

GOLD PROSPECTS IN AUSTRALASIA

by

David S. Tyrwhitt,

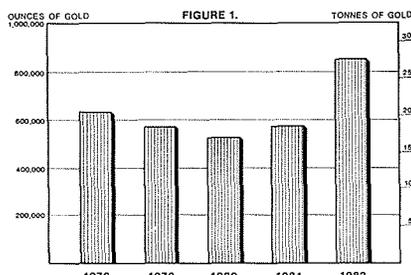
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The following is an edited version of the address by David Tyrwhitt to a seminar entitled, 'Outlook for Gold' held jointly by The Securities Institute of Australia (N.S.W. Division) and The Earth Resources Foundation, Sydney, May 26, 1983.

INTRODUCTION

This paper draws on company reports and discussions with senior geologists from the major producers. The excellent paper given by Roy Woodall, Exploration Director of Western Mining Corporation, to a gold seminar at the University of Western Australia in 1978 is especially acknowledged. Collectively these data have formed the basis of this summary, suitably updated with recent production statistics, some expansion and new developments. I have chosen to examine gold deposits in their relative position in the geological column, which underscores the major contribution made by the Western Australian Archaean producers. It extends offshore to cover the island archipelago of the SW Pacific which has contributed an annual production rate equal to or larger than Australia's for the past decade. This production, dominated by Bougainville, is from the very youngest rocks in the geological column. Some of these volcanics are so recently formed that they are still cooling down and associated with hot springs and fumarolic activity.

Australasian gold production is now examined in the context of the age of the enclosing host rocks in the following sections of this report. Provisional statistics released by the Bureau of Mineral Resources indicates a 50 per cent increase in Australian mine production of gold to 2740 tonnes in 1982*, some 880,930 ounces (Fig. 1).

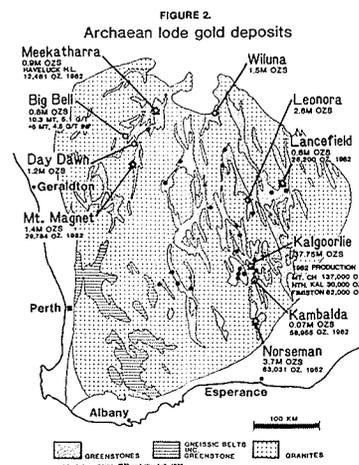


Australian gold production
INFORMATION FROM
AUSTRALIAN MINERAL INDUSTRY ANNUAL REVIEW BY BMR

*Subsequently revised downwards to 26.7 tonnes, May 1983.

ARCHAEAN

Archaean rocks are mainly confined to the two large cratonic areas in Western Australia, dominated by the Yilgarn Block including the major gold production of the Golden Mile and the smaller Pilbara Craton. Individual mines in the Archaean with a production exceeding 100,000 ozs are marked on the simplified geological plan of the Yilgarn Block shown, with those deposits where production has exceeded a million ounces being named. Production details for the major Western Australian gold mines for the year ending December 31, 1982 are also recorded on this map. Further details of gold production from these mines and other Australian producers are summarised in the table.



Mt. Charlotte

This deposit, with a reserve of about 8.5 million tonnes of 4.5 g/t Au, has been a major producer for many years and is likely to be the single largest gold mine in Australia in 1983 (Woodall 1979). Last year Mt. Charlotte produced 137,000 ozs, exceeded only by one other Australian producer the Telfer Project with 162,810 ozs. Kalgoorlie Mining Associates, (Homestake 48 per cent, KLV 52 per cent), the operators of Mt. Charlotte, are busy with expansion plans including the sinking of the Cassidy

TOTAL GOLD PRODUCTION FROM MAJOR AUSTRALIAN MINES

(All figures in ozs)

Mine	Region/ State	Present Ownership	Prod'n— To Dec 1977	Jan-June 1978	1978/ 1978	1979/ 1980	1980/ 1981	1981/ 1982	June-Dec 1982	Total Jan 1978 To Dec	Total to Dec '82 1982
Victory Hunt Sand King Great Boulder (cleanup)	Kambalda W.A.	Great Boulder Holdings Ltd. (100% WMC)	—				6,228 1,389 666	17,387 3,144 3,570 2,419	37,841	72,644 (58,955)	72,644
Mt. Charlotte Fimiston	Kalgoorlie ³ W.A.	Kalgoorlie Mining Associates	1,067,000	39,367	110,246	105,257	96,629	99,616	74,534	525,649 (137,030)	1,592,649
Nth Kalgoorlie	"	Metals Exploration- 31%	?	—	—	—	1,765	15,305	17,302	34,372 (30,121)	?
Central Norseman	Norseman W.A.	Central Norseman Gold Corp. Ltd. (WMC - 50.5%)	3,312,000 (to June '78)		83,611	77,194	73,002	79,672	44,153	357,632 (83,031)	3,669,632
Lancefield	W.A.	Great Boulder Holdings-50% Shell-50%	529,000					10,908	15,292	25,200 (26,200)	555,200
Hill 50	Mt. Magnet W.A.	Hill 50 Gold Mines N.L. (WMC-38.6%)	1,357,000					23,191	17,349	40,540 (29,784)	1,397,540
Whim Creek	Meekatharra W.A.	Whim Creek Consol. 84.6%	—	—	—	—	2,958	11,703	7,236	21,897 (12,481)	21,897
Telfer	Paterson RA., W.A.	NHPL - 70% BHP LTD:30%	143,000	227,009	172,349	132,015	130,860	162,810		825,043 (162,810)	1,000,000 ²
Warrego Gecko ⁶	Tennant Ck., N.T.	Peko-Wallsend	3,172,000	#51,000	131,927	122,654	67,802	81,087	59,867	514,377 (112,582)	3,714,436
Nobles Nob Golden 40	"	Australian Dev'tment Ltd		#3,900	7,809	5,946	8,039	N/A	2,405	28,099 (6,000)#	
Mt. Morgan ⁵ Mt. Chalmers ⁴	Queensland	Peko Wallsend	7,896,000	15,400	11,743	12,614	22,587	15,310	3,142	(1,739) 80,796 (5,055)	7,976,796
Mt. Lyell	Queenstown Tas.	Mt. Lyell Mining & Railway Co.	794,000	11,244	14,040	12,232	11,000#	13,500		62,016 (13,500)	856,016
Que River	Tas.	Aberfoyle Ltd		—	—	—	12,867	23,498		36,737 (23,498)	36,737
Rosebery	Tas.	EZ Industries	667,526	38,906	33,125	22,125	38,906	31,875		164,937 (31,875)	832,499

Estimates only

Figures in brackets denote total for 1982 Production

1982 TOTAL 797,087⁷

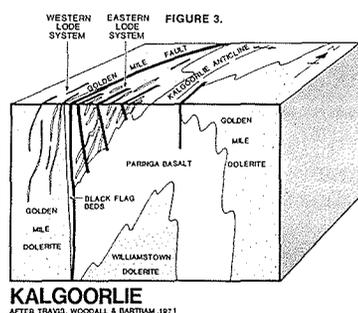
NOTES TO ACCOMPANY ABOVE TABLE ON AUSTRALIAN GOLD PRODUCTION

- Woodall, R. 1979. "Gold-Australia and the World" in Glover, J.E. & Groves, D.I. (eds) Gold mineralization. Extension Service, Uni. W.A. Publication No. 3.
- Telfer production reached one million ozs in March 1983.
- Additional production for the Kalgoorlie goldfield is 36,039,000 (Golden Mile), giving total production from Kalgoorlie of 37,718,000 ozs.
- Mt. Chalmers ceased production March 24, 1982.
- Mt. Morgan tailings retreatment operation with Australian Anglo American Ltd. (40 per cent interest) commenced April 1982. Total production for tailings retreatment 1,739 ozs. The Mt. Morgan mine closed in July 1981.
- The Gecko Mine ceased production at the end 1981.
- Mine production of gold for Australia for 1982 (estimates by BMR) 27,400 kg (880,930 ozs)*
Current producers not listed in table are:
Australis NL — Norseman, W.A. 2,277 oz
Chewton Gold Mines — Wattle Gully, Vic. 3,090
Epoch Minerals Exploration NL — Burbanks 1,550
Golconda Ltd. — Blue Spec, W.A. 957
— Lancefield, W.A. 642
Jones Mining NL — Good Enough, W.A. 2,017
Kia-Ora Gold — Marvel Loch, W.A. 6,696
— Nevoria Ore (Custom Treatment) 733
17,962
(*From: Australian Mineral Industry Annual Review — Preliminary Summary 1982. BMR Canberra)
- Nevoria was an exploration and development J.V. (BHP 60 per cent, Esso 40 per cent) recently sold to Southern Goldfields.
- Paringa Mine, W.A. (CSR 80 per cent, Hampton GM 20 per cent) produced its first gold during March 1983. The treatment plant is due for completion in mid 1983.

Shaft to 1,200 metres. The ore body is a steeply plunging pipe comprising a quartz-pyrite vein stockwork zone terminated to the north and south oblique faults trending NE.

Fimiston

Within this group of mines are the largest of the Australian producers, dominated by Great Boulder and Perseverance production of 16 million ozs from 18 million tonnes mined from several rich lodes on the Golden Mile (Woodall 1979, Travis et al 1971). Present production comes from deeper and generally lower grade zones within these vein type deposits. During 1982 KMA produced some 63,000 ozs from numerous stopping areas in the eastern lode system on the Fimiston leases (Fig. 3). Recovered grades of this telluride gold ore range from 4-6.5 g/t, well below the levels recorded from the shallower production around the turn of the century. Gold, pyrite and tellurides occur in rather diffuse silicified and hydrothermally altered lodes (0.5-3 metres wide) along steeply inclined structures transecting several of the major stratigraphic zones or units within the Golden Mile Dolerite.

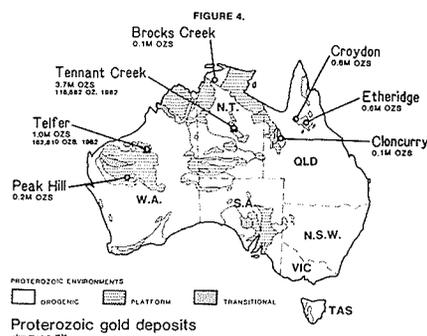


Norseman

Over 3.7 million ounces have now been produced from this goldfield, mostly from the Crown and Mararoa reefs. The reefs or veins are quartz-sulphide-gold zones generally 1-2 metres wide which cut across the Archaean Greenstone host rocks at a high angle (Hall & Bekker 1965). The enclosing metabasalt and metagabbro rocks of the Norseman Greenstone Belt dip and face steeply to the west, whereas the gold bearing reefs dip at 45° to the east. It seems likely that these veins, whose strike is parallel to the host Greenstone Belt, occupy shear or thrust zones which are persistent over several kilometres of strike length. Higher grade shoots occur within the dipping vein system. The fairly high grade of the ore mined last year at 12.5 g/t Au, clearly shows how important these shoots are in this relatively small tonnage operation. Continuing exploration, involving both surface and underground diamond drilling has led to the discovery of additional "pay shoots" which has supported 50 years of mining operation at Norseman.

PROTEROZOIC

Proterozoic rocks occupy a very extensive area of Australia but in only two highly localized districts has significant gold production been recorded. The Tennant Creek goldfield in the Northern Territory and Telfer in Western Australia have produced 3.7 and 1 million ounces respectively, a very modest production when compared with the massive 650 tonnes of gold produced each year from the Witwatersrand deposits in South Africa of Lower Proterozoic age.



Warrego

The Warrego copper-bismuth-gold mine is located 45 km north-west of Tennant Creek within sedimentary rocks of the Middle Carraman Formation of Lower Proterozoic age (Ryan, 1976). Copper production commenced in 1972 and by 1974 gold production was initiated from the deeper levels of this underground mine. Published ore reserves in 1976 were 5 million tonnes grading 7.0 g/t Au, 2.6 per cent Cu and 0.3 per cent Bi.

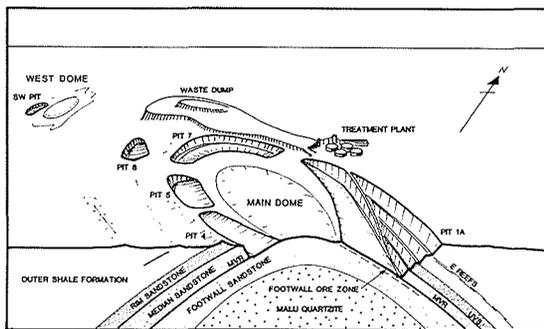
Gold, bismuth minerals and chalcopyrite are disseminated within a pipe like body of massive magnetite ironstone, containing minor quantities of quartz and chlorite. The close association of gold-copper mineralization with magnetite-hematite bodies and chloritic slates is a feature of the Tennant Creek district including the gold mines at Nobles Nob, June & Peko. Not surprisingly the use of airborne and ground magnetic surveys has played a critical role in exploration and discovery in this district.

Telfer

The Telfer gold deposits were discovered in mid 1971 and staked by Newmont early in 1972 (Tyrwhitt, 1979). Mining operations commenced early 1977, five years after the claim staking and only six years after the recording of the first gold assay. It required some \$3 million in exploration, mining engineering and metallurgical studies before a decision was made to develop an open pit mining operation. Some \$24 million was then invested by the Project owners, Newmont and BHP, in

the construction of a treatment plant (CCD 1,400 tpd), village, airport, access road and communications link. Telfer produced its 1 millionth ounce in March 1983 and the 1982 production of 162,810 ozs ranked it as the largest gold mine in Australia.

Within the Telfer district, Proterozoic rocks of the Yeneena Group (1.2 — 1.4 billion years) are folded into domes comprising more resistant sandstones with narrow interbeds of siltstone and shale, separated by poorly exposed limestones and shales in adjacent basinal structures. All economically significant gold mineralization at Telfer occurs in a series of layered or stratabound quartz-limonite reefs in which the former pyrite mineralization has been oxidized to limonite. This oxidation is prevalent to a depth of 100 metres and has vital importance in the metallurgical character of the ore, as the deeper sulphide mineralization is refractory and can probably not be economically treated in the existing Telfer Mill.



TELFER

FIGURE 5.

The most important gold reef, the Middle Vale Reef "MVR", occurs at the base of a siltstone horizon within the enclosing sandstone formations of the Main Dome structure. Additional ore of a similar grade occurs in two parallel reefs best developed over a 1.2 km strike length to the east of Main Dome. These are referred to as the E1 and E2 reefs and are about 10 metres apart and some 100 metres stratigraphically above the MVR reef. The MVR reef varies from a few centimetres thick to a maximum width of 2.5 metres. It can be traced continuously around a 4 kilometre strike length within Main Dome. It is overlain by a weakly mineralized halo reflected by a distinctive pink, iron stained colouration of the siltstone. The sandstone immediately underlying the MVR is cut by narrow quartz veinlets carrying lower grade gold values lying along joint and fracture planes.

The E reefs are also mineralized, but at a lower grade, within the West Dome structure some 2 kilometres to the west of Main Dome. Detailed drilling of these mineralized zones has shown them to be more complexly folded and faulted than at Main Dome,

further the mineralization is stacked within three to five separate horizons broadly equivalent to the E1-E2 reefs at Main Dome. Mining will only commence at West Dome during 1983, subsequently it will constitute an increasing proportion of mill feed to the Telfer treatment plant.

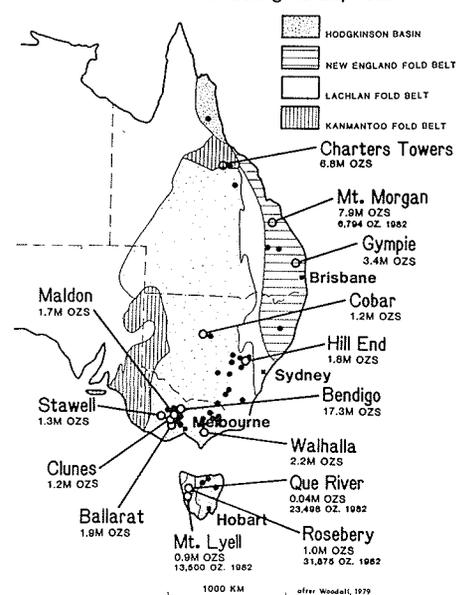
Metallurgical and economic studies are currently proceeding on the lower grade mineralization lying in the immediate footwall of the MVR reef. This mineralization is more strongly developed on the eastern flank of Main Dome and is well exposed on the gently dipping slope of the No.1A pit. Depending on gold price, metallurgical recovery and estimated mining cost, this mineralization averaging about 2.4 g/t Au. may be treated sometime after 1983 by heap leaching.

PALAEOZOIC

Historically gold production from rocks of Palaeozoic age, especially the rich Goldfields of Victoria, exceeded 100 million ounces. More than half of this production was from alluvial operations and very few of the hard rock or lode gold mines have a recorded production exceeding a million ounces (Fig. 6). Thus the very significant production of 17 million ounces from the Bendigo field of Victoria represents many separate mining operations, exploiting different portions of the strike of a particular reef system. Only the Long Tunnel mine at Walhalla and Stawell in Victoria exceeded a million ounces of gold, however the Mt. Morgan copper-gold deposit in Queensland has a recorded production of just under 8 million ounces and the Charters Towers district in North Queensland some 6.8 million ounces.

FIGURE 6.

Palaeozoic lode gold deposits



Currently gold production from Palaeozoic rocks is limited to relatively minor amounts produced as a byproduct from base metal mining at Rosebery, Que River and Mt. Lyell in Tasmania. A small production is also recorded from the Mt. Morgan district through the retreatment of mine tailings.

Rosebery

Massive sulphide base metal ores at Rosebery occur within acid volcanic rocks of the Mt. Read Belt of Cambrian age, and contain on average close to 3 g/t Au, consequently the milling of some 650,000 tonnes of sulphide ore each year leads to a significant byproduct of gold, amounting last year to over 31,000 ounces. In times of depressed base metal prices Rosebery has survived largely through the byproduct gold and silver production, supplementing the much larger tonnages recovered of zinc, lead and copper.

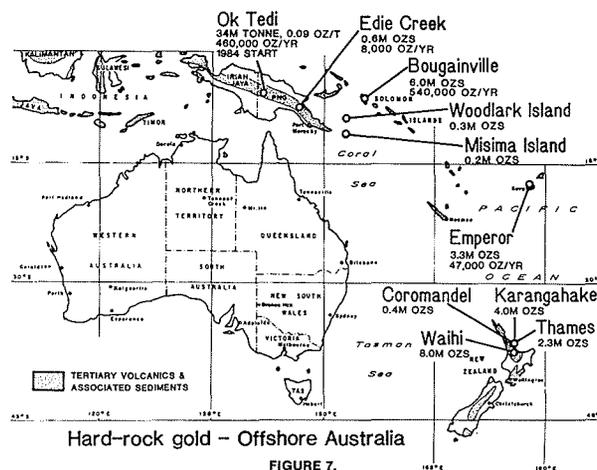
Mt. Morgan

The Mt. Morgan massive sulphide deposit occurs in a volcanic sequence of Lower to Middle Devonian age (Frets 1974). Copper sulphides and gold mineralization occur within siliceous and porphyritic rocks of both volcanic and intrusive affinity.

In the 100 year mining period, following the discovery of this copper gold deposit in 1882, over 50 million tonnes of ore was mined from open pits and underground with a production of almost 8 million ounces of gold, making this mine the second largest single producer in Australia. The last sulphide ore mined from Mt. Morgan was milled during 1981. This great mining centre will continue as a minor gold producer with the retreatment of some 40 million tonnes of mine tailings through a CIP plant for the recovery of about 40 per cent or more of the remaining 1 g/t Au (Peko 60 per cent, Australian Anglo American 40 per cent).

TERTIARY TO RECENT

Historically the considerable alluvial production of the Eastern States of Australia especially Victoria, belongs in this category. However, today these deposits have been largely exhausted and no significant gold production came from these sources during 1982. Since the scope of this review was to include the island arcs just off the coast of Australia, it includes the very large production from the Bougainville operation in Papua New Guinea. This mine and some other minor producers accounted for an estimated 548,000 ounces of production in 1982.

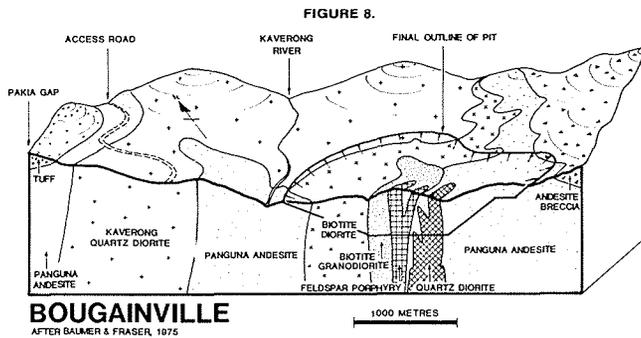


New Zealand has been important as a past producer, dominated by one operation at Waihi in the North Island which produced about 8 million ounces of gold. The Emperor mine in Fiji has recorded over 3 million ounces in its life and accounted for some 43,000 ounces last year. The Ok Tedi project in PNG is likely to come into production in 1986 at an annual rate of 460,000 ounces, only marginally lower than the present production from Bougainville.

These deposits all show a close association with Tertiary volcanic rocks of basic to intermediate composition, or with high level intrusives within the volcanic pile.

Bougainville

In 1963 Ken Phillips, then senior exploration geologist with CRA, visited the Atlas copper-porphyry mine in the Philippines. Early in 1964 when Phillips was exploring in the Bougainville area of PNG, specifically following up copper and gold indications reported by the geological survey from Kupei and Panguna, he was struck by the association of Tertiary diorite intrusives with the early indications of copper and gold mineralization, an environment strikingly similar to the Atlas mine on Cebu Island. Subsequent stream sediment geo-chemistry and geological mapping completed by Ken Phillips and his party outlined a widespread area of copper and gold mineralization in the deeply dissected and jungle clad terrain. Diamond drilling revealed a very similar geological setting to Atlas of high level intrusive plugs of diorite invading fractured andesitic volcanic rocks. By July 1967 CRA had completed 81 drill holes and were able to estimate a resource of 200 million long tons grading 0.63 per cent copper and 0.018 oz/t Au. These reserves have subsequently been substantially increased through continuing programmes of deeper diamond drilling.



Last year Bougainville produced some 17.53 tonnes (540,000 ozs) of gold as well as 170,004 tonnes of copper in concentrates and over 43 tonnes of byproduct silver, making this mine one of the worlds largest gold producers. By December 1982 Bougainville had produced over 6 million ounces of gold. The grade of ore mined last year was only 0.6 g/t Au, however the treatment rate of over 1 million tonnes of ore per week results in the large annual production rate.

EXPANSION AND NEW PRODUCERS OF THE MID 80's

The existing producers are well placed with a firm gold price of around \$A500 per ounce to maintain their operations at no less than 1982 production levels. Some of them, particularly Western Mining Corporation, have been successful in developing new gold deposits within the established mining camp of the Eastern Goldfields. In the year ending June 30, 1983, WMC expect to produce 90,000 ozs from their newly discovered Victory open cut and underground mine south of Kambalda, including minor production from the Golden Mile and Kambalda itself. The speed with which this group brought the Victory deposit from a drilling stage into a large mining operation, with ore treatment in a modified section of the Kambalda nickel mill, was most impressive and follows the pattern of the Kambalda development. Other producers on the Golden Mile in Kalgoorlie are refurbishing old treatment plants or building new ones and we can expect expanded production from North Kalgurlie, new production from the Paringa leases by CSR 80 per cent and Hampton 20 per cent of around 25,000 ozs per annum, with possibly some expansion by KMA at Fimiston.

Recent discoveries by Pancontinental at Paddington of low grade open pitable mineralization, similar in geological setting to the Mt. Charlotte deposit, offers the prospect of 90,000 ozs per annum within a few years of continuing development. Other discoveries at Harbour Lights (Esso Carr Boyd), Ora Banda (BHP) and the Mystery Lode (Occidental & Black Hill Minerals) near Mt.

Charlotte are at an earlier stage of development but may well lead to increased production from the Eastern Goldfields area.

ACM are at an advanced feasibility stage in the redevelopment of the Big Bell deposit near Cue. This underground resource of some 15 million tonnes of 4.5 g/t Au could yield up to 100,000 ozs per annum on the higher treatment rate being considered, however its location and complete lack of infrastructure and treatment facilities will make this a highly expensive investment.

Smaller companies and prospecting syndicates are actively developing heap leach operations on shallow oxidized mineralization and the retreatment of mine tailings. Collectively these operations could add a further 20,000 to 50,000 ozs per annum. Telfer is examining the possibility of treating low grade reserves of about 2.5 g/t Au by heap leaching which will supplement declining production from the main open pit operation where grades are falling.

In the Eastern states a number of companies are drilling and conducting mining and metallurgical studies on low grade volcanic pipes and breccia deposits in NE Queensland. In some of these deposits the reserves are substantial although the average grade at 1.5-2.0 g/t Au is very low, and some form of heap leaching is the only likely means of economic treatment. The most advance project is the Mungana deposit owned by Amoco Minerals 51 per cent Mungana Mines 49 per cent in the Chillagoe area of North Queensland. Mungana is a pipelike mineralised body of 13 million tonnes grading 2.3 g/t Au, 0.46 per cent copper and 5.25 g/t Ag which could be mined by open pit method with a 3.75:1 strip ratio. At a treatment rate of about 1 million tonnes per year this could yield about 80,000 ozs/annum, depending on Au recovery from this metallurgically complex mineralization.

Clearly if all of these projects reach development by the mid 1980's we could be looking at a further 50 per cent increase over the 1982 Australian gold production.

Finally in PNG the development of the Ok Tedi project by 1984 together with expansion at Edie Creek will substantially increase production in this country.

ACKNOWLEDGEMENTS

The author wishes to thank the directors of Newmont Holdings Proprietary Limited for permission to publish this review and also those staff officers who contributed to the production of the review.

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BOOK REVIEW

FAST MONEY The Money Market in Australia

by

Edna Carew

Fast and pacey, like the money market itself is my positive reaction to Edna Carew's book. It is packed with all the ingredients, a mixture of a financial encyclopaedia and a handbook, with all the facts the reader can absorb in a small book of 159 pages, excluding the index and a useful 19 page glossary.

Practical and down to earth, this book is a fascinating insight for the avid student, Edna says in her acknowledgements that if the book on publication is overtaken by further innovations, she can only applaud. Since the time of writing in mid-1982, the speed of change continues both with the new freedoms for Semi-Government Authorities from Loan Council and the Martin Committee of Inquiry, which will be reporting to the Government on the Campbell Committee's recommendations later this year.

We have also seen in recent weeks the first issue of an inflation-linked security and the study given to the reforms in New Zealand, which if introduced here would see the trading banks losing their monopoly of foreign exchange business.

Edna Carew deserves a lot of credit as a financial journalist, and with her colleagues, provides daily essential reading, both for dealers and other participants in the capital markets. Her book is a necessary passport to understanding that arcane world.

Let us hope other equally gifted writers take up the cudgels and report on the fixed interest markets in greater detail. It deserves a lot of exposure.

Ray Block