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Amount and redox state of sulfur in primitive magmas of Kamchatka

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We present new data on composition of melt inclusions in olivine (Fo 88-68) from Holocene and historic eruptions of seven volcanoes in the Kamchatka Eastern Volcanic Front (EVF): Vysoky, Krasheninnikov, Karymsky, Zavaritsky, Zhupanovsky, Ksudach and Zheltovsky. The rocks (volcanic ash and lapilli) belong to low- and medium-K island-arc series and are representative for the entire compositional range of the EVF magmas. Sulfur concentrations in melt inclusions correlate negatively with K_2O in all samples and range from 2500-3000 ppm in high Fo olivines (Zhupanovsky and Zavarisky volcanoes) to less than 200 ppm in evolved olivines and groundmass glasses, suggesting an extensive degassing of magmas during crystallization. We estimate that magmas in Kamchatka lose typically up to 50% of initial sulfur content after just $\sim$30-40% of crystallization. More than 90% of sulfur is lost from magmas after 70% crystallization. A preferential partitioning of sulfur into fluid phase during crystallization can be explained by a high proportion of sulfate species dissolved in melts. A ratio S^{6+}/S^{Total} in melts was estimated on average as 0.40$\pm$0.16 (the entire range of S^{6+}/S^{Total} is 0.63-0.089) from S K-alpha shift electron probe measurements. The data on sulfur speciation suggest an oxygen fugacity during crystallization of the EVF magmas at 0.5-1.8 log units above FMQ buffer.

Together with previously published results (Portnyagin et al., 2007, EPSL 255), our data suggest that parental magmas in Kamchatka had sulfur concentrations in the range of 1500-3000 ppm, which is 1.5 to 3 times higher than estimated for arc magmas

on a global basis (Wallace, 2005, J Volcanol Geotherm Res 140). This data allow precise determination of sulfur degassing rates for volcanoes with well reconstructed history. Combined with volcanic output estimates in Kamchatka during Holocene (Ponomareva et al., 2007, AGU Monograph 172), our data suggest a minimum sulfur emission from the EVF volcanoes as high as 1.2-1.4$\times 10^5$ t per year, which is 2-2.5 times higher than the present-day sulfur flux estimated for the entire Kuril-Kamchatka Arc from COSPEC measurements (Hilton et al., 2002, Rev. Miner. Geochem., 47).