THE INDIVIDUALITY OF ON- AND OFF-CRATON MEGACRYST SUITES IN SOUTHERN AFRICA.

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Megacrysts (i.e. discrete crystals > 1 cm in diameter) occur at localities both on and off the Kaapvaal craton in southern Africa.

Complications arise from classifications involving field descriptions (size, mineral assemblages) as opposed to those which are based on analytical results (mineral compositions). On the basis of mineral compositions, it is apparent that some megacrysts represent coarse disaggregated minerals from peridotite and eclogite xenoliths; these will not be discussed. Several other suites of compositionally distinct megacrysts can be distinguished on the basis of related mineral compositions and the occasional presence of co-existing phases. These include:

Cr-poor suite (olivine ± orthopyroxene ± clinopyroxene ± garnet ± ilmenite ± phlogopite ± zircon)

Fe-rich suite (olivine ± phlogopite ± zircon ± ilmenite ± clinopyroxene)

Granny Smith suite (clinopyroxene ± phlogopite ± ilmenite)

Group II suite (garnet ± olivine ± clinopyroxene ± rutile)

The Cr-poor suite

The Cr-poor suite (Nixon and Boyd, 1973; Gurney et al., 1979) is present in both on- and off-craton Group I kimberlites. Major and trace element compositional trends are consistent with fractional crystallization. However, comparison of the megacryst suites from individual Group I localities (cf. Schulze, 1987) indicates differences in mineral compositions and, in some instances, differences in mineral abundances (e.g. abundance of olivine) and mineral assemblages (e.g. absence of ilmenite). Nd and Sr isotopic compositions of clinopyroxenes from the Cr-poor suite are depleted relative to bulk earth and are similar to some ocean island basalts. Differences in isotopic compositions between clinopyroxenes from the same locality are more significant than differences between localities themselves.

The observed differences in mineral compositions, mineral assemblages and mineral abundances attest to the individuality of the Cr-poor suite at each locality and suggest that each must represent a localized feature rather than a continuous horizon in the upper mantle. Thermobarometric evidence suggests that the megacryst suite represents a 'thermal perturbation' of the steady state geotherm consistent with a localized feature. In contrast, certain features particularly the limited variation in mineral compositions and the similarity in isotopic compositions, imply similar Mg-rich asthenospheric source material for all Cr-poor megacryst suites. Differences between localities can be attributed to variable degrees of partial melting, to different

crystallization environments, to differences in the proportions of crystallizing phases and to different degrees of fractional crystallization. The Cr-poor megacrysts are xenocrysts in their host kimberlites.

The Fe-rich suite

The Fe-rich suite has been identified at the on-craton Monastery kimberlite (Moore et al., in prep). A tenuous link has been established between the Cr-poor suite and the more evolved Fe-rich suite at Monastery. However, the ilmenite compositions require that assimilation and/or magma recharge has occurred, subsequent to garnet and clinopyroxene crystallization, if the two suites are related. Such processes may have been active late in the fractionation sequence when only relatively small volumes of magma existed, possibly in vein-like isolated intrusions.

The Granny Smith suite

The Granny Smith suite has been identified at several on-craton localities near Kimberley and Jagersfontein (Boyd et al., 1984). The clinopyroxenes are found both as discrete and polycrystalline nodules and significant compositional differences are found between localities. The limited range in calcic compositions of the clinopyroxenes corresponds to a small range of temperatures (at approximately 1000^{o}C) if the diopside solvus is applicable, and equilibration to lithospheric conditions is suggested. Nd isotopic ratios of Granny Smith clinopyroxenes are equivalent to those of the Cr-poor clinopyroxenes, but Sr isotopic ratios are higher. These characteristics suggest that the Granny Smith suite might also represent the crystallization products of asthenospheric melts, but in association with assimilation of lithospheric wallrocks, possibly under sub-solidus conditions.

The Group II suite

Megacrysts were previously thought to be absent from Group II kimberlites, but recently, Daniels and Gurney (1989) identified Cr-poor garnet megacryst compositions in a study of the heavy mineral concentrate from the Dokolwayo kimberlite in Swaziland. Moore et al. (1990) demonstrated that the major and trace element compositions of the Dokolwayo garnets differ from those of the Cr-poor suite. Directed investigations have since recognised the presence of garnet megacrysts in a large number of Group II kimberlites in South Africa (Moore and Gurney, this volume). The diversity of mineral assemblages in this suite is, however, limited in comparison to the Cr-poor suite.

The Group II kimberlites in the Barkly West dyke swarm host Cr-rich clinopyroxene and garnet megacrysts.

Overall

Several megacryst suites might be present at a particular locality. The individuality of the respective suites between the different localities establishes that each must represent a localized feature rather than a continuous horizon in the lithosphere.

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