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*Perth, Brisbane, Vancouver, Johannesburg, London*

13 October 2006

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Vulcan Resources Limited  
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Dear Sirs

### **COMPETENT PERSONS' REPORT ON THE MINERAL ASSETS OF VULCAN RESOURCES LIMITED**

At your request, Snowden Mining Industry Consultants ("Snowden") has prepared a Competent Persons' Report on the mineral assets of Vulcan Resources Limited ("Vulcan") which comprise the Kylylahti Copper Project in Eastern Finland, the Kuhmo Nickel Project in Central Finland, and nickel and vanadium exploration assets. It is our understanding that this report will be included in documentation ("Admission Documents") to support Vulcan's application for admission to the Alternative Investment Market (AIM) of the London Stock Exchange. The purpose of the Admission Document is to offer for subscription Vulcan shares in order to raise capital to fund development of the Kylylahti Project and Vulcan's other Finnish assets.

The objective of this report is to present for the Kylylahti Project a geological description, an outline of previous exploration work, a review of the resource estimates, mining and metallurgical studies, verification of the reasonableness of the technical assumptions supporting operating and capital cost forecasts, and an opinion on the potential of the projects. Vulcan's mineral resources at Kuhmo and exploration projects are also described.

Snowden has based its assessment of Vulcan's mineral assets and operations upon a site visit to Finland in August 2006, discussions with key company personnel and a library of technical information compiled by Vulcan, including previous company reports.

Consents have been sought from Vulcan and its consultants to include technical information and opinions expressed by them. None of the other entities referred to in this report have consented to their inclusion in the Admission Documents and have only been referred to in the context of reporting material fact.

Snowden has based its findings upon information known to us as at 26<sup>th</sup> September 2006 and has satisfied itself that all material information in the possession of Vulcan has been fully disclosed to Snowden. A draft version of this report was provided to the directors of Vulcan for comment in respect of omission and factual accuracy. Vulcan has agreed to indemnify Snowden from any liability arising from its reliance upon inaccurate or incomplete information provided.

Snowden has prepared this report on the understanding that all Vulcan's granted tenements are currently in good standing and that there is no cause to doubt the eventual granting of any tenement applications. Snowden has not attempted to establish the legal status of the tenements within each project area with respect to potential environmental and access restrictions. Snowden also has not independently verified ownership and the current standing of Vulcan's agreements and is not qualified to make legal representations in this regard. Rather we have relied upon information provided by Vulcan. It is our understanding that the current ownership status and standing of the tenements has been reviewed as part of legal due diligence conducted in connection with the issue.

From Snowden's assessment of Vulcan's project areas, it is our opinion that the projects are of merit, are worthy of further exploration and that the exploration programmes proposed over the respective projects have been carefully conceived and costed.

This report has been prepared by Mr Ian Glacken (Group General Manager Resources), Mr Peter Myers (Divisional Manager - Mining), Mr Narayan Krishnan (Associate Metallurgical Consultant), Mr Jeames McKibben (Senior Consultant Geologist) and Mr Jonathan Bell (Consultant Geologist) and was reviewed by Dr Philip Snowden (Executive Consultant) of Snowden's Perth and Brisbane offices in accordance with the Australasian Code for the Technical Assessment and Valuation of Mineral and Petroleum Assets and Securities for Independent Experts Reports ("the VALMIN Code") and the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves ("the JORC Code").

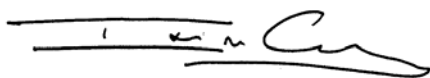
Snowden is an independent firm providing specialist mining industry consultancy services in the fields of geology, exploration, resource estimation, mining engineering, geotechnical engineering, risk assessment, mining information technology and corporate services. The company, with its principal office at 87 Colin Street, West Perth, WA, also operates from offices in Brisbane, Johannesburg, Vancouver and London and has prepared Competent Persons' Reports and valuations on a variety of mineral commodities in many countries.

Neither Snowden nor those involved in the preparation of this report have any material interest in Vulcan or in the mineral properties considered in this report. Snowden is remunerated for this report by way of a professional fee determined according to a standard schedule of rates which is not contingent on the outcome of this report.

Pursuant to Rule 23 of Annex 1 of the AIM PD, Snowden has given its consent to the inclusion of this report in the Admission Documents, and to the inclusion of statements made by Snowden and the reference of its name in other sections of the Admissions Documents in the form and context in which the report and the statements appear.

Snowden confirms that it has taken all reasonable care to ensure that all information contained within the Competent Persons' Report is, to the best of its knowledge, in accordance with the facts and contains no omissions likely to affect its import.

Yours faithfully



**Mr I M Glacken** *MSc, FAusIMM(CP), CEng*  
Group General Manager Resources



**Dr P A Snowden** *PhD, FAusIMM(CP)*  
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## 1.0 SUMMARY

### 1.1 OVERVIEW

#### Purpose

Snowden Mining Industry Consultants (Snowden) has prepared a Competent Persons' Report on the mineral assets of Vulcan Resources Limited (Vulcan) in Finland for inclusion in the Admission Documents to accompany Vulcan's application for admission to the Alternative Investment Market (AIM) of the London Stock Exchange and associated capital raising.

The report presents the view of a group of independent experts on the geology, data quality, mineral resources, mine plan, infrastructure, processing options, environment and permitting of the Kylylahti copper project, and on the geology, mineral resources and exploration potential of Vulcan's nickel, vanadium and platinum group element (PGE) prospects. The Kylylahti project and the vanadium and PGE prospects are 100% owned by Kylylahti Copper Oy, a 100% owned Finnish subsidiary of Vulcan. The nickel prospects are 100% owned by Kuhmo Nickel Plc, which is a joint venture between Kuhmo Metals Oy, a 100% owned Finnish subsidiary of Vulcan (95%) and Polar Mining Oy, a subsidiary of Dragon Mining NL (5%).

#### Responsibility

Mr I M Glacken is the principal author of the Competent Persons' Report and carried out a site visit to Vulcan's Finnish assets in August 2006. Mr P E Myers reviewed the mine planning, scheduling, capital and operating cost aspects of the Kylylahti project. Mr N Krishnan reviewed the processing aspects of the Kylylahti project. Mr J A J McKibben and Mr J A Bell reviewed Vulcan's nickel, vanadium and PGE assets. The report was reviewed by Dr P A Snowden. In preparing this report Snowden has relied on information provided both by Vulcan, its consultants, a number of reports by previous owners of the assets described herein and by various academic and Finnish Governmental institutions.

#### Vulcan's assets

Vulcan's principal asset is the Kylylahti copper-cobalt-nickel-zinc-gold project, located in central eastern Finland some 380 km northeast of the capital Helsinki (Figure 1.1). Vulcan defined a Mineral Resource estimate in September 2006 which has been reported according to the JORC Code (2004). This resource estimate is reproduced in Table 1.1 and has been verified by Snowden.

**Figure 1.1 Location of Vulcan projects in Finland**



<b>Resource Classification</b>	<b>Tonnes (Mt)</b>	<b>Cu (%)</b>	<b>Co (%)</b>	<b>Ni (%)</b>	<b>Zn (%)</b>	<b>Au (g/t)</b>
Indicated	6.6	1.1	0.2	0.2	0.4	0.7
Inferred	0.4	1.2	0.2	0.3	0.5	0.7
<b>Total</b>	<b>7.0</b>	<b>1.1</b>	<b>0.2</b>	<b>0.2</b>	<b>0.4</b>	<b>0.7</b>

Vulcan acquired the Kylylahti project in December 2004 and is currently carrying out a definitive feasibility study which it hopes to complete in 2007. Subject to the awarding of permits to operate, Vulcan plans to commence construction of a concentrator onsite in the third quarter of 2007 and to commence production in the last quarter of 2008. The Kylylahti processing plant will produce two concentrates, a copper-gold concentrate which will be railed to the west coast of Finland and thence sold directly to a smelter in northern Europe, and a bulk sulphide cobalt-nickel-zinc concentrate. Vulcan currently plans to truck and rail this concentrate 100 km to a third party roasting facility and acid plant, where it will be roasted to remove sulphur. The calcine produced by roasting will be subject to atmospheric acid leach in a facility to be built by Vulcan, yielding a number of products including cobalt and nickel hydroxides. Vulcan has signed a letter of intent with the owner of the roasting facility and is negotiating with a number of potential customers for off take of these products.

Vulcan's nickel projects are situated in the Kuhmo-Suomussalmi greenstone belt of northeastern Finland. This belt of rocks has close geological similarities to the nickel-rich Wiluna-Leinster greenstone belt in Western Australia, and many of Vulcan's prospects are geological analogues of significant Australian nickel mines. Mineral resources have been defined at three of these prospects; Vaara, a high-tonnage, high-tenor, low-grade deposit hosted in serpentinite, Hietaharju, a low-tonnage, high-grade, low-tenor deposit hosted in talc-carbonate ultramafics, and Peura-aho, a low-tonnage, high-grade, low-tenor, folded deposit hosted in komatiites and felsics. These resources have been reported according to the JORC Code (2004) and are presented in Table 1.2, reported above a nickel equivalent (see Section 5.2.5) cut-off of 0.3%.

<b>Vaara</b>						
<b>Resource Classification</b>	<b>Tonnes (Mt)</b>	<b>Ni (%)</b>	<b>Cu (%)</b>	<b>Co (%)</b>	<b>Pt (g/t)</b>	<b>Pd (g/t)</b>
Indicated	2.4	0.37	0.03	0.01		
Inferred	3.7	0.33	0.02	0.01		
<b>Total</b>	<b>6.1</b>	<b>0.35</b>	<b>0.03</b>	<b>0.01</b>	<b>0.25</b>	<b>0.25</b>
<b>Peura-aho</b>						
<b>Category</b>	<b>Tonnes (Mt)</b>	<b>Ni %</b>	<b>Cu %</b>	<b>Co %</b>	<b>Pt (g/t)</b>	<b>Pd (g/t)</b>
Indicated	0.4	0.50	0.21	0.03		
Inferred	0.2	0.53	0.26	0.03		
<b>Total</b>	<b>0.6</b>	<b>0.51</b>	<b>0.22</b>	<b>0.03</b>	<b>0.18</b>	<b>0.4</b>
<b>Hietaharju</b>						
<b>Category</b>	<b>Tonnes (Mt)</b>	<b>Ni %</b>	<b>Cu %</b>	<b>Co %</b>	<b>Pt (g/t)</b>	<b>Pd (g/t)</b>
Indicated	0.4	0.64	0.36	0.04		
Inferred	0.6	0.45	0.22	0.03		
<b>Total</b>	<b>1.0</b>	<b>0.53</b>	<b>0.28</b>	<b>0.03</b>	<b>0.19</b>	<b>0.26</b>

In addition to the nickel projects in the Kuhmo-Suomassalmi area Vulcan owns the Haukiaho nickel-copper- PGE prospect in central northern Finland.

Vulcan has a number of vanadium assets whose location is depicted in Figure 1.1 and has identified five separate projects spread over a wide geographic area. Some of the projects, such as the Syöte and Portivaara projects, are in close spatial and geological association to some of Finland's former vanadium operations such as the Mustavaara mine. The Otanmäki project encompasses the former mine of the same name, which was Finland's largest iron ore mine, also producing significant quantities of vanadium. All of the vanadium prospects are associated with large layered mafic intrusions which are known to host vanadiferous magnetite in certain horizons.

Vulcan has a PGE prospect centred on the Tornio layered intrusion near the border with Sweden (Figure 1.1). This is hosted in a similar geologic environment to the Arctic Platinum Project, owned by Gold Fields and North American Palladium, which contains a Mineral Resource of several million ounces of platinum, palladium and gold. Vulcan has yet to test the prospective horizons at Tornio with drilling.

## 1.2 RISK ASSESSMENT

Table 1.3 summarises Snowden's rating of the relative risk of various technical issues associated with Vulcan's Kylylahti and Kuhmo projects.

<b>Table 1.3 Vulcan Resources summary risk tabulation</b>		
<b>Item</b>	<b>Rating</b>	<b>Comments</b>
<b>Kylylahti project</b>		
Resources	Low risk	The orebodies at Kylylahti are based upon a well-known mineralogical and geological association (the Outokumpu Association). Mineralisation boundaries are visual. The estimate has been made according to best industry practice and has been validated by Snowden. The system is open down dip and up-dip potential for the lower lens exists.
Mine plan and schedule	Low risk	No reserve has been defined for Kylylahti but the mining method, involving sequenced longhole stopes and paste fill, is both technically feasible and provides a high level of recovery. The development design is achievable and the schedule appropriate for the size and orientation of the orebody.
Processing – copper-gold concentrate	Low risk	The generation of a copper-gold concentrate is low risk, entailing proven technology.
Processing – cobalt – nickel – zinc concentrate	Low/medium risk	Recent testwork reveals that a sulphating roast is possible, resulting in a product which needs to be subject to low pressure (atmospheric leach) only. Vulcan will construct a roaster and a leach plant.
Capital and operating cost estimates	Low/medium risk	Mining costs have been estimated to a degree of accuracy commensurate with the current stage of the project and have a low risk. Onsite concentrator capital and operating costs are conservative and have some potential to be reduced. Pre feasibility level roast/leach capital and operating costs reflect the current uncertainty associated with the final flowsheet and will be updated in the Definitive Feasibility Study.
Marketing and off take	Low risk	The copper-gold concentrate is clean and readily saleable. Vulcan has received a number of expressions of interest in the cobalt, nickel and zinc products.
Water and tailings management	Low risk	Vulcan plans to place tailings underground via paste fill, thus avoiding any acid drainage issues. Process water will come from old open pit mines and will form a 'closed circuit' with storage and tailings water.
Permitting	Low/medium risk	Vulcan has fulfilled all of the requirements of the permitting and environmental approval process to date and no impediments have arisen. However, achievement of permitting by mid-2007 may be slightly optimistic.
<b>Kuhmo project</b>		
Resources	Low risk	Vulcan has defined mineral resources at three of the Kuhmo prospects. There is a strong likelihood that this resource inventory will grow as other prospects are subject to detailed exploration and drilling.

## 2.0 INTRODUCTION

### 2.1 TERMS OF REFERENCE

At the request of Vulcan Resources Limited (Vulcan), Snowden Mining Industry Consultants Pty Ltd (Snowden) has prepared a Competent Persons' Report on the Finnish mineral assets of Vulcan. These comprise a copper-cobalt project (Kylylahti) for which Vulcan is currently undertaking a Definitive Feasibility Study, three nickel sulphide projects for which Mineral Resources have been estimated, a number of nickel sulphide exploration projects, a nickel-copper-PGE exploration project, a number of vanadium exploration projects and a PGE exploration prospect. The locations of the principal projects are shown in Figure 1.1.

This Competent Persons' Report is intended to properly inform readers of Vulcan's Admission Documents of the status of work on and potential of Vulcan's Kylylahti copper project and of Vulcan's other Finnish assets. It should be noted that Vulcan is in the midst of the Definitive Feasibility Study on the Kylylahti asset and thus some of the information presented in this report will be subject to change.

### 2.2 PURPOSE FOR WHICH THE REPORT WAS PREPARED

Snowden understands that this report will be included in Vulcan's Admission Documents for the Alternative Investment Market (AIM) of the London Stock Exchange.

The objectives of this report are to:

- provide a brief overview of the geology, copper and nickel mineral deposits and mining history of Finland
- describe the current status of the Kylylahti copper project, Vulcan's proposed timetable for establishing a mining operation, and provide Snowden's opinion on the technical viability of Vulcan's plans and assumptions

- describe Vulcan's nickel sulphide exploration prospects in the Kuhmo JV and convey the potential for significant nickel sulphide discoveries through exploration
- briefly describe Vulcan's vanadium and PGE exploration properties and strategy.

### **2.3 RESPONSIBILITY FOR THE COMPETENT PERSON'S REPORT**

Mr I M Glacken of Snowden is the principal author of this Competent Persons' Report, and undertook a site visit to Vulcan's main exploration and development properties in Finland during August 2006. Mr P E Myers of Snowden reviewed and commented on mining, scheduling and cost estimation aspects of Vulcan's Kylylahti project. Mr N Krishnan of OM Metals Trust reviewed and commented on processing aspects of the Kylylahti project, including details of the concentrates produced, roasting and oxidation options smelting and refining and the status of marketing and off take agreements. Mr J A J McKibben of Snowden, assisted by Mr J A Bell of Snowden, compiled information on Vulcan's nickel and vanadium assets. Dr P A Snowden of Snowden reviewed the report.

In preparing the report Snowden has relied upon information provided by Vulcan, its advisers and consultants, and previous holders of the mineral properties described below. Snowden staff have had detailed discussions with Dr Alistair Cowden (Managing Director), Mr Campbell Baird (General Manager – Operations), Mr Jarmo Vesanto (Manager – Finland) and Mr Nicholas Walker (Chief Geologist) of Vulcan.

### **2.4 OVERVIEW OF VULCAN PROJECTS**

Vulcan's principal asset is the advanced Kylylahti copper-cobalt-zinc-nickel-gold project in central eastern Finland; the company is currently working towards the completion of a Definitive Feasibility Study in the second quarter of 2007 and plans to commence construction activities on site before the end of the year, with production commencing from an underground mine in the second half of 2008.

Vulcan's nickel assets include a large landholding in the Kuhmo-Suomussalmi greenstone belt in northeastern Finland. These projects are held as part of the Kuhmo joint venture (Vulcan 95%) with Dragon Mining subsidiary Polar Mining Oy. The Kuhmo Project includes defined mineral resources at Vaara, Peura-aho and Hietaharju, and prospects at Sika-aho, Arola, Riihilampi, and Piiraisen Malmi, all of which contain drilled nickel sulphide occurrences. Outside of the Kuhmo-Suomussalmi greenstone belt Vulcan owns the Haukiaho nickel-copper-PGE prospect which features promising drilled intersections in a differentiated layered intrusive.

In addition to the copper and nickel assets Vulcan has a number of vanadium projects in northeastern and northern Finland. Vulcan has identified a number of prospects which are either adjacent to former magnetite-vanadium mines or which are associated with favourable horizons in large layered intrusions containing vanadiferous magnetite.

Vulcan's only other significant exploration asset is the Tornio platinum group elements (PGE) project, located adjacent to the border with Sweden in northwestern Finland. This is geologically similar to the nearby Arctic Platinum Project, which has a reported resource of over 12 million ounces of palladium, platinum, and gold.

## **3.0 GEOLOGY AND MINERAL RESOURCES OF FINLAND**

### **3.1 INTRODUCTION TO FINLAND**

Finland is one of the northernmost countries in the world. With a total land area of 338,145 km<sup>2</sup>, it is Europe's seventh largest and the European Union's fifth largest country. As much as 74% of the land area is classified as forest land and lakes, and only nine per cent is cropland. Lakes and various varieties of peatland are characteristic features of the Finnish landscape.

The climate of Finland is cold, although, on the average, several degrees warmer than in most other European areas at the same latitudes. The growing season is short, limiting both agricultural production and forest growth.

The population of Finland is around 5.2 million, making Finland the third most sparsely populated country in Europe. The population increase is very slow, and the population is rapidly aging. About one million people live in the Helsinki metropolitan area. There is a strong internal migration from small municipalities to urban areas.

Finland has a highly industrialised economy, which is rapidly integrating with Europe and the world. The key economic sector is manufacturing – principally the wood, metals, engineering, telecommunications and electronics industries.

Trade is important, with exports equalling two-fifths of gross domestic product (GDP). Almost 90% of the paper and board production is exported, and in the base and ferrous metals industry the share of export products is also high. The majority of Finland's exports go to the European Union, with other important trading partners being Russia, the United States and emerging market economies such as China.

For a number of decades the Finnish economy was characterised by fast growth combined with sensitivity to international cyclical fluctuations. In the early 1990s, Finland fell into a deep recession; the rate of unemployment increased to 17% and

the GDP plummeted by about ten per cent between 1991 and 1993. Private consumption levels regained their pre-recession levels by 1997, and Finnish companies were also successful in bolstering their financial structures.

Successive Finnish governments have targeted growing the economy as a top priority, trying to reduce unemployment and the indebtedness of state finances. In recent years, the Finnish economy has been growing fast – between 1997 and 2003 GDP grew by an annual average of 3.6 per cent. In 2003, Finland's gross national product (GNP) per capita was around €27,500, in comparison to a GNP of €17,700 in 1990.

Finland's economy is largely dependent on its information and communications technology (ICT) sector, which is dominated by Nokia, the world's leading mobile telephone handset producer, and related companies. The rapid expansion of the Finnish electrical and electronics goods industry in the 1990s significantly boosted industrial output. Production of radio, television and communications equipment rose at an annual average rate of 36.3% between 1995 and 2000, largely reflecting the expansion of the mobile phone and related equipment sectors. The growth in Finnish industry, from 25.8% of GDP in 1990 to 28.4% by 2000, is atypical for developed countries, where the services sector has tended to increase more than industry. Even in 2001 (following the onset of a global downturn in the ICT sector) industry still accounted for 27.7% of GDP. As in other developed countries, the primary sector (agriculture, fishing and mining) has declined in Finland.

Recent economic developments have propelled Finland to the top ranks of global comparison studies. For example, Finland was number one in the World Economic Forum's competitiveness ranking in 2001 and 2003, and number two in 2002. Since 2000, and most recently in 2005, Finland has also been the leading country in the World Economic Forum's Environmental Sustainability Index (ESI), benchmarking countries on the basis of their national environmental stewardship.

## **3.2 GEOLOGY AND MINERAL RESOURCES**

### **3.2.1 Introduction**

Finland has an unusually diverse suite of mineral resources hosting significant deposits of copper, nickel, zinc, cobalt, gold, chromium, iron and vanadium. Mining has in the past provided the raw material base for Finland's metal industry, with significant processing and refining of copper and nickel concentrates at Pori and Harjavalta, zinc and cobalt at Kokkola, stainless steel at Tornio and iron at Raahe. The major industrial minerals mined in Finland are carbonates, apatite and talc. Significant processing facilities for phosphorous fertilisers, titanium pigments, coating carbonates and talc also exist. Finnish metallurgical technology and manufacturers of mining equipment are well known and are renowned throughout the international mining community.

### **3.2.2 Mining's contribution to the Finland economy**

Finland has an advanced industrial economy based on exports, with the metals, engineering and electronics industries accounting for 50% of export revenues and the forest products industry for another 30%. Mineral production accounted for about 1% of Finnish GDP in 2004, with the industry remaining a significant source of income and employment. In 2004, the mining industry comprised about 40 firms employing about 1,165 persons, principally in quarrying operations.

### **3.2.3 History of mining**

The history of mining in Finland dates back to 1540 when quarrying of iron ore commenced in the southern part of the country. Since then some 260 metal mines have been exploited, with the total amount of ore extracted being around 250 Mt.

The discovery of the historically important Orijärvi copper-zinc deposit in 1757 marked the beginning of extensive mining in the south, with the last mine in the area having closed in 1974. Other mines in this district include Malmberg (iron) from 1670 - 1866, Aijala (copper-zinc) from 1948 - 1961 and Metsämonttu (copper-zinc-lead) from 1951 - 1974. Alluvial and placer gold deposits were first discovered in 1868 in northern Lapland and have been mined consistently on a small scale basis since that time.

The famous Outokumpu copper deposit was discovered in 1910 and ore production from the region continued until 1989. The first modern nickel production began at Makola in 1941, and since then nine nickel deposits have been exploited for a total production of more than 41 Mt at an average grade of 0.67% nickel and 0.28% copper.

Notwithstanding the lessening of copper and nickel mining in recent times, the total volume of mining in Finland has been increasing continuously since 1995. The main reason for this is the steady growth of mining of industrial minerals. Furthermore, dimension stone, not covered by the Mining Act, was mined from about 60 quarries. Four metal mines were in production in 2003, processing a total of 3.64 Mt of ore. In 2003, the Orivesi gold mine in southern Finland was placed on care and maintenance after operating for 9 years and producing an estimated 385,000 ounces of gold. In 2003, the Pahtavaara gold mine in Lapland produced 34,000 ounces of gold from 418,300 t of ore.

In total, 39 mines and quarries covered by the Finnish Mining Act were in production in 2004 (40 in 2003), and the mines produced a total of 19.4 Mt of ore. Ore production at the Pyhasalmi copper-zinc-pyrite mine reached a record 1.34 Mt averaging 1.21% Cu, 2.96% Zn and 40.7% S. At the end of 2004, the ore reserves were estimated at 16 Mt at 1.2% Cu, 2.4% Zn and 41% S.

### 3.2.4 Exploration and mining tenure in Finland

Finland has a well developed mining act and the government is generally pro mining. Under Finnish mining law, only Finnish citizens or companies with offices registered in any European Union member state can own title to mineral rights in Finland. Notwithstanding this the Ministry of Trade and Industry, at its discretion, can confer these rights to individuals or corporations from outside the European Union. Vulcan holds its rights to the Kylylahti project and its vanadium, PGE, and nickel-copper-PGE projects through its wholly owned Finnish incorporated subsidiary, Kylylahti Copper Oy, whereas the Kuhmo nickel prospects are held by another Finnish subsidiary Polar Mining Oy. The three main types of tenure are reservations, claims, and concessions. Reservations grant to the owner the exclusive right to stake a claim to mineral deposits located in the reservation area for a 12 month period. Drilling or sampling within a reservation requires the owner's permission. Claims or exploration licences allow the holder to carry out exploration activities without the consent of the landowner. There are no annual expenditure commitments, but claims have a limited tenure and must be converted to mining concessions for the holder to proceed with development activities. Mining concessions will only be granted where a resource which is deemed to be technically and economically exploitable has been defined. Vulcan has reservations, claims, and mining concessions at the Kylylahti project.

### 3.2.5 Geology of Finland

The geology of Finland is the result of a complex sequence of geological events characterised by the evolution of the Fennoscandian Shield during late Archean to early Proterozoic times. The Fennoscandian Shield is the largest exposed area of Precambrian rocks in Europe and is known to cover large parts of Finland, northwest Russia, Norway and Sweden. The Fennoscandian Shield may be broadly divided into Archean rocks in the east (Russia and Finland), Palaeo-proterozoic rocks in the central parts (southern Finland and Russia) and younger Meso- to Neo-proterozoic crust in the southwestern part of the Shield.

The Fennoscandian Shield can be subdivided into three broad domains that have shared a common history since about 1.8 Ga, the Svecofennian, Karelian and Kola-Lapland domains. These crustal units essentially comprise a Late Archean cratonic nucleus, (the Karelian Craton) flanked to the northeast and southwest by two early Proterozoic mobile belts (the Kola-Lapland and Svecofennian domains respectively). Locally the Karelian craton underwent numerous rifting events which led to widespread ultramafic to mafic volcanic and subsequent felsic plutonic activity, deformation and metamorphism.

The Kola-Lapland domain represents a complex tectonic collage of Archean and Palaeo-proterozoic terranes, and is more characteristic of collisional tectonic processes. In contrast, the Svecofennian domain is entirely early Proterozoic in age, and indicates relatively rapid formation and accretion of new crust between about 1.97–1.86 Ga.

The Karelian Craton is characterised by a series of narrow northerly trending greenstone belts surrounded by extensive granitoids and granite-gneiss terranes. The Kuhmo and Suomussalmi greenstone belts are the most extensive and well preserved supracrustal units in the Archean of Finland and outcrop over a strike length of nearly 200 km and a up to a maximum width of 10 km. These greenstone belts both contain abundant ultramafic to mafic volcanic units, together with related intrusive and subvolcanic cumulates and lesser felsic volcanic and volcanoclastic units.

Limited cover sediments of Palaeozoic age are preserved within western Finland. Basement rocks are extensively obscured by Recent glacial deposits and by lakes that developed as a consequence of the last phase of glaciation, which ended approximately 9,000 years ago. The direction of glacial movement was broadly from the northwest to the southeast. Erosion of the bedrock by scouring at the base of the glaciers produced long linear depressions that host many of Finland's current lakes, whilst deposition of the transported material has resulted in a layer of boulders and sand, dominantly seen as glacial till, over most of the country.

With a geological history related to the development of two major mobile belts and covering a time span from the Late Archean Palaeozoic to the Cenozoic, Finland's mineral endowment encompasses a wide variety of mineralisation styles. These include volcanic hosted massive sulphide (VHMS) base metal, komatiitic nickel-copper, ultramafic-mafic chromite, platinum group metals (PGM), Kiruna-type iron oxide copper-gold, orogenic gold, epithermal gold, alluvial gold and carbonatite-hosted apatite deposits.

## 3.3 COPPER DEPOSITS OF FINLAND

Finland has a long established copper industry, with both the primary extraction of copper bearing ore and the downstream processing of this ore, dating back to 1910. For much of the twentieth century the copper industry in Finland has been dominated by primary or co-production of copper from the polymetallic Outokumpu type copper-cobalt-nickel-gold-zinc deposits in eastern Finland. The mining of the Outokumpu style deposits commenced in 1910 although early operations were small and marginal. In 1924, the Outokumpu operations were re-opened under a state owned entity and were re-configured for economies of scale, significantly improving profitability. Since this time mining in Finland has been dominated by large Nordic companies and para-state organisations, both of whom were driven largely by the need to support the existing mining and metal extraction infrastructure. It was not until the mid 1990s, as a result of Finland's incorporation into the European Union, that foreign-owned companies were allowed to participate in the domestic mining industry, and the full mineral potential of the Fennoscandian Shield began to be recognised. Since the deregulation and removal of trade barriers Finland has shown itself to be proactive in revitalising the primary mineral industry by maintaining a well defined, workable and attractive mining legislation to support the excellent regional infrastructure base in Finland.

The original Outokumpu mines dominated much of the base metal production in Finland, although by 1989 these mines had largely been exhausted. When the Outokumpu operations ceased production, they were credited with having produced some 1Mt copper metal and 20 t gold from some 28.5 Mt of ore at a grade of 3.8% copper, 0.24% cobalt, 0.12% nickel, 1.1% zinc and 0.8 g/t gold. Copper production continued in Finland as by- and co-products from other (mainly nickel) deposits, although much of the smelter feed was sourced from overseas.

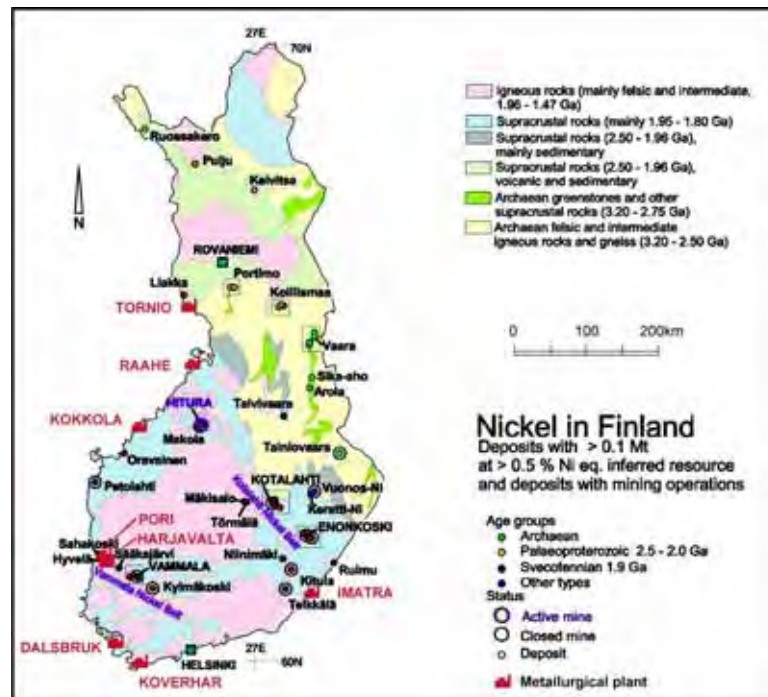
The treatment of copper bearing ores commenced in 1913 adjacent to the original Outokumpu polymetallic deposits. The main copper plant was later moved to Imatra to benefit from a new hydro-electricity source, but in 1944 was subsequently moved to Harjavalta in southwest Finland, where downstream processing has remained to date. A postwar energy price spike resulted in the innovation of a new flash smelting technology. This redefined the copper industry cost curves and confirmed Finland's reputation as an innovative and significant leader in downstream ore processing, a reputation which it has maintained to date.

Current domestic copper concentrate is sourced from the Pyhasalmi (copper, zinc, sulphur, silver and gold) and Hitura (nickel and copper) mines, with the concentrates being treated at the Harjavalta smelter and Pori refinery. Between 2003 and 2005 domestic copper concentrate production remained steady at around 51,000 t and copper cathode production, which includes imported feed concentrate, averaged over 132,000 t. The downstream processing of minerals remains a cornerstone of the Finnish economy and in conjunction with the favourable geology represents a significant opportunity for the Finnish extractive industry to be revitalised as part of a major global metallogenic province.

### 3.4 THE FINNISH NICKEL INDUSTRY

Nickel was first discovered in Finland in 1921, with the first large scale commercial extraction of nickel commencing in 1941 at the Makola nickel mine in central Finland (Figure 3.1). A total of 13 nickel mines have been exploited to date within Finland, of which only one mine remains in operation (Hitura) in central Finland. Approximately 50 Mt of ore for 0.3 Mt of nickel metal is estimated to have been produced to date, with 0.02Mt of nickel metal having been produced as a by-product of talc mining operations in eastern Finland.

Figure 3.1 The geology of Finland with nickel mineralisation highlighted (reproduced from the Geological Survey of Finland)



Downstream processing facilities have been established in western and southern Finland in order to support the nickel mining sector, with the nickel smelter and refinery located at Harjavalta, and nickel and cobalt hydrometallurgical facility at Kokkola remaining in production to date.

## **4.0 KYLYLAHTI COPPER PROJECT**

### **4.1 OVERVIEW**

Vulcan's principal asset is the Kylylahti Copper Project, located in central eastern Finland (Figure 1.1). The project is 380 km northeast of Helsinki, and is accessible by a sealed road and by air via Joensuu, 40 Km to the southeast. The Kylylahti deposit was discovered by Outokumpu Oy in 1984 and sits within the historic Outokumpu mining district centred on the North Karelia Schist Belt.

The project was purchased by Vulcan's subsidiary company, Kylylahti Copper Oy, in December 2004. 90 holes were drilled into the deposit by Outokumpu and Vulcan has drilled 16 holes up until the cut-off date for estimation of the latest resource estimate. This was completed in August 2006 by Vulcan and its consultant Quantitative Geoscience Pty Ltd. The estimate was reported according to the JORC Code (JORC, 2004) and has a total Indicated plus Inferred Mineral Resource of 7.05 Mt at a grade of 1.1% copper, 0.2% cobalt, 0.2% nickel, 0.2% zinc, and 0.7 g/t gold within geologically defined domains.

Vulcan is in the process of generating a Definitive Feasibility Study (the DFS) for the mining, processing, and sale of products from the Kylylahti deposit. Vulcan's current timetable (Vulcan, 2006a) sees completion of the DFS at the end of the first quarter of 2007, with the commencement of construction activities at the project site at the start of the third quarter of 2007 and the first ore production predicted for the start of the fourth quarter of 2008. Vulcan proposes an underground mining operation accessed by a decline which will see ore generated from conventional longhole open stopes with filling of underground voids with paste fill injected from surface. Ore production will commence at a rate of 260 ktpa, rising to a peak production rate of approximately 550 ktpa in the third year of production. Geotechnical studies have confirmed that stope spans are limited only by orebody dimensions.

Vulcan's current processing plan is to crush and concentrate the ore by flotation on site to yield two products – a copper-gold concentrate and a polymetallic bulk sulphide concentrate. The copper-gold concentrate will be trucked to a railhead at Vuonos, some 15 km to the southwest of the minesite, and then railed to the Finnish port of Harjavalta, some 400 km to the west of Kylylahti. Letters of intent to purchase the copper-gold concentrate have been obtained from New Boliden, which owns a smelter at Harjavalta and a refinery at Pori (27 km to the northwest), and from Norddeutsche Affinerie AG, which owns a smelter and refinery in Hamburg, Germany (accessible by sea from Harjavalta). The bulk sulphide concentrate is planned to be trucked to the railhead and then railed to Siilinjarvi, some 100 km to the northwest of Kylylahti. Vulcan then plans to utilise a roaster owned by Kemira GrowHow at Siilinjarvi to produce a calcine product which will be treated in a moderate temperature (220 °C), moderate pressure (30 bar) acid leach plant to be built by Vulcan adjacent to the Siilinjarvi roaster. The products from the leach plant will be cobalt and nickel hydroxide and probably zinc sulphide and copper sulphate, which are all high value, low volume products for which Vulcan is currently negotiating off take agreements with a number of interested parties.

The Kylylahti project and proposed plant site are located on three granted mining leases. The proposed tailings storage facility requires a lease extension which is expected to be granted on or around the second quarter of 2007. Vulcan commenced environmental permitting in 2005 with baseline studies which have to date indicated no significant environmental issues. Vulcan has engaged in formal community consultation with the residents of Polvijarvi, located two kilometres from the proposed minesite. This has resulted in the commissioning of a Social Impact Study which has in turn resulted in positive comments from both the local community and local government. Vulcan plans to apply for a permit to operate in November 2006 with the expectation that this will be granted in the second quarter of 2007.

Vulcan has appointed SNC-Lavalin Australia as Study Engineer and has engaged Outokumpu Technologies to advise on roasting options. Ammttec in Perth is carrying out roasting and leaching testwork.

### **4.2 LOCATION, HISTORY, AND REGIONAL GEOLOGY**

The Kylylahti project is located approximately 22 km northeast of the historic mining town of Outokumpu in the Karelia district of Finland. The Keretti copper-cobalt-zinc-gold deposit, which underlies the modern town of Outokumpu, was discovered in 1910 following the location of the source of a massive sulphide glacial boulder found some 50 km to the southeast. The mine operated continuously between 1914 and 1989, producing some 28 million tonnes of ore with a grade of 3.8% copper, 0.24% cobalt, 1% zinc and 0.8 g/t gold. In 1965 the Vuonos deposit was discovered about 10 km to the northeast of the Keretti mine, and produced 5.5 million tonnes of copper-cobalt-zinc-nickel-gold ore until closure in 1985. In all, and excluding Kylylahti, approximately 48 Mt of copper-cobalt-zinc-nickel-gold ore was produced or delineated from more than 40 occurrences in the Outokumpu area up to 1986 (Kontinen, 1985). The Kylylahti deposit was discovered in 1984 by Outokumpu geologists using diamond drilling following the application of geophysical techniques within rocks which form part of the Outokumpu trend.

The Outokumpu mining district (including the Kylylahti deposit) is situated within the North Karelia Schist Belt. This is a structurally complex package of amphibolite to granulite facies metasedimentary rocks located at a major crustal tectonic boundary between the Proterozoic Svecofennian belt of rocks to the southwest and the Archean age Karelian Craton to the northeast. The Outokumpu district is dominated by northeast-southwest striking isoclinal folds with subvertical fold limbs. The regional geology and main deposits are shown in Figure 4.1, which also highlights Vulcan's leaseholding in the Outokumpu area.

Figure 4.1 Regional geology of the Outokumpu region showing major deposits



### 4.3 DEPOSIT GEOLOGY

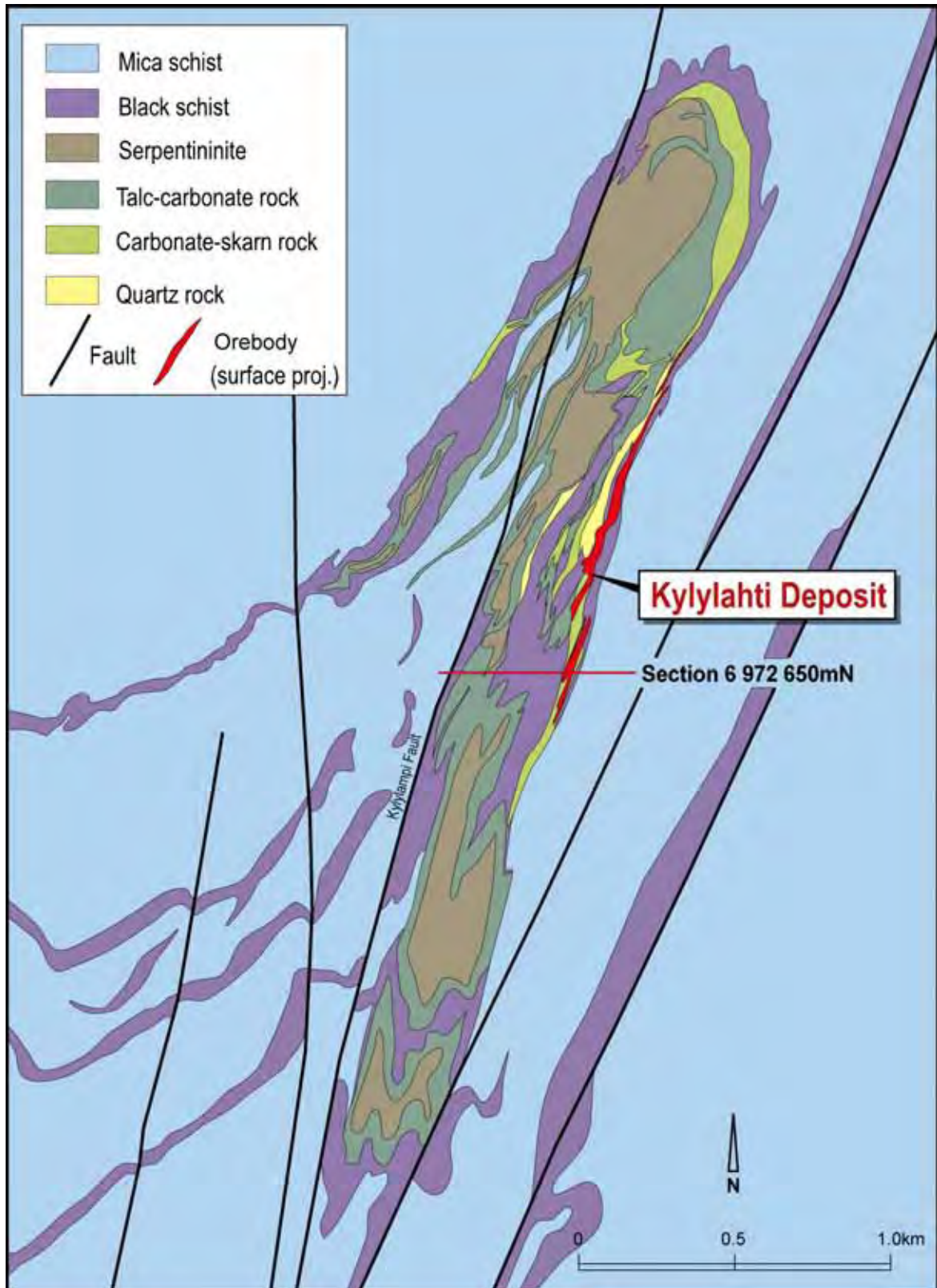
The Kylylahti deposit is hosted within a package of serpentinite, talc-carbonate, tremolite-quartz and quartz-sulphide rocks which form a distinctive association (the Outokumpu Association) within the district. The ultramafic rocks have been metasomatically altered to a tremolite-quartz-sulphide assemblage in close proximity to the Outokumpu deposits. This assemblage is termed a skarn throughout the Outokumpu region, including the Kylylahti area. Kylylahti mineralisation is hosted at the contact of these rocks and black sulphidic shales. Outokumpu association rocks occur as pods or lenses of serpentinite, altered to talc-carbonate on the margins, which have been complexly deformed and elongated within the black shales. The sequence of ultramafic rocks and enclosing shales is interpreted to have been thrust into a thick sequence of mica schists and gneisses (Figure 4.2). The folded belt of Outokumpu Association rocks can be traced over a strike length of 300 km. At Kylylahti these rocks show multiple phases of deformation and strong foliations within a tight synformal fold structure, with the mineralisation located along the near vertical eastern limb. The location of a cross-section (Figure 4.3) is shown on Figure 4.2, and illustrates the podiform nature of the Kylylahti mineralisation, along with a recognisable coarse-grained core containing semi-massive sulphides surrounded by disseminated sulphides on the foliated black schist contact. The semi-massive mineralisation comprises 40% to 60% sulphide (predominantly pyrrhotite, pyrite and chalcopyrite, with subordinate local accumulations of cobalt-rich pentlandite, sphalerite, cobaltite and gold), and ranges in thickness from 5 m up to 20 m.

The disseminated zone contains medium to coarse grained sulphides (5% to 40% sulphides) and veinlets, with pyrrhotite predominating and lesser amounts of chalcopyrite, pyrite, cobalt-rich pentlandite and sphalerite. The disseminated zone is locally gold-rich, with grades up to 20 g/t gold. The semi-massive zone grades sharply into the disseminated ore over one to two metres, although isolated pods of semi-massive mineralisation may occur entirely within the disseminated zone.

Mineralisation at Kylylahti occurs in two elongated lenses which strike to the northeast, dip near vertically to the northwest and plunge at between 25° and 40° to the southwest. The total length of the mineralised corridor as currently defined by Vulcan is 1.5 km and the orebody is open at depth. It is of note that the mineralised systems at Keretti and Vuonos are both 3 – 4 km in length. Vulcan has named the two lenses Wallaby and Wombat (Figure 4.4, showing the semi-massive zones in red, the disseminated zones in green and minor hangingwall lenses in pink). Recent drilling has focussed on filling in the gap between Wallaby and Wombat, and one hole, OKU-923, has delineated an up-plunge extension of Wallaby which has been modelled in the latest resource estimate (Table 1.1). Vulcan is employing directional drilling and sophisticated electromagnetic (EM) prospecting techniques for the first time in Finland to explore the limits of the Wallaby shoot. A

portion of the upper part of the orebody sits outside and to the north of Vulcan's lease on ground owned by Mondo Minerals Oy (a talc mining and processing company) (Figure 4.4). Vulcan's resource estimate and mine plan reflect this split.

**Figure 4.2 Surface geology of the Kylylahti area after Kontinen (2005)**



The Outokumpu style deposits are currently thought to have formed as a result of complex multiphase processes involving remobilisation of copper-cobalt-zinc sulphide rich rocks deposited on the ancient sea floor and their interaction with nickel sulphide rich rocks within the Outokumpu assemblage. Multiple stages of deformation coupled with this interaction have led

to the thin but laterally extensive rocks (up to 4 km at Keretti) forming the lenses of mineralisation which have been mined since 1914.

Figure 4.3 Cross-section at 6972650N through Kylälahti

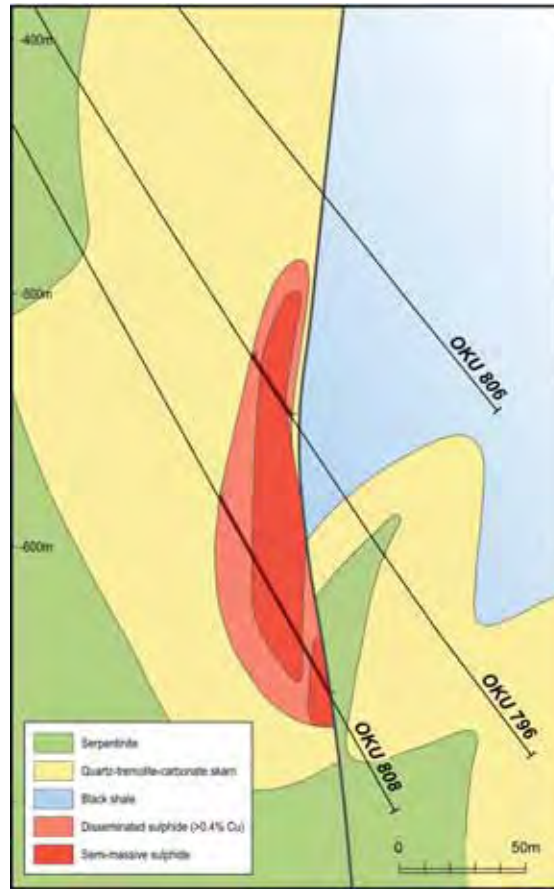
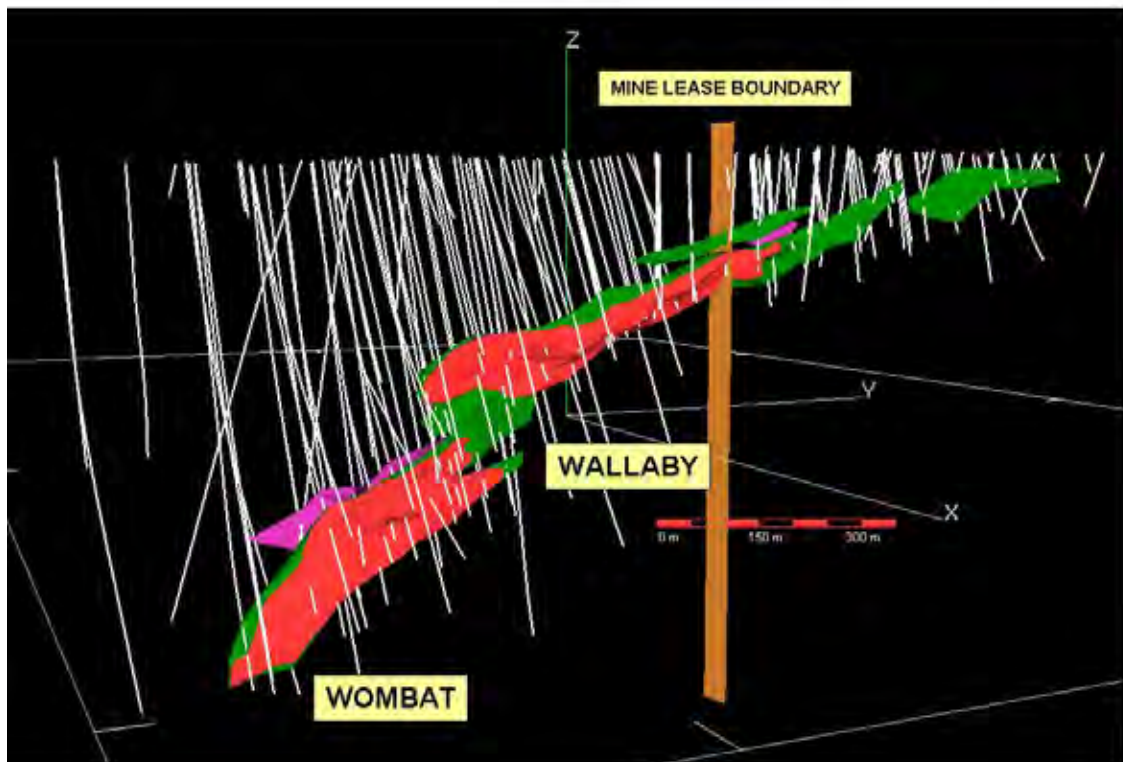


Figure 4.4 Three dimensional view of the Kylälahti orebody looking northwest



## 4.4 DRILLING AND MINERAL RESOURCES

### 4.4.1 History of exploration

Following the discovery of the Kylylahti deposit in 1984 by Outokumpu, some 29 km of diamond drill core was drilled up to 1986. Outokumpu estimated a resource of 3.5 Mt at a grade of 1.6% copper and 0.3% cobalt in 1986 (Hakanen et al., 1986). Between 1991 and 1998 Outokumpu carried out three drilling campaigns, resulting in an updated resource estimate (classified all as inferred under the JORC Code) of 3.45 Mt at a grade of 1.8% copper, 0.3% cobalt, 0.2% nickel, 0.6% zinc and 0.9 g/t gold (Pekkarinen et al, 1998). Outokumpu Oy withdrew from its global mining business in 1996 to focus on stainless steel manufacture but retained a Finnish mining subsidiary Polar Mining Oy, which acquired the Kylylahti asset. This was sold to Dragon Mining in 2003 as part of a larger package of mining and exploration assets. Dragon subsequently sold the Kylylahti project to Vulcan in November 2004 without adding to the drilling database.

### 4.4.2 Database and assay validation

Vulcan has undertaken an extensive programme of validation of the historical database and assays. Finnish speaking Polar Mining personnel were commissioned by Vulcan in 2005 to validate a representative selection of holes in the digital database against original paper records, with acceptable results.

Since there is little information about assaying methods and checks carried out during the Outokumpu era, Vulcan decided to re-assay a selection of 87 pulp rejects from three selected diamond drillholes which cover the temporal and spatial range of Outokumpu drilling. Check assays were carried out by Genalysis Laboratories in Perth, Western Australia, a reputable facility. The pulps were re-milled to increase the homogeneity and were then assayed for a suite of elements using inductively coupled plasma spectrometry, an accepted technique (the original assays were obtained by atomic absorption spectroscopy). Of the revenue-generating elements, copper, cobalt, nickel and zinc correlate well with the original assays, although copper and cobalt in particular show a positive bias in favour of the Genalysis re-assay. In its review of the inputs to the 2006 Vulcan resource estimate, Quantitative Geoscience (QG, 2006b) recommended a further check assay programme to confirm whether any upgrade of the Outokumpu assays was justified. Gold shows a lower correlation in the re-assay programme, which may reflect the low concentrations and the inherent associated sampling error. A further re-assay programme on 256 gold samples using fire assay showed a moderate correlation with the original Outokumpu assays. Snowden is of the opinion that there is little risk associated with the historical Outokumpu assays, which show signs of some conservatism, particularly for copper and cobalt.

Vulcan has an assay quality control programme for its own drilling, comprising the insertion of certified standards and the repeat assaying of selected pulps at an umpire laboratory. Analysis of the standards by QG (2006b) showed acceptable levels of accuracy in the assaying. Analysis of the pulp duplicate assays showed good repeatability for all elements of interest except gold and sulphur, reinforcing the findings from the re-assay of the Outokumpu samples. The sulphur precision improves when results are subdivided by assay methodology. Overall, Snowden concurs with QG, who concludes that there are no material issues associated with assay quality at Kylylahti.

Vulcan has instigated a programme of re-survey of hole collar positions using a differential GPS system. Approximately 65% of the Outokumpu drillholes which intersect the mineralisation have been re-surveyed. A number of collar positional shifts were noted and the resultant of these was used to adjust the locations of those hole collars which were not resurveyed. One drillhole which could affect the resource estimate was excluded as its location could not be established with confidence.

Approximately 80% of the Outokumpu drillholes which intersect the Kylylahti orebody had downhole hole dip measurements and azimuths measured. All of the Vulcan holes have been downhole surveyed using the Maxibor method, which provides high quality results.

### 4.4.3 Rock quality and bulk density

Analysis of Rock Quality Designation measurements (RQD) generated by Outokumpu between 1993 and 1998 reveal that 60% of the greater than 2000 measurements taken have RQD values which are good to excellent, and less than 8% are classified as very poor. Recent detailed geotechnical work commissioned by Vulcan confirms the Outokumpu findings. Snowden's limited examination of Kylylahti core suggests that rock quality is very good and that overall fracture frequency is very low.

Vulcan has adopted Outokumpu's database of bulk density determinations, which are made on approximately 10 cm lengths of core taken at 1 m intervals. A database of about 7,000 measurements which correspond with assayed intervals exists and was generated using industry standard weight in air/weight in water techniques. In Snowden's opinion this database is more than adequate for estimation purposes. Vulcan has carried out both bulk density (weight in air/weight in water) and specific gravity (pycnometer measurements on pulps). Unlike the Outokumpu database, the Vulcan measurements show a good correlation between bulk density and sulphur (a proxy for sulphide) content.

#### 4.4.4 August 2006 resource estimate

The August 2006 Kylylahti Mineral Resource estimate was carried out by Vulcan with technical input and review of the processes and results from QG. Technical inputs from QG included variogram modelling and kriging neighbourhood analysis (QG, 2006a). Snowden carried out independent validation of the resource block model estimate against the input drillhole sample data for the purposes of this document.

Mineralised areas of differing geological and statistical characteristics generally require the determination of separate geological domains for resource estimation purposes. The validated drillhole database for the Kylylahti copper project was used to define domain solids within the Surpac mining software package. Three domains have been defined at Kylylahti, representing different styles of mineralisation. These domains represent the semi-massive, disseminated and hangingwall mineralisation styles. The hangingwall domain is also known as the cobalt domain due to its elevated cobalt values and, as its name suggests, is usually located in the hangingwall of the other domains. The main criterion used to define the disseminated mineralised domain was the inclusion of copper sample values greater than 0.4% but less than 1%. Copper values less than 0.4% were deemed to be waste for domaining purposes. Copper values greater than 1% were used to assist the definition of the semi-massive domain, which is generally internal to the disseminated domain. QG (2006b) notes that at copper grades greater than 0.4%, the copper mineral chalcopyrite becomes visible to the naked eye in the drill core. The domain boundary between disseminated and waste is therefore not only grade-based but also mineralogical in nature. Definition of domains commenced with the digitising of closed polygons in section along every drilling line honouring the domain definition criteria mentioned above. Drill line spacings are generally 35 m to 50 m apart and are oriented east west. These polygons were then used to construct three dimensional solids by wireframing successive polygons together to discriminate the mineralised package from the background waste. Finally, the wireframes were visually checked to ensure coincidental surfaces between the semi-massive and disseminated domains were free of overlaps and gaps.

Mining software packages such as Surpac make use of block models for resource estimation. Block models are made up of regularly shaped cuboids which represent a volume of rock within the deposit. At Kylylahti the cuboids had dimensions of 5 m x 25 m x 5 m (east, north, elevation), with subcelling set to half these dimensions. The subcelling allows the block model to better fit the margins of the domains and provide an accurate volume representation. The domain wireframes were used to code the block model. This coding ensures that estimates for a particular domain are only sourced from drillhole samples which are coded with the same domain code, thus honouring the geological model.

The distribution of drillhole samples was analysed to determine the presence of any outlier values that may require a top cut. The application of top cuts is a process that reduces the effect of isolated (and possibly unrepresentative) outlier values on the estimation. Elements such as gold, which often have skewed grade distributions, can contain outlier values. A very high gold grade of 53 g/t was identified by Vulcan as an outlier sample and was consequently cut (reset) to a value of 3.5 g/t. All other gold values were unchanged and no other elements were subject to top cutting. The drillhole samples were composited to a downhole length of 2 m. The compositing methodology honoured all domain boundaries. The compositing process began at the top of the hole and continued down until a domain boundary was intersected. It is very unlikely that the length of the last composite before a domain boundary is 2 m in length, and therefore if the composite was greater than 1.5 m, the composite would be accepted into the composite database, otherwise composites less than 1.5 m were discarded. A uniform compositing length is desirable to ensure the validity of weighting factors during the estimation process.

In order to gain an insight into the grade continuity of the project, experimental variograms were calculated from the composited drillhole data. Variograms are a graphical representation of how the grade varies over increasing distances and in different directions. A variogram model is fitted to the experimental variogram to represent the anticipated spatial relationship of grades for the deposit and is used as input to the estimation method. Variograms were produced for copper, cobalt, sulphur, nickel, gold, zinc, and bulk density. The variograms produced from the Kylylahti drillhole samples were deemed to be poorly structured (QG, 2006a). Even within the plane of mineralisation in both Wallaby and Wombat, directional variograms proved poor with no clear spatial structure to model. QG believes that this is due in part to a lack of samples, which is a consequence of the current drillhole spacing. Only omnidirectional (averaged over all directions) variograms were modelled and the parameters that define the models were used in the estimation of the block model. The range of the variograms, (the distance at which two samples exhibit no relationship), was quite variable. The ranges for the elements in the disseminated domain vary from 45 m to 160 m and those for the semi-massive domain vary from 27 m to 140 m. The gold range used in the estimation process for the disseminated domain is 105 m which in Snowden's opinion seems excessive given that QG modelled it at 37 m (although it was set at 37 m for the semi-massive domain). Since the gold has a low impact on project economics this is not a material issue.

The estimation of grades into the domained block model was made using the method of ordinary kriging. Surpac mining software system was utilised for this task. The kriging method makes use of the parameters defined during the variogram analysis to determine the weights applied to the drillhole samples when averaging them into block grades. The estimation process made use of a three search pass strategy. This is a commonly used technique that successively expands the size of the search ellipsoid in order to calculate a grade for all blocks in the model. As the search ranges increase with each successive search pass, the edge of the estimation is pushed further out until all blocks are informed. The initial search range used was 150 m by 150 m in the plane of the deposit and 50 m perpendicular to it, defining an ellipsoid. The search range of the initial ellipsoid was expanded to a range of 300 m x 300 m x 100 m for the second pass and 400 m x 400 m x 150 m for the third pass. The minimum and maximum number of samples required to estimate a single block in the domained block model was defined through a process called kriging neighbourhood analysis. With the objective of avoiding estimation errors or oversmoothing of grades, the minimum and maximum number of drillhole samples used for most elements was determined to

be 8 and 32 respectively. Exceptions to this include the semi-massive domain cobalt estimates, where the maximum number of samples was set at 24. For the disseminated domain sulphur estimates and all gold and zinc estimates the maximum was set at 40 samples. The bulk density of each block was calculated from the sulphur estimates using a regression equation, since the coverage of actual density measurements was insufficient for interpolation.

Confidence in the quality of the estimate was achieved by validating the block model against the components of its construction. This involved the comparison of the overall volume of the block model per domain with the domain wireframes, with the result that the volume of the regularly shaped block model closely matches the volume of the irregularly shaped wireframes. Snowden, in its validation, compared the mean grade of the input drillhole composites (declustered to minimise the effect of irregular spatial sampling) to the tonnage weighted block estimates for each domain per estimated element. The outcome of the comparison showed that most of the block model values compared favourably. One notable exception is gold which appears to have slightly higher grades in the model than are indicated by the drillhole sample data (17% difference). Visual inspection of plots of drilling overlain upon the block model shows that model grades compare reasonably well with the input composite grades. Snowden notes that the estimate is fairly smooth due to the lack of data. Visual comparisons in an area of close spaced drilling show that there is significant local variability in the drillhole data which is not reflected in the estimate, although on the whole, broad trends are honoured. Snowden notes that Vulcan will be drilling the orebody to a much more detailed spacing from underground for local grade control purposes before mining commences. Moving window trend graphs were used to test the local estimation of the mean within narrow slices generated through each domain along all three axes. The dimensions of the slices used for this process are 5 m x 25 m x 5 m (easting, northing, elevation). For each slice, the declustered mean grade of the composites was compared to the tonnage weighted mean grade of the estimate for the deposit lens. The effectiveness of the moving window validation is dependent on obtaining a reasonable number of sample composites. Although the number of sample composites for most units is quite low, there is a good correlation between the block model and drillholes.

The classification of the resource was largely based on search criteria. Blocks that were informed in the first pass have been classified as Indicated, while the remainder of the model has been classified as Inferred. Areas where the orebody is intersected on a spacing of 50 m x 50 m or better have been accorded a higher level of classification. Isolated domains of limited dip and strike have been downgraded. The classification was carried out by Vulcan in accordance with the JORC Code (2004) and was found to be acceptable by QG (2006b). Snowden endorses this classification and the resource estimate as being a reasonable to good representation of the mineral inventory of the Kylylahti deposit.

## 4.5 MINE PLAN AND SCHEDULE

A conceptual mine plan has been prepared by Vulcan's mine planning consultants which exploits the mineralisation contained in the Wallaby and Wombat shoots of the Kylylahti resource. The plan is structured around recovering the mineralisation contained in both the disseminated and semi-massive domains of the Wallaby and Wombat Indicated Resources as estimated by Vulcan in April 2006. This plan has recently been updated to exploit the recently-discovered mineralisation between Wallaby and Wombat. Recent directional drilling between Wallaby and Wombat has enabled some of this material to be added to Vulcan's resource estimate, and further drilling of this zone is planned. Vulcan has not yet reported an ore reserve resulting from the mine plan; however, the plan will be further optimised and an ore reserve will be reported in the Definitive Feasibility Study.

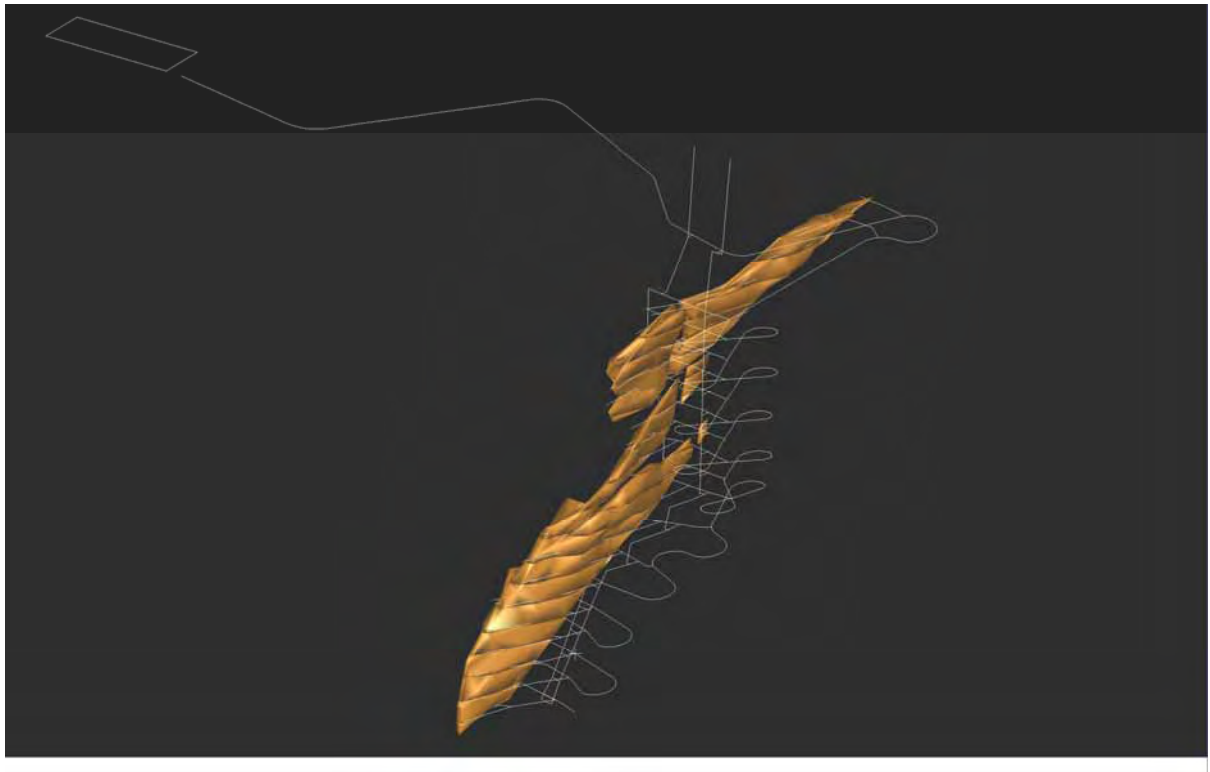
### 4.5.1 Overview of mine plan

The mine plan uses the longhole stoping method with cemented paste backfill to ensure high recovery of the valuable resource. The conceptual mine plan accesses the stoping areas with a decline driven from surface in rocks in the footwall and below the keel of the deposits. The decline acts as an access and haulage ramp. A schematic of the mine plan is shown in Figure 4.5, showing the designed mining levels and the decline path.

Stoping will be by conventional sublevel open stopes in a transverse configuration where deposit widths allow, and with longitudinal alignment for narrower areas. A 25 m interval between levels is planned. The smallest stoping block considered is 20 m wide (across strike), 15 m long (along strike) and 25 m high. Maximum dimensions have been determined by assessing rock conditions and through the application of empirical design guidelines. Stopes up to 35 m wide and 75 m high, or up to 30 m wide and 100 m high, are expected to be stable.

The stoping sequence is top down with regional rib pillars between stopes planned at the ends of stoping panels along strike. In this way, a number of concurrently active production areas can be maintained on a single level. The pillars host cross cut drives which provide access to hangingwall stopes and which form part of the primary ventilation circuit. Final recovery of the pillars is planned to be achieved by uphole bench retreat from the hangingwall through to the footwall.

The primary ventilation circuit will initially be established with a 4 m diameter raisebored ventilation shaft (210 m long) from surface at 110 mRL to the top of the Wallaby deposit at -100 mRL. A decline driven in the hangingwall of the Wallaby deposit extends the ventilation fresh air circuit along strike to crosscuts through the retreat pillars. The pillar crosscuts connect the hangingwall intake decline to the footwall access decline, which serves as the primary exhaust airway. The pillar crosscuts also provide secondary access to the primary circuit. When the ventilation decline reaches the top of the Wombat deposit at -200 mRL, a vertical shaft will be developed between -450 m and -650 mRL. The shaft will be developed in stages as the access decline advances to depth, providing a series of breakthrough locations. Crosscuts through rib pillars are again used to establish a connection between the primary intake airway and the access decline, providing exhaust capacity.

**Figure 4.5 Schematic of the conceptual Kylylahti mine plan looking to the northwest**

Conventional drilling and blasting is planned, with up and down holes of 64 mm and 89 mm diameter respectively to be drilled with modern electro-hydraulic drill rigs. Loading will be by diesel powered load-haul-dump units (LHD) of 15 t to 25 t capacity. Haulage will be by articulated underground trucks of 40 t to 50 t capacity or roadtrain configuration trucks of up to 90 t capacity.

Backfilling will be by paste fill which is expected to consume most of the mill tailings, thus reducing the risk of surface acid drainage issues. Some development waste will also be deposited in mined stope voids.

No specific considerations regarding inflow or drainage of mine waters have been described in the conceptual plan; however, Vulcan has commissioned a hydrology study which is currently underway.

The requirements of a preliminary mine plan are well met by the plan being used by Vulcan as the basis of its project feasibility study. Mine planning concepts are based on appropriate consideration of geotechnical principles applied to what is reported to be high quality data. The data used to characterise the footwall rock is sparse although Vulcan has taken a conservative position in specifying the anticipated ground support regime for the footwall. It is understood that additional geotechnical data is being collected to enable an assessment of footwall conditions to be made with a greater level of confidence. Sophisticated analysis, such as numerical stress modelling of the mine plan, will be undertaken as part of the feasibility study to ensure no issues are likely to arise through stress effects on the planned rib pillars and their extraction, the access decline and the zone between Wallaby and Wombat.

The proposed ventilation circuit will be effective, although it makes some compromises on commonly held design principles. In particular, the arrangement of having man and machinery access and haulage activities in the primary exhaust airway is not desirable. This establishes a condition where many workers and work places will rely on the second or third use of ventilating air. Air quality will need to be maintained to the highest standards. The ventilating arrangements also carry an inherent risk which may materialise in the event of a fire emergency. It is understood that the ventilation system is a consequence of the mine operating in a cold climate and that it is common practice in such an environment. Vulcan is aware of the risks inherent in such an arrangement and is actively seeking a risk mitigation strategy as part of the Definitive Feasibility Study.

There may be an opportunity to improve the proposed drilling and blasting regime by using holes of a larger diameter than those currently being considered. The stope dimensions and rock characteristics appear amenable to larger holes which would provide efficiency, cost and quite possibly, fragmentation and productivity benefits.

The use of paste fill is appropriate given the value derived from high recovery of the ore, and the ability to reduce the environmental risks associated with building large tailings storage facilities on surface.

There is no indication that the mine will experience difficult groundwater conditions. However, the current feasibility study should confirm this as a low risk.

#### 4.5.2 Schedule

Development and production schedules have been prepared based on the conceptual mine plan, with modifications by Vulcan in response to Vulcan's updated geological understanding and estimates of the resource. The schedules are based upon mining at a steady state rate of 550,000 tonnes of ore per year to produce on average 6,500 t of copper, 1,500 t of cobalt, 5,500 t of zinc and 8,200 oz of gold.

The development schedule places a high priority on advancing the access decline and primary ventilation circuit to gain access to the higher grade (but deeper) Wombat resource early in the mine life. The first year of development sees the surface box-cut developed and the decline advanced 1 km to approach the top of the Wallaby resource. Wallaby is accessed during Year 2 when production commences. Wombat is accessed during Year 3 with production scheduled to commence in Year 4. Production starts from the high grade zone of Wombat in Year 5. The decline reaches its maximum depth at – 650 mRL in Year 7. The summary decline development schedule is shown in Table 4.1.

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Distance	m	1,039	2,160	1,287				700
Level reached		-15 mRL	-350 mRL	-550 mRL				-650 mRL
Depth below surface	m	125	460	660				760

In addition to the decline development, there is a requirement for development for level access, stoping and other purposes, averaging 615 m per year between Year 1 and Year 11.

Year 2 sees the maximum scheduled annual development requirement of 3,350 m, including decline and other development.

The production schedule has been derived from an estimate of the potential mining inventory made by interrogating the interpreted disseminated sulphide (Cu > 0.4%) and semi-massive sulphide (Cu > 1.0%) zones of the resource model with a "best fit" arrangement of stope shapes defined by the minimum and maximum dimensions described in Section 4.5.1. The resulting Life of Mine production schedule is shown in Table 4.2.

	Unit	Year											Total
		2	3	4	5	6	7	8	9	10	11	12	
Tonnes	kt	261	480	553	554	556	559	559	564	569	570	421	5,647
Cu	%	1.57	1.72	1.29	1.81	1.82	1.66	1.17	0.87	0.72	0.58	0.66	1.25
Au	g/t	0.79	0.93	0.72	0.68	0.73	0.86	0.75	0.56	0.58	0.83	0.68	0.73
Co	%	0.29	0.32	0.26	0.29	0.30	0.27	0.21	0.19	0.19	0.20	0.19	0.24
Ni	%	0.18	0.14	0.19	0.14	0.14	0.18	0.22	0.25	0.27	0.32	0.29	0.21
Zn	%	0.55	0.57	0.53	0.51	0.51	0.58	0.45	0.37	0.34	0.42	0.39	0.47

The mine development and production schedules do not require abnormally high levels of productivity to be achieved. The greatest risk to achieving the schedule is in the uncertainty in footwall ground conditions and the possible effect on the schedule if poor conditions are encountered. Other risks to production appear to be low.

The mining sequence appears appropriate as it concentrates on mining the highest grade material early in the mine life. However, this comes at some cost as advancing the mine decline and consequent capital expenditure must be accelerated to access the better quality but deeper Wombat resource. Vulcan has advised Snowden that the Definitive Feasibility Study will include work to review the mining sequence to ensure that the optimum balance between capital expenditure and timing of revenues is identified and achieved.

There is some risk to achieving the scheduled production inventory tonnes and grade. The current inventory is based mainly upon an Indicated Resource which possesses a degree of uncertainty. The mine plan has been developed to a geological cut-off (which approximates an economic cut-off) rather than purely an economic one. As part of the feasibility study, Vulcan

advises that it will establish an economic approach to the cut-off grade determination or confirm the adequacy of the adopted geological approach. Adopting an economic cut-off grade will have the added benefit of providing an opportunity to optimise the financial results from the project.

#### 4.5.3 Capital cost estimate

The mine operating philosophy provides for all production and development activities to be performed by contractors with contractor supplied equipment. Vulcan will provide management and technical services, including geology, mine engineering and survey functions. The capital cost estimate is based upon unit rates for activities and estimates of lump sum costs for fixed plant required for the mine. Unit rates were sourced from Finnish contractors, equipment suppliers or from Vulcan's in-house database.

Development capital includes estimates for the box-cut and portal, ore pad, contractor facilities, mine water dam, access decline, decline stockpiles, primary ventilation shafts and ventilation drives. The other mine capital includes provisions for pumps, fans, light vehicles, mine technical equipment, mine rescue equipment and other miscellaneous equipment. The paste fill plant capital cost is provided for separately. Vulcan's capital estimate is shown in Table 4.3.

Item	Year						
		1	2	3	4	5	6
Development capital	Euro	4,609,585	5,260,951	2,437,042	0	0	0
Other mine capital	Euro	448,606	1,074,144	660,789	306,122	373,645	200,000
Paste fill plant	Euro		2,200,000	2,200,000			
		<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>
Development capital	Euro	1,325,508	0	0	0	0	0
Other mine capital	Euro	36,551	0	0	0	0	0

The capital costs have been compiled comprehensively and at a level of confidence suitable for evaluating the preliminary mine plan. There appears to be good coverage of all aspects of capital investment required for the operation envisaged by the mine plan except for replacement capital for mine equipment, for which no provision has been made. Most high cost equipment is provided for under the contract rates used to estimate operating costs; however, mine management light vehicles will require replacement over the mine life and this should be provided for as the feasibility study progresses.

#### 4.5.4 Operating cost estimate

Operating costs have been estimated on the same operational basis as capital costs. Costs have been estimated using unit rates supplied by Finnish contractors, Vulcan's consultants or drawn from Vulcan's database.

The operating cost estimate includes specific provision for mine staff, operating development, drilling and blasting, loading and hauling, mine services and paste fill. The operating cost estimate is shown in Table 4.4 with quantum costs expressed in '000 Euro and unit costs as Euro/t.

The operating unit costs have been estimated comprehensively and to a level of confidence suited to the preliminary mine plan. All operating activities have been considered in the cost estimation.

However, the operating cost estimates included in the project evaluation model are based on a production inventory derived from a resource model different (older) to that which is used to provide the current production inventory. The major difference is that Vulcan has recently defined part of the resource between Wallaby and Wombat to a level which allows it to be included in the production inventory, adding about 600 kt, but has not updated the operating cost model to reflect this. Consequently, the production related costs shown in Table 4.4 are about 10% too low. These will be accurately modelled during the Definitive Feasibility Study.

Table 4.4 Operating cost estimate in '000 Euro							
Item	Year						
	1	2	3	4	5	6	
Development		822	1,140	708	1,101	606	
Mine Staff		548	548	548	548	548	
Drilling		485	825	553	685	427	
Blasting		219	423	156	204	111	
Loading		270	487	581	605	619	
Hauling		542	978	2,303	2,400	2,181	
Services		357	644	768	800	818	
Paste Fill		100	1,101	1,201	1,201	1,201	
<b>Total</b>		<b>3,342</b>	<b>6,146</b>	<b>6,816</b>	<b>7,544</b>	<b>6,510</b>	
Unit cost		12.79	12.80	12.33	13.62	11.71	
Item	Year						
	7	8	9	10	11	12	Total
Development	822	1,277	188	589	262	0	7,515
Mine Staff	548	548	548	548	548	548	6,023
Drilling	595	865	240	511	247	0	5,434
Blasting	171	269	43	141	89	0	1,826
Loading	624	627	631	632	632	60	5,768
Hauling	2,199	2,211	1,911	1,916	1,915	182	18,738
Services	825	829	833	835	835	79	7,623
Paste Fill	1,001	1,001	1,001	1,001	0	0	8,806
<b>Total</b>	<b>6,785</b>	<b>7,626</b>	<b>5,396</b>	<b>6,173</b>	<b>4,527</b>	<b>868</b>	<b>61,733</b>
Unit cost	12.13	13.65	9.56	10.84	7.94	2.06	10.93

## 4.6 PROCESSING

### 4.6.1 Ore characteristics and relevant processing mineralogy

The Kylylahti deposit is a typical Outokumpu type multi mineral sulphide ore containing copper, cobalt, zinc and gold occurring in association with a substantial amount of pyrite and pyrrhotite. The gangue mineralogy is generally uniform throughout the orebody, reporting predominantly quartz, with accessory carbonates (dolomite and calcite) biotite, amphibole and talc. The sulphides constitute up to 60% of the ore. Pyrite and pyrrhotite are the dominant sulphides in the ore. There are two geologically distinct ore types in the Kylylahti deposit:

- semi-massive ore dominated by the presence of the sulphides as pyrite
- disseminated ore dominated by the presences of sulphides as pyrrhotite.

The semi massive ore is significantly higher in copper and cobalt values and tends to occur in distinctly separate zones (Table 4.5).

Table 4.5 Kylylahti ore – typical composition grades						
Ore type	Cu	Co	Zn	Ni	Au	S
	%	%	%	%	g/t	%
Semi-massive	2.63	0.39	0.76	0.13	0.90	20.6
Disseminated	0.61	0.18	0.39	0.33	0.9	1.4

The semi-massive ore is dominated by pyrite and pyrrhotite with lesser chalcopyrite and minor amounts of cobalt-pentlandite, pentlandite, and sphalerite as accessory minerals. Pyrrhotite is the main sulphide mineral in the disseminated ore. A general distribution of the sulphide species in the semi-massive ore is given in Table 4.6.

<b>Table 4.6</b>						
<b>Kylylahti semi-massive ore – typical sulphide composition</b>						
<b>Mineral</b>	<b>Total sulphide</b>	<b>Pyrite</b>	<b>Pyrrhotite</b>	<b>Chalcopyrite</b>	<b>Pentlandite</b>	<b>Cobaltite</b>
% weight	45	22	15	8	0.4	0.3

There is a substantial amount of cobalt in association with pyrite. This accounts for in excess of 63% of the total cobalt in the pyrite rich semi-massive ore, with lesser amounts in pyrrhotite-rich semi-massive and disseminated ore types. The remaining cobalt tends to occur as cobaltite (18%) and with cobalt pentlandite (16%). It is interesting to note that the cobalt in cobalt pentlandite tends to range from 28% to 39% with nickel being as low as 19%. The occurrence of cobalt as solid solution in the pyrite grains makes it difficult to produce a high grade cobalt concentrate at acceptable recovery levels. Chalcopyrite generally occurs as coarse free grains. This makes it feasible to extract the copper minerals selectively into a high grade concentrate recovering in excess of 80% of the copper in the ore. At about 0.9 g/t there is a significant amount of gold in the ore. Outokumpu testwork has demonstrated that the gold tends occur as free grains suitable for extraction with the copper concentrate. Although the sphalerite grains are generally liberated, electron probe microanalysis of the zinc sulphide grains indicates the presence of 7% iron. There appears to be some association of magnetite with the zinc sulphide grains, which is likely to make it difficult to produce high grade zinc concentrate from this ore.

#### **4.6.2 History of metallurgical testing**

Investigations aimed at developing a suitable process route for economic extraction of copper, cobalt, gold and zinc were initiated by Outokumpu Oy from 1984 when the deposit was discovered. The development of a flowsheet has since proceeded in two stages:

- metallurgical development carried out by Outokumpu Oy commencing in 1984
- detailed metallurgical development conducted by Vulcan.

#### Outokumpu metallurgical programme

Outokumpu Oy has conducted a detailed program of technical investigation and follow up process development. The initial testing was done by VTT (Finnish government mineral processing research centre). The testing included the establishment of quantitative mineralogy followed by a detailed ore dressing mineralogy. The aim of the programme was to produce copper, cobalt and zinc concentrate suitable for economic processing at the Outokumpu's Kokkola nickel and zinc metallurgical complex, possibly using the operating flowsheet at the Outokumpu-owned Keretti concentrator designed to process Outokumpu-type copper-cobalt complex sulphide ore. The proposed Outokumpu flowsheet for the Kylylahti ore is given in Figure 4.6.

The study confirmed that it is feasible to produce a high grade copper/gold concentrate, recovering in excess of 85% of the copper and 70% of the gold in to a clean marketable concentrate product. As indicated above, the mineralogy of the cobalt minerals is such that it is not possible to extract cobalt selectively against pyrite to produce a high grade cobalt or cobalt/nickel concentrate. In order to maximise the recovery of cobalt, Outokumpu proposed to recover the cobalt, nickel and zinc to a low grade concentrate for possible processing at the company-owned Kokkola metallurgical complex.

#### **4.6.3 Vulcan metallurgical programme**

Vulcan has conducted follow-up metallurgical testing aimed at maximising revenue. The Vulcan process development programme is being conducted in two stages:

- confirmation of Outokumpu's proposed two concentrate process aimed at producing a saleable copper-gold concentrate and collection of the other valuable metals, (cobalt, nickel and zinc) into a bulk concentrate for downstream processing
- examine the options for the downstream extraction of metals from the bulk concentrate and select an established process for follow-up bench scale and pilot testing.

#### Production of two concentrates

Since acquiring the Kylylahti project Vulcan has conducted detailed bench scale testing on selected ore composites to confirm the Outokumpu type flowsheets aimed at producing two separate concentrates as above. The tests were conducted initially by G&T Laboratories in Canada. This was followed by further bench scale tests at Ammttec Metallurgical Laboratories in Perth, Australia. The recent tests confirm the above findings. The proposed two concentrate process flow chart is shown in Figure 4.7. The details of the expected plant feed grades and the associated quality of the two products are listed in Table 4.7 and Table 4.8. Snowden has calculated the concentrate grades and recoveries from the Ammttec cyclic testwork according to accepted convention.

Figure 4.6 Proposed Outokumpu flowsheet for Kylylahti ore

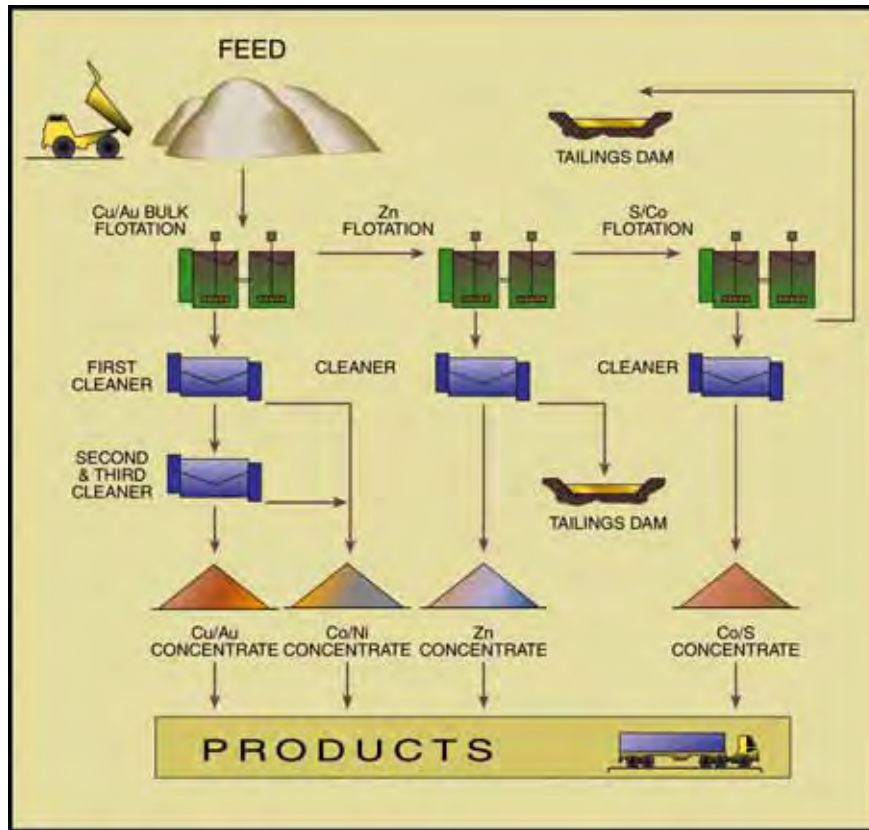
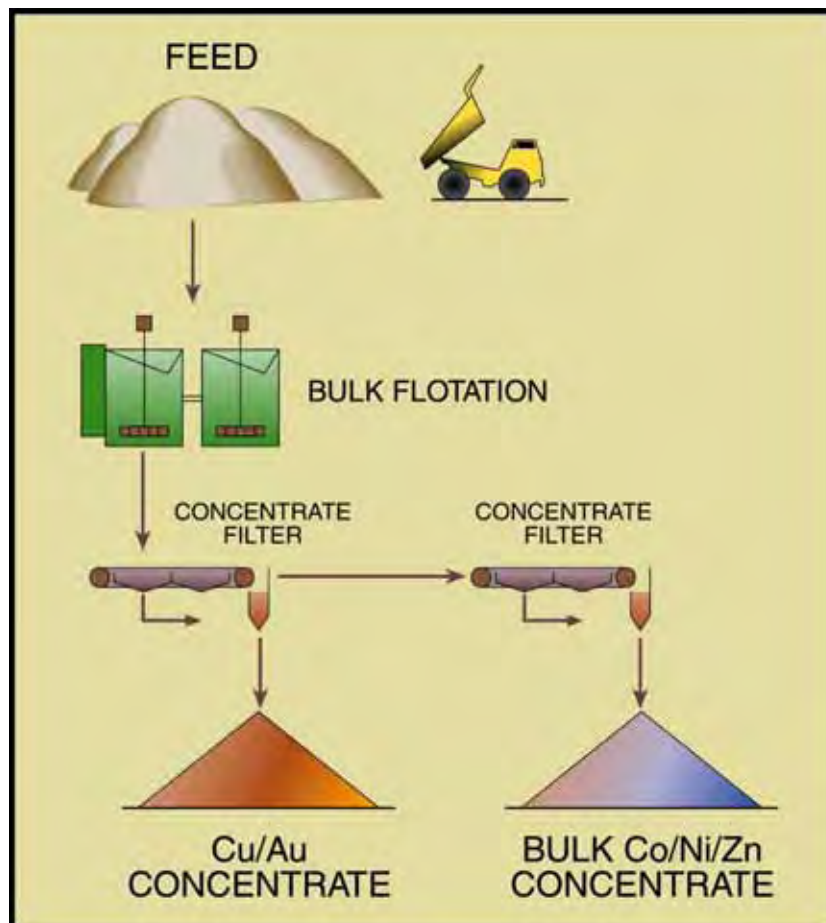


Figure 4.7 Schematic of Vulcan's proposed two concentrate processing option



<b>Table 4.7</b>			
<b>Copper-gold concentrate – forecast grade and recovery</b>			
<b>Metal</b>	<b>Feed grade</b>	<b>Concentrate grade</b>	<b>Recovery %</b>
Copper	1.15%	26.6%	85.6
Cobalt	0.21 %	0.09%	1.6
Nickel	0.2 %	0.09%	1.6
Zinc	0.46 %	0.62%	5.0
Gold	0.65 g/t	12.0 g/t	67.0

<b>Table 4.8</b>		
<b>Cobalt-nickel-zinc bulk concentrate – forecast grade and recovery</b>		
<b>Metal</b>	<b>Concentrate grade</b>	<b>Recovery %</b>
Copper	0.6%	12
Gold	0.42 g/t	15
Cobalt	0.77%	84
Nickel	0.7%	80
Zinc	1.6%	80

According to Vulcan's long term metal price and exchange rate assumptions, the value of the metals in the bulk cobalt/nickel/zinc concentrate far exceeds the value of the copper-gold concentrate as listed in Table 4.7. In order to maximise revenue, a process logic aimed at realising the value of the low grade, high value cobalt/nickel/zinc bulk concentrate was required. This led to the instigation of the bulk concentrate processing options study.

#### **4.6.4 Copper-gold concentrate**

The bench scale testing conducted by Vulcan on representative drill core samples indicates that it is feasible to selectively extract chalcopyrite (recovering over 85% of the copper in the ore) to a product reporting in excess of 26% copper. The mineralogy of gold in the ore is such that up to 70% of the gold in the ore also reports to this product. The copper-gold concentrate will be of high quality and in Snowden's opinion it is eminently suitable as feed to a conventional copper smelter. Vulcan has letters of intent from potential customers and are currently negotiating smelting terms.

#### **4.6.5 Bulk concentrate processing study**

There are several options for the extraction of the valuable metals from the low grade bulk concentrate product, and as part of the 2005 pre feasibility study Vulcan commissioned Lycopodium Engineering Pty. Ltd to conduct a high level conceptual evaluation of the technical alternatives. The following possible options have been canvassed in the above study, including the direct processing of ore:

- biological oxidation using selected bacteria
- pressure oxidation of the metal sulphide in the concentrate under various conditions of temperature and pressure
- roasting of the concentrate followed by high temperature/pressure leaching with acid
- atmospheric leaching
- Bio-heap leaching of ore or concentrate.

In addition to the low levels of copper, cobalt nickel and zinc, the concentrate contains substantial amounts of iron and sulphur (42 to 45% Fe and 42 to 45% S). It is worth noting that any selected extraction process will require the technology for the efficient removal of these two elements. The Lycopodium options study was conducted at a very high level and lacks supporting testwork data. The report states that "significant assumptions about leach response have been made in the cost estimates".

In consideration of the presence of a third party roaster and acid plant which is potentially available (at Siilinjärvi, see below), indications of favourable capital and operating costs, and initial bench scale testing which demonstrates technical feasibility, Vulcan has selected a roast/leach option for the bulk concentrate. An internal status report by Vulcan in September 2006 details a proposed structured testwork programme as part of the next stage of this project. The testwork programme needs to confirm and/or quantify the following issues:

- technical feasibility
- technical risk
- capital and operating cost
- overall impact on the project economics.

The downstream extraction process selected by Vulcan will require the removal of iron and sulphur, which amount to about 90% of the concentrate mass. The Siilinjärvi industrial complex, operated by Kemira GrowHow Oyj (KGH), is situated

100km north of the Kylylahti Project site; at this site sulphuric acid is produced by roasting pyrite concentrate containing 52% sulphur. The acid is used to produce fertilizers which KGH sells to market. The Siilinjärvi roasters are operated under “dead roast” conditions at high temperatures (above 740°C). Vulcan’s current plans involve consideration of three options:

- a sulphating roast and atmospheric acid leach
- utilising the existing dead roast, but at lower temperatures (680°C), followed by pressure oxidation
- utilising the existing dead roast, followed by medium pressure acid leach.

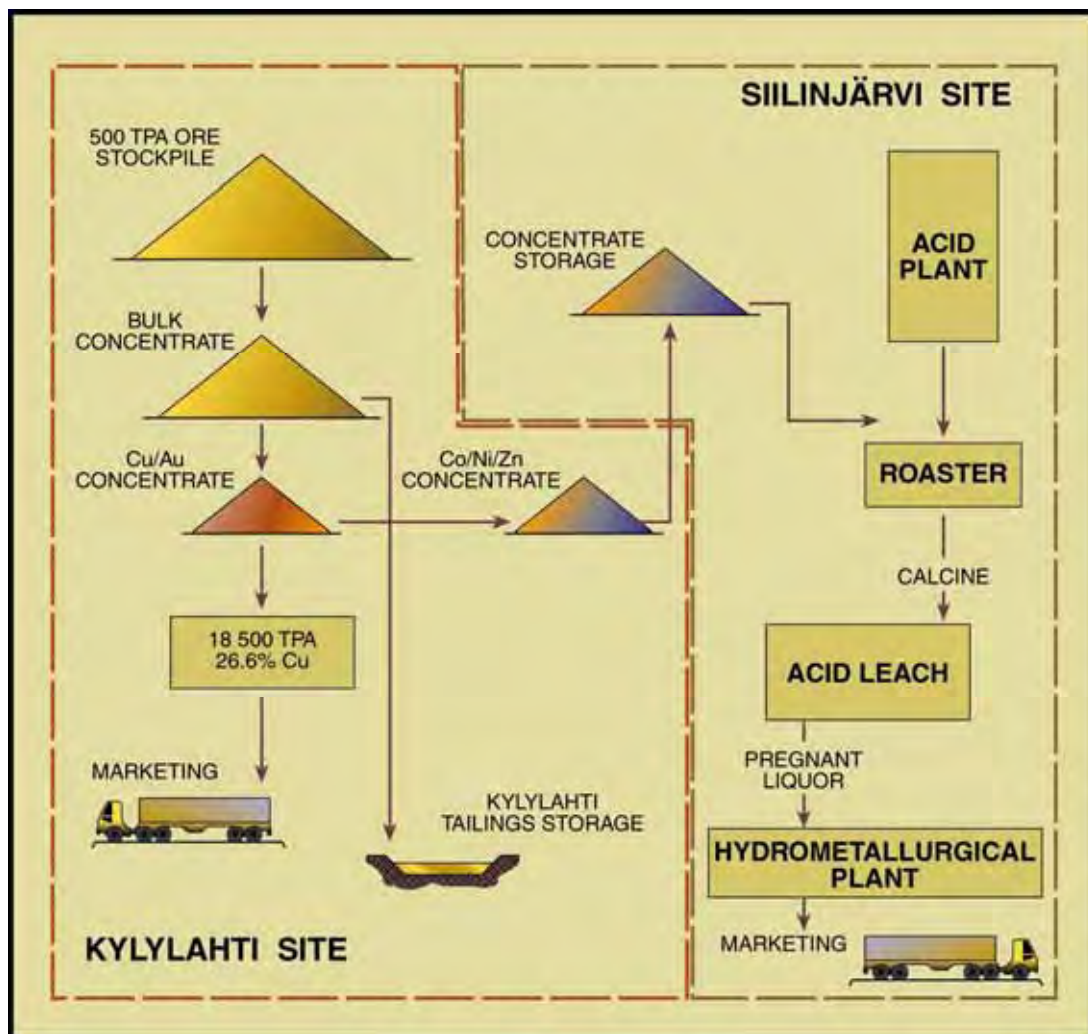
Recent testwork by Outokumpu has indicated that the first option is possible. Vulcan is pursuing this option, which has the least technical risk of the three. This will entail the construction of a roaster and leach/hydrometallurgical plant by Vulcan at Siilinjärvi, with sale of sulphur dioxide (for acid production) and waste energy to KGH. The calcine from the roaster will be processed to extract the metals as a variety of products. Details of the proposed integrated metallurgical extraction process are given in Figure 4.8. The concentrate production data is based on the data listed in Table 4.7 and Table 4.8.

#### Technical feasibility of the proposed roast/leach option

In order to establish the technical feasibility of the proposed roast/leach technology a testing programme to conduct a series of roast/ leach process tests commenced in August 2006. Bulk concentrate was produced as per the established two concentrate flow sheet. This material was used for all roast / leach testing. The objective of the testwork was to establish the following:

- the feasibility of achieving an efficient sulphating roast and thus conversion of the metal sulphides to soluble sulphates for downstream atmospheric leaching
- the feasibility of securing acceptable metal extraction by conventional roasting followed by metal extraction by pressure acid leaching (PAL).

**Figure 4.8 Proposed two concentrate flowsheet for Kylylahti**



### Roast/leach test programme results

The initial programme of testing of the roast leach concept has been completed by Ammtec and a draft report issued. The following points are worthy of note:

- The trials on the sulphating roast option were not successful.
- The best combination of metal extraction to solution with the associated rejection of iron was achieved under conditions of partial roast followed by high temperature acid leaching at a temperature of 220° C in presence of oxygen at an oxygen overpressure of 600 kPa. Acid consumption was noted to be relatively modest at less than 100kg/t and pulp density was high.

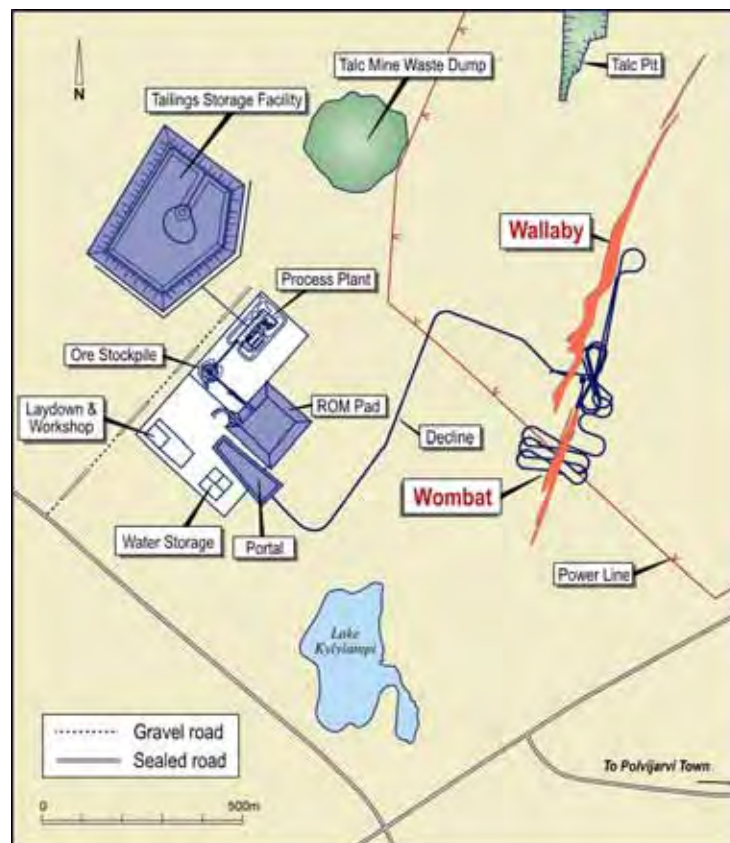
Recent testwork by Outokumpu, in contrast to the Ammtec work, has confirmed that a sulphating roast option is possible. This means that acid leaching can take place at atmospheric pressures and modest temperatures, saving the cost of construction of an autoclave.

### **4.6.6 Concentrator**

Lycopodium has designed a concentrator to be built within the Kylylahti mining lease. The details of the site layout in relation to infrastructure and the orebody are shown in Figure 4.9. Access to the mine site and concentrator is along a private road which is 400 m from a national highway. Vulcan expects that the concentrator will be connected to the Finnish national electrical grid, to the local sewage disposal system and to the Polvijarvi municipal water supply (potable water). There are two old talc pits within 500 m of the proposed concentrator site which are full of water and which can be used for process water. However, Vulcan may be required to delineate an additional source of water dependent upon the quantities of water available via mine recharge and the two old talc pits. Crushing may also be restricted to between the hours of 7 am to 10 pm to minimise noise impact.

The onsite concentrator (Figure 4.10) allows for the recovery of a bulk concentrate via primary and secondary crushing, milling through a single stage ball mill, and a three stage flotation circuit. This circuit comprises bulk roughing and cleaning, separate flotation of the bulk cleaner concentrate to separate the bulk sulphide and the copper-gold concentrate and finally further upgrade of the copper-gold concentrate via another cleaning stage. Both concentrate streams will be thickened and filtered to approximately 8% moisture. Concentrate will be trucked 15 km southwest to the railhead at Vuonos and then to the western coast of Finland.

**Figure 4.9 Kylylahti mine surface layout plan showing details of concentrator and tailings**



#### 4.6.7 Tailings management

Vulcan intends to place as much tailings material underground as possible via the proposed paste plant, and thus has designed a conventional tailings storage facility (TSF) with minimal capacity. The placement of tailings underground will minimise the generation of acidic solution from the surface tailings, although the concentrator has been designed to maximise the recovery of potentially acid-generating sulphide to the twin concentrate streams. The TSF is designed to hold up to three years of tailings (up to 150,000 t) before the placement of tailings underground can commence. Vulcan expects that none of the tailings water will enter the environment, being part of a closed loop between the concentrator and the disused talc pits proposed for water storage.

#### 4.6.8 Processing capital and operating cost estimates

##### Concentrator capital and operating costs

Lycopodium was commissioned to prepare an engineering cost study with capital and operating cost estimates in the range of accuracy of 35% for a concentrator and associated infrastructure as part of a pre-feasibility study. Key details of this estimate are:

- selection of the bulk flotation process, which involves the recovery of a bulk concentrate prior to the separation of a copper/gold and a cobalt/nickel/zinc product with the rejection of pyrite to tailings (Figure 4.10) – Vulcan has since decided to forgo the pyrite rejection stage
- preparation of preliminary process flowsheets and the associated process design to allow the selection of processing and service equipment
- scoping and costing key infrastructure equipment
- preliminary sizing of key process equipment including crushers, the ball mill, flotation machines, thickeners and filters
- the preparation of a preliminary major equipment list
- scoping and costing of key infrastructure requirements
- the preparation of capital cost estimates
- the preparation of operating cost estimates based on in-house data and quotes on consumables.

The conceptual concentrator flowsheet and the associated capital and operating cost estimates for a 500,000 tpa concentrator complex as provided by Lycopodium are presented in the Kylylahti Copper Project Pre-Feasibility Study (Vulcan, 2005).

Capital cost estimates from this document are summarised in Table 4.9. In Snowden's opinion the capital cost is within an acceptable range, if a little high.

<b>Item</b>	<b>Estimate (€ million)</b>
Treatment plant	20.2
Infrastructure	11.0
Management	6.6
Owner costs	2.7
Contingency	5.1
Pre-production and spares	1.3
<b>Total</b>	<b>46.9</b>

Lycopodium has estimated the concentrator operating cost to be 12.64 Euros per tonne of ore processed. This appears to be within an acceptable range. Snowden believes that there may be some opportunity to reduce this cost.

##### Bulk concentrate treatment costs

The capital and operating cost for the proposed concentrate leach plant has been estimated by Lycopodium under the following assumptions:

- 180,000 tpa of bulk concentrate (Vulcan now expects an annual throughput of 140,000 to 160,000 t)
- roasting is to be carried out at the Siilinjarvi roaster requiring no capital expenditure
- leaching of calcine is to be carried out in a single autoclave
- downstream extraction of metals provides an intermediate product.

Recent testwork results from Outokumpu will lead to a revision of these assumptions. Vulcan is currently planning to construct its own roaster at the Siilinjarvi complex. This will carry out dead roasting of the bulk concentrate and will be followed by acid leaching at atmospheric pressures and hydrometallurgical extraction of nickel, cobalt and zinc from the sulphide concentrate. This will not now require the construction of an autoclave. The capital cost of a custom roaster has not been estimated by Lycopodium but Vulcan's preliminary estimates are in the range of 15 M Euros.

The current operating cost estimate by Lycopodium of 15.9 Euros per tonne of ore amounts to about 64 Euros per tonne of concentrate; however, the roast/leach specifications and the associated estimate are technically at an early stage. The Lycopodium report states that the operating cost estimates have been made under conditions of uncertainty regarding process variables and requirements for controlled roasting of concentrate. The operating cost estimate of 15.9 Euros per tonne of ore appears to be low compared to some other base metals pressure oxidation projects currently planned; however, now that a sulphatising roasting process route with atmospheric leaching seems likely the elimination of the operating cost component of an autoclave will probably contribute positively to the 15.9 Euros per tonne estimate.

#### **4.6.9 General comments on process selection**

The testwork conducted on selected ore composites from Kylylahti indicates that it is feasible to produce a marketable copper gold concentrate at acceptable levels of recovery of both copper and gold. There is a substantial amount of cobalt in the ore, which has a net value (at 2006 prices) of 2.5 times the value of copper and gold in the proposed copper gold concentrate. There is therefore a strong financial incentive to develop a suitable process for the extraction of cobalt and other minor elements. The proposed bulk sulphide concentrate is forecast to carry in excess of 90% of cobalt and other valuable metals, ready for downstream processing.

Vulcan's decision to pursue a roast/leach path for the cobalt-nickel-zinc concentrate is supported by a moderate amount of bench scale testing which demonstrates technical feasibility. This preliminary testwork needs to be followed up by a larger and more robust testwork programme. Snowden understands that this testwork is in progress.

#### **4.6.10 Process risk assessment**

##### Generation of a two concentrate stream

A substantial amount of investigative technical work has been conducted by Outokumpu Oy at the VTT technical centres and later by Outokumpu Technology. This work has been followed up by technical review of the reports and further bench scale testing on selected drillhole composites. These results confirm the viability of the two concentrate concept. Assuming that the samples tested represent the orebody, indications are the proposed concept is viable. The next stage, which is variability testing bench testing followed by a bulk or pilot scale test, has started.

##### Extraction of cobalt, nickel, and zinc from the bulk sulphide concentrate

As reported above, refinement of the process for the extraction of cobalt and nickel from the bulk sulphide concentrate is at an early stage. Iron and sulphur amount to over 90% by weight of this concentrate, and the roast/leach process selected by Vulcan will require an efficient route for the rejection of iron and sulphur without associated loss in the valuable metals.

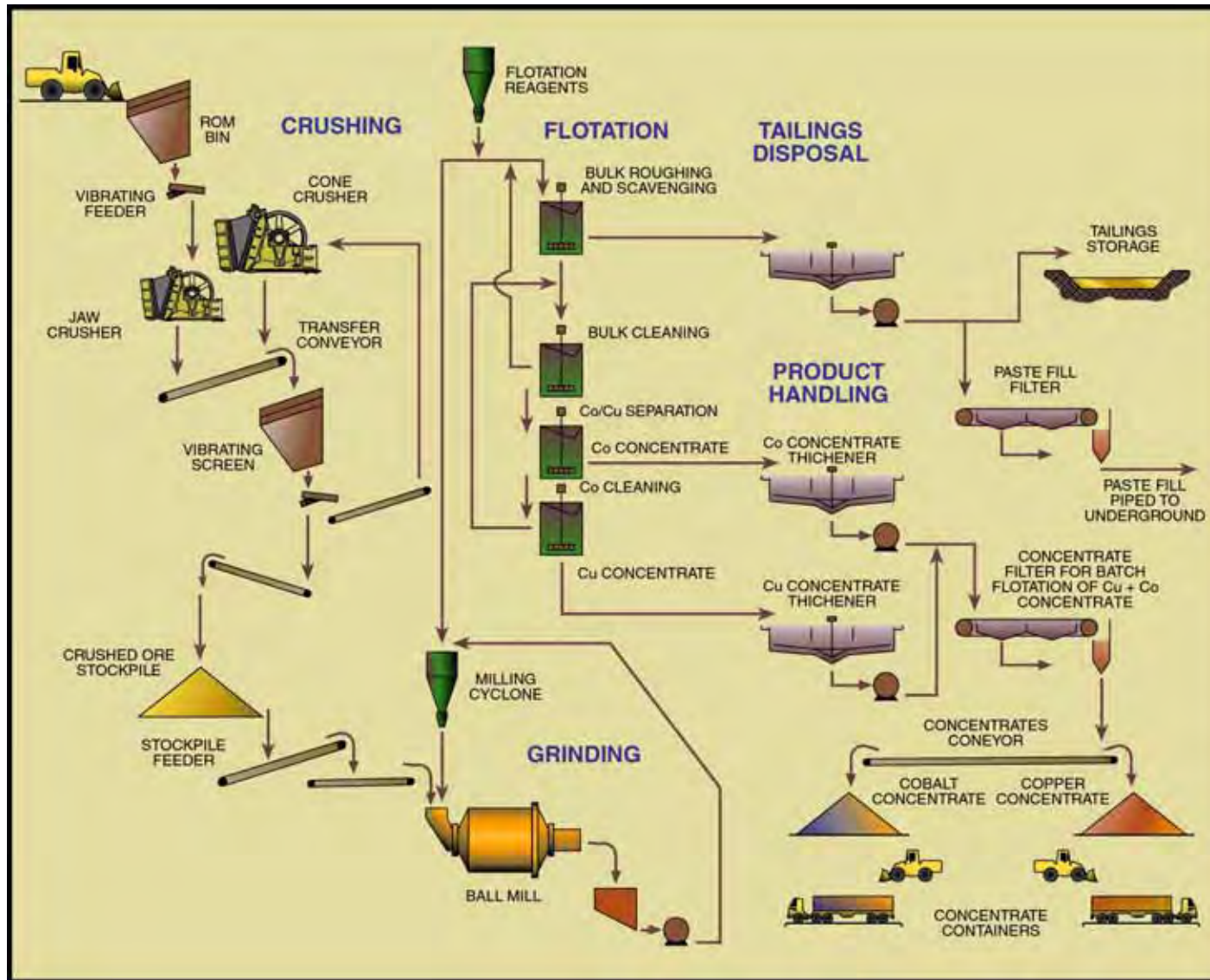
The process route of roasting the concentrate and follow up leaching of the calcine was selected by Vulcan to take advantage of the pyrite roasters at Siilinjarvi industrial complex, with the by-product generation of sulphur dioxide (for acid generation) the generation of surplus heat. Current plans to build a custom roaster will contribute to an increase in the capital cost of the project but will have a positive effect on downstream leaching capital and operating costs. With proposed the sale of sulphur dioxide and energy to KGH the operating costs of the roaster could be neutralised, although these benefits need to be quantified to a higher level of detail.

Vulcan's preferred process route of a sulphatising roast followed by atmospheric acid leaching will require a detailed process analysis supported by series of bench scale testing before arriving at a viable concept for bulk scale pilot testing. In order to minimise risk the project will now move through a systematic testing phase under the supervision of SNC-Lavalin aimed at selecting and developing a process which is both economically and technically viable. Snowden has reviewed and endorses SNC-Lavalin's proposed testwork strategy document.

#### **4.6.11 Marketing and off take**

Vulcan has commenced negotiations with a number of parties for the sale of both the concentrates predicted to be generated from the Kylylahti operation. Letters of intent to purchase the copper-gold concentrate have been obtained from New Boliden, which owns a smelter at Harjavalta and a refinery at Pori (27 km to the northwest of Harjavalta), and from Norddeutsche Affinerie AG, which owns a smelter and refinery in Hamburg, Germany (accessible by sea from Harjavalta). The outputs from the bulk sulphide concentrate, following roasting at Siilinjarvi and leaching at Vulcan's adjacent facility, will be cobalt and nickel hydroxide and probably also zinc sulphide and copper sulphate. Vulcan is currently negotiating off take agreements with a number of interested parties in the northern European regions for the refining of these high value, low volume products.

Figure 4.10 Kylilahti flowsheet for onsite concentrator



## **4.7 ENVIRONMENT, COMMUNITY, AND PERMITTING**

The Kylylahti project sits upon three granted mining leases, although the TSF is on land owned by the Polvijarvi Municipality outside of these leases. Vulcan has applied for an extension of the area of the lease to include the TSF and expects that this will be granted between the first and third quarters of 2007.

### **4.7.1 Environment and permitting**

Vulcan's environmental permitting is subject to the statutes in the Finnish Environmental Impact Assessment (EIA) Act and also Finnish Decree No. 792 on EIA procedures. The EIA act mandates the following procedure:

- an initial scoping stage, including baseline studies
- generation of a report on the proposed impact assessment programme which is subject to two rounds of public consultation followed by review by the local Joensuu Regional Environmental Centre
- expert review of the final EIA by the Finnish Environmental Institute
- a second series of public hearings prior to approval.

The process is driven by a fixed timetable to which both the applicant (Vulcan) and the Finnish environmental authorities are required to adhere for the purposes of timely decision making. Vulcan's permitting process commenced in May 2005 and baseline studies to date have indicated that there are no significant environmental issues. The Kylylahti mining lease adjoins a talc mining lease where open pit mining by Mondo Minerals took place between 1977 and 1982. Mondo has submitted a separate application to recommence talc mining, and Vulcan is co-operating with Mondo to attempt to streamline the permitting process for both parties.

### **4.7.2 Community consultation**

The proposed Kylylahti mine is two kilometres from the town of Polvijarvi. Vulcan has embarked upon a programme of community consultation with residents of Polvijarvi and the Polvijarvi Town Council. The first community consultation session, held in December 2005, resulted in Vulcan commissioning a Social Impact Study of the mine by Jyväskylä University. The findings from this study were largely positive, indicating a significant benefit to the local community in terms of increased employment and indirect benefits. Overall, Jyväskylä University concluded that the project was 70% community positive. Negative impacts were identified as increased traffic flows and the potential of groundwater contamination. The Social Impact Study predicted a 3% total increase in the traffic levels. Vulcan will address the groundwater issue by establishing a 'closed circuit' between the mine, the TSF, and the old talc pits which are expected to supply the process water.

Vulcan expects to apply for its environmental permit to operate in November 2006 and expects to receive approval in the third quarter of 2007.

## **5.0 NICKEL PROJECTS**

### **5.1 INTRODUCTION**

Finland has a well established history of nickel sulphide mining and processing, though most exploitation has focussed on nickel-copper deposits in deformed mafic intrusions, principally within orogenic belts in central and southwestern Finland. It has only been within the last 15 years that the nickel and gold potential of Archean greenstones in eastern Finland has been recognised.

Due to the depressed nickel market during the 1990s, the extent of modern exploration for nickel within the Kuhmo and Suomussalmi greenstone belts of eastern Finland has been limited, though the work that has been carried out is both of high quality and well documented within both the private and public sectors.

Vulcan has a major ground holding in the Kuhmo-Suomussalmi greenstone belt and has access to the large database of previous exploration work carried out by the Finnish Geological Survey and by Outokumpu Oy between the 1960s and the 1990s. All of Vulcan's prospects in the Kuhmo-Suomussalmi belt are managed through the Kuhmo Nickel Joint Venture, in which Vulcan holds 95% via its wholly owned Finnish subsidiary Kuhmo Metals Oy and in which Polar Mining Oy, a subsidiary of Dragon Mining NL holds the remaining 5%.

### **5.2 KUHMO NICKEL JOINT VENTURE**

#### **5.2.1 Location and access**

Vulcan's nickel interests in Finland are located between the regional centres of Kuusamo in the north, and Kuhmo in the south within eastern Finland (Figure 5.1). Access throughout the Kuusamo-Kuhmo area is facilitated by sealed highways, roads and unsealed tracks, with many of the known nickel occurrences being located in close proximity to sealed highways.

The joint venture area is sparsely populated, although small towns exist along the main arteries providing local supply and procurement services, in addition to specialist mining and exploration services from regional centres.

The dominant industry in the project area is primary forestry and winter-based tourism. The terrain is characterised by low, rolling hills locally dissected by streams, but generally interspersed with wide rivers and lakes. The weather is characteristic of sub-arctic latitudes, with cold prolonged winters and extensive snowfall. The amount of daylight is highly dependent on seasonality, with the midnight sun for Kuusamo occurring between June 12 and June 30.

### 5.2.2 Tenure and ownership

In October 2004 Vulcan announced it had entered an agreement to acquire three development and exploration projects in Finland from Dragon Mining NL. As part of this agreement, Vulcan holds a 95% interest in the non-gold rights and a 5% interest in the gold rights to the Kuhmo joint venture (Kuhmo JV) with Dragon subsidiary, Polar Mining Oy. Polar Mining retains a 5% free carried interest in the non-gold rights and a 95% interest in the gold rights to the Kuhmo JV.

In April 2005, the Kuhmo JV partners entered a separate access agreement with Tulikivi Oyj (Tulikivi), whereby Tulikivi will explore the Kuhmo JV tenements for building stone and the Kuhmo JV partners may explore Tulikivi's tenements for non-gold related minerals.

The Kuhmo JV project area comprises 61 tenements covering a combined area of approximately 40 km<sup>2</sup> (Table 5.1 and Figure 5.2). Vulcan has grouped these tenements into the five key project areas, which broadly from north to south are:

- the Vaara project (lease group Vaara-Kauniinlampi)
- the Kiannanniemi project (Kiannanniemi)
- the Hyrynsalmi project (Arola-Harma North)
- the Riihilampi project (Kuhmo Area)
- the Kellojärvi project (Arola-Harma North).

**Figure 5.1 Map of eastern Finland showing regional centres and major roads**



<b>Project</b>	<b>Holder</b>	<b>Number of Leases</b>	<b>Total area (Ha)</b>
Vaara-Kauniinlampi	Kuhmo Metals Oy	6	387.56
Kiannanniemi	Kuhmo Metals Oy	9	224.64
Moisiovaara	Kuhmo Metals Oy	18	1128.81
Arola-Harma North	Kuhmo Metals Oy	12	734.77
Kuhmo Area	Kuhmo Metals Oy	4	151.53
Moisiovaara	Polar Mining Oy	1	815.70
Assorted	Tulikivi Oyj	5	173.3
	<b>TOTAL</b>	<b>56</b>	<b>3,857.11</b>

### 5.2.3 Regional geology

Vulcan's Kuhmo JV tenements form a discontinuous landholding extending over a distance of some 150 km within the Kuhmo and Suomussalmi greenstone belts, part of the larger Karelian Craton. The Karelian Craton is a typical Archean granite-gneiss terrane characterised by narrow northerly trending greenstone belts surrounded by extensive granitoids and higher grade gneiss domains and in this sense closely resembles the northern portion of the Yilgarn Craton of Western Australia.

Located in the western part of the Karelian Craton, the Suomussalmi and Kuhmo greenstone belts are of Archean age and consist of a bimodal volcanosedimentary sequence of mafic-ultramafic lavas and volcanoclastic units which are overlain predominantly by felsic volcanoclastic and sedimentary units. These units have been subjected to predominantly greenschist facies metamorphism, deformed by polyphase folding, shearing and faulting and intruded by dolerites, quartz feldspar porphyries and several large, post-tectonic granitoid bodies. This has resulted in a strong north-south trending fabric, paralleled by a number of regional scale shear and fault systems which are intimately associated with much of the nickel mineralisation of the region. Much of the Suomussalmi and Kuhmo greenstone belts are concealed beneath extensive glacial cover.

The Kuhmo and Suomussalmi belts have a combined strike length of 150 km (Figure 5.2). The belts range between 2 km and 12 km in width with an average width of 6 km. The mafic-ultramafic and volcanoclastic units display the typical curvilinear, geometry of other Archean-age granite-greenstone terranes, with linear segments that splay and terminate against lobate granitoid bodies and isolated remnants of greenstone, which are commonly preserved outside of the main greenstone belts.

**Figure 5.2 Vulcan leases in the Kuhmo-Suomussalmi greenstone belt showing the lease groupings in Table 5.1**



### 5.2.4 Vulcan's exploration model

In contrast to the long mining and exploration history evident in other major Archean granite-greenstone terranes such as the Canadian Shield and the Yilgarn Craton of Western Australia, the greenstone belts of eastern Finland have only seen significant investigation since the 1990s.

The Kuhmo and Suomussalmi belts are amongst the best studied greenstone belts within Finland. These studies suggest that the greenstone sequence and komatiitic units within these sequences are highly prospective for nickel sulphide mineralisation due to their geological and structural similarity with the extensively mineralised Canadian and Western Australian greenstone belts. Similarities include:

- similar age, morphology and deformation history
- the presence of both komatiite lava flow hosted and ultramafic cumulate hosted nickel sulphide mineralisation
- komatiitic units display significant variation in geometries, chemical compositions and rock types, indicative of complex and varied lava fields
- the presence of favourable sulphide rich substrates which may be incorporated into komatiitic lavas and initiate the formation of nickel sulphide mineralisation
- mineralisation intersected to date hosts similar nickel grades and tenors and is accompanied by highly anomalous platinum group element (PGE) and copper values.

Despite the similarities between the Finnish and the Australian/Canadian greenstone belts there are also a number of key differences. The most important difference is the clustered nature of nickel sulphide deposits evident within the Australian and Canadian greenstone belts. These deposits have typically supported a long history of mining, whilst continued exploration has been successful in defining new nickel sulphide deposits (ie Cosmos, Prospero). This can be seen in Figure 5.3, which compares the Agnew-Wiluna greenstone belt of Western Australia with the Suomussalmi and Kuhmo greenstone belts of Finland. This clustered nature is characteristic of ultramafic hosted nickel sulphide deposits.

**Figure 5.3 A comparison map between the SGB and KGB with the Wiluna-Leinster greenstone belt in Western Australia**



Based on the clustered nature of the deposits within the extensively mineralised Canadian Shield and Yilgarn Craton and the lack of systematic regional exploration over much of the Kuhmo JV area, Vulcan believes that the mineralisation encountered to date within the Kuhmo and Suomussalmi greenstone belts is an encouraging indicator of the potential for discovery of additional economically viable nickel sulphide deposits.

### 5.2.5 Vaara region

#### Project description and location

Vulcan's Vaara project area is the most northern project of the Kuhmo JV. Access to the Vaara region is good, being gained by sealed primary and secondary roads which are generally suitable for heavy equipment year round. The landscape consists largely of low sand or till-covered hills forming a gently rolling topography between 230 and 250 meters above sea level. The thickness of sand or till varies between 0.5 and 25 m (average between 2 to 5 m) with only limited outcrop evident within the project area (Figure 5.4).

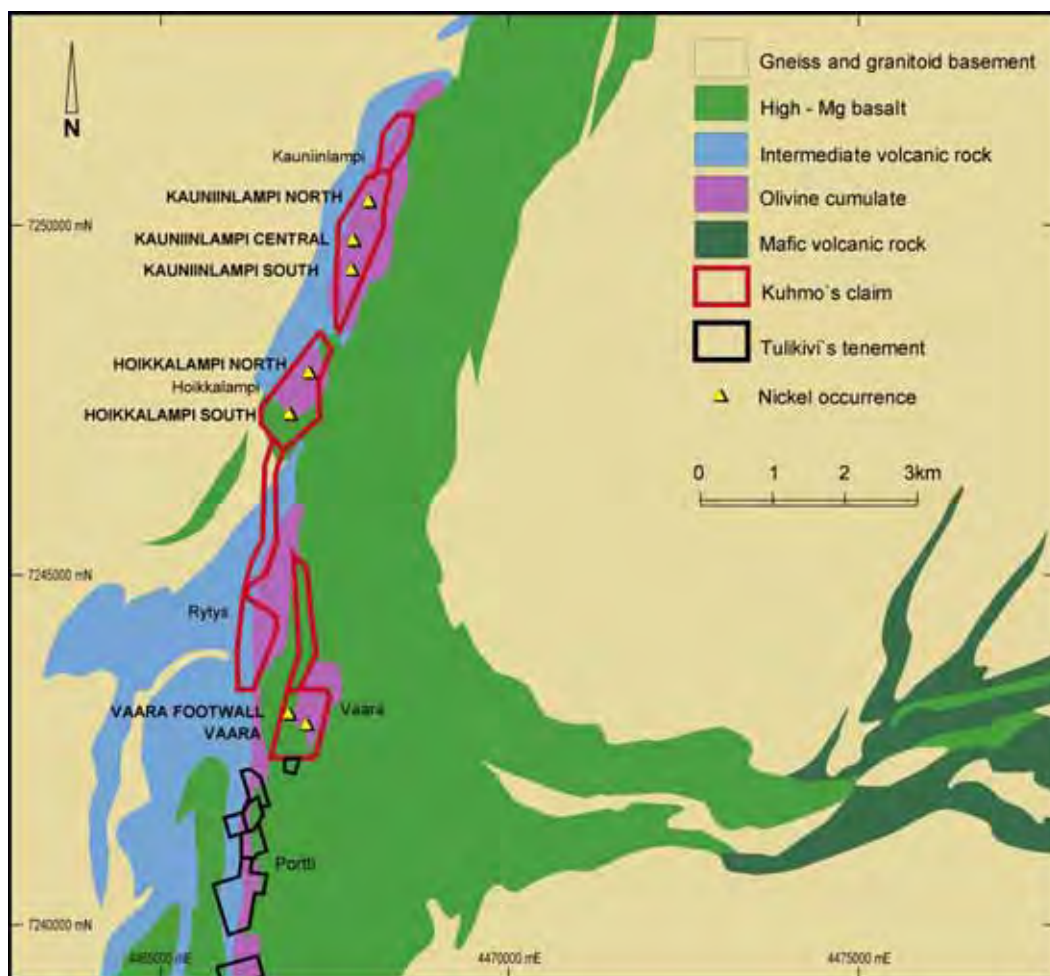
### Geology and mineralisation

The Vaara project covers a sequence of north-northeast trending felsic, mafic and ultramafic units, including five serpentinite lenses known as the Kauniinlampi komatiite cumulate complex. These lenses are developed within a narrow band (up to 0.5 km wide) extending over a 15 km strike length and dipping steeply to the east.

The Kauniinlampi cumulate complex is known to host seven nickel occurrences within the Kuhmo JV tenements. From north to south, these occurrences are as described below.

- Kauniinlampi North, Central and South prospects, which comprise remobilised nickel sulphide mineralisation derived from komatiitic source rocks. The main prospect is Kauniinlampi North, where nickel sulphide mineralisation occurs within altered and sheared cumulate rocks within a northwest trending, northeast dipping fault zone. The principal nickel mineral is pentlandite, with lesser heazlewoodite and with grades varying up to 4.27% nickel.
- Hoikkalampi North and South prospects, which contain disseminated nickel sulphide mineralisation within cumulate lenses.
- The Vaara Footwall prospect, which comprises stringer mineralisation within footwall komatiitic units.
- The Vaara prospect which has disseminated sulphide mineralisation hosted within olivine mesocumulate rocks.

**Figure 5.4 Simplified geology of the Vaara project showing the location of the known nickel sulphide occurrences**



### Previous exploration

The Vaara project area has previously been the subject of concerted, albeit sporadic nickel exploration, with the majority of the previous work focussed towards the assessment of the strike and depth extents to the known deposits. Whilst these programmes delineated some reasonably substantial widths of nickel sulphide mineralisation and demonstrated the continuity of the mineralised channels at depth, no high grade zones were identified.

The most recent exploration campaign was completed by Outokumpu, which conducted a programme of renewed geological mapping, boulder sampling and ground based electromagnetic (EM) and magnetic geophysical surveying. Outokumpu completed extensive diamond drilling programmes at Hoikkalampi and Kauniinlampi North prospects between 2000 and 2001. This drilling confirmed the nature of the previously defined nickel sulphide mineralisation; however, no additional

work was carried out. No drilling was completed at Vaara. Of significance however, was the intersection of disseminated and stringer pyrrhotite-chalcopyrite-nickel sulphide mineralisation within talc-chlorite altered komatiite units to the west of Vaara.

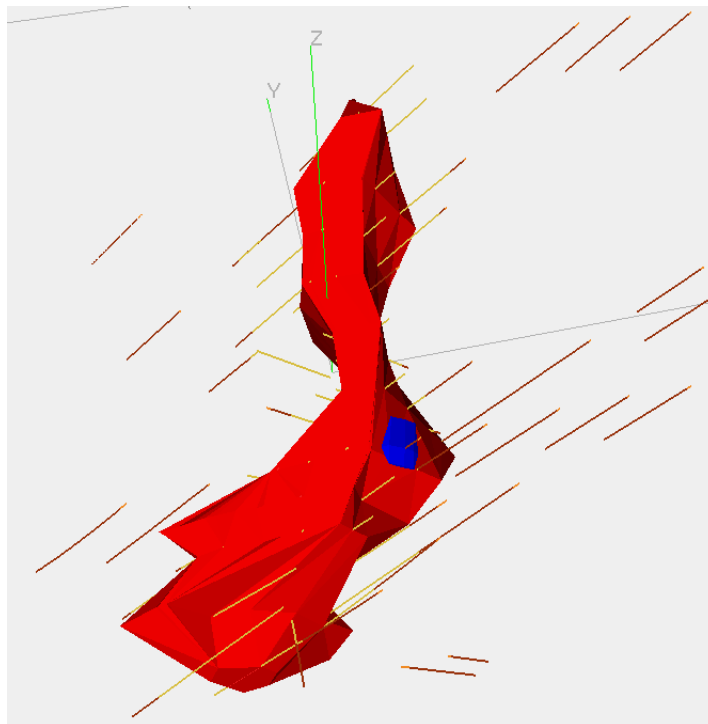
#### Resource estimate

Snowden completed a resource estimate for the Vaara nickel sulphide deposit in August 2006. The estimate was based on diamond drilling completed by Outokumpu and other previous tenement holders. The interpretation and reporting was carried out on the basis of nickel equivalent grades, which consider copper, cobalt, palladium, platinum, and gold grades in addition to nickel. Snowden's estimate for the Vaara nickel sulphide deposit above a nickel equivalent grade of 0.3% nickel total cut-off grade is summarised in Table 5.2.

The Vaara deposit is known to host disseminated nickel mineralisation within narrow, steeply east-dipping lenses. The main lens (Lens A) is roughly 550 m in length and 85 m wide near the centre and dips steeply to the east. Lens A contains a flexure in the middle of the deposit which swings the strike orientation from north-south to a southwest orientation (Figure 5.5). A minor ore body, lens B, is situated wholly within felsic volcanics, and was included in the resource estimate. The disseminated sulphides are of high tenor with the main recognised sulphide minerals being millerite (50-75 % of sulphides) and pyrite. Talc and carbonate are the dominant gangue minerals.

<b>Table 5.2 Vaara Mineral Resource at September 2006</b>						
<b>Resource Classification</b>	<b>Tonnes (Mt)</b>	<b>Ni (%)</b>	<b>Cu (%)</b>	<b>Co (%)</b>	<b>Pt (g/t)</b>	<b>Pd (g/t)</b>
Indicated	2.4	0.37	0.03	0.01		
Inferred	3.7	0.33	0.02	0.01		
<b>Total</b>	<b>6.1</b>	<b>0.35</b>	<b>0.03</b>	<b>0.01</b>	<b>0.25</b>	<b>0.25</b>

**Figure 5.5 Orthogonal view of the Vaara Lens A (red, 550 m long) and B (blue) looking north**



#### Exploration potential

Snowden has drawn the following conclusions on the exploration potential of the Vaara project area from its review of the exploration work completed to date.

- The Vaara project area contains a number of nickel sulphide occurrences which have been the subject of limited exploration. The most notable are at the Kauniinlampi, Hoikkalampi, Rytys and Portti prospects where the footwall contact to the known mineralisation remains largely untested.
- A potential target with a historical resource estimate in the order of 0.4 Mt to 0.6 Mt at between 0.4% and 0.6% nickel was previously outlined at the Kauniinlampi prospect.

- The Kuhmo JV has not drilled any holes at the Kauniinlampi prospect to date.
- Widely spaced drilling at the Hoikkalampi prospect previously encountered low grade disseminated sulphide mineralisation.
- The source for nickel sulphide mineralisation within a glacial boulder at the Rytys prospect remains to be located.
- The Portti prospect does not appear to have been subject to modern systematic nickel sulphide exploration due to the presence of a soapstone quarry over much of the project area.
- The poorly known southwestern footwall contact to the Vaara mineralisation remains to be adequately tested.
- There are six polymetallic geochemical anomalies and numerous untested magnetic anomalies dispersed throughout the Vaara project area.
- Despite the presence of thick mineralised ultramafic bodies over a 9 km strike length, the detailed geology of the Suomussalmi greenstone belt is not well known.
- Previous exploration has been hampered by the presence of thick till cover and limited drilling. Geophysical exploration has also been constrained by extensive sulphidic sedimentary units throughout much of the project area.

## 5.2.6 Kiannanniemi region

### Project location and description

The Kiannanniemi project area lies approximately 85 km south of the Kuusamo township and some 10 km to the southwest of Vulcan's Vaara project area (Figure 5.2). The Kiannanniemi project hosts two nickel deposits, Hietaharju in the south and Peura-aho in the north. The Hietaharju deposit lies approximately 1 km southwest of the Kiannanniemi village, whilst the Peura-aho deposit is located 5 km north of Kiannanniemi. Both deposits are accessible by public gravel roads and secondary tracks.

### Geology and mineralisation

The Kiannanniemi project is located within the southern portion of the Suomussalmi greenstone belt. The project overlies a thick package of northwest to northeast trending mafic and felsic volcanic, black schist and ultramafic units. The ultramafic units are typically serpentinite or talc-carbonate lenses regarded as altered komatiite or high-magnesian basalt units. This sequence has been complexly deformed and cut by a number of northwest to southeast trending faults (Figure 5.6).

The Hietaharju prospect is associated with a north-northeast trending talc-carbonate unit which dips steeply east. The sequence is interpreted to dip vertically or to be overturned, with an eastern quartzo-feldspathic schist and a western pyritic schist hosted within komatiitic basalt within the stratigraphic hangingwall.

The Peura-aho prospect lies along a northeasterly plunging anticline, where a 50 m thick altered komatiite flow or sill overlies a sheared felsic volcanic unit (Figure 5.6). Nickel sulphide mineralisation at Peura-aho occurs as disseminated sulphides within serpentinite and massive sulphide mineralisation within footwall quartzo-feldspathic schist.

Mineralisation at Hietaharju occurs as a series of massive sulphide breccia and disseminated sulphide lenses within talc-carbonates and serpentinites interpreted to be olivine ortho- to mesocumulate host rocks. In comparison, nickel sulphide mineralisation at Peura-aho occurs as disseminations within talc-carbonate rich fault zones and as massive and vein hosted mineralisation within quartzo-feldspathic schist. Nickel sulphide mineralisation within the Kiannanniemi region is generally of low nickel tenor, even in massive sulphide accumulations. The sulphide assemblage, although low in nickel, is relatively high in copper and PGE.

### Previous exploration

The Kiannanniemi region has been subject to extensive nickel exploration since the 1960s when massive nickel sulphide mineralisation was identified at Hietaharju and Peura-aho. Subsequent exploration has been limited and has largely focussed on assessing the strike and depth extents to these deposits, with minimal nickel exploration undertaken on a regional basis despite widespread gold exploration in the 1990s.

Recent work by Vulcan as part of the Kuhmo JV has included till geochemical sampling, airborne magnetic and EM and ground-based mise-a-la-masse geophysical surveying followed by infill diamond drilling. This drilling intersected a number of moderate to wide zones of low grade nickel, copper and PGE mineralisation at both Peura-aho and Hietaharju.

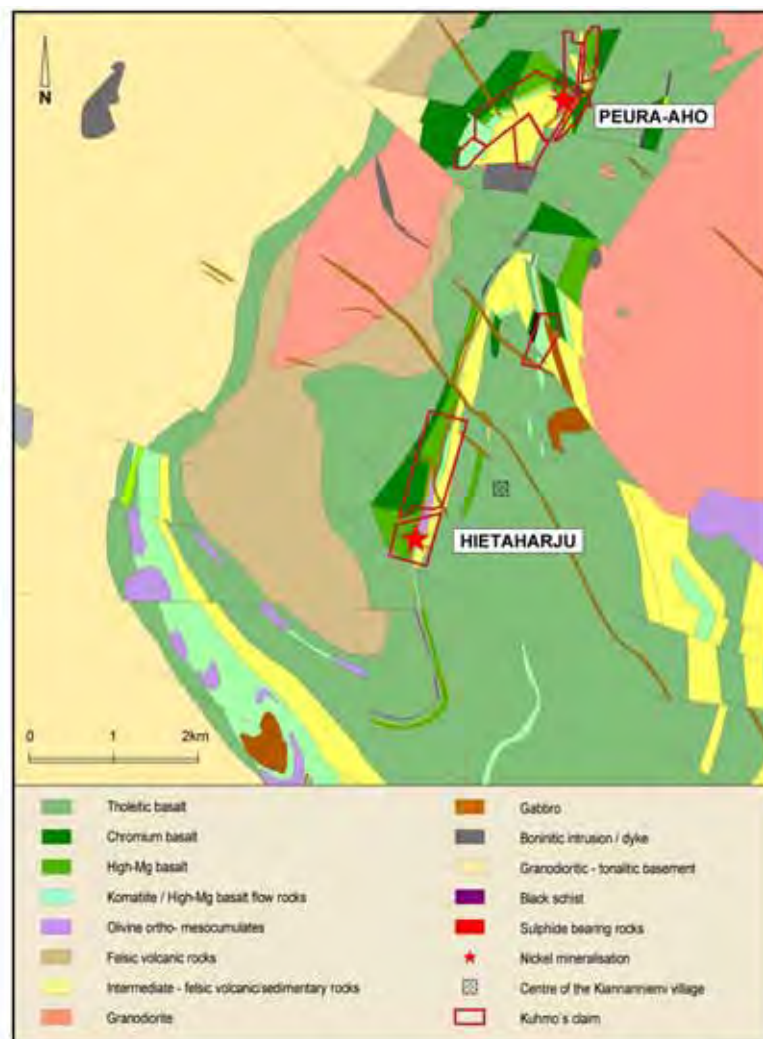
### Resource estimates – Hietaharju and Peura-aho

Snowden completed resource estimates for the Hietaharju and Peura-aho nickel sulphide deposits in September 2006. These estimates were based on diamond drilling completed by previous tenement holders and by the Kuhmo JV partners. Snowden's estimates for the Peura-aho and Hietaharju nickel sulphide deposits above a nickel equivalent grade of 0.3% nickel total cut-off grade are summarised in Table 5.3.

Table 5.3 Peura-aho and Hietaharju Mineral Resources at September 2006						
Peura-aho						
Category	Tonnes (Mt)	Ni %	Cu %	Co %	Pt (g/t)	Pd (g/t)
Indicated	0.4	0.50	0.21	0.03		
Inferred	0.2	0.53	0.26	0.03		
<b>Total</b>	<b>0.6</b>	<b>0.51</b>	<b>0.22</b>	<b>0.03</b>	<b>0.18</b>	<b>0.4</b>
Hietaharju						
Category	Tonnes (Mt)	Ni %	Cu %	Co %	Pt (g/t)	Pd (g/t)
Indicated	0.4	0.64	0.36	0.04		
Inferred	0.6	0.45	0.22	0.03		
<b>Total</b>	<b>1.0</b>	<b>0.53</b>	<b>0.28</b>	<b>0.03</b>	<b>0.19</b>	<b>0.26</b>

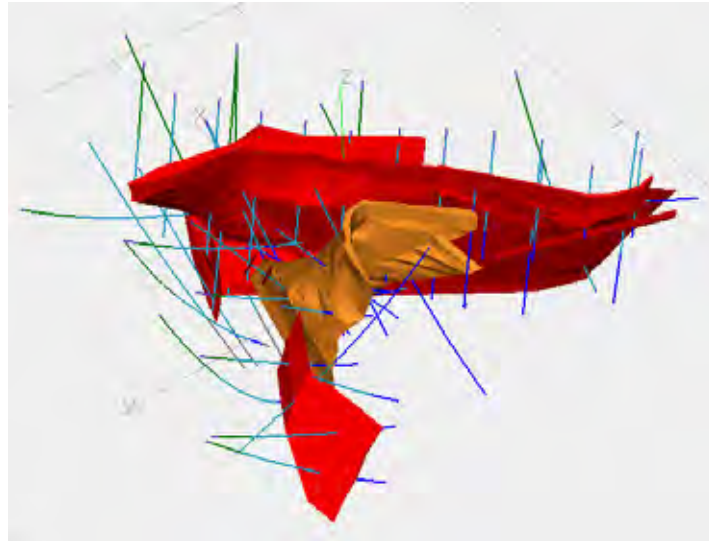
Snowden's resource estimate for the Peura-aho deposit was based on the interpretation of two distinct sulphide lenses, Lens A and Lens B, which were interpreted to dip steeply away from the fold axis. Lens A is interpreted to represent disseminated nickel and copper bearing sulphides within serpentinite. It is well developed on the southern side of the host fold and includes a number of satellite lenses nearby, whereas on the northern fold limb it is less well developed.

Figure 5.6 Simplified geology map of the Kiannanniemi project showing the location of the Peura-aho and Hietaharju prospects



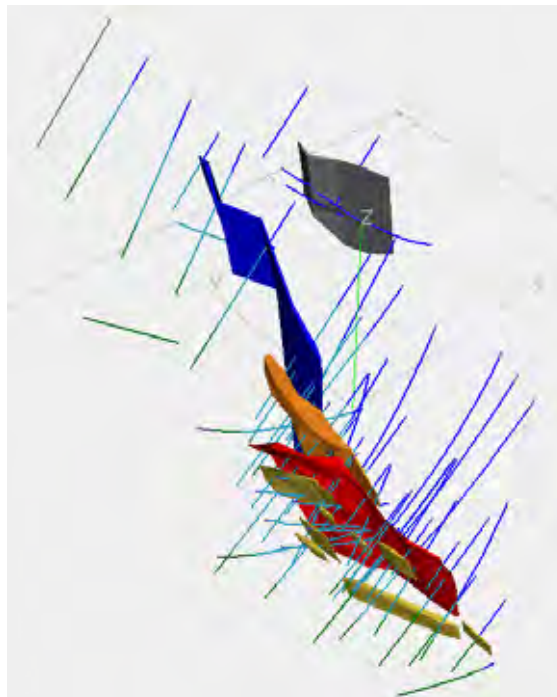
Lens B includes massive and semi-massive nickel bearing sulphide mineralisation within the footwall felsic units. The lens occupies the hinge of the fold within the footwall to Lens A. The near surface strike length of the southern limb of Lens A is almost 300 m and approximately 120 m for Lens B (Figure 5.7).

**Figure 5.7 Peura-aho resource model - view looking southwest showing Lens A (red, 300 m long) and Lens B (orange)**



The Hietaharju deposit has been interpreted by Vulcan and Snowden to comprise two main deposit lenses, A and B, and several thin lenses located to the west and northeast of the main lenses (Figure 5.8). The two main lenses are orientated north-south and dip steeply to the east. The main lens, Lens A is about 200 m long, varies in width from 1 to 10 m and includes both disseminated mineralisation within talc-carbonate altered ultramafic units and massive sulphide breccia veins within chlorite-amphibolite rock or along the contact between talc-carbonate and chlorite-amphibolite altered rocks.

**Figure 5.8 Hietaharju resource model – view looking northeast showing Lens A (red, 200 m long), B (orange), C (blue), D (yellow) and E (grey)**



#### Exploration potential

Snowden has drawn the following conclusions on the exploration potential of the Kiannanniemi project area from its review of the exploration work completed to date:

- the northern strike and depth extents to the Hietaharju deposit remain poorly tested and will require further investigation
- several smaller mineralised ultramafic units located to the east of the main Hietaharju deposit are sparsely drilled and remain to be adequately tested
- the footwall contact zone along the southern limb at Peura-aho remains poorly tested at shallow depth
- regional till geochemical sampling in proximity to Peura-aho has identified three polymetallic anomalies which require further investigation
- significant geochemical results have previously been returned from nickel bearing boulders located near Hietaharju and Huutoniemi prospects.

### 5.2.7 Hyrynsalmi region

#### Project location and description

The Hyrynsalmi project area comprises a discontinuous tenement package stretching over a 40 km strike length within the central portion of the Kuhmo greenstone belt. The project hosts two significant nickel occurrences, one at Sika-aho in the northern portion of the project area, and another at Arola in the south (Figure 5.9). The Sika-aho occurrence is located approximately 30 km east-southeast of the Hyrynsalmi township and Arola some 35 km to the southeast. Access throughout the project area is excellent, being largely provided by the Kuhmontie Road and secondary tracks.

#### Geology and mineralisation

The geology of the Hyrynsalmi project area is dominated by deformed mafic volcanic and ultramafic units of the Kuhmo greenstone belt. The north-south trending belt ranges in width between 2 and 8 km and has been cut by the regionally significant Tammasuo Shear Zone. The Tammasuo Shear Zone separates a multiply deformed synform of komatiite and basalt in the west from mafic and minor ultramafic units in the east.

The Sika-aho nickel deposit is hosted within sheared felsic, mafic, ultramafic rocks and minor graphitic schists. The nickel deposit is associated with talc-carbonate altered komatiitic cumulates and comprises a one to nine metre wide zone of massive sulphide mineralisation developed over an 80 m strike length. In addition, disseminated and sheared mineralisation is evident over a 150 m strike length to the north-northeast of the massive sulphide mineralisation. Previous exploration has shown the nickel sulphide mineralisation extends to at least 150 m below surface and dips steeply to the southeast.

The Arola deposit is hosted within sheared and quartz-carbonate-chlorite altered basalt units juxtaposed against metasedimentary rocks, including greywackes and phyllites. The Arola deposit can be divided into three distinct zones comprising discontinuous lenses over a 400 m strike length and to 400 m below surface. Two north-northeast trending zones parallel the regional schistosity and shearing direction, whilst the third mineralised zone cross-cuts the schistosity at an acute angle. The more coherent of sulphide lenses are interpreted to plunge approximately 40° to the north.

#### Previous exploration

The Hyrynsalmi project tenements host a number of areas of concealed nickel sulphide mineralisation. These occurrences were discovered by diamond drilling completed in the early 1960s designed to test a number of till geochemical and electromagnetic geophysical anomalies. This programme led to the discovery of the Arola deposit in 1963. Follow-up geochemical sampling, geophysical surveying and diamond drilling programmes were completed between 1970 and 1998, and as a result the Sika-aho deposit was discovered in 1994. GTK reported a resource estimate (which has not been classified under JORC) of 0.175 Mt at a grade of 0.665 % nickel at Sika-aho above a 0.35% nickel cut-off in 1998. Similarly, a resource estimate of 0.5 Mt at a nickel grade of 0.5% (with no cut-off specified) was reported for Arola in 1993.

More recent exploration has included till geochemical sampling, low level (30 m) airborne electromagnetic and magnetic geophysical surveys over the Sika-aho and Arola project areas and percussion and diamond drilling by the Kuhmo JV partners in 2005. The diamond drillholes were designed to test geochemical and/or geophysical anomalies at the Luokkivaara, Kelosuo and Arola South prospects. Only minor and thin chalcopyrite-pyrrhotite and pyrite sulphide veins/stringers were encountered and no significant assays were returned; however, these results do not appear to adequately explain the tenor of the till geochemical anomaly. Further investigation is required.

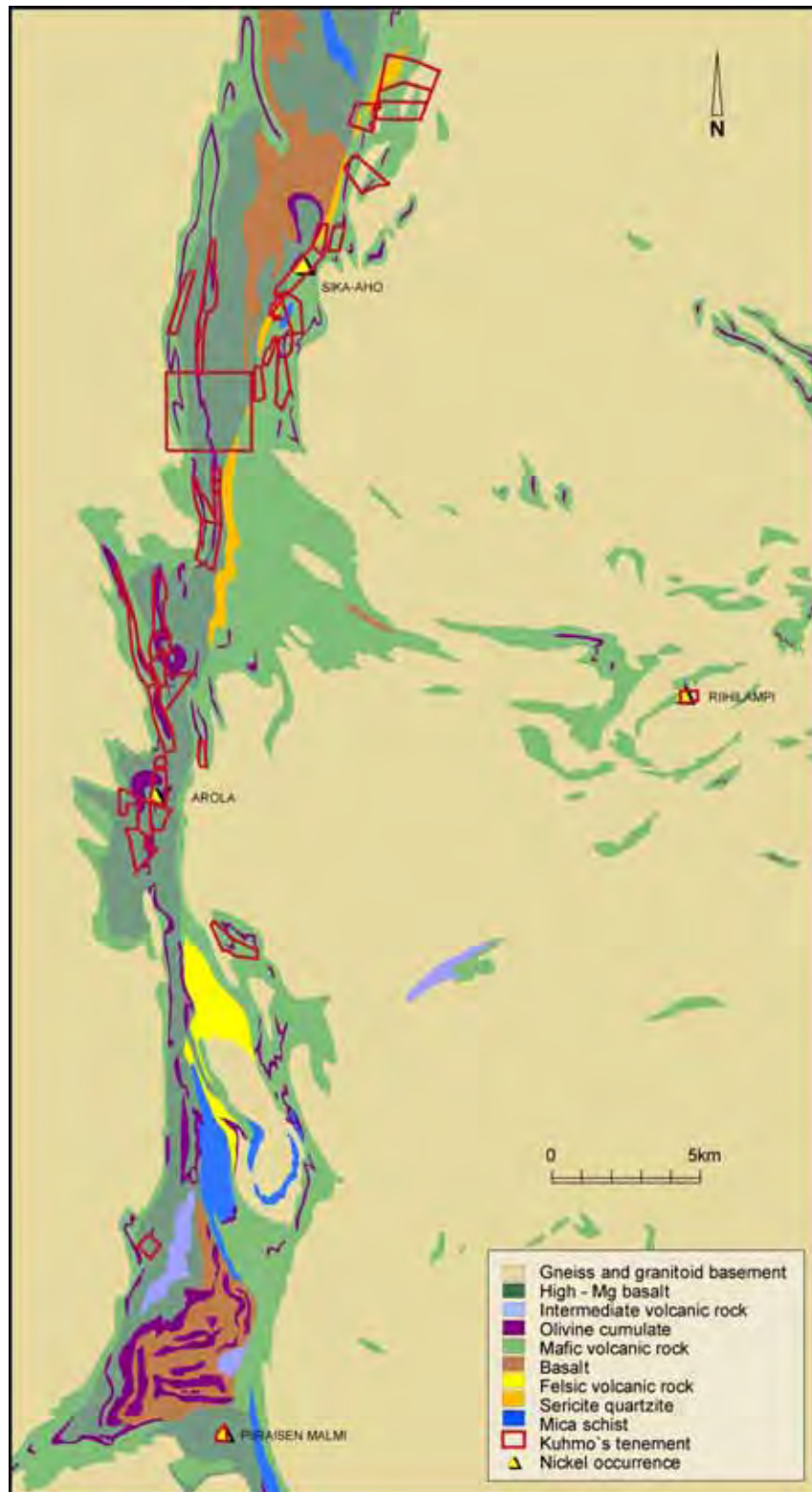
#### Exploration potential

Snowden has drawn the following conclusions on the exploration potential of the Hyrynsalmi project area from its review of the exploration work completed to date:

- a potential target in the order of 0.15 Mt to 0.18 Mt at between 0.6% and 0.7% nickel was previously outlined at Sika-aho
- the southern extensions to ultramafic belt hosting the Sika-aho deposit remain poorly known, with numerous till geochemical, coincident magnetic and EM geophysical anomalies evident
- a poorly known ultramafic cumulate body has previously been drilled and outcrops some 300 m east of the Arola deposit

- within the Kelosuo, Karhujärvi and Likosuo-Luokkivaara areas numerous clusters of coincident nickel-copper till anomalies and several coincident EM/magnetic geophysical anomalies are recorded, but do not appear to have been adequately tested
- in addition to the drilled and mapped ultramafic cumulates, geophysical and geochemical anomalies there are several mineralised boulders and outcrops which have previously returned anomalous to low grade nickel sulphide mineralisation.

Figure 5.9 Hyrynsalmi regional geology and mineral occurrences



### 5.2.8 Riihilampi region

Vulcan's Riihilampi project is located approximately 15 km to 20 km east of its Hyrynsalmi project in the Kuhmo region of eastern Finland (Figure 1.1 and Figure 5.1). The project comprises numerous ultramafic and mafic remnants preserved within granitoid (Figure 5.9 and Figure 5.10). Whilst no ultramafic rocks are exposed at Riihilampi, airborne magnetic data and the presence of widespread glacial boulders containing mineralised serpentinite strongly indicate the presence of bedrock ultramafic rocks.

Reconnaissance exploration work has been completed on a selective wide spaced basis since the early 1980s within the Riihilampi project but has met with limited success. This lack of success may reflect the presence of widespread glacial cover sequences across the majority of the project area. Shallow percussion and diamond drilling has defined zones of anomalous bedrock nickel sulphide mineralisation (up to 2% nickel) associated with altered ultramafic units.

Within the Riihilampi project area there are several small untested magnetic geophysical anomalies associated with weak till geochemical anomalies and mapped ultramafic cumulates. Further work is also required to assess the footwall contact to the known disseminated nickel sulphide mineralisation at Riihilampi.

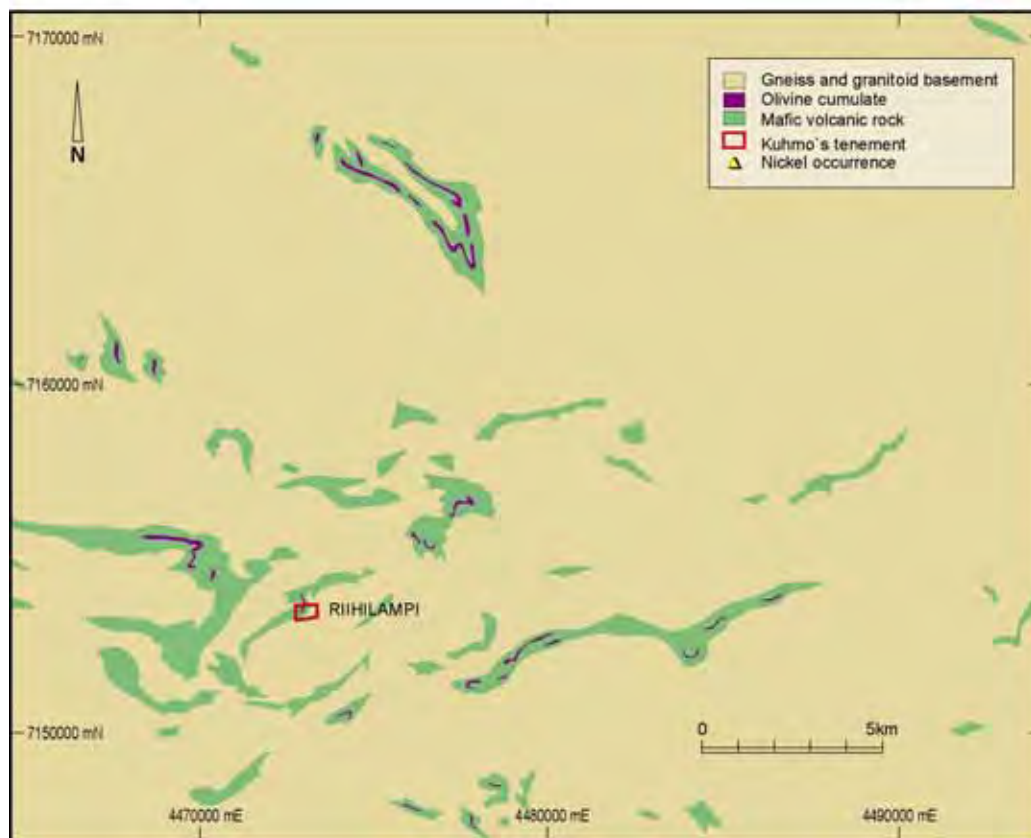
### 5.2.9 Kellojärvi region

Vulcan's Kellojärvi project is located in the southern portion of the Kuhmo greenstone belt and overlies the Kellojärvi ultramafic complex. The Kellojärvi ultramafic complex is interpreted to be the largest komatiitic cumulate body within the Kuhmo greenstone belt and is adjacent to the Piiraisen Malmi nickel occurrence (Figure 5.2). Nickel sulphide mineralisation at Piiraisen Malmi is hosted within a metagabbro at the contact between komatiitic basalt and an ultramafic komatiitic unit.

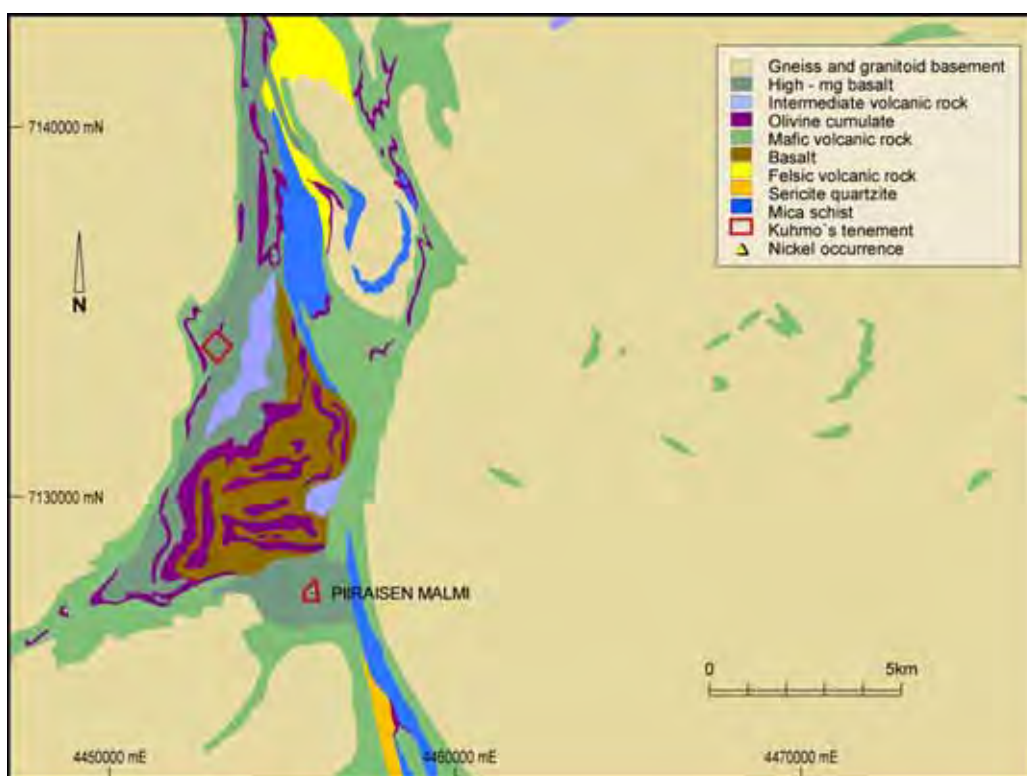
The Kellojärvi project has been the subject of cursory exploration to date, comprising widespread geological mapping and till geochemical sampling, but very little drilling despite the discovery of the Piiraisen Malmi nickel sulphide outcrop in 1978. Subsequent nickel exploration between 1995 and 2003 has provided limited encouragement despite the presence of low to high grade nickel sulphide mineralisation within several glacial boulders and numerous anomalous till geochemical samples.

Despite the area being well mapped and much of the previous geochemical sampling being along close spaced lines, several mapped ultramafic cumulate bodies, magnetic geophysical and till geochemical anomalies remain to be adequately assessed. The source of high grade nickel mineralisation within glacial boulders in the Kellojärvi area remains enigmatic and requires further investigation.

Figure 5.10 Summary geology, prospects and targets at the Riihilampi project



**Figure 5.11 Surface geology of the Kellojarvi project showing the Piiraisen Malmi mineralisation, geology and Vulcan's targets**



### 5.3 VULCAN'S PROPOSED WORK PROGRAMME

Vulcan's planned nickel sulphide exploration programme will focus on the compilation, verification and critical assessment of existing geology and historical exploration data in order to generate new exploration targets for subsequent follow-up assessment. Vulcan proposes to assess these targets through geological mapping, mobile metal ion (MMI), heavy mineral soil and rock chip geochemical sampling, geophysical surveying, and diamond drilling.

In concert with this target generation phase, Vulcan plans to:

- Undertake further evaluation drilling at the advanced prospects at Vaara with a view to upgrading and expanding the currently defined resources.
- Re-evaluate advanced targets, such as structural-stratigraphic positions with favourable geological indicators to define drill targets capable of hosting high-grade nickel sulphide resources. Potential targets include the currently defined mineralisation within the Vaara project area and the Sika-aho and Arola mineralisation at Hyrynsalmi.

Snowden considers the work programme proposed by Vulcan to be well conceived and provides adequate consideration of the differing styles of mineralisation and maturity of the targets to be assessed. These work programmes have been designed to realise the potential of the project areas in a prudent and efficient manner whilst defining and upgrading the known nickel sulphide mineralisation during 2007.

## 6.0 OTHER EXPLORATION PROJECTS

### 6.1 VANADIUM PROSPECTS

#### 6.1.1 Introduction and exploration strategy

In keeping with its copper and nickel strategy, Vulcan has targeted a style of mineralisation that is well understood and has a long history of mining and processing in Finland. Despite little modern exploration over the majority of its project areas, past production in combination with the available geophysical and geological data indicate the potential for large vanadium deposits. The styles of vanadium mineralisation evident within Vulcan's project areas have several well known analogues, including Highveld Steel in South Africa and Balla Balla and Windimurra in Australia. Vulcan's vanadium strategy is a medium-term one in which success will probably see a joint venture with a significant iron ore miner or steel producer.

Vanadium is used primarily in steel and alloy production to provide additional strength and malleability. Only 20% of the world's vanadium is mined as a primary product, with the balance being produced as by-products of the iron and steel, oil refining, power generation and uranium enrichment industries.

### 6.1.2 Location and access

Vulcan holds five project areas in central and northern Finland which it considers to be prospective for mafic-hosted vanadium mineralisation. These project areas encompass or lie adjacent to two former world-class vanadium mining operations. As a consequence the supporting infrastructure and expertise for the projects is of the highest quality.

The location of Vulcan's vanadium projects is outlined in Figure 6.1. Vulcan has grouped its vanadium tenements into five project areas, which broadly from north to south are:

- Koitelainen project
- Akanvaara project
- Porttivaara project
- Syöte project
- Otanmäki project.

Access to the Syöte, Porttivaara and Otanmäki project areas is excellent due to the previous vanadium-iron mining operations within or in the vicinity of these project areas. The more remote Akanvaara and Koitelainen project areas are accessible from secondary sealed and unsealed roads.

**Figure 6.1 Location of Vulcan's vanadium prospects in Finland along with key steel works**



### 6.1.3 Tenure and Ownership

In March 2006, Vulcan announced it had acquired a major vanadium deposit, a number of vanadium prospects and extensive exploration tenure covering a combined area of 213 km<sup>2</sup> within central and northern Finland (Table 6.1). All these tenements are held by Vulcan's wholly owned Finnish subsidiary, Kylylahti Copper Oy.

<b>Tenement Number</b>	<b>Type</b>	<b>Name</b>	<b>Area (ha)</b>	<b>Registered Owner</b>	<b>Grant Date</b>
2005155	Reservation	Porttivaara-4	3,534	Kylylahti Copper Oy	24/01/2006
2005155	Reservation	Syöte 1-4	3,596	Kylylahti Copper Oy	24/01/2006
200602	Reservation	Vuolijoki	4,390	Kylylahti Copper Oy	27/02/2006
200606	Reservation	Otanmäki, Vuorokas	1,796	Kylylahti Copper Oy	27/02/2006
200608	Reservation	Akanvaara 1-2	1,797	Kylylahti Copper Oy	27/02/2006
200664	Reservation	Koitelainen 1-4	3,562	Kylylahti Copper Oy	12/04/2006
200679	Reservation	Koitelainen 5-7	2,660	Kylylahti Copper Oy	12/04/2006
<b>TOTAL</b>			<b>21,335</b>		

#### **6.1.4 The vanadium industry in Finland**

Finland has an established history of mining and downstream processing of vanadium, supported by two world class vanadium mines at Mustavaara and Otanmäki. Together, these mines are estimated to have produced some 10% of the world consumption of vanadium between the 1950s and the 1980s. Both mines closed during the 1980s due to the exhaustion of shallow resources and depressed commodity prices.

The Otanmäki mine generated an estimated 30 million tonnes of ore between 1963 and 1985, and produced both magnetite and ilmenite concentrates along with vanadium pentoxide (V<sub>2</sub>O<sub>5</sub>) via roasting and leaching of magnetite.

The Mustavaara mine generated 13.4 million tonnes of ore with a grade of 0.2% vanadium and produced 27,000 t of vanadium metal from a magnetite concentrate again generated by roasting and leaching.

#### **6.1.5 Regional geology**

Vanadium mineralisation within Finland is largely hosted within layered mafic intrusions where it typically occurs as vanadium and magnetite-rich horizons within gabbroic units. These layered mafic intrusions are of similar style and origin to that of the vanadium-bearing Windimurra and Balla Balla mafic intrusions of Western Australia and the Mapochs iron-vanadium mine in South Africa.

Layered mafic intrusions occur in a number of locations within the Fennoscandian Shield in Finland, having been emplaced during several episodes of crustal rifting in the Late Achaean and Early Proterozoic. To date, the most economically significant deposits are located in central Finland; however, the layered intrusions of northern Finland have not been subjected to same level of exploration.

##### Regional geological setting of the Syöte and Porttivaara projects

Vulcan's Syöte and Porttivaara project areas are located in central Finland and overlie portions of the Koillismaa Layered Igneous Complex (Figure 6.2). The Koillismaa Layered Igneous Complex is one of numerous mafic layered intrusions emplaced in the Fennoscandian Shield during the Proterozoic. The igneous stratigraphy of the layered intrusion can be divided into two principal zones, known as the Marginal Series and Layered Series. The basal Marginal Series ranges from 50 m to 250 m in thickness, and is overlain by the Layered Series. The Layered Series (which is shown in Figure 6.2) is up to 3,000 m thick and comprises a lower mafic sequence of norite and gabbro-norite (shown in green) which is overlain by anorthosite and magnetite-bearing gabbro layers (shown in light brown and dark brown respectively).

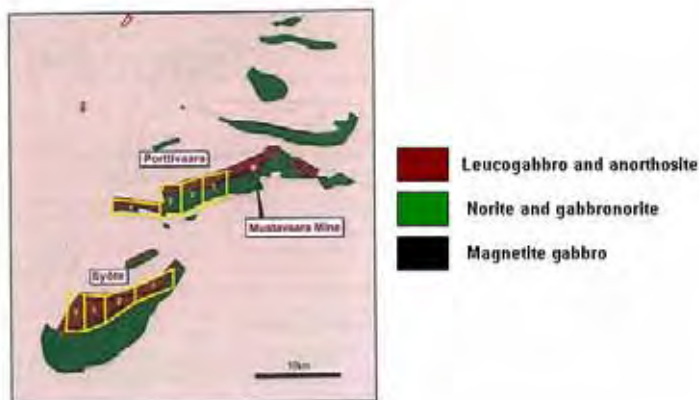
#### **6.1.6 Porttivaara project**

The Porttivaara project is located approximately 15 km along strike and to the west of the former Mustavaara mine, which lies outside Vulcan's project area (Figure 6.2). The Mustavaara mine was developed over a 200 m thick magnetite-bearing gabbro horizon within the Koillismaa Layered Igneous Complex. Vulcan's Porttivaara project is interpreted to overlie the same stratigraphic horizons as those observed at the Mustavaara mine.

#### **6.1.7 Syöte project**

The Syöte project area is located approximately 10 km south-southwest of Vulcan's Porttivaara project in close proximity to major highways, railways and power lines. As a result of structural deformation and tectonic repetition, the prospective magnetite gabbro horizon is much thicker within the Syöte area than elsewhere within the region. Limited diamond drilling within the Syöte project area encountered up to 130 m of magnetite-bearing gabbros. Vulcan has re-assayed core from the Syöte project and has confirmed the original assays. Metallurgical testwork is also underway.

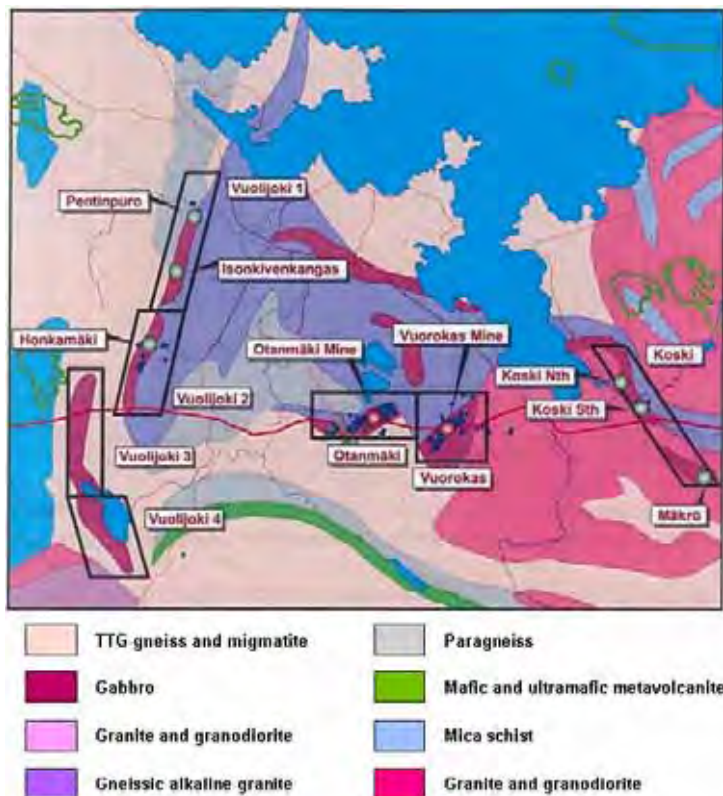
**Figure 6.2 Regional geological map of the Koillismaa layered intrusion showing the Porttivaara and Syöte prospects with Vulcan’s tenements in yellow**



**6.1.8 Otanmäki project**

Vulcan’s Otanmäki project area is located in central Finland, approximately 30 km southwest of the town of Kajaani (Figure 5.1). The Otanmäki project encompasses the former underground Otanmäki and Vuorokas iron-vanadium-ilmenite mines. The former Otanmäki mine was the largest and most important of Finland’s iron ore mines, producing some 29.8 Mt of ore at grades of 33.9% iron, 0.46% V<sub>2</sub>O<sub>5</sub> and 12.7% titanium dioxide between 1953 and 1985. The main mineralised zone is approximately 3 km wide and is hosted within metagabbro, gabbro and anorthosite units along the northern flank of a large gabbro-anorthosite intrusion. The ore comprises irregular, partly elongated lenses of variable size. Previous mining and exploration within the Otanmäki project area has outlined a number of prospective targets (Figure 6.3 – north is towards the top of the diagram) occurring mainly as remnant mineralisation to the former mining operations and collectively containing up to 3 Mt of magnetite rich vanadiferous ore at grades of between 0.25% and 0.5% V<sub>2</sub>O<sub>5</sub>, also containing significant ilmenite.

**Figure 6.3 Simplified geology of the Otanmäki project area showing vanadium targets**

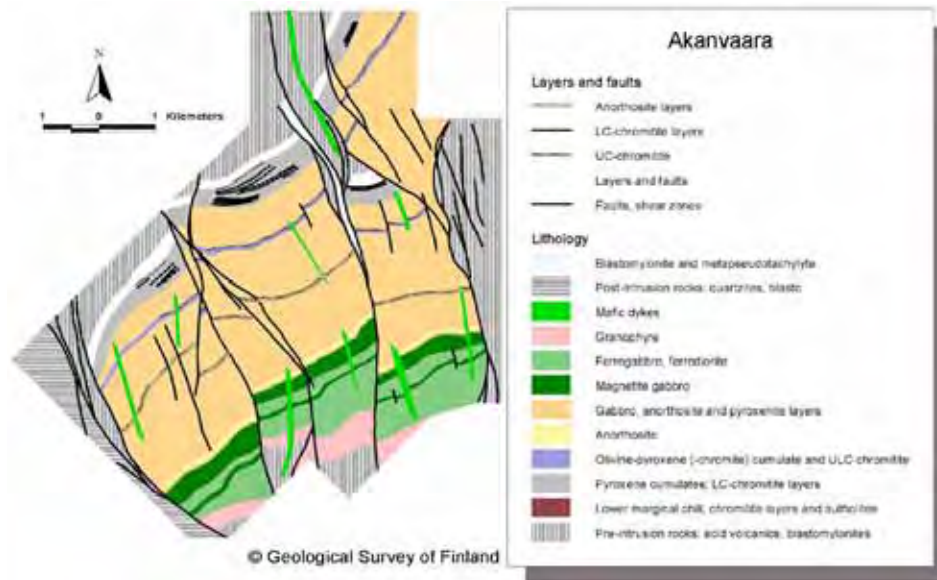


### 6.1.9 Akanvaara project

The Akanvaara project area is located in proximity to the Kamilarvi village in northeastern Lapland (Figure 6.1). The Akanvaara project area overlies the southern margin of the medium sized Akanvaara mafic layered intrusion, which has a surface area of at least 50 km<sup>2</sup> and extends over a west-northwest strike length of approximately 15 km. The intrusion varies in thickness from 2 km in the north to 7 km in the south (Figure 6.4).

The Akanvaara intrusion is interpreted to be a southeast dipping monocline which bound by steep northwest to north-northwest striking faults to the east and west. The eastern fault zone separates the intrusion from older felsic volcanic units and the western fault zone marks the contact between the intrusion and metasedimentary units.

**Figure 6.4 Simplified geology of the Akanvaara mafic layered intrusion**



The Akanvaara project area was extensively explored during the 1990s and then again between 2001 and 2003. Previous geochemical sampling, ground magnetic surveying and limited drilling has outlined anomalous PGE, chromium and vanadium mineralisation within several parts of the Akanvaara intrusion, in particular the northern portion where two horizons of magnetite gabbro are evident; this area was the focus of much of the previous drilling. Despite encouraging vanadium and PGE anomalism, the magnetite gabbro horizons within the southern portions of the Akanvaara intrusion have been subject to limited exploration drilling. Vulcan has pegged two claim reservations, Akanvaara 1 and 2, over the southern portions of the Akanvaara layered intrusion.

### 6.1.10 Koitelainen project

Vulcan's Koitelainen project area is located some 80 km northwest of its Akanvaara project area in northern Lapland. The Koitelainen project comprises 7 claim reservations located over the southeastern and eastern flanks of the Koitelainen mafic layered intrusion. The Koitelainen intrusion is a large, flat lying, oval-shaped body covering an area of some 350 km<sup>2</sup> (Figure 6.5). The Koitelainen intrusion is similar to the Akanvaara intrusion in age and stratigraphy, and can be divided into an ultramafic Lower Zone, a gabbroic Main Zone and a gabbroic Upper Zone containing anorthosite and magnetite gabbros. A granophyre intrusion forms a continuous cap above the mafic succession.

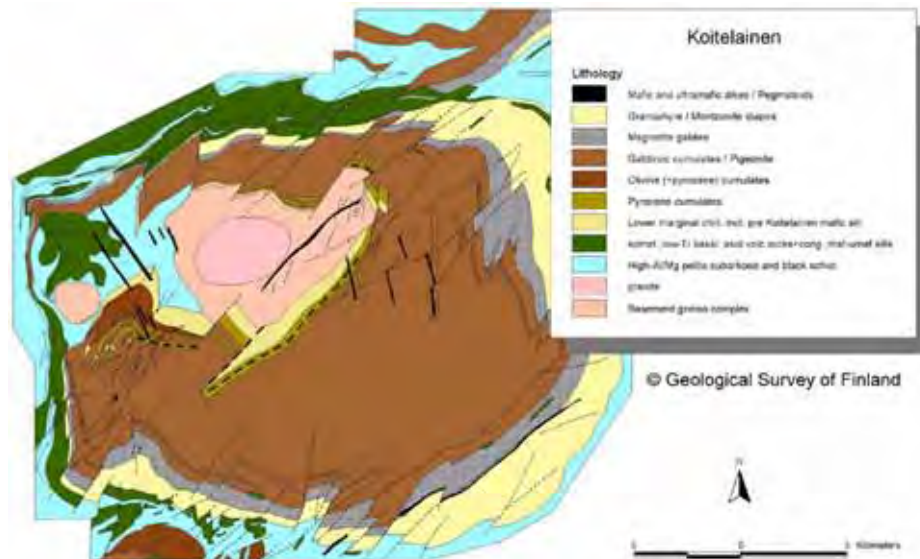
The Koitelainen mafic intrusion was extensively explored between the late 1960s and early 1990s, resulting in the identification of three vanadium-rich magnetite gabbro layers within the eastern portion of the intrusion. These layers range from 20 m to 40 m in thickness with the middle layer being the lowest grade (0.15% V<sub>2</sub>O<sub>5</sub>) whilst the lower and upper layers contain grades between 0.35% and 0.50% V<sub>2</sub>O<sub>5</sub>. Previous widely spaced drilling indicated that there was also a good correlation between vanadium and PGE grades within the magnetite gabbro unit. Vulcan's claim reservations cover these vanadiferous magnetite layers.

### 6.1.11 Exploration potential of Vulcan's vanadium projects

Vulcan holds the exploration rights to a number of layered mafic intrusive bodies within central and northern Finland which are considered by Snowden to be prospective for the discovery of additional vanadium mineralisation. Several of these vanadium project areas overlie or are immediately adjacent to former vanadium mining operations and known deposits, whilst others represent early stage exploration positions with geological attributes considered prospective for mafic-hosted vanadium mineralisation.

Vulcan’s primary objective will be to confirm the potential of the Syöte project area, where previous exploration has intersected vanadium bearing magnetite gabbro horizons over 130 m thick from the surface. Supporting Vulcan’s future exploration efforts are the well developed infrastructure and support networks, the quality of the available technical reporting and associated government institutions and the lack of modern vanadium exploration carried out over Vulcan’s tenements.

**Figure 6.5 The surface geology of the Koitelainen mafic layered intrusion**



## 6.2 TORNIO PLATINUM PROSPECT

### 6.2.1 Introduction

Vulcan’s Tornio project area encompasses a 10 km long layered mafic intrusion located 40 km to the east and outside of the Gold Fields/North American Palladium Arctic Platinum Project hosted within the Penikat and Portimo layered intrusions. Previous exploration at the Arctic Platinum project has outlined some 12 million ounces of platinum, palladium and gold mineralisation which is currently the subject of a Bankable Feasibility Study by North American Palladium. Based on the similar geological setting of the Tornio intrusion to the adjacent Penikat and Portimo layered intrusions, Vulcan has acquired the Tornio project as a conceptual exploration target.

### 6.2.2 Location and Access

Vulcan’s Tornio project area lies in close proximity to Finland’s western border with Sweden (Figure 1.1) and is located 3 km to the northeast of the town of Tornio (Figure 6.6). Access to the project area is gained via a well established and maintained network of roads. Moreover, the Tornio Steel-plant is located in proximity to the project area and ensures ready access to industrial services, supplies and expertise.

**Figure 6.6 Location of the Tornio project area**



### 6.2.3 Tenure and Ownership

Vulcan acquired the Tornio platinum project in October 2004. All tenements are held under Kylylahti Copper Oy. The total project area encompasses 7.78 km<sup>2</sup>, the details for which are shown in Table 6.2.

<b>Claim Number</b>	<b>Name</b>	<b>Holder</b>
7677/1	Tornio 1	Kylylahti Copper Oy
7677/2	Tornio 2	Kylylahti Copper Oy
7677/3	Tornio 3	Kylylahti Copper Oy
7677/4	Tornio 4	Kylylahti Copper Oy
7677/5	Tornio 5	Kylylahti Copper Oy
7677/6	Tornio 6	Kylylahti Copper Oy
7677/7	Tornio 7	Kylylahti Copper Oy
7677/8	Tornio 8	Kylylahti Copper Oy
7677/9	Tornio 9	Kylylahti Copper Oy
7677/10	Tornio 10	Kylylahti Copper Oy
7677/11	Tornio 11	Kylylahti Copper Oy
7677/12	Tornio 12	Kylylahti Copper Oy

### 6.2.4 Regional geology

The Tornio intrusion is the westernmost member of the Tornio-Näränkäväära intrusion belt which forms part of a larger group of layered igneous complexes within the eastern part of the Fennoscandian Shield. These layered mafic intrusions were emplaced during several episodes of crustal rifting in the Late Achaean and Early Proterozoic and are thought to be part of a globally recognised episode of igneous activity which includes the Scourie dykes in Scotland; the Hearst-Matachewan dyke swarm, Copper Cliff Formation and East Bull Lake intrusions in Canada; and the Vestfold Hills and Napier Complex dyke swarms in Antarctica. Structurally the Tornio intrusion is located around an ellipsoidal shaped Achaean basement dome. The broad geology of the intrusion is poorly known due to a lack of outcrop and previous drilling.

Within Finland, three types of PGE mineralisation are known to occur. These are:

- stratiform PGE reefs (with and without base metal sulphide mineralisation or chromite)
- enrichment within disseminated to massive sulphide mineralisation found at the base of layered mafic intrusions
- offset PGE concentrations proximal to, but outside of the layered intrusions.

The Finnish PGE deposits typically have a palladium to platinum ratio of approximately 3 to 1.

### 6.2.5 Local geology

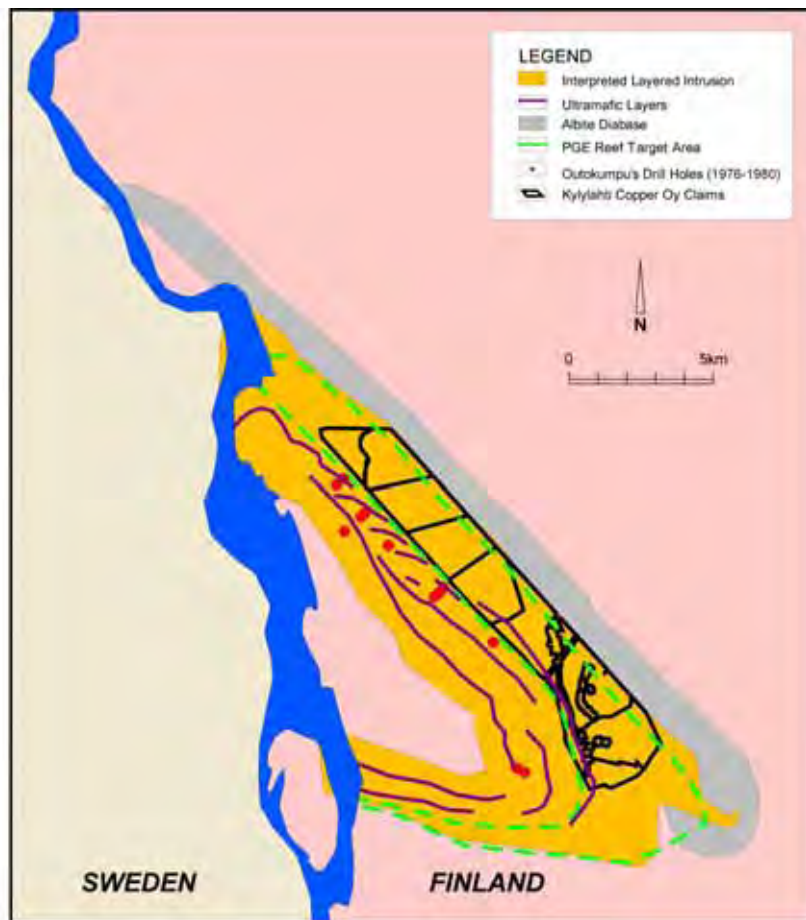
The Tornio layered intrusion has a tightly folded morphology with the axis trending west-southwest and the limbs of the fold appearing to terminate at the Tornio River in the west (Figure 6.7). The northern limb of the Tornio layered intrusion is flanked by an albite diabase. The detailed geology of the Tornio intrusion is poorly known and is largely based upon other well known parts of the Tornio-Näränkäväära layered intrusion belt, such as the Penikat intrusion which lies 40 km to the east.

The Penikat intrusion extends over a total strike length of 23 km and has an average thickness of 2.5 km. It consists of five megacyclic units, characterised by basal ultramafic cumulates, pyroxenites and peridotites which are overlain by gabbroic and anorthositic cumulates. An important peridotite marker horizon is intimately associated with and generally overlies the most significant PGE deposits within the Tornio-Näränkäväära igneous belt. Three PGE reefs have previously been identified within the Penikat intrusion:

- the Sompujärvi reef, comprising two lenses, one about 1 m thick, averaging approximately 8g/t palladium plus platinum plus gold (known as the 3E suite) and the other 2 m wide and grading approximately 17g/t 3E
- the Paasivaara Reef which is typically 1, thick and has average grades less than 1 g/t 3E.

### 6.2.6 Previous exploration

The project area has not been subject to intensive exploration to date, with much of the previous exploration focussed on the chromite potential of the area. Platinum group element values up to 0.9 g/t palladium plus platinum were reported from the chromites.

**Figure 6.7 The Tornio platinum project area geology**

### 6.2.7 Exploration potential

Vulcan's Tornio project area represents a conceptual exploration target which is considered to lie within a similar geological and stratigraphic setting to the Siika-karma reefs at the Arctic Platinum Project within the mineralised Penikat layered intrusion some 40 km to the east. Future exploration would be relatively simple with a first pass geochemical exploration programme undertaken to test the equivalence between the Penikat and Tornio intrusions and to provide a basis for targeted diamond drilling of the prospective PGE-bearing horizon.

## 6.3 HAUKIAHO NICKEL-COPPER-PGE PROSPECT

### 6.3.1 Introduction

Vulcan's Haukiaho project includes a known nickel-copper-PGE deposit within a portion of the Koillismaa Layered Igneous Complex (the KLIC, as discussed in Section 6.1). Haukiaho is considered to have a similar geological setting (albeit on a much smaller scale) to the economically significant Bushveld Complex in South Africa, although the base metal and gold values in the KLIC are higher than that of the Bushveld. Previous exploration has identified that the mineralisation is consistent, predictable and continuous over an approximate 3 km strike length and that it may be amenable to a low grade high tonnage polymetallic style operation.

### 6.3.2 Location and Access

Vulcan's Haukiaho project area is located close to Vulcan's Porttivaara vanadium prospect in central northern Finland (Figure 1.1, Figure 6.1). Access to the project area is via a well established and maintained network of roads; high voltage powerlines are located within 2.5 km of the deposit.

### 6.3.3 Tenure and Ownership

Vulcan acquired the Haukiaho nickel-copper-PGE project in April 2006 via a tender process with the Finnish government. A single tenement of 60.4 km<sup>2</sup> is held over the Haukiaho deposit by Vulcan's 100% owned subsidiary Kylylahti Copper Oy (Table 6.3).

Table 6.3 Haukiahö project – tenement details		
Claim Number	Name	Holder
2006109	Haukivaara	Kylylahti Copper Oy

### 6.3.4 Regional geology

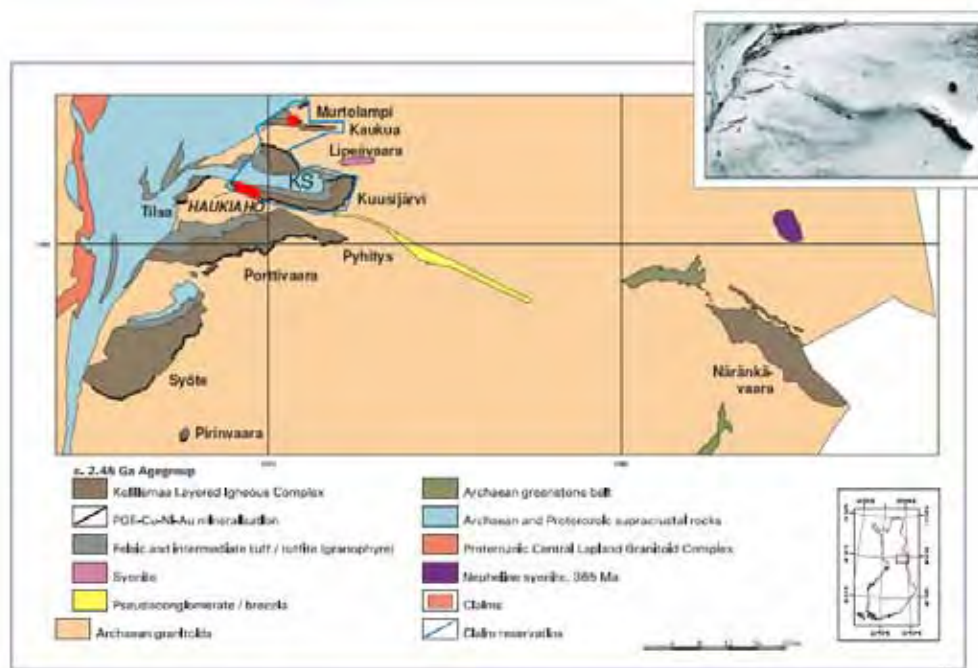
Vulcan's Haukiahö project area is situated within a northern portion of the KLIC, which is covered in Section 6.1.5 and shown in Figure 6.8.

### 6.3.5 Local geology

The Haukiahö project area covers the marginal series and the lowermost layered series cumulates of the Kuusijärvi block in the Western KLIC (Figure 6.8). The project area lies on the southern limb of the Kuusijärvi synform (KS) and locally the stratigraphy dips steeply to the north-northeast. The stratigraphy of the marginal series (which hosts the mineralisation in the Haukiahö project area) is consistent with the rest of the Western KLIC, with the sequence being composed of a gabbroic base followed by pyroxene and olivine cumulates which are overlain by magnetite rich gabbros (Figure 6.9, which shows the GTK leases – Vulcan's leases cover approximately the same area). Within the project area the marginal series is up to a few hundred meters thick, although elsewhere along strike this increases to 1.5 km thick. At the Haukiahö project the nickel-copper-PGE mineralised horizons are constrained to the cumulus units of the marginal series and are associated with disseminated sulphides and thin (10 cm) massive sulphide bands within a mineralised zone that is between 15 m and 40 m thick. The nickel-copper-PGE mineralisation has a relatively high base metal content and a high gold to platinum ratio (Table 6.4). GTK indicates that the total strike length of the mineralised horizon may be in the vicinity of 3 km long, and may average a 20 m thickness and 150 m vertical depth, with much of this falling within Vulcan's tenement.

Table 6.4 Haukiahö project – metal grades and ratios							
Number of Drill Holes	Cu ppm	Ni ppm	Cu+Ni wt. %	Cu:Ni	Pt+Pd+Au ppb	Pd:Pt	Pt:Au
116	3621	2378	0.60	1.56	973	2.64	1.38

Figure 6.8 Location of the Haukiahö project area within the KLIC, with an aeromagnetic image shown in the subset window in the top right



### 6.3.6 Previous exploration

Exploration in the KLIC commenced in the 1960s with a Outokumpu carrying out regional mapping and a diamond drilling campaign of 75 diamond drill holes of which 16 are within the Haukiahö project area. During the early 1980s and early 1990s detailed mapping in conjunction with geochemical sampling and geophysical surveying was carried out. During 1998

and 1999 GTK carried out an extensive exploration programme, including more diamond drilling. Between 2000 and 2002 an extensive ground based and low-altitude airborne geophysical survey was carried out in addition to a diamond drilling programme. After the tenement was relinquished, GTK resumed exploration work on this ground up until 2004. The complete exploration data for all programmes at Haukiaho has been acquired by Vulcan and is centralised, intact, complete and in digital format.

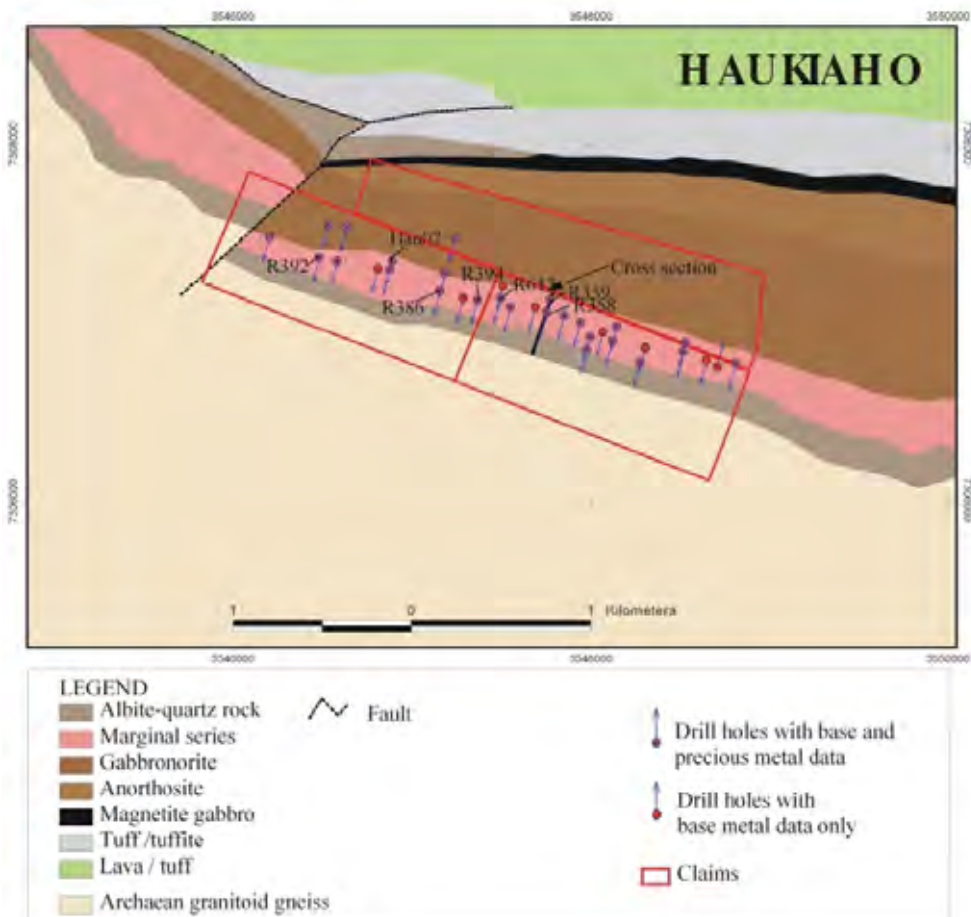
### 6.3.7 Exploration potential

The Haukiaho project area is considered to lie within a similar geological and stratigraphic setting to the deposits of the Bushveld Complex (South Africa) and some of the deposits hosted in the Duluth Complex (Minnesota, USA). Due to the low grades of mineralisation, any commercial concentrations of economic minerals are likely to be associated with one or more large tonnage low grade operations. On such a basis, the GTK outlined a conceptual target of 20 Mt to 30 Mt of ore with grades of:

- platinum - 0.18 g/t to 0.22 g/t
- palladium - 0.5 g/t to 0.55 g/t
- gold - 0.19 g/t to 0.22 g/t
- nickel - 0.2% to 0.25%
- copper - 0.32% to 0.38%.

Future exploration by Vulcan would most likely focus around additional geophysical surveying and infill drilling to better delineate the extent of the mineralisation with view to confirming or improving the GTK conceptual target estimate.

**Figure 6.9 Haukiaho project scale geology and existing drill holes (from GTK)**



## 7.0 COMMENTARY ON EXPLORATION AND PRE-DEVELOPMENT EXPENDITURE

Snowden was requested to review the reasonableness of certain of the technical assumptions within Vulcan's budgeted expenditure relating to exploration and pre-development activities for the 2007 and 2008 financial years (FY, ending in June 2007 and June 2008 respectively). Table 7.1 itemises key expenditure items associated with the Kyllylahti, Kuhmo, vanadium

and Tornio projects. A number of items, such as management fees and overhead costs, are not within Snowden's area of expertise and are not reproduced below. The tabulation also excludes the capital costs of construction and mine development.

Table 7.1 shows that the majority of Vulcan's pre-development expenditure at Kylylahti is forecast to be expended during FY2007, and will be spent upon plant engineering design, geotechnical consulting, tailings testing, environmental studies, and roast/leach testing and cost estimation, all leading to the completion of Vulcan's Definitive Feasibility Study. Pre-development drilling will carry on through FY2007 and FY2008 as production ramps up. At the Kuhmo nickel project all of the expenditure detailed will be split between extension drilling at existing deposits and drill testing of less tested mineralisation, along with geophysical surveys of various types. Vulcan does not plan any exploration expenditure at Kuhmo during FY2008 apart from the tenement rents. Vulcan has budgeted for a small but ongoing exploration programme at the various vanadium projects involving drilling and some metallurgical testwork. The Tornio PGE project will see a small drilling campaign in FY2007 but no expenditure in FY2008.

Snowden believes that the concentration of expenditure on Kylylahti is justified given the advanced nature of the project and the necessity for a cashflow to fund further exploration. Snowden believes that the budget for the exploration and pre-development programme provided by Vulcan is adequate to meet Vulcan's corporate objectives, prime among which is to commence production at Kylylahti before the end of FY2008.

<b>Item</b>	<b>2007 Budget (AUD '000)</b>	<b>2008 Budget (AUD '000)</b>
<b>Kylylahti</b>		
Mining	1,003	30
Engineering and surface facilities	2,729	-
Environmental and permitting	217	20
Geology and drilling	1,843	298
Metallurgy	918	-
<b>Kuhmo</b>		
Pre-development drilling	118	-
Exploration targeting and drilling	247	-
Tenement fees	77	75
<b>Vanadium</b>		
Exploration drilling	125	105
Metallurgy	41	-
Tenement fees	-	12
<b>Tornio</b>		
Exploration and drilling	46	-

## **8.0 DECLARATIONS BY SNOWDEN MINING INDUSTRY CONSULTANTS PTY LTD**

### **8.1 INDEPENDENCE**

Snowden Mining Industry Consultants Pty Ltd is a firm of consultants providing a comprehensive range of specialist technical and financial services to the mining industry in Australia and overseas, through offices in Perth, Brisbane, Johannesburg, Vancouver, and London. Our services include technical audits, project reviews, valuations, independent expert reports, project management plans and corporate advice.

This report has been prepared independently and in accordance with the VALMIN and JORC Codes of the AusIMM. The authors do not hold any interest in Vulcan Resources Limited, its associated parties, or in any of the mineral properties which are the subject of this report. Fees for the preparation of this report are being charged at Snowden's standard rates, whilst expenses are being reimbursed at cost. Payment of fees and expenses is in no way contingent upon the conclusions drawn in this report.

### **8.2 QUALIFICATIONS**

The principal personnel responsible for the preparation and review of this report are Mr Ian Glacken (Group General Manager Resources), Mr Peter Myers (Divisional Manager Mining), Mr Jeames McKibben (Senior Consultant Geologist), Mr Jonathan Bell (Consultant Geologist) and Dr Philip Snowden (Executive Consultant) of Snowden's Perth and Brisbane offices. The Kylylahti processing section was compiled by Mr Narayan Krishnan, Associate Consultant.

Mr Ian Glacken (BSc (Hons), MSc Mining Geology, MSc Geostatistics, Grad. Dip Computing, FAusIMM (CP), MIMMM, MGAA, CEng, DIC) has over 24 years experience in the mining industry and worked with WMC Resources in senior mine geological and ore reserve positions at Kambalda, Olympic Dam and in Perth, working and consulting on resource projects

worldwide. Ian joined Snowden in March 1998 and has specialist skills which include project management, resource estimation, due diligence and auditing, conditional simulation, sampling theory and applications, and reconciliation studies.

Mr Peter Myers (BEng (Min) (Hons), MAusIMM) is a mining engineer with 24 years experience in underground, open pit and dredge mining operations. He has held senior operational and technical roles including those with departmental and whole site management responsibility. He joined Snowden in 2003 and has since taken part in a number of technical reviews, audits and valuations. He has operational experience in copper, nickel, zinc, lead and mineral sands mines employing underground narrow, selective and bulk methods, hard rock open pit methods, and dry and dredge alluvial methods. He is a Member of the AusIMM and holds Mine Manager's Certificates of Competency issued in Queensland, Western Australia and Tasmania.

Mr Jeames McKibben (B Sc (Hons), MBA) is a geologist with 10 years experience in exploration, resource definition, project management and industry development gained through working with several mining companies in Western Australia, Zambia and Morocco, as well as the Tasmanian government. At Snowden, Jeames is involved in independent technical reviews, audits and valuations of mining and exploration assets.

Mr Jonathan Bell (BSc. Applied Geology, Graduate Certificate in Mineral Economics) MAIG, is a geologist with six years experience in exploration, resource definition, mining and project management gained from his work with Western Australian mining and consulting companies. In his Snowden role, Jon is involved in independent technical reviews, audits and valuations of mining and exploration assets.

Dr Philip Snowden (BSc (Hons), PhD, FAusIMM) is a Principal and Founding Director of Snowden Mining Industry Consultants Pty Ltd and has been consulting internationally in the fields of exploration and mining geology since January 1988. His previous experience includes 5 years with Anglo American Corporation in South Africa specialising in structural geology, 5 years lecturing in the Geology Department at Rhodes University in South Africa and 4 years lecturing at the University of Zimbabwe. Phil specialises in technical reviews and independent audits, valuation of exploration and mining assets, structural geology and exploration and mining geology.

Mr Narayan Krishnan (B Tech, MSc, FAusIMM) is the Principal of OM Metals Trust Pty Ltd, and has 38 years experience as a metallurgist specialising in non-ferrous extractive metallurgy. Narayan has held senior positions at a number of major companies, including WMC Resources Ltd (Group Adviser Metallurgy and Manager – Metallurgy, Nickel Operations), Pasmaico Ltd (Manager – Technical Projects and Production Manager), Electrolytic Zinc, Hamersley Iron and Mt Isa Mines Ltd.

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**APPENDIX A  
GLOSSARY OF TECHNICAL TERMS**

Term	Explanation
abbreviations	% - percentage % Cu – percentage copper 3D – three dimensional Au - gold AUD – Australian Dollars Co - cobalt Cu - copper dmt – dry metric tonnes EM – electromagnetic ESI – Environmental Sustainability Index FY – financial year Ga – 1 billion years (10 <sup>9</sup> years) GDP – gross domestic product GNP – gross national product GPS – Global Positioning System GTK – Finnish Geological Survey ICT – information and communications technology IP – induced polarisation JV – joint venture km – kilometre km <sup>2</sup> – square kilometres kt – kilotonnes ktpa – kilotonnes per annum kV – kilovolts kW – kilowatts kWh – kilowatt hours kWh/t – kilowatt hours per tonne lb – pound LOM – life of mine m – metre M – million m/month – metres per month m <sup>3</sup> – cubic metres Mbcm – million bank cubic metres ML – megalitres mm – millimetres MMI – mobile metal ion mRL – metres reduced level Mt – million tonnes Mtpa – million tonnes per annum MW – megawatts Ni - nickel PGE – platinum group elements (platinum, palladium, rhodium, ruthenium, osmium) ppm – parts per million RQD – rock quality designation SAG – semi-autogenous grinding SLC – sublevel cave t – tonnes tpa – tonnes per annum tph – tonnes per hour TSF – Tailings Storage Facility VTT – Finnish government mineral processing research centre Zn - zinc

Term	Explanation
acid heap leach	Metallurgical process using sulphuric acid to extract metal from ore.
albite	An alkali feldspar mineral. It is the sodium end member of the plagioclase solid solution series.
alteration	A change in mineralogical composition of a rock through reactions with hydrothermal fluids, temperature or pressure changes.
alluvial gold	An accumulation of alluvium (sediment), sometimes containing gold in the bed or former bed of a river.
amphibolite facies	Moderate to high temperature and low pressure regional metamorphic facies. Characterized by the presence of amphibole.
anticline	A fold shaped like an arch.
Archean	Era of the geological time scale within the Precambrian aeon containing rocks greater than 2500 million years old.
apatite	A group of phosphate minerals, usually referring to hydroxylapatite, fluorapatite, and chlorapatite.
autoclave	A strong closed vessel for carrying out chemical reactions under high pressure and/or temperature.
backfill	Waste rock, gravel, sand or tailings used as a support in stopes after the removal of ore.
ball mill	A rotating horizontal steel cylinder loaded with steel balls which grind the ore to a fine powder.
bar	A unit of pressure (1 bar = 0.1 Mega Pascal)
basalt	A fine grained igneous rock consisting mostly of plagioclase feldspar and pyroxene.
black shale	Variety of shale that contains abundant organic matter, pyrite, and sometimes carbonate nodules or layers.
block model	A model comprised of rectangular blocks, each with attributes such as grades, rock types, codes that represents a given mineral deposit.
breccia	A detrital sedimentary rock composed of poorly sorted fragments which are all angular to sub-angular in shape, and have a particle size of greater than 2 mm.
brittle deformation	The cracking and fracturing of rocks subjected to stress.
bulk density	A property of particulate materials. It is the mass of many particles of the material divided by the volume they occupy. The volume includes the space between particles as well as the space inside the pores of individual particles.
calcine	To heat (a substance) to a high temperature, but below its melting or fusing point, to bring about thermal decomposition or a phase transition in its physical or chemical constitution.
carbonate	a class of sedimentary rocks composed primarily of carbonate minerals. The two major types are limestone and dolomite.
cemented paste backfill	A substance used to fill voids underground, comprised of mine or mill tailings, water, and powdered cement. It is injected underground as a liquid or a slurry
Cenozoic	The most recent of the three classic geological eras.
certified standard	An analytical reference material of known true value used for quality control of laboratory assays.
chalcopyrite	A copper ore (CuFeS <sub>2</sub> ).
chlorite	A group of mostly green minerals of varying composition often found as alteration products of ferromagnesian minerals.
Classification	A system for reporting Mineral Resources and Ore Reserves according to a number of accepted Codes.
cleaner cell	The second stage of a flotation circuit which prepares copper concentrate for sale.
collection level	The level where ore is loaded out of a block caving underground mining operation.
cobaltite	A sulphide mineral comprised of cobalt and iron (Co, Fe) AsS).
collector	Chemical used in the froth flotation process that reacts with the ore to make the ore surface hydrophobic (sodium ethyl xanthate).
colluvium	Weathered material transported by gravity.
comminution	The crushing and grinding of ore in order to reduce the particle size for further processing.
composite	A sample comprised of a number of smaller samples.
compositing	The process of combining drillhole assay grades into even sample intervals to provide an even representation of sample grades and eliminate bias due to sample length.
conglomerate	A detrital sedimentary rock composed of rounded to sub-rounded shaped fragments,

Term	Explanation
	which have a particle size of greater than 2mm.
contractor mining	Mining method where the mining equipment and fleet are owned and run by a company which is contracted to mine on behalf of the mines owner.
concentrate	End product of the flotation process.
core	See diamond drilling
craton	A stable area of continental crust that has not undergone much plate tectonic or orogenic activity for a long period
crosscut	An underground tunnel excavated generally at right angles to the orebody.
crown pillar	Material at the top of a stope or underground mine deliberately left behind for the purpose of ground support.
cuboid	An individual block that comprises the block model
cut and fill stoping	Underground mining method involving excavation of ore and replacement of cemented material into the void.
cutback	Term used to describe the staged mining of an open pit.
cut-off grade	The grade that differentiates between mineralised material that is economic to mine and material that is not.
dead roasting	A roasting process for complete elimination of sulphur or other volatiles.
decline	Access ramp to underground workings.
declustering	A mathematical technique for reducing bias in drillhole data.
deformation	Term used to describe changes in rocks after their formation, usually caused by tectonic forces.
depletion	Ore reserve material which has been mined out.
development	Any tunnelling work carried out in an underground mine.
diabase	A mafic, holocrystalline, igneous rock equivalent to volcanic basalt or plutonic gabbro.
diamond drilling	Drilling method which produces a cylindrical core of rock by drilling with a diamond tipped bit.
dilution	Waste mined as ore.
dip	Geological measurement – the angle at which bedding or a structure is inclined from the horizontal.
disseminated	An ore deposit consisting of fine particles of the ore mineral dispersed through the enclosing rock.
dolerite	Basaltic rocks which are comparatively coarse grained.
dolomite	A carbonate rock consisting of calcium magnesium carbonate.
domain	A homogenous zone within a mineral deposit consisting of a single grade population, orientation of mineralisation and geological texture.
downhole EM data	Electromagnetic data collected from down a drill hole.
drillhole data	Data collected from the drilling, sampling and assaying of drill holes.
drive	Underground mining horizontal development.
early Proterozoic	The oldest period of the Proterozoic Era of the geological time scale within the Precambrian aeon containing rocks of approximately 2500 million years old.
electromagnetic (EM) geophysical surveys	Survey over an area involving the measurement of alternating magnetic fields associated with currents artificially or naturally maintained in the ground.
epithermal gold	Epithermal gold deposits form in hydrothermal systems related to volcanic activity
exhaust shaft	Ventilation shaft for removal of exhaust from underground workings.
face sampling	Sampling of the exposed face in an underground mine.
fault	A fracture in rock along which displacement has occurred.
fault breccia	Breccia produced by movement along a fault.
feasibility study	A mining and or processing study into the economic development of a project for which the inputs have an accuracy of 5% to 10%.
feldspar	An important group of rock-forming minerals which make approximately 60% of the Earth's crust. Feldspars crystallize from magma in both intrusive and extrusive rocks.
felsic	Silicate minerals, magmas, and rocks which are enriched in the lighter elements such as silica, oxygen, aluminium, sodium, and potassium.
flotation circuit	Process for concentrating metal sulphide minerals. Ore is crushed and ground, mixed with water, frothing and collecting reagents and the mixture is aerated and agitated. The hydrophilic sulphide minerals attach to the bubbles which rise to the surface as the waste material falls to the bottom. The froth is skimmed off, and the water and chemicals removed, leaving a clean concentrate.

Term	Explanation
fold (folded)	A flexure in rocks.
foliation	Parallel orientation of platy minerals or mineral banding in rocks.
footwall	The underlying side of a fault, orebody or mine workings.
frother	Surfactant used to create froth in the froth flotation process (methyl isobutyl carbinol (MIBC))
gabbro	A dark, coarse-grained, intrusive igneous rock chemically equivalent to basalt.
gabbro-anorthosite	An intrusive igneous rock, characterised by predominance of potassium feldspar.
gangue	Waste materials left over after removing the minerals from ore.
geological contact	Boundary between rock types.
geological domains	Spatial domains created to represent areas with similar geological characteristics.
geophysical survey	A survey that measures the physical properties of rock formations, commonly magnetism, specific gravity, electrical conductivity and radioactivity.
geotechnical analysis	Analysis of the factors affecting the stability of a rock mass.
geotechnical core logging data	Data collected on the geotechnical properties of rock mass by examining diamond drill core.
gneiss	A common and widely distributed type of rock formed by high-grade regional metamorphic processes from pre-existing formations that were originally either igneous or sedimentary rocks. Gneissic rocks are coarsely foliated and largely recrystallised.
grade control	The process of collecting geological, sample and assay information for the delineation of mineable ore boundaries; the minimization of dilution and ore loss, and the reconciliation of the predicted grade and tonnage to the grade and tonnage mined and milled.
glacial till	An unsorted glacial sediment. Glacial drift is a general term for the coarsely graded and extremely heterogeneous sediments of glacial origin
granite-gneiss	Metamorphosed igneous rocks or their equivalent
granitic intrusion	Granite rock which has been emplaced into the earth's crust.
granitoid	A common and widely-occurring type of intrusive, felsic, igneous rock.
granophyre	A textural term to describe an igneous rock that contains quartz and alkali feldspar in characteristic angular intergrowths.
graphite	A mineralised form of carbon.
greenstone belt	Greenstone belts are zones of variably metamorphosed mafic to ultramafic volcanic sequences with associated sedimentary rocks that occur within Archean and Proterozoic cratons between granite and gneiss bodies.
greywacke	A variety of sandstone generally characterized by its hardness, dark color, and poorly-sorted, angular grains of quartz, feldspar, and small rock fragments set in a compact, clay-fine matrix.
hangingwall	The overlying side of a fault, orebody or mine workings.
heazlewoodite	A nickel ore commonly associated with serpentinite (Ni <sub>3</sub> S <sub>2</sub> ).
in situ	Material found in its original position of formation. Latin for 'in place'.
Indicated Mineral Resource	'An 'Indicated Mineral Resource' is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence. It is based on exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are too widely or inappropriately spaced to confirm geological and/or grade continuity but are spaced closely enough for continuity to be assumed.' (JORC 2004)
induced polarisation (IP) geophysical survey	Survey over an area involving the application of an electric or magnetic field and measurement of the decay of voltage in the earth when the field is switched off.
Inductively Coupled Plasma Mass Spectrometry	A type of mass spectrometry that is highly sensitive and capable of analysis of a range of metals and several non-metals at below one part in 10 <sup>12</sup> .
Inferred Mineral Resource	'An 'Inferred Mineral Resource' is that part of a Mineral Resource for which tonnage, grade and mineral content can be estimated with a low level of confidence. It is inferred from geological evidence and assumed but not verified geological and/or grade continuity. It is based on information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes which may be limited or of uncertain quality and reliability.'

Term	Explanation
	(JORC 2004)
intake shaft	Ventilation shaft that provides fresh air for underground workings.
isoclinal	A fold in which the limbs are parallel or near-parallel.
JORC Code	The JORC Code provides minimum standards for public reporting to ensure that investors and their advisers have all the information they would reasonably require for forming a reliable opinion on the results and estimates being reported. The current version is dated 2004.
komatiite	Ultramafic mantle-derived volcanic rocks. They have low SiO <sub>2</sub> , low K <sub>2</sub> O, low Al <sub>2</sub> O <sub>3</sub> , and high to extremely high MgO. Komatiites occur with other ultramafic and high-magnesian mafic volcanic rocks in Archean greenstone belts.
kriging	A geostatistical estimation method using a distance weighting technique which is based upon the relative spatial continuity of the samples.
leach pad	Area set aside for heaps of un-leached ore where leaching can take place and the leached solution can be collected.
level	Extraction horizons in an underground mine at approximately the same horizontal height.
lode	Ore zone.
longhole open stoping (LHOS)	Underground mining method comprising the extraction of ore from stopes which are charged up from drillholes put in from one or more elevations within the stope.
longhole stoping	See longhole open stoping.
mafic	Silicate minerals, magmas, and volcanic and intrusive igneous rocks that have relatively high concentrations of the heavier and darker minerals.
magnetic anomaly (high / low)	Magnetic signatures different from the background, made up of a high and a low (dipole) compared to the average field.
magnetic geophysical survey	Survey over an area involving measurements of magnetic intensity of rocks in response to the earth's magnetic field. Different rock compositions show varying degrees of magnetic intensity, which can be used to infer changes in geology.
Measured Mineral Resource	'A 'Measured Mineral Resource' is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence. It is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are spaced closely enough to confirm geological and grade continuity.' JORC 2004.
mesocumulate	Igneous rocks with between 93-85% accumulated minerals in a groundmass.
metalogenic province	geographic area characterized by a particular assemblage of mineral deposits, or by a distinctive style of mineralization.
metasedimentary	A sediment or sedimentary rock that shows evidence of having being subjected to metamorphism.
mica schist	A group of medium-grade metamorphic rock, chiefly notable for the preponderance of lamellar minerals such as micas, chlorite, talc, hornblende, graphite, and others.
mill feed	Ore processed through the mill.
millerite	A nickel sulphide mineral (NiS).
mineral inventory	A quantity of mineralisation, expressed as tonnage and grade, which has not been classified according to the JORC Code.
Mineral Resource	'A 'Mineral Resource' is a concentration or occurrence of material of intrinsic economic interest in or on the Earth's crust in such form, quality and quantity that there are reasonable prospects for eventual economic extraction. The location, quantity, grade, geological characteristics and continuity of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge. Mineral Resources are sub-divided, in order of increasing geological confidence, into Inferred, Indicated and Measured categories.' JORC 2004.
mobile belt	An elongated zone of the Earth's crust subjected to relatively great structural deformation.
modifying factors	Factors affecting extraction which are taken into consideration and applied to Indicated and Measured Mineral Resources to produce Ore Reserves. The factors include mining, metallurgical, economic, marketing, legal, environmental, social and governmental considerations.
moving window trend graph	Geostatistical method for testing local estimation of mean within narrow slices through domain.

Term	Explanation
mudstone	A detrital sedimentary rock composed of clay minerals similar to shale but lacking the well developed bedding planes.
olivine	A magnesium iron silicate, common in ultramafic and mafic rocks.
open stoping	Underground mining method.
ore	Mineralised material which is economically mineable at the time of extraction and processing.
ore loss	Ore left as waste after the mining process.
ore Reserve	‘An ‘Ore Reserve’ is the economically mineable part of a Measured and/or Indicated Mineral Resource. It includes diluting materials and allowances for losses, which may occur when the material is mined. Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction could reasonably be justified. Ore Reserves are sub-divided in order of increasing confidence into Probable Ore Reserves and Proved Ore Reserves.’ (JORC, 2004)
ore zone	Zone of mineralised material.
orebody	Usually refers to the deposit as a whole.
orogeny	The process of mountain building, and may be studied as a tectonic structural event, as a geographical event and a chronological event, in that orogenic events cause distinctive structural phenomena and related tectonic activity, affect certain regions of rocks and crust and happen within a time frame.
owner mining	Mining method where the mining equipment and fleet are owned and run by the company that also owns the mine.
oxidation, oxidized	The addition of oxygen to the metal ion, generally as a result of weathering.
palaeoproterozoic	The first of the three sub-divisions (eras) of the Proterozoic occurring between 2500 Ma and 1600 Ma (million years ago).
paste fill	Cemented material used to fill voids of worked stopes in underground mining.
pentlandite	An iron-nickel sulphide, (Fe,Ni) <sub>9</sub> S <sub>8</sub>
pH	measure on a scale from 0 to 14 of the acidity or alkalinity of a solution (where 7 is neutral and greater than 7 is more basic and less than 7 is more acidic)
peridotite	a dense, coarse-grained ultramafic rock, consisting mostly of the minerals olivine and pyroxene.
phyllite	A type of foliated metamorphic rock primarily composed of quartz, sericite mica, and chlorite.
plunge	The inclination of a fold axis or other linear structure measured in the vertical plane.
pluton	An intrusive igneous rock body which crystallized from a magma below the surface of the Earth. Plutons include batholiths, dikes, sills, laccoliths, lopoliths, and other igneous bodies.
polymetallic	Co-existence of 2 or more metals within an ore deposit.
polyphase folding	A term used when there are multiple episodes of folding
porphyry	A variety of igneous rock consisting of large-grained crystals, such as feldspar or quartz, dispersed in a fine-grained feldspathic matrix or groundmass.
portal	The surface entrance to an underground mine.
pressure acid leach	An extraction process involves leaching at high temperatures and generally high pressures using sulphuric acid in an autoclave in order to liberate one or more elements.
Pressure oxidation	Conversion of metal species to oxides and hydroxides, usually at considerable temperature and pressure, inside an autoclave.
Probable Ore Reserve	A ‘Probable Ore Reserve’ is the economically mineable part of an Indicated, and in some circumstances, a Measured Mineral Resource. It includes diluting materials and allowances for losses which may occur when the material is mined. Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors These assessments demonstrate at the time of reporting that extraction could reasonably be justified. (JORC, 2004)
production schedule	Planned and timed order of areas, tonnes and grade for mining.
Proterozoic	Era of the geological time scale within the Precambrian eon containing rocks of approximately 1000 – 2500 million years old

Term	Explanation
Svecofennian Orogeny	A period of the Proterozoic characterised by orogenic activity and associated geological processes
Proved Ore Reserve	A 'Proved Ore Reserve' is the economically mineable part of a Measured Mineral Resource. It includes diluting materials and allowances for losses which may occur when the material is mined. Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction could reasonably be justified. (JORC, 2004)
pulp	A pulverised laboratory sample .
pycnometer	A device used for measuring fluid density, also known as a specific gravity.
pyrite	Iron disulphide, (FeS <sub>2</sub> ).
pyroxenite	An ultramafic igneous rock consisting essentially of minerals of the pyroxene group.
pyrrhotite	An iron sulphide mineral (FeS)
quartz	crystalline silica (SiO <sub>2</sub> ).
quartzite	Metamorphosed sandstone.
raise board ventilation shaft	A vertical cylindrical hole used for ventilating an underground mine, created by pulling a large rotating drillhead up to the surface through a pre existing pilot hole.
reconciliation	Measured assessment of the forecast and review of its correctness.
recovery	Metallurgical: The percentage of metal that can be recovered given the limitations of the processing equipment. Mining: The percentage of ore material that can be recovered once ore loss is taken into account due to the sampling or mining resolution.
re-crystallisation	The process where the crystals in a rock become solution and then solid again with a new set of crystals.
refining	The process of purification of copper metal.
reverse circulation drilling (RC)	Drilling method that uses compressed air and a hammer bit to produce rock chips.
rib pillars	Vertical slices of rock left between stopes in an orebody for the purposes of stability.
rift	In geology, a rift is a place where the Earth's crust and lithosphere are being pulled apart.
rock quality designation (RQD)	The cumulative length of core pieces longer than 10cm in a run divided by the total length of the core run.
rock stress	Internal forces within a rock mass that occur because of an external force acting to change its shape or volume.
rougher cell	The first stage of a flotation circuit.
scavenger cell	The third stage of a flotation circuit where copper concentrate is extracted from tailings.
schist	A group of medium-grade metamorphic rocks, chiefly notable for the preponderance of lamellar minerals such as micas, chlorite, talc, hornblende, graphite, and others.
schistosity	A metamorphic rock comprised of large grains aligned in parallel layers.
scoping study	a preliminary study into the development of a mining project generally with a low degree of accuracy.
search pass	A process used in grade estimation to find samples from a given point.
sedimentary	Rock forming process where material is derived from pre-existing rocks by weathering and erosion.
semi-autogenous grinding mill (SAG)	a mill for the grinding of rock with the addition of grinding media.
serpentinite	A metamorphic rock comprised of an admixture of serpentine minerals.
shale	A detrital sedimentary rock composed of clay minerals with a well marked bedding plane usually due to the alignment of the clay minerals.
shear	Fault.
shotcrete	A cement mixture sprayed onto the surfaces of mine openings with a pressure gun to provide ground support, prevent erosion by air and moisture, and provide a smooth surface for airflow.
silica	Most commonly quartz (SiO <sub>2</sub> ).
silicification	The process of bringing in silica into a non-siliceous rock.
siltstone	A detrital sedimentary rock composed of clay minerals similar to mudstone but with

Term	Explanation
skarn	mostly silt-grade material ( $1/16$ - $1/256$ ) mm. Skarns form at the contact between an intrusive rock and a carbonate rock or a clastic sediment rich in carbonate and have a characteristic mineral composition – calcium, magnesium and iron silicates.
sludge holes	Underground drilling technique utilising a percussive hammer; samples are returned as a sludge or slurry with drilling water.
slurry	Liquid containing suspended solids.
smelting (smelter)	Heating and melting ore then separating the molten copper metal from other elements.
stacked	Material placed onto pads for heap leaching.
stockpile	Heap of mined ore waiting to be milled.
standards	See certified standards.
stockwork	A network of veins.
stope, primary / secondary / tertiary / quaternary	Timing of stoping operations.
stopping operations	The process of underground mining.
stratigraphy	The study of stratified rocks, their timing, characteristics and correlations in different locations.
stream sediment sampling	Soil sampling of sediments from stream beds.
strike	Geological measurement – the direction of bearing of bedding or structure in the horizontal plane.
stringer	An irregular filament or a narrow vein of one or more minerals traversing a rock mass.
stripping	Open pit mining term relating to the removal of uneconomic waste material to expose ore. Metallurgical term relating to the removal of copper from the organic phase in the solvent extraction process.
subcell	A cell that comprises a larger cuboid. Subcelling increases the resolution of the block model to better reflect domain margins and provide a more reliable volume representation.
sublevels	Levels in between the main levels in underground workings.
sulphating roast	Conversion of sulphide to sulphate through thermal decomposition of ore.
sulphide	Minerals consisting of a chemical combination of sulphur with a metal. Also refers to fresh or unoxidised material.
supracrustal zone	Rocks that overlie basement rocks.
surface heap leaching	Leaching of ore by staking un-leached ore on the surface in heaps and passing reacting solutions through it.
syncline	A fold shaped like a basin.
tailings	Waste left over after removing the gangue from ore, usually finely ground rock materials left after milling is complete.
tailings storage facility (TSF)	A dam constructed to contain milled waste from a process plant.
talc	A hydrated magnesium silicate.
talc-carbonate	A mineral assemblage that is commonly associated with ultramafic intrusions.
tenor	Weight percent (wt%) of a metal sulphide in 100 wt% sulphide.
thickener	Are substances which, when added to a mixture, increase its viscosity without substantially modifying its other properties
top cut	A process that reduces the effect of isolated (and possible unrepresentative) outlier assay values on the estimation.
transitional	The partially oxidised zone between oxidized and fresh material.
tremolite-quartz-sulphide	A mineral assemblage that is commonly associated with skarn deposits.
ultramafic	Igneous rocks with very low silica content (less than 45%), generally >18% MgO, high FeO, low potassium and are composed of usually greater than 90% mafic minerals.
ultramafic to mafic layered intrusions	Ultramafic to mafic layered intrusions are found in typically ancient cratons. The intrusive complexes exhibit evidence of fractional crystallization and crystal segregation by settling or floating of minerals from a melt.

Term	Explanation
unconformity	A structural break in the geological profile representing unrecorded time.
uphole bench retreat	A method of open stoping characterised by drilling holes for blasting upwards and by mining away from a pre-excavated opening.
vanadiferous magnetite	A mineral association that is commonly associated with layered intrusions.
variogram	A graphical representation of how the grade varies over increasing distances in different direction within a given domain.
ventilation shaft (rise)	Shaft for intake of fresh air or expelling exhaust from underground workings.
volcaniclastic	All volcanic particles regardless of their origin
volcanosedimentary sequence	A stratigraphic sequence comprised of volcanic and sedimentary units in vertical succession, usually formed in tectonic rift environments.
waste	Material which is not mineralised or mineralised material which is not economically mineable.
waste dump	Heap of either non-mineralised material excavated to expose ore, or mineralised material below economic cut-off grade.
water table	The depth below which the ground is saturated with water (the surface in an unconfined aquifer or confining bed at which the pore water pressure is equal to atmospheric pressure).
weathering	The process by which rocks are broken down and decomposed by the action of wind, rain, changes in temperature, plants and bacteria.
wireframe	A surface or 3D volume formed by linking points together to form triangles. Wireframes are used in the construction of block models.

**APPENDIX B  
PROPERTIES OWNED BY VULCAN RESOURCES**

<b>Asset</b>	<b>Holder</b>	<b>Interest (%)</b>	<b>Status</b>	<b>Licence expiry date</b>	<b>Licence area (km<sup>2</sup>)</b>	<b>Comments</b>
Kylylahti project	Kylylahti Copper Oy	100%	Development	30/08/2009*, 31/12/2009, 7/11/2010	2,214.7	Definitive Feasibility Study underway – to be completed end of first quarter 2007
Kuhmo project	Kuhmo Metals Oy	95%	Exploration	27/3/2008 to 3/11/2010	3,857.11	Drilling and exploration activities underway
Vanadium projects	Kylylahti Copper Oy	100%	Exploration	27/12/2006 to 15/2/2007	21,335	Drilling, exploration and metallurgical testing underway
Tornio project	Kylylahti Copper Oy	100%	Exploration	16/2/2009	7.78	Exploration planned
Haukiaho project	Kylylahti Copper Oy	100%	Exploration	27/03/2007	60.4	Exploration planned

\* Note that there are 3 granted mining licences at Kylylahti with a total area of 114.1km<sup>2</sup> which have no expiry date.