26–30 October
GSA 2020
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241-1 - TRACING VOLATILE, HALOGEN, AND CHALCOPHILE METAL BEHAVIOUR DURING MELT EVOLUTION AT MONOGENETIC CONES OF THE TOLBACHIK VOLCANIC MASSIF, KAMCHATKA

Saturday, 31 October 2020

2:05 AM - 2:20 AM

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Abstract

This study aims to reveal how volatiles, halogens and chalcophile metals evolve in magmas erupted from spatially proximal basaltic monogenetic cones compared with a central edifice. Melt inclusions offer a direct record of evolving magma compositions prior to shallow volatile degassing and associated changes in metal contents. We therefore present data for olivine- and clinopyroxene- hosted melt inclusions from five monogenetic cones within the Tolbachik volcanic field, Kamchatka. We analysed naturally quenched, glassy melt inclusions for volatiles (H_2O, CO_2), halogen (F, Cl), S concentrations, and B isotope compositions, and for chalcophile metals and other trace elements.

A narrow range in melt inclusion $\delta^{11}B$ suggests a plumbing system that is fed by a common primitive melt, but the large range in incompatible trace element ratios and volatiles indicates variable initial volatile contents, storage conditions, and late-stage degassing paths. Our new melt inclusions and a wider Tolbachik dataset also confirm that these magmas are strongly enriched in Cu compared to almost all other Kamchatka rocks. Despite literature evidence for sulfide saturation early in the magmatic history (e.g. sulfide inclusion-rich olivine crystals) the melt inclusions still record ≥ 450 ppm Cu at 4 – 5 wt.% MgO. Such high Cu contents require unrealistically large degrees of crystal fractionation under sulfide-free conditions, and we therefore suggest a ‘multistage dissolution-upgrading’ model may be applicable. Here, more evolved, oxidised, and sulfur-saturated melt batches will partially redissolve any coexisting sulfide liquid upon mixing with hotter, more primitive, sulfide-undersaturated recharge melt. Repeated cycles of recharge, and fluctuations between a sulfide-undersaturated and saturated system, upgrade the chalcophile metal concentrations in the sulfide melt. Late-stage S-degassing during eruption destabilises any remaining sulfide and returns metals into the silicate melt. This process may be common among frequently active volcanic fields with complex plumbing systems. We conclude that the magma storage region at Tolbachik must evolve through episodes of mixing between progressively evolving magmas and more primitive recharge melts, concurrent with crystal fractionation and volatile exsolution.

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