Petrology of mafic enclaves in andesites of October 2007 eruption of Bezymianny volcano (Kamchatka)

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The October 2007 eruption products of Bezymianny volcano contain mafic enclaves of rounded shape, 5 to 40 cm in diameter. Enclaves are composed of plagioclase, low- and high-Ca pyroxene and glass. Increasing of crystal and bubbles size toward the center of enclave, large sieve core plagioclase phenocrysts, elongated and skeletal crystals in groundmass are inherent to all found enclaves, which suggests that they formed as a result of injection of hotter magma into magma reservoir. Olivine (Fo_{76-78}) and high-Al hornblende (up to 14 wt.% Al_2O_3) phenocrysts surrounded by reaction rims are common in enclaves. A few enclaves contain harzburgite xenolites of mantle origin (Shcherbakov, Plechov 2010). Enclaves are basaltic andesites in composition (~54 wt.% SiO_2) and which is slightly less evolved than host rocks (~56 wt.% SiO_2).

Coexisting pairs of low- and high-Ca pyroxenes gives the temperature of enclave goundmass crystallization in range 940-1010°C, which is a little higher than crystallization temperature of phenocrysts assemblage of host andesites (Shcherbakov et al. 2011). Presence of high-Al hornblende and sieve-textured plagioclases attributed to large scale decompression melting (Nelson, Montana, 1992) argue for deep origin of the enclaves. Based on recently developed thermobarometer (Ridolfi et al. 2010) pressure of hornblende crystallization is 630±70 MPa, which correspond to depth of ~20 km.

Based on petrological observation we suggest that Bezymianny magma system contains at least two crustal magma chambers at different depth. The shallow magma chamber (77-87 MPa) is periodically supplied with slightly less evolved magma from beneath. Due to small compositional and thermal contrast between host and intruding magma interaction between them results only into oscillatory zoning of phenocrysts in host magma due to thermal fluctuations (Shcherbakov et al. 2011) and fast crystallization (quenching) of enclaves resulting in strong normal zoning and skeletal shape of crystals. Large compositional diversity of rock-forming minerals common for andesitic volcanoes is not observed due to close mineral compositions in host andesite and enclaves.

Magma intruding into shallow magma chamber likely originated at large depth (630±70 MPa) and experienced large scale ascent before injecting into shallow chamber, which is recorded in large sieve-textured plagioclases. Low Mg# of pyroxenes argue for relatively evolved bulk composition of the deep magma chamber (e.g. basaltic andesites), however olivine xenocrysts and mantle xenoliths of mantle harzburgites found in the enclaves suggest influx of more primitive magmas.