Preliminary Geologic Map of the Alameda Quadrangle, Bernalillo and Sandoval Counties, New Mexico

By

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May, 1997

New Mexico Bureau of Geology and Mineral Resources
Open-file Digital Geologic Map OF-GM 10

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.

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OF-DM 10

GEOLOGY OF THE ALAMEDA 7.5-MINUTE QUADRANGLE, BERNALILLO AND SANDOVAL COUNTIES, NEW MEXICO

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Open-File Report DGM-10
May, 1997

Printed on August 25, 1998

INTRODUCTION

The Alameda 7.5-minute quadrangle comprises an area of about 158 km^2 (61 mi^2) along western flank of Rincon Ridge and Sandia Mountains, in Bernalillo and southern Sandoval County, New Mexico (Fig. 1). Recent growth of Albuquerque and vicinity resulted in increased demands on the development of local groundwater supplies and suitable building sites. Initial work in the study area and vicinity have been regional reconnaissance studies that primarily focused on the Sandia Mountains and basin fill (Herrick and Johnson, 1900; Bryan, 1909; and Hayes, 1951). Later studies of the geology included a reconnaissance of the piedmont geology (Connell, 1996), Sandia Mountains (Kelley and Northrop, 1975 and Hayes, 1951), and the Albuquerque basin (Hawley and Hasse, 1992; Hawley and others, 1995; Kelley, 1977; and Lambert, 1968) (Fig. 2). The geologic map (Plate I) and cross sections (Plates II and III) are the result of additional field reconnaissance mapping and incorporation of borehole data that has refined the structure and stratigraphy of the eastern margin of the Albuquerque basin. The topographic base for the geologic map is the Alameda quadrangle, 7.5-minute topographic series, published by the United States Geological Survey at a scale of 1:24,000 (one inch equals 2000 feet). Development of gravel pits along the western margin of the quadrangle and residential and commercial growth throughout the City of Albuquerque and vicinity has obscured many exposures. Lambert (1968) produced a geologic map (scale of 1:48,000) of the region prior to significant ground disturbance. Portions of this map are incorporated onto the geologic map. Areas of extensive disturbance are delineated using several vintages of aerial photography and supplemented by previous mapping.

Principal contributions and revisions to previous work include refinement of Lambert's mapping, recognition and delineation of several buried faults using subsurface data, differentiation of piedmont and axial-river facies of the upper Santa Group in subsurface, and documentation of a segment of the Rincon fault that last ruptured the ground surface during the Holocene (Connell, 1996).

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.

Accessibility and Land Use

The study area is traversed by several paved and improved dirt roads. Tribal lands of the Pueblo of Sandia occupy nearly half of the quadrangle area. Land use on tribal lands is primarily rangeland. Open-pit mining of the Edith Blvd alluvium for aggregate resources occurs along the western margin of the piedmont. Land use to the south is primarily residential, commercial and light industrial. Areas south and west of tribal lands is under private ownership or administered by several city and county entities. Access to tribal lands is by dirt road and is prohibited or locally restricted. Permission should be obtained prior to entering tribal and private lands.

Geologic and Physiographic Setting

The quadrangle lies within the Basin and Range physiographic province, an area characterized by alternating, block-faulted ridges and valleys. The study area traverses the western flank of the Sandia Mountains and eastern margin of the Albuquerque basin of the Rio Grande rift in central New Mexico (Woodward and others, 1978; Chapin and Cather, 1994). The Rincon and Sandia faults are major range-bounding structures that juxtapose east- and north-tilted blocks of Phanerozoic sedimentary and Proterozoic crystalline rocks of the Sandia Mountains against upper Cenozoic basin sediments.

The study area exhibits 790 m (2592 ft) of topographic relief, with a maximum elevation of 2283 m (7490 ft) along the crest of Rincon Ridge, and a minimum elevation of 1494 m (4900 ft) along the floor of the Rio Grande Valley. Topography is steep and rugged on Rincon Ridge where Proterozoic rocks are exposed. The piedmont of Rincon Ridge and the Sandia Mountains slopes to the west between 1 to 4˚. The valley of the Rio Grande is marked by a prominent 12 to 24-m high escarpment.

The study area vicinity has a warm, arid-to semi-arid continental climate with a mean annual precipitation of 178 to 254 mm (7 to 10 in) in lowland areas (Williams, 1986; Hacker, 1977). The foothills receive 254 to 356 mm (10 to 14 in) of rainfall per year, and the mountains receive 635 to 762 mm (25 to 30 in) (Hacker, 1977; Williams, 1986). Mean annual temperatures range from 14˚C in the lowest regions, to 10˚C along the foothills, to 4˚C at Sandia Crest (Hacker, 1977). Vegetation is generally sparse, except at springs and along the floors of major arroyos, and consists primarily of juniper, grasses, shrub and cacti at lower elevations. The foothills and Rincon Ridge support a sparse to moderate cover of juniper and piñon trees.

STRATIGRAPHY

All map units are described in Table 2. The age and stratigraphic relationships of these map units are summarized in the *Correlation of Map Units* section. The following is a brief summary of stratigraphic and geomorphic relationships of units in the study area.

Quaternary Deposits

The Quaternary alluvial sequence, as discussed in this report, is a sequence of stepped piedmont, valley-fill and valley-border landforms, deposits and geomorphic surfaces that unconformably overlie Cenozoic basin fill and older rocks. Members of this sequence range from historical to early Pleistocene in age and are informally defined, mapped and correlated on the basis of stratigraphic superposition, surface morphology, landscape-topographic position and soil-profile characteristics. Deposits are a mixture of poorly to moderately consolidated, poorly to well sorted gravel, sand and silt, deposited by perennial and ephemeral streams and debris flow. Correlation of alluvial units described in previous studies are noted in Table 3. Alluvial deposits unconformably overlie basin-fill deposits of the Santa Fe Group and are divided into three major classes. General characteristics of these classes are:

Valley-fill and Valley-border alluvium of the Sandia Mountains piedmont (QHva and Qvy subunits) — Stream (floodplain and arroyo-terrace) deposits restricted to major entrenched tributary valleys, such as Bear, Pino, Juan Tabo, Domingo Baca Creeks.

Piedmont-slope alluvium (Qpo and Qpm subunits) — Alluvial deposits on constructional and erosional parts of piedmont slopes of the Llano de Sandia. Units include coalescent piedmont-fan and alluvial-slope deposits, debris-flow deposits and shallow-valley fills that are not graded to major entrenched arroyo systems.

Valley-fill alluvium of the ancestral Rio Grande (QHvr and Qvr subunits) — Stream (floodplain and arroyo-terrace) deposits that are restricted to former and current positions of the Rio Grande.

Unit Qpo is topographically the highest unit on the piedmont. The base of this unit is not exposed, but the unit is inset against mixed piedmont and axial facies of the Santa Fe Group to north of Sandia Wash (Connell, 1996) and is probably unconformable with the Santa Fe Group in the study area. This unit is deeply dissected with minimal preservation of stripped calcic soils on interfluves. The western margin of this unit abruptly terminates against a buried escarpment associated with the eastern limit of fluvial terraces deposited by the Rio Grande as the river incised into basin fill of the Santa Fe Group (Connell, 1996). The surface is deeply dissected and soils are partially stripped and locally preserved on interfluves.

Unit Qpm is inset against Qpo and forms an areally extensive set of coalescent alluvial fans that grade to the top of the Edith Blvd alluvium (Qvr1). The surface is moderately dissected and exhibits subdued bar-and-swale topography. Soils are variable but are, in general, moderately developed and possess brown to light gray Btk and Bk horizons with stage III calcium-carbonate morphology. The surface is complex, locally dissected or buried by younger deposits.

Unit Qvy forms broad, generally elongate, valley-floor and valley-border deposits associated with major piedmont drainages. This unit is common along the base of Rincon Ridge and along the distal portions of the piedmont. Qvy overlies Lambert's (1968) Menaul Blvd alluvium (Qvr2). Soils are weakly to moderately developed and possess a stage I to II carbonate morphology. This unit is inset against Qvr1 and Qvr2 north of Albuquerque.

Unit QHva forms historic to late Holocene alluvium associated with the floors of modern drainages. Deposits exhibit none to very slight soil development.

Two prominent terraces deposited by the ancestral Rio Grande occur along the western margin of the piedmont. These units were informally named the Edith formation (older) and Menaul formation by Lambert (1968).

Tertiary Deposits

Tertiary deposits of the Alameda quadrangle are a mixture of poorly to moderately sorted, poorly to moderately stratified, clast-and matrix-supported alluvium having predominantly gravelly and sandy textures. These deposits comprise the Santa Fe Group, a thick sequence of fluvial and piedmont deposits that represent the Neogene to Pleistocene syntectonic fill of the Rio Grande rift. Gravity models of the Albuquerque basin suggest about 1.5 km of Santa Fe Group basin fill within the study area (Birch, 1982). In the quadrangle, the Santa Fe Group is informally divided into an intrabasinal piedmont lithofacies that interfingers to the west with an extrabasinal lithofacies that was deposited by an ancestral Rio Grande. Pumice clasts derived from the Bandelier tuff of the Jemez Mountains are locally recognized in the axial lithofacies (see Lucas and others, 1993; Cather and others, 1995; Lambert, 1968), indicating an early Pleistocene maximum age of deposition in the study area.

Mesozoic Rocks

Lower Mesozoic strata occur as relatively small inliers along the base of Rincon Ridge and eastern margin of the study area. These rocks consist of highly faulted reddish-brown mudstone and yellowish-brown sandstone that may represent a tectonic horse of the Entrada Sandstone or Petrified Forest Formation of the Chinle Group along the frontal fault system of the Sandia Mountains. Another explanation for the anomalous stratigraphic position of these rocks is that they are related to old landslide deposits that slid down the mountain front during initial uplift in the Miocene; however, these deposits sit on the hanging wall of the frontal fault, an unlikely position for preservation of such deposits.

Proterozoic Rocks

Proterozoic rocks in the Alameda quadrangle consist of plutonic and metamorphosed sedimentary rocks of the Sandia granite and Juan Tabo sequence, respectively (Hayes, 1951). These rocks formed in orogenic belts along the periphery of the craton of North America. Rocks of the Juan Tabo sequence are resistant quartzite and quartz-mica schist that were metamorphosed during emplacement of the Sandia Granite at about 1600 Ma (Brookins, 1982 and Kelley, 1977)

STRUCTURAL GEOLOGY

Faults in the Alameda quadrangle are dominated by normal, down-to-the-west slip associated with the development of the Rio Grande rift. The Jaral Canyon fault is named for a relatively short, northeast-striking fault zone that connects the Rincon fault with the Sandia frontal fault system. This fault is recognized by the juxtaposition of highly faulted Mesozoic strata against Proterozoic rocks.

The Rincon fault was named by Kelley and Northrop (1975) for the range-bounding fault of Rincon Ridge. This fault displaces Holocene-uppermost Pleistocene deposits of Qvy by about 1.8 to 2.6 m and middle- to lower Pleistocene deposits of Qpo by about 6.2 to 37 m (Connell, 1996). The fault last ruptured the ground surface during the middle Holocene (Connell, 1996, p.143-149) and therefore, is a potential source of ground rupture and ground shaking. The southern extent of surface rupture is poorly constrained. Subtle variations and local steepening of the topography suggests offset of Qpm during the middle Pleistocene. The mapped distance (Connell, 1996) is too short as compared to displacement-length relations of North American normal faults (Wells and Coppersmith, 1994), suggesting that the fault extends south of Rincon Ridge. Water table levels (Table 1) rise along the projected southern trace of the fault.

A series of buried faults beneath the piedmont are mapped on the basis of comparisons of lithologic and geophysical (electrical conductivity) logs of several water-supply and monitoring wells drilled in the area (Table 1). Correlations of log signatures among wells illustrate considerable vertical shifts among several of the wells (Appendix A). These faults offset basin fill of the Santa Fe Group down-to-the-west that is consistent with faulting along the eastern basin-margin. These structures confirm the results of gravity modeling studies (Cordell, 1978ab) that predict a series faults along the eastern margin of the basin. Correlation of available cuttings and lithologic logs to the geophysical logs are of limited use because most of the silt, clay and fine-grained sand fraction were lost during cleaning of the samples. However, variations in clast composition aided in the delineation of extrabasinal (QTsa) and intrabasinal (QTsp) lithofacies. Furthermore, clasts of a white pumice is locally recognized in wells along the western part of the quadrangle. This pumice is interpreted to be one of the Bandelier Tuff units and may indicate fault activity as recently as the early Pleistocene.

The Rincon “monocline” is an informal term used herein to describe a broad, northwest trending zone where Qvy overlies Qvr1 and Qvr2 to the south and Qvy is inset against Qvr1 to the north. The base of Qvr1 (Edith Blvd alluvium) abruptly rises from about 15 m to 24 m across this line. The structure may represent a complex set of step-over faults or ramps of *en echelon* intrabasinal fault segments or a buried cross fault rather than a monocline.

HYDROGEOLOGIC FRAMEWORK

A detailed assessment of the groundwater resources in the study area is beyond the scope of this study. The New Mexico Bureau of Mines and Mineral Resources has conducted detailed studies of the basin-fill and valley-fill aquifer systems (Hawley and Hasse, 1992 and Hawley and Whitworth, 1996). In general, the study area is underlain by relatively thick accumulations of sand and gravel of the upper Santa Fe Group, the primary aquifer unit for the City of Albuquerque.

GEOLOGIC HAZARDS

An assessment of potential geologic hazards is beyond the scope of this project. However, the delineation of deposits and their geomorphic setting can be used to delineate geological constraints on land use. Geologic hazards discussed in this section refer to only a few of the potential hazards that could effect residential development in New Mexico. These hazards include, but are not limited to, problems associated with differential movement of the foundation substrate, slope instability, flooding, and seismic hazards (see Haneberg, 1992ab). This section presents a preliminary and qualitative assessment of potential geologic hazards within the Placitas quadrangle and is intended only as a general guide to potential geologic hazards, **not** as a substitute for site-specific studies of potential hazards conducted by qualified, professional engineers or scientists.

Potential geologic hazards in the Alameda quadrangle include, earthquakes, flooding along entrenched drainages, slumping along the margins of deep arroyos (such as Bear, Pino and Domingo Baca arroyos) and hydrocollapsible soils. Quaternary faulting along the Rio Grande rift represents a potential regional risk. Most notably, Holocene surface rupture recognized along the Rincon fault and possible displacement of Santa Fe Group deposits containing early Pleistocene tephra indicate a local potential for surface rupture and groundshaking (Plates I and II). Water levels are low east of the Rio Grande Valley. Water levels are within a few meters of the ground surface within the inner valley of the Rio Grande; therefore, much of the inner valley may be susceptible to liquefaction during an earthquake. Liquefaction should not pose a problem east of the inner valley escarpment; however, areas underlain by faults and projections of fault, may be subject to ground rupture or intense localized shaking during an earthquake event.

Hydrocompactive soils are low-density, silty to very fine-gained sand having high void ratios (Dudley, 1970). Compaction occurs when the soil volume decreases when saturated by water (Das, 1984), typically by the introduction of concentrated storm runoff, landscape irrigation or ponding of septic-system effluent on the substrate. Hydrocompactive deposits generally occur within Holocene-aged, fine-grained, weakly to non-cemented sediments that have a low bulk density, high void ratio and have not been extensively irrigated (Haneberg, 1992a; Hollingsworth and Grover, 1992; Shaw and Johnpeer, 1985ab). Quaternary deposits and valley fills of Qpo, Qpm and coarse-grained portions of Qpy are consolidated and slightly indurated and should not pose a collapsible soil hazard. Areas underlain by sandy valley-fill and valley-border deposits of Qvy exhibit only weak soil development and may contain hydrocollapsible soils. Hydrocollapsible soil conditions may pose problems to permanent buildings if not mitigated during construction.

Slope instability involves a variety of failure and transport mechanisms, including rock falls, landslides and debris flows (Varnes, 1978). Slope failure can occur during earthquakes, after intense rainfall, or by intensive landscape irrigation (Spittler and others, 1990; Haneberg and Tripp, 1991; and Haneberg and Bauer, 1993). Areas susceptible to slope instability may be qualitatively evaluated by: 1) occurrence of existing slope failures; 2) physical properties of substrate and orientation bedding or other planes of weakness; 3) intensity and duration of rainfall; and 4) steepness and height of slopes (Brabb and others, 1989; Crozier, 1984). No morphologic evidence of major shallow or deep-seated landslides was recognized along Rincon Ridge, therefore, upland slopes have been relatively stable during past and current climates. Relatively thick accumulations of colluvium within steep mountain-front drainages could pose a potential for debris-flow activity near the mouths of incised stream canyons. Landslide deposits were not recognized during this study. Upland areas are underlain by resistance gneiss, schist and granite and should not be subject to landslide failure. However, steep slopes may locally pose rockfall problems.

Potential hazards from storm-induced flooding are generally confined to incised drainages (arroyos) that may overflow during intense rainfall events. Steep hillslopes may be subject to run off during intense rainfall events, resulting in local gullying of slopes. Destabilization of cut-banks along low arroyo terraces and the floodplain may occur during flood events, notably during intense summer storms.

ACKNOWLEDGMENTS

Mapping of this quadrangle was funded in part, by a grant from the STATEMAP program of the National Geologic Mapping Act, coordinated by the U.S. Geological Survey and the New Mexico Bureau of Mines and Mineral Resources. Special thanks to the Pueblo of Sandia, the Honorable Alex Lujan, Mr. Archie Chavez and Ms. Elizabeth Janello for logistical assistance and access to their lands during this study.

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