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NA-SANIDINE MEGACRYSTS FROM THE SHAVARIN CARAM VOLCANO, MONGOLIA

J. ULRYCH, E. PIVEC, P. POVONDRA*, G. BUDA**

* Geological Institute, Academy of Sciences of the Czech Republic
** Department of Mineralogy, Eötvös University

ABSTRACT

Na-sanidine crystals, their fragments and corroded relicts occur in scoria of leucite trachyte from the Shavarin Caram volcano, NW Mongolia. Opalescent perfect crystals of gem quality (up to 40 mm size) of moderate Or contents (46-49) reveal the following unit cell parameters: a = 0.8334(9)nm, b = 1.2997(6), c = 0.7159(6), β = 116.17°(5), V = 0.6949(15) nm^3. Na-sanidine together with garnet (Pyr-Alm), Al-clinopyroxene, Ti-phlogopite megacrysts represent a very strange, mostly high-pressure near-liquidus phenocryst association of high-potassic magma. Na-sanidine megacrysts, however, would crystallize probably from a Fe and fluid rich melt at lower pressure in near-solidus regions.

INTRODUCTION

The Shavarin-Caram volcano (2,450 m a.s.l.) occurs in the Khangai Mts. 650 km, W of the capital of Ulan Bator, 17 km SE of the district centre of Tariat Somon on 48°00' N and 99°59' E. Crystalline basement and Paleozoic volcano-sedimentary sequences are frequently pierced by Plio-Pleistocene sills, dykes, plugs, pipes and rare volcanoes. Earlier differentiates are represented by subalkaline olivine basalts and hawaiites, the younger ones belong to an alkali basalt suite (leucite tephrite to melanephelinite). The Cenozoic volcanism is associated with the deep-seated Tariat Fault limiting the Tariat depression (rift?) active since the Early Paleozoic in the Khangai volcanic area. The Shavarin-Caram volcano lies in the intermonate valley with exposed Devonian quartzites just near the volcano (ULRYCH and ŠEVČIK 1986).

Products of the Shavarin-Caram volcano (volcanic bombs, lapilli sand, ash, as well as welded eruptive breccia and scoria) have unusual compositions. Most of them are of leucite trachyte to leucite basanite, and only rarely of melanephelinite composition (KEPEZHINSKAS 1979). The common accessories are represented by monazite, zircon and rare moissanite. According to the chemical classification of LE MAITRE ed. (1989) they, however, plot mostly into the field of phonotephrite (cf. the analysis of parental rock of the sanidine in Table 1). The rock corresponds to leucite tephrite and has clastic-porphyritic texture, with matrix enriched in K-rich glass and microlites of olivine, clinopyroxene and plagioclase.

* CZ-165 02 Prague 6, Rozvojová 135, Czech Republic
** H-1088 Budapest, Múzeum krt. 4/A, Hungary

ANALYTICAL METHODS

Wet chemical analyses of all reported minerals were made by the routine procedures used in the laboratory of the Department of Geochemistry, Mineralogy and Mineral Resources, Charles University. Rock forming minerals were analysed in polished sections using a JEOL JXA 50A electron microprobe, equipped with EDAX 711 (Geological Institute, Academy of Sciences of the Czech Republic), operating at 15 kV, beam currents of 30 nA, a beam diameter of 2μm and a counting time of 30s. Used standards are natural minerals (jadeite, diopside, leucite, apatite, barite) and synthetic phases.

Sanidine phenocryst was extracted manually in the form of single crystal from the host rock. Crystal was crushed to pass a 120 mesh sieve and powdered. The X-ray procedure (Dron 3 diffractometer at 40 kV, 20 mA using CuK_α filtered radiation) is esentially the same as that of WRIGHT and STEWART (1968). The sample was rotated during the step counting (0.5°/min). Cell parameters were computed using modified version of the program of BURNHAM (1962). Final cell parameters were computed from 18 peaks, the indices of which were carefully checked and found to match those recommended by WRIGHT and STEWART (1.c.)

The IR investigation was made by using the SPECORD IR 75 instrument and the powdered feldspar sample mixed with KBr was pressed into tablets. The obtained infrared absorption spectra were studied in the 6.25–32.25 μm region. Absorption bands 16.50–16.66 μm and 18.18–20.00 μm, recommended by HAFNER and LAVES (1957) and KUZNETSOVA (1971) as important for the study of ordering of Si and Al in the structure of the crystal lattice, were used. The obtained data are shown in a modified diagram (*Fig. 2*, SMITH 1974). Sanidines of liparites and trachyliparites from Central Caucasus (KUZNETSOVA, 1971) are also plotted for comparison.

XENOLITHS AND PHENOCRYSTS OF ERUPTIVE BRECCIA

Homogenous dunite to spinel lherzolite mantle xenoliths attaining the size up to several tens of cm are homogenously disseminated in the Shavarin-Caram eruptiva breccia, together with individual mineral components originated by their disintegration (IONOV and BORISOVSKII 1987). Xenoliths reveal following modal composition: olivine Fo_{91} (80–100 vol.%), enstatite (0–15%), Cr-diopside (0–5%), Cr, Al-spinel (0–2%). KEPEZHINSKAS (1979) mentioned more rare xenoliths of garnet lherzolite, garnet harzburgite, garnet websterite, clinopyroxenite, eclogite and granulite.

High-magnesium ($Fo_{90\text{-}91}$) isometrical olivine grains (5–8 mm) originate from disintegrated peridotitic xenoliths, cf. analyses in Table 1. However, low magnesium ($Fo_{79\text{-}82}$) magmatically corroded subhedral phenocrysts of olivine (1–15 mm) occur genetically associated with early crystallization phases of the parental rock, see Table 2.

Garnet (Pyr-Alm), Al-clinopyroxene, Ti-phlogopite (and Na-sanidine) megacrysts from Shavarin-Caram represent a very strange, mostly high-pressure near-liquidus phenocrysts association of high-potassic magma. Na-sanidine megacrysts, however, would crystallize probably from a Fe and fluid rich melt at lower pressure in near-solidus regions (cf. KAPEZHINSKAS 1979).

Garnets of a pyrope-(almandine) composition (see Table 1 and 2), cf. ULRYCH and ŠEVČIK (1986), sometimes in a monomineral garnetolite aggregates (mostly 5–20 mm, up to 10 cm in size) belong to the best known megacrysts (5–50 mm) of the site. The garnets

Wet chemical analyses of parental rock and megacrysts from Shavarin-Caram volcano (wt. %)

	Rock	Ol	Gar	Cpx	Fsp
SiO_2	48.09	40.09	40.82	48.6	65.46
Al_2O_3	15.68	0.31	17.82	9.5	19.63
TiO_2	1.11	–	1.48	1.95	–
Cr_2O_3	–	0.24	–	–	–
Fe_2O_3	1.64	0.52	6.02	2.95	0.05
FeO	7.36	8.76	12.77	5.69	–
MnO	0.16	0.12	0.41	0.15	tr.
MgO	6.98	48.55	14.72	12.57	0.5
NiO	–	0.39	–	–	–
Na_2O	5.39	0.03	0.05	2.47	5.81
K_2O	4.17	0.05	0.48	0.12	7.69
Li_2O	–	–	–	–	0.004
CaO	6.61	0.02	5.12	16.53	0.8
BaO	n.d.		n.d.	n.d.	0.18
P_2O_5	1.23	–	–	–	–
H_2O^+	1.05	–	–	–	–
Total	99.47	99.08	99.69	100.53	100.124
Recalculated to		8 (O)	24 (O)	6 (O)	32 (O)
Si		1.986	6.088	1.777	11.776
Al^{IV}		0.014	–	0.223	4.160
Al^{VI}		0.005	3.133	0.438	–
Ti		–	0.166	0.054	–
Cr		0.010	–	–	–
Fe^{3+}		0.019	0.674	0.081	0.010
Fe^{2+}		0.363	1.597	0.174	–
Mn		0.006	0.052	0.005	–
Mg		3.578	3.270	0.658	0.134
Ni		0.016	–	–	–
Na		0.002	0.144	0.175	2.025
K		0.002	0.096	0.005	1.764
Ca		0.002	0.188	0.648	0.155
Ba		–	–	–	–
X		2.000	6.088	2.000	15.936
Y		4.001	9.950	2.014	4.091
		Fo 90.4	Pyr 52.2	Wo 41.9	Or 51.2
		Fa 9.6	Alm 33.9	En 43.3	Ab 44.9
			And 4.3	Fs 14.8	An 3.9
			Grs 8.8		
			Sps 0.8		

Rock – parental phonotephrite
Gar – garnet
Cpx – clinopyroxene
Ol – olivine
Fsp – Na-sanidine
n.d. – not determined

Na-SANIDINE

The most interesting phenocrysts of the Shavarin Caram volcano are represented by alkali feldspar. They form colourless to whitish (i) perfect tabular crystals (up to 40 mm) of gem quality with opalescence found in cavities of scoriaceous facies of the tephritic rock, (ii) mechanical fragments of the above mentioned crystals, and (iii) magmatically corroded crystals (up to 20 mm) with narrow clinopyroxene reaction rims in more homogenous facies of the parental rock. We had only the first type (i) at disposal in a satisfactory amount. The chemical composition of the megacrysts (see Table 1 and 2) reveal their pertinence to Na-sanidine (Or_{46-49}) in the sense of SMITH (1974) with midly increased Na contents. KEPEZHINSKAS and ANTIPIN (1975) data on sanidine (Or_{71}) from the same locality pointed to the substantial variation in megacrysts chemical composition. KEPEZHINSKAS (1979) presented very broad array of Or contents (22–71) from the potassic alkaline province of the Tariat depression. SALTYKOVSKII and GENSHAFT (1985) report megacrysts of Na-rich alkali feldspars with low Or contents (4–56) from Cenozoic basalts of the Dariganga plateau in SE Mongolia. Nevertheless, the Dolina Ozer volcanic area in western Mongolia characterized by the limited range of composition of sanidine autolits (Or_{71-76}). A similar chemical composition was reported from megacrysts of alkali feldspars of volcanites of New Mexico (An_{22-32}) by HOFFER & HOFFER (1973), New South Wales (Or_{12-18}) by BINNS et al. (1970) and Victoria (Or_{18-33}) by IRVING (1974), cf. in *Fig. 1*.

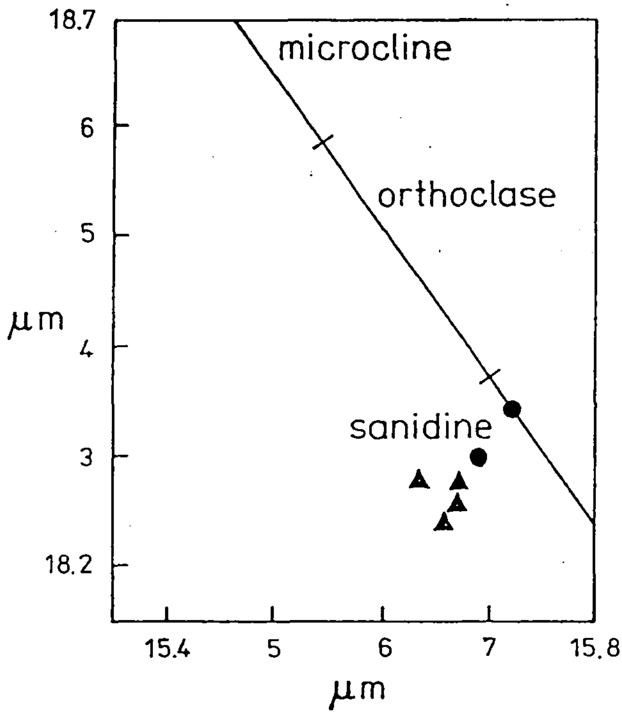

Fig. 2. Relation between two chosen absoption wave length for the studied alkali feldspars in diagram modified after SMITH (1974a). Studied feldspars (full circles), sanidines from liparites and trachyliparites (full triangles), Central Caucasus (KUZNETSOVA, 1971) for comparison.

The BaO contents (0.3–0.6 wt.%) show homogenous distribution of Ba in the Na-sanidine megacrysts. SMITH (1974a) reports Ba contents in phenocrysts of volcanic rocks in K-feldspars up to 10,000 ppm.

Then Na-sanidine has the following unit cell data: a = 0.8334(9) nm, b = 1.2997(6), c = 0.7159(6), β = 116.17°(5), V = 0.6949(15) nm^3. The results of X-ray investigations reveal the following characteristics: (i) high albite-sanidine structural state, (ii) presence of normal unit-cell parameters, and (iii) 42 mol. % of Or component by equation of WRIGHT and STEWART (1968); 44.0 % Or component follows from the average of chemical analyses (Table 2).

The obtained IR data correspond to sanidine (*Fig. 2.*). The 2Vx optical angle is substantially low and fluctuate in array of 25–30°, which is characteristic for the series sanidine – anorthoclase (DEER et al. 1963).

DISCUSSION

BAHAT (1979) has suggested that feldspars megacryst commonly appearing with rounded or subrounded partially rounded shapes show no recognizable crystal forms. On the other hand feldspars that crystallize from host melts in plutonic pegmatites under equilibrium conditions, or terminate the magmatic differentiation in sölvsbergites under shallow conditions are often euhedral. According to BAHAT (1979) there are two possible interpretations of the rounded morphology: either the relative growth rate of the planes involved did not remain constant, or these crystals suffered from chemical solution or mechanical attrition prior to eruption under low water pressure and at shallow depth.

The assignment and genesis of Na-sanidine in alkaline volcanic rocks remains to be limited owing to the lack of high-pressure experiments concerning triclinic feldspars and sanidines. However, the stability of sanidine in high-pressure conditions in coesite-sanidine grospydite from kimberlite was confirmed by SMYTH and HATTON (1977). Deep crustal fractionation of high-pressure Al-rich augite–pyrope–Ti-rich phlogopite–Na-sanidine megacrysts association in the parental high-magnesium K-rich basaltic magma, ascertained in the Shavarin-Caram volcano, lead to a specific differentiation trend in the whole Khangai potassic volcanic province. Together with the results of BAHAT (1979), STOSH et al. (1986) and PRESS et al. (1986) our results may serve an argument in the debate on asthenospheric vs. continental lithospheric potassic magma generation and on heterogeneity of upper mantle regions, respectively.

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