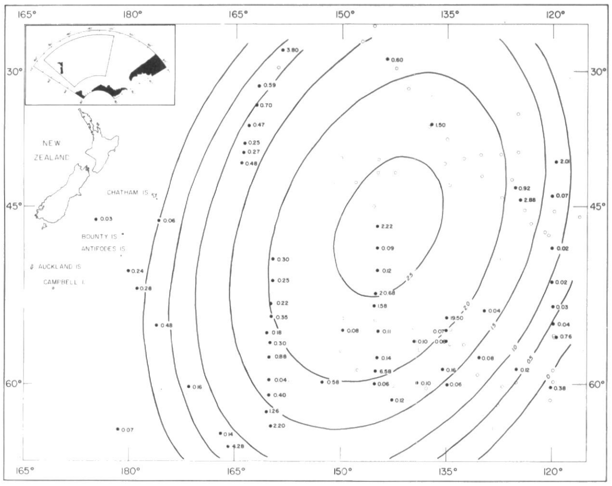

Figure 4. Manganese in surface sediment of the subantarctic Pacific Ocean with contours of the second-degree trend surface. Manganese values are in weight percent. Contour interval is 0.5 percent.

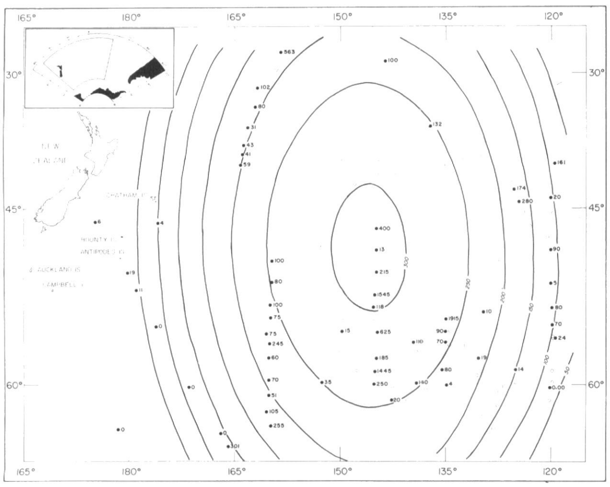

Figure 5. Cobalt in surface sediment of the subantarctic Pacific Ocean with contours of the second-degree trend surface. Cobalt values are in ppm. Contour interval is 50 ppm.

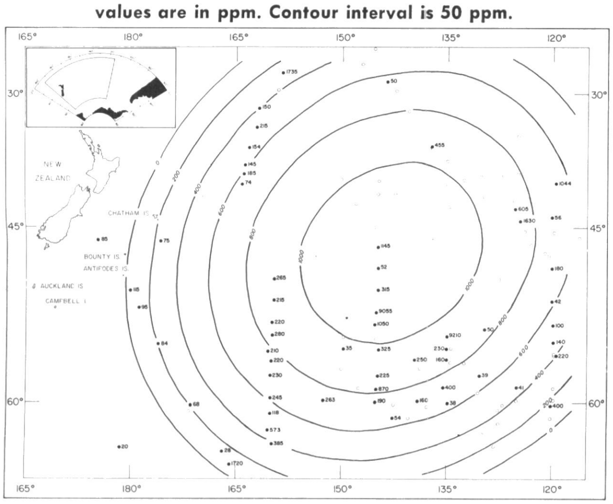

Figure 6. Nickel in surface sediment of the subantarctic Pacific Ocean with contours of the second-degree trend surface. Nickel values are in ppm. Contour interval is 100 ppm.

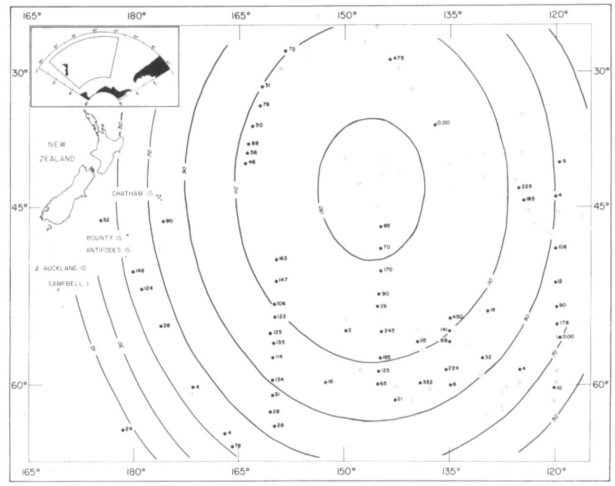

Figure 7. Chromium in surface sediment of the subantarctic Pacific Ocean with contours of the second-degree trend surface. Chromium values are in ppm. Contour interval is 20 ppm.

rine volcanism generated turbidity currents, which would flow down-slope and spread volcanic material (Nayudu, 1969). Mineral associations strongly suggest *in situ* alteration of the volcanic sediment. A detailed discussion of these units and the chemistry of surface sediments will be presented in a separate paper.

A study is in progress on significant changes at depth in these cores in order to evaluate the origin of the sediments and the paleoclimatic history and the paleocurrent regime of the region. Also, a study is being conducted of the chemistry, origin, and distribution of manganese nodules in the area.

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The Marine Geophysical Program of USNS *Eltanin*, 1968-1969

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The marine geophysics program aboard *Eltanin* during 1968–1969 consisted of several phases, including the routine collection of continuous underway gravity, magnetic, and seismic-profiler data. As part of a cooperative program, the geophysics group of the University of New South Wales provided one or two observers (generally advanced graduate students) who assisted in the data collection on Cruises 34–37. Geophysical observations made on board *Eltanin* continue to provide the bulk of geophysical information on the extreme southern oceans.

A new program of sediment-velocity determination was introduced on Cruise 37. This program utilizes the normal reflection profiling equipment in conjunction with passive, expendable radio-sonobuoys (Le Pichon *et al.,* 1968; Houtz *et al.,* 1968). Sonobuoys were made available to the program from those supplied to the Lamont-Doherty Geological Observatory by the Office of Naval Research. A commercial radio receiver (Communications Electronics No. 501A) was used to receive the sonobuoy signals. Sixteen wide-angle sonobuoy stations (Fig. 1) were made which produced useful sediment-velocity information.

Figs. 2a and 2b illustrate seismic data collected at sonobuoy station 14. Fig. 2a shows the normal, vertical-incidence seismic profiler record: the record quality is poor and sub-bottom penetration is generally less than 0.5 sec. The wide-angle reflection record, collected simultaneously with the record of Fig. 2a, is shown in Fig. 2b. The additional penetration achieved with the sonobuoy technique frequently reveals total sediment thickness in areas where basement reflections are not recorded with the vertical reflection technique. This record yields the following sediment-velocity information:

layer 1 (5.0–5.9 sec reflection time)
interval velocity $V_p = 2.26 \pm 0.10$ km/sec

layer 2 (5.9–6.6 sec reflection time)
interval velocity $V_p = 2.70 \pm 0.03$ km/sec

layer 3 (~6.6–? sec reflection time)
refraction velocity $V_p = 3.80$ km/sec

Interval velocities from wide-angle reflection data have been corrected for dip, but the refraction velocity has not been corrected. If we assume that the refracting horizon is parallel to the sea floor, the correct velocity of layer 3 is 3.50 km/sec. These records demonstrate the complementary nature of these two seismic reflection techniques. A knowledge of sediment velocities and their variations with depth will help evaluate the possible relationships of sediments of the southern oceans to those elsewhere. The sonobuoy program has now become a routine part of the *Eltanin* geophysical program.

Geophysical data reports (navigation, bathymetry, and magnetics) have been issued for *Eltanin* Cruises 16–27 (Heirtzler *et al.,* 1969; Hayes *et al.,* 1969) and are in preparation for the more recent cruises. Of particular interest are data collected on Cruises 34, 36, and 37 in the vicinity of the Macquarie Ridge–Trench complex and on numerous crossings of the mid-oceanic ridge south of Australia. Studies are in progress of these areas (*e.g.,* Houtz *et al.,* in press) and numerous others. A regional gravity map of the South Pacific compiled largely from data collected on *Eltanin* will be available shortly (Talwani *et al.,* in preparation).

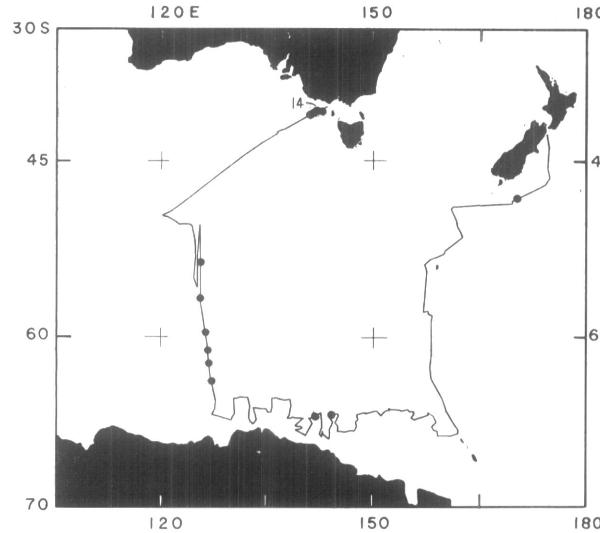

Figure 1. Index map of *Eltanin* Cruise 37 showing location of wide-angle seismic-reflection observations using expendable sonobuoys.

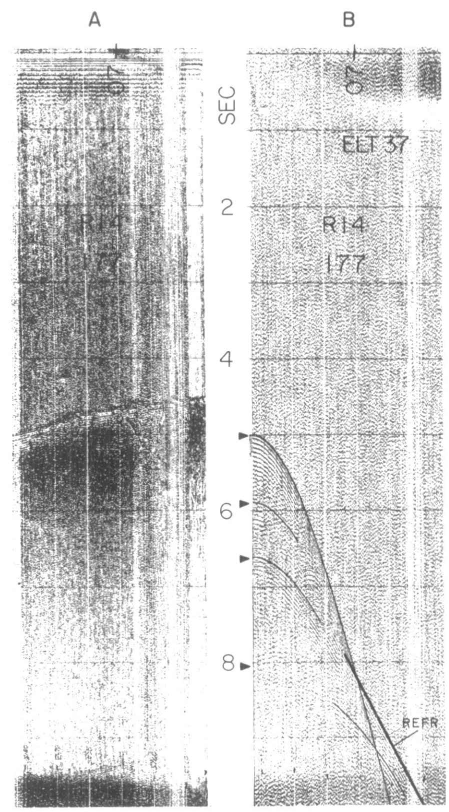

Figure 2. Sonobuoy station 14 (39°41'S. 141°12'E.), *Eltanin* Cruise 37. Reflection time for both records in seconds (1 sec=400 fm in water). (a) Vertical-incidence reflection record using normal seismic profiling technique. (b) Wide-angle reflection record using a sonobuoy. Black diamonds indicate major reflectors. Reflection line is labelled REFR.

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Physical Oceanography on *Eltanin* Cruises 32-37

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The Lamont-Doherty Geological Observatory conducted the physical-oceanography program aboard USNS *Eltanin* continuously from Cruise 32 to 37. Cruise 37 was devoted entirely to this program (see *Antarctic Journal* vol. IV, no. 4, p. 162–163). The table summarizes the data collected.

Water samples, obtained from Nansen-bottle casts and Niskin bottles surrounding the STD sensors (Gerard *and* Amos, 1968), are analyzed for salinity, oxygen (Carpenter modification of Winkler method), and micronutrients–nitrate, phosphate, and silicate (Auto-Analyzer). The temperature and depth of water samples are determined by the standard reversing thermometer. The STD sensors transmit information via sea cable to the ship, where it is recorded in analog and digital form on magnetic tape for analysis at Lamont-Doherty. Since the ship drifts during the lowering and raising of the STD sensors, and the small-scale temperature and salinity structure differs in the two traces, a separate station number is given to each descent and ascent.

The information from the Nansen-bottle casts and STD (with the calibration data of the SAMS) is fully processed at Lamont-Doherty. The data from Cruises 32–36 will appear in the 1968 report (previous reports are listed in references under Jacobs), to be distributed in late 1969. Cruise 37 data (with those of 39 and 41) will appear in the next data report.

The bottom photographs,[1] bottom-current measurements, and nepheloid measurements of the water column are accomplished by one lowering of a tripod apparatus developed at Lamont-Doherty by Drs. Ewing and Thorndike. The current-meter and nephelometer data are processed soon after completion of the cruise. Analysis of the current-meter data and correlation with evidence of currents in the bottom photographs is being conducted and the results will be published. The relation of the nepheloid data to the STD data and the form and position of the nepheloid layer in antarctic waters is also under investigation. During Cruise 35, close-up photos[1] were obtained from an elevation of 12 inches above the sea floor in addition to the regular bottom photographs.

Analysis of the hydrographic data is proceeding along various lines. Cruise 32 data, which are mostly from the Ross Sea area, combined with Cruise 27 and earlier data from that area, form the basis for a study of the oceanography of the Ross Sea with special emphasis on the sea as a bottom-water producer and the interaction of the Ross Ice Shelf with the Ross Sea waters. Evidence has been found of freezing of sea water to the bottom of the ice shelf; the resultant water, which contributes to the dense Ross Sea shelf water (salinities above 34.75°/oo), finally escapes into the deep ocean. The ice shelf also appears to be related to numerous thin filaments of cold water in the Ross Sea. A Ross Sea study cannot be fully completed until the water under the ice shelf can be investigated.

During Cruise 37, dense bottom water flowing from the northwest Ross Sea was traced as a bottom salinity maximum in the deep ocean region north of Adélie Coast. It is expected that the Ross Sea bottom water flows between the Balleny Islands and Antarctica. The Ross Sea-originated bottom water is deflected northward at 140°E. by newly formed bottom water on the continental shelf of Adélie Coast. This bottom water has lower salinities than the Ross Sea bottom water and its oxygen saturation is over 90 percent.

The microstructure of the Ross Sea STD data is also being analyzed. The power spectra of the temperature and salinity microstructures (wave numbers from 10 to 500 cycles/km) are found by averaging the spectra from individual stations. The results of this study are most interesting and will be published in the near future.

The *Eltanin* bathythermograph data consist of mechanical BT and expendable BT (XBT) information. The BT data extend to 275 m, while the XBT data

[1] Available from the Smithsonian Oceanographic Sorting Center.