GEOTHERMOMETRY OF THE POÇOS DE CALDAS NEPHELINE SYENITES, SOUTHERN BRAZIL* – MABEL NORMA COSTAS ULBRICH, presented by A. C. ROCHA-CAMPOS – *Instituto de Geociências, Universidade de São Paulo, São Paulo, SP* – Nepheline syenites (NeS), the only phaneritic rocks outcropping in the Poços de Caldas alkaline massif, southern Brazil, are leucocratic to hololeucocratic varieties. The main felsic minerals are K-feldspar (KF, 40-60%) and nepheline (Ne, 20-36%); the former is K-rich (>80% Or), mostly structurally inhomogeneous (highly ordered microcline and orthoclase sometimes coexisting in the same grain, or in different grains of the same sample). Ne is mediopotassic. Sodic pyroxene (soda augite, aegirine-augite or aegirine) is usually subordinate, joined sometimes by minor biotite or Mg-arfvedsonite (this last one in agpaitic rocks); biotite is the only mafic mineral in some facies. Agpaitic rocks may show up to 10-15% rare-metal silicates (mainly eudialite); miaskitic or intermediate facies (which are predominant) are characterized by sphene, fluorite and magnetite. NeS, although monotonous, appear as several different facies, identified by variations in texture and accessory mineralogy; they crop out mainly in the northern half of the district, as small to medium-sized magmatic bodies (which rarely cover more than 5 or 6 km^2). Geothermometry of NeS was based on Ne and Ne-KF diagrams of Hamilton (1959, *J. Geol.*, **69**, 321-329) and Powell & Powell (1977, *Contr. Min. Petrol.*, **62**, 193-204) using electron microprobe data (ARL 3-channel manual equipment).

Tne *coarser-grained NeS* (both agpaitic and miaskitic) show Ne with slight excess SiO_2 (<5%), with data clustering around the Morozewicz-Buerger convergence field (limited by the Buerger, $Ne_{73}Ks_{27}$, and Morozewics, $Ne_{75.1}Ks_{20.9}Qz_{4.0}$, compositions; cf. Tilley, 1954, *Am. J. Sci.*, **252**, 65-75). KF (usually, Or 80%) is unzoned or weakly zoned, with Na-richer centers. Three cases are identified in these rocks: 1) agpaitic facies, with coexisting orthoclase and microcline, with geothermometric T of 500-540°C, thus defining probably true magmatic crystallization T; 2) facies with highly ordered microcline as the predominant KF, with T less than 500°C, recording reequilibration during cooling, with Na-K magmatic exchange reactions; 3) some facies show Ne with near-Buerger compositions accompanied by maximum microcline, attesting to submagmatic re-equilibration.

Finer-grained NeS are generally more rapidly quenched border facies. Ne are tipically Qz-rich (5% or over), and KF is mainly orthoclase. In miaskitic varieties, Ne is compositionally homogeneous; KF is zoned (e.g Or_{76} Ab_{24} at the center, and Or_{95} Ab_5 at the border). Textures are usually poikilitic, with larger KF plates enclosing small Ne euhedra. Ne compositon, plotted on a Hamilton diagram, shows crystallization T of 730-800°C for miaskitic types. In similar finer-grained agpaitic facies, KF is weakly zoned, and textures indicate KF-Ne joint crystallization along cotectic lines; compositions of the two phases suggest crystallization T of 580-600°C. – (*13 de novembro de 1984*).

THE ULTRAMAFIC-ALKALINE AND GABBROIC ALKALINE LINEAGES: DERIVATION BY FRACTIONATION OF ULTRABASIC ALKALINE MAGMAS?* – HORSTPETER H. G. J. ULBRICH, presented by A. C. ROCHA-CAMPOS – *Instituto de Geociências, Universidade de São Paulo, Cidade Universitária, São Paulo, SP* – Most nepheline syenites (NeS) are associated with ultramafic rocks (peridotites, pyroxenites, jacupirangites, rocks of the ijolite series), both with and without accompanying alkaline gabbroic rocks. If the main difference between these rock associations is given by the presence, or absence, of calcic plagioclase, then two distinct lineages can be set up: the gabbroic-alkaline an the ultramafic-alkaline, as already pointed out in the literature (Sheynmann *et al.*, 1963, *Internat. Geol. Rev.*, **5**, 451-457). The anorthite component of plagioclase is unstable at higher pressures and crystallizes only from magmas which are relatively Ca- and Al-rich. It is thus tempting to propose a common origin for the two lineages, whose main difference would be given by the pressure level at which Ca is fractionated out of the parental magmas.

There is little doubt that most NeS are rocks derived from parental basic or ultrabasic magmas. Possible compositional ranges of these parents, although varied, can be determined both from actual examples (e.g., possible primary magmas) and on theoretical grounds (e.g., what melts can be derived from a peridotitic mantle?): these parental magmas have to be relatively SiO_2-poor, rich in MgO and CaO, with low Al_2O_3 and probably also very poor in alkalies.

Chemically, conversion of these magmas into NeS magmas means enrichment in SiO_2, Al_2O_3 and alkalies, and very strong depletion both in MgO and CaO. These chemical trends can be duplicated if wehrlitic fractions can be separated from the parental magmas (i. e., separation of Mg-olivine and Ca-pyroxene). Wehrlitic fractionation opens up two possibilities: a) efficient early separation of a wehrlitic fraction, depleting the parental magma strongly in Ca and inhibiting a lower-pressure crystallization of Ca-plagioclase, thus giving rise to the ultramafic-alkaline lineage; b) enhanced early separation of Mg-olivine, over that of Ca-pyroxene, may drive the compositions of derived magmas into the plagioclase phase volume, allowing this mineral to crystallize at lower pressures, thus reproducing a gabbroic-alkaline trend.

A general problem remains, mainly related to the very low alkali content of most ultrabasic parental magmas (e.g., komatiites, picrites). The problem may be solved if it is assumed that the primary ultrabasic magmas of alkaline trends are already alkali-enriched (e.g., by melting of alkali-rich mantle metasomatites). Rocks which represent such hypothetical magmas are unknown. The

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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*).

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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 Minero Industrial, Mina Osamu Utsumi, Caldas, MG* – The Poços de Caldas alkaline massif, southern Brazil, covers over 800 km^2, 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_2O, 3.4 to 8.8%; K_2O, 5.9 to 13.5%; Al_2O_3, 14.7 to 22.5%; SiO_2, 49.5 to 56.3%; total FeO, 2 to 9% (usually, Fe_2O_3 < 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^2, is almost totally affected by HA. Within this structure,

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