A NEW DIAMONDIFEROUS ECLOGITE-BEARING KIMBERLITIC OCCURRENCE FROM FINLAND

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Introduction

Kimberlitic rocks were first discovered in Finland in 1965 by Malmikaivos OY when a magnetic anomaly was drilled during base metal exploration. Two further occurrences were located in 1983 and 1985. Joint venture diamond exploration with Ashton Mining Ltd, since 1986, has led to the current knowledge of twenty-two kimberlitic bodies located in four separate areas of northern Finland. A diamondiferous eclogite xenolith (SE1-4) was recovered during sampling to assess the diamond content of one of the kimberlites.

This paper presents preliminary data on the host kimberlite and the first data on a diamondiferous eclogite xenolith from this region.

Geological setting and field occurrence

The pipe is located within a cluster of pipes on the southern margin of the Archaean craton, a zone of juxtaposed lower Proterozoic and Archaean rocks, near the northern Finnish border. The age of the older unit varies from 2.6 to 2.9 Ga while the lower Proterozoic metamorphics and granitoids represent the northern limit of the Svecokarehan domain, dated in the range 1.8 to 2.0 Ga.

There are eleven kimberlitic bodies known from this field which extends over an area of approximately thirty by fifteen kilometres. The bodies are typically ovoid to elongate pipes, one to two hectares in area, but irregular dyke and sill-like occurrences are also present. The preservation of crater facies sediments over some pipes is evidence of only a small amount of erosion since kimberlite emplacement. The pipe is composed of relatively homogeneous tuffisitic kimberlite breccia with no evidence of multiple phases. Other pipes in the cluster contain more than one tufficitic phase and a magmatic phase is often also present. Whole rock ages from nearby pipes suggest an emplacement age around 450 - 600 my.

Pipe petrography and mineralogy

The pipe is composed of relatively homogeneous tuffisitic kimberlite breccia . It has a fragmental texture with abundant country rock xenoliths, xenocrysts, rounded olivine and phlogopite phenocrysts and small lapilli set in a fine-grained matrix. Serpentine replaces all olivine and with minor calcite dominates the groundmass. Fine sphene and diopside grains are present through the matrix and sphene/rutile intergrowths rim picro-ilmenite macrocrysts (?xenocrysts). Perovskite is absent in the sections examined Mantle xenocrysts present include picro-ilmenite and chromian, sub-calcic pyrope (G9: Dawson and Stephens, 1975). In heavy mineral concentrates (HMC) the mantle component is dominated by picro-ilmenite (56%) and garnet (24%), with lesser chromian diopside (20%) and rare chromian spinel. The garnet fraction is dominated (75%) by pyrope of eclogitic affinity. Some country rocks are chromium rich and provide a component of the chromian diopside in the HMC. Amphibolite facies country rock xenoliths and their disaggregated amphibole (hornblende and gedrite), biotite, apatite and K-feldspar grains are abundant.

Xenolith petrography and mineral chemistry

A suite of five coarse grained eclogitic xenoliths, including one diamondiferous xenolith, have been examined. One xenolith is an ilmenite-cpx assemblage, the remainder are cpx-gnt bimineralic eclogites. Each of the xenoliths has distinctive mineral chemistry (table 1). Phlogopite, ?serpentine, barite,and trace Cu,Fe sulphide are present as minor phases along grain boundaries and as inclusions. The diamond-bearing xenolith contains abundant Fe sulphide. All specimens have undergone minor alteration/metasomatism with veins of quartz, and minor jadeite,sphene, partial coronas of rutile on the ilmenite, ?serpentine, Cu-Fe and Ni-Fe sulphides in the ilmenite-cpx xenolith.

Eclogitic diamond characteristics

The diamondiferous eclogite sample is small (35x35x15 mms) yet has sixteen, 1-4 mm sized diamonds projecting from its surface. The diamonds appear evenly distributed throughout the eclogite, present at the cpx-gnt grain boundaries and usually in association with Fe sulphide (figure 1). A polished section has been made through the centre of the xenolith and a further four diamonds are exposed, ranging from 0.1 to 1.5 mm in maximum dimension. In this polished section, diamond is 0.88% of the surface area which represents, assuming uniform diamond distribution, a carbon (as diamond) content of approximately 1.6 wt%,or approximately 80,000 carats per ton.

Two forms of diamond are present in the eclogite. Eighteen diamonds are octahedra, either as single crystals or aggregates. Faces are commonly stepped and/or contain occasional large, shallow trigonal pits. Crystal edges appear sharp and overall the diamonds appear to be relatively unresorbed. In situ they appear colourless and massive with only occasional internal fractures or inclusions. The second form of diamond is ovoid aggregates of polycrystalline diamond up to 2mm in length. The outer surfaces of these aggregates are composed of minute complex octahedral terminations, varying from finely stepped to sharp-edged faces. Cathodoluminescence and secondary electron images of the diamonds in the polished section show a predominance of regular octahedral growth overprinted by cross-hatched deformation induced lamellae. The exposed diamonds are fractured; some fractures are filled by Fe sulphide. The same sulphide is present as inclusions in two of the diamonds and also within the garnet.

Discussion

The host pipe most closely resembles a group I kimberlite (Smith et al., 1985; Mitchell, 1994) on the available petrographic and mineralogical data. The absence of perovskite and presence of groundmass diopside is considered to reflect contamination by digestion of country rock.

The presence of the mantle eclogite xenoliths and other xenocrysts, including the diamond content, indicate that this pipe has sampled a deep mantle region comparable to that known from other diamond provinces, e.g. South Africa (Hatton and Gurney, 1985) and Yakutia (Z.V.Spetsius, pers.comm.)

The presence of similar inclusions in the diamonds and garnet of the diamondiferous eclogite xenolith may suggest contemporaneous growth of diamond and garnet. The intimate association of diamond and Fe sulphide in this eclogite support suggestions that sulphur has an important role in eclogitic diamond formation (Bulanova and Spetsius, 1991).

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Table 1: Representative eclogite xenolith mineral compositions*

	SE1-1		SE1-2		SE1-3		SE1-4 (diamondiferous)	
	cpx	gnt	cpx	gnt	cpx	ilm	cpx	gnt
SiO2	55.03	42.32	54.62	42.00	55.10		55.04	41.23
TiO2	0.15	n.d.	n.d.	n.d.	n.d.	53.74	n.d.	0.42
Al2O3	5.71	23.48	5.61	22.82	2.05	0.76	4.82	21.98
Cr2O3	0.24	0.24	0.22	0.59	0.53	1.34	n.d.	0.00
FeO	3.09	9.28	3.40	8.31	3.74	31.01	5.97	14.35
NiO						n.d.		
MnO	n.d.	n.d.	n.d.	n.d.	n.d.	0.24	n.d.	0.32
MgO	14.78	19.13	14.22	16.23	16.31	12.71	14.77	16.61
CaO	17.01	5.57	18.35	10.35	20.30	n.d.	15.42	4.62
Na2O	3.62	0.08	3.01	0.11	1.94	n.d.	3.52	0.13
Total	99.63	100.02	99.43	100.30	99.97	99.80	99.54	99.76
Mg no	96.28	79.18	91.01	79.10	94.12	42.87	88.52	69.69
%pyrope		67.92		58.05				60.79
%almandine		17.86		15.34				26.44

* all analyses by EDS following the methods of Ware (1981) except the Na2O in garnet was analysed by conventional WDS.

n.d.= not detected: TiO2 < 0.12 wt%, NiO < 0.2 wt%, MnO < 0.14 wt%