INTENSE DEGASSING OF THE ALKALINE MAGMAS OF THE CHUKCHI PENINSULA

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The occurrences of alkaline extrusive rocks in the southern coast of the Chukchi Peninsula (Russia) are part of the Barents Sea province, which also include volcanic fields in Alaska, and St Lawrence, Nunivak, and Pribilof islands. The volcanic rocks of the Chukchi Peninsula make up lava flows, plugs, domes, and scoria cones (Akinin, 1994). Their age was estimated by the K-Ar method as ca. 6 Ma (Akinin and Apt, 1994). Olivine melanephelinite is the most widespread rock type. Akinin (1994) studied mantle nodules borne by these rocks and argued that the primary magma of the melanephelinites was generated at a pressure of 30-32 kbar (about 100 km) and a temperature of 1300-1320°C. We report here the results of an investigation of melt and fluid inclusions in these rocks, which provided new insights into the conditions of their crystallization and degassing.

The olivine melanephelinite consists of olivine phenocrysts (Fo_{89-75}) enclosed in a porous fine-grained holocrystalline groundmass. Olivine phenocrysts contain numerous primary and late melt and fluid inclusions. Melt inclusions, up to 40-50 µm in size, are randomly distributed in olivine crystals. They are composed of daughter crystals (clinopyroxene, nepheline and magnetite were identified) and a deformed gas bubble. Combined fluid/melt inclusions with varying volume proportions of gas and crystals are common. Even the smallest melt inclusions were never completely homogenized in thermometric experiments and contained liquid + gas. The complete resorption of their daughter crystals was observed at 1190°C, which constrains the lowest temperature of melt entrapment. The vacuoles acquired negative crystal faces at 1200-1220°C. Thus, we conclude that the crystallization of olivine phenocrysts commenced at temperatures of no less than 1200°C.

The magmatic system has been fluid-saturated starting from rather early stages of melt evolution. Strong degassing under near-surface conditions is suggested by numerous gas pores and cavities in the rock groundmass. The abundance of fluid inclusions coexisting with melt inclusions indicates that the gas phase could be released in transitional magma chambers or magma conduits.

Table. Results of the investigation of fluid inclusions

Sample	n	Type of inclusion	Temperature, °C			CO_2 density, g/cm^3	P, kbar (T°C)*
			Freezing	Melting	Homogenization		
N-2	1	Primary, liquid+gas	-87.3	-57.1	26.6	0.69	3.7 (1200)
	2		-81.2	-56.6	28.8	0.63	3.2 (1200)
	3	Secondary, liquid+gas	-80.0	-57.4	23.8	0.74	3.7 (1000)
	4	Secondary, gas	-71.1	-57.7	-	-	-
N-3	5	Primary, liquid+gas	-69.3	-57.4	25.1	0.71	3.7 (1100)
	6		-79.3	-57.4	27.1	0.66	3.2
	7	Secondary, liquid+gas	-71.5	-56.7	26.6	0.69	3.6 (1100)
	8	Secondary, gas	-71.9	-56.7	-	-	-
N 4	9	Primary, liquid+gas	-87.0	-57.2	22.4	0.75	4.7 (1200)
	10		-79.8	-56.9	29.0	0.65	3.5 (1200)
	11	Primary, gas	-71.3	-57.0	-	0.24*	0.7 (1200)
	12		-70.0	-57.2	-	0.07*	-
	13	Secondary, gas	-71.9	-56.7	-	-	-
	14	Fluid in melt inclusion,	-84.5	-58.7	29.0	0.63	3 (1150)
	15	liquid+gas	-85.0	-58.3	28.0	0.66	3.5 (1150)
Gyd-2	16	Primary, liquid+gas	-91.4	-57.7	-1.9	0.94	8 (1200)
	17	Secondary, liquid+gas	-78.2	-56.9	23.2	0.74	3.7 (1000)
	18	Fluid in melt inclusion, gas	-77.0	-56.6	-	-	-

Note: *Pressure of fluid entrapment calculated from fluid density and the temperature of olivine crystaslliztion (in parentheses) estimated from thermometric experiments with melt inclusions.

Primary fluid inclusions are up to 30 µm in size and bear negative crystal shapes. There are also larger (up to 60 µm) late or psedosecondary inclusions. All fluid inclusions show evidence for partial decrepitation as aureoles or trails of tiny satellite inclusions. Nonetheless, many fluid inclusions and fluid parts of melt inclusions contain gas and liquid under ambient temperature. The melting temperature of the material of fluid inclusions ranges from -56.6 to -57.7°C (table) suggesting CO_2-dominated composition with a possible admixture of another substance. However, a Raman investigation revealed only CO_2 without any additional compounds. The densest primary fluid inclusions show a CO_2 density of 0.94-0.63 g/cm^3 (table). Given the temperature of fluid entrapment no lower than 1200°C, the pressure of the beginning of phenocryst crystallization was as high as 8 kbar (table). It should be pointed out that this is the minimum estimate, because all the inclusions have lost part of fluid. The distribution of the densities of fluid inclusions suggests that there were at least two stages of inclusion decrepitation, at 7-8 and 3.5-3.0 kbar. The crystallization of the groundmass occurred at a temperature of 950-1000°C and a pressure of 0.5-0.7 kbar.

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