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GEOCHEMICAL AND ISOTOPIC CONSTRAINTS ON THE TECTONIC SETTING OF THE SERRA DOS CARAJAS BELT, EASTERN PARA, BRAZIL;

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The lower part of the Serra dos Carajas belt (Fig 1) is the metavolcanic and metasedimentary Grao Para Group (GPG) (1-6). The GPG is thought to unconformably overlie the older (but undated) Xingu Complex, composed of medium and high-grade gneisses and amphibolite and greenstone belts. The Lower Metavolcanic Sequence of the Grao Para Group (LMS) is estimated to be about 4-6 km thick, consisting of massive, vesicular, and porphyritic mafic volcanic flows and agglomeratic breccias and about 10-15% massive, flow-banded, brecciated, and tuffaceous prophyritic rhyolite (6). The LMS is overlain by the extensive, 100-400 m thick, and high-grade banded iron formations of the Carajas Formation, followed by an Upper Sequence (US) of 1-3 km of mixed volcanic and clastic and chemical sedimentary rocks. The stratigraphy of the US is poorly known, but it is thought to contain some quartz-rich arenites, suggesting mature continental provenance (6). Much thicker quartz-rich sandstones and conglomerates overlie the Upper Sequence, with unknown degree of conformity.

Petrographic, geochemical, and isotopic analyses of the bimodal metavolcanics of the LMS show these to be basalts, basaltic andesites, trachyandesites (shoshonitic), and rhyolites (6,8). Spilitic alteration is locally apparent, but the coherence of alkali element ratios and readily-altered trace element compositions suggests that most samples did not undergo strong alteration. Good correlation between HREES, Ti, and magnesium number in the mafic rocks demonstrate the effects of fractional crystallization in the mafic rocks. LREES, Si, K, Rb, Cs, and Ba do not correlate with magnesium number, suggesting that variable enrichments of these elements (fig. 2) reflect variable contamination of the basaltic melts with crustal material. Several contamination components must have been involved, since these elements are only weakly correlated among themselves, and with U, Th, Nb, and Ta. Rhyolite patterns show significant negative Eu anomalies.

Zircons from two quartz porphyritic rhyolites give an age of 2758 + 39 Ma (7), the best estimate of the age of eruption of the LMS. Rb-Sr whole-rock analyses of mafic rocks yield an isochron of 2687 + 54 Ma, similar within the range of calculated errors of the zircon age. Thus the GPG's Late Archean age is well established. The high initial Sr isotopic ratio 0.7057 for the mafic rock isochron is significantly higher than values of CHUR (0.7012, 9) or depleted mantle (0.7008, 10) for 2758 Ma. This indicates contamination by older continental crust. Sm-Nd results are too restricted in distribution to yield a usable isochron.

e Sr vs. e Nd values (Fig. 3) show a cluster around e Sr +50 and e Nd +3. These indicate that the magma was more likely derived from a depleted source than from a CHUR-like source. The high e Sr values are probably either the results of seawater interaction, leaving Nd isotope ratios intact; or contamination with older, presumably mafic crust that had elevated Rb/Sr ratios, but mantle-like Sm/Nd ratios. One rhyolite has similar e Nd and e Sr values, suggesting derivation from similar sources by similar processes. Three of the mafic samples have negative e Nd and positive e Sr values, possibly indicating contamination by older granulitic and granitoid crust. Note that the ranges of diversity in the e Sr and e Nd data can be seen in the basalts alone: the isotopic variation does not correlate directly with silica content. Diverse sources of contamination are indicated, and might be found in the diverse lithologies of the underlying Xingu Complex.

The geochemical data indicate that the GPG has many features in common with ancient and modern volcanic suites erupted through continental crust. The mafic rocks clearly differ from those of most Archean greenstone belts, and modern MORB, IAB, and hot-spot basalts. The geological, geochemical, and isotopic data are all consistent with depostion on continental crust, presumably in a marine basin formed by crustal extension. The isotopic data also suggest the existence of depleted mantle as a source for the parent magmas of the GPG. The overall results suggest a tectonic environment, igneous sources, and petrogenesis similar to many modern continental extensional basins, in contrast to most Archean greenstone belts. The Hammersley basin in Australia and the circum-Superior belts in Canada may be suitable Archean and Proterozoic analogues, respectively.

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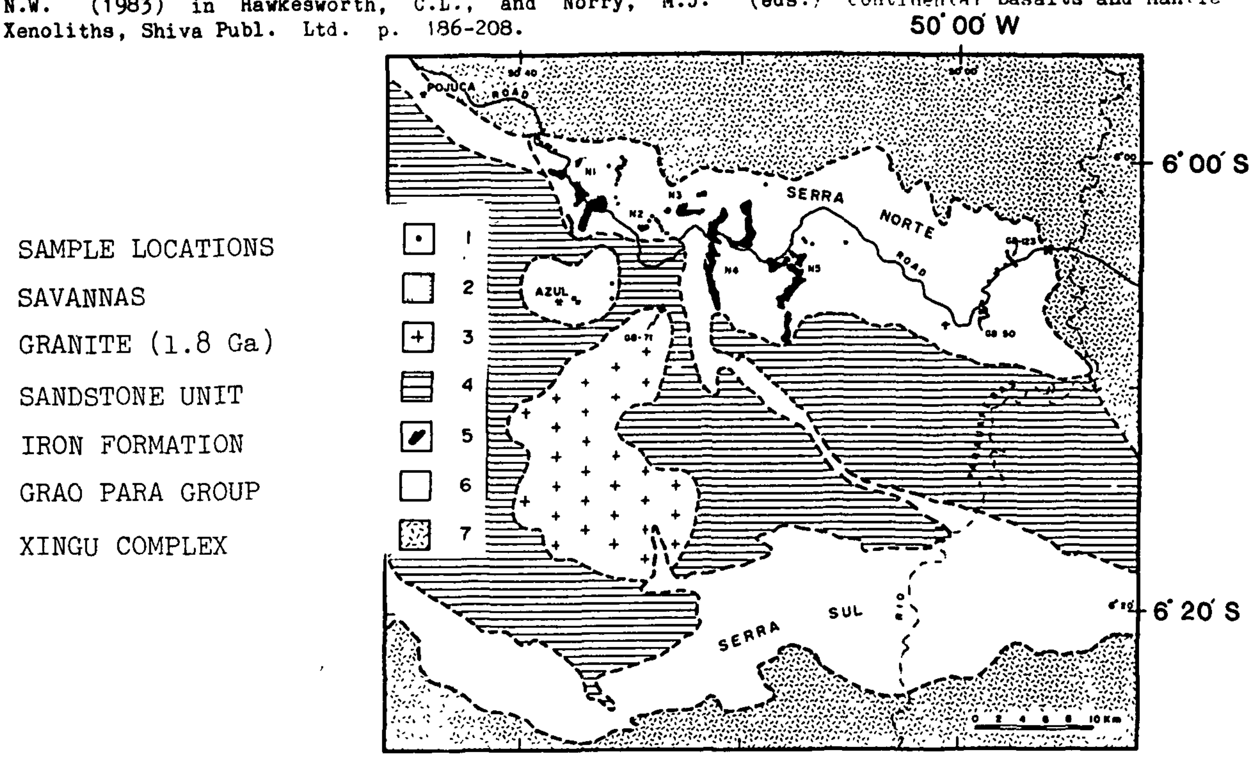

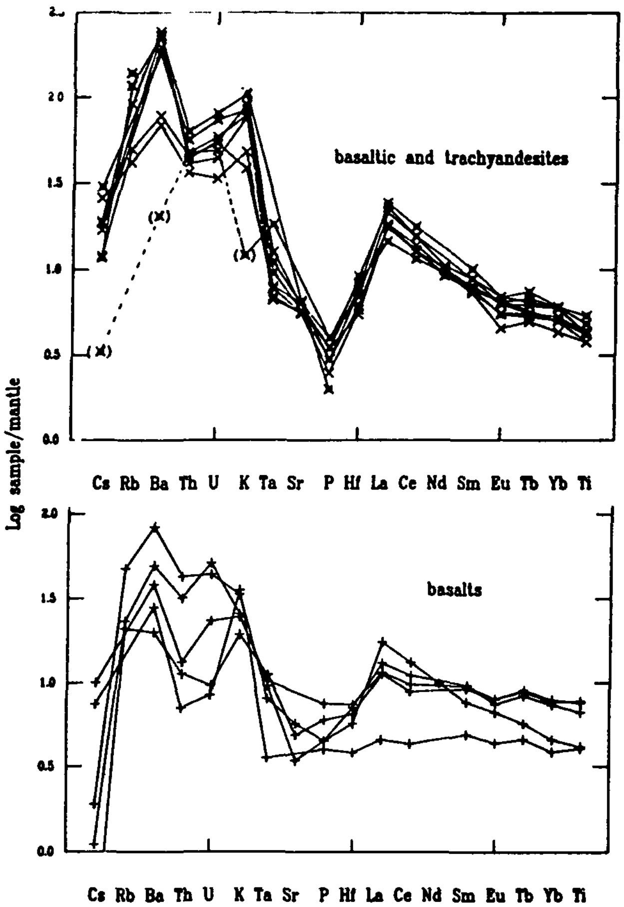

Fig. 2: Incompatable element diagrams for mafic rocks, normalized for model primitive mantle of Wood et al. 1979, and Hf, Eu, and Yb interpolated from chondrite data. Karoo basalts have similar enrichment patterns.

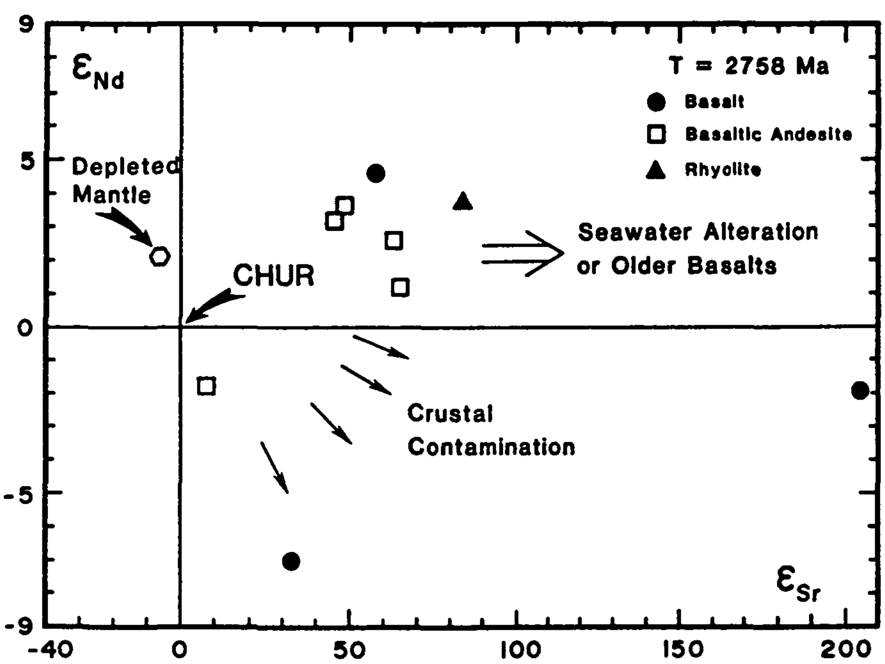

Fig. 3: Sr - Nd diagram for Grao Para Group metavolcanic rocks.