown in blue

D. J. McCraw and P. Brown: digital cartographic production

SCALE 1:24,000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

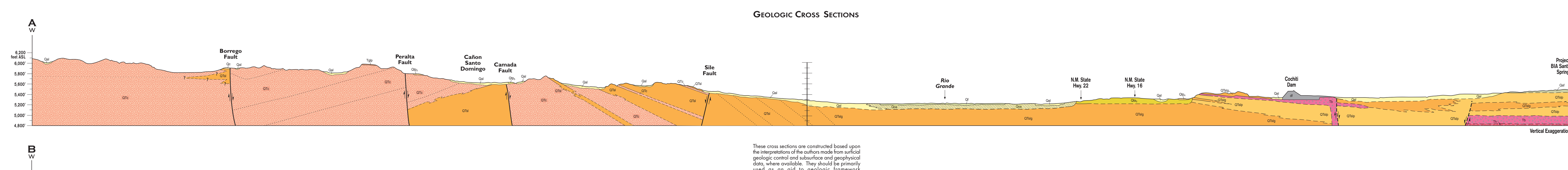
UTM GRID AND 1993 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

QUADRANGLE LOCATION

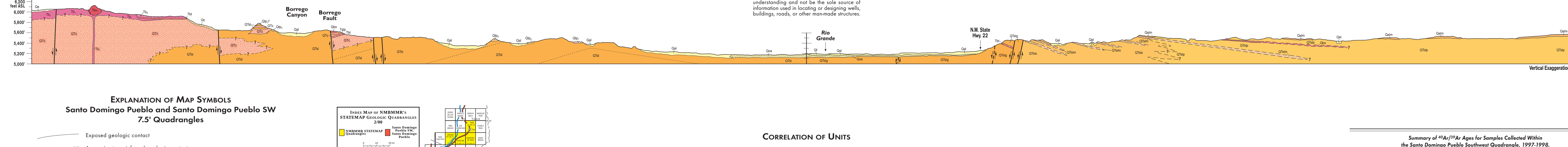
Base from U.S. Geological Survey 1953, photorevised 1993
1927 North American datum, Projection and10,000-foot grid based on New Mexico coordinate system, cental zone (Transverse Mercator)
1000-meter Universal Transverse Mercator grid ticks, zone 13, shown in blue

D. J. McCraw and G. E. Jones: digital cartographic production

Geologic Cross Sections

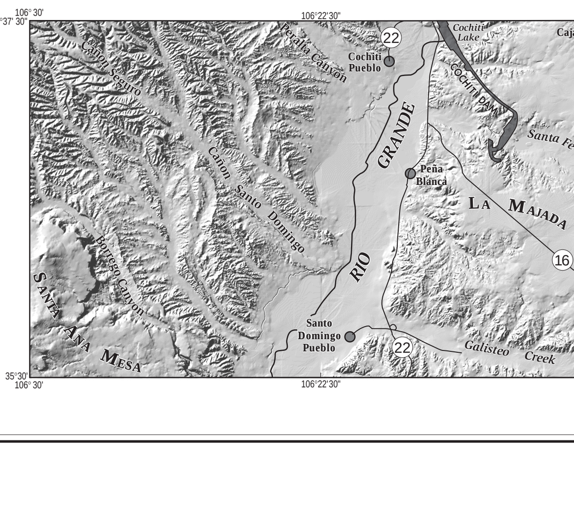


These cross sections are constructed based upon the interpretations of the authors made from surficial geologic control and subsurface and geophysical data, where available. They should be primarily used as an aid to geologic framework understanding and not be the sole source of information used in locating or designing wells, buildings, roads, or other man-made structures.

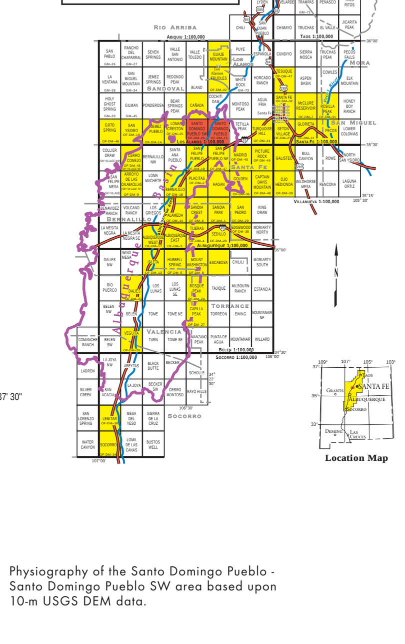


Explanation of Map Symbols
Santo Domingo Pueblo and Santo Domingo Pueblo SW 7.5' Quadrangles

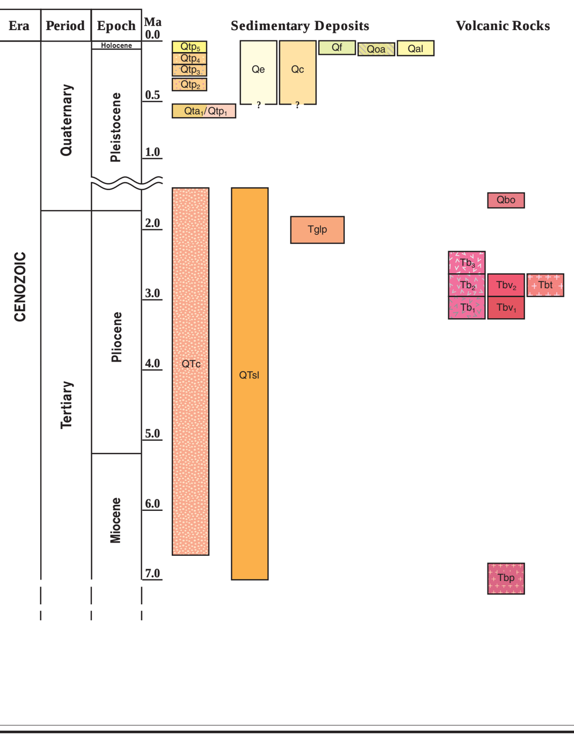
- Exposed geologic contact
- Approximate or inferred geologic contact
- High-angle normal fault, tick showing dip, bar and ball indicates downthrown side
- Normal fault, approximately located on the basis of outcrops, bar and ball indicates downthrown side
- Normal fault, approximately located on the basis of well logs, D indicates downthrown side
- Concealed normal fault, D indicates downthrown side
- Strike and dip of bedding
- P — **Peralta Tuff Member biotite - rhyolite pumice lapilli (upper Miocene)** abundant in fluvial sediment.
- T — **Tschicoma Formation dacite pumice lapilli (Pliocene)** abundant in fluvial sediment.
- B — **Bandelier Tuff rhyolite pumice lapilli (lower Pleistocene)** abundant in fluvial sediment.
- © — Prominent zone of calcite cementation. Generally located along exposed fault planes or in coarse-grained beds in close proximity to faults.
- ✱ — Approximate positions of vents from which units *Tb* and *Tbt* were erupted
- X — Location of $^{40}Ar/^{39}Ar$ geochronology samples

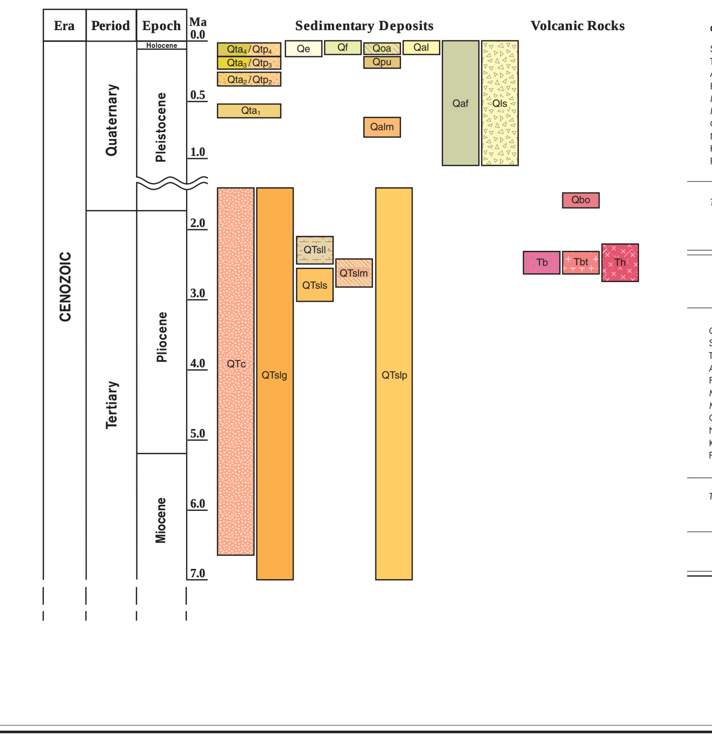


Physiography of the Santo Domingo Pueblo - Santo Domingo Pueblo SW area based upon 10-m USGS DEM data.



Correlation of Units





Chemical Analysis of Tb Samples Collected Within the Santo Domingo Pueblo Southwest Quadrangle, 1997-1998.

Oxide Component	Map Unit (Sample No.) Tb_1 (SD376) Percentage	Tb_2 (SD311) Percentage
SiO_2	51.25	51.16
TiO_2	1.46	1.47
Al_2O_3	15.98	15.89
Fe_2O_3	10.58	10.60
MnO	0.16	0.17
MgO	5.87	6.75
CaO	9.10	8.51
Na_2O	3.49	3.70
K_2O	1.12	1.45
P_2O_5	0.28	0.37
Total	99.29	100.07

Chemical Analysis of Tb Sample Collected Within the Santo Domingo Pueblo Quadrangle, 1996-1997.

Oxide Component	Percentage
SiO_2	48.57
TiO_2	1.47
Al_2O_3	15.61
Fe_2O_3	10.73
MnO	0.19
MgO	7.82
CaO	10.32
Na_2O	3.04
K_2O	1.38
P_2O_5	0.52
Total	99.63

Major-element XRF analyses by J. Husler, University of New Mexico

Summary of $^{40}Ar/^{39}Ar$ Ages for Samples Collected Within the Santo Domingo Pueblo Southwest Quadrangle, 1997-1998.

Map No.	Sample No.	Location (UTM)	Description	Age (Ma)
	Groundmass Concentrate:			
1	GSSD367	64943174	Basalt; thin flow intercalated within near-vent agglutinate (Tbv_1) on Santa Ana Mesa	2.62 ± 0.15
2	GSSD311	70863049	Olivine basalt (Tbv_2); lava flow overlying hydromagmatic tuff north of Borrego Canyon	2.41 ± 0.03
	Sanidine:			
3	GSCP9601	74453744	Rhyolite pumice, reworked; collected within axial quartzite-rich gravel of the Sierra Ladrones formation (*QTsl*) northwest of Sile; correlative to pyroclastic deposits in Peralta Tuff	6.82 ± 0.04
4	GSCP9603	73924242	Rhyolite tephra, perhaps slightly reworked, collected within axial quartzite-rich gravel of the Sierra Ladrones formation (*QTsl*) west of Cochiti Pueblo; correlative to pyroclastic deposits in Peralta Tuff	6.88 ± 0.01
5	GSCP9615	73564277	Crystal-poor rhyolite fallout tephra (cemented) collected from Peralta Tuff member of the Bearhead Rhyolite (*Tbp*) in an outcrop area southwest of Peralta Canyon where Peralta Tuff is interbedded with axial gravel of the Sierra Ladrones formation (*QTsl*).	6.81 ± 0.02
6	GSCP9623	70704304	Ignimbrite collected from Peralta Tuff member of the Bearhead Rhyolite (*Tbp*) south of Peralta Canyon	6.84 ± 0.06

Summary of $^{40}Ar/^{39}Ar$ Ages for Samples Collected Within the Santo Domingo Pueblo Quadrangle, 1996-1997.

Map No.	Sample No.	Location	Description	Age (Ma)
	Sanidine:			
1	GSCP9605	35.590°N 106.293°W	Reworked pumiceous ash collected within axial quartzite-rich gravel just east of the south abutment of Cochiti Dam; most probably reworked lower Bandelier Tuff	1.62 ± 0.01
	Whole Rock:			
2*	DN9615	35.588°N 106.303°W	Lower of two basalt flows interbedded with Sierra Ladrones formation (*QTsl*) near Cochiti Spring in the Santa Fe River valley downstream of Cochiti Dam	2.71± 0.04
3	SCST640-650	35.592°N 106.251°W	Hawaiite (?) lava flow sample collected from cuttings at 640-650' in the BIA Santa Cruz Springs Tract well	2.67± 0.06
4	SCST720-730	35.592°N 106.251°W	Hawaiite (?) lava flow sample collected from cuttings at 720-730' in the BIA Santa Cruz Springs Tract well	2.57 ± 0.03
5	SCST850-860	35.592°N 106.251°W	Hawaiite (?) lava flow sample collected from cuttings at 850-860' in the BIA Santa Cruz Springs Tract well	2.57 ± 0.02

* Collected by Dr. David P. Dethier
All $^{40}Ar/^{39}Ar$ age determinations provided by Dr. William C. McIntosh, New Mexico Geochronology Research Laboratory, New Mexico Institute of Mining and Technology, Socorro, NM