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GIANT PSEUDOLEUCITES OF GHORI, CHHOTA UDAIPUR, INDIA

R. N. SUKHESWALA AND S. F. SETHNA, *Geology Department, St. Xavier's College, Bombay, India.*

INTRODUCTION

Pseudoleucite occurs in a tinguaite dyke near the village of Ghori (Long. 74°2′ E., Lat. 22°9′ N., Survey of India toposheet No. 46 F/12, 16), about 8 miles east of Phenai Mata, south of Chhota Udaipur. The pseudoleucite-bearing tinguaite is one of many dykes with a prominent ENE trend. The dyke cluster occurs to the east of Phenai Mata hill in which are exposed basalt, gabbro, granophyre, syenite, and nepheline-syenite (Sukheswala and Sethna, 1964). This complex of Deccan trap age is intrusive into the Baghs (Cretaceous) underlain unconformably by the pre-Cambrian Dharwars.

PETROGRAPHY OF THE TINGUAITE

Individual phenocrysts of pseudoleucite in tinguaite measure two inches or more in diameter (Fig. 1). Some crystals have thin indistinct margins which may be reaction rims. The characteristic leucite form (211) is observed in every big phenocryst, with sharp boundaries against fine grained groundmass. This may indicate their intratelluric origin, and

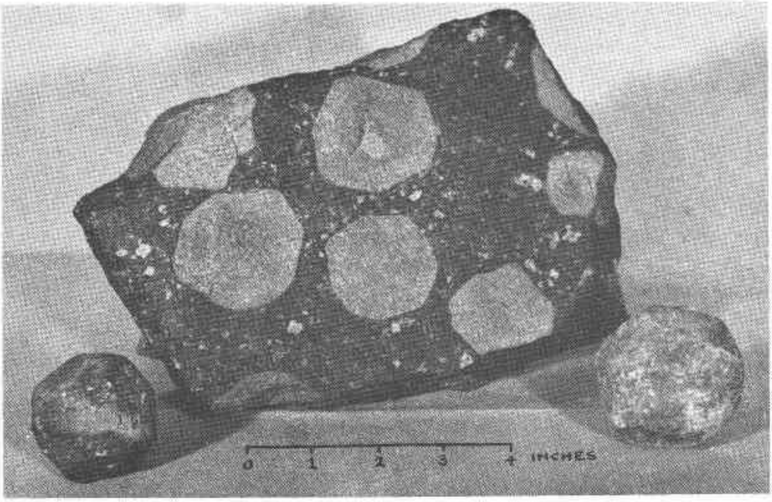

FIG. 1. Pseudoleucite tinguaite with two separate phenocrysts of pseudoleucite.

quick chilling of the melt in which they developed. Specific gravities for two crystals are 2.436 and 2.408.

The pseudoleucite under the microscope is a coarse intergrowth (Fig. 2) of orthoclase and nepheline with small amounts of cancrinite and rare grains of acmite and iron ore. The slightly turbid nepheline ($\Sigma = 1.530$, $\omega = 1.533$) differs from turbid orthoclase which is less idiomorphic and biaxial negative with $2V = 60°–70°$. Narrow elongated crystals of nepheline have a peg structure (Fig. 2) like that of melilite, which gives an impression of unmixing. The pegs or rods with high relief and lower refractive index than the enclosing nepheline are isotropic, possibly analcite. Clear, colourless cancrinite has $\Sigma = 1.495$, $\omega = 1.508$.

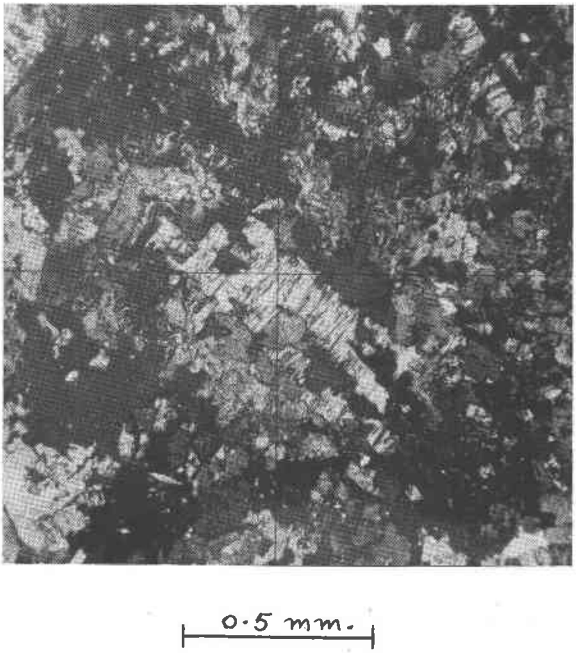

FIG. 2. Pseudoleucite showing coarse intergrowth of nepheline and orthoclase; and peg structure in nepheline with rods of analcite. Crossed polarizers.

Dark and light varieties of pseudoleucite rocks are identical in mineral composition, except for the presence of analcite and zeolite and lower content of acmite in the light variety. Both types have a nepheline base with orthoclase intergrown as tiny dots and patches (sodium cobaltinitrite stain). The rectangular pink phenocrysts so prominently seen in hand specimens maintain their rectangular habit under the microscope. Such phenocrysts are aggregates of randomly oriented crystals of fresh cancrinite, with stray tiny rectangular crystals of orthoclase ($2V_{\mathrm{x}}=57^\circ$). The mafics in the rock are represented by acmite, biotite, augite and melanite. Acmite is distributed throughout the groundmass as small needles (0.1 mm), with distinct pleochroism from dark green (X) to pale brown (Z), and almost straight extinction. Microphenocrysts of biotite (0.4 mm) with X=pale yellow, $Y=Z$=dark brownish green can be distinguished from acmite by their uniaxial character. The phenocrysts of titanaugite, 2 mm in size ($2V_{\mathrm{z}}=54^\circ$, $\beta=1.715$, $Ca_{40}Mg_{22}Fe_{38}$) show reaction rims of acmite (Fig. 3). Melanite is distinguished by its red brown colour, high refractive index, octagonal form, zonal character and isotropic nature. In some cases it alters on the margins with sieve structure (Fig. 4), the open spaces filled with nepheline. Primary calcite and rare crystals of lozenge-shaped sphene are visible. Iron ore is spread all over the groundmass as tiny granules.

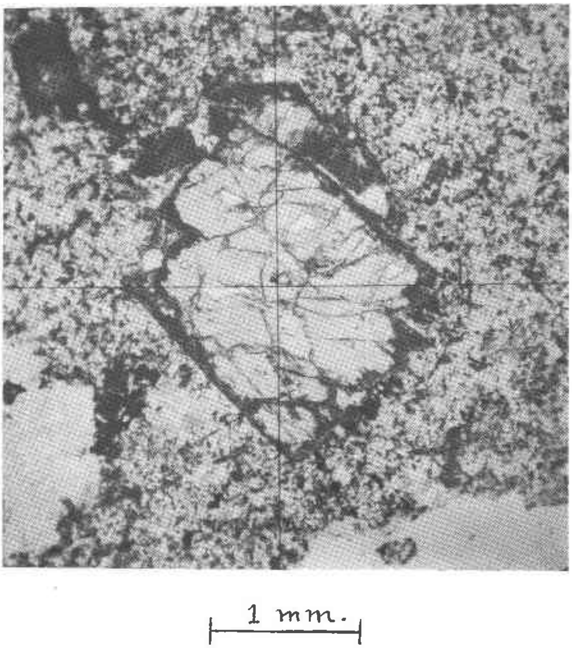

FIG. 3. Tinguaite groundmass with phenocrystal titanaugite showing reaction rim of acmite. Polarizers not crossed.

Barring the mafics, the groundmass of the rock is mineralogically almost identical with that of the pseudoleucite. This may suggest a sort of equilibrium established in the crystallizing magma and the pseudoleucite.

Mineralogically the Ghori pseudoleucite and the Bearpaw variety (Zies and Chayes, 1960) are almost identical, but there are marked differences in their chemical contents (Table 1), probably depending on the proportions of different minerals.

ORIGIN OF PSEUDOLEUCITE

Few instances of leucite and/or pseudoleucite-bearing rocks have been described in literature, and none from India. The present find of pseudoleucite-tinguaite gains added significance for it occurs not very far from the carbonatite-alkalic complex of Amba Dongar (Sukheswala and Udas, 1963, 1964).

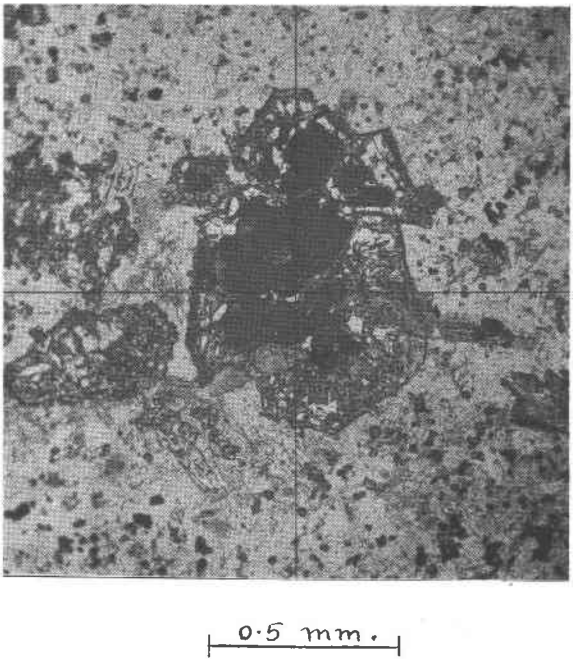

FIG. 4. Tinguaite groundmass with melanite altering along margins with sieve structure. Polarizers not crossed.

Knight (1906) discussed the origin of pseudoleucite indicating that it can form by breakdown of sodium-leucite to an intergrowth of orthoclase and nepheline. This view found support in the later works of Larsen and Buie (1938, p. 849) and Yagi (1954, p. 99). An argument against the hypothesis of unmixing of sodium-rich leucite is that the replacement of potash by soda is of a limited degree ($Na_2O = 1–1.5\%$ in most of the analysed samples of leucite). Recently, however, Fudali (1963) and Seki and Kennedy (1964) have demonstrated experimentally that leucite may contain a maximum of about 40 weight percent $NaAlSi_2O_6$ (Fudali, 1963, p. 1120); below the solidus, sodium-rich leucite becomes unstable and breaks down to nepheline and feldspar as the temperature falls.

TABLE 1. CHEMICAL ANALYSES AND NORMS OF PSEUDOLEUCITE AND ASSOCIATED ROCKS

	1	2	3	4	5
SiO_2	54.54	54.42	57.42	46.04	45.30
TiO_2	0.02	Tr.	0.24	0.50	1.18
Al_2O_3	24.58	23.53	21.85	19.37	18.79
Fe_2O_3	1.69	2.11	1.70	8.19	7.59
FeO	0.60	0.60	—	0.84	2.04
MgO	Tr.	Tr.	0.07	1.04	1.27
CaO	1.64	1.48	0.19	7.58	7.91
Na_2O	5.60	5.83	4.78	6.15	6.20
K_2O	10.45	9.73	13.40	6.83	6.50
H_2O^+	1.40	2.70	0.27	3.10	3.72
H_2O^-			0.03		
Total	100.52	100.40	100.26	99.64	100.50
C	1.12[a]	0.61[a]		—	—
Or	61.72	57.27		27.80	25.30
Ab	0.52	6.29		—	—
An	8.06	7.51		5.28	4.17
Lu	—	—		9.59	10.25
Ne	25.28	23.28		28.12	28.40
Di	—	—		5.62	6.91
Wo	—	—		10.56	10.90
Mt	1.86	1.86		1.39	3.02
Hm	0.48	0.80		7.20	5.60
Il	—	—		0.91	2.28

1. Pseudoleucite phenocryst in the light coloured tinguaite of Ghori.
2. Pseudoleucite phenocryst in the dark coloured tinguaite of Ghori.
3. Pseudoleucite, Bearpaw Mountains, Montana (Zeis and Chayes, 1960), includes 0.28 BaO, and 0.03 MnO.
4. Groundmass of the light coloured tinguaite of Ghori.
5. Groundmass of the dark coloured tinguaite of Ghori.

[a] Formation of corundum may be due to the alteration of feldspar.

Bowen (1928) and Bowen and Ellestad (1937, p. 415) derive pseudoleucite by reaction of early formed leucite with the residual soda-rich melt. Zies and Chayes (1960, p. 97) oppose this view because their pseudoleucite and groundmass are remote from the pseudoleucite reaction point *R*,

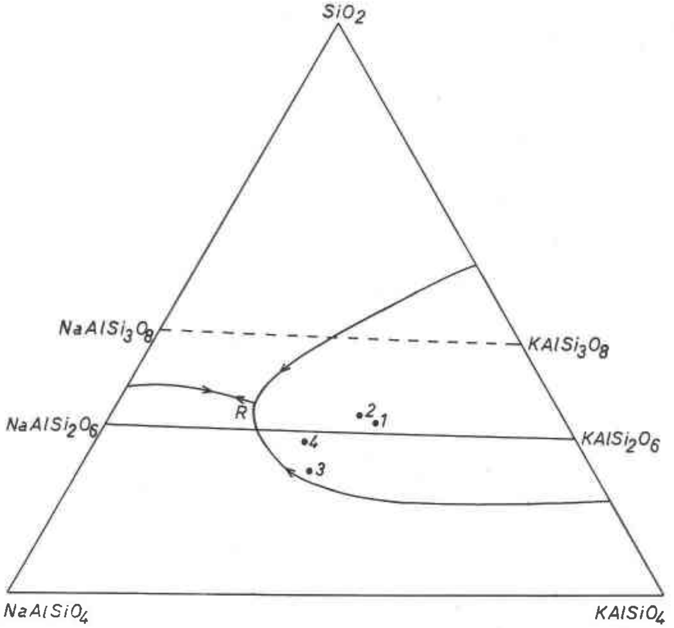

FIG. 5. Plots of pseudoleucite and tinguaite groundmass of Ghori on the ternary diagram SiO_2-$NaAlSiO_4$-$KAlSiO_4$ (Fudali, 1963). (1) Pseudoleucite, light coloured tinguaite. (2) Pseudoleucite, dark coloured tinguaite. (3) Groundmass of the light coloured tinguaite. (4) Groundmass of the dark coloured tinguaite. (*R*) Reaction point in Bowen's residua system.

which is also true in the case of Ghori pseudoleucite and groundmass (Fig. 5).

The very large and idiomorphic forms of Ghori pseudoleucite and the absence of second generation crystals in the groundmass suggest intratelluric origin of primary sodium-rich leucite. Also, since boundaries of pseudoleucite are not destroyed—rather they are quite sharp against the fine-grained groundmass—chances of reaction of residual liquid with the primary leucite are remote. This leads us to conclude that sodium-rich leucite, having crystallized in the tinguaite magma of Ghori, broke down on cooling to form pseudoleucite.

This appears more conclusive when we plot the chemical analyses on the ternary diagram $KAlSiO_4$-$NaAlSiO_4$-SiO_2 of Fudali (1963, p. 1124, Fig. 11). Natural pseudoleucite formed by simple subsolidus breakdown of sodium-rich leucite solid solution, should plot on or near the $KAlSi_2O_6$-$NaAlSi_2O_6$ join. The Ghori pseudoleucites plot very close to the $KAlSi_2O_6$-$NaAlSi_2O_6$ join around 40 percent $NaAlSi_2O_6$, but remote from the reaction point *R* which invalidates the reaction hypothesis of Bowen.

ACKNOWLEDGMENT

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