GEOCHEMISTRY OF Cr-POOR MEGACRYSTS FROM THE LACE (GROUP II) KIMBERLITE, SOUTH AFRICA.

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The Lace (also known as Crown) kimberlite in the northern Orange Free State, South Africa is a group II micaceous kimberlite containing abundant garnet megacrysts. Such megacrysts occur in several group II kimberlites of the O.F.S., and occur sporadically elsewhere in southern Africa in these host rocks (Moore and Gurney 1991). A magmatic origin for Cr-poor megacrysts in group I kimberlites is generally accepted, but the composition and petrologic relationship of the megacryst parent magmas to kimberlite, in particular the host kimberlite have been debated. The occurrence of Cr-poor megacrysts in the geochemically and petrographically distinctive group II kimberlites allows some of these petrologic relationships to be tested. In this study we have examined the geochemistry of a suite of megacryst minerals from the Lace kimberlite and compare it to megacrysts from the well-studied Monastery kimberlite, some 200 km to the south. The Monastery Kimberlite is a relatively Fe-rich kimberlite belonging to the so-called Group IB kimberlites of Smith et al (1985). We also compare aspects of the geochemistry with megacrysts from Jagersfontein, a group 1A kimberlite in the southwestern O.F.S. (Hops 1989, Hops and Gurney 1990).

The garnet megacrysts at Lace measure up to 7 cm and are extremely abundant in the concentrate tailings dump. In contrast, only 3 discrete clinopyroxene megacrysts have been recovered. However, clinopyroxenes occur included in garnet of all compositions. Large, cm-sized olivines falling into two compositional groups on the basis of Fo content, are found in samples of hypabyssal kimberlite, but were not recovered from dumps. Altered inclusions possibly representing serpentinized olivine, have been observed in a few garnet megacrysts. A petrologic relationship of these large olivines to the other megacryst phases thus remains to be confirmed and at least some large olivines are likely to be derived from peridotites. Ilmenite occurs only as inclusions in the most Fe-rich (Mg#<74) garnets and has not been observed as a discrete phase. Most samples used in this study were recovered from concentrate dumps, but garnet and olivine megacrysts were seen in situ in samples of hypabyssal kimberlite. This kimberlite differs from the dominant pipe fill, which is a kimberlite breccia.

Garnet and clinopyroxene megacrysts, including a number of coexisting pairs, were analyzed for major and trace elements on the electron probe (Na, Mg, Al, Si, P, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Ni), the ion probe (Sr, Y, Zr, REE), and by Mössbauer- (Fe^{3+}, Fe^{2+}) and infrared (OH) spectroscopy. Similar analyses were performed on representative megacrysts from the Monastery (Group 1B) kimberlite.

The Lace megacrysts are broadly similar in composition, appearance and association to megacrysts from group I kimberlites, yet exhibit some subtle, but distinct differences. The suite as a whole is more Mg-rich than that at Monastery, with the most magnesian garnets having Mg* [=100Mg/(Mg+total Fe)] = 84 (80, 82 for Monastery and Jagersfontein, respectively) and a mode in the overall distribution at Mg* = 77 (75, 78). Clinopyroxenes are not as subcalcic for a given Mg* as for the Group I kimberlites, yet display a regular inverse correlation between Mg* and Ca/(Ca+Mg), indicating a temperature decrease associated with compositional evolution, but at lower temperature for a given Mg* than for the group I kimberlites (Fig. 1). On the whole, the Lace garnets and clinopyroxenes display extremely tight compositional trends of the type previously interpreted to represent fractional crystallization sequences in other suites (Fig 2). No inflection is observed in the trend of TiO_2 vs Mg* (Fig. 3), with the exception of a single anomalous sample, consistent with the observation that ilmenite is not a co-crystallizing phase until the very last stages recorded.

Minor and trace element contents indicate an enrichment in H, K, Sr, Sc, V, Cr, Fe^{3+}/Fe and Ce/Yb and a depletion in Na, Ti, Zr, Y, HREE and P in the Lace suite relative to Monastery. These differences are interpreted to reflect differences in the geochemistry of the parental megacryst magmas and their source regions. In several ways, these differences correspond to general or average differences between group I and group II kimberlites, and suggest that the magmas parental to these megacrysts are either genetically related to kimberlites of the type that transported the megacrysts to the surface, or reflect derivation from mantle similar to their respective host kimberlite sources. This is supported by isotopic studies of the Lace suite (C.B.Smith et al, this volume). Differences in certain incompatible trace element ratios, which should remain relatively unfractionated by magmatic processes, and differences in major and compatible element abundances suggest that the sources of both major and incompatible trace elements are different for the Lace and Monastery megacryst suites.

Hops, J. J. 1989 Some aspects of the geochemistry of high-temperature peridotites and megacrysts from the Jagersfontein kimberlite pipe, South Africa. Ph.D. thesis, University of Cape Town.

Hops, J.J., Gurney, J.J. and Harte, B. 1992. The Jagersfontein Cr-poor megacryst suite - towards a model for megacryst petrogenesis.

Moore, R.O. and Gurney, J.J. 1991 Garnet megacrysts from Group II kimberlites in southern Africa. Extd. Abstrs., 5th International Kimberlite Conference, Brazil, 298-300.

Fig. 1. Clinopyroxene megacrysts

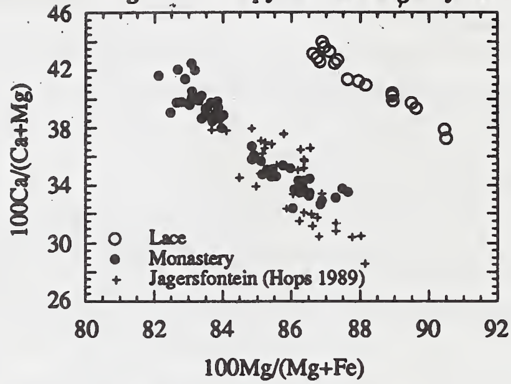

Fig. 2. Lace garnet megacrysts

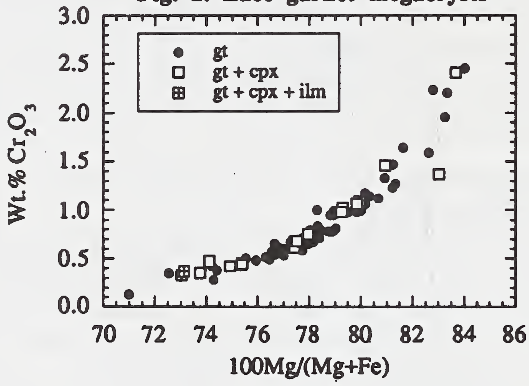

Fig. 3. Garnet megacrysts