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IDOE

INTERNATIONAL SCIENTIFIC WORKSHOP ON THE GEOLOGY, MINERAL RESOURCES AND GEOPHYSICS OF THE SOUTH PACIFIC

NOTES COMPILED IN PREPARATION FOR WORKSHOP DISCUSSIONS

by

John C. Mutter

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SUMMARY

The author prepared these notes before attending a workshop meeting in Suva on 1-6 September 1975. The workshop was organised by the Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas, with the Intergovernmental Oceanographic Commission as part of the International Decade of Ocean Exploration (CCOP/SOPAC - IOC/IDOE). The workshop was titled "International Scientific Workshop on the Geology, Mineral Resources and Geophysics of the South Pacific."

The object of the workshop was to devise a work program to be carried out in the South Pacific to establish the occurrence and tectonic setting of mineral deposits in that region.

The notes compiled in this report suggest five areas as being in need of more intensive study. These are

1. Lord Howe Rise
2. Norfolk Ridge
3. Coral Sea Basin
4. Bismarck/Solomons/Woodlark Basins
5. Mellish Rise

For each of these areas the scientific and economic problems are stated and a survey program suggested which would investigate, and hopefully solve these problems.

Two further suggestions are made: firstly that a study be made of the relation between opening of the Coral Sea and the overthrust of the Papuan Ultramafic Belt, and secondly that a study be made of the convergent plate boundary from New Guinea to New Zealand if the proposed transects of the International Programme of Ocean Drilling (IPOD) in the area are not implemented.

A short bibliography of important papers, mostly recent, on the geology and geophysics of the S.W. Pacific is included.

1. INTRODUCTION

The first two days of the meeting are devoted to the presentation of general review (1st day) and specific research (2nd day) papers on the geology and tectonic setting of the South Pacific. The organisers hope that by the end of these sessions the meeting will have arrived at a 'definition of the state of the art' and thus be able to indicate future avenues of research and prospecting.

In the next three days a number of working groups organized around specific disciplines will meet to formulate projects to be undertaken within the regions to research the problems and problem areas defined in the first two days. The organizers make the point strongly that the emphasis is on the development of a work program.

With the above aims of the meeting in mind, the opportunity has been taken to prepare some notes to aid in workshop discussions which will define projects to be carried out within the area of the South Pacific with which Australia has a mutual interest with CCOP countries. This area is considered to lie between Australia and the line from New Zealand north to the New Hebrides, then along the outer Melanesian Arc to north of New Guinea. This excludes the Fiji Basin, Tonga-Kermadec Arc, and Fiji islands which are within or on the boundary of the Australian lithospheric plate. The area considered to be the South Pacific for the purpose of the meeting is much larger, extending about twice as far east from Australia as the limit considered here. The member countries are New Zealand, Papua New Guinea, Western Samoa, Fiji, Cook Islands, Tonga, Solomon Islands, and Nauru.

Within Australia's mutual interest area BMR has carried out multisensor geophysical surveying of some 50 000 nautical miles of dominantly east-west lines on the continental margin of Australia. This represents coverage of about 40 percent of the mutual interest region by BMR. Major features surveyed were the Bismarck Sea, Gulf of Papua, Queensland and Marion Plateaus, northern Tasman Sea, continental margin off southeast Australia, and the Dampier Ridge. Seven exploration holes were drilled in the region on DSDP legs 21 and 30. Only one (209) fell within the area surveyed by BMR. Any surveying proposed in the mutual interest area will be designed to complement previous BMR work.

BMR's program for future work in the South Pacific plans to study some areas east of the previous BMR work. The programme is only tentative, and major alterations could occur in the future. It should not be assumed that any area will definitely be surveyed. In any event no area will be surveyed in the immediate future.

The following is a summary of major areas (geographical and theoretical) which it is felt are in need of a major research effort. An outline of the study program necessary to solve these problems is also given. No commitment or suggestion is made as to who should carry out the programs.

2. SUGGESTED STUDY AREAS

2.1 LORD HOWE RISE

Problems

Two basic questions about the Lord Howe Rise need to be answered:

1) What is its economic importance?

2) What is its tectonic setting and history?

Information from surveying carried out to date (Jongsma, pers comm.) would suggest that some parts of the Rise are promising for oil: water depth is 1200-1700 m, up to 3 km of Tertiary sediments, lowermost unit is terrigenous, high temperature gradients, many possible structural traps and some possibility of cap rocks.

The tectonic question involves the relation of the Rise to the Australian continent and to the Dampier and Norfolk Ridges and New Caledonia and Lord Howe/Middleton Basins. The exact fit of the rise against the continent has been argued about in the literature for some time and different propositions vary considerably. The nature of the Dampier Ridge is still in question and its tectonic relation with Lord Howe Rise is unknown. The timing of breakup of Australia and Lord Howe Rise is somewhat in doubt (DSDP 283 did not agree with Hayes & Ringis ages) and the style of breakup is uncertain owing to the absence, or lack of recognition of 'rift-valley' structures.

The rise has been surveyed in part by a number of organizations but no compilation is available to give an overall impression of the structure.

Study Program

The problems which exist are of major importance and require a major effort for their solution.

To fully define the prospectivity of the Rise a major survey program is required. High-quality seismic reflection profiling (multi-channel digital) plus gravity and magnetic

sensing are essential to examine the distribution of sediments and to detail the structures present within sediments and basement. It should be possible to arrange a survey program which begins with reconnaissance work and is followed up by more detailed investigation. Refraction and heat-flow stations would be very useful during the reconnaissance phase. Follow-up work involving dredging and/or coring at selected sites to determine the age of important reflecting horizons on the flanks of the Rise.

The major tectonic questions can probably be answered with less intensive surveying and the inclusion of deep crustal refraction work and more heat-flow stations. In both cases the need for reconnaissance work might be avoided by a compilation and thorough assessment of survey data already available on the Rise as the density of coverage already represents good reconnaissance coverage. However, the quality of this data might degrade its usefullness.

2.2 NORFOLK RIDGE

Problems

The two basic questions which were applied to the Lord Howe Rise can also be applied to the Norfolk Ridge. The possibility of an economic return from the Ridge appears to be about the same as the Lord Howe Rise.

The tectonic question is somewhat more difficult. Some argument still exists as to whether the basement of this Ridge is oceanic or continental with the majority opinion favouring the latter.

However, it is unusual to find long, narrow ridges of continental crust in a mid-ocean situation and this may indicate a peculiar tectonic evolution. If the crust is continental the question of the timing and nature of its separation from Lord Howe Rise then becomes important.

The Ridge is located in a paired configuration with Lord Howe Rise and Dampier Ridge as shown

and this might suggest that the Ridge is volcanic if the pairing has a tectonic origin.

Study Program

The study program required would be very similar to that required for Lord Howe Rise with more emphasis on heat flow and deep crustal work in view of the more puzzling nature of the tectonic question. It may also be possible to influence the IPOD program to include Norfolk Ridge as a drilling target. They have a high-priority traverse planned across the Tonga-Kermadec Arc which ends just west of the West Norfolk Ridge; it would require only a minor extension of this traverse to include the Ridge and this would solve the fundamental question of the ridge's nature.

A set of long multi-sensor geophysical traverses which include deep refraction, sonobuoy refraction, heat-flow stations, sampling and dredging which would extend from the Tasman Basin east to the South Fiji Basin should be included to establish the overall tectonic relations.

2.3 CORAL SEA BASIN AND MARGINS

Problems

Recent work has shown that the Queensland Plateau is underlain by continental crust of the Tasman Geosyncline and that its outer margin is rifted. Hence part of the Geosyncline has been split off and has drifted away from the mainland and may be located in the margin south of Eastern Papua. The Coral Sea Basin appears to be neither a simple Atlantic-type basin with a prolonged rifting history, nor a Western Pacific marginal basin formed by accretion behind an island arc. This is a fundamental tectonic question which also bears on the economic potential of the basin margin as the majority of oil-producing margins are those which have experienced a prolonged rifting history which results in the sedimentary regime and structures suitable for oil accumulation. If the margins of the basin can be demonstrated to have rift valley structures then its economic importance would be considerably upgraded.

Study Program

A program of high-quality seismic profiling (multi-channel digital) with gravity and magnetic sensing would be required.

Surveying should be more intensive on the margins of the basin with the object of detecting rift valley structures such as block-faulting. Sonobuoy refraction shooting should also be incorporated. Within the basin itself traversing could be more widely spaced. Magnetic results would be most important in determining the spreading history of the basin. Deep crustal refraction work on the area of junction between oceanic and continental crust would throw light on the nature of the junction. Heat flow stations should also be included.

2.4 MELLISH RISE REGION

Problems

The major problem surrounding this area is the nature of the structures present. It is a fundamental tectonic problem which cannot be seen to have any immediate relation to economic questions. The trend of this structure can be detected from the Australian margin, northeast to the southern end of the Solomon Islands. The trend creates the separation between the Tertiary Coral Sea Basin and the Cretaceous Tasman Basin, the two being almost connected through the Cato Trough, a feature of unknown age and origin.

Elevated ridges and deep basins exist within the zone and marked trends within it intersect the Townsville Trough and a major physiographic break in the Australian margin near Frazer Island. BMR traversing on the southwest corner of the Rise revealed a rugged (?)volcanic basement with a thin sediment cover.

One important aspect of the Mellish Rise is that it lies at the sharp northern termination of Chesterfield Reefs north of the Lord Howe Rise. The most probable suggestion is that the Mellish Rise zone is a fossil fracture zone active during the breakup of Lord Howe Rise and Australia. Other views suggest that it may be a fossil spreading ridge. The tectonic consequences of these two alternatives are vastly divergent. The area is poorly surveyed, unsampled and undrilled. It has apparently been overlooked in favour of other structures on major survey programs.

Study Program

For this region their is no need for intensive or very sophisticated survey techniques.

Single-channel seismic reflection and sonobuoy refractions with magnetic and gravity sensing on selected profiles would probably do the job. Coring and dredging would be

important and heat-flow stations would also be valuable. A set of carefully selected profiles would be as valuable as a systematic survey in understanding the nature of this structure.

To further demonstrate the nature and significance of the zone a review of the geology of the Tasman Geosyncline in the region where it is intersected by the Rise should aim at investigating structures related to a possible prolongation of the Rise into the continental mass.

2.5 BISMARCK/SOLOMONS/WOODLARK BASINS

Problems

These are a string of Western Pacific 'marginal' basins forming a northwest trend immediately southwest of the boundary between the Australian and Pacific lithospheric plates. In the region a number of small sub-plates have been proposed to explain the complex tectonic features observed in the region.

Only the Bismarck Sea is well surveyed and none of the basins were sampled by DSDP drilling. However the temporal and tectonic relation of these basins is of critical importance in understanding the tectonic evolution of the region. For instance, the Solomon Sea could be either a part of the old Australian Plate or a new feature generated from spreading at the Woodlark Ridge. The relation of the basins to the Coral Sea and other basins is also important.

Study Program

The compilation of a tectonic profile similar to the type envisaged for the Tasman Geosyncline under the Geodynamics Project would be a useful exercise. Apart from the information so gained on tectonic relations this work would point to the need to collect more data in critical areas. This could then initiate specific disipline work programs in selected areas.

The work should be combined with a reassessment of the geology of the Papuan and New Britain regions as they are related to basin evolution.

3. OTHER SUGGESTIONS

A study of the temporal and tectonic relation between the opening of the Coral Sea and overthrust of the Papuan Ultramafic Belt.

These major tectonic events occurred very close together in time during the Eocene and/or Oligocene. The opening of the Coral Sea is dated from DSPP drilling. The time of overthrust is poorly dated but is probably the younger of the two events. The two events are most probably inter-connected, linked by the consequences of major plate motion. They may also be related to opening of Australia from Antarctica which occurred at around the same time. Having the sequence of events firmly resolved into time order is therefore important to an understanding of the tectonic history of the region.

The study would require no survey work but rather involve a critical re-evaluation of the data presently available with the view to correlating events.

Four 'active margin traverses' have been proposed by IPOD to look at the Australian/Pacific plate boundary. One of these, across the Tonga/Kermadec Trench and South Fiji Basin, is highpriority and will probably be retained. However, it is unlikely that all three of the others will be retained and it is quite possible that none will be. The three of lower-priority are well placed to investigate some fundamental questions concerning the nature of the plate boundary in the region. In particular the northernmost traverse crosses the Solomon Islands which is a highly anomalous arc, then traverses the Ontong-Java Plateau, another anomalous feature having a crustal thickness of 40 km. The southern of the three low-priority traverses crosses the Fiji Plateau or North Fiji Basin. In this region an east-dipping lithospheric slab associated with the New Hebrides arc-trench system faces a west-dipping lithospheric slab associated with the Tonga arc-trench. The Fiji Islands lie between the two.

If any of the four traverses are cancelled major gaps which could have been filled will still exist in our understanding of the region. If any are cancelled suitable alternate study programs should be undertaken to investigate the question of plate boundary processes from New Guinea to New Zealand.

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CHAPTER 28 FIGURE 1. BATHYMETRY of the SOUTH PACIFIC

BY
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Scripps Institution of Oceanography

PLATE I

MERCATOR PROJECTION
CONTOURS IN FATHOMS
CORRECTED FOR SOUND VELOCITY
AUGUST 1971

SOURCES OF DATA

Scripps Institution of Oceanography, University of California, San Diego
Lamont-Doherty Geological Observatory of Columbia University
U.S. Naval Oceanographic Office
Office de la Recherche Scientifique et Technique Outre Mer, New Caledonia
Hydrographic Service, Royal Australian Navy
New Zealand Oceanographic Institute
Ocean Research Institute, University of Tokyo
Woods Hole Oceanographic Institution

Research supported by the Oceanographic Section, National Science Foundation, NSF grant GA-27155, A-1.

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CHART PREPARATION: V. Klitz
DRAWING: H. Klitz, C.L. Bellinger

BMR multi-sensor survey

BMR crustal survey (Finlayson, et.al., 1975)

DSDP site

Proposed IPOD active margins traverse

Top priority IPOD active margins traverse

Proposed IPOD passive margins traverse

LOCATION DIAGRAM
SHOWING BMR SURVEYS AND
PROPOSED IPOD TRANSECTS

CHAPTER 28 FIGURE 1. BATHYMETRY of the SOUTH PACIFIC

BY
J. Mammerickx, T.E. Chase, S.M. Smith, and I.L. Taylor
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PLATE 2

MERCATOR PROJECTION
CONTOURS IN FATHOMS
CORRECTED FOR SOUND VELOCITY
AUGUST 1971

SOURCES OF DATA

Scripps Institution of Oceanography, University of California, San Diego
Lamont-Doherty Geological Observatory of Columbia University
U.S. Naval Oceanographic Office
Office de la Recherche Scientifique et Technique Outre-Mer, New Caledonia
Hydrographic Service, Royal Australian Navy
New Zealand Oceanographic Institute
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SOUTHWEST PACIFIC PROBLEM AREAS

Possible economic (petroleum) potential

Tectonic problem with economic spin-off

Record No. 1975/142

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