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Evaluating the contribution of high temperature fluids to surface waters using Se/SO4 ratios and the stable isotopes of sulphur and carbon for the Aso caldera, Japan

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Volcanic areas, considered as hotspots of weathering at a global scale, are ideal systems to study hydrothermal alteration and mixing processes with surface waters due to their relatively high temperature gradient. The aim of this study is to determine the hydrothermal contribution to the surface waters of the Aso caldera in Japan, in terms of weathering processes and related hydrochemical fluxes. During several field campaigns spring and river water samples were collected along the two main rivers of the caldera. Major ions and trace element concentrations together with stable isotopes of water, d13C-DIC and d34S-SO4 were determined. The hot springs in this region are associated with high sulphate concentrations, related to the contribution of magmatic sulphur. In contrast, for most cold springs the hydrochemistry reflects surface water infiltrating soils. In particular, cold springs have a significantly higher Se/SO4 molar ratio than hot springs. The lower apparent mobility of Se in the hydrothermal system is also suggested by the good correlation between Se and Fe for hot spring samples. The stable isotope analyses indicate that sulphate can be derived from at least three different sources, acid hydrothermal waters, alkaline hydrothermal water and sulphate from the soils. Altogether, the results show that hydrothermal waters significantly impact the hydrochemistry of the caldera outlet, implicating that dissolution of magmatic CO_2 and oxidation of sulphur of magmatic origin represent an important contribution to the total observed weathering fluxes.