Time scale evaluation of transitions of chemical weathering reactions in Kirishima volcanic area, Japan

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The Kyushu Island in southern Japan is located within very high potential area of the chemical weathering and suggested as an area showing the highest discharge potential of dissolved silicates and some cations within the Japanese Island arc. Based on dissolved ion concentrations information, many studies have reported that geochemically evolved (old) and un-evolved (young) groundwater have different chemical weathering stages. However, the knowledge of water-rock interaction time scale that requires for the transition of each secondary mineral is not sufficiently known in natural systems due to the lack of groundwater age information together with chemical weathering index.

The objective of this work was to investigate the time scale of transitions of chemical weathering reactions in natural groundwater systems. In total of 197 spring water samples were collected during 2007-13 around Kirishima volcanic area, southern Kyushu Island (1700 m in altitude, average annual precipitation of 2600 mm/yr). These samples were analyzed for groundwater residence time and geochemistry to be compared.

The geochemical features of spring water samples with geological information of this area suggested that dominant reactant minerals are pyroxene and plagioclase. Precipitation minerals were also estimated using Geochemist's workbench software. Then, kaolinite and smectite were deduced as major secondary minerals precipitating from the system. In order to verify the water-rock interaction occured in the system, stoichiometry calculation was attempted on measured dissolved ions. Estimated concentration from weathering equation was plotted against measured concentrations of dissolved ions and found, the samples which are indicating of smectite precipitation has longer residence time compare to those samples indicating of kaolinite precipitation.

Our observation suggest that at least 20 years of interaction is needed for the alteration of precipitation reaction from kaolinite to the smectite.