Isotope composition of the sub-continental lithosphere underling the SW Sao Francisco craton margin, Brazil: clues to the origin of EMI-type enriched mantle reservoirs.

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The nature and restricted range of Sr and Nd isotopic composition of Cretaceous kimberlites, olivine melilitites, tuffaceous diatremes of kamafugitic affinity and carbonatite complexes intruded through the Proterozoic rocks which overly and flank the southwestern Sao Francisco craton margin indicate that these magmas either interacted extensively with or where derived from a light rare earth element (LREE) enriched homogeneous lithospheric mantle source isotopically similar to the "Enriched Mantle I" (EMI) component. The shallower alkalic rocks contain a greater proportion of this EMI-like component, whereas the lower time-averaged Rb/Sr, Nd/Sm and Pb/U ratios of the kimberlites compared to the other rock types may indicate mixing of the EMI-like mantle material with variable amounts of a high $^{238}U/^{204}Pb$ (HIMU-like) component. Systematic variations in rock types and geochemistry are evident on a regional scale and are believed to be indicative of vertical geochemical heterogeneities which are translated into lateral heterogeneities by different depths of melting. It is proposed that HIMU-, and EMI-like signatures in particular, are concentrated in laterally extensive but vertically distinctive portions of the mantle beneath the southwestern Sao Francisco craton.

The sources of the shallower alkalic rocks at Coromandel, the high-Ti of the nortern Parana basin and some Ocean Island Basalts (OIB) with Dupal signatures in the South Atlantic (with the Walvis Ridge Basallts) all appear to be related to the EMI component, In general, EMI signatures in continental settings appear to be restricted to shallow-derived volcanism (e.g. carbonatites and rift-volcanics in Brazil and East Africa) where HIMU-type signatures (e.g. high-temperature megacrysts and diamond bearing Southern African kimberlites) may originate from a source that was hotter and which started melting deeper in the mantle. This source of the HIMU-type signatures could be the asthenosphere, brought up by a mantle plume which was active at the time of the emplacement or, it may have developed by long-term entrapment of blobs and weak plumes accumulated in the lower subcontinental lithosphere.

Upper-Mesozoic binary mixing between up-welling HIMU-like melts and volumetrically dominant old EMI-like mantle materials from the overlying Mechanical Boundary Layer (MBL) of the lithospheric mantle is capable of satisfying the constraints of the data obtained in this study. The radiogenic isotopes are consistent with a sequence of events in which the local mantle lithosphere was enriched in incompatible elements during extensional which predated the formation of the

Brasilia fold and trust belt. Plotted against crystallization age, the initial ε_{Nd} values of the studied volcanics tit the evolution path defined from the Proterozoic crustal sequences of the Tocantins Province. Starting on the mantle evolution curve and progressing linearly to lower values with time, the data clearly show that the ultimate origin of the EMI-type ε_{ND} values is connected to the tectonic processes which led to the formation end evolution of the crustal sequences within the Proterozoic Tocantins Province.

Compared to the source of micaceous Group II kimberlites, both the isotopically transitional kimberlites from Prieska in southern Africa, and the Brazilian rocks described here originated from sources with lower time-averaged Rb/Sr. It might not be a coincidence that the Prieska kimberlites, which in terms of isotopic composition and PGE signatures are the closest kimberlite equivalents to the Brazilian kimberlites, also intrude a cratonic margin which has been affected by meso-Proterozoic thin skinned tectonism The east-African Carbonatites (Bell and Blenkinsop, 1987), which intrude the eastern margin of the Tanzanian craton which has been affected by neo-Proterozoic thin skinned tectonism during the Pan-African orogeny, also have isotopic signatures very similar to the LoNd line. The high $^{143}Nd/^{144}Nd$ low $^{87}Sr/^{86}Sr$ North American lamproites also intrude overthickened craton margins which were tectonically reactivated in the meso-Proterozoic (e.g. Mitchell and Bergmann, 1991). It is possible, therefore, that the similar $^{87}Sr/^{86}Sr$ ratios observed in all those areas might reflect firts-order modifications to ancient upper lithosphere imposed by thin-skinned Proterozoic tectonic processes in peri-cratonic domains.

It is speculated that the lower $^{87}Sr/^{86}Sr$ of those Mesozoic volcanics relative to Group II kimberlites and other enriched mantle derived may represent time-integrated Rb depletion attained gabbro-eclogite-granulite phase transformations (which could have been accompanied by CO_2 metasomatism) following tectonic overthickening at cratonic margins. The nature of the shallow-derived EMI-type materials may possibly by reconciled with the models of delamination of enriched continental lithocphere of sufficient phase transformations occurred and density inversion and delamination were attained, with a consequent removal of EMI-like material into the convecting asthenosphere. Large portions of delaminated ancient Brazilian lithosphere could have contaminated a belt of South Atlantic asthenosphere which is now erupting at hot spot islands which. in turn contaminate nearby sections of the Mid-Atlantic ridge. According to this model, the Walvis ridge basalts are maxtures of delaminated lithosphere, which was affected previously by Proterozoic tectonism and overthickeing of the western margins of the Central African crtaton, and more typical "normal" oceanic compositions lying within the oceanic mantle array.

References:

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