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Record 1977/13

R/V "VEMA", CRUISE 33 LEG 14, IN THE SOUTHWEST PACIFIC OCEAN 21 JANUARY TO 18 FEBRUARY, 1977: OBSERVERS REPORT

by

D. JONGSMA

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SUMMARY

Marine geophysical and geological data were collected during a joint venture between Lamont-Doherty Geological Observatory and BMR. The shipboard program on the R.V. Vema was concerned with the evolution of plate boundaries in the Melanesian region, and investigated the Coral Sea, New Hebrides and South Fiji basins. Cruise 33 leg 14 of the Vema commenced on 21 January in Townsville and ended on 18 February in Suva (Fiji Islands). Preliminary results of magnetic and seismic profiling data indicate opening of the Coral Sea in the Paleocene, opening of the New Hebrides basin in the Eocene and confirmed opening of the South Fiji basin in the Oligocene. Data from the cruise consist of gravity, bathymetry, magnetics, seismic reflection, sonobuoy refraction and geological data including 4 cores and 3 dredges.

1. INTRODUCTION

Marine geophysical and geological data were collected in the Southwest Pacific during the fourteenth leg of Cruise 33 of the Lamont-Doherty Geological Observatory research vessel Vema. The chief scientist on this leg was Dr T.A. Watts. Three scientists, Mr A. Lapouille from the Office de la Recherche Scientifique et Technieque Outre-Mer (ORSTOM), Noumea, Mr A. James from Sydney University and myself from the BMR participated in leg 14. The BMR contributed to the program in the Melanesian region covered by legs 13 and 14 of Vema cruise 33 by providing $A10 000 towards the cost, supplying track charts and data from its Continental Margin Survey and placing a geophysicist on each leg.

The research program was primarily concerned with studying the evolution of plate boundaries in Melanesia. Three inactive marginal basins, the Coral Sea, New Hebrides and South Fiji were selected for detailed surveying with particular emphasis on their magnetic fabric. Underway measurements over shallower areas such as the Louisiade Rise, Norfolk Ridge and Three Kings Rise provided additional information on these structures. A total of 6000 kms of bathymetric, magnetic, seismic reflection and gravity profiling was completed during leg 14 which started in Townsville (Australia) and ended in Suva (Fiji Islands). The ships track is shown in Plate 1.

2. CRUISE SUMMARY

The Vema completed leg 13 of Cruise 33 on Tuesday 18 January and arrived in Townsville in the early morning. A BMR report of this leg has been prepared by G. Karner who participated in the survey of the Coral Sea. While in Townsville a gravity tie with several stations in Townsville was made. The Vema departed from Townsville at 1200 hrs on Friday 21 January. After passing through the Great Barrier Reef via Palm Passage the Vema ran a track along the southern margin of the Queensland Plateau in an easterly direction. On 23 January the vessel proceeded NNE along the eastern margin of this Plateau. One sonobuoy probe at right angles to the margin was completed and a preliminary refraction velocity of 5.0 km/sec was obtained. To complete the survey of the Coral Sea commenced during the previous leg, three lines were run over the eastern extremity of this basin

during 24 and 25 January. Identifiable ESE-WNW magnetic lineations were mapped in the Coral Sea basin. These lineations indicate opening of the Coral Sea basin prior to anomaly 26 time (Early Paleocene-65 m.y. B.P.). The spreading appears to have ceased at anomaly 24 time (Middle Paleocene-60 m.y. B.P.). On several crossings of the basin, the seismic reflection profiles exhibit the axial region of an extinct spreading system. A core and heat flow station was occupied on 24 January, but due to the recorder malfunctioning no heat flow record was obtained.

After completion of the Coral Sea basin work the Vema proceeded towards the New Hebrides basin in an easterly course across the Louisiade Rise. On 27 January another heat flow station was attempted but this time the recording instrument was flooded and no measurement was obtained. From the afternoon of the 27th until 30 January a survey was made of the northern New Hebrides basin. Two sonobuoys were recorded in the basin which gave good refractions from basement. The magnetic fabric in the northern part of the New Hebrides basin is complicated by the rough morphology of the basement. Another sediment core was obtained on 30 January. A heat flow measurement attempted at the same time as this core station failed. This time due to the wire on the winch becoming entangled.

On 31 January the Vema proceeded to the southern part of the New Hebrides basin where 9 north-south tracks were run over the next 5 days. In the southeast part of this basin ENE-WSW magnetic lineations were mapped between the Loyalty Islands and the New Hebrides Trench. Preliminary identification of these lineations points to the presence of anomalies 21 through 18 (lower to mid-Eocene - 52 to 45 m.y. B.P.). It appears that oceanic crust increases in age to the north where DSDP site 287 recovered mid-Eocene basal sediments.

The Vema headed south on 5 February towards the Three Kings Rise. Seismic reflection profiling along the eastern flank of the Norfolk Ridge indicate sediment thicknesses of up to 3000 m. The Three Kings Rise was reached on the evening of 7 February. During the 8th and 9th February, three dredge stations were occupied on the Three Kings Rise. At two of these stations mafic volcanic material was recovered. In addition to these stations a sonobuoy probe was completed on the Three Kings Rise on 8 February.

From 9 February until the end of the cruise, the Vema surveyed the South Fiji Basin. From an earlier survey on the Vema in 1975 a pattern of seafloor spreading anomalies produced by a triple junction was discovered in this basin. This leg confirmed that the basin evolved from a three-plate system, and the anomaly pattern was extended further into the northeast corner of the basin. The anomalies in the South Fiji Basin range from 12 through 7A and thus indicate opening during Oligocene times (35-26 m.y. B.P.). The Vema completed the survey on 17 February and berthed in Suva on the morning of Friday 18 February.

3. DATA OBTAINED

The bulk of the data obtained during this leg needs to be photographed and processed at Lamont before it is sent to BMR. I obtained a set of 9 track charts at a scale of one to a million which shows bathymetric data at six minute intervals. A computor plotted track map of the whole leg at a scale of 1:4 000 000 was produced in Suva and I received a copy of this track chart. During the cruise I made copies of several maps showing tracks in the Melanesian area with magnetic anomaly profiles plotted along these tracks. These maps include the tracks and magnetics completed by ORSTOM in this region.

4. DISCUSSION

The work completed on the two legs in which the BMR participated will add considerably to our present knowledge of the evolution of the plate boundaries in the Melanesian region. The three marginal basins under scrutiny during this project revealed seafloor spreading anomalies which will assist significantly in reconstruction of the area. Broadly speaking we are dealing with a continental margin which was once adjacent to Australia. This margin was rifted in stages. The mechanism of spreading is probably related to back-arc spreading caused by the eastward migration of a subduction zone. The area is complex but the available data together with the data from this cruise should provide a useful time-space framework for the region.

The cruise itself was well planned and its objects were well defined. Its success was partly due to the availability during both legs of the data from BMR's Continental Margin Survey and from the cruises conducted by ORSTOM. This applies particularly to the magnetic data because it enabled us to select the location and orientation of the tracks so that optimum results could be obtained. Because the cruise was mainly concerned with the evolution of the plate boundaries, for which the answers lie in the deeper oceanic areas, the shallower regions such as the Lord Howe Rise and Norfolk Ridge received only marginal attention. We discussed the possibility of running a line across the abovementioned structures but came to the conclusion that the necessary detour would severely restrict time spent on the major problem. There seemed little point in making the detour since the seismic profiling equipment had neither the power nor the resolution needed for obtaining optimum results and the obvious gap in our knowledge of the heat flow of these ridges could not be filled because the recorder was malfunctioning.

5. CONCLUSIONS

From the two-month shipboard program designed to investigate the tectonic histories of some of the marginal basins of Melanesia, the preliminary results are as follows. In the Coral Sea basin we mapped ESE-WNW magnetic lineations which consist of a broad positive anomaly flanked on both sides by one or more narrower positive anomalies. On some crossings of the basin the broad positive anomaly occurs over basement morphology which may represent the axial region of an extinct spreading system. We suggest that the magnetic lineations reflect a two-limb spreading system and comprise anomalies 26 through 24 ($\sim$ 65 to 60 m.y. B.P.). The inferred crustal ages are consistent with mid-Eocene ages determined from basal sediments at DSDP sites 210 and 187. In the New Hebrides basin the magnetic fabric is complicated probably due to rough basement morphology. However, we mapped ENE-WSW magnetic lineations in the southeast part of the basin between the Loyalty Islands and the New Hebrides trench. We suggest that anomalies 21 through 18 ($\sim$ 52 to 45 m.y. B.P.) occur in this part of the basin and that oceanic crust increases in age to the north where DSDP site 287 recovered mid-Eocene basal sediments.

In the south Fiji basin the new geophysical data have confirmed the previous suggestion of a three-plate evolution for this basin. The new data provide evidence for magnetic lineations generated at the third of three accreting plate margins that were active during the Oligocene. We were able to extend the previously mapped NE-SW trending lineations further into the northeast corner of the basin.

The results of Vema cruise 33 legs 13 and 14 should enable a comprehensive picture of the evolution of the Melanesian area. This region is one of the few remaining areas in the world where the plate tectonic evolution has not been satisfactorily worked out. It will be of interest to earth science to unravel the sequence of events which have led to the present configuration of islands, ridges, trenches and basins in the region. Details concerning timing and type of rifting of the Coral Sea will be vital to the understanding of the evolution of the margins of the Queensland and Papuan Plateaus. Both these plateaus are of concern to Australia since they present future exploration targets for hydrocarbon. In addition the results of this cruise should add to our knowledge of the rifting of a former Australian continental margin which is now represented by the Lord Howe Rise and Norfolk Ridge. On both of these structures there are areas which will be under Australian jurisdiction and are therefore suggested as sites for future surveys by BMR.

BATHYMETRY of the SOUTH PACIFIC

BY
J. Mammerickx, T.E. Chase, S.M. Smith, and I.L. Taylor
Scripps Institution of Oceanography

Chart No. 11 of 21

11	12	13	14	15	21a	21b
16	17	18	19	20	21a	21b

Chart No. 12 of 21

11	12	13	14	15	21a	21b
16	17	18	19	20	21a	21b

130° 135° 140° 145° 150° 155° 160° 165° 170° 175° 180° 175° 170°

0° 5° 10° 15° 20° 25° 30° 35° 40°

WEST IRIAN
NEW GUINEA
PAPUA
GULF OF CARPENTARIA
AUSTRALIA
ARU ISLANDS
NEW GUINEA TRENCH
WEST NEW GUINEA BASIN
MELANESIAN TRENCH
MANUS BASIN
NEW BRITAIN
NEW BRITAIN TRENCH
ONTONG JAVA PLATEAU
NAURU ISLAND
OCEAN ISLAND
GILBERT ISLANDS
NOVA CANTON TROUGH
PHOENIX ISLANDS
ELLICE ISLANDS
LINE ISLANDS
KIRIBATI
TUVALU
TUNAFUTI IS
NANUMEA IS
STEWART IS
WOODLARK BASIN
PAPUAN PLATEAU
SOLOMON TRENCH
VITIAZ TRENCH
ROBBIE RIDGE
SAMOA ISLANDS
CORAL SEA BASIN
LOUISIADE RISE
NEW HEBRIDES TRENCH
FIJI PLATEAU
FIJI ISLANDS
QUEENSLAND PLATEAU
HOLMES REEF
FLINDERS REEF
DIANE BANK
WILLIS ISLET
LIHOU REEF
MELVILLE REEF
MARION REEF
THE GREAT BARRIER REEF
TOWNSVILLE
CHESTERFIELD GROUP
NEW CALEDONIA
LOYALTY IS
SOUTH NEW HEBRIDES
CONSTANTINE BK
HEBRIDES TRENCH
COOK FRACTURE ZONE
MINERVA REEFS
LAU BASIN
LAU RIDGE
TONGA TRENCH
TONGA ISLANDS
CAPRICORN SEAMOUNT
OSBOURN SEAMOUNT
KELSO BANK
ARGO BANK
FREDERICK REEF
RECORDER GUYOT
MORTON SEAMOUNT
BRISBANE GUYOT
QUEENSLAND GUYOTS
NORTHFIELD GUYOTS
STRADBROKE GUYOT
WOOLLOOMOOLOO GUYOT
ELIZABETH REEF
DERWENT HUNTER GUYOT
SAN MARCOS BANK
TASMAN PLAIN
LORD HOWE RISE
NORFOLK RIDGE
VENING MEINESZ FRACTURE ZONE
NORFOLK BASIN
KINGS TROUGH
BETTY GUYOT
WEST NORFOLK BASIN
MANGANELLA BK
CASCOYNE SEAMOUNT
BELLONA GAP
CHALLENGER PLATEAU
NEW ZEALAND
COLVILLE RIDGE
HAVRE TROUGH
KERMADEC TROUGH
KERMADEC TRENCH
LOUISVILLE RIDGE
SYDNEY
MELBOURNE
ADELAIDE
BRISBANE

MERCATOR PROJECTION
CONTOURS IN FATHOMS
UNCORRECTED FOR SOUND VELOCITY
1971 - 1974

SOURCES OF DATA

Atlantic Oceanographic Laboratory, Dartmouth, Nova Scotia
Bureau Hydrographique International, Brittany, France
Defense Mapping Agency, Hydrographic Center, Washington, D.C.
Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii
Hydrographic Office, Royal New Zealand Navy, Auckland, N. Z.
Hydrographic Service, Royal Australian Navy, Garden Island, NSW, Aus.
Institute of Oceanology, Academy of Science, Moscow, USSR
Lamont-Doherty Geological Observatory, Columbia University, New York
National Geophysical & Solar-Terrestrial Data Center, Washington, D.C.
New Zealand Oceanographic Institute, Wellington, New Zealand
Ocean Floor Analysis Division, U.S. Naval Oceanographic Office, Washington, D.C.
Ocean Research Institute, University of Tokyo, Japan
Office de la Recherche Scientifique et Technique Outre-Mer, Centre de Noumea, New Caledonia
Oregon State University, School of Oceanography, Corvallis, Oregon
Pacific Oceanographic Laboratories, N.O.A.A., Seattle, Washington
School of Marine & Atmospheric Science, Miami, Florida
Scripps Institution of Oceanography, University of California, San Diego
Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

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• 23 position at 0000 HRS on date

Scale: ≈ 1:10000000 (at 20°S Lat.)

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CHART PREPARATION: V. Moore
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TRACK OF R.V. VEMA CRUISE 33 LEG 14

Plate 1