DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

CRUISE REPORT OF R/V S.P. LEE, Leg 4, 1990
CALIFORNIA CONTINENTAL BORDERLAND

by

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OBJECTIVES AND DESCRIPTION

U.S. Geological Survey conducted a geophysical survey over the California Continental Borderland using the *R/V S. P. Lee* during the period 9 May, 1990 to 25 May 1990. The borderland survey was the last leg (LA-90-SC) of a 1.5 month cruise that consisted of four legs. The leg began in Santa Cruz, CA and ended in Redwood City, CA. Multichannel seismic-reflection (MCS), gravity, and seismic-refraction data were collected from Pt. Buchon to the Mexican border between the 50 meter contour near the mainland coast and Patton Escarpment, which marks the seaward edge of the borderland off shore (Fig 1). Most of the data were collected along 2800 km of tracks that form a grid covering a large part of the borderland south of the northern Channel Islands. These lines now form the most comprehensive dataset available to the public covering this area. Additional lines, totalling 330 line km, were surveyed between Pt. Buchon and the northern Channel Islands, in the offshore part of the Santa Maria basin, primarily to augment existing data and to provide a tie between well logs that are available as part of the public record.

The objective of the borderland leg was primarily to improve our understanding of the structural framework and tectonic history of this part of the California continental margin. The borderland region is important to the Cenozoic history of the North American continental edge because it is here that the Pacific-Farallon spreading center is thought to have first encountered the continent at ~29 Ma as the Kula Plate was subducted . Thus, the borderland off Southern California probably marks the place from which triple junctions migrated to the north and south along the continental edge during the rest of the Cenozoic. Prior to triple junction initiation, the borderland is thought to have developed as an accretionary wedge above a subduction zone. Its post-29 Ma tectonic history includes the development of large lateral faults and basin-ridge physiography.

Numerous authors (Shepard and Emery, 1941; Emery, 1960; Moore, 1969; Vedder et al. 1974; Howell, 1976; Blake et al., 1978; Crouch, 1981; Vedder, 1988) attributed the north-south basin-ridge physiography to the dextral relative motion between the Pacific and North American plates. Yeats (1968) emphasized the extensional history of the Southern California Continental Borderland, while Crouch (1981) called attention to the evidence for wrench tectonics and folding in the same area. Analysis of our data should reveal the relative importance and timing of each of these processes over time. Earthquakes occur frequently along active faults in the Borderland. Oil and gas deposits are common in the nearshore basins of the borderland, the largest being those of the Los Angeles basin, a subareal eastern extension of the borderland province.

Figure 1 shows the tracks along which data were collected on leg L4-90-SC in relation to other tracks along which MCS data were collected on two, earlier USGS cruises. Our primary objective was to obtain new 2-D seismic-reflection coverage over the basin-ridge physiographic elements that make up the province while complementing the previously collected data. Line 120, which began offshore of Oceanside at 22:00 hrs PST on May 16, was designed to provide an acoustic source for an on-land array of seismometers set up by a contingent of scientists from the CALCRUST program with NSF support. The onshore array consisted of 6 Passcal Reftec instruments with 1 Hz geophones and 600 MB hard disks and 5 Kinemetric instruments with 2 Hz geophones and 20 MB disks situated along a northeast-trending line from which the *Lee* steamed to the southwest with the airgun array firing at a 20 second interval. Shots were recorded 70 km inland when the Lee was 60 km offshore giving a total offset of 130 km. Preliminary results suggest that first breaks consist of prominent reflectors from the Moho or very deep crust beneath the shoreline.

EQUIPMENT

The *R/V Samuel P. Lee* is a 208-ft AGOR-class research vessel owned by the U.S. Navy and operated by the United States Geological Survey. The primary underway navigational sensor was Loran-C operated in the range-range mode. Loran-C calibration factors were derived from GPS solutions when GPS coverage was adequate (approximately 12 hours per day). The seismic source consisted of a 10-airgun array with a total chamber volume of 2424 cu. in. (Fig. 2). This array is double the array (5 guns, ~1300 cu. in.) used by the USGS in previous surveys of this region in 1978 and 1979. MCS data were recorded on a DFS-V recording system from a 44-channel analog streamer which consisted of 50-meter groups with a far-offset of approximately 2250 meters. The shot interval was 50 meters, resulting in 25-meter, 22-fold CDP coverage. Records were recorded to 12 seconds at a 2 msec sample rate, prefiltered between 8 to 128 Hz.

In addition to the MCS data, single-channel seismic-reflection profiles were collected with a separate 200-meter streamer. Wide-angle reflection and refraction data for deep-crustal velocity information were recorded at 66 sonobuoy stations along the seismic tracklines. The single-channel and sonobuoy data were recorded digitally with the MCS data on the DFS-V tapes. Analog acoustic-reflection data were collected continuously at 3.5 and 12 kHz for high-resolution imagery of near-surface geology and for bathymetry. Continuous (20 second sample interval) gravity measurements were also made using a LaCoste-Romberg sea gravimeter.

Processing of the seismic, navigation, and gravity data will be done at the USGS marine data processing center in Palo Alto, California. The MCS data are expected to be fully processed through post-stack migration within two years, at which time the processed sections and digital data will be made available to the public. Digital navigation, gravity,

and bathymetry will also be publicly released at that time. Prior to official release, the data are available for use at the USGS offices in Palo Alto, California.

Inquiries concerning these data should be directed to:

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References

Blake, M. C. J., Campbell, R. H., Dibblee, T. W. J., Howell, D. G., Nilsen, T. H., Normark, W. R., Vedder, J. G., and Silver, E. A., 1978, Neogene basin formation in relation to plate-tectonic evolution of San Andreas fault system, California: American Association of Petroleum Geologists Bulletin, v. 62, p. 344-372.

Crouch, J. K., 1981, Northwest margin off California Continental Borderland; marine geology and tectonic evolution: American Association of Petroleum Geologists Bulletin, v. 65, p. 191-218.

Emery, K.O., 1960, The Sea of Southern California, a modern habitat of petroleum: John Wiley and Sons, New York, 366 p.

Howell, D.G.(ed.) 1976, Aspects of the geologic history of the California Continental Borderland: American Association of Petroleum Geologists Pacific Section Miscellaneous Publication 24, 561 p.

Moore, D.G., 1969, Reflection profiling studies of the California continental borderland: structure and Quaternary turbidite basins: Geological Society of America Special Paper 107, 142 p.

Shepard, F.P. and K.O. Emery, 1941, Submarine topography off the California coast: canyons and tectonic interpretations: Geological Society of America Special Paper 31, 171 p.

Vedder, J. G., Beyer, LA, Junger, A., Moore, G. W., Roberts, A. E., Taylor, J. C., Wagner, H. C., 1974, Preliminary report on the geology of the continental borderland of southern California: U.S. Geological Survey, Miscellaneous Field Studies Map MF-624, 9 sheets, 1:500,000 scale, 34 p.

Vedder, J.G., 1988, Regional geology and petroleum potential of the southern California borderland: in, Scholl, D.W., A. Grantz, and J.G. Vedder, (eds.), Geology and resource

potential of the continental margin of western North America and adjacent ocean basins, Beaufort Sea to Baja, California, Circum-Pacific Council for Energy and Mineral Resources, Houston, Texas, Earth Science Series, v. 6.

Yeats, R. S., 1968, Rifting and rafting in the southern California Borderland, *in* W. R. Dickinson and A. Grantz, eds., Proceedings of conference on geologic problems of San Andreas fault system: Stanford University Publications, Geological Sciences, v. 11, p. 307-322.

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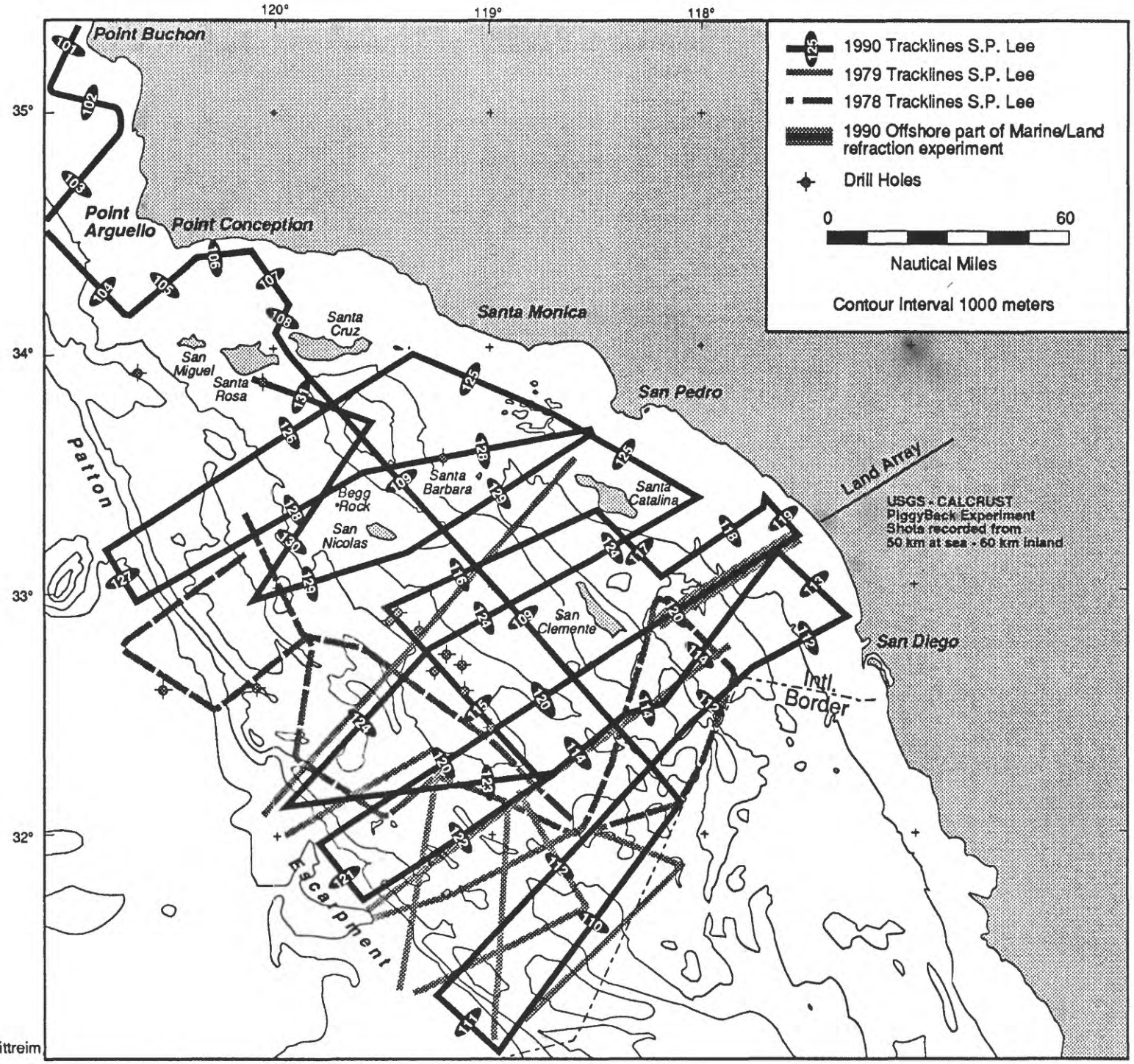

Figure 1
(Bohannon, Eittreim and Childs)

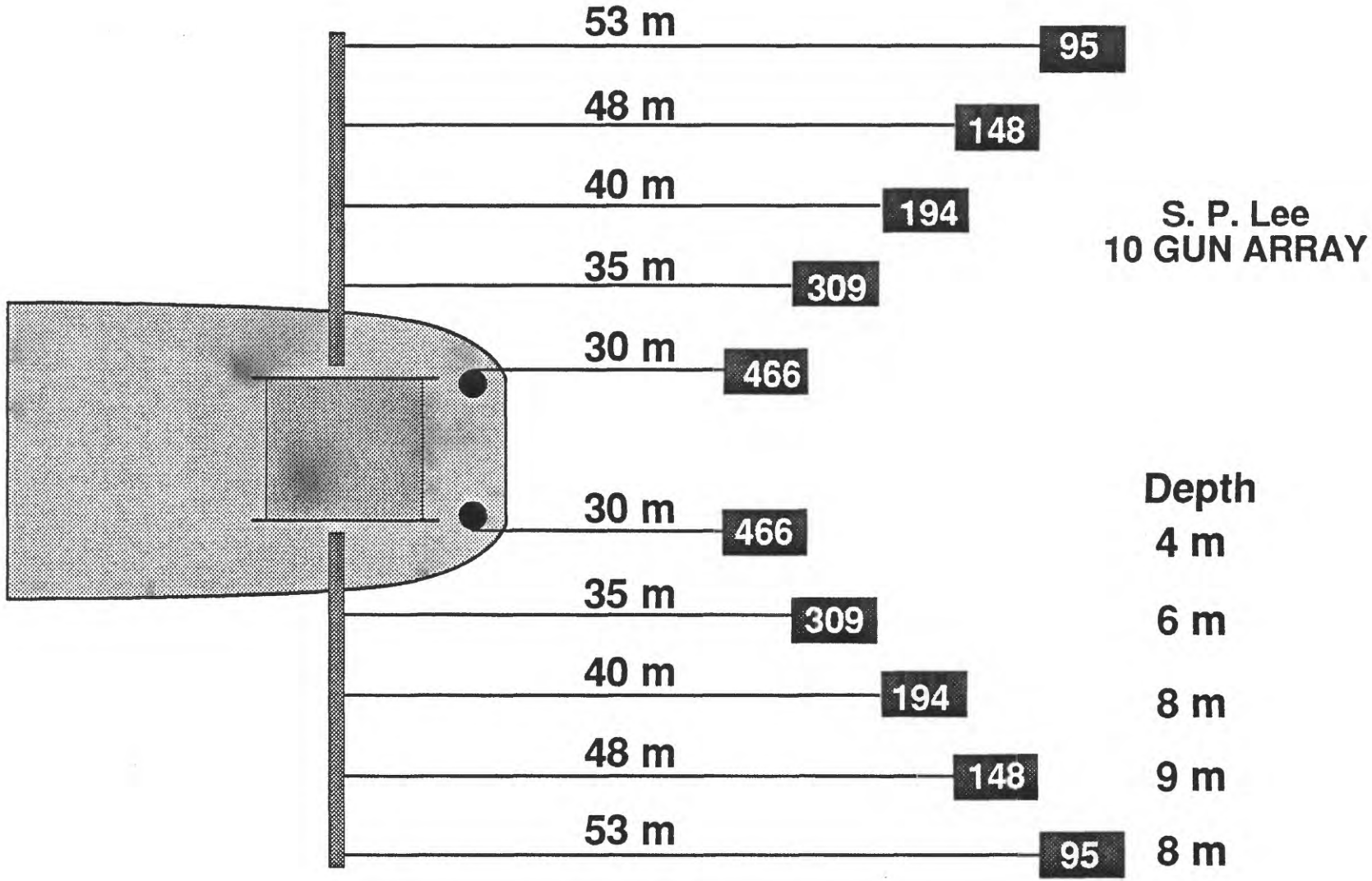

Figure 2
(Bohannon, Eittreim, and Childs)