Report on
Exploration Licence 11/2006
Adamsfield Project
South West Tasmania

Prepared for Zelos Resources NL
by
Hellman & Schofield Pty. Ltd.

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H &S **Hellman & Schofield Pty Ltd**
Technical specialists to the minerals industry

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Executive Summary

The Adamsfield Licence EL11/2006 is located 60km WNW of Hobart in SW Tasmania. The area is part of an excised section of the World Heritage Area that is designed for mineral exploration and exploitation. Evidence of substantial past human activity is demonstrated by the Adamsfield Township, the trial workings at Halls Open Cut and the numerous old sluicing operations that went on in the 1920's and 1930's. Zelos have secured access to all parts of the tenement through diligent negotiation with other stakeholders.

The purpose of this report is to review all data relevant to the area and compile a new geological interpretation. This interpretation will be used in combination with new geological concepts to provide an exploration strategy for the licence and allow for the design of an exploration programme.

The geology of the area comprises a fault-bounded, thrust emplaced ultramafic sequence of Mid-Cambrian age, the Adamsfield Ultramafic Complex (AUC). This unit is hosted within mainly Cambro-Ordovician siliciclastics including conglomerates and Mid-Cambrian sediments. The Cambro-Ordovician sequences are overlain by Ordovician limestones folded into localised synclines. The area has been subjected to Recent glaciation which has left behind mainly glacio-lacustrine sediments with small amounts of fluvial-derived unconsolidated alluvium.

Platinum group elements (PGE) are the primary commodity being sought, possibly in association with gold. A small Inferred Resource has been estimated from previous drilling data for a narrow osmium-iridium-platinum lode at Halls Open Cut comprising 14,500 tonnes at 6.54g/t Ir, 7.33g/t Os and 0.13g/t Pt

Other hard rock Os-Ir mineralisation occurs at Pollards New Shaft in the Cambro–Ordovician sediments as palaeo-placers, with values up to 200g/t (Os-Ir). The past mining activity was mainly of Recent alluvium material around the margins of the Adam River Plain. There are some workings on the west side of the plain seemingly beyond the reach of the AUC and therefore possibly represent weathering of Cambro-Ordovician palaeo-placers. Other mineralisation reported on the licence includes:

- Past alluvial mining of gold with a maximum nugget size of 2.25ozs.
- Some minor alluvial gold near Adams Falls.
- A 5Mt resource of metallurgical grade chromite (pre-JORC) in the alluvial Adam River Plain.

Past exploration work has mainly concentrated on the AUC and the alluvial plains draining the AUC. Work on the former has mainly been for nickel from the 1950's to the 1970's (with no PGE assaying). This previous work has included airborne magnetic surveys, localised ground grids with geophysical and geochemical coverage. From the 1980's osmium and iridium has been the target both as a hard rock and alluvium occurrences. Diamond drilling is confined to three holes around Halls Open Cut along with an additional 12 RAB holes. The latter of which were used to define the Inferred Resource. The alluvial plains work has included substantial amounts of pitting and augering work along with a traverse of RAB drilling. .

Previous hard rock PGE exploration reported by Metals Exploration Ltd encountered substantial problems with getting accurate PGE assays. This seriously impeded their exploration effectiveness.

A proposed new exploration strategy will use new geological concepts to target for stratiform PGE mineralisation in the layered AUC. In addition, field examinations of the palaeo-placer potential are to be undertaken on specified target areas. The exploration work will comprise a mixture of detailed mapping and soil sampling traverses in selected areas, followed by test drilling (RC and DD).

Contents

List of Figures

List of Tables

1 Introduction

The purpose of this report is to undertake a literature review of all relevant data for the Adamsfield area, held under licence by Zelos Resources NL, as EL 11/2006. The review will include searching and summarising previous competitor activity in the general area from reports digitally available online from the Mineral Resources Tasmania (MRT) Library. In addition government data in the form of digital datasets will also be used to formulate a geological synthesis of the area. From the data synthesis and combining new target model concepts an exploration programme will be designed, including the identification of possible drill targets.

The primary target is stratiform platinum group element (PGE) mineralisation within the Adamsfield Ultramafic Complex (AUC).

The area is within the Franklin-Gordon Wild Rivers National Park which is classified as a World Heritage Area. The Adamsfield area has been excised from the WHA specifically to allow for mineral exploration and exploitation. The website for the WHA management plan can be viewed at www.parks.tas.gov.au/wha/managem. Any exploration work in the Adamsfield area will require world's best practice methods to be employed in order to keep visual impact to the ground at a minimum.

Past Explorer, Metals Exploration Ltd, completed an archaeological study of the main areas of interest. Their report can be found in MRT's digital library report no.TCR 88-2842.

2 Location

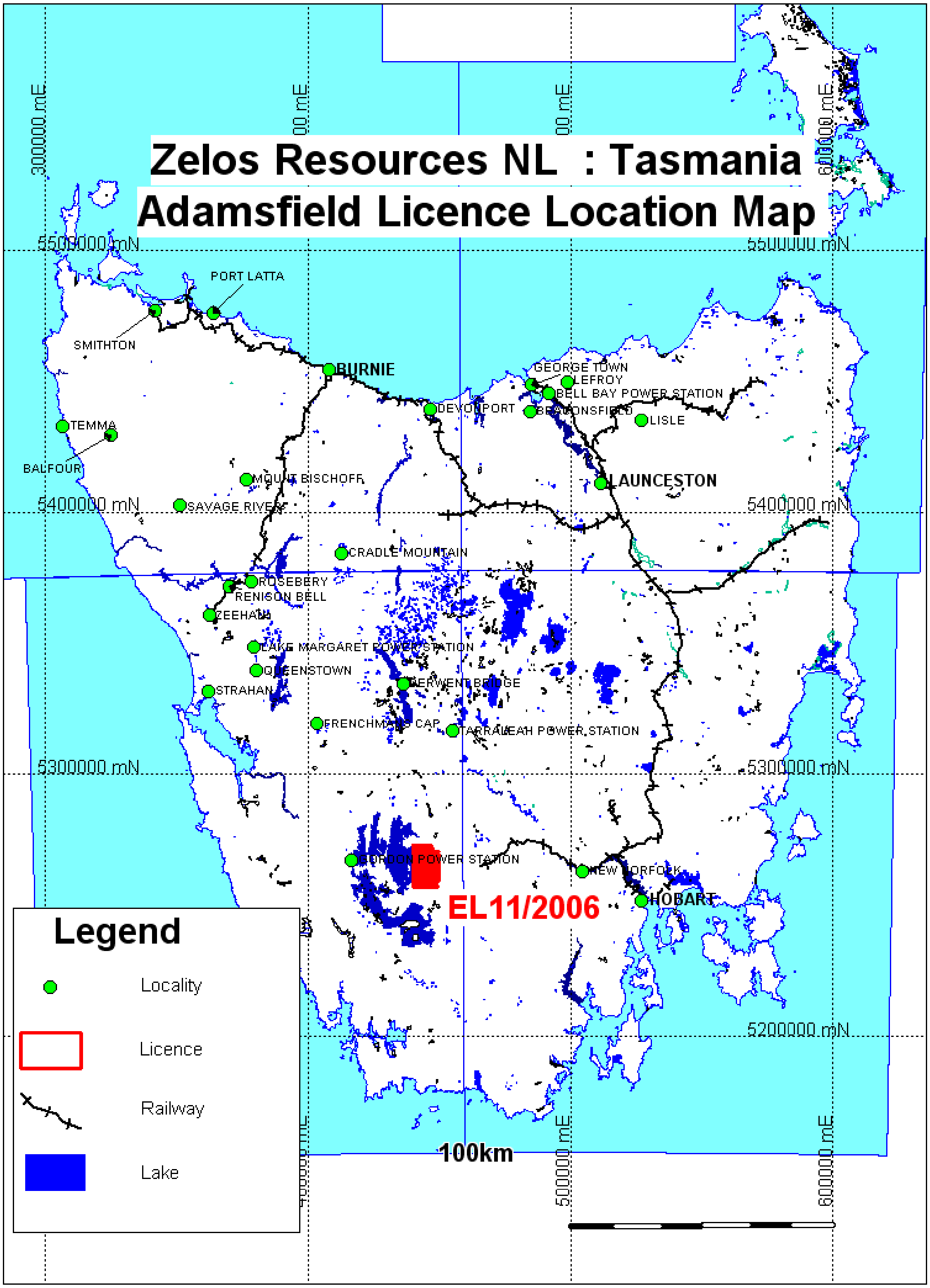
The exploration licence application EL11/2006 measures 150km^2 and is located 80km WNW of Hobart within the Franklin-Gordon Wild Rivers National Park (figure 1).

Access to the southern part of the licence area is facilitated by the sealed Gordon River Road connecting to the Maydena and Strathgordon roads. The northern part of the tenement can be reached by using the Clear Hill Road or the Sawback Range 4WD track, both of which connect to the 4WD Adamsfield Track. Some of these 4WD tracks will need refurbishment for exploration access purposes.

The Clear Hill Road, along the edge of Lake Gordon, will provide the main access to the northern part of the AUC, whilst additional access to the remainder of the AUC will be via the Sawback Range Track.

A natural spring occurs near Adamsfield (location 443697mE and 5269845mN). The landowner, a Mrs Josephine Wrigley, initially raised concerns as to the impact potential mining would have on the quality of water emanating from the spring, which she had identified as a possible business opportunity for bottled spring water. Zelos have been in discussions with Mrs Wrigley and have reached an amicable agreement regarding access and any exploration programmes.

Figure 1 Location Map



3 Physiography and Vegetation

The area comprises a mixture of low lying overgrown swamp areas in conjunction with moderate to high relief ranges (figure 2). These ranges have a general N-S trend rising to heights of 1200m ASL. The area likely to be of major interest is the western flank of the Sawback Range which rises from 350m to 700m ASL. Mt Wedge lies to the south of the licence whilst Mt Muller lies to the east. The low lying areas are the alluvial plains for the Adam and Eve/Lanham Rivers which have a mean height of 350m ASL.

Parts of Lake Gordon cover about 15% of the licence area, on its western side.

The climate is typical of West Tasmania with an annual rainfall of nearly 2m, with snow occurring during the winter months.

Vegetation is typical of Tasmania with button grass plains in the low lying areas, passing into denser scrub on the hill sides (figure 3). Earlier mineral exploration reports indicate that parts of the ultramafic rocks have caused poor quality soil to form and hence contain sparser vegetation. However this was not apparent from a recent field visit, with most of the previous alluvial workings substantially overgrown by natural vegetation (figure 4).

The area around the Halls Open Cut remains poorly vegetated due to extensive previous workings (figure 5). These workings were undertaken in the late 1930's as part of Osmiridium (Tasmanian) NL attempts to mine the hard rock occurrence of 'osmiridium'.

Figure 2 Sawback Range (looking south)

Figure 3 Adams River

Figure 4 Tasmanian Bush

Figure 5 Halls Open Cut (looking SW)

4 Tenure

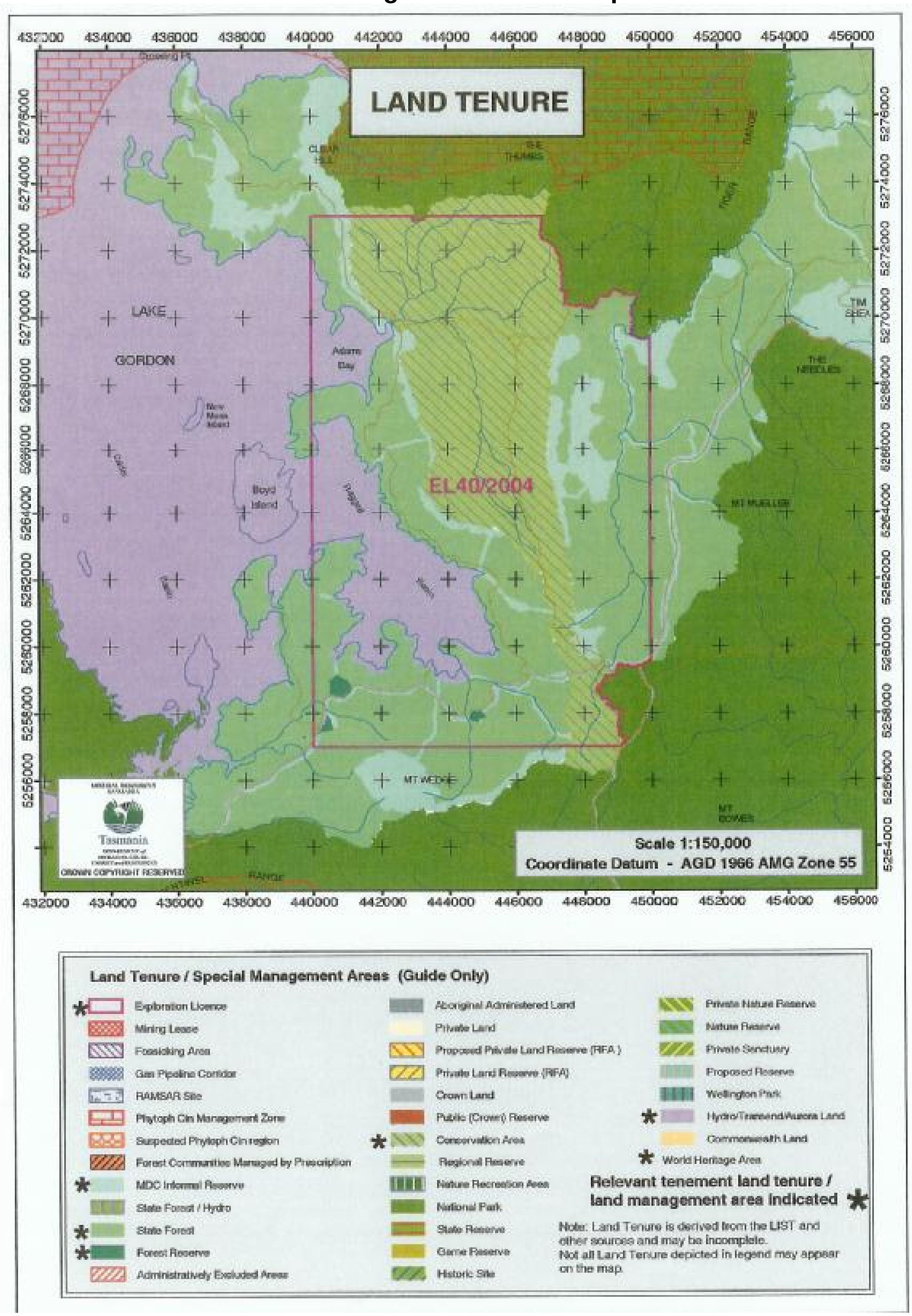
The land tenure situation in Tasmania is based on a series of classifications that have resulted from the Regional Forestry Agreement (RFA). This act established, in conjunction with other stakeholders interests, which land is available for exploration and mining e.g. State Forest. Some of the main land use categories that are covered by the RFA, and which allow for mineral exploration and mining subject to a project activities review, are Nature Recreation Areas, Regional Reserves and Conservation Areas. These three categories can be regarded as the same for mineral exploration purposes; they have different objectives for other land users e.g. hunting, forestry etc. An exploration work programme that is planned within any of the above three categories triggers the Mineral Exploration Working Group (MEWG) which reviews the planned work programme, making recommendations and/or modifications to the plan. This group is convened by MRT on behalf of any applicant with the review process undertaken in a timely manner. Other land categories which allow mineral exploration/exploitation include a Forest Reserve which is not available for forestry use; an MDC Informal Reserve is a forestry-related category that has a very minor impact on mineral exploration. The main areas where mineral exploration is not permitted are Nature Reserves, State Reserves and National Parks.

For the Adamsfield licence 45% of the tenement is State Forest with 30% classified as a Conservation Area with 8% as an MDC informal reserve and 2% as Forest Reserve. The remaining 15% is part of Lake Gordon. A more in depth review of proposed exploration programmes will be required due to the tenement's location within the WHA. However it is anticipated that any reasonable exploration programme will be approved.

A map detailing the tenure and land use situation is included as Figure 6.

A non-metal exploration lease EL 62/2004 is held by Southern Oceana Science Pty Ltd. over part of the Adams River Plain. This is unlikely to prevent Zelos testing its prime target areas. The lease is held for the possible extraction of clay minerals for the cosmetics industry.

Figure 6 Tenure Map



5 Geology and Mineralisation

5.1 Regional Geology

Tasmania has been geologically divided by MRT into seven Proterozoic-Lower Palaeozoic regions or "Stratotectonic Elements", each with a different geological history and economic mineral associations (table 1). As a result of multiple subduction episodes these elements or terranes were welded together during geological history, which has produced the current geological framework for Tasmania. The Zelos exploration licence lies within the Adamsfield-Jubilee element.

Table 1 Tasmanian Stratotectonic Elements

Element Name	Mineral Deposit Association
Rocky Cape	Savage River Iron Ore, Balfour Copper, Magnesite deposits
Dundas	Rosebery and Hellyer copper, lead & zinc mines, Mt Lyell Copper-Gold Mine, Henty Gold Mine, Renison Tin Mine, Avebury Nickel Deposit
Sheffield	Mount Bischoff Tin Deposit, tungsten skarns and numerous small scale skarn deposits & occurrences
Adamsfield-Jubilee	PGE mining
Northeast Tasmania	Beaconsfield Gold Mine, NE Tasmania Goldfields & Anderson's Creek Nickel

An abbreviated stratotectonic history of Tasmania is detailed below (see also figure 7):

1. Formation of basement as Early Neoproterozoic shelf clastic sedimentation with an age range of 900-1000 million years ago (ma) followed by a major orogenic event at 760ma, which included granite intrusions. This produced the Rocky Cape Element.

2. A failed rift episode then followed with its associated clastic sedimentation and volcanic inputs ensued by a second, successful rift event that happened in the Late Neoproterozoic to Early Cambrian. This added an assortment of units including mafic lavas to the Rocky Cape Element.

3. An island arc-continent collision east or northeast of Tasmania occurred in the late Early Cambrian and the emplacement of a series of allochthonous slices across Tasmania, including oceanic assemblages (ultramafics and associated mafic lavas) and other units. This formed the Dundas, Sheffield, Tyennan and Adamsfield-Jubilee Elements.

4. A series of Mid to Late Cambrian clastic basins developed post-collision and were concomitant with major calc-alkaline volcanism – the Mt Read Volcanics which contain a world class volcanogenic hosted massive sulphide (VHMS) province.

5. This was followed by Late Cambrian orogenesis comprising fold belt style tectonics at 500-510ma and includes some thrust stacking of units.

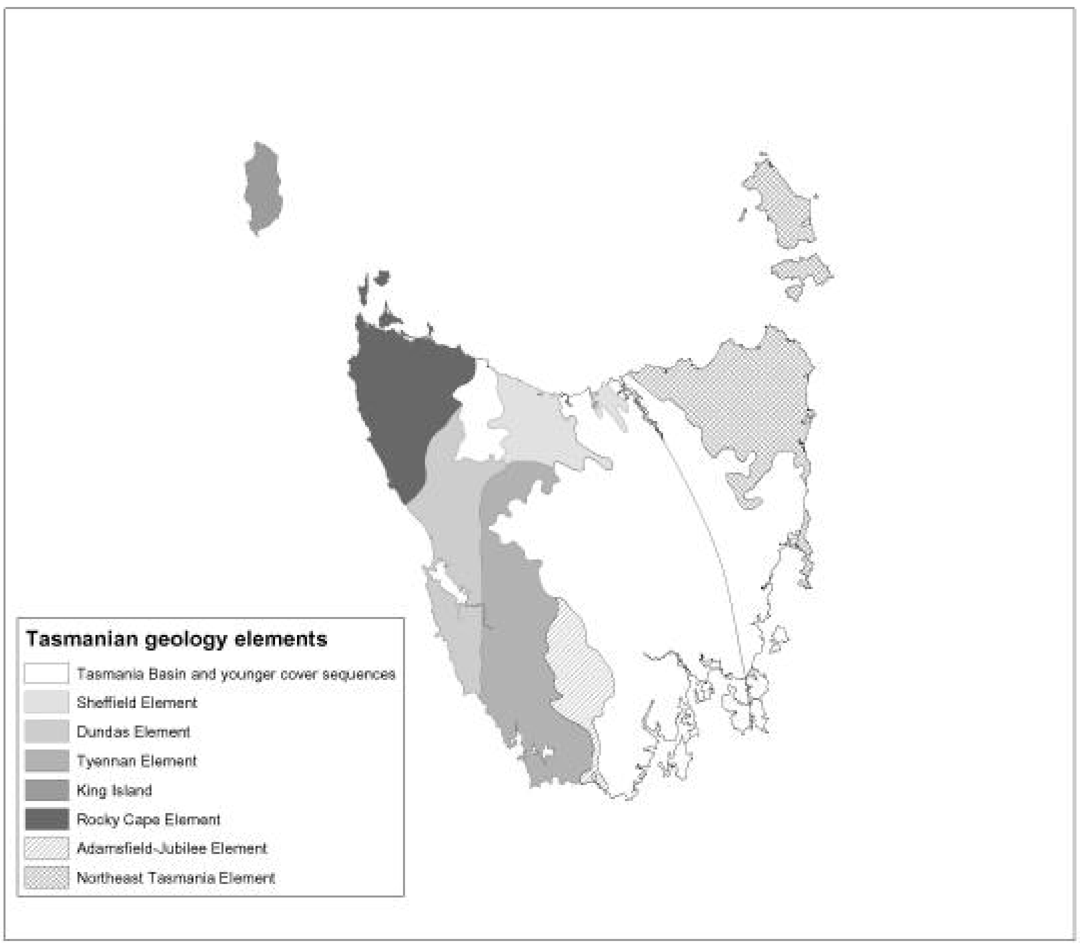
6. The establishment of a state wide clastic basin began in Late Cambrian times with initial basal conglomerates overlain by limestone lithologies followed by a gradually

deepening marine clastic sequence up to Mid Devonian times. At the same time the Northeast Tasmanian Element developed as a turbiditic basin quite distinct from the other elements and lies east of an inferred subduction suture zone.

7. Cessation of sedimentation was caused by uplift and erosion associated with the Tabberabberan Orogeny (Mid-Devonian) and with a subsequent Late Devonian to Early Carboniferous phase of major granitic intrusions. This included the Heemskirk, Meredith and the Northeast Tasmanian Granites, with the first two causing modifications to the Cambrian morphology via structural overprints and hydrothermal alteration effects. These granite intrusions resulted in the formation of many skarn and vein deposits for tin, nickel, lead/zinc etc. The tectonism also resulted in the structurally controlled Henty gold deposit. . In Northeast Tasmania the Devonian-aged intrusions and deformation are associated with gold mineralisation

8. Minor sedimentation including glacial deposits and coal measures occurred in the post-Devonian Tasmania Basin. Substantial amounts of dolerite and basalt were formed as a result of continental break up associated with Jurassic and Tertiary global events. Continental extension and rifting began in Mid Jurassic times with separation occurring in the Mid Cretaceous. Major Jurassic dolerites related to a Gondwana event occur as sills across Tasmania and are similar to the Karoo series in Africa.

Figure 7 Stratotectonic Elements for Tasmania (MRT)



Details of the major mineral deposits for Tasmania are provided in table 2

The Adamsfield-Jubilee Element is characterised by an area of deformed but relatively unmetamorphosed Proterozoic and Lower Palaeozoic rocks lying east of the Tyennan Proterozoic basement. The Adamsfield area lies within the Cambrian aged Ragged Basin Complex which is an extensively disrupted formation with many faulted contacts. It is believed, by MRT, to be an allochthonous unit transported from the east due to overthrusting in the Early Middle Cambrian. Associated with this deformation is the belief that the rocks comprise an imbricate series of east dipping thrust slices that postdates earlier folding. Late Middle to Late Cambrian deformation produced two sets of overprinting structures, a W to NW striking set and an open NE striking set. Subsequent Devonian deformation produced a N to NNW cleavage with open folds. The Devonian tectonic episode appeared to have weak effects in the Adamsfield area and there are no indications of any nearby Late Devonian granite intrusions.

Table 2 Major Mineral Deposits of Tasmania (source MRT 2002-2005)

Mine or Deposit	Mineral Style	Commodity	Tonnages (production + reserves)
Mt Lyell	Volcanic hosted disseminated	Cu, Au	135Mt @ 1.2%Cu and 0.4g/t Au
Rosebery	Volcanic hosted massive sulphide	Zn, Pb, Ag, Cu, Au	28Mt @ 0.6%Cu, 14.3%Zn, 4.3%Pb, 145g/t Ag & 2.4g/t Au
Hellyer	Volcanic hosted massive sulphide	Zn, Pb, Ag, Cu, Au	15.5Mt @ 0.4%Cu, 14.3%Zn, 5.9%Pb, 140g/t Ag & 2.2g/t Au
Que River	Volcanic hosted massive sulphide	Zn, Pb, Ag, Cu, Au	2.5Mt @ 0.45% Cu, 7.5%Pb, 13.6%Zn, 172g/t Ag and 2.8g/t Au
Hercules	Volcanic hosted massive sulphide	Zn, Pb, Ag, Cu, Au	2.6Mt @ 0.4%Cu, 16.7%Zn, 5.2%Pb, 159g/t Ag & 2.7g/t Au
Henty	Structurally controlled/vein	Au	0.5Mt @ 29g/t Au
Beaconsfield	Structurally controlled/veins	Au	1.085Mt @ 24.5g/t (production); 0.67Mt @ 24g/t (resource 1990)
Renison Bell	Skarn	Sn	28Mt @ 1.5% Sn approx
Cleveland	Skarn	Sn	10.3Mt @ 0.78% Sn and 0.45%Cu
Mt Bischoff	Skarn	Sn	10.32Mt @ 1.13% Sn
Queen Hill	Skarn	Sn	3.6Mt @ 1.2% Sn
Savage River	Massive magnetite	Fe	>330Mt @ 35%Fe
Main Creek	Magnesite	Mg	47.4Mt @ 43.4% MgO
Keith River	Magnesite	Mg	29Mt @ 42.8% MgO
King Island	Skarn	W	16.9Mt @ 0.78% WO_3
Kara	Skarn	W	2.2Mt @ 0.8% WO_3
Avebury	Skarn	Ni	4Mt @ 1.5% Ni
Melba Flats	Mafic hosted massive sulphide	Ni	7400t of ore @ 10% Ni & 5% Cu
Oceana	Carbonate hosted	Pb, Ag, Zn	4Mt @ 18%Pb and 4%Zn
Zeehan Field	Lode/veins	Ag, Pb	0.19Mt Pb,26Moz Ag,71t Zn,945t Cu & 5.3t Sn
Balfour	Structurally controlled	Cu	6177t of Cu Ore at 20-30% Cu
Grieves	Carbonate hosted and oxidised	Zn oxides	Small resource

5.2 Local Geology

The geology of the Adamsfield tenement is made up of a thick sequence of Neoproterozoic and Cambrian siliciclastic sediments, with facing east, that are part of the Adamsfield-Jubilee Stratotectonic Element (figure 8). Towards the top of this sequence lies the 12km long Adamsfield Ultramafic Complex (AUC), which is related to the ophiolitic ultramafics of the Dundas Element, having initially crystallised in similar, shallow crustal magma chambers and were then tectonically emplaced during obduction. The AUC is composed of three major 'stratigraphic' rock types (with the 'youngest' first):-

1. Massive pyroxenites,

2. Interlayered serpentinite (and variably serpentinised dunite) and pyroxenite,

3. Serpentinite (and serpentinised dunite and some harzburgite),

These lithologies appear to represent the basal layered part of an ultramafic magma chamber possibly from a spreading ridge environment. Whole rock XRF data (see TCR 89-2984) has identified harzburgite, dunite and orthopyroxenite, which are characteristic lithologies associated with basal magma chambers and can be hosts to platinum group minerals (PGM). Nye (1925) in his report stated that the serpentinite consisted of orthopyroxene layers (enstatite $MgSiO_3$). Tectonic overprints have served to complicate this simple layered picture and have produced areas of dislocation within the generally massive units.

Brown (1972) noted chromite layering made up of 6 lenses 1m long by 3cm wide and consisting of 80% chromite at the NW end of the layered ultramafics.

The AUC itself can be divided into three regions with the northernmost section seemingly comprising a large 700m wide body of continuous layered ultramafic rocks. The central section, south of 5264000mN, appears to be made up of discontinuous layers of strongly sheared ultramafic rocks interspersed with sediments. The southern most section south of 5260000mN, consists of a more continuous ultramafic body, which continues off the licence according to old open file reports and airborne magnetic data. This part of the AUC is hosted by Cambrian sediments rather than Cambro-Ordovician sediments as per further north.

Overall it appears that the ultramafic unit is a fault-bounded thrust slice with possible east-dipping thrust faults, hosted within the siliciclastic units.

An airborne magnetic survey accredited to BHP by MRT in the late 1960's has been reprocessed by Nigel Hungerford (2006) and shows very clearly the highly magnetic outline of the ultramafic unit (figure 9). The 1^{st} vertical derivative image shows a clear cut, narrow, highly magnetic band which appears to have small scale dextral offsetting by NW striking faults (figure 10).

An additional outcrop of ultramafics is mapped in the extreme south of the property hosted within Cambrian units (figure 8). This outcrop coincides with a positive magnetic feature in the airborne 1VD data.

The complex is seemingly overlain by a series of Cambro-Ordovician siliciclastics including conglomerates. In the magnetic data, particularly the 1VD image, there is a series of small scale anomalies within these overlying basal conglomerates that may represent heavy mineral concentrations from erosion of the AUC eg magnetite with chromite and possibly gold and PGE, which have formed palaeo-placers from weathered ultramafics.

Figure 8 Geology Map of Adamsfield EL 11/2006

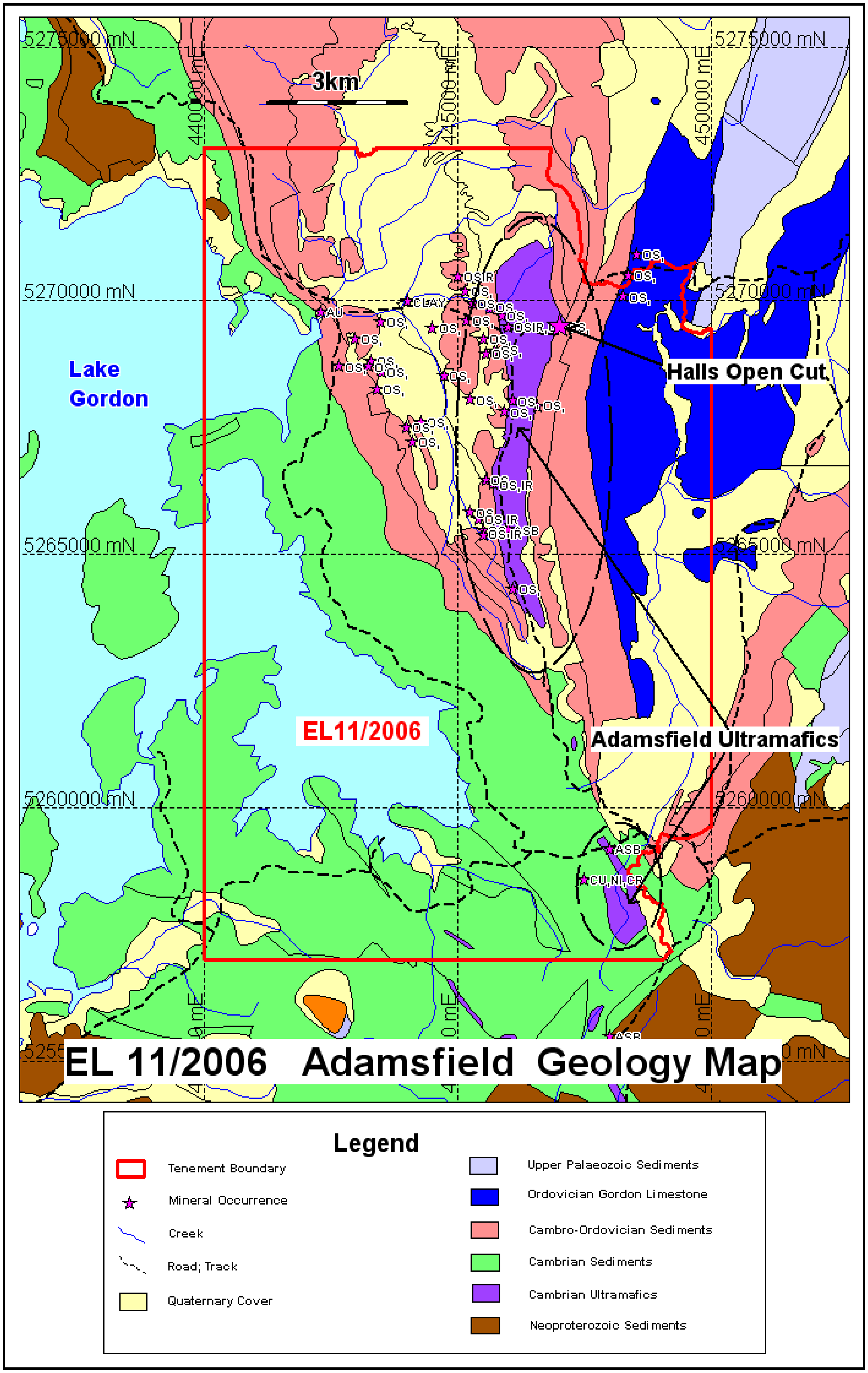
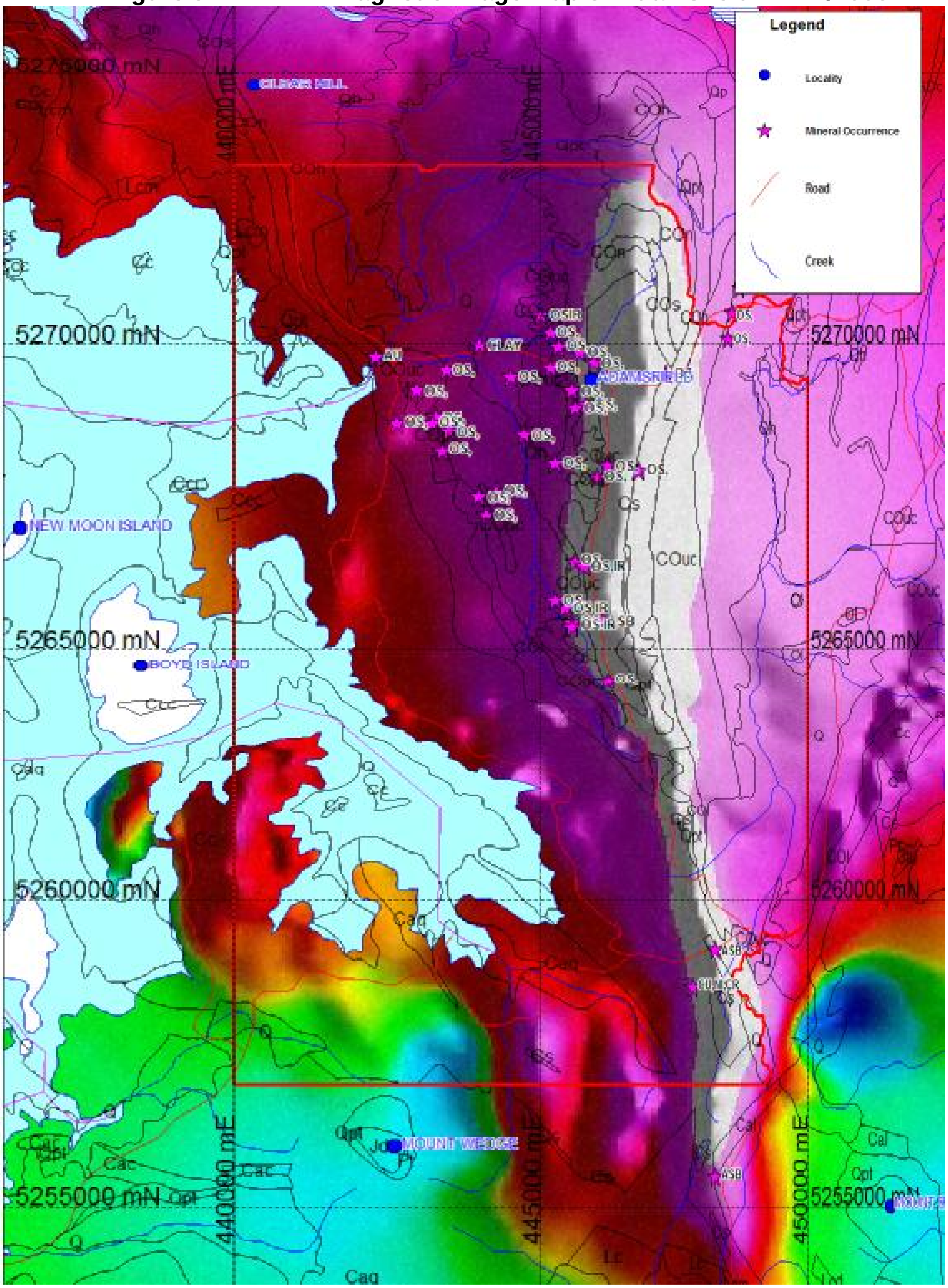


Figure 9 TMI-RTP Magnetic Image Map of Adamsfield EL 11/2006



The Gordon Limestone conformably overlies the Cambro-Ordovician siliciclastics. The Ordovician sediments in the east of the licence occur within a north-northeast striking syncline, cored by the Gordon Limestone and subsequent Silurian-Devonian sediments. In this area, in the Florentine Valley, there is a reasonably large magnetic anomaly in the 1VD data, associated with the outcropping limestone. There is no obvious reason for this but speculation might be that this phenomenon is due to basal limestone having siderite alteration, which in turn is related to zinc mineralisation, similar to that seen for the Gordon Limestone sub-basin around Zeehan. Alternatively the potential eastward continuation up stratigraphy) of the AUC may have some influence on the magnetic data.

Although not obvious from the published mapping it appears from exploration drilling that the syncline in the north central of the licence is cored by an outlier of Gordon Limestone which is outcropping beneath Quaternary cover.

In Tertiary and/or early Quaternary times it has been suggested that the Adams River Plain was scoured out leaving a karst topography in the Ordovician limestones. Subsequent damming of the river downstream meant that the area became a Quaternary lake giving rise to the glutinous clays that now exist. This implies that conditions were not suitable for the development of wide expanses of alluvial gravels to allow for economic placer accumulations for PGM's and chromite. The greatest accumulations of gravel lie at the foot of the Sawback Range where they comprise a green cobble wash having been derived from the ultramafics. Previous explorers are confident in asserting that PGM's are actively being shed from the ultramafics as based on their pan concentrate sampling work.

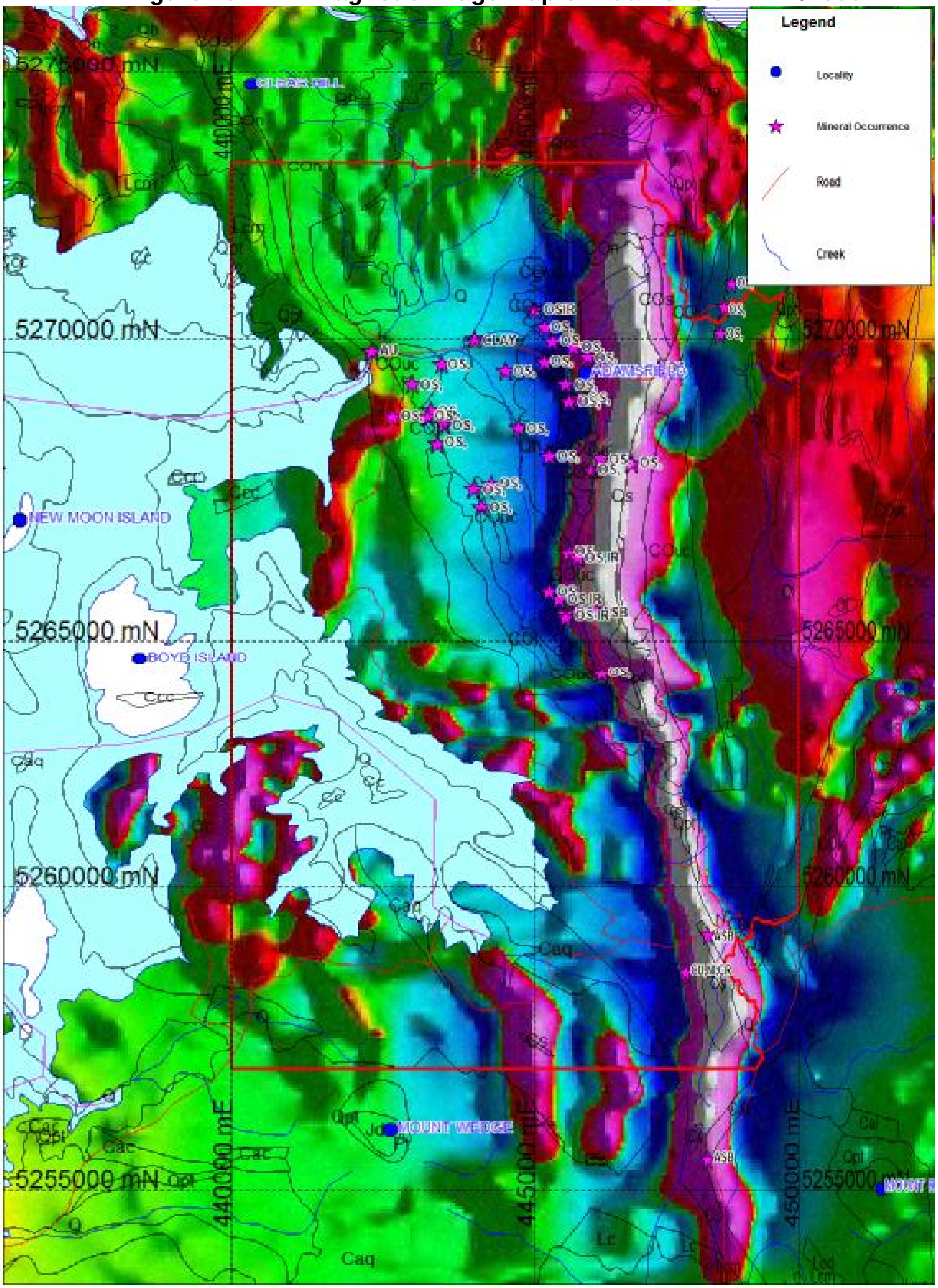
5.3 Mineralisation

There are numerous mineral occurrences within the tenement, the majority of which were for osmium and iridium, platinum group elements (PGEs). Previous attempts at alluvial mining in the 1920's looked to win the osmium and iridium which were found as an alloy called osmiridium, its proper name is iridosmine. A lot of these PGE occurrences are hosted by Quaternary cover i.e. placer deposits. There are some osmium occurrences in the underlying Cambro-Ordovician conglomerates i.e. are palaeo-placer deposits eg Marriott Hill and Pollards New Shaft. There is also an occasional gold occurrence e.g. Adam's River Falls, which lies several kilometres away from the AUC. There are no PGE occurrences reported in the Cambrian clastic units. Open file reports have indicated that the ultramafic units are actively shedding chromite and PGEs into the local drainage.

At a location at the north eastern end of the AUC, known as Halls Open Cut (not a real open pit) small scale trial mining occurred, 70 years ago, for osmiridium. There were reported grades of up to 42g/t Os+Ir within a narrow (1-2m wide), sheared, serpentinised ultramafic unit. This work also included the identification of "visible non-payable gold". Exploration by Metals Exploration Limited in the mid 1980's around the Halls Open Cut consisted of percussion drilling and diamond drilling, which reported significant narrow intercepts of osmium and iridium e.g. AHP1 1m @ 14g/t Ir, 18g/t Os and 0.25g/t Pt from 21m. The observations reported in the open file data are consistent with the Author's experience of stratiform platinum group mineralisation hosted by ophiolitic sequences.

At the south end of the licence the ultramafics are hosted by Cambrian rocks. A small low level Ni, Cu, Cr mineral occurrence is recorded in this area that is due to a soil sampling anomaly discovered by BHP in 1971. Follow up soil lines either side of the anomaly failed to add any strike length to the feature.

Figure 10 1VD Magnetic Image Map of Adamsfield EL 11/2006



6 Previous Competitor Activity

Past exploration work has been focussed on the outcropping ultramafics, the Adamsfield Ultramafic Complex, and on the alluvial plains 600m to the west of the old Adamsfield Township. Minor work has been completed on the Cambro-Ordovician clastics in the west of the licence. A list of open file reports used in compiling this report is included as appendix 1.

6.1 Pre 1950 Exploration Work

The Adamsfield area is well known in Tasmania for the alluvial and hardrock mining of 'osmiridium' in the 1920's and 1930's. Nye (1929) in his report provides some detail on the alluvial operations, which at their height had nearly 800 men working on site, running a series of sluicing operations. Despite considerable alluvial chromite and osmiridium material no hard rock source was found. Gold was also found, associated with the osmium, with the largest recorded nugget weighing $2^{1}/_{2}$ oz. Nye also commented on the mineralogy of the deposits stating that nevyanskite and siserskite were the main osmium/iridium alloy minerals with the former having >40% Ir and the latter <30% Ir. He also mentions the occurrence of millerite and native platinum at the Halls Open Cut. The total Os-Ir production for the period mid-1925 to mid-1928 was 7,666oz, 8dwt and 7 grains for a projected then value of 175,292 pounds (presumably Australian). The current price for osmium and iridium is US$400/troy oz each (www.thebulliondesk.com and www.mine.mn). The main payable areas were the Main Creek to below the junction with South Creek (draining the eastern, northern and western slopes of Football Hill).

The gold ?alluvial prospect at Adam River Falls produced several pennyweights per ton.

In 1937 a prospectus was issued by Osmiridium (Tasmania) NL to raise funds to continue the hardrock mining of the osmiridium lode discovered at Halls Open Cut. Work completed included a 47' deep shaft with sluicing of the first 10-20' of material. A 240' long tunnel was driven from the north, 100' short of the lode. A resource of 6-10' wide, 70-80' deep and 900' long was estimated to provide 30,000 tones of ore. A substantial amount of testwork was completed with recoveries of 1 to 1.5 oz/ton initially reported.

Testing of recoveries for osmiridium by the Tasmanian Mines Department produced the following table of results (table 3):

Table 3 Bulk Sample Test Results for Halls Open Cut Workings

Sample No	Type	Location	Wt of Sample	Ozs	dwts
1	Bulk	?	65 lbs	3	11
2	Bulk	?	60 lbs	26	14
3	Bulk	?	60 lbs	4	1
4	Conc & sand	40' Shaft	?	50	12
5	Bulk	?	60 lbs	27	5
6	Bulk	?	25 lbs	12	4
7	Bulk	?	60 lbs	5	18
8	Bulk	Outside mine	?	0	10
9	Bulk	?	25 tons	6	16
10	Bulk	?	25 lbs	1	18

6.2 Post 1950 Exploration Work

Following the apparent failure of Osmiridium (Tasmania) to mine, recent exploration began in 1959 with a modest amount of exploration completed to the modern day, see table 4.

Table 4 Summary of Previous Competitor Activity for EL11/2006

Company	Year	Licence No	Drilling	Other Work
Osmiridium (Tasmania) NL	1937	NA	None	Trial workings & test pits Shaft & drive excavations
Lyell-EZ JV	1959-1961	EL1/59	None	Used regional airborne geophysical work (magnetics and EM) with reconnaissance and local mapping completed for nickel
BHP	1966-1972	EL13/65	None	Airborne magnetic survey with ground mag, EM and SP follow up; also completed some mapping and soil sampling; initially for nickel & then asbestos
Metals Exploration Ltd	1985-1991	EL4/85	3 DDH for 190.7m, 31 RAB holes for 653m	Regional mapping, stream sediment & pan concentrate sampling, trenching, pitting & auger drilling for both hard rock & alluvial PGEs
Jervois Mining	1991-1994	EL26/91	Auger work	Tested Quaternary sand deposits for chromite and PGEs.

In 1952 an unknown company, ?Lipscombe (author Warren Carey), explored for placer-style mineralisation at the base of the Cambro-Ordovician conglomerates that lie unconformably on the Cambrian sediments. He identified six square miles of the prospective unconformity up to 300m below surface. Bits of the report are missing but it is clear that there was some bulk sampling around an area known as Pollards New Shaft (figure 11), but no maps are provided. Four cross trenches were completed underground with a best result of one sample in trench 2 yielding $7^{3}/_{4}$oz/ton Os-Ir. No further work is reported.

The Lyell-EZ work searched for nickel resources and used newly flown airborne magnetics and EM in conjunction with ground follow up, including mapping of airborne anomalies using ground EM and IP. No digital data or hardcopy/open file maps of the surveys were found in the MRT online library. They concentrated on the AUC although identified an anomaly A5/1 on the lower western slopes of the Ragged Range area (figure 11). Anomalies A6/1 and A6/2 were reported to be hosted by sheared serpentinite with both anomalies having airborne EM responses that were weak ground conductors. This led to the speculation that the airborne features were the response to conductive overburden. A6/2 had an EM response 600-700' west of the main mag high but is still within the ultramafic rocks. It is wondered by the author if this marks a weak sulphide dissemination in the ultramafics.

Other points of note in the EZ work include:

1. That the "banded ultrabasics contain visible chromite in sufficient quantities to cause the observed magnetic values".

2. The Picton Fault is a strike parallel fault within the AUC, interpreted by air photo work to be a normal fault, dipping 60^{o} west with a dextral sense of movement.

3. The Ragged Fault is a barren "gossan" at surface, potentially an east dipping thrust

4. Anomaly 5/1 has a narrow breccia bed of pyrite at the Ordovician/Cambrian contact.

Figure 11 Work Done Map Adamsfield EL 11/2006

BHP held the licence in the late sixties and early seventies concentrating on the ultramafic complex looking for massive sulphide nickel deposits. They processed another airborne magnetic dataset flown by Aeroservice in 1965, see chapter 5, figures 10 & 11 mof this report (details of the various relevant airborne surveys are in appendix 2). They also undertook substantial ground-based geophysics including magnetics, EM and SP as well as soil and rock chip sampling. The initial work was around Adamsfield with a large grid being cut. Subsequent geophysics was completed but there is no record of any soil sampling being undertaken or any results published/discussed. The cut grid extended the length of the main continuous section of the AUC (figure 8) but the entire grid was not covered by the ground geophysical work. Generally the results were described as disappointing and resulted in there being no follow up work including drilling. They did note that "observed anomalies [could be] explained by the magnetic properties of the rock types" i.e. they could define stratigraphy.

A second phase of exploration was completed by BHP and involved the cutting of grids further south, over the smaller outcrops of the AUC, named as areas A, B and C (appendix 3). They undertook detailed/reconnaissance soil sampling for a total of 286 soils and 17 whole rock analysis. Area A consisted of a detailed soil grid just south of Ibsen's Peak whilst area B involved reconnaissance lines over the western headwaters of the Florentine River. Area C contained reconnaissance lines infilling between areas A and B. The work indicated a mixed sequence of ultramafics and mudstones for area A, whilst indicating greater ultramafic sequences further south. The areas of greater ultramafic thicknesses may have potential for stratiform PGEs. There was no PGE analysis for any of the EZ or BHP soil samples. Some additional work was completed by BHP south of the current Zelos licence.

In TCR72-0859 there is a map that identifies 3 aeromagnetic anomalies at the south end of the current Adamsfield licence that were not investigated. Two of these features lie within the licence, one corresponds to a mapped outcrop of ultramafics, whilst the other has no explanation but presumably the geology is similar to the other anomaly.

Negative results for nickel in the soil and rock sampling coincided with a change in corporate strategy whereby asbestos became the main focus of exploration on the licence. Not only that but the existence of small mine leases around the Adamsfield placer deposits prohibited BHP from looking at the Os-Ir potential for that area.

In 1985 Metals Exploration Ltd took up the Adamsfield exploration lease and initially aimed to locate a hard rock source for the osmium and iridium at Halls Open Cut. Conspicuously they did not analyse for the other platinum group elements i.e. platinum, palladium, rhodium and ruthenium despite invoking the Bushveld model of stratiform PGE mineralisation. Initial work comprised regional mapping including an air photo interpretation, rock sampling and 44 heavy concentrate stream sediment samples. The rock sampling was around the Halls Open pit area, but no maps showing the sample locations has been found to date. They immediately reported assay problems with osmium, iridium and other PGE analysis. The author of this report is aware that between 1986 and 1990 there were global problems with PGEs' analysis.

Metals Exploration work at Halls Open Cut included excavating 3 trenches for 208 1m channel samples, diamond drilling 3 holes for 190.7m and percussion/RAB drilling 12 holes for 461m (figure 12). The trenches failed to locate any Os-Ir mineralisation even when passing over the expected position of the lode (presumably it had been mined out for the Osmiridium (Tasmania) testwork and then backfilled). The diamond drillholes were assayed (half core samples) for Ni, Au and Ir only. Results were low tenor but the holes may not have properly tested the known mineralisation. Follow up work included percussion hole drilling, which managed to intersect a PGE lode in several instances and had analyses for all six PGEs. Some points of interest to come out of the work are:

1. The lode was definitely intersected in some percussion holes allowing for a small resource to be identified (see later), including anomalous platinum values.

2. AD86-01 was an angled diamond drillhole aiming to test the lode at 70m below the old shaft. It encountered weak mineralisation between 103.5 and 107.7m as a 2m wide lode dipping steeply to the east. This has confirmed the potential existence of the lode at depth but has so far indicated poor grade continuity.

3. Nickel sulphides, millerite and heazlewoodite, of both magmatic and metamorphic origin respectively, occur in serpentinised dunite in the Halls Open Cut. The trenching recorded 9m @ 0.64% Ni, suggesting a nickel-in-silicates contribution of 0.18-0.25% Ni. [The maximum level of nickel-in-silicate for olivine-rich rocks i.e. dunites is about 0.4% Ni].

4. Weak gold mineralisation, with a peak value of 0.34g/t over 0.7m in AD85-01, is recorded in some of the holes, presumably related to carbonate veining as reported in the drill logs.

5. And the following statement "*As a consequence, all stream, grab/chip channel and core samples Ir values obtained to date [1986] are still suspect*". This includes the diamond drilling but the statement predates the percussion drilling.

Figure 12 Halls Open Cut Workings

Subsequent work by Metals Exploration involved looking at the placer potential of the Adams River and Lanham Creek plains for chromite and Os-Ir. This involved a sixteen percussion hole E-W traverse across the plains (for 116.5m) and a 500m by 100m hand auger grid. The drilling technique was considered unsatisfactory and the augering achieved a two thirds success rate in reaching bedrock. Three additional percussion holes were completed at Football Hill (75.5m) but were beset with technical problems. Interestingly the E-W traverse of percussion holes identified limestone as the bedrock for the whole traverse. This had not been mapped by previous explorers despite there being limestone outcrops in the Adams River adjacent to the road access. This limestone assists the spring water flows of interest to Mrs Wrigley. As a follow up to the auger programme, a pitting programme was undertaken over the alluvials' of the Adam River plain on a 250 by 100m grid. 70% of the pits reached bedrock and where bedrock was not achievable a 'wacker-auger' technique was used to obtain a sample.

The results of the alluvial deposits' work were used to identify a 5Mt (2.5Mm^3) resource of metallurgical grade chromite (based on Cr:Fe ratios) at a stripping ratio of 1:1 to produce 125,000 tonnes of chromite (2.5Wt%). This resource is pre-JORC and is not to a JORC standard. Other interesting points include:

1. No basal gravels were found, this indicates that the last phases of Quaternary glaciation had stripped any pre-existing Tertiary/Quaternary gravels.

2. The PGE-bearing alluvials are shallow channel gravels feeding into a lake system and are regarded as very late stage features.

3. Head grades for detectable PGE's ranged from 0.39g/m^3 to 0.01g/m^3 (20% of the samples had detectable PGE's)

Other work completed by Metals Exploration including excavating 10 pits, 3.5m deep, for bulk sample analysis on the western margin of Football Hill. The results from this work indicated the presence of iridium and osmium as expected, with the most anomalous pit samples being ABS2, 4 and 6 for Os-Ir and ABS1, 5 and 6 for gold, with ABS6 having the presence of platinum and gold (up to 67 g/t in concentrate). A concomitant pan concentrate survey in the same general area yielded values up to 800ppb Pt with 3.5g/t Au, 28g/t Os and 34g/t Ir. These results raise an issue as to whether the heavy minerals are from the siliciclastics of Football Hill or are from sediment washed around the hill having been originally sourced from the AUC.

Further prospecting using an excavator and sluicing was completed by Metals Exploration on the periphery of the Adam River Plain. This work recorded locally anomalous PGEs on the west flank of Football Hill, as to be expected from the earlier pitting work. However much more interesting was site 8 (TCR89-2984) on Barratt Creek which recorded gold and significant osmium, upstream from an anomalous pan concentrate site. The creek sits at the north end of a distinctive N-S air magnetic positive feature (figure 10) hosted in Cambro-Ordovician siliciclastics close to its base and the underlying Cambrian sediments. The nature of the feature would seemingly preclude the creek immediately to the south being able to source any detritus form it. This appears to be the case as the creek was tested by the prospecting method outlined above and returned negative results.

One final effort by Metals Exploration involved the collection of an additional 24 pan concentrate samples and 6 rock chip samples. Three sites displayed significant anomalism, the first was the Barratt Creek sample mentioned above. The second was much further south towards the head waters of Adam River where the likely source is directly from the AUC. Finally a third site was located near the south east corner of the licence associated with limestone in the Florentine Valley near Frodsham's Pass. No explanation is offered for this suffice to say that if, as BHP indicate, the head waters of the Florentine River drain the southern portion of the ultramafics then this may be the source.

One of the open file maps supplied by Metals Exploration had four traverses marked on an area around a possible hard rock osmium occurrence immediately south of Marriott Hill. To date no reference to this work has been found in any of the reports but it is assumed that Metals Exploration put these grid lines in but then never carried out any work.

The final explorer prior to Zelos was Jervois Mining who held the licence for a short period in the early 1990's. Initial work was held up by discussions regarding the World Heritage Area due to the potential for conflict with respect to mining in such an area. Once this was resolved Jervois undertook an exploration programme that targeted the Quaternary alluvial chromite (and Os–Ir) in Adam River and Lanham Creek Plains. Using a hand held power auger they completed 40 holes on the alluvial plains obtaining 116 samples with a range of head grades from 1.15 to 47.7 kg Cr_2O_3 per M^3, average 21.66kg/m^3. More work was proposed but seemingly was not carried out and Jervois relinquished the licence. In Jervois's relinquishment report they made the following statement:

> *"It was noted that the Pt values, while low, were consistently higher than those for Os and Ir. As this was not the normal rule at Adamsfield, Amdel were asked to carry out check assays. The same general relationship of Pt to Os and Ir was obtained, for which there is no immediate explanation."*

This again raises the question of the reliability of any assays for the platinum group elements in any of the work at Adamsfield. Whilst it is unlikely high grade mineralisation has failed to register as high grade assays, lower levels of anomalism may have been missed. It must be remembered that platinum was only added to any assay suite from 1987 onwards, for the Halls Open Cut percussion drilling.

Attempts to accurately locate various sample points, survey lines, collar locations etc from old hardcopy maps has proved in some instances to be very difficult. In particular the BHP grid lines for the Southern Area, which includes grids B and C, were very difficult and are likely to have an error of up to 150m. Only best fit digitising could be applied to the drafting of these survey lines.

6.3 Resources

6.3.1 Historical

In 1937 Osmiridium (Tasmania) NL reported a resource of 45,000 tons at a grade of 8dwts per ton (1 dwt (pennyweight) = 1.5552g) which roughly equates to 45,722 tonnes @ 12g/t Os+Ir. This was based on reports of 1350 feet of strike length having been successfully sluiced to 10-20 feet below surface and a range of ore widths from 6 to 10 feet. In addition two shafts were sunk in ore, one to 40 feet and one to 60 feet with both in ore at their respective bases. Grab sampling at the base of the 40 foot shaft produced 6 samples averaging 8dwts Os+Ir per ton. The 1937 prospectus also reports that the ore is uncovered for strike lengths of 1550 feet and even to 2000 feet

6.3.2 Inverse Distance Squared Method

A review of the drilling completed at the Halls Open Cut by Metals Exploration in 1987, indicates that it is possible to design a small resource shape for the osmium-iridium lode. This is the same lode that was subject to trial mining in 1937.

A total of five RAB holes have been used to define the resource shape. There is a diamond drillhole, AD86-01, that was supposed to be drilled into the same lode, but there are location problems with the hole collar and there is a reference in a report by Metals Exploration that the PGE assays are suspect. Hence this hole has been discounted from the resource estimation.

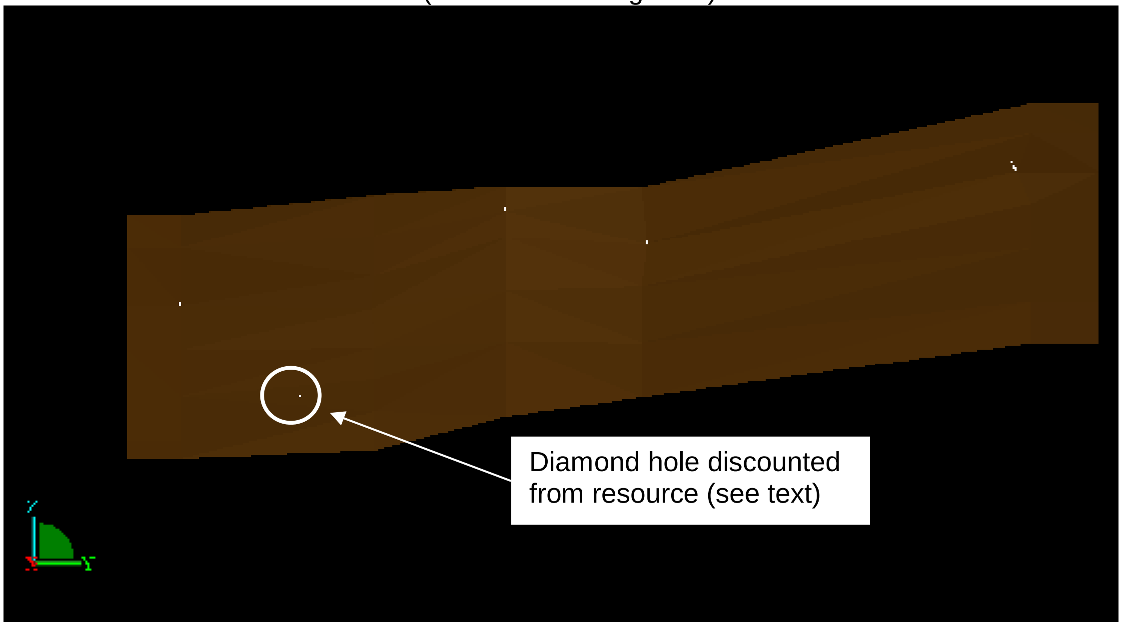
For the RAB holes, collar locations were picked up by a competent surveyor in local grid coordinates only. Zelos have picked up the collar positions in AMG coordinates using a hand held GPS. The error associated with using a GPS to locate points on the surveyor's map has indicated some errors up +/-15m at the peripheries of the map (see appendix 3). However the GPS readings around the bulk of the RAB drilling (holes AHP1-8), indicates an error of less than +/-4m. Drill hole spacing for the resource is approximately 30m along strike. There are no twinned holes containing mineralisation and there are no indications of any down hole surveys for the RAB holes.

RAB hole sampling consisted of a composite sample made from 3 separate spear samples for each 1m interval. There appears to be no down hole smearing in the RAB holes associated with the mineralised Os-Ir horizon, with the high grade samples usually surrounded by samples with results below detection limits for Os and Ir. The mineralised horizon is not easily recognised in the RAB holes, but in 3-D the high grade intercepts appear to line up in a near vertical plane with varying vertical depths (figure 13). There is no mention in the RAB logs of sample recovery and there is no QA/QC data for the assay results.

Based on the paper logs and sections it appears that the high grade interval is a very steeply dipping zone hosted by serpentinite which is an alteration lithotype of dunites and/or pyroxenites. Within the serpentinite body there are highly fissile shear zones. Additional evidence for the stratiform nature of the lode comes from the identification of a parallel silica/jasper zone to the lode direction.

Drilling information in the paper logs was converted by the author to digital data loaded into an Access database. Converted geological information included rocktype and alteration. The Access database was then connected to Surpac and a 3D digital shape was designed (figure 13). The design of the shape was based on assay grades (cut off 1g/t Os/Ir) combined with an interpretation of the geology and the use of the geological model for stratiform PGEs in ultramafics. The designed shape measures 200m long, 50m in depth with average width of 0.5m.

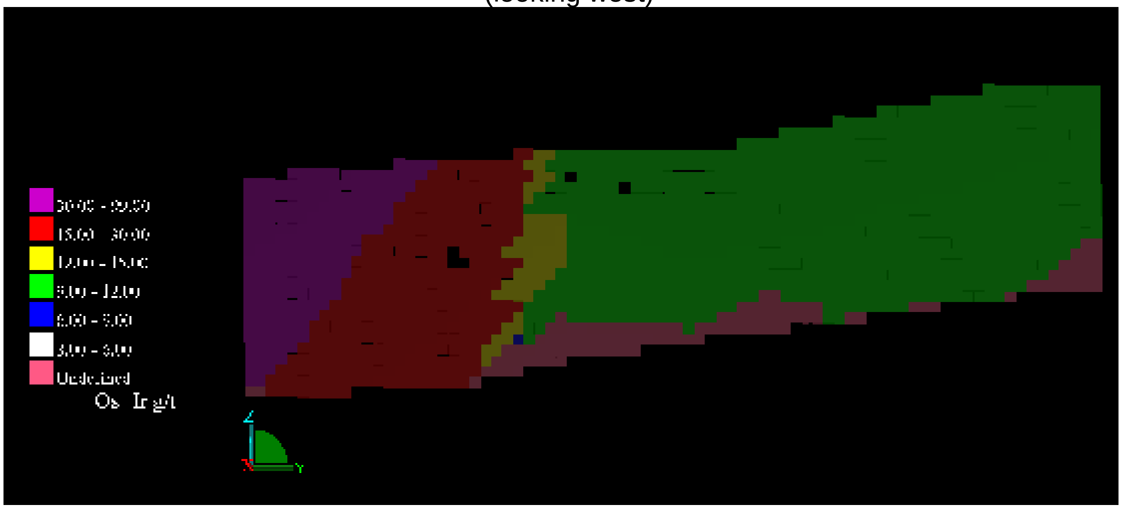
Figure 13 Halls Open Cut Resource Shape & Drillhole Intercepts
(in white – looking west)



The resource estimation method involved using the wireframe shape of the lode to constrain the drillhole data. Compositing of the drillhole data was at 1m intervals with 75% of the sample included. A block model with a block size of 10m by 1m by 10m was created with sub-celling to 5m by 0.25m by 5m. An inverse-distance squared method was used to fill the block model with a 60m search radius and a minimum of one sample used. There was no top cut applied to the data (figure 14).

Reporting of the resource figure was done by constraining the blocks to inside the wireframe, using a density figure of $3 g/cm^3$ for basic rocks, which is based on the AusIMM Field Geologist's Manual.

Figure 14 Halls Open Cut Block Model Combined Os & Ir
(looking west)



A figure of 16,369 tonnes at an average grade of 6.54g/t Ir, 7.33g/t Os and 0.13g/t Pt was produced.

The risks associated with this figure are mainly drilling related:

- The nature of the drilling ie RAB as opposed to diamond
- The lack of detailed drilling,
- No checks on the assay data
- The lack of any recovery data from the RAB drilling.

6.3.3 Sectional Polygonal Method

A sectional polygonal interpretation was also completed to provide a check for the above resource estimation (table 5). This involved extrapolating the section outline for each drillhole to half the distance between itself and the next drill hole. A notional width of 0.5m was used for the lode to account for the uncertainty of the actual dip of the lode and the dip angle of the hole. A notional 50m depth was allocated for the down dip length based on the varying height of intersection of the lode by the drilling. Thus each block has an attributed volume for each drill hole, which was converted to a tonnage by using the density figure of $3 g/cm^3$. A summation of the blocks produced is shown in table 5.

Table 5 Sectional Polygonal Figures for the Halls Open Cut Os-Ir Lode

Holeid	Length	Width	Depth	Volume	Density	Tonnes	Os g/t	Ir g/t	Pt g/t
AHP1	21.25	0.5	50	531.25	3	1593.75	18	14	0.25
AHP4	33.5	0.5	50	837.5	3	2512.5	13	11	0.22
AHP5	28.0	0.5	50	700.0	3	2100.0	4.7	4.2	0.11
AHP6	48.5	0.5	50	1212.5	3	3637.5	3.4	6.6	0.15
AHP7	49.0	1	50	2450.0	3	7350.0	5.8	4.6	0.08
Total	**180.25**		**Total**	**5731.25**	**Total**	**17193.75**			

The main risk associated with the sectional polygonal model is the interpretation of the true width which is a function of the dip angle of the lode and the angle of the drillhole intersection with the lode. A best guess of 0.5m true width was applied to the 1m down hole sample width.

Table 6 is supplied to demonstrate the various resource estimations. The ID2 and sectional polygonal methods have similar results.

Table 6 Comparison of Estimates

Model	Volume	Tonnes	Ir g/t	Os g/t	Pt g/t
Historical		45722	Combined 12g/t		n/a
ID2	5456	16369	6.54	7.33	0.13
Sec Poly	5731	17194	6.78	7.34	0.13

The slight differences between the two newer estimates are due to the fact that some of the blocks from the ID2 block model have no grade assigned to them as they were beyond the search radius. This would account for a slightly lower tonnage relative to the sectional polygonal.

The above figures have not taken into account the trial mining completed in 1937 by Osmiridium (Tasmania) NL. According to the records 10-20 feet off the top of the lode were extracted and sluiced (no crushing involved). This would seemingly require up to 12% being removed from the resource tonnage figures estimated in this report. Unfortunately there are no maps showing the old workings. It is proposed here that 10% of the resource is deemed to have been removed by trial mining

Incorporating the above correction the resource and its classification is as follows:

Inferred Resource 14,732, rounded to 14,500, tonnes at a grade of 6.54g/t Ir, 7.33g/t Os & 0.13g/t Pt

The resource status can be upgraded with additional infill drilling including diamond drillholes. Potential for additional resource appears to exist to the north beyond AHP7 and down dip. Drillholes AHP2, 3 and 8 appear to close off the resource to the south.

Metallurgical testwork by Osmiridium (Tasmania) appeared to show no significant recovery issues.

7 Exploration Potential

PGE mineralisation within the Adamsfield ultramafics is considered the main exploration potential for the licence. This can be in two forms, firstly as stratiform deposits in the layered serpentinite and dunites or secondly as palaeo-placers within the overlying Cambro-Ordovician clastics. A possible third option is as placer accumulations in the Quaternary unconsolidated sediments.

Of secondary exploration importance could be the option of nickel-sulphide and chromite mineralisation within the ultramafics.

In addition to nickel and chrome, there is potential for gold deposits possibly related to faulting associated with the ultramafics. If there are placer accumulations, palaeo or recent, for PGE's then there is also the possibility of similar type gold accumulations.

7.1 Target Concept for Stratiform PGE's

Magmatically derived PGE's, mainly platinum (Pt) and palladium (Pd) have been shown to occur in oceanic floor basic magma chambers (figure 15 and Prichard & Lord 1993 in appendix 4). The Pt and Pd enrichments occur at the base of well fractionated macrorythmic units formed shortly after an influx of primitive magma into the chamber. These enrichments are only a few cm's thick but occur within well defined bands slightly displaced stratigraphically above disseminated chromite layers. The stratigraphic PGE zone may be quite narrow e.g. <1m but can have the potential to have kilometres of strike length e.g. the Leka Ophiolite Complex in Northern Norway (appendix 5).

The new magma injections are marked by a significant change in the cumulate mineralogy, particularly towards the base of the igneous stratigraphy i.e. within the dunites. PGE's occur in chromitites hosted in supra-moho dunites and dunites of uppermost stratigraphic levels of the mantle sequence but they remain independent of the chromite composition. The actual position and concentration of the PGE's depends on the levels of chromite and sulphide saturation. The highest Pt-Pd enrichments happen with sulphide bearing dunites that accompany chromites layers and bands associated with layered intrusions of an ophiolitic origin. The stratigraphic point of PGE enrichment coincides with the first appearance within a new cycle of disseminated sulphides. This is believed to be soon after the precipitation and settling of layers of disseminated chromite.

The Merensky Reef in the Bushveld Complex is <1m thick but runs for 10's of kms, PGE's are concentrated in a very small band. The Leka Ophiolite in Norway has a 1-2m thick band of disseminated chromite layering with a strike length of at least 2km (appendix 5). The chromite unit and surrounding lithotypes (up to 10m stratigraphically above) had elevated PGE grades of up to 360ppb Os, 410 ppb Ir, 4600ppb Pt and 2700 Pd in grab samples corresponding to 2ppb Os, 4ppb Ir, 200 ppb Pt and 240 Pd in 0.5m lengths of drillcore, see table 7. In other instances at Leka anomalous Os-Ir grades in chromites and sulphide bearing dunites can be related to anomalous Pt and Pd grades (see appendix 5).

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Figure 15 Platinum Mineralisation in the Unst Ophiolite

Stratigraphic Position of Platinum Group Minerals in Layered Intrusives, Unst Ophiolite Complex, The Shetlands

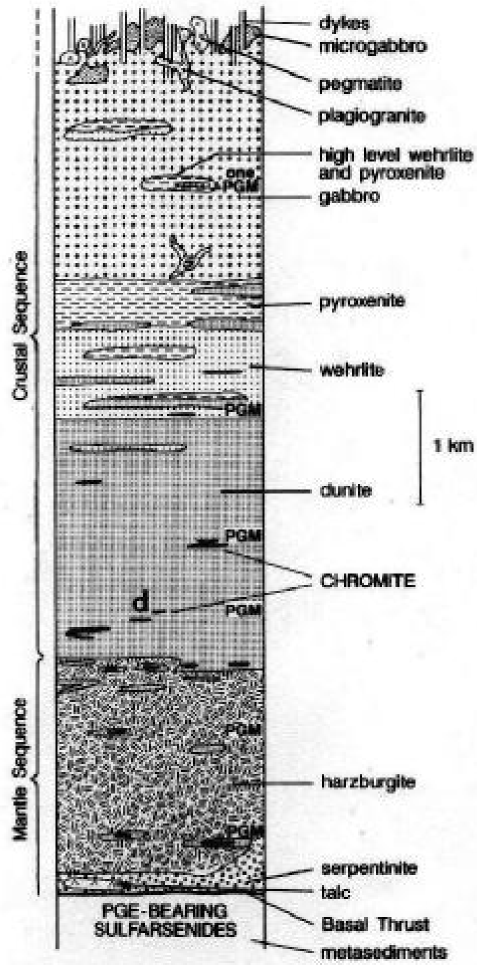

FIG. 1. Section through the ophiolite showing the locations of the PGM-rich assemblages. The letter d marks the stratigraphic level of the drill core from north of Baltasound. The symbol PGM indicated in the harzburgite refers to PGM within pods of dunite. PGE-bearing sulfarsenides occur in serpentinite and talc at the basal thrust.

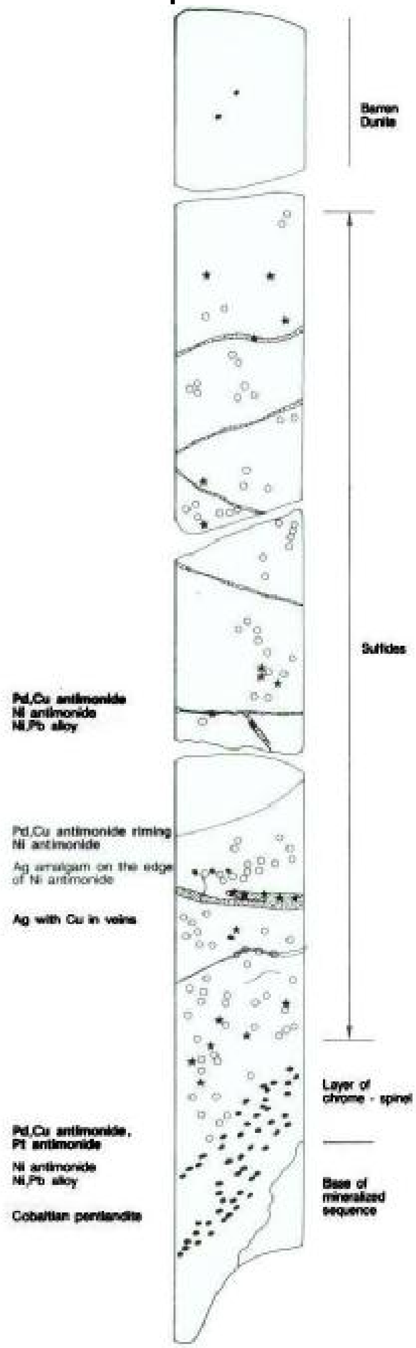

FIG. 3. Sketch of the minerals visible on the flat surface of a section of drill core showing the sequence of chromite, sulfides and PGM typical of the PGE-bearing assemblage in the dunite unit. Thin sections were cut across this section of core and revealed the distribution of the PGM. Unnamed minerals, analyzed qualitatively, are noted beside the section at the horizon where they were located. Symbols: ●: chromite, ○: sulfides, and ★: native copper. Length of the scale bar is 1 cm.

Source : Prichard et al 1994

Table 7 Selected PGE grades from the Chromite Layering at the Leka Ophiolite

Sample	Sample No	Length	Os ppb	Ir ppb	Ru ppb	Rh ppb	Pt ppb	Pd ppb	Au ppb	Total ppb
Drillcore	N/A	0.5m	2	4	5	7	200	240	14	472
Drillcore	N/A	0.5m	2	2	3	3	140	780	170	1100
Drillcore	N/A	0.5m	32	20	84	8	40	23	64	271
Rk Chip	84-24B	N/A	30	16	75	6	11	48	6	192
Rk Chip	87-P2	N/A	130	83	260	55	640	1000	110	2278
Rk Chip	84-26B	N/A	4	4	5	6	520	150	130	819
Rk Chip	89Lek9a	N/A	2	18	20	45	890	2100	250	3325
Rk Chip	89Lek6a	N/A	20	13	26	14	200	790	180	1243
Rk Chip	89Lek31	N/A	20	63	120	42	550	820	62	1677
Rk Chip	Lek88-1b	N/A	360	410	60	210	4600	2700	170	8510
Rk Chip	Lek88-3a	N/A	400	240	84	300	1000	550	28	2602

Subsequent metamorphic and hydrothermal fluid effects particularly serpentinisation do not seem to cause significant remobilisation of PGE's. Many PGE minerals are in fact arsenides and antimonides after PGE sulphides although mineralogical evidence suggests the level of movement at the sub-mm scale. It is possible that later hydrothermal events may have leached, concentrated and transported PGE's to preferential structural sites where reprecipitation occurred, mainly as arsenides and antimonides. In addition, metamorphic enrichment can occur in major structural zones i.e. within thrusts and can have an accompanying gold and arsenic enrichment.

Pathfinder elements for such mineralisation included Ni, Cr, Cu and Au. The former three represent primary sulphide mineralogy of pentlandite, chromite and native copper. Geochemical orientation over the Unst Ophiolite Complex concluded that Ni especially expressed as Ni/MgO highlighted the PGE enriched zones. This work utilised partially panned concentrates as the most effective sampling technique.

Thus an inherent problem with exploration for PGEs in ophiolitic ultramafics is being able to deduce the intrusion's evolution and defining the 'stratigraphic' sequence.

Not only that but seeing that the target horizon maybe <1m, possibly only a few centimetres of high grade material, the need for correct sampling is crucial. Other sampling related problems include the lab analyses, in particular the quality of the lab digest, and the measure of inter-element interaction associated with the laboratory procedures. It is also pertinent to note at an early stage any potential mineralogical issues that may defeat the delineation of an economic body e.g. refractory minerals.

Methods that can help resolve some of these problems include the use of panning as a prospecting tool, quality geological observations and mapping, recognition of the correct sulphide stratigraphy and the use of standards.

7.2 Other PGE Target Concepts

As previously mentioned the ultramafic units of the AUC were probably tectonically emplaced oceanic crust that happened towards the end of the Cambrian. This thrust emplacement it believed to be accompanied and followed by tectonic uplift. Subsequent erosion is believed to have exposed the AUC and other Cambrian rocks eg the Mt Read Volcanics. If the original rocks contained substantial amounts of heavy minerals, these are likely to have accumulated within the Cambro-Ordovician siliciclastics, particularly the basal conglomerates. Assuming the AUC was exposed at this time then there is the possibility of placer deposits to have accumulated in the conglomerates. This was the basis of the 1952 exploration, particularly the work done at Pollards New Shaft, and remains valid. It is also worth noting that one Os-Ir mineral occurrence is located on top of a hill, south of Marriott Hill and presumably is not an alluvial deposit. This occurrence coincides with a 4km long N-S magnetic feature in the 1VD data that appears to follow strike. In addition there are a series of small magnetic features hosted by Cambro-Ordovician siliciclastics further south that appear to lie along strike; these maybe are smaller palaeo-placers.

7.3 Other Target Concepts

The opportunity of finding an Avebury-style nickel resource is considered remote as a perceived key element for Avebury is the proximity to a Devonian granite. From the published map data there is no such granite in the general area and the airborne magmatic data does not show any sign of a buried granite. The above comment does presume that Avebury is the result of thermally metamorphically-driven accumulation of nickel into a pseudo-stratigraphic position and is not an original magmatic feature formed at the time of basic magma crystallisation.

The 1966 airborne magnetic data shows some minor positive magnetic features, especially in the 1VD image, that coincide with MRT mapped ultramafic units. There is no geochemical coverage of these areas therefore any potential for economic mineralisation is uncertain and thus these areas should be tested via geochemistry for nickel, chromium, gold and PGEs.

Generally speaking the Gordon Limestone has a low magnetic signature as exemplified by the limestone around Zeehan, except where there is hydrothermally-produced siderite alteration that is associated with zinc mineralisation. Thus in the Adam River valley the magnetic low corresponds to limestone as identified in outcrop and in the RAB drilling by Metals Exploration. However the magnetic high over the Gordon Limestone in the Florentine Valley is intriguing. It may be that the two limestone units are not the same age or one has some overprint feature, presumably alteration rather than different Quaternary cover. Stream sediment and shallow soil sampling of the area is likely to prove ineffective due to the amount of Quaternary cover. Consideration should be given to the possibility that the Quaternary cover may contain washout from the AUC from an older point in time to the present day's drainage pattern.

In summary the exploration potential for the Adamsfield licence is as follows:

1. Stratiform PGE mineralisation associated with chromite and disseminated sulphide layering in the layered dunite rocks of the Adamsfield Ultramafic Complex. The emphasis for exploration will be the northern section of the AUC including the Halls Open Cut.

2. Palaeo-placer PGE (and gold) mineralisation associated with the Cambro-Ordovician siliciclastics and conglomerates. The emphasis for exploration will be around Pollards New Shaft and the magnetic feature near Adams Falls.

3. Other concepts include massive sulphide nickel and PGE's in previously untested ultramafic outcrops.

4. Zinc mineralisation in the Gordon Limestone of the Florentine Valley.

7.4 Targets

A target map is included as figure 16. Apart from the whole of Adamsfield Ultramafic Complex being a target for stratiform PGE, there are seven other target areas that require field inspections and some degree of sampling.

1. Pollards New Shaft with anomalous PGEs (200g/t Os & Ir) from underground sampling of Cambro-Ordovician sediments (palaeo-placers)

2. The alluvial gold anomaly at Adam Falls

3. The magnetic feature south of Marriott Hill that is coincident with the Barratt Creek pan concentrate anomaly.

4. A series of small scale magnetic anomalies along the Clear Hill Road associated with the basal Cambro-Ordovician sequence; for the possibility of palaeo placers.

5. The positive magnetic feature associated with the Gordon Limestone in the Florentine Valley, SW of Stacey Lookout.

6. The Florentine Valley pan concentrate anomaly near Frodsham's Pass, which may have resulted from sediment shedding from the AUC at its southern end.

7. Two positive magnetic features at the south end of the licence possibly little known ultramafic outcrops in Cambrian sediments; at Boyd River and Boyd Lookout.

Figure 16 Target Map of Adamsfield EL 11/2006

8 Recommended Exploration Programme

The exploration strategies for this tenement recognise that stratiform PGE mineralisation can be found towards the base of layered ultramafic magma chambers of the type seen at Adamsfield. The methodology for the PGE exploration will incorporate recent geological and mineralogical theories for locating platinum/palladium mineralisation in ophiolites. These theories were published after most of the previous PGE exploration work was completed at Adamsfield. In addition improved assaying techniques for PGE's, which were not available to previous explorers, can help the detection of low grade surface anomalies that may be an indication of economic mineralisation at depth.

Detailed mapping and rock sampling traverses in conjunction with detailed soil sampling will be the best initial method of prospecting for PGE's. An important aspect of the exploration strategy will be to map out the layered ultramafic stratigraphy and establish favourable positions for PGE mineralisation. The target horizon is likely to be very narrow (circa 1m) and steeply dipping. The ground conditions will govern the sampling programme. Three options appear to exist:

1. A fence of ten angled RC drillholes, approximately 80-100m depth, with one hole completed per day. The risks are the drilling cost and the potential for poor recovery.

2. Uncover a complete line of bedrock across the ultramafic outcrop in the northern area and then channel sample using a Stihl circular saw with a diamond blade. Make two vertical cuts about 3cm apart and 3cm deep, and use a hammer and bolster chisel to remove the cut material. Assuming 800 1m samples, it should be possible to achieve 30 samples per day. Risks are a lack of rock exposure particularly in incised channel areas and potential silicification of the ultramafics.

3. Soil sampling at 5m intervals aiming to sample the soil weathered bedrock interface.

The best option may be a combination of 2 and 3 at this stage, i.e. soils for deep soil cover and channel sampling for areas of shallow soil or soil disturbance.

Delineation of coherent stratabound anomalies for nickel, copper +/-chromite and PGE (and gold) in rock chips and/or detailed soil sampling at favourable stratigraphic levels will warrant possible follow up geophysics and reconnaissance drilling.

For the palaeo-placer and other targets a standard field procedure of site inspection, rock sampling, mapping and possible soil sample lines should be undertaken.

8.1 Proposed Order of Work

AUC Northern Section

- Complete a detailed traverse of the AUC. This to include detailed mapping, soil sampling and may include auger sampling. Try to sample the soil immediately above bedrock; looking to detect any downslope PGE weathering train(s) from a narrow source.

- If results are encouraging then follow up with 2 more lines 50m either side of the initial line.

- Then RC or diamond drill any coherent horizon geochemically anomalous in PGE. If results are still encouraging expand the whole project to include fence lines of RC and/or diamond drillholes. In addition the search should be expanded to cover more of the AUC to the south.

Halls Open Cut

- Drill additional holes in an effort to expand the resource; a three hole RC programme is proposed initially followed by diamond drilling. The aim being to define the northern extent of the mineralisation and add to its depth.

Pollards New Shaft

- Inspect, map and sample the old occurrence.
- If encouraging results sink 2 RC scissor holes to establish more information on the mineralisation.

S Marriott Hill

- Inspect, map and sample the old occurrence.
- If encouraging results sink 2 RC scissor holes to establish more information on the mineralisation.

Florentine Valley – Frodsham's Pass

- Inspect, map and sample around the anomalous site. Look to establish the alluvium source, which may be the ultramafics at the south end of the licence.

Additional Work

- Inspect the small magnetic features in the west of the licence as mentioned in the above text, establish the nature of the feature and undertake some rock and/or soil sampling.
- Traverse the Florentine Valley Gordon Limestone syncline looking for clues as to the nature of the magnetism associated with the limestone.
- Inspect the small magnetic features in the south of the licence supposedly due to ultramafic outcrop and undertake some rock and/or soil sampling.

9 Conclusions

The Adamsfield Licence EL11/2006 is located 60km WNW of Hobart in SW Tasmania. The area is part of an excised section of the World Heritage Area that is designed for mineral exploration and exploitation. Substantial past human activity is demonstrated by the Adamsfield Township, the trial workings of Halls Open Cut and the numerous old sluicing operations that went on in the 1920's and 1930's. Zelos have secured access to all parts of the tenement through diligent negotiation with other stakeholders.

The geology of the area comprises a fault-bounded, thrust-emplaced ultramafic sequence of Mid-Cambrian age, called the Adamsfield Ultramafic Complex (AUC). This complex is hosted within mainly Cambro-Ordovician siliciclastics including conglomerates and Cambrian sediments. These Cambro-Ordovician sequences are overlain by Ordovician limestones folded into localised synclines. The area has been subjected to Recent glaciation which has seen most of any earlier Tertiary and Quaternary alluvials and glacio-sediments removed. The final ice phase has left behind mainly glacio-lacustrine sediments with small amounts of fluviatile alluvium. It has been interpreted that the ultramafics are actively shedding material.

Mineralisation associated with the licence consists of a 1-2m wide lode at Halls Open Cut with significant levels of osmium and iridium up 32g/t combined. Other hard rock Os-Ir mineralisation occurs at Pollards New Shaft in the Cambro–Ordovician sediments with values of up to 200g/t and in a small working south of Marriott Hill. The mining activity of the 1920's was mainly of alluvium material around the margins of the Adam River Plain with some workings on the west side of the plain, seemingly beyond the AUC and therefore possibly the representation of eroded Cambro-Ordovician palaeo-placers.

Halls Open Cut is a hard rock Os-Ir occurrence that was initially intended to be a mine with a prospectus having been issued in 1937. No mining was subsequently reported. RAB drilling by Metals Exploration in 1987, has identified a small Os-Ir Inferred Resource associated with the narrow vertical lode of 14,500 tonnes at 6.54g/t Ir, 7.33g/t Os and 0.13g/t Pt. Other non-PGE mineralisation reported on the licence includes

- Past alluvial mining of gold with a maximum nugget size of 2.25ozs. Some minor alluvial gold near Adams Falls.
- 5Mt resource of metallurgical grade chromite (pre-JORC) in the alluvial Adam River Plain.

Past exploration work has mainly concentrated on the AUC and the alluvial plains draining it. Work on the former was mainly been for nickel from the 1950's to the 1970's (with no PGE assaying). Work included airborne magnetic surveys, localised ground grids with geophysical and geochemical coverage. Later work from the 1980's onwards was for PGE's with moderate amounts of geochemical coverage and drilling. Diamond drilling is confined to three holes around Halls Open Cut which also has an additional twelve RAB holes. The alluvial plains work has included substantial amounts of pitting and augering work along with a traverse of RAB drilling.

Previous PGE exploration reported by Metals Exploration encountered substantial problems with getting accurate PGE assays, which seriously impeded their exploration effectiveness. A key component to any exploration programme will be the commercial laboratories ability to produce accurate results; the use of standards in routine analysis is strongly recommended.

The recommended exploration strategy is to target for stratiform PGE mineralisation in the layered ultramafics of the AUC using new geological concepts developed in the 1990's. In addition hard rock palaeo-placer potential in Cambro-Ordovician siliciclastics is to be inspected in the field. The exploration work will comprise a mixture of detailed mapping and geochemical sampling in selected areas, followed by test drilling (RC and/or diamond).

10 Expert Competency

Hellman & Schofield Pty Ltd ("H & S"), a geological consulting company based in Sydney, Brisbane and Perth, Australia, prepared this geological report at the behest of the directors of Zelos. Simon Tear, a Consulting Geologist, has a BSc (Hons) in Mining Geology from The Royal School of Mines, London, U.K. and has over 22 years worldwide experience in the mineral exploration industry. He is a member of the IMM (18 years), the AusIMM (9 years) and the Institute of Geologists of Ireland (PGEO and EurGeol, both 12 years). He was Team Leader for CRAE Pty Limited's Tasmanian exploration program from 1995-1996. That program successfully explored Western Tasmania, accounting for nickel and lead/zinc discoveries.

The Author's Tasmanian experience consists of:-

- Led the field team in the discovery of the Avebury Nickel deposit (now with Allegiance Mining NL) (1996).
- Devised and executed CRAE's and Noranda Pacific's carbonate hosted base metal programmes in the Gordon Limestone near Zeehan (1995-6 and 2001 respectively).
- Undertook exploration on CRAE's Balfour copper licences in NW Tasmania (1996)
- Worked on the Lynchford (Sulphide Creek EL- Zelos) gold licence for CRAE (1996/7)
- Project generation for sediment hosted gold targets for CRAE in Northern Tasmania (1996)
- Consulting geologist for the Zeehan Zinc Comstock project (1999-2006)
- Nickel project generation for Tasmania for Falconbridge (2002)
- Literature Study and Resource Assessment of the Nelson Bay Iron Project for Zelos Resources NL (2006)

Other relevant experiences include:-

- Industry supervision of a MIRO sponsored research project into Platinum Group Mineralisation in the Unst Ophiolite, UK
- Exploration experience in Cambro-Ordovician island arc related volcanic terranes similar to the Mt Read Volcanics in SE Ireland; explored around the Avoca Copper Mine (very similar scenario to Mt Lyell).
- Nine years gold exploration experience, mainly field related, including vein and 'Slate Belt' styles.
- Independent Geologists Report for Zinico (now Zelos) Resources NL successful IPO in 2005.

The above experiences and qualifications make Simon Tear adjudged to be a competent person under the JORC Code and has completed this report in accordance with the VALMIN Code.

The digital geological and geophysical information used in this report was supplied by the directors of Zelos. Additional open file information was sourced from Mineral Resources Tasmania via their websites and through personal communication. H & S has relied upon and assumed without verification the accuracy and completeness of all information provided and cannot take any responsibility to guarantee its accuracy.

Limitations and Consent

This assessment has been based on data, reports and other information made available by Zelos or otherwise obtained through publicly available sources. A draft copy of this report has been provided to Zelos for comment as to errors of fact, omissions or incorrect assumptions. H & S has no reason to believe that the information provided by Zelos is misleading or that any material facts have been withheld.

The opinions expressed herein are given in good faith and H & S believes that any assumptions or interpretations are reasonable.

This report is provided to Zelos for the purpose of assessing its Adamsfield exploration licence. Neither the whole nor any part of this report, nor any reference thereto, may be included in, or with, or attached to any document or used for any purpose without H & S's written consent to the form and context in which it appears.

Respectfully submitted,

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Consulting Geologist
Hellman & Schofield Pty Limited

23rd August 2006

11 References

Anonymous		1993	Annual Report 1993 – EL 26/91 Adamsfield.
Anonymous		1993	Relinquishment Report 1993 – EL 26/91 Adamsfield.
Bottrill et al	RS	1998	A Summary of the Economic Geology and Mineral Potential of the Late Proterozoic and Palaeozoic Provinces in Tasmania
Carthew	SJ	1989	Adamsfield EL 4/85 Proposed Exploration 25/7/88 to 25/7/89.
Carthew	SJ	1989	Adamsfield Prospect, S.W. Tasmania. EL 4/85, Annual Report for the Period Ending 25th July 1989
Flood	B	1972	EL 13/65 – Adamsfield, SW Tasmania. Results from Geological Investigations and Soil Sampling of the Adamsfield Ultrabasic Body – 1970/71 Season.
Flood	B	1972	EL 13/65 – Adamsfield, SW Tasmania. Part 1. Fieldwork and Results from 1971/72 Season. Part 2. Review of All Relevant Work to Date.
Hungerford	N	2006	Reprocessed Images from Airborne Magnetic Data
Nye	P	1929	The Osmiridium Deposits of the Adamsfield District GSB39 Tas Mines Dept
Pedersen et al	R	1992	Stratiform PGE Mineralisation in the Ultramafic cumulates of the Leka Ophiolite, Central Norway. Econ Geol 88 pp782-803
Prichard Lord	HM R	1993	An overview of the PGE Concentrations in the Shetland Ophiolite Complex. In Prichard et al (eds) Magmatic Processes and Plate Tectonics Geol Soc Spec Pub 76 pp273-294
Prichard et al	HM	1996	A model to Explain the Occurrence of Platinum- and Palladium-rich Ophiolite Complexes. Jour of Geol Soc vol 153 pp323-328
Ruxton	PA	1982	EL 55/80 – Adamsfield, Progress Report on Exploration During the Period 18/5/81 – 1/7/82.
Seymour Calver	DB CR	1995	Mineral Resources Tasmania. Tasmanian Geological Survey Record 1995/01. TASGO NGMA Project. Sub-Project 1: Geological Synthesis. Explanatory notes for the Time-Space Diagram and Stratotectonic Elements Map of Tasmania.

Appendix 1
Open File Listing of Competitor Reports

Searched for: Dataset: Company Reports - OnshoreDataset: Company Reports - Offshore HydrocarbonsDataset: MRT Documents, Location: Spatial Criteria Used

Downloaded	Report details
	02_4819 - Tasmania - Regional Bulk Sampling - Inter-Office Memorandum
	Ellis, P.D.
	27_0039 - Notes on Report by C. Howard on the Country between Low Rocky Pt and Fitzgerald.
	Howard, C.
Yes	**37_0070 - Prospectus of Osmiridium (Tasmania) NL**
	Anon
Yes	**52_0115 - Adamsfield Report for Lipscombe (incomplete report)**
	Carey, S.W.
	57_0173 - Preliminary Programme - L.E.E.
	Scott, B.
Yes	58_0232 - A Preliminary Interpretation of the Precambrian - Palaeozoic Geology of S.W. Tasmania
	Scott, B.
Yes	59_0268 - Geophysical Report to Lyell-E.Z. Explorations No. 3
	Hancock, H.S.
Yes	59_0286 - Airborne Geophysical Anomalies A5/1, A6/1, and A6/2, Arthur Area
	Scott, B.
	59_0290 - Annual Report, Year Ending 30th June, 1959
	Hudspeth, G.F., Scott, B.
	59_0292 - Summary of Precambrian of S.W. Tasmania
	Scott, B.
Yes	60_0304 - Structural Geology of Western Tasmania
	Scott, B.
Yes	61_0332 - Final Report on Airborne Anomaly A5/1 Arthur Area - EL 1/59
	Cottle, V.M., Gregory, I.S., Kingsbury, C.J.R.
	61_0333 - Report on the Examination of the Mt Wedge Area - EL 1/59 Arthur Area.
	Cottle, V.M., Kingsbury, C.J.R.
Yes	64_0379 - Summary of Investigations South-western Tasmania.
	Whitehead, R.C.
	66_0418 - Ground Magnetic Survey, Adamsfield, Tas.
	Taylor, C.P.
	66_0444 - Aeromagnetic Survey - S.W. Tasmania
	Anon
	66_0445 - Interpretation Report, Airborne Magnetometer Survey in Southwest Tasmania.
	Curtis, C.E., Hartman, R.R.

Yes	67_0488 - Memorandum Report, Reconnaissance Structural Evaluation, Coastal Tasmania. **Barton, R.H.**
Yes	68_0523 - EM, SP and Magnetic Survey Adamsfield, E.L. 13/65 Tas. **Hillsdon, P.**
Yes	71_0768 - Geological Investigation and Soil Sampling of the Adamsfield Ultrabasic Body **Flood, B.**
Yes	71_0769 - Adamsfield, Tasmania, Report on Part of Exploration Licence 13/65, April and May, 1971 **Flood, B.**
Yes	72_0859 - El 13/65 - Adamsfield, S.W. Tasmania. Results from Geological Investigations and Soil Sampling of the Adamsfield Ultrabasic Body - 1970/71 Season. **Flood, B.**
Yes	72_0890 - B.H.P. Co. Ltd E.L. 13/65 - Adamsfield, S.W. Tasmania. Part 1. Fieldwork and Results from 1971/72 Season. Part 2. Review of All Relevant Work to Date. **Flood, B.**
Yes	72_0926 - Rock, Soil Sampling and Magnetics, Miscellaneous Area, EL 13/65. **Anon**
	82_1764 - Exploration Licence 8/79 Maydena, Tasmania. Report for the Six Months Ended 30th April, 1982 **Anon**
	82_1779 - Exploration Licence 30/80 South-East Tasmania. Report for the Six Months Ended 15 April, 1982. **Anon**
Yes	**82_1821 - EL55/80 Adamsfield, Progress Report on Exploration during the Period 18/5/81 and 1/7/82** **Ruxton, P.A**
	82_1853 - Exploration Licence 30/80 South East Tasmania Report for the Six Months Ended 15th October, 1982 **Anon**
	83_2000 - Exploration Licence 30/80, South East Tasmania, Report for the Six Months Ended 15th April, 1983 **Anon**
Yes	84_2084 - Exploration Licence 8/79 Maydena, Tasmania Final Report **Anon**
	84_2169 - The Lower Freshwater Sequence of the Parmeener Supergroup, Tasmania **Summons, T.G.**
Yes	84_2179 - Exploration Licence 19/83 Mt Mueller, Tasmania, Final Report. **Anon**
Yes	84_2179A - Report on DIGHEM II Survey, E.L. 8/79, Maydena, Tasmania. **Staltari, G.**
Yes	84_2289 - Exploration Licence 30/80 South East Tasmania Final Report **Anon**

Yes	86_2574 - Adamsfield Prospect, South West Tasmania, E.L. 4/85, Annual Report for the Period Ending 25 July 1986	**Anon**
Yes	87_2729 - Adamsfield Prospects South West Tasmania E.L. 4/85 Annual Report for the Period Ending 25 July 1987	**Anon**
	88_2842 - Adamsfield Prospect, South West Tasmania, E.L. 4/85, Annual Report for the Period Ending 25 July 1988	**Bellairs, P.G., Carthew, S.J., Jannink, A.**
Yes	88_2851 - EL 29/87, Strahan, Tasmania, Annual Report Year 1 (19.9.87 - 18.9.88)	**Cromer, W.C.**
	88_2884 - Adamsfield Prospect, South West Tasmania, E.L. 4/85. Addition to the Annual Report for the Period Ending 25 July 1988.	**Bellairs, P.G., Carthew, S.J., Jannink, A.**
Yes	89_2966A - Untitled	**Volkman, J.K.**
	89_2984 - Adamsfield Prospect, S.W. Tasmania, E.L. 4/85, Annual Report for the Period Ending 25th July 1989	**Carthew, S.J.**
	89_3065 - Basic Aeromagnetic Data, EL 1/88	**Anon**
	91_3234 - Annual Report Conga Oil Pty Ltd. Licence EL 1/88.	**Leaman, D.E.**
Yes	91_3235 - Progress Report Interpretation of Gravity and Magnetic Data EL 1/88 Central Tasmania	**Leaman, D.E.**
Yes	93_3492 - Annual Report 1993 - EL 26/91 Adamsfield	**Anon**
	93_3508 - Relinquishment Report EL 26/91 Adamsfield	**Anon**

26 Reports

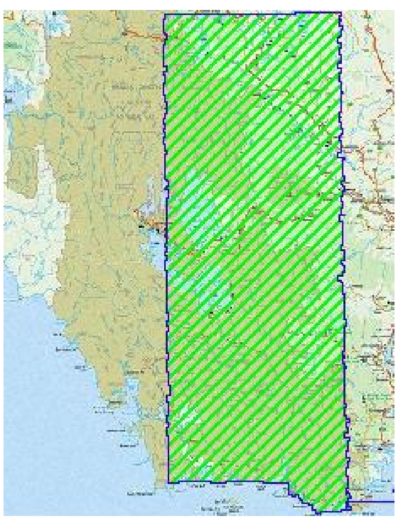
Appendix 2
Details of Relevant Airborne Surveys

Airborne Geophysical Surveys for the Adamsfield Area

Mineral Resources Tasmania - Airborne Survey Details

Survey Name	**1966 BHP Southwest Tasmania Aeromagnetic Survey**	
State	**TAS**	
Operator	**BHP**	
Contractor	**Aero Service Ltd**	
Processor	**Exploration Computer Services**	**Hand contoured by Aero Service**
Custodian	**Tasmanian Geological Survey**	
Start Date	**28 February 1965**	
End Date	**01 May 1966**	
Total Km	**22481**	
Survey Type	**Regional**	
Vessel Name	**Aero Commander, Dornier, DC-3 VH-MJR**	
Vessel Type	**Plane**	
On / off shore	**Onshore**	
Crystal Volume (l)		
Upward Crystal Volume (l)		
Mean AGL (m)	**-999.000**	
Description	**Nominal terrain clearance 500 feet (152 metres). Line spacing mainly 440 yards, some 1760 yards. Digitised from hand contoured plans by ECS International in 2004 and processed using modern levelling techniques. The contour plans are in TCR66_0444 and the specifications are in TCR66_0445. Captured digital data available. Flying speed between 87 and 180 knots.**	
Data Sampled	**Magnetics**	
Digital Data Sampled		

Traverse Direction	Spacing	Numbers
90	402m	60-4110

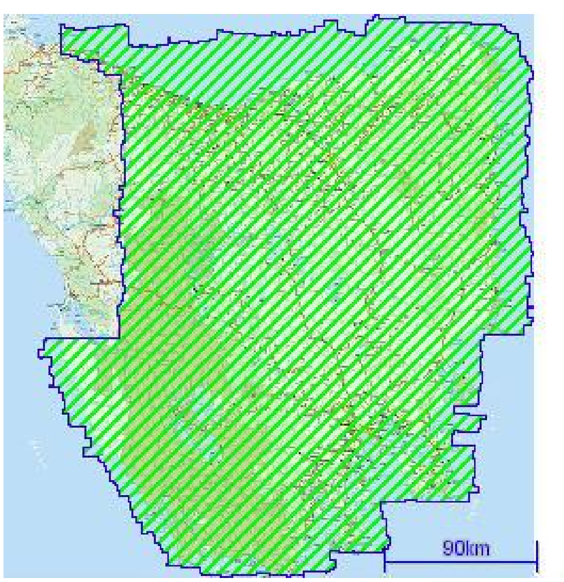


Mineral Resources Tasmania - Airborne Survey Details

Survey Name	1985 (BMR P502) Tasmania Regional
State	TAS
Operator	Bureau of Mineral Resources (AGSO)
Contractor	Bureau of Mineral Resources (AGSO)
Processor	Bureau of Mineral Resources (AGSO)
Custodian	Australian Geological Survey Organisation
Start Date	29 January 1985
End Date	30 March 1985
Total Km	55755
Survey Type	Regional
Vessel Name	VH-BMG Otter, VH-BMR Aero Commander
Vessel Type	Plane
On / off shore	Onshore
Crystal Volume (l)	
Upward Crystal Volume (l)	
Mean AGL (m)	261.000
Description	Precise levelled version available. Extremely large variation in terrain clearance.
Data Sampled	Magnetics
Digital Data Sampled	Magnetics

Tie Spacing	Tie Numbers
30000m	100-550

Traverse Direction	Spacing	Numbers
90	1500m	1010-3160
180	1500m	3185-4507

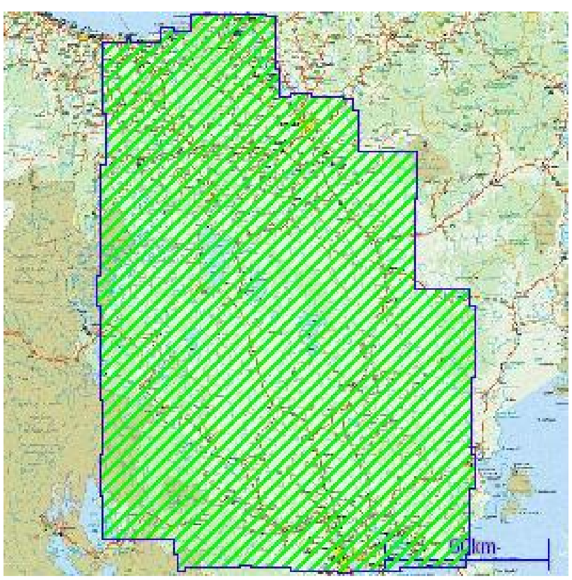


Mineral Resources Tasmania - Airborne Survey Details

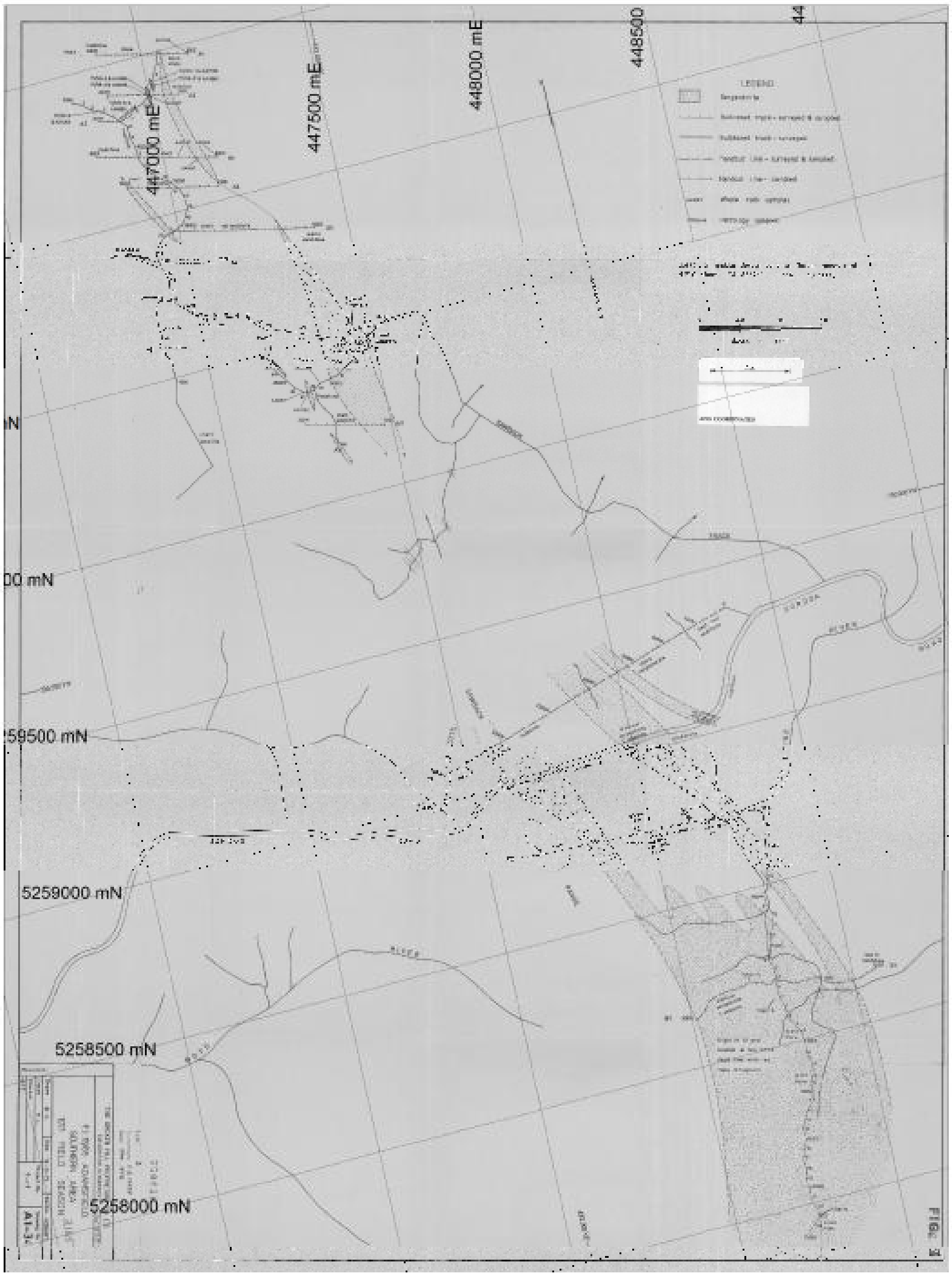
Survey Name	1989 Midlands
State	TAS
Operator	Conga Oil
Contractor	Austirex
Processor	Austirex
Custodian	Tasmanian Geological Survey
Start Date	12 February 1989
End Date	21 February 1989
Total Km	5686
Survey Type	Regional
Vessel Name	VH-MEH Aerocommnader 500S
Vessel Type	Plane
On/off shore	Onshore
Crystal Volume (l)	
Upward Crystal Volume (l)	
Mean AGL (m)	-9999.000
Description	Flown at 1600m barometric altitude.
Data Sampled	Magnetics
Digital Data Sampled	Magnetics

Tie Spacing	Tie Numbers
25000m	17010-17062

Traverse Direction	Spacing	Numbers
90	5000m	10010-11411



Appendix 3
Selected Maps from Open File Reports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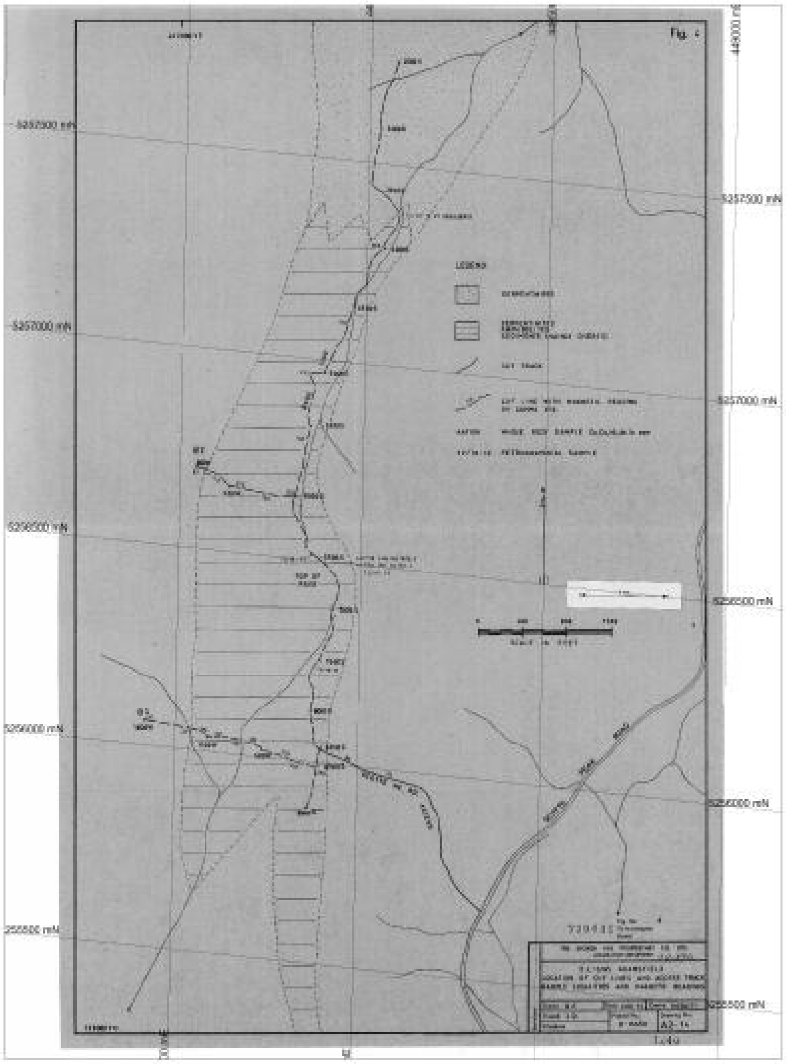
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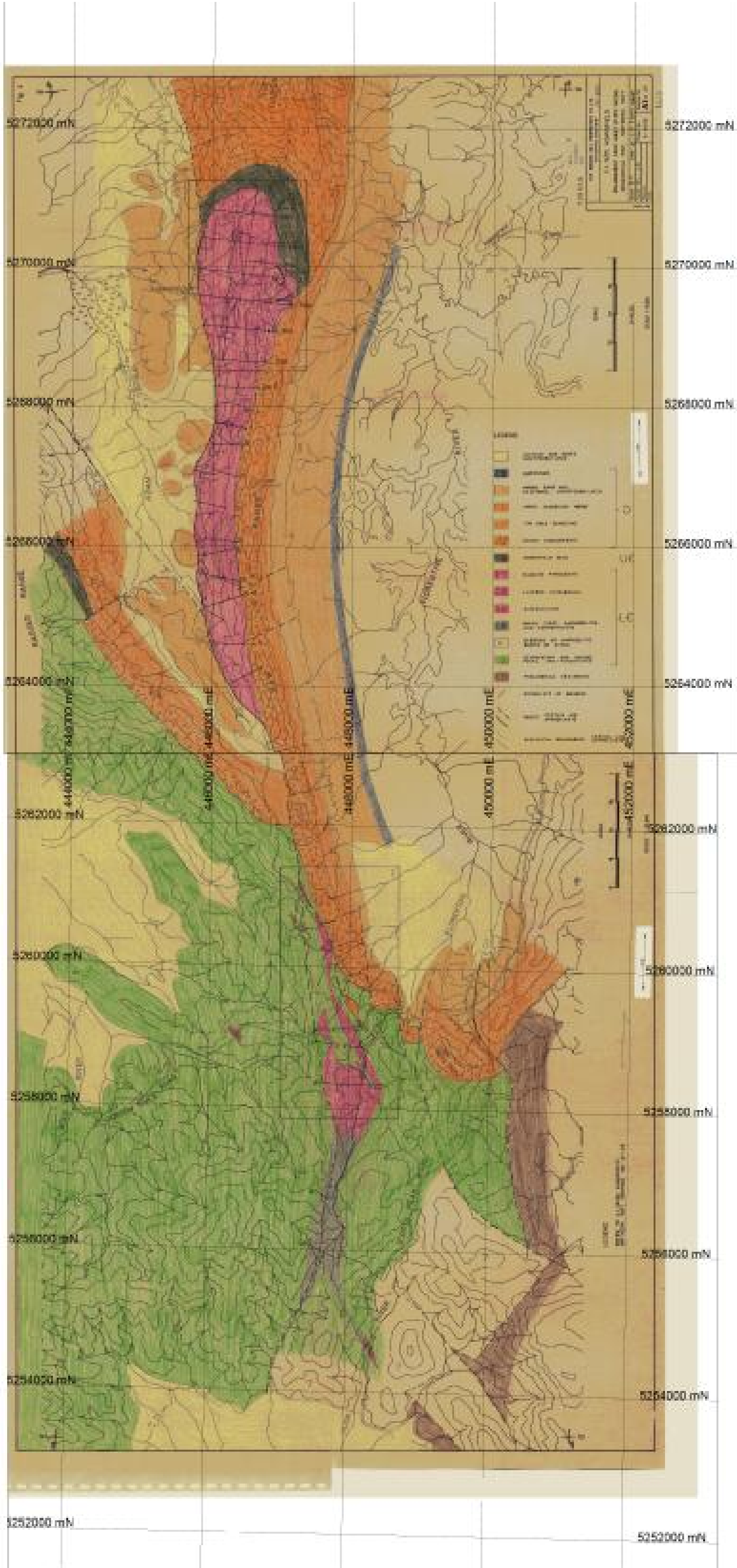
CUT TRACK
A2-14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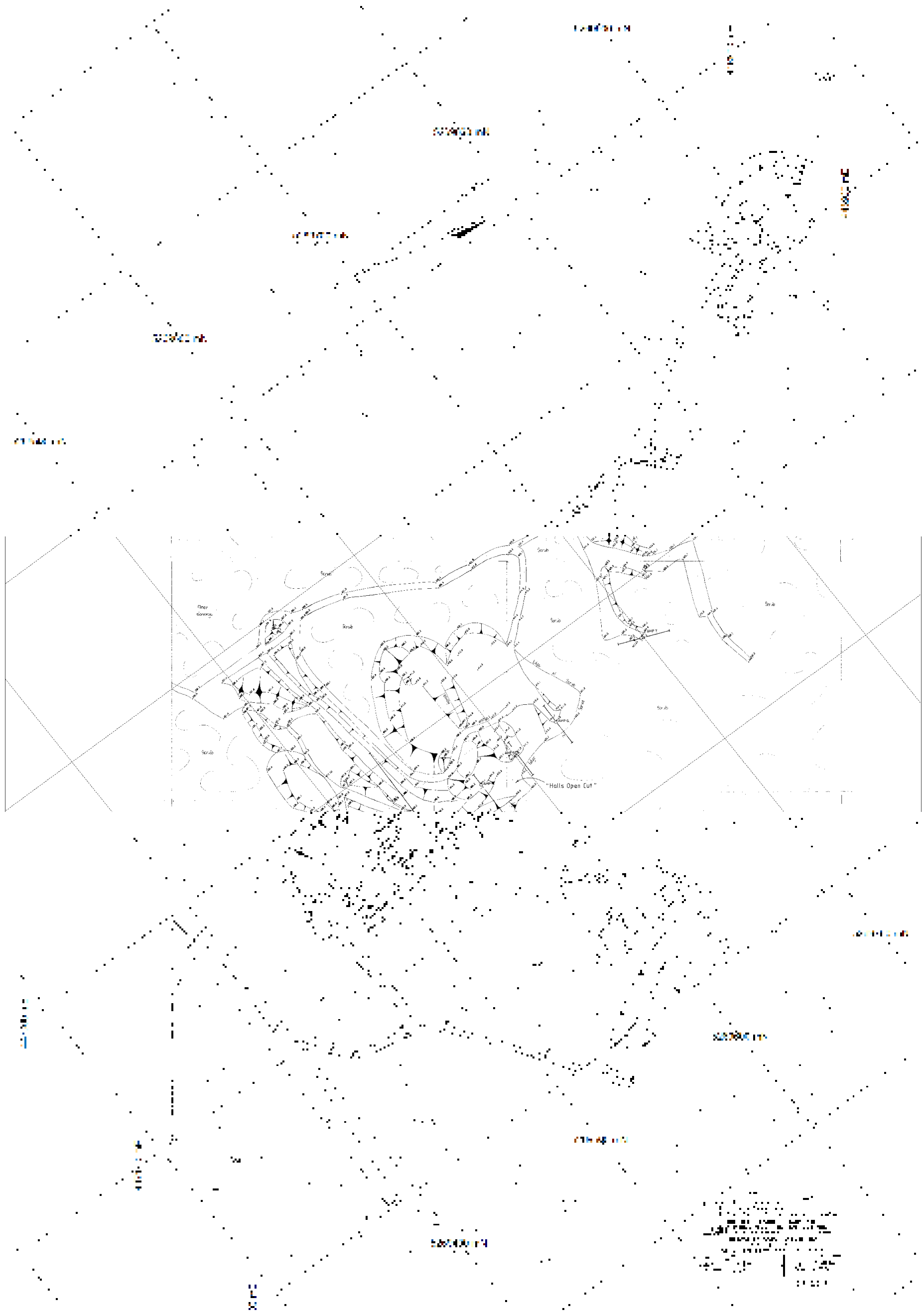
"Halls Open Cut"

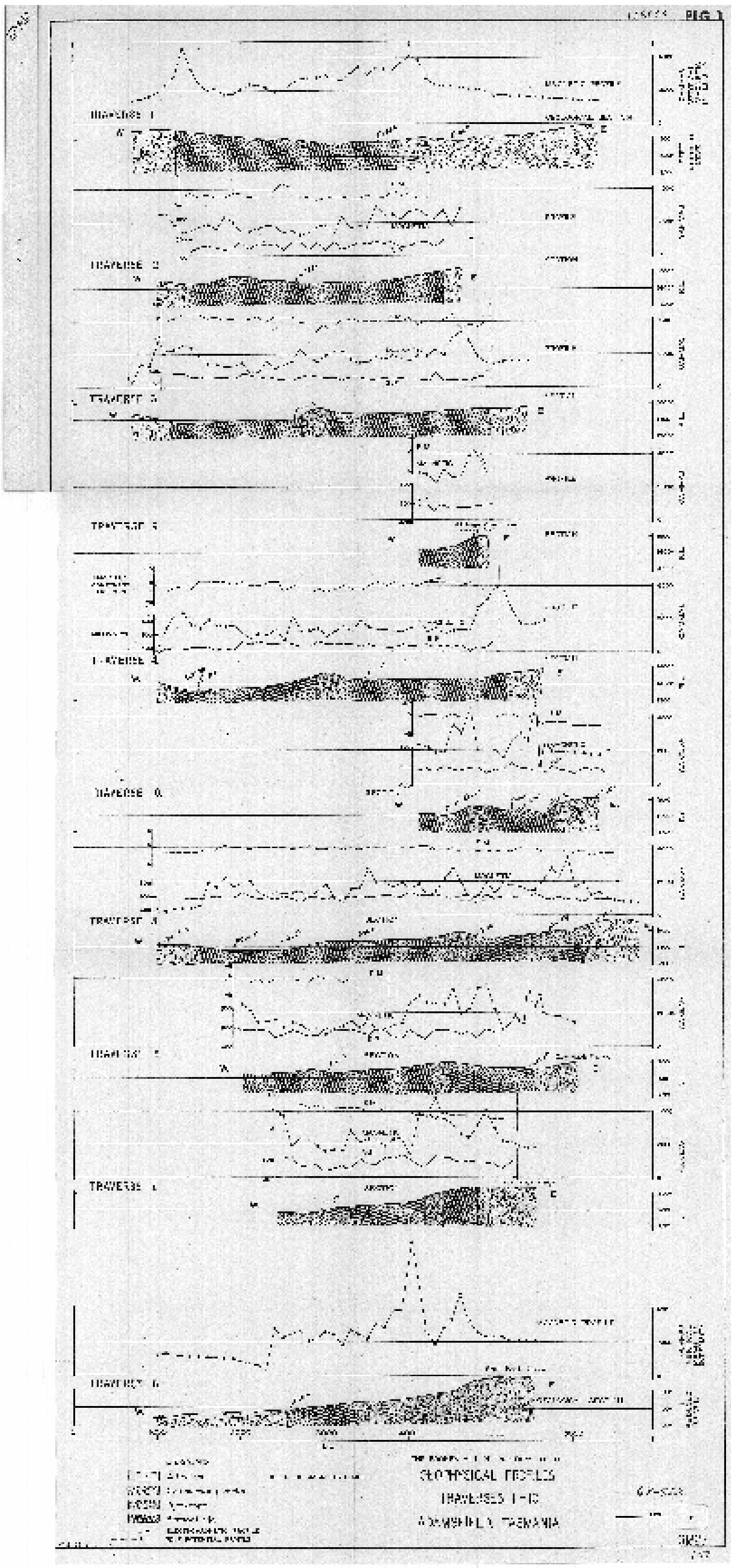
FIG 1
TRAVERSE 1
TRAVERSE 2
TRAVERSE 3
TRAVERSE 5
TRAVERSE 6
GEOPHYSICAL PROFILES
TRAVERSES 1-10
ADAMSFIELD, TASMANIA

Appendix 4
Published Paper by H.M.Prichard et al

Journal of the Geological Society, London, Vol. **153**, 1996, pp. 323–328, 3 figs. 1 table Printed in Northern Ireland

A model to explain the occurrence of platinum- and palladium-rich ophiolite complexes

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Abstract: During the last ten years significant concentrations of Pt and Pd (more than 1000 ppb Pt + Pd) have been reported from several ophiolite complexes including Shetland, Leka, Al 'Ays, Zambales, Ceruja and Thetford. Similar studies on others, including those in Cyprus and Oman, have failed to reveal equivalent concentrations. Here we compare the characteristics of these ophiolite sequences and propose that Pt- and Pd-rich ophiolites contain thick sulphur bearing ultramafic crustal units that crystallized from PGE-rich boninitic magmas produced by excess partial melting in a water-rich subduction zone.

Keywords: Shetland Islands, ophiolite, platinum, palladium, boninite.

Traditionally osmium (Os), iridium (Ir) and ruthenium (Ru) concentrations in podiform chromitites were the only platinum-group elements (PGE) consistently reported from ophiolite complexes and they occur as laurites [$Ru(Os,Ir)S_2$] and alloys usually enclosed within chromite grains (Augé 1985; Talkington *et al.* 1984). In the early 1980s analytical techniques for platinum (Pt) and palladium (Pd) analysis improved and analysis became cheaper. This allowed investigations for Pt and Pd in geological environments not conventionally thought to host concentrations of these elements. Extremely high Pt and Pd values were recorded in chrome-spinel-bearing dunite, enclosed in mantle harzburgite, in the basic and ultrabasic complex on Unst, the most north easterly island of the Shetland Isles (Neary *et al.* 1984; Prichard *et al.* 1986; Gunn 1989). Platinum-group minerals containing Pt and Pd were found to be associated with sulphides, either interstitial to chromite grains or in chromite-poor dunite and wehrlite (Prichard *et al.* 1994). At approximately the same time as the discovery of these high Pt and Pd values, geochemical and field observations confirmed that the Shetland igneous complex forms the lower part of an ophiolite complex (Prichard 1985; Prichard & Lord 1988). The presence of these high Pt and Pd concentrations in ophiolite complexes such as Shetland had been considered unlikely (Crocket 1981) and therefore the values in Shetland were surprising. So to understand this unusual occurrence a further systematic survey was initiated which documented the distribution of the PGE throughout the complex (Prichard & Lord 1993). Although it became apparent that the large concentrations of 60 000 ppb Pt + Pd were restricted to one locality and had been hydrothermally enhanced (Lord *et al.* 1994) other, more widespread, magmatic Pt + Pd concentrations of 1000–3000 ppb were located in the lower crustal ultramafics.

The aim of this paper is to review the evidence for the presence of Pt- and Pd-rich and -poor ophiolites and to determine the processes which concentrate PGEs in some ophiolites but not in others. In order to achieve this aim and to examine the differences between PGE-rich and -poor ophiolites, four complexes, all studied by the authors, have been selected for comparison. The two PGE-rich ophiolites chosen are Unst in Shetland and Al 'Ays in Saudi Arabia and the two PGE-poor ophiolite complexes chosen are the classic Troodos ophiolite in Cyprus and the Semail ophiolite in Oman. The PGE distribution within the Shetland ophiolite complex has been described extensively elsewhere (Prichard *et al.* 1986; Gunn 1989; Lord 1991; Prichard & Lord 1993; Lord *et al.* 1994) but the characteristics of the silicate sequence and PGE concentrations are summarized here. In addition to the Shetland ophiolite complex, a preliminary study of the Al 'Ays complex by the authors has revealed significant PGE concentrations. Details are currently being prepared for publication but the results are summarized in Prichard *et al.* (1992) and the general conclusions are used in this paper. The results of a comprehensive study of the Troodos ophiolite complex have been published already (Prichard & Lord 1990) and the results of a similar study of the PGE concentrations in the northern part of the Semail ophiolite complex are described here for the first time. It is not the intention to document the distribution of PGE in northern Oman but rather to illustrate the lack of PGE enrichment in this ophiolite. Examples of PGE studies on other ophiolite complexes described in the literature are also considered.

The Pt- and Pd-rich ophiolites

The igneous stratigraphy and distribution of the PGE concentrations in the Shetland ophiolite can be summarised as follows. The Shetland ophiolite is incomplete but the lower part of the complex is well preserved with mantle harzburgite overlain by a magmatic lower crustal sequence of ultramafic dunite, wehrlite and pyroxenite which in turn is overlain by gabbro. The sequence is characterized by an unusually great thickness (1500–2000 m) of dunite (Prichard & Lord 1988) which forms the basal part of the lower crustal ultramafics (Fig. 1a). Dunite grades gradually upwards into wehrlite and clinopyroxenite and these ultramafic rocks contain cyclic units (10 cm to 10 m thick) of all three

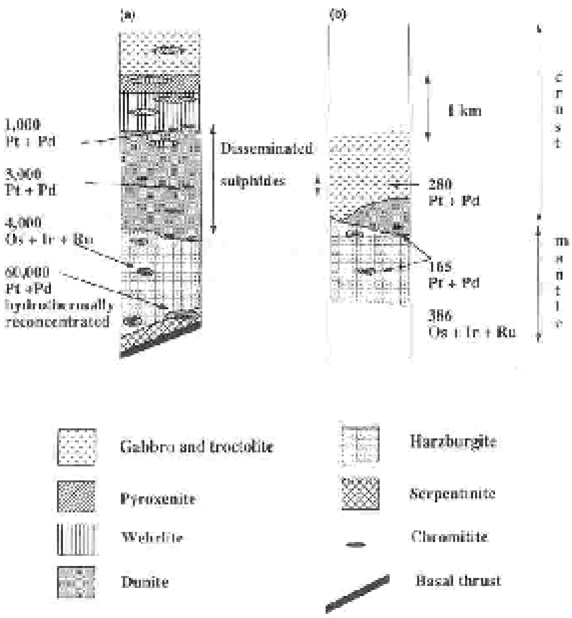

Fig. 1. Schematic sections of PGE-rich and -poor ophiolite complexes. PGE (ppb) are maximum values recorded. **(a)** Sequence typical for a PGE enriched ophiolite, based on Shetland. **(b)** Sequence typical for a Pt and Pd barren ophiolite, based on sections from northern Semail and Cyprus.

lithologies. Extensive crystallization of clinopyroxene, prior to initial crystallization of plagioclase, produced plagioclase-free ultramafic rocks, and troctolites are absent from the ophiolite sequence. Discontinuous layers of chromitite occur at several stratigraphical levels within the ultramafic portion of the ophiolite, in dunite lenses in mantle harzburgite and throughout the lower crustal dunite and wehrlite. Magmatic Pt and Pd concentrations occur in these lower crustal ultramafic rocks especially where they are sulphide-bearing. The sulphides are described in Prichard *et al.* (1994), are visible in hand specimen and form 1–2 % of the rock (Lord *et al.* 1994). The Pt + Pd concentrations occur at several stratigraphic levels. The highest stratigraphical occurrence of significant Pt – Pd is in the sulphide-bearing wehrlite, often associated with thin (1–2 cm thick) discontinuous chromitite layers. These wehrlites form part of the cyclic units in the upper part of the lower crustal ultramafic rocks and have Pt + Pd values of 500–1000 ppb. Below this, sulphide-bearing dunite, situated within the basal part of the lower crustal ultramafic rocks, have Pt + Pd values of 1000–3000 ppb. These PGEs are present within magmatic cycles marked at the base by a discontinuous layer of chromitite, overlain by dunite containing Pt, Pd and base metal sulphides and grading up into barren dunite. Lower in the sequence, below the petrological Moho (marked by the junction between the lower crustal dunite and the residual mantle harzburgite) dunite lenses, often chromite-rich, are located within harzburgite. Chromitite in one of these lenses contains enriched Os, Ir and Ru with Os + Ir + Ru values of 1000–4000 ppb. Another chromitite-rich dunite lens in harzburgite, at Cliff, 300 m from the basal thrust of the ophiolite, has the extremely anomalous hydrothermal Pt and Pd. Concentrations of Pt + Pd reach as high as 60 000 ppb (Prichard *et al.* 1986) formed by local remobilization and reconcentration from the magmatic source rock within the dunite lens (Lord 1991). In contrast with the ultrabasic section of the ophiolite the gabbro in the Shetland ophiolite complex is depleted throughout in PGE with Pt and Pd values of less than 10 ppb.

The Al 'Ays ophiolite complex is also incomplete but the basal part is preserved and folded into an anticline with a harzburgite core surrounded by dunite grading up into a sequence of pyroxenite, overlain by gabbro (Neary 1974). As in Shetland there is a thick lower crustal dunite unit of 400–600 m. Thirty one sulphide-bearing samples were analysed for PGE during an initial study (Prichard *et al.* 1992) and Pt + Pd concentrations of up to 3120 ppb have been recorded in the chromitites from Al 'Ays. Os + Ir + Ru values are also high with maximum values of 15 000 ppb and an average of 840 ppb.

Similar magmatic Pt and Pd concentrations to those in Shetland and Al 'Ays (Pt + Pd = 1000–3000 ppb) have been described, recently, from a number of other ophiolite complexes (Fig. 2) including Thetford in Canada (Corrivaux & LaFlamme 1990), Zambales in the Philippines (Bacuta *et al.* 1988), Leka in Norway (Pederson *et al.* 1993) and Ceruja in Albania (Ohnenstetter *et al.* 1991). In all these complexes Pt and Pd occur in thick lower crustal ultramafics with 500–2000 m of basal dunite and cyclic units of dunite, wehrlite, pyroxenite, websterite and lherzolite (although it is not always easy to estimate thicknesses, especially if there has been folding and faulting as in Leka and Al 'Ays). These ophiolites are also variably reported as containing sulphur-bearing ultramafics, for example in Zambales (Orberger *et a*l. 1988) and as having chromitites throughout the lower crustal dunite, as for example in Ceruja (Ohnenstetter *et al.* 1991). These complexes have ages ranging from Proterozoic (1100 Ma.) for Al' Ays to Cenozoic for Zambales suggesting that Pt- and Pd-rich complexes are independent of formation age, as they span the entire geological age range of ophiolites, but rather are dependent on magmatic processes which produce a thick sequence of ultramafic rocks.

Pt- and Pd-poor ophiolites

Typical Pt- and Pd-poor sequences (Fig. 1b) occur both in northern Semail, Oman and in Troodos, Cyprus. In northern Semail thicknesses of lower crustal ultramafics range from zero in some sections, where gabbro lies directly on mantle harzburgite, to a maximum of about 100 m. The magmatic dunite and wehrlite are very poor in sulphides and none were observed in hand specimen. PGE analysis of 32 samples (this study, Table 1) from northern Semail, gave very low PGE abundances, despite samples being chosen specifically to locate PGE anomalies, by collection of lithologies similar to those enriched in PGE in the Shetland and Al 'Ays ophiolite complexes. Lithologies sampled included chromitites and dunites in lenses within mantle harzburgite, dunites and wehrlites from the lower crustal sequence and gabbros from higher in the stratigraphic sequence. The maximum values of PGE recorded in northern Semail are minor and occur in chromitite within dunite lenses enclosed by mantle harzburgite (maximum Os + Ir + Ru values of 386 ppb with an average of 165 ppb and maximum Pt + Pd values of 60 ppb with an average of

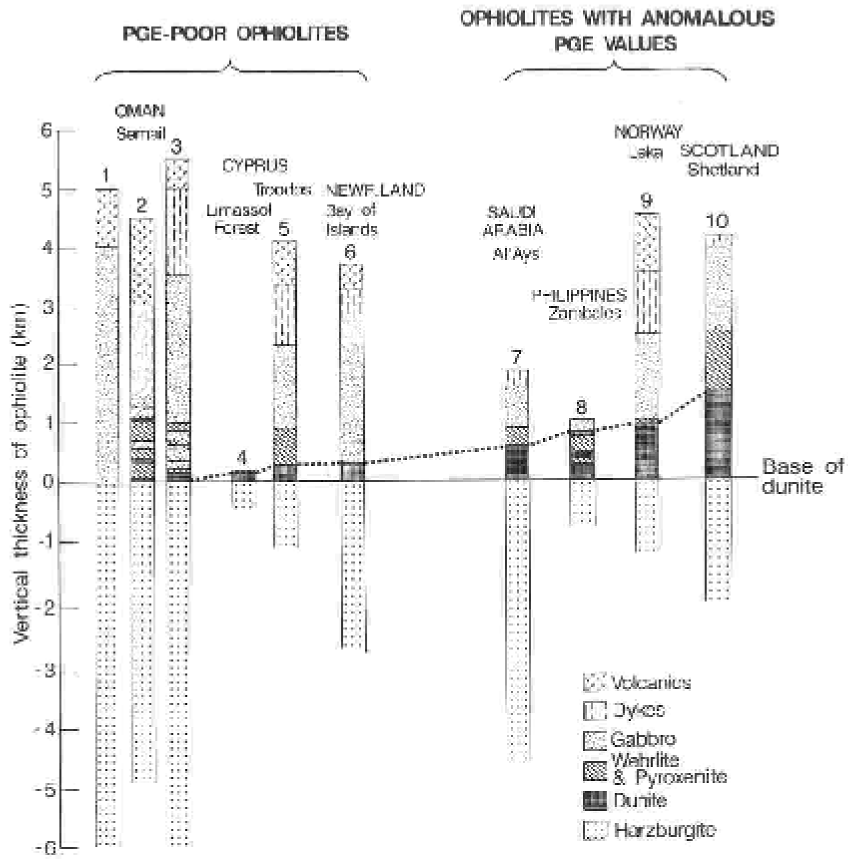

Fig. 2. Measured sections of ophiolite complexes illustrating the relationship between the maximum recorded values of Pt and Pd (ppb) in the ultramafic lithologies and the thickness of dunite and ultramafic crustal sequences (both increasing from left to right). Thicknesses are measured from the base of the dunite (which also marks the petrological Moho at the junction between crustal dunite and mantle harzburgite). Horizontal black lines correspond to thin layers of wehrlite and pyroxenite within dunite. Sections are: 1, Wadi Bani Kharus; 2, Wadi Shafan; 3, Wadi Jizi all in the northern part of Semail in Oman (Browning 1982) (Pt 42, Pd 18 this study). 4, the Limassol Forest section (Murton 1986); 5, Troodos, Cyprus (Wilson 1959) (Pt 2, Pd 5) (Prichard & Lord 1990); 6, Bay of Islands, Newfoundland (Malpas & Stevens 1977) (Pt 517, Pd 406) (Edwards 1990); 7, Al'Ays, Saudi Arabia (Neary 1974) (Pt 1020, Pd 2100, this study); 8, Zambales, Philippines (Orberger *et al.* 1988) (Pt 5958, Pd 8351) (Bacuta *et al.* 1988); 9, Leka, Norway (Pt 2700, Pd 4600) (Pederson *et al.* 1993); 10, Shetland (maximum magmatic values of Pt 870, Pd 2100) (Lord 1991). Two other ophiolite complexes with thick crustal dunite sequences include: Thetford, Canada (Pt 1900, Pd 600) (Corrivaux & LaFlamme 1990) and Coruja, Albania (Pt 2800, Pd 5900) (Ohnenstetter *et al.* 1991).

15 ppb, for 13 samples). Other studies (Lachize *et al.* 1991) revealed the presence of minor PGE in sulphide-bearing gabbro just above the ultramafic sequences with maximum recorded values of 280 ppb Pt + Pd. Thicker dunite units (up to 300 m) are known in the southern part of Semail, Maqsad area. These contain Pt and Pd concentrations of a few thousand ppb in sulphide-bearing serpentinites, but are interpreted as hydrothermally enhanced low grade magmatic concentrations of originally much lower grade (Leblanc *et al.* 1991).

In Cyprus the lower crustal dunite is thicker than in northern Oman, reaching 300–500 m (Fig. 2) on Mount Olympus, Troodos. Apart from this, many characteristics of the PGE abundance and associations in Cyprus are similar to those in Oman. The dunite is very poor in sulphides and with the exception of the basal chromitites also lacks chromitite lenses in the main dunite unit. PGE concentrations are low throughout the ophiolite complex. Maximum values of 70 ppb Os + Ir + Ru and 7 ppb Pt + Pd were located in a chromitite from the base of the lower crustal dunite, at Kokkinorotsos, Cyprus (Prichard & Lord 1990). Maximum Pt + Pd values (124 ppb) occur in sulphide-bearing gabbro just above the ultramafic gabbro junction on Troodos (Prichard & Lord 1990). PGE analyses of Cypriot chromitites show Os, Ir and Ru enrichment relative to Pt and Pd.

In the Lewis Hills complex, in the Bay of Islands, Edwards (1990) reports rare Pt + Pd values of just less than 1000 ppb in pyroxenite in the mantle sequence. However throughout the Bay of Islands complex the dunite unit is relatively thin (maximum thickness of 350 m) and significant Pt and Pd concentrations have not been recorded in the ultramafic crustal sequence. Another example of a PGE-poor ophiolite is the Lizard complex in Cornwall, UK. Although incomplete, the lower crustal/upper mantle sequence in the Lizard is preserved on the coast at Coverack where very thin lower crustal ultramafic rocks with troctolites directly overlie mantle harzburgites (Kirby 1979). Massive chromitites are absent. Significant PGE values have not been recorded from this ophiolite and analyses (with a detection limit of 2 ppb) of a sulphide bearing pyroxenite and of a chrome-spinel-bearing dunite from Coverack (this study) failed to detect Pt and Pd.

In these Pt and Pd-poor ophiolites magmatic Pt + Pd enrichments of over 1000 ppb have not been reported in the crustal sequence despite detailed sampling and analysis for PGE. These ophiolites are characterized by sulphur-poor lower crustal dunite which is thin or absent as a result of crystallization processes (rather than removal by tectonic disruption). Plagioclase tends to crystallize before pyroxene and so lower crustal ultramafic rocks are thin with troctolite produced rather than wehrlite and pyroxenite. Chromitites are present in dunite lenses within mantle harzburgite and at the base of the lower crustal dunite but are virtually absent

Table 1. *PGE analyses from northern Semail, Oman. (values in ppb)*

Locality	Lithology	Os	Ir	Ru	Rh	Pt	Pd
Wadi Bani Kharus	Gabbro	2	0	0	1	2	4
Wadi Bani Kharus	Gabbro	2	0	4	1	4	2
Haymiliyah	Gabbro	0	0	2	0	4	8
Wadi Ragmi	Gabbro	2	0	2	1	8	12
Wadi Ragmi	Gabbro	2	0	4	1	4	14
Wadi Ragmi	Gabbro	2	0	2	1	12	12
Wadi Ragmi	Gabbro	2	0	0	0	2	0
Wadi Ragmi	Gabbro	2	0	2	1	4	5
Wadi Ragmi	Gabbro	0	0	2	0	0	2
Wadi Ragmi	Gabbro	0	0	4	0	2	2
Wadi Ragmi	Gabbro	0	0	2	0	4	2
Wadi Ragmi	Picrite dyke	2	2	4	2	14	18
Wadi Bani Kharus	Wehrlite	0	0	4	1	6	14
Wadi Zaymi	Wehrlite	2	0	4	2	12	28
Wadi Ragmi	Pyroxenite	0	0	6	1	8	14
Gashibie 2	Dunite	6	2	10	1	4	2
Gashibie 2	Dunite	6	4	16	2	14	12
Wadi Ragmi	Dunite	2	16	48	7	12	4
Wadi Ragmi	Harzburgite	6	4	12	2	8	10
Haymiliyah	Chromitite	88	78	220	10	2	2
Wadi Ragmi	Chromitite	16	16	58	4	6	8
Wadi Ragmi	Chromitite	16	14	54	3	4	4
Wadi Ragmi	Chromitite	36	28	86	8	4	2
Wadi Ragmi	Chromitite	48	38	120	12	4	6
Wadi Ragmi	Chromitite	32	28	74	5	4	4
Wadi Wassit	Chromitite	74	38	180	9	16	10
Wadi Wassit	Chromitite	72	32	178	7	10	8
Farfar 2	Chromitite	8	8	50	4	8	4
Farfar 2	Chromitite	8	6	44	3	4	6
Gashibie 2	Chromitite	16	12	50	4	6	2
Gashibie 2	Chromitite	58	76	140	10	42	18
Wadi Zaymi	Chromitite	4	4	22	2	20	6

at higher levels within the lower crustal dunite and the overlying pyroxene-bearing ultramafic rocks. Unlike the Pt- and Pd-rich ophiolites, Pt and Pd have been reported in basal sulphide-bearing gabbro just above the ultramafic sequences and although these Pt and Pd concentrations are low they are the highest values recorded in these PGE poor crustal sequences.

Discussion and conclusions

From the preceding sections it has been suggested that ophiolites with thick sulphide-bearing lower crustal dunite have significant Pt and Pd concentrations and a model is required to explain the development of these sequences. In theory the composition of the lower crustal ultramafic rocks must be related by magmatic processes to mantle composition, degree of partial melting of the mantle, degree of crystallization in the magma chamber and composition of the co-magmatic lavas. In practice the lava stratigraphics within ophiolites are complicated because lavas were intruded into each other during varying phases of oceanic crust formation, as they formed at different times and stages of subduction. Consequently even in well-preserved ophiolites it is often difficult to relate (in the field) the different mantle/lower crustal sequences to their derived lavas. However, the geochemistry of lavas exposed on the modern ocean floor or accessed by drilling, (and hence their associated lower crustal ultramafics), is known to vary between oceanic settings. Thus Pt and Pd enrichments in the lower crustal ultramafics can be linked through their co-magmatic lavas to oceanic setting. Much discussion has focused on the differences between lavas formed above subduction zones and at mid-ocean ridges. These are summarized by Pearce *et al.* (1984) as follows. Subduction zone lavas are derived from partial melts formed above the down going slab of oceanic crust. Initially water from the slab causes lowering of the mantle melting point and allows increased partial melting of already depleted mantle producing boninitic magmas. In contrast mid-ocean ridge basalts (MORB) originate from less depleted mantle subjected to drier melting at spreading centres. True MORB is now considered rare in ophiolites; different lavas are produced at different stages during subduction (Fig. 3). Compositions can be interpreted as a continuum between early boninitic and later MORB-'like' magmas as melting occurs under progressively drier conditions, initially leaving residual depleted mantle harzburgite and subsequently less depleted mantle lherzolite (Pearce *et al.* 1984). The degree of partial melting required to produce oceanic boninites is discussed in Pearce *et al.* (1992).

To produce PGE-enriched magmas it is likely that a high degree of partial melting is responsible as this enables the removal of the very refractory PGE from the mantle. This suggestion is not new. Barnes *et al.* (1985) and many others have pointed out that at least 20% partial melting of the mantle is required to to consume all the sulphides in the mantle. The reason that PGE are retained in the mantle at the lower degrees of partial melting is that some of the sulphides remain in the mantle and as long as this is the case the PGE will be retained by the residual sulphides. The suggestion that boninitic magmas produce PGE-rich melts also has been proposed previously by Hamlyn & Keays (1985) and Barnes (1989) who suggested that a PGE-rich boninitic magma provided a source for the PGE in the Bushveld layered igneous complex. The aim here is to relate these PGE-rich boninitic magmas and their associated high degree of partial melting to an oceanic context. Thus, as in the other geological environments, to locate PGE

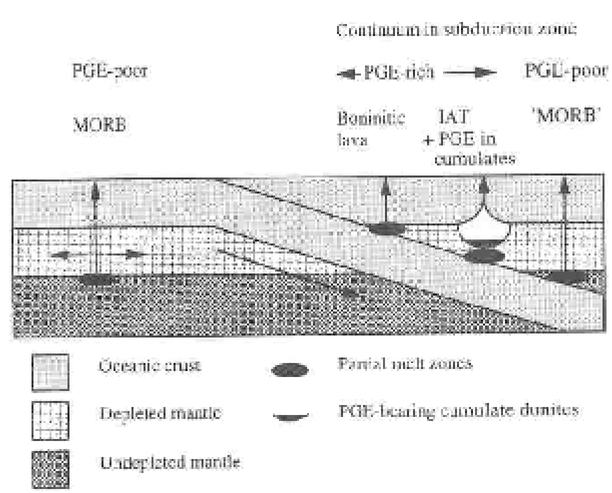

Fig. 3. Schematic section of oceanic crust showing the continuum between boninitic and MORB type lavas and the tectonic settings likely to result in PGE rich or -poor ophiolite complexes.

concentrations in an oceanic setting it is necessary to identify circumstances where a high degree of partial melting occurs. As already stated such a situation exists in the early stages of subduction where boninitic magmas are produced. The high degree of partial melting ensures that these magmas are enriched in refractory elements such as Ni and Cr (Pearce *et al.* 1984, 1992) and this will also maximize the potential for the boninitic magma to be PGE enriched. The conditions of formation of a boninitic magma during the early stages of subduction involve high degrees of partial melting due to water derived from the down going slab of oceanic crust. This water may itself facilitate the removal of PGE from the mantle.

Subsequently if such a boninitic magma, rich in Mg, Si, Ni and Cr, resides in a magma chamber then time will allow thick lower crustal ultramafics to crystallize from the magma (including chromitite, dunite, wehrlite and pyroxenite) (Pearce *et al.* 1984, 1992). As it is also PGE-rich the boninitic magma will provide a source for potential collection and concentration within the ultramafics, where, indeed, PGE have been documented. The formation of these Ni, Cr- and PGE-rich lower crustal ultramafics will produce a Ni, Cr- and PGE-depleted magma which on eruption will produce Ni, Cr and PGE-depleted island-arc tholeitic lavas (IAT).

In contrast there are two situations during subduction where Cr- and Ni-rich thick lower crustal ultramafic rocks will not form (Pearce *et al.* 1984, 1992). Firstly if the boninitic magma does not reside in a magma chamber but is erupted immediately then the magma will retain its Ni and Cr. This unfractionated boninitic magma will form boninitic lavas with a high Mg content, which are Si-rich and enriched in Ni and Cr. In fact boninitic lavas will be an indication that thick lower crustal ultramafic rocks did not have time to crystallize and this situation may occur during the early stages of subduction when a magma chamber has not yet formed. Secondly thick lower crustal ultramafics will be absent if smaller amounts of partial melting of less depleted mantle in drier conditions result in a less picritic parental magma. This will produce lavas with a MORB-type geochemistry and the less picritic nature of this magma will result in thin, chromite-poor lower-crustal ultramafics due to the lack of high Mg, Cr or Ni in the magma. These MORB-'like' magmas will be generated during more advanced stages of subduction, perhaps formed in a mature subduction zone where back arc spreading is established and the supply of water from the down going slab has been exhausted. In both these cases, in addition to the lower crustal ultramafics being depleted in Ni and Cr, they will be barren of PGE. This is because in the first case, although the boninitic magma is enriched in PGE, they will be retained during the rapid eruption of the magma and will be contained in the lavas. In the second case the MORB-'like' magmas will never have been PGE enriched because the small degrees of partial melting are insufficient to remove PGE from the mantle and consequently both the lower crustal ultramafics and MORB lavas will be PGE-poor (Fig. 3). Leblanc (1991) also appeals to high degrees of partial melting to produce PGE-rich crustal sequences in ophiolites. However, instead of high degrees of melting at a subduction zone, his model proposes that the high degree of melting occurs at fast spreading rather than slow spreading mid-ocean ridges. This idea is not consistent with evidence from modern fast and slow spreading ridges where there does not appear to be a correlation of greater melting at fast spreading ridges and less melting at slow spreading ridges (Klein & Langmuir 1989). In addition sulphides in mantle harzburgite from the Hess Deep, formed at the fast spreading East Pacific Rise, have been shown to retain PGE (Prichard *et al.* in press) and by Leblanc's model these harzburgites should have had their PGE removed. These Hess Deep harzburgites, recovered during drilling on the Ocean Drilling Project Leg 147, remain partially fertile in PGE and thus provide a potential source of PGE supply to boninitic magmas produced by high degrees of partial melting during subsequent subduction of this oceanic crust.

Assuming that PGE-rich ophiolites derive from boninitic magmas, once a PGE-rich magma enters the oceanic magma chamber a mechanism is required to concentrate PGE during magma crystallization. Experimental studies and the examination of layered intrusions have shown that in a magma Pt and Pd are both incompatible and chalcophile and are collected by immiscible sulphide liquids (Naldrett 1981; Barnes *et al.* 1985). On sulphur saturation PGE-rich sulphides crystallize and because Pt and Pd are incompatible in the magma they will crystallize early with or in solid solution within the first sulphides and with subsequent first sulphides from new batches of PGE-enriched magma which replenish the magma chamber.

If similar mechanisms operate in ophiolitic magma chambers then Pt and Pd should be concentrated with the first magmatic sulphides. Field evidence from ophiolites confirms this in both PGE-rich and -poor complexes. In Cyprus (Prichard & Lord 1990) and Oman (this study) the ultramafic sequences are barren of magmatic sulphides and Pt and Pd crystallize with first sulphides at the base of the gabbro. In Pt- and Pd-rich ophiolite sequences sulphur saturation occurs early, with crystallization of sulphides within the lower crustal ultramafic rocks. Sulphur saturation and Pt and Pd concentrations are associated with chromite-rich dunite or chromitite and they are often located above the base of the lower crustal sequence. Frequently Os, Ir and Ru are concentrated with chromitite (Talkington *et al.* 1984) and commonly therefore Os, Ir, Ru, Pt, and Pd all occur together with chromitite and with the first sulphides. Enriched Os + Ir + Ru values (greater than 1000 ppb) have been recorded in Shetland and Al 'Ays but not in Cyprus or Oman and so occur in the Pt + Pd-rich ophiolite sequences. It is possible that the high degree of partial melting proposed to cause the Pt + Pd enrichment in the boninitic magmas is also responsible for stripping more Os, Ir and Ru from the mantle.

Previously the ultramafic parts of ophiolite complexes were considered barren of sulphides. This major difference was proposed to account for the lack of significant Pt and Pd concentrations in ophiolites compared with layered complexes (Naldrett & Gruenewaldt 1989). Although this is the case for Oman and Cyprus, others, including Shetland, commonly have fine-grained disseminated sulphides (up to 1–2%) in their lower crustal ultramafics and these sulphides are Pt- and Pd-rich. In conclusion Pt and Pd enrichment only occurs in ophiolites where melting has been sufficient to remove PGE from the mantle giving enriched boninitic magmas and where sulphur saturation has concentrated the PGE within the thick lower crustal dunite units produced by crystallization of the boninitic magma prior to eruption of PGE depleted IAT. The Shetland and Al 'Ays ophiolites are two of a number of these Pt- and Pd-rich complexes.

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References

Augé, T. 1985. Platinum-group mineral inclusions in ophiolitic chromitite from the Vourinos complex, Greece. *Canadian Mineralogist*, **23**, 163–171.

Bacuta, C. C. Jr., Lipin, B. R., Gibbs, A. K. & Kay, R. W. 1988. Platinum-group element abundance in chromite deposits of the Acoje ophiolite block, Zambales ophiolite complex, Philippines *In*: Prichard, H. M., Potts, P. J., Bowles, J. F. W. & Cribb, S. J. (eds) *Geo-platinum symposium volume*. Elsevier, 381–382.

Barnes, S. J. 1989. Are Bushveld U-type parent magmas boninites or contaminated komatiites? *Contributions to Mineralogy and Petrology*, **101**, 447–457.

——, Naldrett, A. J. & Gorton, M. P. 1985. The origin of the fractionation of Pt group elements in terrestrial magmas. *Chemical Geology*, **53**, 303–323.

Browning, P. 1982. *The petrology, geochemistry, and structure of plutonic rocks of the Oman ophiolite*. PhD thesis, Open University.

Corrivaux, L. & LaFlamme, J. H. G. 1990. Minéralogie des éléments du groupe du platine dans les chromitites de l'ophiolite de Thetford Mines, Québec. *Canadian Mineralogist*, **28**, 579–595.

Crocket, J. H. 1981. Geochemistry of the platinum-group elements. *Canadian institute of Mineralisation and Metallurgy*, Special issue **23**, 47–64.

Edwards, S. J. 1990. Harzburgites and refractory melts in the Lewis Hills massif, Bay of Islands ophiolite complex: the base metals and precious metals story. *Canadian Mineralogist*, **28**, 537–552.

Gunn, A. G. 1989. Drainage and overburden geochemistry in exploration for platinum-group element mineralisation in the Unst ophiolite, Shetland, UK. *Journal of Geochemical Exploration*, **31**, 209–236.

Hamlyn, P. R & Keays, R. R. 1986. Sulfur saturation and second stage melts; application to the Bushveld Pt metal deposits. *Economic Geology*, **81**, 1431–1445.

Kirby, G. A. 1979. The Lizard ophiolite complex. *Nature*, **282**, 58–61.

Klein, E. M. & Langmuir, C. H. 1989. Local versus global variations in ocean ridge basalt composition. *Journal of Geophysical Research*, **94**, NB4, 4241–4252.

Lachize, M., Lorand, J. P. & Juteau, T. 1991. Cu-Ni PGE magmatic sulfide ores and their host layered gabbros in the Haymiliyah fossil magma chamber (Haylayn block, Semail ophiolite nappe, Oman). *In*: Peters, T. J., Nicolas, A. & Coleman, R. G. (eds) *Ophiolite Genesis and Evolution of the oceanic lithosphere: Proceedings of the ophiolite conference held in Muscat, Oman*. Kluwer Academic Publishers, 209–229.

Leblanc, M. 1991. Platinum-group elements and gold in ophiolite complexes: distribution and fractionation from mantle to ocean floor. *In*: Peters, T. J., Nicolas, A. & Coleman, R. G. (eds) *Ophiolite Genesis and Evolution of the oceanic lithosphere: Proceedings of the ophiolite conference held in Muscat, Oman*. Kluwer Academic Publishers, 231–260.

——, Ceuleneer, G., Al Azri, H. & Jedwab, J. 1991. Concentration hydrothermale de palladium et de platine dans les péridotites mantellaires du complexe ophiolitique d'Oman. *Comptes Rendus de l'Academie des Sciences, Paris*, **312**, Série II, 1007–1012.

Lord, R. A. 1991. *Platinum-group elements in the Shetland ophiolite complex*. PhD thesis, Open University.

——, Prichard, H. M. & Neary, C.R. 1994. Magmatic PGE concentrations and hydrothermal upgrading in the Shetland ophiolite complex. *Transactions of the Institute of Mining and Metallurgy*, **B103**, 87–102.

Malpas, J. & Stevens, R. K. 1977. The origin and emplacement of the ophiolite suite with examples from western Newfoundland. *In*: Malpas, J. & Talkington, R. W. (eds) *Ophiolites of the Canadian Appalachians and Soviet Urals*. Memorial University, Newfoundland, Contribution to IGCP Project 39, 21–41.

Murton, B. J. 1986. *The tectonic evolution of the western Limassol Forest complex, Cyprus*. PhD thesis, Open University.

Naldrett, A.J. 1981. Nickel sulfide deposits: classification, composition and genesis. *Economic Geology*, **75**, 628–685.

—— & Von Gruenewaldt, G. 1989. Association of platinum-group elements with chromitite in layered intrusions and ophiolite complexes. *Economic Geology*, **84**, 180–187.

Neary, C. R. 1974. *Chromitiferous ultrabasic rocks in the northern Hijaz of Saudi Arabia*. PhD thesis, University of Leeds.

——, Prichard, H.M. & Potts, P.J. 1984. Chromite, platinoids, gold and moly in the Shetlands. *Mining Magazine*, Dec. 559–60.

Ohnenstetter, M., Karaj, N., Neziraj, A., Johan, Z & Cina, A. 1991. Le potentiel platinifère des ophiolites : minéralisations en éléments du groupe du platine (PGE) dans les massifs de Tropoja et Bulquiza, Albanie. *Comptes Rendus de l'Academie des Sciences, Paris*, **13**, Série II, 201–208.

Orberger, B., Friedrich, G. & Woermann, E. 1988. Platinum-group element mineralisation in the ultramafic sequence of the Acoje ophiolite block, Zambales, Philippines. *In*: Prichard, H. M., Potts, P. J., Bowles, J. F. W. & Cribb, S. J. (eds) *Geo-platinum symposium volume*. Elsevier, 361–380.

Pearce, J. A., Lippard, S. J. & Roberts, S. 1984. Characteristics and tectonic significance of supra-subduction zone ophiolites. *In*: Kokelaar, B. P. & Howells, M. F. (eds) *Marginal Basin Geology*. Geological Society, London, Special Publications, **16**, 77–94.

——, Van Der Laan, S. R., Arculus, R. J., Murton, B. J., Ishii, T., Peate, D. W. and Parkinson, I. J. 1992. Boninite and harzburgite from leg 125 (Bonin-Mariana forearc): A case study of magma genesis during the initial stages of subduction. *In*: Fryer, P. *et al.* (eds) *Bonin/Mariana region*. Proceedings of the Ocean Drilling Program, **125**, 623–656.

Pedersen, R. B., Johannesen, G. M. & Boyd, R. 1993. Stratiform PGE mineralisations in the ultramafic cumulates of the Leka ophiolite complex, central Norway. *Economic Geology*, **88**, 782–803.

Prichard, H. M. 1985. The Shetland Ophiolite. *In*: Gee, D. G. & Sturt, B. A. (eds) *The Caledonide Orogen: Scandinavia and related areas*. Wiley & Sons, Ltd, 1173–1184.

—— & Lord, R. A. 1988. The Shetland ophiolite: evidence for a supra-subduction zone origin and implications for platinum-group element mineralisation. *In*: Boissonnas, J. & Omenetto, P. (eds) *Mineral deposits within the European Community*. Special publications of the Society for Geology Applied to Mineral deposits. Springer-Verlag, 289–302.

—— & —— 1990. Platinum and palladium in the Troodos ophiolite complex, Cyprus. *Canadian Mineralogist*, **28**, 607–617.

—— & —— 1993. An overview of the PGE concentrations in the Shetland ophiolite complex. *In*: Prichard, H. M., Alabaster, T, Harris, N. B. W. & Neary, C. R. (eds) *Magmatic Processes and Plate Tectonics*. Geological Society, London, Special Publications, **76**, 273–294.

——, Ixer, R. A., Lord, R. A., Maynard, J. & Williams, N. 1994. Assemblages of platinum-group minerals and sulfides in silicate lithologies and chromite-rich rocks within the Shetland ophiolite. *Canadian Mineralogist*. **32**, 2, 271–294.

——, Neary, C. R. & Lord, R. A. 1992. New evidence of platinum-group element concentrations in the Al 'Ays ophiolite complex, Saudi Arabia : Significance for prediction in other ophiolite complexes. *In*: Foster, R. P. (ed.) *Mineral deposit modelling in relation to crustal reservoirs of ore-forming elements*. Abstract, Institute of Mining and Metallurgy, London.

——, —— & Potts, P. J. 1986. Platinum-group minerals in the Shetland ophiolite. *In*: Gallagher, M. J., Ixer, R. A., Neary, C. R. and Prichard, H. M. (eds) *Metallogeny of the basic and ultrabasic rocks*. Institution of Mining and Metallurgy, London, 395–414.

——, Puchelt, H., Eckhardt, J.-D. & Fisher, P. C. In press. Platinum concentrations in mafic and ultramafic lithologies drilled from the Hess Deep. *In*: Gillis, K., Mevel, C. The ship board scientific party. *ODP special volume 147*.

Talkington, R. W., Watkinson, D. H., Whittaker, P. J. & Jones, P. C. 1984. Platinum-group minerals and other solid inclusions in chromite of ophiolitic complexes: occurrence and petrological significance. *Tschermaks Mineralogische und Petrographische Mitteilungen*, **32**, 285–301.

Wilson, R. A. M. 1959. *The geology of the Xeros–Troodos area*. Cyprus Geological Survey Department Memoirs, **1**.

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Appendix 5
Extract of Paper by R-B Pedersen et al on the Leka Ophiolite in Northern Norway

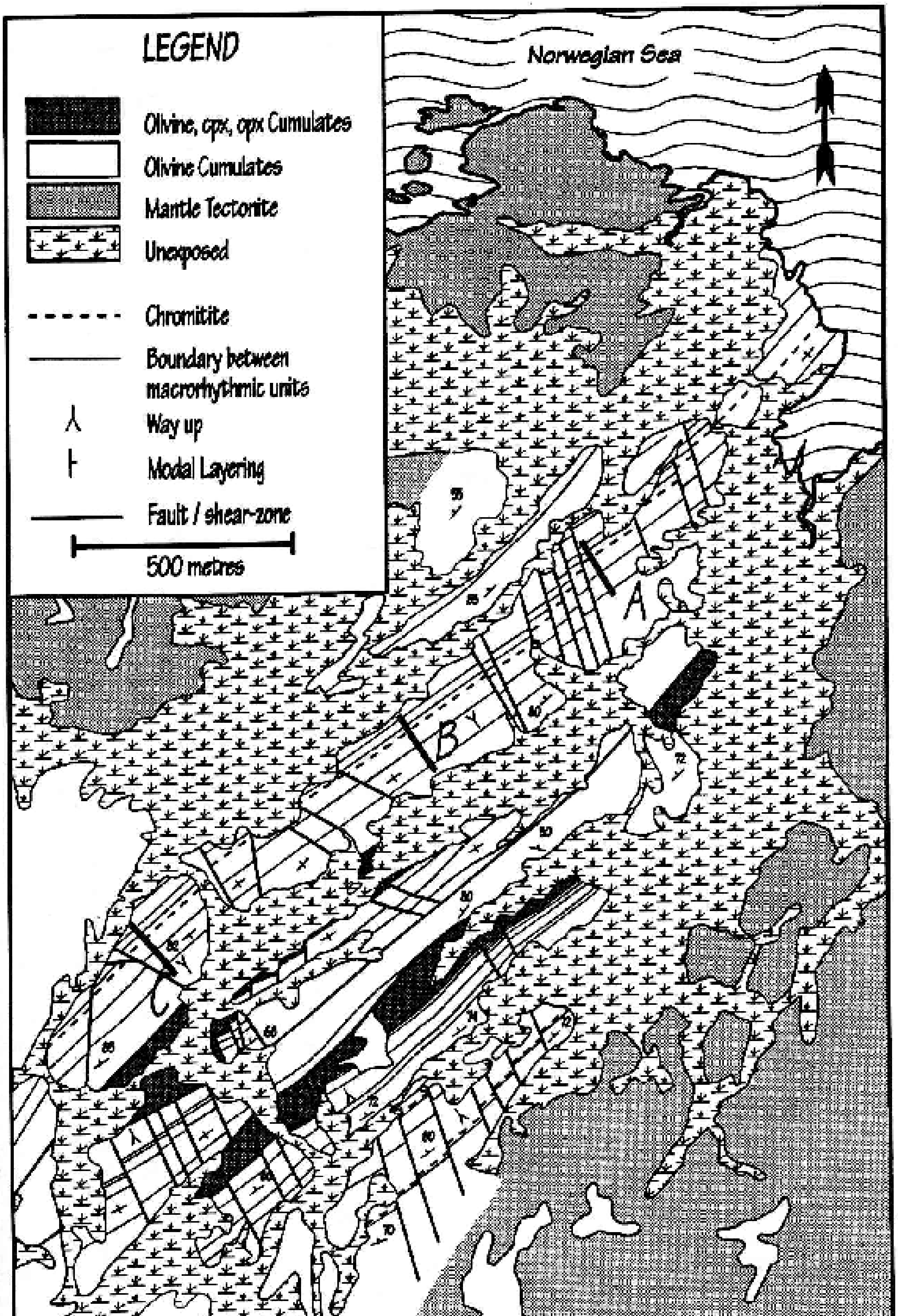

FIG. 2. Detailed map of part of the ultramafic zone of the layered series showing sub-zones of olivine and olivine- clinopyroxene cumulates. Macrorhythmic units are shown within the olivine cumulate sub-zones where they can be defined in the field. The locations of the geochemical profiles referred to in the text are marked A, B and C.

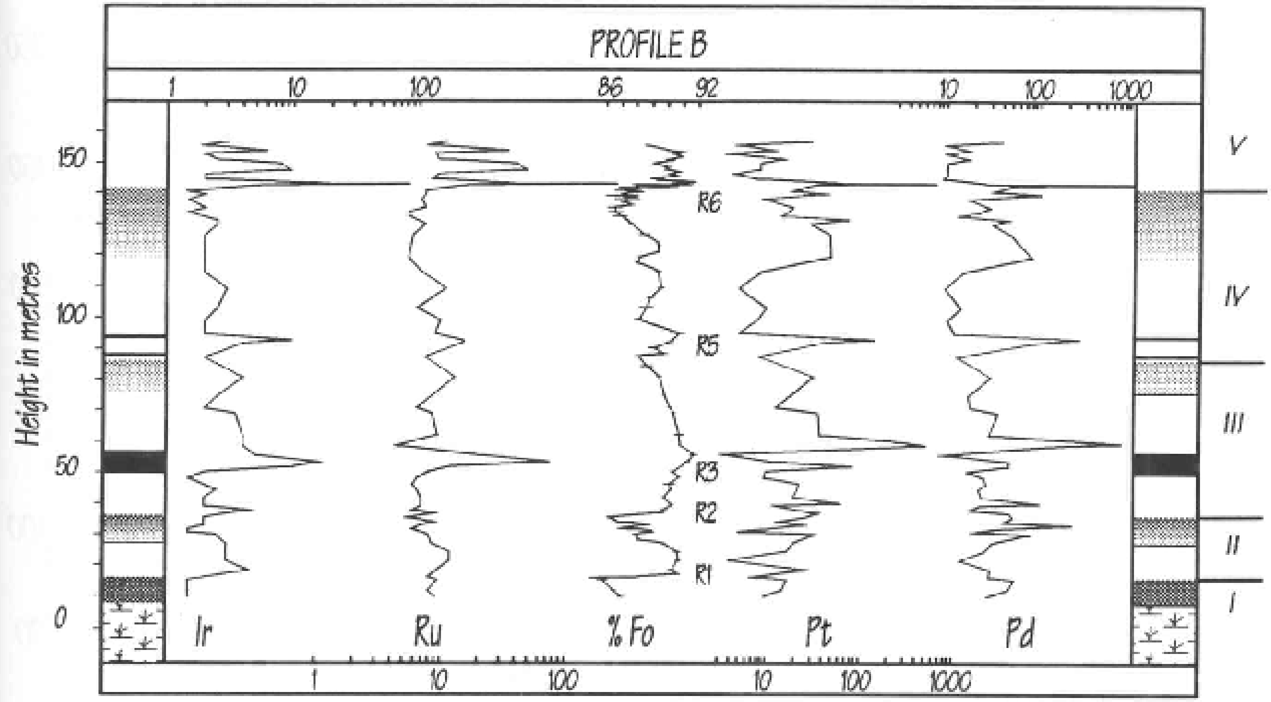

FIG. 6. Variation in content of Ir, Ru, Pt and Pd along profile B.

pronounced peaks are evident in the IPGE trends. The lowermost is situated, predictably, within the main chromite horizon, while the uppermost is located just above the base of the uppermost macrorhythmic unit, where a few thin, relatively sulfide-rich chromitite seams are located. The total IPGE content is, however, relatively low in both samples - in the order of a few hundred ppb. The presence of three clear peaks in the Pt and Pd curves , two of which yielded > 1000 ppb Pt+Pd, is more surprising. Whereas the lowermost of these peaks is positioned 1-2 m above the top of the main chromite horizon (R3) the two others are associated with R5 and R6 (Fig. 6).

The bases of four macrorhythmic units and the main chromite horizon were resampled with 10-30 metre drill holes. Several cores were also taken across the base of the same macrorhythmic unit to assess lateral variations in composition. The holes were all taken with ca. 60 degrees inclination to the layering (which is vertical) so that 2 m of core represents a 1 m section of the rocks. The drill cores were split, and 50 cm- lengths (subsequently 1 m-lengths) were crushed and analysed. Part of the analytical data are presented in Table 3.

The results confirm that the PGE contents may fluctuate by an order of two magnitudes across a few metres of the layered rocks (Fig. 7). The data also show the presence of several PGE-enriched horizons that yield 0.5 and 1-m averages of around 1ppm ∑PGE (mainly Pt and Pd). Drill core across R6 (88B4 and 88B1), from which a hand sample with ca. 2 ppm PGE had been collected (sample 87P2, Table 2), yielded 0.5-m averages of only a few hundred ppb which suggests that the enriched horizon is very thin and that it had been sampled directly with the hand specimen.

The drill cores across and above the main chromite horizon (R3) show the presence of two Pt-Pd-enriched horizons immediately above the chromite enrichment, and a third 15 to 20 m above the chromite horizon coinciding with a minor reversal in olivine composition (R4) . These PGE-rich horizons can be traced laterally from profile A to B and C, a distance of around 1.5 km. An enriched horizon discovered just above R2 (profile 88B6) yielded close to 1ppm PGE over 1 m of core.

The variations in PGE content across and immediately above R2 (core 88B6) are shown in more detail in Fig. 8. The change from wehrlite to dunite, which defines the base of the macrorhythmic unit II in the field, is reflected in the diagram by a sudden drop from > 10 wt% to < 0.5 wt% CaO about 8 m above the beginning of the core (the considerable variation in CaO below this level reflects a smaller scale interlayering of dunite and wehrlite). The reversal in composition at the base of the macrorhythmic unit is shown by an increase in the Ni content of the rocks from 800 to above 2000 ppm across 3 m of the layered rocks.

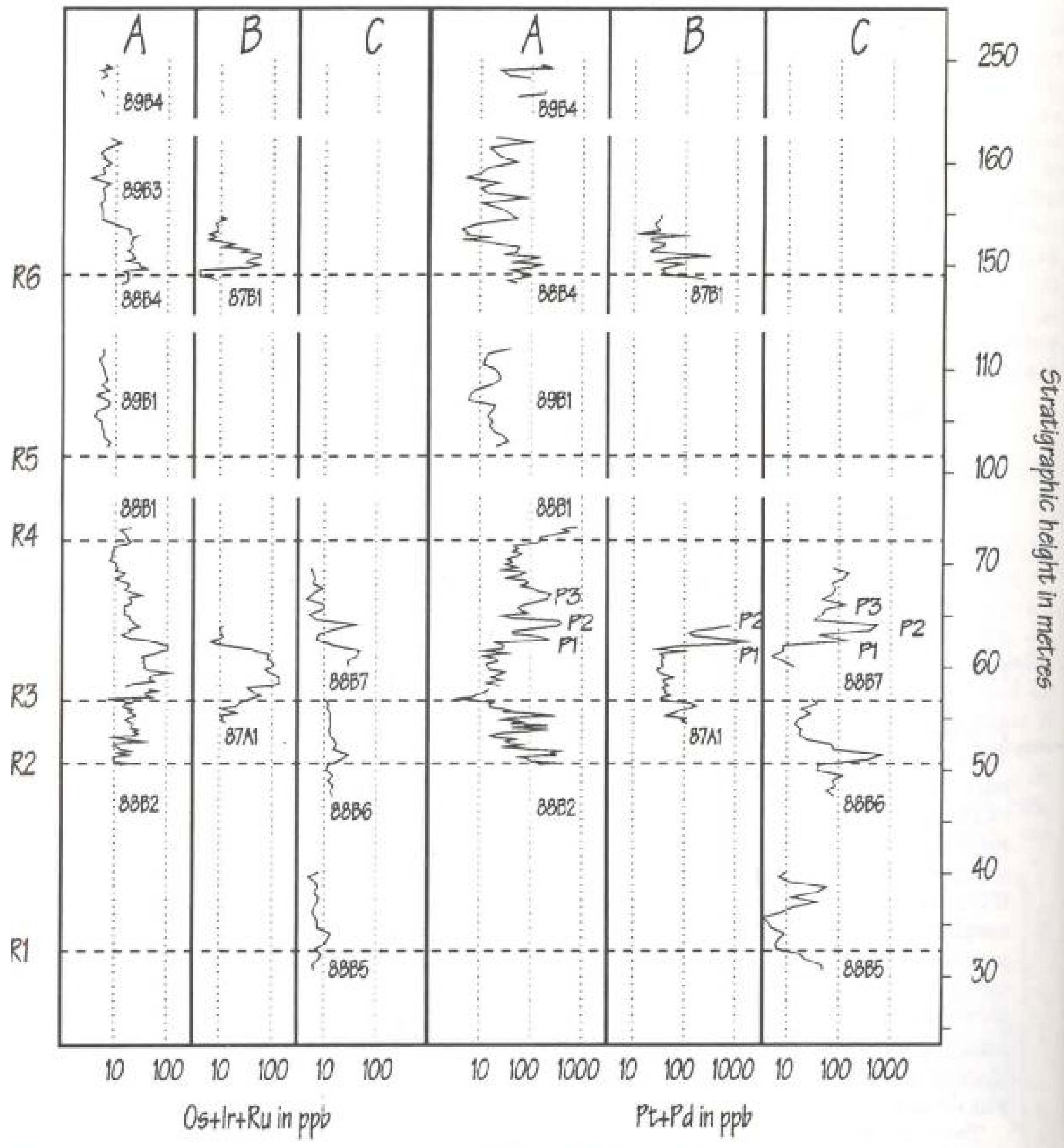

FIG. 7. Graphical depiction of the content of IPGE and Pt+Pd in drill cores across the bases of cyclic unites (numbered R1 - R6).

The enriched horizon (mainly Pt, Pd and Au) is clearly situated at the exact base of the macrorhythmic unit, and is associated with a minor peak in S.

R2 was also penetrated by core 88B2 in profile A. Two PGE- enrichments are here present close to the base of the unit, and several more, which are not present in profile C, are present 5-10 metres above the base of the unit (Fig. 7). A hole (88B1) drilled from a position just below the base of the chromite horizon shows the compositional evolution through this horizon and 10 m above (in profile A). The IPGE- and Cr-contents of the horizon have a strong positive correlation (Fig. 9). Three Pt-Pd peaks are recorded above the chromitite horizon and a fourth is present at the end of the core. These peaks can be traced laterally: the two lowermost are intersected by hole 87A1 (in profile B), and all four are present in cores 88B7 and 89B9 drilled in profile C (Fig. 7).

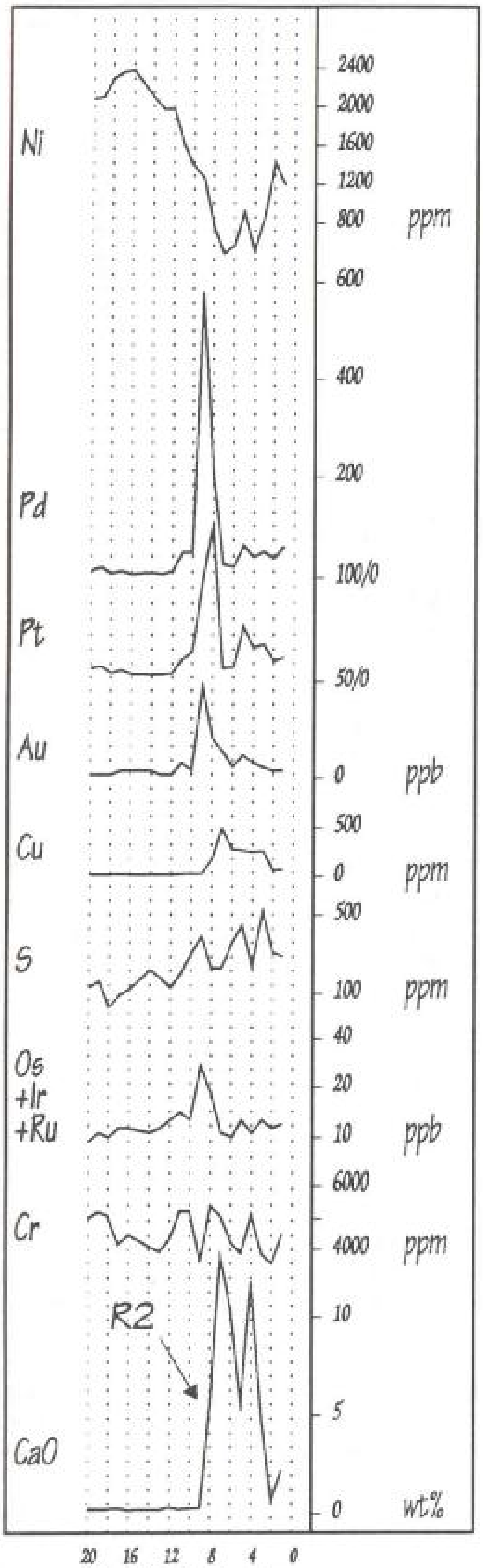

FIG. 8. Compositional variation across R2 in profile C (core 88B6).

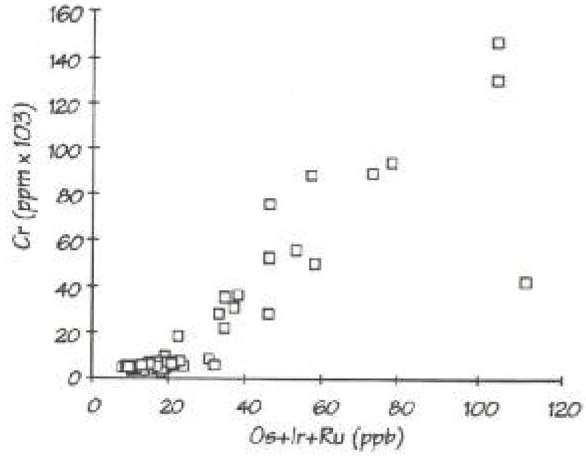

FIG. 9. Plot of IPGE against Cr within the main chromite horizon.

PGE in the Ultramafic Zone of the Layered Series - Lateral Variations

There appears to be a systematic lateral variation in the Pt/Pd ratio of the three peaks located above the main chromite horizon (see Fig. 7) . In profile A, which is assumed to have had the most central position in the magma chamber, the peaks are slightly to strongly enriched in Pt relative to Pd with an average Pt/Pd ratio of 1.6 (Fig. 11). In profile C, however, the average Pt/Pd ratio of the three peaks is 0.4. A sulfide-rich horizon located at the level of the lowermost of these three PGE peaks can be traced in the field from profile A to B to C. Hand samples from this horizon yielded 137, 1,038 and 1,879 ppb from profiles A, B, C, respectively, or an increase in the PGE content towards what we assume are the more distal parts of the intrusion. The Pt/Pd ratio of this horizon seems, however, not to change dramatically (0.33, 0.44 and 0.40) which contradicts the pronounced lateral changes observed in the core-data (Fig. 11). Both PGE and the Pt/Pd ratio of samples from the sulfide-rich horizon in profile C are compatible with the values obtained for the lowermost of the three peaks at this location. The reason for the above inconsistency can be found in profile A where the PGE in the sulfide-rich horizon appears to be nearly an order of magnitude below that of the peak composition in the core. It appears, therefore, that the main PPGE-enrichments along this profile are displaced relative to the sulfide-rich horizon. This relationship is shown by the variation of these elements with stratigraphic height, and is particularly evident in

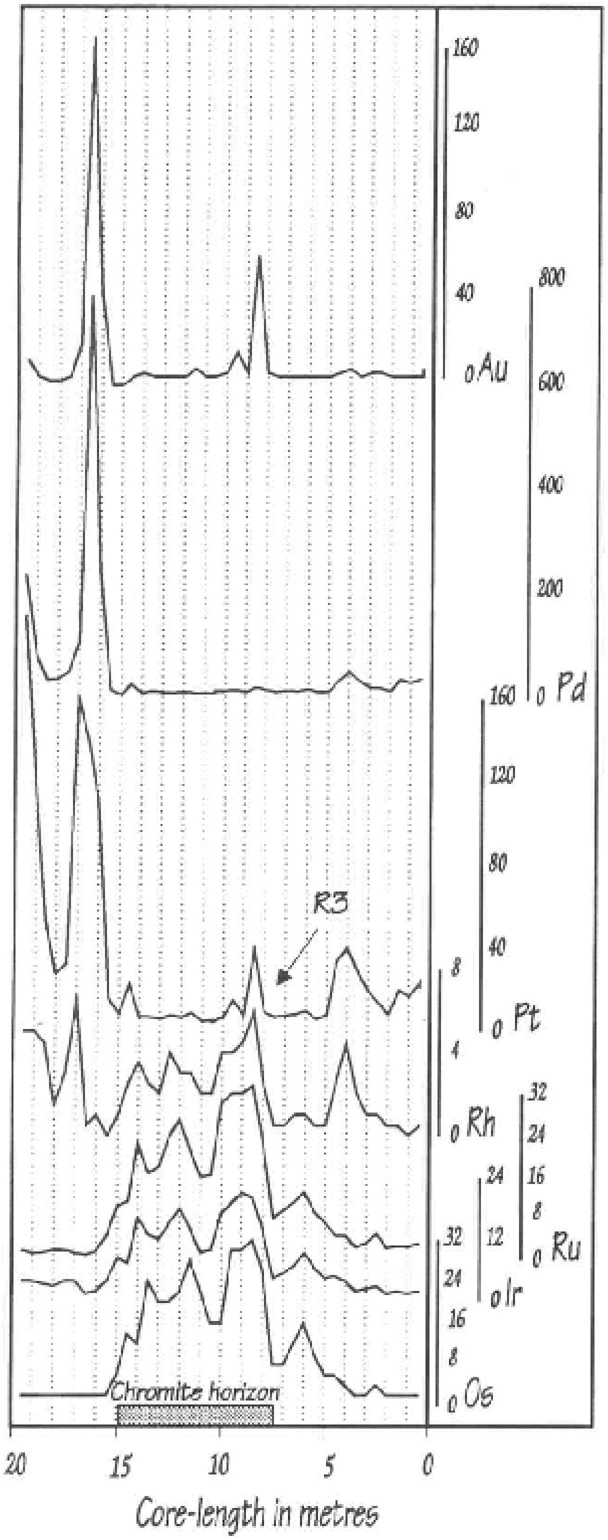

FIG. 10. Compositional variation across the main chromite horizon in profile B (core 87A1).

core 88B1 where the parts that are most enriched in Pt and Pd show the lowest S-concentration (Fig. 12). A similar scattergram of the data from the hole that was drilled through the base of the uppermost macrorhythmic unit (across R6 close to profile A)

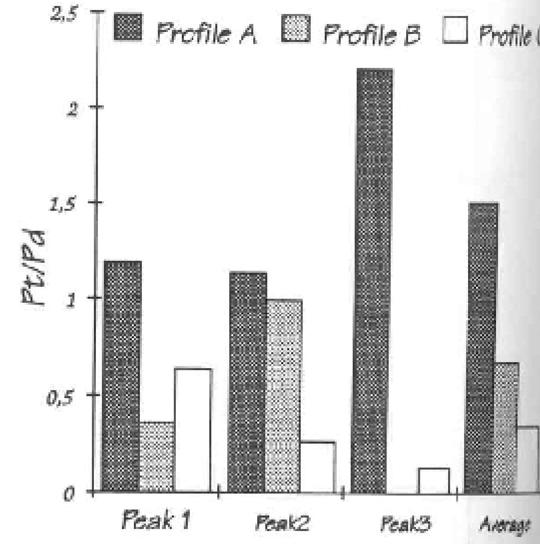

FIG. 11. Histogram showing lateral variation in the Pt/Pd ratio of three PGE-enriched horizons above the main chromite horizon. See Fig. 7 for the location of the peaks.

shows a different picture with the data points spreading out as a fan (Fig. 13). The reason for this covariance can be deduced from Fig. 14, which shows compositional variation with height across R6. The base of the macrorhythmic unit is here again marked by an abrupt decrease in CaO. A 1 m-thick sulfide-rich horizon can be observed in the field 1 m above the base of the macrorhythmic unit, and this is depicted in the core as two marked peaks in the S content. Cu is particularly enriched in the uppermost part of this horizon while the lowermost part is enriched in Pd. The main Pt peak occurs, however, below the sulfide horizon. This peak exhibits a Pt/Pd ratio of 2.4 while the peak associated with the sulfide-rich horizon has a Pt/Pd ratio of 0.4, which compares well with the lateral variation in the Pt/Pd ratio observed along the PGE-enrichments above the main chromite horizon from profile A to profile C (Fig. 11).

The layered series contains both Pt-dominated PGE enrichments not associated with sulfides, and Pd-dominated enrichments associated with discrete sulfide-rich horizons. The present data suggest that the Pt-dominated enrichments are positioned just below the Pd-dominated ones, and that they fade towards distal parts of the intrusion, and vice versa for the Pd-dominated enrichments.

Composition of Sulfide-rich Horizons

The maximum 0.5 and 1 m averages obtained for the Pt- and Pd-dominated enrichments are of the

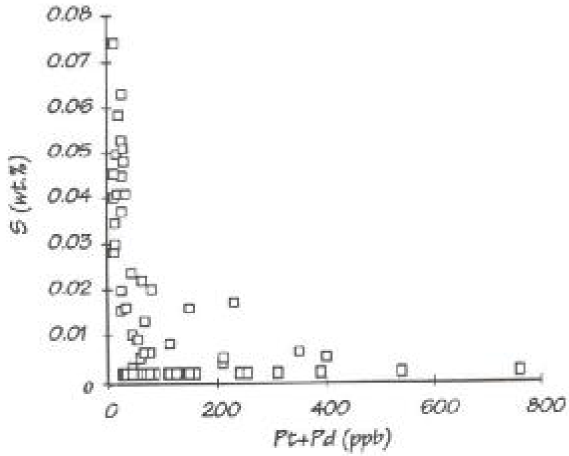

FIG. 12. Plot of Pt+Pd against S for PGE-enriched horizons above the main chromite horizon in profile A (core 88B1).

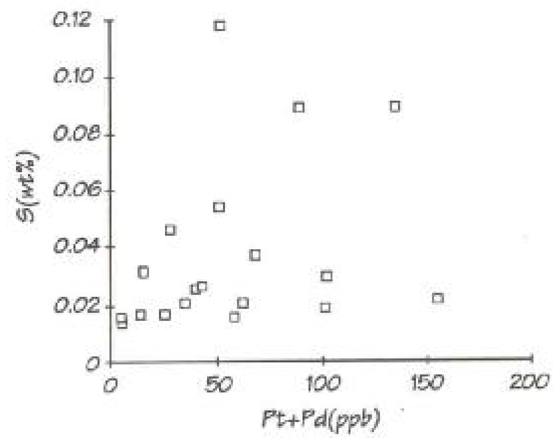

FIG. 13. Plot of Pt+Pd against S for PGE-enriched horizons above R6, between profiles A and B, (core 88B4).

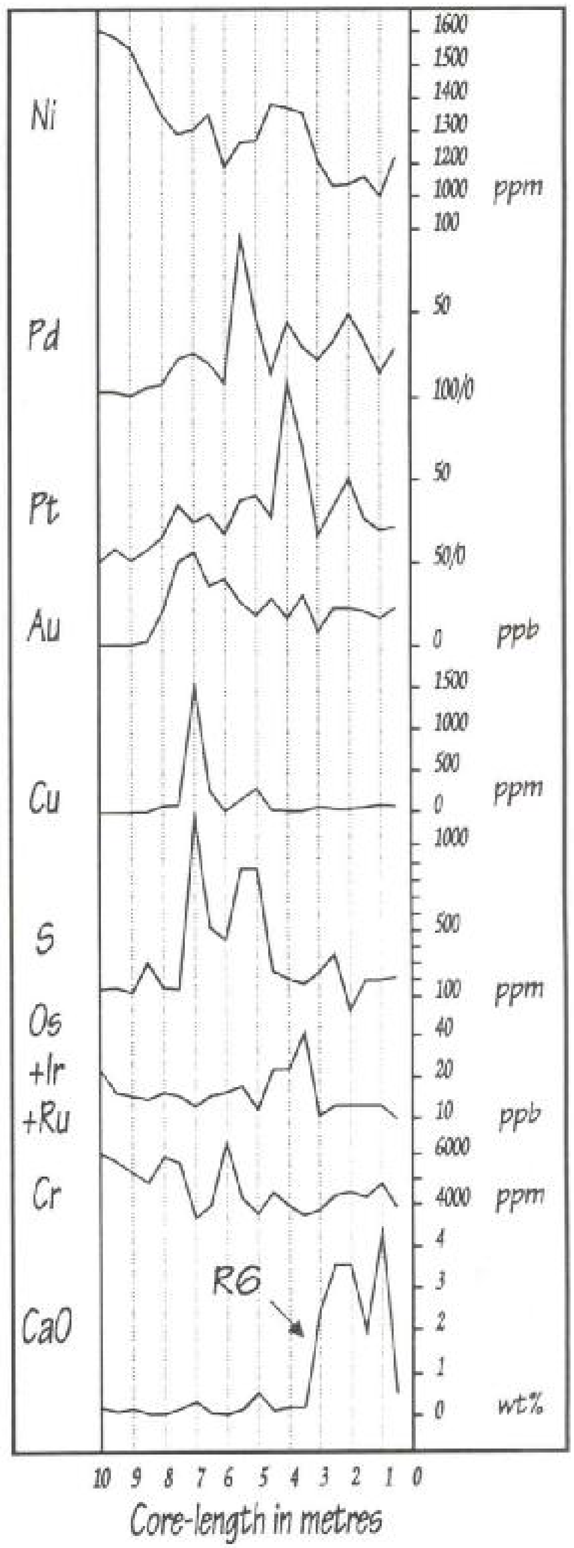

FIG. 14. Compositional variation across R6 (core 88B4) that show how a Pd-enrichment is displaced upsection relative to a minor Pt-enrichment.

order of 1 ppm for Pt+Pd. Hand-samples of 12 sulfide-enriched horizons (maximum S content only 0.6wt%) show that the peak composition of the Pd-dominated enrichments may be > 3 ppm PGE (Table 4). The most enriched samples (89lek9 & 21) are from a horizon ca. 30 m above R6. The second most enriched sample (89lek31) was the only one taken outside the area studied in detail, and points to the presence of enriched horizons outside this area.

No hand-specimens have yet been taken from the Pt-dominated horizons because their exact locations are difficult to establish in the field, due to the lack of other associated phases such as sulfides or chromite. However, the peak compositions of these horizons would also be expected to be significantly higher than the 0.5 m averages obtained from the cores.

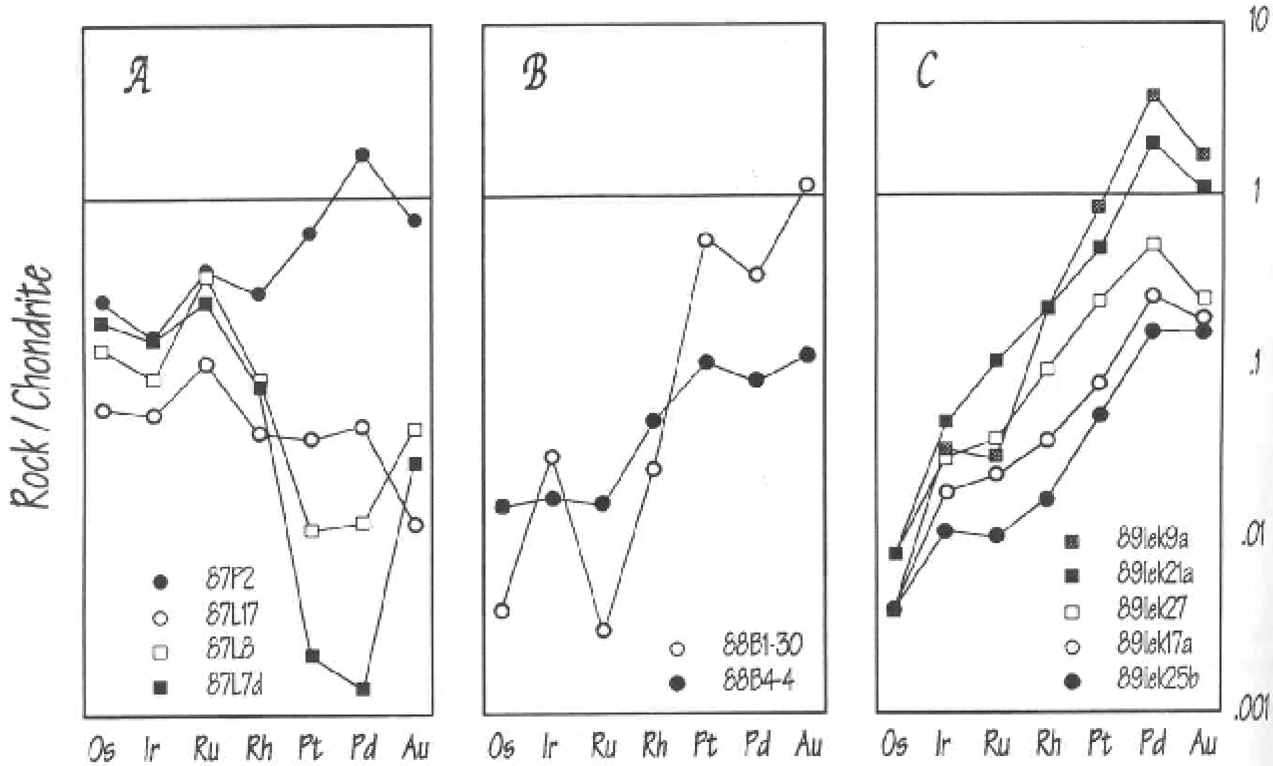

FIG. 15. Chondrite normalized patterns of: A) IPGE-enriched stratiform chromitites. All the analysed chromite horizons from Leka, except one, show the typical ophiolitic, IPGE-enriched pattern. The one that is anomalous (87P2) differs from the other in having visible sulfide; B) Pt-dominated stratiform enrichments and C) Pd-dominated stratiform enrichments associated with sulphide-bearing horizons.

Chromitites from the Layered Series

The chromitites and chromite horizons sampled by drilling yielded low contents of both PPGE and IPGE, although modest enrichment in the latter group can be observed through such horizons (Fig. 10). Hand samples were taken from a number of chromitite horizons in the ultramafic zone of the layered series (Table 5). The highest values are obtained in 87P1 and P2, which contrast with the rest in that they are enriched in both PPGE and IPGE. These samples were taken from a thin chromite seam located a few tens of centimetres above R6 in profile B, and differ from the other samples in that they contain visible sulfides. In samples without visible sulfides the maximum PGE content is 405 ppb, mainly Ru. The average Ru#, (Ru/(Os+Ir+Ru)), of these samples is 0.51, and is slightly higher than the Ru# obtained from laurite grains in chromitites of the White Hills Peridotite (Ru# 0.46) (Talkington and Watkinson, 1986), which suggests that all the IPGE may be confined to laurite which has also been identified as inclusions in chromite grains.

Chondrite-normalized Patterns of the PGE-enriched horizons

Chondrite-normalized patterns of representative samples of the Pt-dominated enrichment, the sulfide-bearing Pd-dominated enrichments as well as of the chromite horizons are shown in Figs. 15 a,b and c respectively. The Pt- and Pd-dominated enrichments both show PPGE enriched patterns similar to those from deposits such as the J-M Reef of the Stillwater Complex and the Merensky Reef of the Bushveld Complex (Fig. 16). The chromite horizons show IPGE-enriched patterns, similar to those reported from the other ophiolite-hosted chromitites (Fig. 16, Fig. 5b). One chromitite horizon, the one containing visible sulfides, deviates by having a pattern that can be visualized as a combination of the Pd-dominated pattern of the sulfide-rich horizons and the typical pattern of the stratabound chromitites. This pattern resembles those reported from chromitites in the Stillwater Complex (Fig. 16).

Sample #	Rock Type	Os	Ir	Ru	Rh	Pt	Pd	Au	Total
lek88-2c	Dunite	6	5	-	2	8	8	2	30
lek88-3f	Dunite	2	5	-	3	10	7	2	28
lek88-4a	Dunite	4	5	-	2	6	5	4	25
lek88-5d	Dunite	12	6	-	2	8	6	4	38
lek88-6b	Dunite	2	3	-	1	3	4	6	18
lek88-7b	Dunite	4	4	-	2	3	2	2	16
lek88-8b	Dunite	10	4	-	2	15	12	4	47
lek88-1e	Harzburgite	8	7	-	3	24	14	2	58
lek88-2d	Harzburgite	8	7	-	3	13	8	2	40
lek88-3e	Harzburgite	10	7	-	3	9	10	6	44
lek88-3g	Harzburgite	10	5	-	2	8	7	4	36
lek88-4b	Harzburgite	8	5	-	2	9	8	4	35
lek88-5e	Harzburgite	8	7	-	2	9	9	4	38
lek88-6c	Harzburgite	4	4	-	2	5	5	2	22
lek88-7c	Harzburgite	4	4	-	2	7	4	2	22
lek88-8c	Harzburgite	8	4	-	2	5	8	2	28
lek88-2b	Pyroxenite	2	2	-	1	8	7	2	22
lek88-5f	Pyroxenite	2	2	-	1	4	3	6	17
lek88-1b	Chromitite	360	410	60	210	4600	2700	170	8510
lek87-P1	Chromitite	180	240	370	150	2400	1600	20	4960
lek88-1a	Chromitite	340	220	56	150	1800	1200	44	3810
lek88-1d	Chromitite	240	220	48	160	2100	960	46	3774
lek88-1c	Chromitite	210	210	40	140	1500	690	42	2832
lek88-3a	Chromitite	400	240	84	300	1000	550	28	2602
lek88-3b	Chromitite	270	170	64	210	1100	730	32	2576
lek88-8a	Chromitite	180	76	40	80	740	1400	50	2566
lek88-3c	Chromitite	370	250	96	270	1000	420	30	2436
lek88-3d	Chromitite	80	39	26	39	270	180	18	652
lek88-6a	Chromitite	30	14	16	4	2	4	8	78
lek88-2a	Chromitite	12	7	9	2	16	9	2	56
lek88-5a	Chromitite	4	3	13	2	6	13	2	42
lek88-5b	Chromitite	4	3	13	2	6	5	2	34
lek88-7a	Chromitite	2	2	13	1	7	2	4	31
lek88-5c	Chromitite	4	3	9	2	6	4	2	29

TABLE 1. PGE and Au contents of barren harzburgite, dunite and pyroxenite and of chromitites and chromite-rich rocks within the mantle tectonites of the LOC. (Ru-values for the harzburgites, dunites and pyroxenites are partly omitted due to incosistant results for Ru during a particular run.). The values given in this and in the following tables are in ppb.

Sample #	Os	Ir	Ru	Rh	Pt	Pd	Au	Total
84-1B	2	2	9	3	10	28	8	61
84-2B	2	2	8	3	15	46	8	84
84-3B	2	2	10	4	17	54	6	94
84-4B	2	2	8	5	8	29	6	59
84-5B	2	5	10	10	27	30	6	89
84-6B	2	3	12	3	4	14	6	44
84-7B	2	3	12	4	17	26	6	70
84-8B	2	3	9	6	20	31	6	77
84-9B	2	3	8	4	34	76	8	135
84-10B	2	2	7	2	5	21	4	43
84-11B	2	2	6	3	11	34	4	61
84-12B	2	2	7	4	26	220	16	277
84-13B	2	2	9	3	14	42	2	74
84-14B	2	2	6	3	27	52	4	96
84-15B	2	3	9	6	37	48	6	111
84-16B	2	5	6	8	21	18	4	63
84-17B	2	2	7	4	13	23	4	55
84-18B	2	2	7	3	20	24	4	62
84-19B	2	3	7	4	22	22	4	63
84-20B	2	2	6	5	23	27	4	69
84-21B	2	2	7	2	10	26	6	54
84-22B	2	2	8	3	10	17	4	46
84-23B	6	10	12	16	85	47	6	182
84-24B	30	16	75	6	11	48	6	192
84-25B	8	5	20	3	4	10	4	53
84-26B	4	4	5	6	520	150	130	819
84-27B	4	4	10	6	38	29	6	97
84-28B	2	4	9	7	36	36	6	99
84-29B	2	2	7	3	13	18	6	51
84-30B	2	3	9	4	18	17	4	56
84-31B	4	4	13	4	32	30	6	93
84-32B	2	2	8	2	9	13	10	45
84-33B	6	4	15	6	43	89	42	205
84-34B	4	2	9	2	5	12	6	40
84-35B	2	2	10	3	8	10	14	49
84-36B	2	3	7	3	10	14	4	42
84-37B	4	3	11	3	5	10	4	39
84-38B	2	2	7	3	9	15	6	44
84-39B	2	2	6	4	49	81	16	159
84-40B	2	3	5	4	51	53	4	121
84-41B	2	3	8	5	30	31	6	84
84-42B	2	3	7	5	74	45	6	141
84-43B	2	2	6	3	14	13	4	43
84-44B	2	2	6	3	17	22	8	59
84-45B	2	2	8	3	19	29	8	71
84-46B	2	2	7	3	10	17	4	44
84-47B	2	2	8	3	42	100	10	167
84-48B	2	2	8	3	19	32	12	77
84-49B	4	6	16	4	34	55	10	129
87-P2	130	83	260	55	640	1000	110	2278
84-50B	18	19	38	10	64	26	4	179
84-51B	2	2	9	3	8	9	4	36
84-52B	2	2	10	2	5	10	6	36
84-53B	16	10	49	6	9	10	4	103
84-54B	14	8	41	5	9	10	6	92
84-55B	4	3	10	5	15	17	6	59
84-56B	2	2	9	3	4	10	6	36
84-57B	8	6	34	4	12	17	4	85
84-58B	4	2	8	3	5	10	4	36
84-59B	4	3	11	5	30	37	6	96

TABLE 2. PGE and Au contents of hand samples collected along profile B (see Fig. 6).

Core len.	Os	Ir	Ru	Rh	Pt	Pd	Au	Total
19,5	2	4	5	7	200	240	14	472
19,0	2	4	4	7	120	82	6	225
18,5	2	4	4	7	54	36	4	111
18,0	2	3	5	4	28	38	4	84
17,5	2	4	5	5	33	51	6	106
17,0	2	4	4	9	160	110	22	310
16,5	2	2	3	3	140	780	170	1099
16,0	2	2	5	3	110	250	46	418
15,5	2	4	12	2	16	17	2	55
15,0	6	9	26	3	9	7	2	62
14,5	14	8	28	5	23	28	6	112
14,0	12	16	56	6	7	11	8	116
13,5	24	13	42	5	7	15	6	112
13,0	20	12	45	4	6	13	6	106
12,5	20	15	60	6	8	12	6	127
12,0	22	18	68	5	7	14	6	140
11,5	28	14	53	5	9	12	10	131
11,0	22	10	40	4	5	11	6	98
10,5	16	13	56	5	6	12	6	114
10,0	16	17	76	6	7	15	8	145
9,5	30	19	80	6	15	17	18	185
9,0	30	21	80	7	8	13	8	167
8,5	32	20	84	8	40	23	64	271
8,0	26	14	57	5	10	17	8	136
7,5	8	5	20	3	7	13	6	62
7,0	8	6	24	3	8	16	6	70
6,5	12	7	28	3	9	14	6	79
6,0	16	10	33	3	10	19	6	97
5,5	10	7	23	3	6	13	6	68
5,0	6	5	18	3	8	13	6	59
4,5	6	5	12	5	34	35	8	105
4,0	4	4	12	7	41	52	10	130
3,5	2	2	7	4	29	35	6	85
3,0	2	3	9	3	20	23	8	68
2,5	4	3	13	3	14	21	8	66
2,0	2	2	6	3	9	15	6	42
1,5	2	2	7	3	20	37	6	77
1,0	2	2	7	2	17	31	6	67
0,5	2	2	9	3	24	38	6	83

TABLE 3. PGE and Au contents in drillcore 87A1 across R3, the main chromite horizon and overlying PGE-enriched horizons (see Figs. 7 and 10).

Sample #	Os	Ir	Ru	Rh	Pt	Pd	Au	Total
89lek9a	2	18	20	45	890	2100	250	3325
89lek9c	8	23	63	42	850	1700	110	2796
89lek21a	4	25	75	44	500	1100	160	1908
89lek22	2	20	50	27	440	1100	240	1879
89lek31	20	63	120	42	550	820	62	1677
89lek21b	2	17	41	33	460	910	66	1529
89lek6a	20	13	26	14	200	790	180	1243
89lek18a	2	13	22	15	360	580	84	1076
89lek21c	2	11	29	22	310	530	78	982
89lek2d	4	9	20	4	280	480	140	937
89lek1a	6	12	28	9	2	780	24	860
89lek5a	12	20	39	19	47	370	180	687
89lek27	4	16	26	20	250	280	35	631
89lek21d	2	7	21	15	200	350	28	623
89lek9b	2	4	5	9	140	320	46	526
89lek16	2	8	12	4	110	290	94	520
89lek30	2	10	17	11	140	260	54	494
89lek11a	4	12	16	9	120	180	42	383
89lek28b	2	13	19	10	95	190	50	379
89lek8a	6	9	10	6	110	160	48	348
89lek13a	2	8	8	3	88	160	64	332
89lek26b	6	8	9	5	51	150	82	311
89lek17a	2	10	16	8	83	140	28	287
89lek24b	2	13	30	9	83	120	12	269
89lek29	2	10	14	7	73	130	24	260
89lek4c	2	9	9	4	62	91	70	246
89lek20b	2	9	14	7	63	99	20	213
89lek10a	4	8	6	3	58	68	54	200
89lek7c	8	8	6	4	41	58	64	189
89lek25b	2	6	7	4	54	88	24	185
89lek14a	4	9	7	4	44	71	38	176
89lek3a	2	10	7	6	27	81	4	137
89lek19a	2	7	5	3	38	39	32	125
89lek2a	2	7	5	2	3	54	42	114
89lek23a	2	7	6	3	25	45	14	102
89lek15	2	7	5	2	20	25	34	95
89lek12a	2	6	3	2	19	17	16	65

TABLE 4. PGE and Au contents of sulfide-bearing horizons.

Sample #	Os	Ir	Ru	Rh	Pt	Pd	Au	Total
lek88-1b	360	410	60	210	4600	2700	170	8510
lek87-P1	180	240	370	150	2400	1600	20	4960
lek88-1a	340	220	56	150	1800	1200	44	3810
lek88-1d	240	220	48	160	2100	960	46	3774
lek88-1c	210	210	40	140	1500	690	42	2832
lek88-3a	400	240	84	300	1000	550	28	2602
lek88-3b	270	170	64	210	1100	730	32	2576
lek88-8a	180	76	40	80	740	1400	50	2566
lek88-3c	370	250	96	270	1000	420	30	2436
lek88-3d	80	39	26	39	270	180	18	652
lek88-6a	30	14	16	4	2	4	8	78
lek88-2a	12	7	9	2	16	9	2	56
lek88-5a	4	3	13	2	6	13	2	42
lek88-5b	4	3	13	2	6	5	2	34
lek88-7a	2	2	13	1	7	2	4	31
lek88-5c	4	3	9	2	6	4	2	29

TABLE 5. PGE and Au contents of stratiform chromitites and chromite horizons.

Glossary

Abbreviation	Explanation & Units of Measure
cm	Centimetre - 100 centimetres = 1 metre
g	Gram - 1000 grams = 1 kilogram
g/t	Gram/tonne,1g/t =1ppm
km	Kilometre - 1 kilometre = 1000metres
m	Metre
ma	Million years ago
oz	Troy ounce - 12 troy ounces = 1 Avoirdupois pound (lb), 1oz = 31.103477g
sq.km.or km^2	Square kilometre - an area equal to 1000 metres by 1000 metres
t	Tonne - a metric tonne, 1 tonne = 1000 kilograms
ppm	Parts per million, 1ppm = 1 g/t
ppb	Parts per billion, 1000ppb = 1 ppm
Ag	Silver
Au	Gold
Cu	Copper
Fe	Iron
Ir	Iridium (a platinum group element)
Ni	Nickel
Os	Osmium (a platinum group element)
Pb	Lead
Sn	Tin
W	Tungsten
Zn	Zinc

Technical Name	Explanation of Term
Adit	Horizontal passage from the surface into a mine.
Aeromagnetic survey	An aerial survey made for the purpose of recording magnetic characteristics of rocks.
Allochthonous	A block of rock (any scale) transported to its current position usually by tectonic forces
Alluvial	Deposited by a stream or river. Said of a placer deposit formed by the action of running water.
Alteration	Change in the mineralogical and chemical composition of a rock, generally produced by hydrothermal fluids or by weathering.
Amphibole	A calcium, iron, magnesium silicate mineral usually dark green
Andesite	A dark coloured, fine-grained, usually extrusive rock of intermediate composition. The fine-grained equivalent to gabbro.
Ankerite	An iron, magnesium carbonate mineral
Anomaly	Value higher or lower than the expected norm.
Archaean	Geological era >2400 million years old
Arsenic	A common element associated with gold; elemental analysis used a as pathfinder for gold mineralisation
Auriferous	Gold bearing.
Autochthonous	A block of rock (any scale) that was formed in its current position and was not transported
Basalt/basaltic	A fine-grained dark coloured extrusive volcanic rock with a low silica content.
Base metal	Generally a non-ferrous metal inferior in value to the precious metals; usually and especially copper, lead, zinc and nickel.
Bifurcating	A single structure which splits into two
Biotite	A rock forming mineral of the ring silicate group
Breccia	A course-grained rock consisting of angular broken rock fragments held together by a fine-grained matrix, distinct from conglomerate.
Brownfield	Of exploration; generally an area with previous work undertaken, often close to a mine or deposit

Technical Name	**Explanation of Term**
Calc-alkaline	Calcium-rich feldspar igneous rock
Cambrian (Cambro-)	A geological time period from 435 to 395ma
Carbonaceous	Containing carbon - often of organic origin.
Carboniferous	A geological time period ranging from 345 and 280 million years ago.
Chalcopyrite	A sulphide of copper and iron.
Channel sample	A sample obtained by cutting a rectangular channel across a rock face: more representative than a chip sample or a grab sample.
Chert	A quartz-rich sedimentary rock formed by chemical precipitation
Chlorite (-ic)	Iron rich alteration mineral
Clastic	of sediments derived by erosion of landmasses
Cleavage	A rock fabric of fine fractures imparted during deformation
Colluvial (-ium)	A general term applied to loose and incoherent deposits usually at the foot of a slope.
Complex	A stratigraphic unit that includes a mass of structurally complicated rocks.
Conformable	One package of sediments lying on top of another with no discernible difference in bedding angles
Conglomerate	A sedimentary rock formed by the cementing together of rounded, water-worn pebbles, distinct from breccia.
Craton	A major structural unit of the Earth's crust characterised by a large stable mass of crystalline rock
Detection limits	In laboratory analysis the lowest and highest level at which an element concentration can be accurately measured
Devonian	A geological time period from approximately 410 to 345 million years ago.
Dip	The angle that a stratum or planer feature such as a fault makes with the horizontal, measured perpendicular to the strike and in the vertical plane.
Disseminated	Descriptive of mineral grains which are scattered throughout the host rock.
Dolerite	An igneous iron-rich rock usually found as dykes
Dunite	An igneous ultramafic rock composed 90% of olivine minerals
Dyke	A tabular igneous intrusion which cuts across the bedding or other planer structure in the enclosing rock.
Epithermal	A deposit formed by low temperature hydrothermal fluids at shallow depths in the earth's crust; associated with volcanic rocks
Evaporitic	Relating to minerals form from evaporation of shallow seas and lakes e.g. salt, gypsum
Exposure	A place where rocks can be seen in situ
Facing	Used to describe which way the sedimentary rocks are younging
Fault bounded	A group of rocks that are constrained by geological faults
Feldspar	A common group of aluminium silicate minerals.
Felsic	Igneous rock composed mainly of light coloured minerals like quartz and feldspar (opposite of mafic; synonymous with acid); relatively high in silica and alumina and low in iron and magnesium.
Fissure vein	A cleft or crack in solid rock, commonly filled with mineral matter different from the enclosing walls.
Fluviatile	Of sediments deposited within a river system and its flood plain
Fold belt	A somewhat linear or curvilinear group of rocks, of sub-continental scale, that have suffered a common history of deformation (folding) and other geological events, such as mineralisation.
Formation	A (named) succession of sedimentary beds having some common characteristics.
Gabbro	A mafic intrusive igneous rock.
Galena	Lead sulphur mineral
Garnet	A calcium, iron, magnesium silicate mineral with different extra elements producing different colours
Geochemical sampling	Systematic collection of rock or soil samples in order to study their chemistry.
Geochemical survey	A systematic study of the variation of chemical elements in rocks or soils.
Geochemically anomalous	An area having elevated levels of specified elements in rocks or soils.
Geophysics	Study of the earth by quantitative methods.

Technical Name	**Explanation of Term**
Geoscientific	A term used to describe a range of disciplines related to the study of the earth
Geosynclinal	Relating to a major structural and sedimentalogical unit of the Earth's crust which exhibits substantial deformation
Glacial deposits	Accumulation and deposition of debris associated with glacier movements
Glaciomarine	A sediment derived from glacial deposits formed offshore
Gondwana	A supercontinent that existed in the Mesozoic Era
Graben	A downthrown block between faults
Grade	Average quantity of ore or metal in a specified quantity of rock.
Granite (-ic)	Course-grained felsic igneous rock containing quartz and feldspar.
Granulite	Usually a high grade metamorphic rock with a granular texture
Greenfield	Of exploration; generally were there has been no previous work or only very minor amounts
Greenschist	A moderate to low grade of regional metamorphism, usually involves the formation of green chlorite
Ground EM	An electromagnetic (EM) ground based geophysical method for detecting sulphide mineral accumulations
Ground magnetic survey	Surface geophysical survey investigating variations in the earth's magnetic field intensity.
Group	The formal stratigraphic unit next in rank above Formation. A Group contains two or more associated Formations with significant features in common.
Hydrothermal	Of, or pertaining to, heated waters which transport minerals in solution.
Igneous	Rocks formed from solidification of molten material either at surface (volcanic) or at depth (intrusive).
Induced Polarisation ("IP")	A surface electrical geophysical surveying method.
Inlier	A collection of older rocks (or a region) surrounded by a much younger sequence of rocks
Intermediate	Descriptive of igneous rocks lying midway between acid and basic (or felsic and mafic) in composition
Intrusive	An igneous rock mass emplaced in a largely molten state within surrounding older rock.
Island Arc	A chain of islands formed by volcanic activity related to subduction
Isoclinally	Of a fold whereby the two fold limbs are strongly deformed so as to be parallel
Jurassic	A time period from approximately 205 to 141 million years ago.
Limestones	Calcium carbonate-rich sedimentary rocks
Lithological competency contrast	Packages of rocks that display different physical properties when deformed; usually associated with structurally controlled deposits
Lithology (-ies)	The same as rock type, the description of rocks.
Lode	Aggregate of minerals in a mineral deposit.
Mafic	Igneous rocks with dark colouration due to high magnesium and iron content (opposite of felsic; synonymous with basic.
Magma chambers	Cavernous area formed and filled by molten rock deep within the earth
Magnesite	Magnesium carbonate mineral (listed as MS on the included maps)
Magnetite	An iron oxide mineral that is magnetic
Mesoproterozoic	A geological era form 1000 to 1600ma
Meta-	A prefix indicating that the rock-type has been metamorphosed
Metalliferous	Of or pertaining to metals; metal-rich or metal-bearing.
Mineral occurrence	An existence of a mineral accumulation; can range in size from a small solitary vein to a large mine
Mining lease ("ML")	A tenement on which mining may take place.
Mudstone	A fine grained sedimentary rock in which the proportion of clay and silt are approximately equal.
Neoproterozoic	A geological era from 570 to 1000ma
Obduction	A process that causes large blocks of rocks (many kms) to be scrapped off a subsiding geological plate (from subduction) and welded on to the opposite plate

Technical Name	Explanation of Term
Olivine	A calcium, iron, magnesium silicate
Ophiolites	Iron and magnesium-rich rocks formed on the seafloor and magma chambers, and then caught up in subduction
Ordovician	A geological time period from 500 to 435ma
Orogeny	A major phase of upheaval in the earth's crust
Ounce (oz)	Refers here to a troy ounce which is a unit of measure for precious metals, there are 12 troy ounces to one avoirdupois pound
Outcrop	Rock that comes to surface; can be covered by unconsolidated material and not visible
Palaeo-	A combining form meaning old or ancient.
Palaeoproterozoic	A geological subdivision of the Proterozoic era 1800Ma to 2400Ma
Palaeozoic	A geological era from 570 to 250ma
Palladium	A precious metal usually associated with ultramafic rocks (a platinum group element)
Pelite	A metamorphosed fine grained siltstone or mudstone
Permian	A time period from approximately 280 to 248 million years ago.
Permo-Carboniferous	Strata not differentiated between the Permian and Carboniferous systems, particularly in regions where there is no conspicuous stratigraphic break and fossils are transitional.
Phanerozoic	Part of geological time represented by rocks in which the evidence of life is abundant i.e. from 540Ma to present day
Phyllite	A metamorphosed fine grained siltstone or mudstone usually with a strong cleavage
Placer deposit	River derived sediment rich in economic minerals e.g. gold, diamonds
Platinum	A precious metal usually associated with ultramafic rocks
Platinum Group Elements (PGE)	A group of rare and precious metals; includes platinum, palladium, rhodium, ruthenium, osmium and iridium
Platinum Group Minerals (PGM)	Minerals containing platinum group elements
Pluton	A high level, cylindrical mass of granitic rock which was emplaced at low temperature in a near solid state.
Polymetallic	A number of different metallic species, applied to a vein or other type of deposit.
Porphyry (-itic)	An igneous rock in which large crystals ("phenocrysts") are scattered through a matrix of smaller crystals ("groundmass"); rocks displaying such textures.
Precious metals	Includes gold, silver and the platinum group metals.
Proterozoic	A geological eon from 570 to 2500ma
Province	A geological region with a common theme
Pyrite	Common iron sulphide mineral.
Pyroxene	A calcium, iron, magnesium silicate
Pyroxenite	An igneous ultramafic rock composed mainly of pyroxene minerals
Pyrrhotite	A magnetic iron sulphide mineral
Quartz	A mineral composed of silicon and oxygen.
RC Drilling	Reverse Circulation Drilling - A percussion drilling technique in which the cuttings are recovered up the inside of the drill rods to minimize contamination from the wall of the hole.
Radiometric Data	Data that measures the concentrations of certain different radioactive isotopes found within rocks; usually an aerial survey
Regional metamorphism	Large scale alteration of existing rocks by fluids generated by being buried, heated and deformed
Reserve	The economically mineable part of a resource.
Resource	An estimate of the total amount of a commodity or mineral in a given place, province, country etc.
Rhyolite	An acid igneous extrusive rock
Rifting	Splitting and separation of very large landmasses through geological forces
Rock chip sampling	Obtaining a sample, generally for assay, by breaking chips off a rock face.
Schist	Regionally metamorphosed rock characterised by parallel arrangement of mineral constituents
Sericite	A fine grained form of mica formed by the chemical alteration of other minerals.
Serpentinite	An ultramafic rock that has been wholly altered to serpentine mineral

Technical Name	Explanation of Term
Shaft	A vertical or steeply-inclined excavation used for access to a mine.
Shale	A very fine grained clastic rock
Silicic	Said of a silica rich igneous rock or magma.
Silicified	The introduction of, or replacement by, silica, which may replace existing minerals
Siltstone	Sedimentary rock composed of silt-sized particles.
Silurian (Siluro-)	A geological time period from 570 to 500ma
Sinistral	Used to describe apparent fault movement in this case to the left
Sinter	Silica deposited by hot springs
Skarn	Metamorphosed calcareous sediment into which silica and other elements, often including metals, have been introduced from an adjoining intrusive body.
Soil geochemistry	A systematic sampling and chemical analysis of soils.
Sphalerite	A sulphide mineral of zinc and iron, the main ore mineral of zinc.
Splay	A subsidiary fault that splits off from a main fault
Stratiform	Monominerallic layers usually parallel to bedding and sediment deposition
Stratigraphy (-ic)	The study of stratified rocks and the rock beds relationships
Stratotectonic	A unique combination of stratigraphy and structural history for a particular large section of rock mass
Stream sediment geochemistry	Systematic sampling and chemical analysis of sediments within drainage channels.
Strike	Trend or direction of rock strata in a horizontal plane; to extend in that direction.
Structurally controlled	A general term for geological features formed by faulting and/or deformation
Structure	A general term used to describe a linear feature e.g. a vein, fault, dyke, fissure
Subduction zone	A region where oceanic crust descends into the Earth's mantle.
Suite	A particular arrangement of associated rock types
Sulphide	A mineral compound characterised by the linkage of sulphur with metal.
Swamping'	An image effect on a geophysical map whereby a large and intense magnetic anomaly masks subtle geological detail on the surrounding imaged data
Syncline	A basin shaped fold in the rocks
Syndepositional fault	A fault penetrating deep into the earth that is moving whilst sedimentation is going on; often related to orebody formation
Synvolcanic	Movement of a fault during volcanic activity
Tectonic	General term descriptive of all movement of the Earth's crust caused by directed pressures.
Tectonic suture	A linear feature or zone that marks the welded junction of two geological plates (can be terranes)
Tenement	A land use instrument issued by state governments for regulation of mineral exploration and mining.
Terrane	A term to denote a group of formations with a linked heritage
Tertiary	A geological time period between 65 and 2 million years ago.
Tholeiite	A type of basalt of distinct mineral composition
Thrust stacking	A sequence of shallow dipping faults overlying each other
Triassic	A time period from approximately 251 to 205 million years ago.
Tuff (-aceous)	Volcanic ash strata (derived from weathering of, or containing, tuff strata).
Turbidite	A quartz-mica sediment deposited in a rapid fashion at great distances offshore
Ultramafic	Igneous rocks containing a high proportion of iron and magnesium silicate minerals with no quartz
Unconformable (-y)	Descriptive of rocks on either side of an unconformity.
Unconformity	Lack of parallelism between rock strata in sequential contact, caused by a time break in sedimentation.
Vein	Generally tabular mineral deposit, usually relatively narrow and occurring between well defined walls.
Volcanic hosted massive sulphide	A major accumulation of sulphide minerals, usually pyrite, sphalerite and galena, within and parallel to the stratification of volcanic material
Volcanic(s)	Pertaining to volcanoes, a rock produced by volcanic activity.
Volcaniclastics	A clastic rock containing material derived from volcanic source rocks.
Younging	The direction to which the youngest rocks occur in a sedimentary layered sequence