Molybdenum isotope behaviour accompanying vapour-phase transport in geothermal systems

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Molybdenum (Mo) isotopes are highly sensitive to oxidation state and can be used to provide a measure of redox conditions in the oceans. Geothermal systems play an important role in the Mo flux to the oceans, as well as in the formation of Cu-Mo ore deposits. Vapour-phase transport of Mo within such systems appears to be important [1], but there is little information regarding the extent of isotope fractionation during vapour transport and condensation.

This study presents Mo isotope and elemental data for geothermal liquids and their associated condensed vapour phases from four geothermal systems in Iceland. Reykjanesvirkjun represents a sea-water endmember (Cl = 18800 ppm), whereas Krafla and Bjarnaflag represent meteoric reservoirs (Cl < 100 ppm), and Svartsengi a mixed system (Cl < 12500 ppm). Mo concentrations in the liquid phases range from 0.3 to 14.3 ppb and were found to be correlated with salinity. The corresponding $\delta^{98/95}$Mo values range between 0.18 and 2.10‰ (seawater = 2.07 ± 0.08‰). All of the condensed vapour phases contain a significant concentration of Mo (up to 3.3 ppb), and are isotopically lighter than their corresponding liquid phases. Isotopic values in these condensed vapour samples are always lighter than the corresponding liquid phase, and are generally negative (δ^{98}Mo -0.37 to 0.07‰). The Reykjanes vapour samples show the largest isotopic variation which encompasses the entire measured condensed vapour range, suggesting that the extent of liquid-vapour fractionation is independent of the initial $\delta^{98/95}$Mo composition.

Our results indicate that significant $\delta^{98/95}$Mo fractionation occurs between liquid and vapour phases in geothermal systems, and results in an isotopically light vapour phase. Understanding the processes that result in this fractionation is key to quantifying geothermal Mo transport, and will help characterise what mechanisms control the formation of Mo porphry ore deposits.

[1] Rempel *et al.*, 2006, *GCA*, **70** 687–696.