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BMR SYMPOSIUM CANBERRA, 22-23 APRIL 1975 ABSTRACTS

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ABSTRACTS

<u>CONTENTS</u>

Annual Operating Cost, year 1974

Cost Categories → / Cost Centres ↓	Salaries & Wages (inc. leave, payroll tax, work.comp. superan. insurance schemes, predicted overtime etc.				Utilities		Operating supplies (inc. fuel, expl., reagents, grind.iron)		Maintenance Supplies		Overheads
	Supervision	Operating	Maint.	General	Power	Water	Mobile Equip.	Fixed Plant & consumables (fuel expl.ropes reagents, etc.	Mobile Equip.	Fixed Plant	
Mining											
Drill											
Blast											
Load trucks											
Haul											
Mine Services											
Mine Wksp. & store											
Changehouse											
Explos. Mag.											
Mine Drainage											
Mine Power Retic.											
Offices & Office Eqp.											
Pre-prod. strip.											
Mill											
Crush											
Grind											
Flotation etc.											
Engineering											
Power Station											
Water supply											
Central Wksp.											
Tailings dams etc.											
Town											
Town Maint.											
Food subsidy etc.											
Inward Transport											
Fuel, food, reagents, grinding media, etc.											
TOTALS											

An underground mine might have many of the same cost centres as those listed down the left hand side above (i.e. all those under mining from mine services to office inclusive) plus for instance separate cost centres for sink shaft, rise, drive & crosscut ahead of roduction, stope preparation, break & load ore in stopes, fill stopes, haul ore on haulage level, hoisting, pumping, ventilation, mainte nce of underground equipment, underground geology and sampling, surface transport.

MINING COSTS

J. ERSKINE

The object is to show the range of mining costs typical under Australian conditions in 1974. All the costs listed have been calculated from theoretical models of assumed operations, not of actual operations (although the theoretical costs agree reasonably well with published costs both here and overseas) and not every type of operation listed in this paper is represented by an actual Australian mine.

The main tabulation to be presented will consist of types of mines with the associated Capital Costs and Operating Costs. The tabulation will also include the likely revenue from the type of ore produced from each typical mine. Such a tabulation could be used by a geologist, for instance, to quickly get a rough estimate as to whether an orebody is an economic proposition or not. It is not intended to replace the need for an engineer to make a detailed estimate of costs when a full scale study of a mining proposal is being studied.

Every mine, expecially every underground mine, is a particular case, and for a proper feasibility study every such case has to be calculated on its own merits using those conditions peculiar to itself. A serious cost analysis requires that the proposed operation be visualized and understood accurately and in fine detail. The operation is then broken down into a series of independent activities called "Cost Centres", each cost centre then being broken down into the "cost categories" relevant to it - as in the following example for the estimates for an open-pit mine. Note that exactly the same list of cost centres for the Capital Cost Estimate (total capital expenditure required), can be used as for the Operating Cost Estimate (operating costs for any one year, a separate operating cost estimate being made for each year of the feasibility study). Note also that any one cost centre may have only one or two, or all, of the ten possible cost categories listed here.

The main tabulation (Capital Costs, Operating Costs, and Revenue) shows a list of typical mines in the categories of open pit, underground, alluvial and eluvial. The costs for each type of mine are divided into Capital costs and Operating costs. In this first part of the tabulation the costs are calculated as costs per tonne of ore and are the total of the costs at the mine site only (i.e. costs of Capital per tonne of ore for exploration development, mine and mill construction, and town road and rail construction, plus costs of Operating per tonne of ore, for mine operating, mill operating and town operating.) We then deal in terms of costs per tonne of metal throughout the right hand half of the table, for all the costs away from the mine site, i.e. for the costs of transport of concentrates to smelter, and costs of smelting, refining and marketing. One can best think of these transport, smelting, refining and marketing costs as costs per tonne of metal, because if one tries to put them into terms of per tonne of ore then varying ore grades between one mine and another, or between two years' operations in the same mine, would make any comparison of costs different. There are also of course traps in any blind use of costs per tonne of refined metal. A recent newspaper article showed how high the costs were at Mt. Lyell per tonne of refined metal, and left the impression that Mt. Lyell was a high cost mine, whereas it is of course an efficient low cost underground mine - low cost per tonne of ore - its costs per tonne of refined metal are high because it is working very low grade ore. Note that there is no overt cost of capital in the list of costs of transport smelt and refine - there are in fact hidden costs for capital included in these operating costs of transport smelt and refine, as distinct from the system of tabulation used for costs at the mine site, where both capital and operating costs are listed separately. Note also that in the section on "Capital Cost" the rather hypothetical figure finally arrived at as the Capital Cost per tonne of ore for operations at the mine site is in fact an average cost per tonne during the years when capital is being 'repaid' - in some cases it is an average over 5 years, i.e., for relatively small operations, and an average over 10 years for most of the larger operations.

The best way to think of capital costs is to consider all the capital as equity capital, charge no interest, but expect say a 12% D.C.F. rate of return. Another way is to use equity and loan fund proportions close to what would be used in practice (say 30% equity, 70% loan), charge 10% on the loan and expect say, a 20% D.C.F. rate of return on equity. A third method is to consider all the capital to be borrowed, charge 10% for the loan, and allow for it to be paid back at a realistic rate - i.e., no more than 5 years for a small operation, and perhaps up to 10 years for a very large operation. It is this last system that is used in the tabulation of costs here. The resulting figure for Capital Cost at mine site per tonne of ore is admittedly a general figure averaged over the years, and is not the sort of figure which would ever be used by an accountant, or by an engineer in a feasibility study, but it does provide a measure of how much revenue has to be generated by the orebody to pay off the real annual charges for capital. For the open pit mines listed here all the mines considered are given a waste to ore ratio overall of 2:1. For the underground mines all the small mines are allowed a requirement for forward development ahead of stoping of 25 tonnes of ore per metre of development, for medium sized mines 50 tonnes of ore developed per metre of drives, cross-cuts, etc., and for large mines 250 tonnes of ore per metre of development. For alluvial and eluvial mines operating costs are per tonne of total material waste and wash combined.

The large difference between column 19 of the main tabulation and column 15 (value of metal at the city versus value at the mine) illustrates the very large cost to transport concentrate to smelter, smelt, refine and market the metal. For instance, when refined copper sells for $1000 a tonne in the capital city, that same amount of copper contained in concentrates is worth only $580 a tonne at the time. I have assumed a distance of 550 km from mine railhead to smelter, which might produce transport costs for concentrate as follows:-

	per tonne of conc.
Mine to rail siding load (trucks, tpt say 20 km unload store)	$ 1.75
Handling at railhead (i.e. load rail trucks)	0.35
Railage from railhead to Pt. Kembla refinery (550 km x $0.05)	27.50
Handling at Pt. Kembla	0.30
Insurance	0.10
Transport cost per tonne of concentrate =	$30.00

If concentrate contains 25% Cu, then transport cost per tonne of copper = $30 \times \frac{100}{25}$ = $120 per tonne of contained copper. For the record, if the concentrates are to go overseas, the costs of transport might be as follows:

	per tonne of conc.
Mine to rail siding (load trucks, tpt say 20 km unload store)	$ 1.75
Handling at railhead	0.35
Railage from railhead to say Pt. Kembla port (say 450 km x 0.05)	22.50
Handling and storage at Pt. Kembla	3.00
Export documentation etc.	0.20
Stevedoring at Pt. Kembla (i.e. load ship)	3.00
Outward wharfage	0.50
Seafreight - Pt. Kembla to Japan	15.00
Stevedoring Japan	3.00
Transport cost per tonne of concentrates =	$49.30

In this case the transport cost per tonne of contained copper would be $\$49.30 \times \frac{100}{25}$ = $197.20, almost $200 per tonne of copper. The total costs from leaving the mine concentrator until the metal is sold at the capital city may be set out as follows:

<u>Metal value at mine</u> - copper (assume $30/tonne concentrate for tpt to smelter). Refiner pays for 96% of say 25% Cu conc., capital city price say $1000/tonne of copper, less 1.3 units ==

$= 0.96 \times \frac{25-1.3}{100} \times 1000$		$228 per tonne of conc.
Less refine & market $160 per tonne of paid Cu		
$= 160 \times \frac{25-1.3}{100}$ =	38	
	190	"
Less sample and smelt at $15 per tonne of conc. =	15	
Value 1 tonne conc. at entrance smelter =	$175	"
Less transport, mine to smelter, $30/t conc. =	30	
Value 1 tonne <u>conc</u>. as it leaves mine =	$145 per tonne of conc.	
Value 1 tonne <u>Cu metal contained in conc</u>. ex-mine is worth $\frac{145 \times 100}{25}$ =	$580 per tonne COPPER	

when copper is selling for $1000/tonne at capital cities. From this $580 per tonne Cu-$5.80 per 1% metal in the ore - one must now deduct all the costs at the mine site, (mining, concentrating, engineering, administration, town operating) before arriving at one's "profit per tonne of ore" (one must here also allow for mill losses and mine dilution.)

The main information in the tabulation is found by comparing column 13 (Total Cost at mine site) with column 14 (Value of metal in conc. at mine site per 1% metal in the ore). If for instance column 13 indicates that a mine might have total costs at the mine site of say $16 per tonne of ore then from column 14 this cost is satisfied by 2.8% Cu, or by 13% Pb, or 15% Zn, or 0.7% Ni, or 0.4% Sn, (assuming 100% recovery). With a lode tin mine at say 60% recovery the required grade might be

$$\frac{0.4}{0.6} = 0.7\% \text{ Sn.}$$

$ AUSTRALIAN YEAR 1974			CAPITAL COST					OPERATING COST					TOTAL COST
1		2	3	4	5	6	7	8	9	10	11	12	13
TYPE OF MINE		RATE OF ORE EXTRACTION (per year)	EXPLORATION AND LEASE	MINE EQUIP., MINE BLDGS, MINE DEV.	MILL	TOWN, RAIL, ROADS	TOTAL CAPITAL & INTEREST (per Tonne Ore)	MINE OPERATING: PER T. WASTE (Open Pit) Fwd Dev./T. Ore (Underground Mine)	MINE OPERATING: PER TONNE ORE (including Column 8)	MILL OPERATING (excluding SM & REF)	TOWN OPERATING	TOTAL OPERATING PER T. ORE (excluding TPT, SM, REF)	UP TO PRODUCTION OF CONCENTRATES
OPEN PIT (HARDROCK)	SMALL	100 000 – 500 000 (Tonnes)	0.1 – 0.5M	0.5M	1M – 5M	0.1M	(INCL. W. CAP) $3.00 – $4.50 (5 year)	$0.45 – $1.50 Waste only	(W. ORE = 2.1) $1.75 – $4.50	$1.00 – $10.00	$0.25 – $0.50	$ 3 – $ 12	$ 6 – $ 16½
OPEN PIT (HARDROCK)	MEDIUM	500 000 – 2 000 000 (Tonnes)	1M – 4M	1M – 4M	5M – 20M	0.5M – 10M	$3.00 – $4.00 (10 year)	$0.40 – $0.85 Waste only	$1.60 – $2.25	$0.85 Cu S $4.50 WO_3 $7.00 SnO_2	$0.30 – $1.00	$ 2½ – $ 9	$ 5½ – $ 13
OPEN PIT (HARDROCK)	LARGE	2 000 000 – 50 000 000 (Tonnes)	3M – 10M	3M – 30M	20M – 80M	3M – 30M	$0.50 – $1.00	$0.35 – $0.65 Waste only	$1.20 – $1.60	$0.75 – $3.50	$0.30 – $0.50	$ 2½ – $ 5	$ 3 – $ 6
UNDER-GROUND	SMALL	15 000 – 100 000 (Tonnes)	0.1M – 1M	0.5M – 4M	NIL – 2M	NIL – 0.5M	$5.00 – $25.00 (5 year)	$3.00 per Tonne Ore (Fwd Dev.)	$15.00 – $30.00	$1.10 – $10.00	$0.50 – $1.00	$ 17 – $ 40	$ 22 – $ 65
UNDER-GROUND	MEDIUM	100 000 – 500 000 (Tonnes)	1M – 5M	3M – 15M	2M – 8M	0.1M – 5M	$6.00 – $14.00 (10 year)	$1.50 (Fwd Dev.)	$4.00 – $20.00	$0.85 Cu S $4.50 WO_3 $7.00 SnO_2	$0.50 – $2.00	$ 5½ – $ 28	$ 11½ – $ 42
UNDER-GROUND	LARGE	500 000 – 2 000 000 (Tonnes)	2M – 10M	10M – 20M	8M – 20M	3M – 10M	$5.00 – $6.00	$0.50 (Fwd Dev.)	$3.00 – $10.00	As above	$0.50 – $2.00	$ 4½ – $ 15	$ 9½ – $ 21
ALLUVIAL	DREDGE (LARGE) BUCKET LINE WET PLANT ON DREDGE	8 000 000 m^3 per year Overburden & Wash (None so big in Aust.)	1M	7.7M (dredge 6.0 wkshop 0.3 spares 0.2 fee 0.5 power 0.5)	0.1M	0.5M	$0.33 / m^3 (5 year)		$0.20 / m^3	$0.02 / m^3 (Tin Dressing)	$0.03 / m^3	$0.25 / m^3	$0.58 / m^3
ALLUVIAL	DREDGE (SMALL) BUCKET LINE	2 000 000 m^3 per year	0.5M	3.0M (dredge 2.2 wkshop 0.2 power 0.2)	0.1M	0.1M	$0.51 / m^3		$0.25 / m^3	$0.05 / m^3	$0.05 / m^3	$0.35 / m^3	$0.86 / m^3
ALLUVIAL	BEACH SAND SUCT. DREDGE, SEP. HULL FOR WET PLANT	7 000 000 m^3 per year	0.5M	7.8M (dredge 2.3 wet pl. 4.5 wkshop 0.3 fee 0.5)	2.0M Dry Plant 100 T.P. Hr	0.7M	$0.45 / m^3 (5 year)		$0.20 / m^3 Dredge and Wet Treatment	$0.10 / m^3 TPT to Dry Pl. & Separate	$0.15 / m^3	$0.45 / m^3	$0.90 / m^3
ALLUVIAL	TRACTOR SCRAPER OPEN PIT SOFT MATERIAL	3 000 000 m^3	0.5M	2 M	0.25M	0.15M	$0.28 / m^3	$0.30 / m^3 Waste only	$0.40 / m^3 Waste & Gravel	$0.10 / m^3	$0.05 / m^3	$0.55 / m^3	$0.83 / m^3
ALLUVIAL	MONITOR AND GRAVEL PUMP	850 000 m^3 per year	0.3M	0.2M	0.2M	0.2M	$0.30 / m^3		$0.40 / m^3		$0.05 / m^3	$0.45 / m^3	$0.75 / m^3
DRAGLINE (COAL STRIP MINING) SEAM 3 m DEPTH 35 m		25 000 000 m^3 Overburden 2 000 000 Tonnes Coal	2 M	15M (60 m^3 bucket)	15M (Washer, Conv., Loader)	8 M (300 men)	$3.50 / m^3 Tonne Coal (10 years)	$0.10 / m^3 Waste only	$2.00 per Tonne Coal (including Col. 8)	$3.00 per Tonne Coal (Wash $1.50) (Handle $1.50)	$0.50 per Tonne Coal	$5.50 per Tonne Coal	$9.00 / T. Coal Pithead (Now add $7.80 for Rail, Handle, Royalty, Shiploader) $22.80 f.o.b.
ELUVIAL		100 000 m^3 per year	0.05M	0.05M	0.03M	$0.15M	$0.75 / m^3		$1.50 / m^3		$0.25 / m^3	$1.75 / m^3	$2.50 / m^3 (Excluding Royal., TPT, Conc. 0.13)

VALUE: METAL IN CONC. AT MINE SITE		COSTS AFTER LEAVING CONCENTRATOR: PER TONNE METAL IN CONCENTRATE			REVENUE AT CAPITAL CITIES
PER 1% METAL IN THE ORE (14)	PER TONNE CONTAINED METAL IN CONCENTRATES (15)	FREIGHT CONCENTRATE TO SMELTER (16)	SMELT (17)	REFINE (18)	(PER TONNE REFINED METAL) (19)
COPPER $5.80	$580 (Deduct $420 from metal price)	$30 / T. Conc. = $120 per T. Cu	COPPER $15 / T. Conc. = $60 per T. Cu	(1.3 units) $160 (ref) $240/T. Cu in Ore	COPPER $1000
LEAD $1.20	$120 (Deduct $140 from metal price)	$30 / T. Conc. = $40 / T. Pb	LEAD $50 / T. Conc. + $23 (units) = $90 / T. Pb	$10 / T. Pb	LEAD $260
ZINC $1. 06	$106 (Deduct $314 from metal price)	$30 / T. Conc. = $57 / T. Zn	ZINC $116 / T. Zn (units) $75/ T. Conc. (141 / T. Zn) = $257 / T. Zn		ZINC $420
NICKEL $22.64	$2264 (Deduct $1152 from metal price)	$106 / T. Ni	NICKEL $30 / T. Conc. = $230 / T. Ni	$200 / T. Paid Ni + Units = $816 / T. Ni	NICKEL $1.55 / lb $3416 / T.
TIN $40.30	$4030 (Deduct freight only)	$70 / T. Sn	TIN (AUSTRALIA) 'Metal' price not relevant 'Conc.' price x 100 = value / T. Sn No Smelt and Refine Charge		TIN $4100 per T. Cont. Metal (Unit price x 100)
TUNGSTEN $60.70	$6070 (Deduct freight only)	$150 / T. Conc. $230 / T. 100% WO_3 (Bagged Conc. to Europe)	TUNGSTEN No Smelt or Refine Charge Smelter pays $\frac{65}{100}$ x 6300 = $4095 per T. Conc.		TUNGSTEN $63 / unit WO_3 $6300 / T. of 100% WO_3

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THE GRANITES-TANAMI REGION: PROTEROZOIC STRATIGRAPHY, REGIONAL CORRELATIONS, AND ECONOMIC POTENTIAL

D.H. BLAKE

The Granites-Tanami region, mapped between 1971 and 1973, lies in the northwest of central Australia between the mainly Precambrian Kimberley, Victoria River, and Amadeus regions to the northwest, north, and south, respectively, and the Phanerozoic Canning and Wiso Basins to the west and east, respectively. It consists mostly of Precambrian rocks largely concealed by Cainozoic superficial sediments.

The oldest rocks exposed belong to the Archaean or Lower Proterozoic Tanami complex. They consist of steeply dipping and tightly folded schistose to phyllitic greywacke, siltstone, shale, sandstone, tuff, and basic to acid volcanics, together with chert, and quartzite. These rocks have been subjected to low grade regional metamorphism. The complex is overlain unconformably by Lower Proterozoic and younger rocks, and is intruded by granite dated at 1700-1800 m.y. It is correlated with the lithologically similar Halls Creek Group of the Kimberley region and with part of the Arunta complex in the Amadeus region to the south. Gold and minor copper mineralization is present at Tanami and The Granites, and gossans, some of which contain traces of copper, are common locally.

The Lower Proterozoic rocks have not been affected by regional metamorphism. They comprise the Pargee and Supplejack Downs Sandstones, the Mount Winnecke Formation, which includes some acid volcanics, and the Winnecke Granophyre, which intrudes the Mount Winnecke Formation. The extrusive and intrusive acid rocks are dated at about 1800 m.y., and are considered to be comagmatic. They are probably younger than the Whitewater Volcanics and associated intrusions of the Kimberley region.

The granitic intrusions and older rocks together make up The Granites-Tanami Block, which is overlain unconformably by sedimentary rocks of the Birrindudu Basin.

The oldest rocks preserved in the Birrindudu Basin belong to the Carpentarian Birrindudu Group and its probable equivalents in the northwest - the Lake Willson, Pindar, Nelligan, and Meteorite Crater Beds. These units consist mainly of quartz-rich sandstone with little or no matrix. The Birrindudu Group comprises the Gardiner Sandstone at the base, which includes sandstone beds containing glauconite dated at 1400-1550 m.y., the overlying Talbot Well Formation, which includes stromatolitic chert, and the Coomarie Sandstone at the top. The Group is overlain unconformably to the west and south by the Adelaidean Redcliff Pound Group. It is correlated with the Mount Parker Sandstone and Bungle Bungle Dolomite of the Kimberley region and the Limbunya Group of the Victoria River Region. Minor uranium and rare earth mineralization is present at the base of the Gardiner Sandstone at the Killi Killi Hills, and this is the only mineralization known in the Birrindudu Basin of The Granites-Tanami region.

The Redcliff Pound Group comprises the quartz-rich Lewis Range, Muriel Range and Munyu Sandstones, which are laterally equivalent basal units, the overlying Murraba Formation, which includes distinctive chert granule conglomerates, and at the top the mainly lithic Erica Sandstone. In the northwest the probable equivalents of the group are the Denison, Jawilga, and Boee Beds. The Redcliff Pound Group is overlain, probably comformably, by quartz-rich sandstone of the Hidden Basin Beds, the youngest Proterozoic unit in The Granites-Tanami region. The Munyu Sandstone, the basal unit of the Redcliff Pound Group in the south, is correlated with the Heavitree Quartzite and Bitter Springs Formation of the Amadeus region and the Vaughan Springs Quartzite of the Ngalia Basin. Hence the Redcliff Pound Group is probably younger than the Wade Creek Sandstone of the Kimberley region and the Wattie, Bullita and Auvergne Groups of the Victoria River region, and is older than the glacials of the Duerdin Group to the north and northwest and equivalents of thelatter to the south and southeast.

The Precambrian rocks of The Granites-Tanami region are overlain unconformably by Lower Cambrian Antrim Plateau Volcanics and terrestrial sediments ranging from Palaeozoic to Cainozoic. They are overlapped to the west and east by Phanerozoic sediments of the Canning and Wiso Basins, respectively.

The economic potential of the region is largely unknown, as little exploration has taken place. This is probably because of the isolation of the region, the widespread cover of superficial sediments, and the lack of known major mineral deposits either within the region or in adjacent regions. However, the region should not be considered unprospective as it is known to contain some mineralization - gold and minor copper, and numerous gossans, are present in the Tanami complex, and uranium and rare earth mineralization has been found at the base of the Birrindudu Group.

GRANITE DIAPIRISM IN THE RUM JUNGLE AREA, NORTHERN TERRITORY

K. JOHNSON

Early studies in the Rum Jungle area indicated an intrusive relationship between the Rum Jungle and Waterhouse 'Granites', and the overlying sediments. It was later shown that the granitic 'intrusions' were Archaean basement complexes on which Lower Proterozoic sediments had been deposited. Polyphase folding was postulated as being responsible for doming of the basement and cover rocks.

The purpose of this talk is to show that the domed structures in the Rum Jungle area, and the emplacement of certain Middle Proterozoic granites in the Pine Creek Geosyncline were related, and caused by diapiric intrusion of granites into the basement complexes and cover rocks.

Structural and metamorphic evidence in support of diapiric intrusion in the Rum Jungle area includes: pebble deformation within steeply dipping beds of quartz conglomerate, disappearance of polyphase fold structures away from the basement complexes, bending of folded country rock strata into concordance with the complex-sediment contact, and metamorphic and metasomatic alteration of sediments in contact with the basement complexes. Gravity data show mass deficiencies in the Archaean complexes which possibly coincide with young granite diapirs.

Diapiric granites in the Pine Creek Geosyncline may have been a source of metals and non-metals, and could also have mobilized and concentrated any pre-existing syngenetic mineralization.

THE GEORGETOWN PROJECT: AN OLD MINING DISTRICT RE-EXAMINED

J.H.C. BAIN and A.G. ROSSITER

Between 1869 and the mid-1950's more than ten million grams of gold and silver bullion were produced from the district around Georgetown and Forsayth, in the central part of the Georgetown Inlier. Production of a variety of other minerals, including lead and copper, took place during the same period. Although recent exploration in most of the district has not been exhaustive, a major deposit of fluorite with uranium and molybdenum minerals has been found at the Maureen prospect to the north-northwest of Georgetown.

Since 1972 a joint Bureau of Mineral Resources-Geological Survey of Queensland party has been re-examining the Georgetown and Forsayth 1:100 000 Sheet areas, and part of the Red River 1:250 000 area; the Gilberton 1:100 000 area will be mapped this winter. Detailed geological mapping is being integrated with geochemical and geophysical studies in an attempt to refine understanding of the district's geological evolution, and to evaluate its economic mineral potential.

The district contains three main rock assemblages. The oldest of these consists of Proterozoic metamorphic rocks which have undergone polyphase deformation, and are mainly of upper greenschist and amphibolite grade. They are assigned to the Robertson River and Einasleigh Metamorphics; metadolerite occurs in both units. Veins with chalcopyrite occur locally in the Einasleigh Metamorphics, most notably at Einasleigh itself, and small veins of highly argentiferous galena within the Robertson River Metamorphics have been mined in the Mosquito Creek area.

The metamorphic rocks are intruded by multiphase syn- and late-kinematic Proterozoic (and possibly early Palaeozoic) granitic rocks which are assigned to several units. One of these, the Forsayth Granite (redefined as the variably melanocratic, sporadically porphyroblastic, biotite granite around Georgetown and Forsayth), contains all major gold-bearing veins known in the district. These are commonly aligned along northwest-trending faults and shear zones. Primary gold ore commonly contains pyrite, chalcopyrite, galena and sphalerite: however, production from all but the largest mines was from oxidised ore.

The mid-Carboniferous Newcastle Range Volcanics and later Palaeozoic granites constitute the youngest assemblage. The volcanic rocks occur in two separate stratigraphic sequences in the main and eastern parts of the Newcastle Range. Both sequences are dominated by rhyodacitic ignimbrites, but also include some epiclastic and pyroclastic sedimentary rocks. Several types of mineralization occur in the unit, the type with the most apparent economic promise being an association of uranium and molybdenum minerals, with and without fluorite, as at the Maureen prospect. In places the late Palaeozoic granites have been altered to greisen containing cassiterite and minor molybdenite, bismuthinite, wolframite, chalcopyrite, and fluorite; topaz is common locally.

Application of geochemical prospecting to the detection of the major mineralization types of the Georgetown region.

Element	Nature of deposits	Useful pathfinders	Applicability of heavy mineral technique
Uranium	Hydrothermal veins	As, F, Mo, W. Ce and Th contents exceeding 100 ppm and 120 ppm respectively indicate monazite	Microscopic examination of heavy mineral samples useful in deciding whether a high U value is due to mineralization or monazite
Copper	Hydrothermal veins and replacements	Pb, Zn	Microscopic examination of heavy mineral samples for malachite
	Porphyries	Mo. Possibly Zn.	-
Zinc	Hydrothermal veins and replacements	Cu, Pb. On rare occasions Co, Cr, Ni	-
Lead	Hydrothermal veins	Ag, Cu, S, Zn	Chemical analysis of heavy mineral samples
Tin	Hydrothermal veins	Be, Li, W. Possibly As, Bi, Mo	Microscopic examination of heavy mineral samples for cassiterite
Gold	Hydrothermal veins	Cu, Pb, Zn where the veins are sulphide-rich. Bi has potential	Microscopic examination of heavy mineral samples for detrital gold
	Disseminated deposits e.g. in breccia pipes	One company reports success with As	"

Geochemical orientation studies carried out by the BMR during 1972-73 indicate that stream sediment geochemistry is potentially a powerful exploration method in the Georgetown area. Using a combination of samples sieved to minus 180 microns (85 mesh BSS) and heavy-mineral concentrates, uranium, copper, lead-zinc, tin, and gold deposits can all be detected.

Uranium levels of greater than 12 parts per million in sieved stream sediments can be due either to mineralization or to detrital monazite ((Ce, La, Th)PO_4). To ascertain the cause of a high uranium value it is necessary to determine other elements - arsenic, fluorine, molybdenum, and tungsten indicate mineralization; cerium and thorium indicate monazite - or examine a heavy mineral sample.

Heavy-mineral concentrates are very sensitive in tracing vein-type copper deposits. In a number of mineralized areas no anomalous copper is found in sieved stream sediment, but malachite is conspicuous among the heavy minerals. Sieved samples appear better suited to exploration for porphyry-type copper deposits. In areas of basic igneous rocks, values of 150 ppm should be regarded as worthy of follow-up work; in granitic terrains a threshold of 60 ppm is more realistic.

Sieved samples collected in the vicinity of lead-zinc mineralization are characterized by lead and zinc contents greater than 140 and 150 ppm, respectively. Associated heavy mineral concentrates are very high in lead (up to several thousand ppm) but low in zinc. The fact that mechanical processes play a more dominant role in the dispersion of lead can be attributed to the insolubility of the lead sulphate (anglesite) relative to its zinc analogue.

Tin deposits show up equally well in sieved or heavy-mineral samples. A tin content exceeding 20 ppm in sieved material, and the presence of cassiterite among the heavy minerals, both indicate the proximity of mineralization.

The optical examination of heavy mineral concentrates is a proven means of detecting gold lodes, but chemical methods also appear to have potential. Near gold mineralization sieved samples generally contain anomalous copper, lead, zinc, bismuth, and silver, and the possibility of the chemical detection of gold itself cannot be discounted. Certainly the analysis of soils for gold proves effective in delineating prospects, although an analytical technique with a detection limit of 0.10 ppm or less is required.

Future BMR geochemical work in the Georgetown region will take the form of regional stream sediment surveys, utilizing both sieved and heavy-mineral samples. During 1974 the Forsayth 1:100 000 Sheet was covered at a density of approximately 1 sample per 2.5 sq. km. No results are available as yet.

TENNANT CREEK - A GEOCHEMICAL UNDERSTANDING

A.D. HALDANE and S.E. SMITH

The Tennant Creek mineral field lies in a belt of Precambrian rocks in the central part of the Northern Territory. The field contains lenticular "ironstones", bodies which are worked for gold/bismuth and copper. An investigation was made of the geochemistry of the various rock units and the ironstones to determine the chemical factor involved in the genesis of the mineralisation, and to attempt to establish useful criteria for mineral exploration.

The rock units examined were the unmineralised Warramunga sediments, granite, porphyry, lamprophyres, mineralised sediments, dolomite, and ironstones. The Warramunga sediments, granite, and porphyry do not show any general abnormality in their trace element contents which would suggest a source for the mineralisation.

A simple hydrothermal model is proposed in which the intrusion of the granite results in a reaction rim of dehydration and leaching of potassium from the Warramunga sediments. This has caused extensive replacement of ferromagnesian minerals in granite and the release of iron and magnesium to the aqueous phase. At the same time the aqueous phase may accumulate other trace elements, particularly the chalcophile group. The possibility that the Warramunga sediments have contributed elements to the aqueous phase is not excluded.

The aqueous phase invades the Warramunga sediments along pre-existing cleavage in the sericitic shales where further reaction has converted sericite to chlorite, and magnetite, talc, and dolomite have been deposited.

The deposition of magnetite reduced the ferrous iron content of the aqueous phase as it penetrated further into the sediments. At the same time there was a reduction in temperature and pressure, and this resulted in the deposition of hematite to leave an aqueous phase which finally deposited quartz.

Sulphides were deposited early, either before or with the chlorite/magnetite phase, whereas gold and bismuth were deposited with the hematite.

The porphyries were derived from the granitic melt in the early phase of the intrusion, and may later have been chloritised to form the "quartz porphyries". The lamprophyres are a late-stage residue from the melt phase.

According to this model gold/bismuth deposits would be found mainly in the hematitic ironstones remote from granite, whereas any sulphide deposits should be closer to the granite margin: they may not necessarily be associated with the chlorite/magnetite ironstones. Quartz veins and reefs should all be barren, Lamprophyres may contain the same trace elements as the ore bodies, and gives rise to false geochemical anomalies.

APPLICATIONS OF ERTS-1 (LANDSAT-1) AND OTHER REMOTE SENSING DATA TO GEOLOGY AND MINERAL RESOURCES

J. PERRY

In October and November 1974 a team of five government scientists visited Canada and the United States to investigate how ERTS-1 and other remote sensing data were being applied in the earth resources field. This talk presents some examples, in the geological, mineral resources and related fields, of applications described by workers visited by the speaker, who was the geological member of the team.

The examples are grouped into seven categories: 1. regional geological studies, 2. lineament analysis, 3. environmental monitoring, 4. monitoring the state of active volcanoes, 5. water resources studies, 6. land-use mapping, and 7. terrain analysis.

The principal uses of ERTS-1 data for geology derive from the enormous coverage of each scene (34,225 km^2). These are i) the recognition of new and curvilinear features, ii) the extension of previously known linear features, and iii) the generation of new ideas about the geology of a region. The multispectral nature of ERTS-1 imagery aids in determining the location and vigour of vegetation, and the distribution of surface water and of soil moisture, information that provides clues to interpreting geological conditions. Current research suggests that the nature of some surface materials in arid terrains may be inferred from the multispectral magnetic tape data. Repetitive coverage is vital for monitoring dynamic phenomena, but normal geological requirements for data are satisfied once seasonal coverage of an area is obtained.

In the United States the extractive industries are the principal purchasers of ERTS-1 data, followed by 2. foreign countries, 3. Federal government and universities and 4. private individuals.

Many workers studying land-use find very high altitude photography valuable in bridging the scale gap between ERTS imagery and conventional photography. Some exploration companies are flying thermal infrared imagery over arid terrain seeking structural information, but little use is being made of multispectral photography.

LINEATIONS IN THE BISMARCK SEA

L.A. TILBURY

The Bismarck Sea is a complex tectonic region lying in a zone of interaction between the Pacific and Australian plates. Several small crustal plates have been outlined in the region. Although the Bismarck Sea has a crustal thickness of about 20 km it appears to be oceanic in origin.

Data from some 10 000 n.ml of traversing in the Bismarck Sea have thrown some light on the understanding of the structure and evolution of the sea. Oceanic basement occupies the northern two-thirds of the Bismarck Sea region while the southern third appears to be primarily of andesitic composition. Minor northeast magnetic trends underlie major east-west trends associated with volcanic ridges. These minor trends appear to have arisen from sea floor spreading. Preliminary interpretation indicates the anomalies are possibly of Oligocene age.

The structure and sediment distribution of the West Melanesian Arc suggests that it is a sheared arc which formed as a feature continuous with the New Britain Arc.

A simple but speculative evolution consistent with most of the facts can be put forward.

a) The Bismarck Sea region formed during the <u>Oligocene</u> on the southern limb of a spreading centre. The fossil ridge is now possibly situated between Manus Island and the PNG margin.

Until this time the Northern New Guinea Arc, New Britain Arc and the West Melanesian Arc formed a continuous island arc to the south.

b) About <u>early Miocene</u> time the Northern New Guinea Arc collided with the Australian plate. Subduction ceased along the island arc and a shear zone was formed along the southern boundary of the West Melanesian Arc to release stress.

c) Between the <u>early Miocene and early Pliocene</u> the West Melanesian Arc moved 1000 km northwest along the shear zone (rate about 7 cm/yr). Shearing could explain the absence of volcanism during this period, the formation of tensional features in the eastern Bismarck Sea, and the 'arc type' volcanics of Oligocene/Miocene age on the northeast of the West Melanesian Arc.

d) Post-Pliocene time saw the readjustment of plate boundaries and resumption of subduction under New Britain. The left-lateral Bismarck Sea fault formed to accommodate movement originally along the West Melanesian Arc. A zone of andesitic volcanism from eastern New Britain to the Schouten Islands formed by subduction of the Australian plate to the north and northeast.

INTERPRETATION OF BISMARCK SEA STRUCTURES

J.B. CONNELLY

The Bismarck Sea is a small marginal sea situated immediately north of the island of New Britain and the New Britain Trench. The land areas which surround it on three sides are island arc structures which have been active periodically since the Upper Cretaceous but which have been most active during the Tertiary. A magnetic contour map, a sediment distribution map of the Sea, and the results of two dimensional magnetic and gravity modelling along five north-south traverses are presented. The magnetic map shows that while the general trend of the anomalies is on an east-west direction, anomalies which persist over distances of more than 150 km are present only in the eastern half of the Sea and near the coast of mainland New Guinea. The water depth in the Sea is about 2000 m and Bouguer gravity of the order of +180 mGal. Sediment distribution shows a general thickening towards land with a sediment-free region in the centre and depths of up to 2 km of sediment round the margin.

The magnetic models and the pattern of sediment distribution indicate that north-south extension at 8 cm/year has been occurring in the eastern half of the Sea for the past 1.5 million years and corroboratory evidence is provided from other geophysical data. The western half of the Sea is more complex but some extension has occurred here too in the recent past. The general tectonic grain of the western half is parallel to the New Guinea mainland and tensional features predominate in this area at present although there is evidence of earlier compressive features.

The interpretation strongly supports the idea of an extensional origin for marginal seas as suggested by a number of authors and throws some doubts on the existence of large scale east-west strike slip motion between the two sub-plates of the Bismarck Sea. The extension is different in character from the process occurring at mid-ocean ridges, is probably episodic, andpossibly occurs in the same area several times, thereby effectively erasing magnetic lineations. The complexity of the area precludes accurate reconstruction prior to the past 1.5 million years.

THE CORAL SEA PLATEAU

J.C. MUTTER

The Coral Sea Basin is a small ocean basin lying between the continental margin off northern Queensland and the S.W. Papua-Louisiade Archipelago orogenic belt. Its tectonic setting is similar to many Western Pacific "marginal" basins but it has yet to be shown than an origin by back-arc accretion is a valid model for the Basin.

The major physiographic feature lying within the continental margin adjacent to the Coral Sea Basin is the Coral Sea Plateau. This structure has been tested by DSDP drilling and covered by an extensive systematic multi-sensor geophysical survey. These two sets of data have been married to deduce the geological history of the Coral Sea Plateau. An uplift stage, probably in the Upper Cretaceous, is followed by a stage of orogenic, differential subsidence from upper Paleocene to middle Oligocene, then by uniform, epeirogenic subsidence during the Neogene.

Using DSDP data from drilling in the Coral Sea Basin a fairly complete model of ocean basin-continental margin evolution can be deduced. This model differs significantly from that proposed by Dewey and Bird, and Falvey for Atlantic-type continental margins. The main difference appears to be the absence of a protracted rift valley stage, characteristic of Atlantic margins.

The divergence from Atlantic-type behaviour might suggest a mode of formation for the ocean basin different from the mid-ocean accretionary model. However if a back-arc accretionary model is suggested it requires the existence of a subduction zone island arc system in the southwest Papua-Louisiade region in the Paleocene and Eocene. There is no evidence for such a situation in the geology of these regions.

The Coral Sea Basin, although it is a "marginal" basin geographically, appears to be of a modified Atlantic type. The departure from the simple Atlantic model may be explained by employing two thermal anomalies, and rapid basin formation.

EASTERN AUSTRALIA HELICOPTER GRAVITY SURVEY, 1973/74

I. ZADOROZNYJ

Between November 1973 and June 1974 the BMR carried out a helicopter gravity survey of parts of New South Wales, Victoria, Tasmania and South Australia which completed the reconnaissance gravity coverage of Australia. About 8000 new readings were made at 11 km spacing over most of the survey area, and at 7 km spacing in Tasmania, South Australia and the Broken Hill area of New South Wales.

The Bouguer anomaly contour pattern has been examined in relation to known geology. Arcuate gravity highs in western New South Wales are correlated with the Willyama and Wonaminta Blocks and probable subsurface extensions of these units are indicated. A narrow elongate low separating the highs is the gravity expression of the Bancannia Trough.

A southwest trending belt of low Bouguer anomaly in the western Murray Basin is interpreted as being mainly due to thick sediments. Seismic and drilling evidence in the northern part of the low support this interpretation. Over the remainder of the Murray Basin, Bouguer anomaly values range from -20 to +10 mGal. Relatively intense gravity features are attributed to intrabasement density variations whereas the broader features may reflect variations in depth to basement.

Gravity values are generally high in southwestern Victoria suggesting that basement rocks are of high density. Relative gravity lows within this high area apparently reflect granite bodies or sediment troughs; several sub-basins of the Otway Basin have clear gravity expressions.

Bouguer anomaly values are low over much of the eastern part of the Lachlan Geosyncline suggesting that the rocks are predominantly granitic. The more intense lows can, in general, be correlated with known granite batholiths.

A high Bouguer anomaly zone of varying width can be traced continuously from the north of the survey area southwards to the coastline of eastern Victoria. It extends through the Snowy Mountains region as a narrow sinuous gravity ridge which corresponds closely to the topographically highest areas. Over much of its area, the high Bouguer anomaly zone can be correlated with Ordovician and Silurian metamorphics of the Lachlan Geosyncline.

Low gravity values on the south coast of eastern Victoria are believed to be due to the Gippsland Basin sediments.

A strong Bouguer anomaly rise towards the New South Wales coast indicates a rapid thinning of the continental crust.

High Bouguer anomalies along the coast of Tasmania are probably indicative of a thinning of the continental crust. A northeast trending high in the northwest corner of the island, however, can be correlated with Cambrian ultrabasics. Gravity lows in the north central part of Tasmania are attributed to granites.

A POSSIBLE GEOPHYSICAL METHOD FOR PROSPECTING FOR PRECIOUS OPAL IN WESTERN QUEENSLAND

B.R. SENIOR and C.L. HORSFALL

A chemical weathering profile, developed in sedimentary rocks of the Lower to Upper Cretaceous Winton Formation, is the host to precious opal deposits in western Queensland. The profile, consisting of kaolinitic, siliceous and ferruginous rocks, has a preserved thickness in excess of 100 m, and is widespread in western Queensland. Significant production of precious opal however is restricted to a belt about 90 km wide. Within this belt the weathered profile has been truncated by erosion near folds and faults. In such situations the weathered profile averages only 30 m in thickness and the basal ferruginous portion lies just below the peneplained landsurface.

The distribution of ironstone is often strongly controlled by the bedding configuration of the weathered host rock. Iron oxides accumulated in thin beds, or as lenticular or concretionary bodies in bedding structures floored by impermeable rock. Ironstone along the base of palaeochannels, differential compaction faults, or undulatory bedding contacts, formed local sites for the deposition of precious opal. Concentric, radial and subparallel voids in ironstone acted as reservoirs to silica-laden groundwater. Along the basal portions of bedding traps, movement of groundwater was restricted, due to lateral closure, and the ironstone was bathed in silica-rich groundwater for long periods. In these exceptionally quiet zones the colloidal silica formed a gel which hardened by hydration into precious opal.

Following a promising preliminary investigation, ground magnetic surveys were conducted at three opal prospects northwest of Quilpie to evaluate the suitability of ground magnetometer surveys in locating ironstone. The results of this work suggest that the method is of doubtful usefulness and if applied in a favourable situation the survey should be supervised and interpreted by a qualified person.

Susceptibility and remanence measurements show that the susceptibilities are low and that there is generally little susceptibility and remanence intensity contrast between the ironstone and weathered host sediments. The logarithmic means of these values are:

ironstone:	log. mean susceptibility	= 64×10^{-6} cgs units
	log. mean remanence	= 41×10^{-6} cgs units
country rock:	log. mean susceptibility	= 30×10^{-6} cgs units
	log. mean remanence	= 39×10^{-6} cgs units

Remanent magnetization direction measurements on oriented samples of ironstone show that their remanent magnetization is sub-parallel to the present direction of the earth's magnetic field and that both normal and reversed magnetizations occur. The degree to which remanent magnetization contributes to magnetic anomalies is thus dependent upon the intensity of magnetization in a given direction and the relative proportions of material possessing normal and reversed magnetization in a deposit of ironstone.

For the cases of totally normal and totally reversed remanent magnetization, effective susceptibility values were calculated for samples on the assumption that their remanent and induced magnetization was totally induced. These values also show little magnetic contrast between ironstone and country rock as indicated below.

log. mean ironstone effective susceptibility = 178×10^{-6} cgs units

log. mean country rock effective susceptibility = 118×10^{-6} cgs units

The logarithmic means of susceptibility, remanence, Koenigsberger Q and effective susceptibility for ironstone lie within the range of one logarithmic standard deviation about the logarithmic mean of the corresponding property of the country rock. However, it is possible that the method may work in some areas if the country rock has low and homogeneous susceptibility and remanence relative to that of the ironstone.

Anomalies encountered on two opal prospects were related to variations in susceptibility in the weathered country rock, to contacts between clayey alluvium and iron stained sandstone and to variations in depth to the ferruginous zone of the weathering profile. Some anomalies could be related to the effect of lightning strikes on remanence. On two other prospects magnetic anomalies appeared to be related to the subsurface extension of exposed ironstone occurrences, but there is insufficient sample measurements and excavation to support this.

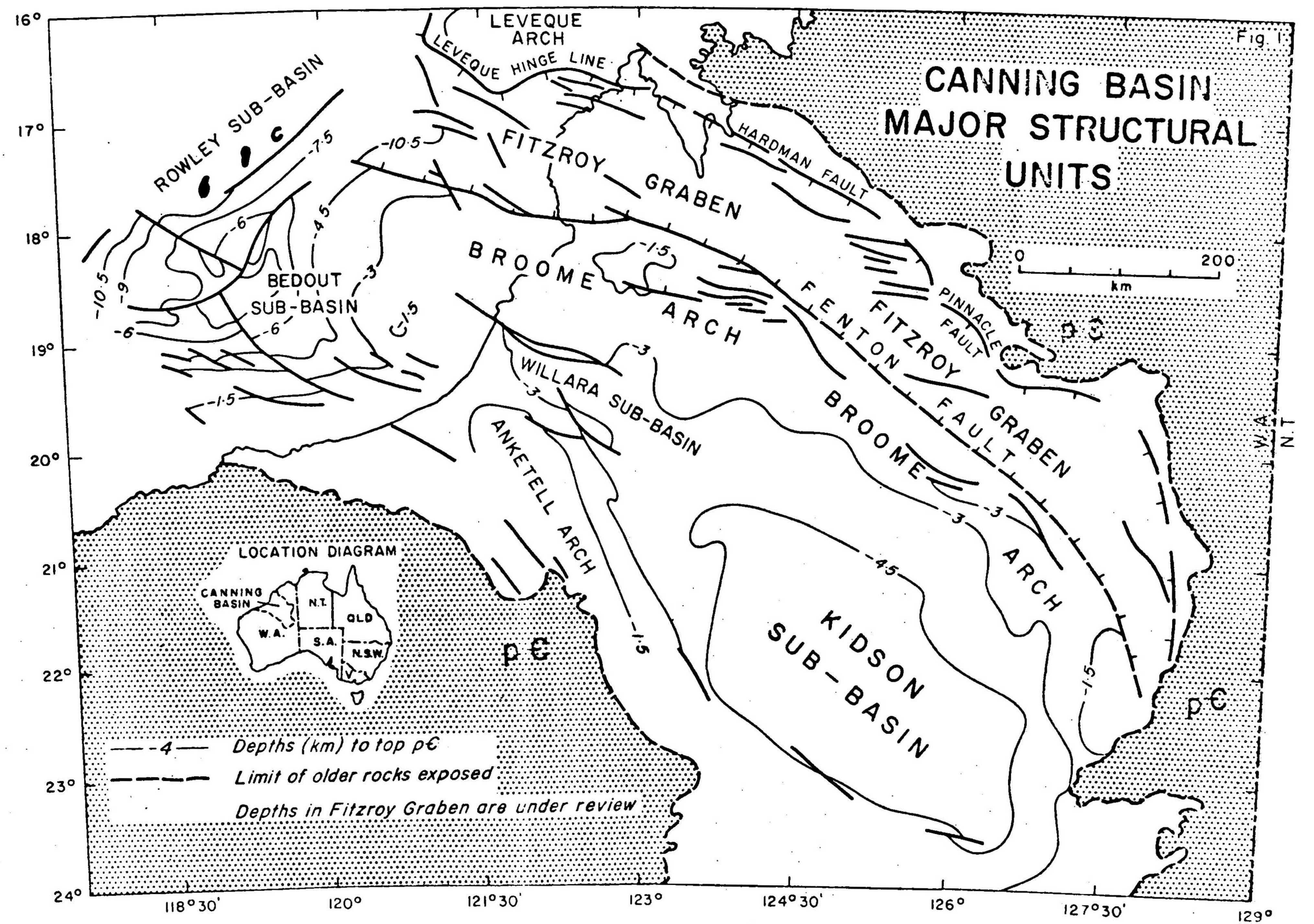

Fig. 1
CANNING BASIN
MAJOR STRUCTURAL
UNITS
LEVEQUE ARCH
LEVEQUE HINGE LINE
ROWLEY SUB-BASIN
FITZROY GRABEN
HARDMAN FAULT
BROOME ARCH
BEDOUT SUB-BASIN
FENTON FAULT
FITZROY GRABEN
PINNACLE FAULT
WILLARA SUB-BASIN
BROOME ARCH
ANKETELL ARCH
KIDSON SUB-BASIN
pЄ
0
200
km
LOCATION DIAGRAM
CANNING BASIN
N.T.
QLD
W.A.
S.A.
N.S.W.
V.
W.A.
N.T.
-4 Depths (km) to top pЄ
Limit of older rocks exposed
Depths in Fitzroy Graben are under review
16°
17°
18°
19°
20°
21°
22°
23°
24°
118°30'
120°
121°30'
123°
124°30'
126°
127°30'
129°

CANNING BASIN STUDY

Introduction - L.W. Williams

The objectives of the work of the Basin Study Group, Petroleum Exploration Branch, are outlined. The Canning Basin study has involved the assimilation of a large amount of data covering an area totalling some 600,000 km^2. The varied sequence of post-Cambrian sediments contains several prospective formations. Information from 26,000 subsidised seismic line kilometres, and 53 subsidised wells, coupled with results of surface geological mapping and reconnaissance gravity and magnetic data, form the basic material of the study. The work completed is summarised, and the future plans of the Group are described.

Structure of the Canning Basin - D.H. Tucker

Structure contour maps and cross sections illustrate the topography of the basement, and the Upper Carboniferous and Upper Triassic regional unconformities. The major structural features of the basin are (from northeast to southwest): the Kimberley Uplift; a system of gravity faults (including Pinnacle and Hardman Faults); the Fitzroy Graben; the 800 km long northwesterly trending Fenton Fault; the Broome Arch; an irregular synclinal zone which includes the Kidson Sub-basin, Willara Sub-basin, and Bedout Sub-basin; and the Pilbara Uplift (Fig. 1). The history and mechanism of development of these features are discussed.

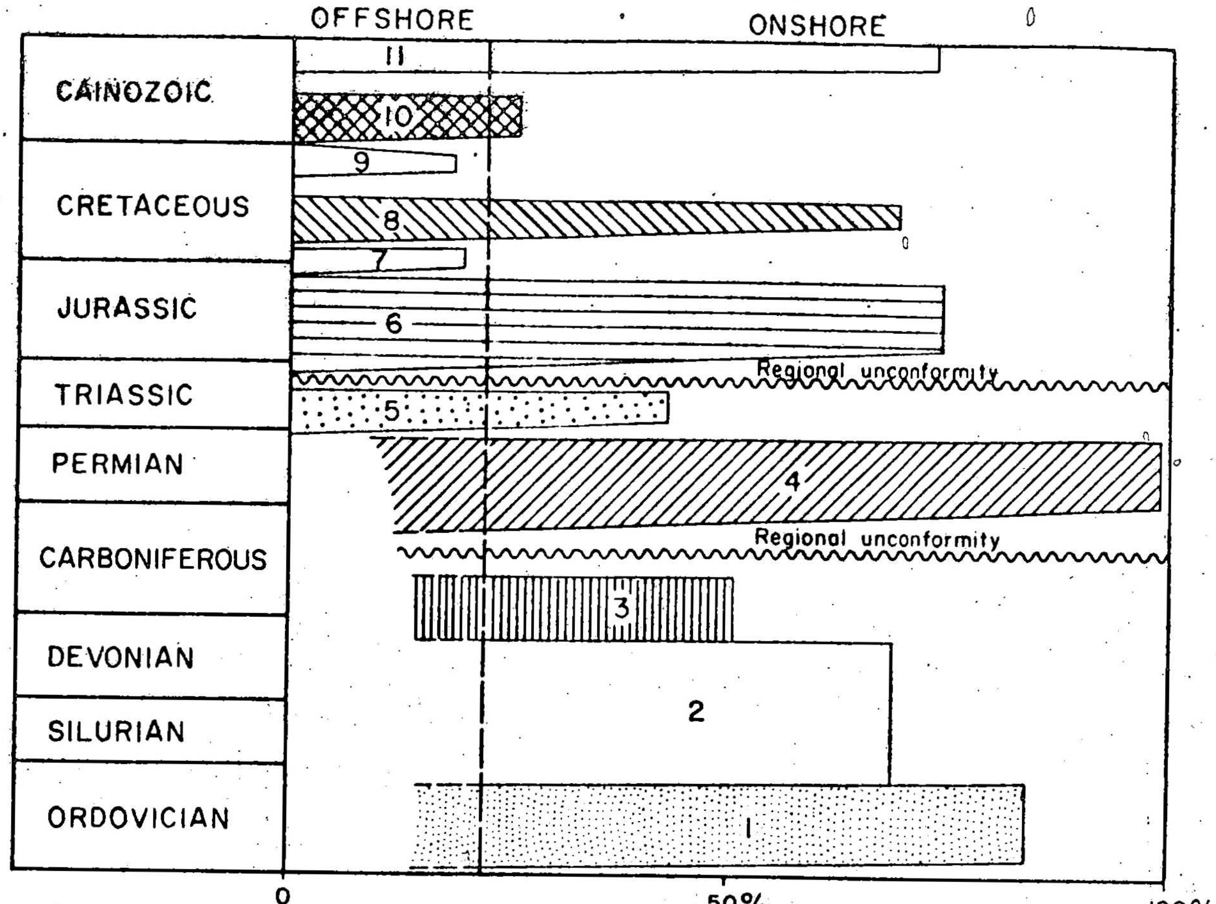

Fig. 2 CANNING BASIN - Informal stratigraphic intervals used in the study (numbered). See explanation on facing page.

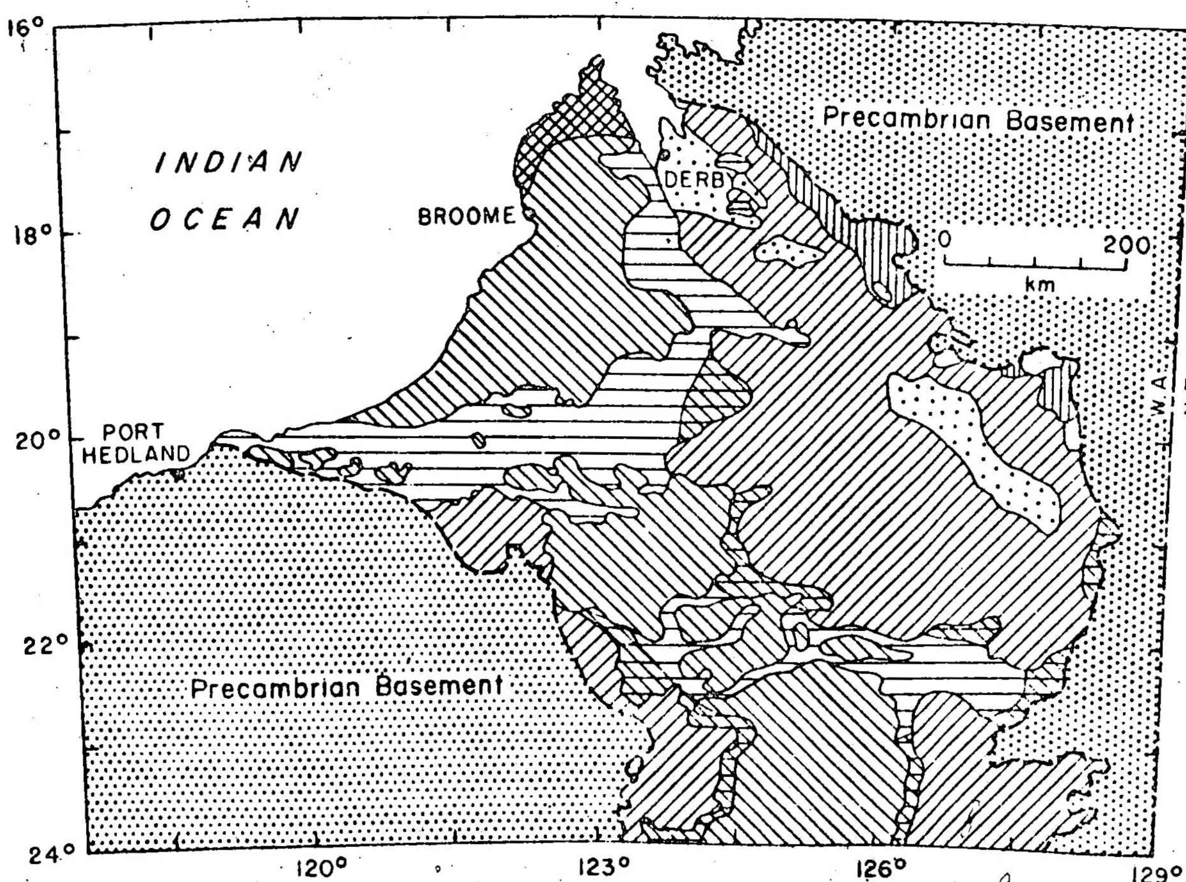

Fig. 3 CANNING BASIN - Outcrop and shallow subcrop of informal stratigraphic intervals. See Fig. 2 for key to intervals, and explanation on facing page.

History of Sedimentation in the Canning Basin - A.G.L. Paine

The Phanerozoic sediments of the Canning Basin have been grouped into eleven stratigraphic intervals for the purposes of the basin study (Figs 2 and 3). The basis for the interval selection is summarised. The depositional environments, lithofacies, areal extent and total thickness of the sediments within each interval are illustrated and discussed.

Glacial Sediments of the Canning Basin - J.D. Gorter

Palaeozoic glacigenic deposits in the basin reflect an older (Late Carboniferous) glaciation and a later (Early Permian), less severe glaciation, separated by an interglacial period which lasted for between 5 and 10 million years. Palaeontological and sedimentological features suggest that the glacial rocks were deposited in dominantly marine environments. The original distribution of the older glacial sediments has been obscured by erosion. The younger glacials interfinger with continental sediments and are preserved over a wide area overlying Precambrian rocks. Facies analysis of these sediments has been undertaken using a model proposed by Reading and Walker (1966).

The Upper Triassic-Jurassic Transgression - V.L. Passmore

Three main depocentres developed above a regional unconformity in the late Triassic-Jurassic: the Rowley Sub-basin, the Bedout Sub-basin, and the Fitzroy Graben. The environments and depositional history are discussed in detail. The limited offshore drilling in the basin has not yet adequately evaluated the petroleum potential of this interval. Reservoir rocks of this age exist in the deltaic and marine sandstones, and potential source rocks may exist in the Rowley Sub-basin.

Figures 2 and 3 - Explanation

Figure 2 shows the time-span of each informal stratigraphic interval, and the present areal extent of each interval expressed schematically as a percentage of the total area of the basin.

Figure 3 is a solid geology map which shows the present distribution of the rocks of the six intervals which crop out, and shallowly subcrop, onshore. Interval 11 onshore consists of desert sand and other superficial deposits, and has been omitted from the map. Intervals 7 and 9 are entirely offshore. Interval 2 is widespread onshore deep in the subsurface, but is not known to crop out. Combination hachuring (Intervals 6 and 8) is used to indicate areas of undifferentiated Mesozoic sediments.

Problems of Seismic Interpretation in the Canning Basin - J.S. Rasidi

Seismic data obtained from 62 surveys undertaken between 1965 and 1972 have been used in the study. The variable quality of this processed data, coupled with the geological complexity of the area, results in problems in identifying significant subsurface structures and in tracing important horizons. An example of these problems is the difficulty which has been experienced in identifying buried reefs north of the Fitzroy Graben similar to the one located in Meda No. 1. This is considered in some detail and conclusions are reached that could add to the exploration interest in the area.

Prospectivity of an Intra-Upper Devonian Unconformity in the Canning Basin - R.V. Burne

The disappointing record of application of the reef model in petroleum exploration of the Upper Devonian sediments of the Canning Basin is analysed. An alternative model relates to an intra-Upper Devonian unconformity which has been traced over the south-western margin of the Lennard Shelf. This event may be correlated across the Fitzroy Graben. Facies analysis of the lithologies about the unconformity has enabled the crude definition of the prospective situations.