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ABSTRACTS

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VARIABLE FLUIDS AND MANTLE SOURCES DOCUMENTED IN THE GEOCHEMISTRY OF KAMEN VOLCANO AND THE KLUCHEVSKAYA VOLCANIC GROUP

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Kamen volcano is located in centre of the Kluchevskaya Group of Volcanoes (KGV) surrounded by active Klyuchevskoy, Bezymianny and Ploskie Sopky (Ushkovsky and Krestoivsky) volcanoes. This group of Quaternary volcanoes is dominantly of basaltic to andesitic composition and overlies an older plateau of mostly basalt–basaltic andesite lavas.

Kamen and Bezymianny volcanoes form single geochemical trends on all petrochemical diagrams suggesting a common source. Lavas of the Ploskie Sopky, Kluchevskoy and Kamen/Bezymianny form distinct trends and also differ in mineral composition and thus probably originated from different primary magmas [Churikova et al., 2010]. All rocks of the Kamen volcano as well as lavas of the neighboring volcanoes (see Figure) have typical island-arc signatures with significant but different enrichment in LILE and LREE and low HFSE.

The concentrations of HFSE and HREE in water-rich fluid are negligible [Brenan et al., 1995], and their concentrations in the rocks are determined by mantle sources. Approximating curves, drawn through HFSE and HREE for plateau basalts, Kamen and Kluchevskoy stratovolcanoes show that trace element contents are systematically decreasing in this sequence with younger ages (see Figure).

The plateau lavas with eruptive centres below Ushkovsky volcano formed at about 270 ka [Calkins, 2004]. At that time the mantle wedge was close in composition to NMORB mantle and was not as depleted by previous magmatic events as for more recent lavas. The ratios of middle to heavy REE in plateau basalts and in NMORB mantle are close to unity. The High-K series rocks from Ploskie Sopky volcano were also derived from such magmas. With time the upper mantle under KGV became more and more depleted as result of voluminous eruptions of plateau basalts.

Kamen volcano, which ended it's activity in the Late Pleistocene [Melekestsev, Braitseva, 1984] has depleted HREE compared to NMORB and formed from a more depleted upper mantle. Nb, Ta and HREE in most magnesian basalts from Kamen volcano are lower than in NMORB, the ratios $HREE_{Kamen}/HREE_{NMORB}$ are about 0,7 (see Figure). It is important that most mafic rocks from Bezymianny volcano with MgO>5% have the same degree of depletion and in fact are similar to Kamen volcano lavas in other trace element characteristics as well, which testify to the same primary magmas for both volcanoes.

Holocene and historical lavas of the Klyuchevskoy and Krestovsky volcanoes were formed from an even more depleted mantle source, which is shown by lowest Nb, Ta and HREE. $HREE_{Kluch}/HREE_{NMORB}$ varies from 0,52 to 0,55. The rocks of the monogenetic cones from the western slope of Kamen volcano have the same characteristics. Thus, the same upper mantle source, which is tapped by magmas with the same degree of melting (10-12% [Churikova et al., 2001]) is systematically depleted with time.

It was shown by melt inclusion studies in olivines across the Kamchatka arc [Churikova et al., 2007], that the fluid composition gradually changes with increasing slab depth. The fluid that dominates at the arc front carries the highest amounts of B, Cl and chalcophile elements as well as LILE F, S and LREE. The fluids released below the Central Kamchatka Depression is more enriched in S and U and show highest S/K_2O and U/Th ratios. Additionally this fluid is enriched in ^{87}Sr and ^{18}O. A third, distinct back arc fluid is observed at the Sredinny Ridge and is enriched in F, Li Be, LILE and LREE.

Lavas from KGV volcanoes have largely different fluid signatures, owing to their location all three fluids are involved in it's magma genesis. (1) the B-rich for arc fluid, which was transported it maximum distance to this depth with the still relatively cold subducted slab, (2) The

"central" fluid dominates below the KGV and (3) the influence of the back arc fluid just starts to be seen. The Cl/S ratio in Kamen melts is 2-3 times higher than in melts of Klyuchevskoy volcano. Kluchevskoy melts show good correlations of F/Yb with B/Yb, but not with Li/Yb, suggesting the influence of frontal and central fluids. Samples from Kamen volcano are enriched in all three ratios resulting in positive correlation between them and suggesting the influence of all three fluids. While Kluchevskoy volcano rocks are systematically enriched in U/Nb, Cs/Yb and Ce/Nb ratios, Kamen volcano lavas show enrichment in Li/Yb. These data imply that Kluchevskoy and Kamen volcanoes, which are situated nearby each other, show quite different fluid patterns.

Thus, trace and volatile elements distribution in rocks and melt inclusions KGV show that the fluid composition can be different even at neighboring volcanoes. The KGV appears to be a place where several fluids occur together, suggesting a large heterogeneity in the fluids that modified mantle.

Thus, the observed geochemical diversity of KGV rocks is the result of both gradual depletion with time of the mantle NMORB-type source due to the intense previous magmatic events in this area and by the addition of distinct fluids to this mantle source.

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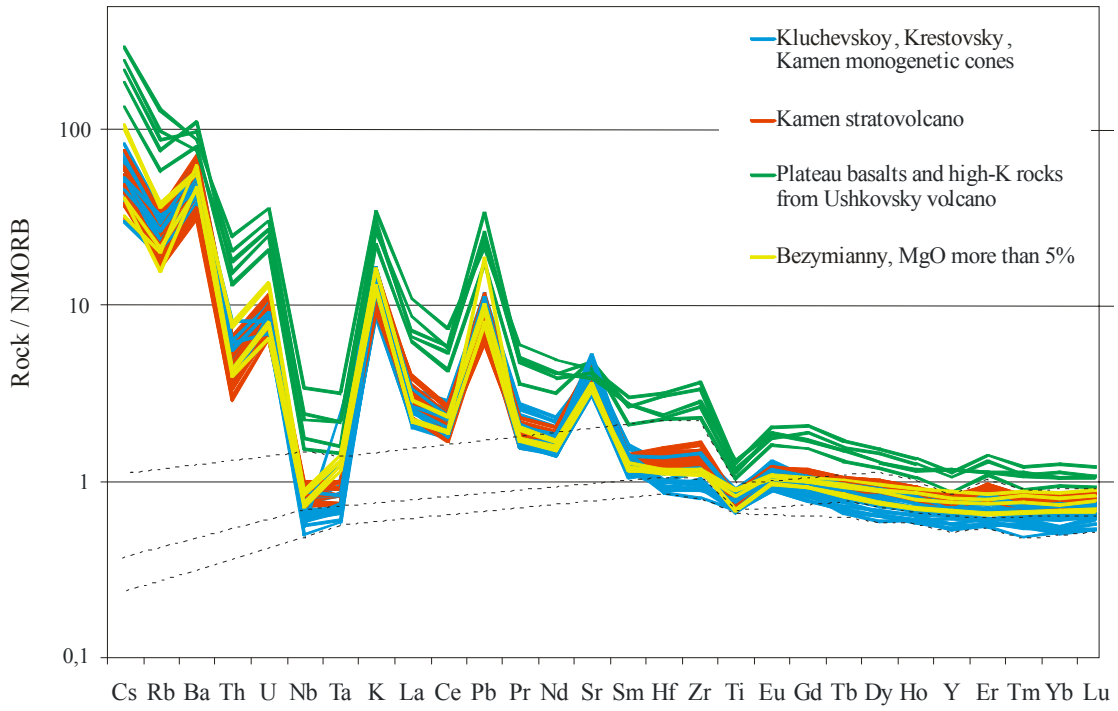

NMORB-normalized trace element patterns for KGV rocks. Dashed lines show the approximated patterns without the subduction component for three different in age volcanic suites. Only samples with MgO>5% are shown for Bezymianny volcano. N-MORB values are from Sun and McDonough (1989).