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GEOLOGIC MAP OF THE RIO PUERCO QUADRANGLE, BERNALILLO AND VALENCIA COUNTIES, NEW MEXICO

By

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Pamphlet to accompany
MISCELLANEOUS FIELD STUDIES MAP
MF–2397

DESCRIPTION OF MAP UNITS

[Geology was interpreted from aerial photographs and field checked (1998–1999). Fractional map symbols (for example, Qe/Tscu) denote areas where eolian sand sheets or dune sand (Qe) form a nearly continuous mantle on an older underlying unit. Pedogenic carbonate morphology descriptions follow the morphogenetic stage classification system of Gile and others (1966) as modified by Birkeland (1984). Rock chart colors are from Goddard (1948). Grain sizes of sand deposits are defined using Wentworth's (1922) grain-size scale as follows: very fine (0.06–0.125 mm), fine (0.125–0.250 mm), medium (0.250–0.50 mm), coarse (0.50–1.0 mm), and very coarse (1.0–2.0 mm). Thickness of beds are after Ingram (1954) as follow: very thick (thicker than 1 m), thick (30–100 cm), medium (10–30 cm), thin (3–10 cm), very thin (1–3 cm), thickly laminated (0.3–1 cm), and thinly laminated (thinner than 0.3 cm). Stratigraphy and some mapping for the lava flows of the Cat Hills were taken from Kelley and Kudo (1978) with some modifications to subscripts of map unit symbols. Suffix numbers indicate relative position of flows—higher numbers indicate a relatively higher (younger) stratigraphic position (for example, Qch7) and lower numbers indicate a relatively lower (older) stratigraphic position (for example, Qch1). The lava flows generally have the same mineralogy so individual flows were mapped on aerial photographs using geomorphic expression. Modal analyses of lava flows are from Frank Byers, Jr., (U.S. Geological Survey, written commun., 1997). Modal analyses are presented as percent amount of phenocrysts versus groundmass with percent amount of respective phenocrysts shown in parentheses. Geology in southwesternmost part of quadrangle (sec. 7 and northern parts of secs. 13 and 18, T. 6 N., Rs. 1 and 2 W.) modified from Lozinsky and Tedford (1991). Some mapped faults have been realigned to fit the new aeromagnetic map of the area (U.S. Geological Survey and Sander Geophysics, Ltd., 1998; Grauch 1999). Some minor concealed faults interpreted from aeromagnetic signatures (V.J.S. Grauch, U.S. Geological Survey, written commun., 2001; Grauch 2001) and indicated on map in blue. The Mohinas Mountain fault, in southwestern part of map area, is a newly discovered fault interpreted from surface geology]

ALLUVIAL, COLLUVIAL, AND EOLIAN DEPOSITS

Qal **Alluvial deposits (Holocene)**—Yellowish-gray (5Y7/2) and light-brown (5YR6/4), unconsolidated, uncemented, poorly to well sorted, fine to coarse sand; interbedded gravelly beds. Gravel clasts are pebble to cobble in size and reflect compositions of clasts eroded from upland Santa Fe Group sediments and local volcanic fields in map area. Locally includes abundant white calcium-carbonate nodules (peds) eroded from calcic soils that form in the top of unit Tscu on the Llano de Albuquerque. Unit deposited in arroyos inset in alluvial and colluvial deposit mapped as unit Qac. Locally includes well-sorted eolian sand. Thickness variable but commonly less than about 2 m

Qac **Alluvial and colluvial deposits (Holocene)**—Yellowish-gray (5Y7/2) to pale-yellow (5Y8/4), unconsolidated, uncemented, poorly to well sorted, fine to coarse sand, and pebbly sand; deposited on valley margins and slopes; interbedded gravelly beds. Gravels are unconsolidated, pebble- to cobble-size clasts eroded from upland Santa Fe Group sediments and local volcanic fields in map area. Locally includes abundant white calcium-carbonate nodules (peds) eroded from calcic soils that form in the top of unit Tscu on the Llano de Albuquerque. A charcoal sample from a charcoal pit in this unit located in sec. 25, T. 8 N., R. 2 W., in southwestern part of the Dalies Northwest quadrangle approximately 3 km north of map area (Maldonado and Atencio, 1998b), has been dated at 1,920±50 years (J.P. McGeehin, U.S. Geological Survey, written commun., 1997, sample number CH-34) using the ^{14}C method. Locally includes well-sorted eolian sand. Thickness variable but commonly less than about 3 m

Qec **Eolian and colluvial deposits (Holocene and upper Pleistocene)**—Thin unconsolidated sand and silt. Sand is poorly to well sorted and fine to coarse. Deposits typically found in topographically low areas and within low areas on lava flows. Thickness variable, less than about 3 m

Qe **Eolian sand deposits (Holocene and upper Pleistocene)**—Light-brown (5YR6/4) and grayish-orange (10YR7/4) to very pale orange (10YR8/2), unconsolidated, noncemented to weakly cemented, very fine grained to fine-grained, well-rounded, well-sorted sand composed mostly of quartz grains. Eolian sand includes mostly sheets; local dunes have orientation that indicates winds directions were predominantly from the west-southwest. In southwest corner of map area unit correlates with unit Qed of Love and others (1998). Thickness of sand is variable; sheets are approximately 1–5 m thick; dunes are probably less than 5 m thick

Qe/Qac **Eolian sand veneer on alluvial and colluvial deposits (Holocene and upper Pleistocene)**—The alluvial and colluvial deposit (Qac) has been described previously. Unit Qe is light-brown (5YR6/4) and grayish-orange (10YR7/4) to very pale orange (10YR8/2), unconsolidated sand, composed of very fine grained to fine-grained, well-rounded, and well-sorted quartz grains

Qe/Qsc **Eolian sand veneer on sand, silt, and clay unit of Chavez Grant (Holocene to lower Pleistocene)**—The sand, silt, and clay unit of Chavez Grant (Qsc) is described subsequently. Unit Qe is light-brown (5YR6/4) and grayish-orange (10YR7/4) to very pale orange (10YR8/2), unconsolidated sand, composed of very fine grained to fine-grained, well-rounded, and well-sorted quartz grains. Correlates to unit Qed/Qka of Love and others (1998)

Qe/Tscu **Eolian sand veneer on soils of the upper sand and gravel unit of the Ceja Formation (Holocene to upper Pliocene)**—The upper sand and gravel unit (Tscu) of the Ceja Formation of the Santa Fe Group is described subsequently. Unit Qe is light-brown (5YR6/4) and grayish-orange (10YR7/4) to very pale-orange (10YR8/2), unconsolidated sand, composed of fine-grained, well-rounded, and well-sorted quartz grains. Locally contains sand and pebbles composed predominantly of chert, quartzite, chalcedony, granite, petrified wood, sandstone, basalt, and limestone. Clasts are probably eroding from underlying unit Tscu

Qe/Tscl **Eolian sand veneer on the lower sand and gravel unit of the Ceja Formation (Holocene to Pliocene)**—The lower sand and gravel unit (Tscl) of the Ceja Formation of the Santa Fe Group is described subsequently. Unit Qe is light-brown (5YR6/4) and grayish-orange (10YR7/4) to very pale orange (10YR8/2), unconsolidated sand, composed of very fine grained to fine-grained, well-rounded, and well-sorted quartz grains

LANDSLIDE DEPOSITS

Qls **Landslide deposits (Holocene to middle Pleistocene)**—Dark-gray (N3) to grayish-black (N2) blocks, debris, and rubble breccia composed predominantly of intrusive rocks of Mohinas Mountain (Tm), which consist of basaltic and olivine diabase sill, dikes, and cone sheets (Lozinsky and Tedford, 1991). Deposits are very poorly sorted, angular to subangular blocks that exhibit a hummocky topography and are associated with steep slopes around Hidden Mountain and Mohinas Mountain (located south of Hidden Mountain) in southwestern part of map area. Landslide appears to have slid on the clay, clayey sand, and silt of the Popotosa Formation (Tsp)

FLUVIAL DEPOSITS OF THE RIO PUERCO

Qrc **Present channel and tributary deposits (Holocene)**—Yellow-gray (5Y), fine-grained sand, silt, and clay. Unit was delineated from river channel present on aerial photographs dated 1990. The present river channel in the adjacent Dalies Northwest quadrangle to the north deviates from the former river channel that is shown on the 1952 base, suggesting rapid lateral movement of the channel. Bryan (1928) indicated that the present river channel started cutting between 1885 and 1890. In southwestern part of map area, deposits along the Arroyo Garcia are locally included with unit Qrc. Variable thickness, as much as 3 m

Qrt3 **Young terrace deposits (Holocene)**—Forms the first fluvial terrace above the present river channel deposits (Qrc). Deposits consist of grayish-yellow (5Y8/4), well-sorted, very thin to very thick bedded silty sand and silt; yellowish-gray (5Y7/2) interbedded lenses of clayey silt and clay. Terraces are erosional straths 1–3 m above present river channel and are inset against the intermediate terrace (Qrt2) and in some areas inset against the old terrace deposits (Qrt1). Mapped as lower terrace (unit Qrt3) by Maldonado and Atencio (1998b) in adjacent Dalies Northwest quadrangle north of map area. Thickness varies from 0 to 3 m

Qrt2 **Intermediate terrace deposits (Holocene)**—Forms the second fluvial terrace above the present river channel deposits (Qrc). Deposits are grayish-yellow (5Y8/4), well-sorted, very thin to very thick bedded silty sand and silt; yellowish-gray (5Y7/2) lenses of clayey silt and clay. Terraces are erosional straths about 3–7 m above present river channel and are inset against the old terrace deposits (Qrt1). Mapped as middle terrace (unit Qrt2) by Maldonado and Atencio (1998b) in adjacent Dalies Northwest quadrangle north of map area. Thickness varies from 0 to 3 m

Qrt1 **Old terrace deposits (Holocene)**—Forms the valley floor of the pre-1890 Rio Puerco and the third fluvial terrace about 10–13 m above the present river channel; traversed by several erosional gullies near the edge of the post-1890 incision. Composed of an alternating stack of grayish-yellow (5Y8/4), well-sorted, fine-grained, very thin to very thick bedded sand and silt and yellowish-gray (5Y7/2) interbedded clay. Mapped as upper terrace (unit Qrt1) by Maldonado and Atencio (1998b) in adjacent Dalies Northwest quadrangle north of map area. Base not exposed; thickness may range from 15 to 40 m

Qrp **Fluvial deposits of the ancestral Rio Puerco (upper Pleistocene)**—Light-brown (5YR6/4), fine- to coarse-grained sand; minor interbedded gravel. Gravels are predominantly pebbles of Pedernal Chert Member of the Abiquiu Formation, chert, quartzite, chalcedony, granite, permineralized wood, sandstone, jasper, limestone, basalt, volcanic rocks of intermediate composition, and obsidian eroded from Santa Fe Group deposits. Thin (less than 30 cm) Stage II to III pedogenic carbonate horizon locally developed within soil at top of unit (shown as blue color on map). Forms slightly dissected terrace treads about 25 m above channel of the present Rio Puerco deposits (Qrc). Locally overlies dissected volcanic rocks of Mohinas Mountain (Tm) in southwestern part of map area. Thickness estimated to be as much as 10 m

VOLCANIC ROCKS OF CAT HILLS

Qcc **Cinder deposit of Cat Hills cones (upper Pleistocene)**—Grayish-red (10R4/2), moderate-reddish-brown (10R4/6), grayish-brown (5YR3/2), and dark-gray (N3) lapilli-size cinders and rare bombs. Deposits form four cones and part of another in northeastern part of map area. These cones are part of a northeast-trending chain (fig. 1) that contains 21 centers and extends into the adjacent Wind Mesa (Maldonado and Atencio, 1998a) and Dalies Northwest (Maldonado and Atencio, 1998b) quadrangles to the northeast and north, respectively. These cones are commonly 10–25 m high; one of the lowest cones in the chain, called the Blackbird cone, forms the northernmost cone in the adjacent Wind Mesa quadrangle (Maldonado and Atencio, 1998a); the highest cone, called here the "Floripa cone" (fig. 2), forms the southernmost cone. Locally, some cones have Stage II calcic soils on their flanks. A dike in the Blackbird cone has been dated at 180±0.80 ka using the $^{40}Ar/^{39}Ar$ method (Maldonado and others, 1998, 1999). The date for this dike appears to be discordant because samples for the oldest Cat Hills flow (Qch1) have yielded younger dates as described subsequently

Qch7 **Lava flow 7 of Cat Hills (upper Pleistocene)**—Dark-gray (N3) to grayish-black (N2), vesiculated, basaltic lava flow. Groundmass is microgranular and composed of plagioclase, clinopyroxene, opaque minerals (ilmenite and magnetite), and olivine. Contains approximately 9 percent phenocrysts of plagioclase (58 percent), about 2 mm in length, olivine (41 percent), about 3 mm in length, and clinopyroxene (1 percent). Tops of ridges or mounds mark depressions, resembling grabens that may have formed due to flowage, that are filled with eolian sand. Locally contains lava tubes in adjacent Dalies Northwest quadrangle north of map area. Mapped as Qb4 by Kelley and Kudo (1978). Dated at 490±160 ka and 250±80 ka (Maldonado and others, 1998, 1999) using the $^{40}Ar/^{39}Ar$ method. Dates for this flow appear to be discordant or stratigraphically inconsistent because the stratigraphically higher (younger) flows (Qch7) yield older dates than the oldest Cat Hills flow (Qch1). This discordant older date might be attributed to contamination of the basalt during emplacement. Estimated thickness as much as 38 m

Qch6 **Lava flow 6 of Cat Hills (upper Pleistocene)**—Dark-gray (N3) to grayish-black (N2), vesiculated, basaltic lava flow. Groundmass is microgranular and composed of plagioclase, clinopyroxene, opaque minerals (magnetite and ilmenite), and olivine. Contains about 6 percent phenocrysts of olivine (70 percent), about 3 mm in length, and plagioclase (30 percent), about 2 mm in length. Characterized by ridges and depressions similar to those on Qch7 that possibly formed due to flowage. These depressions typically are filled with eolian sand that in some cases have trees growing in them. Mapped as Qb3a by Kelley and Kudo (1978). Estimated thickness as much as 38 m

Qch5 **Lava flow 5 Cat Hills (upper Pleistocene)**—Dark-gray (N3) to grayish-black (N2), vesiculated, porphyritic, basaltic lava flow. Groundmass is microgranular and composed of plagioclase, clinopyroxene, opaque minerals (magnetite and ilmenite), and olivine. Composed of 6 percent phenocrysts of olivine (51 percent), about 3 mm long, and plagioclase (49 percent), about 2 mm long. Tops of ridges with depressions are common and commonly filled with eolian sand. Flow resembles lava flow 6 (Qch6) but distinguished on basis of geomorphic expression. Mapped as Qb3 by Kelley and Kudo (1978). Estimated thickness as much as 12 m

Qch4 **Lava flow 4 of Cat Hills (upper Pleistocene)**—Dark-gray (N3) to grayish-black (N2), vesiculated, basaltic lava flow. Groundmass is composed of plagioclase, olivine, clinopyroxene, and opaque minerals. Contains about 3.5 percent phenocrysts of plagioclase (29 percent) and olivine (71 percent). Mapped as Qb2a by Kelley and Kudo (1978). Estimated thickness as much as 5 m

Qch3 **Lava flow 3 of Cat Hills (upper Pleistocene)**—Grayish-black (N2), vesiculated, porphyritic, basaltic lava flow. Groundmass is composed of plagioclase, olivine (may include orthopyroxene with some clinopyroxene), and an opaque mineral (magnetite?). Consists of about 6 percent phenocrysts of olivine (84 percent), about 5 mm in length, and plagioclase (16 percent), about 2 mm in length. Vesicles contain microcrystalline filling of quartz and alkali feldspar. Mapped as Qb2 by Kelley and Kudo (1978). Estimated thickness as much as 30 m

Qch2 **Lava flow 2 of Cat Hills (upper Pleistocene)**—Grayish-black, vesiculated, basaltic lava flow. Contains about 7 percent phenocrysts of olivine (69 percent) and plagioclase (31 percent) in a groundmass of plagioclase, clinopyroxene, opaque minerals, and olivine. Mapped as Qb1a by Kelley and Kudo (1978). Estimated thickness as much as 6 m

Qch1 **Lava flow 1 of Cat Hills (upper Pleistocene)**—Dark-gray to grayish-black, vesiculated, porphyritic, basaltic lava flow. Groundmass is microgranular and composed of plagioclase, clinopyroxene, opaques minerals, and olivine. Composed of about 6 percent phenocrysts of olivine (78 percent), about 4 mm in length, plagioclase (20 percent), and clinopyroxene (2 percent). Locally overlies calcic soils of Stage II–III carbonate morphology and the “Los Duranes Formation” of Lambert’s Ph.D. dissertation (1968) (Qld) in adjacent Wind Mesa quadrangle (Maldonado and Atencio, 1998a). Mapped as Qb1 by Kelley and Kudo (1978). Samples from this flow have $^{40}Ar/^{39}Ar$ whole rock dates of 110±30 and 98±20 ka (Maldonado and others, 1998, 1999). An earlier K-Ar date for this flow is 140±38 ka (Kudo and others, 1977). As indicated in preceding paragraph, the dates for this flow appear to be discordant or stratigraphically inconsistent with the older dates obtained from the stratigraphically higher (younger) flows (Qch7), possibly because of contamination of the basalt during emplacement. Estimated thickness as much as 9 m

UPPER PART OF THE SANTA FE GROUP

This sequence of sediments includes fluvial deposits derived from the ancestral Rio Puerco and possibly the Rio San Jose drainages and a local fine-grained deposit. The local deposit is informally referred to as the sand, silt, and clay unit of Chavez Grant (Qsc), equivalent to the sand, silt, and clay lithofacies of Isleta Reservation (QTsi) as mapped by Maldonado and Atencio (1998a). The fluvial units are correlated to parts of Kelley’s (1977) Ceja Member of his Santa Fe Formation. As used in this map, Kelley’s member will be referred to as the Ceja Formation and considered here to be the upper formation of the Santa Fe Group. The units are equivalent to Machette’s (1978) Sierra Ladrones Formation and Connell’s Arroyo Ojito Formation (Connell and others, 1999). Maldonado and Atencio (1998a, b) informally referred to these units as lithofacies of the Isleta Reservation. The Ceja Formation is divided here into three informal units and consist in descending stratigraphic order of: (1) upper sand and gravel unit (Tscu); (2) middle silt, sand, and clay unit (Tscm); and (3) lower sand and gravel unit (Tscl). Kelley (1977) did not include the middle (Tscm) and lower units (Tscl) in his Ceja Member

Qsc **Sand, silt, and clay unit of Chavez Grant (lower Pleistocene)**—Grayish-orange (10YR 7/4) and grayish-yellow (5Y8/4) to yellowish-gray (5Y7/2), well-sorted, interbedded, fine-grained sand, clayey silt, and clay beds; thin pebbly sand and pebble to cobble gravel beds (less than 1 m thick) towards top of unit. Locally cemented. Gravel clasts are mostly limestone, quartzite, granite, sandstone, chert, Pedernal Chert Member of the Abiquiu Formation, silicified wood, basalt, and rare obsidian. Obsidian clast may have been derived from Mount Taylor, located northwest of map area. Top of unit exhibits moderately developed calcic soil with Stage II–III pedogenic carbonate morphology (shown as red on geologic map). In adjacent Dalies quadrangle (Love and others, 1998) to the east, unit locally contains rounded pumice clasts near top of section and below a calcic soil horizon. Pumice has been dated at 1.2 Ma and correlated to the upper part of the Bandelier Tuff (Nelia Dunbar, New Mexico Bureau of Geology and Mineral Resources, oral commun., 2000). Northwest of the Los Lunas volcano (Dalies quadrangle), unit unconformably overlies well-developed calcic soil at top of unit Tscu and is overlain by colluvial deposits derived from the Los Lunas volcano, which contains a 1.2 Ma tephra (Love and others, 1998) dated by Bachman and Mehnert (1978). Shown as sand, silt, and clay lithofacies of Isleta Reservation (QTsi) by Maldonado and Atencio (1998a). Base not exposed. Exposed thickness about 50 m, but thickens in the adjacent Belen Northwest quadrangle, south of quadrangle boundary. Unit is not exposed west of the Cat Mesa fault, however, it may still have its provenance in the Rio Puerco basin area because of (1) its greater thickness in this quadrangle relative to areas east of quadrangle and (2) presence of Mount Taylor obsidian clast

Ceja Formation

Tscu **Upper sand and gravel unit (upper Pliocene)**—Stacked sequence of alternating pale-brown (5YR5/2) to light-brownish-gray (5YR6/1) and grayish-orange-pink (5YR7/2) to very pale orange (10YR 8/2), poorly consolidated, poorly sorted, intercalated gravelly sand, gravelly silt, and pebble to cobble gravel beds. Upper contact contains strongly developed calcic soil exhibiting Stage III–IV pedogenic carbonate morphology (shown as light blue color on map) beneath the Llano de Albuquerque surface. Gravel is composed of granule- to cobble-size, angular to well-rounded clasts predominantly of the Pedernal Chert Member of the Abiquiu Formation (black and white variegated chalcedony and chert), chert, quartzite, chalcedony, granite, petrified wood, sandstone, jasper, limestone, basalt, volcanic rocks of intermediate composition, and reworked pelecypod valves. In the adjacent Wind Mesa quadrangle (Maldonado and Atencio, 1998a) to the northeast, pebbles are scattered on basalt of Wind Mesa about 5 m above its contact with unit Tscu, indicating that unit Tscu at least partially buried this flow, which is now exhumed. Pliocene (Blancan) fossil fragments were recovered from unit Tscu by the author from a local exposure in the adjacent Dalies quadrangle east of map area and identified by Morgan and Lucas (1999; New Mexico Museum of Natural History and Science NMMNH site L-3738). In the adjacent Wind Mesa quadrangle, unit varies in thickness from about 12 m in northwestern part of map area to at least 100 m in eastern part where the base is not exposed; shown as upper sand and gravel lithofacies of Isleta Reservation (QTui) by Maldonado and Atencio (1998a, b). Thickness about 25 m in this quadrangle

Tscm **Middle silt, sand, and clay unit (upper Pliocene)**—Interbedded grayish-yellow-green (5GY7/2) and yellowish-gray (5Y7/2) to grayish-yellow (5Y8/4), very fine grained, semiconsolidated, well-sorted sand, clayey silt, and light-olive-gray (5Y5/2) to dusky-yellow (5Y4/4) clay that locally contains carbonate concretions. Unit is predominantly fine grained, but in the northeastern part of the Dalies Northwest quadrangle and northern part of the Wind Mesa quadrangle (to the north and northeast, respectively), upper part of unit contains at least two thin sand and gravel intervals. Locally (sec. 1, T. 8 N., R. 1 W), in the adjacent Dalies Northwest (Maldonado and Atencio, 1998b) quadrangle to the north, unit contains a 3-cm-thick interval of rounded fluvially transported pumice dated at 3.12±0.10 Ma using the $^{40}Ar/^{39}Ar$ method (Maldonado and others, 1999). There, the pumiceous interval overlies a pinkish-colored sand bed just above base of unit. Pinkish-colored bed is characterized by cucumber- or potato-shaped concretions and contains Blancan rodent fossils (Morgan and Lucas, 2000). In northern part of this quadrangle, the basalt of Cat Mesa (Tcm, described subsequently) is found locally at base of unit Tscm. This flow has been dated at 3.0±0.01 Ma using the $^{40}Ar/^{39}Ar$ method (Maldonado and others, 1998, 1999). Unit Tscm pinches out in south-central part of map area, making differentiation of units Tscu and Tscl difficult. Shown as silt, sand, and clay lithofacies of Isleta Reservation (Tssi) by Maldonado and Atencio (1998a, b) in Wind Mesa and Dalies Northwest quadrangles. Thickness about 10 m

Tscl **Lower sand and gravel unit (Pliocene)**—Grayish-orange-pink (5YR7/2), pinkish-gray (5YR8/1) and light-brown (5YR6/4), subrounded to rounded, unconsolidated, well-sorted, matrix-supported, fine-to coarse-grained sand; minor interbeds of pebbly sand and gravel. Gravels contain clasts predominantly of pebble size, some of cobble size, in a coarse sand matrix. Clasts are mostly quartzite, sandstone, limestone, Pedernal Chert Member of the Abiquiu Formation, brownish-yellow chert, granite, Tertiary- and Mesozoic-age permineralized wood, intermediate-composition volcanic rocks, pelecypod valves, and basalt. Rare moderate-brown (5YR4/4) clayey sands interbedded with thin-bedded grayish-orange-pink (10R8/2) silt. Locally contains buried calcic soil horizons. Shown as lower sand and gravel lithofacies of Isleta Reservation (Tlsi) by Maldonado and Atencio (1998a) in Wind Mesa quadrangle. Exposed approximate thickness as much as 125 m

LOWER PART OF THE SANTA FE GROUP

Tsp **Popotosa Formation (Miocene and upper Oligocene)**—Light-brown (5YR6/4) to moderate-reddish-brown (10R4/6) clay, clayey sand, fine- to medium-grained sand, and rare thin gravel beds (Lozinsky and Tedford, 1991). An interval of gravel and trough cross-bedded sand occurs within this unit just west of the map boundary, representing a rare fluvial gravelly lens within the Popotosa Formation. Gravels are composed of white and red quartzite, intermediate-composition volcanic rocks, chert, and permineralized wood clasts. Unit is exposed in the Hidden Mountain and Mohinas Mountain area in southwestern part of map area, where it is intruded by the diabasic rocks of Mohinas Mountain (Tm). Equivalent to unit 1 of Lozinsky and Tedford (1991). As thick as 235 m south of map area (Lozinsky and Tedford, 1991) but exposed thickness only about 70 m

VOLCANIC ROCKS OF CAT MESA

Tcm **Lava flow of Cat Mesa (upper Pliocene)**—Dark-gray (N3) to grayish-black (N2), porphyritic basaltic flow, locally vesicular. Groundmass is coarsely microgranular and is composed of plagioclase, olivine, clinopyroxene, magnetite(?), and ilmenite(?). Contains approximately 25–30 percent phenocrysts of plagioclase (62 percent), about 5 mm in length, clinopyroxene (23 percent), about 1 mm in length, olivine (9 percent), about 2 mm in length, magnetite (3 percent), and ilmenite (3 percent). Locally occurs at the contact between units Tscm and Tscl; here unit Tcm overlies a calcic soil at top of unit Tscl that contains scattered, cylindrical carbonate-cemented nodules. Dated at 3.00±0.01 Ma using the $^{40}Ar/^{39}Ar$ method (Maldonado and others, 1998 and 1999). Exposed thickness as much as about 25 m

INTRUSIVE ROCKS OF MOHINAS MOUNTAIN

Tm **Diabase of Mohinas Mountain (Miocene)**—Grayish-black (N2) to dark-gray (N3) basaltic and olivine diabase sill, dikes, and cone sheet(s) in southwestern part of map area; some vesicular rocks may be lava flows (Kelley and Kudo, 1978; Lozinsky and Tedford, 1991). Rocks forming cone sheets contain plagioclase and olivine phenocrysts as long as 4 mm in a fine-grained (about 1 mm) groundmass (Kelley and Kudo, 1978). Rocks intrude the Popotosa Formation of the lower Santa Fe Group (Tsp) and have been dated at 8.3±0.02 Ma using the K/Ar method (Baldridge and others, 1987). Sample location approximately located on map. Exposed thickness of unit is variable but is as much as 38 m

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