Geologic Map of the Chimayo Quadrangle, Rio Arriba and Santa Fe Counties, New Mexico

By

Daniel J. Koning

May, 2003

New Mexico Bureau of Geology and Mineral Resources
Open-file Digital Geologic Map OF-GM 71

Scale 1:24,000

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

GEOLOGIC MAP OF THE CHIMAYO 7.5-MINUTE QUADRANGLE, RIO ARRIBA AND SANTA FE COUNTIES, NEW MEXICO

Technical Report

BY

DANIEL KONING[1]

May, 2003

[1] New Mexico Bureau of Geology and Mineral Resources, New Mexico Tech, 801 Leroy Place, Socorro, NM, 87801-4796; dkoning@nmt.edu.

EXECUTIVE SUMMARY

The Chimayo 7.5-minute quadrangle is underlain by late Oligocene- to late Miocene-age clastic basin fill deposits (generally sand, silt, and gravel with subordinate clay) that have an estimated cumulative thickness of up to 2.1 km. These deposits have been tilted northwestward and thicken northwestward due to associated tilting of the Española basin half-graben. This tilting occurred during rift tectonism from the late Oligocene through the present. The basin fill deposits are mapped as the Tesuque Formation, and are interpreted to range in age from about 30(?) to 7 Ma. Consistent with the bedding attitudes, the Tesuque Formation on this quadrangle becomes younger northwestward away from the Sangre de Cristo Mountain front. A period of net erosion during the Pliocene and Quaternary removed much of the upper Miocene basin fill. This erosion also left a series of strath terrace deposits preserved in the northern portion of the quadrangle.

The Tesuque Formation on this quadrangle is subdivided into 31 lithostratigraphic units on the basis of composition (provenance), texture, and other general sedimentologic characteristics. The units reflect three general depositional environments. The first environment was a west- to northwest-sloping alluvial slope that flanked the western margin of the Sangre de Cristo Mountains, over which flowed numerous, probably ephemeral streams derived from the Sangre de Cristo Mountains south and west of Truchas Peaks. This environment is represented by units of lithosome A of Cavazza (1986), which are characterized by silty sandstone extra-channel deposits interbedded with various proportions of coarse channel-fill deposits of pebbly sandstone and pebble-conglomerate. The gravel of lithosome A on this quadrangle is generally dominated by granite, with subordinate quartzite, and the sand fraction has

abundant pinkish potassium feldspar. The second depositional environment was a south- to southwest-flowing fluvial system on a sloping basin floor that was sourced in the Sangre de Cristo Mountains north of Truchas Peaks. This environment is represented by units of lithosome B of Cavazza (1986), which are characterized by having very thin to medium beds of siltstone, mudstone, and fine sandstone floodplain deposits interbedded with subordinate, relatively broad channel-fill deposits of sandstone and conglomerate. The gravel of lithosome B consists of a hetereolithic clast assemblage dominated by Paleozoic sandstone, siltstone, and limestone; the sand fraction has a grayish color due to a relative lack of pinkish potassium feldspar grains and a relative abundance of lithic grains containing volcanic detritus and greenish quartz grains derived from weathering of greenish Paleozoic sandstone rock. The third environment consists of eolian deposition on the distal alluvial slope of lithosome A, which was subjected to fluvial reworking

In the southern part of this quadrangle, these lithostratigraphic units are well exposed. Detailed sedimentologic study and mapping of these units have indicated two important trends. First, the Tesuque Formation progressively coarsens-upward since about 16 Ma, with a particularly significant coarsening at ~13 Ma. Second, both lithosomes B and A have progressively prograded westward and northwestward since about 16 Ma, with a pronounced progradation commencing at about 12.8 Ma. A possible interpretation explaining these two trends is that rift tectonism (i.e., extension) increased after about 16 Ma. This resulted in increased rates of progressive westward tilting of the hanging wall of the Española basin half-graben and more accommodation space being formed near the western master fault (probably the Pajarito and Santa Clara faults), which caused the drainages depositing lithosomes A and B to shift to the west. Other factors that need to be considered include the degree of fluvial integration of the Española basin with downstream basins and the rate of sediment flux (a function of

climate and slope) from the source areas. It is important to note that these units are not chronostratigraphic units but lithostratigraphic units. Consequently, many of these units were being deposited at the same time, albeit in different locations within the basin, and some units are very diachronous.

A number of significant faults displace the Tesuque Formation. In the south, the north-trending Chimayo and White Operation faults are associated with westward-steepening of strata and down-to-the-west faulting. The Chiquito fault has down-to-the-east offset, and appears to join with the prominent fault that bounds the eastern side of the bedrock horst (Cerro Chimayo) 1 km east of the town of Chimayo. In the northwest corner of the quadrangle, both the Velarde and Rio de Truchas fault zones terminate southward into west-facing monoclines or subsidiary fault splays.

INTRODUCTION

The Chimayo 7.5-minute quadrangle is located in the eastern Española basin, which is one of many north-south trending basins formed by the Rio Grande rift. Important geographic features in this quadrangle include the Santa Cruz River, which flows west near the quadrangle's southern boundary, and the town of Chimayo located near the Santa Cruz River. Most of the northern and central portions of the quadrangle consist of a high, northwest-sloping plateau incised by drainages of the Rio de Truchas, Cañada Ancha, and Arroyo del Palacio. The southern end of this plateau ends abruptly in an escarpment a few kilometers north of the Santa Cruz River, an escarpment I will informally refer to as the Santa Cruz escarpment. The Tesuque Formation in the southern and western quadrangle is generally well exposed, especially in the Santa Cruz escarpment, and these areas provide an ideal setting to study sedimentologic

trends associated with the Tesuque Formation. Exposure is poorer in the northeastern and eastern parts of the quadrangle. Detailed unit descriptions are provided below, with brief interpretations regarding their age and depositional environment. Then, structural and sedimentologic trends of the strata are discussed and related to rift tectonism. **Tables 1-2** and **Figures 1-2** are provided to help with geologic terms and stratigraphic concepts used in this summary. The age ranges of chronostratigraphic divisions (e.g., Miocene, Quaternary, Pliocene, Paleozoic) relevant in this report are shown in **Figure 3**, which also provides a temporal correlation of the map units. **Figure 4** illustrates the depositional environments of the map area during the general time that many of the units were being deposited (i.e., middle Miocene).

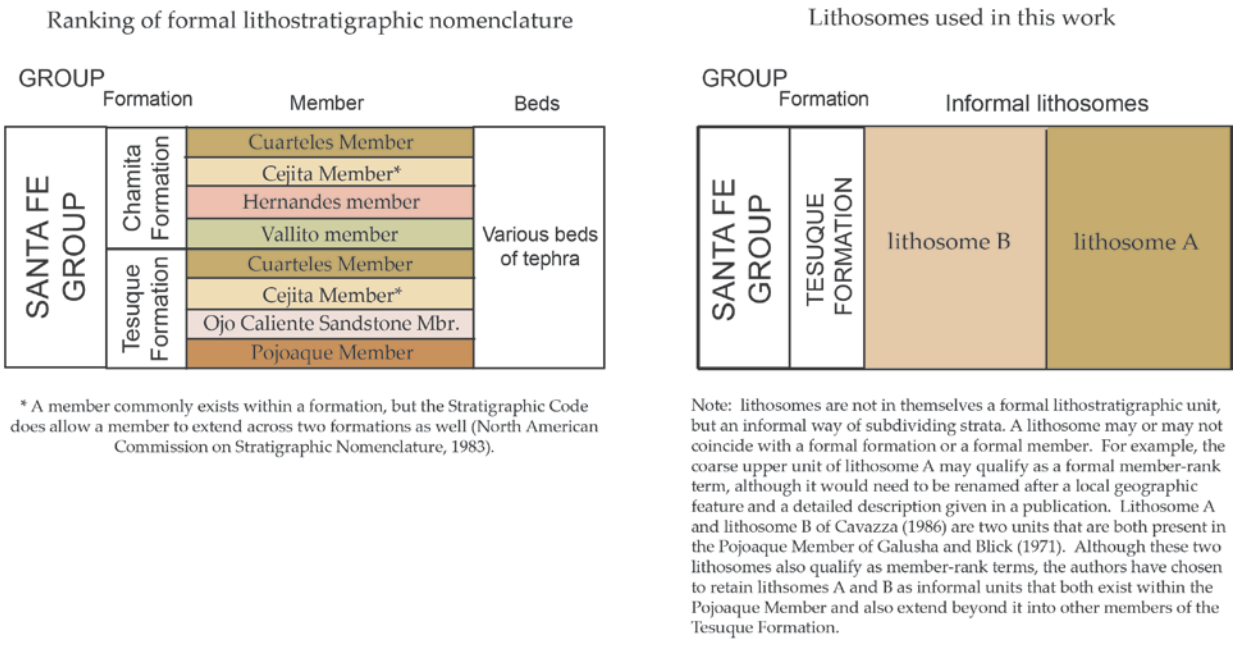

Figure 1. Illustration of lithostratigraphic unit ranking (e.g., group, formation, member, bed) using examples from this quadrangle.

Table 1. Simplified definitions of select geologic terms used in of this map.

Term	Definition
Alluvial slope	A "blanket" of sediment flanking and paralleling the foot of a mountain range that was deposited by streams draining that mountain range. This "blanket" generally lacks the distinctive fan-like shape of alluvial fans as seen in map- or aerial-view.
Alluvium	Sediment (e.g., sand, gravel, mud) laid down by flowing water in a river or stream.
Arkosic	A compositional term applied to sand derived from granitic sources; this sand generally has abundant quartz grains, potassium feldspar grains (generally over 25%), and granite fragments
Ash	*Tephra* having a median diameter of 1/16 to 2 mm (coarse ash) or less than 1/16 mm (fine ash)
Bed	A layer of sediment commonly ranging in thickness from 1 cm to a few meters, and distinguishable from beds above and below
Bioturbation	Churning or mixing of sediment by living organisms (e.g., plant root growth and animal burrowing)
Channel	The carved-out path of a river or stream
Channel-fill	Bed(s) of sediment (typically sand and gravel) that has filled a channel on the Earth's surface
Contact	The three-dimensional surface or boundary of a stratigraphic unit (e.g., bed, member, formation)
Cross-stratified	Beds that initially were deposited at steep angles, either by wind or by water
Half-graben	A valley created by tilting of the Earth's surface towards a *normal fault*
Incision	Act of down-cutting of a river or stream that forms a valley, gorge, arroyo, gully, etc
Lamination	A layer of sediment less than 1 cm thick
Lapilli	*Tephra* having a median diameter of 2-64 mm
Lithostratigraphic unit	A stratigraphic unit recognized solely by properties inherent in the rock or sediment (such as texture, composition, bedding style, color) and by stratigraphic position; age is not a factor
Lenticular	A bed that wedges out on either end, like a cross section of a lens or a somewhat flattened oval with pointed ends
Massive	A descriptive term referring to a lack of observable beds or laminations in a deposit.
Normal fault	A crack or split between two blocks of earth or rock, commonly sloping at angles of 45-90 degrees from horizontal, along which the overlying block has slid downward
Overbank sediment	Fine sediment (particularly silt and clay) deposited by the settlement of suspended particles during a flood that overtops the banks of a river or stream
Phreatomagmatic	Sediment consisting of tephra and other debris that fell from the air after being expelled by an explosive eruption; the eruption was caused by upward-moving magma superheating groundwater

Piedmont	A sloping area of relatively low topographic relief, located just below the base of mountains or hills, that commonly serves or has served as a place of deposition
Relief	The amount of vertical or elevational variation of a *contact* or the Earth's surface
Strata	Layered sediment commonly deposited by water- or wind-related processes
Stratigraphic section	A band-like area along which thicknesses of various strata within a *lithostratigraphic unit* have been measured and described
Stratigraphy	Study of the space and time relations of geologic units
Tephra	Volcanic fragments and debris that were once air-borne because they were explosively expelled from a volcano during a volcanic eruption
Terrace deposit	Sediment that was initially deposited under an active stream or river in a valley bottom, but later is left above the flood level because that stream or river had cut a more recent, deeper canyon; the surface of the deposit is commonly flat or gently sloping
Terrace strath	Base of a terrace deposit
Type section	A *stratigraphic section* that constitutes a formal example of a *lithostratigraphic unit*; needed in the formal designation of a formation or member (see Figure 1)
Vesicular	A term applied to hardened lava that has cavities created by former gas bubbles
Volcaniclastic	Sediment consisting of volcanic-derived sand, gravel, and/or mud

Note: Bates and Jackson (1984) and North American Commission of Stratigraphic Nomenclature (1983) were used, in part, for many of the above definitions.

Table 2. Textural terms for unconsolidated to consolidated sediment.

Clast median diameter (mm)	Clast median diameter (in)	Sediment name for non-consolidated or non-cemented sediment	Sediment name for consolidated or strongly cemented sediment
>256	>10.08	Boulders	Boulder-conglomerate
128-256	5.04-10.08	Coarse cobbles	Cobble-conglomerate
64-128	2.52-5.04	Fine cobbles	
32-64	1.26-2.52	Very coarse pebbles	Pebble-conglomerate
16-32	0.63-1.26	Coarse pebbles	
8-16	0.31-0.63	Medium pebbles	
4-8	0.15-0.31	Fine pebbles	
2-4	0.08-0.15	Very fine pebbles	

Grain median diamater (mm)	Sediment name for non-consolidated or non-cemented sediment	Sediment name for consolidated or strongly cemented sediment
1-2	Very coarse sand	Very coarse sandstone
0.5-1	Coarse sand	Coarse sandstone
0.25-0.5	Medium sand	Medium sandstone
0.125-0.25	Fine sand	Fine sandstone
0.06-0.125	Very fine sand	Very fine sandstone
0.004-0.06	Silt*	Siltstone*
<0.004	Clay*	Clay*

* A mix of silt or clay (siltstone or claystone) is called mud (mudstone)

Tables modified from table 4-1 of Compton (1985)

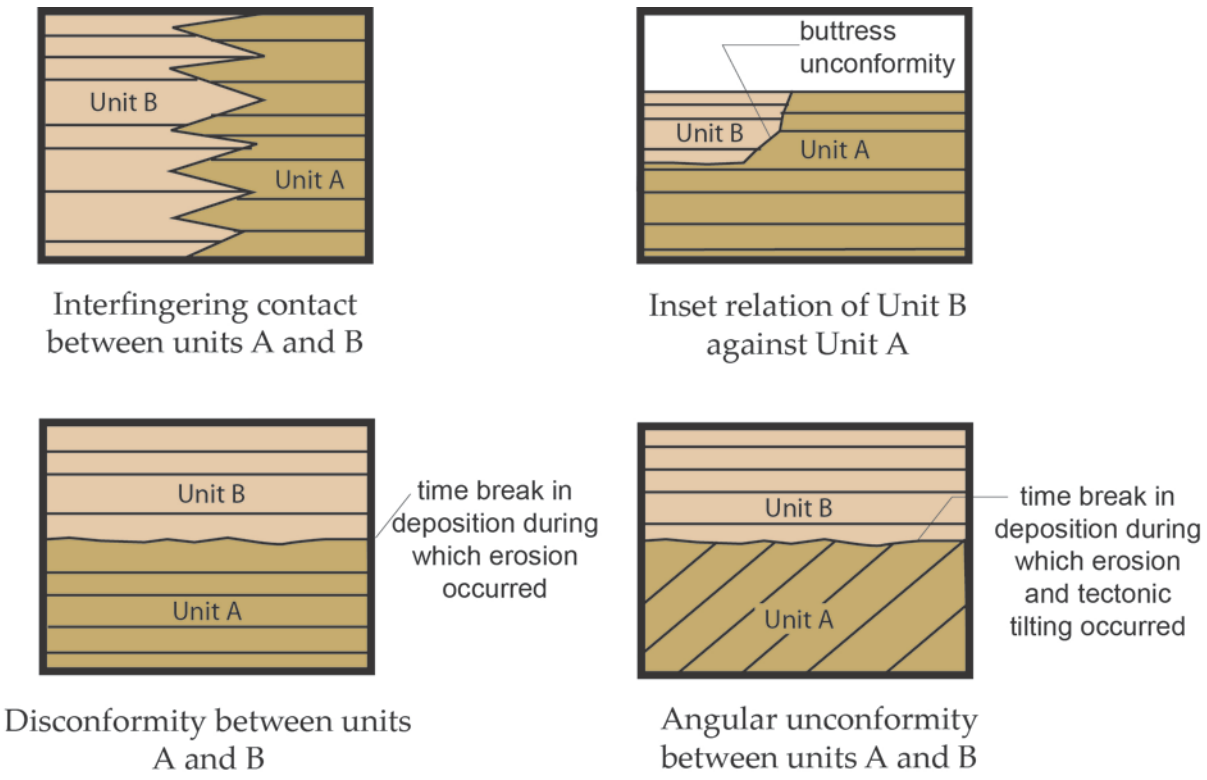

Figure 2. Illustrations of stratigraphic relations observed on this quadrangle (interfingering contact, inset relation and buttress unconformity, disconformity, and angular unconformity). Parallel thin lines represent bedding.

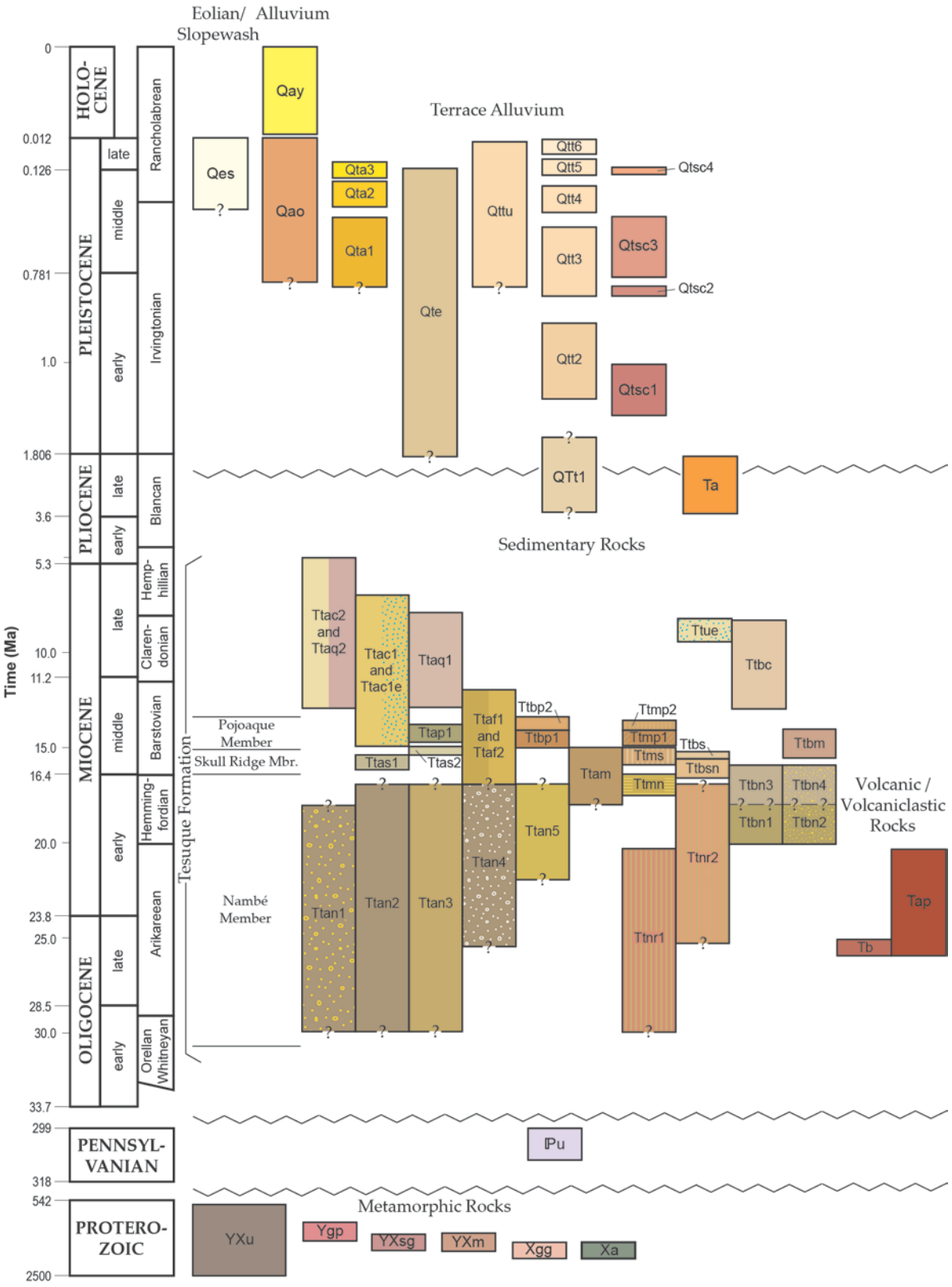
Eolian/ Alluvium
Slopewash
Qay
Terrace Alluvium
Qes
Qao
Qta3
Qta2
Qta1
Qte
Qttu
Qtt6
Qtt5
Qtt4
Qtt3
Qtt2
Qtsc4
Qtsc3
Qtsc2
Qtsc1
QTt1
Ta
Sedimentary Rocks
Ttac2 and Ttaq2
Ttac1 and Ttac1e
Ttaq1
Ttap1
Ttas1
Ttas2
Ttaf1 and Ttaf2
Ttbp2
Ttbp1
Ttam
Ttmp2
Ttmp1
Ttms
Ttmn
Ttbs
Ttbsn
Ttue
Ttbc
Ttbm
Ttbn3
Ttbn1
Ttbn4
Ttbn2
Volcanic / Volcaniclastic Rocks
Tap
Tb
Ttnr2
Ttnr1
Ttan5
Ttan4
Ttan1
Ttan2
Ttan3
Pojoaque Member
Skull Ridge Mbr.
Nambé Member
Tesuque Formation
IPu
Metamorphic Rocks
YXu
Ygp
YXsg
YXm
Xgg
Xa
Time (Ma)
0
0.012
0.126
0.781
1.0
1.806
3.6
5.3
10.0
11.2
15.0
16.4
20.0
23.8
25.0
28.5
30.0
33.7
299
318
542
2500
HOLO-CENE
PLEISTOCENE
PLIOCENE
MIOCENE
OLIGOCENE
PENNSYL-VANIAN
PROTERO-ZOIC
late
middle
early
late
early
late
middle
early
late
early
Rancholabrean
Irvingtonian
Blancan
Hemp-hillian
Claren-donian
Barstovian
Hemming-fordian
Arikareean
Orellan Whitneyan

Figure 3 (preceeding page). Correlation of map units with respect to age. Time (in millions of years), chronostratigraphic divisions (eons, periods, epochs), and North American Land Mammal "ages" are plotted on the vertical axis. Additionally,ages of formal units proposed for the eastern and central Española Basin by Galusha and Blick (1971) are plotted in the gray-shaded boxes. Age control for the units of Galusha and Blick (1971) is obtained from synthesis of geochronologic data from Barghoorn (1981), Tedford and Barghoorn (1993), McIntosh and Quade (1995), Izett and Obradovich (2001), Smith (2000a), Aldrich and Dethier (1990), Giday Woldegabriel (personal communication, March, 2003), this work, and Koning and Manley (2003).

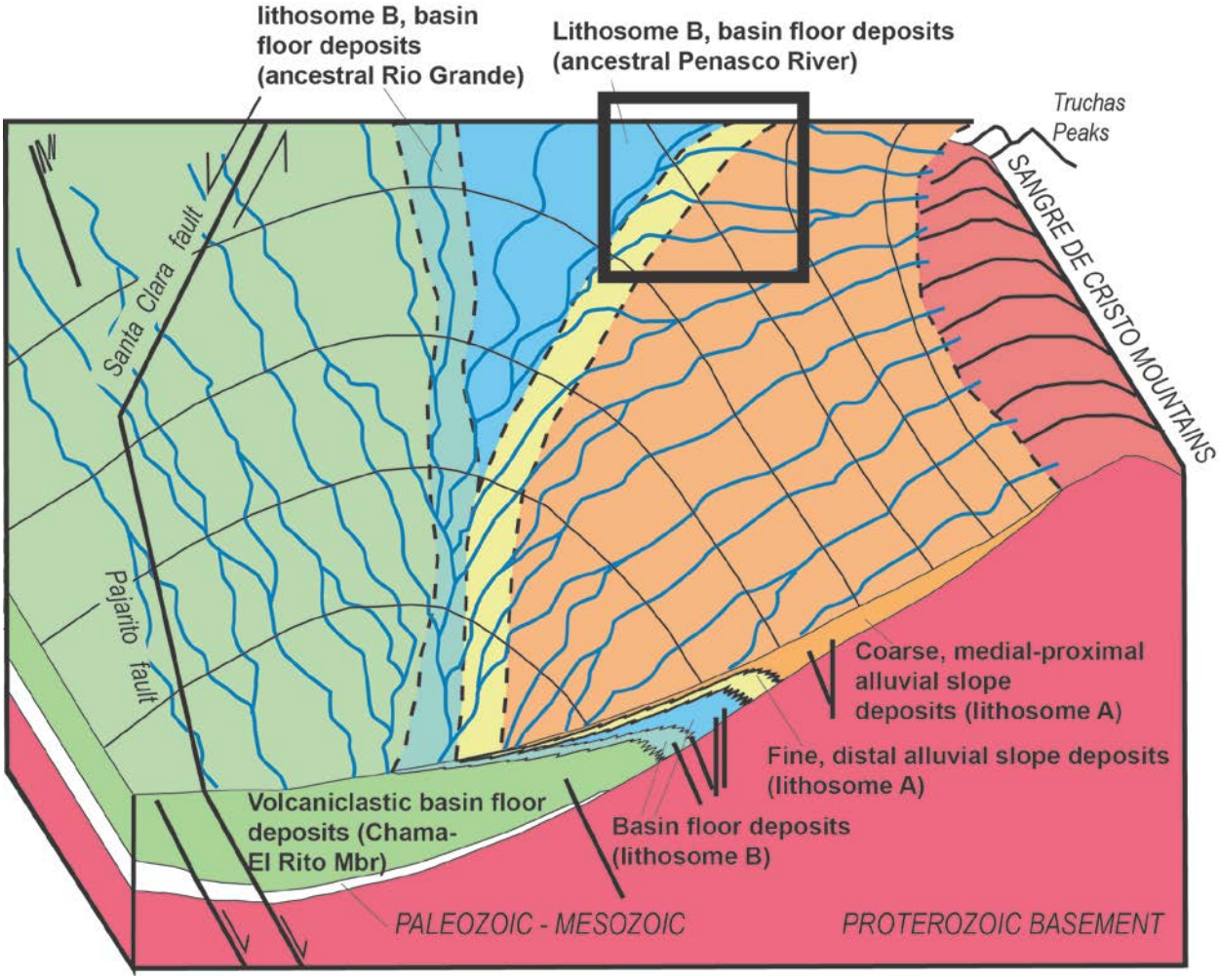

Figure 4. A three-dimensional block diagram illustrating the paleogeography of the Española basin about 14-15 million years ago. View is to the northeast. Various depositional environments and their correlation to the lithosomes of Cavazza (1986) are depicted, as well as important faults. Approximate area of quadrangle is outlined by the thick-lined square.

DESCRIPTION OF MAP UNITS

Grain sizes follow the Udden-Wentworth scale for clastic sediments (Udden, 1914; Wentworth, 1922) and are based on field estimates. Pebble sizes are subdivided as shown in Compton (1985). The term "clast(s)" refers to the grain size fraction greater than 2 mm in diameter. Clast percentages are based on counts of 100-150 clasts at a given locality. Descriptions of bedding thickness follow Ingram (1954). Sandstone is classified according to Pettijohn et al. (1987). Colors of sediment are based on visual comparison of dry samples to the Munsell Soil Color Charts (Munsell Color, 1994). Surficial units are only delineated on the map if estimated to be at least 1 m thick. Soil horizon designations and descriptive terms follow those of the Soil Survey Staff (1992) and Birkeland (1999). Stages of pedogenic calcium carbonate morphology follow those of Gile et al. (1966) and Birkeland (1999).

Mapping of geologic features was accomplished using field traverses, close inspection of numerous outcrops across the quadrangle, and aerial photographs. Terrace correlations were made by comparison of mapped strath heights (the main consideration), lithologic characteristics, and deposit thickness. The interpreted ages of the map units are correlated in **Figure 3**.

QUATERNARY EOLIAN / SLOPEWASH DEPOSITS

Qes **Older eolian sand and slopewash deposits, Española Formation (middle to upper Pleistocene) –** Light brown to reddish yellow to brown to strong brown (7.5YR 6-7/4-6), silt and very fine- to fine-grained sand with minor coarser sand and pebbles. Deposit is generally massive. Pebbles and coarser sand generally located within 0.5 m of the lower contact; pebbles are very fine to coarse, poorly sorted, subangular to subrounded, and granitic. Above 0.5 m from the base, pebbles generally only occupy about 0.5% of the sediment and may have

been emplaced there through bioturbation processes. Coarser sand and pebbles near base probably represent small channel-fill alluvium or slopewash deposits. Finer sediment above was initially deposited by wind but may have been reworked by slopewash. A zone of calcium carbonate precipitation (less than 1 m thick, generally about 0.5 m-thick) has commonly developed in the Tesuque Formation immediately under the base of this deposit. This unit commonly overlies terrace deposits. Correlates to unit **Qes** of Koning (2002a), unit **Qe** of Koning and Manley (2003), and the Española Formation of Galusha and Blick (1971). The Española Formation is reported to contain Rancholabrean-age (approximately 10-300 ka; Tedford *et al*., 1987) fossils that include *Canis dirus*, *Equus*, *Bison*, and *?Camelops* (Galusha and Blick, 1971, p. 80-81). Weakly consolidated and 1-2 m thick.

QUATERNARY ALLUVIUM

Qay **Younger alluvium (Holocene) –** Sand, silty sand, gravelly sand, and sandy gravel, with minor silt beds, that underlie modern valley floors. Beds are mostly planar to lenticular to channel-shaped, and laminated to very thinly- to thick-bedded. Gravel is clast-supported, poorly sorted, subrounded to subangular, and generally consists of pebbles. Correlates to units Qam, Qay2, Qayi, and Qay1 of Koning (2002a) and Koning et al. (2002), and to unit Qay of Koning and Manley (2003). Sand is very fine- to very coarse-grained, subangular to subrounded, and poorly to well sorted. Texture and composition of sediment depend on source area of drainage. Weakly consolidated to loose, but silt beds may be moderately consolidated. Unit generally exceeds 2 m in thickness, but because the basal contact is rarely exposed, maximum thickness is not well constrained.

Qao **Older alluvium (middle to upper Pleistocene) –** Light yellowish brown to very pale brown (10YR 6/4 and 10YR 7/3-4), terrace deposits of sand and gravel; these generally are comprised of channel-fill deposits from tributary drainages for larger modern drainages, and are at various heights relative to the modern streams. Beds are very thin to medium, planar to lenticular to low-angle cross-stratified to channel-shaped. Gravel is clast-supported, subrounded to subangular, and moderately to poorly sorted. Composition depends on source area of sediment. Sand is poorly to moderately sorted, subrounded to subangular, and commonly arkosic. Loose, but there are local calcium carbonate-cemented zones. Up to 9 m thick.

SANTA CRUZ RIVER TERRACES

Qtsc4 **Lower thick terrace deposit of Santa Cruz River (middle to upper Pleistocene) –** Sandy gravel, gravelly sand, sand, and silt. The basal 2-4 m is composed of grayish, clast-supported cobbles with abundant quartzite (about subequal to granite) while the overlying sediment contains much fine-grained sediment (overbank deposits) with about 25-35% coarse channel-fill deposits. Quartzite clasts are rounded to subrounded and generally cobble-size, but granite clasts are subangular to subrounded and generally pebble-size. Gravel clasts in upper sediment are dominated by poorly sorted granite (along with associated feldspar and quartz) with minor quartzite. Upper fine-grained, overbank sediment is light brown to reddish yellow (7.5YR 6/4-6) silt and very fine- to medium-grained sand, with 5-50% coarse- to very coarse-grained sand and pebbles. Strath is 27-37 m above the Santa Cruz River. Unit correlates to Qtsc4 in the Española quadrangle to the southwest (Koning, 2002a), which is interpreted to be around 70-90 or 120-130 ka based on C-14 and amino-acid racemization chronologic data for various Rio Grande terraces presented in Dethier and Reneau (1995) and Dethier and McCoy (1993). Deposit is loose and up to 18 m thick.

Qtsc3 **Middle terrace deposit of Santa Cruz River (middle Pleistocene) –** Loose sand and gravel up to 9 m-thick. Not described in detail on this quadrangle, but on the Española quadrangle to the southwest (Qtsc3 of Koning, 2002a) it is: light yellowish brown to light brown (10-7.5YR 6/4) sandy gravel (color from sand); thin to thick, non-distinct, lenticular to channel-shaped beds; gravel is mostly subrounded, poorly sorted, cobbles with subordinate pebbles; clasts are mostly granite with subordinate quartzite; sand is very fine- to very coarse-grained, poorly sorted, subrounded to subangular, and arkosic to lithic-rich arkosic. Correlates to unit Qtsc3 of Koning (2002a). Strath is 68-72 m above the Santa Cruz River. Comparison of these strath heights (relative to the Rio Grande) with C-14 and amino-acid racemization chronologic data for various Rio Grande terraces presented in Dethier and Reneau (1995) suggests an age of 150-280 ka. Deposit is loose and 1-8 m thick.

Qtsc2 **Upper terrace deposit of Santa Cruz River (lower to middle Pleistocene) –** Sandy gravel; bedding is very poor; gravel has subequal, or slightly more, cobbles compared to pebbles; gravel is clast-supported, subrounded, poorly sorted, and composed of granite with subordinate quartzite and minor quartz. Sand is light yellowish brown to brownish yellow (10YR 6/4-6), medium- to very coarse-grained, subangular, poorly sorted, and arkosic; scoured lower

contact. Correlates to unit Qtsc2 on the Española quadrangle (Koning, 2002a) and Qtsc2 on the San Juan Pueblo quadrangle (Koning and Manley, 2003). Strath is 86-90 m above the Santa Cruz River. Comparison of the strath height with C-14 and amino-acid racemization chronologic data for various Rio Grande terraces presented in Dethier and Reneau (1995) suggests an age of 250-500 ka. Deposit is loose and 1-6 m thick.

Qtsc1 **Uppermost terrace deposit of Santa Cruz River (lower Pleistocene) –** High-level sandy gravel adjacent to the deep canyon cut by the Rio Quemado in the extreme southeast corner of the quadrangle. Gravel is mostly cobbles and boulders, with subordinate pebbles. Clasts are generally subrounded to rounded, and consist of quartzite with 1-5% sheared granite and 20-35% vein quartz (the latter only is found in the pebble fraction, and may be angular to subangular). Deposit south of gorge correlates to Qtsc1 of Koning et al. (2002). Approximately 3-5 m thick.

CAÑADA ANCHA TERRACES

Qta1-3 **Lower, middle, and upper terrace deposits of Cañada Ancha (middle to upper Pleistocene?) –** Sandy gravel with 10-25% boulders and approximately subequal cobbles and pebbles. No clear bedding seen in available exposures; unit is coarser than underlying **Ttac2**. Gravel is clast-supported, poorly sorted, subrounded (granite may be subangular), and granite clasts are subequal or more abundant than quartzite clasts. Sand is subrounded to subangular, moderately to poorly sorted, and arkosic. Loose; generally 1- 2 m-thick. This is a strath terrace that is restricted to the south side of Cañada Ancha and its tributary Cañada de Apache. It is subdivided into three units based on topographic position of the straths; however, because the correlated terrace straths appear to have a lower gradient than the modern arroyo floor (i.e., the terraces converge upstream with the modern arroyo floor), height above the modern valley floor varies considerably for a given terrace:

Qta3: 6-30 m above the modern valley floor.

Qta2: 1-6 m above **Qta3**.

Qta1: 6-9 m above **Qta2**.

CAÑADA DE LAS ENTRAÑAS TERRACE

Qte **Terrace deposits on the south slopes of Cañada de las Entrañas (lower to middle Pleistocene) –** Sandy gravel. Gravel consists of approximately 50% cobbles, 30% pebbles, and 20% boulders (by volume) and composed totally of quartzite. Maximum clast sizes: 45x28, 42x28, 43x18, 30x22, and 32x25 cm.

RIO DE TRUCHAS TERRACES

Qtt1-6 **Terrace deposits of the Rio de Truchas (Pliocene to upper Pleistocene) –** Sandy gravel with minor boulders and approximately subequal cobbles and pebbles; no clear bedding seen in available exposures; coarser than underlying **Ttac2** and **Ttac1**. Generally less than 3 m thick. Six terrace levels are differentiated based on topographic position of the straths. However, because the correlated terrace straths appear to have a lower gradient than the modern arroyo floor (i.e., the terraces converge upstream with the modern arroyo floor), height above the modern valley floor varies considerably for a given terrace:

Qtt6: 24-30 m above the Rio de Truchas.

Qtt5: 12-43 m above the Rio de Truchas.

Qtt4: 30-60 m above the Rio de Truchas.

Qtt3: Approximately 48-84 m above the Rio de Truchas and 8-24 m above **Qtt4.** Locally subdivided into Qtt3a (slightly higher) and Qtt3b (slightly lower).

Qtt2: Also on top of ridge between Cañada Ancha and Rio de Truchas, but approximately 30 m below **Qtt1**.

QTtt1: Occupies top of ridge between Cañada Ancha and Rio de Truchas.

Qttu **Thick fill terrace deposit of Rio de Truchas, undifferentiated (middle to upper Pleistocene) –** Sandy gravel to gravelly sand; bedding is vague and in thin to medium, lenticular to planar beds; more pebbles than cobbles, and 1-10% boulders; gravel is moderately to poorly sorted, subrounded, and consists of quartzite with 20-35% granite, 20-30% quartz (including quartzite), and 1-5% gneiss. Loose to weakly consolidated. Base of deposit not observed, but map relations suggest a maximum thickness of 18-35 m.

Ta **High-level sandy gravel (Pliocene?) –** Sandy gravel composed of pebbles and cobbles with 1-20% boulders (by volume); gravel composed of quartzite with about 10% granite and 10-15% quartz. Bedding not exposed. Loose and up to 25 m thick.

MIOCENE SEDIMENTARY ROCKS

TESUQUE FORMATION

The Tesuque Formation was first proposed by Spiegel and Baldwin (1963) for Miocene basin-fill sediment, composed primarily of pinkish-tan, silty, arkosic sandstone, that was deposited in the Rio Grande Rift near Santa Fe. Galusha and Blick (1971) later subdivided the Tesuque Formation into several members, the pertinent ones for this quadrangle being the Nambé, Skull Ridge, and Pojoaque Members. These three members lie atop of each other in layer-cake fashion, with the Nambé Member at the base and the Pojoaque Member at the top. An additional member-rank unit, the Cejita Member, was proposed by Manley (1976, 1977 and 1979).

Although the author mapped the Nambé, Skull Ridge, and Pojoaque Members in the Cundiyo quadrangle to the south (Koning et al., 2002), lithologic differences between these three members are slight to none on the Chimayo quadrangle. Furthermore, the lithostratigraphic characteristics of their respective contacts are generally not present here. For example, White Ash #1, which constitutes the basal contact of the Skull Ridge Member, is not present on this quadrangle. Also, the upper contact of the Skull Ridge Member was originally defined where a prominent lithosome B fluvial channel-fill sand overlies pinkish siltstone and very fine- to fine-grained sandstone of lithosome A (Galusha and Blick, 1971; Tedford and Barghoorn, 1993) – lithosomes A and B are explained below. Although it is possible to use this relationship to map the upper Skull Ridge contact in the southwestern quadrangle, this relationship is not found as one moves eastward into exclusively alluvial slope sediment associated with lithosome A

(i.e., east of the White Operation fault zone). Due to the difficulties in mapping the Nambe, Skull Ridge, and Pojoaque Members on this quadrangle, and in an attempt to further refine the stratigraphy of the Tesuque Formation in this area, the author differentiated thirty informal units, and one formal unit (the Cejita Member), based on texture and composition. Correlation with the Pojoaque, Skull Ridge, and Nambe Members is attempted, but some lithologic units clearly extend across the projected contacts of these three members. With the exception of unit **Ttue**, these units are summarized in **Table 3**. The contacts between these units are gradational, unless otherwise noted below, and locally approximate.

In terms of composition and sedimentary characteristics, two general lithosomes having unique provenance were differentiated, following Cavazza (1986) (**Figure 4**). Lithosome A is typified by medium to thick, tabular beds (also locally massive) of clayey-silty sandstone interbedded with coarse channel-fill deposits. It was deposited on an alluvial slope (see Smith, 2000b, for discussion of alluvial slopes) along the western flank of the Sangre de Cristo Mountains, and derived from the granite-dominated crystalline bedrock of these mountains south and west of Truchas Peaks. The gravel of lithosome A is composed of granite with subordinate quartzite, and its sand has relatively abundant pinkish potassium feldspar grains. Lithosome B is characterized by very thin to medium, tabular beds of siltstone, very fine- to fine-grained sandstone, mudstone, and claystone (low-energy floodplain deposits) adjoining relatively broad, fluvial channel-fills composed of cobble- to pebble-conglomerate and sandstone. The gravel of lithosome B is much more hetereolithic than that of Lithosome A, and consists of Paleozoic limestone, sandstone, and siltstone with subordinate clasts of quartzite, chert and quartz, felsic to intermediate volcanic rocks, and granite. Lithosome B sand is somewhat greenish gray in color due to the presence of greenish quartz, probably derived from erosion of Paleozoic sandstone, in addition to minor

volcanic grains (neither of these is generally seen in lithosome A sand). Within lithosome A or B, the sediment is further subdivided based on gross texture, which also considers the relative abundance of channel-fills in the unit. Subdividing lithosome A on the basis of texture generally results in finer units corresponding to the distal part of the alluvial slope and coarser units corresponding to the medial and proximal parts of the alluvial slope.

Three terms utilized in the following descriptions need to be explained. One, "extra-channel sediment" is an informal term used by the author for clayey-silty sandstone and pebbly silty-clayey sandstone generally deposited in medium to thick, tabular beds which do not appear to fill discrete or well-defined channels. They are relatively structureless or bioturbated, and locally contain reddish, Bt or Bw soil horizons at their tops, typically 10-30 cm-thick. Consequently, the author interprets extra-channel sediment as representing either: 1) depositional lobes deposited on the alluvial slope at the mouths of discontinuous gullies (see Bull, 1997, for discussion of aggradation found at the mouths of discontinuous, ephemeral gullied streams in the southwest United States), or 2) they were deposited in very broad channels so that a discrete channel form is not noticeable in most outcrops. In either case, extra-channel sediment appears to have been emplaced relatively quickly and in sufficient volume to form a local topographic high on the alluvial slope, on which there was surface stability and opportunity for bioturbation and soil development. Two, channel sediment generally is present as thick complexes of stacked channel-fills, within which are smaller-scale channel bedding; the following descriptions discriminate between these "channel-fill complexes" and their smaller-scale "internal bedding." Third, the term "northeast-derived lithics" signifies detritus containing greenish quartz and lesser amounts of volcanic sand grains. The greenish quartz grains are probably derived from erosion of

Paleozoic strata in the Sangre de Cristo Mountains. Northeast-derived lithics are generally found in sand associated with lithosome B gravel.

It is important to note that these thirty-one Tesuque Formation map units are lithostratigraphic units and do not correspond to geochronostratigraphic units. As such, they are almost all diachronous to some extent, and many climb and become younger to the west (particularly those associated with lithosome A). Age control for these units is obtained from published dates of tephra found within them in addition to fossil data. In general, the units on this quadrangle probably have age ranges within 30 to 7 Ma, with most exposed units having age ranges within 18-7 Ma. The entire Tesuque Formation is likely up to 2.1 km thick in the western part of the quadrangle, but the thickness of a given lithostratigraphic unit may vary with distance. Detailed descriptive data for most of these units is also provided in **Appendix I**, which lists description data and location data for four stratigraphic sections measured in the Santa Cruz escarpment. These lithostratigraphic units are plotted and correlated in **Figure 3 and Plate I.** The stratigraphic relations of units exposed in the Santa Fe escarpment are illustrated in **Plate I (presented in a separate PDF file due to size)**.

TABLE 3. SUMMARY OF LITHOSTRATIGRAPHIC UNITS WITHIN TESUQUE FORMATION IN THE CHIMAYO 7.5-MINUTE QUADRANGLE[1]

LITHOSOME B	MIXED PROVENANCE	LITHOSOME A
		Ttaq1: Unconsolidated Ttaq. Same stratigraphic position as unit **Ttac2**; overlies **Ttaq1** over a gradational contact.
		Ttaq1: Like **Ttac1** but clast assemblage is generally dominated by quartzite. Grades laterally southwestward into unit **Ttac1**.
Ttbc: Fluvial floodplain mudstone and siltstone with minor thick, tabular channel complexes of conglomerate and sandstone; channels are generally loose. Interbedded within unit **Ttac1** in the northwest quadrant. Lower part of unit (exposed in the Santa Cruz escarpment) is channel conglomerate and sandstone in thick to very thick, tabular channel complexes; channels have cross-stratification up to 1.5 m-thick; 5-30% of channels strongly cemented. Associated floodplain deposits consist of siltstone, fine sandstone, and claystone. Granitic clasts are most abundant near basal contact. Basal contact is significantly scoured and may be a disconformity.		**Ttac2:** Like **Ttac1** but coarser (generally sand and gravel channels, with <30% sandy extra-channel sediment). Non- to weakly consolidated and non-cemented. Generally 25-50% cobbles and 1-5% boulders in gravel fraction. Overlies unit **Ttac1** over a gradational contact.
		Ttac1: Slightly-silty sandstone extra-

LITHOSOME B	MIXED PROVENANCE	LITHOSOME A
		channel deposits with >20% channel-fills of pebble-conglomerate to pebbly sandstone. Channels are commonly strongly cemented, particularly in lower part of unit; mostly pebbles in gravel fraction, with minor cobbles. Overlies units **Ttaf1** and **Ttbc** over gradational contacts.
		Ttaf2: Extra-channel and overbank deposits of silty very fine- to medium-grained sandstone with 35-50% coarse channels of pebbly sandstone and sandy pebble-conglomerate. No cemented beds observed. Light brown to reddish yellow color. Otherwise similar to unit **Ttaf1** (except this has more cobbles and is grossly coarser); unit grades westward into unit **Ttaf1**.
	Ttbp2: Lithosome B fluvial sediment interbedded with subordinate sediment of unit **Ttaf1**. Lithosome B sediment consists of floodplain deposits of claystone, mudstone, and siltstone, together with subordinate thick to very thick (up to 300 cm), tabular to lenticular channel complexes of sandstone and some pebbly sandstone. Underlies and interbedded with unit **Ttaf1**, and overlies units **Ttmp2**.	**Ttaf1:** Extra-channel and overbank deposits of silty very fine- to medium-grained sandstone with 3-30% (generally 3-20%) coarse channels of pebbly sandstone and sandy pebble-conglomerate. 10-50% of channels are strongly cemented. Weakly to moderately consolidated and erodes more readily than overlying strata. Upper part of unit grades laterally eastward into **Ttaf2**. Unit overlies **Ttam**, **Ttms**, and **Ttbp2**.
	Ttmp2: Siltstone and very fine- to fine-	**Ttap1**: Extra-channel and overbank

LITHOSOME B	MIXED PROVENANCE	LITHOSOME A
	grained sandstone in thick and tabular beds; 1-5% of sediment is composed of channel complexes up to 1 m thick. Grades laterally eastward into **Ttaf1** probably also grades laterally into **Ttap1**.	deposits with 3-5% coarse channels of pebbly sandstone and sandstone. Extra-channel and overbank deposits consist of very fine- to fine-grained sandstone and siltstone, with minor mudstone. Coarse channels commonly fine-upward, with pebbles locally near base, and are arkosic.
Ttbp1 and Ttbs: Floodplain siltstone and very fine- to fine-grained sandstone with 3-10% pale brown (10YR 6/3) channel sandstone and conglomerate. Channel complexes are tabular to broadly lenticular, and individual channels are generally up to 60 cm deep; channels are locally indurated by calcium carbonate but otherwise are loose; A thick (up to 15 m) interval of aeolian fine sandstone is observed west of the mouth of Arroyo de la Marada, where tangential cross-bedding is up to 90 cm tall. Unit **Ttpb1** underlies **Ttmp1**. Unit Ttbsr underlies **Ttas2**.	**Ttmp1:** Interbedded Lithosomes A and B, and commonly a ledge-former. Lithosome A consists of silty very fine to medium-grained sandstone and siltstone in thick, tabular beds; minor sandstone channels. Lithosome B consists of floodplain deposits of siltstone, mudstone, and fine sandstone, with subordinate channel deposits of sandstone, pebbly sandstone, and pebble-conglomerate. The channels are in complexes up to 1.5 m. thick. Unit overlies **Ttan5** and underlies **Ttac1**.	**Ttam:** Extra-channel and overbank deposits with 3-10% coarse channels of pebbly sandstone and sandy pebble-conglomerate. Extra-channel and overbank deposits consist of silty very fine- to medium-grained sandstone together with minor siltstone and claystone. Channel deposits are composed of pebbly sandstone and sandstone with minor sandy pebble-conglomerate (subordinate cobbles), and are in medium to thick, tabular channel complexes up to 150 cm-thick. Channels are loose to strongly cemented. Unit becomes coarser (e.g., more gravel in channels and higher relative proportion of cobbles to pebbles) and more channel rich (up to 40% channel deposits) towards Sangre de Cristo Mountains. Unit underlies **Ttaf1** and overlies **Ttas1**, **Ttbn4**, and **Ttan5**. Unit grades laterally westward into **Ttas2**.

LITHOSOME B	MIXED PROVENANCE	LITHOSOME A
	Ttms: Lithosome A alluvial slope sediment interbedded with zones of Lithosome B fluvial sediment. The former consists of very fine- to fine-grained sandstone and siltstone in medium to thick, tabular beds; 1-5% channel complexes, up to 80 cm thick, composed of fine- to very coarse-grained sandstone with local granitic pebbles. Lithosome B fluvial sediment consists of floodplain deposits of siltstone, mudstone, and fine sandstone, with minor channel deposits up to 1.5 m thick composed of gravelly sandstone. Lithosome A channels are weakly to strongly cemented, but Lithosome B channels are generally loose to weakly cemented. Most of unit is lithosome B.	**Ttas2:** Siltstone and silty very fine- to fine-grained sandstone with less than 3% relatively coarser channel deposits; beds are medium to thick and tabular, or else massive. Channel complexes are locally up to 1-2 m in thickness, but generally only 10-30 cm thick and lenticular, and composed of fine- to medium-grained sand. Locally, this unit contains abundant mudstone in thick, tabular beds or else massive. Unit is well to moderately consolidated and channels are weakly to strongly cemented. Grades laterally eastward into unit **Ttam**; underlies unit **Ttaf1** and overlies unit **Ttms**.
	Ttmn: Interbedded Lithosomes A and B. Lithosome B generally consists of siltstone and mudstone floodplain deposits; about 5-10% channel complexes up to 2 m thick that are composed of pebbly sandstone and sandy pebbles. Lithosome A generally consists of pinkish very fine- to fine-grained sandstone with subordinate siltstone and mudstone; about 10% channel complexes up to 6 m thick that are composed of pebbly sandstone. Many channels in unit have pebble	**Ttas1:** Siltstone and silty very fine- to fine-grained sandstone with less than 3% coarse channel deposits; beds are thin to thick (mostly medium to thick) and tabular; minor mudstone beds. Channels are in complexes up to 1 m thick and composed of sandstone, locally with fine granitic pebbles. Well to moderately consolidated and channels are weakly to strongly cemented. Unit is commonly a ledge-former. Unit underlies **Ttam** and overlies fluvial Lithosome B units

LITHOSOME B	MIXED PROVENANCE	LITHOSOME A
	composition that reflects mixing of Lithosome B with granite-rich alluvial slope sediment of Lithosome A.	correlative with **Ttbn4** and **Ttbn3**.
Ttb4: Large, relatively coarse channel deposits of fine- to coarse-grained sand, with minor very coarse sand, pebbles, and cobbles (subequal or more pebbles than cobbles). Loose to weakly consolidated; generally non to weakly cemented with local moderate to strong cementation. Overlies **Ttbn3** and underlies **Ttam**.		
Ttbn3: Mudstone and siltstone floodplain deposits. Bedding is thin to thick and tabular. Weakly to moderately consolidated and non-cemented. Unit includes minor channel deposits of pebbly sandstone and very fine- to medium-grained sandstone. Underlies **Ttbn4** and overlies **Ttan5**.		
Ttbn2: Sandy conglomerate to pebbly sand; estimate ¾ : ¼ cobbles to pebbles; about half of channel is strongly cemented, but cementation is discontinuous. Interbedded within **Ttbn1** and **Ttan5**.		
Ttbn1: Siltstone, mudstone, and sandstone; not well exposed; sand is very fine- to medium-grained. Interbedded within **Ttan5** and **Ttbn2**.		
		Ttan5: Silty very fine- to medium-grained sandstone and siltstone to

LITHOSOME B	MIXED PROVENANCE	LITHOSOME A
		mudstone; medium to thick, tabular beds. Interbedded amongst **Ttan4** and **Ttnr2**.
	Ttnr2: Red to light reddish brown (2.5YR 5/6 to 5YR 6/4) pebbly sandstone to sandy pebble- conglomerate channel deposits (cobbles locally comprise up to 60% of the gravel); bedding is very thin to medium, and planar to lenticular (trace channel-shaped); maximum measured channel depth of 15 cm. To north, there is subordinate overbank sediment of muddy very fine- to medium-grained sandstone. Interbedded amongst **Ttan4** and **Ttan5**.	**Ttan4:** Extra-channel deposits with subordinate to subequal (25-70%) coarse channel deposits near Arroyo de la Ancha; proportion of channels increases to 80-100% southwards towards bedrock highs. Extra-channel sediment consists of very fine- to fine-grained sand with subordinate medium- to very coarse-grained sand (sand becomes coarser southward towards bedrock highs); massive or in medium to very thick, tabular beds; moderately to well consolidated and weakly cemented. Channel sediment consists of pebbly sandstone, sandstone, and sandy pebble-conglomerate – sediment becomes redder, and sandy pebble-conglomerate more common, towards bedrock hills to south; locally cobbles comprise up to 60% of gravel; channel complexes are up to 1 m-thick and tabular. Interbedded amongst **Ttan5** and **Ttnr2**.
		Ttan3: Extra-channel and overbank deposits consisting of silty very fine- to medium-grained sandstone with minor siltstone; massive. Less than 5% channel complexes (up to 150 cm-thick and having a broad lenticular shape) consisting of pebbly fine- to very coarse-

LITHOSOME B	MIXED PROVENANCE	LITHOSOME A
		grained sand that locally grades downward into a sandy pebble-conglomerate. Generally weakly to moderately consolidated and non- to weakly cemented by calcium carbonate. Overlies **Ttan2** and **Ttan1**, and underlies **Ttam** and **Ttan4**.
		Ttan2: Extra-channel deposits interbedded with 25-60% channel deposits. Extra-channel sediment consists of very fine- to very coarse-grained sandstone (mostly very fine- to medium-grained); massive or in thick to very thick, tabular beds; weakly to well consolidated with weak to moderate cementation by calcium carbonate. Channel complexes consist of pebbly sandstone and sandy pebble-conglomerate, and is in medium to thick, broadly lenticular to tabular channel complexes up to 4 m-thick; gravel includes minor cobbles; weakly to strongly cemented by calcium carbonate. Underlies **Ttan5** and overlies **Ttan1**.
	Ttnr1: Reddish pebbly sandstone to sandy pebble- conglomerate channel deposits (cobbles comprise up to 35% of the gravel); bedding is very thin to medium and planar to lenticular (minor channel-shaped); maximum measured channel depth of 70 cm. Moderately	**Ttan1:** Extra-channel deposits interbedded with 40% - 90%(?) coarse channel deposits; proportion of channels increases towards the mountains as to comprise virtually all of the sediment, channel sediment also becomes redder (near Proterozoic bedrock exposures due

LITHOSOME B	MIXED PROVENANCE	LITHOSOME A
	consolidated and weakly to strongly cemented. Interbedded within **Ttan1**.	to clay coatings on the grains. Extra-channel sediment consists of clayey (estimate 5-10% clay) very fine- to very coarse-grained sandstone (mostly very fine- to medium-grained away from bedrock exposures); massive or in thick to very thick, tabular beds. Channel sediment consists of pebbly sandstone and sandy pebble-conglomerate, and is in channel complexes up to 1.5 m-thick; up to 30% of gravel are cobbles; weakly consolidated and non- to strongly cemented. Underlies **Ttan2** and **Ttan3**.

Note:

[1] Unit **Ttue** not included.

Ttac2 **Lithosome A, coarse upper unit, non-cemented (upper middle to upper Miocene) –** Non-cemented sandy gravel and gravelly sand channel-fill complexes interbedded with minor (less than 30%), slightly-muddy, extra-channel sediment consisting of sand. Channel-fill complexes are tabular and up to 90 cm-thick; internal bedding is laminated to very thin to medium, planar to lenticular (only minor channel-shaped and minor low-angle, planar cross-stratification). Gravel are commonly clast-supported, subrounded to rounded (quartzite) and subrounded to subangular (granite), poorly to moderately sorted, locally imbricated as to indicate northwest-directed paleoflow, and consist of pebbles, 20-50% cobbles, and 1-5% boulders. Granite clasts generally exceed quartzite clasts in abundance, but some beds have greater quartzite than granite, particularly near the laterally gradational contact with unit **Ttaq2**. Channel-fill sand is very pale brown (10YR 7/3-4) to light yellowish brown (10YR 6/4), fine- to very coarse-grained (mostly medium- to very coarse-grained), subangular to angular, poorly to moderately sorted, and arkosic arenite; sand is commonly planar-laminated or planar-very thinly bedded. Extra-channel sediment is light brown to reddish yellow (7.5YR 6/4-6), slightly clayey-silty, very fine- to very coarse-grained sand; medium to thick, tabular beds; sand is very fine- to very coarse-grained (mostly fine- to medium-grained), subangular to angular; moderately to poorly sorted, arkosic arenite, and may include 1-20% scattered pebbles. Extra-channel sediment is weakly to moderately consolidated; channel sediment is generally loose to weakly consolidated, with possibly trace strongly cemented beds interspersed in non-cemented strata near its lower contact. Local paleosols compose 1-3% of exposure, are 10-30 cm thick, and generally marked by having a reddish Bw or Bt horizon(s) with moderate to strong, coarse, subangular to angular blocky ped structure. This unit is generally found under the highest surfaces of the plateau in the central and northeastern parts of the quadrangle and differs from the underlying **Ttac1** unit by being generally non-cemented and coarser, and the contact between the two is gradational over ~30 m; the contact is generally mapped at the top of the gradational zone. Since the Alcalde tuffaceous zone and the Española tephra zone locally extends across both **Ttac1** and **Ttac2**, the two are interpreted as basically one unit which has undergone different degrees of cementation based on texture and amount of burial. That the two units mainly differ because of diagenesis (or cementation) is also suggested by the irregular map pattern of the basal contact of this unit (i.e., 2 km west and 3 km south-southeast of the center of the quadrangle). **Ttac2** may never have been buried to great depths by younger strata and stayed above the saturated zone, resulting in little to no cementation. Local unconformities are likely near the top of the unit. It was deposited on a medial to proximal alluvial slope in a

relatively high-energy depositional environment. This unit contains the coarse white zone, the Española tephra zone, and the Alcalde tuffaceous zone (these extend from unit **Ttac1** into the lowermost part of this unit). One of the coarse white ashes at the head of Arroyo de Cueva in the southeast quadrant (UTM coord: 3988470 N, 419720 E ± 20 m) was dated at 12.7 Ma using zircon fission-track dating methods (Manley, 1979). The Pojoaque white ash zone has not been found in this unit. Thus, this unit is interpreted as having an age of 13 to 8 Ma, and possibly even younger near the very top of the unit. 150-170 m thick.

Ttac1 **Lithosome A, coarse upper unit (upper middle to upper Miocene) –** Slightly clayey-silty sandstone extra-channel deposits interbedded with greater than 15% coarse channel-fill deposits of sandy conglomerate to gravelly sandstone. Extra-channel sediment is pink to very pale brown (7.5-10YR 7/3-4) and light brown (7.5YR 6/4), the silt-clay content is estimated at 1-5%, and it generally is moderately to well consolidated and weakly cemented by calcium carbonate; bedding is thin to very thick (mostly medium to very thick) and tabular, also locally structureless. Its sandstone is an arkosic arenite, subangular, poorly sorted, and is generally very fine- to coarse-grained, with minor very coarse sand and trace to 3% scattered pebbles. Trace to 3% siltstone and claystone in very thin to thin, tabular beds or planar-laminations. Coarse channel-fill deposits are in medium to very thick, tabular to broadly lenticular channel-fill complexes; internal bedding is very thin to medium, planar to lenticular to channel-shaped (general channel trend is west to north); maximum channel depth generally is ~60 cm. Conglomerate is clast-supported, includes pebbles with minor cobbles, poorly to moderately sorted, and composed of granite (subangular to subrounded) with subordinate quartzite (subrounded to rounded). Channel-fill arkosic arenite sandstone may be planar-laminated and is medium- to very coarse-grained, subangular, poorly to moderately sorted; commonly exhibits moderate to strong cementation by calcium carbonate, especially near channel bases. Paleosols occupy 1-5% of sediment volume. These are commonly 20-30 cm in total thickness and contain a 10-25 cm-thick reddish yellow to yellowish red (7.5YR 6/6 and 5YR 5-6/6) Bt or Bw horizon, often with a moderate to strong, medium to coarse, subangular to angular blocky ped structure, and locally overlie a calcic horizon exhibiting Stage I carbonate morphology. Lower contact is gradational with units **Ttbc** (to west) and **Ttaf1** (to east). Above unit **Ttaf1** this gradation covers 15-50 m of stratigraphic distance; the basal contact was placed at the top of this gradational interval, specifically at the base of the lowest, strongly cemented channel-fill above which coarse channel-fills occupy greater than ~20% of the sediment volume. Where it overlies unit **Ttbc**, the contact was placed at the

first appearance of lithosome A-dominated sand or gravel, above the highest floodplain deposits associated with lithosome B. It was deposited on a medial to proximal alluvial slope in a relatively high-energy depositional environment. The unit contains the coarse white ash zone, the Española tephra zone, and the Alcalde tuffaceous zone, and appears to lie above the Pojoaque White Ash zone. Thus, it is interpreted to range in age from 13.2 to 7 Ma on this quadrangle. 130-230 m thick.

Ttaq2 **Quartzite-dominated, coarse unit of upper Tesuque Formation, non-cemented (upper middle to upper Miocene) –** Similar in sedimentologic properties to unit **Ttac2** except that quartzite clasts are generally more abundant than granite clasts and sand grains are more subrounded; non-cemented and loose to weakly consolidated. Lower contact of this unit is gradational (over 12-25 m) with the underlying unit **Ttaq1** and is well-exposed on the ridge northeast of Rio de Truchas. This unit is in the same stratigraphic position as unit **Ttac2**, and its age range is also probably 13-8 Ma. 150-170 m thick.

Ttaq1 **Quartzite-dominated, coarse unit of upper Tesuque Formation (upper middle to upper Miocene) –** Similar in sedimentologic properties to unit **Ttac1** except that quartzite clasts are generally more abundant than granite clasts and the sand is more subrounded. In the Velarde quadrangle 0.5-1.0 km to the north of the Chimayo quadrangle, this unit contains the basal black ash of the Alcalde tuffaceous zone, which has an $^{40}Ar/^{39}Ar$ age of 9.4 ± 0.46 Ma. Base of unit is probably in a similar stratigraphic position as that of **Ttac1**. Thus, the interpreted age of the unit on this quadrangle is 13-9 Ma. 130-150 m thick.

Ttue **Primary and fluvially reworked eolian deposits of the upper Tesuque Formation (upper Miocene) –**Unit is interbedded with a few fluvial channel-fills that are medium, tabular- to lenticular-bedded and composed of sandstone and pebbly sandstone (internal planar-laminations); pebbles are granitic; very sparse, thin claystone beds are associated with these channel-fills; both the claystone and the channel-fills become more abundant near the unit's lower and upper contacts. Unit is moderately consolidated and interbedded within unit **Ttac1**. It is interpreted to represent eolian deposition on the distal lithosome A alluvial slope in the upper Miocene. Unit lies at least 6 m above the upper beds of the Alcalde tuffaceous zone, one of which had an $^{40}Ar/^{39}Ar$ age of 9.4 ± 0.46 Ma. Accordingly, this unit is probably around 9 Ma. 4-24 m thick.

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Ttbc **Lithosome B, Cejita Member (upper middle to upper Miocene) –** This unit is best described in two sections. The lower section, exposed along the escarpment north of the Santa Clara River, consists of fluvial sandstone and conglomerate channel-fill deposits and associated floodplain deposits of silt, fine sand, and clay. Channel deposits are in thick to very thick, tabular channel-fill complexes that are internally very thin to thick, planar- to lenticular-bedded or channel-shaped; common thin to medium, planar to tangential cross-bedding and local epsilon foresets up to 150 cm tall. Conglomerate is clast-supported, composed of pebbles with 20-50% cobbles, and the clasts are poorly to moderately sorted, locally imbricated (giving south to west paleo-flow), and generally subrounded. The ratio of lithosome B : lithosome A provenance increases up-section. A clast count at the base of the Cejita Member (unit 25b of Martinez section; Appendix 1) gives: 40% granite, 22% quartzite, 13% quartz, 15% Paleozoic limestone, 9% Paleozoic siltstone and sandstone, and 1% mylonite. Clast at a site 2-3 m below transitional contact with overlying **Ttac1**, gives: 4% granite, 7% quartzite, 9% quartz, 1% mafic-rich rock, 2% hypabyssal felsic intrusive, 19% greenish to grayish Paleozoic, 57% Paleozoic limestone, and 1% mylonite. Channel-fill sand may be in planar-laminations or very thin beds; sandstone is pale brown to light yellowish brown (10YR 6/3-4) and very pale brown (10YR 7/3), fine- to very coarse-grained, subangular to subrounded, moderately to poorly sorted, and a litharenite to lithic arkose (ratio of 50-65% northeast-derived lithics : 50-35% potassium feldspar). Channel-fills commonly fine-upward. Floodplain deposits consist of pale brown to light yellowish brown (2.5Y-10YR 6/3), light gray (10YR 7/2), and light brown to reddish yellow (7.5YR 6/4-6) siltstone, very fine- to medium-grained sandstone, and brown (7.5YR 5/3-4) mudstone and claystone; very thin to thin, tabular beds and planar laminations; 1-10% medium, lenticular channel-fills of fine- to coarse-grained sand are present within the floodplain deposits; locally, floodplain deposits have ~5% laminae that are strongly cemented by calcium carbonate; floodplain sand is well sorted, subrounded to subangular, and has subequal potassium feldspar : northeast-derived lithic grains. Lower 4-8(?) m of unit is a light gray (10YR 7/1-2) pebble-conglomerate dominated by granitic clasts with 1-3% lithosome B clasts; the sediment is generally planar-, very thinly-bedded, with minor tangential cross-stratification up to 20 cm-thick; this basal granitic conglomerate probably represents input onto the lithosome B fluvial plain by lithosome A tributaries. Weakly to well consolidated, and non- to strongly-cemented by calcium carbonate; about 5-30% of channel-fills are strongly to moderately cemented by calcium carbonate. Upper contact is conformable with unit **Ttac1** and the lower contact with unit **Ttaf1** is disconformable: it is

sharp and scoured with up to 60 cm of relief, and contains large rip-ups (up to 140 cm long) of underlying strata. Up to 50 m-thick near western quadrangle boundary but pinches out to east. Sediment deposited by a large fluvial system derived from the Sangre de Cristo Mountains north of Truchas Peaks, but mixed with significant granite-rich detritus derived from the Sangre de Cristo Mountains south and west of Truchas Peaks. The lower section of the Cejita Member lies stratigraphically above the Pojoaque White zone and below the coarse white ash zone. Northeast of the town of Llano (~2 km west of the western quadrangle boundary), fossils assigned to the late Barstovian land mammal "age" (14.9-12.5 Ma; Tedford et al., 2004) were located in strata either in the basal part of this unit or in **Ttaf1** strata intebedded in the basal part of this unit (Gary Morgan and Dave Love, personal communication, 2004). Based on these geochronologic data, the age range of the lower, coarser part of the Cejita Member is about 13.0-12.8 Ma Ma. Up to 80 m thick.

The upper section of the Cejita Member, exposed in the northwest corner of the quadrangle, generally consists of floodplain deposits with minor channel-fill complexes of conglomerate and sandstone. Floodplain deposits are comprised of thin to thick, tabular beds of brown to light brown (7.5YR 5-6/4) and light yellowish brown to pale brown (10YR 6/3-4) mudstone and pale brown to very pale brown (10YR 6-7/3) siltstone, moderately consolidated. Channel-fill complexes are generally tabular and thick; internal bedding is laminated to very thin to thick, lenticular to planar; gravel is generally pebbles with 10-25% cobbles; clasts are subrounded to rounded and poorly to moderately sorted. Clast count at Arroyo del Pueblo yields: 39% quartzite, 30% grayish Paleozoic limestone, 20% Paleozoic sandstone and siltstone, 5% granite, 4% quartz, 2% unidentified. Channel-fill sandstone may be laminated, and is generally light yellowish brown to pale brown (2.5Y-10YR 6/3) or pale yellow (2.5Y 7/3), subangular to subrounded, moderately to poorly sorted, and litharenite (about 75% northeast-derived lithics : 25% to potassium feldspar). Only minor strong to moderate cementation; channel-fills are generally loose. Deposited in a fluvial environment by a river sourced in the Sangre de Cristo Mountains north of Truchas Peaks. Unit contains the basal black ash of the Alcalde tuffaceous zone (see description below), which projects just above (within 10-15 m) of the Osbornoceros Quarry of Galusha and Blick (1971). The Osbornoceros Quarry was thought to contain a Hemphillian faunal assemblage such as found in strata north of the Rio Chama-Rio Grande confluence (Galusha and Blick, 1971; Tedford and Barghoorn, 1993; MacFadden, 1977). However, recent $^{40}Ar/^{39}Ar$ dating of the upper, pumiceous bed of the Alcalde pumiceous zone returned an age of 9.4 ± 0.46 Ma, which would make the Osbornoceroso quarry in the range

of 9.5-10 Ma. The exposed upper Cejita Member on this quadrangle is at least 20 m thick, and probably 9-10 Ma.

Ttaf2 **Lithosome A, finer upper unit, non-cemented (lower to middle Miocene) –** Extra-channel sediment with 35-50% channel-fill complexes. Sediment similar to unit **Ttaf1** (see below) but is weakly to moderately consolidated and lacks cemented channel-fills. Extra-channel sediment is structureless and composed of a light brown to reddish yellow (7.5YR 6/4-6), subangular, moderately sorted, silty very fine- to medium-grained (minor coarse and very coarse) arkosic arenite sandstone. Channel-fill complexes are comprised of 1-2 m thick pebbly arkosic arenite sandstones, medium- to very coarse-grained, subangular, poorly sorted, and conglomerates. Conglomerate gravels contain 15-30% poorly sorted cobbles, and consist of ~35-50% rounded to subrounded quartzite clasts, and 50-65% subrounded to subangular granite clasts. Internal channel-fill bedding is very thin to medium, lenticular to planar. Contact with the underlying **Ttaf1** unit is gradational over about 30 m. Unit grades upward into **Ttac1** and was deposited on a medial alluvial slope associated with Lithosome A. Age is probably similar to that of **Ttaf1** (13-17 Ma). Approximately 65-70 m thick.

Ttaf1 **Lithosome A, finer upper unit (lower to middle Miocene) –** Extra-channel and overbank deposits with 3-30% (mostly 3-20%) coarse channel-fills of pebbly sandstone and sandy pebble-conglomerate. Extra-channel sediment consists of an arkosic arenite silty sandstone, pink to very pale brown (7.5-10YR 7/3-4), reddish yellow (7.5YR 6/6), light brown (7.5YR 6/4), and light yellowish brown (10YR 6/4), very fine- to medium-grained (minor coarse- to very coarse-grained sand), subangular to subrounded, and moderately to well sorted; bedding is medium to thick (minor thin) or structureless. Overbank sediment consists of siltstone, very fine- to medium-grained sandstone, and subordinate mudstone (the latter is commonly in brown to light brown (7.5YR 5-6/4), thin to thick, tabular beds). Well to moderately consolidated. Channel-fills are in tabular to lenticular complexes up to 150 cm thick; internal bedding is thin to thick, planar to lenticular to channel-shaped, with planar-laminations to planar cross-laminations up to 5-6 cm tall. Channel-fills are composed of fine- to very coarse-grained sandstone and sandy-pebble conglomerate. The conglomerate is clast-supported, dominated by pebbles (with a ratio of 1-35% cobbles : 99-65% pebbles), and clasts are subrounded to subangular, poorly to moderately sorted, and composed of granite with 3-45% quartzite (generally 5% quartzite). Channel-fill sandstone is arkosic arenite, typically fine- to very coarse-grained, subangular to subrounded, and moderately to poorly sorted. 10-50% of

channel-fills are strongly to moderately cemented, while the remainder are weakly to non-cemented.

The uppermost part of this unit tends to be redder, which corresponds to the "salmon interval" of Galusha and Blick (1971) and the Ttap2 unit of Koning (2002a) and Koning and Manley (2003). Near the eastern quadrangle boundary, the ratio of channel-fills to extra-channel sediment increases to about 25-40% : 75-60%; the amount of quartzite clasts within the gravel also increases to 35-50%. Lower contact is gradational. Weakly to moderately consolidated and erodes more readily than overlying strata. **Ttaf1** underlies **Ttbc** and **Ttacu**, and overlies **Ttbp2**, **Ttmp1**, **Ttbp1**, **Ttms**, and **Ttam**. It was deposited on a distal to medial alluvial slope associated with lithosome A, and contains the Pojoaque White Ash zone in its upper portions. Between Arroyo de los Ajuelos and Cañada de los Mogote, it contains the "upper Skull Ridge white ash," which may correlate with the upper white ashes of the Skull Ridge Member of Galusha and Blick (1971). If the latter correlation is correct, the base of this unit may possibly include strata containing the Road Ash of Izett and Obradovich (2001), which returned an $^{40}Ar/^{39}Ar$ age of 15.1 ± 0.06 Ma. Based on age data for these two tephra intervals (Izett and Obradovich, 2001), the age of the western part of this unit is likely 13-15.2 Ma. However, the fence diagram of **Figure 5** indicates that the eastern part of this unit is probably older than that in the eastern part, perhaps extending to 16-17 Ma. 80-120 m thick.

Ttap1 **Lower lithosome A unit in Pojoaque Member (middle Miocene) –** Extra-channel and overbank deposits with 3-5% coarse channel-fills of pebbly sandstone and sandstone. Extra-channel and overbank deposits consist of light yellowish brown (10YR 6/4) to reddish yellow (7.5YR 6/6), very fine- to fine-grained sandstone and siltstone, with minor brown (7.5YR 5/4) mudstone. Coarse channel-fills commonly fine-upward, with pebbles locally near base, and are arkosic. Unit contains at least two strongly cemented ashes and ashy sandstones up to 50 cm thick. Channel-fills are commonly moderately to strongly cemented; extra-channel and overbank sediment are weakly to moderately consolidated. Unit correlates to unit Ttap1 in the San Juan Pueblo quadrangle to the west (Koning and Manley, 2003). White ashes in this unit appear to lie below the Pojoaque white ash zone, so this unit probably has an age of 14-15 Ma. Approximately 15-20(?) m thick.

Ttam **Middle lithosome A unit in Tesuque Formation (lower to middle Miocene) –** Extra-channel and overbank deposits with 3-10% coarse channel-fills of pebbly sandstone and sandy pebble-conglomerate. Extra-channel and overbank deposits consist of pink to light brown (7.5YR 6-7/4), with local reddish yellow

(7.5YR 6/6) or light yellowish brown (10YR 6/4), silty very fine- to medium-grained sandstone together with minor tabular beds of siltstone and claystone. Sandstone is an arkosic arenite, subangular, moderately to well sorted, and weakly to well consolidated. Channel-fill deposits are composed of pebbly sandstone and sandstone with minor sandy pebble-conglomerate (subordinate cobbles), and are in medium to thick, tabular channel-fill complexes up to 150 cm-thick. Internal bedding is very thin to thick, planar to lenticular to channel-shaped, planar laminations also present in sand and there is local cross-stratification with foresets up to 40 cm-thick. Pebbly beds are clast-supported, subrounded to subangular, poorly to moderately sorted, and composed of granite with subordinate quartzite. Channel-fill sandstone is an arkosic arenite, pink (7.5YR 7-8/3) to very pale brown (10YR 7/3) to light yellowish brown (10YR 6/4), and fine- to very coarse-grained, subangular (some subrounded), poorly to well sorted, and loosely to strongly cemented by calcium carbonate. Unit becomes coarser (e.g., more gravel in channel-fills and higher relative proportion of cobbles to pebbles) and contains more channel-fills (up to 30-40% channel-fill deposits) towards the Sangre de Cristo Mountains near the eastern quadrangle boundary. It generally underlies **Ttaf1**, and overlies various units that include **Ttas1**, **Ttbn3,** and **Ttbn4**. Unit deposited on a distal to medial alluvial slope associated with lithosome A. Unit generally lies below the "upper Skull Ridge white ash," which may possibly correlate with one of the upper Skull Ridge Member white ashes depicted in Galusha and Blick (1971). One of these upper Skull Ridge Member ashes, informally called the Road Ash, was dated at 15.1 ±0.06 Ma. Ma by $^{40}Ar/^{-39}Ar$ methods (Izett and Obradovich, 2001). Along the west margin of Arroyo de los Encinos, this unit also includes White Ash #4, dated at 15.3-15.5 Ma by $^{40}Ar/^{39}Ar$ methods (Izett and Obradovich, 2001; McIntosh and Quade, 1995). In the southeastern quadrant, this unit likely includes strata correlative to the upper Nambé Member of Galusha and Blick (1971), the age of which is discussed in Koning et al. (2002). Thus, unit **Ttam** may range in age from 15 to 18 Ma, and predominantly lies in the Skull Ridge and Nambé Members of the Tesuque Formation, but it may possibly extend into the lowest Pojoaque Member at its westernmost extent. 120-170 m.

Ttas2 **Upper lithosome A unit of Skull Ridge Member (middle Miocene) –** Pink to very pale brown (7.5YR-10YR 7/3-4) and light brown to light yellowish brown (7.5-10YR 6/4) siltstone and silty, very fine- to fine-grained, well sorted arkosic arenite sandstone with less than 3% relatively coarser channel-fill complexes. Beds are medium to thick and tabular, or else massive.Channel-fill complexes are locally up to 1-2 m in thickness, but generally only 10-30 cm thick and

lenticular, and composed of fine- to medium-grained, subangular to subrounded, well sorted, arkosic arenite sandstone. Locally, this unit contains abundant light brown (7.5YR 6/3-4), brown (7.5YR 5/4), and light yellowish brown (10YR 6/4) mudstone in thick, tabular beds or else massive; well to moderately consolidated and channel-fills are weakly to strongly cemented. The unit probably correlates with units Ttas2 and Ttas3 of the Española quadrangle to the southwest (Koning, 2002a), and is the westward (basin-ward) equivalent of unit **Ttam** on this quadrangle. It underlies **Ttbp1**, overlies **Ttbs** and **Ttms**, and was deposited on a basin floor at the toe of the alluvial slope represented by lithosome A. Based on the interpretation that this unit immediately underlies the Pojoaque – Skull Ridge contact of Galusha and Blick (approximate age of 14.9 Ma, as interpreted by Koning, 2002a), unit **Ttas2** has an interpreted age of 15.2-14.9 Ma. 60-70 m thick.

Ttas1 **Lower lithosome A unit of Skull Ridge Member (middle Miocene) –** Pink to very pale brown (7.5YR-10YR 7/3-4) and light brown (7.5YR 6/4) siltstone and silty, very fine- to fine-grained, well sorted arkosic arenite sandstone with less than 3% coarse channel-fill complexes. Beds are thin to thick (mostly medium to thick) and tabular. Minor brown to light brown (7.5YR 5-6/4) mudstone beds. Channel-fills are in complexes up to 1 m thick and composed of fine- to very coarse-grained sand, locally with fine granitic pebbles; internal channel-fill bedding is generally thin to medium and lenticular to planar; channel-fill arkosic arenite sandstone, which is subangular and poorly sorted. They are well to moderately consolidated and weakly to strongly cemented. Unit is commonly a ledge-former (more so than **Ttas1**). This unit, which underlies **Ttam** and overlies **Ttbsn**, was deposited on a basin floor at the toe of the alluvial slope represented by lithosome A. North of Chimayo in the south-central part of the quadrangle, this unit contains the Skull Ridge White Ashes 4 and 2, dated at 15.3-15.5 Ma and 15.5 Ma, respectively, by Izett and Obradovich (2001) and McIntosh and Quade (1995). The unit is interpreted to have an age range of 15.2-16.0(?) Ma. 50-70 m thick.

Ttmp2 **Upper, mixed provenance unit of Pojoaque Member (middle Miocene) –** Generally pink (7.5YR 7/3) very fine- to medium-grained, subrounded to subangular, well-sorted, moderately consolidated arkosic sandstone and silty sandstone in medium to thick, tabular beds; also massive. Minor (~10%) thin to thick, tabular beds of light brown to pink (7.5YR 6-7/4) siltstone and mudstone that are well-consolidated. 2-8% channel-fills that consist of thin to medium, lenticular beds of fine- to coarse-grained sandstone; internal planar-laminations to planar-very thin beds, and local low-angle, tangential, cross-laminated

foresets 10 cm-thick. Channel-fill sand is subangular to subrounded, poorly to moderately sorted, and has an approximate ratio of 60-80% potassium feldspar : 20-40% possible northeast-derived lithic grains. Overall, unit is composed of lithic arkose sand (lithosome A slightly mixed with lithosome B sand), and is interpreted to have been deposited on the transition between the distal alluvial slope and basin floor. The unit underlies **Ttbp2**, overlies **Ttmp1**, and has yielded fossils consistent with the late Barstovian North American land mammal "age." It is correlative to Ttmp2 on the San Juan Pueblo quadrangle (Koning and Manley, 2003), where it lies within the lower to middle Pojoaque white ash zone; thus it is probably 14.0-13.5 Ma. 25-30 m thick.

Ttmp1 **Lower, mixed provenance unit of the Pojoaque Member (middle Miocene) –** Located west of Arroyo de los Martinez, this unit consists of distinctive distal alluvial slope (lithosome A) sediment interbedded with sediment of the basin floor (lithosome B). The former consists of very pale brown (10YR 7/3) to light yellowish brown to light brown (7.5-10YR 6/4), very fine- to medium-grained, subrounded to subangular, moderately sorted arkosic arenite sandstone (with an approximate ratio of 20-50% northeast-derived lithics : 50-80% potassium feldspar), silty sandstone, and siltstone in thick, tabular beds. There are minor channel-fill complexes up to 1 m-thick that commonly fine-upward, and are composed of very fine- to very coarse-grained sandstone; moderately to well consolidated. The lithosome B sediment consists of floodplain deposits with subordinate channel-fill deposits. These floodplain deposits are light brown to light yellowish brown (7.5-10YR 6/4) to brown (7.5YR 5/3) siltstone, mudstone, and very fine- to fine-grained, well sorted, sandstone, with an estimated ratio of 50-70% northeast-derived lithics to 30-50% potassium feldspar. They occur in very thin to thick, tabular beds and are moderately consolidated. The lithosome B channel-fill deposits are pale brown (10YR 6/3) to minor light yellowish brown (10YR 6/4) sandstone, pebbly sandstone, and sandy pebble-conglomerate. The sandstone is a litharenite with greenish quartz grains and reddish volcanic grains. It is fine- to very coarse-grained, subrounded to subangular, and moderately sorted. The conglomerate gravel clasts are subrounded, mostly pebbles with minor cobbles, poorly sorted, and are distributed throughout the channel-fill; two clast counts give: 11-33% Paleozoic limestone, 26-60% Paleozoic sandstone and siltstone, 8-9% quartz, 1-4% granite, 6-7% intermediate to felsic volcanic clasts, 1% mylonite, 7-9% quartzite, 1% intermediate to felsic hypabyssal intrusives, and 1-2% unidentified mafic-rich rocks. Channel-fill complexes are up to 1.5 m-thick, and internally are structureless to planar-very thinly bedded and planar-cross-stratified (foresets up to 4-5 cm-thick) and are loose to strongly cemented. The unit underlies

Ttmp2, overlies **Ttbp1**, and lies above the interpreted Skull Ridge – Pojoaque Member contact of Galusha and Blick (1971), which is interpreted at 14.9 Ma based on magnetostratigraphic and biostratigraphic data (Koning, 2002a; Tedford and Barghoorn, 1971; Barghoorn, 1981), and below the Pojoaque white ash zone. These stratigraphic constraints support an age range of 14.9-14.0 Ma. Approximately 25-45 m thick.

Ttms **Mixed provenance unit of the Skull Ridge Member (middle Miocene) –** Lithosome A alluvial slope sediment interbedded with zones of lithosome B fluvial sediment. The former consists of pink to light brown (7.5YR 6-7/3-4), very pale brown (10YR 7/3-4), or light yellowish brown (10YR 6/4), very fine- to fine-grained, well sorted arkosic arenite sandstone (with 3% muscovite grains), silty sandstone, siltstone, and minor mudstone in medium to thick, tabular beds or else massive. It is moderately to well consolidated and weakly to strongly cemented by calcium carbonate. This Lithosome A sediment has 1-5% channel-fill complexes, up to 80 cm thick, composed of fine- to very coarse-grained, subangular to subrounded, moderately sorted arkosic arenite sandstone with local granitic pebbles; internal bedding is planar-laminated and planar-very thinly to thinly bedded, and it is weakly to strongly cemented by calcium carbonate. The lithosome B fluvial sediment consists of floodplain deposits with minor coarse channel-fill deposits. Floodplain deposits are pale brown to brown (10YR 5-6/3) and light yellowish brown (10YR 6/4) siltstone, mudstone, and very fine- to fine-grained sandstone; very thin to thick, tabular bedded or else massive; within the floodplain deposits are 1-5% channel-fill deposits, up to 25 cm thick and commonly strongly cemented, that are composed of fine- to medium-grained, subrounded, well sorted, litharenite sandstone (estimated ratio of 1/3 pinkish potassium feldspar grains : 2/3 northeast-derived lithic grains); weakly to moderately consolidated and not significantly cemented except for scattered calcium carbonate laminae. Major lithosome B channel-fill deposits are planar-laminated conglomerates up to 1.5 m thick. The sandstone is a litharenite (with an approximate ratio of 35-50% potassium feldspar : 50-65% northeast-derived lithic grains), subrounded to subangular, moderately to well sorted, and generally loose to weakly cemented by calcium carbonate. Gravel clasts are mostly subrounded, poorly sorted pebbles with lesser cobbles; clast counts (62.7-64.2 m interval in Martinez section) are: 45% greenish Paleozoic siltstone and sandstone, 39% Paleozoic limestone, , 5% quartzite, 4% granite, 3% felsic to intermediate volcanic rocks 3% quartz, and 2% calcium carbonate nodules. The unit overlies **Ttam** and underlies **Ttas2** and **Ttaf1**. It's interpreted provenance is a basin floor depositional environment, with temporary progradations of alluvial slope

sediment associated with lithosome A. The unit lies beneath the interpreted 14.9 Ma Pojoaque – Skull Ridge contact of Galusha and Blick (1971), and also contains White Ashes 2 and 4 (as well as intervening ashes), which have interpreted ages of 15.3-15.5 and 15.5 Ma, respectively (Izett and Obradovich, 2001; McIntosh and Quade, 1995). Thus, this unit probably ranges in age from 16.0-14.9 Ma. 90-110 m thick.

Ttbp2 **Upper lithosome B unit of Pojoaque Member (middle Miocene) –** Lithosome B fluvial sediment interbedded with minor sediment of unit **Ttaf1**. The lithosome B sediment consists of: 1) floodplain deposits of pale brown to brown (10YR 5-6/3) to light gray (2.5Y-10YR 7/2) to light brown (7.5YR 6/3) claystone, mudstone, and siltstone, and light yellowish brown (10YR 6/4) very fine- to medium-grained sandstone in thin to thick, tabular beds. 2) Thick to very thick (up to 300 cm), tabular to lenticular channel-fill complexes with very thin to thin, planar internal bedding, planar-cross-stratification up to 15 cm tall, or planar-laminations; these channel-fills are composed of sandstone, with some pebbly sandstone, and commonly fine-upwards. The sandstone is light yellowish brown (10YR 6/4), fine- to very coarse-grained (but very fine and fine near top of a fining-upward channel-fill), subrounded to subangular, moderately to poorly sorted, and has an approximate ratio of 50-65% northeast-derived lithics :35-50% potassium feldspar. Pebble clasts are very fine to coarse, subrounded, and moderately to poorly sorted. They are composed of mostly Paleozoic sedimentary clasts with 25-50% granite. A tongue of this unit extends eastward near Arroyo de la Marada and Arroyo de los Martinez; here, the sediment consists of lithosome B, clay-rich floodplain deposits and sandy channel-fill complexes up to 2 m thick. These channel-fill sediments are in very thin to thin, laminated, planar beds. The sandstone is subrounded, moderately to well sorted, and has an approximate ratio of 50-75% northeast-derived lithics : 50-25% potassium feldspar. Local pebbles are rich in Paleozoic limestone, sandstone, and siltstone. Channel-fills are generally loose to weakly cemented, with 10-40% being strongly to moderately cemented by calcium carbonate. Finer sediment is weakly to moderately consolidated and erodes readily. The proportion of lithosome B sediment increases to the west. **Ttaf1** sediment within **Ttbp2** is pink to light brown (7.5YR 6-7/4) and reddish yellow to strong brown (7.5YR 5-6/6) siltstone and very fine- to fine-grained sandstone, with minor brown and light brown (7.5YR 5-6/4) mudstone; thin to thick, tabular bedding; ~3% channel-fills composed of very fine- to fine-grained, well sorted, subrounded to subangular, sand. Unit underlies **Ttaf1** and overlies **Ttmp2** near the western quadrangle boundary; it pinches out eastward within unit **Ttaf1**. It was deposited on the lithosome B basin floor, with some mixing of

sediment inputted by lithosome A tributary drainages, and contains occasional, minor progradations of the alluvial slope associated with lithosome A. It contains fossils compatible with the late Barstovian North American land mammal "age" (Gary Morgan, personal communication, 2003). To the west, this unit lies within the upper Pojoaque white ash zone, and on this quadrangle overlies the lower white ashes of this zone. Thus, this unit is interpreted to be 13.2-14.0 Ma. 55-80 m thick.

Ttbp1 **Lower lithosome B unit of the Pojoaque Member (middle Miocene) –** Light brown (7.5YR 6/4), brown to strong brown (7.5YR 5/3-6), and light yellowish brown (10YR 6/4) siltstone and claystone together with light yellowish brown (10YR 6/4) very fine- to fine-grained, well sorted lithosome B (slightly more northeast-derived lithic grains compared to potassium feldspar) sandstone and silty sandstone floodplain deposits, moderately consolidated. Very thin to thick, tabular beds that are planar-laminated to internally massive. Within the floodplain deposits are 5-10% thick and tabular to broadly lenticular channel-fill complexes. Channel-fill conglomerate generally consists of poorly sorted, subrounded, clast-supported, very fine to very coarse lithosome B pebbles and minor cobbles. A clast count (interval 164.0-165.2 m in the Martinez section) gives: 60% Paleozoic siltstone sandstone, and meta-sandstone, 11% Paleozoic limestone, 9% quartzite, 9% quartz, 6% intermediate to felsic volcanic clasts, 3% intermediate to felsic hyperbyssal intrusives, 2% unidentified mafic-rich rocks, 1% granite, and 1% mylonite,. Clast count near Arroyo de los Martinez (UTM coordinates: 3,985,760 N, 411,440 E ± 20 m) gives: 32% greenish Paleozoic siltstone and sandstone, 21% grayish Paleozoic limestone, 14% granite and associated quartz and feldspar, 13% angular calcium carbonate-indurated nodules (from paleo spring mounds?), 10% intermediate to felsic volcanic rocks and tuff, 4% mylonite, gneiss, and schist, 3% quartzite, and 2% reddish mudstone. Channel-fill sandstone is pale brown (10YR 6/3) to minor light yellowish brown (10YR 6/4) and minor brown (10YR 5/3), fine- to very coarse-grained, subrounded to subangular, moderately to well sorted, and litharenite to lithic arkose in composition (greenish quartz grains and reddish volcanic lithics strongly suggest derivation from Paleozoic sandstone and Oligocene volcanic rocks, respectively). Channel-fills are locally indurated by calcium carbonate but otherwise are loose. West of the mouth of Arroyo de la Marada, a thick (up to 15 m) interval of eolian lithic arenite to feldspathic arenite sandstone is observed. It consists of pink to very pale brown (7.5-10YR 7/4), fine-grained, well-sorted, subrounded, slightly frosted, in tangential cross-beds up to 90 cm tall (sand may also be massive, bioturbated, or in cusps). This eolian sediment contains local 40-50 cm-thick zones of rhizoliths. Pebble-size

calcium carbonate nodules may be present in siltstone and very fine-grained sandstone beds. Medium to thick, tabular, grayish to whitish, limestone beds are locally present. Generally weakly to moderately consolidated. The unit underlies **Ttmp1**, which grades laterally eastward into **Ttmp1**, and overlies **Ttas2**. It was deposited on a basin floor by a fluvial system from the Penasco embayment that probably flowed south to southwest; the lithosome B fluvial system appeared to have lower clast competency, and perhaps less stream power, than it had in the early Miocene. It lies between the base of the Pojoaque Member and the Pojoaque white ash zone. Given the age of the Pojoaque white ash zone and the inferred base of the Pojoaque Member (see Koning, 2002a), this unit probably is 14.9-14.0 Ma. Up to 130 m thick in the southwest corner of the quadrangle.

Ttbs **Lithosome B unit of the Skull Ridge Member (middle Miocene) –** Pink (7.5YR 7/3-4) to light brownish gray to pale brown (10YR 6/2-3) siltstone; pale brown to light yellowish brown (10YR 6/3-4) very fine- to fine-grained, subrounded to subangular, and well-sorted, litharenite to lithic arkose sandstone; and light brown (7.5YR 6/3-4) claystone floodplain deposits with ~10% channel-fills of pale brown to light yellowish brown (10YR 6/3-4), fine- to very coarse-grained, subangular to subrounded, moderately to poorly sorted, litharenite to lithic arkose (with greenish northeast-derived quartz grains) sandstone and pebbly sandstone. Floodplain deposits are in thin to thick, tabular beds that are generally internally planar-laminated or else massive; sand in the floodplain Channel-fill bedding is generally not exposed. Gravel in channel-fills is generally scattered in the sandstone, and consists of mostly subrounded and poorly sorted pebbles with minor cobbles. Clast count at the 62.7-64.2 m interval in the Martinez section (just within the **Ttbs** unit) gives: 42% greenish Paleozoic siltstone and sandstone, 39% Paleozoic limestone, 5% quartzite, 4% granite, 3% quartz, 3% grayish to reddish volcanic rocks (intermediate to felsic), 3% reddish fine-grained sandstone, and 2% calcium carbonate nodules (perhaps associated with the Paleozoic limestone). This unit generally underlies **Ttas2**, overlies **Ttms**, and is weakly to well consolidated. It was deposited on a basin floor by a fluvial system from the Penasco embayment that probably flowed south to southwest. It lies between White Ashes 2 and 4, indicating an age of 15.5-15.3 Ma. 45-50 m-thick.

Ttbsn **Lithosome B unit in basal Skull Ridge and uppermost Nambe Members (lower Miocene) –** Strata are similar to unit **Ttbs**. It is present near Chimayo, where its upper contact underlies White Ash #2 by ~30 m. Unit probably interfingers southwards with **Ttmn,** interfingering northeastward with **Ttam**,

and underlies **Ttas1**. The position of the basal contact below White Ash #2 is not well-constrained, but probably lies in the upper Nambe Member because lithosome B is common in the upper Nambe Member to the south. White Ash #2 has been dated by $^{40}Ar/^{39}Ar$ methods at 15.5 Ma based on data in Izett and Obradovich (2001). Thus, this unit probably ranges in age from 16.5(?)-15.8 Ma on this quadrangle. Minimum thickness of 45-50 m.

Ttmn **Interbedded lithosomes A and B and mixed lithosomes A and B in Nambe Member (lower Miocene) –** Located south of the Santa Cruz River, this unit consists of intercalated intervals of lithosomes A and B. The former consists of pinkish very fine- to fine-grained sandstone with subordinate siltstone and mudstone, while the latter are siltstone and mudstone floodplain deposits, with about 5-10% channel-fill complexes up to 2 m thick that are composed of pebbly sandstone and sandy pebble-conglomerate. Lithosome A has about 10% channel-fill complexes up to 6 m thick that are composed of pebbly sandstone; internal bedding of channel-fills is very thin to thin. Many channel-fills have a pebble composition that is a mix between lithosome B and granite-rich lithosome A, reflecting multiple progradations of alluvial slope sediment onto a basin floor occupied by a south-southwestward flowing river derived from the northeast. **Ttmn** appears to interfinger with **Ttas1**, **Ttbsn**, and **Ttam** in the vicinity of Chimayo. It lies in the upper Nambé Member of Galusha and Blick (1971); based on age data of Izett and Obradovich (2001) and discussion of this data for the Nambé Member in Koning et al. (2002), this unit probably has an age of 17-16 Ma. At least 70 m thick.

Ttbn4 **Coarse #2 unit of lithosome B of the Nambe Member (lower Miocene) –** Broad, relatively coarse channel-fill deposits interbedded with 30-40% floodplain deposits. The channel-fill sediments are comprised of pale brown (10YR 6/3) to pinkish gray (7.5YR 7/2) fine- to coarse-grained, subrounded to subangular, moderately to well sorted sandstone (about 30-40% pinkish potassium feldspar : 60-70% northeast-derived lithic grains), and minor conglomerates of very coarse sandstone, pebbles, and cobbles (subequal or more pebbles than cobbles). Beds are very thin to medium, planar to lenticular. Gravel clasts are subrounded and moderately sorted. The clast count from one site (UTM coordinates 3985990 N, 416770 E; NAD 27; zone 13) was: 42% grayish to greenish Paleozoic limestone, 30% quartz and quartzite, 23% greenish Paleozoic sandstone and siltstone, , 2% granite, 2% felsic tuff, and 1% mylonite. Clast count in the Encinos stratigraphic section (at ~163 m) gives: 42% quartzite, 31% Paleozoic sandstone and siltstone, 22% Paleozoic limestone, 3% felsic volcanic rock and tuff, 1% foliated quartzite, and 1% meta-

conglomerate. Loose to weakly consolidated; generally non to weakly cemented with local moderate to strong cementation by calcium carbonate. Floodplain deposits consist of light brown (7.5YR 6/3-4) mudstone and siltstone and very fine- to fine-grained sandstone; weakly to moderately consolidated. The unit underlies **Ttam**, overlies **Ttbn3**, and was deposited by a large fluvial drainage flowing south-southwest from the Penasco embayment. No detailed age control is available for this unit; it likely correlates with the upper Nambé Member of Galusha and Blick (1971), whose stratigraphic interval probably has an age range of 20-16 Ma. Up to approximately 22 m thick.

Ttbn3 **Fine #2 unit of lithosome B of the Nambe Membe (lower Miocene) –** Light brown to brown (7.5YR 5-6/4 and 6/3) to reddish yellow (7.5YR 6/6) mudstone, siltstone, and sandy (very fine to fine) mudstone. Bedding is thin to thick and tabular. Weakly to moderately consolidated and non-cemented. Very minor channel-fill deposits of light brown to brown (7.5YR 5-6/4) pebbly sandstone and very fine- to medium-grained, subrounded to subangular, moderately sorted sandstone (subequal to slightly more northeast-derived lithic grains compared to pinkish potassium feldspar grains) are included; bedding of the channel-fill deposits is very thin to medium and planar, also planar-laminated, and about half of channel-fills are moderately to strongly cemented by calcium carbonate. The unit underlies **Ttbn4,** overlies **Ttbn2**, and was deposited on floodplain adjacent to channel represented by unit **Ttbn4**. No detailed age control is available for this unit; it likely correlates with the upper Nambé Member of Galusha and Blick (1971), whose stratigraphic interval probably has an age range of 20-16 Ma. 65-75 m thick.

Ttbn2 **Coarse #1 unit of lithosome B of the Nambe Member (lower Miocene) –** Sandy conglomerate to pebbly sandstone channel-fill (~65-75% pebbles : 25-35% cobbles), about half of which is strongly cemented, but cementation is discontinuous. Largest clasts: 29x14, 22x7, 10x8, 14x4, 17x9, 17x11 (cm). Gravel clasts are subrounded and poorly sorted. Clast count at 74.0 m in the Encinos stratigraphic section gives: 45% Paleozoic limestone, 30% Paleozoic sandstone and siltstone, 22% Proterozoic quartzite, and 9% granite (clast count is by Stake D). The unit underlies **Ttbn3** and overlies **Ttbn1**, and was deposited by a large fluvial drainage that probably flowed south-southwest from the Penasco embayment, similar to unit **Ttbn4**. No detailed age control is available for this unit; it likely correlates with the upper Nambé Member of Galusha and Blick (1971), whose stratigraphic interval probably has an age range of 20-16 Ma. 1-2 m thick.

Ttbn1 **Fine #1 unit of lithosome B of the Nambe Member (lower Miocene) –**Light brown (7.5YR 6/3) siltstone, mudstone, and sandstone; not well exposed; sand is very fine- to medium-grained. It was deposited on the floodplain adjacent to and beneath **Ttbn2** channel deposits, and overlies **Ttbn3**. No detailed age control is available for this unit; it likely correlates with the upper Nambé Member of Galusha and Blick (1971), whose stratigraphic interval probably has an age range of 20-16 Ma. 13-16 m thick.

Ttan5 **Fine #2 unit of lithosome A of the Nambe Member (lower Miocene) –**Light brown (7.5YR 6/4), with some reddish yellow (7.5YR 6/6), silty very fine- to medium-grained, subangular to subrounded, well to poorly sorted, arkosic arenite sandstone and siltstone to mudstone in medium to thick, tabular beds. It has 1-3% channel-fills of arkosic arenite sandstone and pebbly sandstone, which are typically strongly cemented by calcium carbonate, and moderately to well consolidated. The unit overlies **Ttan3**, interfingers southwards with unit **Ttan4**, and generally underlies **Ttbn1** and **Ttbn2**. It signifies a distal alluvial slope depositional environment. No detailed age control is available for this unit; it likely correlates with the middle(?) Nambé Member of Galusha and Blick (1971), whose stratigraphic interval probably has an age range of 22-17 Ma. 10-60 m thick.

Ttan4 **Coarse #2 unit of lithosome A of the Nambe Member (upper Oligocene(?) to lower Miocene) –** Extra-channel deposits with 25-70% coarse channel-fill deposits near Arroyo de la Ancha; proportion of channel-fills increases to 80-100% southwards towards bedrock highs. The extra-channel deposits consist of pink (7.5YR 7/4) and light brown to reddish yellow to brown (7.5YR 6/4-6; 7.5YR 5/4) [minor yellowish red to reddish brown (5YR 5/6 & 5/4) close to bedrock highs] silty, very fine- to fine-grained, mostly subangular to subrounded, moderately to poorly sorted arkosic arenite sandstone, moderately to well consolidated and weakly cemented (weak to moderate HCl effervescence), which coarsens southward towards bedrock highs to medium- to very coarse-grained sandstone with sparse pebble- to cobble-size calcium carbonate-cemented nodules, in massive or medium to very thick, tabular beds. Channel-fill sediment consists of reddish yellow, strong brown, and light brown (7.5YR 5-6/6, 6/4) to light yellowish brown and brownish yellow (10YR 6/4-6) to pinkish white (5YR 8/2) pebbly sandstone and sandy, clast-supported, poorly sorted pebble-conglomerate, which also becomes redder and coarser (up to 40% cobbles) southward. Channel-fill beds are up to 1 m-thick and tabular; internal channel-fill bedding is massive or in very thin to thick, lenticular to planar beds or channel-shaped (up to 30 cm deep), with some planar- to

tangential- cross stratification up to 30 cm-tall. Clasts are and composed of granite (subangular) with 1-8% quartzite (subrounded), 10-15% quartz, and 0-9% yellowish Paleozoic limestone. Clast counts at two site (UTM coordinates: 3984400 N, 417025 S ± 20 m; 3984380 N, 416740 S ± 20 m; zone 13; NAD 27) record: 71-76% granite, 13-15% quartz (probably associated with granite), 5% quartzite, 1-2% Paleozoic siltstone, 0-9% Paleozoic limestone, 0-1% chert, and 0-1% amphibolite, 0-2% schist and granitic gneiss; clast count at another site (UTM coord: 3985340 N, 417190 E ± 20 m; zone 13, NAD 27) gives: 85% granite, 13% quartz, and 1% quartzite. Channel-fill arkosic arenite sandstone is generally fine- to very coarse-grained (medium- to very coarse-grained near bedrock highs), subangular (mostly) to subrounded, moderately to poorly sorted, and moderately to well consolidated, with 3-50% of the channel-fills being strongly to moderately cemented by $CaCO_3$. Contains occasional paleosol horizons: 15-20 cm total thickness; moderate, coarse, subangular blocky ped structure; reddish yellow (7.5YR 6/6) color; no clay films (~5% clay). The unit appears to interfinger northward with **Ttan5**. **Ttan4** is interpreted to have been deposited on a medial to proximal alluvial slope, and likely correlates to the lower Nambé Member, probably within the age range of 25-17 Ma based on age data listed in Obradovich and Izett (2001), Smith (2000a), and discussion in Koning et al. (2002). 10–70(?) m thick.

Ttnr2 **#2 mixed provenance, reddish, fluvial unit of the Nambe Member (Upper Oligocene(?) to lower Miocene) –** Red to light reddish brown (2.5YR 5/6 to 5YR 6/4), medium- to very coarse-grained, subangular to subrounded, poorly to well sorted, and probably arkosic arenite (reddish clay coatings on grains makes the latter determination difficult and also accounts for the reddish hue) pebbly sandstone to sandy pebble-conglomerate channel-fill deposits (cobbles locally comprise up to 60% of the gravel). Bedding is very thin to medium and planar to lenticular (trace channel-shaped). The maximum measured channel had a depth of 15 cm. Conglomerate is clast-supported, subrounded (granite clasts may be subangular), and poorly to moderately sorted; local weak clast imbrication indicates southwest-direct paleo-flow. Clast count at one site (UTM coord: 3985320 N, 417210 E ± 20 m; zone 13; NAD 27) was: 40% yellowish to grayish Paleozoic limestone, 24% granite, 16% quartz (probably associated with granite), 9% quartzite, 9% yellowish to grayish Paleozoic siltstone and sandstone, 1% schist, and 1% felsic volcanic tuff. Another clast count at a site closer to an exposed bedrock high (UTM coord: 3984370 N, 416830 E ± 20 m; zone 13; NAD 27) was: 34% granite, 27% quartz (probably associated with granite), 22% yellowish Paleozoic sandstone and siltstone, 10% quartzite, 2% muscovite-schist, 2% felsic to intermediate volcanic tuff. 1% rounded quartz

derived from Paleozoic(?), 1% yellowish Paleozoic limestone, and 1% amphibolite. Channel -fill sandstone may be planar laminated, and is weakly to moderately consolidated and non- to weakly cemented by $CaCO_3$. To the north, there is subordinate overbank sediment of pink to reddish yellow (7.5YR 7/4-6/6), muddy very fine- to medium-grained subangular, moderately to poorly sorted, arkosic arenite sandstone. The unit is intercalated within **Ttan4**, and was deposited by a large fluvial drainage that flowed southwest and passed near paleo-topographic highs of Proterozoic rock near present-day Chimayo. It likely correlates to the lower Nambé Member whose stratigraphic interval probably has an age range of 25-17 Ma. 75-90 m thick.

Ttan3 **Fine #1 unit of lithosome A of the Nambe Member (upper Oligocene to lower Miocene) –** Light brown to brown (7.5YR 5-6/4), strong brown to reddish yellow (7.5YR 5-6/6), and light yellowish brown to very pale brown (10YR 6-7/4) extra-channel and overbank deposits consisting of silty very fine- to medium-grained, subangular (minor subrounded), well to poorly sorted arkosic arenite sandstone with minor siltstone. Structureless. Channel-fill complexes (up to 150 cm-thick and having a broad lenticular shape), consisting of pebbly fine- to very coarse-grained sandstone that locally grades downward into a sandy pebble-conglomerate make up less than 5%. Their pebbles are subangular to subrounded, poorly sorted, and dominated by granite (minor quartzite); the sandstone is subangular, poorly to moderately sorted, and an arkosic arenite, with ~1% muscovite flakes locally. West of the town of Rio Chiquito, unit consists of very fine- to very coarse-grained sandstone and muddy sandstone with ~5% granitic pebbles of probable local origin, in planar-laminated or in very thin to thick, tabular beds. The unit overlies, and may grade laterally into, unit **Ttan2** and underlies **Ttan5**. It is weakly to moderately consolidated, non- to weakly cemented by calcium carbonate (local moderate cementation), and pebble-size calcium carbonate nodules occur locally. The unit was deposited in a distal alluvial slope depositional environment, and likely correlates to the lower Nambé Member whose stratigraphic interval probably has an age range of 30-17 Ma. 210-230 m thick.

Ttan2 **Gradational unit between the coarse and fine #1 units of lithosome A of the Nambe Member (upper Oligocene to lower Miocene) –** Extra-channel deposits interbedded with 25-60% channel-fill deposits. The extra-channel sediment consists of light brown to pink (7.5YR 6-7/4), very pale brown (10YR 7/3), and light yellowish brown (10YR 6/4), clayey-silty (estimate ~5-15% fines), very fine- to very coarse-grained, subangular (mostly) to subrounded, poorly to moderately sorted arkosic arenite sandstone in massive or thick to very thick,

tabular beds. It is weakly to well consolidated with weak to moderate cementation by calcium carbonate (weak to strong HCl effervescence). The channel-fill deposits consists of pinkish white (7.5YR 8/2) to very pale brown (10YR 7/3), fine- to very coarse-grained, subangular, moderately to poorly sorted, arkosic arenite pebbly sandstone and sandy pebble-conglomerate in medium to thick, broadly lenticular to tabular beds up to 4 m-thick. Internal channel-fill bedding is very thin to medium, lenticular to planar. The pebble-conglomerate is clast-supported, and includes minor cobbles (up to 15% of the gravel) near the **Ttan1** contact (but no cobbles near the **Ttan3** contact). Clasts are moderately to poorly sorted and composed of granite (mostly subangular, some subrounded) with minor quartzite (subrounded). Clast counts contain: 80-84% granite, 7-11% quartz, and 4-13% quartzite. It is weakly to strongly cemented by calcium carbonate (weak to strong HCl effervescence). It also contains either minor (<3%) possible soil development or clayey overbank deposits, 10-20 cm thick, manifested by yellowish red color (5YR 5/6) and abundant clay (~20% clay). The unit underlies **Ttan3**, overlies **Ttan1**, and may also laterally grade into these two units. The depositional environment represents a transition from the distal to medial alluvial slope. It likely correlates to the lower Nambé Member, whose stratigraphic interval probably has an age range of 30-17 Ma. 55-70 m thick.

Ttnr1 **#1 mixed provenance, reddish, fluvial unit of the Nambe Member (upper Oligocene to lower Miocene) –** Channel-fill deposits comprised of red to light reddish brown (2.5YR 5/6 to 5YR 6/4), fine- to very coarse-grained, subangular to subrounded, poorly to well sorted, (probable) arkosic arenite pebbly sandstone (reddish clay coatings on grains makes the latter determination difficult and also accounts for the reddish hue) and sandy pebble-conglomerate (cobbles comprise up to 35% of the gravel). Bedding is very thin to medium and planar to lenticular (minor channel-shaped); sandstone may be laminated to low-angle cross-stratified (up to ~10 cm-thick). Conglomerate is clast-supported, subrounded (granite clasts may be subangular), and poorly sorted. At one site (UTM coord: 3985340 N, 420090 E ± 10 m; zone 13; NAD 27), a clast count was: 60% granite, 19% quartz, 13% yellowish Paleozoic limestone, , 4% quartzite, 2% yellowish Paleozoic siltstone and sandstone, and1% schist. At another site (UTM coord: 3984425 N, 419110 E ± 10 m; zone 13; NAD 27), the clast count was:: 40% granite, 22% quartzite, 11% yellowish Paleozoic siltstone and sandstone, 11% yellow to gray Paleozoic limestone, 10% quartz (probably associated with granite), 5% intermediate to felsic volcanic rocks (no Amalia Tuff), and 1% subrounded quartz of unknown provenance. At a third site (UTM coord: 3984720 N, 419410 E ± 10 m; zone 13; NAD 27), the clast count

was: 34% granite, 25% yellowish to grayish Paleozoic limestone, 14% quartzite, 9% gray to yellow Paleozoic siltstone and sandstone, 9% quartz (probably associated with granite), 3% subrounded quartz of unknown provenance, 3% biotite schist and amphibolite, and 1% felsic volcanic clasts. The maximum measured channel depth is 70 cm. Channel-fill trends and clast imbrication document paleoflow directions to the southwest and northwest. The unit is moderately consolidated and weakly to strongly cemented by $CaCO_3$, and is interbedded within **Ttan1**. It was deposited by a large fluvial system flowing southwest towards paleo-topographic highs of crystalline rock near Rio Chiquito, with local contributions from northwest-flowing tributaries. It likely correlates to the lower Nambé Member, whose stratigraphic interval probably has an age range of 30-18 Ma. Thickness is up to 55 m.

Ttan1 **Coarse #1 unit of lithosome A of the Nambe Member (upper Oligocene to lower Miocene) –** Extra-channel deposits interbedded with 40% to 90%(?) coarse channel-fills, which increase towards the mountains and become redder (to yellowish red, 5YR 5/6) near Proterozoic bedrock exposures due to clay coatings on the grains. The extra-channel deposits consist of light brown (7.5YR 6/4) to lesser amounts of reddish yellow (7.5YR 6/6) and pink to very pale brown (7.5-10YR 7/4), clayey (estimate 5-10% clay) very fine- to very coarse-grained (mostly very fine- to medium-grained away from bedrock exposures), subangular (mostly) to subrounded, poorly sorted arkosic arenite sandstone, occurring in structureless to thick to very thick, tabular beds, which are weakly to moderately consolidated with non- to weak HCl effervescence. The channel-fill sediments consist of very pale brown to pink (7.5-10YR 7-8/3), medium- to very coarse-grained, subangular (mostly) to subrounded, poorly to moderately sorted, arkosic arenite pebbly sandstone and sandy pebble-conglomerate in channel-fill complexes up to 1.5 m-thick. Internal channel-fill bedding is very thin to medium (minor thick), planar to broadly lenticular; local tangential bar cross-stratification is up to 30 cm-tall. The conglomerate includes up to ~30%minor cobbles, is clast-supported, poorly sorted, and composed of granite (mostly subangular, some subrounded) with 5-10% quartzite (subrounded). A clast count records 77-87% granite, 4-12% quartz, 5-16% quartzite, and 1-2% biotite schist and gneiss. It is weakly consolidated and non- to strongly cemented (none to moderate HCl effervescence). This is the lowest and oldest exposed Tesuque Formation unit on the quadrangle. It underlies **Ttan2**, and may grade laterally into it as well. It was deposited on a medial to proximal alluvial slope. It likely correlates to the lower Nambé Member, whose stratigraphic interval probably has an age range of 30-18 Ma. 30-45 m thick.

ASHES OF TESUQUE FORMATION

Chamita lower tuffaceous zone(?) (CLTZw) – White, coarse ash whose grain size is 0.2-2.0 mm. Ash has ~20% pyroxene or hornblende plus biotite together with purple-gray volcanic lithics. The presence of pyroxene or hornblende in this ash supports tentative correlation to the upper ash of the Chamita lower tuffaceous zone to the west, which has an inferred age range of 7.7-8.4 Ma (Koning and Manley, 2003). The stratigraphic position of this ash is also consistent with the Chamita lower tuffaceous zone. It lies above the Alcalde tuffaceous zone (although exact distance cannot be determined due to the west-facing monocline at the tip of the Velarde fault and a west-down fault immediately east of this monocline). This ash is 2-3 cm-thick.

Alcalde tuffaceous zone, upper coarse white ashes (ATZw) – One or two coarse white ash beds; where two are present, they are separated by 1.5 to 2.0 m. The upper ash is composed of pumice whose grain size is 0.2-4.0 mm; it lacks volcanic lithics and is 2-20 cm-thick. The lower ash occurs in an ashy, pale brown (10YR 6/3), slightly silty, very fine- to medium-grained, arkosic sand bed that is 1.0-1.4 m-thick. Its ash fragments appear similar to those in the coarse white ash zone. The ash is approximately 20 m above the middle mixed ash of the Alcalde tuffaceous zone, and has an $^{40}Ar/^{39}Ar$ date of 9.4 ± 0.46 Ma (**Table 4**).

Alcalde tuffaceous zone, middle mixed ash (a laterally extensive ash on the north side of lower Arroyo del Pueblo) (ATZm) -- Medium bed of commonly altered ash that consists of coarse grains of consolidated white ash, abundant grayish, soft lithic fragments, and minor pinkish lithic fragments. It is locally mixed with the arkosic sand within **Ttac1.** This ash is located about 30 m above the basal black ashes of the Alcalde tuffaceous zone. Considering the $^{40}Ar/^{39}Ar$ age of the upper coarse white ash of the Alcalde tuffaceous zone, this ash is probably 9-10 Ma.

Alcalde tuffaceous zone, basal black ashes (ATZb) -- Gray to black basalt(?) or intermediate volcanic ash (generally 0.2 -1 mm long) and minor pumice mixed with various proportions of arkosic detrital sand. Volcanic grains are commonly soft and appear altered. Beds are medium to thick, laterally continuous, and interbedded within unit **Ttac1** in the northwest and north-central parts of the quadrangle. Considering the $^{40}Ar/^{39}Ar$ age of the upper

coarse white ash of the Alcalde tuffaceous zone, this ash is probably 9-10 Ma. 3-60 cm thick.

Española tephra zone (ETZ) – One to eight, dark, coarse ash beds. In the Chimayó quadrangle, these generally lie in a 24 m-thick interval 28-52 m above the CWAZ (an interval called the main ETZ), with the exception of a lone gray ash bed located only 3 m above the uppermost bed of the CWAZ in the Cuarteles stratigraphic section (**Appendix 1**). The tephra of the ETZ contains fine to coarse, dark gray to light gray (basaltic?) ashes that are generally mixed with sandy arkosic detritus. Dark gray ash beds in the upper part of the zone, in particular units 8p and 8j of the upper Cuarteles section (**Appendix 1**), locally contain abundant white, consolidated ash and pumice (0.5 - 17 mm in diameter) that may be of intermediate composition. Pumiceous beds in the upper ETZ may correlate to a dacitic pumice bed located 14 km to the northeast (windmill-72035 tephra of Manley, 1976) that lies about 20 m above gray, coarse ashes similar to those in the ETZ (Koning and Aby, 2003). This northeastern pumice bed is 35-100(?) m above a down-dip projection of a pumice bed that has been dated at 10.8 ± 1.6 Ma using zircon fission-track methods (Orilla-72027 tephra of Manley, 1976 and 1979) and 11.3 ± 1.2 Ma using $^{40}Ar/^{39}Ar$ methods on biotite (Smith et al., 2004). The age range of the main ETZ is inferred to lies in the range of 10.2-11.5 Ma.

Coarse white ash zone (CWAZ) – Thin to medium, grayish white to white ashes containing consolidated grains of white ash plus 3-7% pink to gray volcanic lithic grains (probably rhyolite to dacite in composition), 3-8% biotite grains, quartz(?), and minor (<1%) hornblende. The grain size of the ash is fine to coarse, with volcanic lithic detritus locally being up to fine lapilli in size. It is altered to a greenish color locally. Dating of this ash by $^{40}Ar/^{39}Ar$ methods on the San Juan Pueblo quadrangle give an age range of 12.0-13.0 Ma for the main (lower) part of the coarse white ash zone. Attempts to date two ashes of this zone on this quadrangle returned ages of 15.6 ± 2.4 and 18.3 ± 1.6 Ma (**Table 4**), which are 3-6 m.y. older than ages obtained to the west and are about 2 m.y. older than the underlying Pojoaque white ash zone. Consequently, alteration or contamination seems to have occurred in the two samples on this quadrangle, and I do not use these ages in interpretations regarding this ash zone. Other coarse white ashes that may be higher stratigraphically are present in the Santa Fe Group near southern Black Mesa to the west and in the Buckman well field to the south. The upper coarse white ash at the Buckman well field has an $^{40}Ar/^{39}Ar$ date of 10.9 ± 0.2 Ma (from biotite; W.C. McIntosh, unpublished data). However, these upper coarse white ashes do not appear to

extend into this quadrangle because one of the higher coarse white ashes in the lower Cuarteles section returned an $^{40}Ar/^{39}Ar$ age of 12.63 ± 0.74 Ma (unit 7u, see fig. 9, table 4, and appendix 1 of Koning and Manley, 2003). Also, a bed of CWAZ coarse white ash exposed 5.8 km northeast of Chimayó has been dated at 12.7 ± 1.8 Ma using zircon fission-track dating (Manley, 1976 and 1979). Consequently, I favor an age range of 12.0-12.8 Ma for the main coarse white ash zone found on this quadrangle.

Fine, white ashy sandstone in basal lithosome A coarse upper unit (FWABCU) – Medium bed of white, ashy, very fine- to fine-grained sandstone. Ash is speculated to correlate to either one of the Trapper Creek ashes or to one of the uppermost ashes in the Pojoaque white zone.

Upper Pojoaque white ash zone (PWAZu) – Two laterally continuous ash beds, with a third discontinuous ash in-between locally. The two continuous ashes are white, moderately hard, and generally altered to bentonite(?) with 3% dendritic MnO(?) up to 1 mm long. The lower ash is generally 15-20 cm thick and the upper is generally 50-70 cm thick. The upper ash is less altered than the lower ash (glass shards are still present), but is reworked with about 25% very fine- to fine-grained detrital sand; it grades upwards into silty, very fine- to fine-grained sandstone. Based on magnetic-polarity stratigraphy work by Barghoorn (1981) and the revised geomagnetic polarity time scale of Cande and Kent (1995), the PWAZ was probably deposited between 14.0 Ma and 13.2 Ma; this age is consistent with the early late Barstovian fossils found within and below the PWAZ. To the south near the Pojoaque Member type section (where there are as many as eight separate ashes), one of the lower ashes of the Pojoaque white ash zone has an $^{40}Ar/^{39}Ar$ date of 13.7 ± 0.18 Ma (Izett and Obradovich, 2001). The upper part of the ash zone is thus probably 13.2-13.7 Ma.

Lower Pojoaque white ash zone (PWAZl) – Similar to the non-correlated white ashes in the Pojoaque Member below the Pojoaque white ash zone but stratigraphically higher. These ashes are in a similar stratigraphic position, and appear to project to, the relatively closely spaced fine white ashes of the lower Pojoaque white ash zone in the Cuarteles stratigraphic section (located in the eastern San Juan Pueblo quadrangle to the west).

Non-correlated white ashes in Pojoaque Member below the Pojoaque white ash zone (NCWA) – White, powdery, fine white ash beds. Parts of a bed may be

cemented by calcium carbonate or silica; glass shards are still present locally, but commonly the ash is altered. It grades locally to an ashy sand or silt. 15-40 cm-thick.

Gray coarse ash of lower Pojoaque Member (PLGCA) – Bluish gray to dark bluish gray (10B 4-5/1) ash bed with an average grain size of about 0.2-0.3 mm. Two beds are mapped that are interbedded within siltstone and very fine- to fine-grained sandstone of unit **Ttbm;** these are located approximately 30-60 m above the Skull Ridge-Pojoaque Member contact. 10-20 cm thick.

Fine white ash in upper Skull Ridge (?) Member (SRUA) – Fine white ash with 1-2% biotite and ~5% very fine- to medium-grained detrital sand. Ash is interbedded in light brown (7.5YR 6/4) siltstone and very fine-grained sandstone and light yellowish brown (10YR 6/4) very fine- to medium-grained sandstone. Its stratigraphic position suggests that it correlates to one of the uppermost white ashes of the Skull Ridge Member. One of the white ashes in the uppermost Skull Ridge Member, called the Road Ash, has an $^{40}Ar/^{39}Ar$ date of 15.1 ± 0.06 Ma (Izett and Obradovich, 2001; Koning, 2002a). If this ash does correlate with one of the uppermost white ashes of the Skull Ridge Member, then it likely has an age of 15.0-15.2 Ma. 60-70 cm thick.

Gray ash beds in Skull Ridge Member (SRGA) – Light gray (10YR 7/1-2) to brownish gray (2.5Y 6/2), medium to thick, beds of fine ash and ashy silt located in Arroyo del Carrizo (between Arroyo de los Martinez and Cañada de los Ramones). The northwest ash is not altered, contains glass shards, and is mixed with about 20-40% detrital silt and very fine-grained sand.

Ash Alpha of Skull Ridge Member (SRAA) – White (N8/) ash that is silty-textured and contains glass shards. The ash is interbedded in pink to light brown (7.5YR 6-7/3-4) siltstone and very fine- to fine-grained sandstone, and is reworked with silt and very fine- to fine-grained sand, particularly towards the southwest of the quadrangle. Locally it contains abundant calcium carbonate nodules on top. 10-40 cm thick.

White Ash #4 of Skull Ridge Member (SRWA4) – White, commonly hard ash present above pale brown to light yellowish brown (10YR 6/3-4) or pink (7.5YR 7/3-4), tabular, thin to thick beds of siltstone and very fine- to fine-grained sandstone. The basal part of the ash may be massive and primary fall, but the overlying ash is commonly in planar laminations or very thin to thin beds and probably

fluvially reworked. Local contorted bedding in the ash is due to soft sediment deformation. It is mostly altered to some extent but locally rich in glass shards. It may be very reworked with siltstone and very fine-grained sand. Three thin, white ash beds are locally present in the strata 2 m below this ash. 70 - 250 cm thick. This ash has an $^{40}Ar/^{39}Ar$ age of 15.3-15.5 Ma (Izett and Obradovich, 2001; McIntosh and Quade, 1995).

White Ash #3 of Skull Ridge Member (SRWA3) – White (N8/), hard, silty-textured, non- to slightly-altered, shard-rich ash that contains trace biotite crystals equivalent in size to fine-grained sand. It is massive, slightly wavy- to planar-laminated, or very thinly bedded, and interbedded in pink (7.5YR 7/3), medium to thick, tabular beds of siltstone. This ash has an $^{40}Ar/^{39}Ar$ age of 15.4 Ma (Izett and Obradovich, 2001). 10-35 cm-thick.

White Ash 2a-c of Skull Ridge Member (SRWA2abc) – A single bed correlative to White Ash 2a, 2b, or 2c of Galusha and Blick (1971, fig. 17). To the north the ash is white, not altered, silty-textured, shard-rich, 20-30 cm thick, and lies within very pale brown to light yellowish brown (10YR 6-7/4) to pink (7.5YR 7/3) siltstone and very fine-grained sandstone. To the south, the ash is thicker (up to 100 cm) and significantly reworked with silt and very fine-grained sand.

White Ash #2 of Skull Ridge Member (SRWA2) – White (7.5YR 8/1) ash that is soapy-textured due to alteration to bentonite(?); it contains 1-3% biotite grains equivalent in size to fine-grained sand. The ash is underlain by reddish brown (5YR 5/3) claystone at least 4 m thick and overlain by medium to thick, tabular beds of siltstone and very fine- to fine-grained sandstone. This ash has an $^{40}Ar/^{39}Ar$ age of 15.5 Ma (Izett and Obradovich, 2001). It grades upward into an ashy siltstone indurated by calcium carbonate (40 cm-thick); the lower, weakly consolidated ash is about 80 cm-thick.

ALTERED BED IN LOWER TESUQUE FORMATION

Altered bed east of town of Chimayo, in lower Tesuque Formation (ACWB) – Coarse quartz grains, up to 12 mm long, within a matrix of white powder of unknown composition, calcite crystals, and gypsum. 20 cm thick. It is interbedded within **Ttan4** arkosic sandstone and granite-dominated conglomerate, and located about 3 m above the gradational contact between units **Ttan4** and **Ttnr2**. It is only ~2 m in length, and the upper part is reworked. No microscopic

glass shards or minerals (e.g., biotite, sanidine, plagioclase) indicative of ash were observed, although very little potassium feldspar or granite lithics were seen as well. It may possibly be an alteration product of intense weathering by dissolution of gypsum. 3 m thick.

PROTEROZOIC IGNEOUS AND METAMORPHIC ROCKS

Ygp **Granite and granitic pegmatite (likely Mesoproterozoic)** – Granitic rock consisting of potassium feldspar + quartz + muscovite + plagioclase feldspar + biotite. It varies in grain size from medium-grained to pegmatitic and commonly has a reddish to pinkish weathered surface. It is generally not foliated and intrudes into and cross-cuts older rocks**.** The unit includes minor pods or bodies of gneissic granodiorite(?) (**Xgg**).

YXsg **Biotite schist and granite (likely Paleoproterozoic and Mesoproterozoic, respectively)** – Fine-grained, quartz-biotite-feldspar schist intruded by subequal **Ygp**. Foliation planes have an attitude of 021°\51° NW. Unit is only found in one exposure about 600 m north of Rio Chiquito.

YXm **Mixed granodiorite(?), granite, and amphibolite (likely Paleoproterozoic)** – Slightly more granodiorite(?) than granite and amphibolite. Granodiorite(?) is similar to that in unit **Xgg** but is not foliated.

Xgg **Gneissic granodiorite(?) (likely Paleoproterozoic) –** Grayish white to pinkish white, fine- to medium-grained igneous rock consisting of potassium feldspar + quartz + plagioclase(?) + biotite; generally foliated but foliation ranges from very weak to strong. It locally contains pegmatitic veins of **Ygp**.

Xa **Amphibolite (likely Paleoproterozoic)** – Very dark gray to black amphibole + plagioclase with minor quartz, fine- to medium-grained, weakly to strongly foliated. The unit contains minor feldspar-quartz-amphibole gneiss and local pegmatitic veins of **Ygp**.

UNITS ONLY DEPICTED IN THE CROSS-SECTION

Ttbm **Middle lithosome B unit of Tesuque Formation (middle Miocene)** – Lithosome B fluvial sediment that correlates to units **Ttbp1** and **Ttbs**. May be interbedded with minor lithosome A sediment. The lower contact of this unit is close to the Nambe-Skull Ridge Member contact. Up to approximately 410 m thick.

Ttms **Mixed and interbedded lithosomes A and B in the Skull Ridge Member, Tesuque Formation, undivided (middle Miocene)** – Unit consists of lithosome A and lithosome B map units in addition to mixed provenance map units; generally fine-grained. Includes units **Ttas2**, **Ttas1**, and **Ttms**. Up to 120 m thick.

Ttbns **Lower lithosome B unit of the Tesuque Formation, undivided (lower Miocene)** – Fluvial channel-fills of sandstone and pebble- to cobble-conglomerate interbedded with floodplain deposits of siltstone, mudstone, and very fine- to fine-grained sandstone. Includes units **Ttbn1**, **Ttbn2**, **Ttbn3**, **Ttbn4,** and possibly **Ttbs**. This and the lower part of unit **Ttbm** are grossly similar in sedimentologic properties. On the surface near Chimayó, these two units are separated by a tongue of intervening **Ttam**. To the west in the subsurface, where this tongue of **Ttam** may not be present, the two units are probably not differentiable and thus the contact between the two is somewhat arbitrary at that location. The upper contact lies in the near-vicinity of the Nambe-Skull Ridge Member contact. Up to 900-930 m thick.

Tap **Abiquiu and Picuris Formations, undivided (upper Oligocene to lower Miocene) –** Volcaniclastic sandstone, pebble-conglomerate, and siltstone derived from felsic to intermediate volcanic centers to the north. Thickness is uncertain.

Tb **Basalt flows (upper Oligocene to lower Miocene) –** Black to dark gray basalt flows and basaltic volcaniclastic sediment, as observed in the Kelly Federal #1 well in the Cundiyó quadrangle to the south (see Koning et al., 2001, for location).

PPu **Undivided Paleozoic strata (Mississippian to Permian) –** Limestone, siltstone, shale, and sandstone; under this quadrangle, most of this unit is probably the Madera Limestone (Pennsylvanian). Thickness is uncertain.

XYu **Undivided Proterozoic rocks (Meso- to Paleoproterozoic) –** Probably granite, amphibolite, schist, gneiss, and quartzite.

STRUCTURE

Strata of the Tesuque Formation generally strike northwest and unconformably overlie crystalline Proterozoic rocks (the latter relation is readily observed at outcrops in the southeast corner of the quadrangle). Near the mountain front, the older (lower Miocene to upper Oligocene(?)) strata of the Tesuque Formation generally dip 6-10 degrees to the northwest. As one moves up-section, stratal dips decrease to 2-3 degrees in the northwest part of the quadrangle. However, major structures, such as those discussed below, can locally increase stratal dips to as much as 47 degrees (but generally to 8-22 degrees). The difference in dip magnitudes between older strata in the southeast versus younger strata in the northwest may be explained by two simple models. One, the difference may be attributed to various structural domains within the basin, each having a characteristic range in dip. Two, the Española basin in this area may be viewed as a simple half-graben, with an east-down master fault to the west of the quadrangle (i.e., Santa Clara and Pajarito faults), which has experienced progressive west-northwest tilting throughout the deposition of the Tesuque Formation, albeit at somewhat different rates as a function of time. Both models are in part valid. Based on this mapping and past work (Koning, 2002a, Koning et al., 2002), it can be observed that stratal dips can increase significantly in structural zones. Also, the top of bedrock (i.e., the contact corresponding to the unconformity between Cenozoic basin fill and Proterozoic crystalline and Paleozoic rocks) dips at varying amounts across the basin, as observed in gravity data together with seismic reflection and refraction data (e.g.,

Biehler et al., 1991). However, stratal dips measured in close proximity of each other in non-faulted blocks, such as the area east of the Chimayo structure in the southeast corner of the quadrangle, show a progressive decrease in dip magnitude from upper Oligocene(?)-lower Miocene to middle Miocene strata. Also, SAGE seismic reflection data collected in the Rio de Truchas to the north (Ferguson, 1995) strongly suggest that along a vertical line older Tesuque Formation strata generally have higher dips than overlying younger strata. Thus, the progressive decrease in dip magnitudes from older to younger strata is largely attributed to syntectonic deposition of the Tesuque Formation in a rift half graben, which is consistent with other tectonic interpretations derived from sedimentologic study of the Tesuque Formation (Koning, 2002b and 2002c). However, structures such as faults and monoclines have increased stratal dips locally and various parts of the basin floor have been tilted by different magnitudes.

Three noteworthy north-south structures, each associated with monoclinal folding and normal faulting, are observed in the southern part of the quadrangle. These structures generally offset strata older than unit **Ttac1**, but five faults associated with these structures also offset unit **Ttac2,** although it's difficult to ascertain the northward extent of these structures due to poor exposure. The middle of these three structures, called the "Chimayo fault zone and monocline," is down-to-the-west and is manifested primarily by a monocline that is locally faulted. The Chimayo structure has offset the western side of the Chimayo horst (the bedrock-cored topographic high present 1-2 km east-southeast of the town of Chimayo). The eastern side of the Chimayo horst is bound by an east-down structure called the Chiquito fault, which extends southward into Santa Cruz Lake. Where they intersect the cross-section line, vertical stratigraphic offset across the Chiquito fault is 80-90 m, and vertical stratigraphic offset across the Chimayo structure is approximately 24-50 m. However, the magnitude of these displacements

may increase to the south; in the case of the Chiquito fault, there is about 100 m of east-down throw near Santa Cruz Lake.

Located to the west, the third structure is a continuation of the White Operation fault of Koning et al. (2002) and is generally a west-down structure; however, both east-down west-down faults are present within the fault zone. The structure is manifested by a slight increase in stratal dips to 7-9 degrees and significant normal faulting. Down-to-west faults tend to be on the east part of the structure, and down-to-the-east faults on the west part. Vertical stratigraphic displacement across one fault of this structure is approximately 30 m (down-to-the-west) at the cross section line; the long, westernmost fault associated with this structure probably has ~40 m of down-to-the-east throw.

In addition, in the southern part of the quadrangle there is a set of faults that trend 25° to 55° (i.e., to the northeast). Individual faults within this set may exhibit a sense of motion that is either down-to-southeast or down-to-northwest. This particular trend has not been observed in quadrangles to the south (e.g., Koning et al., 2002; Koning, 2002a), and may be due to the sharp bend of the Sangre de Cristo Mountain front northeast of Chimayo, or due to pre-rift structures.

In the northern quadrangle, faults generally trend north to northeast. The two most important structures here are the west-down Rio de Truchas fault and Velarde monocline, which extend only 1.5-2.1 km into this quadrangle. The Velarde monocline is associated with small, subsidiary fault splays, and these are interpreted to reflect the south tip of the west-down Velarde fault. Both the Velarde and Rio de Truchas faults are discussed in more detail in Koning and Aby (2003).

The stratigraphic fence diagram of **Plate I (separate PDF file)** illustrates how many of the lithostratigraphic units thicken in a westward direction (particular those associated with lithosome B, as well as the strata between the Skull Ridge Ashes #2 and #4). This indicates that the units were deposited during active tilting of the basin floor due to rift tectonism. There seems to be little westward thickening between the main coarse white ash zone and the Española tephra zone, suggesting lesser rates of basin floor tilting between 13 and 11 Ma compared to 13-17 Ma.

SEDIMENTOLOGIC TRENDS AND DEPOSITIONAL HISTORY

It is interpreted by the author that both lithosomes A and B of the Tesuque Formation were concurrently being deposited since the beginning of the Miocene, and quite possibly even earlier in the Oligocene. This interpretation is based on this mapping effort plus investigation of subsurface cuttings of the Kelly Federal #1 well to the south (see Koning et al., 2002, for location) and the Chimayo #1 well on this quadrangle (NW1/4 Sec. 36, T21N, R9E; shown on the map and depicted in **Plate I**). In both of these wells, lithosomes A and B are interbedded in strata that pre-date ca. 16 Ma. In the Kelly Federal #1 well, the interbedding of these lithosomes occurs over the upper 540 m of the penetrated depth (740 m) of the Tesuque Formation (probably in strata that is approximately 16-20[?] Ma in age). Thus, the boundary between these two depositional systems did not appear to significantly shift from 20(?) to 16 Ma, but rather stayed within a horizontal band about 5 km wide.

Initial deposition of this basin fill over much of this quadrangle, particularly the southeast quadrant, is interpreted to have occurred on a former uplifted terrain with appreciable relief. This uplifted terrain probably was created during the Laramide

orogeny, based on Baltz (1978), Biehler et al. (1991), Baldridge et al. (1994), and Koning et al. (2002). This interpretation is from three observations: (1) the basal 200 m of the Tesuque Formation, as observed in the Kelly Federal #1 well cuttings, is both coarse (generally coarse sand) and dominated by lithosome A (the longest interval of continuous lithosome A in the well); (2) considering the strike of the lower beds of the Tesuque Formation northeast of Chimayo, the lower Tesuque Formation clearly is buttressed to the south against Proterozoic bedrock highs, and (3) the basalt flow in the Kelly Federal #1 well is only 3 m (based on cuttings) to 14 m (based on geophysical interpretation by David Sawyer, personal communication, 2003) above bedrock, but a possibly correlative basalt flow exposed 9.7-9.8 km to the southeast is underlain by 70-80 m of coarse Tesuque Formation sediment (Koning et al., 2002, fig. 3). That the lower 200 m of the Tesuque Formation is coarse and dominated by lithosome A sediment of local provenance is interpreted to reflect appreciable relief of crystalline terrain in the late Oligocene to early Miocene. After the initiation of rifting in the late Oligocene and concomitant formation of the Española basin, locally derived, granite-rich detritus from this terrain was able to accumulate in the quadrangle and probably progressively lapped up eastward onto the Sangre de Cristo Mountains – this onlap is represented by the 200 m of coarse detritus observed in the lower Kelly Federal #1 well. After approximately 20(?) Ma, there was deposition of coarse and fine sediment of both lithosomes A and B relatively close to the modern mountain front near Chimayo.

Following approximately 16 Ma (after the deposition of White Ash #1 of the Skull Ridge Member of the Tesuque Formation), the sediment of the Tesuque Formation gradually coarsens up-section and the depositional systems associated with Lithosomes A and B progressively prograded westward (see **Plate I**). This progradation had been inferred based on earlier work by the author (e.g., Koning, 2002a, 2002b, 2002c), but the exposures in the tall escarpment north of the Santa Cruz River firmly establish both of

these trends. These exposures are particularly useful because one can trace a given geochronologic stratigraphic interval over long lateral distances transverse to the basin axis (an endeavor aided by distinct ash beds), note the position of the lithosome A-B boundary in this interval, and then compare the position of this boundary with younger or older geochronologic stratigraphic intervals. Although the lithosome A-B contact fluctuates over a scale of 10^5 years (perhaps due to paleoclimatic changes), over a scale of millions of years the boundary progressively progrades westward past the modern Rio Grande (e.g., Koning and Manley, 2003). This long-term progradation may be the result of changes in the rate of westward basin floor tilting of the rift half-graben (Koning, 2002b and 2002c) or due to paleoclimatic factors.

HYDROGEOLOGIC NOTES

Springs and seeps are much more common east of, and within, the Chimayo fault zone and monocline than to the west of it (where the only other area of significant springs is between Cañada del Mogote and Arroyo de los Ajuelos). It may be that the Chimayo structure acts as a groundwater barrier, and has resulted in higher groundwater table elevations to the east of it compared to the west. Individual faults within the Chimayo structure, such as northwest of Arroyo de los Encinos (e.g., UTM coord: 3987380 N, 416940 E, and 3987740 N, 416860 E; zone 13; NAD 27) also serve as groundwater barriers and locations of groundwater discharge. The hydrogeologic implications of the Chimayo structure needs to be further studied, particularly in regards to its influence on groundwater flow and possible influences on groundwater quality.

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COMMENTS TO MAP USERS

A geologic map displays information on the distribution, nature, orientation, and age relationships of rock and deposits and the occurrence of structural features. Geologic and fault contacts are irregular surfaces that form boundaries between different types or ages of units. Data depicted on this geologic quadrangle map are based on 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.

The map has not been reviewed according to New Mexico Bureau of Mines and Mineral Resources standards. Revision of the map is likely because of the on-going nature of work in the region. The contents of the report and map should not be considered final and complete until reviewed and published by the New Mexico Bureau of Mines 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. Cross-sections are constructed based upon the interpretations of the authors made from geologic mapping, and available geophysical (regional gravity and aeromagnetic surveys), 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.

APPENDIX 1. UPPER CUARTELES, MARTINEZ, CHIMAYO, AND ENCINOS STRATIGRAPHIC SECTIONS

This appendix presents four stratigraphic sections of the Santa Fe Group that were measured in the Chimayo 7.5-minute quadrangle. Colors of sediment are based on visual comparison of dry samples to the Munsell Soil Color Charts (Munsell Color, 1994). Grain sizes follow the Udden-Wentworth scale for clastic sediments (Udden, 1914; Wentworth, 1922) and are based on field estimates. Sand textures are abbreviated as in the following: very fine-lower, vfL; very fine-upper, vfU; fine-lower, fL; fine-upper, fU; medium-lower, mL; medium-upper, mU; coarse-lower, cL; coarse-upper, cU; very coarse-lower, vcL; very coarse-upper, vcU; rounded, rnd; subrounded, subrnd; subangular, subang; angular, ang. (m) and (l) are used to abbreviated "mostly" and "lesser," respectively. Pebble sizes are subdivided as shown in Compton (1985). The term "clast(s)" refers to the grain size fraction greater than 2 mm in diameter. Clast percentages are based on counts of 100-150 clasts at a given locality, except where noted. Clast compositions may be abbreviated as follows: gr, granite; ss; sandstone; lm, limestone; Pz, Paleozoic; slst, siltstone; qtzite, quartzite. Quartzite may be further subdivided into: sil-qtzite, siliminite-bearing quartzite; cs-col or col-cs, colored coarse-grained quartzite; gray-smooth, gray-colored, smooth-textured quartzite; colored-smooth, colored, smooth-textured quartzite. Listed clast sizes are of the a and b axes (in that order). Descriptions of bedding thickness follow Ingram (1954). Sandstone is classified according to Pettijohn et al. (1987). Soil horizon designations and descriptive terms follow those of the Soil Survey Staff (1992), Birkeland et al., 1991, and Birkeland (1999). Stages of pedogenic calcium carbonate morphology follow those of Gile et al. (1966) and Birkeland (1999). Each stratigraphic section was measured upsection from unit 1 using a Jacob staff and Abney level (note that unit 8 is the lowest unit in the upper Cuarteles stratigraphic section). Numerical unit designations were established up-section for measured section, but listed in descending stratigraphic order. GPS localities for sites are in UTMs (NAD 27, zone 13), errors for the sites are 4-10 m. The locations of the stratigraphic sections are shown on the geologic map by depiction of a white line connecting labeled stake localites.

Upper Cuarteles stratigraphic section. Reference section of Tesuque Formation that encompasses the lithosome A, coarse upper unit (proposed Cuarteles member in a future publication). Measured and described in Arroyo Quarteles north of the Santa Cruz River and Highway 76. Described by D.J. Koning in July of 2003. UTM coordinates of base: 3989307 N, 410432 E (Zone 13, NAD 27), Chimayo 7.5-minute quadrangle, New Mexico. Note that cumulative thicknesses continue from the Cuarteles section on the San Juan Pueblo quadrangle to the west. Stake localities are preceeded by "UCS-" on the geologic map.

Unit	Description	Thickness (m) (Unit)	(Total)
	LITHOSOME A, COARSE UPPER UNIT OF THE TESUQUE FORMATION (unit Ttacu; will be renamed Cuarteles member in the near-future):	**76.1**	**446.6**
	UPPER CUARTELES SECTION		
	Stake G placed on top of hill underlain by unit 9c. 3989840N, 410370E		
9c	**Similar to unit 9a.**	2.5	446.6
9b	**Pebbly sandstone to pebble-conglomerate channel complex sediment:** Channel complex is composed of pebbly sandstone and pebble-conglomerate (subequal proportions); beds are laminated to v thin-thin, tangential- and trough-cross-stratified and also lenticular. Channel-shaped beds also present that are up to 60 cm deep. In conglomerate beds, pebbles are clast-supported, subang (most of granite) to subrnd (quartzite) and modly to poorly sorted. Clast count: 77% granite, 18% qtzite (16% coarse-colored, 2% siliminite-bearing), 3% quartz, 2% biotite granitic gneiss. 13x6 cm, 10x9 cm, 13x10 cm, 18x13 cm. Channel sand is mostly mL-vcU, subang, poorly sorted, and an arkose in composition. Channels are generally moderately to well cemented. Clasts are vaguely imbricated as to indicate a NW-directed paleoflow. Paleoflow data: N62°W ± 11° (50-60 cm-thick cross-stratification); S88°W ± 4° (25 cm-deep channel trend); N70°W (35 cm-tall channel margin); N58°W ± 20° (15 cm-deep channel); N68°W (25 c-tall channel margin). N33°W (20 cm-tall channel margin). Maximum calst sizes are: 13x6, 10x9, 13x10, and 18x13 cm.	1.5	444.1

Unit	Description	Thickness (m) (Unit)	(Total)
9a	**Sandy cobble-conglomerate channel complex:** Very thin to medium, lenticular beds whose gravel is comprised of 65-75% cobbes and 25-35% pebbles; 10-15% strong to moderate cementation, rest is weakly cemented. Max clast sizes: 32x16 cm, 35x19 cm, 23x18 cm, 19x18 cm, 47x19 cm.	3.5	442.6
8u	**Extra-channel sediment, with 35-40% coarse channel-fill sediment:** Light brown to reddish yellow (7.5YR 6/4-6), muddy (est 5% mud) vfL-vcU sandstone. Thin to thick, tabular beds. Sand is subang, poorly to moderately sorted and an arkose in composition. Moderately to well consolidated, and internally massive. 0.5-1% possible scattered reddish soil horizons. Channel complexes are thick, tabular, and composed of pebbly sandstone to sandy pebble-conglomerate; ~25% are strongly to moderately cemented, rest are weakly to non-cemented; conglomerate is clast-supported, moderately to poorly sorted, and composed of subang granite together with 1-2% vein quartz and 0-3% quartzite (cs-col); 0.5% of gravel are cobbles; channel sand is light brown (7.5YR 6/4), vfL-vcU but mostly cL-vcU, ang-subrnd but mostly subang, poorly sorted, and an arkose in composition.	13.3	439.1
8t	**Extra-channel sediment of Ttacu, with 25-35% coarse channel-fill sediment:** Light brown to reddish yellow (7.5YR 6/4-6 and 5/6) silty-clayey (est 3-40% fines) vfL-vcU sandstone. Medium to thick, tabular beds. Sand is subang, poorly sorted, and an arkose in composition. Moderately to well consolidated, and moderately cemented. Channels are in medium to thick, lenticular to tabular channel complexes with internal very thin to thin, lenticular beds, with minor planar and channel-shaped beds; well graded mixture of strong to poor cementation by CaCO3. Channels are composed of sandy pebble-conglomerate (most common) to pebbly sandstone (least common); conglomerate is clast-supported, subang-subrnd, moderately-poorly sorted, and granitic with ~1% quartzite. No cobbles. Channel sand is light brown (7.5YR 6/4), fL to vcU, subang (m) to subrnd(l), poorly sorted, and an arkose in composition. *From unit s, measured along ridge-top using 2 degree app dip, N10°E trend.*	7.2	425.8
8s	**Sandy pebble conglomerate channel complex:** Three stacked channels of strongly cemented, clast-supported sandy pebble conglomerate and subordinate pebbly sandstone. Ledge-former. Very thin to medium, lenticular to channel-shaped to planar (most common to least common) beds. Clasts are moderately to poorly sorted and subrnd-subang. Clast cnt (n=107): 89% granite, 8% quartz, 3% coarse-colored quartzite). Max clast sizes: 9x7, 6x4, 6x5, 5x4, 5x4. Channel sand is fL-vcU but mostly mL-vcU, subang (mostly) to subrnd (minor), poorly sorted, and an arkose in composition. *Followed this unit to ridge-top, base of unit climbs 1.3 m in the process.*	2.1	418.6
8r	**Extra-channel sediment, with 10-15% coarse channel-fills:** Light brown to light yellowish brown (7.5-10YR 6/4), silty-muddy vfL-vcU sandstone (mostly silt, mud, and vf-f sand). Internally massive to med-thick, tabular beds. Sand is subang (mostly) to subrnd (minor), poorly sorted, and an arkose in composition. Well-consolidated and no HCl effervescence. 10-15% channels (medium, lenticular to channel-shaped) are scattered in this unit.	3.0	416.5
8q	**Sandy conglomerate and pebbly sandstone channel complex:** Sandy conglomerate(m) to pebbly sandstone(l); very thin to thin, planar-lenticular beds. Clasts are all pebbles. Conglomerate is clast-supported, subang-subrnd, moderately sorted (within a bed), and granitic. Imbrication of ~5 clasts: N25-30°W. Sand is very pale brown (10YR 7/3), mL-vcU, subangular, poorly sorted, and an arkose in composition (one green ash grain). 2/3 weak-strong cementation, 1/3 moderate-strong cementation. @ 412.8 m: Channel complex has 25-30 cm-deep channels (25 cm scour depth); channel trend is N30°W±20°.	2.1	413.5
8p	**Extra-channel sediment:** Light brown (7.5YR 6/4) silty-muddy vfL-vcU ss (mostly silt, mud, and vf-f sand). Internally massive. Sand is subang (mostly) to subrnd (minor), poorly sorted, and an arkose in composition. Well-consolidated and	1.4	411.4

Unit	Description	Thickness (m) (Unit)	(Total)
	moderately cemented by CaCO3. 10-20 cm-thick reddish soil(?) horiz on top of unit. Two tephra beds project into the section from 85 m to S32E. Lower and upper are 7 and 16-17 cm thick, respectively; upper is 80 cm below unit 8q; the two are separated by 37 cm of extra-channel sediment. The black ashes are composed of gray-black ashy sand; ~1/4 : 3/4 ratio of tephra : detrital sand. Black ash is cL-vcU sand-size and probably basaltic. Top 1-2 cm of upper bed is rich in white, consolidated ash clasts and grains 0.5 - 17 mm diam – this may perhaps correlate to the Orilla pumice (10.8 Ma; Manley 1979).		
8o	**Strongly cemented, sandy pebble-conglomerate channel complex:** Very thin to medium, lenticular (mostly) to channel-shaped (lesser in porportion, up to 10-15 cm deep) internal bedding. Gravel are clast-supported, subrnd-subang, and poorly to moderately sorted. Clast count (n-108): 93% granite, 7% quartz. Channel sand is mostly mL-vcU, subang, poorly sorted, and an arkose in composition.	1.0	410.0
8n	**Channel complexes of pebbly sandstone and sandy pebble-conglomerate, interbedded with ~20% extra-channel sediment:** Generally medium to thick, tabular to broadly lenticular channel complexes of pebbly sandstone and sandy pebble-conglomerate. Internal very thin to medium, planar to lenticular beds. Conglomerate is clast-supported, poorly to moderately sorted, and subang to subrund. Only 1-3% of gravel are cobbles. Gravel is granitic with ~1% quartzite. Max clast sizes from channel at 401.7 m: 9x7, 9x7, 9x6, 8x7, 9x9, 7x7 cm. About subequal strong-moderate : weak cementation. Channel sand is very pale brown (10YR 7/3), fL-vcU but mostly mL-vcU, subang (m) to subrnd (l), poorly sorted, and an arkose in composition. Extra-channel sediment is in thick, tabular beds, moderately cemented, and composed of silty (est 3-5% silt) vfL-vcU sand [subang (m) to subrnd (l), poorly sorted, and an arkose in composition]. Top of extra-channel beds commonly have 10-20 cm-thick, reddish soil horizons. @406 m: 5.4 m below 1q base is a 30 cm-thick basalt-rich sand (15-35% basaltic sand grains that are fU-mU).	8.9	409.0
8m	**Ashy sandstone:** Light gray to light brownish gray (10YR 6-7/2), vfL-cU arkose sandstone with 20% very dark gray volcanic lithics and mafic grains. Sand is moderately consolidated and mostly subang.	0.2	400.1
8L	**Extra-channel sediment:** Very pale brown (10YR 7/3), slightly silty-muddy (est 1-3%) vfL-vcU sandstone; internally massive massive. Sand is subang(m) to subrnd(l), poorly sorted, and an arkose in composition. Well-consolidated and moderately cemented by CaCO3.	1.6	399.9
8k	**Pebbly sandstone-sandy pebbles channel-fill**: (channelized at base, planar, thin beds at top). Channel trends: S56°W±19°, S82°W±18°, N81°W±14°, N65°W±12°, S88°W±11°.	0.6	398.3
8j	**Upper bed of prominent black, coarse ash:** Light gray (10YR 7/2), basalt-rich arkosic arenite sand. 1/3 basalt or int vf-f sand and mafic grains. 3-15% white pumice 0.5-8.0 mm-long. Arkosic sand is vfL-vcU, and poorly sorted. ~5% Lith A pebbles. This tabular bed is scoured into up to 50 cm by overlying unit. *Stake E at 8K/8J contact; UTM coord: 3989499 N, 410257 E. 7 m to NW, stake F is at base of correlative unit 1J; UTM coord: 3989612 N, 410172 E.*	0.7	397.7
8i	**Fining-upward, coarse channel to finer extra-channel sediment:** Lower 2/3 is pebbly sandstone; pebbles are subang (mostly) to subrnd (minor) and granitic. Sand is light yellowish brown (10YR 6/4), fL-vcU, subang-subrnd, poorly sorted, and arkosic arenite (~7% dark gray volcanic lithics). Weakly consolid and weakly cemented. Upper 1/3 is a slightly silty (est. 3-5% silt) sand. Sand is vfL-vcU, subang (mostly) to subrnd (minor), poorly sorted, and arkosic arenite; well consolidated and well-cemented. Probable 10-15 cm thick, 7.5YR 5/6 soil on top (clay-rich but no clay films).	1.8	397.0
8h	**Middle bed of prominent black, coarse ash:** Light brownish gray to light gray (10YR 6-7/2), basalt-rich arkosic arenite sand. Basalt is dark gray to gray and fine- to	0.9	395.2

Unit	Description	Thickness (m) (Unit)	(Total)
	medium- grained. Arkosic sand is fL-vcU, subang (mostly) to subrnd (minor), and poorly sorted.		
8g	**Pebbly sandstone and sandy pebble-conglomerate channel complex:** Beds are very thin to thin, lenticular to cross-stratified. Upper channel like lower but no cross-stratification. Both fine-upward. Pebbles are clast-supported, subrnd-subang, moderately-poorly sorted, and granitic w/ <1% qtzite. Channel sand is fL-vcU, subang(m) to subrnd(l), poorly sorted, and an arkose in composition. Weak-strong cementation.	2.2	394.3
8f	**Lower bed of prominent black, coarse ash:** 25-35% black ash (f-m) mixed with 65-75% f-vc arkosic sandstone; internal v thin-thin bedding to massive. Light gray to light brownish gray (10YR 6-7/2); 10-20% 10-15 cm-thick lenticular beds of pebbly sand to sandy pebbles (also mixed in with the ash). Volcanic grains are dark gray and subrounded. Arkosic sand is subang and moderately to poorly sorted. Moderately consolidated and very weakly cemented. *Stake C placed at base of middle prominent black ash bed; UTM coord: 3989466 N, 410299 E. Followed this bed to west, where another section was measured between the lower and upper prominent black ash beds (the description in the text above is from the western section). Used N48°E\0 (along-strike); stake D placed at base of unit 8f (poor UTM coord: 3989495 N; 410251 E).*	1.4	392.1
8e	**Extra-channel sediment, with ~5% coarse channel-fills:** Light brown (7.5YR 6/4) slightly muddy (est ~3% mud) vfL-vcU sandstone; thick, tabular beds to massive; sand is subang (mostly) to subrnd (minor), poorly sorted, and an arkose in composition. ~5% 10-40 cm-thick channels of pebbly sandstone; pebbles are granitic; sand is light brown (7.5YR 6/4), subang (mostly) to subrnd (minor), poorly sorted, and arkosic; channels are moderately cemented by CaCO3. Well to moderately consolidated.	4.0	390.7
8e'	@ 386.8-387.3 and 389.2-389.4 m: **Basaltic(?) ashy sand:** 20-40 cm-thick bed of pink to very pale brown (7.5YR-10YR 7/3), slightly silty (est 1-3% silt) vfL-mL sandstone [subang (mostly) to subrnd (minor), modly sorted, and arkosic] with ~5% dark gray to gray volcanic (basalt?) lithic grains.		
8d	**Pebbly sandstone channel-fill:** Laminated to very thin to thin, lenticular to planar internal beds; well-distributed weak to strong cementation. Lower 0.5-1 m is sandy pebble-conglomerate; ~1% cobbles (8x5 and 7x4 cm diam); pebbles are clast-sup (in pebble-congl), subang to subrnd, and granitic with 3-7% qtzite and very minor pink volcanic lithics; channel sand is 7.5YR 6/4, fL-vcU (mostly mL-vcU), subang (m) to subrnd (l), poorly sorted, and an arkose in composition. Basal channel margin (15 cm-tall): S54°W.	0.9	386.7
8c	**Extra-channel sediment**: Light brown (7.5YR 6/4) slightly silty to muddy (est 1-3% fines), vfL - vcU sandstone with 3-5% pebbles; massive; sand is subang (mostly) to subrnd (minor), poorly sorted, an arkose in composition; well consolidated. ~2/3 up this unit are two med - thick, pebbly sandstone beds. Pebbles are poorly sorted and granitic; sand is f-vc, subang (m) to subrnd (l), poorly sorted, and arkosic; weakly cemented.	3.2	385.8
8b	**Sandy conglomerate channel-fill**: Internal bedding not well-exposed but appears to be thin to med and lenticular. Pebbles are clast-supported, subrnd to subang, and poorly sorted. Max clast sizes: 13x9, 8x7, 8x7, 8x6, 8x7, 7x5. Clast count (n=116): 6% quartzite (cs-col), 3% quartz, and 91% granite. Channel sand is 7.5YR 7/2-3, f-vc, subang(m) to subrnd(l), poorly sorted, and an arkose in composition. Weakly to strongly cemented by CaCO3 (more strongly cemented towards the base).	0.9	382.6
8a	**Extra-channel sediment, with ~3% coarse channel-fills**: Slightly silty to muddy (est 1-3% fines) vfL-vcU sandstone; massive; sand is subang, poorly sorted, and an arkose in composition; 3-5% scattered pebbles; well consolidated. Lower 2 m is light yellowish brown (10YR 6/4). Upper 1.5-2 m is light brown to reddish yellow (7.5YR 6/4-6); some of reddening may be due to two 20-30 cm reddish soil horizons (probly Bt); these are 5YR-7.5YR 6/6 and 5YR 5/6, and have hard, 3csbk ped structure and	3.2	381.7

Unit	Description	Thickness (m) (Unit)	(Total)
	3d-ppf clay films. Within the massive sediment are ~3% thin to med (up to 15 cm thick) channels of sandy pebble conglomerate; pebbles are clast-sup, subang (mostly) to subrnd (minor), poorly sorted, and granitic with 1-5% estimated quartzite; ~25% of channels are strongly cemented, rest are weakly to moderately cemented by CaCO3 (weak to moderate HCl effervescence). *@379.2 m: stake B (N 3989392 N, 410359 E); above, use N42°W\ 2°NW.*		
	Covered: 370.5-378.5 m. ***Shot along-strike from stake BB using an average attitude of N48E\3NW; add 4 m over this shot (error of +/- 1 m). Stake A placed at UTM coord: 3989307 N, 410432 E. Avg att in lower section is N48E\3NW, so used bearing of N42W\3NW.*** **Note that cumulative thicknesses continue from the Cuarteles section on the San Juan Pueblo quadrangle to the west.**	8.5	378.5 370.5

Martinez stratigraphic section. Measured in upper Arroyo del los Martinez and Arroyo Chinguague. Described by Daniel Koning and Chi Le on July 9, 10, Oct. 1, 2002; D.J. Koning on October 1, 2002 and August 25, 2003; D.J. Koning, S.D. Connell and D. Love on August 18, 2003. UTM coordinates of base: 3984357 N, 409170 E (Zone 13, NAD 27), Chimayo 7.5-minute quadrangle, New Mexico. Stake localities are preceeded by "MS-" on the geologic map.

Unit	Description	Thickness (m) (Unit)	(Total)
	Stake II placed on top of hill, marking top of upper Martinez section; UTM coord: 3990091 N, 411547 E.		
	Sandy gravel Plio-Pleistocene(?) terrace deposit: Gravel has ~65% cobbles, 30% pebbles, and 5% boulders; clast-supported, poorly sorted, and loose. Scoured, sharp basal contact with 20 cm of relief.	2.5	
	LITHOSOME A, COARSE UPPER UNIT OF THE TESUQUE FORMATION (unit Ttacu; will be renamed Cuarteles member in the near-future):	**219.5**	**558.9**
63d	**Pebbly sand to sandy pebbles channel complex sediment**: Similar to that in unit 63.	0.6	558.9
63c	**Basalt(?)-rich sand; probably lower basaltic bed of Alcalde tuffaceous zone:** Fining-upward channel of sandy pebbles (lower 20 cm) overlain by silty sand extra-channel sediment; both contain ssubordinate (3-40%) black grains (probably basalt) that are fL-vcL in size. Overall, a thick, tabular bed that is internally massive. Basal sandy pebbles are clast-supported and like those in unit 63b; max channel depth of 35 cm. Extra-channel sediment is of vfL-vcU (mostly vfL-mU) sand with an estimated 5-8% silt; sand is moderately to poorly sorted, subrnd (basalt) to subang-subrnd (arkosic sand); some intervals have as much as 70% black ash grains; extra-channel sediment is generally light brownish gray to light gray (10YR 6-7/2), but top is pale brown to very pale brown (10YR 6-7/3) and light yellowish brown (10YR 6/4); well to modly consolidated; not cemented except for minor (1-3%) strongly cemented CaCO3 nodules 3-7 cm in size.	1.9	558.3
63b	**Pebbly sand to sandy pebbles channel complex sediment**: Not cemented and weakly consolidated. About 2/3 pebbly sand and 1/3 sandy pebbles. Very thin to medium, lenticular (subord channel-shaped and planar) beds. Conglomerate beds are clast-supported; ~5% of gravel are cobbles; one boulder seen. Gravel are poorly sorted; granite are subrnd-subang, qtzite are surnd-rnd. Max clast sizes: 25x17, 13x7, 10x8, 10x8, 7x5, 9x5, 8x6 cm. Clast count (n=126): 85% granite, 15% quartzite (13% cs-col, 2% sil). Sand is very pale brown to light yellowish brown (10YR 7/3-6/4(and subequal reddish yellow (7.5YR 6/6), fL-vcU (mostly mL-vcU), ang-subrnd (mostly subang),	6.1	556.4

	poorly sorted, and an arkose in composition (trace felsic volc grains). *@550.8 m: Stake HH placed; UTM coord: 3990076 N, 411558E; from here we measure down-dip using att of N70°E\2°NW (bearing of N20°W\2°NW).*		
63a	**Pebbly sand to sandy pebbles channel complex sediment:** As in unit 63b, but 3-5% of channels are strongly cemented. Unit has 5-10% extra-channel deposits of light brown to reddish yellow (7.5YR 6/4-6; some 10YR 7/3) slightly silty (est 3% silt) vfL-vcU sand (mostly vfL-mU); sand is ang-subrnd (mostly subang), v poorly sorted (some moderate to poor sorting), and an arkose in composition; internally massive and moderately consolidated. Uppermost cemented channel trends N80°W ± 10° (by 3-D shape) and is 40 cm thick -- trend is consistent with weak clast imbric of N40°W (from 3 clasts).	5.5	550.3
62	**Extra-channel sediment**: Light yellowish brown to very pale brown (10YR 6-7/3, 10YR 7/4), silty (est 3-5% silt) vfL-fU sand (minor mL-vcU sand and 3±2% scattered pebbles). Internally massive. Sand is subang, modly sorted, and an arkose in composition. Modly consolidated and weakly cemented (weak HCl eff).	3.7	544.8
61	**Extra-channel sediment**: Strong brown to reddish yellow (7.5YR 5-6/6) clayey (est 3-5% clay) vfL-vcU sand (slightly more vf-f than m-vc sand); internally massive; sand is ang-subrnd (mostly subang), v poorly sorted, and an arkose in composition. Well consolidated and weakly cemented (weak-mod HCl eff).	0.9	541.1
60	**Sandy pebble-conglomerate channel complex**: ~1/3 pebbly sandstone. Channel complex extends at least 150 m in west (downstream) direction. Mostly strongly cemented, and is a prominent ledge-former; cement is not sparry. Internal beds are v thin to med, and lenticular, tabular, and channel-shaped; v minor cross-strat (up to 20 cm-tall). Conglomerate beds are clast-supported; gravel are vc-vc pebbles (1% cobbles) that are poorly to modly sorted, and rnd-subrnd (qtzite) to subang-surnd (gr). Max clast sizes: 13x10, 8x5, 5x4, 4x3, 5x3, 8x6, 3x3 cm. Clast count (n=107): 24% quartzite (1% sil, 20% cs-col, 3% clr-gray), 71% granite, 4% vein qtz, 2% amphibolite. Channel sand is v pale brown (10YR 7/3), mostly mL-vcU, ang-subrnd (mostly subang), poorly sorted, and an arkose in composition. 30 cm-tall channel margin trends N27°W. Sharp lower contact.	2.3	540.2
59	**Extra-channel sediment, with subordinate channels:** Light brown to reddish yellow (7.5-10YR 6/4-6), vfL-vcU sand (est 0.5% silt), mostly vfL-mU sand. Internally massive. Sand is subang, modly-poorly sorted, and an arkose in composition. Generally poor exposure; interbeds of pebbly sand-sandy pebbles (similar to those in unit 57) may possibly comprise up to half of exposure. Modly-weakly consolid and not cemented.	2.3	537.9
58b	**Sandy conglomerate channel:** Similar to 58a but poorly exposed. ~10% strongly cemented beds.	3.6	535.6
58a	**Sandy conglomerate channel:** Gravel are poorly sorted and include granite (subang-subrnd) and subordinate quartzite (rnd-subrnd); subequal cobles and pebbles. Max clast sizes: 13x9, 14x8, 12x9, 14x12, 13x8, 10x7, 8x7 cm. Clast count (n=101): 42% quartzite (9% sil, 29% cs-col, 4% clr-gray), 57% granite, 1% Pz yellowish limestone. Channel sand is mL-vcU, ang-subrnd (mostly subang), poorly to modly sorted, and an arkose in composition. Beds are not well exposed. Strongly cemented. This gravelly zone appears to correlate with unit 8w gravels at top of upper Cuarteles section (i.e., seems like one can follow it westward to that locality).	0.9	532.0
57	**Pebbly sand channel complexes, with subordinate extra-channel sediment:** Similar to unit 55, but extra-channel sediment may be lt yellowish brown (10YR 6/4) or reddish yellow (7.5YR 6/6), and has subordinate cL-vcU sand. Channels are in v thin to thin (minor med), lentic to planar beds. Channel pebbles are granitic with ~25% quartzite in uppermost part; in middle and lower parts pebbles are granitic with about 5% quartzite. Quartzite clasts are subrnd-rnd and granite clasts are ang-subrnd (mostly ang-subang); gravel is poorly to modly sorted. Weakly to modly consolid; non- to weakly cemented.	10.3	531.1
56	**Covered by Holocene valley fill. Probably like unit 55.** *@511.8 m: Stake GG placed near bottom of arroyo; UTm coord: 3989968 N, 411387 E; continue shooting across arroyo at N62°E.*	10.5	520.8

@510.3 m: Stake FF placed on top of ridge; UTm coord: 3989877 N, 411209 E; shoot across arroyo at N62E to Stake GG. Bedding exposure parallel to section line confirms 0.5° dip.

55	**Pebbly sand channel complexes, with 25-35% extra-channel sediment:** Sparsely exposed channel beds are v thin and lenticular. Sand has trace silt, 1-3% vfL-vfU sand, and rest is fL-vcU sand (mostly mL-vcU); sand is pink (7.5YR 7/3-4 and 5YR 7/4), ang-subrnd but mostly subang, poorly sorted, and an arkose in composition; 3-20% gravel in channels; gravel are pebbles with ~5% cobbles, poorly sorted, and composed of granite (subang) with 10-20% quartzite (subrnd-rnd); weakly cemented (mod-strong HCl eff);. Est 25-35% extra-channel sediment of modly consolidated, light brown to reddish yellow (7.5YR 6/4-6), slightly muddy (est 1% fines), vfL-mU sand with minor cL-vcU sand and vf-f pebbles; medium, tabular beds; sand is subang, modly to poorly sorted, and an arkose in composition. Gradational lower contact.	1.3	510.3
54	**Gravelly sand to sandy gravel channel complex:** Approx 65% : 35% ratio of cobbles : pebbles. Sharp and scoured (10 cm of relief) lower contact. Basal 10 cm is strongly cemented, overlying sediment is loose to weakly cemented (except for 1-3% v thin CaCO3-ind lenses or zones). Bedding at base is v thin to thin and lentic; beds not exposed elsewhere. Gravel are clast-supported and poorly to v poorly sorted. Max clast sizes: 22x13, 22x12, 18x11, 19x12, 22x14, 20x17 cm. Clast count (n-101): 33% quartzite (31 cs-col, 2 clr-gray), 67% granite. Channel sand is light yellowish brown (10YR 6/4), fL-vcU but mostly mL-vcU, subang, poorly to modly sorted, and an arkose in composition. Unit may correlate with unit 9a of upper Cuarteles section (based on texture, composition, and attitude data).	3.4	509.0
53	**Extra-channel sediment, with 20-25% pebbly to sandy channels:** Reddish yellow (7.5-5YR 6/6) vfL-vcU (but mostly fL-vcU) sandstone with ~1% estimated clay; thick, tabular beds that are internally massive; sand is subang, v. poorly sorted, and an arkose in composition; modly consolidated, with weak-mod HCl eff. 20-25% channel deposits (medium to thick but can't tell bed shape) of pebbly sandstone to sandy pebble-conglomerate. No cobbles. Pebbles are modly-poorly sorted, ang-subrnd (mostly subang), and granitic with 1-3% quartzite; channel sand is lt brown to reddish yellow (7.5YR 6/4-6), fL-vcU but mostly mL-vcU, ang-subrnd but mostly subang, poorly sorted, and an arkose in composition; ~20% of channels are modly to strongly cemented by CaCO3, rest are weakly to non-cemented. Soil at top of unit consists of 15 cm of 5-7.5YR 5/6 Bt with 2csbk, hard peds and 2f-dpf clay films; below Bt is a Bk hor with stage I+ to II carbonate morphology.	7.0	505.6
52	**Pebbly sandstone channel complex:** Contains ~25% clast-supported sandy pebble-conglomerate. Laminated to v thin to thin, lentic beds; v minor planar-cross-stratication up to 20 cm thick; minor planar lamination; pebbly beds are v thin to thin. ~5% of gravel are cobbles. Max clast sizes: 12x9, 12x9, 8x5, 7x6, 7x5, 6x6, 6x5 cm. Pebbles are subang-subrnd, and modly to poorly sorted. Clast count (n=102): 1% biot-gneiss, 1% quartzite (cs-col), and 98% granite. Weak clast imbric: N65°W(2), N65°W(2), N80°W(2). Channel sand locally has a muddy vf to f sand matrix. Sand generally ranges from fU-vcU, but mostly is mL-vcU; sand is v pale brown (10YR 7/3), ang-subrnd but mostly subang, poorly sorted, and an arkose in composition. ~75% of channels are strongly-modly cemented by CaCO3, rest are weakly cemented (weak-mod HCl eff).	2.3	498.6
51	**Extra-channel sediment, with subordinate pebbly to sandy channels:** V. Poor exposure. Extra-channel sediment is internally massive, and larger-scale bedding is not exposed; composed of clayey-silty (est 3-8% fines) sandstone; sand is vfL-vcU, lt brown to reddish yellow (7.5YR 6/4-6) and lt yellowish brown (10YR 6/4), subang(m), to subrnd(l), poorly to v poorly sorted, and arkosic with ~5% basaltic lithics; modly consolidated and weakly cemented (mod to str HCL eff). Channel sediment is strong brown to reddish yellow (7.5YR 6/5-6), vfL-vcU (mostly mL to vcU), poorly to v. poorly sorted, subrnd-ang (mostly subang), and arkosic; weakly to non-cemented. Pebbly channel beds are composed of poorly sorted, subang-subrnd granite with 1% quartzite; ~3 (±2)% of gravel are cobbles.	10.0	496.3

	@495.8 m: contact from stake DD may project to here using N33°W\2° NW; 8-16 m of inferred error in this shot (asssuming 2.5 and 3 degree dips, respectively).		
	Stake EE placed at base of upper Martinez section: *UTM coor: 3989838 N, 411129 E. Red flagging tied to nearby tree. Section measure almost along-strike at N62°E\0.5° NE.*	1.5	486.3
	@488.4 m: stake DD placed on top of hill (2.7 m strat above fence post); UTM coord is 3989126 N, 0411612 E. *From here, I shoot across Arroyo de Chinguague using a bearing of N33°W\2°NW, gaining 1.5 m; this brings us to base of uppermost Martinez section, with an error of +/- 5 m (not including error assoc with accuracy of attitudes use to determine bearing and dip).*		
50	**Channel complex of sandy conglomerate with subordinate extra-channel sediment:** Poorly exposed; about 60-65% : 35-40% ratio of channel : extra-channel deposits. Channel sediment consists of pebbly sandstone to sandy pebble-conglomerate; channel bedding is thin to medium, lenticular to broadly lenticular; pebbles are subang, some are subrnd, and composed of granite with trace quartzite; pebble-conglomerate beds are clast- supported; max clast sizes are 8x5, 6x4, 8x5, 6x4, 6x4, 5x4 cm. Channel sand is fL to vcU, mostly mL to vcU, ang to subrnd (most subang), poorly sorted, and an arkose in composition. 3-5% of channels are strongly to moderately cemented by CaCO3. Extra-channel sediment is lt brown to reddish yellow (7.5YR 6/4-6) to lt yellowish brown (10YR 6/4). Sand is vfU to vcU, mostly mL to mU; 1-3% mud; 3% gray to black volcanic lithics, otherwise arkosic (subrounded to angular but mostly subangular; low moderately sorted to high poorly sorted). Modly consolidated, weak to mod HCL eff.	12.6	484.8
	@ 475.9-476.4: an ashy sand bed is lt brownish gray (10YR 6/2); est 3-7% black basaltic(?) ash, fL to fU in size, mixed with arkosic sand, vfL to vcL in size.		
49	**Ashy sandstone of Espanola tephra zone:** Color is lt brownish gray (10YR 6/2); fU to vcU, mostly mL to mU. Sand is subrnd to subang, modly to poorly sorted (mostly modly sorted), and arkosic arenite with 10% grayish volcanic lithics that are mostly fU to mU in size; trace pink felsic volcanic grains and 5-15% grayish basalt(?) grains. Bedding is not exposed. Weakly to moderately consolidated sand.	1.3	472.2
48	**Channel complex of pebbly sandstone with ~20% sandy pebble conglomerate:** Internal bedding is lenticular to channel shaped to planar; v thin to medium; minor tangential cross stratification up to 25cm tall; max scour depth of channel is 20-25 cm; conglomerate is clast-supported; clasts are angular to subrounded (but mostly subangular), moderate to poorly sorted; max clast sizes are 7x4, 5x5, 10x5, 8x4, 8x4, 5x3, 4x3; clast count yields: 87% granite, 12% quartz, 1% quartzite. (cs-col). Sand is fU to vcU (mostly mU to vcU), and is ang to subang, poorly sorted, and arkosic in composition. Strongly cemented.	1.8	470.9
47	**Extra-channel sediment with 25-35% channel complexes:** Extra-channel sediment is lt yellowish brown (10YR 6/4) and composed of slightly silty (est ~1% silt) very fine to very coarse sand (mostly fU to mU). Beds are massive to thick and tabular but generally not exposed. Sand is subrnd to subang (mostly subang), modly to poorly sorted, and an arkose in composition. Some thick beds contain basalt grains that are fL and fU and comprise 5-10% of given bed. Both this and underlying unit has 3-5% medium-thick reddish horizons that may be soils. Channels are composed of pebbly sandstone to sandy pebble conglomerate, and up to ~15 m in width. Pebbles are clast supported (in conglomerate), subang, and composed of all granite; no cobbles present; channel sand is fL to vcU (mostly mL to vcU), subang (m) to ang(l), poorly sorted, and an arkose in composition. Weakly consolidated.	12.4	469.1
	@461.2-461.9 m: Upper black ash is 70 cm thick and composed of 40-50% fine-sand-size ash (probly basaltic) with 50-60% vf-c feld arenite sandstone. @459.1-459.7 m: Middle black ash is 60 cm thick and appears to fill a channel; tephra are 0.1-1.0 in size, probably basaltic, and are mixed w/ subequal f-vc arkosic sandstone.		

46	**Pebbly sandstone to sandy pebble-congl channel complexes, with 25-35% extra-channel sediment:** Channels are in v thin to medium, lenticular internal beds; <10% cobbles; gravely beds are clast-supported, modly-poorly sorted, and composed of granite (subang, some subrnd) with ~5% quartzite (subrnd-rnd; cs-col). Sand is lt reddish brown to reddish yellow (5YR 6/4-6), fU-vcU, subang (minor subrnd), poorly sorted, an arkose in composition, and has sparse clay in the matrix. ~25% of channels are modly-strongly cemented, rest are weakly to non-cemented. Extra-channel sed as in unit 45.	1.8	456.7
45	**Extra-channel sediment:** Slightly clayey (est 3% clay) vfL-vcU (mostly vfL-mU) sandstone. Internally massive and well consolidated. Sand is subang, poorly sorted, and an arkose in composition. Top 25 cm of unit is probly a soil (10-20% clay + coatings on clasts), 5YR 5/4-6, 2-3cabk peds). @453.6-453.9 m: 28 cm-thick black ash; cinders are black and basaltic(?), and mL-vcU sand-size but mostly cL-cU (some clasts up to 7 mm diam); lower 4-5 cm is 5Y 8/8, upper 4 cm is composed of reddish to black cinders in reddish yellow (5YR 6/6) clayey sand .	4.1	454.9
44	**Pebbly sandstone channel sediment**: Pebbles are subrnd, poorly sorted, and granitic with ~25% qtzite. Gravel are not in beds but rather are scattered. Sand is planar-laminated, mL-vcU, subang, poorly sorted, and an arkose in composition. Strongly cemented by CaCO3.	1.1	450.8
43	**Pebbly sandstone channel sediment, with 25% extra-channel sediment:** Coarse channels are in thin to thick, lenticular to channel-shaped internal beds; max channel depth of 40 cm; one 40 cm-thick channel is at least 20 m wide in direction tranverse to flow; pebbles are composed of granite with ~3% quartzite (cs-col); 1-2% cobbles; pebbles are poorly sorted; sand is generally mL-vcU, ang-subrnd (mostly subang), poorly sorted, and an arkose in composition. ~35% of channels are strongly cemented. Extra-channel sediment is slightly muddy (est 3%) vfL-vcU sandstone (mostly vfL-mU); internally massive; sand is subang-subrnd, poorly sorted, and an arkose in composition. Well consolidated.	1.8	449.7
42	**Pebbly sandstone channel complex sediment:** 1/3 sandy pebbles. Very thin to medium, lenticular beds. Gravely beds are clast-supported. Pebbles are subang-subrnd (gr) to subrnd-rnd (qtzite), and poorly to modly sorted. Clast cnt (n=104): 71% gr, 23% qtzite (19% cs-col, 4% sil), 4% qtz, 1% biot gn, 1% amphib. Max clast sizes: 10x7, 7x5, 4x4, 4x4, 6x3, 5x3, 6x4, 6x5 cm. Sand is pink (5YR 7/4), vf-vc, subang, poorly sorted, and an arkose in composition. Loose. *Stake BB placed at base of unit to southwest (UTM coord: 3988787 N, 411705 E). Follow base of unit to NE (1-2 m poss error in this). Stake CC placed at base of unit to NE (UTM corrd: 3988990 N, 411,720 E) -- start measuring 5 m due north of the stake cc.*	1.5	447.9
41b	**Extra-channel sediment of Ttacu:** Light brown (7.5YR 6/4) clayey sandstone with 1-3% very fine to medium, subangular, granitic pebbles. Internally massive. Sand is vfL-vcU (mostly vfL-fU), subangular, very poorly sorted, and an arkose in composition. Well consolidated and weakly cemented. In this and subjacent units, coarse channel intervals and extra-channel sediment intervals are of comparable lateral extent.	1.0	446.4
41a	**Coarse channel complex sediment:** Subequal pebbly sandstone to sandy pebble conglomerate in a tabular bed. Internal bedding is very thin to medium, lenticular to broadly lenticular. Pebbles are very fine to coarse, clast-supported (in conglomerate), subangular (granite) to subrounded (quartzite), and moderately sorted. Clast count (n=119) gives: 80% granite, 16% quartzite, and 4% vein quartz. Sand is pink (7.5YR 7/3), subangular, moderately to poorly sorted, and of quartz, 23-30% Kspar, and 4-5% biotite and mafic minerals. 10-15% mod-strong cementation, rest is weakly to non-cemented.	2.0	445.4
40b	**Extra-channel sediment:** Pink (5YR 7/4) clayey-muddy (est 5-8%) sandstone. Unit is probably tabular. Sand is mostly fU (vcL-vcU range), subangular, poorly sorted, and arkosic with ~1% reworked ash. Weakly consolidated.	1.0	443.4

	@ 442.4 m (below stake cc), there is a 20 cm-thick, white (2/5Y 8/1), mL-vcU sand-size, fluvially reworked coarse white ash. Tephra consists of consolidated white ash, plagioclase(?), and gray volcanic lithic grains mixed with fU-vcU arkosic sand with subordinate pebbles. Ash abundance is greater than clastic detritus only in basal 1 cm.		
40a	**Pebbly sandstone channel complex sediment**: 20-25% pebble-conglomerate beds that are v thin to medium and lenticular. Pebbly sandstone is in very thin to thin, broadly lenticular beds. Gravel are subrnd-rnd (quartzite) to subrnd (gr), poorly sorted, clast-supported (in congl), and composed of gr with estimated 30% quartzite. Max clast sizes: 13x9, 11x7, 10x7, 7x6 cm. Sand is generally planar-lamin, pink (7.5YR 7/4), mostly mL-cL, ang-subang, poorly sorted, and an arkose in composition. ~5% mod cementation, rest is weakly to non-cemented.	2.0	442.4
39	**Extra-channel sediment:** Pink (7.5YR 7/4) clayey (est 5-10% clay) sand. Internally massive and well-consolidated. Non- to weakly cemented. Sand is vfU-cL, ang-subang, poorly sorted, and arkosic with ~3% reworked ash. Top 10 cm is mostly cL-mL sand that is reddish yellow (5YR 6/6) and poorly sorted .	1.6	440.4
38	**Coarse channel complex sediment:** Subequeal sandy pebbles to pebbly sandstone. Loose and bedding poorly exposed over much of unit; basal 20 cm is strongly cemented, and bedding there is med (up to 40 cm tall) and lenticular, w/ minor tangential cross-strat 4 cm thick. Gravel are 70-80% pebbles : 20-30% cobbles, clast-supported in conglomerate beds, and subrnd-subang (gr) to subrnd to rnd (qtzite). Clast cnt (n=119): 62% gr, 31% qtzite (28% cs-col, 3% sil), 4% granitic gn, 2% pilar phyl, 1% qtz. Max clast sizes: 33x20, 22x18, 25x11, 22x13, 22x14, 21x10, 16x14. Sand is light brown (7.5YR 6/3), vfL-vcU, subang(m) - subrnd (l), poorly sorted, and an arkose in composition. *@434.7 m: Stake AA placed at base of unit 38. UTM coord: 3988729 N, 411755 E; from here, used bearing of N60°*W*\4°NW (from app att)*	4.1	438.8
37	**Extra-channel sediment, with 15-20% coarse channel-fills**: Lt brown to reddish yellow (7.5YR 6/4-6) silty to slightly silty vfL-vcU sand (mostly silt to vfL to cL). Tabular, thick beds that are generally internally massive. Sand is mostly subang, poorly sorted, and an arkose in composition. Weakly to modly consolid. Moderately to weakly cemented. 15-20% tabular to broadly lenticular channel complexes up to 70 cm thick; these are composed of lithosome A pebbly sandstone to sandy pebble-conglomerate; the conglomerate is clast-supported; clasts are very fine to very coarse, poorly sorted, granitic w/ 2-7% quartzite (granite is subang-subrnd, quartzite is subrnd-rnd). @429.0-429.3 m: **Coarse White Ash:** 10Y 8/1 altered tephra; generally consolidated white ash and plagioclase that is m-vc sand-size; volcanic lithics compose 3-5% of tephra and are mostly m sand-size; 7% mL-vcU sand-size biotite. Modly cemented by Ca CO3. @428.0-429.0 m: **Channel of pebbly sandstone:** Subordinate sandy pebble-conglomerate. Generally modly-strongly cemented. V thin to as much as 15 cm, planar to lenticular internal beds together with planar-laminations and minor planar cross-laminations. Pebbles are modly sorted, clast-supported (in pbly beds), composed of gr w/ 5-10% est qtzite, and subang-subrnd (gr) to subrnd (qtzite). Channel sand is fL-vUc, subang (v minor subrnd), poorly sorted, and an arkose in composition.	11.0	434.7
36	**Channel complex sediment, with 10-20% extra-channel sediment:** Generally a series of stacked channel complexes of pebble-conglomerate with subordinate pebbly sandstone. Channels complexes have very thin to med, channel-shaped to lenticular to planar beds. 5-10% cobbles. Conglomerate is clast-supported, and gravel are poorly sorted and composed of 87% granite (subang-subrnd), 7% qtzite (subrnd-rnd), and 6% qtz. (n=129). Max clast sizes: 24x15, 27x14, 18x11, 21x13 cm, 14x8 cm. Channel sand is lt yellowish brown to v pale brown (10YR 6-7/4), fL-vcU, subang, poorly sorted, and an arkose in composition. ~20% of unit is modly to strongly cemented, particularly within 3 m of base; rest is weakly to non-cemented. Extra-channel sediment is lt brown to reddish yellow (7.5YR 6/4-6), slightly muddy (est 1% mud), vfL-mU sand with ~3% cL-vcU sand; weakly to moderately consolidated. Channel	18.9	423.7

margins: N36°W (50 cm-deep), S31°W (20 cm deep). Uppermost channel complex is 1.7 m thick and tabular.

35 **Extra-channel sediment, with 25-35% coarse channel-fill complexes:** Lt brown to reddish yellow (7.5YR 6/4-6), silty vfL-vcU sandstone (mostly silt to vfL-fU sand) with 1-10% scattered cL-vcU sand; massive or in vague, very thick and tabular beds. Sand is an arkose in composition, subangular (minor subrounded), and moderately sorted. Well consolidated. Estimate 2-5% silt. No paleosols seen. Coarse channel-fill complexes are composed of pebbly sandstone to sandy pebbles of Lithosome A provenance. Coarse channel-fills consist of pebbly sandstone and sandy pebble-conglomerate. Sand is subangular, mL-vcU, poorly sorted, and of quartz, ~25% Kspar, and 5-7% mafics. Pebbles are very fine to very coarse, subangular (minor subrounded), very poorly sorted, and of granite with <1% quartzite; moderately to well consolidated and commonly indurated by CaCO3; channel internal bedding is laminated to v thick-bedded, planar to lenticular. 24.8 404.8

Within 402.8 to 404.2 m is a **coarse white ash bed**. This ash has 0.25-10 mm-long consolidated ash together with 10-15% pink-gray volcanic lithics and 3-5% biotite.

@~402 m locally is a Bt soil horizon; it is 20 cm-thick, light reddish brown (5YR 6/4), and has 25-50% clay bridges and 5-10% distinct clay films on ped face.

@ approximately 400 m is a 30 cm-thick **coarse white ash**. This ash is 30 cm-thick and consists of fU-mU sand-size consolidated ash mixed with arkosic sand; this tephra contains 5% volcanic lithics and 5-7% biotite that may be up to cL sand-size.

@ approximately 386-391 m is a northwest-down normal fault, having an approximate length of 200-350 m, whose throw is not well-constrained; best estimate is 4 +/-2 m. This will act to cut out section, so 4 m is added to stratigrapic section above.

@ 385.5 m: Channel complex that probably correlates to unit 34 (which has climbed up 5.5 m between stake z and locality 10/1f.) Deepest channel is 30 cm. Trends from channels at arroyo bottom: N60°W ± 10°, N73°W ± 10°, N53°W ± 16°.
Stake Z placed on top of ridge. Keep shooting along trend of N36°W and dip of 5°NW.

34 **Coarse channel complexes:** Like unit 32, with sharp, scoured base with ~40 cm of relief. Channel margins: N75°W (20 cm-deep), S71°W (35 cm-deep). 3.5 380.0

33 **Extra-channel sediment with minor coarse channel-fills:** Lt brown to reddish yellow (7.5YR 6/4-6) silty vfL-vcU sandstone (mostly silt to vfL-fU sand). Sand has trace scattered pebles and 1-5% cL-vcU sand. Some intervals have a slight amount of clay. Sand is subangular (very minor subrounded), moderately to poorly sorted, and an arkose in composition. Vague, thick, tabular beds. Moderately to well consolidated. Estimate 3-6% silt and clay. Top of one yellowish red (5YR 5/6), 20 cm-thick Bw paleosol soil horizon found 130 cm above top of underlying coarse white ash; soil has modly hard peds, 2-3csbk ped structure, and has an est 1-5% clay. About 1 m above the ash, unit contains 10-20% v thin to medium, lenticular coarse channel beds. These coarse channels consist of pebbly fL-vcU sand that is subangular (minor subrounded), poorly sorted, and composed of quartz, ~25% Kspar, and 5-7% mafic minerals. Pebbles are very fine to very coarse, subrounded to subangular, poorly sorted, and dominated by granite. Near top of unit are beds of clast-supported, sandy pebble conglomerate whose clasts are composed of granite with an estimated 10-20% quartzite. 6.5 376.5
@372.8-373.2 m: **Coarse white ash:** 30-40 cm-thick. White (5Y 8/1) coarse ash composed of consolidated ash of mL-vcU sand-size. 3-5% medium-sand-size volcanic lithics and 3-5% biotite. Upper 15 cm is generally medium-sand-size. Weakly consolidated. *Attitude from ash: N54°E\5°NW.*

32 **Pebbly sandstone and sandy conglomerate channel complex:** Channel internal bedding is v thin to medium, planar to lentic to cross-stratified (foresets are up to 90 cm 2.8 370.0

	+/-10 cm tall). Conglomerate is clast-supported, poorly sorted, and composed of 83% granite (subang(m) to subrnd(l)), 9% qtzite (cs-col and sil; subrnd-rnd), 2% biot gneiss, and 4% vein qtz (n=109). About 20% of clasts are cobbles, rest are pebbles. Very coarse granitic pebbles and cobbles tend to be subrounded. Max clast sizes: 20x15, 16x11, 14x9, 10x7, 28x20 cm. Channel sand is pink to v. pale brown (7.5-10YR 7/4), fL-vcU, subangular, poorly sorted, and an arkose in composition. About 50% of channel complex is strongly to modly cemented, rest is weakly to non-cemented. Trend of channels: N89W° ± 8° (25 cm deep), S78°W ± 11°; S51°W ± 6° (20 cm deep), S80°W ± 3° (60-80 cm deep), S80°W (8 cm tall channel margin), S85°W (8 cm tall channel marg), N76°W (13 cm-tall channel marg). Sharp scoured base with ~ 50 cm of scour relief; grades upward into unit 33.		
31	**Extra-channel sediment, with ~5% coarse channel-fills:** Pink (7.5YR 7/4) silty vfL-cU sandstone (mostly vfL-fU sand). Thin to thick, tabular beds. Sand is moderately sorted (some poor sorting), subangular (minor subrounded), and an arkose in composition. ~5% very thin to thick, lenticular (mostly) to planar channel lenses of sandy pebbles and pebbly sandstone (lithosome A provenance); pebbles in these coarse channel-fills are very fine- to very coarse-grained, poorly sorted, subangular (mostly) to subrounded, and composed of granite with an estimated 3% subrouned quartzite Sand is fL to vcU, angular to subangular (mostly) to subrounded, very poorly sorted, and an arkose in composition. 5 paleosols observed that are 5-20 cm thick; these are marked by a reddish yellow 7.5YR 6/6 Bw (possibly Bt) horizon (sharp top and gradational base over 1-2 cm) that has 2csbk ped structures and is slightly more clay-rich than parent material. Three of soils have a Bk horizons 3-5 cm thick, 7.5YR 7/3 color, stage I-II morphology, and bases are sharp or gradational over 1 cm. Possibly more soils are buried under slough.	4.8	367.2
30	**Sandy conglomerate to pebbly sandstone channel complex:** Internal bedding is very thin to thin, planar to lenticular. Sharp, scoured lower contact with about 50 cm of relief. Gravel is clast-supported, poorly sorted, and composed of granite (subangular to subrounded) with ~3% estimated quartzite (subrounded-rounded). Sand is pink (7.5YR 7/4), fU-vcU, subangular (mostly) to subrounded, poorly sorted, and conoposed of quartz, ~25% Kspar, and ~5% lithics of biotite, quartzite, and trace volcanic grains. Strongly cemented in lowermost 30 cm. Top 120 cm has several stacked paleosols that each generally consist of a 10-20 cm-thick, 5YR 6/6 Bw horizon over a 4-5 cm-thick Bk horizon (stage I carbonate morphology); top of Bw horizon is sharp, top and lower Bk hor is gradational over 1-2 cm. Channel trend: S3°W ± 10° and N33°W ± 18°. Channel margin of N47°W (43 cm-tall). *Stake X placed on top of ridge; shot across canyon to north from stake x to stake y.* *Stake X coordinates: 3988311 N, 412071 E.* *Stake Y coordinates: 3988448 N, 411963 E.*	1.2	362.4
29	**Extra-channel sediment:** Reddish yellow (7.5YR 6/6; some 7.5-10YR 6/4) silty to clayey (estimate 10-20% fines) vfL-cU sand. Beds are thin to thick, tabular, and vague. Sand is mostly vfL-fU w/ 1% scattered cL-vcU grains, moderately sorted, subangular with very minor subrounded, and an arkose in composition. Weakly to well consolidated. Conformable and gradational base.	6.9	361.2
28	**Coarse channel complex**: Composed of subequal pebbly sandstone to sandy pebble-conglomerate. Internal bedding is v thin to med, lenticular to channel-shaped to planar. Gravel are clast-supported, poorly sorted, and composed of granite (subang(m)-subrnd(l)) with 3-7% qtzite (subrnd). 2/3 : 1/3 ratio of pebbles : cobbles. Channel sand is pink to v pale brown (7.5-10YR 7/4), generally mL-vcU, subang-subrnd, poorly sorted, and an arkose in composition. Sharp and scoured base. Well-graded, weak to strong cementation by CaCO3. Channel trends: S15°E ± 9° (35 cm deep); S3°W ± 20° (55-60 cm deep). Channel margins: S0°W (60 cm-tall); S13°W (30 cm tall), S17°W (20 cm tall).	3.0	354.3
27	**Extra-channel sediment, with 10-30% coarse channel-fill deposits:** Lt brown (7.5YR 6/4, some 10YR 7/3) silty vfL-vcU sand (mostly vfL-fU sand). V thin to thick, tabular, vague beds or else massive. Most of the v thin to thin beds are composed of silt	11.9	351.3

(1-5% of extra-channel sed). Sand is mostly subang, poorly sorted(m) to modly-well sorted(l), and an arkose in composition; 1-3% muscovite in the sand; extra-channel sed has 3% scattered pebbles and cobbles (max size is 12x10 cm, 10x8 cm, 8x6 cm). Channel complexes are up to 130 cm thick, and are tabular to broadly lenticular in shape; v thin to med, planar to lenticular internal bedding. Channel sediment generally consists of sandy pebble-conglomerate with subordinate pebbly sandstone. Gravel in conglomerate beds is clast-supported, modly to poorly sorted, and consists of 93% granite (subang(m) to subrnd(l)) with 5% qtzite (subrnd-rnd, cs-col), 2% qtz, 1% biot gn (n=133). Max clast sizes: 21x21, 11x7, 15x11, 24x15, 10x7, 7x6, 6x5 cm. Three paleosols are exposed in upper 2 m of the unit. The top paleosol is marked by a reddish Bw horizon and its top is 41-56 cm below the upper unit contact; this paleosol has a 14-15 cm-thick gradational base. The top of the middle soil is 130 cm below the upper unit contact; it has a 7.5YR 6/6 Bw horizon (20 cm thick) over a Stage I Bk horizon (5-10 cm thick); the lower soil is immediately below the middle soil, is 20-30 cm thick, and has one Bw horizon that is 7.5YR 6/6. The Bw horizons of the soils tend to have a sharp upper contact and a gradational (over 10 cm) lower contact; their ped structure is 2csbk, they have no visible clay films, and they are slightly more muddy than the parent material. Unit has sharp and scoured lower contact.

@ 347.4 m (3.9 m below upper contact of unit) is a 0.6 m-thick bed of slightly ashy sand. Sediment has a light gray (10YR 6-7/2) color, 3-7% biotite, and 3-7% muscovite, is moderately sorted, subangular, fL-cL (mostly fL-fU-mL). I estimate 5-15% white fL-fU-mL grains of ash, which generally has been altered to clay. No sign of colored volcanic lithic grains. Surrounding extra-channel sediment has 2-5% biotite and 2-5% muscovite.
@339.4 m: Stake W placed at base of the coarse upper unit. UTM coordinates of: 3988283 N, 412096 E ± 25 ft .

	LITHOSOME B, CEJITA MEMBER, TESUQUE FORMATION (unit Ttbc):	**34.5**	**339.4**
26b	**Floodplain claystone:** Reddish yellow to brown (7.5YR 6/6 to 7.5YR 5/4); poorly bedded but appears medium-bedded and tabular. Lower contact is gradational.	2.2	339.4
26a	**Channel-fill of medium-grained sandstone with 1-3% very fine to coarse pebbles:** Pebbles are largely granitic with subordinate Lithosome B clasts. Pebbles are scattered throughout the channel. Sand is well-sorted, subangular, and a feldspathic arenite with about 1/4-1/3 : 3/4-2/3 possible NE lithics to Kspar. Lower 60 cm is indurated by calcium carbonate, upper 90 cm is loose. Scoured lower contact. *Stake V placed at top of unit 25f. We correlate along top of Ttbu floodplian deposits to the NE, where stake w is placed at top of thick sandy mudstone floodplain deposit. UTM coordinates of Stake V: 3988129 N, 411635 E* ± 16 ft.	1.5	337.2
25f	**Floodplain siltstone:** Pale brown (10YR 6/3); massive. Weakly consolidated with gradational, planar contact with subunit 25e. 5% of sediment has intervals of calcium carbonate-indurated laminae. About 1% of unit is composed of channel bodies that are lenticular, up to 15 cm thick, and composed of fine- to medium-grained sand. Unite grades upward into light brown to light yellowish brown (7.5-10YR 6/4) claystone in vague, medium, tabular beds.	9.2	335.7
25e	**Fine- to medium-grained sandstone with minor, coarse, channel-fill sandstone:** Light yellowish brown (25Y 6/3) overbank sand with about 10% channel sandstone up to 20-30 cm-thick. Unit is poorly exposed. Overbank sand is fine- to medium-grained, well sorted, subrounded to subangular, and contains subequal kspar to NE lithics. Channel sand is medium- to coarse-grained and commonly indurated by calcium carbonate; channels are very thinly- to thinly-bedded and cross-stratified. 4.8 m thick (includes basal channel). @321.7-322.7 m: Pebble conglomerate; gravel are clast-supported and granitic with 10-15% Lithosome B gravel.	4.8	326.5
25d	**Floodplain very fine- to fine-grained sand.** Pale brown to very pale brown (10YR 6-	5.0	321.7

	7/3). Lower contact is semiplanar and sharp. Massive and weakly consolidated.		
25c	**Sandstone channel complex:** Light gray to pale brown (10YR 7/2-6/2). Medium to very coarse-grained sand; sand is moderately to poorly sorted, lithic arkose to litharenite (subequal NE lithics : Kspar), subangular, and loose. A sample of this sand is taken and labeled 120702-djk-a. Subunit fines upward to a medium- to very fine-grained sand. Their are minor pebbles in this unit similar in composition to those of subunit 25b. Lower contact is wavy and abrupt. .	2.4	316.7
25b	**Pebble- to cobble-conglomerate channel complex:** Pale brown to light yellowish brown (10YR 6/3-4). Gravel are clast-supported and comprised of 55%:45% pebbles: cobbles; clasts are poorly sorted and subrounded (very fine to coarse granitic clasts may be subangular).; clasts are significantly larger than those of unit 25a; average max. clast size of 16.8x11.8 cm. (13x8, 16x12, 17x15, 15x10, 16x10, 20x12, 13x13, 26x14, 16x13, 18x14, 11.5x7, 12x10, 13x10, 21x12, 20x14, 18x14, 20x12; more clast imbrication than unit 25a but still uncommon, measurements include S50°W, S45°W, S30°W, S50°W, S10°W; most confident cluster gives a reading of due south. Bedding is thin to medium lenticular to planar; minor very thin bedding. Some beds are composed soley of sand. Subordinate cross-stratification. 10% of unit 25a is indurated by CaCO3. Lower contact is scoured with about 30 cm of relief. Clast count (n=139) gives 40% granite, 22% quartzite, 13% quartz, 15% Paleozoic limestone, 9% Paleozoic siltstone and sandstone, and 1% mylonite.	5.4	314.3
25a	**Pebble- to cobble-conglomerate channel complex:** Light gray (10YR 7/1). Gravel are clast-supported and comprised of 3/4 : 1/4 pebbles: cobbles; clasts are poorly sorted and subrounded(very fine to coarse granitic clasts may be subangular). Generally planar, very thin to thin beds or else cross-stratified very thin to thin beds up to about 50 cm tall. Cobble-size mudstone rip-up clasts are common near the base. Clast count (n=91) gives 52% granite, 22% quartzite, 15% Paleozoic limestone, 7% Paleozoic siltstone and sandstone, and 4% quartz. Degree of cementation varies from moderate to strong. Scoured lower contact that may represent a disconformity. Farther to the west, unit contains Clarendonian fossils.	4.0	308.9
24-25 cont act	At Stake T: Base of unit 25 is underlain by sediment similar to upper unit 24 near stakes. (i.e., light brown to pink, silty very fine- to fine-grained sandstone, massive or poorly-bedded thick tabular beds, with 3-5% granitic/arkosic channels (no Lithosome B gravel); upper part of unit 24 is moderately consolidated but there is no HCl eff. The lower 4 m of unit 25 is a light gray (10YR 7/1-2) pebble-conglomerate dominated by granitic clasts with 1-3% Lithosome B clasts. The sediment is generally planar, very thinly-bedded, with minor tangential cross-stratification up to 20 cm tall. Well consolidated with only weak HCl eff. Large siltstone rip-ups of upper unit 24 are present near the base and are up to 140 cm long and 36 cm tall. The planar bedding is probably upper flow regime. Basal contact is scoured with up to 60 cm of relief. The large siltstone rip-up clasts indicate a large river that tapped mostly Provenance A and some Provenance B (B becomes more important a few m up-section). Maximum gravel size is 13x10 cm. Clast imbrication is not obvious. Channel margin trend at base of unit is S71°W. *Stake S placed at top of unit 24q. From there, we shoot northwest into Arroyo de los Martinez and place stake S'. Moved west from stake S' along lower unit 25 contact to Stake T. From Stake T to Stake U, we use an adjacent attitude of N55°E\4°NW. UTM coordinates of Stake S: 3987736 N, 412129 E; UTM coordinates of Stake T: 3987951 N, 411745 E. UTM coordinates of Stake U: 3987984 N, 411761 E* ± 8 m.		
	LITHOSOME A, FINER UPPER UNIT, TESUQUE FORMATION (unit Ttafu):	**111.5**	**304.9**
24q	**Extra-channel silty very fine- to medium-grained sandstone, with 3-5% coarse channel-fills:** Light yellowish brown (10YR 6/4); massive; weakly consolidated with no HCl effervescence; sand is subangular, moderately sorted, and an an arkose in composition. Gradational lower contact with the ash of unit 24p. Unit is estimated to have 3-5% channels, two of which were traversed by this section.	17.3	304.9

@298.4 m, near Stake T, is the top of a Btk paleosol soil horizone that is 10 cm thick. ~3 m above this soil is another reddish soil horizon. 30 cm below is a 6 cm-thick Bt soil horizon over a ~10cm-thick Bk soil horizon having stage II to stage III carbonate morphology.

@296.4-297.4 m: Lenticular channel deposit 1.0 m thick. Composed of gravelly sand. Scoured lower contact, gradational upper contact. Fines upward from coarse-very coarse sand to very fine-medium sand. Sand is an arkose, subangular, and moderately to poorly sorted. Basal 10 cm is indurated by CaCO3, above this the deposit is loose. Clast count (n=146) gives 95% granitic clasts and 5% quartzite clasts.

@290.6-291.4 m: Lenticular channel deposit 0.8 m thick. Composed of medium- to coarse-grained sand; sand is an arkose, subangular, and moderately sorted. Contains minor granitic gravel (mostly pebbles, minor cobbles). 3% muscovite grains. No sedimentary structures. Mostly loose, only locally indurated by calcium carbonate.

24p	**White ash of upper Pojoaque white ash zone:** 15-70 cm thick, continuous, slightly altered but still has glass shards, and contains 3% corroded biotite or MnO(?) dendrites,. Sharp lower contact and grades upwards into silty very fine- to fine-grained sandstone. Ash is well consolidated near base and moderately consolidated in its upper portions. *Place stake R'; move along ash bed 200-300 ft to northeast to stake r. UTM coordinates of Stake R': 3987771 N, 412007 E. UTM coordinates of Stake R: 3987697N, 412160E.*	0.7	287.6
24o	**Extra-channel silty very fine- to fine-grained sandstone, with 1-2% coarse channel-fills:** Light yellowish brown (10YR 6/4); thick, tabular beds but poorly bedded. Weakly consolidated; weak HCl effervescence and weakly cemented. There is more silt in this unit than there was in unit 24m. Unit has 1-2% lenticular, 10-30 cm-thick channel sandstone indurated by CaCO3 and composed of very fine- to fine-grained sand; sand is a well sorted and an arkose. ~10% of this unit hs 1-2 m-thick intervals of light brown to reddish yellow (7.5YR 6/4-6) silty, very fine- to fine-grained sandstone (which have more silt than the surrounding sediment). Near middle of unit: thin, discontinuous ash bed not sufficiently extensive to be mapped. *Change dip to 4° degrees, trend N40°W.*	23.2	286.9
24n	**White ash of upper Pojoaque white ash zone:** White (2.5YR 8/1), altered (feels soapy), 10 cm-thick ash with 2-3% biotite and MnO(?) dendrites (the latter may be corroded biotite). Very sparse glass shards. Ash is massive and moderately hard. Sharp lower contact.	0.1	263.7
24m	**Extra-channel silty very fine- to fine-grained sandstone:** Light brown to light yellowish brown (7.5-10YR 6/4); poorly bedded; vfL to mL sand; weakly consolidated, no HCl effervescence, and weakly to non-cemented. *Change dip to 4° degrees, trend N45°W.*	3.4	263.6
24L	**Gravelly sandstone channel complex:** Light yellowish brown (10YR 6/4); bedding not exposed; fines-upward from very coarse sand to fine sand; generally loose with 1-2% zones of strong cementation; sand is an arkose, subangular, and moderately sorted. Gravel are found near the base of the deposit and are similar in composition to those of the next described lower channel. Gravel are poorly sorted, clast-supported, and subrounded (very fine to coarse granitic pebbles may be subangular). Average max. clast size (n=17) gives 11.8 cm x 8.3 cm (15x9, 10x9, 10x7, 9x8, 14x7, 13x7, 10x8, 12x9, 11x9, 9x9, 10x9, 13x7, 14x8, 13x5.5, 10x7, 14x12, 14x10 cm (axb axes).	1.6	260.2
24k	**Extra-channel siltstone and very fine- to fine-grained sandstone:** Light brown to light yellowish brown (7.5YR 6-7/4) and pink (7.5YR 7/4); bedding not exposed; sand is well sorted and an arkose in composition; weakly consolidated with moderate HCl	6.9	258.6

	effervescence (indicating weak cementation).		
24j	**Gravelly sand channel complex:** Light yellowish brown (10YR 6/4), gravelly sand channel complex that is very loose except that 5-10% of the coarser zones are strongly cemented by calcium carbonate. Sand is mostly fine- to very coarse-grained, subangular, moderately sorted with some poor sorting, has 3-5% muscovite flakes, and is an arkose. Gravel is mostly found near the base of the channel complex and forms very thin to thin lenticular beds. Minor cross-stratification is 5-10 cm tall. Gravel is clast-supported, subrounded (except that granitic very fine to coarse pebbles may be subangular) and poorly sorted. Clast count of gravel (n= 150) gives 53% granite, 37% quartzite, and 10% quartz (probably associated with the granite).	1.7	251.7
24i	**Extra-channel silty very fine- to medium-grained sandstone:** Reddish yellow (7.5YR 6/6) to light yellowish brown (10YR 6/4) (subequal colors). Weakly consolidated. Sand is an arkose, moderately sorted, and subangular. Unit has about 1% thin to medium, lenticular channel sandstone beds. Sand in these beds is generally medium-grained, an arkose, and has 1-2% muscovite flakes. Subordinate intervals of light yellowish brown (10YR 6/4) very fine- to coarse-grained sand with 3% muscovite.	23.8	250.0
24h	Covered by Qay or not exposed, probably like overlying sediment	13.5	226.2
24g	**Extra-channel silty very fine- to fine-grained sandstone:** Reddish yellow (7.5YR 6/6). Sand is subangular, moderately sorted, an arkose in composition, and loose.	1.2	212.7
24f	**Gravelly sand channel complex:** Light yellowish brown (10YR 6/4); sand is very fine- to very coarse-grained but mostly medium-grained; sand is moderately sorted, subangular, and an arkose; sand is massive or else planar- very thinly bedded or planar-laminated. Channel-fill sand is mostly weakly cemented and weakly consolidated; minor zones of strong cementation. Gravel includes 60% : 40% pebbles:cobbles; gravel are mostly subrounded, clast-supported, and poorly sorted. Average max. clast size (n=11): 11.7x7.7 cm (8x5, 9x7.5, 12x8, 9x5.5, 12x7.5, 11x5, 17.5x10, 10x10, 10x6.5, 14x10, 16x10 cm); clast count (n=191) gives 57% granite and 34% quartzite, 1% mylonite, and 8% quartz (probably associated with the granite). Gravel is found mostly near the base and middle of the channel complex in lenticular beds up to 40 cm thick.	5.8	211.5
24e	**Extra-channel silty very fine- to medium-grained sandstone and subordinate siltstone, with ~5% coarse channel-fills:** Light yellowish brown to reddish yellow (10YR 6/4 to 7.5YR 6/6); 1% muscovite grains; sand is an arkose, moderately sorted, and subangular; weakly consolidated (weak HCl effervescence). Finer sediment appears poorly bedded but this may be due to poor exposure. About 5% thin to thick, lenticular, channel bodies composed of fine- to coarse-grained sand; these channels are commonly indurated by calcium carbonate (whereas extra-channel finer sand deposits are not cedmented) and form the only ledges in the Salmon-colored unit (in contrast to the underlyin Ttasr2 unit, where extra-channel deposits may be cemented and form ledges); channel sand is an arkose, subangular, well to moderately sorted, and contains 0.5% granitic to quartzite pebbles. One channel 50 cm above mudstone is a 15 cm-thick pebble- to cobble-conglomerate; gravel are subrounded, clast-supported, and poorly sorted; clast count (n=120) gives 73% granite and 27% quartzite. Lower contact is sharp, planar, and appears conformable. *Stake P is established at top of uppermost brown mud bed of unit 23c . From there, we move northeast along-strike to stake Q, and then proceed up-section. Local attitude: N45E\6 NW. We will use this attitude until the next ridge. UTM coordinates of Stake P: 3987034 N, 412310 E. UTM coordinates of Stake Q: 3987254 N, 412460E.*	9.0	205.7
23c	**Extra-channel silty very fine- to fine-grained sandstone and minor mudstone, with ~5% coarse channel fills:** Light brown to reddish yellow (7.5YR 6/4-6). 5±3% of sediment is composed of thin to medium, lenticular beds of channel-fill sandstone; channel sand is very fine- to fine-grained and indurated by calcium carbonate; weakly consolidated and in thin to thick, tabular, poorly-bedded beds. Lower contact is gradational with underlying unit. @196.3-196.7 m: At top of unit is a single brown (7.5YR 5/4) mudstone bed.	3.3	196.7

Above base of unit, we use a bearing and trend of N45°W and 6° NW.

	LOWER LITHOSOME B UNIT OF POJOAQUE MEMBER, SUBORDINATE LITHOSOME A INTERBEDS (Ttbp1):	**44.1**	**193.4**
22b	**Floodplain siltstone and mudstone (lithosome B):** Light brown to reddish yellow (7.5YR 6/4-6) and brown (5-7.5YR 5/4). Thick, tabular beds but poorly bedded. Siltstone may have subordinate very fine-grained sandstone. Lower contact not exposed.	2.9	193.4
22a	**Channel sandy pebble-conglomerate of lithosome B:** Planar-very thinly bedded and planar-cross-stratified (foresets up to 4-5 cm thick). Strongly cemented by CaCO3. Max. clast sizes average 11.2 x 7.8 cm (10x7.5, 9x6, 8x5, 9.5x6, 7x5, 8x7.5, 16x12, 13x7.5, 16x13, 11x7, 9.5x4, 9x9, 18x14, 12x8, 8x7.5, 12x7, 14x7, 11x8 cm). Clast count (n=171) gives 33% Paleozoic limestone, 26% Paleozoic greenish to grayish sandstone and siltstone, 8% quartz, 7% intermediate to felsic volcanic clasts, 7% quartzite, 4% granite, 4% coarse-grained metasandstone, 4% reddish sandstone and siltstone, 2% reworked, cemented arkosic sandstone, 1% intermediate to felsic hypabyssal intrusives, 1% unidentified mafic-rich rock, 1% chert, and 1% foliated quartzite. Scoured lower contact.	1.6	190.5
21d	**Floodplain deposits of subequal silty very fine- to medium-grained sandstone and siltstone (lithosome B):** Silty sandstone is light yellowish brown (10YR 6/4); thick, tabular beds but poorly bedded; sand is an arkose to lithic arkose (approximately 20% : 80% northeast-derived lithics : Kspar), moderately sorted, subrounded to subangular. Siltstone is light brown to reddish yellow (7.5YR 6/4-6). Sharp lower contact and weakly consolidated. *Stake O' is established on bed of silicai-indurated fine-grained sandstone. From here, I follow this Si-indurated sandstone along strike to station O. UTM coordinates of Stake O': 3986914 N, 412393 E. UTM coordinates of Stake O: 3986992 N, 412337 E.*	7.4	188.9
21c	**Overbank siltstone and very fine- to fine-grained sandstone (lithosome A):** Light brown (7.5YR 6/4) siltstone and reddish yellow (7.5YR 6/6) very fine- to fine-grained arkosic arenite sandstone; weakly consolidated. No sedimentary structures and local, nodular cementation suggests bioturbation. Overlain by thin to thick, tabular, silica-indurated, fine-grained sandstone marker bed. *Stake N is established on a thin CaCO3 marker bed (see SCV-60); I follow this bed about 100 ft along-strike and place stake N'. UTM coordinates of Stake N: 3986859 N, 412293 E. UTM coordinates of Stake N': 3986907 N, 412339 E.*	4.6	181.5
21b	**Channel-fill sandstone (lithosome A):** Pink (7.5YR 7/4); generally medium-grained but ranging from very fine- to very coarse-grained sand; no sedimentary structures observed; sand is moderately sorted, subangular, and an arkose; weakly to moderately consolidated and not cemented; channel sand sharply overlies underlying siltstone over a scoured contact with 10 cm of relief; within the channel sand is 0.5% scattered pebbles and cobbles that are poorly sorted, subrounded to subangular, and granitic with minor quartzite. One medium, lenticular bed of pebble-cobble conglomerate observed.	3.0	176.9
21a	**Overbank siltstone and very fine- to medium-grained sandstone (lithosome A):** Light brown to light yellowish brown (7.5-10YR 6/4); thick, tabular beds that are internally massive.	3.3	173.9
20f	**Floodplain siltstone and very fine-grained sandstone (lithosome B):** Light brown (7.5YR 6/4) and subordinate light yellowish brown (10YR 6/4); moderately consolidated; very thin to thick, tabular beds.	4.8	170.6
20e	**Floodplain silty very fine- to fine-grained sandstone (lithosome B):** 33 cm of pale brown (10YR 6/3) silty sandstone with no internal sedimentary structures, (well consolidated, sharply overlies the channel sand of unit 20d), overlain by 15 cm of light yellowish brown (10YR 6/4), well sorted, fine-grained sand (moderately consolidated).	0.6	165.8
20d	**Lithosome B channel-fill sand with minor gravel:** Pale brown (10YR 6/3) to minor light yellowish brown (10YR 6/4) and minor brown (10YR 5/3). No sedimentary	1.2	165.2

	structures seen and the channel sand is not vertically graded. Sand is generally fU to vcU and contains about 5% pebbles and cobbles. Maximum clast sizes are: 7.5x4, 6.5x4.5, 6x5.5, 9x6, 8x4, 6x6, 5x5 cm. The sand is moderately sorted, subrounded to subangular, and a lithaarenite with greenish quartz grains and reddish volcanic grains. The gravel are subrounded, mostly pebbles with minor cobbles, poorly sorted, and are distributed throughout the channel. A clast count (n=103) gives 11% Paleozoic limestone, 60% Paleozoic siltstone and meta-sandstone, 1% granite, 1% mylonite, 9% quartzite (no laminations), 9% quartz, 6% intermediate to felsic volcanic clasts, 3% intermediate to felsic hyperbyssal intrusives, and 2% unidentified mafic-rich rocks. Sand is loose and not cemented.		
20c	**Floodplain claystone (lithosome B):** Light brown to pink (7.5YR 6-7/4); planar-laminated.	1.4	164.0
20b	**Floodplain silty very fine- to fine-grained sandstone (lithosome B):** Tabular and internally massive; color of light yellowish brown (10YR 6/4). Sand is well sorted and belongs to Lithosome B (estimated 2/3 : 1/3 ratio of NE lithics : kspar).	1.9	162.6
20a	**Floodplain mudstone and siltstone (lithosome B):** Brown to strong brown (7.5YR 5/3-6); siltstone may be yellowish brown to light yellowish brown (10YR 5-6/4) and contain 0.5% muscovite flakes.	11.4	160.7
	UPPER LITHOSOME A UNIT OF SKULL RIDGE MEMBER, INCLUDING SUBORDINATE MIXED LITHOSOME A-B SEDIMENT AND POSSIBLE EOLIAN SEDIMENT (Ttasr2):	**~52**	**149.3**
19c	**Overbank siltstone and very fine-grained sandstone:** Light yellowish brown (10YR 6/4). Upper contact of unit 19 is approximate and not exposed.	3.4	149.3
19b	**Overbank mudstone:** Brown (7.5YR 5/4). A 25 cm-thick, calcium carbonate-indurated very fine-grained sandstone bed lies on top of the mudstone.	2.6	145.9
19a	**Eolian(?) very fine- to fine-grained sandstone**: Light yellowish brown to yellowish brown (10YR 5-6/4) and light brown (7.5YR 6/4); loose and poorly exposed; sand is well sorted, subrounded, and an arkose. Much of unit may be eolian. Base of unit has a thick, tabular bed of pink (7.5YR 7/3) siltstone and very fine-grained sandstone (internally massive and well consolidated). The lower contact of unit 19 is sharp (over 2 cm) and planar. @ 138.8 m is a medium bed of calcium carbonate-indurated very fine to fine-grained sandstone. Sand is well sorted, subrounded, and an arkose. This bed seems to fill a channel that is at least 50 m long in a southwestward direction. From here, we use a bearing and dip of N48°W and 7° NW.	7.5	143.3
18	**Overbank mudstone, siltstone, and very fine-grained sandstone** Upper 3 m: Reddish brown to light reddish brown (5YR 5-6/3) mudstone, pinkish gray to light brown (7.5YR 7/2 to 6/3) siltstone, and light brown to light yellowish brown (10-7.5YR 6/4) siltstone and very fine-grained sandstone. Beds are thick (minor medium beds) and tabular; one bed is 55-60 cm thick. Very fine-grained sandstone is internally massive. No rhizoliths, and only minor evidence for bioturbation. Moderately to well consolidated. This sediment may reflect basin floor deposition. Bottom 3-4 m: light brown to brown (7.5YR 5-6/4) and light yellowish brown (10YR 6/4) mudstone; weakly consolidated and massive. This sediment may reflect basin floor deposition. *Stake L is at 131.9 m (top of upper CaCO3 bed). From Stake L, we move northeast along-strike following the CaCO3 bed to Stake M. From Stake M, we continue measuring up-section. UTM coordinates of Stake L: 3986563 N, 412488 E. UTM coordinates of Stake M: 3986645 N, 412493 E.*	7.5	135.8
17	**Interbedded fine, eolian sandstone with fluvial fine sandstone, claystone, and siltstone:** Sandstone is reddish yellow (7.5YR 6/6), clean, well sorted, subrounded,	4.8	128.3

	very fine to fine-grained, loose to weakly consolidated, and has an approximate ratio of: 10-20% : 80-90% northeast-derived lithics to Kspar (probably eolian sand); this sand grades upward to a light yellowish brown (10YR 6/4) siltstone and very fine-grained sandstone. Claystone is thinner than the sandstone and light brown to brown (7.5YR 5-6/4) and pale brown (7.5YR 6/3); thick, tabular beds. @ 125.3 m is a 80 cm-thick bed of whitish, muddy ash that is altered. Near top of the unit are two 25-30 cm-thick, whitish, tabular calcium carbonate beds. At base of unit is a sheet-like channel-fill deposit 15-20 cm-thick composed of very fine- to fine-grained sand; sand is well sorted and an arkose; channel sand is oxidized to a reddish yellow color (7.5YR 6/6) and may reflect fluvial reworking of eolian sand; slightly scoured lower contact. *Stake J is at 125.9 m; from here we shift along-strike to Stake K and go up 1.5 m. UTM coordinates of Stake J: 3986540 N, 412480 E. UTM coordinates of Stake K: 3986560 N, 412498 E.*		
16c	**Overbank mudstone:** Light brown (7.5YR 6/3-4) and massive. Abundant, pebble-size calcium carbonate nodules are present on the surface of the mud. Channel bodies are not observed.	11.7	123.5
16b	**Extra-channel deposits of siltstone and subordinate very fine- to fine-grained sandstone:** Light brown to light yellowish brown (7.5-10YR 6/4). Sand and silt is generally massive, but may be in thick, tabular beds. 0.5% muscovite flakes in the sediment. 0.5-1% of sediment is composed of channel-fill deposits 20-50 cm thick and lenticular in shape. Channel sand is well sorted, fine- to medium-grained, mostly subangular, minor subrounded, and an arkose. Channels are locally cemented by calcium carbonate and contain 1% pebble-size nodules of strongly cemented siltstone and/or calcium carbonate rip-ups. Generally, channel-fill and overbank deposits are weakly to moderately consolidated. Edge of a cemented channel: S82°W; trend of a calcium carbonate-indurated channel is N65°W.	4.5	111.8
16a	Covered by Qay	9.9	107.3
	MIXED PROVENANCE UNIT OF THE SKULL RIDGE MEMBER (Ttmsr):	**97?**	**97?**
15c	Covered by Qay	8.2	97?
15b	**Extra-channel deposits of very fine- and fine-grained sandstone with subordinate siltstone (mix of lithosomes A and B):** Light brown to pink (7.5YR 6-7/4). Sand is well-sorted, subangular, and arkosic arenite with minor northeast-derived grains. No sedimentary structures observed, probably because of bioturbation. Poorly exposed. At top is a 70 cm-thick, tabular bed of siltstone and very fine- to fine-grained sandstone. Not well-exposed and weakly consolidated. Lower contact not well-exposed.	5.4	89.2
15a	**Overbank, silty very fine- to fine-grained sand: (lithosome B):** Massive and well-sorted; perhaps eolian; not well-exposed. Overlian by 30 cm-thick, fining-upward channel bed that lacks sedimentary structures; this channel-fill is composed of fU-vcL sand, with minor very fine to medium pebbles near the base. Sand has 6/10 : 4/10 Kspar: northeast-derived lithic grains (latter is marked by reddish volcanic grains and greenish quartz grains), sand is subrounded to subangular, and moderately to poorly sorted. Pebbles are mostly of lithosome B composition and are subrounded; poorly to moderately sorted. Relatively sharp lower contact with Ash Alpha. *On 7/9/02, we ended on Ash Alpha. On 7/10/02, we followed the Ash Alpha bed across arroyo to north, where we establish Station I. UTM coordinates of Stake I: 3986329 N, 412760 E. Above, we use a trend and dip of N52°W and 7° NW.*	2.0	83.8
14c	**Ash Alpha:** White (N8\ ), somewhat shard-rich, silty-textured ash mixed with about 5% detrital very fine-grained sand. 55 cm thick. Minor, very thin beds or laminations of fine- to coarse-grained, micaceous, arkosic arenite sand (Lithosome A) are interbedded with the ash. Locally, the ash is altered. Ash is capped by 10-15 cm of calcium carbonate, which may represent strongly cemented ash. Sharp lower contact.	0.6	81.8

	Weakly consolidated.		
14b	**Extra-channel and overbank deposits of siltstone and very fine- to fine-grained sandstone (mixed lithosome A and lithosome B):** Light brown to brown (7.5YR 6/3-4 and 7.5YR 5/4) and pink (7.5YR 7/3). The very fine- to fine-grained sand is subrounded to subangular, well sorted, and an arkosic arenite. About 1-5% channel-fill deposits; channel deposits attain a maximum 40 cm thickness and are composed of fine-grained sand with minor pebbly sandstone. The sand in the latter is surrounded, poorly sorted, and has an approximate ratio of 1/3 Kspar : 2/3 northeast-derived grains. Unit is poorly bedded and weakly to moderately consolidated. Gradational lower contact with WA #4. Sharp upper contact with Ash Alpha ash. @ 75-76 m: One thick bed of light yellowish brown (10YR 6/4) sand. The sand is fU-mU, subangular to subrounded, well sorted, and has about subequal northeast-derived lithic grains compared to Kspar grains.	7.7	81.2
14a	**White Ash #4:** White (5Y 8/1), non- to slightly altered, and glass shards present. Ash is mixed with minor detrital silt, and has 1% detrital(?) very fine-grained sand-size biotite. Ash is very thinly bedded to planar-laminated. Lower contact is sharp. Upper contact grades to a light brown (7.5YR 6/4) very fine-grained sandstone. Upper about 30 cm of ash is more altered. 1.3 m total thickness. Loose to weakly consolidated. A lithosome B channel that has eroded this ash to west trends S26°W and has a minimum depth of 1.3 m.	1.3	73.5
13	**Extra-channel and overbank deposits of siltstone and very fine- to fine-grained sandstone, with 3-5% coarse channel-fills and minor claystone (lithosome B and lithosome A):** Medium to thick, tabular, ledge-forming beds of siltstone and very fine- to fine-grained sandstone; these are pink (7.5YR 7/3-4, subangular to subrounded, well-sorted, and arkosic – probably lithosome A. 3-5% medium-bedded, relatively tabular, coarse channel-fill deposits of lithosome B. The channel deposits are composed of fine to coarse sand (moderately to poorly sorted, subrounded to subangular, and has an approximate ratio of 50-65% northeast-derived grains : 35-50% Kspar grains). The contact between units 12 and 13 is relatively sharp with 10-20 cm of relief. @75.2 m: Freshwater limestone bed of medium thickness. Between this bed and the White Ash #4 is brown to light brown (7.5YR 5-6/4) claystone and mudstone. @ basal 0.9 m of unit is a fU-mL lithosome B litharenite. Sand is pale brown (10YR 6/3), well sorted, and surbrounded to subangular. Locally, there is another bed like this in the middle of the unit.	4.9	72.2
12i	**10-30 cm-thick marker bed of calcium carbonate:** Calcium carbonate is internally very thinly to thinly planar-bedded (described by Stake G). Probably formed by high evaporation of shallow groundwater along a piedmont/playa interface. Sharp lower contact. *Location of Stake G. UTM coordinates of Stake G are: 3985872 N, 412461 E. We use this marker bed to move northeast 115 m at a bearing of N65°E, and from that point back-track down-section to describe units 12e, 12f, 12g, and 12h. Where units 12e through 12h were described, Stake Hwest was placed on top of unit 12e, 7.5 m below the marker bed of unit 12i. We then use top of the lithosome A to move northeast to Stake H, where Stake Heast was placed 7.5 m above top of unit 12e. Note that 7.5 m corresponds to the thickness of units 12f, 12g, and 12h near Stake Hwest, and so Stake Heast is at the equivalent stratigraphic level as Stake G . UTM coordinates of Stake H is: 3986100 N, 412716 E. We then measure from Stake Heast to Ash Alpha using N70°W bearing and 5° NW dip.*	0.2	67.3
12h	**Floodplain mudstone and siltstone (lithosome B):** Light brown (7.5YR 6/3-4). Weakly to moderately consolidated. Very thin to thick, tabular beds or else massive. @66.7 m: Light greenish gray (N8/1) silty ash to ashy silt and very fine-grained sand.	2.9	67.1

12g	**Channel-fill of pebbly sandstone (lithosome B):** Sand is pale brown to light yellowish brown (10YR 6/3-4), moderately (mostly) to poorly sorted, subrounded to subangular, medium- to very coarse-grained, and a litharenite in composition. Gravel generally are scattered in the sand, and are mostly pebbles with minor cobbles; clasts are subrounded and poorly sorted. Loose, and bedding not generally exposed. Slightly scoured lower contact; probably gradational upper contact. Maximum clast sizes: 9x8, 8x5, 6x5, 8x6, 20x12, 15x12, 8x7 cm. Clast count of 106 clasts gives: 42% greenish Pz sltst and ss, 3% grayish to reddish volcanic rocks (intermediate to felsic), 5% quartzite (no Rinconada qtzite), 4% granite, 39% Pz limestone, 3% quartz, 2% calcium carbonate nodules (perhaps associated with the Pz limestone), and 3% reddish fine-grained sandstone. Channel disappears between stations Hwest and Heast (see SCV-184).	1.5	64.2
12f	**Floodplain mudstone to siltstone (lithosome B):** Light brown (7.5YR 6/3-4) to brown (7.5YR 5-6/4). Weakly to moderately consolidated. Very thin to thick, tabular beds or else massive near Stake Heast. Massive or very poorly bedded near Stake Hwest.	3.0	62.7
	Where units 12f to 12h were described, Stake Hwest was placed on top of unit 12e, 7.5 m below the marker bed of unit 12i. We then use top of unit 12e to step to northeast, where Stake H was placed on top of unit 12e. UTM coordinates of Stake H is: 3986100 N, 412716 E. Above Stake H, Stake Heast was placed 7.5 m above the of unit 12e. Note that 7.5 m corresponds to the thickness of units 12f, 12g, and 12h near Stake Hwest, and so Stake Heast is at the same stratigraphic level as Stake G. We then measure from Stake Heast to Ash Alpha using N70°W bearing and 5° NW dip.		
12e	**Channel-fill sandstone (mixed lithosome A-B). Just northeast of Stake Hwest:** Pale brown to light yellowish brown (10YR 6/3-4). Sand has about 1% scattered pebbles, and is massive except for minor very thin to medium, lenticular beds; about 3% of these beds are of strongly cemented pebbly sandstone and sandy pebble-conglomerate. Pebbles consist of calcium carbonate nodules, quartzite, and granite; pebbles are fine to coarse, subrounded, and moderately sorted. Sand is subrounded to subangular, moderately to well sorted, very fine- to very coarse-grained but mostly fine- to medium-grained, has ~5% muscovite grains, and has an approximate ratio of 60% Kspar : 40% northeast-derived lithics. Weakly consolidated; slightly scoured lower contact; probably gradational upper contact. **At Stake H:** Unit is 2 m-thick; sand is very fine- to fine-grained, pale brown to very pale brown (10YR 6-7/3), generally massive, and grains are well sorted and arkosic arenite (1/3 : 2/3 probable northeast-derived lithics : Kspar). Sand has 5% muscovite grains.	3.0	59.7
12d	**Floodplain mudstone and siltstone (lithosome B):** Light brown to brown (7.5YR 5-6/4). Not well-exposed. There are ~5% float of scattered, broken laminae of calcium carbonate or pebble-size calcium carbonate nodules. Weakly to moderately consolidated; gradational and conformable lower contact.	2.0	56.7
12c	**Floodplain siltstone and very fine-grained sandstone (lithosome B):** Pale brown to light yellowish brown (10YR 6/3-4). The sediment is massive except for about 10% (estimate by volume) scattered laminae of calcium carbonate. One thin bed of calcium carbonate observed (interpreted to be associated with high evaporation of shallow groundwater on a basin floor); scattered calcium carbonate laminae are also interpreted to be due from the same process.	5.0	54.7
	Above unit 12b, we use bearing and dip of N50°W, 8° NW.		
12b	**Floodplain siltstone (lithosome B):** Brown to pale brown (10YR 5-6/3) with minor grains of very fine- to fine-grained sand. Very thin to medium, tabular bedded or else massive. Weakly to moderately consolidated. Estimate 3% channel deposits; channels are up to 25 cm thick and are composed of fL to mL sand (well sorted, generally subrounded, litharenite with 1/3: 2/3 estimated ratio of Kspar to northeast-derived lithics). Sampled the sand (sample # 090702-djk-a). The channel sandstones are indurated by calcium carbonate. Gradational, conformable lower contact.	10.0	49.7
12a	**Pebbly sandstone channel complex (lithosome B):** An extensive, tabular channel	1.0	39.7

deposit that is about 1 m thick; planar-laminated. Sediment fines upwards from medium- to very coarse-grained sand near the base to fine- and very fine-grained sand near the top. Pebbles and lesser amounts of cobbles are located near the base. Overall, channel is composed of pebbly sand. Loose. Sand is subrounded to subangular, moderately to well sorted, and a lithic arenite with an estimate ratio of 35-45% Kspar : 55-65% northeat-derived lithic grains. Gravel is subrounded, poorly sorted, and has a composition consistent with lithosome B.

At base of unit, change bearing to N50°W; dip is still 9° NW.

11	**Overbank siltstone, very- fine-grained sandstone, and mudstone (lithosome B):** Thick, tabular beds that are pink to very pale brown (7.5YR 7/3-4; 10YR 7/3). *@ 34.2 m: Stake F placed. UTM coordinates: 3985774 N, 412565 E..*	4.5	38.7
10	**Generally covered by Holocene sediment:** Unit probably similar to unit 9, with approximately 3-5% coarse channel deposits. @34 m, 30-120 m northeast of section line: At least three discrete channel-fills of coarse lithosome A that are up to 30-60 cm in depth, which is probably indicating much avulsion. These are about 15 m wide. @32.5-33.2 m: **Lithosome A pebbly sandstone channel-fill**. This channel-fill has a scoured lower base with 10-25 cm of relief and is 50-80 cm-deep. The channel-fill is weakly consolidated and weakly cemented. It is composed of fine to very coarse-grained sand (moderately sorted, subangular to subrounded, and an arkose) with minor gravel. Maximum clast sizes of: 8x7, 7x4, 13x9, 7x5, 8x8, 7x6, 7x5 cm. Gravel is poorly sorted, surbrounded, and composed of granite with subordinate quartzite. Clast count of 111 clasts give: 76% granite and 24% quartzite. Gravel is underlain by light yellowish brown to very pale brown (10YR 6-7/4) siltstone and very fine-grained sandstone that are well-consolidated. Channel-fill is greater than 60 m in width. @29.1-29.7 m: **Lithosome A coarse channel-fill**. This channel complex is 60 cm thick, planar laminated to very thinly bedded to thinly bedded, and strongly cemented by calcium carbonate. It is composed of medium to very coarse-grained sand and trace to granitic pebbles. Pebbles are less than 1 cm in diameter. Sand is moderately sorted, an arkose, subrounded to subangular, and is totally of Lithosome A. *Shoot along strike from station d to station e and f, gaining 3 m in the process. Stake E UTM coordinates: 3985688 N, 412474 E. Stake D UTM coordinates: 3985655 N, 412432E.* *4.5 m of Qao gravel to Stake C; used bearing and trend of N48°W and 9° NW. Shoot down-slope from station c to station d and go up 1.5 m. UTM coordinates of Stake C: 3985550 N, 412600 E.*	4.8	34.2
9b	**Unit 9 covered by Qao gravel.** *3.2 m in unit 9 to top of hill Stake A); traverse northeast along-strike to station b (no elevation change). Stake B is within Qao gravel. Stake A UTM coordinates: 3985395 N, 412514 E. Stake B UTM coordinates: 39855460 N, 412540 E.*	4.5	29.4
9a	**Extra-channel and overbank deposits of interbedded siltstone and fine sandstone, with 1-5% sandstone channels (lithosome A):** Channels are composed of fine-grained to medium-grained sand that is an arkose, well-sorted, subangular, has 0.5% muscovite, and has 5% biotite grains. Channels are strongly cemented by calcium carbonate.	3.2	24.9
8	**White Ash #3:** 20-25 cm-thick white ash mixed with 5-8%, very fine-grained sand. Ash is massive, slightly altered, and moderately to strongly cemented by calcium carbaonte. Has a sharp lower contact and sharp, but conformable, upper contact with unit 9a.	0.4	21.7
7	**Overbank deposits of interbedded siltstone and fine sandstone (lithosome A):** Interbedded (a) Pale brown to pink (10YR 6-7/3) very fine- to fine-grained sandstone and siltstone. Sand is well sorted and arkosic arenite. 3% muscovite grains. Forms	5.7	21.3

	medium to thick, tabular beds. Well consolidated. Moderate to strongly cemented. (b): Light brown to pink (7.5 YR 6-7/4) siltstone; medium to thick, tabular beds that are greater than 14 m in length. Weakly to moderately consolidated and poorly cemented.		
6	**White Ash 2a,b, or c:** White, silty-textured, shard-rich, and non-altered.	0.3	15.6
5	**Overbank siltstone (lithosome A?):** Pink to light brown (7.5YR 6-7/4). Massive but near top unit is medium to thick, tabular-bedded. Moderately consolidated. Sharp, conformable contact with unit 6. On west side of ridge, 3-5% burrows are present in this unit (1-2 cm in diameter) and there are minor rhizoliths.	3.2	15.3
4	**Overbank siltstone and very fine- to fine-grained sandstone (lithosome B?):** Light brown (7.5YR 6/3-4) and pale brown (10YR 6/3); thick, tabular, ledge-forming beds; sand is well-sorted and lithic arkose to litharenite in composition. Lithic grains are probably of lithosome B provenance because of greenish quartz grains. Sediment is well consolidated with moderate to strong calcium carbonate cementation. Upper contact is sharp but conformable. 80-90 cm down from top is a 15 cm-thick white, altered ash that is planar-laminated. Sand becomes significantly more arkosic towareds top of unit; here, sand is subangular, well sorted, and its color is pale brown to pink (10YR 6-7/3).	3.5	12.1
3	**Floodplain mudstone to siltstone (lithosome B):** Light brown (7.5YR 6/4). Massive. Upper contact is gradational over 50 cm. Moderately consolidated. This is considered as lithosome B because 360-370 m to the north-northeast White Ash #2 has locally been obliterated by a 4.5 m-thick channel complex of medium to coarse-grained sandstone; this sand is subangular to subrounded, moderately sorted, has 5% muscovite grains, and has approximate ratio of 35-50% northeast-derived lithics : 50-65% Kspar.	3.2	8.6
2	**White Ash #2:** Ash is white (7.5YR 8/1), soapy-textured because of alteration to bentonite(?), and has 1-3% fL-fU sand-size crystals of biotite. Interval includes silty and very fine-grained sandy ash near top which has a light greenish gray (N8/1) color. Ash has a sharp lower contact and a gradational, conformable upper contact over 10-20 cm. Weakly consolidated	1.6	5.4
1	**Floodplain mudstone (lithosome B?):** Reddish brown (2.5YR 4/3 and 5YR 4-5/4). No bedding observed. Weakly to moderately consolidated. Between 30 and 80 cm from base is a calcium carbonate bed: crudely planar-laminated to very thinly bedded; probably a freshwater limestone or evaporative calcium carbonate.	3.8	3.8
	Base of section at unmarked stake near gully bottom. UTM coordinates of: 3985445 N, 412555 E. We use bearing and dip of N53°W and 9° NW.		0.0

Chimayo stratigraphic section. Reference section of Tesuque Formation that encompasses the stratigraphic interval between White Ashes #2 and #4 immediately north of the town of Chimayo. Described by D.J. Koning in October of 2002. UTM coordinates of base and top, respectively: 3985900 N, 414655 E and 3986120 N, 414690 E(Zone 13, NAD 27), Chimayo 7.5-minute quadrangle, New Mexico. Stake localities are preceeded by "CS-" on the geologic map.

Unit	Description	Thickness (m) (Unit)	(Total)
	LOWER LITHOSOME A UNIT OF THE SKULL RIDGE MEMBER LITHOSOME A (unit Ttasr1):		**55.1**
6	**White Ash #4:** Not described in detail.	1.0	55.1
5	**Overbank siltstone:** Light brown to pink (7.5YR 6-7/4); beds are medium to thick and tabular; ledge-former; well consolidated. @47.9-48.2 m: Light gray (2.5Y 7/2) ash; silty-textured and contains glass shards; moderately consolidated.	12.1	54.1

4	**Overbank and extra-channel siltstone with subordinate very fine- to fine-grained sandstone:** Pink to very pale brown (7.5-10YR 7/3); medium to thick, tabular beds; ledge-former and well consolidated.	12.9	42.0
3	**Overbank siltstone and mudstone:** Brown to light brown (7.5YR 5-6/4) and light yellowish brown (10YR 6/4); moderately to well consolidated. @24.3-24.0 m: Channel-fill of medium- to very coarse-grained sandstone bed; arkose in composition, subangular, and poorly sorted; not well-exposed; this bed is well consolidated and locally contains mud and locally contains very fine to fine, granitic pebbles. Not strongly or moderately cemented. @17.3-18.3 m: Strongly cemented channel-fill like the one above but with fine- to very coarse- grained sand grains; beds are generally thin to medium and lenticular to planar.	13.8	29.1
2	**Overbank and extra-channel siltstone and very fine- to fine-grained sandstone:** Very pale brown (10YR 7/4); beds are generally thin to medium and tabular; sand is arkosic arenite; minor brownish mudstone beds; ledge-former and well consolidated.	14.1	15.3
1	**White Ash #2:** Bright white ash; chalky-textured, hard, and has 1-3% biotite that is very fine sand in size.	1.2	1.2
0	**Floodplain mudstone:** Brown (7.5YR 5/4).	**0**	**0**

Encinos stratigraphic section. Reference section of lower-middle Tesuque Formation that encompasses the stratigraphic intervals of the Nambe, Skull Ridge, and Pojoaque Members in addition to the lower part of the lithosome A coarse upper unit. Measured and described east and north of El Rincon de los Trujillos, and crosses Arroyo de los Encinos. Described by D.J. Koning and S.D. Connell on March 23 and March 31, 2003. UTM coordinates of base: *3985296 N, 417161,* Chimayo 7.5-minute quadrangle, New Mexico. Stake localities are preceeded by "ES-" on the geologic map.

Unit	Description	Thickness (m) (Unit)	(Total)
	Unit Ttacu appears to be overlain (with a slight angular unconformity) by early Pleistoce-Pliocene terrace deposits of sandy gravel. About subequal cobbles : pebbles (as observed from a distance). Grayish brown in color. Very thin to medium, lenticular to broadly lenticular beds. Estimate thickness of 6-10 m.	6-10	
	LITHOSOME A, COARSE UPPER UNIT OF THE TESUQUE FORMATION (unit Ttacu; will be renamed Cuarteles member in the near-future):	**161-165**	**577-581**
12	**Interbedded coarse channel-fill and minor extra-channel sediment:** Generally coarse channel complexes, with an estimated 10-15% sandy extra-channel sediment. Channel sediment has an estimated ratio of 35-40% : 60-65% gravelly sand : sandy gravel (most of gravel are pebbles). Gravel are clast-supported, poorly sorted, rnd-subrnd (quartzite) to subrnd (granite). Channel beds are very thin to medium, and lenticular to broadly lenticular. No more cemented beds. Loose. Thickness of unit estimated from geologic map data.	18-22	577-581
11h	**Channel-fill sandy cobble-conglomerate:** Clast-supported, with an estimated ratio of 65% : 35% cobbles : pebbles. Quartzite is rnd-subrnd; granite is subrnd. Channel sand	2.5	559.1

	is 7.5YR 6/4-6, f-vc but mostly m-vc, subang-subrnd, poorly sorted, and an arkosic arenite. Clast count: 31% quartzite (4 clear, 2 sil, 25 cs-col) and 69% granite. Max clast sizes: 20x11, 31x19, 16x16, 23x16, 33x22 cm (axb axis). Clast imbrication (from large 6 clasts at 6 m distance): N68°W. *@ 556.6 m: Stake aa placed at base of cobble-conglomerate. It is unsafe to continue upwards. Stake is placed 6 m east of section line. At the section line, contact is at 556.0 m because of irregular nature of the contact. Continue describing in arroyo to north.*		
11g	**Intercalated coarse channel-fill and subordinate extra-channel sediment of Ttacu and minor coarse white ash beds:** Med to thick, tab to broadly lentic channel complexes of sandy pebbles (m) and pebbly sand (l). 20-25% cobbles. ~25% extra-channel sediment of 7.5YR 6/4-6 slightly silty (est 1-3% silt) vf-vc sandstone; sand is subang(m) to subrnd(l), poorly sorted, and arkosic arenite sandstone; modly consolid. Channels have v thin to thin, planar to lentic beds. Gravel is clast-sup (in congl) and poorly sorted, qtzite are subrnd-rnd & granite is subrnd-subang. Channel sand is 7.5YR 6/4-6, subang, f-vc, poorly sorted, and arkosic arenite (trace volc ltihics). Channel sed is not cemented and weakly consolidated. @550.4 m: Max clast sizes of a well-graded sandy boulder-pebble conglomerate bed (weakly consolid): 22x16, 22x14, 26x15 28x11, 32x23 cm (axb axis). @541.4-541.9 m: Whitish ashy sandstone; f-vc and arkosic; est 5-7% fL to cL white ash chunks. @539.0 m: Clast count in sandy pbl bed: 31% qtzite (cs-col), 69% gr Max clast sizes: 13x11, 11x8, 27x17, 15x10, 41x26 cm (axb axis) . @537.1m: Pebble conglomerate channel deposit; base is strongly cemented. Clast imbric: N50-70°W. @535.4-536.1 m: **coarse white ash:** 10Y 7-8/1; m-vc sand-size; 5-7% biotite and 7-10% pink felsic lithics (minor gray volc lithics). Sampled taken (labeled HW2-CWA-encinos). Somewhat greasy feel and altered, but biotite appears fresh. @531.6 m: **Approx. projection of top of 35 cm-thick coarse white ash from north:** upper 18 cm is grad with overlying extra-channel sed; sampled (HW3-CWA-encinos). *@ 530.5 m: App att of N65°E\6.5°NW; above here, use bearing of N25W and dip of 6.5 NW.* @529.3-530.5 m: relatively coarse channel-fill; max clast sizes: 37x23, 28x22, 30x28, 43x24, 43x31, 28x19 cm (axb axes); grvl are clast-sup and poorly sorted; qtzite is subrnd-rnd and granite is subrnd(m) to subang(l).	27.3	556.6
11f	**Interbedded coarse channel-fill and subordinate extra-channel sediment:** Medium to thick, tabular to broadly lenticular channel complexes of sandy pebbles (m) and pebbly sand (l). 30-40% extra-channel sediment of 7.5YR 6/4-6 slightly silty (est 1-3% silt) vf-vc sand; internally massive with ~3% pebble floaters; sand is subang(m) to subrnd(l), poorly sorted, and feld arenite; modly consolid and no HCl eff. Channels are weakly consolidated and not cemented (no HCl eff); pebbly sand may be laminated, otherwise v thin to med, planar to lentic internal beds with minor channel-shaped beds; channel sand is 7.5YR 7/3, mostly m-vc, subang, poorly sorted, and feld arenite (trace volc lithics) @525 m, clast count: 82% granite, 2% vein-qtz, 16% quartzite (1sil, 17 cs-col).	6.3	529.3
11e	**Interbedded extra-channel sediment and minor coarse channel-fill sediment:** 7.5-10YR 6/4 slightly silty vf-c sand (est 1-3% silt); med to thick, tabular beds; sand is subang (m) to subrnd (l); poorly sorted, feld arenite; modly to well consolid; no HCl eff. 10-20% med, lentic channels of sandy pebbles to pebly sand (as in unit 11c). *@ 517.0 m: Stake y' placed on top of ridge (0.9 m above y); bearing above is N25°W\ 4°NW ; UTM coord: 988572 N, 09416634 E.*	7.4	523.0
11d	**Coarse white ash:** 8 cm thick. Light gray to white (10Y 7-8/1). mU to vcU sand-size; 5-10% biotite, 3% pink to gray volcanic lithics. Relatively pure. Somewhat altered as manifested by greasy feel. Overlain by 7.5YR 5-6/6 clayey (est. 5-8% clay) vf-m ss. Underlain by 7.5YR 6/4-6 silty (est 5% silt) vf-m ss with minor c-vc grains. Modly -	0.8	515.6

well consolidated. UTM: 3988573 N; 416634 E.

11c	**Intercalated coarse-channels and subordinate extra-channel sediment:** Extra-channel sediment is 30-40% of sed and consists of light yellowish brown (10YR 6/4) slightly silty (est 1-3% silt) fl-cU sand; medium to thick, tabular beds but internally massive; sand is subang-subrnd, modly to poorly sorted, and arkosic arenite; modly to well consolid. Channel-fills are mostly of sandy pebbles with lesser pebbly sandstone; channel complexes are med to thick, tab to lentic; internal very thin to medium, planar to lenticular beds; sandy pebbles are clast-suported; est 20-35% cobbles; gravel are poorly sorted, rnd-subrnd (qtzite) to subrnd-subang (gr); loose to weakly consolidated. Channel sand is 7.5YR 6/4-6 to 7.5-10YR 7/3-4; fu-vcU, poorly sorted, subang(m) - subrnd (l), and feld arenite (trace volcanic lithics); minor channel-shaped beds (v thin to med, planar-lentic internal bedding). ~1% reddish soil horizons (Bt or Bw, 2-3csbk, hard peds, 20-30 cm thick). @ 508-510. 4 m: Channel-fill clast count: 58% granite, 38% quartzite (2 sil, 40 cs-col), 2% vein-qtz, and 2% amphibolite. Max clast sizes: 21x14, 14x9, 21x13, 14x10, 11x9 cm (a x b axes). @ 501.5-503.0 m: clast count gives 73% gr, 23 qtzite, (1 sil, 25 col-cs), 3% vein qtz; max clast sizes: 28x17, 11x7, 20x15, 16x12, 22x15 cm (a x b axes).	17.8	514.8
11b	**Coarse white ashy sand:** On northern segment, this is 2.5Y 7/3; sand is fU-vcU, subang-subrnd, poorly sorted, and arkosic arenite. About 1/3 greenish fU-cU ash grains. The coarseness of the ash suggests it belongs to the CWA series. *@ 496.8 m: Stake x' placed at top of ashy sand 210 m to the NE--section line steps two ridges to NE. Used bearing of N25W\5NW b/t stakes x' and 'y. Ashy sandstone correlated b/t two ridges based on llith characteristics & overall stratigraphy.*	0.2	497.0
11a	**Interbedded channel-fill and subordinate extra-channel sediment:** Similar to that of unit 11c above.	3.1	496.8
10e	**Conglomerate and pebbly sandstone channel-fills with subordinate sandy extra-channel sediment:** Channels are generally weakly to non-cemented, with only 10-20% strong to moderate cementation. Generally weakly consolidated. @ 479 m: Attitude of N23°E, 6° NW. Max. clast size: 14x12, 15x11, 16x11, 14x11, 18x14, 29x21. *@ 478.7: Stake u placed on top of ridge in a loose sandy gravel deposit. From stake u, we stepped right (north) to next east-west ridge, gaining 6 m in the process. Stake v placed on this north ridge. Used new bearing and dip of 6, N67W from u. When remeasured, shot along-strike from u to v' (gaining 1.5 m), then shot down-dip from v' to stake w'.* @ 475.9 m: ~20% extra channel sediment, as in unit 10b but with 3% est. silt, 2-5% pebble "floaters", and in thick to very thick, internally massive beds; light brown to reddish yellow (7.5YR 6/4-6). Channel complexes are commonly greater than 0.5 m thick and fine-upwards; gravel are clast-supported, subrnd to subang, and poorly sorted. Channel sand is m to vc (<10% vf to f), and subang, poorly sorted, and arkosic arenite. Max. clast size: 17x10, 14x11, 14x12, 15x12, 14x10 cm. Trends from two 70-80- and 50 cm-deep channels: N36°W +/- 8° and N17°W +/-14°. @ 464 m: 90 cm-deep channel trend: N68°W +/- 17°; channel is strongly cemented.	27.7	493.7
10d	**Pebble-conglomerate and pebbly sandstone channel-fills with subequal extra-channel sediment:** Channels complexes are mostly strongly cemented and have very thin to medium, planar to lenticular to channel-shaped internal bedding. Channel gravel includes minor cobbles; sand is medium to very coarse; subang, poorly sorted, and feld arenite. 3-5% reddish soil horizions (10-30 cm-thick). Extra-channel sediment is silty very fine- to coarse sand (~3% very coarse); estimate 5% silt; 1-3% pebble "floaters"; massive bedding; sand is subang (minor subrnd), poorly sorted, and fled arenite; well consolidated. @456.7 m: Paleocurrent indicators from base of thick channel complex: 16 cm-tall channel margin: N74°W, 17 cm-tall channel margin: N78°W, 40 cm-deep channel: N80°W.	12.8	466.0

10c	**Pebbly sandstone and pebble-conglmerate channel-fill:** Similar to channels of units 10b and 10a. Biggest clasts (cm): 20x17, 13x10, 14x10, 16x10, 11x10, 16x13. 19 cm-tall channel margin: N90W. 25 cm-deep channel: N53W. *@ 448.9-452.2: Northward shift between stakes s and t following a series of channels northwards, gain 3-3.5 m in the step.*	1.0	453.2
10b	**Extra-channel sediment with 1/3 coarse channel-fills:** Light brown to pink to very pale brown (7.5YR 6-7/4; 10YR 7/3) silty very fine- to coarse-grained sand; bedding is massive or in medium to thick, tabular beds; estimate 3-5% silt; sand is subangular (minor subrounded), poorly sorted, and arkosic arenite.; 0.5-1.0% scattered lithosome A pebbles. Coarse channel-fills described below. Well consolidated and weakly cemented (weak HCl eff). @448.1-448.9 m: 5-10% thin to medium, lenticular channels of pebble-conglomerate. Channel pebbly sandstone and pebble-conglmerate of Ttacu: Pebbly medium- to very coarse-grained sand and sandy pebbles. Beds are very thin to medium, planar to lenticular to channel-shaped. Lith A. Generally strongly to moderately cemented. 40 cm-tall channel margin: N10°W. @444.1-448.1 m: Channel pebbly sandstone and pebble-conglmerate of Ttacu: Pebbly medium- to very coarse-grained sand and sandy pebbles. Beds are very thin to medium, planar to lenticular to channel-shaped. Lith A. Generally strongly to moderately cemented. 40 cm-tall channel margin: N10°W. @438.9.9-444.1 m: Extra-channel and overbank sediment of Ttacu: Silty very fine- to coarse-grained sand with minor very pale brown (10YR 7/3) silt; former is in medium to thick, tabular beds, latter is planar-laminated or in very thin to thin, tabular beds. Silty sand is pink to light brown (7.5YR 6-7/4) internally massive, has an est. 3-5% silt, and has minor very coarse sand and 1-3% scattered pebbles. Well consolidated, no HCl eff. Coarse pebbly sand channel fill at 440.9-441.9 m. @437.4-438.9 m: Channel pebbly sandstone of Ttacu: Strongly cemented. @ 434.4-437.4 m: Extra-channel silty sandstone with subordinate channel deposits: Similar for that described below for 417.7-423.9 m. @432.8-434.4 m: Channel pebbly sandstone to sandy pebble-conglomerate of Ttacu: 25 cm-tall channel margin: N54°W. @428.9-432.8 m: Extra-channel silty sandstone with subordinate channel deposits: Similar for that described below for 417.7-423.9 m. @428.3-428.9 m: Channel pebbly sandstone and conglmerate of Ttacu: Pebbly sand to sandy gravel similar to unit 10a channels described below. Sand is planar-laminated. Est. 2/3 : 1/3 pebbles : cobbles. Upper channel is gravel-rich at base but is sand-rich at top. @425.9-428.3 m: Extra-channel silty sandstone of Ttacu with 30-50% channel deposits. Similar for that described below for 417.7-423.9 m. @423.9-425.9 m: Channel pebbly sandstone and conglmerate of Ttacu: Pebbly sand to sandy gravel similar to unit 10 channels described below. Sand is planar-laminated. Est. 2/3 : 1/3 pebbles : cobbles. Upper channel is gravel-rich at base but is sand-rich at top. *@423.9: Base of channel used to step north 60 m. Stake r placed at north end of the step. From here, we use a bearing and dip of N60°W, 5° NW.* @417.7-423.9 m: Extra-channel silty sandstone of Ttau with 30-50% channel deposits: Bedding of channel complexes is very thin to medium, planar to lenticular to channel-shaped (also massive). 1/2 to 1/3 of channels are strongly to moderately cemented, rest are weakly to non-cemented. Extra-channel sediment is generally a v. p. brown (10YR 7/3) silty (est 3-5% silt) vf- to m-gr sand; minor coarse to very coarse sand; medium to thick, tabular beds; sand is subang, poorly sorted, and arkosic; has 1-3% scattered Lith A pebbles ; ~5% reddish soil horizons 10-30 cm thick; well consolidated and weakly cemented. At channel a few m above stake p, max clast sizes: 16x11, 20x9, 12x7, 11x10, 14x12, 15x11, 11x6, 5x6 (cm)	31.2	448.9
10a	**Channel-fill pebbly sandstone:** 1.5 m of pebbly sand that is planar-laminated to very thin to thinly bedded. Basal 15 cm is strongly cemented, rest is non-cemented. Pebbles	1.5	417.7

	are poorly sorted, subrounded (some granite is subangular), and composed of granite with about 20-35% quartzite (est.). Sand is mostly medium to very coarse-grained,subangular, and poorly sorted. 30-40 cm-tall channel margin: N2E (30-40 m), 15cm-deep channel trend: N70W; vague clast imbrication to the north. *@416.2: Basal Ttacu contact placed at the base of first significantly cemented channel depost. Stake P. 35 cm-tall channel margin of this channel: N15E-S15W. We follow this contact to the west to the west wall of Arroyo del Mogote (stake q). This contact crosses two faults, but we see it on the west wall. Contact may climb to the west. Channel margins and channel trends on east wall of Arroyo del Mogote: S33W-N33E (ch marg); S37W-N37E (ch marg); S55W-N55E (ch marg); N46W (basal ch grooves); N51W (ch trend). From stake q, we use a bearing and dip of N67W, 6 degrees.*		
	LITHOSOME A, FINER UPPER UNIT OF THE TESUQUE FORMATION (unit Ttafu):	**84.3**	**416.2**
9c	**Extra-channel silty sandstone, with 10-20% coarse channel-fills:** Very pale brown (10YR 7/3) silty very fine- to medium-grained sand. Medium to thick, tabular beds. Channels are composed of sandstone and pebble-conglomerate, and are in medium to thick, tabular complexes (conglomerate complexes are lenticular). Trace to 1% weak reddish soil horizons ~15-25 cm-thick. Non to strongly cemented and well-consolidated.	17.4	416.2
9c'	**Channel-fill pebbly sandstone and pebble-conglomerate:** Gravel are clast-supported and contain about 1/5 cobbles. Clasts are subrounded, poorly sorted, and are granitic with 25-35% quartzite. Max clast size (cm): 19x11, 16x10, 17x14, 13x11, 11x9, 22x10, 10x9, 8x7, 8x7, 8x7, . Sand is fine- to very coarse-grained, subangular to subrounded, poorly sorted, and arkosic. Lower 1/3 is a well-graded mix of strong to weak cementation; upper 2/3 is weakly to non-cemented.	1.6	398.8
9b	**Extra-channel silty sandstone, with 3-5% coarse channel-fills:** Very pale brown (10YR 7/3) silty very fine- to medium-grained sand. Medium to thick, tabular beds. Channels are thin to medium , lenticular to tabular, and composed of sandy pebble-conglomerate of Lithosome A composition. 1-5% reddish soil horizons up to 20 cm-thick; these are locally underlain by Bk horizons, up to 15 cm-thick, of stage II carbonate morphology. Well consolidated; channels are weakly to non-cemented, some moderate cementation.	11.0	397.2
9a	**Upper part of unit: Extra-channel silty sandstone, with 5-15% coarse channel-fills:** Pink (7.5YR 7/3-4) silty very fine- to fine-grained sand with minor medium to very coarse-grained sand. Medium to thick (minor thin), tabular beds. Sand is subangular (some subrounded), high-moderately sorted, and arkosic. Well to moderately consolidated. @ 386.2: Top of 20-40 cm-thick soil marked by discontinuous, nodular calcium carbonate-cemented sandstone with Stage II carbonate morphology. Abundant krotivina present on cliff face at this locality. We followed this soil to the northeast and continued measuring along the cliff using a bearing and dip of N27°W, 10° NW. *@ 385.4: Stake O placed at base of prominent cliff.* **@359.9: Northward projection of an adjacent coarse channel complex up to about 4 m-thick:** Internal channel bedding is thin to thick, planar to lenticular to channel-shaped. Channel consists of interbedded sandstone and pebble-conglomerate. Conglomerate beds are clast-supported Lithosome A pebbles with about 10% cobbles. Max. clast size:. 8x6, 8x7, 8x7, 7x6, 9x9, 7x6, 9x5 (cm). Channel sand is mostly medium- to very coarse-grained, subangular, poorly sorted, and arkosic. Well-graded mix of strong to weak cementation. Channel trend: S79°W +/- 5; channel	54.3	386.2

	Middle part of unit: Extra-channel silty sandstone, with 5-15% coarse channel-fills: Pink (7.5YR 7/3-4) silty very fine- to fine-grained sand with minor medium to very coarse-grained sand. Medium to thick (minor thin), tabular beds. Sand is subangular (some subrounded), high-moderately sorted, and arkosic. Well to moderately consolidated.		
	Lower part of unit: Extra-channel slightly silty sandstone, with 5-15% coarse channel-fills: Light brown to reddish yellow (7.5YR 6/4-6) and very pale brown (10YR 7/3) 7/4) slightly silty very fine- to medium-grained sand. Medium to thick, tabular beds and also massive. Sand is subangular to subrounded, moderately sorted, and arkosic. Channels are in tabular to broadly lenticular, 10 cm to 150 cm-thick complexes and consist of pebbly sandstone and sandy pebble-conglomerate. Unit contact placed at base of channel, above which channels become more abundant. Basal channel is approximately 30-100 cm thick and composed of pebbly fine- to very coarse-grained sand; lower 1/3 of channel is locally a sandy pebble with 1/3 cobbles; basal channel pebbles are very fine to very coarse, poorly sorted, and Lithosome A in composition; max. clast size: 19x11 cm, 15x6 cm, 14x7 cm, 13x12 cm, and 14x9 cm. Well to moderately consolidated; 1/2 - 1/3 of channels are strongly to moderately cemented, remainder are weakly to non-cemented. One channel-fill is 30 cm-deep and trends S79°W.		
	From 340.1-340.4: 30 cm-thick, well-cemented fine-pebbly sandstone.		
	From 334.0-340.1 m, section line crosses Quaternary alluvium; used nearby exposures to describe the section. *@331.9: Stake M placed at approximate Ttam / Ttasa contact (hangingwall of fault). We pick up contact on footwall of fault and start measuring from stake N. From stake N, we change bearing and dip to N27°W, 10°NW. Est. 5-15 m of error in crossing fault. UTM coord of stake N: 3987307N, 416871E. UTM coord of stake M: 3987138N, 417001E*		
	MIDDLE LITHOSOME A UNIT OF THE TESUQUE FORMATION (Ttam):	**163.5**	**331.9**
8g	**Extra-channel muddy sandstone:** Pink (7.5YR 7/4) muddy very fine- to medium sand with scattered fine pebbles. Poorly exposed and massive bedding.	2.0	331.9
8g'	*No exposure: Probably like unit 8g above.*	3.0	329.9
8f	**Overbank and extra-channel silty sandstone and siltstone:** Pink (7.5YR 7/4) siltstone and silty very fine- to fine-grained sandstone. Poorly bedded, medium to thick, tabular beds. Sand is subangular, moderately to well sorted, and arkosic. One channel observed that is 150 cm thick and composed of pink (7.5YR 7-8/3) fine to very coarse-grained sand; channel sand is subangular (some subrounded), poorly sorted, and arkosic; at the base of the cahnnel is a lenticular, medium bed that is strongly cemented, otherwise channel is internally massive and non-cemented. Well consoldiated. Margin of channel: N68°W.	10.6	326.9
	@320.9-326.9 m: No exposure.		
	@326.9: Encounter down-to-east fault with an estimated 6-15 m of displacement (stake L). We shoot along-strike towards NE to gain TtamL / Ttamu contact. UTM coord of stake L: 3987101N, 416970E.		
	From 286.9 to 316.3: Covered by Quaternary alluvium. Probably unit 8e based on correlation along-strike and structural considerations.	29.4	316.3
8e	**Overbank and extra-channel silty sandstone, minor coarse channel-fills:** Sediment is similar to that in unit 8c, but here there is slightly more medium sand and channels occupy about 5% of exposure but % is variable.	36.5	286.9

From 270.4 to 286.9: Unit 8e is only partly exposed.

8d	**Extra-channel and overbank silty sandstone, 30-40% coarse channel-fills:** Sediment is similar to that in unit 8c, but coarse channels occupy about 30-40% of the exposure. Overbank and extra-channel sediment are mostly in medium to thick, tabular beds, with minor thin beds. The coarse channels consist of sandstone and subordinate gravelly sandstone, and are in medium to thick, tabular channel complexes whose internal bedding is very thin to medium, planar to lenticular to channel-shaped; sand may be massive. Gravel is mostly pebbles that are very poorly sorted and subrounded to subangular. Clast count (n=106) gives: 76% granite, 19% coarse-colored quartzite, 4% clear-gray quartzite, and 1% siliminite-bearing quartzite. Maximum clast sizes of 15x10, 17x12, 10x6, 9x6, and 11x8 cm (a x b axes). One channel-fill trends N33°W +/- 25°. Channel sand is pink to very pale brown (7.5-10YR 7/4), mL-vcU, subrounded to angular (mostly subangular), and composed of quartz with about 25% Kspar and 12% black mafics + biotite. Extra-channel sediment is moderately to well consolidated, and coarse channel-fills have one-third strong cementation by calcium-carbonate but are otherwise loose.	5.0	250.4
8c	**Extra-channel and overbank silty sandstone, minor coarse channel fills:** Light brown to pink (7.5YR 6-7/4) silty very fine- to fine-grained sandstone. Generally medium to thick, tabular beds. Sand is subangular, moderately to well sorted, and arkosic. 1-3% medium, tabular mudstone beds. ~0.5% yellowish red to reddish yellow (5YR 5-6/6) layers, containing an estimated 1-5% clay and up to 10 cm-thick, that may possibly be paleosols but have no significant ped structure or clay films. About 3-5% channel-fills of sandstone and pebbly sandstone that are generally medium to thick and lenticular to broadly lenticular; channel-fill pebbles are very fine to very coarse, poorly sorted, subrounded to subangular, and consist of granite with subordinate quartzite; channel-fill sand is fine- to very coarse-grained, subangular, poorly sorted, and an arkose. Moderately to well consolidated; channels are generally strongly cemented by calcium carbonate.	8.0	245.4
8b	**Overbank sandy mudstone and muddy sandstone:** Light brown to reddish yellow (7.5YR 6/4-6) sandy mudstone and sandy very fine- to fine-grained sandstone. Generally medium to thick, tabular beds. Sand is subangular, well to moderately sorted, and arkosic arenite. Moderately consolidated; *234.4 m: Section steps to northeast (between stakes J and K) following the basal contact of unit 8b. UTM coordinates of Stake K: 3986698 N, 417274 E. Approximate coordinates of Stake J: 3986662 N, 417241 E. Above Stake K, we use bearing and dip of N36°W, 9° NW to stake L. A minor fault (probably < 4 m of throw) is crossed in this traverse, but we follow the same stratigraphic interval across it.*	4.0	237.4
8a	**Extra-channel and overbank silty sandstone, ~10% coarse channel-fills:** Light brown to reddish yellow (7.5YR 6/4-6), slightly silty sandstone to silty sandstone. Medium to thick, tabular beds that are ill-defined. Sand is mostly very fine- to fine-grained, subangular to subrounded, moderately to well sorted, and arkosic arenite. 10% medium to thick (up to 110 cm) channel-fills of pebbly sandstone and sandstone; channels are thin- to medium-bedded and broadly lenticular, and internally massive, with some planar-laminations and very minor tangential, low-angle cross-laminations that are up to 2 cm-thick. Gravel consists of pebbles with about 5% cobbles. Pebbles are subangular to rounded (mostly subrounded) and poorly sorted. Clast count (n=114) gives: 67% granite, 18% colored-coarse quartzite, 11% clear-gray quartzite, 3% siliminite-bearing quartzite, 2% vein quartz, and 1% mylonitized granite. Maximum clast sizes near top of unit: 11x8, 15x13, 10x6, 11x8, 16x10, 9x6, 10x5 cm (a x b axes). Channel-fill sand is very pale brown to light yellowish brown (10YR 6/4-7/3) and pink (7.5YR 7/3-4), fU-vcU, subangular (mostly) to angular, poorly sorted, and consists of quartz, 25-30% Kspar, and 10-15% black mafics. @ 230.4 m: ledge-forming channel of strongly cemented, coarse sandstone of lithosome A composition; 10 cm-thick.	30.4	233.4

	@222.9-223.1 m: Pebble-conglomerate channel: lithosome A composition, well-cemented, 10-30 cm-thick. *@ 5 m plus top of unit 7, Stake I is placed. We followed unit 7 to north, but in the process climbed up 5 m to a higher 80 cm-thick, reddish brown to brown (5-7.5YR 5/3) claystone bed. The intervening sediment is like unit 8a. Approximate coordinates of Stake I; 3986619 N, 417261 E.*		
	LITHOSOME B INTERVAL WITHIN UNIT TTAM, SKULL RIDGE AND NAMBE MEMBERS, TESUQUE FORMATION:	**1.6**	**203.0**
7	**Channel-fill sandstone to pebbly sandstone and floodplain claystone of Ttbsn:** Pale brown (10YR 6/3) sand with 5-10% lithosome B pebbles. Overall, deposit fines-upward. Very thin to medium, planar-beds (sand) and lenticular beds (pebbles); minor planar cross-stratification 10-20 cm-thick. Pebbles are subrounded and moderately sorted. Clast count (n=100) gives: 55% Paleozoic limestone, 21% Paleozoic sandstone and siltstone, 6% colored-coarse quartzite, 5% gray-smooth quartzite, 4% colored-smooth quartzite, 7% granite, 1% black Paleozoic shale, and 1% vein quartz. Sand is fine- to very coarse-grained, subrounded to subangular, and has about 1/3 : 2/3 pinkish Kspar: northeast-derived lithic grains. Loose, with about 10% local strong cementation by CaCO3. Upper part of unit becomes a brown mudstone to the north. **UNIT Ttam CONTINUES BELOW** *@ 201.4 m: Stake H is placed: 3986364 N, 417068 E.*	1.6	203.0
6d	**Channel-fill sandstone and pebbly sandstone of Ttam:** Massive sand with ~20% pebbly sandstone and sandy pebble-conglomerate channel-fills that are channel-shaped (up to 50 cm-thick) or in lenticular to broadly lenticular, medium to thick beds. Pebbles are subrounded to subanglar and poorly sorted. Clast count (n=132) gives: 68% granite and 32% undivided Proterozoic quartzite. Sand is pink (7.5YR 7/3-4), very fine- to very coarse-grained, subangular, poorly sorted, and arkosic arenite. Generally weakly to non-cemented.	4.8	201.4
6c	**Overbank and extra-channel siltstone and sandstone of Ttam: Similar to unit 6a.**	3.2	196.6
6b	**Channel-fill pebbly sandstone of Ttam:** Light yellowish brown (10YR 6/4). Beds are very thin to thick and lenticular to broadly lenticular; internally massive or laminated. Sand is medium- to very coarse-grained, subangular, moderately to poorly sorted, and arkosic arenite. 15-20% clast-supported gravel in lenticular, very thin to medium beds (2/3 : 1/3 pebbles : cobbles); clasts are subrounded to subangular and poorly sorted; max clast sizes: 16x10, 11x6, 9x8, 10x8, and 9x8 cm (a x b axes). Clast count (n=102) gives: 77% granite, 20% colored-coarse quartzite, 2% clear-gray quartzite, and 1% vein quartz. Generally weakly to non-cemented (about 10-20% is moderately cemented), and weakly to moderately consolidated.	3.2	193.4
6a	**Extra-channel and overbank siltstone and sandstone of Ttam:** Light brown to reddish yellow (7.5YR 6/4-6) siltstone and very fine- to medium-grained sandstone (mostly very fine- to fine-grained sand). Ill-defined, medium to thick, tabular beds. 3-5% muscovite grains. 3-5% scattered channel-fills of sandstone, pebbly sandstone, and sandy pebble-conglomerate; these are lenticular and medium to thick; one such channel is 40-70 cm-thick, lensoidal, moderately sorted, has very fine to very coarse pebbles (most of pebbles are <3 cm long), and is weakly to strongly cemented by sparry calcium carbonate; clast count (n=106) gives: 77% granite and 23% undivided quartzite; channel-fill sand is subangular, poorly sorted, and arkosic arenite. Finer sediment is moderately to well consolidated, and non- to weakly cemented.	21.8	190.2
	COARSE #2 UNIT OF LITHOSOME B, NAMBE MEMBER, TESUQUE FORMATION (Ttbnc2):	**6.5**	**168.4**

5h	**Floodplain mudstone of Ttbnc2:** Light brown (7.5YR 6/3) mudstone in ill-defined, medium to thick, tabular beds. Very minor, very thin to thin channel-fills of very fine- to coarse-grained, arkosic arenite sandstone. Weakly to well consolidated, and non-cemented except for local medium pebble-size nodules of strongly cemented (by calcium carbonate) very fine to coarse sandstone that are eroded from the sandstone channel-fills.	3.5	168.4
5g	**Channel-fill sandstone of Ttbnc2:** Pale brown (10YR 6/3) fine- to very coarse-grained sand, with minor pebbles, and cobbles (more pebbles than cobbles); minor very coarse-grained sand by Stake G'. Planar to broadly lenticular, very thin to thin beds and planar-laminations (sand and pebbly sand); thin to medium, lenticular to broadly lenticular beds (pebble-conglomerate). Channel-shaped beds locally near the base. Sand is subrounded to subangular, moderately sorted, and has about 1/3 : 2/3 pinkish Kspar : Lithosome B lithic grains. Max clast sizes (cm): 35x13, 14x12, 19x16, 19x13, 17x15, 27x18, 19x11, 25x9, 15x8. Clast count at Stake G' (n=112) gives: 31% Paleozoic sandstone and siltstone, 22% Paleozoic limestone, 26% clear-gray quartzite, 8% colored-smooth quartzite, 6% colored-coarse quartzite, 2% siliminite-bearing quartzite, 3% felsic volcanic rock and tuff, 1% foliated quartzite, 1% meta-conglomerate. Loose except for 10% strong calcium carbonate cementation (strong cementation is commonly near the base of the unit). Paleoflow data: S45°W (150 cm-tall channel margin), S25°E (80 cm-tall channel margin), S1°E and S37°E (sides of a 15 cm-deep channel, weak clast imbrication is S8°W +/- 40), S19°E (30 cm-tall channel margin), S52°E (20 cm-tall channel margin), S38°E (30 cm-tall channel margin), S42°E (25-30 cm-tall channel margin), S35°E (40 cm-tall channel margin), S49°W and S22°W (50-55 cm-tall channel margin). Clast imbrication of S22°W, S14°W, S20°E, S15°E, and S12°W. *@ 161.9: From stake F', followed base of unit 5f northeastward to stake G'. Stake G' UTM coordinates: 3986300 N, 417140 E. Above Stake G', change bearing and dip to N50°W, 8°* NW.	3.0	164.9
	FINE #2 UNIT OF LITHOSOME B, NAMBE MEMBER, TESUQUE FORMATION (Ttbnf2):	**68.5**	**161.9**
5f	**Floodplain silty sandstone and mudstone:** Mostly light brown to light yellowish brown and very pale brown (7.5YR 6/4, 10YR 6-7/4) silty very fine- to fine-grained sandstone, with about 20-30% light brown (7.5YR 6/4) mudstone. Thin to thick, tabular beds. Weakly consolided and not cemented.	7.6	161.9
5e	**Floodplain mudstone and siltstone:** Light brown to brown (7.5YR 6/3-4, 7.5YR 5/4) mudstone and siltstone. Thin to thick, tabular beds. 1% thin to medium, lenticular channel beds of well-sorted, vfL to mL, sand (2/3 : 1/3 possible Lithosome B lithics : pinkish Kspar). Weakly to moderately consolidated and non-cemented, but the channels are commonly strongly cemented by calcium carbonate.	18.9	154.3
5d	**Channel-fill pebbly sandstone:** Light brown to brown (7.5YR 5-6/4); bedding is very thin to medium and planar, also planar-laminated. Sand is subrounded to subangular, moderately sorted, and has 1/3-2/3 : 2/3-1/3 Lithosome B lithics : pinkish Kspar. About half of channel is moderately to strongly cemented by calcium carbonate, and about half is weakly to non-cemented. Cigar-shaped cemented trends: S30°W to S50°W. Clast imbrication: S85°W. 10 cm-deep channel trend: S50°W.	1.5	135.4
5c	**Upper part of unit: Floodplain mudstone:** Light brown to brown (7.5YR 5-6/4) and reddish yellow (7.5YR 6/6) mudstone and sandy (very fine to fine) mudstone with minor siltstone and claystone. Bedding is medium to thick and tabular. Weakly to moderately consolidated. @ 105.4: Thin to medium and tabular, cemented fine sandstone with sparry calcium carbonate cement. *@ 127.4: Change bearing and dip to N45°W, 7° NW.*	37. 5	133.9

	Lower part of unit: Floodplain siltstone and mudstone: Light brown (7.5YR 6/3-4) and in thin to thick, tabular beds. Moderately consolidated, with very fine to coarse pebble-size calcium carbonate nodules. @ 99.4: Thin to medium and tabular, nodular, micritic calcium carbonate-cemented sandstone brown (7.5YR 6/4) siltstone and very fine- to fine-grained sandstone of Lithosome B composition.		
5b	**Channel-fill gravel and sand:** Approximately 2/3-3/4 : 1:3/1/4 pebbles:cobbles. Gravel are poorly sorted and subrounded. Max clast sizes: 20x14, 26x16, 18x17, 17x13, 16x13, 29x13 (cm). Clast count (n=104 clasts): 55% Paleozoic limestone, 24% Proterozoic quartzite, 18% Paleozoic sandstone and siltstone, 2% vein quartz, 1% foliated quartzite, 1% meta-conglomerate. Bedding not exposed.	1.5	96.4
5a	**Floodplain siltstone and mudstone:** Beds not exposed and moderately consolidated.	1.5	94.9
	FINE #2 UNIT OF LITHOSOME A, NAMBE MEMBER, TESUQUE FORMATION (Ttanf2):	**14.0**	**93.4**
4d	**Weakly to strongly cemented very fine- to fine-grained sandstone of Ttanf2, possibly mixed with ash**	0.4	93.4
4c	**Overbank siltstone and sandstone:** Light brown to reddish yellow (7.5YR 6/4-6), generally massive, siltstone and silty very fine- to fine-grained sandstone, minor medium sand. Sand is subangular, moderately sorted, and arkosic. Weakly to moderately consolidated.	1.6	93.0
4b	**Channel-fill sandstone:** Pink (10YR 7/4) fine- to coarse-grained sandstone, some very coarse sand, and local gravel lenses near base. Channel sand is generally massive or planar-laminated, gravel is in thin to medium, lenticular beds. Gravel are poorly sorted, subangular (some subrounded) and consists of granite with about 10% quartzite. Sand is subangular, moderately sorted, and arkosic. Locally moderately cemented, but mostly moderately consolidated and non- to weakly cemented.	2.5	91.4
4a	**Overbank siltstone and sandstone:** Light brown (7.5YR 6/4) siltstone and very fine- to fine-grained sandstone; <1% muscovite flakes. Moderately consolidated and non-cemented.	9.5	88.9
	FINE AND COARSE #1 UNITS OF LITHOSOME B, NAMBE MEMBER, TESUQUE FORMATION (Ttbnc1 and Ttbnf1):	**16.0**	**79.4**
3c	**Poorly exposed; probably unit 3a as described below.**	5.0	79.4
3b	**Channel-fill of sandstone and conglomerate of Ttbnc1:** Estimate 1/3 : 3/4 cobbles to pebbles (by volume); about 1/3 of channel is strongly cemented, but cementation is discontinuous. Largest clasts: 29x14, 22x7, 10x8, 14x4, 17x9, 17x11 (cm). Gravel are poorly sorted and subrounded. Clast count (n=100) gives: 45% Paleozoic limestone, 30% Paleozoic sandstone and siltstone, 22% Proterozoic quartzite, and 9% granite (clast count is by Stake D). *@ 73.4: Stake D-E northeast step-over, used the base of unit 3b. UTM coordinates of Stake D: 3985569 N, 417001 E. Stake E: 3985709 N, 417140 E. Above Stake E, change bearing and dip to N49°W, 12° NW*	1.0	74.4
3a	**Floodplain siltstone, mudstone, and sandstone of Ttbnf1:** Light brown (7.5YR 6/3); not well exposed; sand is very fine- to medium-grained. Moderately consolidated and non-to weakly cemented.	10.0	73.4
	FINE #2 UNIT OF LITHOSOME A, NAMBE MEMBER, TESUQUE FORMATION (Ttanf2):	**52.5**	**63.4**
2d	**Overbank and extra-channel muddy sandstone, with 1-3% sandy channel-fills:**	39.5	63.4

	Light brown to reddish yellow (7.5YR 6/4-6); bedding is medium to thick and tabular. Sand is generally very fine- to fine-grained with minor medium-grained, moderately to poorly sorted, and an arkose. Subordinate light brown (7.5YR 6/4) mudstone, siltstone, and silty very fine- to fine-grained sandstone in thin to thick, tabular beds. 1-3% medium channels of very fine- to fine-grained sandstone that are strongly cemented by calcium carbonate; this sand is arkosic with subordinate lithics (probably lithosome B lithics). Well to moderately consolidated, and non- to weakly cemented. @ 32.9-36.9 m: Channel pebbly sandstone with subordinate overbank and extra-channel muddy sandstone.		
2c	*Covered by Quaternary alluvium; probably unit 2d as described above* *@ 10.9: Stepped along-strike abut 10-20 m northeast, between Stakes B and C; change bearing and dip to N35°W, 15° NW. UTM coordinates of Stake B: 3985330 N, 417151 E; UTM coordinates of Stake C: 3985337 N; 417162 E.*	13.0	23.9
	COARSE #2 UNIT OF LITHOSOME A, NAMBE MEMBER, TESUQUE FORMATION (Ttanc2):	**10.9**	**10.9**
2b	**Channel-fill sandy pebble-conglomerate and pebbly sandstone:** Very thin to medium, lenticular beds. Pebbles are clast-supported, subangular to subrounded, moderately to poorly sorted, and of: 64% quartzite, 24% quartzite, and 12% vein quartz (clast count of 135 clasts). Sand is white (7.5YR 8/1), mL-vcU, angular to subangular, poorly sorted, and an arkosice. Moderately consolidated and weakly cemented.	3.0	10.9
2a	**Channel-fill sandstone and pebble-conglomerate:** subordinate (25-35%) extra-channel sandstone. Channels are grossly lenticular and up to 1 m thick; internal bedding is planar to lenticular and very thin to thin. Sandy pebble channels are clast-supported, max. clast size of 16x8 cm, subangular to subrounded, and poorly sorted. Channel sand is pink (7.5YR 7/4), angular to subangular, poorly sorted, and an arkose. Extra-channel sediment is in medium to thick, tabular beds (beds are internally massive) and is a light reddish brown (5YR 6/4), clayey very fine- to very coarse-grained sand; sand is subangular, poorly sorted, an arkose. Channel sediment has strong HCl eff. and are moderately cemented; extra-channel sediment has moderate HCl eff., moderately consolidated, and weakly cemented. Clast count: 127 granite and 2 quartzite.	7.9	7.9
	Stake A placed at approximate top of unit 1. Above, used bearing and dip of N46°W, 15°NW. UTM of stake: 3985296 N, 417161 E; zone 13, NAD 27.		0.0
1	**Channel-fill sandstone and conglomerate of Ttmrn2 (#2 mixed provenance, reddish, fluvial unit of Nambe Member):** Light reddish brown (5YR 6/4 pebbly sand and sandy pebbles. Very thin to medium, planar to broadly lenticular beds; internal planar laminations within a bed, some sand beds are thick. Gravel is clast-supported, max. clast size of 19x14 cm, weakly imbricated, 7:3 pebbles to cobbles, subrounded, and moderately to poorly sorted. Sand is fU-vcU (mostly mL-cU), subangular to subrounded, moderately to poorly sorted, and a feldspathic arenite(?) -- minor reddish clay films on sand grains makes it difficult to determine composition. No HCl eff, weakly to moderately consolidated, weak cementation porbably due to clay. Clast count: 10 quartzite, 18 quartz, 26 granite, 10 greenish Pz ss and sltst, 39 yellowish Pz lm, 5 grayish Pz lm, 1 musc sch, and 1 felsic tuff.		>3.0

APPENDIX II.

Select Photographs from the

Chimayo Quadrangle.

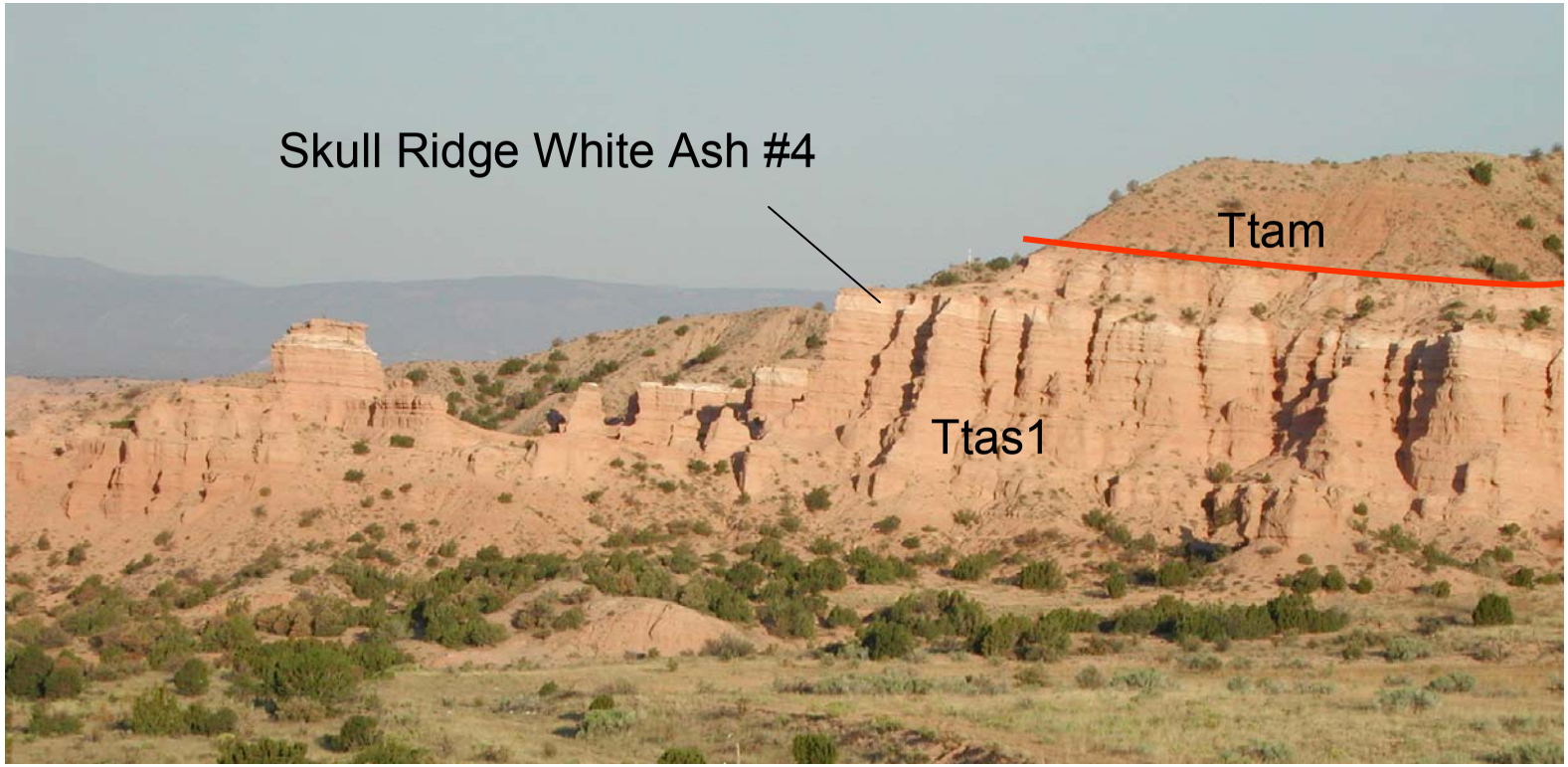
Photo showing the Santa Cruz escarpment north of the town of Chimayo, the namesake of the quadrangle. A thick bed of the Skull Ridge White Ash #4 forms the white band in the low hills left-of-center. Study of this escarpment illustrates two important sedimentologic and stratigraphic trends: Between approximately 16 and 8 Ma, sediment coarsened significantly with time, and the two fluvial environments that deposited these strata progressively prograded westward.

Certain areas near Chimayo have poor groundwater quality. At Los Pachecos, located about 1 km north of the Chimayo plaza, the National Guard hauls in drinking water for local residents. The geologic information contained on this quadrangle will provide useful data for existing and future groundwater and hydrogeologic studies.

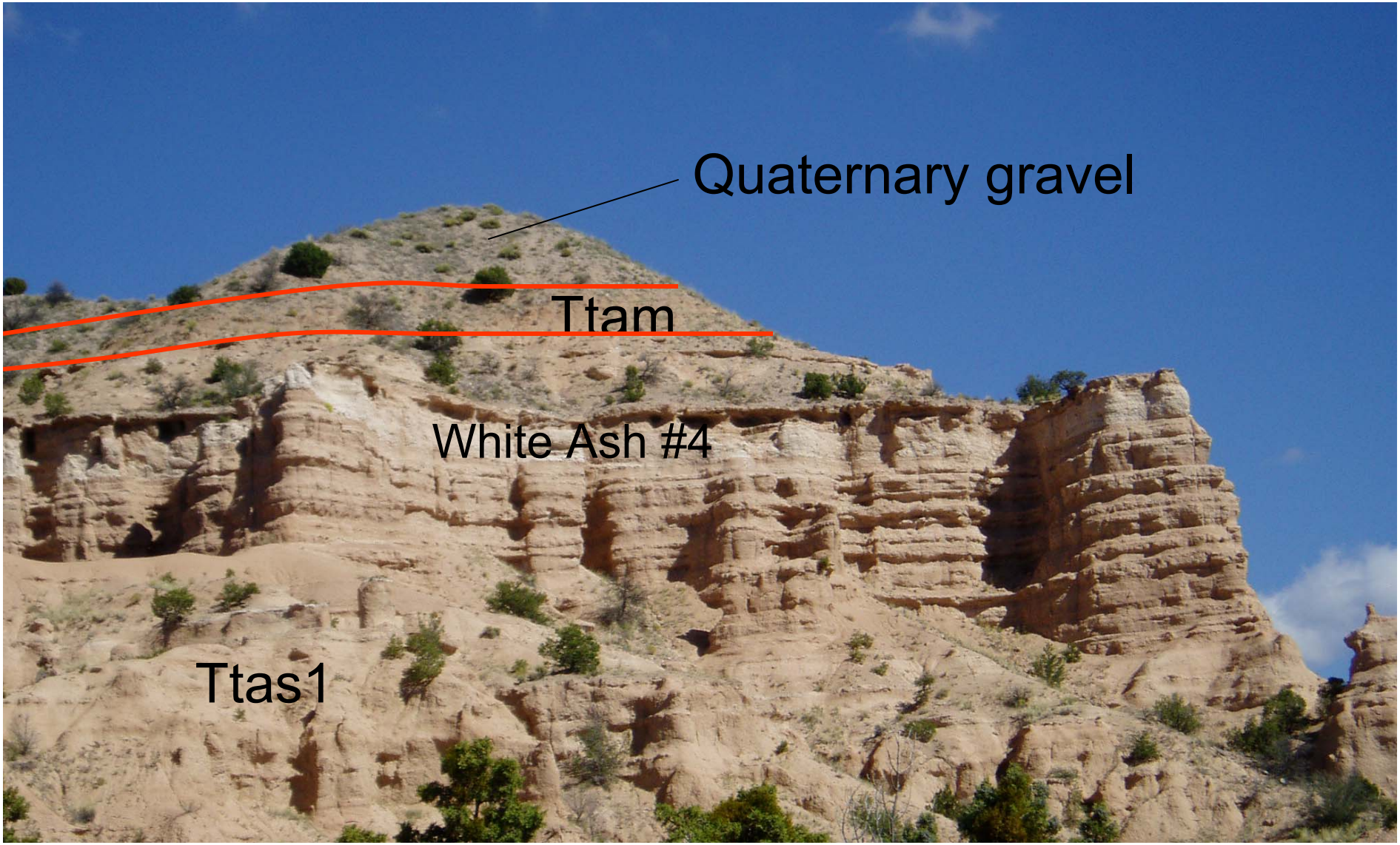
View of strata above and below Skull Ridge White Ash #2. In almost all places where it is exposed, strata underneath the ash is reddish brown claystone to mudstone, and strata above are medium to thick, tabular beds of siltstone and very fine- to fine-grained sandstone. The lithologic characteristics and composition of these strata suggest deposition near the boundary between the lithosome A allvuial slope and the fluvial system associated with lithosome B. Photo taken at the mouth of Arroyo de los Ajuelos.

A thick bed of the Skull Ridge White Ash #2, underlain by reddish brown claystone – a typical relation seen in the quadrangle. Baseball cap for scale.

View of two lithosome A units of the middle Tesuque formation (Ttam and Ttas1). Ttas1 is characterized by tabular, medium to thick beds of siltstone and silty very fine to fine sandstone that are moderately to well consolidated and a ledge-former. The white bed is the Skull Ridge White Ash #4. Photo taken along west side of Canada del Mogote by Sean D. Connell.



Close-up photo of Ttam/Ttas1 contact and the Skull Ridge White Ash #4 bed.



Close-up of the strata subjacent to the Skull Ridge White Ash #4 bed. Below ash are medium to thick, tabular beds of siltstone and very fine- to fine-grained sandstone. Near the top of the exposure, just underneath Quaternary gravel, is slightly redder Ttam.

Thick bed of Skull Ridge White Ash #4, underlain and overlain by siltstone and very fine- to fine-grained sandstone of lithosome A. The top of the Chimayo stratigraphic section is located on the other side of the small ridge at the extreme right of the photograph. Photo taken on the east side of the mouth of Arroyo de los Ajuelos.

A view of Skull Ridge White Ash #4 within lithosome B strata (mostly siltstone and very fine- to fine-grained sandstone beds, with 5-10% fine- to very coarse-grained channel-fill sandstone beds). Distinguishable tephras such as this one provide useful chronostratigraphic units. In the previous photo, located about 3 km to the east-northeast, this bed was within lithosome A strata of the distal alluvial slope. Thus, the boundary between the lithosome A alluvial slope and the lithosome B fluvial system lies between these two locations. On top of the Skull Ridge White Ash #4 bed in this photo is artificial fill.

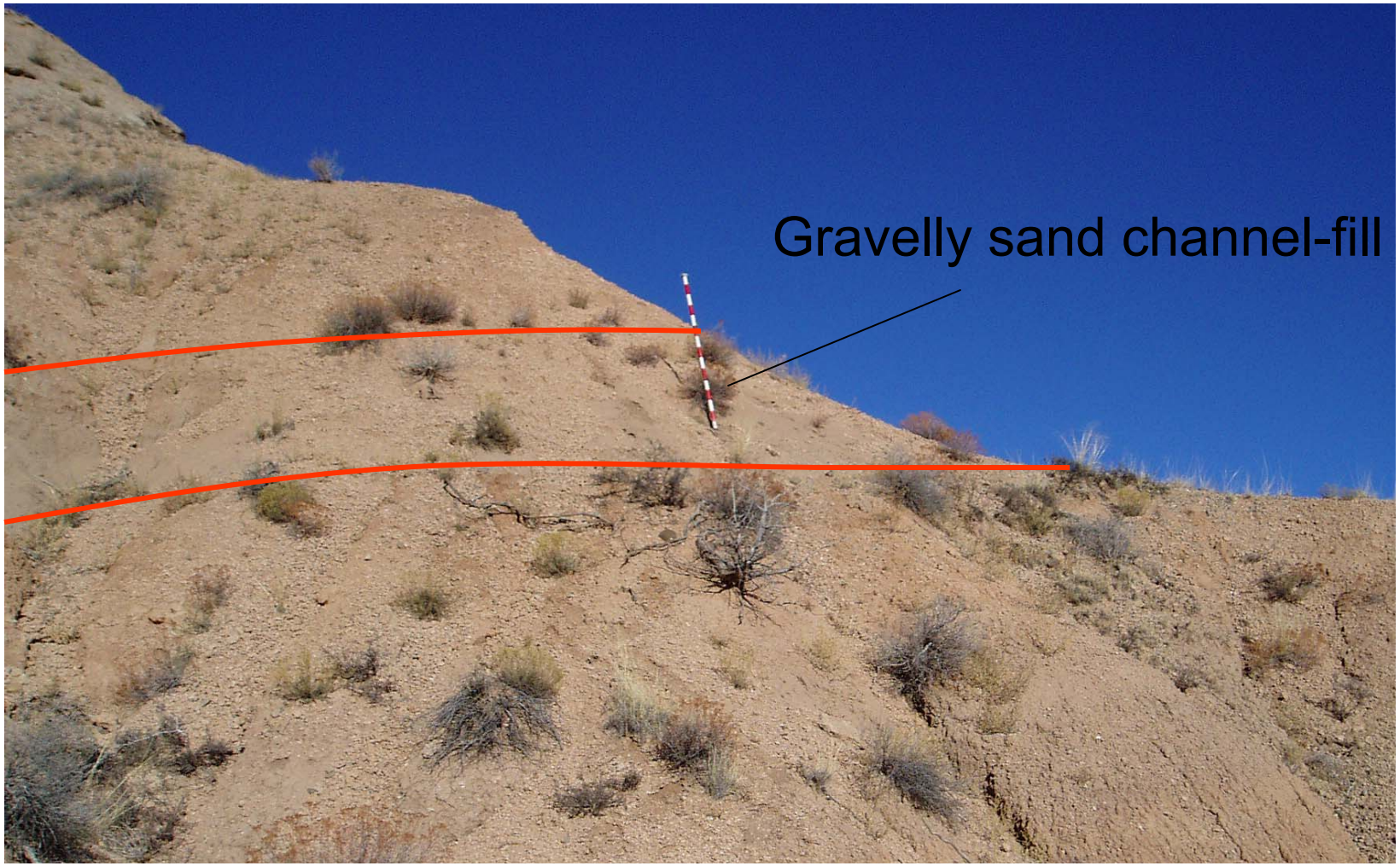
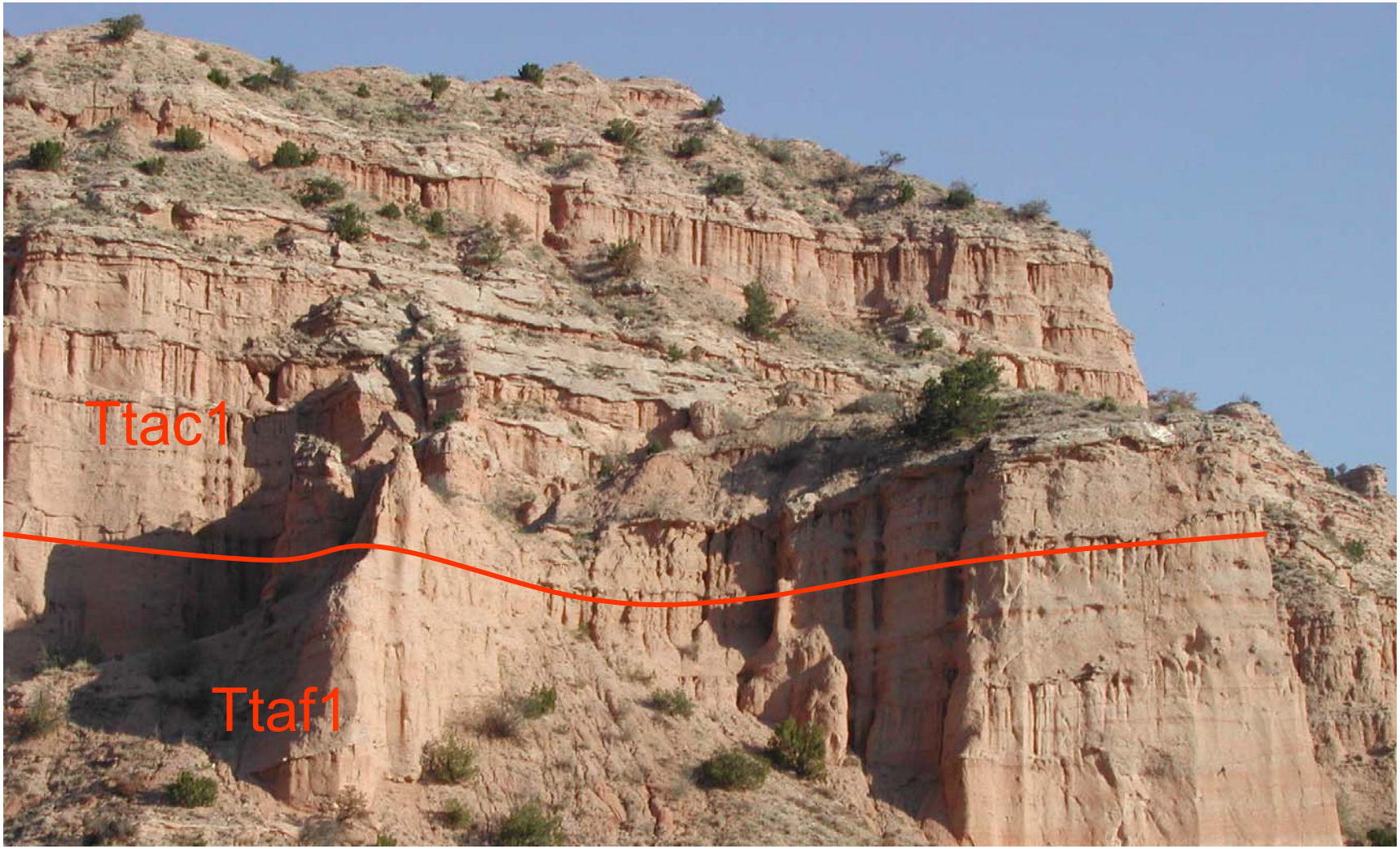


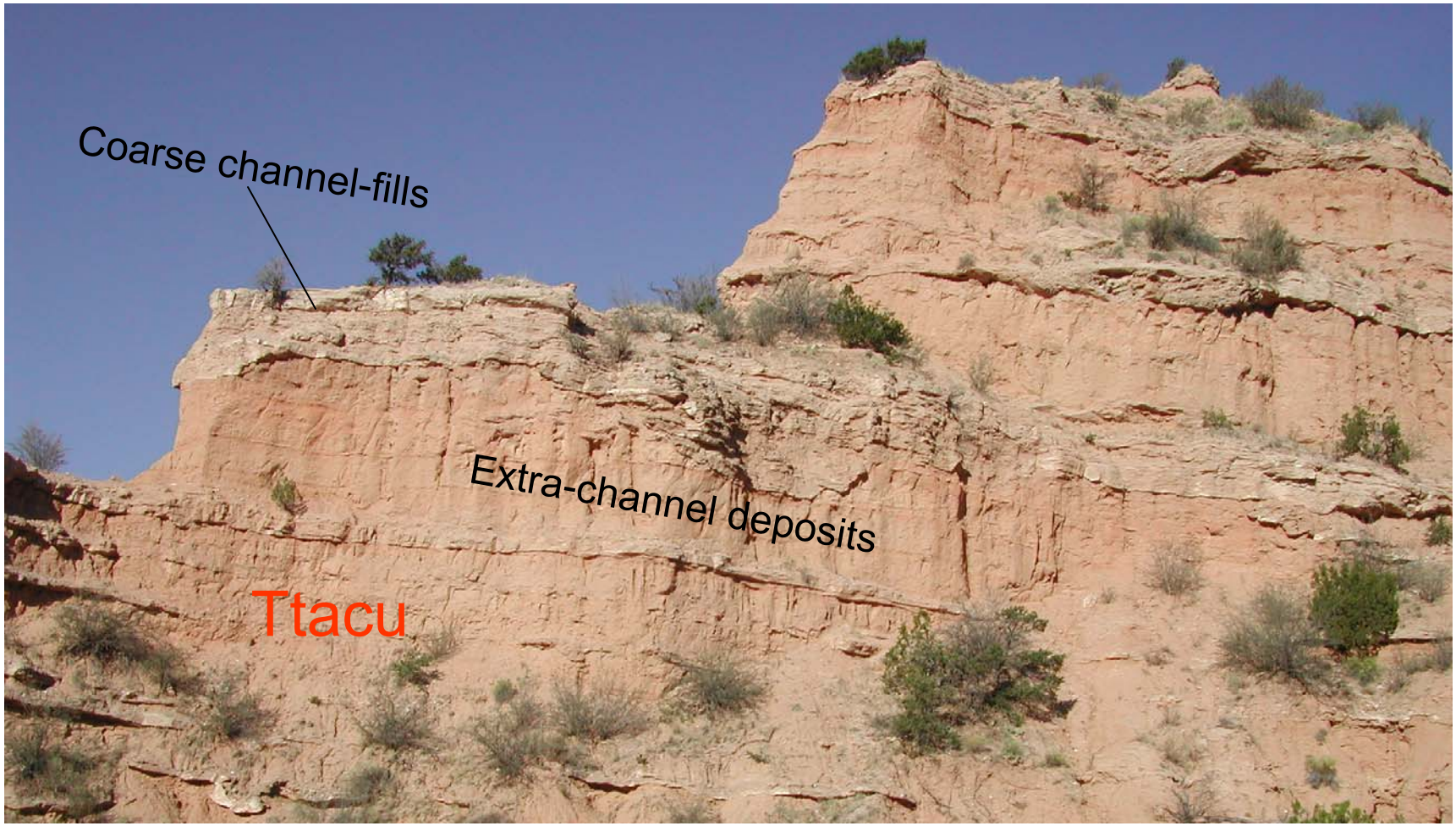
Photo of unit Ttbsr on the ridge immediately east of lower Arroyo de los Martinez. Lithosome B of the Skull Ridge Member mostly consists of siltstone, very fine- to fine-grained sandstone, and claystone floodplain deposits. Channel fills, such as the one labeled in the photo, are minor. The floodplain deposits have a light brown to grayish color. Staff is 1.5 m-tall.

Photo of the gray-colored and coarse-grained lower Cejita Member near the western quadrangle boundary. The Cejita Member contains abundant channel-fill deposits of sandstone and conglomerate, in which cross-stratification is common. Photo taken in Arroyo de Quarteles.

View of the lowest part of the upper coarse unit of lithosome A of the Tesuque Formation (unit Ttacu), where it gradationally overlies unit Ttafu. This part of Ttacu is characterized by having greater than 30% channel-fill deposits, many of which are strongly cemented. This cementation has resulted in the lowest part of the unit being a general clifff-former in the Santa Cruz escarpment. Photo taken by Sean D. Connell in Arroyo de los Ajuelos.



Close-up photo of the planar and conformable contact between units Ttac1 and Ttaf1.



Coarse channel-fills (commonly strongly cemented) and finer extra-channel deposits in unit Ttac1. Reddish horizons in the extra-channel sediment may be paleosols.

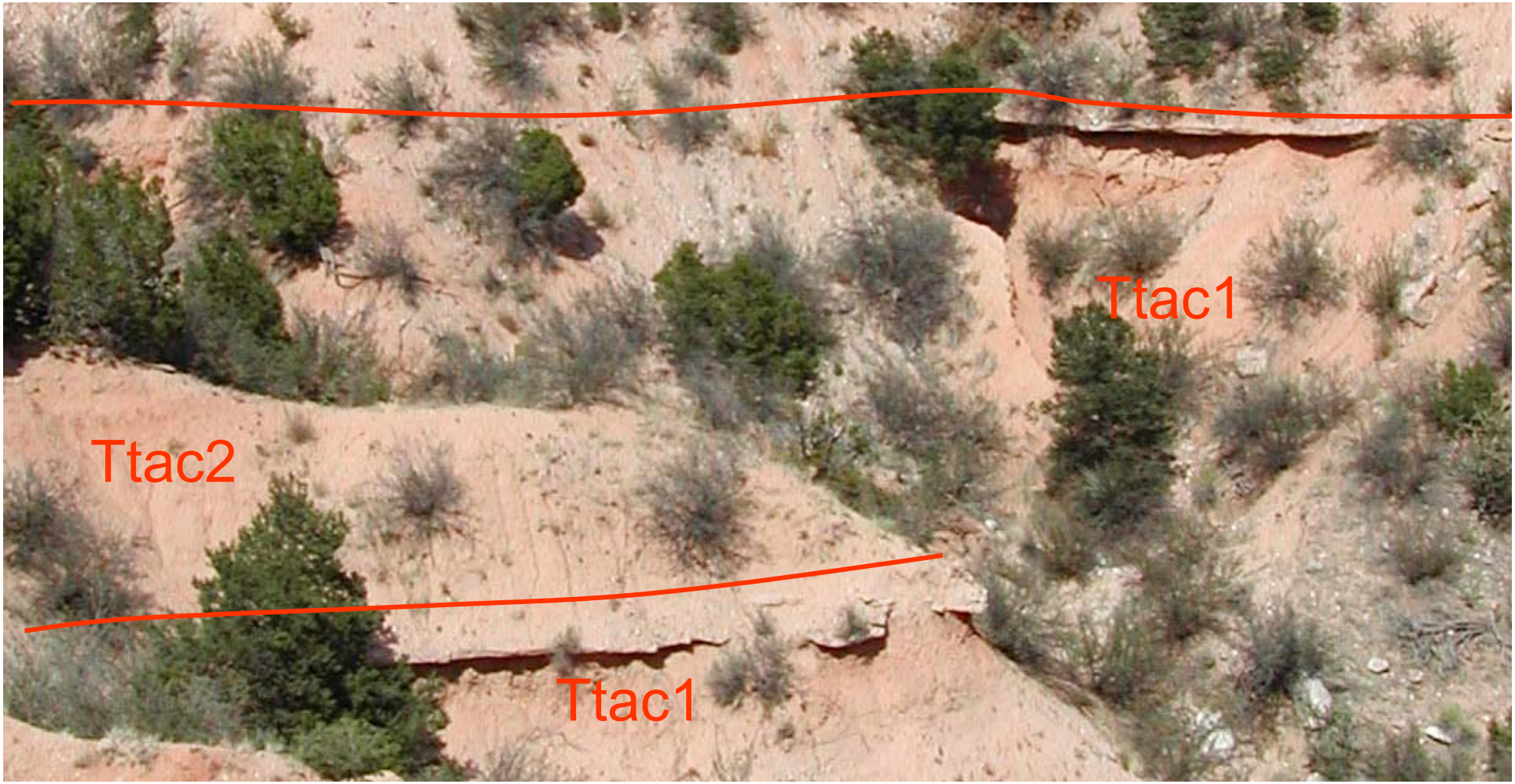
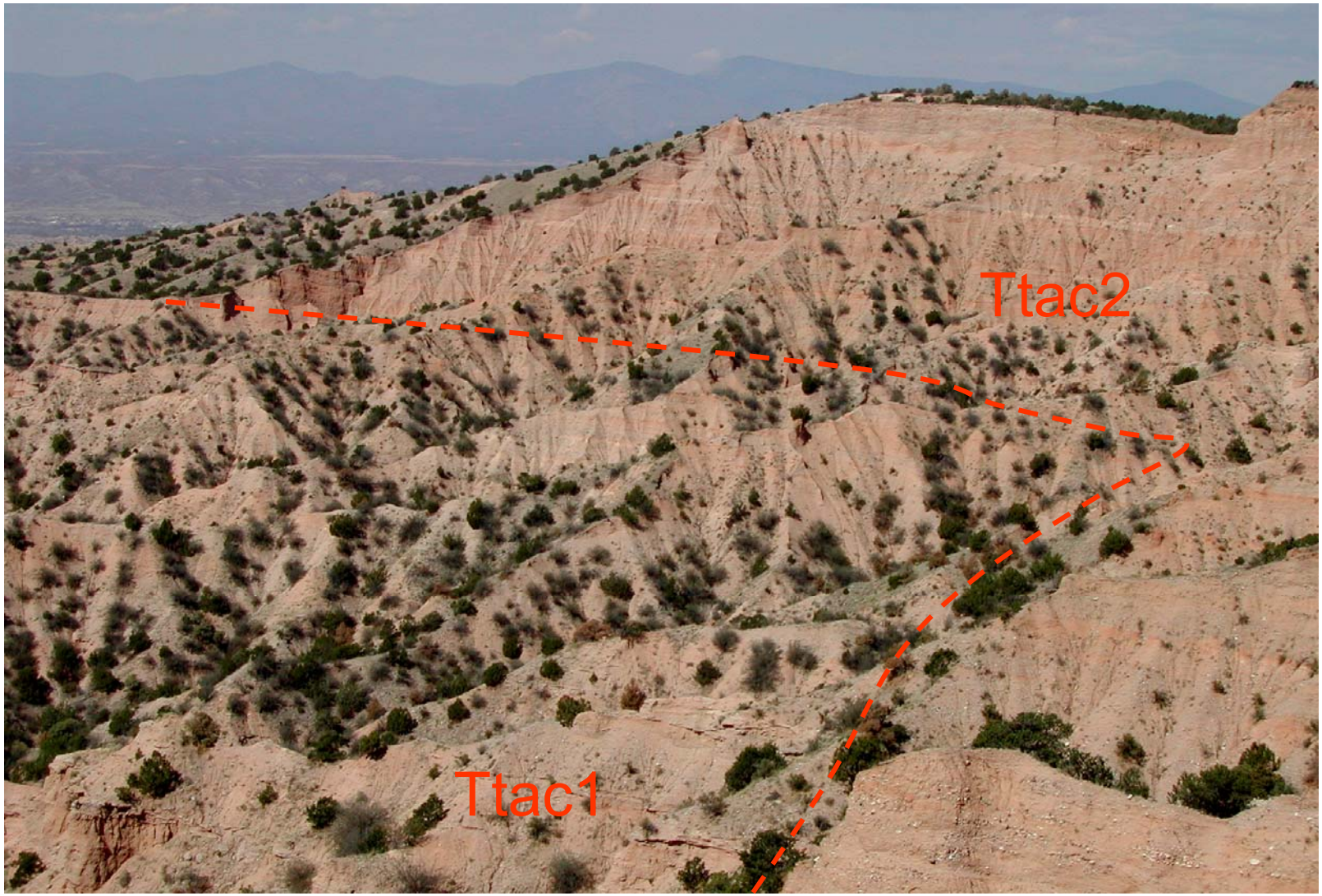


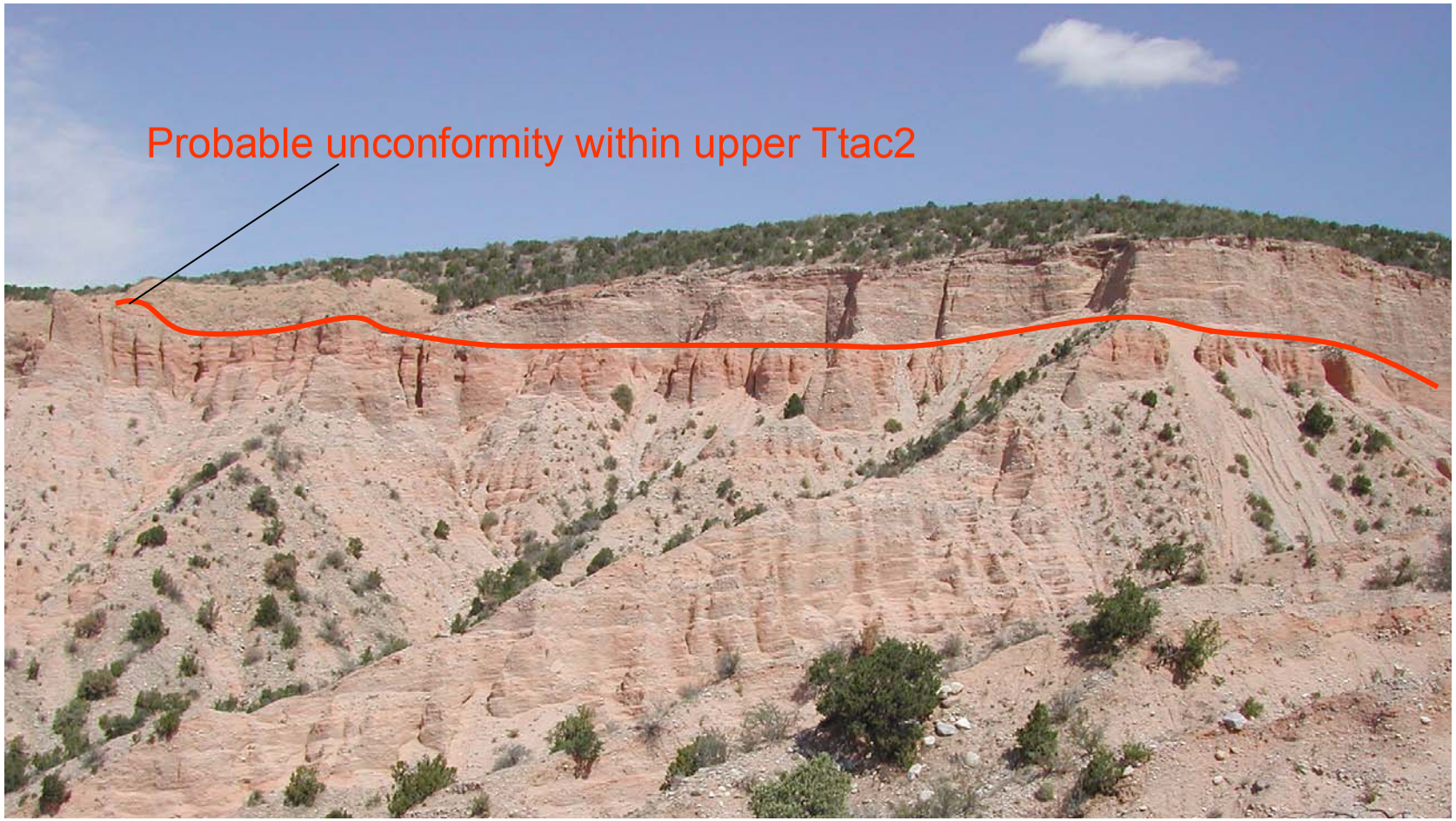
Photo of the Ttac2/Ttac1 contact. The contact is commonly gradational over about 30 m (100 ft), and the line is drawn at the top of this gradation. Note that texture and color does not change immediately across the contact. However, as one moves upward from the contact the Ttac2 unit becomes coarser because of the upward-coarsening trend of the Tesuque Formation. The key differentiation between the two units is the degree of cementation and consolidation. The main coarse white ash zone (12.0-12.8 Ma) extends across both Ttac1 and Ttac2, so the two are not separated by a significant hiatus (time gap). Photo taken by Sean D. Connell in upper Arroyo del los Ajuelos.

View to southwest from near the top of the Santa Cruz escarpment. The gravelly, non-consolidated Ttacun unit is in the foreground, and the Ttacu unit is in the back. Note the abundant strongly cemented channel-fills in the Ttac1 unit. Photo taken by Sean D. Connell near the head of Arroyo de los Ajuelos.

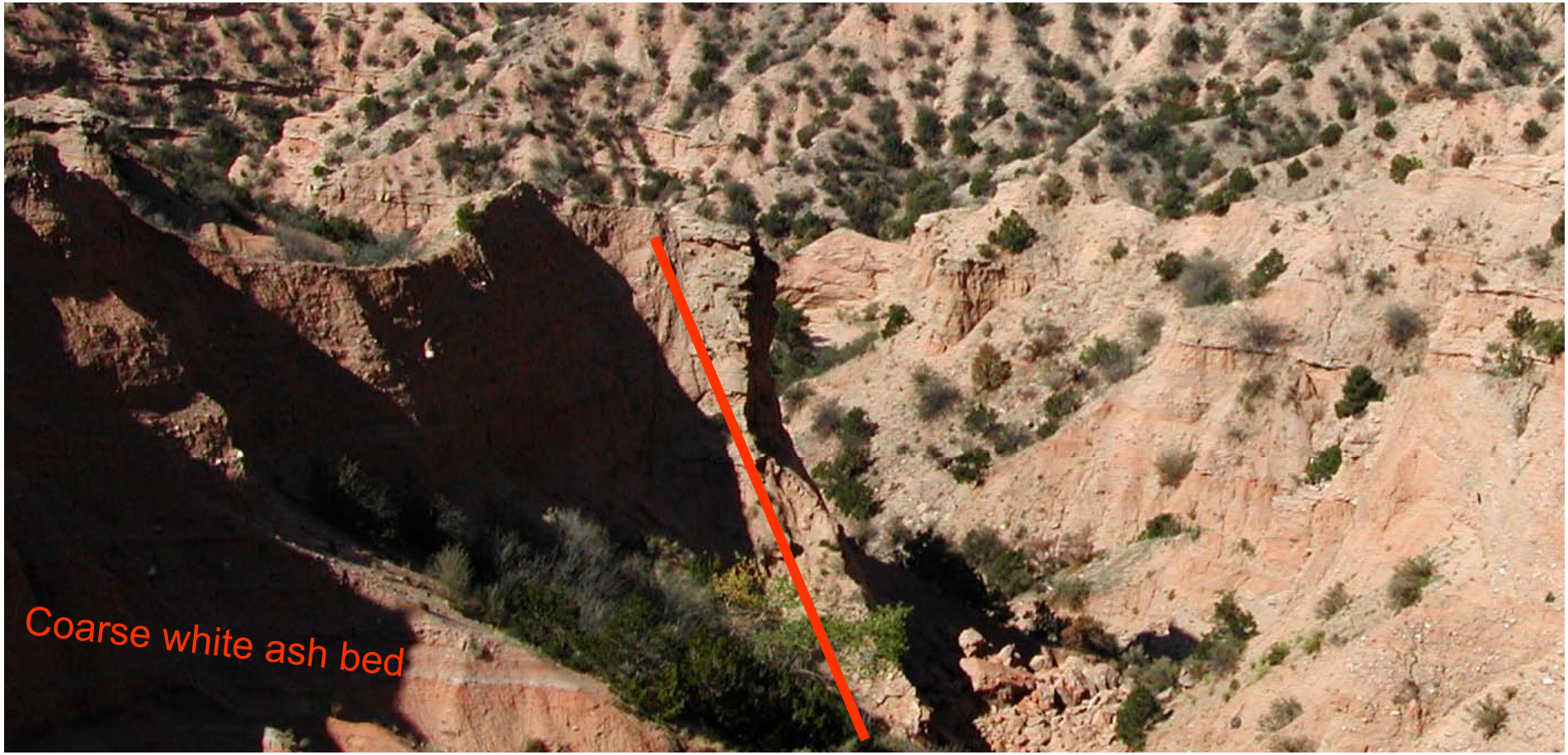


View of the upper Santa Cruz escarpment, where the non-consolidated and gravelly Ttac2 unit overlies the more consolidated and locally cemented Ttac1 unit. Photo taken by Sean D. Connell in upper Arroyo de los Ajuelos.

Close-up view of unit Ttac2. Note the coarse texture of the unit, a result of the progressive coarsening-upward trend of the Tesuque Formation. Photo taken by Sean Connell in upper Arroyo de los Ajuelos.



View of the non-cemented, coarse upper unit of lithosome A (Ttac2). This unit may span an appreciable amount of time (millions of years) because of the noticeable decrease in bedding dips observed at certain locailities, including this shot in upper Arroyo de los Ajuelos (photo by Sean D. Connell). There are likely unconformities (time gaps in deposition) in this unit, which cannot be extensively mapped at a scale of 1:24000. One such unconformity may be present between the upper reddish sand bed and the overlying sandy gravel.



East-down normal fault near the Ttac2/Ttac1 contact in upper Arroyo de los Ajuelos (shown by thick, red line). Photo taken by Sean D. Connell, and looks west. Faults such as these are important for groundwater studies because commonly there is local cementation on one or both sides of the fault. This cementation likely acts as a groundwater barrier to some degree. A coarse white ash bed is also labeled.

A thick bed of the main coarse white ash zone.