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Tracing Origin of sulfur in hydrothermal system of Eastern Taiwan

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Multiple sulfur isotope results and sulfate concentrations are reported for different hydrothermal system in many countries. However, Taiwan is a seismically active country with plenty of hot spring resources, but only a few studies discuss about sulfur isotopes of them. No exhaustive study has been done to explain the high concentration and origin of sulfur in hydrothermal system of Taiwan, and chemical reaction between sulfide and sulfate. The true sulfur speciation in geothermal waters is difficult to preserve in samples for laboratory analysis. However, isotopic analysis is possible for the two species SO_4^{2-} and $S_2O_3^{2-}$, together. Analysis of other species was also carried out for a possible study to understand the inter-conversion mechanism of sulfur species, and transport of other elements in aquifers, along with sulfur cycling in hydrothermal system of Taiwan. Fifteen samples, hot spring (5) and river water (10) were collected from East Taiwan and 5 hot spring samples were also collected from Japan for comparison.

The samples were pre-concentrated and subjected to separation with anion exchange resin AGI-X8 and isotopic analysis with MC-ICPMS. The anions and cations were determined by Ion chromatography and ICP-OES, respectively. Samples from western Japan have been defined as Na–Cl type ground water and originate from 'fossil seawater' entrapped in the formations. The K/Cl and SO_4/Cl ratios in hot spring water samples lie into a range between rain water and sea water. The Br/Cl ratios in hot spring water samples were close to that of sea water line, and could be distinguished from river water samples. Trace elements Li and B were high in hot spring samples from eastern Taiwan. This can be due to strong weathering in groundwater system. δ^{34}S values in most of the hot spring samples were in the range between 15.74-24.87 ‰ which is close to δ^{34}S in seawater(+21 ‰). However, δ^{34}S in samples from Zhiben (Taiwan) and Kurama (Japan) were -1.50‰ and -3.17 ‰ respectively. The lighter sulfur isotope ratios indicate the reduction of sulfate, probably by bacteria, because of domestic contamination in the groundwater system in these two hot spring resorts. The data on major elements and sulfur isotopes showed that the river water samples, which were collected near hot spring wells, were influenced by the hot springs. Based on the water chemistry of end members i.e., Br/Cl, Na/Cl, K/Cl and SO_4/Cl and sulfur isotope signatures, most of the samples were considered to be mixture of rain water and sea water (or brine).