

17th IGES Exploring the Tropics Townsville, Australia

EXCURSION GUIDE Excursions 4, 5, 6 & 7 May, 1995

- Drummond Basin
- Ravenswood Block
- Far North Qld Gold/Nickel/ Tin/Base Metal Deposits

Tour Leader: Simon Beams

17th International Geochemical Exploration Symposium



Jointly sponsored by the Economic Geology Research Unit. Department of Earth Sciences, James Cook University of North Queensland & the Association of Exploration Geochemists





Front Cover Centre photo: Dry Monsoonal Australia - Rob Jung, CSIRO DC & ET Left photo: Tropical Rainforest Nicaragua - Russell Myers, James Cook University 17th International Geochemical Exploration Symposium Exploring the Tropics

> EXCURSION GUIDE EXCURSIONS 4, 5, 6 & 7 MAY 1995

DRUMMOND BASIN RAVENSWOOD BLOCK FAR NORTH QLD GOLD/NICKEL/TIN BASE METAL DEPOSITS

Tour Leader: Simon Beams

17th IGES 15-19 May 1995 Townsville, Australia

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Foreword and acknowledgements

Simon D. Beams

Terra Search Pty Ltd, P.O. Box 981, Hyde Park, Townsville, Qld 4812

The Northeast Queensland excursions associated with the 17th International Geochemical Exploration Symposium in Townsville in May 1995 will visit most of the major mineral deposits of the region. These deposits are at various stages of development from advanced exploration projects to operating and decommissioned mines. They also occur in a range of geological environments, tectonic settings and cover a diverse group of commodities. They include the two largest gold mines in Eastern Australia (Kidston and Mt Leyshon breccia deposits), the largest economic lateritic nickel deposit in Australia (Greenvale), one of the few truely bonanza grade gold deposits (Pajingo epithermal vein) and one of the most prospective belts for polymetallic massive sulphide mineralization (Mt Windsor Subprovince/Balcooma Belt).

The exploration geochemistry and discovery history of each deposit will be emphasized together with the mine scale geology and, if relevant, the role of geochemistry in the evaluation, exploration and waste management aspects. Insights into the regolith of the region will also be gained.

This handbook briefly summarizes what participants will see on the excursions. It is a companion volume to EGRU Contribution No. 52 *The Mineral Deposits of Northeast Queensland: Geology and Geochemistry*, which is a comprehensive up to date compendium on the mineral deposits of the region.

I have received great support from all facets of the mining and exploration industry to organize these excursions. Sincere thanks go to all the companies and individuals involved:

Excursion 4

Pajingo Gold Mine:	Battle Mountain (Australia) Inc. Bruce Jones, Ian Tredinnick and Jim Cornwell		
Yandan, Wirralie, Mt Coolon:	Ross Mining Mike Seed, Roger Mustard, John Lawton, Peter Ruxton		
Excursions 5 and 6			
Ravenswood:	MIM Exploration Pty Ltd Ken Harvey, Don McIntosh, Chris Green, David A-Izzeddin		
Mt Leyshon:	Mt Leyshon Gold Mines Ltd Tom Orr, John Campbell		
Highway/Reward:	Aberfoyle Resources Ltd Ed Dronseika, Tony Hespe		
Thalanga, Liontown & Waterloo:	Pancontinental Mining Jeff Ford, Rod Sainty, Wally Hermann, Craig Miller		

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Excursion 7				
Greenvale:	Queensland Nickel Pty Ltd John Parianos, Norm Morwood, Peter Burger (Consultant), David Newton (Woodward Clyde AGC)			
Balcooma:	Lachlan Resources N.L. Stuart Moore			
Kidston:	Kidston Gold Mines Ltd Frank Tullemans, Ron Furnell (Rocsol Pty Ltd)			
Triple Crown:	Strike Mining N.L. John Gallo			
Mt Garnet Zn Skarn:	Perilya Mines Ltd John Hartley			
Mt Garnet Wriggilite	Mike Rubenach (James Cook University, Department of Earth Sciences)			
Herberton Tin:	Graham Greaves (Consultant), Gavin Clarke (JCU).			

In addition the following exploration service companies provided support for the production of the guidebook:

Amdel Laboratories Ltd Cherlor Drillers Pty Ltd Klondike Exploration Ltd Laing Exploration Pty Ltd Rowe Enterprises (Qld) Pty Ltd

Thanks to the Economic Geology Research Unit (EGRU) at James Cook University, Townsville and its Director Associate Professor Roger Taylor for providing the ideal forum to unite such an industry group.

Finally, thanks go to Terra Search Pty Ltd for providing logistics support for the excursions, Deirdre Rodwell from Terra Search Pty Ltd for typing and collating the guide, Adam Scott for helping with the drafting of the diagrams and Kaylene Camuti from Lantana Exploration for editing and organizing the printing.

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Major base and gold deposits of Northeast Queensland. Visited by Excursions 4 to 7.



Excursions 4 to 7 in relation to major geological provinces of Northeast Queensland.



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Excursion 4 Epithermal gold deposits of the Drummond Basin

Tour Leader: Simon Beams

Terra Search Pty Ltd, PO Box 981, Hyde Park, Townsville Qld 4812

Itinerary

Day One

Thursday, 11th May, 1995

7.30 AM	Depart Sheraton Breakwater Casino Hotel, Townsville.				
9.00 - 9.15	Charters Towers.				
9.15 - 10.15	Drive to Pajingo. Meet Ian Tredinnick, Jim Cornwell, Battle Mountain				
	Australia, Pajingo Gold Mine.				
10.15 - 12.30	Tour Pajingo mine operations.				
12.30 - 1.15	Lunch and core yard.				
1.15 - 2.00	Pajingo mine operations. Depart Pajingo.				
2.00 - 4.30	Drive Pajingo - Mt Coolon. Meet Mike Seed, Roger Mustard, Ross				
	Mining N.L.				
4.30 - 5.30	Tour Koala deposit Mt Coolon.				
5.30 PM	Arrive Ross Mining N.L.'s Mt Coolon Camp.				

Dinner Mt Coolon Camp

Day Two

Friday, 12th May, 1995

Breakfast 7.00 - 7.45 Mt Coolon Camp

8.00 AM	Depart Mt Coolon.
9.00 - 9.00	Drive to Yandan.
9.00 - 11.30	Tour to Yandan led by Mike Seed.
11.30 - 12.30	Lunch and core examination.
2.30 - 2.00	Drive Yandan to Wirralie.
2.00 - 4.00	Wirralie pit tour.
4.00 - 7.30	Drive Wirralie to Townsville.
7.30 PM	Arrive Sheraton Breakwater Casino Hotel, Townsville.



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Trip Log (See also Morrison, 1988)						
<i>Day One</i> 0 km	Depart Sheraton Breakwater Casino Hotel, Townsville.					
14 km	Stuart.					
	Hills here and to east going toward Woodstock are Permo-Carboniferous intermediate volcanics and cogenetic granites of the Coast Range Igneous Province.					
37 km	Woodstock-Calcium.					
	Hills to west are Devonian continental and shallow marine sediments unconformable on the Ordovician-Devonian Ravenswood Batholith and intruded by Permo-Carboniferous granite. Marble quarries near Calcium feed the Stuart Cement Works.					
70 km	Haughton Valley Bluff.					
	To south is a bluff of Upper Devonian conglomerate overlying Siluro- Devonian granodiorite of Ravenswood Batholith. The granodiorite forms prominent tors as we ascend the Mingela Range.					
83 km	Mingela.					
	Top of Leichardt Range and on a plateau of the Ordovician to Devonian granodioritic Ravenswood Batholith of the Charters Towers Province.					
108 km	Burdekin River.					
	Largest river in North Queensland. A major source of irrigation water for coastal canefields and supplemental water supply for Townsville City.					
135 km	Charters Towers.					
	Historic mining centre that produced over 200 tonnes (6 million oz) of gold from mesothermal quartz veins hosted in Devonian tonalite and Ordovician granodiorite. Workings are predominantly under the town and the mullock heaps have been removed as railway ballast and road metal. A few cyanide tailings dumps are still evident, some have been reworked and now require rehabilitation as contaminated sites. Charters Towers Gold Mines have put a decline down in the last 12 months to the deeper levels of the original lodes.					
135 km	Pass former pyrite works processing plant, Dalrymple Cattle Yards and Shire Workshops and turn south on Clermont Highway. Traverse across Ordovician Siluro-Devonian granitoids of the Ravenswood Batholith. At Broughton River prominant tors of hornblende biotite magnetite Siluro- Devonian Broughton River Granodiorite.					
151 km	Mount Leyshon turnoff.					
	From the Mount Leyshon turnoff on the Clermont Highway we drive south over various Ordovician and Devonian granitoids of the Ravenswood Batholith, including the prominent black soil area and dark outcrops of the Black Knob Gabbro. Old workings follow thin gold bearing vein structures cutting the gabbro.					

	Liontown turnoff.				
	Liontown is a Cambro-Ordovician volcanogenic Cu-Zn massive sulphide deposit with Au credit and historic production of 526 kg Au from the oxide zone.				
	Just west of Mount Farrenden we cross the intrusive contact with the Cambro-Ordovician Seventy Mine Range volcano-sedimentary package. To the west, the prominent flat-topped Mount Windsor is composed of rhyolite with some andesite and dacite. East of the road, Mount Farrenden consists of hornfelsed Puddler Creek Formation micaceous sandstones. Further to the east, the highest hills are porphyritic rhyolites of the Mount Windsor Volcanic unit. The Truncheon advanced argillic alteration system and the nose of the Highway Syncline occupy hills in the middle distance on the eastern side of the road.				
169 km	Highway Mine.				
169 - 208 km	Highway to Pajingo.				
	Low relief region commences just south of Highway Mine, where the Tertiary-Quaternary fluviatile sediments and lateritized duricrust of the Campaspe Formation onlap onto the Palaeozoic basement. Low hills are eroded remants of basement.				
188 km	Turnoff to Pajingo Mine.				
208 km	Pajingo plant site.				
228 km	Return to Clermont Highway.				
228 - 409 km	Pajingo turnoff to Mt Coolon traverses Tertiary-Quaternary sediments with low hills of Devonian to Carboniferous Drummond Basin volcanic- sedimentary units.				
357 km	Bowen Development Road Junction near Belyando.				
	Low relief region between Belyando and Mt Coolon traverses over thick Tertiary sedimentary cover of the Suttor Formation and black soil.				
409 km	Mt Coolon.				
	Old gold mining centre, discovered 1913. Main production 1931-1939 by Gold Mines of Australia. Total production 137 000 ounces Au.				
<i>Day Two</i> 0 - 45 km	Mt Coolon to Yandan.				
	Traverses mostly areas of no outcrop covered by Tertiary sediments or low outcrop of Drummond Basin.				
45 - 90 km	Return to Mt Coolon.				
90 - 125 km	Mt Coolon to Wirralie.				
	Hills of Drummond Basin rocks overlain by low relief areas of Tertiary to Quaternary cover.				

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125- 185 km	Wirralie to Burdekin Dam.				
	Hills of Devonian to Carboniferous volcanics and sediments of the Drummond Basin intruded by Permo Carboniferous granitoids. Older Tertiary land surface forms prominent mesas of fluviatile sediments capped by laterite and duricrust. Gorge of Carboniferous volcanics cut by the Burdekin River at the Burdekin Dam.				
185 - 265 km	Burdekin Dam to Ravenswood.				
	Basal sequence of Drummond Basin sediments and volcanics exposed for the first 5km then cross back into the Ravenswood Batholith. Siluro- Devonian granitoids intrude Cambro Ordovician volcano-sedimentary remnants. Younger Permo Carboniferous high level intrusive complexes intrude the Lower Palaeozoic rocks to the east eg. Rangeview, Mt Glenroy, Mt Canton and some of the hills to west eg. Camp Oven Mountain.				
265 km	Ravenswood.				
	Old gold mining centre, discovered 1868, back into production since 1986. Total gold production to date stands at 1.1 million oz Au.				
265 - 302 km	Ravenswood to Mingela. Mt Wright a Permo-Carboniferous breccia forms a prominent hill 5km north west of the town. The road to Mingela traverses various Ordovician to Siluro-Devonian age plutons of the composite Ravenswood Batholith.				
302 - 385 km	Return to Townsville.				

Reference

Morrison, G.W., 1988. Epithermal and Porphyry Style Gold Deposits in North Queensland. EGRU Contribution No. 29. James Cook University. p112.

Pajingo gold mine: field excursion

Ian Tredinnick¹ Jim Cornwell¹ Simon Beams²

¹Pajingo Gold Mine, Battle Mountain (Australia) Inc. PO Box 237, Charters Towers, Qld 4820 ²Terra Search Pty Ltd, PO Box 981, Hyde Park, Townsville, Qld 4812

Mineralisation Style and Status

Bonanza grade epithermal vein system hosted in Permian andesite with some volcanic breccia. Overlain to south by Tertiary lateritized colluvium. Pajingo is a partly decommissioned mine. Mining of the Scott Lode has finished, currently the Cindy Vein is being mined underground. Waste heaps have been rehabilitated. Acid mine drainage is being monitored.

Main Stops: (Figure 1)

- 1. Overview of tailings dam with discussion of environmental geochemistry. Figure 2.
- 2. Waste dump reclaimation overview.
- 3. Outcropping Janet A Vein part of discovery vein set.
- 4. Overview of Pajingo pit.
- 5. Traverse from Molly Darling sandstone, volcanic breccia to Scott Lode and southern wall of the pit.
- 6. Examination of laterite weathering profile.
- 7. Stream sediment sampling localities.
- 8. Core yard. Examination of holes:
 - JMD 200 (82 132m) representative vein intersection in western limb of Scott Lode
 - JMD 221 (51 120m) vein intersection in bend area
 - JMD 181 (59 127m) agrillic and propylitic alteration within andesite
 - JMD 220 (36 41m) carbonate replacement textures
- JMRD 1518 Cindy Vein mineralization.
- 9. Cindy Vein mineralization overview of pit.
- 10. Low grade ore stock pile typical epithermal textures within quartz vein material colloform banding, cockade textures, through to massive chalcedonic silica and brecciated quartz vein material.

References

Bobis, R.E., 1990. Geologic Setting of a Bonanza Vein Gold Deposit at Pajingo, Northeast Queensland. Quarterly Report, February 1990, Epithermal Gold Deposits in Queensland. Amira Project p.247,. unpublished.

Porter, R., 1988. The Pajingo Gold Mine. In: *Bicentennial Gold 88 Epithermal and Porphyry Style Gold Deposits in North Queensland.* (Ed. G. Morrison), pp.23-42. EGRU Contribution 29. James Cook University of North Queensland.

Porter, R.G., 1991. The Pajingo Epithermal vein deposit. A review of the geological setting, geochemical signature and relationship between quartz, vein textures and gold mineralisation. Msc Thesis James Cook University of North Queensland. Unpubl.

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Quartz Vein Textures

JMD 220 : 36.85 - 41.16m

Bladed textures is considered to be a replacement texture in the quartz-limonite vein pseudomorphing calcite blades. Note strong quartz-limonite multidirectional veins/veinlets developed adjacent to the main vein. Wallrock is argillic (kaolinite-illite-smectite-quartz) altered porphyritic andesite. Gold tenor averages 1.42 g/t (Renato Bobis).

Alteration (Renato Bobis)

Petrography and extensive XRD analyses of samples were performed in drillhole JMD 181. JMD 181 is located 220 meters ENE of the Lode's hinge zone and is inclined NW at 50 degrees (Figure 4).

Sample Depth	Rock Type Alteration Petrography/X Mineralogy		Petrography/XRD Mineralogy Clay:	
59.5	andesite	epi-bearing propylitic	pl, q, c, py, chl, epi, k	sm/chl, I, k
59.5	vein		q, pl, chl, c, ank, k	
66.0	andesite	epi-bearing propylitic	q, pl, ank, chl, k	k, chl, s
79.5	andesite	propylitic	q, pl, ank, k, chl	k, chl (Mg>Fe), I
81.2	breccia	propylitic	q, py, jk, l, pyr, c, chl	k, l, chl (Mg>Fe), (V, k/s, l/s)
82.2	breccia	argillic	q, k, l, pyr, c, ank	I, k, pyr
84.6	clays			k, I, I/s
97.0	lithic tuff ?	argillic	q, py, k, I	k, I
98.5	lithic tuff ?	argillic	q, py, k, l	k, I
127.5	clays		q, py, I, ank	I, km I/s, k/s
plagioclase - pl quartz - q calcite - c		kaolinite - k illite - I smectite - s		

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chlorite - chl

pyrophyllite - pyr vermiculite - V

ankerite - ank

siderite - sid

pyrite - py



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Summary Log JMPD 200 (Porter, 1988)

Representative vein intersection in western limb of Scott Lode. Refer to Figure 4 for location, graphic log and gold assay summary.

0 - 20 m	Lateritised colluvium.
20 - 59 m	Lateritised andesitic crystal tuff.
59 m	Limit of percussion precollar.
59 - 91 m	Oxidised andesitic crystal tuff with local lithic fragments. Sparse crustiform quartz veins.
91 m	Limit of pervasive oxidation.
91 - 109.4 m	Porphyritic andesite lava with pyrite replacing feldspar phenocrysts and pervasive ilite-clay alteration. Sparse crustiform quartz veins.
109.4 - 131 m	Brecciated andesitic lava with strong illite alteration and 20% quartz as a stockwork of colloform and massive quartz veins.
	112 - 118.7m: Pervasively silicified and veined lava with strong rebrecciation in multiple events. Bands and fragments of dark silica with finely divided sulphide as well as colloform, crustiform and crystalline fragments and infill.
131 - 142.7 m	Gradational contacts top and 138 m from clay altered to propylitic (hematite- chlorite) altered plagioclase-pyroxene porphyritic lava. Sparse crustiform

quartz veins.



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Summary Log JMD 221 (Porter, 1988)

Representative vein intersection in "bend area" of Scott Lode. Refer to Figure 3 for location, graphic log and gold assay summary.

- 0 20 m Lateritised volcanic.
- 20 55 m Andesitic crystal tuff with sparse lithic tuff bands. Broken in zones that in part define grain size boundaries suggesting faulting. Completely oxidised to hematite-goethite to 44.8m, partly oxidised fracture controlled to 50.8 m, weakly oxidised to 55.3 m overprinting clay alteration. Sparse colloform and milky microcrystalline veins.
- 55 70.3 m Andesitic crystal tuff, illite alteration with zones of variably oriented quartz veins. Veinlet networks (55 - 60.1 m and 63.7 - 70.3 m) orthogonal or multiple veinlet sets with microcrystalline weakly colloform texture. Thicker parallel vein sets (60.1 - 63.7 m) have similar texture to main vein.
- 70.3 78.2 m Main vein domninated by colloform and crustiform chalcedonic, microcyrstalline massive and crytalline banded quartz locally with bladed and fibrous pseudomorphs, amethystine bands, cavities and partly oxidised sulphide partings.
- 78.2 96.9 m Coarse and fine crystal tuff with pervasive illite alteration with networks of quartz veinlets and local thicker veins.
- 96.9 104 m Coarse crystal tuff with background chlorite-montmorillonite alteration and vein related illite-siderite alteration now as prominent brown oxidised selvages.
- 104 120 m Crystal and lithic tuff with weak stockwork fractures illite-quartz alteration and some pyrite after feldspar phenocrysts.

116.4 - 120 m: Breccia with fine fragments and sheared and fractured margins suggesting hydrothermal rather than volcanic origin.



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Mt Coolon/Koala epithermal vein: field excursion

Led by Roger Mustard

Ross Mining NL, Yandan Gold Mine, PO Box 242, Collinsville, Qld 4804

Mineralisation Style and Project Status

Epithermal quartz vein mined in the period 1914 - 1939. Currently undergoing redevelopment by Ross Mining N.L.

The following paper reprinted from: Excursion Notes. NQ Gold 1989, Ed: C. Cosstick, Australasian Institute Mining & Metallurgy, North Queensland Branch.

THE GEOLOGY AND EXPLORATION OF THE MT COOLON GOLD DEPOSIT

By K. WELLS¹ , A.M. MURRAY² , R.D. CUNNEEN³

ABSTRACT

Exploration in the vicinity of the abandoned Mt Coolon mine has shown that the shape and attitude of the quartz lode is controlled by the interaction between the lode and a converging syncline. Gold grades within the lode are enhanced along intersections with a welded ignimbrite, and decline rapidly where the lode intersects unwelded ignimbrite.

Mineralogy and textures indicate the vein has an epithermal origin modified by a later intrusive event.

INTRODUCTION

The Mt Coolon mine is located approximately 250kms south of Townsville in the Drummond Basin. The quartz lode was discovered in 1913 and initial development involved a number of small syndicates. In 1931 Gold Mines of Australia rationalised the tenements into one operation which continued until the mine was abandoned in 1939.

Table 1 - Production from Mt Coolon Gold Mine (modified from Coldham 1953)

	Production		Value g/t		
Period	Tons Ore	OL AV	Recovered	Ore	Level
				(approx)	
1914 - 1931	38973	41337	33.8	-	
1931 - 1934	142218	82139	18.4	20.2	NO 263
1935- 1937	84716	36988	13.9	15.5	NO 3
1938	53421	18126	10.9	12.2	NO 4
TOTAL	280355	137253	14.6	16.3	

Following the closure of the mine therewas little activity in the area until the 1970s. when the area was investigated for base metals. With the advent of the 1980s gold boom the region became the focus of intense explorationactivity and a Joint Venture between Saracen Minerals N.L. and Renison Limited commenced work at Mt Coolon in 1985.

GEOLOGICAL SETTING

The geological setting is shown in Fig. 1. There are three main structural units. 1. The Anakie Inlier is a broadly North to

1. The Anakie Inlier is a broadly North to South trending early Paleaozoic inlier within the Drummond Basin. The inlier consists of fine grained metasediments: slate, phyllite and schist, isoclinally folded around NNE axes.

The Drummond Basin consists of a mixed 2. sequence of Devonian-Carboniferous sediments and volcanics. In the Mt Coolon area the bulk of the sequence has been assigned to the Mt Formation/Silver Hills volcanics Wyatt comprising medium to thick bedded ignimbrites, dacitic tuffs. basalts. rhvolitic and sandstones, siltstones and shales (Grimes et al 1986).

3. The Bulgonunna Volcanics in the North East part of the area form the Southern portion of a large, late Carboniferous to early Permian volcanic and plutonic province. A thick sequence of ignimbrites and acid volcanics are associated with (co-magmatic?) acid to intermediate intrusives.

Cainozic sediments obscure much of the area and the entire region has undergone Tertiary lateritic weathering.

MINE GEOLOGY

COUNTRY ROCK

 Regional Manager, 2. Chief Exploration Geologist and 3. Senior Geologist, RGC Exploration Pty. Limited, 16 Douglas Street, Milton, Brisbane, Queensland, 4064. In the immediate mine area the Drummond Basin wedges out and the Anakie Metamorphics are in direct contact with the Bulgonunna volcanics which host the mineralization. The host rocks consist exclusively of shallow dipping ignimbrite flow sheets which range from rhyolitic to andesitic in composition (Fig. 2). The bulk of the lode occurs within the andesitic ignimbrite which forms the basal sequence of the Bulgonunna volcanics. The lode transmits only weakly into the overlying rhyolitic ignimbrite.

Recent interpretation of drill core indicates the sequence is gently folded about (grid) NNW axes, with shallow plunges to the south.

Approximately 500m to the (grid) west of the Mt Coolon lode a major granodioritic intrusion outcrops (Fig. 2). The edge of this plutom is subparallel to the lode, which together with the host rocks shows the effects of contact metamorphism and metasomatism.





MT COOLON REEF

Shape and Attitude

The reef has been traced over 1.3 kms (9600N-10900N). For most part the lode occurs as a single vein of variable width, with numerous small irregular splays. Widths vary from 1.5m to 8.0m, with an average of 2.5m (Morton 1935).

South of 9800N the lode horsetails into several smaller verns with irregular strikes and dips. Between 9800N and 10200N the lode strikes north to south and dips west at 75° to 85° .

From 10200N to 10350N the lode thins and changes strike and dip. The lode curves eastward to 15° to 20° east of north and the dips "rollover" from steeply west, through to steeply east.

Between 10350N and 10500N the lode thickens but maintains its eastward dip and strike direction. However, it is cut by several post mineral faults orientated (grid) NW and WNW, which divide the lode into a series of offset blocks. The WNW set has sinistral offsets with northside downthrown and NW set has dextral offsets with northside upthrown. The largest fault at 10350N has a maximum offset of 40m horizontally or 200m vertically. North of 10500N the lode maintains its east dip (85°) but resumes its north to south strike.

Mineralogy

Quartz is the principal mineral. It is mainly chalcedonic in appearance but two distinct types can be recognized: an early, crustiform, banded phase and a later, massive, cherty quartz. Other minerals roughly in order of abundance are adularia, pyrite (< 1%), biotite, actinolite, magnetite, tourmaline, epidote, zeolites and carbonates.

Locally the vein has a narrow, highly pyritic, sericite selvage, but wall rock relationships vary from sharp to diffuse depending upon rock type. Where the lode intersects welded ignimbrite the contacts are sharp reflecting the more competent nature of the welded unit and its ability to sustain a brittle fracture. In the unwelded unit the contact is more diffuse, grading through a lm to 2m zone of partial silicification to a Significant gold grades are silicifed core. restricted to the silicified core and largely confined within the zone of welded ignimbrite.

EXPLORATION PROGRAMME

Examination of old mine records indicated that:

1. Cut off grade was 9 g/t Au

2. The main stoped area extended from 9700N to 10200N, but there were two other small isolated stopes at 10300N and 10400N (Fig. 4).

This data suggested the possibility of lower grade (< 9 g/t Au) yet still economically attractive reef beyond the stope limits. In addition sampling of old workings gave significant grades and widths in country rock.

Accordingly an RC drilling programme was undertaken to test the margins of the vein as well as a deeper diamond drilling programme to test for depths extensions to the reef system. The RC programme failed to detect any mineralization of economic significance, but the diamond drilling intersected low grade but strongly developed reef beneath the old stopes.



Further diamond drilling traced the reef northwards and indicated ore grade mineralization north of 10300N (Fig. 4). However, only minor tonnages of ore were detected immediately below the old stopes and the reef fades at depth.

Subsequently the zone of interest was diamond drilled on 50m centres with the oxidized zone being closed up to 25m centres using RC drilling.

The total resource is in the order of 600,000 tonnes at 4.5 g/t Au. The proposed operation would consist of an open pit of 200,000 tonnes at 5.5 g/t Au, plus reprocessing of tailings. Some potential for further underground mining also exists.

COMMENTS AND CONCLUSIONS

ORE CONTROLS

The base of the economic mineralization coincides with a change in the country rock from welded to unwelded ignimbrite. As the reef passes downwards it becomes more diffuse and "deflects" (Fig. 3). This change in dip is



in part due to refraction of the lode as it passes through rocks of varying competence. However, the overall shape and variations in attitude are controlled by the structural relationship between the lode and a syncline located immediately to the East. The axis of the syncline and the lode converge northwards and cross in the vicinity of 10350N, where the cross faulting is sub parallel to the axial plane.

In longitudinal section (Fig. 4) the sloping base of the main stoped area, north of 10000N reflects the south plunge of the syncline. The reappearance of welded ignimbrite and ore grade reef north of 10300N is due to down faulting.

Paragenesis

Detailed examination reveals three distinct vein stages.

1. An initial colloform banded quartz/adularia vein filling.

2. A later K silicate phase comprising predominantly massive silica associated with biotite, actinolite, epidote, magnetite and pyrite. This phase is coeval with metamorphism of the host rocks.

3. A final stage of localized sericite alteration which converted the K silicate minerals to a sericite/pyrite assemblage.

Joyce (1986) established that the banded quartz was a seperate phase, devoid of fluid inclusions, which had been recrystallized by the hornfelsing event. Jones (1985) examining fluid inclusions in the massive silica identified high temperature, high saline fluids characteristic of plutonic fluids.

The genesis of the Mt Coolon lode is thought to have involved the establishment of an early epithermal vein, which has been overprinted by a later massive silica phase of intrusive affinities.

ACKNOWLEDGMENTS

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17thIGES, May 1995, Townsville, Queensland

MOUNT COOLON - EXCURSION GUIDE

ACCESS

From Mt Coolon township travel south on Nebo road for 3 km. Turn left across cattle grid into Mt Coolon Project camp (150 m). Just before entering camp, bear right and follow track to corner of fence enclosing old workings (approx 200 m). Park here.

STOP 1. HECTORINA SHAFT

Enter fenced area and walk to old shaft in extreme SE corner of enclosure. (CAUTION: numerous old workings exposed; EXTREME CARE required). Principal vein exposed in collar of shaft is quite massive, shows banding structures, and dips 60 deg to W.

Walk NW along line of old workings. Observe horsetailing of vein, with pits and shafts following lines of minor splays. 70 m NW of Hectorina, immediately before the first open stope, is a good outcrop of the vein.

STOP 2. WEST SIDE OF OPEN STOPE

Note change of strike as vein starts to trend N. Low grade pillar immediately to N. Looking into SE end of stope, shallow dipping underground stope can be seen at base. A thin vertical vein has also been found extending to surface, indicating another horsetail. (EXTREME CARE). Portal of exploratory decline is 100 m E of this.

Follow E side of open stopes northwards to Main Shaft, approx 250 m.

STOP 3. MAIN SHAFT

Shaft is open to at least 100 m depth and was used for ventilation and power to exploratory decline. May be viewed from the NE corner of concrete collar, with EXTREME CARE. Shaft is collared on the vein, which at this point dips 75-80 deg to W. This dip can be seen in open stope to the S.

Wallrock andesite showing regional hornfelsing, and also samples of mineralized lode, can be found in the mullock heap adjacent to shaft.

Proceed N over part of dump and along E side of open stope (140 m). W side of stope actively collapsing.

STOP 4. N END OF OPEN STOPE

Roof pillars only 2 m thick; TARE CARE. Stope timbers still in place. Lode now vertical to steep E dip. Change from outcropping hard (welded?) andesite to soft highly weathered and lateritized (unwelded?) andesite. Lode no longer detectable on surface either as siliceous vein or geochemical feature.

Continue N past dumps around Water Shaft to Collinsville Syndicate Shafts (200 m).

STOP 5. COLLINSVILLE SYNDICATE SHAFTS

Last surface workings. Sunk to locate possible westerly displacement of lode, but just missed because still on S side of fault. Major fault zone now known to be 20 m wide striking SE-NW immediately N of shafts, with 40 m sinistral throw of lode. No visible signs on surface. Proposed new open pit would be centred here, extending 100 m to S and 250 m to N.

Proceed NE down small creek tributary to main channel.

STOP 6. CREEK CHANNEL

Channel is cut in laterized rhyolite, distinguished by yellow colour and common quartz grains. In tributary bed about 50 m to SW, contact with underlying weathered andesite is defined by change to reddish quartz-poor laterite. On hill slope to E, lag of relatively fresh rhyolite forms scree on surface. Return up creek tributary and follow track at approx 10220 N to tailings dump. Keep tailings on right and continue on track southwards to old plant area near Main Shaft.

STOP 7. OLD PLANT AREA

Foundations of ball mill, leach tanks, assay office, etc.. Old compressor still on site.

Climb N flank of Mt Coolon to summit. Outcropping fresh andesite with clasts and fiamme visible on etched surfaces.

STOP 8. MT COOLON SUMMIT

Overview andesite over lain by acid ignimbrites and lavas of the Bulgonunna Volcanics to the E. Bulgonunna Peak on E horizon. To W, depressed ground is occupied by intrusive tonalite complex. To N, Bungobine-Wirralie area visible on horizon.

Descend S flank of hill back to vehicles.



17thIGES, May 1995, Townsville, Queensland

Yandan gold mine: field excursion

Led by Mike Seed

Ross Mining NL, Yandan Gold Mine, PO Box 242, Collinsville, Qld 4804

Mineralisation Style & Project Status

Epithermal disseminated deposit hosted within volcaniclastics and andesites. Mined by open pit.

- **STOP 1** View north to hanging wall. North dipping sediments.
- **STOP 2** Siliceous alteration core.
- **STOP 3** Bottom of pit. Sandy hydrothermal breccia with sediments. ENE structures. Yandan Feeder Zone. The main hydrothermal conduct and the highest grade ore.
- **STOP 4** Site of original -80# stream sediment sample.
- **STOP 5** Top of East Hill. Sinter deposit folded around the nose of an anticline with the Yandan Andesite in its core.



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Wirralie Gold Mine: field excursion

Led by Mike Seed

Ross Mining NL, Yandan Gold Mine, PO Box 242, Collinsville, Qld 4804

Mineralisation Style and Project Status

Disseminated and stockwork epithermal deposit hosted with volcaniclastic sediments. Open cut mine operated 1987 - 1992.

- **STOP 1** View of pit ; West Wall Juggler Fault, Hanging Wall crystal tuffs. Footwall sediments.
- **STOP 2** Moderate angle structure (MAS) Pit A.
- STOP 3 Juggler Fault gouge.

17thIGES, May 1995, Townsville, Queensland



Field demonstration of the PIMA II: an infrared spectrometer for field-based alteration mapping

Sasha Pontual and Nick Merry

SPic Pty Ltd, 7 Upalong Road, Mount Dandenong, Vic 3767

Introduction

The Portable Infrared Mineral Analyser (PIMA II) is a field-portable infrared spectrometer that provides field-based analyses of sample mineralogy, allowing detailed alteration studies of prospects or mine sites to be made quickly and cheaply. The PIMA also provides a method for rapid assessment of the relationship between ore grade and alteration mineralogy through the routine measurement of geochemical pulps.

One of the most significant applications of the PIMA is in delineating mineralogical variations within alteration systems, either at the surface from measurements of outcrop and soils, or at depth from analyses of percussion and drill core samples.

By using the PIMA the exploration geologist greatly increases the speed and accuracy with which they can:

- locate potential targets;
- delineate alteration systems;
- understand the relationships between alteration and economic mineralisation;
- evaluate the 3D geometry and extent of mineralisation;
- locate overburden/bedrock boundaries;
- delineate stratigraphic horizons in paleo-lakes and channels.

Over recent years, the PIMA has been effectively applied to mineral exploration in Australia, USA, South Africa, Chile and Europe.

This paper accompanies the demonstration of PIMA, which will be given on the field excursion to the Drummond Basin epithermal deposits: Pajingo, Wirralie and Yandan. The data discussed in this paper are from samples representative of the significant alteration signatures of each deposit. On-site measurements will also be made at each locality during the course of the excursion.

The PIMA II

The PIMA II is a fully field-portable infrared spectrometer, which measures the reflectance spectra of rocks and minerals in the short wavelength infrared (SWIR), from 1300-2500nm. The PIMA measures the reflected radiation from the surface of a sample using an internal light source producing laboratory quality spectral data of minerals. Aside from mineral identification, the spectra recorded by the PIMA also permit the determination of fine spectral details, such as crystallinity variations and elemental substitution. Each measurements requires no sample preparation and takes 30-60 seconds, allowing the rapid collection of a large number of analyses.

Measurements can be made of all types of samples including diamond drill core, RC and RAB chips, outcrop and soil samples and selective measurements may be made of *in situ* veins, breccia clasts and small-scale alteration zoning. Given these unique advantages, the PIMA is rapidly becoming an invaluable tool in mineral exploration and mine development.

Mineral Identification Using the PIMA II

Although visual interpretation of PIMA spectral data by a trained geologist is often required, project specific automatic mineral identification is possible at many sites. Mineral identification from these data is a structured step-by-step process that allows the user to quickly assess both single and mixed mineral spectral data.

The spectral absorption features observed in the spectral data are related to the bending and stretching of molecular bonds. The bonds giving rise to absorption features in the SWIR include those in hydroxyl, water, carbonate and ammonia and between Al-OH, Mg-OH, and Fe-OH. These molecules are found as major components in phyllosilicates (including clay, chlorite and serpentine minerals), hydroxylated silicates (such as epidotes and amphiboles), sulphates (including alunite, jarosite and gypsum) and carbonates. Because of unique crystallographic and lattice conditions and compositional influences, each mineral has a distinctive spectral signature. These distinctive spectral signatures may be quickly identified using spectral libraries and examples are illustrated in Figure 1.

In addition to mineral identification, the PIMA spectra can also provide information on the degree of crystallinity of a mineral and on compositional variations within a mineral group. These factors are often important in establishing the relationship between ore grade and mineralogy. Furthermore, this type of information can be invaluable to exploration programs aimed at extending known mineral resources. Many studies have shown that mineral composition and crystallinity may vary systematically in an alteration system as a function of the temperature and composition of the altering fluids and with proximity to zones of mineralisation (Lentz, 1994). mapping these variations using the PIMA can allow field geologists to evaluate mineralisation/alteration relationships and to locate themselves within an alteration system.

Examples of Mineral Spectra at Pajingo, Yandan, and Wirralie Gold Mines

The PIMA is ideally suited for mapping alteration zoning in epithermal systems, as the alteration minerals in such systems have distinctive spectral signatures. This section illustrates some examples of the spectral responses of the alteration mineralogy in core samples from the Yandan and Wirralie core displays, and from thin section stubs from Pajingo. All these samples will be on display during the excursion. In addition to demonstrating the PIMA with these same samples, the PIMA will be onsite throughout the excursion and used to analyse samples at each locality.

Pajingo Gold Mine

Figure 2 illustrates examples of mineral spectra of samples from different positions and different lithologies within the Pajingo alteration system, and illustrates how the spectral signature varies between various lithologies, such as quartz sandstone-shale, porphyritic andesite, breccias and vein breccias.

Yandan Gold Mine

Figure 3 illustrates examples of mineral spectra from mineralised samples in the core display.

Wirralie Gold Mine

Figure 4 illustrates examples of mineral spectra from core display samples

Summary

The versatility of the PIMA provides a rapid, effective and low cost indication of mineralogical, crystallinity and compositional variations in a suite of samples that can often be related to grade variations. This type of analysis can often replace or supplement XRD and other expensive lab-based techniques. Given these unique advantages, the PIMA is rapidly becoming widely used for mineral exploration and geological mapping.

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Excursion 5 and 6 Ravenswood/Charters Towers

Tour Leader: Simon Beams

Terra Search Pty Ltd, PO Box 981, Hyde Park, Townsville Qld 4812

Itinerary

Excursion 5:	Saturday 13th May, 1995 - Sunday 14th May, 1995	
Excursion 6:	Saturday 20th May, 1995 - Sunday 21st May, 1995	

Day One			
7.30 AM	Depart Townsville. Drive to Ravenswood.		
9.00	Overview of Carpentaria Gold Pty Ltd/MIM Exploration Pty Ltd's		
	operations at Ravenswood. Meet Don McIntosh, Chris Green,		
	David A-Izzeddin, Don Macansh, MIMEX personnel.		
9.30 - 10.30	Ravenswood pit areas.		
10.30 - 12.15	Mt Wright area.		
12.15 - 12.30	Return to Ravenswood.		
12.30 - 2.00	Core examination and lunch		
2.00 - 3.00	Drive Ravenswood to Charters Towers		
3.00 - 3.30	Examine regolith profile Charters Towers area		
330 - 500	Core display polymetallic massive sulphides Mt Windsor Subprovince		
PM	Thalanga (Pancontinental Mining): Reward Highway		
1 1 1	Handcuff (Aberfoyle Resources/Sabminco): Waterloo/Agincourt		
	(Pancontinental Mining)		
	Meet: Wally Hermann Pancontinental/Thalanga		
	Ed Dronseika Aberfovle Recourses		
	Pod Spinty, Depoentinental Mining		
	Rou Sainty, I ancontinental Winning.		
Overnight:	Charters Towers		
U	Commercial Hotel Ph: 077-871391		
	Crown Hotel Ph: 077-872471		
	Rix Hotel Ph: 077-871605		
	Dinner for whole party at Commercial Hotel.		
Day Two			
7 2 0 4 3 4	6.30 - 7.15 Breakfast for whole party at Commercial Hotel.		
7.30 AM	Depart Charters Towers for Mt Leyshon.		
8.00 - 9.00	Meet John Campbell, Tom Orr, Mt Leyshon Gold Mines Limited.		
	Presentation and review Mt Leyshon regional geology, geochemistry,		
	mine geology and evaluation.		
9.00 - 11.30	Overview of plant, mining operations, visit open cut Mt Leyshon.		
11.30 - 1.00	Core review and lunch.		
1.00 - 1.45	Depart Mt Leyshon, drive to Highway/Reward.		
1.45 - 2.30	Meet Ed Dronseika, Aberfoyle Resources. Reward surface geology and		
	Campaspe cover.		
2.30 - 3.00	Highway pit area.		
3.00 - 3.30	Drive Highway to Liontown, passing Waterloo.		
3.30 - 4.15	Meet Craig Miller (Pancontinental Mining). Liontown surface traverse.		
4.15 - 5.00	Liontown core examination.		
5.00 - 7.00	Drive Liontown to Charters Towers to Townsville.		
PM			

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Figure 1. Excursion 5 & 6: Mines and localities to visit, core to examine. Relationship to basement geology of Eastern Lolworth - Ravenswood Province after Hutton et al., 1993.

Trip Log (See also Morrison, 1988)		
<i>Day One</i> 0 km	Depart Sheraton Breakwater Casino Hotel, Townsville.	
14 km	Stuart.	
	Hills here and to east going toward Woodstock are Permo-Carboniferous intermediate volcanics and cogenetic granites of the Coast Range Igneous Province.	
37 km	Woodstock-Calcium.	
	Hills to west are Devonian continental and shallow marine sediments unconformable on the Ordovician-Devonian Ravenswood Batholith and intruded by Permo-Carboniferous granite. Marble quarries near Calcium feed the Stuart Cement Works.	
70 km	Haughton Valley Bluff.	
	To south is a bluff of Upper Devonian conglomerate overlying Siluro- Devonian granodiorite of Ravenswood Batholith. The granodiorite forms prominent tors as we ascend the Mingela Range.	
83 km	Mingela.	
	Top of Leichardt Range and on a plateau of the Ordovician to Devonian granodioritic Ravenswood Batholith of the Charters Towers Province.	
83 - 124 km	Mingela to Ravenswood.	
	Traverse over felsic coarse grained granites/ademellites and moderately mafic hornblende-biotite-magnetite granodiorite of the composite Ravenswood Batholith. 5 km north of Ravenswood is a triangular shaped hill, Mt Wright, a Permo-Carboniferous breccia body which is contoured with drill tracks. Cleared area around Ravenswood within Siluro-Devonian Jessop Creek Tonalite now mainly covered with introduced vegetation species such as Chinee apple and rubber vine in creeks. Hills to north are of Ordovician felsic coarse grained Millaroo Granite.	
124 - 162 km	Return to Mingela.	
162 - 191 km	Burdekin River.	
	Largest river in North Queensland. Country between Mingela and Charters Towers consists of typical semi-arid savannah woodland tropics - marginal cattle grazing country developed on granites of the Ravenswood Batholith.	
191 - 210 km	Charters Towers.	
	Historic mining centre that produced over 200 tonnes (6 million oz) of gold from mesothermal quartz veins hosted in Devonian tonalite and Ordovician granodiorite. Workings are predominantly under the town and the mullock heaps have been removed as railway ballast and road metal. A few cyanide tailings dumps are still evident, some have been reworked and now require rehabilitation as contaminated sites. Charters Towers	

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Gold Mines have put a decline down in the last 12 months to the deeper levels of the original lodes.

Day Two	
0 km	Charters Towers
	Pass former pyrite works processing plant Dalrymple Cattle Yards and Shire Workshops and turn south on Clermont Highway. Traverse across Ordovician Siluro-Devonian granitoids of the Ravenswood Batholith. At Broughton River prominant tors of hornblende biotite magnetite Siluro- Devonian Broughton River Granodiorite.
16 km	Mount Leyshon turnoff.
16 - 24 km	Mount Leyshon.
	The road from the Clermont Highway traverses across a large Siluro Devonian pluton of the hornblende-biotite-magnetite bearing Broughton River Granodiorite, within the Ravenswood Batholith. Immediately north of Mount Leyshon at Clarke Creek, we cross the contact into the older Ordovician age Schreibers Granodiorite, then some thin screens of Cambro-Ordovician metasediment and into the strongly outcropping felsic Ordovician Fenian Granite. The Mount Leyshon breccia complex occurs on the contact of the Fenian Granite and Cambro- Ordovician country rock sediments.
24 - 32 km	Return to Clermont Highway.
32 - 50 km	Mount Leyshon turnoff to Highway/Reward.
	From the Mount Leyshon turnoff on the Clermont Highway we drive south over various Ordovician and Devonian granitoids of the Ravenswood Batholith, including the prominent black soil area and dark outcrops of the Black Knob Gabbro. Old workings follow thin gold bearing vein structures cutting the gabbro.
	Liontown turnoff.
	Liontown is a Cambro-Ordovician volcanogenic Cu-Zn massive sulphide deposit with Au credit and historic production of 526 kg Au from the oxide zone.
	Just west of Mount Farrenden we cross the intrusive contact with the Cambro-Ordovician Seventy Mine Range volcano-sedimentary package. To the west, the prominent flat-topped Mount Windsor is composed of rhyolite with some andesite and dacite. East of the road, Mount Farrenden consists of hornfelsed Puddler Creek Formation micaceous sandstones. Further to the east, the highest hills are porphyritic rhyolites of the Mount Windsor Volcanic unit. The Truncheon advanced argillic alteration system and the nose of the Highway Syncline occupy hills in the middle distance on the eastern side of the road.
50 - 54 km	Retrace north to Liontown turnoff.

54 -73 km	Clermont Highway to Liontown.
	Road traverses primarily over low relief areas of Ravenswood Batholith granitoids which become more poorly outcropping as we head west. The hills to the south are the Seventy Mile Range consisting of rhyolitic units within the Cambro Ordovician Mt Windsor Volcanics. 5km north of Liontown the low relief area to the east contains the Waterloo and Agincourt massive sulphide deposits buried under 30 to 50 m of cover. The low outcrop on the western side of the road hosts a Pb rich gossan. The majority of the low relief area between Waterloo and Liontown is covered by Tertiary sediments. Outcrop/subcrop is only present on the low hills at Liontown itself.
73 - 253 km	Return Liontown to Charters Towers and then on to Townsville.

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Carpentaria Gold Pty Ltd's Ravenswood Operations

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Mineralisation Style & Project Status

Porphyry related vein breccia and quartz sericite lodes within tonalite. Historic mining area, redeveloped in 1987 with open cut and underground operations.

STOP 1 - RAVENSWOOD TOWN BACKGROUND

Historical Perspective

Old Courthouse - originally built in 1885 - recently returned to original site and restored - many mining disputes settled here - focal point of Ravenswood's mining history.

Ravenswood township recognised by Queensland Department of Environment and Heritage as a significant site worthy of preservation.

Carpentaria Gold Pty Ltd, a wholly owned subsidiary of MIM Holdings Limited, has successfully operated at the interface of heritage/environmental values and mining values with : collaboration on historic preservation projects; ongoing rehabilitation projects, and operated under special conditions regarding blasting, dust and noise, and completely back filling one pit.

Significant historical events - District explored by Leichardt in the 1840's. Gold first found at Ravenswood 1868, short lived gold rush until easily won gold exhausted in gold recovery problems from sulphide ore. Formation of New Ravenswood Company in 1896, with metallurgical problem solved and amalgamation of major mines. Town population exceeds 4500 in 1906. From 1912 rapid decline of Ravenswood due to extended miners strike and then of World War I. Almost no activity untilk Carpentaria Gold commenced intensive gold exploration in 1986.

Total gold production from Ravenswood to date stands at 1.1 million oz Au.

Rebirth of Mining at Ravenswood: MIM 1987 - Present

MIM's mining operations at Ravenswood commenced in 1987 and were essentially confined to the town area until 1992 when operations extended to the Mt Wright property 10 kms north of Ravenswood.

All mining activities to date have been undertaken by contractors who supply ore to MIM's crushing and processing plant 2 kms east of Ravenswood. The average number of MIM employees on site for operations to date is 30.

To 1993 about 1.75 million tonnes of Ravenswood ore has been mined and processed with an average head grade of 3.2 g/t Au.

Initially all mining was by open pit, switching to underground mining from 1991.

During the currency of open pit mining both Heap Leach and Carbon in Pulp gold extraction processes were used. With the advent of underground mining only CIP has been used. Average gold recoveries achieved were 65% for Heap Leach and 90% for CIP.

Geological Perspective

Oldest rocks in the district are a sequence of volcanics and sediments of Cambrian to Ordovician age intruding these is the Regional Ravenswood Granodiorite Complex of Ordovician to Devonian age within which the Ravenswood district occupies the south eastern corner. Isolated residuals of overlying Upper Devonian sediments remain in the area. A variety of subordinate Carboniferous to Permian intrusives were then emplaced. Throughout the protracted intrusive history of the area, regionally significant structural forces were applied to the country rock resulting in numerous fractures and shears.

General nature of Ravenswood mineralization

A series of hydrothermal systems have developed a complex of superimposed alteration and mineralization phases located in zones of fractured, sheared and brecciated rock.

Two economically significant phases are : (i) auriferous quartz sulphide dominated fracture infill mineralization which has yielded more than 80% of the gold produced to date from Ravenswood. (ii) auriferous chlorite altered shear structures of which the so called "Buck Reef" structure is the largest.

Buck Reef Mining

Three pits and one underground project have worked the Buck Reef structure. Production to 1993 from these is as follows:

SYC Pit	526467t @ 2.73g/t Au
OCA Pit	297811t @ 3.40g/t Au
BRW Pit	168852t @ 2.79g/t Au
OCA Underground	135000t @ 4.10g/t Au

The pit mining involved drilling and blasting benches of 5 metres, that were mined as two, 2.5 metre flitches. Intensive grade control was applied to the mining which involved sampling of all blast holes, mapping of all flitch surfaces and a geologist being present during all mining of ore.

Lode Structure Mining

Three pits and one underground project have worked quartz sulphide lode structures. Production from these is as follows:

Area 4 Pits	50158t @ 2.4g/t Au
Area 5 Pit	285726t @ 2.42g/t Au
MSA Pit	48176t @ 3.47g/t Au
Area 2 Underground	52140t @ 10.30g/t Au

The pit mining proceeded in the same fashion as for the Buck Reef mining. The MSA Pit was backfilled with waste rock on completion of mining as part of the mining lease requirements. The Area 5 Pit is currently being used as a water reservoir.

The Area 2 underground project which is now being extended, is accessed by a 600 metre long decline with a portal in the wall of the BRW Pit. On reaching the Area 2 lode the decline zig zags downwards but maintains a position 10 - 20 metres into the footwall of the lode structure, to a total depth of 90 metres below surface. At 10 metre vertical intervals, cross-cuts extend across to either the northern or southern end of the lode structure. Sill drives were then developed using hand held drills, along the length of the lode. Grade control was applied to the sill developments and included detailed mapping of the face and back and sampling of each face.

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