ROCKS AND MELTS OF CHIKURACHKI VOLCANO, KURILE ISLANDS

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Peculiarity of Chikurachki volcano (the highest point of Paramushir island) is the recurrent Plinian eruptions of basaltic composition (51-54% SiO_2). There is data about eruptions in 1853-1859, 1958, 1961, 1964, 1973, 1986 including Plinian eruptions in 1853 and 1986 [Belousov et al 2003]. Plinian eruptions are characterized by a large amount of material (mostly tephra) erupting during short period of time. Such way is common for viscous magmas and very unusual for mafic magmas.

We have studied a lava flow formed at the end of 1986 eruption, which contains plagioclase, olivine, clino- and orthopyroxenes. Olivine phenocrysts ($Fo_{72\text{-}75}$) were selected as a host-mineral and trapped melt inclusions were studied. Contents of naturally quenched and obtained homogenisation experimental inclusions were analysed. These data was used for calculating the melt composition and conditions in magma chamber. Only middle size primary melt inclusions without daughter phases were used.

Analytical technique

Analyses were made in the microanalysis laboratory of petrology department of Moscow State University using electron microscope CamScan4DV with microprobe LinkSystem10000. Chemical analyses were carried out by reflected electrons under standard voltage 15kV. Major elements (Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K) and also Cr, Ni, P, S and Cl were determined during measurements of mineral phases and melt inclusions. Analyses of mineral phases were performed with a focusing electron beam of 3x3 microns and glasses - in scanning mode with a raster 10x12 microns.

Experiment

Series of experiments on homogenisation of inclusion contents were conducted in the muffel stove with selit heaters under approximate melt crystallization temperature 1150^{o}C calculated using model [Ford et al, 1983]. All the way through olivine grains were placed in graphite capsule and covered by graphite crumbs for keeping outer redox conditions on the level of buffer C-CO and preserving grains from oxidisation under high temperatures.

Melt inclusion composition before and after experiment

In natural glass inclusions there were a lot of daughter phases which crystallised under decreasing P-T conditions with relatively slow crystallization rates. After experiment the inclusions became homogeneous with their content approaching to content of captured melt. Makes sense that a lot of Fe sulphide globules were found in the inclusions after experiment. Crystallization of sulphide can be explained by several ways: by loss of Fe in melt inclusions [Danushevsky, 2002] and decreasing of solubility of sulphur, by low pressure in experiments in comparison with natural capture, by local conditions of crystallization on the boundary melt-crystal. It seems to be usual enough the crystallization of sulphide is possible during sulphur transition from sulphate to sulphide form under oxygen fugacity indicative buffer FMQ+1-FMQ+2 [Matthews, 1999] that is in accordance with experiment conditions. So sulphur concentrations in melt inclusions are higher than the measured ones such as sulphide addition was not calculated.

Melt composition and conditions of its existence

Corrections of melt inclusions content were made by modelling of olivine fraction fusing from inclusion walls into the melt [Ford et al, 1983]. Oxygen fugacity was accepted as corresponding to buffer FMQ+1, general content of Fe as 8.5% and Fe^{+2}/Fe^{+3}=7 that is typical for island arcs.

In studying of melt inclusions the temperature of inclusion capture was determined as 1100-1050^{o}C and composition of magma of Chikurachki volcano was obtained (Table 1). Magma of Chukurachki volcano is high-Al (Al_2O_3> 18 wt%), high-Ti (TiO_2 is about 1.2 wt%), high-Ca (CaO up to 13 wt%) basalt and it has medium content of K and medium alcalinity (Fig. 1).

Table 1.

Calculated melt composition of Chikurachki volcano.

Number	T,C	#host Ol	SiO_2	TiO_2	Al_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Cr_2O_3
CH03GL1	1097	76.49	52.15	1.17	18.78	0.02	4.3	9.96	3.61	1.05	0.33	0.03
CH09GL1	1092	76.15	52.25	1.1	18.78	0.15	4.26	10.02	3.56	0.93	0.35	0
CH14GL1	1081	76.03	52.03	1.38	18.08	0.1	4.23	10.86	3.43	0.88	0.3	0.14
CH14GL3	1046	73.63	50.67	1.19	18.17	0.25	3.7	12.6	3.7	0.97	0.14	0
CH17GL1	1066	76.13	50.11	1.13	18.65	0.33	4.17	12.35	3.57	0.91	0.22	0.01
CH18GL1	1093	76.02	52.63	1.21	18.67	0.13	4.22	9.76	3.35	1.11	0.32	0.04
CH20GL1	1103	76.58	52.93	1.16	18.5	0.17	4.34	9.41	3.61	0.99	0.28	0.03
CH69GL1	1097	75.6	52.43	1.25	18.88	0.2	4.14	9.23	3.73	1.05	0.34	0.06
CH98GL2	1089	76.27	51.85	0.93	19.13	0.22	4.37	10.24	3.17	1.02	0.45	0

High content of Ca is especially unusual for Kuril-Kamchatka arc. It can be explained by:
a) fusing of some fragment of oceanic core with different composition,
b) changing of primary composition of melt in the result of assimilation of parental rocks.

The last one explains the connection of high content of Ca and explosivity of eruptions better, but the both contradict with data of studying of microelements in tephra (Gurenko et al. 2003).

Contents of major rock-forming elements in the rocks and obtained melt have negligible difference. For example, melt contains more K, Na, Ti and Mg and rocks have more Al. Possible explanation of this fact and fact of higher content of Ca is fusing of clinopyroxen or plagioclase trapped from melt.

Obviously there is also influence of high content of fluid component: S (up to 2700 ppm), Cl (up to 2500 ppm) and H_2O (up to 3.8 wt%) (Gurenko et al. 2003), that strongly decreased the crystallization temperature and established strongly oxidized conditions under active degassing.

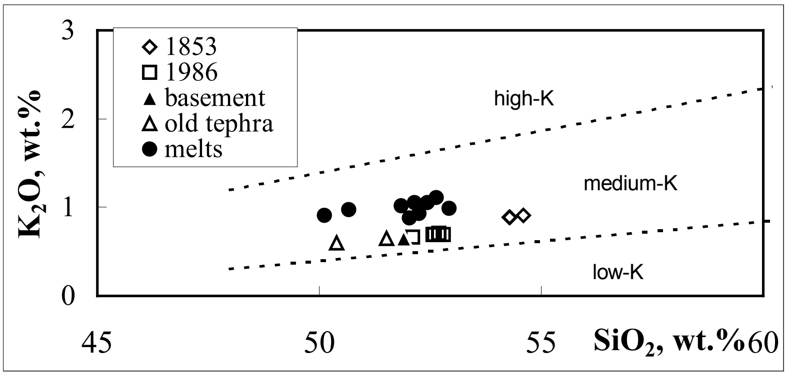

Fig 1. K_20-SiO_2 classification diagram

Conclusions:

- Studying of melt inclusions allows to evaluate the temperature of trapping of inclusions as 1100-1050°C and to obtain melt compositions of Chikurachki volcano.
- Typical feature for melt of Chikurachki volcano is high content of fluid components and unusual high content of Ca.
- High content of fluid components had influence on eruption character decreasing the melt crystallization temperature and creating strong oxidized conditions during degassing.
- Volatile is of great importance. Probably melt mixed with gas phase immediately before eruption or melt saturated by volatile just before eruption and eruption started in the moment of active degassing. High concentration of Ca can be of different nature.

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