# $^{18}O/^{16}O$ ratio of sulfate in acidic hot spring waters from Kusatsu-Shirane volcano, Japan for the estimation of cooling rate of the water

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Mt. Kusatsu-Shirane located on the central part of Honshu island, Japan is characterized by the development of volcanic hydrothermal system (Ohba et al., 2000). Many hot spring discharges and active crater lakes are distributed on the mountain. We have sampled several acidic hot spring waters on the flank of volcano and measured the $^{18}O/^{16}O$ ratio of water and sulfate.

The apparent equilibrium temperature defined between the $^{18}O/^{16}O$ ratio of sulfate and water based on the fractionation factor calibrated by Mizutani and Rafter (1969) was 20 to 90C higher than the outlet temperature of hot spring. The $^{18}O$ exchange reaction between sulfate and water depends on pH and temperature (Chiba and Sakai, 1985). At 200C the half time of exchange reaction is 4 day and 700 year at pH=4 and 7, respectively. The observed apparent temperature could be interpreted as a quenched state produced during the cooling processes the initial temperature of which would be much higher than the apparent temperature.

The $^{18}O/^{16}O$ ratio change during the cooling was numerically simulated. Cooling rates consistent to the observed $^{18}O/^{16}O$ ratios were 0.002 to 0.2 degree per day. A fast cooling rate was estimated to a hot spring discharge with large flux accompanying steam discharge. On the other hand, hot springs with relatively small flux show a slow cooling rate. If the estimated cooling rate depends on only the speed of conductive heat loss, the fast cooling for the high flux spring can not be explained. For the fast cooling rate, isoenthalpic adiabatic decompression of hydrothermal water will be applied, where a steam phase is separated from liquid water during the ascending of fluid.

## References

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# Strontium isotopic signature of atoll dolomite from Daito-jima Islands, Okinawa

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The mechanism for the formation of sedimentary dolomites is one of the most interesting and mysterious problems in carbonate geochemistry. Dolomites have often been encountered by drilling into the subsurface of the Pacific atolls. Kita-daito-jima is an uplifted atoll and was drilled to 432 m in 1936. The drill cores consist of shallow coral-reef carbonates. We used the core samples to determine carbonate mineralogy and for Sr isotope measurements. Strontium isotopes are useful for estimating the timing and mode of dolomitization in carbonate sequences (Vahrenkamp et al. 1988; Ohde and Elderfield 1992; Aharon et al. 1993; Ohde et al. 2002).

Dolomite is abundant at the upper part of the Kita-daito-jima, over a range of ~270 m in the atoll column (74 m elevation to 196 m deep in the core), and gives two distinct Sr isotope ages of 2 and 5 Ma, overprinting the record of original sedimentation. The 5 Ma event has affected about 70 m of the atoll core. The 2 Ma event has affected the top 50 m of the core (together with 74 m of dolomite above sea-level on the island). In addition, three dolomites separated from calcite/dolomite mixtures (depths of 161, 177 and 193 m) show very young ages of 2 Ma compared with the surrounding calcite sediments of 15-16 Ma, showing that partial 2 Ma dolomitization has extended to depths greater than that of the 5 Ma dolomite.

Dolomite is also abundant on Minami-daito-jima. We collected samples of dolomite from coastlines of the two islands, and obtained Sr isotope ages of 2 Ma in samples from an altitude of 10-64 m and 5 Ma in samples from an altitude of 0-10 m. A palaeosoil layer separates the two ages of dolomite. Fissures are common in the coasts of the islands. Some of them have fractures both 2 and 5 Ma dolomites, whereas others have fractured only 5 Ma dolomites. From this body of evidence and Sr isotope data, it seems that there are two discrete dolomitization events on Kita- and Minami-daito-jima Islands.

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