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## 1. SUMMARY

CRA Exploration Pty. Limited (CRAE) is exploring EL 36/92 for low grade Ni mineralisation and hydrothermal Cu-Au mineralisation in the Cambrian mafic-ultramafic Heazlewood River (HRC) and Mount Stewart (MSC) Complexes.

Review of previous exploration within the Heazlewood licence area is continuing. Compilation of previous workers stream sediment sample data shows low sample density (particularly base metal) over the HRC and MSC. Stream sediment sampling used in conjunction with the detailed geological maps of previous workers may be useful in vectoring Ni sulphide and Cu-Au mineralisation given the poor soil development over the complexes.

Reconnaissance geochemical and petrological rock chip sampling of areas highlighted by previous explorers returned best assays of 5.4% Ni & 1.2 g/t Au from the Brassy Mine, and 1.2% Ni from the Fentons Knob.

Geochemical and petrological sampling of mullock heaps of adits into silica-carbonate altered tholeiitic lavas of the HRC returned best assays of:

18.7% Cu, 2.5% Pb, & 1.5% Zn;  
16.8% Cu & 1.4 g/t Au; and  
34.3% Zn, 15.3% Pb, 6.0% Cu, & 8.2 g/t Au.

The ambiguous coincidence of elevated Au-Cu-Pd with disseminated sulphide textures and Pb-Zn in NW faulted silica-carbonate rocks probably represents Devonian granite mineralisation (cf. the Magnet Mine) superimposed (remobilising/enhancing?) on Cambrian hydrothermal mineralisation related to the extrusion of the tholeiitic lavas.

The major focus for exploration in 1994 will be identifying areas/units within the HRC and MSC prospective for Ni and Cu-Au mineralisation.

## 2. INTRODUCTION

EL 36/92 Heazlewood was granted on the 6th of March 1993 for an initial tenure of one year. The exploration licence encompasses an area of 109 sq km and is located on the Arthur River 7915 and Pieman 7914 1:100,000 map sheets as shown in Plan Tv 645. During the period under review, CRAE has a statutory obligation to expend \$21,800. This report details all exploration activities conducted within EL 36/92 by CRAE during 1993.

CRA Exploration is exploring Heazlewood EL36/92 for low grade Ni deposits. Exploration activities by CRAE elsewhere in Australia have led to the recognition that certain types of ultramafic complex may host low-grade Ni mineralisation in a form that offers superior metallurgical characteristics to the conventional pyrrhotite-pentlandite ores. While the mechanism to produce this style of mineralisation is not yet understood, serpentine development and low Fe may be key requirements. CRAE is investigating the development of this type of Ni mineralisation within the HRC and MSC.

Recognition of highly mineralised zones (Cu-Au  $\pm$ Pb-Zn) in mafic extrusive rocks of the HRC warrants follow up work given the potential for a large Cambrian hydrothermal Cu-Au resource.

### 3. RECOMMENDATIONS

Review of previous exploration data should be completed as a priority.

A program of stream sediment sampling should be carried out over the HRC and MSC to supplement sparse data already compiled. Results of sampling will aid in the identification of Ni and Cu-Au prospect areas.

Areas leaking anomalous geochemistry not already tested by previous workers should be followed up by a program of detailed mapping (on established or new grids) and systematic geochemical and petrological rock chip sampling - with the aim of identifying potential drill targets.

Results from analysis of samples taken from adits into low-Ti tholeiitic basalt lavas warrant follow-up (as above) - given the potential for a large "Cambrian hydrothermal" Cu-Au resource.

### 4. REGIONAL GEOLOGY

#### 4.1 Regional Geological Setting

The Heazlewood River and Mount Stewart Complexes are two of several mafic-ultramafic complexes occurring within Cambrian volcano-sedimentary troughs in western Tasmania. The HRC and MSC are located within the northern part of the Dundas Trough which comprises Eocambrian and Cambrian volcanic and sedimentary sequences, and is host to most of Tasmania's ultramafic complexes.

The mafic-ultramafic complexes are allochthonous bodies that were tectonically emplaced during the middle Cambrian (Brown, 1986). In general, there is a predominance of olivine and orthopyroxene cumulates, locally abundant gabbroic dykes and sills, and an association between the cumulates and two volcanic suites - boninite and low Ti-tholeiitic basalts.

The HRC must represent a high level intrusion and cannot be classified as an ophiolite (Rubenach, 1973; Brown et al., 1980; Varne & Foden, 1987) in the absence of upper mantle rocks (Peck & Keays, 1990). The association between the cumulates and boninite indicates that the mafic-ultramafic complexes probably formed in an island-arc environment (Berry & Crawford, 1988).

#### 4.2 Geology of the HRC

Recent accounts of the geology of the HRC were summarised by Peck and Keays (1990) - that summary is presented below. The distribution of rocks types is shown in Fig.1.

- The largest (50 sq km) and least dismembered ultramafic complex in Tasmania.
- Initially emplaced during the Middle Cambrian and subsequently re-emplaced during an episode of compressional deformation during the Devonian (Rubenack, 1973; Brown, 1986).
- Consists of 5 km (max.) of layered ultramafic cumulates and cross cutting gabbroic rocks and 3 km (max.) of overlying low-Ti tholeiitic basalt and boninite (Brown, 1986).
- Hosts a tonalite complex and probable tectonic melanges (Creenaune, 1980).
- Cumulate layering is well developed in many parts of the complex and trends NE with near vertical dips (young to the E).
- Variably serpentinised.
- Cut by many faults and shear zones which trend NW, N and NE (parallel to layering).
- A major NS fault divides the complex into western and eastern sections (Peck & Keays, 1990).

##### 4.2.1 Western Cumulates:

The western section represents the product of two major cycles. The earliest cycle produced a sequence:

Nineteen Mile Creek dunite  
Fenton's Spur peridotite  
Cawdry's Hill pyroxenite

The subsequent cycle produced:

Gabbro Hill Plagioclase pyroxenite

Both cycles show an upward (easterly) increase in opx at the expense of ol. Dunite and harzburgite are the predominant rock types at the base of the succession. Orthopyroxenite and plagioclase websterite are most common at intermediate levels, and postcumulus cpx and plg occur at the top of both successions.

A strong Fe enrichment trend in spinel composition over the lowermost 3 km of the system suggests that the western section has evolved as a closed system. On a finer scale, sharp reversals in spinel composition, and well developed rhythmic layering is consistent with several periods of magma addition.

#### 4.2.2 Eastern Cumulates:

By contrast, the large numbers of compositional reversals and absence of protracted fractional trends in spinel composition suggest the eastern succession evolved as an open system.

The nature of the contacts between the Nineteen Mile Creek dunite sequence and Bronzite Hill orthopyroxenite sequence with the Purcell's Plain lherzolite sequence is unclear. The Bronzite Hill sequence is correlated with the *orthopyroxenite-rich parts of the Nineteen Mile Creek sequence*. However, neither the Purcell's Plain sequence nor the Brassey Hill harzburgite sequence can be correlated with the cumulate successions of the western section.

The Purcell's Plain lherzolite comprises a basal dunite-harzburgite succession and an overlying rhythmically layered plagioclase dunite-plagioclase peridotite succession. It is conformably overlaid by the Brassey Hill sequence which is made up of several cyclic units comprising dunite (base), poikilitic harzburgite, olivine orthopyroxenite, and orthopyroxenite (top).

#### 4.2.3 Mafic Dykes:

Three suites of dykes are recognised within the cumulate sequences:

- (i) fine grained gabbro
- (ii) medium grained leucogabbro & anorthosite
- (iii) coarse grained & pegmatitic gabbro and plagioclase pyroxenite

Dykes are generally less than one metre thick and tabular (type i - up to 200 m thick). Dykes are common in the *eastern section* and intrude the Gabbro Hill, Caudry's Hill, and Brassey Hill sequences in the *western section*.

#### 4.2.4 Volcanics:

Creenaune (1980) and Brown *et al.* (1980) identified two distinctive volcanic suites within the HRC including:

low-Ti tholeiitic basalt; and  
high-Mg andesite - analogous to modern boninite lava (Brown & Jenner, 1989).

Contacts between the volcanic rocks and cumulate sequences are assumed to be faulted - although most contacts are not well exposed, and most faults are inferred (Peck, 1990).

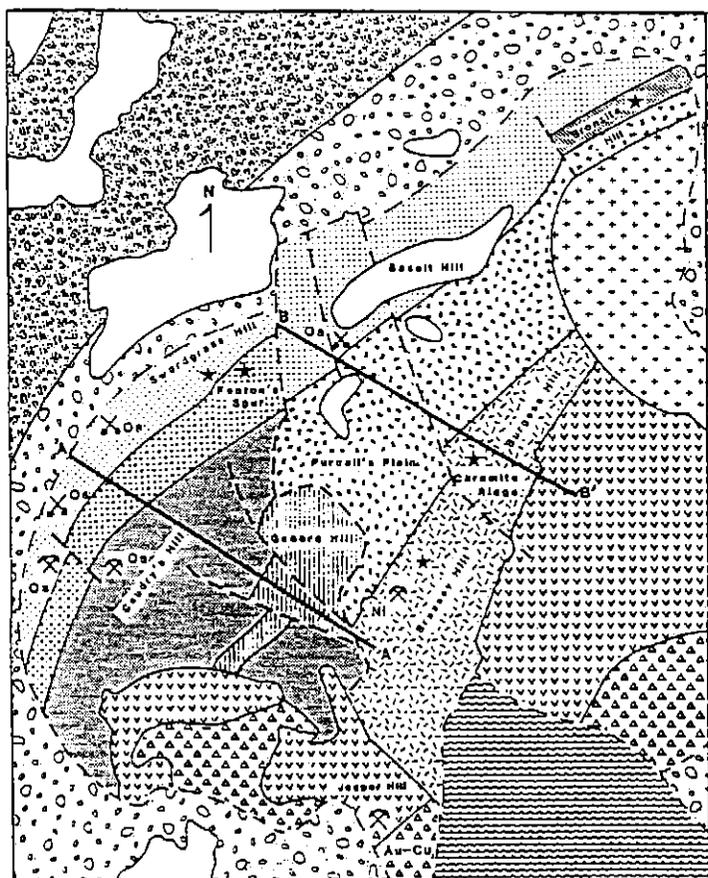
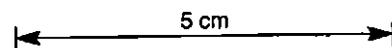


Figure 1 Generalized geology of the Heazlewood River Complex. Ultramafic sequences mapped by D. C. Peck (unpub.). Geology of the volcanic and sedimentary units is derived from Rubenach (1973) and Brown (1986).



## 5. MINERALISATION

The HRC and MSC have a long history of mineral exploration and mining. The area was initially explored during the late 1800's when gold prospectors were working alluvial deposits of the Savage River - immediately to the west of the complexes. Exploration began in earnest in 1889 when a road was constructed between Waratah and the Heazlewood River. In the late 1890's exploration delineated several minor mineral deposits, including Ni at the Lord Brassey Mine, Cu-Au at Jasper Hill, and many minor Pb-Zn occurrences scattered throughout the Heazlewood area. In the first 20 years of this century the HRC and MSC were mined for alluvial Os-Ir alloy deposits; during that period, the HRC became the world's major supplier of Os and Ir. [from Peck (1990)]

### 5.1 Nickel

The Lord Brassey Mine consists of about 300 m of driving on the summit of Brassey Hill. Nickel mineralisation consists of heazlewoodite ( $Ni_3S_2$ ) and lesser amounts of pentlandite; both oxidising at the surface to zaraitite.

Nickel minerals and magnetite were probably emplaced during the serpentinization of the original pyroxenite. Mineralisation is hosted by shears that probably acted as fluid pathways during serpentinization. Shears are orientated NE and mine development followed three of them. The mine has no recorded history of production. [from Hughes (1965)]

### 5.2 Copper-Gold

Cu-Au mineralisation was exploited in two workings on Jasper Hill - the Old Jasper and New Jasper Lodes. Copper mineralisation involves stringer-style chalcopyrite and is associated with quartz and jasper gangue. Copper occurs as coarse grained "blebby" to massive chalcopyrite within strongly silicified amygdoidal basalt. Later alteration has resulted in bornite, covellite, chalcocite, native Cu and Cu-Fe alloy replacing chalcopyrite. Au alloys and Ag tellurides occur as isolated inclusions within chalcopyrite, and appear to have formed by exsolution from chalcopyrite or coprecipitation with chalcopyrite. On a larger scale mineralisation is fracture controlled.

The Cu mineralisation at Jasper Hill is believed to represent a Cambrian hydrothermal system that evolved during extrusion of the low-Ti lavas (Groves, 1966; Rubenach, 1973). *The absence of carbonate gangue and the presence of jasper in the lodes has been cited as evidence against a genetic link between the mineralisation and the emplacement of Devonian granites (Groves, 1966).* The suggestion for a Cambrian age for the ore is substantiated by the presence of minor chalcopyrite and pyrrhotite mineralisation in low-Ti basalts from other parts of the study area. The sulphides occur in association with quartz gangue as vesicle-fillings and locally appear to have replaced amygdales.

These minor occurrences are not related to fractures or joints and their distribution is not controlled by Devonian faults.

Drilling at Jasper Hill by Metals Exploration has proven that some lodes are clearly fault controlled. These lodes probably represent Cambrian hydrothermal mineralisation remobilised (upgraded???) during Devonian deformation. [from Peck (1990)]

### 5.3 Silver-Lead-Zinc

Early prospectors discovered several small galena occurrences within the Heazlewood area that were similar in appearance to structurally-controlled Ag-Pb-Zn mineralisation at the Magnet Mine (Groves, 1965). Many shallow workings were found in association with these occurrences - particularly on Brassey Hill. The mineralisation consists of banded galena-siderite-ankerite occurring as fracture filling in sheared and brecciated serpentinite. The distribution of the occurrences is related to northwest-trending Devonian faults and is probably analogous to the Magnet Mine deposit which is interpreted to have formed as a consequence of the emplacement of the Meredith granite (Groves, 1965). [from Peck (1990)]

### 5.4 Platinum Group Elements (PGE's)

PGE's were mined from streams draining the Nineteen Mile Creek dunite sequence; Older Tertiary gravels beneath Tertiary basalt on Reversal Hill; and Loughnan Creek within the MSC. Mining within the HRC yielded a recorded production of 15,000 ounces of Os-Ir alloy (Jenning *et al.*, 1967). Nuggets were thought to be of magmatic origin because they were not cemented by secondary material and were locally intergrown with chromite (Twelvetrees, 1914). Occurrences of Pt-Au alloys and rare diamonds with alluvial Os-Ir alloy deposits are also recorded.

A hard rock Os-Ir alloy occurrence was discovered and worked by W.Caudry on the western side of Caudry's Hill (1914). Two short adits, an open cut, and a 100 m long 1-2x1-2 m trench targeted a "magmatic schlieren lode" (Twelvetrees, 1914), from which about 250 ounces of Os-Ir alloy was extracted (Hughes, 1965). Reinvestigation of this area by Metals Exploration Ltd. failed to detect similar PGE mineralisation, and noted the trench was excavated along a NW-trending fault (Peck, 1990) - this observation throws doubt on the primary magmatic nature of the mineralisation. Similar Os-Ir alloy occurrences in structural planes in serpentine were described by Reid (1921) at Mt. Stewart.

## 6. PREVIOUS EXPLORATION

A search of the Department of Mines, Tasmania database yielded a record of previous exploration within the Heazlewood licence area. Compilation of previous workers' data is continuing.

### ***HRC derived from Sulfur undersaturated magmas? - review of Peck (1990).***

Peck's (1990) conclusion that "...that the HRC was derived from S- undersaturated magmas and consequently, the precious (and base) metal distribution was not influenced by the development of cumulus sulphides", is based mainly on:

- (i) The low S tenor of mafic and ultramafic rocks of the HRC. In particular, an estimated parental magma S content of 400 ppm; and
- (ii) The observation that all sulphide mineralisation within the HRC is hydrothermal in origin.

Assertion (i) does not take into account the high mobility of S in the oxidising zone. Peck's S-Se plot indicates S depletion which may simply represent S mobilisation/depletion in the weathering profile.

Peck's determination of the S content of the parental magma is based on S assays of intercumulus liquids - which in the *western section* are hosted by only relatively late crystallizing phases. The relatively early production of an immiscible sulphide liquid would mean that residual intercumulus liquids were relatively S depleted. Pentlandite mineralisation at Fenton's Knob is hosted in the basal (earliest) cumulate phase of the HRC - the Nineteen Mile Creek dunite - and may represent early cumulus Ni-sulphide mineralisation contrary to Peck's observations (ii). Magmatic Ni sulphides may provide an important Ni pool in the generation of a low grade Ni resource. Peck's work on the development of cumulus sulphides has failed to discount their presence within the early cumulate sequences of the HRC.

## **7. WORK UNDERTAKEN**

Compilation of Aberfoyle and Comstaff stream sediment sampling data within the Heazlewood licence area revealed poor sample coverage of the central-northern portion of the HRC. Infill sampling is planned; multi-element geochemical analysis of samples should provide a good geochemical lithology signature while vectoring Ni-sulphide and Cu-Au mineralisation.

As part of a literature review, film copies of Metals Exploration enclosure no.'s 1-3 and 7-14 (Annual Report EL 21/85 - period ending 1.12.89) showing grids and mapped geology within the Heazlewood licence area were obtained from the D.M.T.. A copy of David Peck's PhD thesis (1990) - a study of PGE geochemistry and petrogenesis within the HRC - was also obtained.

During the reporting period, 15 outcrop and subcrop/float rock chip grab samples were collected as part of a reconnaissance rock chip geochemical sampling program. Samples weighing 1-2 kg were sent to:

ALS where they were crushed, pulverised, and analysed for Au by PM219 (50 g fire - AAS/GFA) and Cu Pb Zn Ag As Fe Mn Mo Bi Cr Co Ni S by IC586 (HF/HNO<sub>3</sub>/HCl digest - ICP). Samples with Ni > 0.4% were also assayed for Pt Pd by PM 217 (50 g fire - AAS).

or

Analabs where they were dried, crushed, pulverised (GPO33) and analysed for Cu Pb Zn Ag Ni Co Fe Mn by GA140 (0.3 g aqua regia/perchloric acid digest - AAS), As by HA140 (hydride generation - AAS), Au Pt Pd by GG316 (50 g fire - AAS), and S by OM613 (Leco).

Rock sample locations are shown on Plan Tv 644. Sample ledgers and laboratory reports are included in Appendix I.

Nine rock chips submitted for geochemical analysis were selected for petrological description. Samples were sent to R.N. England for transmitted and reflected light thin section preparation and description. Results for three samples are awaited; petrological laboratory reports of returned samples are included in Appendix II.

Reconnaissance visits were made to areas within the HRC highlighted by previous workers as prospective for Ni, PGE, and Cu-Au mineralisation. Prospects names are after Metals Exploration, except Duffs Hill Prospect which was named by the author. The location of the Duffs Hill Prospect is shown on Plan Tv 644.

#### 7.1 Fenton's Knob Prospect

Fenton's Knob within the Fenton's Knob Prospect is host to crackle-brecciated, talc-serpentine altered dunite - with interstitial pentlandite. Best assays of this mineralisation yielded:

1.2% Ni, 0.2 g/t Au, 0.3% Cu, 7.5% Fe, 573 ppm Co, & 11 ppm Mo (#3530504).

Petrology of this sample described pentlandite with frozen sulphide liquid textures confined to interstitial spaces between crackle brecciated dunite. Ni mineralisation may be the product of brecciation and concomitant alteration by S-rich serpentinising fluid - with Ni released from the breakdown of olivine or, orthocumulate pentlandite mineralisation in an Fe-poor magma which has acted as a locus of brecciation. High Cu, Co, and Au are not inconsistent with either of these mineralisation styles however, it is unusual to see elevated Mo associated with exclusively magmatic mineralisation.

#### 7.2 Brassey Prospect

The Lord Brassey Mine (LBM) lies within the Brassey Prospect. Mineralisation at the LBM has already been discussed in Chapter 6. Best assays from a strongly deformed chlorite-grossular-heazlewoodite sample collected from the LBM mullock heap are:

5.41% Ni, 1.15 g/t Au, 0.2% Cu, 0.2% Co, & 14 ppm Mo (#3530505).

Mineralisation at the LBM has a similar geochemical signature to mineralisation at Fenton's Knob.

A sample of an anorthosite dyke within the Brassey Prospect returned best assays of 0.1 g/t Au, 0.26% Ni & 0.2% Cu. Ni probably occurs as a sulphide species within this rock.

### 7.3 Jasper Hill Prospect

The Old and New Jasper Lodes (JL) lie within the Jasper Hill Prospect. Mineralisation at the JL has already been discussed in Chapter 6. Best assay from a silicified tholeiitic basalt with Py and Cpy stringers and amygdales collected from the JL is 0.2% Cu (#3530505).

### 7.4 Duffs Hill Prospect

1:10,000 scale mapping at the Duffs Hill Prospect about old adits (Plan Tv 646) revealed a fault bounded sequence of extrusive low-Ti tholeiitic basalts hosting Cu-Au-Pb-Zn mineralisation. Rocks are similar, and host similar mineralisation styles to rocks of the Jasper Lodes. Geochemical and petrological sampling from mullock heaps of adits into the basalts returned best assays of:

18.7% Cu, 2.5% Pb, 1.5% Zn, 180 g/t Ag, & 0.4 g/t Au (#3530503);  
16.8% Cu, 0.35% Zn, 164 g/t Ag & 1.4 g/t Au (#3530562); and  
34.3% Zn, 15.3% Pb, 6.0% Cu, 40 g/t Ag & 8.2 g/t Au (#3530508).

The rocks are strongly qz-chl-carb altered and have preserved relict disseminated chromite indicative of a mafic-ultramafic original rock. Sequences are orientated NW and dip steeply to the NE and shallowly to the SW. The eastern contact of the basalt and cumulate sequence is faulted and steeply dipping (55°). Prominent shearing is orientated N-S. Adits lie along a NE trending line - it is unclear whether this represents a structural or stratigraphic control on mineralisation.

The ambiguous coincidence of elevated Au-Cu-Pd with disseminated sulphide textures and Ag-Pb-Zn in NW faulted silica-carbonate altered rocks probably represents Devonian granite mineralisation (Ag-Pb-Zn mineralisation - Chapter 6) superimposed (remobilising/enhancing?) on Cambrian hydrothermal mineralisation related to the extrusion of the low-Ti lavas (Cu-Au mineralisation - Chapter 6).

## 8. ENVIRONMENT AND REHABILITATION

Activities conducted during the reporting period had no impact on the environment. No rehabilitation was necessary.

A visit to the Heazlewood EL was made with David Gatehouse of the Department of Mines. The Department holds a bond for the rehabilitation of disturbance caused by Metals Exploration to the relinquished EL 21/85; this past tenement covers much of the area included in CRAE's current Heazlewood licence. The purpose of the visit was to confirm what disturbance (tracks, drill pads, etc.) CRAE wanted left unrehabilitated for future use. CRAE requested only main access tracks be left open - in doing so CRAE assumes responsibility for stabilization and maintenance of those tracks.

Most rehabilitation will not permanently close tracks and pads due to restricted funds.

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1987

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### KEYWORDS

Copper, Nickel, Gold, PGE, Lead, Zinc, Cambrian, Devonian,  
 Hydrothermal, Geology, Mineralisation, Rock Geochemistry, Basalt, Ultrabasic,  
 Fault, Chemical Analysis, Geological Mapping Detailed, Literature Review.

### LOCATION

Burnie	1:250,000	SK55-3
Authur River	1:100,000	7915
Pieman	1:100,000	7914

### LIST OF DPO'S

77203, 77204, 77208.

### LIST OF FIGURES

Figure One - Generalised Geology of the Heazlewood River Complex.

### LIST OF PLANS

<u>Plan No.:</u>	<u>Title:</u>	<u>Scale:</u>
Tv 645	Heazlewood EL 36/92 - Location Plan	1:100,000

Tv 644	Heazlewood EL 36/92 - Rock Chip and Prospect Location Plan	1:25,000
Tv 646	Heazlewood EL 36/92 - Duffs Hill Prospect Geology - Corinna Road Traverse	1:10,000

**LIST OF APPENDICES**

Appendix I	-	Geochemical rock sample ledgers and laboratory reports
Appendix II	-	Petrology laboratory reports

5 415 000mN

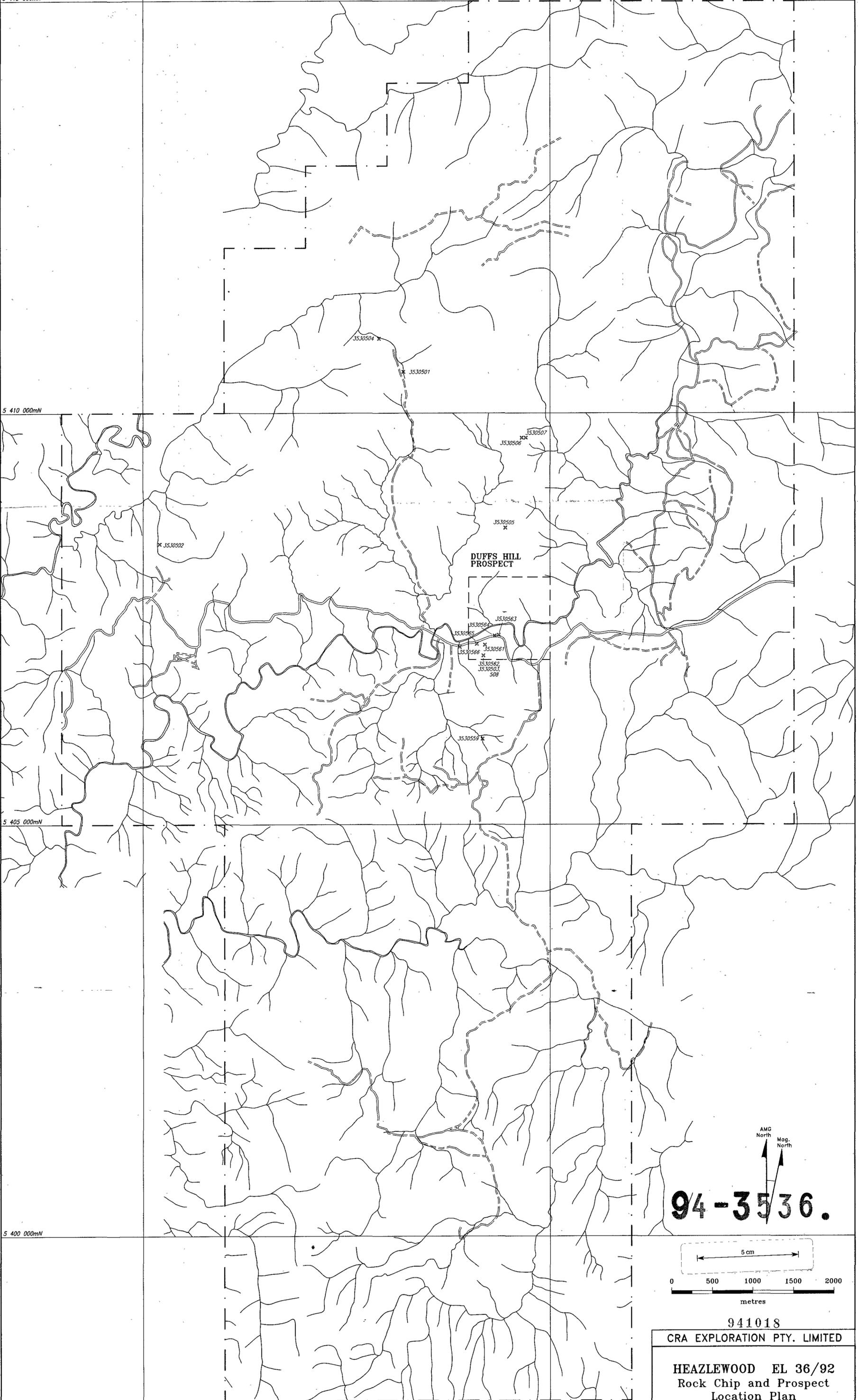
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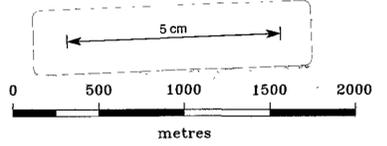
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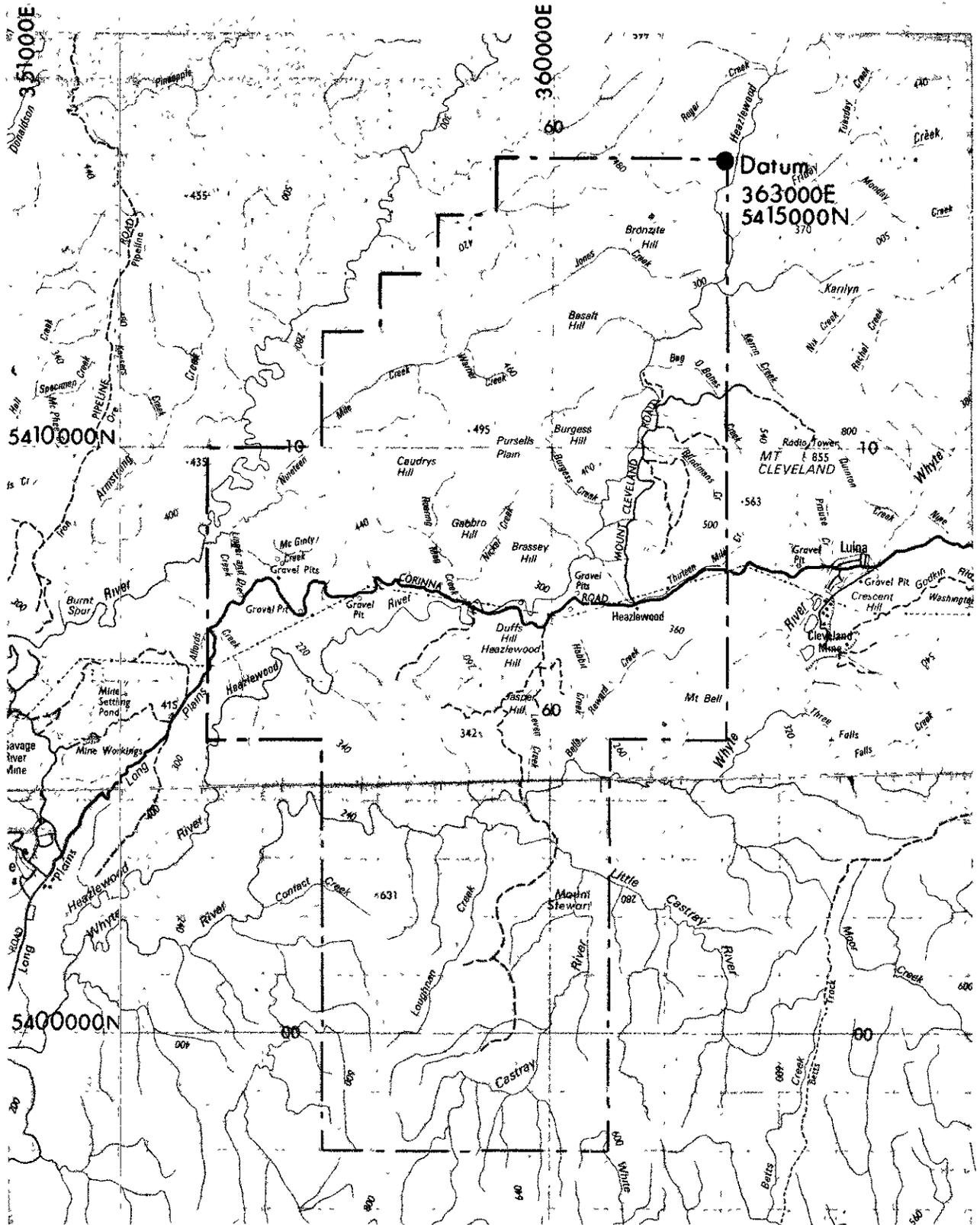


AMG North  
Mag. North

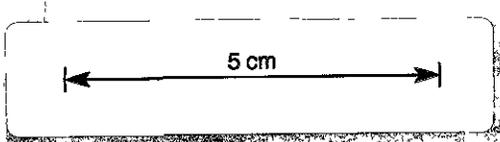
**94-35/36.**



941018	
CRA EXPLORATION PTY. LIMITED	
<b>HEAZLEWOOD EL 36/92</b>	
<b>Rock Chip and Prospect</b>	
<b>Location Plan</b>	
Ref.: SK 55-03	File: Hazlwood\644
Scale: 1 : 25000	Date: Feb. 1994
Author: S. Maher	Report No.: 19566
Drawn: R Traverso	Plan No.: Tv 644



94-3536.



941019

CRA EXPLORATION PTY. LIMITED

HEAZLEWOOD EL 36/92

LOCATION PLAN

Ref.: 7915, 7914	Scale: 1:100 000
Author: R. Parkinson	Report No.: 19566
Drawn: S. Brook	Plan No.: Tv 645

Sept. 1992

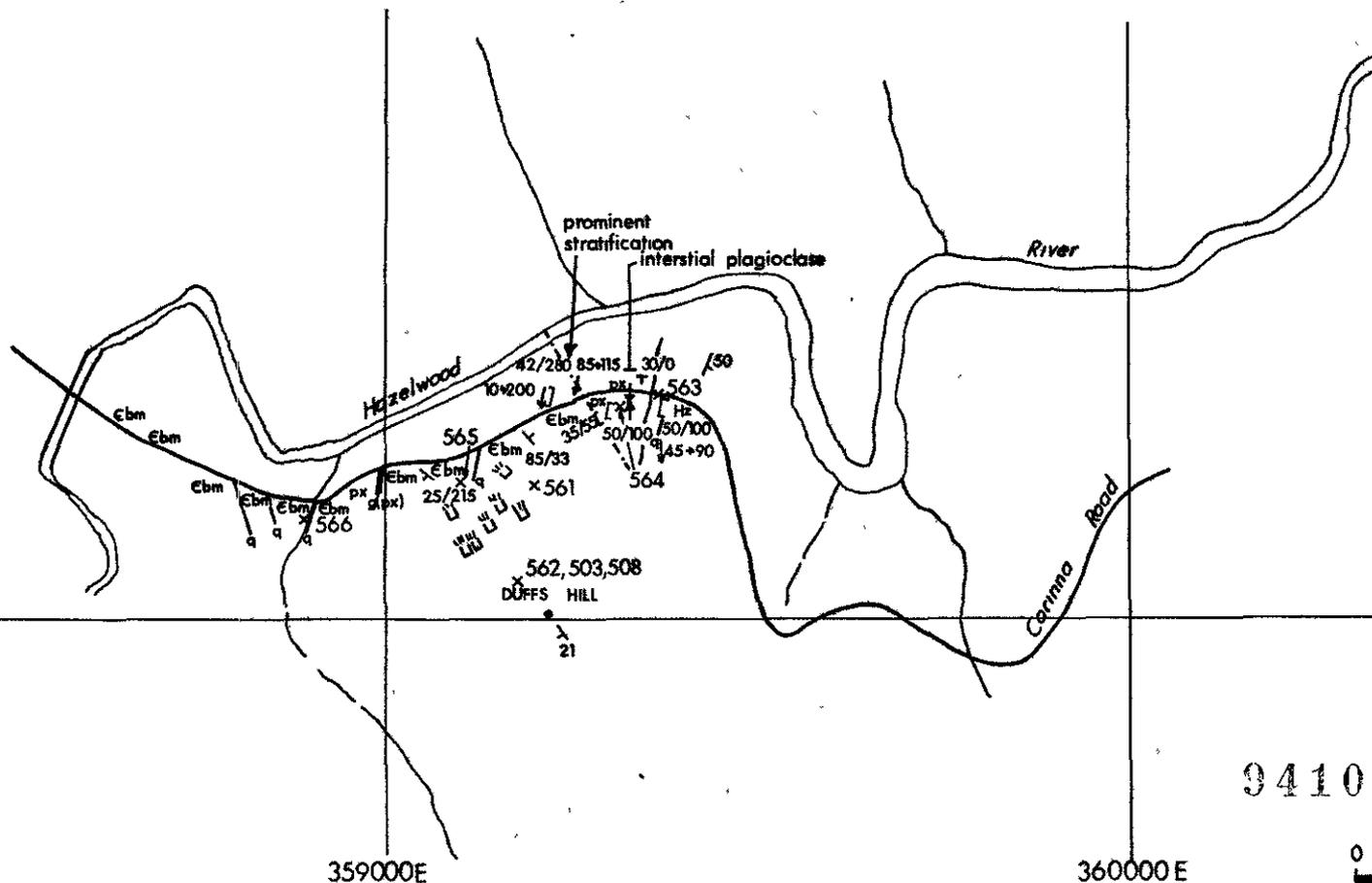
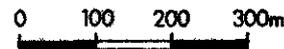
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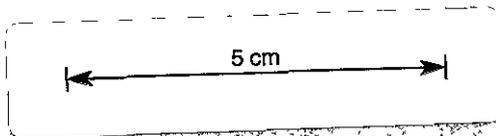
94-3536



- H<sub>z</sub> Harzburgite - prominent olivine/serpentine development/and tectonism
- px Pyroxenite
- E<sub>bm</sub> Fine grained plagioclase pyroxenite/variably silicified/rare amygdates  
± hornblende (volcanic variations in crystal size <4mm - aphyritic - possibly pillows)
- g(px) Coarse gabbroic dyke
- a Vein quartz
- Layering
- Prominent jointing/shearing
- 45+90 Lineations
- Adits
- Fault/fault breccia

x563 Rock chip sample locations (prefix 3530)

Lithology boundary



CRA EXPLORATION PTY. LIMITED

**HEAZLEWOOD EL 36/92**

**DUFFS HILL PROSPECT**

**GEOLOGY - CORINNA ROAD  
TRAVERSE**

Ref SK55 - 3

Scale 1:10 000

Author S.Maher

Report No 19566

Drawn A.Jelen Feb '94

Plan No Tv 646

APPENDIX I:

GEOCHEMICAL ROCK SAMPLE LEDGERS AND LABORATORY  
REPORTS

CRAE Exploration Pty Ltd GEOCHEMICAL SAMPLE LEDGER: ROCK

Project: ultramafic Ni      Map Sheets      Sampler: SM  
 Tenement: EL 36/92      250,000: SK55-3 & SK55-4      Date: 24/9/93  
 DPO: 77203      100/25,000: 7914, 7915/3439-41, 3639-41

SAMPLEno.	EASTAMG	NORTHAMG	EL	PROSP.	sampleTYPE	ROCKtype	NOTES
3530501	358200	5410500	36/92	Fnt.Knb.	sel.grab-subcrop	chromitite	North C.R. saddle. Coarse 5mm chromite beads with pyroxene filling interstitial closed matrix.
3530502	355200	5408400	36/92	Caudry's	sel.grab-outcrop	serpentinized dunite	Track to Caudry's workings. Serpentinized dunite with relict spinels (Cr) and gold coloured PGEs?.
3530503	<del>359180</del>	<del>5407050</del>	36/92	Duffs Hill	comp.-mullock	silicified breccia	Adit north Corinna Rd. Silicified dunite breccia. Interstitial and replacement az, mall, ga, pyrr, pent, nat Cu, cov, chalco, nickeliferous?.
3530504	357900	5410900	36/92	Fnt.Knb.	sel.gab-outcrop	dunite breccia	Variably brecciated/serpentinized mass. dunite. Serpentine is developed interstitial to breccia clasts; pent. (lesser hellyerite) show a strong association w/ serp.
3530505	359450	5408600	36/92	BrasseyMine	comp.-mullock	sheared serpentinitised u.m.	Strongly serpentinitized, sheared. plag. peridotite. Hosts hazlewoodite, hellyerite, zaratite.
3530506	359650	5409700	36/92	Brassey	sel.grab-outcrop	anorthosite dyke	Brassy Hill Rd. Anorthosite dyke with native Cu and green zaratite.
3530507	359700	5409700	36/92	Brassey	sel.grab-outcrop	chromitite	Chromitite schleiren cut by An dyke. Hosted by confused dunite/pyroxenite. Green mineral is Cr garnet.
3530508	<del>359180</del>	<del>5407050</del>	36/92	Duffs Hill	comp.-mullock	silicified breccia	Adit north Corinna Rd. Silicified dunite breccia. Interstitial and replacement galena and accessories (as for 503).

Lab: ALS  
 Det.Limit: 5 10 5 0.001 0.001 0.01 0.01 5 5 5 1 1 0.01 5 10 10 5  
 Method: IC586 IC586 IC586 PM219 CHECKS PM217 PM217 IC586 IC586 IC586 IC586 IC586 IC586 IC586 IC586 IC586 IC586

	Ni ppm	S ppm	Bi ppm	Au ppm	Au PM ppm	Pt ppm	Pd ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	As ppm	Fe %	Co ppm	Cr ppm	Mn ppm	Mo ppm
3530501	268	113	<5	0.008				103	16	139	<1	48	2.78	41	3.01%	258	<5
3530502	2260	125	<5	0.003	0.002			<5	5	35	<1	13	3.09	81	385	605	<5
3530503	272	3.77%	20	0.375	0.399			18.70%	2.45%	1.52%	180	100	5.72	48	1170	904	20
3530504	1.20%	9850	<5	0.195		<0.01	<0.01	2890	368	307	3	78	7.57	573	3050	777	11
3530505	5.41%	2.49%	<5	1.15		<0.01	0.01	2020	240	682	2	116	7.25	1860	455	277	14
3530506	2600	804	<5	0.1	0.104			2130	43	55	1	14	1.14	80	193	280	<5
3530507	397	200	<5	0.015				267	53	116	<1	22	1.59	27	1.48%	268	<5
3530508	88	17.40%	<5	8.12	8.2			6.03%	15.30%	34.30%	40	124	1.72	69	207	190	127

341023

CRAE Exploration Pty Ltd GEOCHEMICAL SAMPLE LEDGER: ROCK

Project: ultramafic Ni      Map Sheets      Sampler: SM  
 Tenement: EL 36/92      250,000: SK55-3      Date: 15/11/93  
 DPO: 77208      100/25,000: 7914, 7915/3439-41, 3639-41.

SAMPLEno.	EASTAMG	NORTHAMG	EL	PROSP.	sampleTYPE	ROCKtype	NOTES
3530559	359170	5406040	36/92	Jspr.Hll	s.g.-mullock	Silicified tholeiitic basalt	From Old Jasper Mine. Pervasively silicified aphyritic mafic pillow? lava. Vescicles and qz & cc filled amygdales 3%. Pyrite and chalco. (2%) occur as vescicle fillings, along partings, and as disseminations and stringers in mafic host. PET sample.
3530561	359200	5407180	36/92	Dffs.Hll	s.g.-mullock	Silicified basalt?	From 2nd adit from E. Pervasively silicified aphyritic (volcanic?) mafic rock. Pyrite and chalco <1% occur as disseminations in host. PET sample.
3530562	359180	5407050	36/92	Dffs.Hll	s.g.-mullock	Sulphidic rock	From most SW adit. Predominantly black fine sooty chalcocite? and other Cu secondaries. 1-2% brassy Ni? metallic sulphide which tarnishes violet. PET sample.
3530563	359370	5407300	36/92	Dffs.Hll	s.g.-outcrop	Fault melange	From Corinna Rd traverse. Includes strongly serpentinised predom. olivine harzburgite with prom. slick.s. Rare vein quartz, and white feldspar (may be shear localised along less competent gabbro dyke?).
3530564	359320	5407290	36/92	Dffs.Hll	s.g.-outcrop	Fault melange	From Corinna Rd traverse. Strongly serpentinised pyroxenite (4-5mm) occurs as aligned pods in 50cm serp. fault zone. Boundary btwn volc/intr?
3530565	359100	5407190	36/92	Dffs.Hll	s.g.-outcrop	Vein quartz	From Corinna Rd traverse, climb. Barren? comb vein quartz with relict serp. margins.
3530566	<del>359100</del>	5407150	36/92	Dffs.Hll	s.g.-outcrop	Vein quartz	From Corinna Rd traverse, creek. Comb vein quartz (3cm, NS trend) in fine plag. pyroxenite lava?

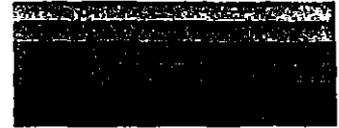
	Cu	Cu	Pb	Zn	Ag	Ag	Fe	Fe	Mn	Mn	Ni	Co	As	S	Au	Pt	Pd
UNITS	ppm	%	ppm	ppm	ppm	ppm	%	%	ppm	%	ppm	ppm	ppm	%	ppm	ppm	ppm
Det.Limit:	2	0.01	3	2	1	10	0.01	0.01	3	0.01	3	3	0.5	0.005	0.005	0.05	0.005
METHOD	GA140	GA104	GA140	GA140	GA140	GA104	GA140	GA104	GA140	GA104	GA140	GA140	HA140	OM613	GG316	GG316	GG316

3530559	1822	-	19	92	<1	-	4.25	-	610	-	51	20	34.5	0.41	0.025	<0.05	0.007
3530561	-	1.21	19	169	4	-	-	5.12	859	-	64	17	13	1.2	0.08	<0.05	0.013
3530562	-	16.8	437	3450	-	164	-	7.84	1261	-	190	37	0.5	4.25	1.44	<0.05	<0.005
3530563	35	-	<3	31	<1	-	-	5.58	2089	-	1291	77	7	0.01	<0.005	<0.05	<0.005
3530564	35	-	<3	37	<1	-	3.85	-	521	-	249	28	3.5	0.01	<0.005	<0.05	<0.005
3530565	28	-	<3	29	1	-	3.6	-	449	-	193	44	2	0.01	<0.005	<0.05	<0.005
3530566	902	-	111	127	2	-	4.62	-	-	0.79	78	16	29	0.03	0.019	<0.05	<0.005

941025



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Facsimile: (07) 352 5109

# ANALYTICAL REPORT

PAGE 1 of 4

CLIENT: CRA EXPLORATION PTY LTD  
ADDRESS: P O BOX 8093  
NORTHLAND CENTRE  
VIC 3072

LABORATORY: BENDIGO  
BATCH NUMBER: BE1286-0

CONTACT: MR S MAHER

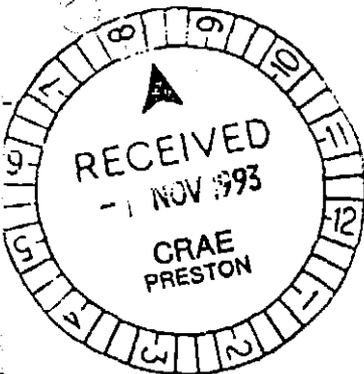
No. of SAMPLES: 11  
DATE RECEIVED: 28/09/93  
DATE COMPLETED: 28/10/93

ORDER No: 77203

SAMPLE TYPE: ROCK CHIP

PROJECT No:

SAMPLE NUMBER	ELEMENT UNIT METHOD	Cu	Pb	Zn	Ag	As
		ppm IC586	ppm IC586	ppm IC586	ppm IC586	ppm IC586
3530501		103	16	139	<1	48
3530502		<5	5	35	<1	13
3530503		18.70%	2.45%	1.52%	180	100
3530504		2990	368	307	3	78
3530505		2020	240	682	2	116
3530506		2130	43	55	1	14
3530507		267	53	116	<1	22
3530508		6.03%	15.30%	34.30%	40	124
3530509		618	946	2180	1	9
3530510		1520	2170	4020	2	37
3530511		316	246	589	1	29



DETECTION LIMIT:

5

5

5

1

1

COMMENTS: Cu values >1.00% reassayed by Method A101.  
Pb values >1.00% reassayed by Method A101.  
Zn values >1.00% reassayed by Method A101.  
Ag values >25ppm reassayed by Method A101.  
Cr values >0.1% will be understated if present as chromite.

Townsville Laboratory  
Phone: (077) 79 9155 Fax: (077) 79 9729  
Charters Towers Laboratory  
Phone: (077) 87 4155 Fax: (077) 87 4220  
Orange Laboratory  
Phone: (063) 63 1722 Fax: (063) 63 1169  
Bendigo Laboratory  
Phone: (054) 46 1390 Fax: (054) 46 1389

Perth Laboratory  
Phone: (09) 249 2988 Fax: (09) 249 2942  
Kalgoorlie Laboratory  
Phone: (090) 21 1457 Fax: (090) 21 6253  
Alice Springs Laboratory  
Phone: (089) 52 8020 Fax: (089) 52 8020  
Mt Isa Laboratory  
Phone: (077) 49 5545 Fax: (077) 48 5546

All pages of this report  
have been checked and  
approved for release.

*[Signature]*  
Signed



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Facsimile: (07) 352 5109

## ANALYTICAL REPORT

PAGE 2 of 4

CLIENT: CRA EXPLORATION PTY LTD  
ADDRESS: P O BOX 8093  
NORTHLAND CENTRE  
VIC 3072

LABORATORY: BENDIGO  
BATCH NUMBER: BE1286-0

CONTACT: MR S MAHER

No. of SAMPLES: 11  
DATE RECEIVED: 28/09/93  
DATE COMPLETED: 28/10/93

ORDER No: 77203

SAMPLE TYPE: ROCK CHIP

PROJECT No:

SAMPLE NUMBER	ELEMENT UNIT METHOD	Fe	Co	Cr	Mn	Mo
		% IC586	ppm IC586	ppm IC586	ppm IC586	ppm IC586
3530501		2.78	41	3.01%	258	<5
3530502		3.09	81	385	605	<5
3530503		5.72	48	1170	904	20
3530504		7.57	573	3050	777	11
3530505		7.25	1860	455	277	14
3530506		1.14	80	193	280	<5
3530507		1.59	27	1.48%	268	<5
3530508		1.72	69	207	190	127
3530509		0.96	13	3830	121	<5
3530510		3.64	37	1.53%	38	7
3530511		9.27	111	7050	50	<5
DETECTION LIMIT:		0.01	5	10	10	5

COMMENTS:

Toowoomba Laboratory  
Phone: (077) 79 9155 Fax: (077) 79 9729  
Charters Towers Laboratory  
Phone: (077) 87 4155 Fax: (077) 87 4220  
Orange Laboratory  
Phone: (063) 63 1722 Fax: (063) 63 1189  
Bendigo Laboratory  
Phone: (054) 46 1390 Fax: (054) 46 1389

Perth Laboratory  
Phone: (09) 249 2988 Fax: (09) 249 2942  
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PAGE 3 of 4

CLIENT: CRA EXPLORATION PTY LTD  
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VIC 3072

LABORATORY: BENDIGO  
BATCH NUMBER: BE1226-0

CONTACT: MR S MAHER

No. of SAMPLES: 11  
DATE RECEIVED: 28/09/93  
DATE COMPLETED: 28/10/93

ORDER No: 77203

SAMPLE TYPE: ROCK CHIP

PROJECT No:

SAMPLE NUMBER	ELEMENT UNIT METHOD	Ni ppm IC586	S ppm IC586	Bi ppm IC586	Au ppm PM219	Au PM219 ppm CHECKS
3530501		268	113	<5	0.008	
3530502		2260	125	<5	0.003	0.002
3530503		272	3.77%	20	0.375	0.399
3530504		1.20%	9850	<5	0.195	
3530505		5.41%	2.49%	<5	1.15	
3530506		2600	804	<5	0.100	0.104
3530507		397	200	<5	0.015	
3530508		88	17.40%	<5	8.12	8.20
3530509		174	1790	<5	0.054	0.042
3530510		574	3570	<5	0.100	0.094
3530511		2300	541	<5	0.038	0.045
DETECTION LIMIT:		5	10	5	0.001	0.001

COMMENTS:

Toowoomba Laboratory  
Phone: (077) 79 9155 Fax: (077) 79 9729  
Charters Towers Laboratory  
Phone: (077) 87 4155 Fax: (077) 87 4220  
Orange Laboratory  
Phone: (063) 63 1722 Fax: (063) 63 1189  
Bendigo Laboratory  
Phone: (054) 40 1390 Fax: (054) 46 1389

Perth Laboratory  
Phone: (09) 249 2988 Fax: (09) 249 2942  
Kalgoorlie Laboratory  
Phone: (090) 21 1457 Fax: (090) 21 6253  
Alice Springs Laboratory  
Phone: (089) 52 6020 Fax: (089) 52 6028  
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Facsimile: (07) 352 5109

# ANALYTICAL REPORT

PAGE 4 of 4

CLIENT: CRA EXPLORATION PTY LTD  
ADDRESS: P O BOX 8093  
NORTHLAND CENTRE  
VIC 3072

LABORATORY: BENDIGO  
BATCH NUMBER: BE1286-0

CONTACT: MR S MAHER

No. of SAMPLES: 11  
DATE RECEIVED: 28/09/93  
DATE COMPLETED: 28/10/93

ORDER No: 77203

SAMPLETYPE: ROCK CHIP

PROJECT No:

SAMPLE NUMBER	ELEMENT UNIT METHOD	Pt	Pd			
		ppm PM217	ppm PM217			
3530501						
3530502						
3530503						
3530504		<0.01	<0.01			
3530505		<0.01	0.01			
3530506						
3530507						
3530508						
3530509						
3530510						
3530511						
DETECTION LIMIT:		0.01	0.01			

COMMENTS:

Townsville Laboratory  
Phone: (077) 79 9155 Fax: (077) 79 9729  
Charlton Towers Laboratory  
Phone: (077) 87 4155 Fax: (077) 87 4220  
Orange Laboratory  
Phone: (063) 63 1722 Fax: (063) 63 1189  
Bendigo Laboratory  
Phone: (054) 46 1390 Fax: (054) 46 1389

Perth Laboratory  
Phone: (09) 249 2986 Fax: (09) 249 2942  
Kalgoorlie Laboratory  
Phone: (080) 21 1457 Fax: (080) 21 6253  
Alice Springs Laboratory  
Phone: (089) 52 6020 Fax: (089) 52 6028  
Mt Isa Laboratory  
Phone: (077) 49 5545 Fax: (077) 48 5546



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Telephone: (07) 352 5577  
Facsimile: (07) 352 5109

# ANALYTICAL REPORT

PAGE 1 of 3

CLIENT: CRA EXPLORATION PTY LTD  
ADDRESS: P O BOX 9093  
NORTHLAND CENTRE  
VIC 3072

LABORATORY: BENDIGO  
BATCH NUMBER: BE1286-0

CONTACT: MR S MAHER

No. of SAMPLES: 11  
DATE RECEIVED: 28/09/93  
DATE COMPLETED: 28/10/93

ORDER No: 77203

SAMPLETYPE: QUALITY CONTROL

PROJECT No:

SAMPLE NUMBER	ELEMENT UNIT METHOD	Cu	Pb	Zn	Ag	As
		ppm IC586	ppm IC586	ppm IC586	ppm IC586	ppm IC586
*** 3530509		646	909	2040	1	10
*** 3530510		1430	1840	3530	2	35
DETECTION LIMIT:		5	5	5	1	1

COMMENTS: Results which appear on this report are routine laboratory checks for QUALITY CONTROL purposes.

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Charters Towers Laboratory  
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Facsimile: (07) 352 5109

# ANALYTICAL REPORT

PAGE 2 of 3

CLIENT: CRA EXPLORATION PTY LTD  
ADDRESS: P O BOX 8093  
NORTHLAND CENTRE  
VIC 3072

LABORATORY: BENDIGO  
BATCH NUMBER: BE1286-0

CONTACT: MR S MAHER

No. of SAMPLES: 11  
DATE RECEIVED: 28/09/93  
DATE COMPLETED: 28/10/93

ORDER No: 77203

SAMPLE TYPE: QUALITY CONTROL

PROJECT No:

SAMPLE NUMBER	ELEMENT UNIT METHOD	Fe	Co	Cr	Mn	Mo
		% IC586	ppm IC586	ppm IC586	ppm IC586	ppm IC586
*** 3530509		1.00	13	4030	117	15
*** 3530510		3.32	32	1.45%	29	7
DETECTION LIMIT:		0.01	5	10	10	5

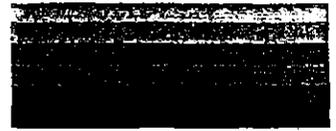
COMMENTS:

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Facsimile: (07) 352 5109

# ANALYTICAL REPORT

PAGE 3 of 3

CLIENT: CRA EXPLORATION PTY LTD  
ADDRESS: P O BOX 3093  
NORTHLAND CENTRE  
VIC 3072

LABORATORY: BENDIGO  
BATCH NUMBER: BE1286-0

CONTACT: MR S MAHER

No. of SAMPLES: 11  
DATE RECEIVED: 28/09/93  
DATE COMPLETED: 28/10/93

ORDER No: 77203

SAMPLETYPE: QUALITY CONTROL

PROJECT No:

SAMPLE NUMBER	ELEMENT UNIT METHOD	Ni	S	Bi		
		ppm IC586	ppm IC586	ppm IC586		
*** 3530509		177	1680	<5		
*** 3530510		531	3400	<5		
DETECTION LIMIT:		5	10	5		

COMMENTS:

Townsville Laboratory  
Phone: (077) 79 9155 Fax: (077) 79 9729  
Charters Towers Laboratory  
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Phone: (054) 46 1390 Fax: (054) 46 1389

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Alice Springs Laboratory  
Phone: (089) 52 6020 Fax: (089) 52 6028  
Mt Isa Laboratory  
Phone: (077) 49 5545 Fax: (077) 48 5545

APPENDIX II -

PETROLOGY LABORATORY REPORTS

PETROGRAPHIC NOTES FOR 6 SAMPLES  
FROM THE HEAZLEWODD RIVER COMPLEX

Prepared for Simon Maher, CRA Exploration Ltd..

3530501. Massive chromitite.

About 85% of this sample is 0.5-5 mm subhedral (probably mostly octahedral) chromite, which is free of magnetite alteration. The dominant interstitial mineral is tremolite, probably an epitaxial, metamorphic replacement product of original intercumulus clinopyroxene and orthopyroxene. Subordinate fine boxworks of brownish iddingsite may be weathering products of olivine. In extremely rare cases these contain <50- $\mu$ m anhedral magnetite.

A careful check revealed no sulphide inclusions in chromite (the most likely site for laurite,  $RuS_2$ ), or interstitial sulphides (for other PG minerals; Peck & Keays, 1990a).

The massive texture and rarity of magnetite alteration suggest that this is a Type III chromitite of Peck & Keays (1990a, Table 1).

3530503a. Cu-Pb-Zn sulphide-rich replacement or cavity filling in ?boninitic volcanic or chilled intrusive breccia.

Most of the sample consists of fine-grained sulphides and quartz, with minor relics of host rock. The latter are altered to irregular masses up to a couple of mm across, of <0.1-mm anhedral and prismatic quartz, and anastomosing lenses of <0.1-mm flaky chlorite. Both the quartz and the chlorite zones contain very minor disseminated 30-200  $\mu$ m roughly octahedral chromite similar to that in 3530503b. Thus it seems likely that this was similar starting material.

The sulphide-rich patches contain about 60% of 20-100  $\mu$ m anhedral and roughly prismatic quartz, followed in abundance by 30-200  $\mu$ m anhedral bornite (25%), blue digenite, galena, chalcocopyrite, and sphalerite, all but digenite enriched in patches. The blue digenite, dusted with a little fine covellite, forms <10  $\mu$ m-thick crusts on and veinlets in bornite, and is almost certainly supergene. Chalcocopyrite is reddish, with a low reflectance suggesting submicroscopic intergrowth with a little bornite. Sphalerite is Fe free. Supergene carbonates (10%), mainly magnesite or dolomite, but clearly supergene malachite, cerussite, and possibly smithsonite, replace many sulphide grains.

The sulphide mineral assemblage recalls that in reaction zones between various enclaves and serpentinite in the Coolac ophiolite belt (Ashley, 1974).

3530503b. Cu-Pb-Zn sulphide-rich replacement in ?boninitic volcanic or chilled intrusive breccia.

This rock is a breccia of irregular to subround fragments up to a couple of cm across. Most are in a similar state to those in

3530503a, with more quartz and carbonates, including quite abundant azurite, and less sulphide (2-3%). Rare fragments have abundant <0.2-mm laths, and spherulite-like masses of radiating albite: these may be basaltic, as they seem to contain less chromite. Generally, chromite is coarser (<0.4-mm) and more common (0.2%) than in the clasts of 3530503a. Chalcopyrite is pinkish, due to submicron intergrowth with bornite.

These two samples seem to belong with the boninites (Peck & Keays, 1990b). Perhaps they are from an intrusive equivalent.

3530504. Crackle-brecciated, talc-serpentine altered dunite with interstitial pentlandite.

The original rock consisted very largely of 0.2-1 (seldom 2) mm anhedral olivine, with moderate development of strain lamellae and subgrains. About half the olivine has been altered to <0.2-mm flakes of talc and subordinate lizardite which wander around olivine grain boundaries, and fill irregular <2 mm-thick crackle zones separating <10-mm *in-situ* fragments.

Equant subhedral 50-400  $\mu\text{m}$  chromite forms about 3% of the rock. More than half of it is altered to colloform aggregates of ?ferritchromit and a softish phase with a refractive index similar to that of talc. Altered chromites are quite strongly concentrated in some talc-rich crackle zones, from which substantial amounts of rock (notably Cr which is usually immobile) have been removed.

<3-mm masses of pentlandite (4%) with very minor <20  $\mu\text{m}$ -thick veinlets of millerite (NiS) are confined to the crackle zones. Their textures are much like those of interstitial frozen blobs of sulphide liquid. If they do have this origin, then they have been a locus of brecciation, probably as a result of their much greater ductility than the surrounding olivine. They must also have lost Cu and Fe during alteration, since any sulphide liquid exsolved from a picritic melt would crystallise abundant pyrrhotite and prominent chalcopyrite, both of which are missing. It might be simpler to suggest that they are derived from reaction of comparatively S-rich, talc-serpentinising fluid with Ni released from the breakdown of olivine.

This is probably a cumulate which has suffered some ductile deformation at high T, followed by brecciation concomitant with talc-serpentine alteration.

Chemographic relations of the sulphides here and in Sample 3530505, together with possible compatibilities are given in Fig. 1.

3530505. Strongly deformed chlorite-grossular-heazlewoodite rock.

More than half the rock consists of <1-mm flakes of optically positive Mg-Al rich chlorite. In a few places chlorite forms rosettes, but it occurs mostly as strongly kinked flakes and anhedra, oriented either randomly or roughly parallel to very prominent streaky, vein-like 0.1-5 mm-thick layers of massive,

fine-grained (10- $\mu\text{m}$ ) euhedral grossular (greenish cream in hand specimen).

Anhedral 2- $\mu\text{m}$  to 2-mm heazlewoodite ( $\text{Ni}_3\text{S}_2$ , about 15% of the sample) has spectacular anisotropic colours (crimson to grey). Some of it is altered at grain margins to fine-grained millerite, and fine lamellar intergrowths of millerite and violarite. In the heazlewoodite-rich zone, chlorite commonly forms 1-4 mm subround clots of highly deformed 10-100  $\mu\text{m}$  anhedral, separated by anastomosing subparallel trains of greenish serpentine (?garnierite, which contains Ni), heazlewoodite, grossular, and very minor <100- $\mu\text{m}$  euhedral magnetite dusted with heazlewoodite. This texture may be related to the one involving olivine and pentlandite in 3530504, so the mineralisation could be a highly altered and strongly deformed magmatic sulphide ore. The difference in mineralogy reflects lower  $a_{\text{FeS}}$  in this sample. An  $a_{\text{FeS}}$  gradient may have developed during serpentinisation. Though the silicate assemblage is more typical of reaction zones (Ashley, 1974), the sulphides are more in character with uncontaminated serpentinite (Ashley, 1975).

I have not seen such coarse-grained or abundant heazlewoodite before. The grossular may contain some Cr and  $\text{H}_2\text{O}$ .

#### 3530507. Semi-massive chromitite

Roughly to perfectly octahedral 0.1-1 mm chromite forms 40-70% of the rock. The commonest interstitial mineral is coarse intercumulus clinopyroxene with a grain size of several mm. In a 10 mm-wide zone, the interstitial material is massive pale green grossular-uvarovite garnet,  $\text{Ca}_3(\text{Al,Cr})_2\text{Si}_3\text{O}_{12}$ , with a grain size of a few  $\mu\text{m}$ . This is most likely to have replaced intercumulus plagioclase. Minor serpentinised peridotite or orthopyroxenite occurs in interstitial patches and rare <2-mm veinlets, in which chromite is depleted but not absent.

A couple of 10-20  $\mu\text{m}$  interstitial sulphide grains could be laurite or sperrylite, but more likely pyrite.

The uvarovite, and lack of magnetite alteration suggest that this chromitite is also Type III (Peck & Keays, 1990a, Table 1).

#### GENERAL COMMENTS

The chromitites probably have elevated PGE, perhaps tens to hundreds of ppb Pt.

The 3530503 samples are clearly hydrothermal sulphide. PGE are unlikely to be enriched unless they have some affinity with the very atypical mineralisation at New Rambler, Wyoming, which also contains gold (McCallum et al., 1976).

PGE content could be a test of magmatic or hydrothermal origin for the sulphides in 3530504, 5. More than a few tens of ppb Pt would suggest a magmatic origin (again, unless there has been some atypical hydrothermal mobilisation of PGE). PG minerals are not obvious in them, but they would be hard to see amongst the highly reflective Ni-bearing sulphides.

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R.N.ENGLAND,  
11 Victor St.,  
Cranbrook  
(Townsville),  
Queensland 4814.  
(077)735407  
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FIGURE 1. Chemographic relations of the sulphides in Samples 3530504 and 3530505 in the system Fe-Ni-S, together with possible compatibilities.

