DESCRIPTION OF GLOBAL POSITIONING SYSTEM NETWORKS SURVEYED IN CALIFORNIA, 1992

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Three static Global Positioning System (GPS) surveys were completed during 1992 as part of land-subsidence investigations near Mammoth Lakes, and in Antelope Valley, California (see Ikehara #2 and Pool #2 abstracts for GPS applications in land-subsidence investigations). The network near Mammoth Lakes, designed to monitor crustal motion related to subsurface magmatic movement, was modified to include bench marks sited near a geothermal field. Most of the stations of a GPS network established in 1989 at Edwards Air Force Base (EAFB) in Antelope Valley were resurveyed (see Blodgett abstract), and a new GPS network was created and observed in southern and western Antelope Valley.

MAMMOTH NETWORK

An existing GPS network that included the Mammoth Lakes area was densified to obtain information for bench marks within an active geothermal area associated with a resurgent volcanic dome and Long Valley caldera, relative to marks outside the area of geologic unrest (see related abstract by Farrar and others). During a 2-day period, 3 new bench marks were observed simultaneously with 14 stations that are part of the existing Long Valley GPS network (fig. 1). The additional bench marks are Z123 and D916, both of which have been leveled many times, and SRP, a mark newly constructed to establish vertical control for a well used to monitor hydraulic head and subsurface temperature.

All marks were observed with Ashtech Global Positioning System dual-frequency receivers for a period of 6 to 6-1/2 hours. The latitude, longitude, and ellipsoidal heights of the 14 stations were calculated by using fiducial methods, Bernese software, and precise coordinates of the three global tracking stations located in the United States (Jerry Svarc, written commun., U.S. Geological Survey, Menlo Park, CA). The network vectors and geodetic coordinates of the three new stations were calculated with Ashtech postprocessing software. The horizontal coordinates of the existing stations, except for a geographic outlier to the southeast (OVRO), were held fixed to compute geodetic coordinates for the new stations. Marks D916, CONV, and RET had been included in first-order leveling done earlier in 1992 and these elevations were used to define the local vertical control datum (Kenneth Yamashita, oral commun., U.S. Geological Survey, Vancouver, WA.).

A surface gravity map produced in 1992 by the National Geodetic Survey (NGS) shows that gravity measurements used to compute the geoidal separation in the Mammoth Lakes area are coincident with level lines. As a result of this coincidence and the large amount of leveling data over the past decade, the geoid here is well-defined. The GPS-computed elevation and the leveled elevation for Z123 agreed within several millimeters. The error at 1 standard deviation for each of the x, y, and z coordinates measured with GPS was not more than 5 mm.

EDWARDS NETWORK

The primary objective of the GPS survey at EAFB (fig. 2) was to obtain current geodetic measurements of bench marks to aid in the determination of the magnitude and rate of land subsidence in the study area (see related abstracts by Blodgett, and by Londquist). Of the original 41 stations of the GPS

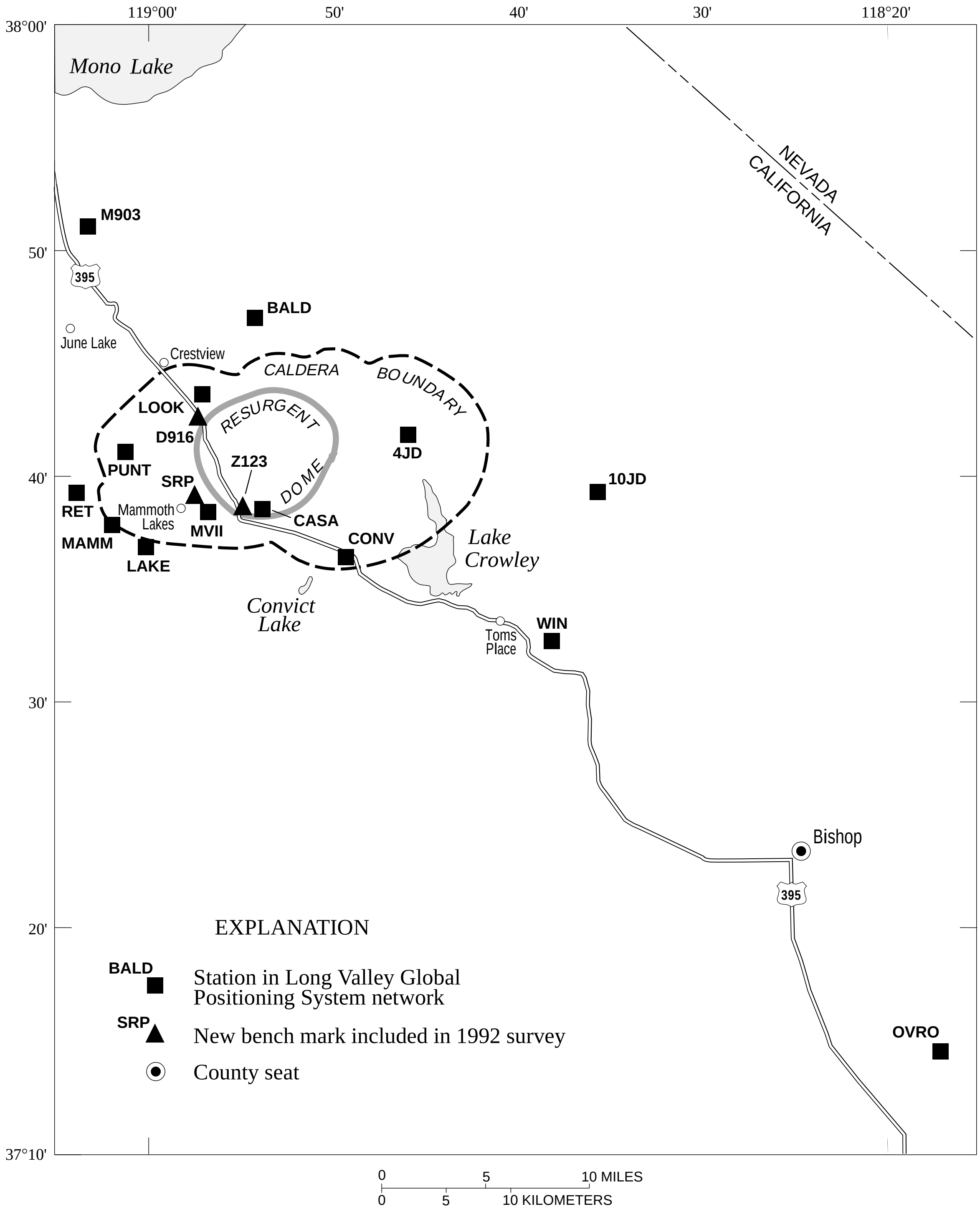

Figure 1. Geodetic control stations monitored by the U.S. Geological Survey for crustal-motion studies in the Long Valley Region, California.

network originally observed in 1989, all but 3 were reobserved in 1992, and 4 new stations were added to the network. Of the 4 new stations, 3 were sited on the perimeter of Rogers Lake to establish vertical control for conventional leveling surveys. The fourth new mark is part of the statewide High Precision Geodetic Network (HPGN).

Three to five Ashtech GPS dual-frequency receivers were operated daily. Satellites were tracked for a period of 7 hours at most of the stations from mid-March through mid-April. Because Rogers and Rosamond Lakes were flooded until summer, some stations on and adjacent the lakebeds were not occupied until August, when the fieldwork was completed.

The magnitude of land subsidence occurring at EAFB in the past 3 years may not have exceeded the magnitude of the measurement error associated with the vertical component of the 1989 GPS-computed coordinates which is on the order of 3–5 cm. The preliminary error estimate of 1–2 cm for the 1992 survey indicates that the new vertical coordinates provide a more accurate basis for future subsidence comparisons than did the previous survey, which was relatively limited by the older GPS-receiver technology and fewer available satellites in the GPS constellation.

Vector coordinates are related to the local horizontal and vertical datum by holding the positions of geodetic control stations fixed in a network adjustment. Control stations used in the 1989 adjustment will also be fixed in one of the adjustments for 1992 data to produce coordinates that can be examined for changes (exceeding the error), such as those resulting from land subsidence. Another adjustment will be made holding fixed some of the control stations that have been tentatively selected for a regional-scale adjustment of vectors from both the Edwards network and the GPS network newly established in the southwestern part of Antelope Valley.

SOUTHWESTERN ANTELOPE VALLEY NETWORK

A network of bench marks in the part of Antelope Valley south and west of EAFB boundaries (fig. 2) was designed and GPS-surveyed to establish baseline measurements in conjunction with a valley-wide subsidence monitoring program. Increasing demands on ground water and a history of and potential for further land subsidence throughout Antelope Valley have prompted a regional ground-water and land-subsidence investigation. The subsidence-monitoring network may become an integral part of a ground-water (and subsidence) management approach to controlling the location and quantity of ground-water use (see Phillips abstract).

Network stations were selected on the basis of several criteria. The objectives were to extend and tie to the Edwards network, and to include as many Los Angeles County bench marks as possible, particularly those that had a several-decade history of relatively large elevation loss measured by leveling, and those used as control ties between primary level lines established by Los Angeles County. Fifty-two stations, including 10 in common with the Edwards network, comprise the Southwestern Antelope Valley network, which extends from Hi Vista and Llano westward to Gorman (fig. 2). The fieldwork was completed in 3 weeks during April and May with cooperation from Los Angeles County, Department of Public Works. A mixture of Ashtech and Trimble GPS dual-frequency receivers was used and posed little problem during initial postprocessing and vector computation.

Horizontal coordinates of several HPGN stations and possibly a crustal motion network station will be held fixed for horizontal control in a network adjustment. Two of the four bench marks proposed for vertical control are also part of the revised Edwards network control. Network adjustments are being delayed until verification of the new elevation of a bench mark being releveled to a higher degree of accuracy in conjunction with other (non-USGS) GPS surveys. The modeled geoidal separations will be compared with elevations measured by second-order leveling along a 35-km line, completed within a few months after the GPS observations, to determine the magnitude of error associated with the geoid model locally. Vectors from the Edwards network and the Southwestern Antelope Valley network will be combined in a regional adjustment that will use a mixture of control stations observed in each subset of the region-wide Antelope Valley GPS network.

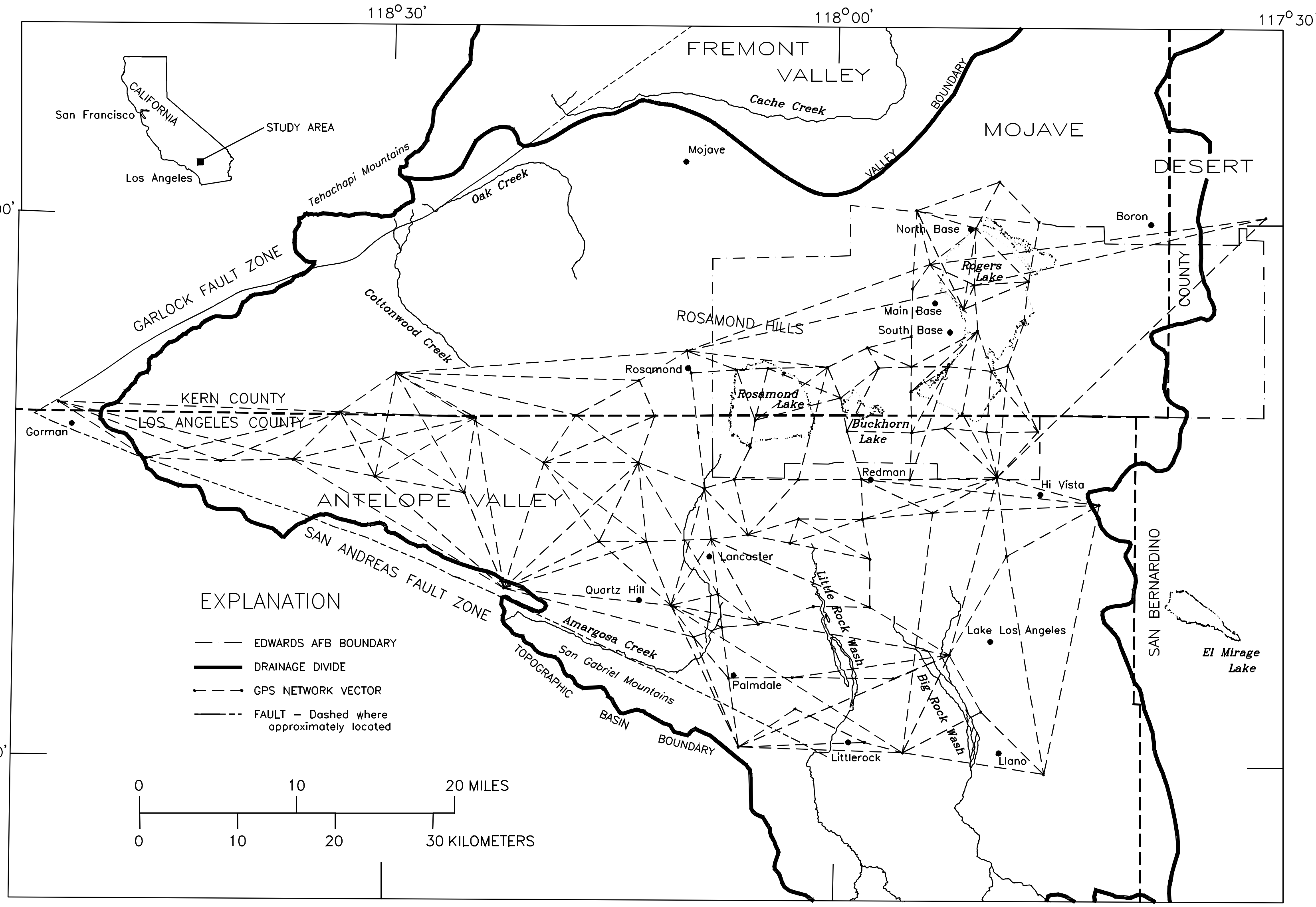

Figure 2. Southwestern Antelope Valley and Edwards Air Force Base Global Positioning System networks.