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Pseudoleucites from Rio de Janeiro State, Brazil

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Abstract

Pseudoleucites up to 15 cm in width are described from subvolcanic and plutonic rocks of the Itauna and Tangua complexes in Rio de Janeiro State, Brazil. Those occurring in subvolcanics have very well-preserved leucite morphology, whereas the plutonic pseudoleucite morphologies are less well preserved. Mineralogically the pseudoleucites contain K-rich microperthite, nepheline, and very minor amounts of analcime, pyroxene, and biotite. Chemically, the pseudoleucites from the Tangua complex have compositions similar to pseudoleucites from other localities, whereas the sample from the Itauna complex is the most orthoclase-rich pseudoleucite hitherto reported. From its composition it is unlikely that the Itauna pseudoleucite was derived by any mechanism as yet proposed for the genesis of pseudoleucites. Based on its morphology relative to that of orthoclase in the host rock, this pseudoleucite cannot be considered a "pseudo-orthoclase."

Introduction

The earliest descriptions of pseudoleucites by Hussak (1887) and Derby (1891) were from Serra de Tingua, Brazil. Since then many other occurrences have been described from throughout the world. A number of theories of their origin have been suggested, and have recently been reviewed by Taylor and MacKenzie (1975).

This note describes pseudoleucites from 2 to 15 cm in diameter from the Itauna and Tangua complexes in the alkaline rock belt extending 100 km east of the city of Rio de Janeiro, Brazil. This belt consists primarily of circular complexes 6 to 30 km^2 in area, ranging in composition from syenite to nepheline syenite. These complexes, which intrude Proterozoic gneisses, are 51–72 m.y. old (Amaral *et al.*, 1967). Although pseudoleucites occur in a number of these complexes (Valenca, 1974, 1975; Valenca *et al.*, 1974; Reis and Licht, unpublished report, 1974), they are spectacular in the subvolcanic nepheline-bearing microsyenite which occurs as a very fine-grained marginal facies of the Itauna complex, and in the fine-grained microsyenite dykes and nepheline syenites of the Tangua complex (Fig. 1). In the finer-grained rocks, pseudoleucites have hexagonal or octagonal outlines (Fig. 1A,D), whereas in the coarse-grained varieties the pseudoleucites tend to be rounded to subrounded (Fig. 1B,C), presumably because of slower cooling rates. Locally these pseudoleucites may constitute up to 30 percent of the rocks.

Geology, mineralogy and chemistry

The Itauna complex consists of at least four individual phases in non-continuous concentric rings of pseudoleucite-bearing nepheline syenites and nepheline microsyenites surrounding a younger core of phonolites. The sharp contracts between these phases and the presence of a variety of xenoliths suggest multiple intrusions, with phonolites as the last phase (Valenca, 1974, 1975).

The Tangua complex is mineralogically zoned with the more nepheline-rich rocks occurring at the center of the complex. In this complex pseudoleucite-bearing rocks are particularly common along the northwest margin, and less common along the northeastern margin and in the central parts of the complex.

Mineralogically, pseudoleucites of both complexes

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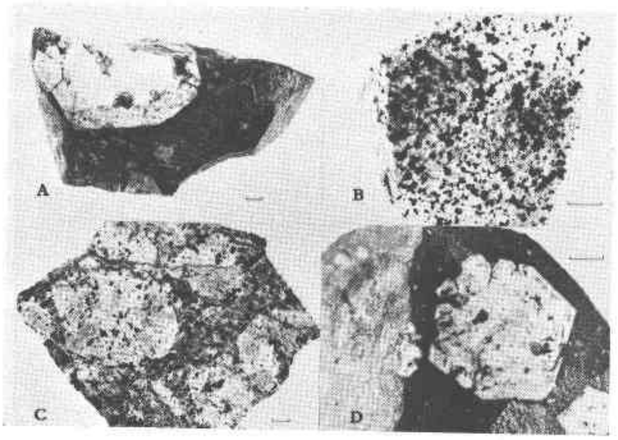

Fig. 1. Pseudoleucites from the Rio de Janeiro state, Brazil, Scale represents 1 cm. A. Itauna complex. B, C, and D. Tangua complex.

consist principally of microperthitic orthoclase and nepheline, with minor analcime and other zeolites, and minor mafic minerals, principally pyroxene and biotite. Feldspar and nepheline are usually intergrown, and in the finer-grained rocks have their longest dimensions perpendicular to the edges of the pseudoleucites, producing a distinct zonation (Fig. 1A,D). Lack of zonation in the pseudoleucites in the coarser-grained rocks and the more diffuse nature of their boundaries led Valenca (1975) to suggest that these pseudoleucites may represent a more advanced stage of magmatic "resolution" of the original pseudoleucites, such as those preserved in the finer-grained rocks.

Table 1. Chemical analyses of pseudoleucites and host rock

Samples(1)	A	A'	B	C	D
SiO_2	56.35	55.56	54.70	55.45	54.05
TiO_2	0.18	1.02	1.28	0.22	0.35
Al_2O_3	23.82	19.87	19.79	24.12	23.06
Fe_2O_3	0.50	2.16	2.28	0.75	1.42
FeO	0.36	1.15	1.80	0.32	0.56
MgO	0.11	0.43	1.41	0.18	0.23
MnO	0.02	0.14	0.17	0.04	0.05
CaO	1.06	2.51	3.38	0.82	1.51
Na_2O	1.75	4.92	5.20	5.23	5.01
K_2O	13.20	9.83	8.24	12.10	11.76
H_2O^+	1.84		1.05	0.41	1.55
H_2O^-	0.15	2.02(2)	0.08	0.09	0.14
CO_2	0.70		0.16	0.07	0.29
P_2O_5	0.03	0.13	0.24	0.02	0.10
Total	100.07	99.74	99.78	99.91	100.08

CIPW Norms

A. 77.84 Or, 4.72 Ab, 0.83 An, 5.40 Ne, 6.53 C, 0.20 Ol, 0.46 Mt, 0.16 Hm, 0.46 Il, 1.60 Cc. Recalculated to 100% Ne + Ks + Qtz: 9.04 Ne, 50.30 Ks, 40.66 Qtz

A'. 57.82 Or, 8.91 Ab, 6.12 An, 17.61 Ne, 2.38 Di, 1.28 Wo, 1.16 Mt, 1.44 Hm, 1.98 Il, 0.34 Ap. Recalculated to 100% Ne + Ks + Qtz: 27.91 Ne, 40.90 Ks, 31.19 Qtz

B. 48.37 Or, 14.67 Ab, 6.39 An, 15.90 Ne, 6.70 Di, 0.56 Ol, 2.55 Mt, 0.48 Hm, 2.43 Il, 0.34 Ap, 0.40 Cc. Recalculated to 100% Ne + Ks + Qtz: 30.21 Ne, 34.82 Ks, 34.97 Qtz

C. 60.05 Or, 3.61 An, 8.72 Lc, 23.86 Ne, 1.12 C, 0.42 Ol, 0.23 Mt, 0.64 Hm, 0.46 Il, 0.10 Cc. Recalculated to 100% Ne + Ks + Qtz: 25.76 Ne, 43.67 Ks, 30.57 Qtz

D. 56.16 Or, 4.73 An, 10.46 Lc, 23.04 Ne, 0.31 C, 0.42 Ol, 0.93 Mt, 0.80 Hm, 0.76 Il, 0.34 Ap, 0.70 Cc. Recalculated to 100% Ne + Ks + Qtz: 25.70 Ne, 44.05 Ks, 30.25 Qtz

Analysts: K. Ramlal (A-D), J. G. Valenca (A')

(1) Samples A-D refer to pseudoleucites shown in Fig. 1. Sample A' is host rock of pseudoleucite A.

(2) Determined as loss on ignition.

Prior to chemical analysis, large portions of pseudoleucites from each locality were carefully sliced to include all parts of the pseudoleucite but exclude any of the host rock. The pseudoleucite was then crushed, ground, and thoroughly mixed to give a representative sample. Most oxides (SiO_2, TiO_2, Al_2O_3, MgO, MnO, CaO, and P_2O_5) were determined by X-ray fluorescence methods, alkalies were determined by atomic absorption techniques, and FeO, Fe_2O_3, H_2O and CO_2 by wet-chemical methods. Each sample was analyzed in duplicate by different laboratories. Results of the chemical analyses of the pseudoleucites shown in Figure 1 are given in Table 1 and plotted on the $NaAlSiO_4$(Ne)–$KAlSiO_4$(Ks)–SiO_2(Qtz) system in Figure 2. Sample A (Fig. 1) from the Itauna complex is distinctly different from the samples from the Tangua complex, and represents the most "orthoclase-rich" pseudoleucite yet reported (see Fig. 2). Of the pseudoleucites from the Tangua complex, sample B has considerably less K_2O than samples C and D (Fig. 2) and is the only sample which does not contain normative corundum (Table 1).

Petrogenesis

The differences in the compositions of the pseudoleucites described here suggest that sample A from the Itauna complex was derived by a different process from the other three samples from the Tangua complex. Samples A and D (Fig. 1) are from fine-grained subvolcanic rocks with well-preserved leucite morphology, whereas samples B and C are from more slowly cooled plutonic rocks with less well-preserved leucite morphology. This slower cooling may have resulted in subsolidus alkali ion exchange, with the addition of sodium taking place after the breakdown of original leucite. This suggestion is supported by Taylor and MacKenzie's (1975) experiments, and by the fact that the pseudoleucites fall within the compositional ranges reported by these authors for natural pseudoleucites (shaded area, Fig. 2). A similar process may also have taken place in the more rapidly cooled, finer-grained sample (Fig. 1D) from the same complex (Tangua), as its composition is al-

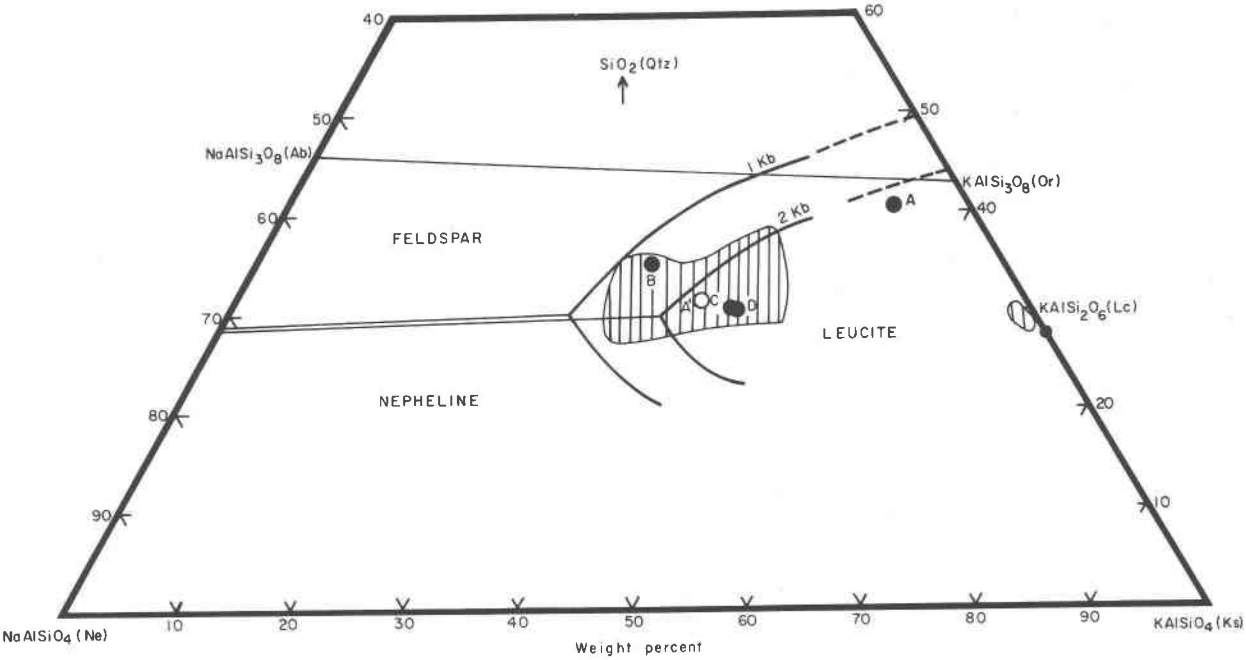

Fig. 2. Compositions of pseudoleucites recalculated to 100 percent normative Ne + Ks + Qtz. Pseudoleucites–solid circles, host rock–open circle. Shaded areas represent range of pseudoleucite compositions given by Taylor and MacKenzie (1975). Phase relations are by the same authors. For abbreviations see Fig. 1.

most identical to that of C and falls in the common compositional range for pseudoleucites (Fig. 2).

The morphology (Fig. 1A) and mineralogy of the Itauna pseudoleucites are the same as most pseudoleucites; however, their bulk chemistry (Fig. 2A) is so different that we can offer no explanation, at this time, for their genesis. Certainly none of the mechanisms proposed to date is satisfactory.

They could not be derived by an alkali-ion exchange mechanism (Taylor and MacKenzie, 1975), by the breakdown of sodium-rich leucite to nepheline and feldspar (Knight, 1906; Fudali, 1963), nor by reaction of original leucite with a liquid much richer in sodium (Bowen, 1928; Bowen and Ellestad, 1937). Indeed, perhaps the most pertinent observation we can make is that it appears impossible for them to be genetically related, in any straightforward way, to the liquid from which the host rock crystallized (Fig. 2,A'). The possibility that the Itauna pseudoleucites are in fact "pseudo-orthoclases" seems highly unlikely, as their morphologies and sizes are quite distinct from the orthoclase microphenocrysts which occur in the host rock.

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