Bernalillo 7.5" quadrangle
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GEOLOGY OF THE BERNALILLO 7.5-MINUTE QUADRANGLE, SANDOVAL COUNTY, NEW MEXICO

By

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May 1998

Printed August 27, 1998

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INTRODUCTION

The Bernalillo 7.5-minute quadrangle comprises an area of about 158 km^2 (61 mi^2) along Rio Grande Valley in Sandoval County, New Mexico. The study area encompasses portions of the City of Rio Rancho, Town of Bernalillo and the Pueblos of Sandia and Santa Ana. The study area also traverses the southern margin of the San Felipe graben, part of an intrabasinal boundary that separates the northern Albuquerque (Calabacillas basin of Hawley, 1996) and Santo Domingo sub-basins. Early work in the study area and vicinity involved regional reconnaissance studies of the Albuquerque Basin and Sandia Mountains (Herrick and Johnson, 1900; Soister, 1952; and Stearns, 1953; Hoge, 1970; Smith and others, 1970). Later studies of the basin-fill deposits east of Albuquerque were conducted by Bryan and McCann (1937) in the Rio Puerco Valley, southwest of the study area. They divided the Santa Fe Group into lower gray, middle red and upper buff units. Lambert (1968) and Spiegel (1961) extended these stratigraphic concepts into the Rio Grande Valley and delineated and named several Quaternary deposits that unconformably overlie the Santa Fe Group. Kelley (1977) summarized much of the Albuquerque Basin stratigraphy and structural geology; however, no detailed geologic mapping of the study area had been attempted at a scale of 1:24,000. Recent studies of the hydrogeology of the Albuquerque Basin (Hawley and Haase, 1992; Hawley and others, 1995; Hawley, 1996) primarily involved studies of subsurface data gathered from drilling records, cuttings, and borehole geophysical logs. Recent geologic mapping of the study area involved delineation of post-Santa Fe Group deposits east of the Rio Grande (Connell, 1996). The geologic map (Plate I) and cross sections (Plate II) are the result of field reconnaissance mapping and incorporation of borehole data that has refined the structure and stratigraphy of this part of the southern margin of the Santo Domingo Basin. Much of the study area west of the Rio Grande is covered by a thin (generally less than 2- to 5-m thick) veneer of fine-to medium-grained sand with scattered gravel that obscures many outcrop relationships. In areas with nearly continuous cover by these sandy deposits, aerial photography was relied upon to delineate several geologic contacts.

The topographic base for the geologic map is the Bernalillo quadrangle, 7.5-minute topographic series, published by the United States Geological Survey at a scale of 1:24,000 (one inch equals 2000 feet). Development of gravel pits and a municipal landfill along the western margin of the quadrangle and residential development within the Cities of Rio Rancho and Bernalillo has obscured many exposures, making stratigraphic relations unclear in developed areas.

Principal contributions and revisions to previous work include refinement of Spiegel’s (1961) mapping, radiometric dates for tephras within the Santa Fe Group (Table 1), limited incorporation of subsurface data from numerous water-supply wells (Table 2), and differentiation of facies within the Sierra Ladrones Formation. The middle red formation (Spiegel, 1961) has been reassigned to the Santa Ana Mesa member (modified after Soister, 1952).

COMMENTS TO MAP USERS

Mapping of this quadrangle was funded by a matching-funds grant from the 1998 STATEMAP program of the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number 1434-HQ-97-AG-01781, to the New Mexico Bureau of Mines and Mineral Resources (Dr. Charles E. Chapin, Director; Dr. Paul W. Bauer, P.I. and Geologic Mapping Program Manager).

This quadrangle map has been Open-Filed in order to make it available as soon as possible. The map has not been reviewed according to NMBMMR standards, and due to the ongoing nature of work in the area, revision of this map is likely. As such, dates of revision are listed in the upper right corner of the map and on the accompanying report. ***The contents of the report and map should not be considered final and complete until it is published by the NMBMMR.***

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 such as faults and folds. Geologic contacts are irregular surfaces that form boundaries between different types or ages of units. Data depicted on this geologic map are based on 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. Significant portions of the study area may have been mapped at scales smaller than the final map; therefore, the user should be aware of potentially significant variations in map detail. 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 everywhere.

Any enlargement of this map could cause misunderstanding in the detail of mapping and may result in erroneous interpretations. The information provided on this map cannot be substituted for site-specific geologic, hydrogeologic, or geotechnical investigations. The use of this map to precisely locate buildings relative to the geological substrate is not recommended without site-specific studies conducted by qualified earth-science professionals.

The cross-sections in this report are constructed based on surficial geology, and where available, subsurface and geophysical data. The cross sections are interpretive and should be used as an aid to understand the geologic framework and not used as the sole source of data in locating or designing wells, buildings, roads, or other structures.

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 U.S. Government.

DESCRIPTION OF MAP UNITS

Post-Santa Fe Group Deposits (Quaternary System)

Quaternary surficial deposits are a mixture of poorly to moderately consolidated, poorly to well sorted gravel, sand and silt, deposited by perennial and ephemeral streams, debris flow, wind, and mass movement processes. Correlations of mapped units are illustrated on Figure 1. Alluvial deposits unconformably overlie basin-fill deposits of the Santa Fe Group and are divided into three major classes:

Valley-fill alluvium of the ancestral Rio Grande (QHvr and Qvr subunits) — Stream (floodplain and channel) deposits that are restricted to former and current positions of the Rio Grande.

Valley-fill and Valley-border alluvium (QHva, Qvy, and Qvm subunits) — Stream (floodplain and arroyo-terrace) and fan deposits restricted to major entrenched tributary valleys, such as Sandia Wash, Arroyo Barranca, and Arroyo Venada.

Piedmont-slope alluvium (Qpy, Qpm, and Qpo subunits) — Alluvial deposits on constructional and erosional parts of piedmont slopes associated with drainages originating from the Sandia Mountains. Units include coalescent piedmont-fan and alluvial-slope deposits, debris-flow deposits and shallow-valley fills that are not graded to major entrenched arroyo systems.

Valley-floor and valley-border alluvium

Valley-fill and valley-border deposits unconformably overlie fluvial deposits of the Santa Fe Group basin fill sequence. Deposits are primarily light gray-brown, brown, yellowish-brown and reddish-brown (5 to 10YR hues) sand, gravelly sand, and gravel with minor silt and clay. Clast lithology is variable and reflects the character of local (recycled basin fill and basin-margin rocks) and distant (extrabasinal) source terrains. Clasts along the eastern margin of the study area are dominated by subangular to subrounded granite and schist, with rare subrouned limestone derived from drainages that originate along the western front of the Sandia Mountains. Deposits associated with the modern (floodplain and channel) and former valley floors (fluvial terraces) of the Rio Grande Valley are primarily composed of subrounded quartzite and welded tuff with subordinate granite and basalt. Deposits along the western margin of the study area contain subangular to subrounded clasts of red granite, basalt, and light-gray tuff with subordinate sandstone and chert recycled from hillslopes underlain by basin fill of the Santa Fe Group.

Alluvium of the Rio Grande

QHvrg Stream alluvium (historic) — Unconsolidated sand and gravel within the active channel of the Rio Grande. Locally divided into two floodplain units on the basis aerial photographic shading and vegetation.

QHvrfp Stream and floodplain alluvium (historic) — Unconsolidated coarse-grained sand and pebbly sand with subordinate lensoidal interbeds of fine-grained sand, silt and clay. Locally divided into younger (**QHvrfp$_2$**) and older (**QHvrfp$_1$**) on the basis of inset relationships determined from aerial photography.

Qvrg Stream and floodplain alluvium, undivided (uppermost Pleistocene through historic) — Unconsolidated fine-to medium-grained sand, and gravel with silt and clay lenses Unit is up to 20- to 24-m thick and forms the alluvium of underlying the inner valley of the Rio Grande. Unit is shown in cross section only (Plate II).

Qvry Young stream alluvium (upper Pleistocene) — Poorly consolidated deposits of sandy pebble to cobble gravel recognized along the northwester margin of the Rio Grande Valley. Clasts are primarily rounded quartzite and volcanic rocks (commonly welded tuff with minor pumice). Soil development is very weak with stage I carbonate morphology. The base is approximately 15 m above the Rio Grande floodplain. Unit is approximately 3 to 6 m thick.

Qvrm Alluvium of Menaul Blvd. (upper Pleistocene) — Poorly consolidated deposits of yellowish-brown pebble conglomerate and pebbly sand derived from the ancestral Rio Grande. Clasts are dominated by rounded quartzite that are generally smaller in size than clasts associated with Qvre. Forms discontinuous exposures east of the inner valley escarpment of the Rio Grande. The base is approximately 26- to 36-m above Rio Grande floodplain and buries unit Qvre. Soils associated with piedmont alluvial overlying this unit are weakly developed with stage II carbonate morphology (see Connell, 1996). This is an informal term named by Lambert (1968) for exposures along Menaul Boulevard. Thickness is generally less than 3 m.

Qvre Alluvium of Edith Blvd. (middle Pleistocene) — Poorly consolidated deposits of pale-brown to yellowish-brown conglomerate, sand and sandy clay derived from the ancestral Rio Grande. Forms a upward fining sequence consisting of a basal quartzite-rich, cobble conglomerate that grades up-section into a yellowish-brown sand, and reddish-brown silty clay. Clasts of welded Bandelier Tuff are locally recognized. Unit unconformably overlies the Sierra Ladrones Formation and is overlain by Qpm. Forms extensive outcrops along the inner valley escarpment of the Rio Grande. The base is approximately 12- to 24-m above the floodplain of the Rio Grande. This is an informal term defined by Lambert (1968) for exposures along Edith Boulevard. Lambert (1968) and Lucas and others, (1984 and 1988) report Rancholabrean fossils (notably, *Bison*) and assign the Edith alluvium to the late Pleistocene. However, moderately developed soils on unit Qpm, which conformably overlies unit Qvre, (see Connell, 1996; 1997) suggest that Qvre is much older than Qvry. The stratigraphic range of *Bison* and the Rancholabrean land mammal age extend into the middle Pleistocene in the northern Great Plains (Wayne and others, 1991, p.458-459), therefore, Qvre is interpreted to be middle Pleistocene in age. Thickness is variable and ranges from 3.3 to 12 m.

Qvro Older stream alluvium (middle Pleistocene) — Moderately well consolidated deposits of sandy pebble to cobble gravel primarily composed of subrouned to rounded quartzite, welded tuff and granite with subordinate basalt. The base is not exposed; the top is approximately 70 to 75 m above the Rio Grande floodplain. Correlative deposits to the south underlie the Albuquerque Volcanoes basalt (approximately 156 ka, Peate and others, 1996). Thickness is generally less than 5 m.

Valley-floor and valley-border alluvium

QHva Stream and piedmont alluvium, undivided (Holocene to historic) — Unconsolidated deposits of brown, light gray-brown, and yellowish-brown sand, sandy clay loam and gravel. Inset against Qvy and grades to the floodplain of the Rio Grande. Weakly developed soils exhibit trace accumulations of pedogenic carbonate and stage I carbonate morphology at depth. Unit commonly forms coalescent alluvial fans along valley margins. Unit is locally subdivided on the basis of inset relations and deposit lithology. Thickness is generally less than 10 m.

$QHva_1$ Stream and piedmont alluvium (Holocene to historic) — Unit is locally differentiated where cut by $QHva_2$.

$QHva_2$ Stream and piedmont alluvium (Holocene to historic) — Unit is locally differentiated where inset $QHva_1$.

Qvy Stream alluvium, undivided (uppermost Pleistocene through Holocene) — Poorly consolidated deposits of very pale-brown to light-brown (7.5-10YR) sand to sandy clay loam and gravel. Inset against Qpm. Distal margin is truncated by an fluvial escarpment of the Rio Grande. Slightly dissected surface possesses well-developed constructional bar-and-swale topography. Weakly developed soils exhibit stage II carbonate morphology and minor clay film development. Estimated thickness is less than 21 m. Associated with broad valley fill units within modern stream valleys that grade west to the floodplain of the Rio Grande.

Qvm Stream alluvium, undivided (middle Pleistocene) — Poorly consolidated deposits of light reddish-brown sand to sandy clay loam and gravel. Inset against Qvo. Surface is dissected, soil development is variable and possesses stage II to III carbonate morphology. Delineated west of the Rio Grande, where deposits are associated with broad valley fill units that grade east to the alluvium of Edith Boulevard (Qvre). Estimated thickness is generally less than 15 m.

Qvo Stream alluvium, undivided (middle Pleistocene) — Poorly consolidated deposits of light reddish-brown sand with pebble to cobble gravel interbeds primarily composed of red granite, chert and basalt recycled from the Ceja Member. Unit is poorly exposed and commonly capped by ≤2 m thick veneer of unit Qae. Soil development is variable and possesses stage I to III carbonate morphology. Associated with broad valley fill units that grade east to the unit Qvro. Estimated thickness is generally less than 15 m.

Piedmont-slope deposits

Qpyo Stream alluvium, undivided (upper Pleistocene) — Poorly consolidated deposits of very pale-brown to strong yellowish-brown (7.5-10YR), stratified, poorly sorted silty clay and loamy sand and gravel. Slightly to moderately dissected surface that possesses subdued constructional bar-and-swale topography. Soils are moderately developed and characterized by stage II carbonate morphology. Alluvium unconformably overlies Qvrm and forms buttress unconformity against Santa Fe Group deposits. Estimated thickness is 36 m.

Qpm Piedmont alluvium (middle Pleistocene) — Moderately consolidated deposits of light- to strong-brown (7.5YR) and very pale-brown to light-gray (7.5-10YR) sand and gravel with minor silt and clay interbeds. Forms dissected surface possessing subdued ridge-and-ravine topography. Subdued bar-and-swale constructional topography is locally preserved on stable interfluves. Moderately well developed soils with stage III carbonate morphology and many moderately thick clay films. Estimated thickness is at least 15 m.

Qpo Old piedmont alluvium (middle to lower(?) Pleistocene) — Moderately consolidated deposits of yellowish-brown (10YR), poorly sorted, subangular to subrounded sand and conglomerate. Surface possesses erosional ridge-and-ravine topography. Surface is locally recognized by stripped soil locally possessing stage IV carbonate morphology. Differentiated into three subunits on the basis of stratigraphic position and soil-profile development.

Qpo5 Pediment alluvium (middle Pleistocene) — Moderately consolidated deposits of pale- to dark-brown (7.5-10YR) clay loam to silty clay loam and cobble to boulder conglomerate. Clasts are dominated by limestone and metamorphic rocks. Unit forms broad, northwest-sloping surface covered by a relatively thin conglomeratic veneer inset against Qpo2. The deposit is slightly dissected, exhibits subdued bar-and-swale topography and thickens to the northwest. Soils are moderately developed and exhibit weak stage III carbonate morphology and many to continuous, thick clay films.

Qpo4 Pediment alluvium (middle Pleistocene) — Moderately consolidated deposits of pale- to dark-brown (7.5-10YR) clay loam to silty clay loam and cobble to boulder conglomerate. Clasts are primarily composed of limestone and metamorphic rocks. Unit forms broad, northwest-sloping surface covered by a relatively thin conglomeratic veneer inset against Qpo2. The deposit is slightly dissected, exhibits subdued bar-and-swale topography and thickens to the northwest. Soils are moderately developed and exhibit weak stage III carbonate morphology and many to continuous, thick clay films

Qpo2 Pediment alluvium (middle to lower(?) Pleistocene) — Moderately consolidated deposits of brown, very pale-brown to white (7.5YR - 2.5Y) sandy loam, sand and subrounded to subangular cobble to pebble conglomerate overlying remnants of extensive, relatively smooth, northwest-sloping surface that caps the top of the Sierra Ladrones Formation. Deposit surface is moderately dissected and sits about 34 to 50 m above local base level. Soils exhibit stage III+ carbonate morphology and very few, thin clay films. Deposit is less than 5 m thick.

Qp Piedmont alluvium (lower Pleistocene to Holocene) — Undivided piedmont and valley-border alluvium. Shown in cross section only (Plate II).

Artificial fill, colluvial and eolian deposits

af Artificial fill (Historic) — Dumped fill and areas effected by human disturbances. Mapped where deposits are areally extensive. Unit not mapped everywhere on quadrangle.

daf Disturbed areas and artificial fill, undivided (Historic) — Dumped fill and areas effected by human disturbances, including gravel quarry sites. Mapped where disturbance is areally extensive. Unit not mapped everywhere on quadrangle.

Qae Eolian and alluvial deposits, undivided (Holocene) — Poorly consolidated light reddish-brown to light-brown, fine-to-medium-grained sand and silty sand with scattered pebbles that commonly form a relatively thin ($\leq$5 m thick) discontinuous mantle over upland areas west of the Rio Grande. Mapped where areally extensive. Unit not mapped everywhere.

Qe Eolian deposits (Holocene) — Light yellowish-brown, fine-to medium-grained sand primarily recognized in narrow, elongate zones along the western flank of the Rio Grande and major arroyos west of the Rio Grande. Surface is locally stabilized by vegetation. Soil development is very weak to nonexistent.

Qcb Basaltic colluvium (Holocene through upper Pleistocene) — Poorly consolidated and sorted breccia composed of angular to subangular basalt boulders derived from mesa-capping basalt along the southeastern margin of Santa Ana Mesa. Estimated thickness is less than 5 m.

Qls Landslide deposits (upper through middle Pleistocene) — Well consolidated and partially rotated (Toreva) blocks of gravity-transported basalt and Sierra Ladrones Formation strata. Unit is recognized by surface morphology and exhibits a hummocky surface bowl-shaped closed depressions at the head (top) of the unit. Two distinct generations of mass movement are recognized by nesting of bowl-shaped heads. Unit was deposited during slope instability followed by local steepening of slopes during encroachment of the Rio Grande Valley on the margin of Santa Ana Mesa. Arrows indicate direction of movement.

Basin-Fill Deposits of the
Santa Fe Group (Quaternary and Tertiary Systems)

The Santa Fe Group comprises the syntectonic sedimentary fill and associated volcanic rocks of basins within the Rio Grande rift of central Colorado, New Mexico and northern Chihuahua (Bryan, 1938; Chapin and Cather, 1994). The Santa Fe Group consists of axial-fluvial and piedmont-slope related to deposition within the Santo Domingo Basin prior to widespread valley incision. The Santa Fe Group is divided into the Sierra Ladrones Formation (Machette, 1978; Hawley, 1996), and middle red formation (Lambert, 1968, Spiegel, 1961) and Cochiti Formation (Manley, 1978). The Sierra Ladrones Formation is the uppermost unit of the Santa Fe Group and contains coarse-grained sand and gravel deposited by thoroughgoing perennial streams of the ancestral Rio Grande fluvial system.

Sierra Ladrones Formation (upper Miocene to middle(?) Pleistocene) — Thick sequence of horizontal to subhorizontally stratified fluvial sand and gravelly sand with minor silt and clay that represents the upper portion of the Santa Fe Group. Smith and Kuhle (1998) report that axial-fluvial deposits related to the ancestral Rio Grande system are as old as 7 Ma. The Sierra Ladrones Formation is subdivided into upper unnamed members: axial-fluvial, piedmont and transitional facies, and two lower members: the Ceja Member and the Santa Ana Mesa member. The Santa Ana Mesa member is a new term introduced in this report.

QTsa Axial-fluvial deposits — Light-gray to yellowish-brown horizontal to subhorizontally stratified sand and gravelly sand recognized east of the Rio Grande. Sand is typically crossbedded. Clasts are dominated by quartzite and volcanic rocks (welded tuff and porphyritic subvolcanic rocks) with subordinate granite, basalt, and chert. Mudstone is rare; sandstone is typically crossbedded. Bedding is generally subhorizontal but exhibits moderate dips near faults. Clasts of the Otowi Member of the Bandelier Tuff are locally recognized. The base is not exposed, however, Smith and Kuhle (1998) report axial-fluvial deposits associated with late Miocene phreatomagmatic deposits to the north.

QTst Transitional axial-piedmont deposits — Interfingering axial river deposits (QTsa) and piedmont deposits (QTsp). Transitional deposits are defined as the zone of overlap between the *easternmost* outcrops of axial river deposits and the *westernmost* outcrops of piedmont sandstone and conglomerate.

QTsp Piedmont deposits — Subhorizontally stratified sandstone with subordinate siltstone and moderately to poorly sorted, pebble conglomerate; mudstone is rare. Clasts are primarily composed of limestone, schist and granite with subordinate sandstone. Unit is recognized along the eastern margin of the quadrangle.

Tsc Ceja Member — Slightly tilted, stratified sand and pebbly sand with minor silt and clay. Clasts are dominated by subangular to subrounded red granite, light-gray tuff, and basalt with subordinate chert, sandstone and minor quartzite. Recognized by fairly abrupt increase in gravel content. Kelley (1977) used this term for coarse-grained gravel and sand recognized along the eastern margin of the Rio Puerco Valley. The name Ceja Member is expanded here to include all deposits having a western and northwestern provenance. Unit conformably overlies, and may interfinger with, the Santa Ana Mesa member (Tsa).

Tsa Santa Ana Mesa member (upper Miocene to Pliocene) — Sequence of yellowish-brown to yellowish-red, fine-grained silty sand and clay. Well cemented and weakly cemented sandstone lenses and scattered cobbly to bouldery gravel lenses composed of subrounded, light-gray tuff and basalt. Interfingers with QTsa to the east. Base is not exposed but is at least 425 m thick in borings (Table 2). This unit is named after a sequence of reddish-brown argillaceous to arkosic sandstone, siltstone, and claystone with granule to pebble conglomerate underlying the southern margin of Santa Ana Mesa (Soister (1952, p.38-43). The term Santa Ana member has been formally defined for a limestone bed of the Maravillas Formation of Puerto Rico (Glover, 1961); therefore, the term Santa Ana Mesa member is used to avoid introducing a synonymous stratigraphic term. Spiegel (1961) assigned these strata to the middle red formation of Byran and McCann (1937). Manley (1978) reassigned these strata to the Cochiti Formation of Bailey and others (1969); however, Smith and Lavine (1996) recommend restricting the Cochiti Formation to deposits consisting entirely of volcaniclastic sediments that overlie volcanic rocks of the Keres Group. Clasts recognized in the sedimentary sequence under and south of Santa Ana Mesa are primarily red granite, basalt, and light-gray tuff. Because this unit is not entirely volcaniclastic, use of the term Cochiti Formation in the Bernalillo quadrangle should be abandoned. The Cochiti Formation, as mapped by Smith and Kuhle (1998) to the north, interfingers with axial-fluvial facies of the ancestral Rio Grande system of the Sierra Ladrones Formation. Cather and Connell (1998) report interfingering of reddish-brown sandstone, siltstone and conglomerate sequence with axial-fluvial facies along the eastern margin of Santa

Ana Mesa. The Santa Ana Mesa member, as used in this report, is an informal member of the Sierra Ladrones Formation and interfingers with unit QTsa to the east and overlies, and possibly interfingers with, the Ceja Member along the western margin of the quadrangle. An occurrence of primary airfall lapilli tuff (Locality 2, Table 1) has been dated at 6.79±0.75 Ma and is probably associated with the Peralta Tuff of the Bearhead rhyolite (McIntosh, oral communication, 1998). This unit contains a thick sequence of reddish-brown sandstone with interbedded siltstone, claystone, and rare pebble to boulder conglomerate. Clasts are primarily subangular red granite, subrounded basalt and light-gray tuff, and minor sandstone derived from the western margin of the Santo Domingo Basin.

Tsa Santa Ana Mesa member, colluvial submember (upper Miocene to Pliocene) — Sequence of reddish-brown to orangish-brown sandstone and mudstone associated with the hanging wall of the Luce fault along the northern margin of the quadrangle (Section 11, T13N, R03E). Estimated thickness is up to 15 m against the Luce fault and pinches out to the east. Interpreted to be an intraformational colluvial wedge associated with movement along the Luce fault.

Volcanic rocks

Tb Basalt of Santa Ana Mesa (Pliocene) — Tholeiitic flood basalt with modal affinities to alkali olivine basalt (Kelley and Kudo, 1978, p. 9). Thickness is about 6-12 m (20-40 ft) along eastern margin of mesa and thickens to over 50 m (150 ft) west of the eastern edge of the mesa (Cather and Connell, 1998). A ≤4 m thick basaltic tuff underlies the base (Spiegel, 1961, Cather and Connell, 1998). Bachman and Mehnert (1978) report a K-Ar date of 2.5±0.3 Ma for this sequence of basalt.

Tc Canjilon Tuff (Pliocene) — Oval-shaped tuff-breccia diatreme that intrudes gently dipping Santa Ana Mesa member sandstone just south of the basalt of Santa Ana Mesa. Tuff generally dips less than 50˚ into the center of the diatreme, however, dips are near vertical near faults. Contains numerous basalt dikes and brecciated basalt dikes, flows and plugs, locally differentiated as Tcb. Alto contains a circular tuff ring near the center of diatreme. Simplified and modified from the work of Kelley and Kudo (1978).

Tcb Basalt of Canjilon Hill (Pliocene) — Basalt and basaltic breccia beds. Kelley and Kudo (1978) report at K-Ar date of 2.61±0.09 Ma (Table 1).

LOWER PROTEROZOIC ERATHEM

Xs Schist, phyllite, quartzite and gneiss — Schist and phyllite with local quartzite and gneiss of the Juan Tabo sequence of Hayes (1951).

ACKNOWLEDGMENTS

Mapping of this quadrangle was funded in part, by a grant from the STATEMAP program of the National Geologic Mapping Act, coordinated by the U.S. Geological Survey and the New Mexico Bureau of Mines and Mineral Resources. Thanks to the Governor's Office of Santa Ana Pueblo, including Mr. Nathan Tsosie (Acting Tribal Administrator) and Mr. Todd Caplan (Environment Department) for facilitating access to Santa Ana Pueblo. Thanks to Mr. Archie Chavez (Realty Office) and the Governor's Office of Sandia Pueblo for facilitating access to Sandia Pueblo. Mr. John Sorrel of the Bureau of Indian Affairs (BIA), Mr. John Sanchez of the BIA Southern Pueblos Agency for access to subsurface data. Mr. Russ Pederson and Ms. Stephanie Pecos of the Indian Health Service provided subsurface data for two exploratory wells (ESA-1 and ESA-2) along the eastern margin of Santa Ana Reservation.

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Table 1. Summary of radiometric dates and biostratigrphy of the Bernalillo 7.5-minute quadrangle.

Locality	Unit	Description	Age or Date (method)	Reference
1	**QTsa**	Pumice clast of lower Bandelier Tuff (Otowi Member)	1.62 Ma (Ar/Ar)	NMBMMR Argon lab
2	**Tsa**	Primary lapilli tuff (Peralta Tuff of the Bearhead Rhyolite)	6.79±0.75 (Ar/Ar)	NMBMMR Argon lab
3	**QTsa**	Pumice clast of Bandelier Tuff	early Pleistocene	---
4	**QTsa**	*Glypotherium* in gravel pit	Irvingontian lma (biostratigraphic)	Lucas and othters (1993, p.6)
---	**Tcb**	Basalt of Canjilon Hill	Pliocene/ 2.61±0.03 (K-Ar)	Kelley and Kudo (1978)
---	**Tb**	Basalt of San Felipe Mesa	Pliocene/ 2.5±0.3 (K-Ar)	Bachman and Mehnert (1978)

Table 2. Summary and interpretation of driller's and cutting's logs for selected wells of the Bernalillo 7.5-minute quadrangle. Logs obtained from the Office of the State Engineer, Pueblo of Santa Ana and the Bureau of Indian Affairs. The terms used to describe rock materials do not necessarily have the same connotation in all logs and may even have distinctly different meanings because of different usage by different drillers. n.a. = not available.

Name:	RWP-SA-17	NMOSE:	n.a.
Driller	Bureau of Indian Affairs, rotary mud	Year Completed:	June 1997
Elevation (ft):	5450±10	Water Level (ft)	n.d.
Location:	13N.03E.12.341, Bernalillo quadrangle, Santa Ana Pueblo		
Comments:	Cuttings logged by S.D. Connell, NMBMMR		

Depth (ft)	**Thickness (ft)**	**Log of Drill Cuttings** (dry colors)	**Interpretation and Remarks**
0-20	20	SAND: medium-to coarse-grained, light reddish-brown (5YR 6/4d) to reddish brown (5YR 5/4).	Quaternary alluvium Sampled at 10-ft intervals
20-40	40	GRAVELLY SAND: color same as above.	Ceja Member(?) of the Sierra Ladrones Formation (Tsc)
40-90	50	MUDDY SAND AND GRAVEL: red (2.5YR 5/6) to reddish-brown (5YR 5/4) and yellowish-red (5YR 5/6), subrounded clasts of basalt, chert, quartzite and sandstone, upward fining sequence.	
90-190	100	MUDDY SAND with rare GRAVEL: light reddish-brown (2.5YR 6/4 and 5YR 6/4), white (N8/0 sandy nodules)	Santa Ana Mesa member of the Sierra Ladrones Formation (Tma)
190-200	10	SAND, clean: light reddish-brown (5YR 6/4).	
200-350	150	CLAYEY SAND AND SANDY GRAVEL: light reddish-brown (5YR 6/4) to reddish-yellow (5YR 6/6), subangular to subrounded clasts of basalt, quartzite, red granite, Pedernal(?) chert, and sandstone.	Abundant white (N8/0) nodules below 325 ft. Sample interval changed to 25-to 45-ft intervals.
350-490	140	CLAYEY SAND: light reddish-brown (2.5YR 7/3 & 6/4) and red (2.5YR 5/6), abundant white (N8/0) carbonate nodules.	
490-515	25	GRAVEL: light reddish-brown (2.5YR 7/3), well sorted, subrounded and subangular clasts of red granite, quartzite, basalt, chert and sandstone.	Clasts are dominated by granite and basalt, suggesting a western basin-margin (Sierra Nacimiento?) source
515-580	65	CLAYEY SAND: light reddish-brown (2.5YR 6/4).	Bottom elevation: 4870 ft

Name:	SAP 1	NMOSE:	n.a.
Driller:	Rodgers and Company, rotary mud	Year Completed:	1997
Elevation (ft):	5140±10	Water Level (ft)	n.a.
Location:	13N.03E.25.244 Bernalillo quadrangle, Santa Ana Pueblo		
Comments:	Cuttings logged by S. D. Connell		

Depth (ft)	**Thickness (ft)**	**Log of Drill Cuttings** (dry colors)	**Interpretation and Remarks**
0-10	10	SAND with minor GRAVEL: light brown (7.5 YR 6/4).	Quaternary alluvium.
10-20	10	SAND, clean: color same as above.	Qvrm: alluvium of the Rio Grande .
20-50	30	GRAVEL: light brown (7.5 YR 6/4), poorly to well sorted, subangular to subrounded quartzite and basalt, subangular granite.	Base reddens to 5 YR 6/4, upward fining sequence.
50-90	40	SILTY SAND and GRAVEL: light brown (7.5 YR 6/4).	Qvre: alluvium of the Rio Grande.
90-150	60	SILTY CLAY to CLAYEY SAND: light reddish-brown (2.5 YR 6/4) to red (2.5 YR 5/6).	Santa Ana Mesa member of the Sierra Ladrones Formation (Tsa)
150-210	60	CLAYEY SAND with GRAVEL: light reddish-brown (2.5 YR 7/3 & 6/4) to red (2.5 YR 5/6), base marked by 20 ft of GRAVEL containing subangular Pedernal chert, quartzite, red granite, tuff, and sandstone.	
210-320	110	CLAYEY SAND: reddish-brown (2.5 YR 4/4 & 5/4) to light reddish-brown (2.5 YR && 5 YR 5/4), base marked by 10 ft of GRAVEL containing quarzite, Pedernal chert, sandstone and basalt.	Upward fining sequence. Abundant white (N8/0) sandstone and carbonate nodules from 200-810 ft . Possible Rio Grande source.
320-360	40	GRAVEL (clean) to SILTY-SANDY CLAY: reddish-brown (2.5 YR 7/3 & 6/4) to red (2.5 YR 5/6).	Upward fining sequence.
360-400	40	GRAVEL (clean) to SILTY-SANDY CLAY: reddish-brown (2.5 YR 7/3 & 6/4) to red (2.5 YR 5/6).	Upward fining sequence.
400-440	40	GRAVEL (clean) to SILTY-SANDY CLAY: same as above.	
440-580	140	SANDY CLAY to CLAY: dark reddish-brown (2.5 YR 3/4) to light red (2.5 YR 6/6), rare basalt, Pedernal (?) chert, yellowish-brown chert, and light gray tuff.	
580-610	30	CLAYEY SAND with minor GRAVEL: pinkish gray (7.5 YR 7/2), subrounded to subangular basalt, red granite, sandstone, brown chert and obsidian (?).	Missing interval 590-610 ft.
610-810	200	CLAYEY SAND to SANDY CLAY with scattered GRAVEL: light reddish-brown (2.5 YR to 5 YR 6/4), scattered subangular basalt, quartzite, red granite.	Bottom elevation: 4330 ft

Name:	Santa Ana Golf Course (SAGC)	NMOSE:	n.a.
Driller:	Rodgers and Company	Year Completed:	1990
Elevation (ft):	515±10 ft	Water Level (ft)	n.a.
Location:	13N.4E.19.433, Bernalillo quadrangle, Santa Ana Pueblo		

Depth (ft)	**Thickness (ft)**	**Driller's Log**	**Interpretation and Remarks**
0-3	3	SAND	Qvre and Qvrm: alluvium of the Rio Grande
3-5	2	CLAY	
5-18	133	SAND	
18-39	21	Large GRAVEL	
39-80	41	Red CLAY	Santa Ana Mesa member (Tsa)
80-125	45	Red CLAY with stringers of cemented SAND	
125-161	36	Red clay with stringers of cemented sand	
161-183	22	Red CLAY with stringers of cemented SAND	
183-194	11	Med to coarse SAND, with small GRAVEL	
194-201	7	Med to coarse SAND with small GRAVEL, with thin red CLAY layers	
201-220	19	Red CLAY	
220-294	74	Red CLAY with layers of clay-sand and cemented GRAVEL	
294-321	27	Red CLAY with layers of course SAND	
321-342	21	Coarse SAND	
342-363	21	(Hard) red clay	
363-380	17	Coarse SAND with thin CLAY layers	
380-426	46	Coarse sAND	
426-442	16	CLAY with SANDY CLAY layer	
442-454	12	Coarse SAND	
454-462	8	(Hard) CLAY with mixed GRAVEL	
462-480	8	Coarse sAND	
480-491	11	(Hard) CLAY with embedded GRAVEL	
491-545	54	Coarse SAND	
545-560	15	Thin layers of fine SAND to CLAY	
560-635	75	Coarse SAND	
635-639	4	Cemented SAND with some GRAVEL	
639-690	51	Coarse SAND with layers of cemented GRAVEL	
690-758	68	Layers of SANDY CLAY, cemented SAND, brown CLAY	
758-773	15	Coarse SAND	
773-800	27	Cemented layers of SAND, coarse SAND, and CLAY	
800-835	35	Med to fine SAND	
835-837	2	White CLAY	
837-900	63	Med to coarse SAND	

Name:	SASF #1	NMOSE:	n.a.
Driller:	Rodgers and Company	Year Completed:	1995
Elevation (ft):	5240±10 ft	Water Level (ft)	
Location:	13N.035.24.214, Bernalillo quadrangle, Santa Ana Pueblo		

Depth (ft)	Thickness (ft)	Log of Drill Cuttings	Interpretation and Remarks
0-8	8	Light brown (5 YR 6/4), poorly sorted, subrounded, clayey very fine SAND to granule GRAVEL	alluvium of the Rio Grande (Qvrm and Qvre)
8-11	3	Light brown (5 YR 6/4), medium sorted, subangular, pebble and cobble GRAVEL	
11-35	24	Light brown (5 YR 5/4, poorly sorted, subangular to subrounded, fine sand to pebble GRAVEL	
35-45	10	Pale yellowish brown (10 YR 6/2), poorly sorted, subangular, very coarse sand to pebble GRAVEL	
45-58	13	Light brown (5 YR 5/4), poorly sorted, subangular to subrounded, medium SAND to small pebble GRAVEL	
58-60	2	Pinkish gray (5 YR 8/1), CLAY	
60-66	6	Light brown (5 YR 6/4), poorly sorted, subangular, very coarse SAND to pebble GRAVEL	
66-80	4	Moderate reddish brown 10 YR 4/6), SANDY CLAY	Santa Ana Mesa member (Tsa)
80-113	33	Moderate reddish orange (10 YRR 6/6), poorly sorted, subrounded, CLAYEY very fine sand to medium SAND	
113-122	9	Light brown (5 YR 6/4), poorly sorted, subrounded, CLAYEY very fine sand to coarse SAND	
122-145	23	Light brown (5 YR 5/4), poorly sorted, subangular to subrounded, very fine SAND to small pebble GRAVEL	
145-170	25	Light brown (5 YR 6/4), poorly sorted, subangular to subrounded, very fine SAND to small pebble GRAVEL	
170-203	33	Light brown (5 YR 5/6), poorly sorted, subrounded, clayey very fine SAND to granule GRAVEL	
203-211	8	Moderate orange pink (10 YR 7/4), SANDY CLAY	
211-223	12	Light brown (5 YR 6/4), poorly sorted, subangular to subrounded fine SAND to granule GRAVEL	
223-235	12	Light brown (5 YR 5/6), SAND to granule GRAVEL	
235-295	60	Light brown (5 YR 5/6), poorly sorted, subangular to subrounded, CLAYEY very fine SAND to granule GRAVEL	
295-315	20	Light brown (5 YR 5/4), poorly sorted, subrounded, very fine SAND to granule GRAVEL	
315-355	40	Light brown (5 YR 6/4), poorly sorted, subangular to subrounded, fine SAND to granule GRAVEL	
355-387	32	Light brown (5 YR 6/4), poorly sorted, subangular to subrounded, fine SAND to small pebble GRAVEL	
387-430	43	Light brown (5 YR 6/4), poorly sorted, subangular to subrounded, CLAYEY very fine SAND to granule GRAVEL	
430-448	18	Light brown (5 YR 6/4), SANDY CLAY	

SASF # 1 (continued).

Depth (ft)	Thickness (ft)	Log of Drill Cuttings	Interpretation and Remarks
448-478	30	Pale yellowish brown (10 YR 6/2), poorly sorted, subangular to subrounded, fine SAND to very coarse SAND	
478-485	7	Light brown (5 YR 6/4), poorly sorted, subrounded, very fine SAND to granule GRAVEL	
485-520	35	Light brown (5 YR 5/6), poorly sorted, subangular to subrounded CLAYEY very fine SAND to very coarse SAND	
520-540	20	Light brown (5 YR 6/4), poorly sorted, subangular to subrounded, fine SAND to granule GRAVEL	
540-560	20	Light brown (5 YR 6/4), poorly sorted, subangular to subrounded, very fine SAND to granule GRAVEL	
560-585	25	Light brown (5 YR 6/4), SANDY CLAY	
585-595	10	Light Brown (5 YR 6/4), poorly sorted, subrounded, CLAYEY very fine SAND to coarse SAND	
595-640	45	Light brown (5 YR 6/4), poorly sorted, subangular to subrounded, fine SAND to granule GRAVEL	
640-657	17	Light brown (5 YR 5/6), SANDY CLAY	
657-670	13	Light brown (5 YR 6/4), poorly sorted, subangular to subrounded, very fine SAND to very coarse SAND	
670-680	10	Light brown (5 YR 6/4), poorly sorted, subangular to subrounded, CLAYEY very fine SAND to very coarse SAND	
680-685	5	Light brown (5 YR 5/6), SANDY CLAY	
685-708	23	Light brown (5 YR 6/4), poorly sorted, subangular to subrounded, CLAYEY very fine SAND to very coarse SAND	
708-820	12	Light brown (5 YR 6/4), poorly sorted, subangular to subrounded, fine SAND to very coarse SAND	
820-1011	191	Light brown (5 YR 5/6), poorly sorted, subangular to subrounded, very fine sand to very coarse SAND	
1011-1015	4	Light brown (5 YR 5/6), SANDY CLAY	
1015-1030	15	Light brown (5 YR 6/4), poorly sorted, subangular to subrounded, fine sand to very coarse SAND	
1030-1043	13	Light brown (5 YR 6/4), poorly sorted, subrounded, CLAYEY very fine sand to coarse SAND	

Name:	WMP-N	NMOSE:	n.a.
Driller:	J & J Drilling, Inc., rotary mud	Year Completed:	1995
Elevation (ft):	5400±50	Water Level (ft)	n.a.
Location:	Western Mobile Placitas Northern Aggregate Operations		

Depth (ft)	**Thickness (ft)**	**Driller's Log**	**Interpretation and Remarks**
0-11	11	CLAY	Sierra Ladrones Formation axial facies (QTsa)
11-21	10	medium to large GRAVEL	
21-38	17	SAND and GRAVEL	
38-42	4	CLAY	
42-43	1	GRAVEL layer	
43-49	6	CLAY	
49-53	4	SAND	
53-55	2	CLAY w/embedded GRAVEL	
55-64	9	layers of small red GRAVEL & CLAY	
64-80	16	medium GRAVEL w/layers of red CLAY	Santa Ana Mesa member (Tsa)?
80-96	16	red CLAY	
96-100	4	coarse SAND w/CLAY layers	
100-120	20	coarse SAND w/CLAY layers	
120-130	10	coarse SAND w/CLAY layers	
130-140	10	red CLAY w/stringers, SAND	
140-160	20	coarse SAND w/CLAY stringers	
160-180	20	coarse SAND, small GRAVEL w/CLAY stringers	
180-200	20	CLAY w/stringers of SAND	Santa Ana Mesa member (Tsa)
200-220	20	CLAY w/stringers of SAND	
220-240	20	fine to coarse sand w/CLAY stringers	
240-260	20	fine to coarse SAND w/CLAY stringers	
260-280	20	coarse SAND & small GRAVEL	
280-300	20	coarse SAND & small GRAVEL	
300-320	20	coarse SAND to CLAY	
320-340	20	CLAY w/stringers, small GRAVEL	
340-360	20	fine to coarse SAND	
360-365	5	fine to coarse SAND w/CLAY stringers	
365-375	10	CLAY	
375-395	20	red CLAY	
395-400	5	rec CLAY w/fine to coarse sandy layers	
400-415	15	coarse SAND, small GRAVEL w/CLAY stringers	
415-430	15	red CLAY w/stringers, coarse SAND	

Name:	Albuquerque Utilities Well 12 (RRU12)	NMOSE:	RG-6745-S-21 (W#12)
Driller:	Southwest Water Industries	Year Completed:	1987
Elevation (ft):	5240	Water Level (ft)	n.a.
Location:	13N.04E 26.433, Bernalillo quadrangle		

Depth (ft)	**Thickness (ft)**	**Driller's Log**	**Interpretation and Remarks**
0-20	20	SAND and top soil	Quaternary alluvium, undivided
20-30	10	GRAVEL and SAND	
30-415	385	SANDY CLAY, CLAY, very little sand	Santa Ana Mesa member (Tsa)
415-455	40	Coarse SAND, small gravel, clay	
455-535	80	CLAY, small GRAVEL, SAND, more clay 455-520	
535-590	55	CLAY with some SAND	
590-610	20	GRAVEL streaks, SAND ROCK and CLAY	
610-640	30	Coarse SAND, LSAND ROCK, some CLAY	
640-700	60	Brown CLAY, with sAND 660-675	
700-720	20	Coarse SAND, CLAY streaks	
720-760	40	Brown CLAY, with sand strips	
760-830	70	SAND and GRAVEL	
830-880	50	SAND and Clay strips	
880-925	45	Fine grain SAND, some GRAVEL	
925-942	17	SAND and GRAVEL	
942-995	53	Coarse SAND, GRAVEL, some CLAY	
995-1065	70	SAND and GRAVEL strips, some CLAY layers	
1065-1110	45	CLAY, some GRAVEL and SAND	
1110-1145	35	Tight sticky CLAY	
1145-1200	55	Mostly CLAY with some sAND and fine GRAVEL 1180-1200	
1200-1290	90	SAND, with some gray CLAY strips, good SAND 1220-1240	
1290-1300	10	ROCK and CLAY, slow drilling	
1300-1369	69	SAND, GRAVEL, sand rock , with little CLAY	
1369-1435	66	Coarse SAND, very little CLAY, drills good	
1435-1487	52	CLAY, very little SAND, drills slow	

Name:	RWP-SA-14	NMOSE:	n.a.
Driller	Bureau of Indian Affairs	Year Completed:	1978 (abandoned)
Elevation (ft):	5250±10	Water Level (ft)	between 215 and 265 ft

Location: 13N.03E.24.221 Bernalillo quadrangle, Santa Ana Pueblo

Depth (ft)	**Thickness (ft)**	**Driller's Log**	**Interpretation and Remarks**
0-3	3	top soil	Alluvium of the Rio Grande, undivided
3-95	92	sand and boulders	
95-110	15	red clay	Santa Ana Mesa member (Tsa)
110-265	155	sand and gravel	

Name:	Placitas Trails Subdivision	NMOSE:	RG-43276
Driller:	J & J Drilling, Inc. rotary mud	Year Completed:	1985
Elevation (ft):	5250±50	Water Level (ft)	238
Location:	Lot 22, Tract 138 and 139 of the Placitas Trails subdivision.		

Depth (ft)	**Thickness (ft)**	**Driller's Log**	**Interpretation and Remarks**
0-8	8	red CLAY	piedmont alluvium (Qpm)
8-21	13	large GRAVEL	
21-27	6	red CLAY	
27-74	47	small GRAVEL	alluvium of Edith Boulevard (Qvre)
74-81	7	large GRAVEL	
81-84	3	red CLAY	Sierra Ladrones Formation
84-166	82	small GRAVEL	axial facies(?) (QTsa)
166-170	4	red CLAY	
170-228	58	small GRAVEL	
228-235	7	red CLAY	
235-345	10	small GRAVEL	
345-352	7	red CLAY	
352-402	50	small GRAVEL	
402-410	8	red CLAY	
410-451	41	small GRAVEL	

Name:	Centex American Gypsum Company	NMOSE:	RG-51722
Driller:	Rodgers and Company, Inc.	Year Completed:	5065
Elevation (ft):	5065±5	Water Level (ft)	45
Location:	13N.4E.28.121, Bernalillo quadrangle		

Depth (ft)	**Thickness (ft)**	**Driller's Log**	**Interpretation and Remarks**
0-10	10	Clay	Alluvium of the Rio Grande (Qvrg)
10-20	10	Clay	
20-25	5	Gravel	
25-70	45	Sandy red clay	
70-95	25	Gravel	
95-105	10	Red clay	Santa Ana Mesa member (Tsa)
105-110	5	Fine sand	
110-117	7	Red clay	
117-129	12	Fine sand	
129-132	3	Clay	
132-136	4	Sand	
136-141	5	Clay and gravel layers	
141-147	6	Sand	
147-155	8	Clay	
155-175	20	Medium sand	
175-180	5	Fine sand	

Name:	Amos Montoya	NMOSE:	RG 64146
Driller	Murray Drilling Co., Inc.	Year Completed:	1996
Elevation (ft):	5180±10	Water Level (ft)	200
Location:	Alameda Grant		

Depth (ft)	**Thickness (ft)**	**Driller's Log**	**Interpretation and Remarks**
0-80		Sand/clay	alluvium of Rio Grande (Qvre)
80-120		Small gravel	
120-150		Boulders	
150-155		Clay	Santa Ana Mesa member (Tsa)
155-200		Sand, clay	
200-260		Clay, sand, slow	
260-330		Small gravel and sand	
330-335		Clay	

Name:	Barry Moore	NMOSE:	RG 62203
Driller	Murray Drilling Co., Inc.	Year Completed:	1995
Elevation (ft):	5160±10	Water Level (ft)	180
Location:	X = 390,750; Y = 1,557,800, Alameda Grant		

Depth (ft)	**Thickness (ft)**	**Driller's Log**	**Interpretation and Remarks**
0-60		Sand	alluvium of Rio Grande (Qvre)
60-120		Small gravel	
120-150		Large gravel	
150-260		Sand clay	Santa Ana Mesa member (Tsa)
260-280		Red clay	
280-310		Sand, some gravel	
310-340		Small gravel and sand	

Name:	Fraech Construction	NMOSE:	RG 64585
Driller	Murray Drilling Co., Inc.	Year Completed:	1996
Elevation (ft):	5150±10	Water Level (ft)	199
Location:	Alameda Grant		

Depth (ft)	**Thickness (ft)**	**Driller's Log**	**Interpretation and Remarks**
0-40		Sand and clay	alluvium of Rio Grande (Qvre)
40-90		Clay, sand, slow drilling	
90-120		Boulders and sand	
120-200		Sand and gravel	Santa Ana Mesa member (Tsa)
200-290		Sand and clay	
290-320		Clay	
320-360		Sand and clay	
350-380		Large sand	

Name:	Illiff Construction	NMOSE:	RG 62037
Driller	Murray Drilling Co., Inc.	Year Completed:	1995
Elevation (ft):	5065±10	Water Level (ft)	70
Location:	Alameda Grant		

Depth (ft)	**Thickness (ft)**	**Driller's Log**	**Interpretation and Remarks**
0-40		Sand	alluvium of Rio Grande (Qvrg)
40-90		Gravel	
90-140		Clay	Santa Ana Mesa member (Tsa)
140-170		Large sand	

Name:	Frank Larrabee	NMOSE:	RG 64408
Driller	J & J Drilling, Inc.	Year Completed:	1996
Elevation (ft):	5080±10	Water Level (ft)	80
Location:	Alameda Grant		

Depth (ft)	**Thickness (ft)**	**Driller's Log**	**Interpretation and Remarks**
0-12		Sandy brown clay	alluvium of Rio Grande (Qvrg)
12-20		Sand	
20-36		Coarse sand	
36-85		Pea gravel	
85-104		Brown clay	Santa Ana Mesa member (Tsa)
104-178		Small gravel and sand	
178-191		Brown clay	
191-210		Small gravel	

EXPLANATION OF MAP SYMBOLS

Compound unit description. Unit in numerator describes discontinuous thin veneer that covers unit in denominator.

Strike and dip of bedding.

Horizontal bedding.

Paleoflow direction based on pebble imbrication.

Strike and dip of jointing.

Strike and dip of faulting.

Water-supply well.

Exploratory (geotechnical) borehole.

Geologic contact, approximate. Dotted where concealed, queried where poorly constrained or inferred.

Approximate location of geologic contact within disturbed areas (daf).

Approximate eastern limit of axial-fluvial facies of the Sierra Ladrones Formation (QTsa).

Fault, showing dip and up- and down-thrown sides. Dotted where concealed, queried where poorly constrained or inferred.

Loma Colorada transverse zone of Hawley (1996).

Deformed bedding.

Approximate location of high-resolution aeromagnetic anomally (from Grauch and Labson, 1997).

Selected localities (Table 1).

Approximate eastern boundary of terrace (Qvro).

Approximate eastern boundary of terrace (Qvr).

Tuff ring.

Selected basalt bed in the Canjilon hill diatreme.

Location of preliminary geologic cross sections (Plate II).