Oxygen isotopes in Miocene-Quaternary volcanic rocks from Sredinny Range, Kamchatka

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Volcanic rocks of Kamchatka have broad variations of oxygen isotope composition (Bindeman et al., 2004, 2005; Dorendorf et al., 2000; Pokrovsky and Volynets, 1999; etc.). Here we present new data on $\delta^{18}O$ in volcanic rocks from Sredinny Range (SR) of Kamchatka. We analyzed 11 samples from Quaternary rocks of Alnej volcano, Sedanka, Kekuknajsky and Right Ozernaya monogenetic lava fields, Tobeltsen and Nilgimelkin cinder cones (north SR), as well as 6 samples of Miocene-Pliocene plateau basalts of Left and Right Ozernaya rivers, Dvuh'urtochnoe plateau and Kruki Ridge. Only fresh, inclusion-free olivine grains were selected for the analyses. Composition of olivine in selected rock samples is Fo65-87 in plateau lavas and Fo60-85 in monogenetic lava samples. Measured $\delta^{18}O_{olivine}$ values vary from 5.47 to 7.78 ‰, and are substantially higher than mantle values ($\delta^{18}O_{olivine}$~5-5.5‰, Eiler, 2001). Calculated $\delta^{18}O_{melt}$=6.17-8.48 ‰ ($\delta^{18}O_{melt}$= $\delta^{18}O_{olivine}$+0.7). The observed variations cannot be connected to the fractional crystallization processes, which is confirmed by the absence of correlations with Mg# and SiO_2 content in the whole rocks. Oxygen isotope composition also does not correlate with the age of the studied rocks and with the geographic location of the volcanic edifices (from the south to the north of SR): high $\delta^{18}O$-olivines are found both in young and old rocks, in the southern and northern parts of SR. Depending on the other geochemical characteristics of the rocks, subduction fluids (Dorendorf et al., 2000), sediment melts and/or crust material contamination (Bindeman et al., 2005) have been suggested as heavy oxygen isotope sources for the island-arc volcanic rocks. SR volcanic rocks have mantle-like $^{87}Sr/^{86}Sr$ (0.7028-0.70336, Volynets et al., 2010) and non-radiogenic lead isotope composition (for ex. $^{206}Pb/^{204}Pb$ ~ 18.2, Volynets et al., 2010). Crust or sediment contamination would be expressed in elevated Sr and Pb isotope values which should be correlated with ^{18}O enrichment (not observed). On the other hand, the mantle wedge below SR has been strongly metasomatized by the fluids during the previous subduction episode in Miocene-Pliocene, when SR represented the volcanic front of the subduction zone (Lander & Shapiro, 2007). This is confirmed by the elevated fluid-mobile elements content and variably high fluid-mobile/incompartible element ratios in all volcanic rocks from SR, both old and young. However, such fluid-mobile element enrichment is observed in many arc magmas but is not related to such elevated ^{18}O. Thus, a distinct scenario must be envisioned. We argue that ^{18}O enrichment in SR rocks may be caused by massive fluid influx from the subducting Emperor Seamount chain into the cold frontal part of the mantle wedge leading to serpentinization (with >15% H_2O). Reheating and melting of such old serpentinized mantle wedge during arc migration and back arc rifting results in heavy oxygen isotope enrichment in young volcanic rocks in the back-arc environment.
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