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CRUISE REPORT

Ship Name: VEMA

Cruise No: 3601

Departure: July 4, 1979 (Date) from Suva, Fiji (Port)

Arrival: August 5, 1979 (Date) at Auckland, New Zealand (Port)

Days at Sea: 29*
(Count day of departure but not day of arrival in port)

Days Foreign Port: 10*
(number of days in arrival port before next leg)

Area of Operation: Southwestern Pacific, east of New Zealand

Program Description:

Magnetic and seismic profiling of the oceanic crust near the Eltanin Fracture Zone. Dredging on the Louisville seamount chain.

Program supported by what ~~contract~~ grant: NSF OCE 77-25993

Participants: (All L-DGO unless otherwise specified)

Name	Title
Roger L. Larson	Chief Scientist
Charles Salcedo	Electronics Technician
Dwight Mossman	Electronics Technician
Martin Iltzsche	Airgun Engineer
Hector Smith	Airgun Technician
John Bodine	L-DGO graduate student observer
Paul Woodroffe	Electronics Technician
Mariel Oakman	Univ. of Colorado student observer
Ropate Qali	3rd Mate and Coring Bosun
Samu Selo	Coring Bosun

All inquiries regarding cruise should be made to the chief scientist.

*July 6, 7, 8 counted as "days in foreign port" (Suva) between test cruise and departure for Auckland.

CRUISE REPORT

VEMA 3601

Suva, Fiji Islands to Auckland, New Zealand
July 4 to August 5, 1979

Vema's cruise 36 leg 1 began on July 4 with a 2-day test cruise southeast of Viti Levu in the vicinity of Kandavu and Matuku Islands. This test cruise allowed us to check out scientific and ship's equipment that had not been used in underway working conditions during Vema's 11-month layup in Suva. It also allowed us to delay sailing for Auckland while waiting for delayed air-freight shipments to arrive. The new ship's magnetic compass was calibrated; the new dredge wire was tested at dredge station #1; and the magnetometer, single-channel profilers, Lamont airgun, and 12 KHz PDR were found in good working order. The 3.5 KHz PDR gave very weak returns even in shallow water, probably due to a fouled transducer that should be replaced in Auckland. We returned to Suva on July 6 (Friday) and waited that weekend for the air-freight shipments that were victims of the worldwide DC-10 groundings. The shipments did not arrive by Monday, July 9 and could not be traced, so we sailed for Auckland without the Magnavox satellite positioning system, the gravity table and high pressure fittings for the newly-installed big airgun air supply system.

We sailed southeast across the Lau Ridge, Lau Basin, Tonga Arc and Tonga Trench, crossing the trench at nearly its deepest point (∿5600 fms) (Figure 1). Directly after crossing the trench we encountered the first of five gales that hampered our progress throughout the leg. Gales are common in this region during the southern winter, drifting easterly and southeasterly across the

South Pacific accompanied by 30-45 kt winds from random directions. These gales generally slowed progress, made it difficult to keep on the track, and in our case made celestial positioning difficult. Despite the gales and accompanying cloudy skies, celestial positioning was adequate to excellent throughout the area of interest, in that never more than 24 hours elapsed without stellar observations, usually supplemented by solar and lunar sights. This was largely due to good fortune and the extremely professional sights taken by Chief Mate Rigamoto Nakaoro and Captain Henry Kohler, often in gale conditions. Positioning of the entire track is probably good to five miles or less, and navigation was possible within 10 miles of the optimum track. Satellite positioning information was also received on the old satellite receiver in the upper lab and will hopefully yield a satellite-positioned track after processing at Lamont.

We continued southeast, making a profile parallel to and north of the Louisville seamount chain and the Heezen Fracture Zone of the Eltanin Fracture Zone system (Figure 1). This profile crossed a recognizable sequence of magnetic anomalies from 34 to 25 (80 to 59 m.y.). This profile and one adjacent to it show that spreading was oblique from 34 to 30 time at a whole rate of 20 cm/yr across the Pacific-Aluk plate boundary, and orothogonal from 28 to 25 time at 9 cm/yr across the Pacific-Antarctic plate boundary. This plate boundary transition occured with a ridge crest jump at anomaly 29, and minor ridge jumps also occured between 31 and 32 time. We also tested the big airgun system on this profile and revealed several towing problems, an airline leak, and a firing cycle malfunction. Rough weather precluded further testing prior to our arrival in Auckland. A two-hour test of the big airguns in the bay just outside Auckland proved that the guns fire properly, but that they tow in an unstable manner. The tow point must be moved as far forward as possible to keep the guns from "fishtailing" and tangling behind the ship.

Returning to the description of geophysical results, we then cut across the Heezen Fracture Zone and made a parallel profile between Heezen and Tharp Fracture Zones up the middle of the Eltanin Fracture Zone system (Figure 1). This profile encountered anomaly 19 just south of 50^{o}S latitude, and showed a continuous sequence through anomaly 31 with spreading rates that correspond to the Pacific-Antarctic plate boundary (4 to 14 cm/yr, whole rates). Anomaly 32 is missing in an area of seamounts and normal faults that suggest tectonic disruption, although 32 and its mirror image may be present on the parallel Eltanin 17 profile that suggests a substantial ridge crest jump at that time. Anomalies 33 and 34 and the upper Cretaceous Quiet Zone are clearly present at the northwest end of this profile, again showing Pacific-Antarctic rates. These results suggesting the Pacific-Antarctic plate boundary between Heezen and Tharp Fracture Zones between 34 and 30 time are in conflict with those of Weissel et al. (1977) who report no anomalies older than 29 in the same fracture zone compartment across the present-day ridge near Antarctica.

After completing this profile we successfully dredged volcanic rocks from near the top of one of the Louisville seamounts at 41^{o}S. Many of these presumed basalts have the plate-like characteristics common to the roofs of evacuated pillows or lava tubes and associated with sheet flow basalts at modern ridge crests.

A short pair of profiles were then made across anomalies 33 and 34 south of Tharp Fracture Zone near the eastern nose of the Chatham Rise (Figure 1). The northern of these profiles shows an excellent anomaly 34 that dates the breakup of Antarctica-New Zealand at just prior to anomaly 34 (80 m.y.) at this location. The rates recorded on these profiles also suggest this was part of, or nearly part of, the Pacific-Antarctic plate boundary even at breakup.

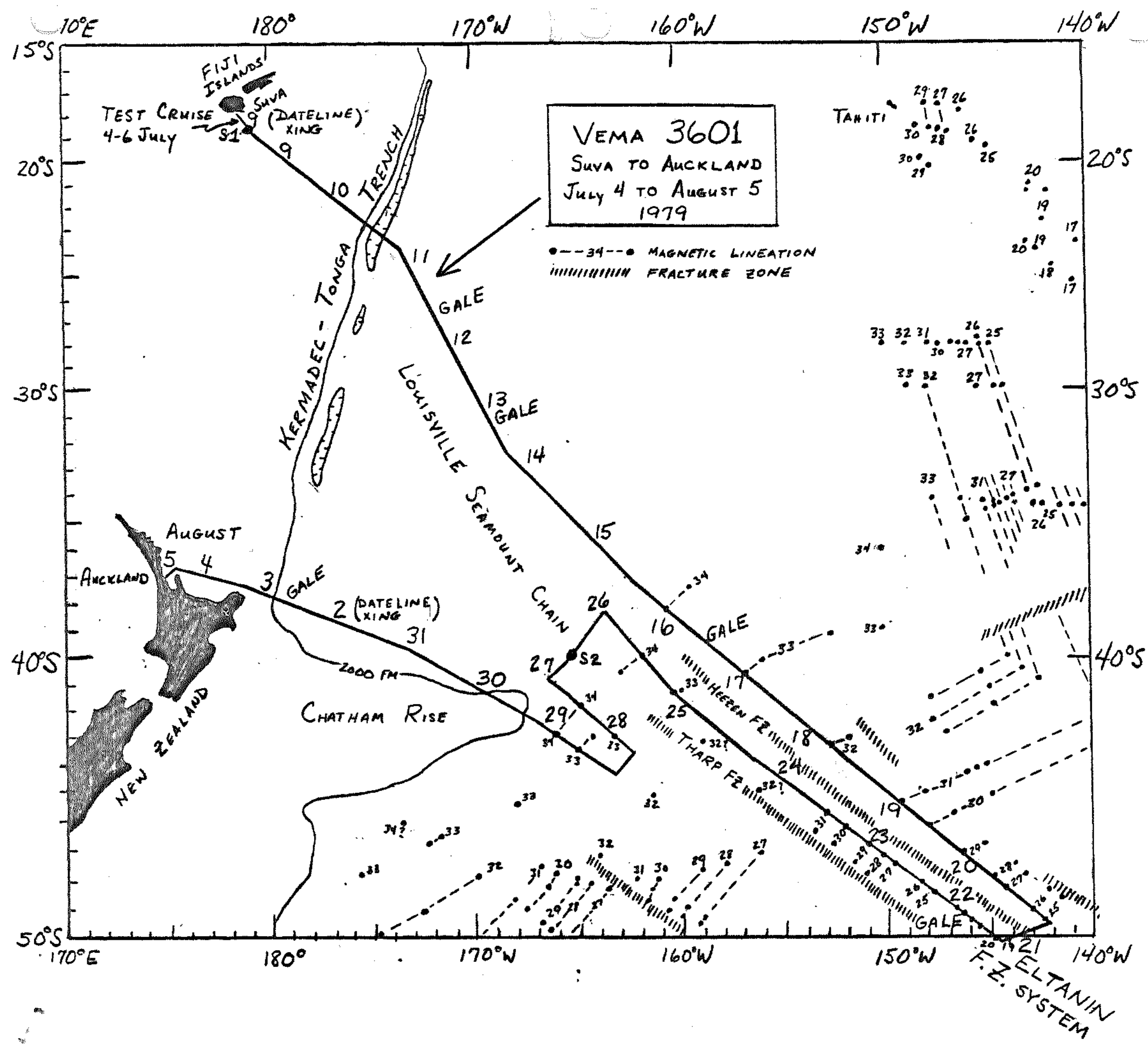
Probably the most significant result of this cruise is the documentation of the Late Cretaceous-Paleocene sequence of magnetic anomalies that record the time during which the vast majority (830 km) of the present-day offset (1000 km) across the Eltanin Fracture Zone occured. Four new crossings in three different fracture zone compartments show essentially no offset across the entire Eltanin Fracture Zone system at anomaly 34 time. This, along with the 34-time break up of New Zealand-Antarctica, suggest that the latter crust occured as a result of the Pacific-Aluk (Phoenix) plate boundary propagating southwards until it aligned with the New Zealand-Antarctica rift zone. Up until then it was probably transformed northwest along a fracture zone now occupied by the Louisville Seamount Chain, but at 80 m.y. the transformed ridge probably jumped to the other (southeast) side of New Zealand and began spreading it apart from Antarctica.

This breakup and subsequent spreading occured at the Pacific-Antarctic plate boundary that extended across the Tharp Fracture Zone to the Heezen Fracture Zone where it formed one arm of the Pacific-Antarctic-Aluk (Phoenix) triple junction from 34 until 30 time. A tectonic disruption at 32 time between Heezen and Tharp Fracture Zones produced 450 km of offset and may have resulted from a ridge jump of the Pacific-Antarctic ridge, a brief excursion of the Pacific-Aluk plate boundary into this fracture zone compartment, or both of the above.

At anomaly 29 time the Pacific-Antarctic plate boundary migrated northeast by one fracture zone compartment leaving Pacific-Antarctic anomalies north of Heezen Fracture Zone and locating the Pacific-Antarctic-Aluk triple junction somewhere north of that. The spreading rate at the Pacific-Aluk plate boundary was about twice that at the Pacific-Antarctic plate boundary during Late Cretaceous-Paleocene time. This spreading rate difference, plus some ridge crest jumping produced 830 km of offset across the Eltanin Fracture Zone from anomaly 34 (80 m.y.) to anomaly 28 (64 m.y.).

After completing the magnetic profiles, we steamed directly ot Auckland through the last of the South Pacific winter gales, arriving on Ausust 5. The cruise was extremely productive despite bad weather and missing equipment. Both the scientific and ship's crews are composed of hard-working, dedicated professionals, whose efforts made success possible and whose personalities made the cruise delightful. The food, incidently, was excellent.

Roger L. Larson
Chief Scientist
VEMA 3601



VEMA 3601
SUVA TO AUCKLAND
JULY 4 TO AUGUST 5
1979
--34-- MAGNETIC LINEATION
FRACTURE ZONE
FIJI ISLANDS
SUVA
TEST CRUISE 4-6 JULY
(DATELINE XING)
KERMADEC - TONGA TRENCH
LOUISVILLE SEAMOUNT CHAIN
TAHITI
AUGUST
AUCKLAND
NEW ZEALAND
CHATHAM RISE
2000 FM
GALE
HEEZEN FZ
THARP FZ
ELTANIN F.Z. SYSTEM
15°S
20°S
30°S
40°S
50°S
170°E
180°
170°W
160°W
150°W
140°W