MESOZOIC KIMBERLITES AND RELATED ALKALIC ROCKS IN SOUTH-WESTERN SÃO FRANCISCO CRATON, BRAZIL: A CASE FOR LOCAL MANTLE RESERVOIRS AND THEIR INTERACTION.

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Proterozoic rocks which flank the late Archean Sao Francisco craton, and which were last deformed during the 800-450 my Braziliano event, are intruded by upper Cretaceous kimberlites, olivine melilitites, tuffaceous diatremes and carbonatite complexes. The most important focii of alkalic magmatic activity occur in an area of late Jurassic to early Cretaceous continental extension (the Alto Paranaiba uplift) over a period of about 40 Ma concomitant with the deposition of the Cretaceous Mata da Corda Formation (Fig.1).

The studied kimberlites are hypabbysal calcite-monticellite types, with uniformly distributed groundmass minerals. Their mineralogy comprises macrocrysts and phenocrysts of olivine, phlogopite and scattered ilmenite set in a groundmass of serpentinized monticellite, phlogopite, opaque minerals, perovskite, serpentine and calcite. Mica Rb-Sr emplacement ages of 95 Ma were obtained for kimberlitic rocks from the Tres Ranchos and Indaia/Perdizes river localities.

Sediment and breccia-filled maars or diatremes of alkalic affinity contain sporadic olivine macrocrysts and abundant phenocrysts set in a groundmass of serpentinized monticellite, phlogopite, clinopyroxene, pseudo-leucite, opaque spinel and perovskite. Some of the occurrences contain rare sodium-rich or potassium-rich glass phases which are assumed to be representative of more evolved melt components which crystallized under supercooled conditions. Mica Rb-Sr emplacement ages ranging from 85 to 109 Ma were obtained from alkaline rock samples from Carmo do Paranaiba, Presidente Olegario and the Pantano peridotite.

In the carbonatite complexes of Catalao, metasomatised magnetite and mica-peridotites and pyroxenites of an early stage are associated with five other late-stage magmatic carbonatites and late hydrothermal activity represented by foscorite, sovite, cryptocrystalline berforsite, glimmerite and lamprophyre. Enrichment of incompatible elements observed in the carbonatitic rocks is represented to some extent in the studied kimberlites within 20 km distance of the carbonatite complexes. A Rb-Sr emplacement age of 119 Ma was obtained on micas from the late-stage phases, which contrasts with the 83 Ma K/Ar age obtained previously (Hassui and Cordani, 1968).

One locality of basalt breccia and composite lava flows near Patos de Minas was also studied. Angular to rounded xenoliths, mineralogicaly similar to matrix material, with clinopyroxene, opaque minerals, perovskite, altered olivine, ghost relicts of feldspar and rare leucite, phlogopite and apatite are set in a groundmass of secondary clay, chlorite and serpentine. A mica Rb-Sr emplacement age of 118 Ma was obtained.

Xenoliths of spinel lherzolite, harzburgite and dunite, with evidence of spinel and phlogopite metasomatism, are common in some kimberlites from the

Coromandel area. In the Presidente Olegario and Patos de Minas areas cognate nodules with cumulus perovskite and olivine are fairly common, suggesting sampling of temperature-zoned reservoirs within the lithosphere.

Geothermobarometric calculations and the lack of high-pressure xenolith populations (i.e. garnet peridotites and diamonds) in these rocks compared to other kimberlites elsewhere in the world, point to a shallow lithospheric source for the xenoliths and possibly the alkalic rocks.

Figure 2 shows that the studied rocks have a relatively restricted range of Sr-Nd isotopic compositions approximated as a single component with average present-day 143Nd/144Nd = 0.51228 and 87Sr/86Sr = 0.7058. Nd model ages (CHUR) average 478 Ma. Present-day Pb signatures range as follows: 206Pb/204Pb = 17.066 to 20.957; 207Pb/204Pb = 15.309 to 15.679 and 208Pb/204Pb = 30.157 to 40.149. These are the first documented examples of kimberlites and related rocks with such isotopic compositions falling between those of Group I and II South African kimberlites (Smith, 1983). The source character of these Brazilian kimberlites is thus dissimilar to kimberlites in general worldwide, whereas their petrography and mineralogy are similar to South African Group I kimberlites.

The studied alkalic rocks have Sr and Nd isotopic signatures like those of the kimberlites although their Pb/Pb signatures show slight differences. A common source character can, therefore, be postulated for the kimberlites, para-kimberlites, carbonatites and alkali basalts. Increasing alkalinity and exceptionally high incompatible element concentrations (eg La, Ce, Th, Nb and Nd) in some of the kimberlites may be inherited from heterogeneously enriched portions of the lithosphere. In the more evolved rocks interelement ratios of incompatible elements suggest that differentiation processes were dominated by assimilation and fractional crystallization (AFC) rather than different degrees of partial melting.

Heterogeneities in the U/Pb and Pb/Pb isotopic ratios correlate with different enrichment styles, suggesting involvement of different magma reservoirs within the same source region and/or successive interactions of different source regions at different times. Negative correlation between U/Pb and K/Nb suggests that U/Pb fractionation was strongly influenced by a potassic phase, probably phlogopite. It is therefore likely that the trace element enrichment events, in which phlogopite had a key role, have taken place at relatively shallow depths (<250 km) in the upper-mantle.

Derivation of the different rock types by crustal contamination alone seems unlikely, given the clustering of Sr-Nd isotopic signatures, low Rb/Sr, low Ba/La and the relatively high Ti/K2O contents. However, a case can possibly be made for some recycling of metasomatized lithosphere in view of the higher Ba/Nb, Ba/La and Sr/Nd ratios observed in samples from Presidente Olegario and Carmo do Paranaiba. The relatively higher assimilation of continental crust and the nature of the nodules in these occurrences could possibly be pointing to a major discontinuity (the Western limits of the Sao Francisco craton) in the sub-continental lithospheric mantle in this area as delineated at the surface by the rocks of the Mata da Corda Formation preserved within a NE-SW system of grabens (Fig.1).

Isotopic and chemical similarities of the studied volcanics with those of the high-Ti Continental Flood Basalts of the Northern Parana Basin (within approximately 200 km of the study area) and with those of the Oceanic Basalts at the Walvis Ridge in the South Atlantic, suggest that their sources are closely related and were all affected by the "Dupal type" mantle enrichment. The relative input of mantle plumes, asthenospheric and lithospheric sources in the generation of the Minas Gerais rocks is under investigation. At this stage of the study, the preferred petrogenic model for the studied rocks assumes their derivation by partial melting

of upper-mantle similar to an enriched (E-type) source which had become heterogeneous on a small scale due to introduction of small volume melts and metasomatic fluids.

References:

Hassui and Cordani (1968). Cong. Bras. Geol. XXII-B.Horizonte.
Smith,C.B. (1983).Nature 304, 51-54.

Fig.1 - Location map (after Thompkins and Gonzaga, 1989)

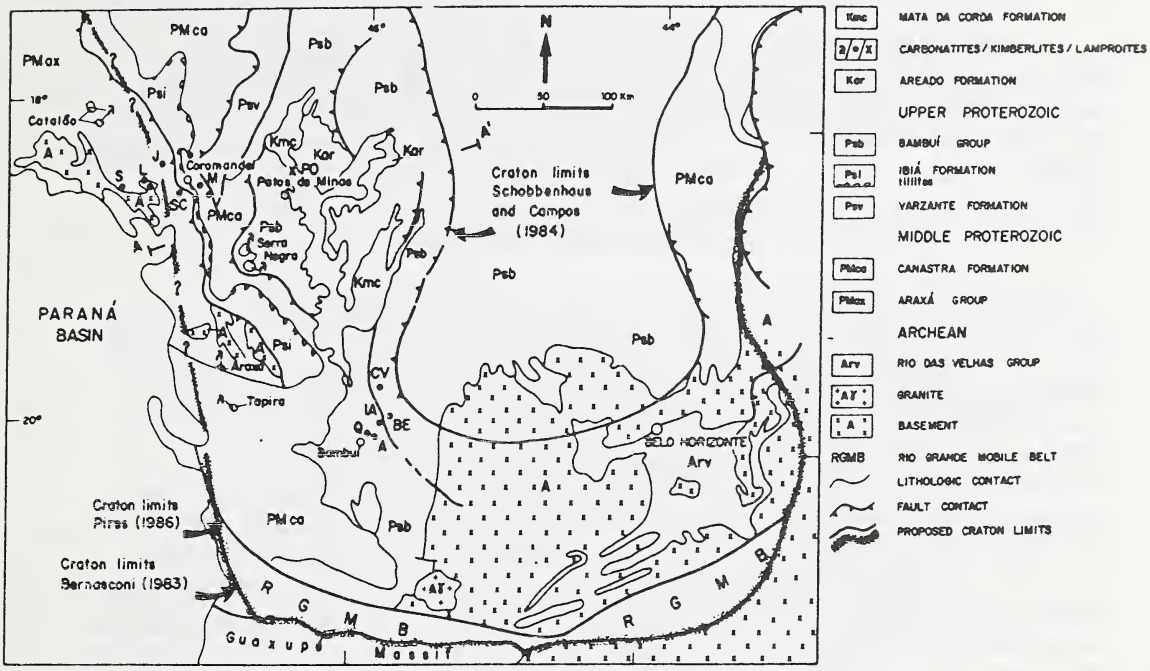
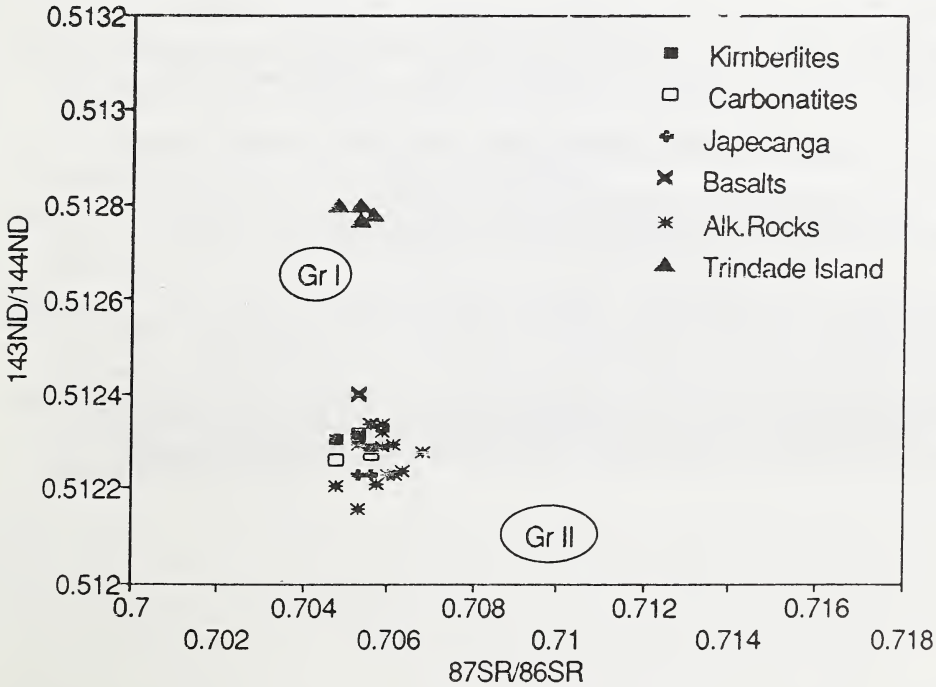
Fig.2 - Present-day isotopic signatures (Group I and II kimberlites after C.Smith, 1983).