

closest chemical equivalents are some Na-enriched (non-cumulate?) picrites, and limburgites. Limburgites show both Mg-olivine and Ca-pyroxene as phenocrysts and xenocrysts in an alkaline undersaturated glassy matrix of syenitic composition (e.g., Ishibashi, 1977, *Sci. Rep. Dept. Geol. Kyushu Univ.*, **12**, 263-271). Alternatively, the high density of such parental magmas may preclude its ascent to the surface in an unfractionated state. — (13 de novembro de 1984).

#### NEPHELINE SYENITE MAGMAS: DERIVED FROM ASTHENOSPHERIC SOURCES?\*

— HORSTPETER H. G. J. ULBRICH, presented by A. C. ROCHA-CAMPOS — Instituto de Geociências, Universidade de São Paulo, Cidade Universitária, São Paulo, SP — Rather severe constraints are imposed on the origin of nepheline syenites (NeS) magmas based on petrological and isotopic arguments, and the evaluation of geochronologic age pattern. The case is discussed with special reference to the Poços de Caldas alkaline massif, southern Brazil, almost entirely composed of phonolites, with a subordinate but significant amount of NeS. Pertinent observations are summarized below:

- 1) General petrological principles show that NeS magmas can be derived from ultrabasic or basic parental magmas of mantle origin. Poços de Caldas is no exception, even if outcrops of ultramafic-mafic rocks are very rare or absent at the present level of erosion.
- 2) Origin of NeS magmas by melting of crustal rocks is rejected as a general hypothesis, mainly because suitable "fertile" crustal rocks are rarely found (e.g., nepheline gneisses; see also next point).
- 3) K/Ar ages from Poços de Caldas rocks (Bushee, 1971, *Ph. D. thesis*, UC Berkeley) show an age difference of over 30 my between "early" ("ankaratrite" blocks, 87 my) and "late" (phonolites, 53 my) activities, with NeS around 60-62 my. Two Rb/Sr isochrons (Kawashita *et al.*, 1984, *33 Congr. Bras. Geol. Resumos*, p. 244) obtained from several cogenetic NeS from the northern half of the massif show ages of  $86,3 \pm 6,0$  my (initial ratio of 0,7052) and  $89,8 \pm 2,8$  my (i.r. 0,7050). It is believed that total activity of the massif, contrary to K/Ar ages, is restricted to a span of about 1-2 my; Rb/Sr ages point in this direction.

Poços de Caldas is one of several dozen alkaline massifs, dotting the E and W border of the Paraná Basin, and is clearly related, as marginal magmatic activities, to the huge earlier intra-basin basaltic outpourings. Geodynamic considerations place the following constraints on age pattern and/or depth of origin:

- a) Assumption of a *fixed* asthenospheric source for the Poços de Caldas parental magmas prohibits large age intervals. Such a situation would mimic the action of a hot spot and emplace magmas along linear belts, as long

as 3000 km (10 cm/year westward drift of the South American plate over the alleged 30 my K/Ar interval) or as short as 200 km (2 my interval).

- b) Lithospheric mantle source (i.e., no relative movement between source and emplacement site).

- c) Still better, a *moving* asthenospheric mantle source, which "travels" as fast as the lithospheric plate. This case can only be reconciled, geologically, with structural control mechanisms of magma generation, at depth. Crust is thinner under the Paraná Basin, and thickens under its margin, thus creating a marginal structural inflection; probably, similar structural inflections are found at depth, at the asthenosphere-lithosphere interface, so that the moving lithosphere may create (e.g., by pressure release) favorable sites for asthenospheric magma generation at the margins of the Paraná Basin. — (13 de novembro de 1984).

#### HYDROTHERMAL ALTERATION IN THE POÇOS DE CALDAS ALKALINE MASSIF: A PRELIMINARY APPRAISAL\*

— HORSTPETER H. G. J. ULBRICH, LUIS BARROSO MAGNO FILHO, GIANNA M. GARDA and EDUARDO W. YOSHINO, presented by A. C. ROCHA-CAMPOS — Instituto de Geociências, Universidade de São Paulo, Cidade Universitária, São Paulo, SP and Nuclebrás S/A, Complexo Minerário Industrial, Mina Osamu Utsumi, Caldas, MG — The Poços de Caldas alkaline massif, southern Brazil, covers over 800 km<sup>2</sup>, and is composed mainly of phonolites and nepheline syenites (NeS). Most NeS (as well as phonolites) are sodic-potassic to perpotassic rocks, with total alkali content of 12-15%; Na<sub>2</sub>O, 3.4 to 8.8%; K<sub>2</sub>O, 5.9 to 13.5%; Al<sub>2</sub>O<sub>3</sub>, 14.7 to 22.5%; SiO<sub>2</sub>, 49.5 to 56.3%; total FeO, 2 to 9% (usually, Fe<sub>2</sub>O<sub>3</sub> < FeO), and very low to low CaO and MgO.

Detailed mapping showed that miaskitic and intermediate NeS are predominant (more than 80% of outcrops) over agpaitic varieties; the latter usually present eudialyte and show higher contents of Zr, Nb, U, etc. Hydrothermal alteration (HA) is widespread, and directly responsible for caldasite (zircon-baddeleyite) and U-Mo-Zr mineralization. Several observations follow:

- 1) Primary caldasite occurrences, usually located along veins, are concentrated mainly in a crescent-shaped area, in the southern half of the district.
- 2) On aerial photos, several "circular structures" (e.g., PARADELLA & ALMEIDA, 1976, *An. 29 Congr. Bras. Geol.*, **3**, 181-190) are observed, representing either subvolcanic domes and/or collapse structures; some are simple erosional features. The most important is the "eastern-central structure", clearly marked by radial and peripheral drainage, caused mainly by several phonolite (and NeS) subvolcanic domes (?); its periphery is dotted by numerous radioactive anomalies. This whole structure, covering over 100 km<sup>2</sup>, is almost totally affected by HA. Within this structure,

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