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Studies on the origin of underground brine using I-129 systematics

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High salinity underground water with a high iodine concentration occurs in different places in Japan. However, their origin and the accumulation mechanisms are not well known. In our previous studies, we have analyzed iodine in many geological samples and found that nearly 70% of iodine in the Earth's crust is estimated to exist in marine sediments (Muramatsu and Wedepohl 1998). Since sediments should largely be transported into the mantle, it is important to understand the behavior of iodine and other halogens during subduction processes. We assumed that the production of iodine rich brine should be related to the subducting processes (Muramatsu et al. 20 01).
In this study we present results for brines and hot spring water samples from different locations in Japan (e.g. Pacific side, volcanic front areas and Japan Sea side) where we determined the concentrations of iodine, bromine, chlorine and some other elements by ICP-MS (inductively coupled plasma mass spectrometry) and ion chromatography (IC). We also determined iodine-129 (half-life: 1.57 million years) by accelerator mass spectrometry (AMS) in a subset of the samples to discuss the age of iodine in the samples.
The iodine levels in the samples varied very widely from <0.01 to 140ppm. Samples collected from Kazusa Formation (1000 - 2000m depth) at Chiba Prefecture (the Pacific coast of Japan) contain iodine around 100ppm, which is about 2000 times higher than the seawater iodine value (0.006 ppm). High concentrations of iodine (more than 50ppm) are also found in underground waters collected from Miyazaki, Niigata, Akita and Hokkaido etc. It is interesting to note that methane often coexists in such iodine-rich brines. The I-129/I-127 ratios in this area were found to be around 0.17x10E-12, which corresponds the age of about 50 Ma. This age is much older than the current reservoir formations (ca. 1?2 Ma). These results suggest that the iodine enrichment in the brines was caused by remobilization from subducting marine sediments associated with the release of pore waters in the fore-arc area.
Samples collected from a volcanic front area, Kusatu-Shirane volcano, showed relatively high iodine concentrations up to 9ppm, with chlorine concentrations of about 3000ppm. Relationships between the increase of halogen concentrations and the volcanic activity (e.g. frequency of earthquakes) were observed in the Crater Lake Yugama, in which iodine showed the highest increase among the three halogens. The lowest I-129/I-127 ratios determined in hot springs of Kusatsu Shirane areas were about 0.18 x10E-12 which is compatible with the estimated ratio for iodine derived from subducted marine sediments in this region. Our results for the Kusatsu-Shirane and similar hydrothermal systems demonstrate that recycling of subducted sediments is the dominant source of iodine in volcanic systems at active margins. We also analyzed the I-129/I-127 ratios in iodine rich-brine samples from back-arc areas, Niigata, Akita and Hokkaido. The ratios in these areas were about 0.06 ? 0.5 x10E-12. The lowest ratios were found in Hokkaido samples, suggesting that the iodine was derived from old sediments underlying in Hokkaido.

References:
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