RECORD 1981/11

ABSTRACTS

10th BMR SYMPOSIUM CANBERRA, 5–6 MAY 1981

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Contents

Commodity targets - some relevant factors for Australian Exploration

D.J. Perkin

The quadrupling of oil prices late in 1973 and subsequent increases have resulted in a worldwide decrease in demand for goods, and are reflected in an overall decline in the rate of growth of western economies as measured by their GDP. The rate of growth in metal demand and supply has decreased in response to the new economic growth rate, and a slower longer-term trend in rate of growth of demand for most metals is indicated.

However, metal prices as measured in constant dollars have not declined in this period, and several have increased significantly in real terms. There is no evidence from production growth rates and price trends to show that the 'traditional' base metals represent poorer exploration targets than they have in the past. Price data indicate that relatively higher revenues may be likely, or relatively lower grades than hitherto, of gold, molybdenum, tin, tungsten, and nickel may now be feasibly mined.

On the cost side of the mineral equation, consideration of economies of scale emphasize how successively lower grades may be worked using higher annual throughput, and it is suggested that the combination of relatively higher prices with high production rates from open-pit mining may increase the economic potential of a zone, such as the Tasman Fold Belt, with respect to tin, tungsten and molybdenum mineralisation.

Consideration of the distribution of Australian metal mines and prospects in both time and space and by ore type indicates that most of the world's major classes of metal deposits are represented on this continent. However, comparison of Australian annual mineral output with that from other major mineral producing continents suggests that peak production potential has not yet been attained.

Recent research in the South Australian copper province

T.H. Donnelly, J. Knutson, & I.B. Lambert

Stuart Shelf: There are two major forms of Cu-mineralisation in the Mt Gunson area, 1) discordant sandstone-hosted mineralisation in the early Adelaidean Pandurra Formation, and 2) dominantly concordant mineralisation in the dolomitic mudstones of the interglacial Tapley Hill Formation. The most important is that in the Pandurra Formation which includes the Cattle Grid deposit. Here chalcocite, bornite, chalcopyrite, with some pyrite, carrollite, sphalerite and galena, infill fractures and vugs in the strongly-brecciated palaeo-weathering surface of the Pandurra Formation. An iron-rich halo in rocks overlying and adjacent to the Cattle Grid deposit, as well as petrographic evidence, indicate the replacement of earlier pyrite by Cu-Fe sulphide minerals. Sulphur-isotope values indicate sulphur was most likely formed biogenetically under conditions of unlimited sulphate supply; this was probably generated within early Adelaidean strata and introduced to its present site.

Mostly low-grade and uneconomic Cu-mineralisation occurs in the overlying Tapley Hill Formation. Pyrite framboids can be partly or totally replaced by chalcocite, bornite and chalcopyrite and there has been local remobilisation of sulphide minerals into dewatering channels, desiccation cracks and microfaults. There is vertical zonation from Cu to Pb and Zn inward from both upper and lower surfaces of the Tapley Hill Formation, with a relatively barren pyrite zone in the central portion of the thicker sections. Lateral zonation is indicated by a marked decrease in Cu relative to Pb and Zn outward from Mt Gunson. As in the Pandurra Formation there is an absence of hydrothermal alteration and, in addition to Cu, the mineralised rocks are enriched in Pb, Zn, Co, As and Th. A wide range of positive sulphur-isotope values indicates that sulphur has been derived by bacterial sulphate reduction with a limited supply of sulphate.

Cu-mineralisation in the Tapley Hill Foramtion at Myall Creek in the southern part of the Stuart Shelf is similar to that in the Mt Gunson area with coarse sulphide blebs being most common in the silty and sandy beds.

Adelaide Geosyncline: At Kapunda the Tapley Hill Formation is considerably thicker than on the Stuart Shelf, and has been recrystallised to low to middle greenschist facies metamorphics. Sulphide minerals occur along laminae and in segregations with quartz and carbonate. There are also numerous discordant coarse-grained carbonate-quartz-sulphide veins, and chemical and stable isotope data indicate that sulphides in these veins have been derived by the remobilisation of the associated bedded sulphides. The overall order of abundance is pyrrhotite, pyrite and chalcopyrite. Sulphur-isotope results indicate sulphur was produced by bacterial sulphate reduction and the values are similar to those in the Tapley Hill Formation on the Stuart Shelf.

Cu-mineralisation at Copper Claim occurs in mildly metamorphosed carbonaceous dolomitic-sandstones and siltstones of the Callanna Beds. Chalcopyrite and iron sulphides occur as fine disseminations and in coarser veinlets. Sulphur, carbon and oxygen isotope results indicate that mineralisation processes were similar to those suggested for Kapunda.

Mount Painter Block: This inlier at the NE margin of the Adelaide Geosyncline comprises Early to Middle Proterozoic metasediments, metavolcanics and granites intruded by Early Palaeozoic granites and pegmatites. Isotopic compositions of pyrite and calcite from the granitic, hematitic and chloritic breccias within this Block, interpreted in light of geological relationships and petrographic features, imply that rapid release of fluids from ascending early Palaeozoic magmas played a major role in breccia formation. Chlorite, quartz, K-feldspar, calcite, hematite, fluorite and uraninite were precipitated as these hydrothermal fluids cooled.

Spencer Gulf - a new model for interpreting peritidal carbonate and evaporite associations

R.V. Burne

Sedimentological studies in Spencer Gulf have established a model of peritidal carbonate and evaporite sedimentation which has features intermediate between the models of arid-zone coastal sedimentation derived from studies in the Persian Gulf and models of humid-zone carbonates evolved from studies in the Bahamas and Florida. In addition, the moderate tidal range of Spencer Gulf gives rise to exposed intertidal facies previously described only from terrigenous intertidal environments.

Spencer Gulf sediments display a marked contrast between the sandy exposed intertidal facies and the muddy protected intertidal facies, but both show a distinction between bioturbated and homogenised low intertidal facies and laminated facies of the high intertidal zones.

The unique feature of the Spencer Gulf model is the presence of the sedimentological products of discharging saline continental groundwaters at the top of the intertidal-supratidal sequence. These deposits, which include units of discoidal gypsum, aragonite cemented carbonates, and ironstones, are diagnostic of a coastal sequence in the semi-arid zone. The new model has significance not only for the better understanding of ancient peritidal carbonate rocks, but also for the refinement of models of low temperature sulphide ore genesis.

Aspects of the geochemistry and economic potential of the felsic igneous rocks of the Mt Isa region

Lesley A.I. Wyborn

The Precambrian of the Mt Isa region is made of felsic igneous rocks, mafic igneous rocks, and sedimentary rocks of clastic, volcaniclastic, and carbonate origins. All have been regionally metamorphosed to grades from lower greenschist to upper amphibolite. Chemically the igneous rocks form a classic bimodal suite typical of continental rift zones such as the basin and range province of the western United States.

The oldest known granites are the I-type Kalkadoon and Big Toby Granites which occur in the central basement ridge and the far western part of the Mt Isa region respectively. These are characterised by high Sr and low Zr, Nb, and Th contents. They are followed by the A-type Bowlers Hole Granite and the Garden Creek Porphyry, which are distinguished by exceptionally high Zr and Nb contents. Younger granites crop out in the west, between the Big Toby and Kalkadoon Granites and also to the east of the Kalkadoon Granite. The young western granites can be subdivided into two groups: first the I-type Sybella Granite distinguished by relatively lower Sr and higher K_2O, Zr, Nb, and Th contents than the older I-types; and, secondly, the A-type Weberra Granite characterised by exceptionally high K_2O. The young eastern group can be chemically subdivided in a similar fashion, although limited data on age relationships and chemistry plus extensive metamorphism make the subdivision more difficult. The Naraku Granite is I-type, and the Wimberu Granite is A-type, whilst the Williams and Wonga granites include both I- and A-types.

Most granites in the region have associated comagmatic volcanics. Chemically the Leichhardt Metamorphics are equivalent to the Kalkadoon Granite whereas the Argylla Formation and volcanics within the Mitakoodi and Ballara Quartzite are similar to the Bowlers Hole Granite. Felsic metavolcanics of the Bottletree Formation correspond chemically to the Garden Creek Porphyry. There appear to be no volcanics comagmatic with the Sybella Granite, but the Carters Bore Rhyolite, the Fiery Creek Volcanics, the Alhambra Member and the tuff marker beds within the Mt Isa Group chemically resemble the Weberra Granite. In the east, felsic volcanics within the Corella Formation near Duchess are close chemically to the Wonga Granite, whilst those in the Doherty Formation near Mt Angelay may be equivalent to the Williams Granite.

Economically, the felsic igneous rocks are perhaps more prospective than previously thought. The A-type magmas and the highest temperature I-type magmas seem the most capable of concentrating elements such as Cu, Pb, Zn, and U whilst suitable geological environments for depositing these elements occur where the volcanics are extruded in a submarine environment and where granite intrudes calc-silicate rocks (mainly in the Corella Formation).

Timing of igneous activity and metasomatism, and its bearing on uranium mineralisation in the Mary Kathleen Syncline

R.W. Page

This paper presents the results and economic implications of an isotopic dating study of country rocks and intrusive igneous bodies in the vicinity of Mary Kathleen.

The host Corella Formation in this region consists of thin-bedded calcareous, siliceous, and argillaceous sediments, and lenticular polymict conglomerates. These rocks are intruded by granitic and gabbroic bodies, structurally deformed, and in places extensively altered to high-temperature (500°- 600°C) calc-silicate assemblages. A number of uranium anomalies, including the Mary Kathleen orebody, are contained within this alteration envelope, in units of garnet-rich skarn.

As these metasediments are intruded by the Burstall Granite and associated rhyolitic dykes, most workers have regarded the alteration/ mineralisation event as a contact-aureole phenomenon, and considered that U-rich volatiles derived from these intrusions were the major source of uranium in the Mary Kathleen Syncline.

New U-Pb zircon ages for the relevant intrusive suites (Burstall Granite, Burstall rhyolitic dykes, and Lunch Creek Gabbro), reveal that these bodies are part of a major igneous event in the mid-Proterozoic, having ages of emplacement within the rather narrow time range of 1730 to 1740 Ma. This also provides a minimum age for the host Corella Formation in the Mary Kathleen Syncline, and when combined with other geochronological constraints (Page, 1978), limits the depositional age of the Formation to between 1740 and 1780 Ma.

The age of metasomatic alteration of these calc-silicate metasediments has been studied by means of Rb-Sr isotopic analysis of 1 cm-thick slabs. The various calc-silicates and altered conglomerates have amphibolite-facies mineralogy, and hence this geochronological approach is designed on the grounds that isotopic mixing would have taken place between adjacent slabs during the allochemical metamorphism.

The results indicate that this metasomatic alteration is a relatively juvenile event, taking place no earlier than 1200 Ma ago, in the Late Proterozoic. The alteration envelope and allied uranium mineralisation are therefore several hundred million years younger than the Burstall Granite igneous events to which they have been attributed until now. It can therefore be positively concluded that the alteration and mineralisation are not genetically related to the Burstall Granite or its rhyolitic apophyses.

Considering the high temperature mineralogy of this alteration envelope in the Mary Kathleen Syncline, it is probable that the associated mineralisation is epigenetic, and so we have to postulate either:-

(i) there exists at depth an as yet undiscovered 1200 Ma intrusive,
(ii) the 1120 Ma Lakeview Dolerite intrusion (or equivalent) was a suitable heat-source to have remobilised alkalis, uranium-rich fluids, etc, or
(iii) metasomatism and mineralisation, via hot-spring activity along faults, accompanied Late Proterozoic crustal tectonics expressed as the Mary Kathleen Shear or other major faults in the region.

These geochronological data yield information of far-reaching importance to studies of igneous activity, and provide severe constraints as to the time of high-temperature alteration/mineralisation in the Mary Kathleen Syncline. This is of considerable economic relevance, and would have to be considered in models to which future uranium-prospecting strategy is geared.

Early Proterozoic evaporites and uranium mineralisation in the Pine Creek Geosyncline

I.H. Crick

Carbonate specimens of the Early Proterozoic Coomalie Dolomite obtained from Whites and Intermediate Open-cuts in the Rum Jungle Uranium Field consist mainly of fine-grained dolomite with cross-cutting magnesite veins. Ghost pseudomorphs of evaporite minerals show up clearly under cathode luminescence within the dolomite. Carbonates in drill core provided by Geopeko, from the same formation near Woodcutters, contain early diagenetic gypsum pseudomorphs, now magnesite, within a fine-grained carbonaceous matrix which was formerly an algal mud. The matrix consists mainly of high-magnesium chlorites with minor iron sulphide and calcium phosphate. The phosphate within the Coomalie Dolomite was probably concentrated during formation of a Late Proterozoic regolith to produce the sub-economic phosphate deposits fround at Castlemaine Hill.

The results of this study support the previous interpretation made by Crick and Muir (1980) of a sabkha-type environment of deposition for the Early Proterozoic basal carbonates of the Pine Creek Geosyncline - an environment favourable for concentrating metal-bearing continental groundwaters and the postulated first step in the development of the major uranium deposits of this region. Alkaline brines, suitable for the leaching and transporting of uranium, would have been produced from evaporites during diagenesis and at later stages. In addition, solution of the evaporites producing collapse breccias within the evaporite beds and overlying sediments would have aided in the movement of these brines and in the precipitation of uranium where such breccias were developed in suitable rock types, such as carbonaceous metapelites.

Reference

Crick, I.H., & Muir, M.D. (1980) - Evaporites and uranium mineralisation in the Pine Creek Geosyncline. In URANIUM IN THE PINE CREEK GEOSYNCLINE. Proceedings of the International Symposium on the Pine Creek Geosyncline, Sydney 4-8 June 1979, IAEA, Vienna.

Progress in Irian Jaya

D.B. Dow

Delivery of text delayed; being supplied separately.

Toolebuc Formation oil shale study - progress report

S. Ozimic

Fifteen shallow stratigraphic holes were drilled during 1980 in the southeast of the Eromanga Basin, as part of the BMR/CSIRO Oil Shale Methodology project. The holes were drilled to obtain stratigraphic, petrophysical, geophysical, and geochemical information about the Toolebuc Formation and its oil shale.

BMR Urisino No. 1 hole, located 130 km east of Tibooburra, NSW, intersected a unit thought, from palynological dating and litho-stratigraphic comparisons, to be equivalent to the Toolebuc Formation, but which did not contain oil shale. Of the fourteen holes drilled in Queensland, 10 intersected the complete Toolebuc Formation and contained oil shale, two did not reach the Toolebuc Formation because of structural complications, and the presence of the Formation in two is as yet uncertain because of facies changes.

In Queensland the Toolebuc Formation seems to be associated with a very strong gamma-ray anomaly. This has been attributed to uranium-bearing phosphate minerals. An anomaly was recorded in BMR Urisino No. 1 hole, but it derived from the Coreena Member equivalent underlying the Toolebuc Formation equivalent; this anomaly is attributed to both an increase in potassium associated with an argillaceous horizon, and to uranium associated with carbonaceous matter.

In seven of the Queensland holes a kerosene-like fluid flowed to the surface from the Toolebuc Formation along with the drilling medium. Geochemical analysis showed the fluid to be a mature hydrocarbon of probable terrigenous origin, which could not have been derived from the normal Toolebuc Formation marine-type kerogen, but has most likely migrated up-dip from a more mature oil-generating zone in the Eromanga Basin.

Tentative deductions from the study to date are that:

- oil shale is probably absent from the Toolebuc Formation roughly south of a line joining Bedourie and Charleville, Queensland;
- the gamma-ray anomaly possibly rises continuously in the succession from the southern to the northern margins of the Eromanga Basin, from the upper part of the Coreena Member or its equivalent to the upper beds of the Toolebuc Formation. Thus it is possible that distribution of oil shale and uranium in the Toolebuc Formation was controlled by similar redox conditions;
- the re-assessed inferred resources of shale oil from the Toolebuc Formation are $230 \times 10^9 m^3$.

Minimum Economic Reservoir Size Project

D.J. Forman

The most difficult problem encountered in assessments of Australia's undiscovered petroleum resources has been to decide what is the smallest size oil or gas field that could be developed in a particular area. This is referred to as the economic cut-off for the area. Given this information we can estimate how much of our undiscovered oil and gas is likely to be economic and then, together with other information, we may estimate the probabilities of finding enough new oil to carry us through the next twenty years - valuable information for energy policy planning and for any company searching for oil and gas in Australia.

Early in 1979, the National Energy Research Development and Demonstration Program approved a grant for the Bureau of Mineral Resources to engage consultants to carry out the 'Minimum Economic Reservoir Size' project. Macdonald Wagner and Priddle Ltd/Purvin and Gertz Inc in association were selected to carry out the project which began in July 1979 and was completed in September 1980. It provided BMR and the public with a suite of new computer programs, a summary of cost data, and estimates of the minimum economic reservoir size at seven locations onshore and offshore Australia. The information is contained in two BMR Records, 1980/31 and 1980/58.

The prospects that have been analysed (Fig. 1) comprise examples from a range of petroleum exploration frontiers in Australia. Onshore prospects which were studied lie within the Eromanga and Amadeus Basins in the interior, and the Canning Basin in the northwest. Offshore prospects lie in a range of water depth: the Carnarvon Basin prospect is in conventional water depths; the Bonaparte Gulf Basin prospect is in moderate water depths; the Browse and Exmouth Plateau prospects are in deep water beyond existing production experience.

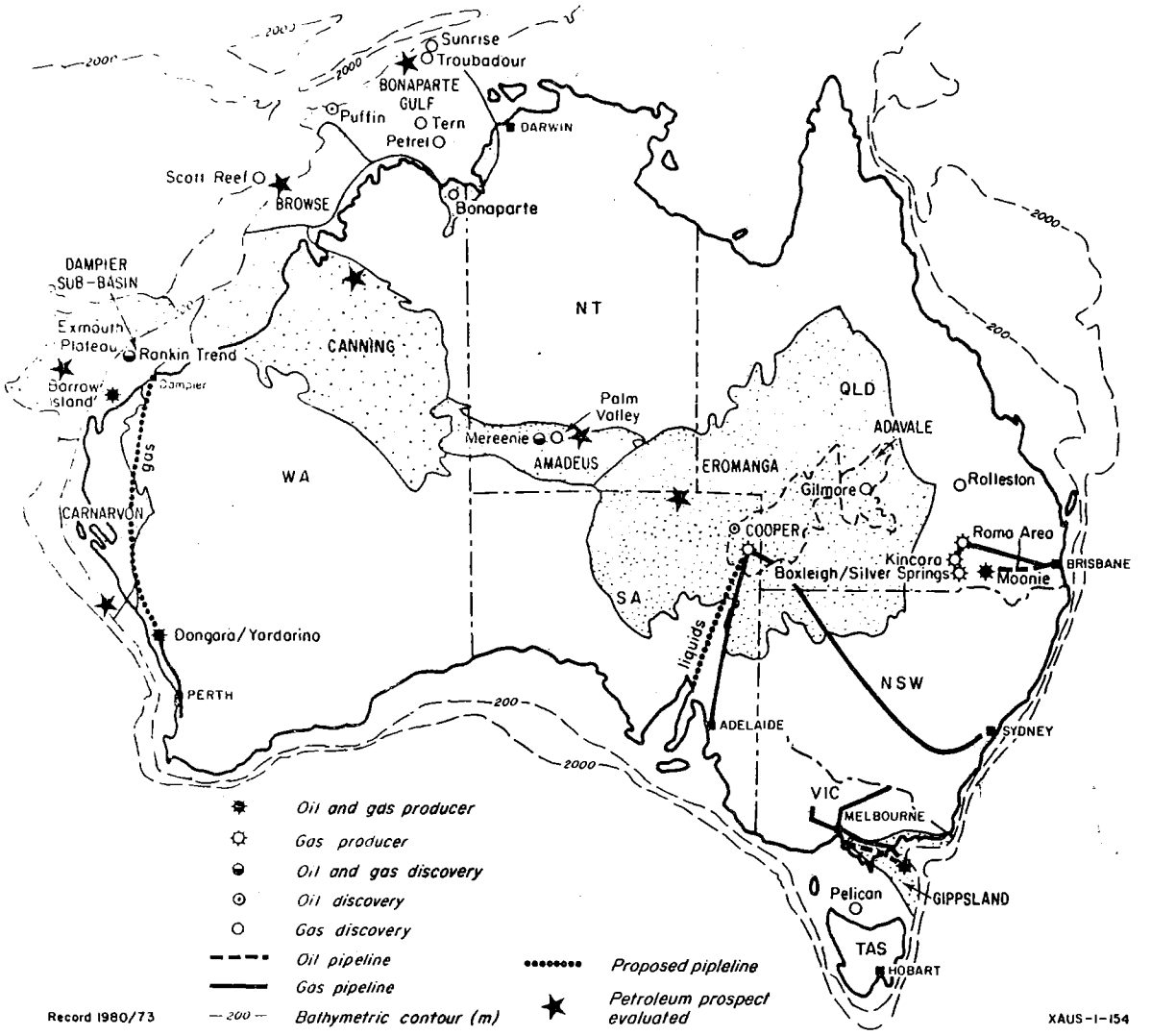
Assuming that oil would be priced at $25 a barrel at the nearest metropolitan centre and that natural gas would be priced at $3.00 per gigajoule, the consultants suggest the following values (Table 1) for the minimum economic reservoir size at the locations shown in Fig. 1.

Table 1

Minimum economic reservoir size

	Oil		Gas	
	Gl	10^6 barrels	$m^3 \times 10^9$	10^{12} cubic feet
Eromanga Basin	2.1	13	4.3	0.15
Amadeus Basin	7.7	48	4.8	0.17
Canning Basin	2.6	16	19.3	0.68
Bonaparte Gulf Basin	36.7	231	-	-
Carnarvon Basin	10.7	67	38.2	1.35
Exmouth Plateau	160	1009	-	-
Browse Basin	73	459	-	-

However, it is apparent that there is no unique answer to the problem and that a variety of answers may be obtained according to which facet is emphasised. The computer program is flexible and allows assumptions to be varied by modifying entered data. Hence the interaction of variables and the relative sensitivity of the minimum reservoir size to these variables may be assessed.



Petroleum prospects evaluated, and location of petroleum resources

Early life in the Precambrian

M.R. Walter

The oldest firmly established evidence of life on Earth is 3.5 Ga old. In cherts of the Warrawoona Group, Pilbara Block, Western Australia, there are filamentous microfossils, and stratiform and bulbous stromatolites. In addition, in these same cherts and in others of about the same age in South Africa in the Swaziland Supergroup, there is kerogen, the degraded remnants of cells. The kerogen has a carbon isotopic composition indicative of autotrophy, the biological process by which some organisms manufacture their cell material from CO_2. The stromatolites occur in facies indicative of shallow water environments: in one example with hypersalinity and intermittent exposure to the atmosphere, indicating that the stromatolite-building organisms were able to cope with high environmental stresses (high and fluctuating light intensity and salinity, and perhaps also desiccation). It is not yet possible to determine the biological affinities of the bacteria making up this microbiota, but it is apparent that already by 3.5 Ga ago a diverse and relatively complex bacterial microbiota existed on Earth. There must have been a substantial period of evolution before that time, but no unequivocal older record is known. Moreover, no record older than 3.9 Ga may ever be found, because of the effects of intense meteoritic bombardment that continued until that time. It seems likely that we are approaching the beginning of the discoverable record.

The known Archaean fossil record is still scanty, but new discoveries are being made more and more frequently. There are now eleven known stromatolite occurrences (counted by major stratigraphic units). Most of these are late Archaean, but there is one occurrence about 3.0 Ga old, in the Insuzi Group of South Africa. By the end of the Archaean, stromatolites were diverse, and they developed in palaeo-environments ranging from lacustrine to shallow marine. Evidence from the stromatolites, from kerogen chemistry, and from some poorly preserved microfossils suggests that by this time cyanobacteria ("blue-green algae") had evolved. Whether or not these were oxygen-releasing cyanobacteria is a moot point, but indirect chemical and sedimentological evidence suggests that they were.

LANDSAT for BMR: present and future applications

R.F. Moore

LANDSAT imagery, acquired by the NASA LANDSAT satellites, which is distributed by the USGS Eros Data Centre and, since November 1980, by the Australian LANDSAT Station, has played an important and increasing role in BMR investigation. LANDSAT photographic products have been routinely used in reconnaissance geological mapping and, in particular, in investigations of geological structure.

More recently, however, LANDSAT data in a computer-compatible form have been used, and will continue to be used, to assist in the solution of geological problems specifically. At BMR, the geoscientist can interact with the processing system and enhance a displayed colour-video image to highlight those features he wants to see. The system has been designed so that the user is not limited to LANDSAT data alone. Recent developments have allowed the merging of other data sets, including aeromagnetic, radiometric, gravity and topographic data, and these integrated images have yielded some interesting and valuable results. Computer processed LANDSAT data have been used operationally by BMR in both the McArthur Basin and Pine Creek projects.

Subduction, porphyry coppers, and igneous petrology: new concepts from New Britain and other island arcs

R.W. Johnson

A popular concept is that the compositions of island-arc mafic magmas are partly determined by seawater or water-rich partial melts fluxed out from the hydrated parts of downgoing oceanic lithosphere into overlying upper-mantle source regions. However, the supporting evidence from trace-element and Sr- and Nd-isotope geochemistry is not compelling, and this raises the long-standing question of the source of metals in the 'porphyry copper' deposits of island arcs.

Sr, Ba, Pb, and to some extent Eu, are partitioned from the light rare-earth elements in many island-arc rocks. This may have been caused in New Britain magmas by (1) repeated partial melting of the island-arc crust, (2) sequential build-up of a felsic-intermediate upper crust, and (3) progressive development of a plagioclase-rich, refractory, lower crust which has contaminated later mafic magmas rising through it. This process may also involve partial melts of crust containing buried, low-grade, volcanogenic ore deposits. These metal-rich melts may be emplaced into the upper parts of maturing arc crust where younger ore deposits already exist and, after solidification and burial, may be partially melted again. Cu, Au, and Mo would become progressively enriched in the upper crust of mature island arcs, and in some circumstances would be concentrated in particularly rich porphyry-copper deposits.

The Wollogorang Formation - a potential host for McArthur River-type base metal deposits?

M.J. Jackson

The sedimentary Wollogorang and Barney Creek Formations form part of the McArthur Basin sequence in the northeastern part of the Northern Territory. Results from field, geochemical and petrological studies of the Wollogorang Formation have been compared with published information on the Barney Creek Formation.

Features in common include:

- deposition within a predominantly epicratonic shallow-water evaporitic sequence;
- they consist mainly of dolomitic siltstone;
- bedding is commonly distinctly laminated and graded;
- the rocks are dark grey to black and rich in organic material;
- they contain interbedded tuffs or tuffaceous sediments;
- there are interbedded breccias;
- they contain distinctive dolomite nodules;
- mineralisation is fine-grained and concordant with bedding;

Dissimilarities include:

- the Wollogorang Formation is about 3 000 m stratigraphically below the Barney Creek Formation;
- the Wollogorang Formation is more widespread and was deposited prior to the development of the Batten Trough;
- the Wollogorang Formation contains more evidence of evaporitic conditions during deposition;
- the Barney Creek Formation is known to contain a major base metal deposit;

The sedimentary features, mineralogy and geochemistry of the two formations suggest they may be closely comparable and therefore indicate that the Wollogorang Formation should be considered a favourable target for syngenetic base metal mineralisation of the McArthur River type, especially if a suitable structural environment, analogous to the Bulburra Depression, can be found.

Some lesser-known aspects of BMR geophysical research

J.C. Dooley

The Bureau of Mineral Resources, Geology & Geophysics, undertakes many activities in the earth science field which are not directly involved in assisting mineral exploration or assessment, although some provide knowledge which is useful for or as a background to exploration. This talk describes predominantly geophysical activities of both these types. The rationale for this wide range of responsibilities devolving on BMR is that there is much common ground with exploration-related activities, both in the basic physical properties being studied, and the principles underlying the techniques of measurement and equipment used, although the scale of operations may be considerably larger, both in space and time.

Crustal studies

One of the main thrusts of such research is directed towards an understanding of the geological and physical framework of the continent, and its past and present tectonics.

The most definitive tool, and also the most expensive, for crustal investigations is deep seismic sounding. Areas selected for its use in recent years include the Pilbara and the Lachlan Fold Belt, not only because of their intrinsic structural interest and mineral potential, but also because of the availability of large quarry blasts as energy sources. Work has also been done in the McArthur, Georgina, and Eromanga Basins, as part of more general projects in these areas; magneto-telluric investigations have also been carried out to provide complementary information on the electrical properties of the main formations.

Because tectonic processes are accompanied by stressing and movement of the crust, measurements and recent crustal movements are being investigated in co-operation with the Division of National Mapping and some State Survey Departments.

Generation and transfer of heat are involved in tectonic processes, both as a cause and as an effect. A systematic program is under way to measure heat flow over the whole of Australia. This will also enable an assessment to be made of potential geothermal energy sources, and has provided evidence of past climatic changes.

Gravity and magnetic studies

Gravity reconnaissance surveys now cover the whole continent and much of the offshore area, resulting in the 1:5M coloured map published in 1976. A very broad reconnaissance of the magnetic field has almost been completed; this is complemented in some areas by the greater detail available from aeromagnetic surveys, but the latter is still missing in many places. BMR is participating in NASA's MAGSAT project, which will provide the long wavelength background for the magnetic field. Palaeomagnetic research helps to understand past movements of the continent and relative movements between its component blocks, and thus helps to unravel the history of its formation.

Standards for gravity and magnetic measurements, including field reference stations, are maintained by BMR.

Observatory recordings

Geophysical observatories record continuously earthquake activity and variations in the magnetic field. BMR operates observatories at Canberra, Mundaring (WA), Macquarie Island, Mawson (Antarctica), Manton Dam and Alice Springs (NT), and many outstations. Data from these stations are co-ordinated with data from other organisations for use in Australian and international research. The aims of this work include the assessment of earthquake risk, detection of nuclear explosions, navigation (magnetic charts), radio propagation, and precise geodetic surveying, as well as applications in geophysical exploration surveying and interpretation.

Regional geology, geophysics and petroleum potential of the Central Eromanga Basin area

F.J. Moss, J. Pinchin & B.R. Senior

The Central Eromanga Basin Project commenced in 1980 with the objective of defining the regional structural and depositional history of the central part of the Eromanga Basin and the underlying Adavale, Cooper and Galilee Basins in southwest Queensland. Seismic and other geophysical surveys, and LANDSAT imagery, geochemical, and source rock maturation studies are being made to provide regional information on the basins and their petroleum potential.

Seismic data from west of the Canaway Ridge were reviewed in 1980, and a series of east-west regional seismic reflection C.D.P. traverses were recorded to fill gaps in the existing coverage. Fair quality seismic data from previous surveys in areas of particular interest were reprocessed. Gravity measurements were made along the 1980 BMR traverses and some private company lines. Deep seismic refraction recordings were made along a 300 km traverse over the main structural elements of the area extending from the axis of the Cooper Basin, over the Warrabin Trough, to a point east of the Canaway Ridge. The central part of this traverse was coincident with a 150 km reflection traverse recorded to 20 s. Magneto-telluric soundings were made at 12 sites along the 300 km traverse. Sequences of drill cuttings from three wells were analysed using the Rock-Eval pyrolysis method to provide source rock and maturation data. This information was integrated with other maturation data derived from conventional drill cores. New LANDSAT imagery was studied to further define fault patterns, and flowing artesian waterwells were sampled for geochemical and isotope analysis and possible hydrocarbon content.

The new good quality seismic data together with the previous data have yielded definitive structural and stratigraphic information over the Devonian Warrabin Trough. Deposition in the trough was probably continuous with that of the Adavale Basin in the east from which it was separated later by the uplifted Canaway Ridge. Along the axis of the trough the Middle Devonian sequence is up to 3 km thick and is concealed below about 2 km of Eromanga Basin rocks. A substantial part of the Devonian sequence is interpreted to be marine, although the exact relationship between the trough sequence and the main Adavale Basin is not fully understood, and will be the subject of further study. Flat-lying or gently-folded Devonian sedimentary rocks extend to the north and west covering an area greater than previously postulated. The Warrabin Trough is complexly folded, with the main fold elements bounded by high-angle reverse faults. Although suitable traps for hydrocarbon appear to be present, the petroleum potential of the trough is unknown since exploration wells, Bodalla 1 and Chandos 1, drilled on structural highs on the western flank of the trough, penetrated only a small part of the sequence.

The eastern extent of the Permian and Triassic sequences in the Cooper Basin are more clearly defined, and do not extend as far eastwards over the southern part of the Warrabin Trough as previously supposed. The seismic results show prograding within the Triassic near the basin margins. Petroleum source rock geochemistry indicates that potential gas-prone kerogens are widespread within the northeast coal measure facies of the Cooper Basin sequence.

The Jurassic-Cretaceous Eromanga Basin sequence shows a number of reflections which clearly illustrate the main structural features of the basin and provide information on stratigraphy. Features such as shoaling and channeling which took place during deposition of the Toolebuc Formation are evident, and beds of coal and carbonaceous shale within the basal Winton Formation are found to have a distinctive reflection character. Oil-prone source rocks have been identified in the Eromanga Basin sequence by geochemical analysis. Results from the hydrochemistry studies together with those from previous hydrogeologic work in the area will be used to further define flow patterns which might have influenced the migration of hydrocarbons.

Gravity, seismic refraction, and magneto-telluric results are being processed and analysed to provide information particularly on the basement rocks and structure in the lower crust and upper mantle. The study of the area will be extended by further interpretation of the deeper regional data together with the shallower seismic and other information.

The use of diagnetic features for evaluating reservoir quality, Sydney Basin

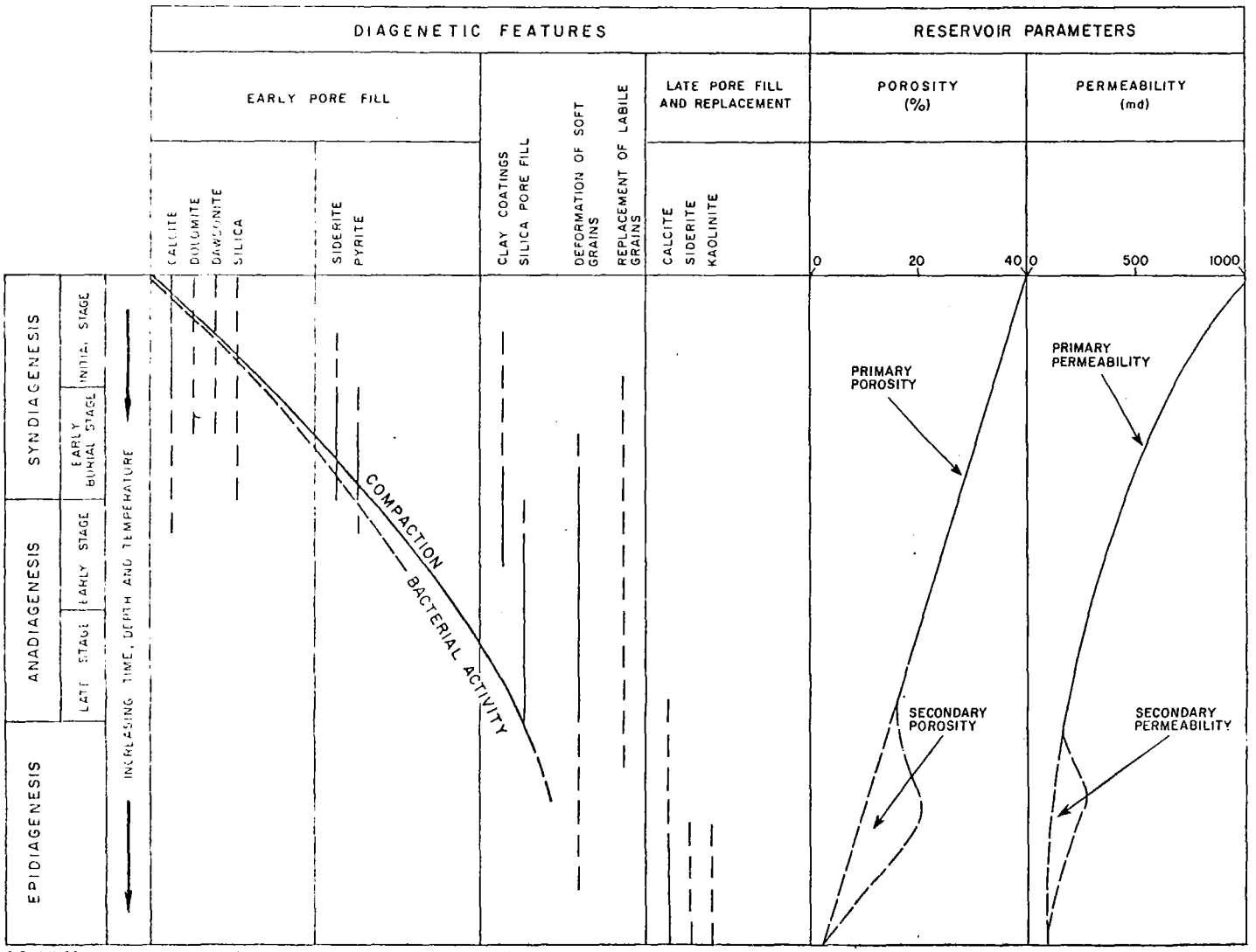
S. Ozimic

The sediments of the Permian Shoalhaven and Maitland Groups in the Sydney Basin have been subjected to at least three diagenetic phases (syndiagenesis, anadiagenesis, and epidiagenesis); and three diastrophic events (Permian Hunter-Bowen orogeny, Upper Triassic movements, and probable Tertiary epeirogenic movements).

In the arenaceous members the progressive diagenesis produced a sequence of diagenetic features (Fig. 1) that have considerably decreased the quality of the potential reservoirs, mainly by the reduction of porosity and permeability. The reduction of primary and secondary porosity as well as permeability is, therefore, attributed to the following diagenetic features that have been produced during the burial and subsequent uplift:

- early pore fill (calcite, dolomite, dawsonite, siderite, silica and pyrite),
- clay coating of detrital grains (illite),
- silica pore fill (quartz overgrowths), and
- late pore and fracture fill (carbonates and clay).

DIAGENETIC FEATURES AND RESERVOIR PARAMETERS IN THE ARENITES OF SHOALHAVEN AND MAITLAND GROUPS



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