LAND SUBSIDENCE AND PROBLEMS AFFECTING LAND USE AT EDWARDS AIR FORCE BASE AND VICINITY, CALIFORNIA, 1990

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Land subsidence in the Antelope Valley, which includes Edwards Air Force Base, was first reported in the 1950's (Lewis and Miller, 1968); by 1967, about 200 mi^2 of the Antelope Valley were affected by as much as 2 ft of subsidence. Prior to 1973, subsidence on the base was not considered significant. To determine current land-subsidence conditions at Edwards Air Force Base and vicinity (fig. 1), a vertical-control network with 41 bench marks was surveyed in 1989 using the Global Positioning System (GPS); (see Ikehara #1, #2, and Pool #2 abstracts for GPS applications in land subsidence investigations). GPS surveying, described by Collins (1989), is a U.S. Department of Defense satellite-based navigation system designed to provide worldwide positioning capability. Field equipment consisted of roving antenna and receiver-processor units. Precise relative positions of two or more bench marks are determined from satellite-tracking data received simultaneously at each bench mark. This network was developed to provide an area-wide basis for comparing historical changes in bench-mark elevations on the basis of selected stable bench marks. Four stable bench marks that were unaffected by subsidence and with known geoidal heights were used in adjusting the GPS surveys to sea-level datum. Accuracy of the ellipsoidal height for the surveyed area, based on North American Datum 1983 (NAD 83), relative to sea level, is about 0.1 ft (see Ikehara #1 abstract for information on the 1992 GPS resurvey of the Edwards network).

Differential levels to third-order standards of accuracy (National Oceanic Atmospheric Administration, 1980) were surveyed for 65 bench marks in 1989–91 to determine the local distribution of subsidence (fig. 1) and to provide data with which to compare GPS-defined bench-mark elevations. For 14 lines and with lengths from 0.7 to 7.9 mi, the mean difference in bench-mark elevation determined using both methods averaged ±0.05 ft. On Edwards Air Force Base, in the vicinity of Rogers Lake, measured land subsidence ranged from 3.3 ft along the southern edge of the lake to about 0.1 ft on the northern edge (fig. 1). A steady decline of aquifer-system hydraulic heads of more than 90 ft since 1947 measured at a well near Scout Road (fig. 1), is associated with the land subsidence. The amount of land subsidence at the base varies depending on the decline of aquifer hydraulic heads related to ground water pumping from various well fields, and the occurrence of fine-grained compressible sediments in geologic substrata near the zones of ground-water production (Londquist and others, 1993). Near the southern edge of Rogers Lake, the land subsided more than 2 ft between 1961 and 1989 (fig. 2). The average rate of land subsidence near the south end of Rogers Lake for the years 1961–89 is about 0.1 ft/yr (fig. 3).

Land subsidence is causing surface deformation at Edwards Air Force Base and surrounding areas. This deformation has caused the formation of sink-like depressions, earth fissures, and cracks on the playa surface of Rogers Lake. These changes adversely affect the use of the lakebed as a runway for airplanes and space shuttles. Repairs to the lakebed have been unsatisfactory because the load-carrying capacity of the repaired lakebed is less than that of the original lakebed. Continued active surface deformation further adversely affects repairs that have been made to the runways.

The playa surfaces of these ephemeral desert lakes characteristically have smooth, hard, flat surfaces. Some have small (cobblestone size) polygons or large (giant) desiccation polygons whose boundaries are defined by cracks that may be up to several inches in width. The small polygons range from 1 to 4 in. in width; the giant polygons may exceed widths of 300 ft (Neal, 1965). Fissures are a major concern because they may extend to the water table, allowing direct access for contamination by toxic materials. In addition, existing sink-like depressions and associated fissures become avenues of vertical water

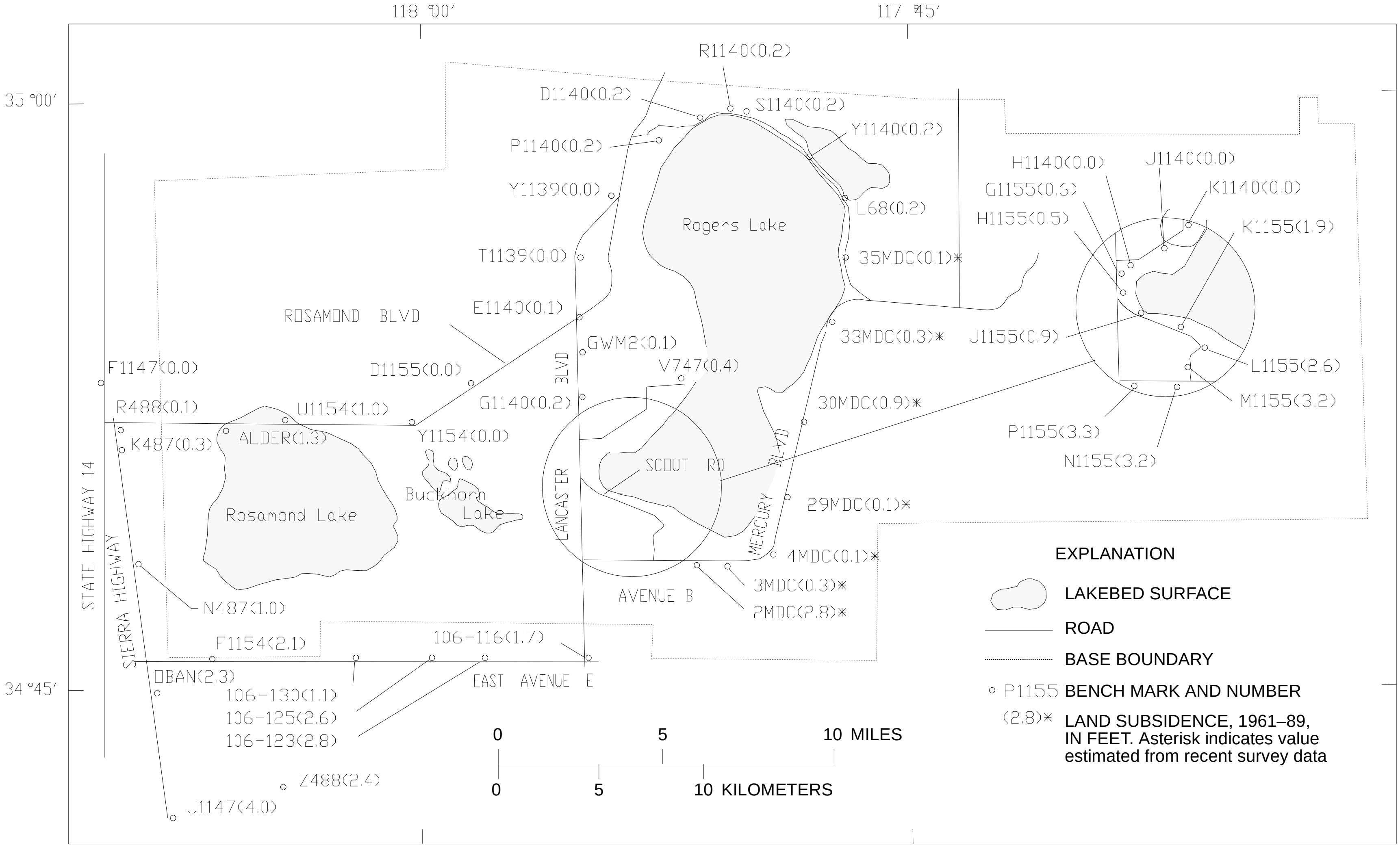

Figure 1. Land subsidence, 1961–89, at selected bench marks at Edwards Air Force Base. Subsidence values are from GPS and differential-leveling surveys.

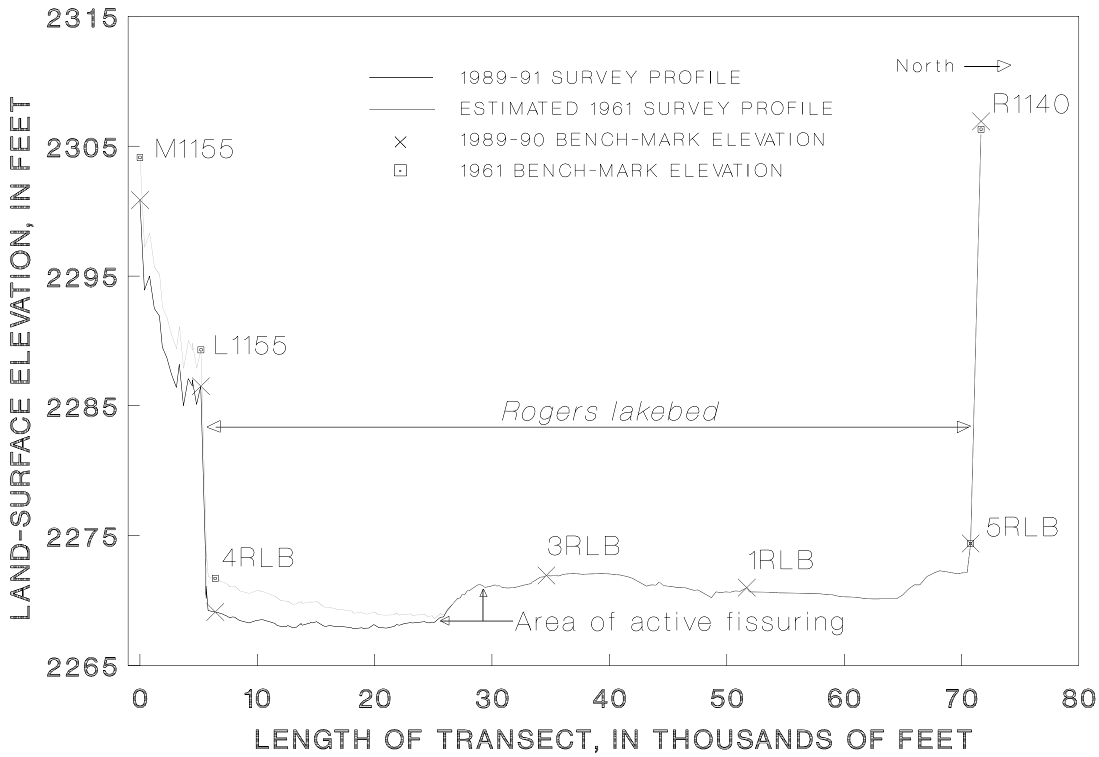

Figure 2. Land-surface elevation, Rogers Lake.

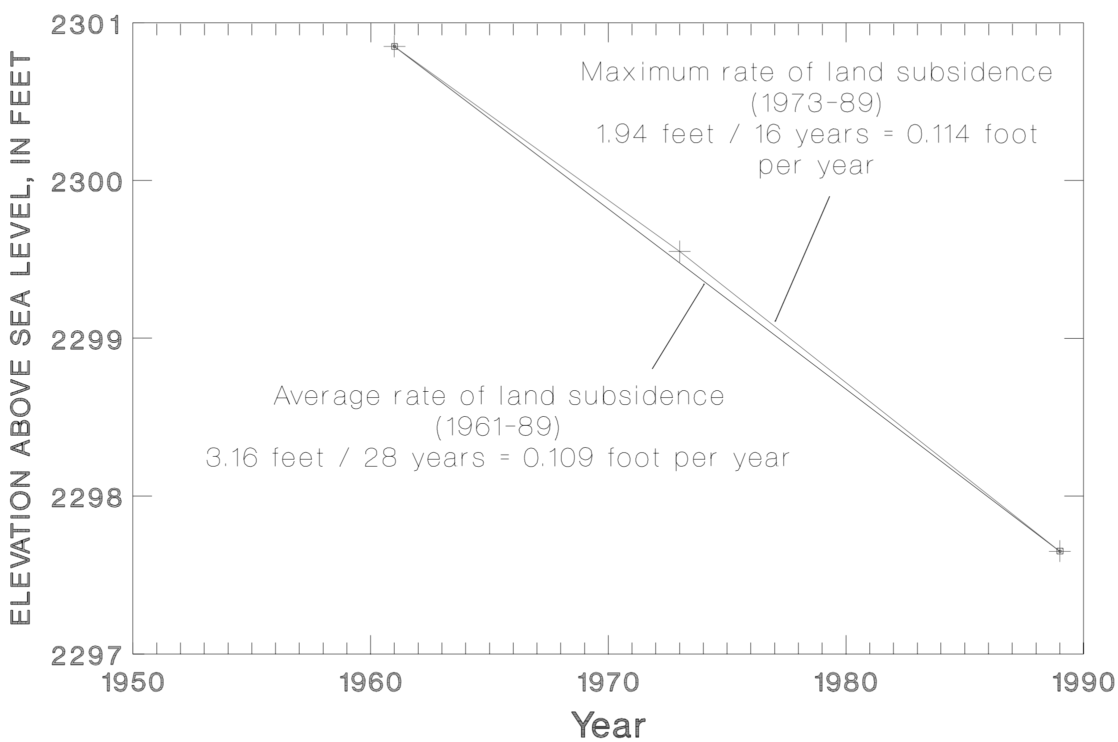

Figure 3. Land subsidence at bench mark M1155 near South Track well field, 1961–89.

movement. Changes in lakebed slope and land subsidence contribute to the formation of new fissures, and new erosion channels, which form patterns collectively called desert flowers (fig. 4), which increase in size and density following periods of direct precipitation or flooding of the lake. The continued subsidence of the lakebed also has contributed to an increase in the depth and duration of flooding at the south end of Rogers Lake where surface runoff collects in the depression on the lake where subsidence of 2 to 3 ft has occurred.

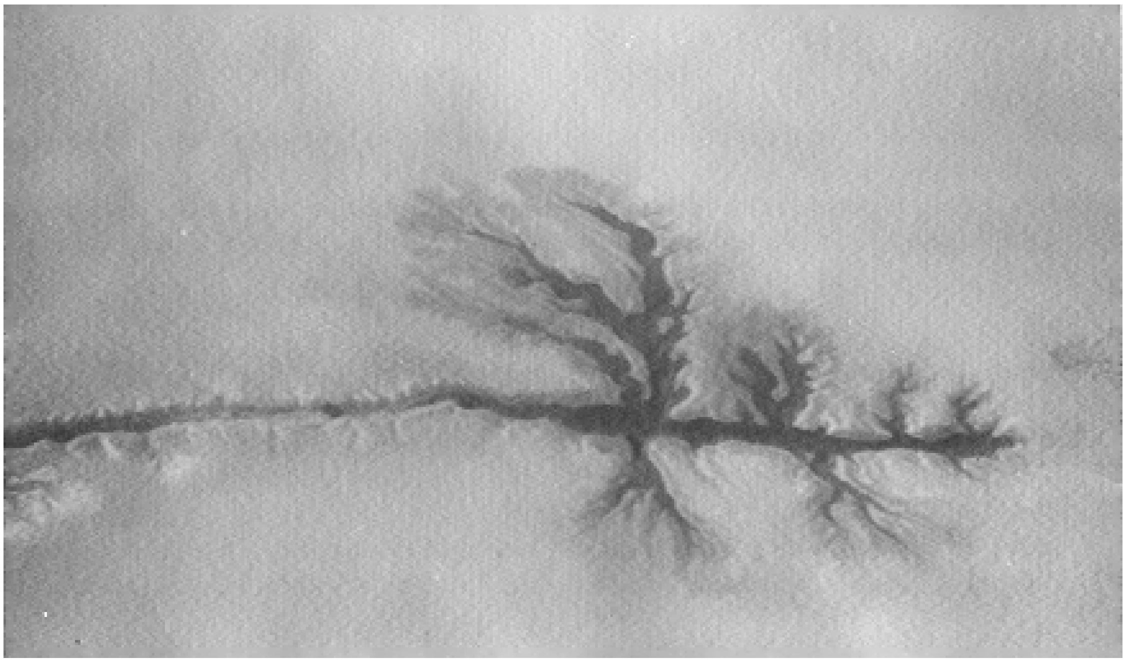

Figure 4. Drainage channels (collectively called desert flowers) caused by erosion during flooding of Rogers Lake. Photographed August 1989.