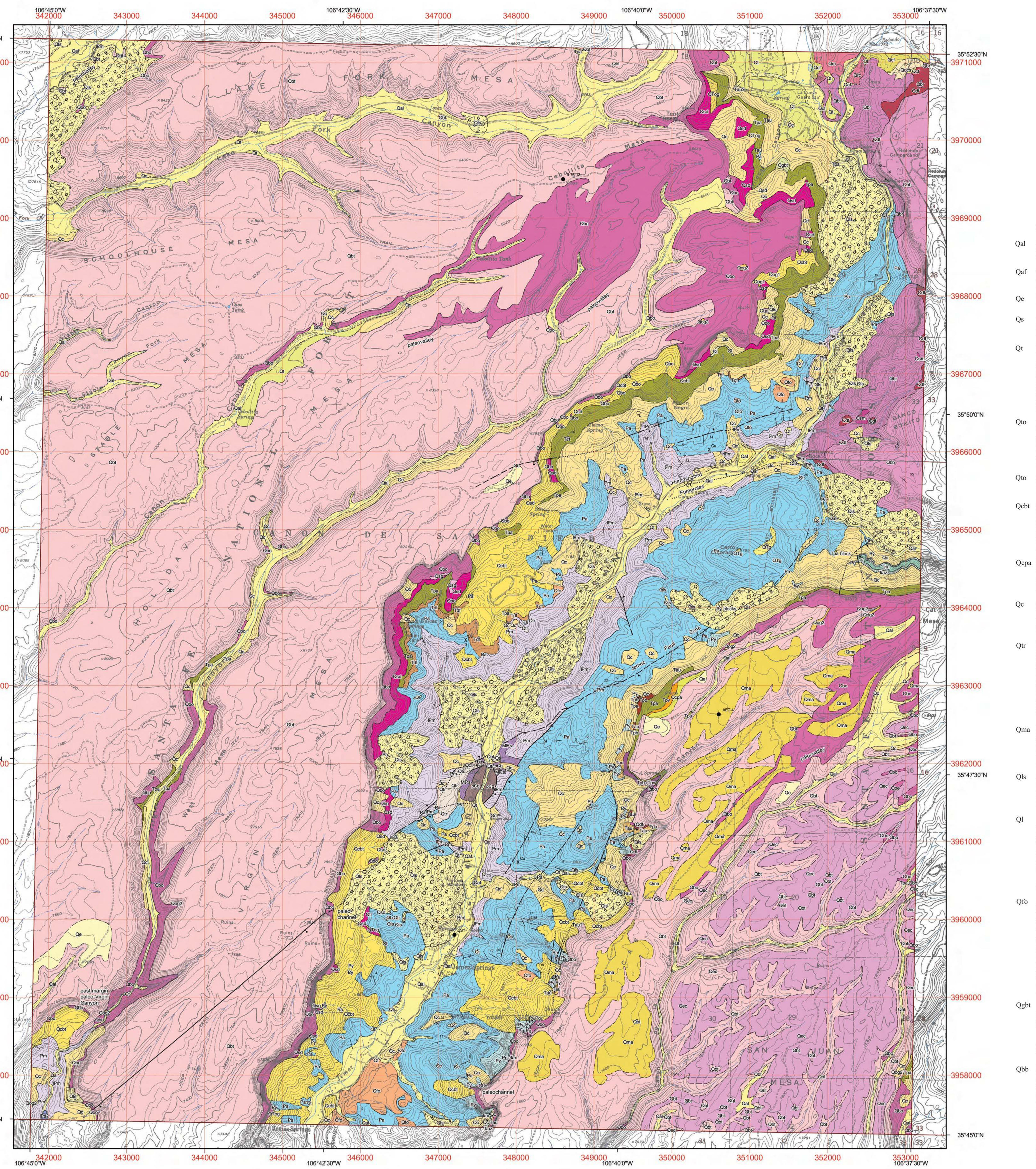


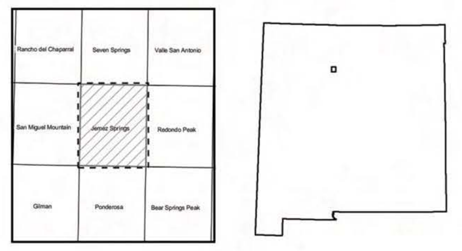
Base from U.S. Geological Survey 1984, from photographs taken 1976 and field checked in 1976. Map edited in 1984. 1927 North American datum, UTM projection -- zone 13. 1000-meter Universal Transverse Mercator grid, zone 13, shown in red

Geologic Map of the Jemez Springs 7.5 - minute quadrangle

by

Shari Kelley, Kirt A. Kempter, Fraser Goff, Mike Rampey, Bob Osburn, and Charles A. Ferguson

May 2003



Magnetic Declination
June, 2003
10° 26' East
At Map Center

1:24,000

Kilometers 0 0.2 0.4 0.8 1.2 1.6

0 0.125 0.25 0.5 0.75 1 Miles

CONTOUR INTERVAL 20 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

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map may be based on any of the following: reconnaissance field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation.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.

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http://geoinfo.nmt.edu/statemap

or contact:
NMBGMR Publications -- [505] 835-5410
NMBGMR Geologic Information Center -- [505] 835-5145

DRAFT

NMBGMR OF-GM 73

This draft geologic map was produced from scans of hand-drafted originals from the author(s). It is being distributed in this form because of the demand for current geologic mapping in this important area. The final release of this map will be made following peer review and redrafting in color using NMBGMR cartographic standards. The final product will be made available on the internet as a PDF file and in a GIS format.

Geology of the Jemez Springs 7.5 minute quadrangle, Sandoval County, New Mexico

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New Mexico Bureau of Geology and Mineral Resources Open-file Geologic Map OF-GM73
May 2003
Updated September 2004

Unit Descriptions

Quaternary Sedimentary Rocks

Qal Alluvium - Holocene: Undivided fluvial gravel, sand, silt, and clay deposited by major drainages and their tributaries. Up to 3 m thick.

Qaf Alluvial Fan - Holocene: Debris flow and fluvial deposits associated with side drainages depositing fan material on the Jemez River floodplain. Maximum thickness ~10 m.

Qe Wind-blown deposits- Holocene: Fine-grained, tan eolian silt on mesa tops. 1 to 3 m thick.

Qs Fine-grained, poorly consolidated, white sandstone of uncertain origin located 10 to 15 m above the modern river level south of La Cueva. Contains pumice clasts. 2-3 m thick.

Qt Terrace deposits - middle Pleistocene to Holocene: Alluvial silt, sand, cobble, and boulder deposits of volcanic, granitic, and sandstone provenance overlying distinct straths and underlying discrete treads related to the large modern drainages of the Jemez River (Rogers, 1996, Formento-Trigilio, 1997, Pazzaglia et al., 1998) and San Antonio Creek. Commonly exhibits a coarse, fine, coarse alternating Pleistocene stratigraphy. Terraces near La Cueva contain abundant rounded Bandelier Tuff pebbles, red sandstone, reworked pumice and a trace of Proterozoic granite. 1-5 m thick.

Qto (La Cueva) Older Terrace Gravel: Contains cobbles of most lithologies described below including rare Precambrian granitic clasts; overlies Battleship Rock Tuff in all exposures; exposure just north of La Cueva junction contains rare cobbles of Banco Bonito Rhyolite and overlies odd-looking, peat-rich slump (?) deposit having a C TM age of 29.0 ? 0.3 ka BP (F. Goff, 1997, unpublished date); maximum exposed thickness about 4 m.

Qto (East Fork) Older Terrace Gravel: Cobble to pebble gravel composed of dacite, green lava, tuff, and Banco Bonito obsidian. Average clast size 14-18 cm. About 1 m thick.

Qcbt Bandelier Tuff colluvium and related hillslope deposits - middle Pleistocene to Holocene (?): Hillslope colluvial deposits composed of pebble to boulder size angular clasts of Bandelier Tuff derived from mesa cap rocks. Poorly sorted and poorly stratified. Matrix and clast supported. Significant accumulations found in Cañon de San Diego. Varies in thickness from ~ 5 - 50 m.

Qcpa Paliza Canyon Formation colluvium - middle Pleistocene to Holocene (?): Hillslope colluvial deposits composed of pebble to house-sized blocks of Paliza Canyon andesite. Large car to house-sized blocks are locally abundant to the west of Battleship Rock. Varies in thickness from ~ 5 - 50 m

Qc Undivided colluvium - middle Pleistocene to Holocene: Hillslope colluvial deposits composed of pebble to boulder size clasts from a variety of lithologies, usually a mix of Bandelier Tuff and Paliza Canyon andesite. Varies in thickness from ~ 5 - 50 m

Qtr Travertine deposits - middle Pleistocene to Holocene: Spring deposits of calcium carbonate ranging from porous tufa to well-developed crystals of aragonite. On Soda Dam, the travertine issues from near vertical fissures up to 3 m wide (Goff and Kron, 1980). The unit includes basal terrace gravel containing rounded cobbles and pebbles of Bandelier Tuff and older volcanic clasts cemented by coarsely crystalline calcite (Goff and Kron, 1980). The unit locally contains, white-fine-grained lake deposits that are <0.1 m thick. The travertine has been dated using the U-Th disequilibrium method and is estimated to be between 0.48 and 1.0 Ma (Goff and Shevenell, 1987).

Qma Mesa top alluvium - late Pleistocene to Holocene: Well-sorted, reddish brown to brown wind-blown silt and fine-grained sand than overlies and is mixed with reworked biotite-bearing pumice tentatively correlated with El Cajete pumice. Found mesa tops, especially on Cat Mesa east of Cañon de San Diego. Varies in thickness from ~ 1 - 5 m.

Qls Landslide deposit - middle Pleistocene to Holocene: Undivided landslide deposits composed of locally derived, cohesive blocks of Bandelier Tuff and Permian bedrock. Generally associated with a head scarp in their source area. Varies in thickness from ~ 5 - 50 m.

Ql Lake deposit - early Pleistocene to Holocene: The unit consists of a basal yellowish-orange sandstone that is <0.5 m thick with no obvious sedimentary structures overlain by ~1 m of white to gray laminated sandstone. The unit is capped by 2 m of white, finely laminated silt to shale that contains gastropods and woody stems. The deposit south of Agua Durme is overlain by a debris flow containing Bandelier Tuff clasts and rests on Abo Formation. A similar, but smaller, deposit is also present west of Jemez Springs, inset into the San Diego Canyon Tuff. This deposit is not shown on the map, but is located at UTM coordinates 346342 395966 (NAD 27).

Qfo Alluvial fan - middle to late Pleistocene?: Old, inactive alluvial fans perched at positions in landscape above modern streams. The fan just east of Jemez Springs near the southern map boundary is composed of generally stratified silt to boulder size alluvium containing clasts of rounded Abo and Yeso sandstone, with some Bandelier Tuff, especially near the base of the deposit, and quartzite pebbles recycled out of the Abo Formation. Unit is underlain by Permian Abo Formation and is locally overlain by Bandelier Tuff colluvium. ~ 5 - 10 m in thickness. Alluvial fans west of Battleship Rock overlie Paliza Canyon colluvium and contain abundant Bandelier pumice. Other fans west of Battleship Rock contain abundant rounded Abo and Yeso sandstone clasts that may have been derived from an ancestral East Fork of the Jemez River.

Qgbt Gravel deposit - middle to late Pleistocene- Gravel composed exclusively of rounded Bandelier Tuff clasts onlapping Cochiti Gravel immediately south of La Cueva; likely derived from an ancestral San Antonio River.

Tewa Group Volcanic and Volcaniclastic Rocks (Quaternary)

Qbb Banco Bonito Rhyolite: Thick viscous lava flows that contain phenocrysts of quartz, biotite, hornblende, clinopyroxene, plagioclase, and rare sanidine in a glassy to devitrified groundmass; contains rare quartz with clinopyroxene reaction rims; consists of at least two thick flow units (Manley and Fink, 1987; Gardner et al., 1986); fills three, west-trending paleocanyons cut into the underlying Battleship Rock Tuff; overlies thin, discontinuous debris flow deposits; upper surface of unit preserves pressure ridges and valleys with up to 10 m of relief; erupted from vent several kilometers east of map area; ESR age on quartz phenocrysts from samples in VC-1 core hole is about 40 + 4 ka (Ogoh et al., 1993); Ne2~ age on quartz phenocrysts from samples collected on pressure ridges is 37 ?+ 5 ka (Phillips et al., 1997); maximum exposed thickness roughly 140 m.

Qdf Debris Flow Deposits: Poorly exposed debris flows and minor interbedded fluvial deposits containing angular to subrounded fragments of pink to tan Bandelier Tuff, gray to black Tertiary andesite and dacite, white to buff Tertiary sandstone, gray Paleozoic limestone, orange to red Paleozoic sandstone, pink Precambrian granite and gneiss, chert of various types, lacustrine clasts, and a variety of rhyolite clasts; from sources to the east around the resurgent dome of Valles caldera; primary deposit discontinuously underlies Banco Bonito lavas and overlies Battleship Rock Tuff in cliffs east of San Antonio Creek; smaller deposit underlies Battleship Rock Tuff and overlies Permian sandstone just east of Battleship Rock; maximum exposed thickness about 65 m.

Qbr Battleship Rock Tuff: Ash flow tuff sheets (ignimbrites) consisting of rhyolitic pumice, lithic clasts, crystal fragments, glass shards, and volcanic ash; consists of at least two flow units; flow unit base is non-welded but center is usually densely welded revealing black glassy fiamme in a gray, devitrified groundmass (Ross and Smith, 1961, p. 4); buff, non-welded pumice clasts are commonly streaked with gray; pumice contains phenocrysts of quartz, biotite, hornblende, clinopyroxene, plagioclase, and rare sanidine. The tuff erupted from the E1 Cajete crater east of map area. This tuff underlies older terrace gravels, Banco Bonito Rhyolite, and debris flow deposits and overlies debris flow deposits east of Battleship Rock; overlies South Mountain Rhyolite, Redondo Creek Rhyolite, caldera fill deposits, Deer Canyon sediments, and Permian red beds. The Battleship Rock tuff laps onto Redondo Creek Rhyolite in a roadcut exposure in La Cueva. An ESR age on quartz phenocrysts is 55 + 6 ka (Toyoda et al., 1995); attempts to date the unit by thermal luminescence and C TM techniques suggest an age >50 ka (Reneau et al., 1996); maximum exposed thickness about 310 m.

Qec El Cajete pumice (El Cajete Member of Valles Rhyolite):White to tan, moderately sorted, pyroclastic fall deposits of vesicular rhyolite; pumice clasts contain sparse phenocrysts of quartz, biotite, and plagioclase with rare microphenocrysts of hornblende and clinopyroxene; some clasts contain resorbed quartz with pale green, clinopyroxene reaction rims; maximum diameter of clasts about _ cm.
The unit forms extensive mesa top cover on San Juan Mesa. Qvec originated northeast of map area from E1 Cajete crater in southern moat of Valles caldera (Bailey et al., 1969; Smith et al., 1970; Gardner et al., 1986; Self et al., 1988; Wolff and Gardner, 1995); unit dated at about 50 to 60 ka (Toyoda et al., 1995; Reneau et al., 1996). A thin pumice interpreted to be El Cajete underlies Battleship Rock Tuff in a roadcut in La Cueva. Possibly, age equivalent to Battleship Rock Tuff. Maximum exposed thickness about 6 m in southeast part of map area.

Qsm South Mountain Rhyolite: Blocky, flow-banded, slightly vesicular rhyolite lava containing phenocrysts of quartz, biotite, hornblende, clinopyroxene, sanidine, and plagioclase in a pale gray, perlitic groundmass; underlies Battleship Rock Tuff; erupted from South Mountain about 9 km east of map area; 40Ar/39Ar age is 0.52 + 0.01 Ma on sanidine (Spell and Harrison, 1993); maximum exposed thickness about 45 m.
Qrc Redondo Creek Rhyolite: Flow-banded lavas and blocky flow breccias of rhyolite containing phenocrysts of plagioclase, biotite, clinopyroxene, and rare sanidine in a gray, devitrified groundmass; most outcrops display weak to intense, low-grade, hydrothermal alteration consisting of silica, clay, and iron oxides; underlies Battleship Rock Tuff; overlies and possibly interbedded with caldera fill deposits; overlies Deer Canyon sediments; erupted from vent in the Sulphur Springs area NNE of map area; fresh outcrop east of State Highway 4 has K/Ar age of 1.34 + 0.07 Ma on plagioclase (Goff and Gardner, in press); maximum exposed thickness about 50 m.

Qcf Caldera Fill Deposits: Poorly exposed debris flows and minor fluvial deposits; debris flows contain blocks 0.25 m or larger of Tertiary andesite, Permian red sandstone, and Pennsylvanian limestone that form a lag on ground; contains rare fragments of Precambrian crystalline rocks; contains occasional fragments of rhyolite lava and Bandelier Tuff; outcrop just north of La Cueva junction consists mostly of andesite and may be landslide block from west wall of Valles caldera; underlies Battleship Rock Tuff and Redondo Creek Rhyolite; overlies Deer Canyon sediments; maximum exposed thickness about 15 m.

Qdcs Deer Canyon Sediments: Primarily white to light gray, well-bedded, pumice-rich sandstone and siltstone; minor pumice-rich debris flows; minor laminated lacustrine deposits containing fossil leaves; displays low-grade, hydrothermal silica and clay alteration; rare fresh pumice contains phenocrysts of quartz and sanidine; pumice presumably from vents of Deer Canyon Rhyolite located east of map area; K/Ar age on sanidine is 1.25 + 0.11 Ma (Doell et al., 1968); underlies debris flow deposits, Battleship Rock Tuff, Redondo Creek Rhyolite, and caldera fill deposits; tilted section in NW corner of map area is over 100 m thick; sequence north of La Cueva is about 15 m thick.

Qbt Upper Bandelier Tuff (Tshirege Member)--White to orange to pink welded to non-welded rhyolitic, ash-flow tuff (ignimbrite) containing abundant phenocrysts of sanidine and quartz, rare microphenocrysts of black clinopyroxene and trace microphenocrysts of hypersthene and fayalite; sanidine typically displays blue iridescence; consists of multiple flow units in a compound cooling unit (Smith and Bailey, 1966; Broxton and Reneau, 1995; Gardner et al., 2000). Upper flow units generally more welded than lower ones. On the north side of Lake Fork Canyon, Qbt is locally highly welded with well-developed pumice fiamme. Locally contains a thin (<2 m) laminated, pumice fall and surge deposit at base of unit (Tsankawi Pumice) that contains roughly 1% of hornblende dacite pumice (Bailey et al., 1969). Locally contains accidental lithic fragments of older country rock entrained during venting and pyroclastic flow, especially on San Juan Mesa, where the white tuff capping the mesa contains 5 to 10% lithic fragments. Qbt forms conspicuous orange to tan cliffs on both sides of Cañon de San Diego; originated from catastrophic eruptions that formed Valles caldera. 40Ar/39Ar age is 1.22 ± 0.01 Ma (Izett and Obradovich, 1994; Spell et al., 1996). Maximum observed thickness ~ 140 m.

Qog2 Old fluvial gravel - early Pleistocene. Fluvial gravel and sandstone deposits underlying air fall Tsankawi pumice of the Tshirege member of the Bandelier Tuff and overlying the Otowi member of the Bandelier Tuff. These gravels and sandstones are found in the southern part of the area east and west of Jemez Springs near the rim of Cañon de San Diego and locally along paleochannels cut in the Otowi member and filled by the Tshirege member on Cat and Virgin mesas. Clasts are generally sub-round to well-rounded and are pebble to boulder sized. The clasts are composed predominantly of Paliza Canyon andesite and basalt (80%) and Abo, Yeso and Glorieta sandstones (20%). Ranges in thickness from ~ 1 - 6 m. Stratigraphically equivalent to the Cerro Toledo Interval epiclastic sediment and tephra deposits on the Pajarito Plateau (Broxton and Reneau, 1995).

Qbo Lower Bandelier Tuff (Otowi Member) - early Pleistocene: White to pale pink, generally poorly welded rhyolitic ash-flow tuff containing abundant phenocrysts of sanidine and quartz, and sparse mafic phenocrysts; sanidine may display a blue iridescence. Contains abundant accidental lithic fragments; consists of multiple flow units in a compound cooling unit. The stratified pumice fall and surge deposit at base of unit (Guaje Pumice) is generally not found in this area. Qbo discontinuously fills in rugged topography on a pre Toledo caldera age volcanic surface and can form spectacular tent rocks; upper surface quite undulatory due to erosion. Very difficult to distinguish from upper Bandelier Tuff in hand samples; best distinguished by poorer degree of welding, greater tendency to form slopes instead of cliffs, more abundant lithic fragments, less abundant iridescent sanidine, and stratigraphic position beneath the Tsankawi Pumice and/or Cerro Toledo interval. On Cat Mesa, the characteristic lithic-rich tuff is overlain by a more welded, pink, lithic-free tuff. On Cebollita Mesa, the lithic rich (10 to 30%), vuggy tuff is overlain by a pink, slightly welded, lithic-poor (5%) tuff, which in turn is overlain by a white, non-welded, lithic-poor tuff beneath the Tsankawi pumice. Originated from catastrophic eruptions that formed Toledo caldera; 40Ar/39Ar ages 1.61± 0.01 to 1.62±0.04 Ma (Izett and Obradovich, 1994; Spell et al., 1996); maximum exposed thickness about 100 m.

Qog2 Fluvial gravel and sandstone - early Pleistocene. Tan fluvial sandstone and gravel deposit between the Otowi member of the Bandelier Tuff and the San Diego Canyon Tuff. Gravel composed of imbricated Paliza Canyon Andesite boulders and pebbles. Best exposed north of Agua Durme. Maximum of 4 m thick.

Qsd San Diego Canyon Tuff - early Pleistocene: Gray to white, nonwelded to poorly welded ash flow tuff containing phenocrysts of quartz and sanadine with trace pyroxene and magnetite. The deposit consists of two units (Tuberville and Self, 1988). The lower unit (A) is nonwelded and is comprised of abundant lithic fragments. The lithic fragments are dominantly basalt and andesite from the underlying Paliza Canyon Formation, with minor Proterozoic plutonic and metamorphic components (Tuberville and Self, 1988). The maximum clast size is 25 cm (Tuberville and Self, 1988). The upper unit (B) is nonwelded to slightly welded and contains large pumice clasts characterized by vesicles with high aspect ratios. The two units are separated by reworked pumice and debris flows at the north end of the exposure and by fluvial gravels and mudstones at the south end of the exposure. The exposure of this tuff is limited to the western rim of Cañon de San Diego from La Cueva to the north to the southern map boundary. The tuff is underlain by the Paliza Canyon debris avalanche in the northern part of the area and by the Cochiti Formation (?) in the southern part of the area. Spell et al. (1990) determined 40Ar/39Ar ages of 1.79 ± 0.04 Ma for the lower unit and 1.78 ± 0.07 Ma for the upper unit. Locally, debris flows or fluvial gravels (Qsdg) occur between the two units but the sedimentary packages are too thin (< 2 m) and too discontinuous to show on the map. One of the best exposures of fluvial gravel between the two units is north of Agua Durme. Thickness ranges from 80 m near La Cueva to 0-2 m on topographic highs associated with top of the Paliza Canyon andesite debris flows; the unit is also ~ 2 m thick in the distal exposures at the south end of the map area.

QTog Old fluvial gravel- late Pliocene(?). Alluvial to fluvial gravel and sandstone deposit underlying the San Diego Canyon Tuff or the Bandelier Tuff. Clasts are generally sub-rounded to well rounded, pebble to boulder size clasts that are matrix to clast supported. Occasional fining upwards sequences are present. Gravel clasts composed predominantly of Paliza Canyon volcanics with occasional granite, sandstone, conglomerates, and rare Pedernal chert supported in a silt to sand size matrix. The sandstones locally contain abundant pumice clasts that are likely derived from the lower unit of the San Diego Canyon Tuff. Well exposed on the east side of Virgin Mesa. A deposit in Church Canyon consists of fluvial gravels at the base that grade up into a matrix-supported debris flow. The unit in Church Canyon, which is up to 10 m thick, is dominated by rounded Paliza Canyon andesite, rounded Abiquiu Sandstone, and angular Pedernal chert clasts. These deposits could be equivalent to gravels of the Quaternary/Tertiary Cochiti Formation (Smith and Lavine, 1996), which contains predominantly rounded, volcanic clasts or they could be Qsdg. Varies in thickness from ~ 1 - 12 m.

QTl Lake deposits late Miocene to early Pleistocene: White, diatomaceous (?) fine-grained sandstone locally sitting on Paliza Canyon Andesite debris avalanche deposits north of Rincon Negro. The margins of the deposit is silicified, preserving finely laminated, alternating light and dark layers. Maximum of 5 m thick. The upper contact relationship is uncertain, but the unit appears to underlie the San Diego Canyon Tuff. Thin (<0.1 m) deposits of this unit are also present on Paliza Canyon debris avalanche deposits the south wall of East Fork

Keres Group Volcanic and Volcaniclastic Rocks (Miocene)

Tpda Paliza Canyon debris avalanche. Dark gray to black debris deposit composed primarily of angular boulders of andesite with abundant plagioclase phenocrysts that is perhaps analagous to deposits described by Siebert (1984) and Stoopes and Sheridan (1992). The andesite often has a glassy matrix. Basaltic andesite clasts with iddingsite are also present. The boulders range in size from 0.1 m to 3 m (need to refine these estimates). There are multiple debris flow units, ranging from clast-supported to matrix-supported flows, sometimes including an ashy magmatic component. The unit often forms imposing cliffs on the west side of San Diego Canyon between La Cueva to the north and Agua Durme Springs to the south. The deposit terminates just south of Agua Durme Springs where the unit overlies a reddish tan, matrix-supported debris flow dominated by clasts of Abiquiu sandstone, Paliza Canyon andesite and Tschicoma (?) dacite. The base of the unit is generally not well exposed, but locally the deposit overlies a debris flow (Tdf) or the Abo Formation. The top of the unit has considerable topography (up to 60 m); San Diego Canyon Tuff filled in paleovalleys, while the Otowi member of the Bandelier Tuff rests on the high spots. Maximum thickness is 180 m on Rincon Negro.

Tdf Debris flow deposit. Miocene A reddish to yellowish tan, matrix-supported debris flow dominated by angular, brecciated clasts of Abiquiu sandstone, Paliza Canyon andesite, and Tschicoma dacite. This deposit appears beneath debris avalanche south of La Cueva and thickens southward to become a mappable unit north of Rincon Negro.
The deposit terminates just south of Agua Durme Springs as a topographic high onlapped by the San Diego Canyon Tuff.

Tct Canovas Canyon Tuff: White pyroclastic flow deposit containing clasts of devitrified rhyolite included within the Paliza Canyon debris avalanche. Overlain by a brown andesitic lapilli tuff and a fine-grained, flow-banded, andesite flow. Basal contact not exposed. Minimum thickness ~10 m.

Tpa Paliza Canyon Andesite: Dark gray, dense lava flows and block-and-ash flows of andesite. The andesite is porphyritic and contains clinopyroxene and zoned plagioclase phenocrysts. Flows common just south of La Cueva and north of and within Church Canyon

Tpv Paliza Canyon volcaniclastic sediments: Volcaniclastic sediments interbedded with and overlying the volcanic rocks of the Keres group. Consists of tan to brown sandstone and conglomerates. Often contains abundant clasts of volcanic rocks, mostly mafic to intermediate in composition. These sediments are well exposed in Church Canyon. Here the unit consists of alternating beds of tan, cross-bedded conglomeritic sandstone and pebble to boulder conglomerate with abundant andesite, basalt and minor rhyolite clasts. 0-70 m.

Tpb Paliza Canyon basalt: Two basalt flows interbedded with the volcaniclastic sediments are exposed in Church Canyon. The lower
flow is vesicular, contains phenocrysts of plagioclase and olivine, and is 3-5 m thick. The upper flow is also vesicular and contains abundant olivine and small phenocrysts of plagioclase. Likely equivalent to the 9 Ma basalts on Borrego Mesa in the Ponderosa quadrangle. Thickness 3-5 m.

Oligocene to Miocene

Tau Abiquiu Formation: Predominantly composed of white to tan, medium-grained, medium-bedded sandstone that is alternately well-cemented and poorly-cemented that correlates with the upper member of the Abiquiu Formation at Cerro Pedernal in the northern Jemez Mountains (Smith et al., 2002). A basal gravel is present in most exposures along the east side of Cañon de San Diego. At the southern end of the area (UTM 347659, 3957351, NAD 27) the base of the unit consists of 0.5 m of red volcaniclastic sandstone, 1 to 1.5 m of thin to medium bedded tan sandstone and 0.3 m of limestone. The basal unit here may be equivalent to the basal volcaniclastic debris flow described by DuChene (1973) and DuChene et al. (1981). North of this point, the basal unit is dominantly an arkosic fluvial conglomeratic sandstone with abundant pebble-sized Proterozoic granite, quartzite and schist clasts, and few Pennsylvanian limestone, Permian sandstone, and intermediate-composition volcanic clasts of uncertain origin. The volcanic clasts are pebble to cobble-sized and can be abundant in local channels. The unit is especially well exposed at the head of Church Canyon. The unit is most commonly underlain by Permian Yeso sandstone on the eastern rim of Cañon de San Diego and is overlain by either Bandelier Tuff or Paliza Canyon basalt. The thickness of the unit varies considerably from about 6 m at south end of the area to 40 m at Church Canyon. The unit abruptly thins to < 1m about 1 km north of Church Canyon. The Abiquiu Formation is poorly exposed just west of La Cueva.

Triassic

TRaz Agua Zarca Formation (Chinle Group): White to yellowish brown, medium- to coarse-grained quartzose sandstone. The sandstone is usually strongly cross stratified, often in trough geometries. The unit is a consistent cliff-former. Exposed along the southern edge of the area and in East Fork Canyon. Maximum thickness 20 m.

TRm Moenkopi Formation (Chinle Group): Reddish brown micaceous shale, silty shale and thin-bedded feldspathic sandstone. The unit is shaly at the base and is a sandstone at the top. Overlain in sharp contact by the contrasting light-colored sands of the Agua Zarca Formation. Underlain by the white sandstone cliffs of the Glorieta Sandstone. Exposed in the southern part of the area on the east side of Cañon de San Diego and in East Fork Canyon. Approximately 20 m thick.

Permian

Pg Glorieta Sandstone: White to gray, massive to planar bedded to cross-stratified quartz arenite. Sandstones are typically well sorted. Exposed in the southern part of the area on the east side of Cañon de San Diego and in East Fork Canyon. Approximately 20 m thick.

Py Yeso Formation: Red orange to dark red, fine to medium grained, quartzose sandstone. The Yeso Formation has traditionally been divided into two members in the southwestern Jemez Mountain region, the lower Meseta Blanca member and the upper San Ysidro member (Wood and Northrop, 1946; Crabaugh, 1988; Stanesco, 1991; Mack and Dinterman, 2002). The basal part of the Meseta Blanca member consists of reddish-orange, medium to thick-bedded, tabular sandstone with thin shale interbeds, occasional fluvial channel structures, and rare mudcracks. The upper part of the Meseta Blanca member is characterized by a distinctive eolian sandstone with meter-scale, tabular-planar, wedge-planar and trough cross-beds that record a paleo-transport direction generally to the south (Stanesco, 1991). The San Ysidro member of the Yeso Formation is primarily medium-bedded, tabular sandstone that is orange red near the base and red near the top. A continuous (1 to 2 m thick) limestone bed is present near the top of the unit. The sandstone under the limestone is altered and bleached due to weathering of the sandstone prior to the deposition of the limestone. The limestone exhibits soft-sediment deformation and fills in low spots in the underlying sandstone. The contact of the Yeso Formation with the overlying Glorieta Sandstone mapped at the transition to predominantly medium to course grained, white quartzose sandstone. The Yeso Formation is 170 m thick in Cañon de San Diego (Stanesco, 1991). Maximum exposed thickness is 150 m. Exposed only on the east side of Cañon de San Diego and in East Fork Canyon.

Pa Abo Formation: Red to dark red medium- and thin-bedded arkosic fluvial sandstone interbedded with red and dark red micaceous siltstone and mudstone. Green reduction spots and reduced layers are common. The discontinuous nature of the channel sandstones makes it difficult to follow faults and folds across this interval. The sandstones are cross-stratified (typically trough and wedge-planar geometries) and exhibit spectacular soft-sediment deformation. Thin pedogenic carbonate beds are common on and just south of Cerro Colorado. The unit locally contains malachite and azurite deposits in channel sandstones. Base is transitional with the underlying Madera Formation. Upper contact with Yeso Formation mapped at abrupt change from medium-grained to coarse-grained arkosic sandstones or brick red mudstone to fine- to medium-grained quartzose sandstones. Equivalent to the Cutler Formation to the north Eberth,1987; Eberth and Miall, 1991; Eberth and Berman, 1993; Crabaugh, 1988). Abo Formation is ~260 m thick on Cerro Colorado. Spencer Lucas (personal communication, 2004) measured 150 m of Abo Formation, (base not exposed, but measured up to the Yeso Formation) south of Jemez Springs on the Ponderosa 7.5' quadrangle. Although this section is incomplete, Lucas notes that the basal portion of the Abo Formation is dominated by mudstones and that channel sands become thicker and more abundant in the upper part of the formation. This trend has also been noted in central and west-central New Mexico.

Pennsylvanian

IPm Madera Formation: Light-gray, fossiliferous limestone, white to buff quartzose sandstones, coarse-grained arkose, light-gray shale with subordinate arkosic limestone (Read and Wood, 1947; Lovejoy, 1958; Sutherland and Harlow, 1967; DuChene, 1974; Swenson, 1977, 1996; Kues, 1996). Upper part of the unit is transitional with Abo redbeds and includes red arkosic sandstone and minor shale. Following Woodward (1987), the top was mapped at the uppermost limestone bed that is ~ 1 m thick. Swenson (1977; 1996) measured the upper 168 m of the unit. Overlies Sandia Formation in the structurally complex area in the Jemez fault zone north of Soda Dam.

IPs Sandia Formation: Fine- to coarse-grained, white to tan, quartzose sandstone interbedded with brown, red, green or gray shale, thin-bedded fossiliferous limestone, and chert. Minor arkosic sandstones also present. Contact with overlying Madera Formation mapped at abrupt increase in proportion of limestone beds. Overlies the distinctive redbeds of the Log Cabin Formation. Base not 45 m thick (Read and Wood, 1947)

Mississippian-Pennsylvanian

MIPs Arroyo Peñasco, Log Cabin, and Sandia formations (undivided): Limestone, thin red beds, and coarse-grained quartz arenite exposed in the Jemez fault zone near Soda Dam. The Arroyo Peñasco Formation is ~12 m thick at Soda Dam (Armstrong, 1955; Armstrong and Mamet, 1974). The Log Cabin Formation is about 3 m thick.

Proterozoic rocks

pCg Proterozoic granitic gneiss: Highly altered and fractured granitic gneiss exposed along the Jemez Fault zone. Although no age data are available, the granite is likely a 1.6 to 1.7 Ga rock since it is foliated. No direct evidence of a Proterozoic ancestry to the fault zone is preserved at Soda Dam because foliation trends are at a high angle to the fault zone and no mylonite zones were observed.

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