DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1973/163

PAPERS TABLED AT ECAFE MEETING
KUALA LUMPUR
OCTOBER
1973

Record 1973/163

PAPERS TABLED AT ECAFE MEETING

KUALA LUMPUR OCTOBER 1973

1. AUSTRALIAN ACTIVITIES IN THE FIELDS OF GEOLOGY AND MINERAL RESOURCES DEVELOPMENT, 1971 AND 1972
2. THE AUSTRALIAN CONTINENTAL MARGIN SURVEY 1970-73
3. PROGRESS ON THE COMPILATION OF REGIONAL MAPS OF AUSTRALIA 1970-73
4. NOTES ON REMOTE SENSING APPLIED TO GEOLOGY IN AUSTRALIA 1970-1973
5. MARINE GEOLOGICAL SURVEYS IN AUSTRALIA 1970-73

AUSTRALIA

AUSTRALIA

AUSTRALIAN ACTIVITIES IN THE FIELDS OF GEOLOGY AND MINERAL RESOURCES DEVELOPMENT, 1971 AND 1972

Bureau of Mineral Resources, Geology & Geophysics
October, 1973

AUSTRALIAN ACTIVITIES IN THE FIELDS OF GEOLOGY AND MINERAL RESOURCES DEVELOPMENT, 1971 AND 1972

Most sectors of the Australian mining industry have increased output since 1970 and notable increases in production of bauxite, black coal, copper, gold, iron ore, manganese ore, nickel, oil, natural gas, and tin have been achieved. The ex-mine value of all minerals produced was a record $A1780 million in 1972, compared to values of $A1648 million in 1971 and $A1450 million in 1970, percentage increases of 8.8 and 14 respectively. Much of the production goes overseas and exports of minera primary products (excluding gold) was a record $A1392 million in 1972 compared to figures of $A1290 million in 1971 and $1178 million in 1970. Imports of mineral primary products continued to fall, as Australia becomes more self-sufficient in mineral commodities, particularly petroleum, and their 1972 value was about $A180 million (excluding gold). Expenditure on petroleum exploration (including government subsidies and operations in Papua New Guinea) increased from $A93 million in 1971 to about $A116 million in 1972, but there was a drop in expenditure on other mineral exploration in Australia from $A168 million in the 1970/71 financial year to $A125 million in 1971/72.

Petroleum exploration activities since 1970 have resulted in substantial discoveries of natural gas with condensate, and some oil, on the Northwest Shelf of Australia. These finds are now being evaluated. On land sufficient natural gas has been proved in the Cooper Basin area of South Australia to supply the New South Wales market. The total recoverable reserves of gas from onshore and offshore at the end of 1972 are estimated to be in excess of 37 million million cubic feet of which

21 million million cubic feet is in the Northwest Shelf. Oil pools have also been evaluated in the Cooper Basin and in Bass Strait, where developed oil fields already provide most of the country's crude oil production which approximates to two thirds of demand. Production at the end of 1972 was about 300 000 barrels per day and reserves were 2350 million barrels of which about a third are natural gas liquids.

Further uranium deposits with reserves of 150 000 tonnes of U_3O_8 were discovered in the Northern Territory and Western Australia.

The pace of systematic geological and geophysical mapping of the Australian continent and adjacent areas has increased during 1971 and 1972. Eighty-five percent of the country is now covered by published geological maps at 1:250 000 scale and the mapping of the remaining 15% should be accomplished by 1980. Colour 1:25 000 scale aerial photographs are increasingly being used to re-map the more complex geological areas at 1:100 000 or larger scale, and side-looking radar (SLAR) and ERTS imagery are also used as aids to mapping. The reconnaissance geological mapping of Papua New Guinea is almost complete and the results have been used to compile a geological map at 1:1 000 000 scale and a mineral deposits map at 1:2 500 000 scale.

Regional gravity surveys of the Australian continent, continental shelf, and slope are almost complete, the last major onshore survey being scheduled for 1974. Aeromagnetic surveys will take longer to complete, but a continent-wide map at 1:2 500 000 scale showing the major anomalies and trends is scheduled for publication in 1976.

A systematic seismic, magnetic, and gravity survey of the Australian continental margin out to 4000 m depth was completed early in 1973, although it will be some years before all the records are processed, interpreted, and published. The marine geological survey of the continental shelf was extended from southern Queensland to Tasmania.

A major project was begun on the hydrology of the Great Artesian Basin with a view to understanding its hydrodynamic behaviour by preparing a digital mathematical model. The results will be used to assess the resources and help in water management. A series of maps at 1:5 000 000 scale showing Australian groundwater resources was published.

AUSTRALIA

THE AUSTRALIAN CONTINENTAL MARGIN SURVEY 1970-73

Bureau of Mineral Resources, Geology & Geophysics
October, 1973

The Australian Continental Margin Survey 1970-73

Introduction

The Continental Margin Survey was carried out under contract for the Bureau of Mineral Resources from December 1970 until January 1973. The survey was a continuation of the 1970 marine survey of the Gulf of Papua and Bismarck Sea, the results of which are included. Its objective was to provide reconnaissance bathymetric, gravity, magnetic, and reflection seismic data around the margin of Australia, generally between the coast and the 4000 m isobath. Most of the continental shelf, slopes, and rise were surveyed. Main areas not surveyed were the Arafura Sea, the Gulf of Carpentaria, the Great Barrier Reef, and the Bass Strait.

About 90,000 nautical miles of traversing were completed, along lines approximately perpendicular to the coast, with a line separation of 20-30 nautical miles. Ship speed was about 9 knots.

Preliminary interpretations over marginal plateaux and areas of thick sediment have been made. Maps have been contoured using preliminary hourly data values, and on-line seismic sections drawn.

Final data values will be obtained from massive reduction by digital computer. Final maps will be machine contoured using ten-minute data points. Magnetic profiles will be drawn from one-minute data.

Equipment and Operations

The principal navigation system was an ITT satellite-Doppler receiver coupled to a Digital Equipment Corporation PDP-8 computer. This provided position fixes at intervals of 1-2 hours. A Marquardt sonar-Doppler navigator, Chernikeeff electromagnetic log, and ship's pressure log were alternative means of dead reckoning. VLF radio navigation was also on board as an experimental set-up.

The gravity meter was a LaCoste Romberg, mounted on a gyro-stabilized platform, with an analogue computer to make cross-coupling corrections.

Total magnetic field was recorded using a Varian proton precision magnetometer with the sensor towed 200 m astern. A second magnetometer was stationed on shore to record daily variations in the earth's field.

An Atlas-Edo echo-sounder was used to record digital water depths of between 0 and 200 metres, and an Elac echo-sounder was used for depths between 200 and about 3500 m. An Edo Digitrac digital conversion unit was used to obtain digital values from the Elac. In depths greater than 3500 m values were obtained from the near trace output of the seismic streamer.

Outputs from the gravity meter, magnetometer, sonar doppler, gyrocompass, electromagnetic log, pressure log, five VLF channels and anenometer, were interfaced with a Hewlett Packard 2116B (16K) computer. These outputs were sampled every 10 seconds. The computer was programmed to test continuity of data and to provide a continual estimate of position from each navigation system, by dead reckoning from the previous satellite fix. The data were stored on digital magnetic tape and the most recent data block was output on a teletype every 10 minutes. Data from all systems were also displayed on analogue strip charts.

The seismic energy source consisted of a 120 000 joule sparker, initially with four pairs of electrodes, but later with a single electrode. A high resolution Geotech streamer, with internal pre-amplifier, was used to record details from the top few hundred metres of sub-bottom. The Geotech streamer contained 28 hydrophones spread over 12 m, with the active section offset by 200 m. The main seismic streamer had six active sections, 200 m apart, each containing 48 hydrophones spread over 50 metres. The nearest active section was towed about 300 m astern. A 6-fold Common Depth Point (CDP) configuration was used, in which the sparker was discharged every 25 m (or approximately every 5 seconds at a boat speed of 10 knots).

Seismic signals were amplified by Sercel AX626 amplifiers with Common Gain control, or by S.I.E. PT 700 amplifiers with Automatic Gain Control, and recorded in analogue form on magnetic tape. The high resolution channel and the first or second channel from the main streamer were also fed to facsimile recorders.

A second Hewlett-Packard 2116B computer (with 8K core and disc storage) was used to provide an on-line 6-fold CDP stack. The computer provided ramping, muting and ~~wave~~ move out adjustments on a real time basis, using velocity functions which were inserted manually. The stacked trace was converted to analogue form and recorded on magnetic tape. It was also output to a facsimile recorder. The stacking system was only operated for a short period. It was still experimental in nature and not essential to this large scale contract survey.

Refraction profiles were obtained using an Aquatronics FM radio receiver and sonobuoys.

Preliminary Interpretation

(i) Bismarck Sea

An interpretation of preliminary data from the 9000 nautical miles (14 500 km) of gravity, magnetic, and seismic reflection traversing in the Bismarck Sea was carried out.

The bathymetric data detailed the main features on existing maps, namely: an overall platform of less than 2000 m depth, an eastern deep of about 2500 m, and a western incursion of the Pacific Ocean of between 2000 and 4000 m. The Melanesian Trench and the extremities of the Planet Deep were also evident. Several ranges of seamounts with a roughly east-west trend were defined.

Bouguer anomalies show a characteristic correlation with depth, and reach +200 milligals in the deeper water. A gradient of 3 milligals/km along the New Guinea coast tends to obscure superficial geological effects. Free-air anomalies are predominantly positive and about 50 milligals. Highs of 70-100 milligals occur over the Witu Islands, Schouten Islands, and other volcanic groups. A pronounced negative of -190 milligals lies between Astrolabe Bay and Vitiaz Strait. This is probably due to thick uncompensated sediments and a 'root effect' from the ranges on Huon Peninsula. The Bougainville trend extends northwest as a high of about 140 milligals superimposed on a broad regional low of -200 milligals. This could result from the combined effects of a downwarped plate and local ultramafic intrusions.

Magnetic anomalies show east, WNW, and northeast trends. Two pronounced east-west magnetic ridges of about 2000 gammas amplitude may be correlated with the Bismarck Sea seismic lineation. Johnson & Molnar (1970) have shown that this probably represents a major left-lateral shear zone. Extending eastwards from Wewak, the lineament is also in proximity to a seamount chain of about 2000 m elevation.

Sonobuoy refraction records were very poor and yielded little information. Seismic reflection records were fair although penetration was variable. The Bismarck Sea is seen to have an overall east-west grain. Thin sediments (about 100 m) occur along a central band and thicken to 2000 m or more in Kimbe Bay, north of the Huon Peninsula, offshore Sepik, and on a ridge stretching between New Ireland and Manus Island. On the ridge the sediments are moderately folded. In the Sepik and Huon areas the basement was not defined. Numerous graben-like features are found between New Britain and New Ireland but are largely absent in the west. The Weitin fault of southern New Ireland extends parallel to the coast and then probably swings WNW. The Wide Bay-Open Bay graben on the southwest Gazelle Peninsula and the New Guinea coast are probably controlled by major faulting. A large trough is found at the foot of the slope, about 25 km off Wewak. Krause (1965, Geol. Soc. Amer. Bull., 76(1), 27-41) has suggested that this marks a continuation of the Ramu-Markham lineament). Sediments in the Northern New Guinea Basin do not extend beyond the top of the slope, about 20 km offshore.

The use of a simple crustal model and filtered free-air anomalies, with densities and depths from the Rabaul Crustal Survey (Cull & Weibenga, BMR, pers. comm.) has indicated that the depth to Mohorovicic Discontinuity in the Bismarck Sea is about 20 km, deepening rapidly at the coasts.

(ii) Gulf of Papua and northwest Coral Sea

In November and December 1970, 5300 miles of multisensor data were acquired between latitudes 8° and 13°30'S, the interpretation of which has answered some old questions and pointed to some interesting possibilities regarding the origin of the region.

The Aure Trough/Papuan Basin has been found to extend southeast down the Moresby Trough to 10°S, its southwest margin being defined by structural rises on which the modern platform reefs (Portlock, Boot, and Eastern Fields) are located. This extension is marked by a deep free-air anomaly low (-100 mgal), interpreted as arising from a basinal thickness of sediment in the Moresby Trough which has a crustal section thinned by about 7 km.

South of the Papuan Basin is a larger fan-shaped plateau (Eastern Plateau) bounded in the west by a tension-faulted graben (Portlock Trough) and underlain by crust of thickness less than 25 km. A further change in crustal thickness occurs when an embayment feature south of 12°S is reached. Thicknesses here are generally less than 20 km, according to gravity evidence.

An oceanic section is not found until the Coral Sea abyssal plain is reached, the northwestern extent of which is limited by a steep scarp which has a strong positive magnetic anomaly and associated intrusions.

All major features of the region appear to have arisen from tensional tectonics. It is contended that this supports current theories which suggest that the Coral Sea opened by rifting in the Upper Oligocene. A reconstruction of the pre-Oligocene situation would require clockwise rotation of the Papuan peninsula to contact the scarp feature and the consequent closing of the Aure/Moresby Trough, without disturbance to any continental features.

(iii) Southern Tasmania

A shelf some 30 m wide parallels the coast around southern Tasmania and is bordered by a fairly uniform slope from 200 to 2500 m.

Two broad plateaus between depths of 2500 and 3500 m are present; one extends directly south of Tasmania and one to the southeast. They are bounded on the east and west by a sharp increase in depth to approximately 4500 m and are separated by a broad channel beginning on the northeastern margin of the shelf and extending in a southerly direction. The Southern Plateau extends southward out of the area surveyed. The topography on the southern plateau is quite rugged compared with the Eastern Plateau, which has considerable sedimentary cover.

One distinctive feature is a topographic high in the eastern end of the Eastern Plateau rising some 1500 m above the surrounding area over a distance of about 30 km. This may be an intrusion. There are also several highs on the Southern Plateau of about 600 m, some of which are north-south ridges.

Both the shelf and the rugged Southern Plateau are overlain b y only a very thin sedimentary cover apart from isolated pockets of sediments containing up to 1500 m of section. Some of these pockets may be fault-controlled.

On the flatter Eastemn Plateau, sedimentation appears to be more continuous and average cover varies from about 500 to 1000 m, again with some deeper pockets. There are several basement highs in this plateau, associated with low-amplitude magnetic anomalies. An apparent intrusive mass appears as a basement feature on the central eastern portion of the plateau together with a second basement high. The intrusion is associated with low Bouguer anomaly values. This anomaly has a gradient of about 6 mgal/mile over a feature 32 km wide.

The most consistently thick sediments occur in the broad channel between the two plateaus. Here horizontally bedded sediments, with an average thickness of 1200 m, extend across the channel. Southwards, the channel veers to the east and its northern flank shows an increase in sedimentation against the Eastern Plateau.

Generally the magnetic values in the area are some 100-400 gammas above the regional field. Some vague north-south trends exist. The only negative anomalies occur on the southwest of the Southern Plateau and are associated with the increase in slope to deep water.

Regionally the Bouguer contours reflect the bathymetry. The shelf and slope region is marked by a gradient of about 40 mgal/mile.

The broad plateau areas show low gradients with a regional Bouguer value of about 130 mgal; the value increases sharply at a rate of 8 mgal/mile to reach a general Bouguer value of about +200 mgal as the depth increases on the eastern and western limits of the area.

Central-eastern Australia

The area extends from the coast to longitude 160°E and lies between latitudes 34°S and 24°S. Surveying was conducted on a 20 nautical mile line spacing using marine seismic (reflection and refraction), gravity, and magnetic techniques. In all, about 16 800 nautical miles of traverse was surveyed along 29 east-west lines, and 1700 nautical miles along north-south tie lines.

The area can be divided into the following physiographic provinces:

Australian continental margin - consists of a narrow shelf averaging about 40-50 km in width south of the Stradbroke Islands and increasing northward to about 100 km at Gladstone. The continental slope, which flattens out at 4500 m depth, is quite steep, having an average slope of 4 to 8°.

The residual magnetic field is marked by positive, small-wavelength anomalies south of 33° and north of 28°. Those south of 33° occur over the offshore Sydney Basin and may be related to outcrops of Lower Permian volcanics on the slope and near-shore shelf. Anomalies east of the Stradbroke Islands may be related to Tertiary volcanics which crop out on the coast north of Brisbane and elsewhere in the central-eastern part of the Ipswich-Clarence Basin. An anomaly northeast of Fraser Island may be the magnetic expression of the basement ridge that is considered to mark the northeastern margin of the Maryborough Basin.

In the southern part of the area the shelf and slope are characterized by a prograded wedge of up to 500 m of sediment, overlying what appears to be a palaeo-slope cut into basement. Basement crops out on the slope at less than about 1500 m, and pockets in the basement are filled with slumped and contorted sediments.

Tasman Basin - an abyssal plain area which ranges in depth from 4500 to 4800 m and extends from the slope to longitude 157°.

The residual magnetic field throughout much of the survey area is characterized by small, irregular closures which tend to show a general NNE trend in the Tasman Basin, but this becomes more nebulous to the east.

In the southern portion of the Tasman Basin, sediments are thickest (greater than about 1.5 km) just east of the base of the slope and generally thin eastwards (0.5 - 1.0 km) towards the Tasmantid seamount chain. The basement surface is very irregular but tends to smooth to the east.

Dampier Ridge - a north-south trending ridge about 100 km wide and 1800 m below sea level at its highest point.

It is associated with a broad, positive, NNE-trending magnetic anomaly on which are superimposed shorter-wavelength anomalies associated with shallow or exposed basement.

The Dampier Ridge is marked by rugged and occasionally exposed basement. Basement highs or intrusions protrude from the sea floor and are usually separated by narrow (less than 5 nautical miles) sediment-filled depressions.

The Lord Howe Rise - the survey area reaches only the foothils of the rise, a depth of 1500 m. They are covered with about 500-800 m of sediment which appears to have slumped somewhat, towards the west.

Tasmantid seamount chain - a roughly north-south trending chain of guyots, which stand 1400 to 4400 m above the Tasman Basin.

Lord Howe Island seamount chain - a roughly north-south chain of guyots and seamounts, lying between the Dampier Ridge and Lord Howe Rise. Some of these occur at sea level as reefs and islands and others are up to 1500 m below sea level.

Short-wavelength, relatively high-amplitude positive and negative magnetic anomalies are associated with many of the guyots and seamounts of the Tasmantid and Lord Howe chains. However, some, such as the Stradbroke, Brittania, Brisbane, and Gifford guyots appear to have little or no magnetic expression. This is probably a function of their depth below sea level.

The guyots in the Tasman Basin are normally very flat topped and appear to have little or no sediment on their tops and flanks.

Middleton and Lord Howe Basins - these basins, which lie between the Dampier Ridge and Lord Howe Rise, are at depths of 3400 m and 3900 m respectively. Their average widths are 130 and 80 km respectively.

The thickness of sediment in the basins is hard to determine, as basement is never reached. However, it is probably greater than 1 km in many areas.

The Bouguer anomaly contours generally bear a very close resemblance to the bathymetry. The guyot chains, although gravitationally positive with respect to their surroundings, tend to exhibit less gravity effect than that calculated theoretically. This may be due to a terrain effect.

The Tasmanian margin

During 1971 and 1972, 9100 nautical miles of traverses were surveyed in the areas of eastern and western Victoria, and Tasmania. The survey extended across the continental shelf and slope to approximately the 4500-m isobath and delineated the northern part of the Tasmania Ridge and the Cascade Plateau to the south and southeast of Tasmania.

On the broad continental slope of the western margin of Tasmania and Bass Strait, basement is not visible on the seismic cross-section but at least 1.5 km of sediment is present. A regional unconformity, probably between Upper Cretaceous and Eocene, can be traced over a large part of this slope.

On the eastern margin a steeper slope has developed with less than 1 km of sediments above an undulating basement. It is characterized by numerous igneous intrusions which form a line, approximately half way down the slope, trending along the margin in a northerly direction. In several places the base of this slope drops abruptly to the abyssal plain and elsewhere oceanic basement can be seen abutting continental basement, indicating the fault controlled origin of this margin.

Evidence for a more abrupt transition from continental to oceanic crust on the eastern margin than on the western margin is shown by a higher Bouguer anomaly gradient in the east.

Sediment cover on the rugged Tasmania Ridge is generally sparse, but some pockets are up to 1 km thick. This contrasts with fairly uniform sediments 1 to 1.5 km thick on the Cascade Plateau. Between these two features a broad channel trending south, then southeast around the Cascade Plateau, is present and contains at least 1 km of sediments. Basement is not apparent in this channel.

Crustal thicknesses of about 17 km beneath the ridge and plateau indicate that they are probably subcontinental blocks. The thicknesses were estimated from free-air gravity anomalies based on a standard model continental crust 34 km thick.

Queensland continental margin, 12-24°S

Twenty thousand nautical miles of combined seismic, gravity, and magnetic data have been collected over the plateaux, troughs, and rises of the continental margin of Queensland between 12°S and 24°S. Although a detailed interpretation has not yet been made, some features of a tentative structural picture which has emerged from work done so far are described.

The Queensland and Marion Plateaux both appear to be underlain by crust of continental thickness. This interpretation is made entirely from the gravity results of the BMR survey and is consistent with the seismic results of Ewing et al. (J. geophys. Res., 75, 1953-72, 1970). The Queensland Plateau is separated from the Queensland coast by the Queensland Trough, which appears to be fault-bounded on both sides, i.e. a graben. It is not possible to postulate a similar character for the Townsville Trough, which forms the southern margin of the Queensland Plateau and separates it from the Marion Plateau. The latter is at a much shallower depth than the Queensland Plateau, is approximately half its size, and has no marginal trough.

Between 500 and 1500 m of stratified sediment on the plateaux overlies acoustic basement ap, ent on the sparker monitor sections, but analysis of magnetic anomalies and sonobuoy refractions indicates that basement is more than 1000 m below sparker penetration. It is suggested that the acoustically observable sediments represent Tertiary, post-subsidence deposits overlying New England Geosyncline sediments. These lower sediments are distributed in a pattern which closely resembles the highs and lows of the New England and Tasman Geosynclines.

Within the ?Tertiary of the Queensland Plateau is an angular unconformity which is believed to represent the regional Oligocene unconformit found by the JOIDES drilling on LEG XXI.

Formation of the plateaux appears to have resulted from a three-stage process: firstly subsidence by downbuckling of the eastern margin following the opening of the Coral Sea; secondly subsidence of the plateau as a whole; and finally formation of the marginal troughs.

East of the Marion Plateau, the Cato Trough was seen to contain more than 1500 m of sediment. Only the northern end of the Mellish Rise was traversed. It was seen to have a very rugged basement and a thin sediment cover. All features east of the plateau appear from the gravity data to have oceanic or suboceanic crustal sections.

(vii) Tasman Sea area

The area under consideration extends from the coast to 160°E and lies between latitudes 40° and 24°S. Since the initial summary in 1971 of work in the area, coverage has been increased from about 18500 to about 26500 nautical miles of traverse. The 8000 nautical miles of traversing completed in 1972 consists of rerunning eleven east-west lines between latitudes 34°S and 24°S, one regional traverse across Lord How Rise, and five regional traverses in the central Tasman Basin between latitudes 34° and 40°S. About 4500 nautical miles of the new traversing was run without a gravity meter. Due to the good quality of the seismic sections obtained these extra traverses have allowed a more confident interpretation to be made of the Tasman Sea area, and deductions about the regional tectonics of this part of the Southwest Pacific.

A description of the major bathymetric magnetic and gravity features in the area has been given in 1971.

The major structural features of the Tasman Sea region are the Tasman Basin, which may be divided into the abyssal plain and abyssal hills provinces, the Dampier Ridge, the Lord Howe Rise, the Middleton and Lord Howe Basins, which lie between the Dampier Ridge and Lord Howe Rise, and Mellish Rise, and a NW-trending, highly disrupted basement ridge, which Ringis (1970) and Hayes & Ringis (1972) suggested may be an extinct spreading centre.

Mutter and Symonds have deduced a tectonic evolution of the Tasman Sea area, which is similar to that proposed by Griffiths & Varne (Nature, 234, 203-7, 1972). Mutter and Symonds tentatively suggest that the Tasman Basin was formed in two discrete stages. The initial stage was due to the seafloor spreading that occurred from about 80 to 60 m.y. B.P., creating a triangular rift between Australia and the southern part of Lord Howe Rise. The oceanic crust created by this stage now exists as the swale and abyssal hill province of the central and southern Tasman Basin. In response to the spreading a rift developed between Australia and the northern part of Lord Howe Rise, which may have been a marginal plateau at this time. The second stage of formation of the Tasman Basin was the result of the 'differential spreading of Australia and the Campbell Plateau from Antarctica during the Tertiary' leading to 'the establishment of a zone of transcurrent displacement through New Zealand' (Griffiths & Varne), namely the Alpine Fault. This produced further rifting between Australia and Lord Howe Rise, thus forming the 'oceanic' basement beneath the present abyssal plain as the rise moved northeast with respect to Australia. Mutter and Symonds suggest that the Mellish Rise may have been formed as a result of igneous activity in a zone of transcurrent displacement resulting from the northeasterly movement of the northern end of Lord Howe Rise. That is, the Mellish Rise may be the northern equivalent of the Alpine Fault. During the second stage of rifting, the Dampier Ridge, which probably formed as an intrusive complex in the initial rift between Lord Howe Rise and Australia, also moved northeast with respect to Australia in a similar manner to Lord Howe Rise. This movement may have been responsible for some rifting between the Dampier Ridge and the rise.

(viii) Naturaliste Plateau

The basement rocks of the Naturaliste Plateau are probably metamorphic of continental origin and are covered by an average of 500 m of pre-Tertiary sediment. The main topographic features of the Plateau are two embayments and a scarp-like southern margin. The Plateau is higher in the west, where basement is generally shallow, than in the east, where over 2 km of sediment are found. Within the sedimentary sequence there are several unconformities, of which two can be traced regionally. The sediments have been largely undisturbed by tectonism.

Structural trends in basement are a N-S zone of fracture east of the plateau, and a NW-SE line across which there is a major change in magnetics, free-air gravity, bathymetry and basement depth. The southern margin appears to have a faulted zone.

A crustal thickness intermediate between continental and oceanic thicknesses has been determined from gravity results.

(ix) Great Australian Bight

Gravity, magnetic and seismic reflection records were obtained in the Great Australian Bight (between 124° and 141°E) as part of the Continental Margin Survey. Lines are oriented north-south and separated by 20-25 nautical miles.

High noise levels and interference from multiples has resulted in poor seismic records over the continental shelf, but elsewhere the quality is fair. Gravity and magnetic data are good throughout.

Bathymetric measurements outlined the continental shelf, continental slope, continental rise, Eyre Plateau, Ceduna Plateau, and small areas of abyssal plain.

Sediment thicknesses of 0.5 - 1 km are confirmed in the offshore Eucla Basin and also on the Eyre Plateau. The Denman Basin probably extends onto the continental shelf for 50 km and occupies a total area of 10 000 km^2. The Polda Trough is a true graben containing at least 2 km of sediments, and with boundary faults extending westwards across the northern edge of the Ceduna Plateau and southern edge of the Eyre Plateau. The gravity anomalies indicate 3 or 4 km of sediments under the Ceduna Plateau. The Duntroon Basin and Ceduna Plateau are probably sediment piles overlying a downfaulted block of the Gawler Craton. Both are bounded by a basement rise or band of intrusions along their southern edges.

The outcropping Gawler Block is encircled by a Bouguer anomaly ridge which may originate from an ancient mobile belt.

Faults along the margins of the Eyre Plateau, Ceduna Plateau and Duntroon Basin, together with the Polda Trough graben, and graben development during the early stages of formation of the Otway Basin, support the notion that the present continental margin developed as a rift during the Jurassic. The fault pattern is consistent with that predicted by the sea-floor spreading hypothesis.

AUSTRALIA

PROGRESS ON THE COMPILATION OF REGIONAL MAPS OF AUSTRALIA 1970-73

by

G.E. Wilford

Bureau of Mineral Resources,
Geology & Geophysics
October 1973

PROGRESS ON THE COMPILATION OF REGIONAL MAPS OF AUSTRALIA 1970-73

by

G.E. Wilford

The last report of progress was made to the Joint (Eighth) Session in Bandung in 1970. Progress since that date is outlined below. Outline maps showing the present status of systematic geological, gravity, magnetic and radioactive mineral surveys in Australia are attached.

Geological Map of the World: Australia and Oceania (1:5 000 000)

This map is prepared on behalf of the Commission for the Geological Map of the World by the Bureau of Mineral Resources, Australia, acting as regional co-ordinating and compiling authority, and the Geological Survey of New Zealand. The map consists of 13 sheets of which the first is a general reference sheet for the series. Each sheet covers 24 degrees of latitude and 24 degrees of longitude and the colour scheme and time and rock subdivision are based on those of the International Geological Legend, supplied by the Commission for the Geological Map of the World.

Sheets 1 (Reference Sheet), 9, and 13 have been published since the last report was submitted, the last two by the New Zealand Geological Survey.

All sheets (1-13) have now been published and copies distributed to contributing countries and to the Secretary-General of the Commission.

Sheets 6, 7, 8, 11 and 12 have been reprinted.

Tectonic Map of Australia and New Guinea (1:5 000 000)

This map, which includes both Papua New Guinea and West Irian, was prepared by the Geological Society of Australia with assistance from the Bureau of Mineral Resources. It is now printed and copies at$A5 each can be obtained from the offices of the Geological Society, Gemmology House, 24 Wentworth Avenue, Darlinghurst, N.S.W.

Metallogenic Map of Australia and Papua New Guinea (1:5 000 000)

The metallogenic map, which makes use of a slightly modified version of the 1:5 000 000 tectonic map, was compiled by the Bureau of Mineral Resources and published in 1972.

Groundwater Resources Maps of Australia (1:5 000 000)

An atlas of four map sheets has been published by the Australian Commonwealth Department of Minerals and Energy for the Australian Water Resources Council. The themes of the four maps are: principal groundwater resources; groundwater resources of unconsolidated sediments; groundwater resources of sedimentary basins; and groundwater resources of fractured rocks. An explanatory booklet is in preparation.

Metamorphic Map of Australia (1:5 000 000)

This map is being compiled by Professor Vallance, of the University of Sydney, as part of the World Metamorphic Map project.

Post-Miocene Volcanoes of the World (1:5 000 000)

The Bureau of Mineral Resources has compiled a map of Papua New Guinea (latitude 0-12½°S; longitude 140°E-160°E), as part of this series, for the International Association of Volcanology and Chemistry of the Earth's Interior; the fair drawing has been sent to I.A.V.C.E.I. but the map has not yet been printed.

Geology of Australia - Distribution of Main Rock Types (1:10 000 000)

A black and white map has been compiled by the Bureau of Mineral Resources at the request of the Australian Convener for the 1:5 000 000 scale Soil Map of Australia; it is designed to illustrate the chapter on geology in the notes to accompany the FAO-UNESCO Soil Map of the World, 1:5 000 000. The map shows the distribution of the main rock types and, where outcrop is poor, the unconsolidated cover. It is to be fair drawn and published by the organizing body for the Soil Map of the World.

Geology of Papua New Guinea (1:1 000 000)

This map, in four sheets, has been published by the Bureau of Mineral Resources.

Minerals Deposits of Papua New Guinea (1:2 500 000)

This map, in one sheet, shows all known mineral occurrences divided, according to size into: prospects, minor, medium, and major deposits. The map with explanatory notes is expected to be printed within the next few weeks.

AUSTRALIA

AUSTRALIA

NOTES ON REMOTE SENSING APPLIED TO GEOLOGY IN AUSTRALIA 1970 - 1973

by

W.J. Perry

Bureau of Mineral Resources,
Geology & Geophysics
October 1973

NOTES ON REMOTE SENSING APPLIED TO GEOLOGY IN AUSTRALIA

1970 - 1973

by

W.J. Perry

The term Remote Sensing refers here to the use of instruments operating at certain wavelength bands of the electromagnetic spectrum, from the ultra-violet to the microwave, to acquire data about objects although not in contact with them. The various electrical and radioactivity methods of geophysical prospecting and the sensing of the earth's natural fields of gravity and magnetism are excluded; however, the combination of some of these methods with remote sensing techniques (in the restricted sense) can provide useful information.

Aerial Photography

During the period, most work in the field of remote sensing was a continuation of the application of panchromatic aerial photographs to geological mapping. (Format 23 cm; nominal scale 1:85 000; camera focal length 88 mm; flying altitute 7620 m; approximate cost for very large areas \$A0.38 km^2). There was, however, increasing use of colour aerial photographs, begun in 1968, as a basis for detailed geological mapping in well exposed mineralized Precambrian and Palaeozoic terrain. (Format 23 cm; nominal scale 1:25 000; camera focal length 152 mm; flying altitude, 3785 m; approx. cost for areas of about 9000 km^2 is \$A1.35 km^2). The colour photographs make much clearer the distinction between, and the boundaries of, different rock types; in addition they greatly aid navigation, photo-interpretation, the location of old workings, and recognition of indications of mineralization.

In 1970, an experimental survey of an irrigation area in northern Victoria using colour and colour-infrared aerial photography showed that these films were useful in detecting channel leakage, for mapping areas affected by groundwater salinity, and for several aspects of farm management. (Format 70 mm; nominal scale 1:30 000; camera focal length 44 mm; flying altitude 1370 m).

Thermal Infrared Imagery

Thermal infrared imagery was acquired in three areas; one of sub-humid temperate climate near Canberra (wavelength 3.5 to 5.5 μm, 1 μ = 1/1000 mm); one in a humid tropical climate in central Queensland and one in a humid tropical climate in Papua New Guinea.

From the first experiment (3.5 - 5.5 μm) it was concluded that in areas of good exposure thermal infrared could be used for differentiating between rock types, provided their thermal properties differed sufficiently. In the second survey an attempt was made to detect concealed shallow coal seams in a well grassed open woodland terrain; the method was shown to be unsuitable as a prospecting tool in the environment studied. (Wavelength 8-14 μm; approx. cost $A11/ line-km). In Papua New Guinea thermal infrared was used to map the location of hot springs and warm ground associated with dormant volcanics at Rabaul; this was satisfactorily done, and a comparison of two wavelength bands 3.5 - 5.5 and 8-14 μm showed that the longer wavelength was superior for this purpose. (Approximate cost, $A13/ line-km). In general for land areas better results are to be expected in arid than in humid terrains because of the masking effect of vegetation in the latter environment. The method is potentially useful for detecting zones of shallow groundwater by virtue of its cooling effect on the ground surface. Ground information and up to date aerial photographs are necessary to interpret the imagery. The method is good for differentiating between waters of different temperatures, e.g. cool groundwater flowing into the warmer sea, or warm water from an industrial plant flowing into a river, and for mapping the extent of hot ground in present-day volcanic terrains. The method can be used for discriminating rock types, but it is desirable to do ground work to ascertain whether the rocks to be separated have different thermal behaviour, before embarking on an airborne survey.

Radar

Side-looking radar (SLAR) imagery obtained by the Department of Army from Westinghouse-Raytheon was used for base map compilation and geological interpretation in western Papua New Guinea, where there are gaps in vertical aerial photographic coverage because of persistent cloud cover. The radar imagery was found to be good for the mapping of major lineaments and faults, and satisfactory for distinguishing some rock types, particularly ultrabasic rocks by their smooth vegetation cover texture, and limestones because of karst weathering features. In general, however, interpretation of rock types was more difficult than on aerial photography.

SLAR imagery of well exposed Precambrian and Palaeozoic mineralized terrain in the Mount Isa area, Queensland, was acquired from Aero Service Corporation-Goodyear Aerospace in support of the Australian

ERTS program. The area imaged is one of the test sites for which there is also coverage by ERTS satellite imagery (approximate cost for small area, 3000 km^2, \$A6 km^2). Stereoscopic imagery was specified and this was found to be easier to interpret than monoscopic radar. For the appreciation of regional topographic expression, and thus to a large extent of regional geological structure, 1:100 000 scale mosaics made from the radar are superior to photo-mosiacs at the same scale prepared from 1:85 000 scale aerial photographs. Lithological units that differ in respect of topographic expression, fracture pattern, or drainage pattern could be readily mapped, but discrimination of other rock types was difficult. SLAR is considered to be better suited (i) for regional rather than for detailed mapping (for the latter, aerial photographs are more suitable); (ii) for areas of persistent cloud cover where aerial photography is difficult to obtain, rather than regions where aerial photography is readily available.

ERTS

Evaluation for geological purposes of ERTS imagery of many areas is in progress. In general, known broad geological features can be recognized, and many new long linear features have been observed. It is expected to provide useful additional data for regional studies, but the question to be decided is whether the benefits to be gained are sufficient to warrant the spending of money to acquire similar data when earth resources satellites become operational.

Photography from Skylark Rocket Project SL 10811

Successful photography of a large area of central South Australia was achieved from a Skylark rocket at a maximum altitude of 297 km using multispectral and colour infrared cameras. Lineaments not previously mapped have been found in a study of the photographs. The project was a joint one conducted by the University of Reading, the CSIRO Division of Mineral Physics, and the South Australian Department of Mines.

Multispectral photography of Australian ERTS test sites

Multispectral aerial photography at 1:90 000 scale has been taken of eleven ERTS test sites in Australia by the R.A.A.F. for the CSIRO Division of Mineral Physics but the study of the photographs has not yet begun. The project is intended to be complementary to the ERTS program.

AUSTRALIA

MARINE GEOLOGICAL SURVEYS IN AUSTRALIA 1970-73

by

H.A. Jones

Bureau of Mineral Resources,
Geology & Geophysics

October 1973

MARINE GEOLOGICAL SURVEYS IN AUSTRALIA 1970-73

by

H.A. JONES

1. RECONNAISSANCE MAPPING

The first regional geological survey of part of the Australian continental shelf took place in 1960-61, when a co-operative study between the Bureau of Mineral Resources (BMR) and the Scripps Institution of Oceanography was undertaken in the Timor Sea. However, it was not until 1967 that a program of systematic reconnaissance mapping of the continental shelf was instigated. Since 1967 large parts of the Northwest Shelf, the Arafura Sea, and the eastern and southeastern shelves have been surveyed (see figure).

Objectives

The broad objectives of this work are to describe and map the various types of sediment and rock forming the sea bed, with particular attention to materials of possible economic significance; to determine the thickness, structure, and stratigraphy of the superficial sediments and hence improve our knowledge of the geological history of the continental margin; and to carry out morphological and provenance studies relating to eustatic changes, sediment transport, and related problems.

Staff and Equipment

The establishment of the marine geology group consists of 5 geologists and 5 supporting technicians. Marine geology cruises last for about three months, and one is usually undertaken each year. The BMR does not operate its own vessel but charters a suitable ship for each survey. Vessels of about 40 m length of the oil rig supply ship, or ocean-going tug type are used. The cost of chartering a ship, crewing, provisions and fuel is of the order of $A1000 per day. All scientific operations on board ship are carried out by BMR personnel, but some analytical work on samples collected is done on shore by contract.

Most sea-bed sampling is done with simple dredges of various designs, and short cores are collected with piston and gravity corers when possible. Continuous seismic reflection profiling provides structural information. A relatively low-energy spark sound source (500 - 3000 joules) is used, with a towed streamer receiving hydrophone array. Standard amplifying and filtering techniques are used and facsimile records are produced on E.P.C. or Ocean Sonics recorders. Photographs of the sea bed are taken with an E.G. & G. camera and light source system to record sediment characteristics and micro-relief.

Techniques

Sea-bed sampling is carried out on a grid pattern, with the distance between stations ranging from 4 to 20 km. The area covered extends from about the 20-m isobath out to beyond the edge of the continental shelf to about 500 m water depth; a limited amount of work has also been done on reefs and sea mounts beyond the continental margin. Seismic profiling, which is usually done at night, is normally carried out along alternate sampling lines at intervals of 30 to 40 km. Continuous bathymetric profiles are also obtained.

Treatment and analysis of the sediments recovered follow usual laboratory practices. Grainsize analyses are carried out with as much use as practicable of automatically recording devices and of computers for the derivation of statistical parameters. Phosphate and carbonate determinations are done on all samples and organic carbon and trace metals on some. Mineralogical work is done by optical and XRF methods and use is made of electron probe and scanning electron microscope facilities in the BMR.

Ancillary projects in the fields of physical oceanography, marine biology, and meteorology are carried out when possible during the cruises in co-operation with CSIRO, Universities, and other institutions. There is an acute shortage of platforms for marine research in Australian waters and every effort is made to make full use of the available facilities on the vessels chartered by the BMR.

Results

The results of the continental shelf reconnaissance surveys are being published in the BMR Bulletin series accompanied by 1:1 million lithofacies maps of the shelf sediments. The presentation of these maps in a meaningful form poses special problems arising from the irregular spacing and sparsity of data and the complexity of sediment characteristics.

2. DETAILED INVESTIGATIONS

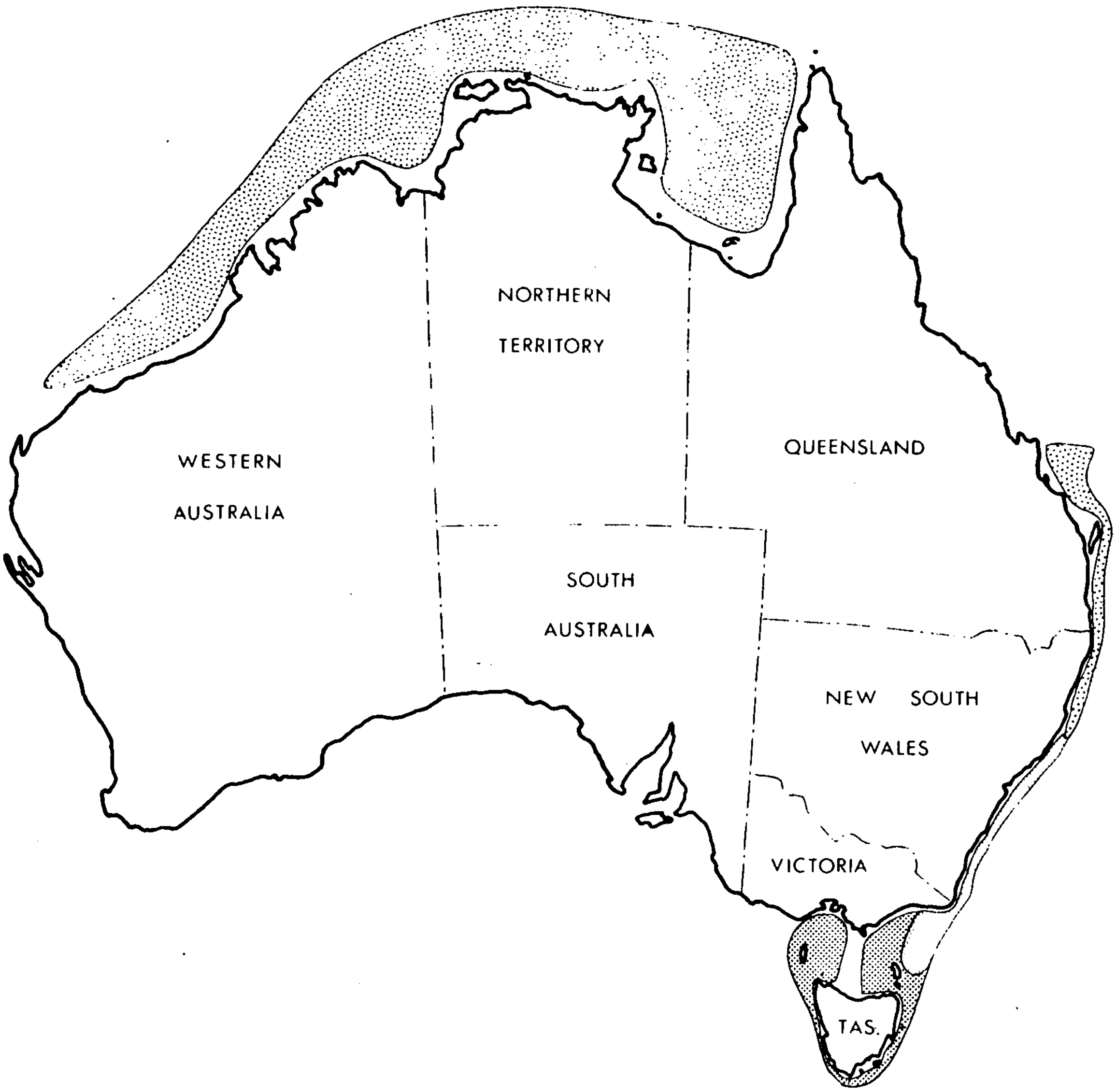
Pending the establishment of the Australian Institute of Marine Sciences at Townsville marine geology activity in Australia, exclusive of BMR, is limited to a number of rather small and poorly financed groups in State surveys and the universities. CSIRO has a large and active Division of Fisheries and Oceanography, but their involvement in geology is at present limited to marine sediment geochemistry in connexion with pollution problems, and is on a small scale.

The Queensland and New South Wales State Geological Surveys have small groups working on coastal geology. Queensland operates a small boat and is undertaking geological mapping of Moreton Bay, but

New South Wales confines itself to coastal engineering geology and economic projects such as heavy mineral sand investigations in coastal lakes.

Several universities have active marine geology groups, but only Sydney and Western Australia operate boats capable of working in open waters. Sydney University has recently launched a boat, 21 m in length, which is probably the largest and best equipped research vessel in Australia at present. Although a shallow-draft vessel primarily designed for river and estuary work for the Departments of Physics and Biology, marine geology projects on the N.S.W. shelf, Norfolk Island, and the Gulf of Carpentaria are planned.

There is currently no mining company activity offshore, but in the late 1960's extensive drilling was carried out off the northern coast of N.S.W. in the search for heavy mineral sand deposits. Large low grade resources of rutile- and zircon-bearing sands were outlined, but the results were not sufficiently encouraging to stimulate further exploration. Additional investigation of these deposits is planned by the BMR in 1974.



MARINE GEOLOGICAL SURVEYS

AUS 2/306