6th Biennial Workshop on Japan-Kamchatka-Alaska Subduction Processes (JKASP-2009)

Mitigating natural hazards in active arc environments

Linkages among tectonism, earthquakes, magma genesis and eruption in volcanic arcs, with a special focus on hazards posed by arc volcanism and great earthquakes

JUNE 22-26, 2009

SCIENTIFIC PROGRAM & ABSTRACTS

GEOPHYSICAL INSTITUTE
UNIVERSITY OF ALASKA FAIRBANKS
FAIRBANKS, ALASKA

UNIVERSITY OF ALASKA FAIRBANKS

PLAGIOCLASE ZONING AS AN INDICATOR OF PROCESSES IN MAGMA SYSTEM BENEATH BEZYMYANNY VOLCANO, KAMCHATKA.

Vasily Shcherbakov[1], Pavel Plechov[1], Pavel Izbekov[2]
[1] *Geological department of Moscow State University, Moscow, Russia*
[2] *Geophysical Institute, University of Alaska, Fairbanks, AK, USA*

Bezymyanny Volcano is located in the Central Kamchatka Depression and is part of the Kluchevskaya group of volcanoes. It is one of the most active andesitic volcanoes in the world. More than 17 large explosive events have occurred since the catastrophic 1956 eruption. The latest decade has been characterized by frequent (1-2 times per year) significant explosive events accompanied by continuous extrusive dome growth. Frequent eruptions allow us to study dynamic changes in the magmatic system as they are recorded in eruptive products.

Plagioclase composition is very sensitive to temperature, pressure, and water content of coexisting melt. Due to very slow interdiffusion of Si and Al in plagioclase, its zoning is often preserved in very fine detail. The complex zoning of plagioclases from eruptions in 2000-2007 was used to determine changes of conditions in the magmatic system.

Zoning of all phenocrysts consists of three main elements (Fig. 1). *Oscillatory zones* have approximately constant composition of 50-60 mol% An with small frequent variations of ±5 mol% An. *Resorption zones* show abrupt jumps in anorthite content with evidence of intensive dissolution. *Normal zones* reflect sequential crystallization of plagioclase with decreasing anorthite content. Zoning of the majority of phenocrysts consists of the following alternation: *oscillatory zoning→resorption zoning→normal zoning→oscillatory zoning.* The outermost parts of phenocrysts usually consist of resorption and normal zoning.

Frequent resorption of plagioclase, in our view, is caused by periodical replenishment of magma chamber by hotter magma. Magma system recharge at Bezymianny may have triggered every eruption during the 2000-2007 period (1-2 magma injections per year), and causes the crystallization of calcium-rich rims around plagioclase. Models of plagioclase-melt equilibria show that crystallization of plagioclase with anorthite content more than 75 mol.% requires mixing with significant amount of mafic magma. The involvement of mafic material is also suggested by the presence of xenocrysts of olivine and products of its breakdown.

Temperature determined by clinopyroxene-orthopyroxene equilibrium show long term heating of magma from ~890±20°C in 1956 [1] to ~930±20°C in 2006. Hornblende breakdown and magnesium rich rims around orthopyroxene also indicate a rise in temperature. Calculations of plagioclase-melt equilibria show that liquidus temperature of anorthite-rich plagioclase (observed in resorption zones in rims) is higher than liquidus temperature oscillatory zones for ~100°C. This temperature gap is consistent with temperatures of crystallization of groundmass (950-1050°C).

Plagioclases from each eruption show a good correlation of rim zoning within eruption groups. They crystallized during the pre-eruptive period after magma recharge. The same T-P history of all phenocrysts from this period is caused by the small volume of magma which ascends to the surface. Poor correlation of plagioclase rims from the May 9th 2006 eruption is caused by the larger volume of erupted magma, in which intensive parameters may differ in widely-separated areas. Uncorrelated zoning of plagioclase cores from a single eruption seems to be the result of a large magma chamber where each phenocryst may have an individual T-P history, but a quantitative estimation of the volume required for this to occur is not possible yet.

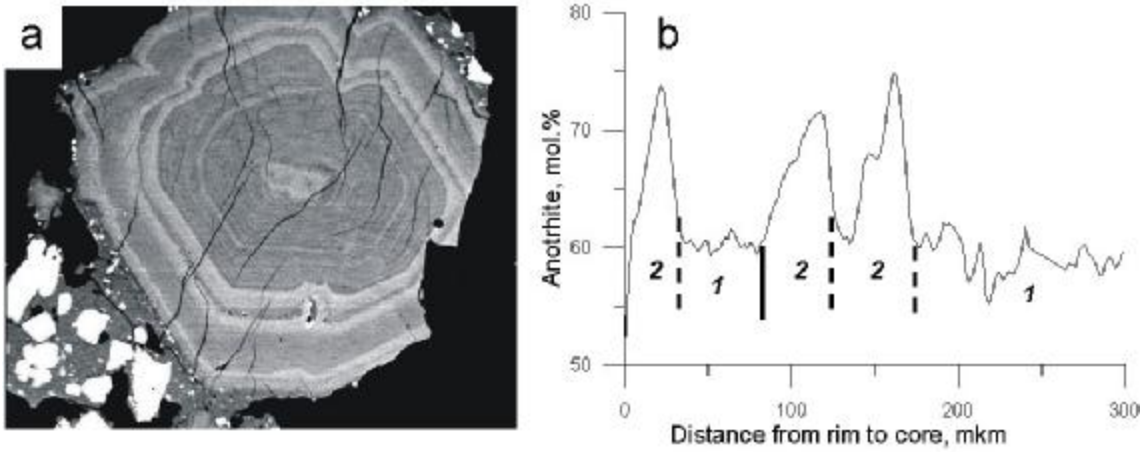

Fig. 1. Typical zoning of plagioclase phenocryst from Bezymyanny andesites. a – BSE image, b – plagioclase composition profile. Dashed lines – zones of resorption, 1 – oscillatory zoning, 2 – normal zoning.

Literature:

1. Plechov P., Tzay A., Scherbakov V., Dirksen O. (2008) "Hornblendes in andesites of 30 March 1956 Bezymyanniy eruption and conditions of their opacitization", Petrology, 16(1): 19-35.