Post-santa Fe Group Units

stock reservoirs. Thickness 0-6m.

Probably less than 20 m thick.

Artificial fill (uppermost Holocene) — Compacted fill as roadway subgrades along U. S. Highway 60;also earthen dams at

Younger valley alluvium, piedmont facies (Holocene to uppermost Pleistocene) - Active channel, low terrace and

alluvial-fan deposits of tributary arroyos. Consists of poorly sorted, non-indurated, volcanic-rich gravel, sand, silt, and

clay. Associated with low graded surfaces formed during last major episode of valley entrenchment and backfilling.

Younger piedmont-slope alluvium (Holocene to upper Pleistocene)— Pebbly to sandy alluvial fan and arroyo-fill

deposits on piedmont slopes; includes thin veneers of eolian sand. Graded to the closed basin floor at La Jencia basin playa.

Playa lake deposits (Holocene to upper Pleistocene) — Unconsolidated mud, silt and sand in the playa lake depression of

the central La Jencia Basin. Depression probably formed by ongoing southwest tilt of the La Jencia Basin (tilted fault block)

Eolian deposits (Holocene to upper Pleistocene) — Light-gray to pale-red, fine-grained, well-sorted, wind-blown sand.

Colluvium and minor alluvium, undifferentiated (Holocene to middle Pleistocene) — Colluvium and talus on steep to

colluvium is typically shown where it masks playa deposits of the Popotosa Formation (Tpp). Widespread colluvial

veneers on dissected piedmont slopes near Sedillo Hill are generally not delineated. Includes minor alluvium on gentler

Landslide deposits and colluvium (upper to middle Pleistocene) — Slump blocks and toreva blocks (rotated blocks) of

indicates composition of slide blocks (Qlb= basaltic andesite, Qld= dacite/rhyodacite, Qlr= rhyolite). Slide blocks and

mudstones are mantled by abundant colluvium. Includes small mudflows and minor alluvium. Slide areas are generally

inactive at present. Widespread around Strawberry Peak, Sedillo Hill and western Socorro Mountains. Characterized by

Fill of small playas in landslide terrane (Holocene to middle Pleistocene) — Unconsolidated mud, silt and sand in small

Older valley alluvium, piedmont facies (upper to middle Pleistocene) — Inset terrace and alluvial-fan deposits of

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 the modern floodplain of the Rio Grande in the Socorro 7.5' Quadrangle (Chamberlin, 1999). The

height of alluvial surfaces above modern drainages progressively decreases upslope into the Water Canyon quadrangle.

The top of **Qvo1** stands about 15-18m above the floor of Sixmile Canyon. Large alluvial fans from South Canyon and Water

Canyon are graded to a higher base level (Nogal Canyon box) than Sixmile Canyon. Consists of poorly to moderately

sorted, bouldery to cobbly, volcanic-rich gravel, gravelly sand and muddy silts. 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 (c) approximately 0.6 m to 0.1 m thick. Correlation with alluvial units

in Socorro Quadrangle is based on lateral continuity along Socorro Canyon and Sixmile Canyon drainages. Tentative

correlation with Quaternary alluvial units in the San Acacia and Las Cruces areas (based on projected height above Rio

Grande and level of soil development) suggest these deposits range in age from middle to late Pleistocene (250,000 years to

Older piedmont-slope alluvium (middle Pleistocene)— Bouldery to sandy alluvial-fan deposits graded to the central

disconformably overlie thick piedmont deposits of the Sierra Ladrones Formation (QTsp) that are lithologically very

Sedillo Hill geomorphic surface of McGrath and Hawley, 1987 (lower Pleistocene) - Erosional remnants of

constructional alluvial fan surface preserved between the mouth of Sixmile Canyon and the top of Sedillo Hill. From 6500

o 6100 feet elevation (227 ft/mi) the surface projects eastward as a concave -upward slope that is continuous with the Las

Canas surface at 5200-5100 ft (166 ft/mi) as mapped in the Socorro quadrangle (Chamberlin, 1999). Surface represents maximum level of aggradation of late Cenozoic basin fill along the Rio Grande valley near Socorro. Defines top of Santa Fe

Group and Sierra Ladrones Formation where present. Characterized by a dark reddish brown clay-rich soil nearly 2 m

thick (Ustollic Paleargid; McGrath and Hawley, 1987). Correlation with Las Canas surface in Socorro quadrangle is based

on projection of graded surface and similar degree of soil development. In comparison, petrocalcic carbonate soils are

typical of the Las Canas surface, which occurs at significantly lower elevations than the Sedillo Hill surface. Sedillo Hill and

Las Canas surfaces are tentatively correlated with the lower La Mesa surface of the Las Cruces area, which has recently

Sierra Ladrones Formation, piedmont facies, upper (lower Pleistocene) – Pebbly to sandy alluvial-fan deposits,

arroyo-fill deposits and interbedded fine-grained eolian sands. Deposits were graded from southwestern Lemitar

Mountains to floor of La Jencia Basin prior to incision along San Lorenzo Arroyo and La Jencia Creek (early Pleistocene

time). Basal beds probably conformable on QTsp. Graded slopes indicate paleocurrent directions. Steeper slopes (~2) on

east flank of La Jencia Basin probably reflect about 1° westerly tilt in middle to late Pleistocene time. Includes thin veneers

QTsp Sierra Ladrones Formation, piedmont facies (lower Pleistocene to lower Pliocene) — Piedmont-slope deposits

consolidated, volcanic-rich, boulder to cobble conglomerates and conglomeratic sandstones and sandstones. Buried calcic

soil horizons (bc) are locally present. Maximum thickness of piedmont facies, estimated from cross section, is about 330 m.

Wedge-shaped unit thickens rapidly westward on hanging wall block of the La Jencia fault; approximately 9-12m thick on

Popotosa Formation, upper, conglomeratic sandstone facies (middle to upper Miocene) — Light-brownish gray to light

gray, heterolithic, conglomeratic sandstones, sandstones and minor mudstones. Characterized by wide variety of volcanic

pebbles and minor cobbles representing the entire middle Tertiary volcanic pile; locally contain minor non-volcanic clasts.

Conglomeratic beds near Strawberry Peak are usually well cemented by carbonate. Conglomerate beds are commonly

clast supported; low-angle trough crossbeds (cut and fill) and planar beds are common. Near Strawberry Peak, crystal-rich

and crystal-poor ignimbrite pebbles (Hells Mesa-type and La Jencia type) are relatively common (5-10%) as are vesicular

mafic lavas. Northeasterly to easterly paleocurrents and clast lithologies are consistent with a deeply dissected source

highland near Magdalena. Unit appears to occur stratigraphically below or interbedded with thick playa deposits (Tpp)

thickness west of Strawberry Peak is 120 m; may be as much as 600 m thick under Strawberry Peak. Unit thins and grades into playa deposits toward Socorro Peak. On Water Canyon Mesa, this unit consists of unconsolidated or poorly cemented

gravels, which also contain a wide variety of volcanic cobbles and pebbles. A distinctive "turkey track" (coarsely

porphyritic) andesite clast that occurs in these gravels implies a northeasterly paleocurrent direction. This turkey track

andesite is only exposed about 6 km to the southwest (south of North Baldy). Approximately 60-120 m thick on Water

Popotosa Formation, playa facies (upper Miocene) — Mostly red or maroon claystone with minor greenish claystone and

thin bedded buff to light gray siltstones to fine-grained sandstones. Gypsum and selenitic veinlets are widespread in this

unit. Claystones are poorly indurated and commonly masked by landslide deposits (Qls) and colluvium (Qca) where they

underlie steeper slopes on west flank of Socorro Peak. Playa deposits contain lavas and ash beds ranging from 9.8 to 7.8 Ma

(Chamberlin, 1999). The youngest known playa deposits locally underlie the east flank of Sedillo Hill, which is capped by

a basaltic trachyandesite lava flow dated at 6.88 ± 0.02 Ma (W. C. McIntosh and R.M Chamberlin, unpublished data).

Correlation Diagram

Maximum thickness estimated from geothermal boreholes north of Sedillo Hill (Chapin et al. 1978) and a cross section of

Sierra Ladrones Formation

Mogollon-Datil volcanism Intrusive Rocks

Volcanic Units in Popotosa Fm.

that contain upper Miocene rhyolite lavas (Tsr) and coeval ash beds in the western Socorro Mountains. Maximum exposed

below Sedillo Hill geomorphic surface of McGrath and Hawley, 1987. Consists of reddish orange to reddish brown, poorly

of upper Pleistocene eolian sands that are generally not shown. Exposed thickness less than 30 m.

bolson of La Jencia Basin. High-gradient fans emanate from Shakespeare, Garcia and Jordan canyons. Fan deposits

similar, since they have the same provenance. Basal unconformity not exposed; probably 3-10m thick.

tributary arroyos associated with five episodes of valley entrenchment and backfilling. From oldest to youngest, graded

lava (derived from **Tbsh**, **Tsrd**, **Tsd** and **Tsr**) have slipped down slope on underlying Popotosa playa deposits (**Tpp**). Suffix

Qe Small dune fields locally cap older surfaces at slope breaks east of the La Jencia playa and NE of larger arroyos. Thickness

Qca moderate slopes in the western Socorro Mountains, Lemitar Mountains and around Water Canyon Mesa. Gravelly

slopes and in narrow drainages. Usually 0.3 -3 m. thick, locally as much as 10 m. thick.

hummocky topography. Thickness of lava slide blocks is as much as 90 m.

25,000 years old; Machette, 1978). Thickness 0–12 m, average thickness 6–9 m.

been dated at 0.73-0.9 Ma (Mack and others, 1993).

footwall block of La Jencia fault near mouth of Sixmile Canyon.

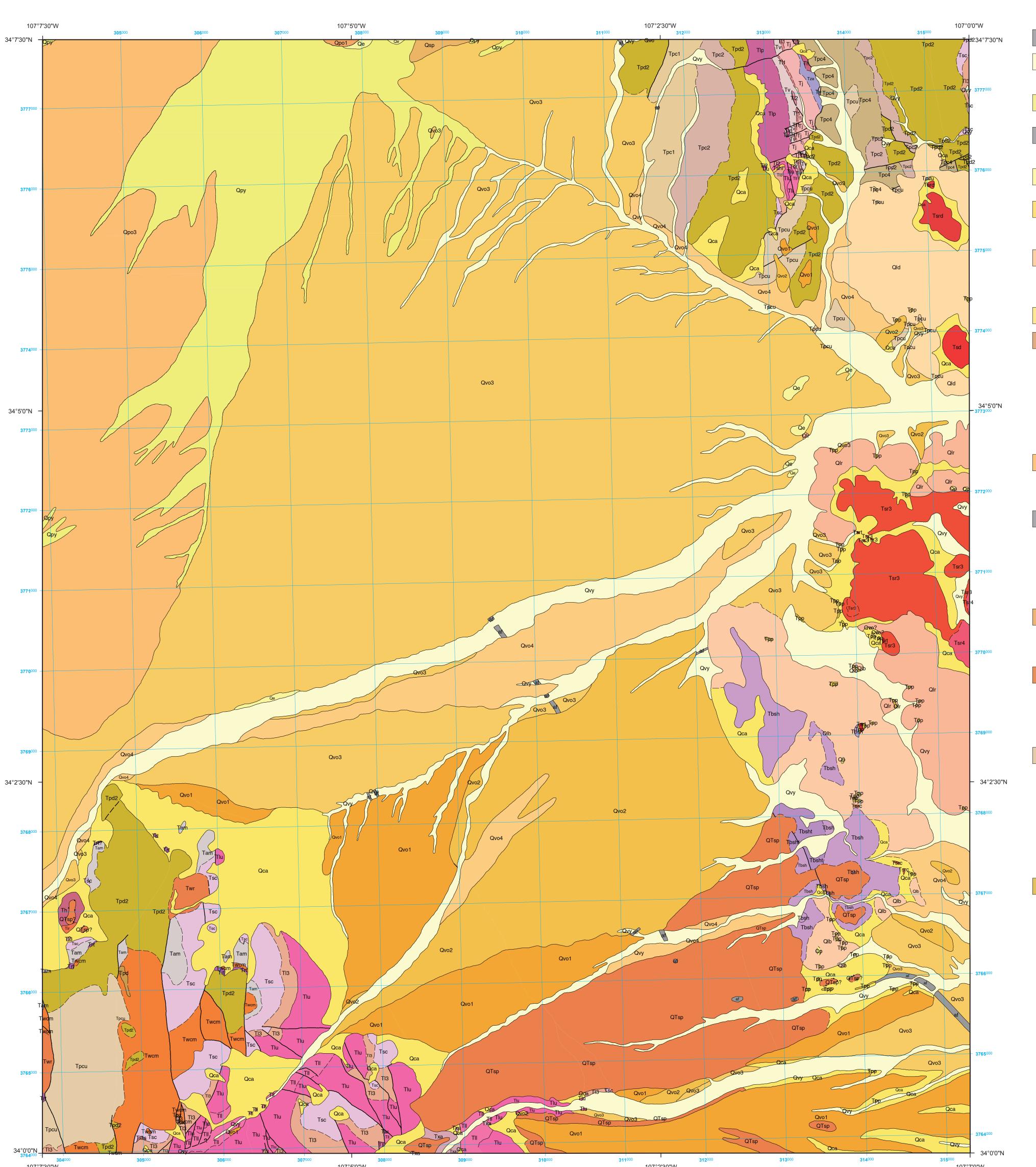
Lower Santa Fe Group

the western Socorro Mountains is 750 m.

Water Canyon Mesa

closed basins on upslope side of toreva blocks. Probably less than 10 m thick.

ombined with northeast progradation of the Water Canyon alluvial fan (Qvo3) in middle to late Pleistocene time.



COMMENTS TO MAP USERS

A geologic map displays information on the distribution, nature, orientation, and age relationships of rock and deposits and the occurrence of structural features. Geologic and fault contacts are irregular surfaces that form boundaries between different types or ages of units. Data depicted on this geologic quadrangle map may be based on any of the following: reconnaissance field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation. Locations of contacts are not surveyed, but are plotted by interpretation of the position of a given contact onto a topographic base map; therefore, the accuracy of contact locations depends on the scale of mapping and the interpretation of the geologist(s). Any enlargement of this map could cause misunderstanding in the detail of mapping and may result in erroneous interpretations. Site-specific conditions should be verified by detailed surface mapping or subsurface exploration. Topographic and cultural changes associated with recent development may not be shown.

Cross sections are constructed based upon the interpretations of the author made from geologic mapping, and available geophysical, and subsurface (drillhole) data. Cross-sections should be used as an aid to understanding the general geologic framework of the map area, and not be the sole source of information for use in locating or designing wells, buildings, roads, or other man-made structures.

The map has not been reviewed according to New Mexico Bureau of Geology and Mineral Resources standards. The contents of the report and map should not be considered final and complete until reviewed and published by the New Mexico Bureau of Geology and Mineral Resources. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the State of New Mexico, or the U.S. Government.

Map Unit Descriptions

- Popotosa Formation, lower, conglomerates and conglomeratic sandstone facies (lower to middle Miocene) Pale reddish gray, purplish gray, light gray and light brownish gray conglomerates and conglomeratic sandstones. Conglomerates are mostly clast supported and crudely bedded to planar bedded. Three distinct sub-units (overlapping fan lobes?) are recognized near San Lorenzo Spring (Chamberlin, 2004). The lowest unit consists of pale red to purplish gray, basaltic-andesite dominated conglomerates with sparse vein quartz and white felsite clasts (Tpc1). A medial sub-unit consists of pale red conglomerates that contain subequal South Canyon Tuff and basaltic andesite clasts (Tpc2). The highest unit is a light to medium brown boulder to pebble conglomerate containing dominantly South Canyon Tuff clasts with less abundant basaltic andesites and sparse flow-banded rhyolites (Tpc3). All these conglomerate sub-units underlie the 15.4-Ma Silver Creek Andesite. Another light brown conglomeratic sandstone unit (**Tpc4**) is similar to a mixture of **Tpc3** and Tpc1. Tpc4 occurs stratigraphically above the Silver Creek Andesite and appears to grade southwards into a stratigraphically higher **Tpc1** type conglomerate. Sub-units 0- 200 m thick. **Tpc3**, **Tpc4** and upper **Tpc1** are present in the Water Canyon quadrangle; lower **Tpc1** and **Tpc2** are absent in the Water Canyon quadrangle.
- Popotosa Formation, lower, debris-flow and conglomerate facies (lower to middle Miocene)— Mostly well indurated, medium reddish brown to dark red, volcanic-rich, matrix supported, debris flows, conglomerates and minor fluvial conglomeratic sandstones. Commonly well cemented by red jasperoidal silica, which is demonstrably associated with potassium metasomatism in the Socorro quadrangle (Chamberlin, 1999). Cobble sized clasts are common; boulder beds occur locally near the base. Locally divided into three overlapping sub-units based on the dominant type of volcanic clasts. Deposits dominated by gray, iddingsite-bearing La Jara Peak Basaltic Andesite clasts are designated Tpd1; deposits dominated by light-gray South Canyon Tuff clasts are designated Tpd2; and deposits dominated by andesite porphyry clasts (Tar-type) are designated **Tpd3**. **Tpd2** is present in the southern Lemitar Mountains; **Tpd1** and **Tpd3** are absent here. Sub-units grade laterally from one composition to another where facies boundaries are shown; debris-flow units also grade laterally into compositionally equivalent conglomerates. Units fill narrow north-trending fault-block depressions in the southern Lemitar Mountains; northerly paleocurrents are dominant here. Thickness of wedge-shaped fills is highly variable, from 0–300 m. An angular unconformity at base of **Tpd2** truncates a south facing monocline of late Oligocene age (Tlu-Tsc age) in the southwestern Lemitar Mountains. On Water Canyon Mesa, Tpd2 contains abundant clasts of South Canyon Tuff, basaltic andesites, Lemitar Tuff and porphyritic dacite (**Twcm**) consistent with a local provenance. Unit ranges from 0-150 m thick in the Water Canyon Mesa area. **Tpd2** and all underlying volcanic strata on Water Canyon Mesa are potassium metasomatized; the minimum age of potassium metasomatism on Water Canyon Mesa is 14.1 Ma.
- Popotosa Formation, basal colluvial breccias and debris-flow deposits (upper Oligocene? to lower Miocene?)— Coarse, blocky, volcanic-derived, monolithic and heterolithic breccias and matrix-supported conglomerates; commonly fill narrow ault-block basins of the early Rio Grande rift. Locally well exposed along the walls of South Canyon. Clast lithologies include angular fragments of South Canyon Tuff, Lemitar Tuff, and andesite (Tam) that are typically well cemented by red jasperoidal silica. Breccias and conglomerates are 10-30m thick near South Canyon. Breccias and overlying dacitic lava (Twd) appear to fill a NE-trending, 50-100 meter deep, paleovalley that cuts across north-trending fault blocks on the north
- Popotosa Formation, undivided (lower to middle Miocene)— Poorly exposed volcanic-rich conglomerates and conglomeratic sandstones on the west flank of Lemitar Mountains. Rounded hills west of the Lemitar Mountains are generally mantled with colluvial soils that contain abundant volcanic cobbles and pebbles. Volcanic Strata Within The Popotosa Formation
- Note: except where indicated, stratigraphic nomenclature is from Osburn and Chapin, 1983.
- Basaltic andesite of Sedillo Hill (formerly the Basalt of Sedillio Hill of Osburn and Chapin, 1983) (upper Miocene)— Medium gray, massive to vesicular, xenocrystic basaltic trachyandesite lava flows. Locally erupted from a NNE-trending issure vent or plug about 2.5 km NE of Sedillo Hill Reservoir (UTM: 0313700 E, 3767600 N). A mixed magma origin is indicated by sparse fine-grained iddingsite (after olivine) in a matrix of plagioclase microlites and interstitial clinopyroxene (trachybasalt magmatic suite) and moderately abundant (3-5%) xenocrysts of plagioclase, sanidine, biotite, hornblende and quartz (rhyolitic magma suite) that commonly exhibit magmatic reaction rims of very fine clinopyroxene. Small rhyolitic/granitic xenoliths are also present. Maximum thickness near vent is 33m; distal flow at north end of Sedillo Hill is about 5m thick. Subtle flow foliations visible in the canyon walls are locally contorted and folded; flow fold axes trend ENE. Basaltic cinder beds (Tbsht), preserved west of the vent, are as much as 100m thick. Unit conformably caps thick playa sequence of the upper Popotosa Formation and is disconformably overlain by piedmont facies of the Sierra Ladrones Formation. Samples from the basaltic trachyandesite of Sedillo Hill (n = 4) yield a tightly clustered mean 40Ar/39Ar age of 6.88 ± 0.02 Ma from groundmass separates (W. C. McIntosh and R.M Chamberlin, unpublished data).
- Socorro Peak Rhyolite: cluster of Late Miocene silicic lava domes centered near Socorro Peak (Osburn and Chapin, 1983) — Individual lava domes range in composition from hornblende dacite (69–70% SiO2) to hornblende-biotite hyodacite (70–73% SiO2) to high silica-rhyolite (75–77% SiO2); compositional data from Bobrow, 1983. Dacitic domes are stratigraphically the oldest, rhyodacites are slightly younger, and rhyolites are associated with 4 younger eruptive centers. The more southerly eruptive centers for dacites and rhyolites appear to be the most siliceous. Pumiceous ash beds and bedded tuffs of dacitic to rhyolitic composition are locally mapped as tephra facies (t) of the Socorro Peak rhyolitic that are interbedded in the Popotosa Formation. Tuffs, lavas and associated shallow intrusions (Tid, Tir) are informally subdivided into three members: 1) early dacites (~9.6 Ma), 2) medial rhyodacites (~9.5 Ma), and 3) rhyolites of 4 different eruptive centers ranging in age from 8.8 to 7.0 Ma. Only the two younger rhyolites are present in the Water Canyon quadrangle.
- Socorro Peak Rhyolite, Rhyolite of "Tripod Peak" member (upper Miocene)— Light gray, light brownish gray, and pinkish gray, moderately phenocryst rich (~15%), flow banded, low-silica rhyolite (72–73% SiO2; Bobrow, 1983). Contains noderately abundant fine to medium-grained phenocrysts of plagioclase, sanidine and biotite with minor quartz. Tripod Peak lavas are petrographically similar to slightly older lavas from the "Jejenes Hill" eruptive center (Tsr3). Basal flow boundary with the older rhyolite (Tsr3) is locally marked by breccia and ash zone that tends to form a recessive slope. Flow units of Tripod Peak center (Socorro quadrangle, Chamberlin, 1999) yield 40Ar/39Ar ages from sanidine of 7.02 ± 0.05 Ma and 7.06 ± 0.03 Ma (Newell, 1997). Rhyolitic surge deposits (Tsrt) and rhyolitic debris-flow conglomerates (Tsrc), locally exposed under the west dipping basaltic andesite of Sedillo Hill, are interpreted as pyroclastic and epiclastic facies from the
- Rhyolite of Socorro Peak, Rhyolite of "Jejenes Hill" member (upper Miocene) Light gray, light brownish gray and pinkish gray, moderately phenocryst-rich (~15%), flow banded, rhyolite lavas (low silica-rhyolite 71–73% SiO2; Bobrow, .983). Contains moderately abundant, fine- to medium-grained (0.5-2 mm) phenocrysts of plagioclase, sanidine and biotite with minor quartz (~1%). Lava domes at "Jejenes Hill" and unnamed hill to north (6542 ft elevation) represent local source vents. Includes moderately eroded lava flow in low rolling hills to east of "Jejenes Hill". Yields two analytically equivalent 40 Ar/39 Ar ages of 7.52 ± 0.09 and 7.45 ± 0.08 Ma from sanidine (Newell, 1997). Flow unit boundaries (margins) are locally marked by breccia and ash zones, which tend to form recessive slopes. Maximum thickness of "Jejenes Hill" lava dome is
- Socorro Peak Rhyolite, rhyodacite member at Strawberry Peak (upper Miocene) Mostly pale-red to light-gray rhyodacite porphyry lavas containing about 10 percent fine- to medium-grained phenocrysts of plagioclase with minor ornblende and biotite (subequal). Larger plagioclase phenocrysts are strongly resorbed and hornblende commonly shows a magmatic reaction to form biotite. The deeply eroded flow dome at Strawberry Peak appears to be compositionally zoned (69.8–71.1% SiO2) from dacite to low silica rhyolite (Bobrow, 1983); hence the compositional name is rhyodacite. Biotite from a slide block east of Strawberry Peak yielded a 40Ar39Ar age of 10.56 ± 0.11 Ma (Newell, 1997); however this date must be inaccurate because the rhyodacite at Strawberry Peak overlies the 9.77 Ma basaltic andesite of Kelly Ranch (Chamberlin, 1999). Biotite from the rhyodacite flow at Radar Peak has yielded an 40Ar/39Ar age of 9.51 ± 0.06 Ma, which appears to be in agreement with other dated units nearby (Chamberlin, 1999). The Strawberry Peak dome, as much as 220 m thick, was probably emplaced at about 9.5 Ma.
- **Socorro Peak Rhyolite, dacite member (upper Miocene)** Mostly medium-gray to reddish-brown dacitic porphyry lavas containing about 10 percent fine- to medium-grained phenocrysts of plagioclase and minor hornblende; biotite if present is are (<0.5%). Medium-grained plagioclase phenocrysts are strongly resorbed and distinctly less abundant than fine-grained plagioclase phenocrysts. "Smooth Dome" is at the north end of a NNW-trending intrusive belt of early dacite domes. The dacite at M Mountain has yielded an apparently spurious 40Ar/39Ar age of 11.56 ± 0.9 Ma from biotite (see Fig. 1). Dacite lavas in the Socorro Peak area are younger than the basalt of Kelly Ranch (9.77 Ma) and older than the rhyolite at Signal Flag Hill (8.66 Ma). They are tentatively estimated to be about 9.6 million years old (Chamberlin, 1999). Individual dacitic flows average about 60–120 m in thickness. Thickness range: 0–120 m.
- Rhyolitic tuffs of uncertain correlation (middle to upper Miocene) Thin-bedded fall-out tuffs and interbedded poorly welded ash-flow tuffs exposed on north flank of Water Canyon Mesa; buff to pale red. Rhyolitic composition indicated by parse, small phenocrysts of quartz and feldspar. May be correlative with pyroclastic phase of rhyolite intrusive domes on Water Canyon Mesa (Trw) or possibly with distal rhyolitic tuffs associated with the rhyolite of Pound Ranch. Thickness
- Rhyolite of Water Canyon Mesa (lower Miocene) Dense, pinkish gray to grayish red lava flows of rhyolitic to dacitic composition. Finely flow banded to weakly foliated lavas contain moderately abundant to abundant (15-40%) phenocrysts of plagioclase, biotite and hornblende. The absence of phenocrystic quartz suggests a dacitic composition. Most outcrops are potassium metasomatized, which is characterized by chalky altered plagioclase (replaced by clays and adularia) and oxidized hornblende. Appears to locally fill a NE-trending paleovalley about 100m deep on the north side of South Canyon. Angular clasts of older volcanic rocks that locally occur near marginal contacts may have been incorporated from the underlying breccias (**Tpx**). Ranges from zero to 180m thick. Phenocrystic biotite from basal vitrophyre has yielded a K/Ar age of 20.5 ± 0.8 Ma (Osburn and Chapin, 1983). Vitrophyric base, approximately 2m thick, is locally well exposed at the date locality on the north wall of south Canyon (Molino Peak quadrangle; 0304675/3763910)

EXPLANATION OF MAP SYMBOLS

Depositional contact, long dashed where approximately located, short dashed where inferred. Dip and dip direction (azimuth) shown where observed. Quaternary contacts are primarily based on air photo interpretation and most are approximately

located. They are generally shown as continuous lines to aid map legibility.

- Unconformity at topographic wall of Oligocene caldera (longer side of hachure toward center of caldera). Dashed where projected under colluvium.
- Rhyolitic ash beds; water-laid rhyolitic ash beds and thin ash-fall beds in the Popotosa Formation.
- Pedogenic carbonate zone or calcrete
 - Sedillo Hill geomorphic surface of McGrath and Hawley, 1987
- Fault trace, dashed where approximately located, dotted where projected under younger deposit. Ball and bar on downthrown side. Where concealed U= upthrown side, D= downthrown side. Short arrow indicates direction and angle of dip. Speartype arrow indicates bearing and plunge of striations or mullions on fault surface. Half-arrows indicate sense of lateral slip.
- Quaternary fault scarp in alluvium; double ticks on downthrown side
- Locus of aligned vegetation in alluvium (probable fault or tension fracture?)
- Minor displacement fault showing sense of offset and/or dip Approximate zero displacement point (o) on scissors fault
- Slump fault bounding rotated landslide block; also generally delineates margin of
- Anticlinal segment of the Socorro accomodation zone--SAZ (a transverse antithetic accomodation zone of the Rio Grande rift)
- Inferred intrusive axis along the Socorro accomodation zone.
- Strike, dip, and dip azimuth of sedimentary bedding, or compaction foliation in
- Inferred approximate location of volcanic vent, queried where more speculative
- Concentric flow-foliation pattern around vent structure of silicic lava dome; generalized from many individual point observations (Chamberlin, 1980)

Outflow Units in Southwestern Lemitar Mountains: South Canyon Tuff (upper Oligocene) — Partially to densely welded, light gray to pale grayish red, phenocryst-poor to moderately phenocryst-rich, 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 (i.e. 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 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;

Eocene-oligocene Volcanic Rocks Of Mogollon-datil Field

(Chamberlin 1983; Cather, et. al., 1994).

in SW Lemitar Mountains.

magnetic polarity is reverse (McIntosh et al., 1991). Correlation here is based on lithology and relative stratigraphic position. Thickness ranges from 0-90 m. La Jara Peak Basaltic Andesite, middle and upper tongues undifferentiated (upper Oligocene) — Basaltic andesite lavas equivalent to T12 and T13 in the southwestern Lemitar Mountains, where the Lemitar Tuff is missing. 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 divided into tongues where thin ash-flow sheets are intercalated with the basaltic pile. Wedge-shaped prisms of basaltic lavas in Lemitar Mountains indicate

Note: Oligocene tuffs in the Lemitar and Magdalena Mountains are commonly potassium metasomatized; phenocrystic

plagioclase is typically replaced by metasomatic adularia and clay minerals; sanidine and biotite are usually not altered.

Except where noted otherwise, stratigraphic nomenclature of Eocene-Oligocene volcanic rocks is from Osburn and Chapin,

La Jara Peak Basaltic Andesite, upper tongue (upper Oligocene) — Mostly medium gray- to purplish-gray, massive and platy to vesicular basaltic andesite lavas characterized by moderately abundant (5-10%) fine- to medium-grained phenocrysts of olivine, usually altered to reddish brown iddingsite. Phenocrystic plagioclase is typically absent. A black to medium gray olivine-bearing basalt is often present immediately above the Lemitar Tuff Thin flows (3-6m) commonly exhibit vesicular tops and reddish basal zones. Upper flows are locally interbedded with grayish to reddish brown, fine-grained sandstones that occasionally contain thin light-colored ash beds. Tl3 is older than South Canyon Tuff and younger than the Lemitar Tuff. Thickness of wedge-shaped prism usually ranges from 60-330 m. Locally includes minor andesitic conglomerates (T13s) at base of South Canyon Tuff (035000/3764170). Locally truncated by angular unconformity

they were erupted contemporaneously with early extension and domino-style block rotation in the Lemitar Mountains

- Lemitar Tuff; upper and lower members (upper Oligocene) 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, red to grayish red, phenocryst-rich (30–45%), dacitic to rhyolitic upper member (Tlu). 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 clots" of dacite/andesite porphyry are typical in outflow of the upper member. Basal vitrophyre often occurs where the lower member is absent. Represents outflow sheet erupted from the Hardy Ridge caldera in the west-central Magdalena Mountains (G. R. Osburn oral commun. 1997, Chamberlin et al, 2004). Lower member (< 40 m) and upper member (< 50 m) locally wedge out onto paleotopographic highs. Lemitar Tuff fills in tilted early rift fault blocks in the central Lemitar Mountains (Chamberlin, 1983). Mean 40Ar/39Ar age (bulk sanidine) is 28.00 ± 0.08 Ma; paleomagnetic polarity is normal (McIntosh and others, 1991). Locally preserved on down-warped southern side of south-facing monocline in southwestern Lemitar Mountains. Monocline represents pre-Lemitar uplift on the south followed by post Lemitar subsidence to the south (i.e. pre-caldera tumescence and post-caldera subsidence).
- Sandstone beds of the Hardy Ridge Formation (new name--upper Oligocene) Red rhyolitic sandstones derived from the underlying upper Lemitar Tuff. 0-10m thick. Lies well outside the Hardy Ridge caldera, but occupies same stratigraphic position as the thick fill of the Hardy Ridge caldera (Chamberlin et.al, 2004), which is here recognized as the redefined Hardy Ridge Formation of post Lemitar Tuff age (not post Hells Mesa Tuff age, as initially defined by Osburn and Chapin,
- La Jara Peak Basaltic Andesite, medial tongue (upper Oligocene) Mostly medium to dark gray and purplish gray, platy to vesicular, fine-grained basaltic andesite lavas generally characterized by sparse small reddish brown phenocrysts of 'iddingsite" Generally represents thin flows, stacked one on another, commonly with vesicular tops and reddish basal zones. Amygdaloidal calcite is common in vesicular zones. Occurs between Lemitar Tuff and Vicks Peak Tuff. Anomalously thin interval (~10m) on south-facing monocline in SW Lemitar Mountains implies pre-Lemitar uplift here.
- Vicks Peak Tuff (upper Oligocene)— Cliff-forming, brown to light brownish gray and light gray, phenocryst poor, pumiceous, densely welded rhyolite ignimbrite. Distinctive aspects include craggy cliff-forming character, pervasive well developed compaction foliation, and large "sandy" (vapor phase) pumice lapilli as much as 30 cm long. Contains 1–5 percent phenocrysts of sanidine and sparse quartz. Represents 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). 60-75 m thick.
- La Jara Peak Basaltic Andesite, lower tongue (upper Oligocene) Medium-gray to purplish-gray, basaltic andesite lavas characterized by sparse small reddish-brown phenocrysts of "iddingsite" (oxidized and hydrated olivine), locally epresents stacked flows. Thickness variations define relative up and down relationships of early rift normal fault blocks (Chamberlin, 1983). 0-30 m thick.
- La Jencia Tuff (upper Oligocene) Light-gray, pale-red and grayish-red, phenocryst-poor, rhyolite ignimbrite, characterized by gray massive basal zone and a medial zone of very densely welded rheomorphic (flow banded) ignimbrite. Flow-banded core grades to normal eutaxitic ignimbrite near base and top. Contains sparse (3–5%) phenocrysts of sanidine and quartz with traces of plagioclase and biotite. Represents outflow sheet erupted from the composite Sawmill Canyon caldera in the west-central and eastern Magdalena Mountains (Osburn and Chapin, 1983). Mean 40Ar/39Ar age from bulk sanidine separate is 28.85 ± 0.04 Ma; paleomagnetic polarity is reverse (McIntosh and others, 1991). As much as 120 m thick in SW Lemitar Mountains.
- Andesite member of the Luis Lopez Formation, medium porphyritic subunit (lower Oligocene) Dark purplish gray, gray, and reddish brown, medium grained (1–3 mm) andesite porphyry lavas. Massive to platy and locally vesicular lavas ontain moderately abundant (5–20%) phenocrysts of altered plagioclase and pyroxene. Distal flow about 20-30m thick. May represent fill of a paleovalley on north rim of the Socorro caldera. Fissure vents for equivalent lavas occur in the northern moat of the Socorro caldera, near Socorro Canyon.
- Hells Mesa Tuff (lower Oligocene) Pale reddish 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, 2004: McIntosh et. al., 1991). Thickness of outflow sheet in Lemitar Mountains is typically 90-150 m.

Outflow and Intracaldera Units in Water Canyon Mesa Area Andesite member of the "Basalt of Madera Canyon" of Bobrow et.al., 1983 (upper Oligocene) — Brownish gray to grayish

- red porphyritic andesite lavas with sparse to moderately abundant (5-15%) phenocrysts of plagioclase and pyroxene with ninor biotite and quartz. Phenocryst-poor pyroxene andesites tend to occur near the base of the unit and more porphyritic plagioclase andesites are dominant near the top. Reaction rims around rare quartz crystals suggest that quartz occurs as xenocrysts. Potassium metasomatism makes primary phenocrystic minerals difficult to recognize. Unit conformably overlies the South Canyon Tuff and is disconformably overlain basal Popotosa breccias (Tpx) and lavas assigned to the Rhyolite of Water Canyon Mesa (**Twcm**). Occupies the same stratigraphic position as plagioclase-olivine andesite, pyroxene andesite, and basaltic andesite lavas previously called the "Basalt of Madera Canyon" by Bobrow et.al., 1983, which have been recently dated at 26.95 ± 0.2 Ma by the 40Ar/39Ar method (R. Chamberlin and W. McIntosh, unpublished data). "Tam" is interpreted as a more proximal and evolved portion of the same eruptive series that has been dated at Rincon Madera Canyon, which is located 5km SE of Water Canyon Mesa. "Basalt of Madera Canyon" is also laterally equivalent to the upper basaltic andesite unit (Tba2) of Osburn, 1978 as mapped in the Pound Ranch area, north of Rincon Madera Canyon. Maximum thickness on NE flank of Water Canyon Mesa is 180m; unit is locally truncated by one or more Miocene erosion
- (where densely welded), phenocryst-poor to moderately phenocryst-rich, pumiceous, high silica rhyolite ignimbrite. See description of South Canyon Tuff in the SW Lemitar Mountains for additional general attributes. In contrast to the SW Lemitar Mountains, lithic-rich zones are commonly present near Water Canyon Mesa. Some lithic-rich pods contain abundant xenoliths of Lemitar Tuff and basaltic andesite lava, which together comprise more than 50% of the rock volume in the pod. A ledge-forming lithophysal zone locally marks the transition from the crystal-poor basal zone to the moderately-crystal rich upper zone of the South Canyon Tuff near Water Canyon Mesa. Abrupt thickness variations of the underlying basaltic andesite (TI3) and lithic-rich pods derived from (scoured from?) the underlying Lemitar Tuff indicate the South Canyon Tuff locally buried east-tilted fault blocks of the early Rio Grande rift in late Oligocene time (near mouth of South Canyon). Outflow-scale thickness here ranges from 60-180 m; locally truncated by Miocene erosion surface near

South Canyon Tuff (upper Oligocene)— Partially to densely welded, light-gray to pale grayish-red to chocolate-brown

- La Jara Peak Basaltic Andesite, upper tongue (upper Oligocene) Medium gray basaltic andesite lavas characterized by moderately abundant (5–10%) fine- to medium-grained phenocrysts of olivine, usually altered to reddish brown iddingsite. Phenocrystic plagioclase is typically absent. See description of Tl3 in the SW Lemitar Mountains for additional general attributes. Thickness ranges from 30-120 m; wedge-shaped prisms locally define east-tilted early rift fault blocks near the mouth of South Canyon. Tl3 lavas appear to lap onto or wedge out against Hells Mesa Tuff at the northwestern topographic wall of the Sawmill Canyon caldera, near the Manganese Queen Mine. The presence of this widespread lava flow unit within and north of the Sawmill Canyon caldera, however, suggests that the Lemitar Tuff buried the north margin of the caldera prior to eruption of the Tl3 lavas. A jasper cemented andesitic conglomerate bed (Tl3s) locally occurs at the top of this unit on the north side of South Canyon.
- Lemitar Tuff; upper and lower members (upper Oligocene) 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 lensely welded, red to grayish red, phenocryst-rich (30–45%), dacitic to rhyolitic upper member (Tlu). See unit description of Lemitar Tuff in the SW Lemitar Mountains for additional general attributes. In contrast to the southwestern Lemitar Mountains, the Lemitar Tuff is 2 to 3 times thicker (180-300 m) near Water Canyon Mesa. Greater thickness here can be ttributed to a more proximal position, partial infilling of a preexisting depression (Sawmill Canyon caldera), and/or local syneruptive subsidence near the northeastern margin of the Hardy Ridge caldera, which is the source of the Lemitar Tuff. Also, the uppermost Lemitar Tuff contains larger fragments of very-crystal rich pumice (comagmatic granite [?], 2-10 cm) and larger mafic clots of comagmatic dacite (2-5 cm), which also reflect a more proximal position than the southwestern
- Andesite member of the Sawmill Canyon Formation (upper Oligocene)— Multiple flows of medium gray to purplish gray andesitic lavas that contain sparse to moderately abundant (5-10%) altered phenocrysts of plagioclase and pyroxene. ase is not exposed in the Water Canyon quadrangle; minimum (exposed) thickness in eastern Sixmile Canyon is 300m. The Sawmill Canyon Formation represents the heterogeneous fill of the Sawmill Canyon caldera (Osburn and Chapin, 1983); it age is bracketed by the underlying 28.9 Ma La Jencia Tuff and the overlying 28.0 Ma Lemitar Tuff (McIntosh et. al., 19991). Maximum thickness of the Sawmill Canyon is approximately 800m (Osburn and Chapin, 1983).
- Hells Mesa Tuff (lower Oligocene) Densely welded, phenocryst-rich (40–50%), quartz-rich, rhyolite ignimbrite. See lescription of Hells Mesa Tuff in the SW Lemitar Mountains for additional general attributes. Bleached, silicified and propylitized Hells Mesa Tuff near the mouth of Water Canyon exhibits anomalous colors ranging from yellowish brown to pale greenish gray. NNE-trending rhyolite dikes (Tir) locally cut the Hells Mesa Tuff here and near the Manganese Queen mine. This fault-bounded sliver is interpreted here as upper caldera-facies Hells Mesa Tuff, just inside the northwestern ring-fracture zone of the Socorro caldera (cf. Chamberlin et. al, 2004). Thickness uncertain here; the nearest completely exposed intracaldera section at North Baldy is approximately 1100 m thick.

Tertiary Intrusive Rocks

rhyolite with sparse to moderately abundant small phenocrysts of sanidine, quartz and minor biotite. Two "intrusive" lava lomes are recognized. The northern dome at Wet Weather Spring is phenocryst poor. It appears to intrude the South Canyon Tuff and is buried by Popotosa debris-flow deposits (Tpd2) along its western margin. N-trending quartz-barite-pyrite veins occur along this western margin; pyrite is oxidized to pseudomorphs of goethite and hematite here. The southern dome, located 3km SSW of Wet Weather Spring, is moderately phenocryst rich. It appears to intrude the Lemitar Tuff and overlying strata as young as the Rhyolite of Water Canyon Mesa (Twcm). Alternatively the apparent intrusive contacts could be interpreted as younger volcanic strata (post Sawmill Canyon Formation) that terminated against a buttress unconformity (i.e. crest of steep-sided lava domes). Similar white rhyolite lava domes are recognized to be onlapped by the Lemitar and South Canyon tuffs in the adjacent Molino Peak quadrangle (Osburn, 1978; Petty, 1979). Together the two white rhyolite lava domes on Water Canyon Mesa most likely define post-caldera-collapse silicic magmatism along the buried ring-fracture zone of the Sawmill Canyon caldera, which trends NNE in this area.

White rhyolite intrusive lava domes (middle Miocene [?] or possibly late Oligocene) — Light gray to white, flow-banded

White rhyolite dikes (late Oligocene?) — Light gray to yellowish gray, flow-banded, phenocryst-poor rhyolite dikes that range in width from 10-100 m. NNE-trending dikes near the Manganese Queen Mine cut silicified Hells Mesa Tuff. nterpreted as post-collapse ring-fracture intrusions of the 32-Ma Socorro caldera or possibly the 28.9-Ma Sawmill Canyon caldera. These ring-fracture zones are essentially coincident near the mouth of Water Canyon (see index map, Fig.1).

of the National Cooperative Geologic Mapping Act, administered by the U. S. Geological Survey, and by the New Mexico Bureau of Geology and Mineral Resources, (L. Greer Price, Director and State Geologist, Dr. J. Michael Timmons, Assoc. Director for Mapping Programs). Geologic map of the Water Canyon quadrangle, Socorro County, New Mexico.

1:24,000

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

CONTOUR INTERVAL 20 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

New Mexico Bureau of Geology and Mineral Resources

Open-file Geologic Map 118

Mapping of this quadrangle was funded by a matching-funds grant from the STATEMAP program

http://geoinfo.nmt.edu

Base map from U.S. Geological Survey 1970, from photographs taken 1965, field checked in 1970, edited in 1993.

QUADRANGLE LOCATION

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This and other STATEMAP quadrangles are available

for free download in both PDF and ArcGIS formats at:

1000-meter Universal Transverse Mercator grid, zone 13, shown in blue

SOUTH MOLINO BALDY PEAK



NEW MEXICO

Magnetic Declinatio

February 2005

10° 0' East

At Map Center



¹NMBGMR, 801 Leroy Pl., Socorro, NM 87801 ² Earth and Planetary Science Dept., Washington University, St. Louis, MO 63130

