Geologic Map of the Albuquerque East Quadrangle, Bernalillo County, New Mexico

By

Hawley, J.; Chamberlin, R. M.; Connell, S. D.

June, 1996

New Mexico Bureau of Geology and Mineral Resources
Open-file Digital Geologic Map OF-GM 003

Scale 1:24,000

This work was supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program (STATEMAP) under USGS Cooperative Agreement 06HQPA0003 and the New Mexico Bureau of Geology and Mineral Resources.

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

Albuquerque east 7.5″
quadrangle
OF-DM 3

GEOLOGY OF THE ALBUQUERQUE EAST 7.5–MIN. QUADRANGLE, BERNALILLO COUNTY, NEW MEXICO

by
John Hawley and Richard Chamberlin

New Mexico Bureau of Mines and Mineral Resources
Open-File Report DGM-3
June 1, 1995

Printed on August 25, 1998

New Mexico Bureau of Mines and Mineral Resources
A division of New Mexico Institute of Mining and Technology
801 Leroy Place
Socorro, NM 87801-4796

COMMENTS TO MAP USERS

Mapping of this quadrangle was funded by a matching-funds grant from the 1998 STATEMAP program of the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number 1434-HQ-97-AG-01781, to the New Mexico Bureau of Mines and Mineral Resources (Dr. Charles E. Chapin, Director; Dr. Paul W. Bauer, P.I. and Geologic Mapping Program Manager).

This quadrangle map has been Open-Filed in order to make it available as soon as possible. The map has not been reviewed according to NMBMMR standards, and due to the ongoing nature of work in the area, revision of this map is likely. As such, dates of revision are listed in the upper right corner of the map and on the accompanying report. ***The contents of the report and map should not be considered final and complete until it is published by the NMBMMR.***

A geologic map graphically displays information on the distribution, nature, orientation, and age relationships of rock and surficial units and the occurrence of structural features such as faults and folds. Geologic contacts are irregular surfaces that form boundaries between different types or ages of units. Data depicted on this geologic map are based on field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation.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. Significant portions of the study area may have been mapped at scales smaller than the final map; therefore, the user should be aware of potentially significant variations in map detail. 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 everywhere.

Any enlargement of this map could cause misunderstanding in the detail of mapping and may result in erroneous interpretations. The information provided on this map cannot be substituted for site-specific geologic, hydrogeologic, or geotechnical investigations. The use of this map to precisely locate buildings relative to the geological substrate is not recommended without site-specific studies conducted by qualified earth-science professionals.

The cross-sections in this report are constructed based on surficial geology, and where available, subsurface and geophysical data. The cross sections are interpretive and should be used as an aid to understand the geologic framework and not used as the sole source of data in locating or designing wells, buildings, roads, or other structures.

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 U.S. Government.

Explanation of map units

Alluvial Deposits — Primarily light gray-brown, brown, and reddish-brown (10 to 5 YR hues), loamy sand and gravelly sand, loam, sand, and gravel. Silt-clay mixtures are uncommon. Clast lithologies in the northeastern two-thirds of the quadrangle reflect bedrock composition of local upland drainage systems (Sandia-Manzanita mountain-front, and Tijeras and Coyote Canyons). The southwestern area, however, is dominated by primary and reworked deposits of the ancestral Rio Grande system (of latest Miocene to earliest Pleistocene age) with source areas in the mainstem, Jemez, and Chama drainage basins that

extend northward into southern Colorado. Horizons of soil-carbonate and -clay accumulation (nonindurated-calcic and argillic) are characterized by weak to moderately well-developed stages of development and rarely exceed 1 m in thickness. Such pedogenic (initial diagenetic) features are best preserved beneath broader and flatter parts of constructional surfaces (e. g. fans and terrace treads) that have not been subject to much erosion or sedimentation since initial landform development.

Alluvial, colluvial, eolian, and lacustrine deposits that are (erosionally) inset against, or bury basin-fill of the Santa Fe Group are:

1. Valley fill (Qa and Qv subunits) — Stream deposits restricted to the entrenched valleys of major tributary arroyo systems (Tijeras, Coyote, Embudo-Embudito and Campus), and the Rio Grande Valley itself.
2. Piedmont-Slope Alluvium (Qp subunit) — Stream deposits on constructional parts of piedmont slopes (e.g. Llano de Sandia and Manzano), including fan alluvium and local debris-flow deposits, and fills of swales and shallow valleys not graded to the entrenched major arroyo-valley and river-valley system.
3. Undivided valley and younger basin fill (Qoa, Qe and Ql units) — Alluvium and local eolian and playa-lake sediments deposited in a transitional piedmont-toeslope and basin-floor environment during earliest states of Rio Grande Valley incision that marked the end of widespread filling to the Albuquerque Basin (Upper Santa Fe Group deposition) in Early Pleistocene time (_1.7 to 0.7 Ma).

d Disturbed land.

Valley Fill

Qat Tijeras Arroyo Channel Alluvium (Upper Holocene) — Light-brown to gray-brown sand and gravel, with lenticular beds of loamy sand. Arkosic and mixed-siliceous clast composition reflects character of Proterozoic to Mesozoic (plutonic and sedimentary) source terranes including Tijeras and Coyote Canyons in the Sandia and Manzanita Mountains, and older basin and valley fill units exposed in the Tijeras-Coyote arroyo system west of the mountains. Thickness ranges from 3 to 10 ft (1 to 3 m). Unit as mapped includes low-terrace remnant of older valley-fill deposits.

Qac Coyote Arroyo Channel Alluvium (Upper Holocene) — Light-gray to brown gravel and sand, with loamy sand interbeds. Clast composition reflects dominant lithologic (Proterozoic metamorphic, Paleozoic sedimentary, and Santa Fe Gp basin-fill) character of Manzanita Mountain and Coyote Canyon source terranes. Estimated thickness less than 10 ft (3 m). Mapping unit includes low-terrace remnants of older valley fills (late Quaternary).

Qvt Alluvium of Tijeras (Arroyo) Valley (Holocene and Uppermost Pleistocene) — Light-brown to reddish-brown sandy loam, loamy sand and gravelly sand exposed in the walls of Tijeras Arroyo and forming the primary inner-valley-fill unit. Clast composition as in unit Qat. Thickness may exceed 30 ft (9 m) in lower reach of valley below Montesa Park area (Sec. 11, T9N, R3E). Includes narrow Qat channel fills and thin interbeds and surficial layers of unit Qvy and along outer edge of the valley floor (toes of flanking sideslopes).

Qvc Alluvium of (Arroyo del) Coyote Valley (Uppermost Quaternary) — Light-brown to gray-brown gravelly loamy sand and loam, gravel, and sand exposed in walls of lower Arroyo del Coyote and forming the primary fill of its inner valley; clast composition as in unit Qac. Estimated maximum thickness ranges from 20 to 30 ft (6 to 9 m). Major mapping inclusions are units Qac and Qry.

Qvy Younger Valley-Border Alluvium (Holocene and Uppermost Pleistocene) — Undivided arroyo-fan and low-terrace deposits in valley-floor areas along the tributary to the inner valleys of the Rio Grande and its major arroyo tributaries. Light-brown, gray-brown, and reddish-brown sandy loam, loamy sand, sand and gravel. Clast composition reflects local hill- and piedmont-slope source areas. Soil carbonate and clay horizons weakly developed or absent. Estimated maximum thickness range from 20 to 30 ft (6 to 9 m).

Qvo Older Valley-Border Alluvium (Upper and Middle Pleistocene) — Dissected arroyo fan and terrace deposits graded to ancestral-river base levels as much as 330 ft (100 m) above the present Rio Grande floodplain. Light-gray, brown, and reddish-brown sandy loam, loamy sand, sand, and gravel with thin lenticular beds of sandy clay loam and clay loam. Soil-carbonate and -clay horizons are moderately well developed (usually less than 3 ft (1 m) thick) beneath stable remnants of Pleistocene geomorphic surface. Correlative with fluvial deposits associated with the Primero Alto to Tercero Alto river-terrace sequence of Machette (1985), and coeval with the Los Duranes Formation, and Edith and Menaul "gravels" of Lambert (1968; Lambert et al., 1982).

Qva Undivided complexes of units Qvy and Qvo in valleys of Llano de Sandia and ancestral Tijeras systems (Upper and Middle Quaternary).

Qvof Fluvial Terrace Deposits of the ancestral Rio Grande (Upper and Middle Pleistocene) — Light gray-brown and brown pebble to cobble gravel, gravelly sand, and sand with some interbedded silt-clay and loam layers. Gravel clasts range from subangular to well-rounded with composition dominated by resistant siliceous sedimentary, igneous and metamorphic types, and andesites and basalts. Discontinuous zones of carbonate cementation (sparry and calcite micritic) represent deep-vadose and saturated-zone (groundwater) accumulations, as well as soil-carbonate horizons. Includes Edith and Menaul "gravels" of Lambert (1968).

Qvou Undivided complex of units Qvof and Qvo (Upper and Middle Pleistocene).

Qvot Terrace Alluvium in Upper Valley of Tijeras Arroyo (Middle Pleistocene) — Deposits capping high valley-border erosion surfaces (straths) cut on older basin fill (Qoat/QTsp) between mouth of Tijeras Canyon and confluence with Arroyo de Coyote. Light-brown and reddish-brown sandy loam, gravelly loamy sand, sand, and gravel, with some lenticular beds of sandy clay loam and loam. Soil-carbonate and -clay accumulations are moderately well developed and up to 3 ft (1 m) thick beneath stable surface remnants. Maximum estimated thickness ranges from 10 to 20 ft (3 to 6 m).

Piedmont Slope Deposits

Qpy Younger Piedmont-Slope Alluvium (Holocene and Upper Pleistocene) — Deposits of coalescent fans and fills of shallow valleys extending west from Sandia and Manzanita Mountain fronts. Light-brown and reddish-brown sandy loam, gravelly loamy sand, sand and gravel. Horizons of soil-carbonate and -clay accumulations are weakly developed or absent. Estimated maximum thickness ranges from 10 to 20 ft (3 to 6 m). Equivalent to unit Qvy.

Qpo Older Piedmont-Slope Alluvium (Holocene to Middle Pleistocene) — Shallowly dissected fan and valley-fill deposits (less than 30 ft (9 m) local relief) mantling upper piedmont slopes west of the Sandia and Manzanita Mountains. Light-brown and reddish-brown to pink sandy loam, gravelly loamy sand, sand and gravel with thin lenticular beds of sandy clay loam and loam. Horizons of soil-clay and -carbonate accumulations are moderately well developed beneath

stable remnants of Pleistocene surfaces. Maximum estimated thickness ranges from 60 to 100 ft (20 to 30 m).

Qpa Undivided complexes of units Qpo and Qpy (Holocene and Middle Pleistocene).

Qpu Piedmont-Slope Alluvium (Quaternary) — Undivided complex of fan and piedmont valley fills including unit Qpa equivalent and underlying deposits of the Sierra Ladrones Formation – piedmont facies (QTsp).

Undifferentiated Basin and Valley Fill

Qoa Older Valley-fill and Piedmont-Toeslope Alluvium on eastern summit plain of Mesa del Sol (Middle Pleistocene) — Surficial alluvial deposits with a thin (< 6 ft, 2 m) discontinuous veneer of eolian sediments (Qe), capping older Tijeras fan alluvium and distal piedmont facies of the Sierra Ladrones Formation (upper Santa Fe Gp) south of the lower valley of Tijeras Arroyo. Light-brown, reddish-brown, and pink (calcareous) sandy loam, loam, pebbly loam to sand, sand, and pebble gravel. Soil-carbonate and -clay horizons are moderately to well developed up to 5 ft (1.5 m) thick, and occur in stacked sequence with as many as three buried soils interbedded with alluvial and eolian deposits that are not significantly affected by pedogenesis. Common arkosic and siliceous clasts in the coarse sand- to pebble-size range reflect the major contribution from the Sandia Granite-sedimentary rock terranes exposed in the upper Tijeras watershed. Estimated maximum thickness 10 to 20 ft (3 to 6 m).

Qoat Older Tijeras Valley Fill and Fan alluvium (Middle to Lower Pleistocene) — Unit is poorly exposed in walls of upper Tijeras Arroyo Valley between Four Hills Blvd (Tijeras quad) and Airport runways. Light-brown, reddish-brown, and pink (calcareous) sandy loam, gravelly loamy sand, sand, and gravel with lenticular beds of loam and sandy clay loam. Clast composition reflects dominantly granitic and arkosic sedimentary terrane in the upper Tijeras watershed. Buried horizons of soil-carbonate and -clay accumulations are commonly present in the exposed basin-fill sequence. Maximum estimated thickness is about 100 ft (30 m). Intertongues with unit Qoac at confluence of Tijeras and Coyote Arroyos. Laterally is transitional upward into unit Qao, grades laterally into unit Qpu and uppermost piedmont facies of Sierra Ladrones Fm; and is partly transitional to basal parts of units Qpo and Qpa.

Qoac Older (Arroyo del) Coyote Valley-Fill and Fan Alluvium (Middle and Lower Pleistocene) — Light-brown, gray-brown, and reddish-brown gravelly loamy sand and sandy loam, sand, and gravel; with lenticular beds loam and sandy loam. Clast composition reflects metamorphic and carbonate-dominated (Precambrian and Pennsylvanian) bedrock terranes of their northern Manzanita Mountain source area. Stacked sequences of buried soils as in unit Qoat. Maximum estimated thickness about 100 ft (30 m). Facies equivalent of unit Qoat.

Undifferentiated Valley and Basin Deposits

Qe Eolian Deposits Undivided (Holocene and latest Pleistocene) — Light-brown to reddish-brown sand, loamy sand, loam and silt loam. Weakly developed horizons of soil-carbonate and -clay accumulation are in older subunits. Estimated thickness usually in the 3 to 6 ft (2 m) range, but local stabilized sand-dune sequences may be 10 to 15 ft (3-4.5 m) thick.

Ql Playa-lake Deposits Undivided (Holocene) — Brown to gray-brown loam, silt loam, sandy clay, and clay loam with intertongues of unit Qe. Estimated maximum thickness less than 5 ft (4.5 m).

Qca Colluvium and Alluvium (Holocene and Upper Pleistocene) — Mass-wasting, slope-wash and stream deposits on valley-sideslopes and hillslopes, and headwater valley floors. Light-brown, gray-brown and reddish-brown, gravelly loam to sandy loam, with lenses of sand, gravel, silt and clay. Thickness usually in 3 to 10 ft (3 m) range.

SANTA FE GROUP (LOWER PLEISTOCENE TO LOWER MIOCENE) — Comprises the sedimentary fill and most associated volcanic rocks of basins within the Rio Grande rift structural province (Bryan, 1938; Chapin and Cather, 1994). As redefined by Machette (1978 a,b) in the Albuquerque Basin area south of 35_N Latitude, the group includes two formal lithostratigraphic subdivisions: the Sierra Ladrones and Popotosa Formations. Kelley (1977) subdivided the Santa Fe "Formation" in the entire basin (from Cochiti Dam to San Acacia) into three members: The upper Ceja Member (generally equivalent to the Plio-Pleistocene Sierra Ladrones Fm), an unnamed "middle" member (primarily mapped as middle and upper Miocene deposits correlative with upper Popotosa Fm), and the basal Zia Member (lower to middle Miocene). Manley (1978) also proposed inclusion of the Cochiti Formation (Bailey and Smith, 1969) as a middle to upper Santa Fe subdivision in the Lower Jemez Valley area. In the west-central basin area (Gabaldon Badlands), adjacent to the Lucero Uplift, the sedimentology, biostratigraphy, and structure of the upper Popotosa and Sierra Ladrones Formations have been described in detail by Lozinsky (1987) and Lozinsky and Tedford (1991). Note that the terms Popotosa Formation and Zia Sand were originally proposed as pre-Santa Fe units, by Denny (1940) and Galusha (1966), respectively. The only part of the Santa Fe Group exposed in the Albuquerque East Quadrangle is the Sierra Ladrones Formation (used here as defined by Machette, 1978a, b). The sedimentology and biostratigraphy of Sierra Ladrones sections in adjacent parts of the Albuquerque West Quadrangle (at the lower end of the valley of Tijeras Arroyo) are also the subject of detailed studies by Lambert (1968) and Lucas et al. (1993). The general subsurface character of the entire group (cross section A-A' to C-C') is illustrated through the use of an informal upper, middle, lower Santa Fe (hydrostratigraphic unit subdivisions) described by Hawley et al., 1995.

Sierra Ladrones Formation (Middle Pleistocene to Upper Miocene). The mapped area includes two major facies and four mapping units: basin-floor (primarily ancestral Rio Grande fluvial facies - Qsf, QTsf, and piedmont-slope facies (mostly fan alluvium, some debris-flow units - Qsp, QTsp).

Qsf Relict basin-floor surface and soils on fluvial facies (Lower to middle Pleistocene). Basal sand and gravel zone, primarily braided-floodplain deposits, grades into unit QTsf; capped by a well-developed, but usually nonindurated, calcic soil zone (up to 4 ft (1.25 m) thick) that formed in mixed fluvial and surficial eolian sediments (reworked by pedogenic processes). Estimated maximum thickness 6 to 10 ft (2 to 3 m). A thin "Qe" veneer is present in most places. Includes part of the Early to Middle Pleistocene Sunport geomorphic surface defined by Lambert (1968) and is laterally transitional to unit Qsp. These combined units (without "Qe") define the top of the Santa Fe Group in the Albuquerque area.

Qsp Relict Piedmont Surface and Soils on Alluvial-Fan Facies (Lower and Middle Pleistocene). Piedmont-toeslope alluvium grading down into unit QTsp; usually capped with a strong calcic soil with a locally well-developed upper argillic horizons) that formed in mixed alluvial and surficial eolian sediments. Estimated maximum thickness 6 to 10 ft (2 to 3 m). A discontinuous "Qe" veneer is also present. Includes part of Sunport geomorphic surface of Lambert (1968), and is laterally transitional to unit Qsf.

QTsf Sierra Ladrones Ancestral-River (Fluvial) Facies (Lower Pleistocene and Pliocene) — Light-gray to yellowish-brown gravelly sand, sand, with discontinuous lenses of partly conglomeratic sandstone. Contains reworked Guaje pumice clasts (1.6 Ma, Wolff and Gardner, 1995), mudballs,

greenish-gray silt-clay and diatomaceous beds, and pebble to cobble gravel lenses. Clast lithology like unit Qvof. Large trough sets of crossbeds (3 to 6 ft (1 to 2 m) amplitude) are the major sedimentary structures. Grades upward to unit Qsf and to the east is overlapped by and intertongues with unit QTsp. Exposed thickness in quadrangle about 250 ft (80 m). Total thickness about 1,300 ft (400 m); see sections A-A' and B-B'. The biostratigraphy of the exposed part of the formation (Upper Pliocene-Lower Pleistocene; Irvingtonian and Late Blancan provincial ages) in the lower Tijeras Valley area has been described by Lambert (1968), Tedford (1981), and Lucas et al. (1993).

QTsp Sierra Ladrones Piedmont-Slope (Alluvial) Facies (Lower Pleistocene and Pliocene) — Light-brown, reddish-brown, and pink sandy loam, pebbly loamy sand, sand and pebble gravel, with lenticular beds of loam and sandy clay loam. Clast composition and buried soils as in units Qaot and Qaoc. Intertongues westward with and overlaps unit QTsf. Exposed thickness in quadrangle about 100 ft (30 m). Maximum total thickness, about 1800 ft (550 m); see Sections A-A' to C-C'.

Note: Symbol QTsf (c) and QTsp (c) delineate hillslopes with thick alluvial cover and/or intensive urban development.

IGNEOUS AND METAMORPHIC ROCKS

Yp Pegmatite dikes

Ys Sandia Granite (Middle Proterozoic) — Megacrystic monzogranite to granodiorite, several-cm-long K-feldspar megacrysts are commonly aligned in a magmatic foliation; contains numerous ellipsoidal enclaves of microdiorite, fine-grained granite, and gabbro (interpreted to be mingled mafic magmas), and xenoliths of quartzite and mafic metavolcanic rock.

REFERENCES

Bryan K., 1938, Geology and groundwater conditions of the Rio Grande depression in Colorado and New Mexico; *in* U.S. Natural Resources Planning Board, The Rio Grande Joint Investigations in the Rio Grande Basin: Washington, D.C., U.S. Government Printing Office, v. 1, pt. 2, pp. 197–225.

Chapin, C. E., 1988, Axial basins of the northern and central Rio Grande rifts; *in* Sloss, L. L., ed., Sedimentary cover—North American Craton (U.S.): Geological Society of America, Geology of North America, v. D-2, pp. 165–170.

Chapin, C. E., and Cather, S. M., 1994, Tectonic setting of the axial basins of the northern and central Rio Grande rift: Geological Society of America, Special Paper 291, pp. 5–25.

Galusha, T., 1966, The Zia Sand Formation, new early to medial Miocene beds in New Mexico: American Museum Novitates, n. 2271, pp. 1–12.

Hawley, J. W., compiler, 1978, Guidebook to the Rio Grande rift in New Mexico and Colorado: New Mexico Bureau of Mines & Mineral Resources, Circular 163, 241 pp.

Hawley, J.W., and Haase, C. S., 1992, compilers, Hydrogeologic framework of the northern Albuquerque Basin: New Mexico Bureau of Mines & Mineral Resources, Open-file Report OF-387, 74 pp., 8 appendices, glossary.

Hawley, J. W., Bachman, G. O., and Manley, K., 1976, Quaternary stratigraphy in the Basin and Range and Great Plains provinces, New Mexico and western Texas; *in* Mahaney, W. C., ed., Quaternary stratigraphy of North America: Stroudsburg, PA, Dowden, Hutchinson, and Ross, Inc., pp. 235–274.

Hawley, J. W., Haase, C. S., and Lozinsky, R. P., 1995, An underground view of the Albuquerque Basin: Proceedings of the 39th Annual New Mexico Water Conference "The water future of Albuquerque and Middle Rio Grande Basin": New Mexico Water Resources Research Institute, Technical Report.

Lambert, P. W., 1968, Quaternary stratigraphy of the Albuquerque area, New Mexico: [unpub. PhD. dissertation]: Albuquerque, University of New Mexico, 329 pp.

Lambert, P. W., Hawley, J. W., and Wells, S. G., 1982, Supplemental road-log segment III-S: Urban and environmental geology of the Albuquerque area: New Mexico Geological Society, Guidebook 33, pp. 97-124.

Lozinsky, R. P., 1988, Stratigraphy, sedimentology, and sand petrology of the Santa Fe Group and pre-Santa Fe Tertiary deposits in the Albuquerque Basin, central New Mexico: [unpub. Ph.D. dissertation]: Socorro, New Mexico Institute of Mining and Technology, 298pp.

Lozinsky, R. P., 1994, Cenozoic stratigraphy, sandstone petrology, and depositional history of the Albuquerque Basin, central New Mexico: Geological Society of America, Special Paper 291, pp. 73-81.

Lozinsky, R. P., and Tedford, R. H., 1991, Geology and paleontology of the Santa Fe Group, southwestern Albuquerque Basin, Valencia County, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 132, 35 pp.

Lozinsky, R. P., Hawley, J. W., and Love, D. W., 1991, Geologic overview and Pliocene-Quaternary history of the Albuquerque Basin, central New Mexico: New Mexico Bureau of Mines & Mineral Resources, Bulletin 137, pp. 157–162.

Lucas, S. G., Williamson, T. E., and Sobus, J., 1993, Plio-Pleistocene stratigraphy, paleoecology, and mamalian biochronology, Tijeras Arroyo, Albuquerque area, New Mexico: New Mexico Geology, v. 15, no. 1, February 1993, pp. 1-8, 15.

Machette, M. N., 1978a, Geologic map of the San Acacia quadrangle, Socorro County, New Mexico: U.S. Geological Survey, Geologic Quadrangle Map GQ–1415, scale 1:24,000.

Machette, M. N., 1978b, Preliminary geologic map of the Socorro 1_ by 2_ quadrangle, central New Mexico: U.S. Geological Survey, Open-file Report 78-607, scale 1:250,000.

Machette, M. N., 1985, Calcic soils of the southwestern United States; *in* Weide, D. L., ed., Quaternary soils and geomorphology of the American Southwest: Geological Society of America Special Paper 203, pp. 1–21.

Manley, K., 1978, Geologic map of Bernalillo NW Quadrangle, Sandoval County, New Mexico: U.S. Geological Survey, Geologic Quadrangle Map GQ–1446, scale 1:24,000.

Tedford, R. H., 1981, Mammalian biochronology of the late Cenozoic basins of New Mexico: Geological Society of America Bulletin, Part I, v. 92, pp. 1008-1022.

Wolff, J. A., and Gardner, J. N., Is the Valles caldera entering a new cycle of activity?: Geology, v. 23, no. 5, May 1995, pp. 411-414.

EXPLANATION FOR CROSS SECTIONS OF ALBUQUERQUE EAST 7.5-MIN QUADRANGLE

Surficial (Post-Santa Fe) map units not shown.

QTs Upper Santa Fe Group Sierra Ladrones Formation (Upper Miocene to Lower Pleistocene)—Undivided fluvial (QTsf) and piedmont (QTsp) facies in zones where ancestral Rio Grande and piedmont-toeslope alluvial deposits are completely interbedded.

QTsp Sierra Ladrones Formation, piedmont alluvial-fan facies.

QTsf Sierra Ladrones Formation, basin-floor fluvial facies.

Tsm Middle Santa Fe Group (Middle and Upper Miocene)—Undivided basin-floor (fluvial, eolian, and lacustrine) and piedmont-slope (alluvial) deposits.

Tsmp Middle Santa Fe Group, piedmont alluvial-fan and eolian facies.

TsL Lower Santa Fe Group (Lower Miocene)—Undifferentiated basin-floor and piedmont-slope deposits. Thick playa-lake and eolian sequences appear to be major facies components.

Tp Undifferentiated volcanic and sedimentary rocks (Paleogene).

MzPz Undifferentiated sedimentary rocks (Mesozoic and Upper Paleozoic).

pC– Undifferentiated igneous and metamorphic rocks (Proterozoic)