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PRELIMINARY GEOLOGIC MAP OF THE ROGERS LAKE SOUTH QUADRANGLE, LOS ANGELES AND KERN COUNTIES, CALIFORNIA

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INTRODUCTION

The Rogers Lake South Quadrangle is located in the Antelope Valley region of the western Mojave Desert of Southern California. The Antelope Valley is a small, closed basin, rimmed by the San Gabriel Mountains, the Sawmill-Liebre Mountains, and the Tehachapi Mountains to the south, southwest, and northwest, respectively, and by various buttes and pediments to the north and east. The most notable boundaries, however, are the Garlock Fault to the north, which separates the Mojave province from the Basin and Range province, and the San Andreas Fault to the south, which separates the Transverse Range province (Fig. 1).

The western Mojave province, in which the Antelope Valley Basin lies, is characterized by many deep Cenozoic sedimentary basins that are separated by low hills of Mesozoic granitic and metasedimentary rocks and Tertiary volcanic rocks. These basins, which surface and geophysical observations show to trend northeast (parallel to the Garlock Fault), were depocenters for upper Tertiary and lower Quaternary sediments; many contain more than 3 km of alluvium. During Tertiary time, the area drained southwest into the Pacific Ocean. Tectonic activity along the San Andreas and Garlock faults and the uplifting of the Transverse, Tehachapi, and southern Sierra Nevada ranges reversed this drainage pattern and formed new closed basins in the Mojave Desert. In Quaternary time these basins were occupied by pluvial lakes; one in particular, Lake Thompson, covered about 500 km^2 and was perhaps as deep as 20 m. Today Lake Thompson is represented by the playas Buckhorn, Rosamond, and Rogers dry lakes (Thompson, 1929).

STRATIGRAPHIC UNITS

Local rock units in the area include tuffs, lava flows, and sediments of the Tertiary Tropico Formation, Tertiary fanglomerates, Tertiary intrusive rhyolites and dacites, and deeply weathered Mesozoic granitic rocks. Dibblee (1967) gives excellent background on this subject. Exposed local Quaternary geologic units include sandy alluvium, playa clay, and beach deposits, most of which are late Quaternary in age and related to pluvial Lake Thompson.

Late Quaternary and Holocene drainages into the playas are from the west and south, along the Garlock and San Andreas faults. Much of the surface west of the playas is exposed granitic rocks and fine pediment gravel, cut by well-defined shallow arroyos. The eastern side of Rogers Lake has a gentler slope characterized by several long, low alluvial fans and fan segments, some of which were periodically innundated with fluctuations in Lake Thompson. South of the playas, long channels have supplied sediment to both the former and modern lakes, channels, such as Big Rock Creek and Little Rock Creek, associated with large alluvial fans along the front of the San Gabriel Mountains. Ponti and Burke (1980) and Ponti and others (1981) have characterized the exposed alluvium as late Pleistocene (90,000 ybp) to Holocene (4,000 ybp) medium grained, moderately to well sorted, moderately to well stratified sediments with textural and soil development characteristics that are dominated by the addition of calcium carbonate during groundwater fluctuations of pluvial lake stands.

Other Quaternary and Tertiary units in the area have been described by well data (Dutcher and Worts, 1963; Neal and Motts, 1967; Neal, 1968). These units are principally alluvial fan and channel deposits from the south as the Transverse Range (San Gabriel Mts.) were uplifted, and the north as the Tehachapis shed debris.

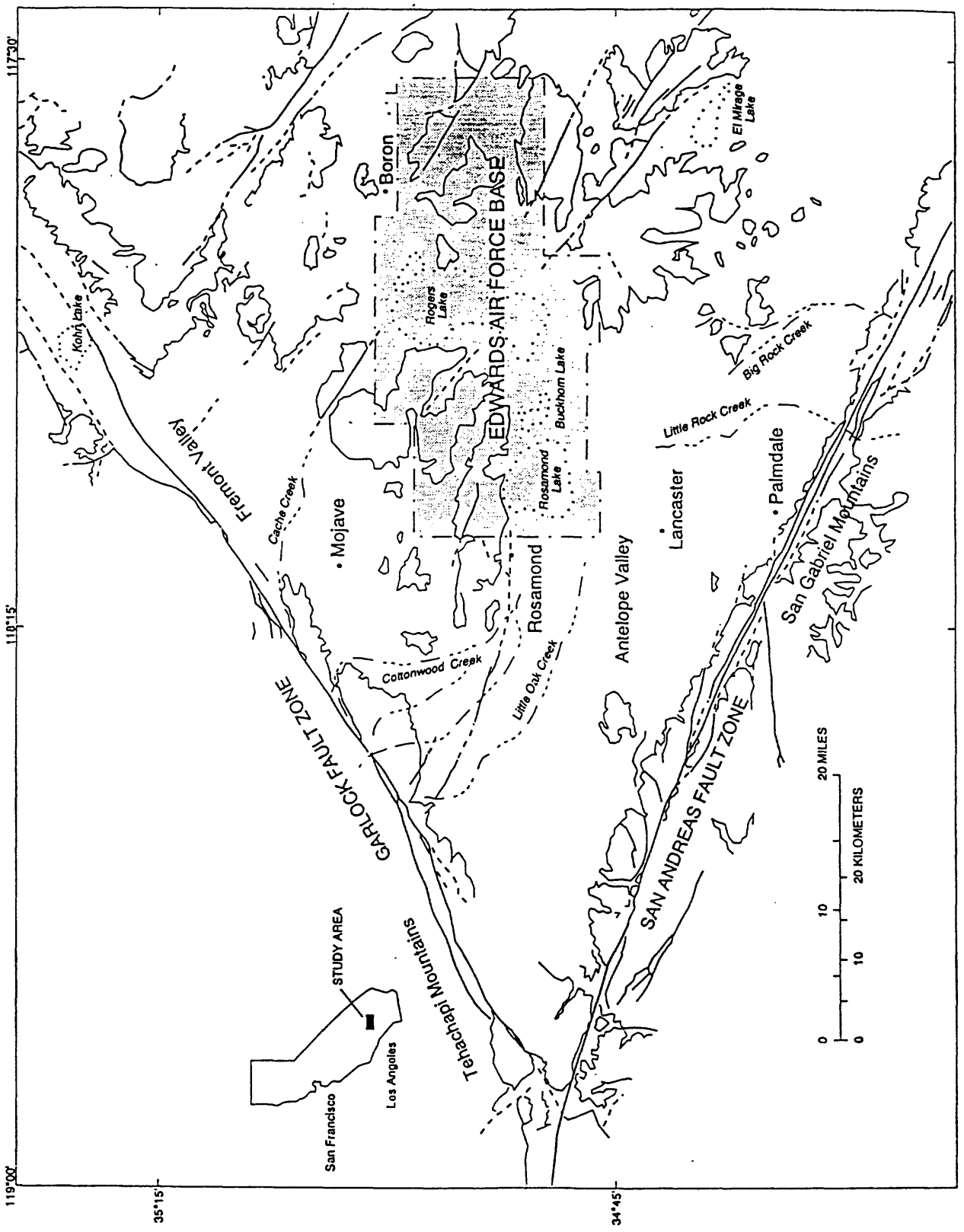

Figure 1. Sketch map showing major features in the western Mojave Desert.

STRUCTURAL SETTING

Maybey (1960) first recognized the East Antelope Basin from a 40-mgal gravity low and suggested that the steep gravity gradients may be fault controlled. The gravity signature suggests that this is a northeast-trending basin, which is deepest just southwest of Rosamond Lake and shallows to the northeast. Confirmation of this being a fault-bounded basin (at least on the northwest side) has come from gravity data (Morin and others, in press) and also from a series of resistivity anomalies (Zohdy, 1990), as well as subtle surface escarpments, alignment of historical spring discharge mounds trending N30-45E, and steep hydrologic gradients (Ward and others, 1991). The southeast boundary of the basin is less apparent, however, but is definable from field observations and geophysics.

Known and inferred faults in the immediate area trend northwest. Major faults can be recognized from juxtaposed bedrock units and associated with long, linear valleys (with Quaternary and Holocene alluvium) that lead to the playa. Dibblee (1967) considers that several such features may have controlled the development and shape of Rogers Lake; the El Mirage fault and several unnamed faults along the north and south edges of the dry lake define and give the playa its hourglass shape. We consider further that the El Mirage Fault probably extends beneath the central portion of the playa and connects with the Bissell Hills fault.

We consider that a geographic "corridor" in the southern part of Edwards AFB is a geologic fault zone, which we herein informally called the Antelope Valley Fault Zone (AVFZ; Ward and Dixon, 1994a,b; Dixon and Ward, 1994). This corridor trends approximately N30E to N40E, and extends from south of Rosamond Playa to the southwestern part of Rogers Lake, a distance of at least 10 km.

Ward and Dixon (1994a,b) and Dixon and Ward (1994) recognize no disturbances of the surface in the AVFZ. This corridor is characterized, however, by several depressions that are former (historically active) spring discharge areas in the adjacent Redman Quadrangle. These springs (approximately 30 m in diameter) are circular depressed features, containing loamy soil and peat and commonly surrounded by dead mesquite. In the Rogers Lake North Quadrangle we recognize complex deposits on Rogers Lake at South Base that overlie the projected AVFZ.

ROGERS LAKE FISSURES

In March of 1991, a large earth fissure opened at the south-east end of Rogers Dry Lake. The fissure is approximately is about 1-2 m wide, 1.16 km long, and extends to an unknown depth. Although somewhat sinuous, its average trend is within a few degrees of north. A second, smaller fissure opened 120 m to the west of the first on February 4, 1993. This second fissure is approximately 1.1 km long and trends approximately parallel to the major segments of the larger fissure. Both fissures appeared, literally, overnight. The playa had standing water, owing to several days of rain, on both occasions. Within a matter of hours, although not observed directly, the fissures appeared and drained significant (20-30%) portions of the lake locally. On occasion, strong winds from the southwest (Ward and Greeley, 1984) have contribute to and accelerate drainage of the lake, when flooded, by blowing water directly into the fissures.

This part of the (geologic) Antelope Basin is part of the (hydrologic) Lancaster groundwater sub-basin, the source for agricultural, municipal, and industrial ground water for the Antelope Valley and the primary source of water for Edwards Air Force Base. Water levels in the base and vicinity have dropped

some 90 feet (27 m) since the late 1950's, when substantial development began. The land surface in the region has also dropped. Land subsidence around Rogers Dry Lake has been generally less than 1 foot, except at the southwest end where subsidence in excess of 3 feet has occurred. Off base, near Lancaster, 4 feet of subsidence was measured along the Sierra Highway.

The great amount of subsidence near Lancaster and the south part of Edwards are highly correlated to production well fields and ground water withdrawals. Ward and others (1991, 1993) consider that land subsidence occurred from the compaction of the fine-grained compressible sediments in the principal aquifer in the Lancaster sub-basin. The subsidence surface at Edwards has its steepest gradient in the southeast portion of the dry lake, a change of 1.5 feet over the short distance of 0.9 miles. The location of this gradient is highly correlated with the giant earth fissures in the lake bed.

The fissures also occur along the slopes of a local gravity low that define a small (600-m deep) sub-basin at the northeast rim of the Antelope Basin. Gravity contours that reflect the shape of the sub-basin trend at angles of 45° or more from the trend of the fissures. Based on this and the NW and NE trends of the major faults in the area, Ward and others (1993) consider that the giant, NS-trending fissures were caused by subsidence due to differential compaction (from to groundwater withdrawal) of Quaternary sediments on a downsloping erosional bedrock surface.

GEOLOGIC UNITS IN THE ROGERS LAKE SOUTH QUADRANGLE

D Disturbed Ground (Holocene)-- Surfaces disrupted by construction and development

Qah Alluvium (Holocene)--Sand and silt (and minor gravel) in active channels and dry washes. Contains unconsolidated and unsorted granitic sediments; fines often have been reworked by wind into ripples

Qaf Fan Alluvium (Late Pleistocene)--Thin deposits of alluvium in fans on slopes immediately adjacent to pluvial Lake Thompson. Moderately sorted sediment derived principally from local granitic rocks, with minor amounts of volcanic and metamorphic rock fragments. Several deposits can be distinguished tentatively by topographic expression and stratigraphic position (older deposits tend to be higher and incised by channels leading to lower, younger fans. Mapped as undifferentiated (Qafu) and older to younger (Qaf1-Qaf4) deposits. Undifferentiated units (Qafu) are considered equivalent to Quca of Ponti and Burke (1980) and Ponti and others (1981) -- late Pleistocene (90,000 ybp) to Holocene (4,000 ybp), undifferentiated alluvial sediments around pluvial lake shorelines; medium grained, moderately to well sorted, moderately to well stratified, but with textural and soil development characteristics that are dominated by the addition of calcium carbonate during groundwater fluctuations of pluvial lake stands. Differentiated units Qaf1-4 correspond to Q4-Q5 sediments of Ponti and Burke (1980) and Ponti and others (1981) in age ranges of 90,000-17,000 ybp (Q4-Q5). Units may also be truncated by wave action during high lake stands.

Qpc Playa Deposits (Late Pleistocene)--Clay and silt of Lake Thompson, thinly stratified on flat floor of Rogers Dry Lake. New exposure occurs in 1200-m and 300-m fissures in southeast part of dry lake (Ward and others, 1991, 1993)

Qcs Clayey Sand (Late Pleistocene)--Moderately indurated, cohesive beach deposits, composed of coarse to fine sands, silt, and clay, at margins of Rogers Lake. Deposits are indurated by the desiccation of clays but also contain $CaCO_3$

Qsc Sandy Clay (Late Pleistocene)--Stratified, silty clay deposits interbedded with clayey sand deposits (Qcs), but may be transitional between playa clay deposits (Qpc) and clayey sands (Qcs)

Qpg Pediment Gravel (Pleistocene)--Grus and thin (undifferentiated) fan alluvium above Rogers Lake. Probably thin remnant of older fan alluvium mostly removed by erosion, exposing weathered surface on bedrock

QTt Calcareous Tufa (Quaternary? and Tertiary?)--Light tan to white deposits of tufa, composed of both fresh and frosted felsic phenocrysts in a groundmass of small (2-5mm) calcareous concretions. Also contains minor amounts of dark (organic?) matter, as well as calcite stringlets throughout the rock. Unit was formed from the precipitation of groundwater discharged from permeable fault zones (most down-to-north) in the Mt. Mesa area. Thickness is variable; age unknown

Klg Leucogranite (Cretaceous?)-- Leucocratic, biotitic granite and granodiorite, weakly foliated; fine to medium grained; color index 1-5. Composed primarily of quartz, potassic feldspar, and plagioclase. Minor minerals (chiefly biotite) less than 1%. Intrudes underlying quartz monzonite (Klqm)

Klqm Quartz Monzonite/Monzodiorite (Cretaceous?)--Light grayish white, medium grained granitic rocks. Color index 5-10; dark where altered. Composed of quartz, potassic feldspar, and plagioclase. Biotite is dark where fresh, minor hornblende, and sphene (3-4 mm). Surface is weathered to depths of three to ten m (altered gruss) at most exposures. Contains numerous NE-trending faults, some down-to-NW, others showing little offset

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— — — · · · Contact, dashed where inferred, dotted where concealed.

— — — · · Fault, dashed where inferred, dotted where concealed. Bar and ball on downthrown side.

CORRELATION OF UNITS

<table>
<tr><td>Qah</td><td>D</td><td></td><td></td><td></td><td></td><td>Holocene</td><td rowspan="6">QUATERNARY</td></tr>
<tr><td>Qaf4</td><td rowspan="4">Qafu</td><td rowspan="4">Qsc</td><td rowspan="4">Qcs</td><td rowspan="4">Qpc</td><td rowspan="4">Qbb</td><td rowspan="4">Late Pleistocene</td></tr>
<tr><td>Qaf3</td></tr>
<tr><td>Qaf2</td></tr>
<tr><td>Qaf1</td></tr>
<tr><td>Qpg</td><td colspan="5"></td><td>Pleistocene</td></tr>
<tr><td>QTt</td><td colspan="6"></td><td>QUATERNARY?
TERTIARTY?</td></tr>
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unconformity

<table>
<tr><td>Klg</td><td>Klqm</td><td>CRETACEOUS?</td></tr>
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