FINAL TECHNICAL REPORT

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PERMANENT GPS GEODETIC ARRAY IN SOUTHERN CALIFORNIA (PGGA) AND GPS OBSERVATIONS IN INDONESIA

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Permanent GPS Geodetic Array in Southern California and GPS Observations in Sumatra, Indonesia

PGGA

The Permanent GPS Geodetic Array (PGGA) is a network of permanent monitoring GPS stations in southern California devoted to the continuous measurement of crustal deformation in near real-time (see enclosed Figure). The PGGA which began as a NASA pilot project with four active stations in 1990 is operated by Scripps Institution of Oceanography in collaboration with JPL, MIT, UCLA, Caltech, the Southern California Earthquake Center, several California county surveying offices, Caltrans, and the USGS. We plan to expand the array by about 5 stations a year over the next five years.

The PGGA plays a unique role in studies of the kinematics of crustal deformation and the earthquake cycle in southern California because it is the only source of continuous, regional geodetic data. On the one hand it is a reference network for ongoing GPS field measurements, providing base stations, links to stable North America and the International Terrestrial Reference Frame, and precise satellite ephemerides. On the other hand it provides for the first time temporally dense geodetic measurements of crustal motion over periods of minutes to years and the ability to distinguish possible temporal variations in regional crustal strain. For example, the baseline between Palos Verdes and JPL provides the only continuous measure of crustal strain across the Los Angeles Basin.

Currently, daily horizontal positions for each station are determined with an accuracy of 1-3 mm, and vertical positions to 5-8 mm, and are available within about 3 days of real time. This capability was demonstrated during the Landers (M_W 7.3) earthquake of June 28, 1992 where significant, centimeter-level, far-field coseismic deformation was detected at all the (five, at that time) tracking stations. Small postseismic displacements were detected at a distance of 70 km from the surface rupture with no significant preseismic deformation. With more than a year of pre-Landers and post-Landers continuous measurements we are able to compare interseismic deformation before and after this major earthquake. The second test of the PGGA was the 17 January 1994 Northridge earthquake during which we detected coseismic contraction of the L.A. Basin.

As it expands and matures the PGGA will play an increasingly important role in the study of active tectonics of southern California by bridging the frequency range between seismology, observatory geodesy, paleoseismology and geology.

Indonesia

Global plate kinematic models in southeast Asia predict the relative motion of 5 major plates (Indian, Australian, Eurasian, Pacific and Philippines). Within this "rigid" scheme, a broad region of crustal deformation extends from north China to the Indonesian archipelago. Direct measurements of this large scale deformation is now made possible in the Indonesian area using GPS data that have been collected since 1989. However, plate tectonic concepts cannot explain the evolution of Indonesia except very generally because deformation is not confined to edges of well-defined plates. Indonesia offers a tremendous laboratory to study some of the outstanding problems in global tectonics; many of the processes that build continents and mountains are active there. We are fortunate to be working there in collaboration with the Indonesian National Mapping Agency for Surveys and Mapping (BAKOSURTANAL) which has provided extensive resources for our yearly measurement campaigns. Part of our program in Indonesia

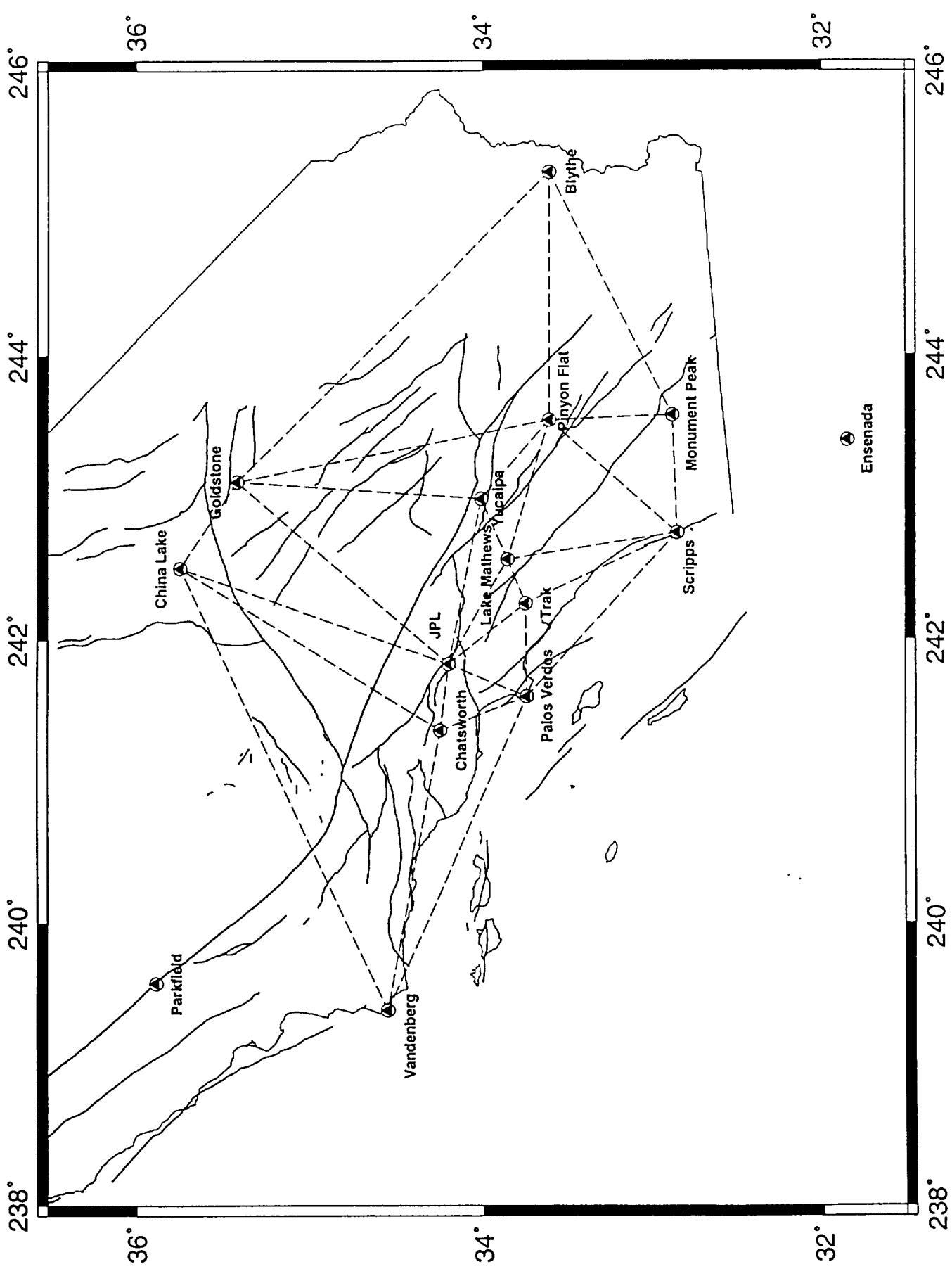
includes a transfer of GPS technology to our Indonesian counterparts, a process which is nearly complete.

We began GPS observations in August 1989 on mainland Sumatra and the Mentawai Islands to the west to study the phenomena of oblique plate convergence. As part of this campaign, we surveyed triangulation pillars established by Dutch and Indonesian surveyors in the late 1800's. In July 1990 we reoccupied most of the mainland Sumatra network and began annual measurements of a number of 10-20 km wide transects across the Sumatran fault in West and North Sumatra. In 1992, we added a transect in Aceh province at the northernmost tip of Sumatra and a small geodetic network across the Sunda Strait in the southernmost region of Sumatra, both of which were resurveyed in 1993. This provides us with measurements of crustal deformation along the entire length of the fault which we can compare to variable slip rate models of Sumatran fault motion and geologic slip rates determined at several points along the fault.

In July 1991 the project was expanded to include six sites in Irian Jaya, the western half of the island of New Guinea. Concurrently with the three-month 1992 International GPS Service campaign, we surveyed sites throughout the entire Indonesian Archipelago, and reoccupied sites in Irian Jaya and Sumatra. The December 12, 1992 earthquake (M_0 = 6.4×10^{20} Nm) in the Flores Sea prompted a resurvey of the East Nusa Tenggara segment of our August 1992 network within a few days of the earthquake, and a resurvey in August 1993. We modeled the observed surface displacement at sites close to the epicenter and delineated coseismic and regional interseismic deformation. In combination with seismic data, the geodetic analysis suggests that the Flores thrust is expanding eastward, having broken new crust in the December strong motion event.

We have analyzed the Indonesian data in conjunction with data collected on Christmas and Cocos Islands and at Darwin, Australia, and with the triangulation data in Sumatra. For example, the relative motion between Christmas Island and West Java, estimated at 71+/-7 mm/yr and azimuth of N11°E, locally perpendicular to the Java trench.

Permanent GPS Geodetic Array (PGGA) - Southern California



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PGGA

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