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CRUISE REPORT

Ship Name: R/V VEMA

Cruise No: 36-03

Departure: October 10, 1979 (Date) from Suva, Fiji (Port)

Arrival: November 10, 1979 (Date) at Guam (Port)

Days at Sea: 31
(Count day of departure but not day of arrival in port)

Days Foreign Port: 2
(number of days in arrival port before next leg)

Area of Operation:
Eastern Caroline Sea,western Equatorial Pacific Ocean.

Program Description:
Detailed study of the tectonic character of the Caroline-Pacific plate boundary. Shipboard techniques used include: underway MG&G, near-bottom hydrophone profiles, digital heat flow profiles, dreding, box coring.

Program supported by what contract: OCE 78-19830

Participants: (All L-DGO unless otherwise specified)

Name	Title
J. K. Weissel	Chief Scientist
D. Roach	Heat flow technician
D. Medlicott	Computer technician
B. Ostrowski	Instr. technician
M. Bolekinaivalu	Core Bosun
H. R. Smith	Air Gun Tech.
M. Iltzsche	Air gun engineer
K. Jacobs	E. T.
P. W. Woodroffe	E. T.
C. A. Salcedo	E. T.
S. Hudson	MCS observer/trainee

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

CRUISE REPORT

V3603 Suva to Guam

October 10 - November 10, 1979

General

Leg 3 of VEMA's cruise 36 left Suva, Fiji on October 10, 1979, and reached Guam on November 10, 1979. During these 31 days, about 5500 n.m. of track were steamed and 14 new ship's stations were occupied. The main scientific objectives of the leg were:

1) To ascertain where the trench section of the Caroline-Pacific plate boundary gives way to the no-trench (overthrusting) section; 2) To provide better definition of the tectonic fabric of the no-trench section of the plate boundary; 3) To compare the geophysical properties of the trench and no-trench sections of plate boundary through heat flow and near-bottom acoustics profiles and by obtaining samples of material involved in the plate boundary tectonics. 4) To make a reconnaissance magnetic survey of the Lyra basin.

Objectives 1) and 2) were largely met through underway marine geological and geophysical techniques. Objective 4) was not addressed through lack of time. Objective 3) was pursued with varying degrees of success as described below.

During the 10 days of transit time at the beginning of the leg, the 12-channel MCS eel was streamed and tested for about 6 hours. As the wings did not fit, the birds were not attached to the eel for the test. All eel sections seemed to be active and all DFSIV systems worked except the UGR. The two Bolt airguns with their new tail sections worked properly. A test tape was made with the guns firing.

Trench to No-trench Transition

Four geophysical profiles across the transition section of Caroline-Pacific plate boundary show that the morphologic characteristics of a true trench system disappear between 3°10'N and 3°24'N on the boundary. The older Lyra Trough does not appear to influence the location of the transition in tectonic style. Immediately north of the disappearance of the morphologic trench, the accretionary prism is ramped upward against the ridge that is the northward continuation of the Mussau Ridge. The disappearance of trench characteristics also coincides with the first appearance of compressional deformation structures within the oceanic crust and overlying sediments.

Fabric of the No-trench Section

Nine new geophysical profiles were run across the overthrust section of the Caroline-Pacific plate boundary, and several shorter profiles were run at higher angles to the NNW-SSE strike of the boundary. One profile near 5°30'N was made using the large Bolt airguns to provide a "ground-truth" structural section for the heat flow, near-bottom acoustics, and sampling stations programs. The highlights of the tectonic fabric survey are:

a) That magnetic lineation number 11 between 5° and 6°N can be traced completely across the present plate boundary without interruption of its continuity. This means that strike-slip movements along the boundary are negligible; b) A large seamount just north of 4°N complicates the overthrust processes at that point on the plate boundary.

Trench Transect

To sample the geophysical properties of the Mussau Trench section of the Caroline-Pacific plate boundary, we first surveyed an EW profile at 1° 36'N with the underway marine geological and geophysical equipment. Two heat flow profiles of seven values each were run, one on the subducting Caroline plate, the second on the overriding Pacific plate. The observed temperature gradients on the upper plate were about twice those on the lower plate. Two dredge hauls were made on the inner wall of the Mussau Trench, but the dredge was lost at a third site which was intended to sample what appears to be an accretionary prism on the lower half of the inner trench wall. Of the two successful dredges, the shallower one (above 1200 fm) yielded mainly basalts, some gabbros, and minor carbonate breccias, the igneous rocks being affected to various degrees by typical seafloor weathering processes. The deeper dredge haul (about 1700 fm) represents a greenschist-grade meta-basalt and gabbro assemblage. Many samples have been thoroughly serpentized. It is not immediately evident whether the metamorphism represents crustal burial metamorphism or tectonism connected with the overthrusting of Pacific plate inner wall of the Mussau Trench.

No-trench Transect

After running a base line with the large Bolt airguns, I selected four station sites for the near-bottom acoustics experiments, heat flow profiles and oriented box cores. Roughly, two station sites were in the central portion and one site each were located on the east and western margins of the 60-km wide plate boundary zone.

Heat Flow: A total of 24 new values were obtained at the four station sites. Occasionally, the heat flow spear bounded or toppled after penetration, probably indicating the presence of hard sediments or possibly oceanic crust. Gradients are variable across the overthrust zone and several measurements had non-linear gradients.

Near-Bottom Hydrophone Experiments: These experiments were done at the same locations as the heat flow profiles and immediately before them. At the third station, the experiment was abandoned when a shock cord snapped, disrupting electrical connections to the hydrophone. On the first two lowerings, seismic energy was provided by the L-DGO 20 cu. in airgun, while on the last two lowerings, one 465 Cu in. Bolt airgun at approximately 1000 p.s.i. was used. Surprisingly, there was little difference in the results using the different sound sources--the seismic data were always poor below about 70 Hz. The poor quality of the seismic data is thought due to low frequency noise induced mechanically by the heave of the ship on the STD cable. We sought to overcome this by altering the suspension of the hydrophone within the cage and by altering the suspension of the cage from the wire. On the first experiment, the hydrophone was wrapped in foam rubber and suspended in the cage by means of shock cords. On the second, third and fourth attempts, the phone was set rigidly in the cage by strands of twisted galvanised steel wire without foam rubber padding. Similarly, the cage suspension was changed from one strand of heavy duty shock cord, to two strands of lighter shock cord, and finally to six strands of lighter shock cord. Although these various suspension configurations were tried, we could not improve the quality of the seismic data below 70 Hz. On the other hand, the 3.5 kHz pinger data were of good quality, seemingly unaffected by the problems plaguing the seismic frequency data. On the first experiment, the pinger-hydrophone distance was 50 fm, and on the succeeding experiments this was shortened to 25 fm.

The results of the near-bottom experiments, even though disappointing, provide ways to improve this potentially valuable tool. The recommendations of myself and the scientific crew aboard VEMA are as follows:

a) The suspension of the hydrophone should be engineered and not subject to ad hoc experimentation;

b) A streamlined pressure case should house the hydrophone and a good pre-amp;

c) Oil under pressure should be used to make the hydrophone case neutrally buoyant at depth;

d) The hyrophone should be connected to the STD wire via a pass-through bulkhead and a shock absorbing system;

e) The system should be capable of being towed at approximately 1.5 kt rather than being at the mercy of drift (which was unfavorable at 3 of the 4 experiments this leg). To accomplish this on VEMA would mean turning the STD winch around so that it faced forward and led through a block midships near the present core winch "A" frame. Secondly, a depressor should be added to the wire at depth to keep the hydrophone assembly near the bottom while towing.

There appears to be no electronic problems associated with receiving acoustic energy of different frequencies and levels and recording these on magnetic tape (although some thought should be given to digital recording). Box Core: One of the major successes of the station work on the no-trench transect was the performance of the new strengthened 6 ft x 1 ft x 1 ft box core. Likewise, one of the major disappointments of the leg was the accidental destruction of the orienting device (a locking compass) prior to the first launch of the box core. Since the potential for orienting our samples was removed, the box core was tested twice and the core and remaining liners saved for future experiments with a new compass. With 15 ft of free-fall, we achieved 4 ft of penetration giving a 4 cu. ft sample of mud. As one of the stations was on a hillside with presumably "harder" sediments, the device shows promise for sampling sediments which have been tectonized or semi-lithified where conventional piston core pipes would likely be bent. It is recommended that the free fall be increased to at least 20 ft.

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Evaluation of On-board Equipment

H. P. Computer: Down for the entire leg. Fixpits, data reduction, and data plotting were achieved through the Tektronix 4051 even though no hard copies of data plots could be made.

Ship's gyro: Erratic and almost useless for most of the leg. Sperry technician replaced most of the unit in Guam.

MC&G Equipment: With the exception of the 12 k Hz transceiver, the underway equipment functioned normally and down-time was extremely small on this leg. A large capacitor in the transmit section of the 12 kHz system blew up, raining oil through the transceiver and other modules below it in the equipment rack. This problem was patched by substituting a comparable component from the spare non-working 3.5 kHz transceiver and a vital chip that is the personal property of one of the ET's. However, due to a chronic shortage of good stylii, the 12 kHz PDR was shut down before the leg ended to ensure that the 3.5 kHz PDR could be kept working.

Upper lab Satellite receiver: This vital piece of backup equipment was not working this leg due to lack of an oscillator of the appropriate frequency. I view this as a serious problem, because the Magnavox navigator needs a back-up system.

Deck equipment: Almost all the winches on board VEMA suffered breakdowns at various times. However, the most serious was the burning out of the fantail winch which hauls and streams the underway gear. The other problems with the core winch, STD winch, and racket winch were all remedied.

Jeffrey K. Weissel

Chief Scientist

Date: Nov 16th 79

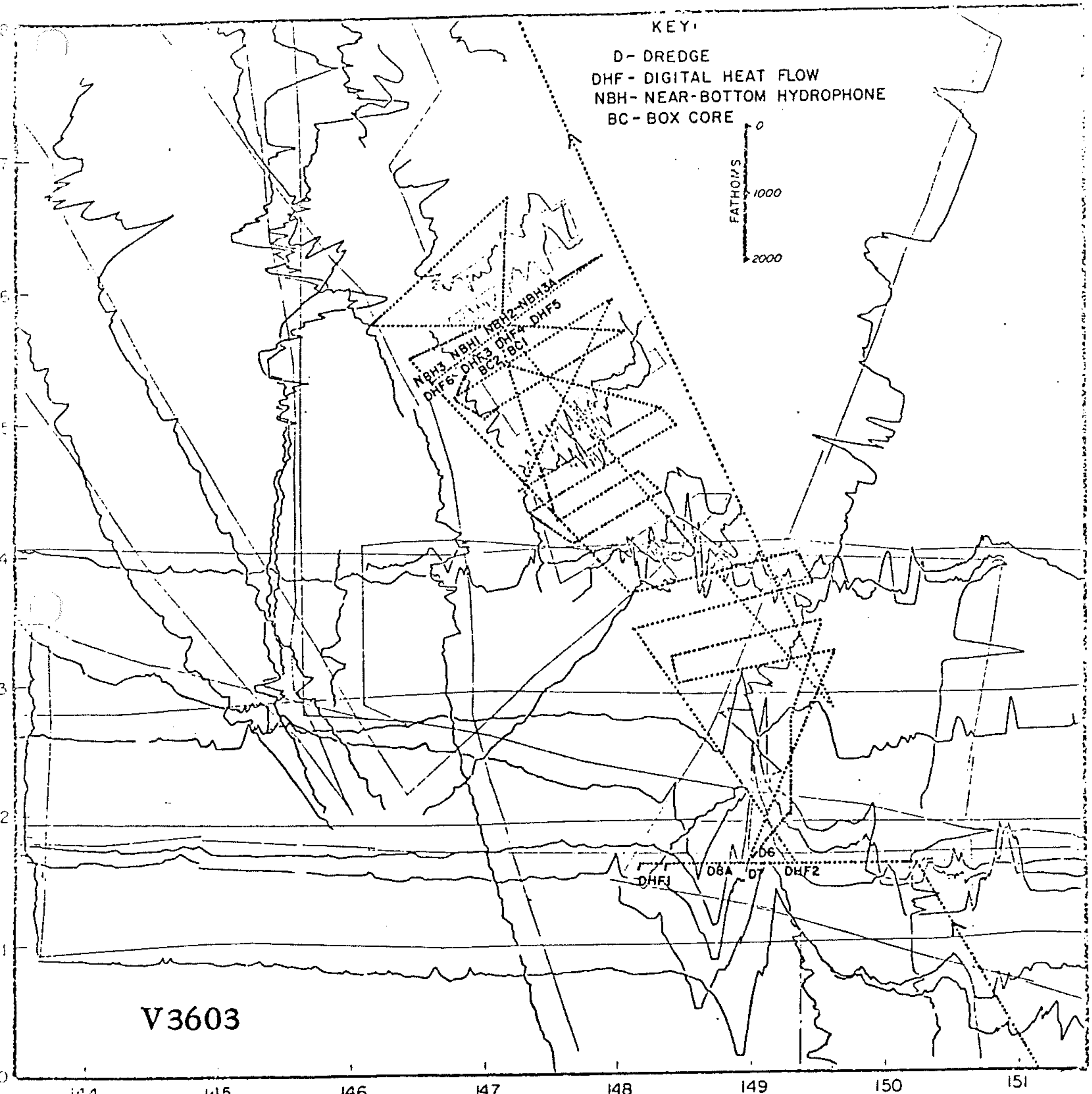

Figure 1

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