



## Multiple sulfur-isotope compositions of serpentinites at Ashadze and Logatchev hydrothermal fields (MAR) and origin of their associated sulfates

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Sulfur in oceanic hydrothermal systems has two main sources with distinct  $\delta^{34}\text{S}$  values: mantle sulfide and seawater sulfate. However, various processes (e.g., leaching, incorporation of seawater sulfate, inorganic and/or bacterial reduction or oxidation, mixing) affect the S-isotope compositions of the fluids, sulfide deposits and basement rocks, and consequently influence the global sulfur cycle. The Ashadze and Logatchev hydrothermal fields are black-smoker hydrothermal systems located along the Mid-Atlantic Ridge (13°N and 15°N, respectively) and are hosted by variably altered ultramafic rocks and mafic rocks. In order to better characterize the processes governing sulfur geochemistry in hydrothermal systems, we analyzed the sulfide mineralogy, sulfur content and multiple-sulfur isotope ( $^{32}\text{S}$ ,  $^{33}\text{S}$ ,  $^{34}\text{S}$ ,  $^{36}\text{S}$ ) compositions of variously serpentinized peridotites of both hydrothermal systems. Sulfide minerals are scarce in the serpentinites of both sites and were in too low amount to be analyzed for S-isotopes. These sulfides form an assemblage of pentlandite, heazlewoodite, millerite, pyrrhotite that would suggest relatively reducing conditions of serpentinization. Chemically extracted sulfates show a wide range of  $\delta^{34}\text{S}$  values (from 9.3 to 30.9‰) suggesting additional processes (e.g., oxidation, mixing) than the sole incorporation of seawater sulfate in the rocks. The multi-isotope compositions of sulfates in  $^{33}\text{S}$ ,  $^{34}\text{S}$  and  $^{36}\text{S}$  show linear trends whose slope, of 0.507 and 1.96 respectively, are clearly distinct from the mass-dependent equilibrium fractionation lines (e.g., 0.515 and 1.89). Two processes may have produced these slopes: equilibrium fractionation in an open-system or kinetic fractionation. Deviations of  $\delta^{33}\text{S}$  and  $\delta^{36}\text{S}$  from the reference lines give positive  $\Delta^{33}\text{S}$  and negative  $\Delta^{36}\text{S}$ , and the slope of the linear trend between  $\Delta^{33}\text{S}$  and  $\Delta^{36}\text{S}$  ( $\sim -7$ ) would suggest that equilibrium fractionation in an open-system is the predominant process. In addition, the positive  $\Delta^{33}\text{S}$  values and the good correlation between  $\delta^{33}\text{S}$  and  $\delta^{34}\text{S}$  ( $r^2=0.99997$ ) rule out mixing processes. Thus our data suggest that oxidation of sulfides to sulfates in an open system would be the predominant process to explain the multiple S-isotope compositions of the sulfates in serpentinites of both hydrothermal systems.