

Hydrothermal influence on rock weathering in the Kirishima volcanic complex

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The global weathering flux of volcanic areas is often scaled with runoff and temperature. However, it was identified that alkalinity fluxes decrease with the age of the basaltic rocks drained. A combination of hydrothermal activity and production of fresh rocks through volcanic eruptions seems to be most likely governing this relationship. In addition, weathering rate equations, from thermodynamics, can be scaled with the reaction time, residence time, the dimension (volume or length) and the temperature of the system. In this study, the chemistry of rivers and springs from the Kirishima volcanic complex (Japan) is analyzed. By combining spring water residence times with multi-isotope composition of $\delta^{13}\text{C}_{\text{DIC}}$, $\delta^{34}\text{S}_{\text{sulphate}}$, $\delta^{18}\text{O}_{\text{sulphate}}$, $\delta^{18}\text{O}_{\text{water}}$, $\delta^2\text{H}_{\text{water}}$ and trace element concentrations, the hydrothermal component can be distinguished. We also compared the apparent chemical kinetic constant of primary minerals in the volcanic rocks with those measured in other studies to determine transport or equilibrium controls on weathering in this system. The magmatic CO_2 and SO_2 are responsible for a significant proportion of the enhanced weathering if compared to inactive volcanic systems. In general, the apparent weathering rate in the Kirishima volcanic complex seems to be transport controlled and can be scaled up with the residence time of the spring waters. Given the complexity of hydrothermal processes and the admixing of different fluids with varying fluid-rock interactions, we also highlight the importance of regional studies in volcanic settings to simplify the investigation of weathering pathways. In this study case, it seems that a first order chemical kinetic equation of Kirishima's primary minerals (augite, hypersthene and plagioclase) may describe the system.

