RECORD No. 1972/33

BMR SYMPOSIUM
CANBERRA, 15-16 MAY 1972
ABSTRACTS

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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CONTENTS

DOLOMITIZATION - ITS INFLUENCE ON THE GENESIS OF THE WOODCUTTERS L.5 LEAD-ZINC PROSPECT, NORTHERN TERRITORY, AUSTRALIA

W.M.B. Roberts

The Woodcutters L.5 lead-zinc prospect in the Northern Territory, Australia, occurs in the Golden Dyke Formation; a sequence of carbonaceous siltstone, dolomite, and greywacke which is part of the Goodparla Group of sediments of Lower Proterozoic age, lying on an Archaean granitic basement.

The environment is dolomitic. The rocks containing the ore are principally strongly dolomitic shale and strongly argillaceous dolostone. The ore minerals, consisting mainly of sphalerite, galena, pyrite, and lead antimony/arsenic sulpho-salts, are in veins which are generally transgressive to the bedding. These veins are filled with dolomite, silica, and minor accessory minerals such as anatase, tourmaline, and muscovite.

The well-known association of lead-zinc deposits with dolomitic rocks throughout the world suggests that the conditions which lead to dolomitization may be also favourable for the formation of lead-zinc deposits.

An attempt has been made to show how factors significant in the formation of dolomite were also important in the genesis of the Woodcutters deposit.

1. The evaporitic environment, which favours dolomite formation, concentrated the lead and zinc in the overlying solutions.

2. The base metals were further concentrated, and fixed in the sediments by co-precipitation with the precursors of dolomite, either Mg-calcite or aragonite.

3. The formation of dolomite during diagenesis resulted in either a structural change if the precursor was aragonite, or an ordering if the precursor was Mg-calcite. The highly ordered dolomite cannot accommodate the relatively large amount of base metal associated with its precursors and as a consequence during dolomitization these are released to the pore solutions.

The metals in the pore solutions complexed with organic materials derived from the degradation of algal protein and so remained in solution during lithification. During folding the metal-enriched solutions were transported to fractures and precipitated as metal sulphides when the organic complexes became unstable.

After lithification the carbonate-quartz-sulphide veins were zones of weakness along which shearing took place, probably over a considerable period of time. This shearing, as well as slight rise in temperature, resulted in facturing, recrystallization, and reaction between the first formed simple sulphides to produce the ore in its present form.

THE CONTINUING SEARCH FOR THE NEXT MT ISA: GEOLOGY, PALAEOGEOGRAPHY AND CORRELATION OF BLACKSHALE DEPOSITS IN THE MT ISA REGION

G.M. Derrick

Black shale deposits from McArthur River to Selwyn south of Cloncurry can be broadly correlated stratigraphically; they all form part of Proterozoic sequences ranging from 1800 m.y. to 1600 m.y. old, and may in fact be confined to a much narrower age range. In this report, the detailed geology of black shales between Cloncurry and Mt Isa is compared with the geology of other shale deposits, to assist in the exploration for further Cu-Pb-Zn deposits of the Mt Isa, Dugald, and McArthur River type.

Most of the shale deposits interfinger with carbonate and pelitic sequences. They contain variable amounts of carbonaceous matter, up to 16%, and one or more of the following: acid and basic tuff and acid volcanics, stromatolites, soda-rich shales, red beds and jaspilite, gypsum and halite casts, manganese, barytes, and, not least, stratiform lead and zinc deposits or anomalies, and copper deposits of both stratiform and epigenetic appearance.

All these features suggest saline, evaporative, and euxinic conditions of sedimentation, in restricted lagoonal, marine, or intra-cratonic basins or troughs. Despite greenschist to amphibolite facies metamorphism in the area of detailed mapping, some basin reconstruction has been possible, assuming that ubiquitous scapolite represents original halite in the metasediments.

In the Selwyn/Marimo/Cloncurry area black shale has been deposited in the deeper areas of a linear trough between a western quartzitic land mass and an eastern basaltic land mass. Towards the margins of the trough carbonate rocks are more abundant, and both rock types appear transitional into a near-shore jaspilite facies, which is characterized by local occurrences of vein barytes and manganese. The latter two minerals occur near the top of the jaspilite sequence, possibly near the argillite-carbonate facies transition zone. Small to moderate-sized copper deposits are confined to areas of black shale, although a lead deposit has been reported recently from a shale carbonate zone.

At Mount Isa, detailed mapping of faulted sequences older than the Mt Isa Group shales and carbonates suggests a possible correlation between faults, trough topography, and distribution of various rock types in the trough; for example, shales overlying up-thrown basement blocks contain Pb-Zn mineralization, abundant pyrite beds, and ferroan dolomites, while shale sequences above down-thrown basement blocks are devoid, or nearly so, of these features.

A correlation has been made between the Dugald River deposit and pyrrhotitic shale found 12 km west of Mary Kathleen, in the topmost part of the Corella Formation. The latter shale is overlain and mostly obscured by massive quartzite (Deighton Quartzite), and is contained in a near-shore euxinic channel or trough. Overlying the Deighton Quartzite a further small basin of black shale deposition, the White Blow Formation, has been outlined.

The source of metals in all the deposits studied is not known, and it appears that covert submarine volcanism is necessary to explain the metal content of the basins, e.g. McArthur River. However, not all volcanic sequences are hidden, and in the Cloncurry/Mary Kathleen area numerous basalt flows, basic tuff, and less commonly pillow lavas are interbedded with the scapolitic and calcareous rocks of the Corella Formation. They could provide metals to the sedimentary environment via late stage hydrothermal fluids, or by submarine and subaerial erosion of copper-bearing flows.

In view of the postulated evaporative nature of many of the shale environments, intrastratal brines are a likely result of compaction and solution during diagenesis, and effective scavenging and reprecipitation of dispersed metals in the sediments themselves is a possible mechanism of ore formation, e.g. copper in the Marimo Slate. Basin hydrogeology allied to tectonic history, as suggested recently by Stanton, could be important factors in the genesis of stratabound ore bodies.

It is recommended that detailed mapping continue in the Lawn Hill/ Mt Isa region in order to rationalize the stratigraphy of the present six, possibly equivalent, black shale-bearing formations in the area. Since barytes and jaspilite appear to be genetically related in the Mary Kathleen/ Cloncurry area, it is suggested that discovery of this distinctive association in the Mt Isa/McArthur River region could considerably aid correlation of potential ore-bearing sequences across the whole region.

Some geochemistry of the black shales in the Cloncurry area will be discussed.

ECONOMIC GEOLOGY OF THE MT ISA - CLONCURRY REGION

I.H. Wilson (C.S.Q.), R. Hill

The basis of this report is the paper presented recently by Wilson at the G.S.A. symposium, dealing with copper mineralization in the area. An abstract of this paper is listed below.

COPPER MINERALIZATION (EXCLUDING MOUNT ISA) IN THE PRECAMBRIAN CLONCURRY COMPLEX OF NORTHWEST QUEENSLAND, AUSTRALIA

I.H. Wilson[1], G.M. Derrick[2], and R.M. Hill[2]

The Precambrian Cloncurry Complex, covering 64,000 km^2 of northwest Queensland, consists of igneous, volcanic and sedimentary rocks metamorphosed in the greenschist and amphibolite facies. It is structurally complex, and is intruded by polyphase acidic and basic rocks. The region has produced one million tons of copper from about 1,000 mines. Mount Isa Mines have produced 90 percent of this.

Detailed mapping of a 50km wide east-west strip across the region has shown that most mines are located in the upper Argylla Formation (acid volcanics), the Marraba Volcanics (meta-basalt), and the middle Corella Formation (scapolitic quartzofeldspathic calc-granofels, para-amphibolite, and slate).

Most copper deposits are epigenetic, occurring with quartz and/or calcite gangue in discordant fractures. Supergene enrichment has been a major concentrating process. Dolerite shows a close spatial relationship to most of the deposits; granite is associated with some deposits near Mary Kathleen. In the Corella Formation large remobilized calcite bodies with chalcopyrite are partly fault-controlled; vein copper deposits in black slate have no obvious igneous source, and are subeconomic below the water table. One stratabound occurrence has been noted, consisting of mainly chalcopyrite blebs in calc-silicate rock.

Most of the copper appears to be genetically related to basic magma; hydrothermal saline fluids derived from metamorphosed, locally evaporitic sediments are possible ore-carrying associates of the basic rock. Geochemical work has shown that copper mineralization is most likely to occur in rocks which originally had high trace copper contents.

1 Geological Survey of Queensland, Brisbane

2 Bureau of Mineral Resources, Canberra

As well as copper, other economic mineral deposits will be discussed including fluorite, limestone (marble), uranium, manganese, barytes, iron, silica, rutile and ilmenite, heavy mineral sands, and alumina silicates. The geological setting of these deposits will be discussed using the four detailed maps of the area so far produced, viz Cloncurry, Marraba, Mary Kathleen and Mt Isa 1:100,000 Sheet areas.

REGIONAL GEOLOGY OF THE GRANITES/TANAMI AREA, N.T.

D.H. Blake

Reconnaissance mapping in the Granites/Tanami area, situated between the Kimberleys 150 km to the northwest and Alice Springs 600 km to the southeast, was begun in 1971, when the Tanami and Birrindudu 1:250,000 Sheet areas were completed. Within this area scattered low outcrops of Proterozoic and Cambrian rocks are separated by expanses of Quaternary sand and Tertiary laterite. There are also outcrops of Tertiary travertine and silcrete and terrestrial sediments of possibly Cretaceous age.

The oldest rocks exposed, mapped as Lower Proterozoic, are tightly folded and cleaved low-grade metasediments and metavolcanics correlated with the Halls Creek Group of the Kimberleys. These crop out in several basement highs in both of the Sheet areas mapped, and are intruded and thermally metamorphosed by granitic bodies, including the Winnecke Granophyre, of possibly Lower Carpentarian age. The Winnecke Granophyre also intrudes 'Mount Winnecke Sandstone' in the east, which consists of folded sandstone and acid volcanics that may be correlated with the Whitewater Volcanics, the basal Carpentarian rocks in the Kimberleys. The Lower Proterozoic rocks are unconformably overlain by a sequence of unmetamorphosed Upper Proterozoic rocks, mainly sandstone but also including shale, siltstone, conglomerate, glauconitic sandstone, and a formation of stromatolitic chert. These rocks have been affected by broad doming and irregular folding. At the base of this sequence in the west is the Gardiner Formation which may be correlated with the Carpentarian Speewah Group of the Kimberleys or possibly with the Adelaidean Vaughan Springs Quartzite of the Ngalia Basin to the south. The Upper Proterozoic rocks are overlain unconformably by flat-lying basalt lavas of the Lower Cambrian Antrim Plateau Volcanics and, in the east, by Cambrian sediments on the western margin of the Wiso Basin.

Of economic interest are auriferous quartz veins, onced mined at Tanami, and uranium-bearing conglomerate at the base of the Upper Proterozoic in the Killi Killi Hills, on the West Australian/Northern Territory border.

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NEW GUINEA HIGHLANDS, RAMU-KARIMUI 1:250,000 SHEET AREAS

J.H.C. Bain

Field work commenced in 1956 and ended in 1970; it totalled about 50 man months and cost about $50,000 (not including geologist's salaries). This estimate does not include work by oil exploration companies who contributed much information for the areas north of the Ramu River and south of the Pio River.

The main object of the work was to elucidate the stratigraphy and structure of the Ramu and Karimui 1:250,000 scale geological sheets.

Office work included the study of more than 500 thin sections and 350 palaeontological specimens.

Summary of Geology

The main geological feature in the map area is the Kubor Anticline, a large double plunging basement arch (60 x 125 km) which exposes metamorphic, igneous, and sedimentary rocks ranging in age from Palaeozoic to upper Tertiary. The core of the anticline consists of low grade (greenschist) metamorphics of Palaeozoic age intruded by late Permian composite plutons of acid to basic composition. Unconformably overlying the basement core are small remnants of Upper Permian to Lower Triassic reef limestone, and Upper Triassic dacitic and basaltic volcanics. About 7000 m of folded and faulted Upper Jurassic to Upper Cretaceous fine clastics and volcanolithic sediments unconformably overlie the basement complex, the Permian-Triassic limestone, and the Triassic volcanics; the Jurassic and Cretaceous rocks form the topographically prominent limbs of the anticline. The volcanolithic sediments, which have been buried to depths of 4500 m or more, contain lime zeolites, prehnite, pumpellyite, and zoisite.

Two slightly smaller synclinal folds that flank the eastern end of the anticline are developed in Tertiary rocks which surround the Kubor Anticline on all but the northern side. Upper Palaeocene clastics occur only south and west of the anticline. Eocene-Oligocene shelf and reef limestone overlie Palaeocene and Cretaceous rocks west, south, east, and northeast of the anticline. The limestone is overlain by lower and middle Miocene volcanolithic sediments and volcanics east and west of the anticline, and by extensive Oligocene to middle Miocene shelf limestone south of the anticline. The Miocene volcanics east of the Kubor Anticline contain undersaturated, high-potash lavas; those to the west are of more normal andesitic composition. About 50 km south of the anticlinal axis there is a 50 km-wide zone of overthrust diapiric folds (long axes parallel to the Kubor Anticline) developed in the Tertiary and uppermost Cretaceous sediments. The folds and thrust faults are believed to have resulted from southward gravity sliding off the Kubor Anticline. The Mesozoic and Tertiary rocks on the northern flank of the Kubor Anticline are cut by an extensive 300 km-long by 10 km-wide fault zone (Bismarck Fault Zone) which lies within the New Guinea Mobile Belt and is thought to mark the northern margin of the Palaeozoic Australian continent. Tertiary limestone and sediments caught in the fault zone have been strongly folded, faulted, and overthrust, and the northern block has been elevated at least 3,000 m relative to the southern block. Middle Miocene composite plutons of acid to basic composition intrude the Bismarck Fault Zone and the area to the north, and there is an upper Miocene porphyry stock in the eastern nose of the Kubor Anticline. The southern and western flanks are dominated by Pleistocene strato-volcanoes, and Pleistocene to Recent alluvial fans partly fill the Wahgi Valley on the northern flank.

The Kubor Granodiorite plutons, emplaced in the Omung Metamorphics during the late Permian, were uplifted, eroded, and exposed soon after emplacement. This was the first development of a topographic high in the Kubor area. During Permian to Triassic time reef limestone developed on and around the exposed Kubor Granodiorite. Episodic sedimentation, volcanism, and erosion continued in the Kubor area from Upper Triassic until Cenomanian time, although at least part of the Kubor area remained above sea level from Lower Jurassic time onwards. In Lower Cretaceous time, the Kubor area began to rise (first stage in the development of the Kubor Anticline), and the source of volcanic material in the sediments moved northwards. The Bismarck Fault Zone became active during late Cretaceous to Palaeocene time, resulting in vertical scissor and possible horizontal displacement of the Mesozoic sediments north of the Kubor Range. Sedimentation recommenced to the south and west of the Kubor area during the upper Palaeocene, and became more extensive to the west, south, and east during middle Eocene to early Oligocene time. Two basins developed in lower and middle Miocene time to the east and west of the Kubor area. They were connected to the south by an extensive shallow sea in which shelf limestone formed. Andesitic volcanism occurred in the basins during middle Miocene time, and numerous large and small plutonic bodies were emplaced to the north of the Kubor area. Commencing in the late middle Miocene there followed major orogenic events which probably reached a peak during the Pliocene: the Bismarck Fault Zone was reactivated, the Yaveufa Syncline formed, and the Kubor Anticline was further arched. Numerous minor folds and faults formed and a hypabyssal pluton was emplaced in the eastern nose of the Kubor Anticline. The Tertiary limestone on the southern flank of the Kubor Anticline slid southwards over the Cretaceous shale, and a 50 km-wide belt of overthrust diapiric folds resulted. The whole region was further uplifted and eroded during late Pliocene and early Pleistocene time. Several large stratovolcanoes then formed to the west and south of the Kubor Anticline. The summit areas of volcanoes and mountains above 3000 m were glaciated during late Pleistocene to Recent time.

<u>Oil, gas and mineral occurrences, mineral prospects, and alluvial gold workings</u> (Fig. 7). Production of minerals is restricted to small quantities of alluvial gold. The two main mineral prospects, both of which were discovered by BMR, are the Yanderra porphyry copper prospect, and the Marum laterite nickel prospect. The former is an extensive but very low grade porphyry copper in which sulphide minerals are mainly localised in joints. Little is known of the Marum prospect other than the area of nickeliferous laterite (about 80 km^2) and the highest grade of ore (about 1.4% Ni).

The occurrence of oil and gas seepages in the folded Ramu and Southern Highlands basins - indicate - is tantalising from the point of view of petroleum prospects but much work remains to be done before structures can be selected for drilling. The metalliferous mineral exploration to date has consisted mainly of regional and local stream sediment sampling and analysis. Only at the two main prospects has detailed geochemical, geological and geophysical work been attempted. Large quantities of stone suitable for road metal, aggregate, or building stone, and unconsolidated gravel suitable for road construction are present in the map area.

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BMR Records: 62/32, 63/31, 63/84, 62/110, 59/43, 62/25, 65/114, 51/30, 63/41, 67/143, 56/100, 56/117, 67/55, 61/73, 67/25, 57/91, 67/26, 67/94, 70/12, 70/79, 72/35.

PNGGS Investigation Notes: 67415, 68403, 67406, 69404, 70401(a), 67403, 69411, 70404, 67404, 69403, 69201.

BMR Bulletins: 3, 75, 133

BMR Reports: 48, 76

BMR Maps and Explanatory Notes: Ramu 1:250,000 Sheet in prep.
Karimui 1:250,000 Sheet prelim ed. 1972
PNG 1:1,000,000 Geology prelim ed. 1972

GEOLOGY OF THE WESTERN CENTRAL RANGES OF PAPUA NEW GUINEA

H.L. Davies, M. Norvick

In 1971 the Bureau of Mineral Resources mapped the geology of the western central ranges of Papua New Guinea between Porgera and the West Irian border, and from the Sepik plains in the north to the Fly-Strickland plains in the south. The area overlaps previous surveys by BMR in the northeast and east (South Sepik, Wabag), and by oil search companies in the southeast and south. The area is of economic interest for its petroleum, copper, and gold potential, and of structural interest because it straddles the border zone between relatively stable Australian continental crust and the mobile Pacific margin.

The area may be described in three provinces: a northern province, which extends from the Sepik plains to the line of the main divide; a central province, which includes the Om and Lagaip drainage basins and the Sepik headwaters; and a southern province, which coincides with the drainage of the Fly River and the Strickland River below the Om-Lagaip junction. The northern province is dominated by igneous, metamorphic, and volcanic rocks, the central province by slightly metamorphosed shallow and deep water marine Mesozoic sediments, and the southern province by unmetamorphosed Mesozoic and Cainozoic sediments.

The main rock units of the northern province are (a) metamorphics (generally sialic), (b) mafic and ultramafic rocks, (c) Cretaceous - Eocene sediments partly metamorphosed and (d) younger (middle Miocene) volcanics, volcanic sediments, and intrusives. The mafic and ultramafic rocks, with associated limestone and high P/T metamorphics, may represent oceanic crust and mantle in a former subduction zone (active in Cretaceous-Eocene or Oligocene). It has been suggested that such a subduction zone was made up of Pacific oceanic crust to the north and Australian continental crust to the south, but this simple model does not explain the present-day occurrence of sialic metamorphics north of the supposed fossil subduction zone (Fig. 1). North-south structural trends in the western part of the northern province suggest the possibility of an original north-south trend to the subduction zone, which trend could have been masked by later east-west left-lateral strike-slip faulting (Frieda-Lagaip fault zone).

The central province consists of Jurassic, Cretaceous, and possibly Eocene marine clastic sediments (mostly siltstone and shale) which are folded, faulted, and slightly metamorphosed. Metamorphic grade increases from the south (unmetamorphosed) to the north (green-schist facies). Total thickness of sediment is guessed at 5000 - 10000 m, and the nature of basement is not known. The east-west extent of some of the rock units and the strong rectilinear nature of the faults (strike around 290°) are probably evidence of strike-slip faulting.

The southern province consists of broadly folded unmetamorphosed Mesozoic and Cainozoic sediments, which, in one area, are seen to overlie a Permo-Triassic granite basement. About 2000 m of Jurassic and Cretaceous marine clastic sediments are overlain conformably by upper Eocene to middle Miocene limestone, which is in turn overlain by upper Miocene and Pliocene marine clastic sediments, and some Plio-Pleistocene volcanics.

Plio-Pleistocene stocks and dykes intrude throughout the province. Some time after the late Miocene or early Pliocene, the Mesozoic and Cainozoic strata were arched into broad major folds (e.g. the Mueller anticline, which is 40 km across) and minor folds, and disrupted by high-angle normal faults and low-angle reverse faults. Sense of movement in the low-angle reverse faults is upper plate southwards, in all cases. This, and the configuration of some of the structures (as recorded in air-photographs and radar imagery), suggest origin by gravity sliding rather than north-south compression. Some normal faulting postdates the low-angle reverse faulting, which has tilted and folded the thrust sheets.

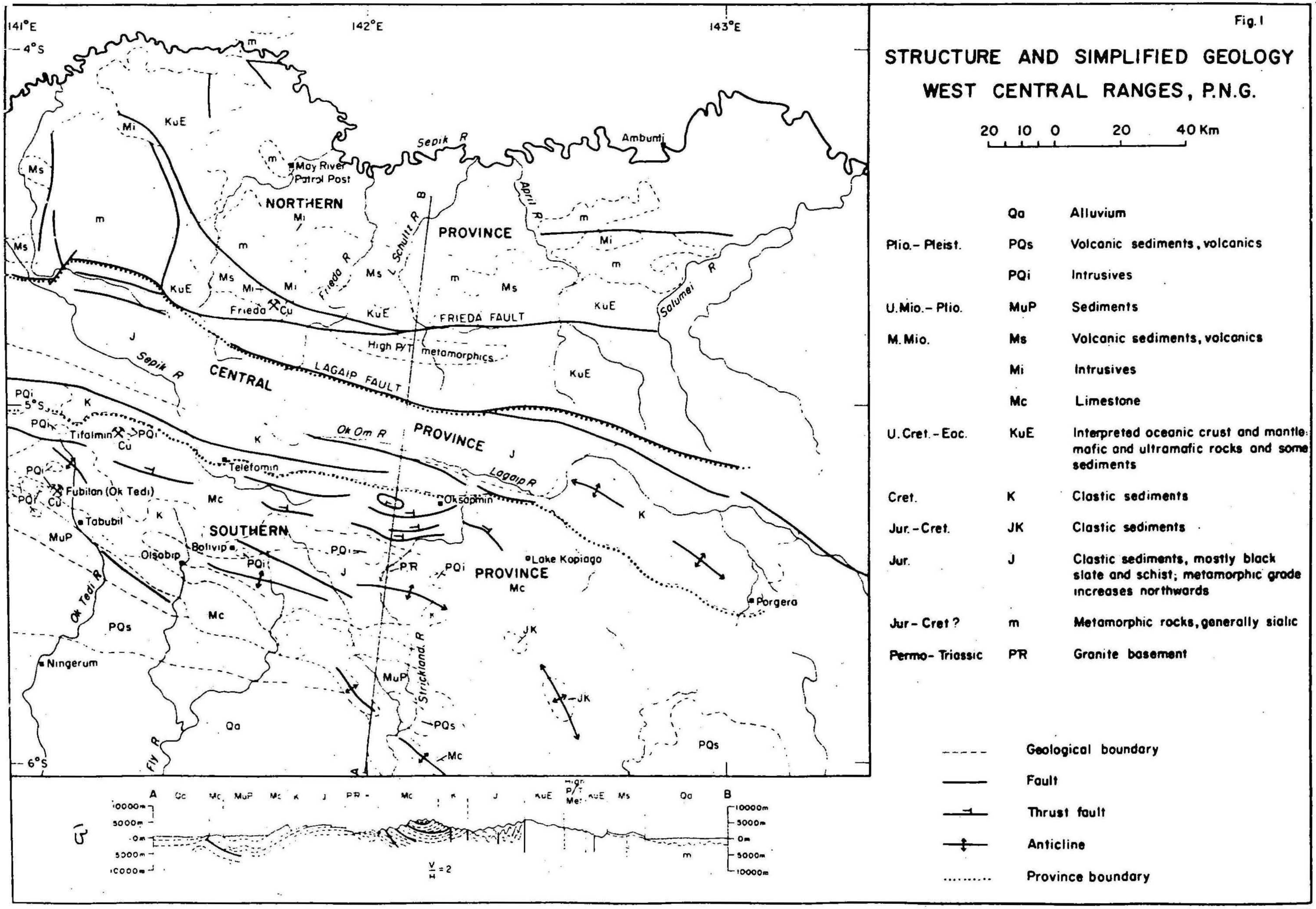
Fig. 1
STRUCTURE AND SIMPLIFIED GEOLOGY
WEST CENTRAL RANGES, P.N.G.
20 10 0 20 40 Km
Qa Alluvium
Plio.- Pleist. PQs Volcanic sediments, volcanics
PQi Intrusives
U. Mio.- Plio. MuP Sediments
M. Mio. Ms Volcanic sediments, volcanics
Mi Intrusives
Mc Limestone
U. Cret.- Eoc. KuE Interpreted oceanic crust and mantle: mafic and ultramafic rocks and some sediments
Cret. K Clastic sediments
Jur.-Cret. JK Clastic sediments
Jur. J Clastic sediments, mostly black slate and schist; metamorphic grade increases northwards
Jur - Cret ? m Metamorphic rocks, generally sialic
Permo- Triassic PR Granite basement
Geological boundary
Fault
Thrust fault
Anticline
Province boundary
141°E
142°E
143°E
4°S
5°S
6°S
Sepik R
Ambunti
May River Patrol Post
NORTHERN
PROVINCE
CENTRAL
PROVINCE
SOUTHERN
PROVINCE
April R
Schultz R
Frieda R
Salumei R
Frieda
FRIEDA FAULT
LAGAIP FAULT
High P/T metamorphics
Ok Om R
Lagaip R
Tifalmin
Telefomin
Oksapmin
Fubilan (Ok Tedi)
Tabubil
Olsobip
Bolivip
Lake Kopiago
Porgera
Ningerum
Ok Tedi R
Strickland R
Fly R
A
B
10000m
5000m
0m
5000m
10000m
V/H = 2

P/A/358

THE GEOLOGY AND MINERAL ENVIRONMENT OF NEW BRITAIN

Roderick J. Ryburn

The island of New Britain lies between the Solomon Islands and mainland New Guinea. It appears to have existed as an island arc on the active West Pacific margin since early Tertiary time and is probably a favourable environment for porphyry copper type deposits.

Upper Eocene lavas, rudites, tuffs, and sediments, derived entirely from contemporary basic to intermediate volcanism, form a basement to much of New Britain. These rocks are highly indurated, faulted and folded, and in some areas slightly metamorphosed. Small to medium sized plubous of upper-Oligocene age intrude the basement. Intrusive rocks include tonalite, diorite gabbro, granodiorite, adamellite, and hypabyssal equivalents. Volcaniclastic rocks of similar age unconformably overlie the basement in some areas. Thick Miocene limestone blankets large areas in the Whiteman, Nakanai, and Baining Mountains. The base of the limestone is unconformable on older rocks and ranges from basal Miocene at the western end of the island to upper middle Miocene in the Gazelle Peninsula.

Predominantly acid and intermediate volcaniclastic rocks of upper Miocene-Pliocene age cover parts of the Gazelle Peninsula and central New Britain. Quaternary volcanoes, some active, are distributed at the western end, along the central north coast, and at Rabaul.

Copper mineralization is associated with upper Oligocene intrusives at the Kulu River, Plessiyumi, and Uasilau prospects as well as minor occurrences in the Gazelle Peninsula and north Nakanai Mountains. The larger plutons are commonly pyritized but are otherwise relatively unaltered. More favourable circumstances may be associated with smaller, possibly younger, intrusive bodies. Other potentially economic prospects include lateritic bauxite on karst limestone, easily accessible pure limestone, manganese in the volcanic basement rocks, sulphur associated with the Quaternary volcanoes, and magnetite beach sands.

EVAPORITES IN AUSTRALIA

A.T. Wells

Major evaporite basins have been discovered in Australia over the past decade chiefly as a result of the large increase in the number of wells drilled in the search for petroleum. The main basins so far known are the Adavale, Amadeus, Canning and Officer Basins. In the Adavale and Canning Basins the evaporites are obscured beneath several thousand feet of sediments. However, in the Officer and Amadeus Basins the less soluble evaporites of the basin sequence are partly exposed in the cores of eroded folds, along fault trends, or in diapiric structures. The evaporites are Precambrian, Cambrian, possibly Silurian, and Devonian in age; over 2000 feet of evaporites have been penetrated in the Canning Basin in one hole drilled into a diapiric structure, and a similar thickness was penetrated in a petroleum exploration well. To date potash has been discovered only in the Adavale Basin, but the beds are less than one foot thick. Native sulphur has only been found in recent playalake deposits.

Further exploration of these evaporite deposits, with location of economic minerals in mind, can proceed logically from an investigation by mapping and shallow drilling of a selected number of the surface occurrences to detailed geophysical investigations of some near-surface deposits. The drilling will primarily be used to establish the mineralogy of the evaporites. Further drilling targets no doubt will present themselves as a result of both petroleum company geophysical investigations and the detailed surveys.

Besides drilling and geophysical surveys lithofacies studies and the elucidation of the palaegeographic history of a basin are the major objectives in determining the distribution and framework of an evaporite deposit. Lithofacies studies of well sections and formations in outcrop can be used to delineate areas for further investigation.

None of the recent surface occurrences of evaporites appear to hold any potential for producing economic minerals apart from halite.

The world resources of sulphur are very large and ample to supply any foreseeable future demand. Resources of potassium compounds are sufficient for several thousand years. If an economic method of recovering potassium from sea water is found then there will be world-wide self sufficiency virtually forever.

It appears that a need exists in Australia for continuing exploration for elemental sulphur deposits and potassium minerals, but not just in times of shortages, when new deposits generally are developed too late to even out the imbalance.

PROGRESS OF REGIONAL MAPPING, CARPENTARIA BASIN

H.F. Doutch

The Bureau of Mineral Resources and the Geological Survey of Queensland started a joint regional survey of the Carpentaria Basin in 1969, beginning where the Eromanga Basin survey finished, at latitude 20°S. Field work in the Carpentaria Basin has been completed as far north as the Mitchell River in Cape York Peninsula.

The Carpentaria Basin is separated by basement ridges from the Eromanga Basin to the south, and the Morehead Basin of New Guinea to the north. All three basins are Jurassic-Cretaceous structures, and have similar stratigraphy.

The older rocks of the Carpentaria Basin are continental quartzose sandstones of late Jurassic age, called the Eulo Queen Group and Gilbert River Formation. The Jurassic-Cretaceous boundary lies somewhere in the latter. Correlations of features on electric and gamma-ray logs of water and petroleum exploration bores in both the Carpentaria and Eromanga Basins suggest that the Eulo Queen Group and Gilbert River Formation are northward continuations of parts of the Injune Creek Group and Hooray Sandstone. The Gilbert River Formation contains plant fossils near its base and marine pelecypods near its top.

The younger rocks of the Carpentaria Basin are early Cretaceous fossiliferous marine mudstones and labile sandstones; some thin limestone beds are present. The Wallumbilla Formation, Toolebuc Limestone, and Allaru Mudstone are continuations of Eromanga Basin formations of the Rolling Downs Group, varying only in the proportions of mudstone to sandstone. The part continental Mackunda and Winton Formations of the Eromanga Basin are represented in the Carpentaria Basin by the Normanton Formation.

The Eulo Queen Group was deposited in basement depressions and the depositional boundary between the Carpentaria and Eromanga Basins was farther north than the present structural boundary, the Euroka Arch. The arch appears to be a still stand area away from which the two basins sagged.

Unconformably or disconformably overlying the Mesozoic sequence in both basins are a number of continental deposits, some of them possibly as old as late Cretaceous. The quartzose Bulimba and Floraville Formations may be this old. The Bulimba Formation was deposited in the Staaten River Embayment after Mesozoic rocks had been mildly warped and eroded; the Floraville Formation is a deposit of the ancestral Leichhardt River. After the Bulimba Formation was deposited a deep weathering event affected the whole region.

Uplift along the eastern margin of the Carpentaria Basin was closely followed by basaltic volcanism during the Pliocene and and Holocene. Contemporaneous downwarping of the embayment produced the Gilbert-Mitchell Trough. The structural movements that shaped the Gulf of Carpentaria probably started at this time. All this tectonism reflects orogeny in New Guinea.

The uplift initiated an erosional phase of the ancestral Mitchell, Gilbert, Norman, Flinders and Leichhardt Rivers. This phase soon gave way to deposition of the clayey quartzose Wyaaba Beds in the east, and the silty clays and sandstones of the Wondoola and Armraynald Beds in the west. The Armraynald Beds contain Pleistocene vertebrates.

The Wyaaba Beds were tilted, then affected by deep weathering processes which also probably modified older deep weathering zones elsewhere; uplift along the basin's southern margins culminated in the Selwyn Upwarp. Erosion has since dominated in the basin, except for the building of the fans of the Gilbert and Mitchell Rivers; they are still growing upward and seaward over the Wyaaba Beds in the trough. The development of the fans was complicated by late Pleistocene variations in sea level, which also resulted in sets of beach ridges along most of the eastern and southern shores of the Gulf. They have not been tectonically disturbed except in the Wellesley Islands.

CONTROLS OF PERMO-TRIASSIC SEDIMENTATION IN THE BOWEN BASIN

A.R. Jensen

The stratigraphy and petrology of part of the Permo-Triassic succession of the Bowen Basin have been investigated to determine the controls of sedimentation. The succession, which reaches a maximum thickness of 2800 m, consists of a red-bed sequence, the Rewan Formation, comprising mudstone and labile sandstone, overlain by the Clematis Sandstone, composed mainly of quartz-rich sandstone.

Earth movements at the close of the Permian created a rapidly subsiding intramontane basin, probably with an internal drainage system, in which coal measures were formed. Sediments of the Rewan Formation were deposited in the same drainage basin in a system of meandering and anastomosing channels, in response to a decreased rate of subsidence relative to the rate of supply of sediment. The red colour of the mudstone is caused by the presence of finely divided hematite, derived from the erosion of red soils of the source area. When the rate of sediment supply exceeded the rate of subsidence, a major reorganization of the drainage pattern took place, together with a general increase in stream gradients as sandy sediment accumulated at the margins of the basin. Changes of relief in the source area, as well as in vegetation, local climate, and rates of erosion and sedimentation, led to podsolic weathering both in the source area and at the site of deposition; fossil soil profiles can now be recognized in the mottled red and green mudstone of the basal part of the Clematis Sandstone. The newly established drainage system of braided and meandering channels spread sand towards the southeastern parts of the basin, where rates of subsidence were greatest.

The progressive increase in the mineralogical maturity of sediments throughout the succession is related to increased chemical weathering of the source area as the relief diminished. The pattern of sedimentation is seen as an example of lithogenesis within an intramontane basin with a humid temperate climate.

ENVIRONMENTAL SIGNIFICANCE OF STRUCTURES IN THE RANGAL COAL MEASURES AT BLACKWATER

W.A. Burgis

The structures in the Upper Permian Rangal Coal Measures in the Utah Development Company open-cut mine at Blackwater, Queensland, are being investigated to determine their origin and environmental significance. The coal seam being mined dips gently to the east and has a slightly undulating surface. The carbonaceous shale, mudstone, siltstone, and sandstone above the coal lie in a number of antiforms and synforms in the mine walls. Carbonaceous shale rests directly on the coal in most of the mine and constitutes a marker horizon. In several cross-sections, however, the carbonaceous shale is split from the coal by lenticular bodies of sedimentary rocks 8 to 28 m thick. Antiform and synform structures found below the carbonaceous shale are concordant with it, while those above are discordant with the marker. Preliminary analysis indicates a genetic relationship between thickness and structure of the coal seam and the antiforms and synforms in the rocks above it. The structures were probably produced by subsidence as a result of differential compaction during deposition of the sediments. The possible operation of this mechanism in several depositional environments is being considered.

1971 SEISMIC SURVEY ACROSS THE EASTERN MARGIN OF THE GALILEE BASIN, QUEENSLAND

R.R. Vine, P.L. Harrison

Reasons for Survey

Sediments in the central part of Queensland occur in several overlapping basins. From youngest to oldest these are the Jurassic-Cretaceous Eromanga Basin, the Permo-Triassic Galilee Basin, the Lower Carboniferous Drummond Basin, and the Devonian Adavale Basin.

Lake Galilee No.1 drilled a Galilee Basin sequence unconformably overlying Devonian sediments contemporaneous with those of the Adavale Basin. The time of deposition of the Drummond Basin sequence is represented by this unconformity. Extrapolation of the sequence drilled in this well eastwards towards the Drummond outcrops using available structural information implies that the eastern margin of the Galilee Basin near the Belyando River is either structurally-controlled or is the site of marked basin-edge thinning. This margin could also coincide with the western margin of the Drummond Basin. Unfortunately widespread alluvium conceals the critical zone.

In view of a significant oil show from near the base of the Galilee sequence in Lake Galilee No. 1 and the widespread subsurface occurrence of Upper Permian coals there was a need to establish the relationships between the Galilee and Drummond Basins and determine if the margins are structurally-controlled.

Operations

BMR conducted a seismic survey in the Galilee Basin between August and November last year. A single seismic traverse was recorded between Lake Galilee No. 1 well and outcrops of Drummond Basin rocks 80 km to the east. The traverse crossed a strong gravity gradient which coincides with the eastern margin of the Galilee Basin. Gravity was read at seismic shot-points and along short cross-traverses to allow detailed modelling.

Results

The area was a difficult one in which to record good seismic data mainly because of the 'P' horizon, a strong fairly shallow reflector associated with the Upper Permian coal measures. Single coverage recording used over most of the traverse yielded data of fair quality only. Several 6-fold CDP multiple coverage probes provided improved quality.

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Reflections were nearly horizontal over most of the traverse. On the eastern part of the traverse there is a zone of complicated structure which corresponds to the steep gravity gradient. Shallow events cannot be followed across this zone. A poorly continuous and disturbed event at about 2.5s occurs below the zone. Anomalous events which occur in the zone have been identified as diffractions and reflected refractions. They provide evidence of faulting. It is possible to identify several unconformities at the eastern end of the traverse. One unconformity identified on both sides of the zone of poor reflections indicates that Drummond Basin sediments do not extend far west of the Belyando River.

Gravity modelling is hampered by the lack of reliable density information. Two contrasting models of the basin margin have been constructed from available geological and seismic reflection information. One involves major displacement in a faulted zone with basement upthrown to the east, whereas the other has basement deepening to the east with negligible fault displacement. Both models are being refined to attempt to explain the observed gravity. Interpretation is continuing.

Conclusions

The implications of the geophysical results are:

a) Upper Permian coals are probably not faulted out along a major stretch of the Galilee Basin margin, but should subcrop at shallow depths below Quaternary sediments west of the Belyando River.

b) There is evidence both of thinning of the Permian sequence eastwards and of tectonic disturbance in the vicinity of the Belyando River, so further petroleum exploration near the margin is justified.

c) A thick Devonian section, possibly a northerly continuation of the Adavale Basin, is present below both the Galilee and Drummond Basins. Exploration of this section for petroleum is justified, particularly as comparable sediments in the Adavale Basin are petroliferous.

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MARINE GEOPHYSICAL RECONNAISSANCE OF THE AUSTRALIAN CONTINENTAL MARGIN

J.A. Brooks; J.C. Mutter; P.A. Symonds

More than 50000 nautical miles of a planned 80000 mile seismic, magnetic and gravity survey of the continental margin have been completed since December 1970. This systematic reconnaissance is designed to provide a better definition of the margin in terms of bathymetry, structure and resource potential than hitherto available.

The program of work has been completed off the eastern and southern coastlines of Australia from Cape York to Eyre Peninsula. Navigation, gravity and magnetic data are being sampled digitally at intervals corresponding to about 50 metres traverse distance. Six fold seismic coverage is being recorded in analogue mode.

Preliminary interpretations of data illustrate the widely differing morphology and structure of our eastern margin and has allowed speculation on some aspects of the tectonic history of the region.

Between 14°S and 24°S the continental margin of Queensland is typical of many younger margins. It is characterised by areas of submerged blocks of continental material such as the Queensland Plateau.

A study of the recent JOIDES results, together with seismic data from 20000 miles of BMR traversing has identified evidence for three stages of subsidence beginning in mid-Eocene. Subsidence progressed westward from an initial downwarping of the eastern margin of the Plateau. Troughs and basins containing up to 2.5 km of sediment have formed on the periphery of the subsiding blocks.

The mechanism of subsidence is a matter for speculation at this stage but seems to be closely related to the opening of the Coral Sea.

In the Tasman Sea region between 24°S and 34°, traversing extended 400 miles offshore to 160°E longitude. The continental margin consists of a narrow shelf, composed of a prograded sediment wedge overlying a palaeoslope cut in basement, and a present slope which is steeper than normal. The latter suggests a tectonic origin for the eastern margin of Australia.

The oceanic basement of the Tasman Abyssal Plain is overlain by about 750 metres of sediment, thickening to about 1 km at the base of the continental slope. A north-south sediment ridge on the abyssal plain is attributed to interaction of eastward sedimentation and deep sea contour currents.

A structural interpretation supports an hypothesis explaining formation of the Tasman Sea in two discrete stages. The first associated with initial separation of Lord Howe Rise from Australia, and the second associated with formation of the Dampier Ridge and the present abyssal plain.

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