accounted by removal of 1.6% of sphene + 1.4% apatite + 30% of alkali feldspar + 16% of plagioclase + 16% of amphibole.

All petrological data, including the compositional trends in both whole rocks and minerals, suggest the probable derivation of the least differentiated essexitic magmas from more primitive ankaratritic parental melts as observed for other Brazilian alkaline complexes (e.g. Piratini, Juquiá, Fortaleza). These alkaline basic magmas could have been generated by a low degree partial melting of enriched mantle source deep in the subcontinental lithosphere.

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PETROLOGICAL AND GEOCHEMICAL STUDIES OF ALKALINE ROCKS FROM CONTINENTAL BRAZIL. 6. tHE PHONOLITE-TEPHRITE SUITE FROM FORTALEZA, STATE OF CEARÁ

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The Fortaleza alkaline district consists of a number of phono-tephritic plugs, smooth domes and dykes (oriented around NE-SW directions) occurring within a radius of 50 km from the city of Fortaleza (Fig. 1). Except for the occurrences of Ancuri and Caruru, cropping out in the Phanerozoic sedimentary cover, the alkaline rocks cut the Precambrian crystalline basement. The available data give K/Ar and Rb/Sr ages around 30 Ma (Cordani, 1970; Teixeira et al., 1978; Guimarães, 1982).

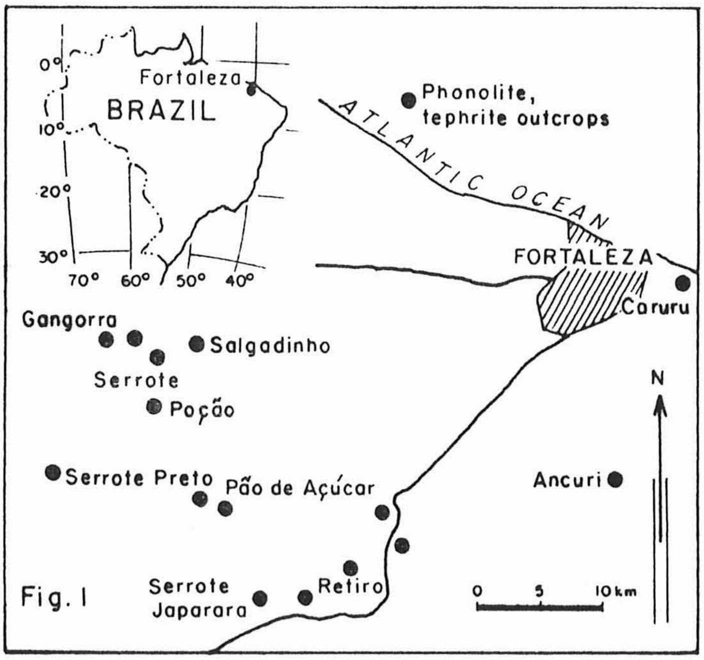

Fig. I

Chemically, alkaline rocks range in composition from tephrites and phonolitic tephrites (often as dykes) to peralkaline phonolites (Fig. 2). The most complete lithological range occurs at Serrote Japarara and Caruru, which show phono-tephritic to peralkaline phonolitic compositions. In the latter locality olivine-clinopyroxenite, monzogabbro and nepheline syenite inclusions of cognate origin were also found within the phonolitic dome. Tephrites (Differentiation Index, D.I. 38) are petrographically characterized by phenocrysts and microphenocrysts of Ti-salite, kaersutite, Ti-magnetite, apatite and andesinic plagioclase $\pm$ olivine. Phonolitic tephrites (D.I. 40-49) have essentially the same mineralogy, except for a lesser content of the mafic phases, whereas in phonolites (D.I. 91-96) alkali feldspar and nepheline are the dominant phases and clinopyroxene shows a continuous increase in the acmite molecule in concomitance with the transition to peralkaline field (agpaitic index in phonolites A.I.=1.02-1.18).

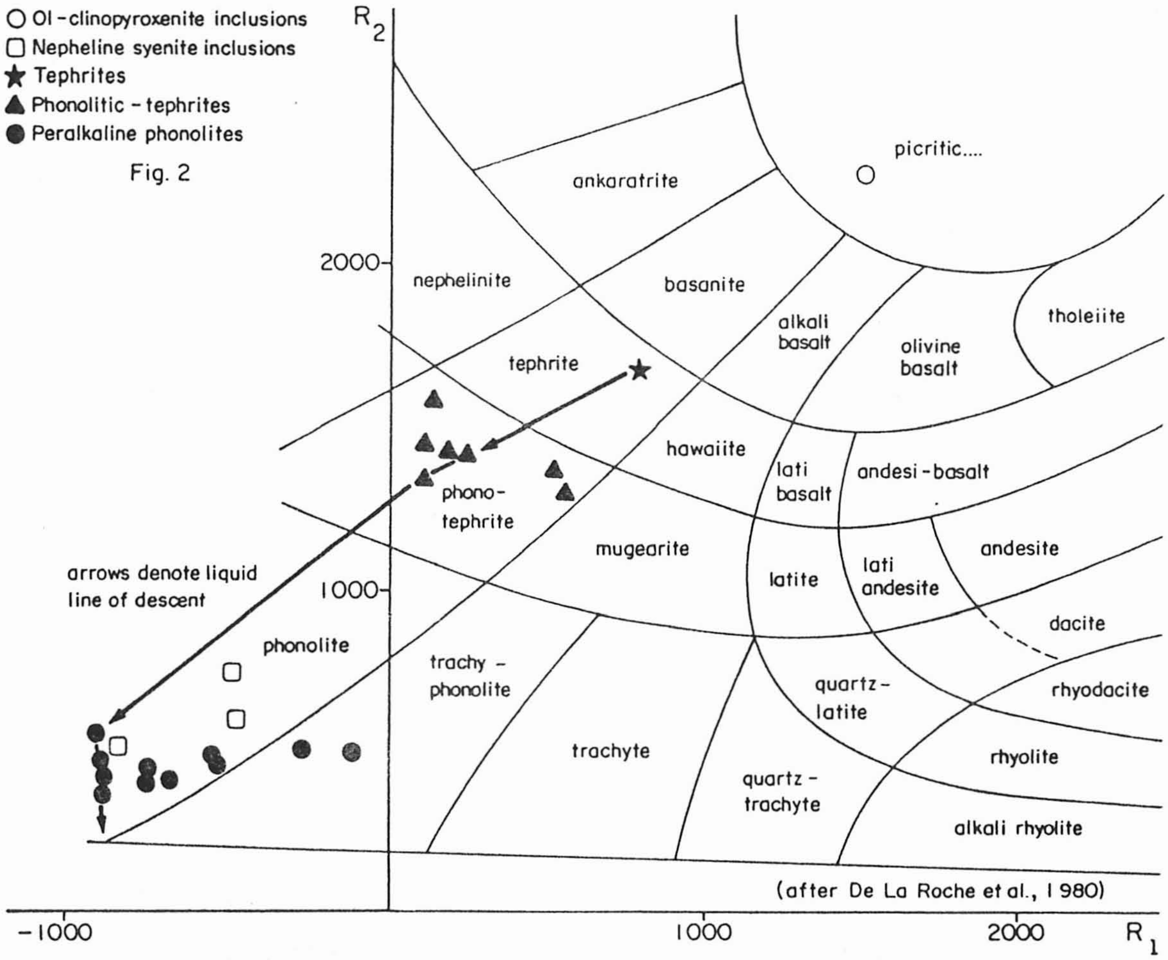

Fig. 2

The cognate inclusions in the Caruru phonolite are meso to orthocumulitic olivine-clinopyroxenites (Mg-olivine + salitic clinopyroxene + Ti-magnetite + phlogopite ± plagioclase), monzogabbros (salitic clinopyroxene + andesine + alkali feldspar + Ti-magnetite + apatite ± nepheline ± phlogopite) and nepheline syenites (alkali feldspar + nepheline + salitic to acmitic clinopyroxene + Ti-magnetite + phlogopite + sphene + apatite ± plagioclase ± richterite ± calcite).

The observed gradual variations of the petrographical, mineralogical and chemical characteristics indicate that the rock suite evolved essentially by shallow fractional crystallization processes leaving behind cumulates which were sometimes brought to the surface as inclusions within the phonolitic lavas.

According to mass balance calculations between host rocks and phenocrysts, the least differentiated tephrites represented in the suite could have produced phonolitic tephrites magmas by subtraction of salite (24%), alkali feldspar (9%), andesine (6%), Ti-magnetite (1.5%), olivine (1%), and apatite (0.5%)

corresponding to a monzo-gabbroic mineral assemblage similar to that of some cognate inclusions. Removal of about 90% of a syenodioritic to nepheline syenitic mineral assemblage from phonolitic tephrites could, in turn, account for the generation, respectively, of phonolitic melts up to the extremely differentiated peralkaline phonolites.

Concomitantly with fractionation of major phases, apatite and sphene were also progressively removed as indicated by the change of intermediate and heavy REE patterns from positively fractionated in phonolitic tephrites to V-shaped in the most differentiated peralkaline phonolites (Fig. 3). The occasional presence in nepheline syenite inclusions of patches composed of calcite+acmitic clinopyroxene+alkali feldspar suggests that this stage of magmatic fractionation may have been close to carbonatite/silicate liquid immiscibility conditions.

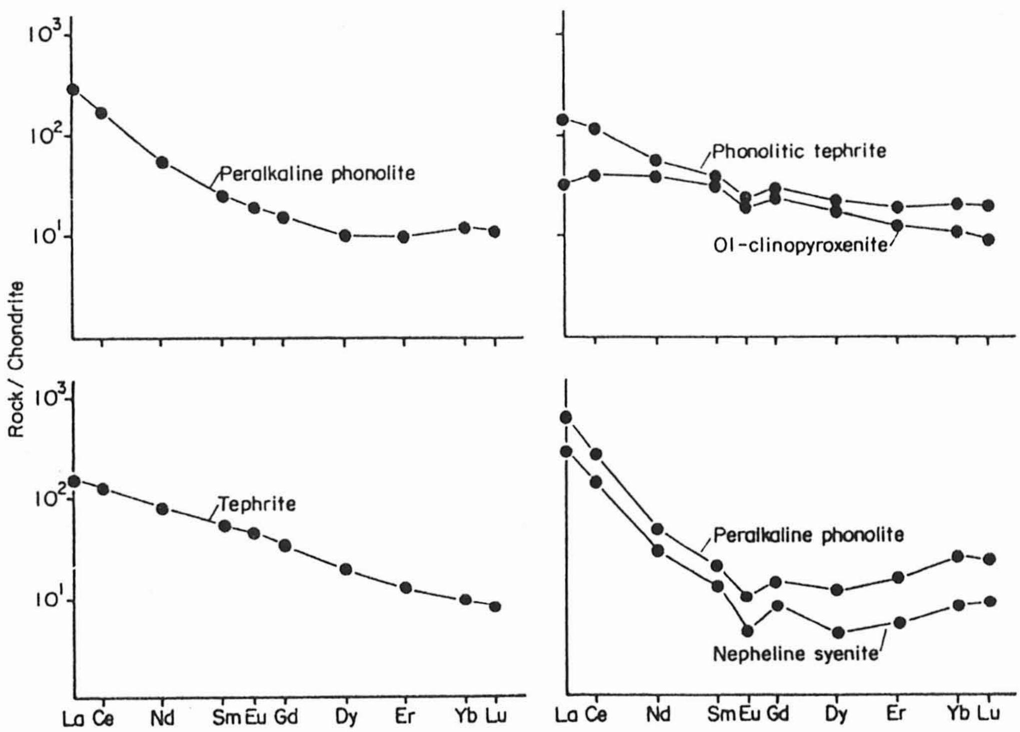

Fig.3

Compositional trends in whole rocks and minerals plus the crystallization order of liquidus phases as well as the existence of olivine-clinopyroxenite cumulate inclusions are in agreement with a fractionation of the least differentiated tephritic magmas from ankaratritic melts apparently not represented in the area. These alkaline basic melts generated deep in the lithospheric mantle appear to represent a widespread magma-type parent of many

Brazilian alkaline complexes (e.g. Piratini, Juquiá, Morro Redondo, Jacupiranga).

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PETROLOGICAL AND GEOCHEMICAL STUDIES OF ALKALINE ROCKS FROM CONTINENTAL BRAZIL. 7. THE LAGES ALKALINE DISTRICT, SC

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Representative samples of leucocratic and ultrabasic alkaline rocks from the Lages Alkaline District (LAD) were studied; the carbonatites and pipe breccias also described by Scheibe et al. (1984) and Scheibe (1986) were not included.

The ultrabasic alkaline rocks are plutonic to subvolcanic olivine melilitites and olivine melteigites (nephelinites). Among the leucocratic terms, volcanic textures can also be found. Plutonites may be described as nepheline syenites and show alkaline to peralkaline characteristics; the peralkaline volcanites and subvolcanites are more evolved than the nepheline syenites and may be classified as foidal microsyenites and phonolites. One sample may be classified as trachyphonolite (Fig. 1).

The major element variations of the olivine melilitites and between these and the nephelinites seem to exclude a connection by crystal/melt fractionation