

NEW MEXICO BUREAU OF GEOLOGY AND MINERAL RESOURCES A RESEARCH DIVISION OF NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

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Correlation of Map Units



Explanation of Map Symbols

approximate

UD	02.11.02 Fault showing local up/down offset—U is on the upthrown block, and D is on the downthrown block.		01.01.15 Internal contact—Identity and existence are certain. Location concealed.
DU	02.11.03 Fault showing local up/down offset—U is on the upthrown block, and D is on the downthrown block.		01.02.01 Key bed—Identity and existence are certain. Location is accur
0	26.01.43 Well used for public-water		01.03.01 Dike (1st option)—Identity and existence are certain. Location accurate.
t	02.11.09 Inclined fault (2nd option)—Showing dip value and direction.		02.01.01 Fault (generic; vertical, subvertical, or high-angle; or unknow unspecified orientation or sense of slip)—Identity and existence are certain. Location is accurate.
I	02.11.10 Vertical or near-vertical fault (1st option)		02 01 02 Fault (comparing vartical subvartical or high angles or unknow
I	02.11.11 Vertical or near-vertical fault (2nd option)		unspecified orientation or sense of slip)—Identity and existence are certain. Location is approximate.
-	04.03.02 Small, minor inclined joint (1st option)—Showing strike and dip.	?	02.01.04 Fault (generic; vertical, subvertical, or high-angle; or unknow unspecified orientation or sense of slip)—Identity or existence are questionable. Location is approximate.
	05.10.05 Plunging fold—Large arrowhead shows direction of plunge.		02 01 07 Fault (generic: vertical subvertical or high-angle: or unknow
\oplus	06.01 Horizontal		unspecified orientation or sense of slip)—Identity and existence are certain. Location is concealed.
<u> </u>	06.02 Inclined bedding—Showing strike and dip.	?.	02.01.08 Fault (generic; vertical, subvertical, or high-angle; or unknow unspecified orientation or sense of slip)—Identity or existence are questionable. Location is concealed.
	06.03 Vertical bedding—Showing strike.		02.02.01 Normal fault—Identity and existence are certain. Location is accurate. Ball and bar on downthrown block.
-J	06.04 Overturned bedding—Showing strike and dip.	— <u> </u>	02.02.03 Normal fault—Identity and existence are certain. Location is approximate. Ball and bar on downthrown block.
	08.01.02 Inclined generic (origin not known or not specified) foliation—Showing strike and dip.	<u> </u>	02.05.09 Rotational or scissor fault, normal-slip offset—Identity and existence are certain. Location is accurate. Rectangles on upthrown blo
-	08.01.03 Vertical generic (origin not known or not specified) foliation—Showing strike.	<u> </u>	02.05.11 Rotational or scissor fault, normal-slip offset—Identity and existence are certain. Location is approximate. Rectangles on upthrow
	08.02.03 Inclined flow banding, lamination, layering, or foliation in igneous rock—Showing strike and dip.		block. 02.08.01 Thrust fault (1st option)—Identity and existence are certain.
1	12.06 Sediment transport direction determined from		Location is accurate. Sawteeth on upper (tectonically higher) plate.
8 	05.01.01 Anticline (1st option)—Identity and existence are certain.	— — — ·	02.08.03 Thrust fault (1st option)—Identity and existence are certain. Location is approximate. Sawteeth on upper (tectonically higher) plate
*	Location is accurate. 05.05.01 Syncline (1st option)—Identity and existence are certain. Location	— ↓ _?	02.08.04 Thrust fault (1st option)—Identity or existence are questional Location is approximate. Sawteeth on upper (tectonically higher) plate
Ť	is accurate.		02.10.09 Detachment fault (sense of slip unspecified) (2nd
t	05.07.17 Overturned syncline (1st option)—Identity and existence are certain. Location is accurate. Beds on one limb are overturned; arrows		upper plate.
	show dip direction of limbs.05.09.01 Monocline (1st option)—Identity and existence are certain.Location is accurate. Arrow shows direction of dip.	<u></u>	02.12.45 Scarp on thrust fault (1st option)—Identity and existence are certain. Location is accurate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp.
	19.03.06 Open pit or quarry(mapped to scale)	<u></u>	02.12.49 Scarp on thrust fault (2nd option)—Identity and existence are certain. Location is accurate. Sawteeth on upper (tectonically higher) plate. Hachures point downscarp.
	01.01.01 Contact—Identity and existence are certain. Location is accurate.		17.13 Head or main scarp of landslide—Inactive, subdued, indistinct, (or) location is approximate. Hachures point down scarp.
<u> </u>	01.01.03 Contact—Identity and existence are certain. Location is approximate.		17.15 Head or main scarp of rotated block in landslide—Arrow shows direction of oblique slip. Hachures point down scarp.
	01.01.07 Contact—Identity and existence are certain. Location is concealed.		31.08 Map
	01.01.09 Internal contact-Identity and existence are certain. Location is		

31.21 Sample locality – Showing sample number.

34°12'30"N Polvadera 34°10'0"N Puertedito del Lemito

This draft geologic map is preliminary and will undergo revision. It was produced from either scans of hand-drafted originals or from digitally drafted original maps and figures using a wide variety of software, and is currently in cartographic production. It is being distributed in this draft form as part of the bureau's Open-file map series (OFGM), due to high demand for current geologic map data in these areas where STATEMAP quadrangles are located, and it is the bureau's policy to disseminate geologic data to the public as soon as possible.

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After this map has undergone review, editing, and final cartographic production adhering to bureau map standards, it will be released in our Geologic Map (GM) series. This final version will receive a new GM



A geologic map displays information on the distribution, nature, orientation, and age relationships of rock

and deposits and the occurrence of structural features. Geologic and fault contacts are irregular surfaces

that form boundaries between different types or ages of units. Data depicted on this geologic quadrangle

map may be based on any of the following: reconnaissance field geologic mapping, compilation of

published and unpublished work, and photogeologic interpretation. Locations of contacts are not surveyed, but are plotted by interpretation of the position of a given contact onto a topographic base map;

therefore, the accuracy of contact locations depends on the scale of mapping and the interpretation of the

geologist(s). Any enlargement of this map could cause misunderstanding in the detail of mapping and may

result in erroneous interpretations. Site-specific conditions should be verified by detailed surface mapping

or subsurface exploration. Topographic and cultural changes may not be shown due to recent

Cross sections are constructed based upon the interpretations of the author made from geologic mapping

and available geophysical and subsurface (drillhole) data. Cross sections should be used as an aid to understanding the general geologic framework of the map area, and not be the sole source of information

The New Mexico Bureau of Geology and Mineral Resources created the Open-file Geologic Map Series to

expedite dissemination of these geologic maps and map data to the public as rapidly as possible while

allowing for map revision as geologists continued to work in map areas. Each map sheet carries the original date of publication below the map as well as the latest revision date in the upper right corner. In

for use in locating or designing wells, buildings, roads, or other man-made structures.

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number and will supercede this preliminary open-file geologic map.

development.

most cases, the original date of publication coincides with the date of the map product delivered to the National Cooperative Geologic Mapping Program (NCGMP) as part of New Mexico's STATEMAP agreement. While maps are produced, maintained, and updated in an ArcGIS geodatabase, at the time of the STATEMAP deliverable, each map goes through cartographic production and internal review prior to uploading to the Internet. Even if additional updates are carried out on the ArcGIS map data files, citations to these maps should reflect this original publication date and the original authors listed. The views and conclusions contained in these map documents are those of the authors and should not be interpreted as







01.01.11 Internal contact—Identity and existence are certain. Location is ernal contact—Identity and existence are certain. Location is y bed—Identity and existence are certain. Location is accurate. ike (1st option)—Identity and existence are certain. Location is

> ult (generic; vertical, subvertical, or high-angle; or unknown or l orientation or sense of slip)—Identity and existence are cation is accurate. ult (generic; vertical, subvertical, or high-angle; or unknown or l orientation or sense of slip)—Identity and existence are

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cation is concealed. ult (generic; vertical, subvertical, or high-angle; or unknown or l orientation or sense of slip)—Identity or existence are le. Location is concealed. ormal fault—Identity and existence are certain. Location is

Ball and bar on downthrown block. ormal fault—Identity and existence are certain. Location is te. Ball and bar on downthrown block. otational or scissor fault, normal-slip offset—Identity and re certain. Location is accurate. Rectangles on upthrown block. otational or scissor fault, normal-slip offset—Identity and re certain. Location is approximate. Rectangles on upthrown

nrust fault (1st option)—Identity and existence are certain. s accurate. Sawteeth on upper (tectonically higher) plate. nrust fault (1st option)—Identity and existence are certain. approximate. Sawteeth on upper (tectonically higher) plate. nrust fault (1st option)—Identity or existence are questionable. s approximate. Sawteeth on upper (tectonically higher) plate. tachment fault (sense of slip unspecified) (2nd lentity and existence are certain. Location is accurate. Boxes on

ures point downscarp. l or main scarp of landslide—Inactive, subdued, indistinct, and n is approximate. Hachures point down scarp. d or main scarp of rotated block in landslide—Arrow shows f oblique slip. Hachures point down scarp

unit – af – Artifical Fill – Mostly represents compacted fill as roadway subgrades along Interstate 25; also represents conveyance channel levees and railroad subgrade. Thickness 0–12 m.

unit–Qa–Active channels of Rio Grande–Sand, gravel and minor mud of historically active Rio Grande channels. Dotted contact shows margins of active channel in February, 1954; solid contact shows active channel in October, 1999. Thickness range: probably 0–9 m. unit–Qvyf–Younger valley fill, axial-fluvial facies–Floodplain deposits of Rio Grande; consists mostly of clay to sand. Grades to well sorted gravel at basal scour surface as much as 30 m below floodplain (McGrath and Hawley, 1987). Intertongues with Qvy and Qa. Thickness

0–30 m. unit–Qvy–Younger valley alluvium, piedmont facies–Active channel, low terrace and alluvial-fan deposits of tributary arroyos. Consists of poorly sorted, nonindurated, volcanic-rich gravel, sand, silt and clay. Associated with low graded surfaces formed during last major episode of valley entrenchment and backfilling. Thickness 0–30 m.

unit-Qe-Eolian deposits-Light gray, fine grained, well sorted, wind blown sand; commonly caps older alluvial and terrace surfaces east of Rio Grande. Occurrs as thin sheets and climbing dunes. Thickness range: 0–5 m.

unit-Qp-Fill of small closed basins-playas-Unconsolidated mud, silt and sand associated with delineated slide blocks near Polvadera Peak. Less than 10 m thick. unit–Qc–Colluvium and alluvium, undifferentiated–Talus,

colluvium and minor alluvium on steep to moderate slopes in the Lemitar Mountains. Also, gravelly slope wash on erosion surfaces cut in poorly consolidated upper Cenozoic deposits in Socorro Basin. Gravelly colluvium is typically shown where it masks ancestral Rio Grande deposits (QTsf). Colluvial veneers on dissected piedmont slopes in the Socorro Basin are generally not delineated. Usually 0.3-3 m. thick, locally as much as 10 m. thick.

unit-Qls-Landslide blocks-Slump blocks and toreva blocks on steep slopes north and south of Polvadera Mountain. Individual blocks are as much as 30 m thick.

unit-Qvo5-Older valley alluvium, piedmont facies, youngest-Inset terrace and terrace-fan deposits of tributary arroyos associated with five episodes of valley entrenchment and backfilling. From oldest to youngest, graded surfaces associated with these alluvial deposits project: 64–70 m (Qvo1), 43–52 m (Qvo2), 30–40 m (Qvo3), 15–21 m (Qvo4) and 6–9 m (Qvo5) above modern drainages and the Rio Grande floodplain. West of Rio Grande these deposits consist of poorly to moderately sorted bouldery to cobbly, volcanic-rich gravel, gravelly sand and muddy silts. East of the Rio Grande, terrace deposits contain abundant reddish sandstone clasts and gray limestone clasts derived from Permian formations. Generally reddish orange to reddish brown, locally light brown to tan in color. Mostly nonindurated, however, uppermost beds beneath graded surfaces are variably cemented by pedogenic carbonate horizons approximately 0.6 m to 0.1 m thick. Tentative correlation with Quaternary alluvial units in the San Acacia and Las Cruces areas (based on projected height above Rio Grande)

suggest these deposits range in age from about 250,000 years to 25,000 years old (Machette, 1978). Thickness 0–20 m, average thickness 6–9 m. unit–Qvo4–Older valley alluvium, piedmont facies, young–Inset terrace and terrace-fan deposits of tributary arroyos associated with five episodes of valley entrenchment and backfilling. From oldest to youngest, graded surfaces associated with these alluvial deposits project: 64–70 m (Qvo1), 43–52 m (Qvo2), 30–40 m (Qvo3), 15–21 m

(Qvo4) and 6-9 m (Qvo5) above modern drainages and the Rio Grande floodplain. West of Rio Grande these deposits consist of poorly to sand and muddy silts. East of the Rio Grande, terrace deposits contain abundant reddish sandstone clasts and gray limestone clasts derived from Permian formations. Generally reddish orange to reddish brown, locally light brown to tan in color. Mostly nonindurated, however, uppermost beds beneath graded surfaces are variably cemented by pedogenic carbonate horizons approximately 0.6 m to 0.1 m thick. Tentative correlation with Quaternary alluvial units in the San Acacia and Las Cruces areas (based on projected height above Rio Grande) suggest these deposits range in age from about 250,000 years to 25,000

years old (Machette, 1978). Thickness 0–20 m, average thickness 6–9 m. unit–Qvo3–Older valley alluvium, piedmont facies, medial–Inset terrace and terrace-fan deposits of tributary arroyos associated with five episodes of valley entrenchment and backfilling. From oldest to youngest, graded surfaces associated with these alluvial deposits project: 64–70 m (Qvo1), 43–52 m (Qvo2), 30–40 m (Qvo3), 15–21 m (Qvo4) and 6–9 m (Qvo5) above modern drainages and the Rio Grande floodplain. West of Rio Grande these deposits consist of poorly to moderately sorted, bouldery to cobbly, volcanic-rich gravel, gravely sand and muddy silts. East of the Rio Grande, terrace deposits contain abundant reddish sandstone clasts and gray limestone clasts derived from Permian formations. Generally reddish orange to reddish brown, locally light brown to tan in color. Mostly nonindurated, however, uppermost beds beneath graded surfaces are variably cemented by pedogenic carbonate horizons approximately 0.6 m to 0.1 m thick. Tentative correlation with Quaternary alluvial units in the San Acacia and Las Cruces areas (based on projected height above Rio Grande)

suggest these deposits range in age from about 250,000 years to 25,000 years old (Machette, 1978). Thickness 0-20 m, average thickness 6-9 m unit-Qvo2-Older valley alluvium, piedmont facies, old-Inset terrace and terrace-fan deposits of tributary arroyos associated with five episodes of valley entrenchment and backfilling. From oldest to youngest, graded surfaces associated with these alluvial deposits project: 64–70 m (Qvo1), 43–52 m (Qvo2), 30–40 m (Qvo3), 15–21 m (Qvo4) and 6-9 m (Qvo5) above modern drainages and the Rio Grande floodplain. West of Rio Grande these deposits consist of poorly to moderately sorted, bouldery to cobbly, volcanic-rich gravel, gravelly sand and muddy silts. East of the Rio Grande, terrace deposits contain abundant reddish sandstone clasts and gray limestone clasts derived from Permian formations. Generally reddish orange to reddish brown, locally light brown to tan in color. Mostly nonindurated, however, uppermost beds beneath graded surfaces are variably cemented by pedogenic carbonate horizons approximately 0.6 m to 0.1 m thick. Tentative correlation with Quaternary alluvial units in the San Acacia and Las Cruces areas (based on projected height above Rio Grande)

suggest these deposits range in age from about 250,000 years to 25,000 years old (Machette, 1978). Thickness 0–20 m, average thickness 6–9 m. unit-Qvo1-Older valley alluvium, piedmont facies, oldest - Inset terrace and terrace-fan deposits of tributary arroyos associated with five episodes of valley entrenchment and backfilling. From oldest to youngest, graded surfaces associated with these alluvial deposits project: 64–70 m (Qvo1), 43–52 m (Qvo2), 30–40 m (Qvo3), 15–21 m (Qvo4) and 6-9 m (Qvo5) above modern drainages and the Rio Grande floodplain. West of Rio Grande these deposits consist of poorly to moderately sorted, bouldery to cobbly, volcanic-rich gravel, gravely sand and muddy silts. East of the Rio Grande, terrace deposits contain abundant reddish sandstone clasts and gray limestone clasts derived from Permian formations. Generally reddish orange to reddish brown, locally light brown to tan in color. Mostly nonindurated, however, uppermost beds beneath graded surfaces are variably cemented by pedogenic carbonate horizons approximately 0.6 m to 0.1 m thick. Tentative correlation with Quaternary alluvial units in the San Acacia

and Las Cruces areas (based on projected height above Rio Grande) suggest these deposits range in age from about 250,000 years to 25,000 years old (Machette, 1978). Thickness 0-20 m, average thickness 6-9 m. unit-Qvof5-Older valley fill, fluvial facies and minor piedmont facies, younger-Complexly intertonguing axial-river deposits (older Rio Grande) and distal alluvial-fan deposits of tributary arroyos. Locally divided into older (Qvof2) and medial (Qvof3) and younger (Qvof5) units based on lateral continuity with older piedmont deposits (Qvo2, Qvo3, and Qvo5). Consists of light gray to light yellowish brown, well sorted, fluvial sands and gravels (transport to south),

interbedded with reddish orange, poorly sorted, sandy to cobbly, volcanic-rich gravels (transport to east), and red-silty mudstones. Well rounded to subrounded quartzite, granite and metamorphic rock pebbles are typical of the axial-river deposits. However, lenses of locally derived volcanic cobbles (reworked piedmont facies) are also present in axial-river deposits. Facies boundary with Qvo placed at approximate western limit of axial river beds that commonly overlie volcanic-rich piedmont-facies gravels or at topographic bluff line indicative of facies change. As much as 20 m thick. unit-Qvof3-Older valley fill, fluvial facies and minor piedmont

facies, medial-Complexly intertonguing axial-river deposits (older Ri Grande) and distal alluvial-fan deposits of tributary arroyos. Locally divided into older (Qvof2) and medial (Qvof3) and younger (Qvof5) units based on lateral continuity with older piedmont deposits (Qvo2 ,Qvo3, and Qvo5). Consists of light gray to light yellowish brown, well sorted, fluvial sands and gravels (transport to south), interbedded with reddish orange, poorly sorted, sandy to cobbly, volcanic-rich gravels (transport to east), and red-silty mudstones. Well rounded to subrounded quartzite, granite and metamorphic rock pebbles are typical of the axial-river deposits. However, lenses of locally derived volcanic cobbles (reworked piedmont facies) are also present in axialriver deposits. Facies boundary with Qvo placed at approximate western limit of axial river beds that commonly overlie volcanic-rich piedmont-facies gravels or at topographic bluff line indicative of facies

change. As much as 20 m thick.

Geologic Cross Section A–A'

Socorro Basin

unit-Qvof2-Older valley fill, fluvial facies and minor piedmont facies, older—Complexly intertonguing axial-river deposits (older Rio Grande) and distal alluvial-fan deposits of tributary arroyos. Locally divided into older (Qvof2) and medial (Qvof3) and younger (Qvof5) units based on lateral continuity with older piedmont deposits (Qvo2 ,Qvo3, and Qvo5). Consists of light gray to light yellowish brown, well sorted, fluvial sands and gravels (transport to south), interbedded with reddish orange, poorly sorted, sandy to cobbly, volcanic-rich gravels (transport to east), and red-silty mudstones. Well rounded to subrounded quartzite, granite and metamorphic rock pebbles are typical of the axial-river deposits. However, lenses of locally derived volcanic cobbles (reworked piedmont facies) are also present in axialriver deposits. Facies boundary with Qvo placed at approximate western limit of axial river beds that commonly overlie volcanic-rich piedmont-facies gravels or at topographic bluff line indicative of facies change. As much as 20 m thick.

unit—Qvou—Older valley alluvium, undifferentiated – Undifferenentiated older terrace and terrace-fan deposits; includes equivalents of Qvo1 to Qvo4. 0-20m thick. heading03-Sierra Ladrones Fm-Sierra Ladrones Formation-Latestage basin fill of the Rio Grande valley characterized by an axial-river facies (ancestral

unit-QTsf-Upper axial-fluvial facies – Axial river deposits of the ancestral Rio Grande, and minor intertonguing distal piedmont-slope deposits. Projected QTsf-QTsp facies boundary is largely concealed; it is placed near the mountainward limit of well sorted, light-gray to pale vellowish brown, quartz-rich river sands or pebbly gravels. Axial river sands and gravels are usually non indurated. Pebbly gravel lenses typically contain well-rounded to subrounded clasts of quartzite, chert, granite, metamorphic rocks, and various volcanic rocks (a few recycled from local piedmont facies). Lenses of rhyolitic pumice are also locally present. River sands often fine upwards into red or greenish gray, poorly indurated, mudstones that probably represent floodplain deposits or abandoned channel fills. Possibly 200-300 m thick near down faulted axis of Socorro Basin.

unit-QTst-Upper transitional facies, axial-fluvial to piedmont - Rio Grande) and intertonguing piedmont facies (alluvial-fan deposits) derived from adjacent mountain ranges. As mapped here, younger piedmont facies (QTsp, upper member) and older piedmont facies (Tslp, lower member) locally lie in angular unconformity on tilted Popotosa beds at the west margin of the basin. Also, the younger piedmont facies (QTsp) is locally inset against or unconformably overlies the older piedmont facies (Tsp). Maximum thickness of Sierra Ladrones Formation probably 300–400 m.

unit–QTse–Upper piedmont facies, east-derived –Conglomerates and sandstones derived from older sedimentary sources in highlands to the east of the Rio Grande. Conglomerates contain abundant clasts of sandstone and limestone of Permian affinity; volcanic clasts are relatively minor component. Occurs east of the Rio Grande.

unit–QTsp–Upper piedmont facies, west-derived – High level remnants of alluvial-fan deposits emanating from ancestral canyons of the Lemitar Mountains. Deposit from ancestral Canoncito del Lemitar (Corkscrew Canyon) near center of quadrangle is locally capped by remnants of Stage 3 calcic soil, tentatively correlated with the Las Canas surface of McGrath and Hawley, 1987. Consists of reddish orange to reddish brown, poorly consolidated, volcanic-rich, gravels and gravely sandstones with sparse to rare clasts of metasomatized lower Popotosa Formation (Tpr). West of the Socorro Canyon fault, the uppermost piedmont facies is about 6–12 m thick Deposits north and west of Polvadera represent alluvial-fan deposits of ancestral San Lorenzo Canyon and Arroyo del Puerticito. These volcanic-rich gravels also contain sparse clasts of red, jasperoidal cemented, lower Popotosa conglomerates (Tpd / Tpr), which distinguish them from older Popotosa conglomerates. The upper piedmont facies (QTsp) disconformably overlies lower Sierra Ladrones piedmont facies (Tsp) of similar composition near San Lorenzo canyon.

unit – Tsf – Lower fluvial facies – Light brownish gray to pinkish gray, siliceous sandstone and conglomeratic sandstone; contains abundant volcanic clasts with rare clasts of granite and quartzite (south of Canoncito del Lemitar). Fine- to coarse-grained sands, tabular to trough cross bedded, locally moderately indurated with calcite cement. Axes of trough cross beds indicate southerly paleoflow suggesting correlation with an incipient Rio Grande facies. Siliceous cross-bedded sandstones near San Lorenzo Canyon may represent a fluvial-fan deposit graded to an incipient Rio Grande. Similar sandstones are present in the lower Sierra Ladrones Formation at Arroyo Tio Lino (San Acacia quadrangle, Machette, 1978). As much as 200m thick. unit-Tso-Lower overbank facies-Reddish brown to light brown

poorly indurated, non-gypsiferous mudstones silt and minor sand; locally exposed south of Canoncito de Lemitar. In Socorro 7.5' Quad (near Nogal/Water Canyon), this fine-grained unit unconformably overlies locally east-tilted maroon gypsiferous mudstones of the Popotosa playa mudstone facies (Tpm) and an interbedded dacitic ash bed of late Miocene age (ca. 9.5 Ma; Chamberlin, 1999). Unit may be as much as 60 m thick. Tso appears to grade eastward and upward into quartzite-bearing older axial river deposits (Tsf) just west of the Socorro Canyon fault. unit-Tse-Lower piedmont facies, east-derived –Light brown to pale

reddish brown sandstones and minor conglomeratic sandstones of distal east- derived piedmont facies. Conglomeratic beds contain variety of moderately rounded volcanic clasts with minor component of granite and gneiss; pebble imbrications indicate southwesterly paleocurrent directions. Only exposed below the trachyandesite of San Acacia (Tas) in northeast part of quadrangle, also well exposed near San Acacia dam (Machette, 1998). Minimum exposed thickness is 40m. unit—Tsp—Lower piedmont facies, west-derived —Westerly derived (east transported) piedmont-slope deposits. Consists of poor to moderately indurated, light brown to pale reddish brown, conglomeratic sandstones and gravels with abundant locally derived volcanic clasts and sparse to rare dark red clasts of jasperoidal

(Tpr/Tpd). Rare clasts of limestone and gneiss are locally present in exposures near Canoncito del Lemitar; unit here probably contains internal unconformities, westerly dips decrease up section. Similar easttransported conglomeratic sandstones and gravels, with rare metasomatized Popotosa clasts, occur near San Lorenzo canyon, where they are moderately tilted and folded. Minimum exposed thickness is 240-300m.

cemented (potassium metasomatized) lower Popotosa Formation

unit-Tas-Trachyandesite of San Acacia -Medium gray to light brownish gray, phenocryst-poor, vuggy microvesicular (diktytaxitic), xenocrystic, trachyandesite lava flow. Contains sparse (1-2%) finegrained phenocrysts of plagioclase, greenish augite and very fine reddish brown iddingsite (after olivine?). Also contains traces of xenocrystic quartz, rimmed with clinopyroxene, and rare phenocrysts of coarse-grained hornblende. Microvesicles are commonly filled with yellowish brown zeolites or clay minerals. Erupted from north-trending fissure vent near San Acacia dam (Machette, 1978). Sample collected northeast of dam yeilds 40Ar/ 39Ar age of 4.87 ± 0.04 Ma (Table 1). Chemical analysis indicates trachyandesite composition with 61% SiO2. Appears to be interbedded in Sierra Ladrones Formation; overlies distal

piedmont facies (Tse, derived from east) near San Acacia dam, disconformably (?) overlapped by axial-river facies (QTsf) north of Bowling Green. Maximum thickness is 40 m; thins to south near original edge of flow at Bowling Green. heading03–Popotosa Fm–Popotosa Formation–Intermontane bolson fill deposits of early Rio Grande rift grabens and half grabens. Defined by Denny, 1940, and redefined by Machette, 1978. Can locally be

divided into lower red and upper buff conglomeratic piedmont facies (Tpr and Tpb). The 9.8-Ma basaltic trachyandesite of Kelly Ranch (Table 1) is stratigraphically younger than Tpr and contemporaneous with Tpb. The red conglomerates(Tpr) are potassium metasomatized and unusually well indurated with jasperoidal silica. Metasomatic adularia in the lower Popotosa near Socorro Canvon (15 km to south) vields a 40Ar/ 39Ar age of 7.4 ±0.1 Ma (Dunbar and Miggins 1996). Further north the lower Popotosa facies contain rhyolitic ash-fall beds deposited at 14.5 Ma (Cather, et al 1994; Table 1). Upper Popotosa Formation consists mostly of maroon gypsiferous mudstones assigned to the play facies (Tpm). Buff conglomeratic sandstones (Tpb) derived from the northwest locally intertongue with the playa facies. Undivided Popotosa Formation (Tp) is shown in cross section only. Probably as

much as 900–1500 m thick under western flank of Socorro Basin. unit—Tpm—Upper playa mudstone facies—Mostly red or maroon claystone with minor greenish claystone and thin bedded buff to light gray siltstones to fine-grained sandstones; locally well exposed south of Canoncito del Lemitar. Thin beds of gypsum and selenite veinlets are also widespread in this unit. Claystones are poorly indurated and commonly masked by colluvium (Qc) where they underlie gravelcapped Quaternary surfaces. Playa deposits are interbedded with and grade north-westward into buff conglomeratic sandstones (Tpb). Locally contains the basaltic trachyandesite of Kelly Ranch (Tbk). Minimum unfaulted thickness west of Kelly Ranch is 390 m; estimated maximum thickness is 750 m. unit—Tpl—Playa-lake deposits —Mudstone and subordinate

volcaniclastic sandstone. Mudstone is reddish brown and locally gypsiferous. unit—Tpt—Transitional distal piedmont-playa beds —Subequal reddish mudstone and volcaniclastic sandstone.

Qvo2 Qvof2 Qvo3

Description of Map Units

unit—Tp—Popotosa Formation, undivided —Intermontane bolson fill deposits of early Rio Grande rift grabens and half grabens. Defined by Denny, 1940, and redefined by Machette, 1978. Can locally be divided into lower red and upper buff conglomeratic piedmont facies (Tpr and Tpb). The 9.8-Ma basaltic trachyandesite of Kelly Ranch (Table 1) is stratigraphically younger than Tpr and contemporaneous with Tpb. The red conglomerates (Tpr) are potassium metasomatized and unusually well indurated with jasperoidal silica. Metasomatic adularia in the lower Popotosa near Socorro Canyon (15 km to south) yields a 40Ar/ 39Ar age of 7.4 ±0.1 Ma (Dunbar and Miggins 1996). Further north the lower Popotosa facies contain rhyolitic ash-fall beds deposited at 14.5 Ma (Cather, et al 1994; Table 1). Upper Popotosa Formation consists mostly of maroon gypsiferous mudstones assigned to the playa facies (Tpm). Buff conglomeratic sandstones (Tpb) derived from the northwest locally intertongue with the playa facies. Undivided

Popotosa Formation (Tp) is shown in cross section only. Probably as

much as 900–1500 m thick under western flank of Socorro Basin. unit-Tbk-Basalt Trachyandesite of Kelly Ranch-Medium gray to greenish gray basaltic trachyandesite lava, vesicular and amygdaloidal zones common at base and tops of flows. Contains sparse to moderately abundant (4-8%), fine to medium-grained (0.5-2 mm) phenocrysts of plagioclase, olivine (commonly altered to yellowish antigorite), and minor clinopyroxene. Small mafic xenoliths are rare. Multiple flow units (locally two stacked flows) is repeated in several fault blocks, south of Canoncito del Lemitar. Three samples from this unit yield a mean 40Ar/ 39Ar age of 9.77 ± 0.06 Ma (Table1). Chemical analyses indicate basaltic trachyandesite composition containing about 53% SiO2 (Chamberlin, 1980). Interbedded in upper Popotosa Formation, locally overlaps facies boundary between westerly derived distal-piedmont facies (Tpb) and playa-facies claystones (Tpm). Maximum thickness of stacked flows is 30 m. unit—Tpb—Buff conglomeratic sandstone facies, upper—Pale

brownish yellow (buff) conglomeratic sandstones and quartzofeldspathic sandstones. Characterized by sparse to moderately abundant subrounded clasts of hydrothermally altered crystal-poor rhyolites. Altered clasts are yellowish brown to gray and speckled with small dots of yellow brown goethite, probably after pyrite. Clast compositions and easterly paleocurrent observations suggest the facies represents a distal alluvial fan or braided channel deposit shed from the Magdalena area about 25 km to west. Unit intertongues with and grades upwards into thick playa facies section in area about 1 km south of Canoncito del Lemitar; estimated thickness here is about 420 m. Locally contains the basaltic trachyandesite of Kelly Ranch (Tbk).

unit-Tps-Piedmont deposits, distal sandstone-Sandstonedominated volcaniclastic piedmont deposits. Unit contains subordinate mudstone and pebbly sandstone; it represents a southwest-facing distal piedmont system. unit-Tpcs-Piedmont deposits, medial conglomeratic

sandstones—Subequal sandstone and conglomerate derived from Tertiary volcanic rocks; represents southwest-facing proximal piedmont system (derived from northeast). unit—Tpc—Piedmont deposits, proximal

conglomerates—Conglomerate and subordinate sandstone derived from Tertiary volcanic rocks to the northeast.; represents southwestfacing proximal piedmont system. Intraformational unconformity appears to occur at base of unit.

unit—Tpr—Basal red conglomerate facies, potassium metasomatized – Well indurated, medium reddish brown to dark red volcanic-rich conglomerates and debris flows. Clast compositions and imbrications generally indicate northerly transport. Eroded from fault blocks of underlying Luis Lopez Formation (andesite to rhyolite lavas) and regional tuffs (mostly Tsc and Tlu). Basal conglomerates were eroded from Miocene early rift fault blocks; an angular unconformity of 10–25 degrees is commonly evident at the base of the lower Popotosa Formation. Unit fills north-trending strike valleys in southern Lemitar Mountains. Monolithic colluvial breccias derived from subjacent volcanic units are common at the base of the lower Popotosa Formation. Dark red color and moderate to extreme degree of induration is derived from jasperoidal silica cement, which is associated with potassium metasomatism of late Miocene age (Dunbar et al, 1994; Dunbar and Miggins, 1996; Chamberlin and Eggleston, 1996). Reddened conglomerates locally appear to grade upwards into buff conglomeratic sandstones, but at other localities they appear to be disconformably overlain by buff conglomeratic sandstones. Thicknesses of wedgeshaped fills are highly variable, from 0–300 m.

unit—Tpd—Conglomeratic debris-flow deposits —Reddish brown, well indurated (potassium metasomatized?), bouldery debris-flow deposits and conglomerates. Clasts consist of locally derived (first cycle) Oligocene volcanic rocks. Basal monolithic conglomerates (locally mapped as Tpda) are derived from underlying basaltic andesite lavas

unit—Tpa—Basin-axis sandstones—Sandstone, mudstone, and minor pebbly sandstone deposited by northwest-flowing braided streams. Interfingers with piedmont deposits in the northwest part of the quadrangle. Thin rhyolitic ash fall near top of unit yields single-crystal sanidine 40Ar/39Ar age of 14.49 ± 0.08 Ma (Table 1). heading03–Mogollon-Datil volcanic field – Mogollon-Datil volcanic field—Mogollon-Datil volcanic field

unit-Tm-Mogollon Group-Oligocene volcanics undivided, in cross section only (30.0-27.3 Ma). subunit—Tsc—South Canyon Tuff—Partially to densely welded, light

gray to pale grayish red, phenocryst-poor to moderately phenocrystrich, pumiceous, high silica rhyolite ignimbrite. Medium grained (1–3 mm) phenocrysts of subequal quartz and sanidine, with traces of biotite and plagioclase; crystals progressively increase upwards from about 5% near partly welded base to as much as 25% near densely welded top (where preserved). Sanidine commonly shows blue chatoyancy (ie. moonstones). Partially welded, phenocryst-poor pumiceous basal zone is commonly about 30m thick and grades upwards into densely welded moderately crystal-rich zone. Generally lithic poor except near base; light gray pumice (1–5 cm) is moderately abundant (5-15%). Represents remnants of thin outflow sheet erupted from the Mount Withington caldera in the northern San Mateo Mountains (Ferguson, 1991). Mean 40Ar/39Ar age is 27.37 ± 0.07 Ma; magnetic polarity is reverse (McIntosh et al., 1991). Correlation here is based on lithology and relative stratigraphic position. Thickness ranges from 0-90 m.

subunit—Tl3—La Jara Peak basaltic andesite, upper—In eastern Lemitar Mountains, this unit is formed by a thick pile of thin autobrecciated basaltic andesite lava flows. In SE Lemitar mountains at least 35 individual flows are exposed, averaging about 3–6 m thick, with a total composite thickness of about 180m. Individual flows consist of medium gray to grayish red purple, massive to vesicular basaltic andesite lava; they are characterized by moderately abundant (5–10%) fine grained phenocrysts of olivine, which are almost always completely altered to reddish brown iddingsite. Phenocrystic plagioclase is usually absent or very rare. Upper flows are about 10 m thick and locally associated with bedded cinder deposits 2–5 m thick. Calcite commonly fills vesicles and fractures. Basal flow near Corkscrew Canyon is grayish black and appears to be a relatively mafic trachybasalt. The La Jara Peak Basaltic Andesite represents a widespread thick pile of alkaline basaltic lavas that accumulated on the SE margin of the Colorado Plateau in upper Oligocene time (Osburn and Chapin, 1983). The pile is locally divisible into tongues where thin ash-flow sheets are intercalated with the basaltic pile. Wedge-shaped prisms of basaltic lavas in Lemitar Mountains indicate they were erupted contemporaneously with early extension and domino-style block rotation in the Lemitar Mountains (Chamberlin 1983; Cather, et al., 1994). Tl3 is older than South Canyon Tuff and younger than Lemitar Tuff. Thickness of wedge-shaped prism ranges from 180-330 m. subunit-Tlu-Lemitar Tuff, Upper Member-Compositionally zoned (77–65 wt% SiO2), ignimbrite subdivided into a partially to densely welded, light gray, phenocryst-poor (5-15%), rhyolite lower member

(Tll), and densely welded, dark red, phenocryst-rich (30–45%), dacitic to rhyolitic upper member (Tlu). Comvetosi Si (202) lygrounder (62/subdivided into a partially to densely welded, light gray, phenocryst-poor (5-15%), rhyolite lower member (Tll), and densely welded, dark red, phenocryst-rich (30–45%), dacitic to rhyolitic upper member (Tlu). Lower member (maximum thickness = 40 m) wedges out onto paleotopographic highs. Contains sparse to abundant, medium-grained (1-4 mm) phenocrysts of quartz, sanidine, plagioclase (altered), and biotite with traces of augite and sphene. Lower third of upper member is relatively guartz poor (<5%) compared to upper two thirds, which is quartz rich (10–15%). Small (1–3 cm) phenocryst-poor pumice is moderately abundant (3-5%) in lower member. Sparse, phenocryst-rich pumice and small (<2 cm) grayish red "magma blobs" of dacite/andesite porphyry are typical in outflow of

the upper member. Represents thin outflow sheet erupted from a small

caldera in the west-central Magdalena Mountains (G. R. Osburn oral commun. 1997). Lemitar ignimbrite locally fills in early rift fault blocks in the Lemitar Mountains (Chamberlin, 1983). Mean 40Ar/39Ar age (bulk sanidine) is 28.00 ± 0.08 Ma; paleomagnetic polarity is normal (McIntosh and others, 1991). Correlation here based on distinctive lithology and stratigraphic position. Thickness in wedge-shaped paleovalleys ranges from 0-90 m.

Rio Grande Qvol3 at at Ovy at 1.250 m above mea subunit—Tll—Lemitar Tuff, Lower Member—Lower member (maximum thickness = 40 m) wedges out onto paleotopographic highs. Contains sparse to abundant, medium-grained (1-4 mm) phenocrysts of quartz, sanidine, plagioclase (altered), and biotite with traces of augite and sphene. Lower third of upper member is relatively quartz poor (<5%) compared to upper two thirds, which is quartz rich (10–15%). Small (1–3 cm) phenocryst-poor pumice is moderately abundant (3–5%) in lower member. Sparse, phenocryst-rich pumice and small (<2 cm) grayish red "magma blobs" of dacite/andesite porphyry are typical in outflow of the upper member. Represents thin outflow sheet erupted from a small caldera in the west-central Magdalena Mountains (G. R. Osburn oral commun. 1997). Lemitar ignimbrite locally fills in early rift fault blocks in the Lemitar Mountains (Chamberlin, 1983). Mean 40Ar/39Ar age (bulk sanidine) is 28.00 ± 0.08 Ma ; paleomagnetic polarity is normal (McIntosh and others, 1991). Correlation here based on distinctive lithology and stratigraphic position. Thickness in wedgeshaped paleovalleys ranges from 0-90 m.

subunit—Tl2—La Jara Peak basaltic andesite, medial —Iddingsitebearing basaltic andesite lavas very similar to Tl3 in eastern Lemitar Mountains, but stratigraphically older. As many as 40 individual flows with aggregate thickness of about 150m are locally exposed in SE Lemitar Mountains. Occurs between Lemitar Tuff and Vicks Peak tuff; top approximately located by projection where overlying Lemitar Tuff locally pinches out. Thickness of wedge-shaped prisms range from 75-210m. subunit—Tv—Vicks Peak Tuff—Light gray to pale red, phenocryst

poor, densely welded rhyolite ignimbrite. Distinctive aspects include lithophysal zone near base and large pumice lapilli as much as 30 cm long near the top. Contains 1–5 percent phenocrysts of sanidine and sparse quartz. Thin outflow sheet erupted from the Nogal Canyon caldera in the southern San Mateo Mountains (Osburn and Chapin, 1983). Mean 40Ar/39Ar age is 28.56 ± 0.06 Ma; paleomagnetic polarity is reverse (McIntosh and others, 1991). Correlation here based on lithology and relative stratigraphic position. 0-75 m thick.

subunit-Tl1-La Jara Peak Andesite, lower-Medium gray to purplish gray, iddingsite-bearing basaltic andesite lava, similar to Tl3; locally represents two or three stacked flows. Wedges out southward against Oligocene transverse fault near Corkscrew Canyon. Thickness = 0-30m.

subunit—Tj—La Jencia Tuff—Light gray, pale red and grayish red, phenocryst poor, rhyolite ignimbrite, characterized by a thick medial zone of very densely welded rheomorphic (flow banded) ignimbrite. Flow-banded core grades to normal eutaxitic ignimbrite near base and top. Locally displays auto-intrusive relationships near probable Oligocene fault (low-angle fault) in SE Lemitar Mountains. Contains sparse (3–5%) phenocrysts of sanidine and quartz with traces of plagioclase and biotite. Represents thin outflow sheet erupted from the composite Sawmill Canyon-Magdalena caldera in the west-central and eastern Magdalena Mountains (Osburn and Chapin, 1983). Mean 40Ar/39Ar age is 28.85 ± 0.04 Ma; paleomagnetic polarity is reverse (McIntosh and others, 1991). Correlation here based on distinctive lithology and relative stratigraphic position. As much as 120 m thick in

eastern Lemitar Mountains

subunit—Tz—Middle tuffs of Luis Lopez Formation—Light brownish gray to light gray, poorly welded, pumiceous, lithic-rich, rhyolitic ignimbrites. Contain moderately abundant pumice (mostly aphyric), and sparse to moderately abundant small lithic fragments in crystalpoor rhyolitic matrix. Lithic fragments consist primarily of andesite porphyries and densely welded, crystal-rich, quartz-rich, Hells Mesa Tuff clasts; the latter tends to be more abundant in upper half of unit (upper cooling unit?). Rare crystals of sanidine and quartz in matrix in lower part are probably primary phenocrysts; sparse crystals of sanidine, quartz and biotite in upper part are mostly xenocrysts. lation were erunted from a small collapse structure partly exposed in the Northern Chupadera Mountains approximately 15 km south of the Lemitar Mountains (Chamberlin et al., in press). Samples from Chupadera Mountains yield mean single-crystal sanidine 40Ar/ 39Ar age of 30.04± 0.16 Ma (Table 1) Thickness approximately 15-30 m.

unit—Tib—Basaltic dike and sill—Medium to dark gray and greenish gray basaltic dike and sill in area south of central Corkscrew Canyon. Propylitically altered, fine-grained, intrusive contains abundant groundmass plagioclase, clinopyroxene and Fe, Ti-oxides with sparse small phenocrysts of olivine. Clinopyroxene and olivine are mostly altered to or replaced by calcite and antigorite. Narrow NW-striking dike cuts Sandia Formation and appears to feed thin sill in lower Madera Limestone. Lithology and attitude (gentle east dip of dike) suggest basalitc intrusion is temporally correlative with the La Jara Peak Basaltic Andesite.

unit—Tim—Biotite bearing altered mafic dikes—Mafic dikes in lowangle normal faults of Tertiary age cutting Proterozoic basement rocks and locally along Polvadera thrust fault (Atokan). Dark gray to brownish gray, fine-grained, biotite-rich dikes commonly weather with spheroidal habit. Contain abundant groundmass plagioclase, altered pyroxenes and FeTi-oxides, which suggest original basaltic composition. Polycrystalline silica commonly replaces small euhedral "phenocrysts" of olivine-like morphology. Apparent basaltic composition and occurrence in Tertiary low-angle normal faults (Chamberlin, 1983) suggests a late Oligocene or Miocene age. unit—Td—Datil Group—Oligocene-Eocene volcanic rocks undivided, in cross section only (38 -32.0 Ma).

subunit-Th-Hells Mesa Tuff-Reddish brown to purplish gray, densely welded, phenocryst-rich (40–50%), quartz-rich, rhyolite ignimbrite. Typically contains abundant medium grained (1–3 mm) phenocrysts of sanidine, plagioclase, quartz and minor biotite. Quartz is minor component (1-2%) only in thin basal zone. Mean 40Ar/ 39Ar age (bulk sanidine) is 32.06 ± 0.1 Ma; paleomagnetic polarity is reverse (McIntosh et al. 1991). Large volume ignimbrite (1200 km3) erupted from Socorro caldera (Chamberlin et al, in press: McIntosh et al., 1991). Correlation is based on distinctive lithology and relative stratigraphic position. Thickness range is 90-150 m.

subunit-Tg-Granite Mountain tuffs-Light gray to grayish red to light brownish gray, non-welded to densely welded, moderately pumiceous, phenocryst-rich, dacitic to rhyolitic ignimbrite. Contains abundant medium-grained phenocrysts (35-45%) of predominantly plagioclase (commonly replaced by adularia), with minor biotite, sanidine, altered hornblende and clinopyroxene (?), with traces of embayed quartz (<0.2%). Small lithics of andesitic composition are sparse to moderately abundant in thin zones; thin-bedded fall deposits locally occur near base. The absence of, or only trace amounts of phenocrystic quartz, distinguish the Tuff of Granite Mountain from the overlying quartz-rich Hells Mesa Tuff. Represents undated, small to moderate volume early ignimbrite sheet of Socorro-Magdalena region (Osburn and Chapin, 1983). Source area unknown, possibly erupted from small vent structure in Magdalena Mountains area that was later obliterated by Socorro caldera. Correlation based on lithology and relative stratigraphic position. 30-60m thick. subunit—Tr—Rockhouse Canyon tuff—Light gray to pinkish gray,

poorly welded, moderately pumiceous, phenocryst-poor, rhyolitic ignimbrite. Contains sparse, small phenocrysts of sanidine, plagioclase, biotite and traces of quartz. Lenticular thin outflow sheet fills shallow paleovalleys in upper Spears Formation. Locally exposed south of Polvadera Mountain and near Corkscrew Canyon. Source unknown; outflow sheet near Datil yields mean 40Ar/ 39Ar age of 34.42 ± 0.12 Ma, magnetic polarity is reverse (McIntosh et al. 1991). Correlation based on lithology and relative stratigraphic position. 0-20m thick.

subunit—Ts—Spears Formation of Datil Group—Grayish red, grayish

red purple, light brownish gray and light gray conglomerates, sandstones, siltstones and reddish mudstones derived from intermediate composition volcanic highlands, primarily to southwest of Lemitar Mountains. Subrounded to subangular dacite and andestite porphyry clasts range from boulders to pebbles; they are common in lenticular to tabular conglomeratic beds, usually 1-3m thick. Dacitic clasts are characterized by sparse to abundant phenocrysts of plagioclase, hornblende and biotite; andesitic clasts are typically plagioclase, pyroxene porphyries. Gray micritic limestone and red siltstone cobbles and pebbles are common in basal conglomerates (lowest 30m). Medium-grained pyroxene monzonite and dark gray, aphanitic basaltic andesite clasts occur sparsely in the upper half of the formation. Calcite and pinkish clays are dominant cements; chalcedonic quartz is relatively rare. Age range from K/Ar dates of volcanic clasts and interbedded tuffs is approximately 39-33 Ma (Osburn and Chapin, 1983). Thickness ranges from 120-330m; appears to thicken rapidly to north on downside of ENE-striking, high-angle fault exposed about 2 km south of Polvadera Mountain. Correlation based on lithology and relative stratigraphic position.

heading02-Laramide conglomerates - Conglomerates associated with the laramide uplift – Conglomerates associated with the laramide uplift

unit-Tb-Baca Formation-Grayish to reddish brown, limestone- and sandstone-clast conglomerates and conglomeratic sandstones. Trough and tabular bedded conglomerates appear to fill paleovalley cut in underlying Madera Limestone about 2 km south of Polvadera Mountain; also present near Corkscrew Canyon. 0-30m thick. Nonvolcanic character and position, at base of Eocene volcaniclastic sediments, implies correlation with Baca Formation.

unit—Pb—Bursum and Abo Formations, undivided—Gray, thin bedded micrites and pale reddish mudstones. Grades upwards into reddish brown to light gray conglomeratic sandstones and mudstones. Quartz and granite pebbles are abundant in the conglomeratic sandstones. Locally truncated by Eocene erosion surface associated with Laramide uplift. 0-60m thick. unit—*m—Madera Limestone—Mostly light- to medium-gray ledge and cliff forming micritic limestones interbedded with dark greenish

gray limy shales and minor sandy limestones. Nodular black chert is common in the micritic limestones. Cliff-forming limestones are medium to thick bedded and moderately fossiliferous (fusulinids, brachiopods, crinoids and corals). Maximum total thickness is 210 m, locally eroded to less than 60m below Eocene surface.

unit—*s—Sandia Formation—Dark gray to black, slope-forming carbonaceous shales with minor fossiliferous biomicrites and finegrained quartz arenites are dominant in the upper third. Lower 2/3 consists of ledge-and cliff-forming quartz arenites that are dark reddish brown to light gray, fine to coarse grained, massive to cross bedded, feldspathic to miaceous, and mostly medium to thick planar bedded. Arenites contain several 1–2 m thick interbeds of gray siltstone and limy mudstone. Upper contact with Madera Limestone is gradational and generally placed at break in slope to ledge and cliff-forming limestones. Quartz-pebble conglomerates locally occur in the medial Sandia just south of the Polvadera thrust fault (north of Corkscrew Canyon). The Sandia Formation is approximately 180m thick on southern lower plate of the Polvadera thrust; it is about 60m thick on the northern upper plate. Also, the Polvadera thrust does not appear to offset the overlying Madera Limestone. These observations indicate a

late Pennsylvanian (Atokan) age for the Polvadera thrust. unit—Mk—Kelly and Caloso Formation, undivided—Gray to buff, fineto coarse-grained bioclastic limestones of Kelly Formation paraconfomably overlie micritic limestones, shales and basal conglomeratic sandstones of the Caloso Formation. Kelly limestones locally contain red silty mudstones in cavernous pockets (paleokarst fills?) near the Polvadera thrust. Absent on upper plate of Polvadera thrust, where well exposed near Polvadera Mountain. 0-30m thick. unit–Oc–Carbonatite Dikes, Sills and Fennites–Brownish gray to

reddish brown, carbonate-rich dikes and sills, contain minor phenocrystic-like apatite, phlogopite and biotite. Xenoliths of wall rock are common. Found only in Proterozoic rocks. Phenocrystic biotite yields K/Ar date of 457 ± 16 Ma (McLemore, 1987), thus indicating an Ordovician age of intrusion.

unit-ZXmd-Mafic Dikes and Pods-Dark gray to greenish gray, finegrained intrusive rocks composed of green hornblende + plagioclase feldspar + magnetite. Found in all Proterozoic lithologies; discrete dikes are probably late Proterozoic in age (Z); mafic pods are probably older

unit—Xp—Pegmatititc Dikes—Coarse-grained dikes and irregular pods onsisting of potassium feldspar + quartz + muscovite with minor epidote. Pegmatites cut all Proterozoic rock units; they are most

abundant along northern margin of Polvadera granite. unit—Xbg—Biotite Granite—Fine- to medium-grained quartz monzonite to granite composed of quartz + potassium feldspar + plagioclase feldspar + biotite

unit—X—Proterozoic rocks undivided —Shown in cross section only.

unit—Xpg—Polvadera Granite—Medium-to coarse-grained granite consisting of quartz + plagioclase feldspar + potassium feldspar with minor amounts of biotite + hornblende + magnetite. Generally unfoliated. Narrow shear zones (0.5 - 1.0 m) display gradational granite. Lineation is generally absent Foliation also well developed along contact with mafic plutonic rocks.

unit—Xfg—Foliated Granite—Strongly foliated granite consisting of potassium feldspar + quartz + plagioclase feldspar + biotite. Foliation defined by aligned biotite grains, augen of K-feldspar porphyroclasts and quartz rods. U-Pb age from zircon is 1648 + 6 Ma (Bowring et al.,

unit—Xmp—Mafic Putonic Rocks—Mostly dark gray plutonic rocks ranging in composition from diorite and gabbro to quartz diorite and quartz gabbro. Mineral assemblage includes hornblende + plagioclase feldspar + quartz. Foliation is generally lacking although locally, well developed along contacts with Polvadera Granite complex. unit-Xccs-Corkscrew Canyon Metasediments - Interlayered arkose,

subarkose and quartzite. Contains small lenses of greenschist and pelitic schist. Relict cross bedding locally preserved, but also isoclinially folded in part; layering maybe transposed in some areas. Migmatitic zone present along northern boundary where adjacent to felsic and mafic igneous rocks. Metasedimentary unit near Corkscrew Canyon yielded a U-Pb age from zircon of 1659 ± 3 Ma (Bowring and others,

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