Oct. 23, 1985

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RESEARCH CRUISE REPORT

R/V ROBERT D. CONRAD 26-08

Attached is a copy of a cruise report for the above CONRAD cruise.

Ann Burns
Marine Office

Enc.

RESEARCH CRUISE REPORT RC2608

Manzanillo to Papeete

June 24 - August 8, 1985

Co-Chief Scientists: Jeffrey K. Weissel, Lamont-Doherty Geol. Obs.

Barry Parsons, Massachusetts Inst. Tech.

Cruise RC2608 departed from Manzanillo, Mexico, on June 24 and arrived in Papeete, Tahiti on August 8, 1985 after steaming about 9400 nautical miles in 45 days. Attached is a preliminary track chart. The scientific objective for this leg was to obtain evidence for the effects on gravity and topography of small-scale mantle convection beneath the young lithosphere of the Pacific plate. Continuous measurements of gravity using the Bell BGM-3 gravimeter and of seafloor topography using the SeaBeam multibeam bathymetric system constitute the principal data obtained during RC2608. Small-amplitude gravity anomalies lineated in the direction of absolute Pacific plate motion had been mapped from Seasat altimeter data by Haxby and Weissel (in press) who interpreted the lineated pattern as a reflection of small-scale mantle convection arising at an early stage of plate cooling history and being organized into longitudinal "rolls" parallel to plate motion under shear imparted by the fast-moving Pacific plate. Independent processing of Seasat altimeter data in the Central Pacific by Barry Parsons had confirmed the reality of the lineated pattern of small-amplitude gravity anomalies. Several ancillary objectives were sought, including an evaluation of the

sensitivity of the Seasat altimeter to bathymetry, and the statistics on occurrence versus plate age of seamounts along the tracks of research vessels.

Experimental Outline

Seven, approximately 1500 km-long SeaBeam and gravity profiles were run at high angles to the absolute motion direction of the Pacific plate in the Central Pacific (see attached track chart). Line 1 was run about 15 km west of the East Pacific Rise, lines 2-4 were run over 8-10 Ma crust, and lines 5-7 over 30-35 Ma crust. In addition, lines 2-6 were all run along Seasat descending sub-orbital paths.

Results

Essentially, the gravity data obtained on RC2608 vindicated the previous processing of the Seasat altimeter data, and substantiated the reality of the lineated pattern of small-amplitude gravity anomalies over the Pacific plate. On the line run close to the Rise axis, the gravity anomalies are very small, ~5 mgal peak-to-trough, as indicated by the altimeter data. Such small amplitudes can be explained by local compensation of near ridge crest topography, using typical values for mean crustal thickness. Lines 2-4 show much larger gravity anomalies (15-20 mgal peak-to-trough) at wavelengths of 150-200 km. Individual anomalies can be traced across the 3 profiles, confirming the strike of

the features in the Seasat data. There are also small bathymetric variations (~200 m peak-to-trough) associated with these gravity anomalies, shallower depths corresponding to higher gravity. This means that the gravity/bathymetry relationship at wavelengths of 150-200 km is close to that for uncompensated topography. On lines 5-7, similar magnitude gravity and depth variations are found, but longer wavelength (400-500 km) components may be present as well.

We believe it is necessary to have a dynamic process to explain the development of the topography and gravity anomalies as the plate cools away from the ridge axis. Small-scale mantle convection of the type described above would provide one such mechanism. There are other explanations, such as deformations due to thermal stress in the cooling plate and the off-ridge separation of melt from a zone of partial melting beneath the lithosphere, which may provide viable alternative mechanisms. At this preliminary stage of data analysis, we favor the hypothesis that the topographic variations which are dynamically supported by small-scale convection increase in wavelength from ~200 km at 10 Ma to ~400-500 km at 30-40 Ma due to the increasing flexural rigidity of the lithosphere and the development of convection cells with larger widths. However, it is possible that the early variations with wavelengths ~200 km can be frozen in and effectively supported by the increasing flexural rigidity of the lithosphere. Clearly, much work needs to be done in order to understand which of the proposed mechanisms will work.

In addition, roughly 400 seamounts were observed on the 7 profiles. With these data, we hope to estimate how the size and shape of seamounts varies with plate age.

Equipment Report

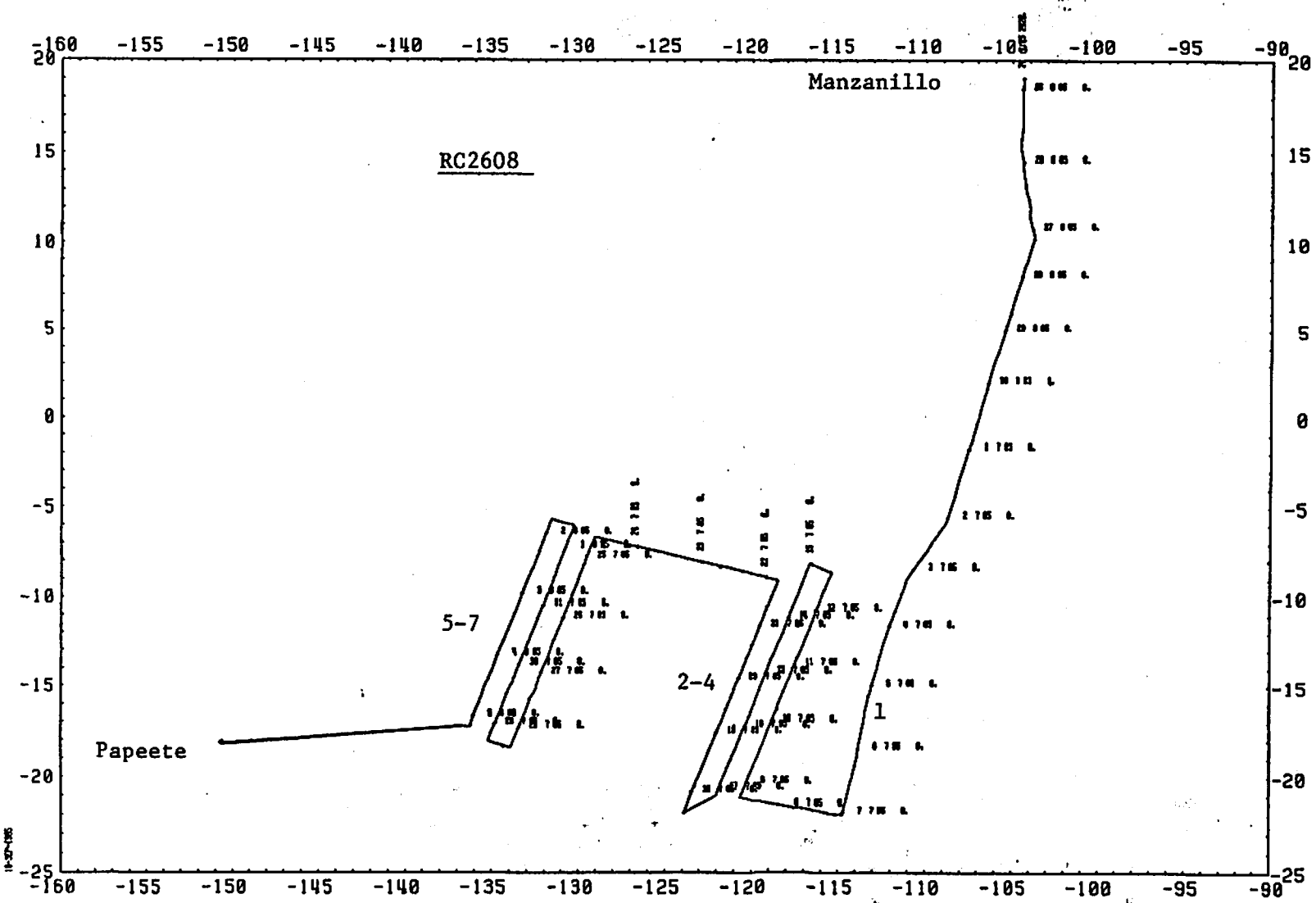
This topic has been discussed in the regular cruise completion forms. The Seabeam system and the BGM-3 gravimeter both performed excellently. The 3.5 kHz PDR gave valuable information on the near ridge axis sediment distribution, although it occasionally interfered with the SeaBeam system over steep topographic slopes. The major disappointment to us on RC2608 was the single-channel seismic reflection system. The seismic profiling system on the CONRAD was excessively noisy even at 6 knots, and was useless at the 9 knot speed we needed to make in order to attain the scientific objectives. The source of the noise lay with the streamer, which we understand was designed to be used in an environment different from normal underway operations. It needs to be replaced.

Reference

Haxby, W.F. and J.K. Weissel, Evidence for small-scale mantle convection from Seasat altimeter data, J. Geophys. Res., in press.

Jeffrey K. Weissel

Barry E. Parsons


RC2608
Manzanillo
Papeete
5-7
2-4
1
-160 -155 -150 -145 -140 -135 -130 -125 -120 -115 -110 -105 -100 -95 -90
20 15 10 5 0 -5 -10 -15 -20 -25

D. Hayes)
Oceanography