GARNET MEGACRYSTS FROM GROUP II KIMBERLITES IN SOUTHERN AFRICA.

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In a study of the heavy mineral concentrate from the Group II Dokolwayo kimberlite in Swaziland, Daniels & Gurney (1989) identified a suite of garnets which they interpreted to be representative of the Cr-poor suite of megacrysts. This represented a significant find, since it was previously believed that the occurrence of Cr-poor megacrysts was confined to Group I kimberlites. Directed investigations have since recognised the presence of garnet megacrysts in a large number of Group II kimberlites in southern Africa, and this contribution aims at characterising these suites.

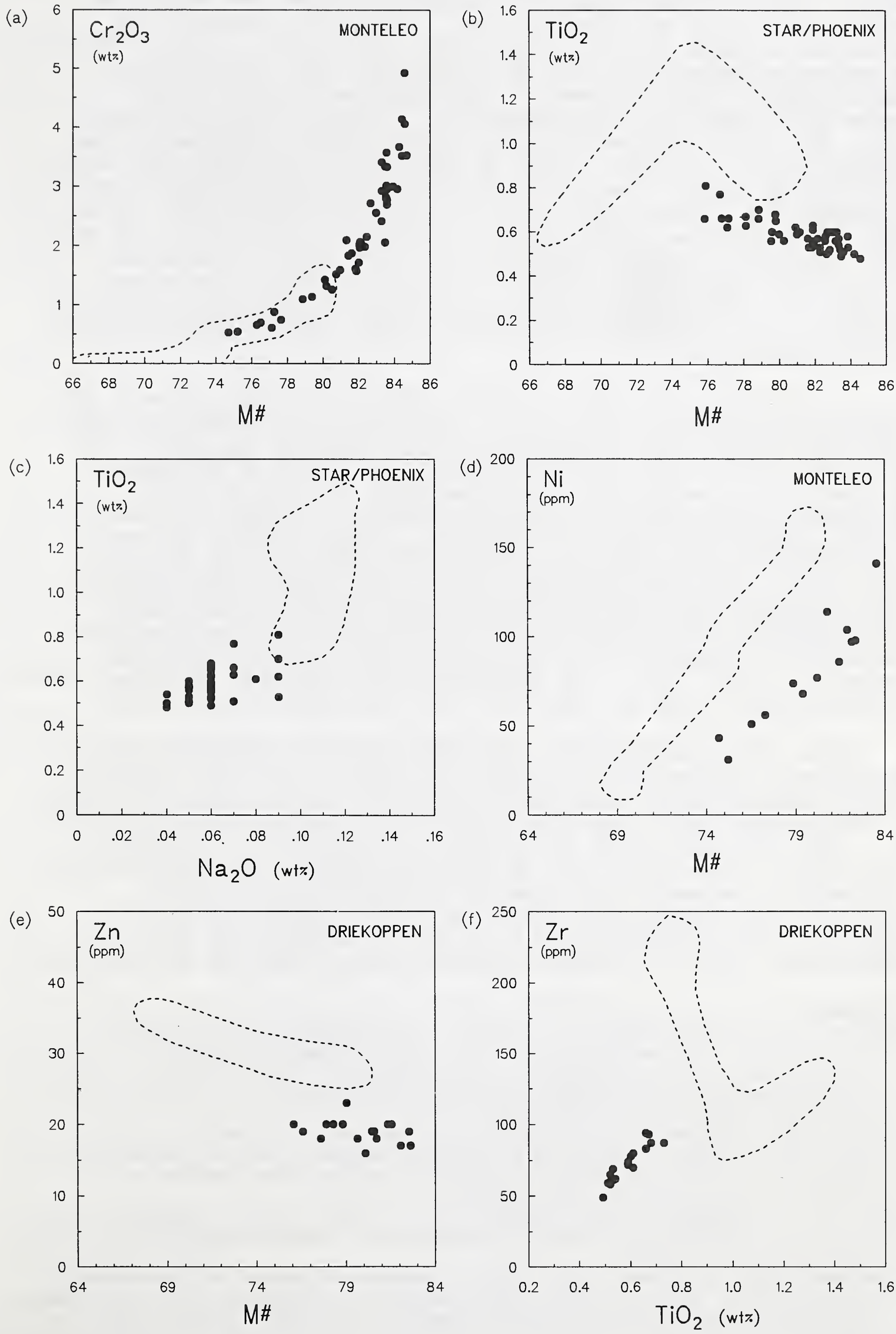
Garnet megacrysts have been recovered from the following Group II kimberlites:- Loxton and Southern Fissures (NE of Kimberley); Excelsior and Newlands (N of Barkly West) and Driekoppen, Monteleo, and the Phoenix Blow (in the vicinity of the Star Mine, O.F.S.). They have also been recovered from the Lace kimberlite in the O.F.S., where olivine and cpx megacrysts are apparently also present (Pers.Comm. D.R. Bell & G. Read). Follow-up work on a suite of garnet megacrysts from Dokolwayo is reported by Moore et al. (1990). Apart from the presence of cpx megacrysts at some of the Barkly West localities (many of which may be from eclogites), none of the other common constituent phases of the Cr-poor megacryst suite have been found at these localities to date.

A random sample of thirty garnets from each locality was selected for study from large collections of garnet megacrysts sampled from the coarse tailings dumps at the mines. Since this material had been processed through a primary crusher, all samples were less than 2 cm in longest dimension. The garnets are deep red in colour, highly fractured and usually have thin kelyphitic rinds developed on grain margins. Major element compositions were determined on a Cameca Camebax microprobe, using routine analytical procedures. Core-rim analyses on a number of test samples revealed no compositional zoning and consequently analyses were undertaken on grain mounts of chips taken from the megacrysts. Fifteen samples from each locality were selected for trace element analysis on the basis of Mg-number (M# = Mg/Mg+Fe atomic). Trace element analyses were undertaken on the proton microprobe at the CSIRO in Sydney, Australia. Details of this instrument and its application to the analysis of geological materials have been described by Griffin et al. (1988).

In assessing the compositional characteristics of the garnets examined in this study, they are compared with a suite of Cr-poor garnet megacrysts from the Monastery kimberlite (Moore, unpublished data). This suite was chosen because it has been well documented and it is considered to be broadly representative of garnet megacrysts in Group I kimberlites.

All seven suites show broadly similar compositional characteristics and a series of representative plots illustrating selected features is presented as Figure 1.

Figure 1: *A selection of plots illustrating typical compositional trends displayed by garnet megacrysts from Group II kimberlites. Compositional fields for Monastery garnets are included for comparison. Monastery data from Gurney et al. (1979) and Moore (unpublished).*



The "Group II" garnet megacrysts are on average more magnesian and chrome-rich compared to the Monastery suite. In general, M# ranges from 86 to 74 and chrome contents from 0.5 to 3.5 wt% Cr_2O_3, but at Excelsior, Monteleo and the Phoenix Blow at Star Mine, chrome contents may be as high as 5 wt% Cr_2O_3. At all localities Cr_2O_3 shows an excellent positive correlation with M# (see Fig. 1a). Titatium contents are moderate to high (~0.5-1.2 wt% TiO_2) and in all cases negatively correlated with M# (e.g. Fig. 1b). The rapid depletion in TiO_2 observed in the Monastery suite which correlates with the commencement of ilmenite precipitation (Fig. 1b) is not evident in any of the suites examined. The garnets show a limited range in calcium (~3.5-5 wt% CaO) which is slightly larger than the even more restricted range commonly observed for garnet megacrysts in Group I kimberlites. They also show elevated trace levels of sodium (~0.03-0.13 wt% Na_2O) but typically, sodium contents are lower than at Monastery (Fig. 1c). Trace enrichments of Na_2O in garnet have been correlated with high formation pressures (>45Kb) in eclogitic systems (e.g. McCandless & Gurney, 1989), and we believe this to be applicable here as well.

In general, the trace element contents of the garnets show systematic variation patterns. This is well illustrated in Fig. 1(d) where the Ni content of the Monteleo garnets decreases from ~150 to ~30 ppm over the range of M# present. Similar trends were noted for the other localities and Monastery, although the Monastery trend is offset by lower values of M#. Zn contents typically range between 15 and 30 ppm which is systematically lower than observed at Monastery (Fig. 1e). Zr (~50-100 ppm) and Y (~20-40 ppm) both show a good negative correlations with M# and as such mimic the behaviour of TiO_2. This is illustrated by the good positive correlation observed between Zr and TiO_2 in the Driekoppen garnets in Fig. 1(f). Ga contents show a general increase with Fe-enrichment, and are typically in the range 10 to 20 ppm.

This preliminary study demonstrates that while the garnet megacrysts recovered from Group II kimberlites show similar basic compositional features to Cr-poor garnet megacrysts (such as restricted CaO & elevated TiO_2), they differ in detail (Fig. 1). The fact that most elements show systematic variations with M# (in particular Cr, Ti and Ni) appears to indicate that the garnets formed in an igneous fractionation process. Moreover, the behaviour of Ni (Fig. 1d) almost certainly implies that olivine was part of the precipitating megacryst assemblage, while Ti trends indicate that ilmenite was absent.

References

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