THE 1955-2010 PERIOD OF ERUPTIVE ACTIVITY AT BEZYMIANNY VOLCANO, KAMCHATKA: STORY IN ROCKS

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Bezymianny volcano in Kamchatka has been in a state of nearly continuous eruptive activity for more than five decades. It started in late 1955 after ca. 1000 years of quiescence. A moderate explosive and extrusive eruption from the central vent of the volcano abruptly escalated on March 30, 1956, when a sudden collapse of the eastern flank of the volcano triggered an energetic directed blast followed by four hours of paroxysmal explosive eruption. The eruption destroyed summit of the volcano and formed a 1.3-km-wide horseshoe crater breached to the east. Within weeks the volcano started rebuilding its edifice through extrusion of the dome in the middle of the crater, intermittent dome collapses, and associated block-and-ash flows. By mid 70s, as the volume of the dome increased, the dome-building extrusive activity became complemented by short explosive events with pyroclastic flows and surges followed by effusions of lava flows. In late 90s the explosive eruptions became remarkably regular with 1-2 events per year.

The erupted Bezymianny magmas were remarkably homogeneous both texturally and compositionally. Their composition changed gradually from 60.9 wt. % SiO_2 in 1956 to 56.8 wt. % SiO_2 in 2010 (figure 1). The composition of exceptionally rare mafic enclaves from the products of the 1997 and 2007 eruptions overlapped with the composition of recent Kliuchevskoy magmas (figure 2, Kliuchevskoy data from Almeev, 2005). The MgO-SiO_2 binary diagram shows that MgO content increased linearly from 1956 to ca. 1973 along the mixing line connecting points corresponding to the 1956 andesite and the high-Mg, Kliuchevskoy-type basalt. In ca. 1973 the linear trend changed the slope and followed a mixing line between 1973 magma and low-Mg Kliuchevskoy-type basalt. The same kink in trend is observed in a variety of other elements (Turner et al., this volume). The 2009 and 2010 magmas of Bezymianny contained light-colored enclaves of vesicular amphibole-bearing andesites, which composition mimicked the composition of magmas erupted in 1989 and during 1997-2003.

The change in whole-rock composition correlated with changes in magma temperature and mineral assemblage. Based on ilmenite-magnetite and two-pyroxene geothermometry the pre-eruptive temperature of Bezymianny magmas increased from 950°C in 1956 to 1050°C in 2006 (Shipman et al., this volume). Amphibole, abundant in 1956 magma, gradually disappeared by mid 60s and most recently occurred only as resorbed cores in OPx-CPx-Pl aggregates. Its composition changed from 8-10 wt. % Al_2O_3 in 1956 to 13-15 wt. % Al_2O_3 in 2010 (figure 4). The modal proportion and size of clinopyroxene crystals gradually increased; its composition became more Mg-rich (figure 6). This correlated with increase of Mg content in orthopyroxenes (figure 5). Despite conspicuous changes in whole rock composition and temperature, the range of compositional variations of plagioclase remained nearly the same. It is remarkable that plagioclase composition returned repeatedly to 48-50 mol. % An throughout the entire period of eruptive activity. The compositional plateaus in the oscillatory zoned plagioclases preceding the outermost dissolution boundaries in the 1956 magma compositionally resembled those in the most recent eruptive products (figure 3).

Although the new data from a trace element study of plagioclases, ion microprobe study of melt inclusions, and phase equilibria experiments may slightly modify our interpretation, the observed compositional trends are generally consistent with continuous input(s) of Kliuchevskoy-like basalts to the magma system of Bezymianny volcano.

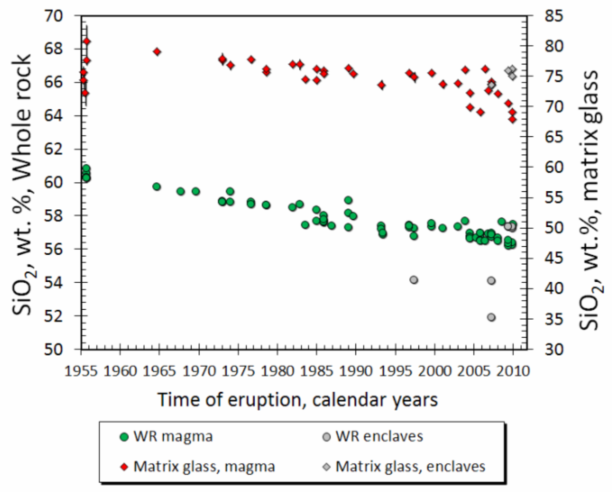

Figure 1: Whole rock and matrix glass compositions

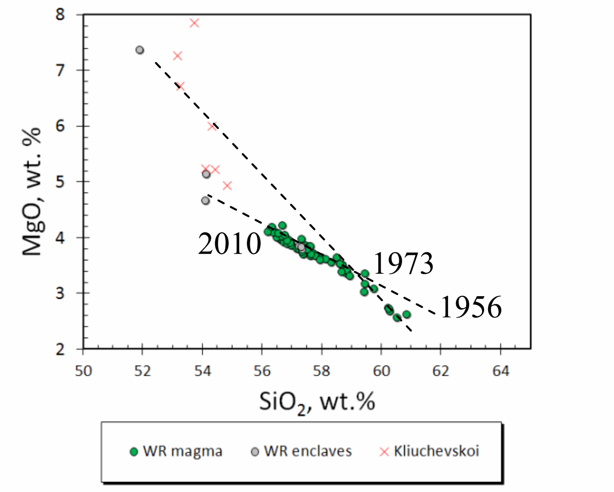

Figure 2: Whole rock composition

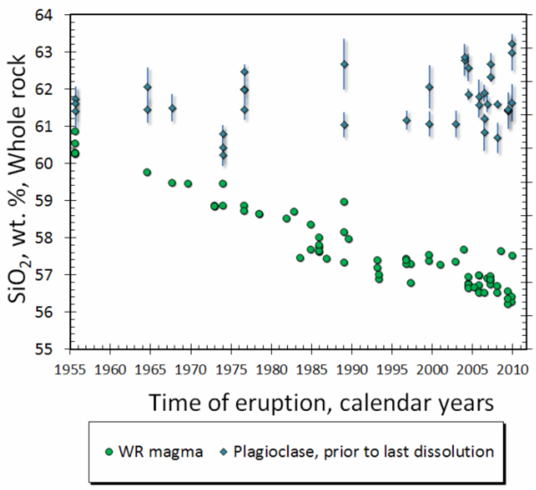

Figure 3: Composition of plagioclase phenocrysts immediately prior to the last dissolution event

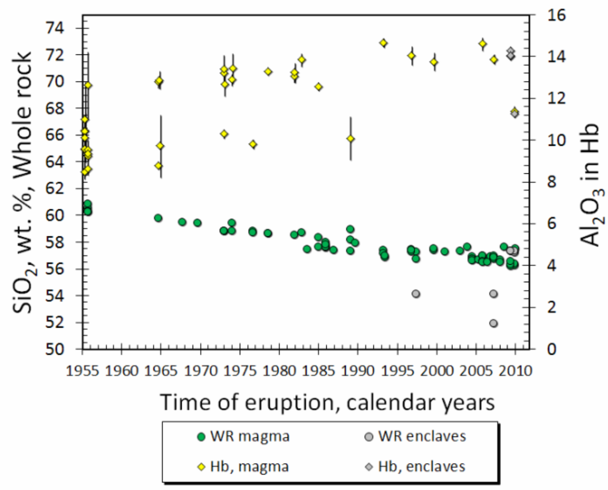

Figure 4: Composition of amphibole phenocrysts

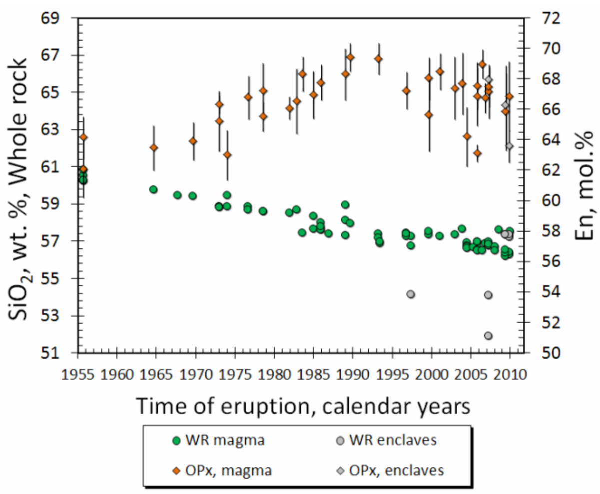

Figure 5: Composition of orthopyroxene phenocrysts

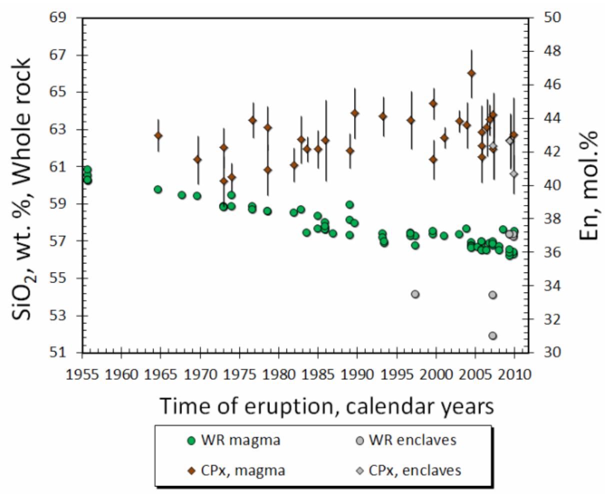

Figure 6: Composition of clinopyroxene phenocrysts