POLYMICT PERIDOTITES - A LINK BETWEEN DEFORMED PERIDOTITES AND MEGACRYSTS FROM KIMBERLITES

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ABSTRACT

INTRODUCTION

Polymict peridotites are an exceptional suite of mantle xenoliths recovered from kimberlites in Kimberley, South Africa. They have breccia-like characteristics and contain rock and mineral fragments derived from the upper mantle. These fragments are embedded in a very variable matrix often rich in phlogopite together with other silicates, ilmenite, rutile and sulphides. Polymict petrogenesis involves sampling of the upper mantle through localised brecciation by a fluid which migrated from depth. This fluid is thought to crystallise the matrix of the rock. The consolidated polymict rocks are later sampled and transported to a near-surface environment by a younger kimberlite intrusion. The polymict rocks provide an excellent opportunity to study aspects of melt infiltration and mantle metasomatism.

POLYMICT GEOCHEMISTRY

Results of detailed petrography and geochemical analysis of garnets in one nodule, BD2394, are presented here. This polymict is unique in its distinct matrix which not only contains subhedral orthopyroxene, partly interstitial phlogopite and irregular opaques but also small cloudy garnets. This is not seen in any other polymict. Large orange, mauve and purple garnets up to 7mm in length are also found in this sample. One particular purple garnet shows a distinct yellow-orange garnet overgrowth. Major element chemistry of these large garnets has shown individual crystals to be homogeneous although collectively the data indicates a wide variety of garnet compositions present in the one sample. This is shown on Fig. 1.

Trace element compositions vary as a function of major element composition and petrography. Fig. 2 shows trace element data for the small yellow-orange matrix garnets and the separate garnet rim. These show almost identical compositions. The very smooth rising and flattening REE profile from La to Lu is typical of megacrystic garnets from kimberlite sources and a high TiO_2, low Cr_2O_3 and moderate CaO in the major-minor element compositions supports this.

Other polymict peridotite nodules have been analysed for major elements. Orthopyroxene, phlogopite and olivine clasts in the polymicts indicate core-rim variations. Each of these three minerals show variable core compositions. The rim compositions of these clasts are very similar particularly with respect to Fe/Fe+Mg value. The major element chemistry of the matrix orthopyroxenes and phlogopites indicates a close compositional similarity with the rims of the clasts.

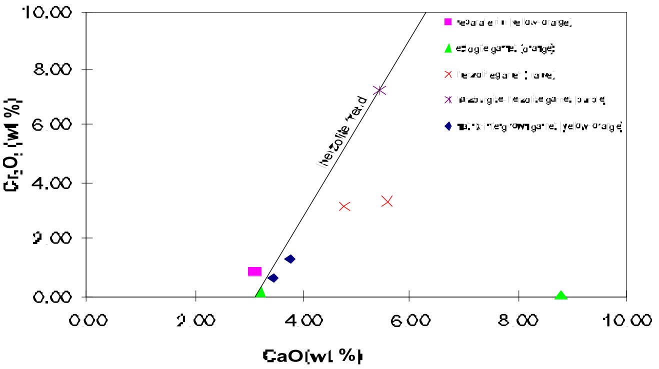

Fig. 1 - CaO-Cr_2O_3 plot of garnet clasts in polymict nodule BD2394.

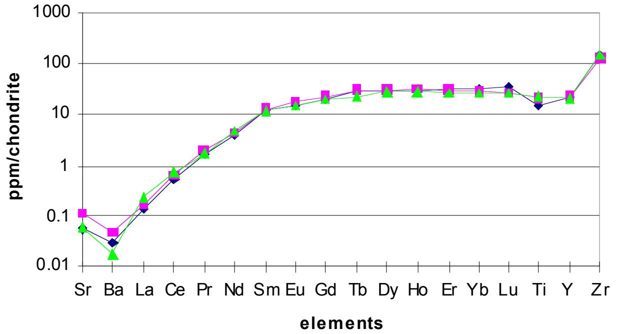

Fig. 2 - LILE, REE and HFSE abundances relative to chondrite for fine grained yellow-orange garnet intergrown with the rock matrix (squares and triangles) or rimming clastic garnet (diamonds).

DISCUSSION

These rocks are clearly disequilibrium assemblages since they contain peridotitic, eclogitic and megacrystic garnets within the same sample (Fig. 1). Metasomatism is inferred to have resulted in chemically distinct rims (major element compositions) in many of the minerals. Due to the congruous nature of the rims and the matrix major element compositions, it is suggested that the fluid which metasomatised these rocks also crystallised the matrix minerals.

The trace element analyses show evidence of relatively constant garnet compositions crystallising as part of the rock matrix and occasionally forming rims on pre-existing clastic garnet grains. This late stage garnet has compositions similar to those of the megacrysts frequently found in kimberlites and indicates a relatively primitive ultrabasic melt of probably asthenospheric origin (Harte et al., 1993). Therefore, it is thought that a high temperature silicate-rich melt, which is involved in the transport process, is simultaneously moving through the rocks, reacting with the clasts and precipitating minerals as it goes.

REFERENCES

Harte, B. Hunter, R.H., Kinny, P.D., 1993. Melt geometry, movement and crystallisation, in relation to mantle dykes, veins and metasomatism. Phil. Trans. Royal Soc. London, A, 342:1-21.