

Lithium isotope geochemistry of the Yellowstone hydrothermal system

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Introduction

The behavior of Li in hydrothermal systems was considered by Giggenbach (1990, 1995) to be conservative and therefore, along with B and Cl, potentially indicative of solute sources and flowpaths. An exploration of the Li chemical and isotopic variations of thermal waters and various rock types from drill-cores and outcrops in the Yellowstone hydrothermal system gives evidence that in this system Li is nonconservative and sensitive to the extent of active water-rock interaction. We have used these data to investigate simple models for the Li cycle and to consider their implications for the geochemical dynamics of the system.

Results

Thermal waters have Li concentrations ranging from 0.27 to 6.5 mg/kg, and $\delta^7\text{Li}$ values from +1.0 to +6.5 per mil. Rocks have Li concentrations ranging from 2.0 to 32.7 mg/kg (in sedimentary rock), and 15.2 to 282 mg/kg (in rhyolite); Li concentrations in rhyolite increase with the extent of hydrothermal alteration because Li is incorporated in hydrothermal minerals. The range in $\delta^7\text{Li}$ values for the sedimentary rock is +1.6 to +22.4, and $\delta^7\text{Li}$ is generally higher in limestone than in shale. The range of $\delta^7\text{Li}$ values for the rhyolite is -3.6 to +7.5 per mil; $\delta^7\text{Li}$ values generally increase with increasing extent of hydrothermal alteration.

Conclusions

Relations of Li and Cl concentrations in thermal waters indicate loss of Li by incorporation into hydrothermal minerals in altered rhyolite. A history of boiling and dilution can be seen in Li/Cl vs. Li of thermal waters. Simple isotopic fractionation models for Li isotope exchange between thermal water and altered rhyolite, with mass transfer constraints from Li/Cl ratios of thermal waters, can account for the observed variations in $\delta^7\text{Li}$. Chemical and isotopic mass balance considerations indicate that the long-term discharge of Li from the Yellowstone hydrothermal system must be sustained in large part by deep input of high-salinity magmatic brine.

References

- Giggenbach, W. F. (1995), *J. Volcanol. Geotherm. Res.* **68**, 89-116.
 Giggenbach, W. F. et al. (1990), *J. Volcanol. Geotherm. Res.* **42**, 13-39.

Organic petrologic characteristics of an zinc-lead mineralization at Fankou Pb-Zn deposit, South China

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The Fankou Pb-Zn deposit, one of the most important strata-bound deposits in North Guangdong, South China, is a sedimentary-accumulated deposit from ore-bearing hot spring. The host rocks are the Upper-Middle Devonian and Lower Carbonate formation.

Most of the collected samples, including 105 bore samples and 25 rocky samples, are duck-gray to black. Among all these samples, most of them are bioclastic limenstone and oncolite limenstone. The contents of total organic carbon (TOC) in the host rock are in the range of 0.14 to 1.49 wt %, (average 0.45 wt %) (Zheng, 1996; Wu, 1987). According to the observations by organic petrology, the organic matter in the host rock has high level of thermal evolution. Micro-components of the organic matter mainly are marine vitrinite, solid bitumen, and pyrobitumen, and their modes of occurrence are scattered along the crevices. Most of the bitumen are scattered in mineral bitumen. The solid bitumen is characteristic of granular, sphaerolitic and rounded structure, which indicate that the bitumen used to be under the mineralization condition of high temperature and rich water, and the bitumen flowed into the mineralization zone with the bearing-ore fluid. Thus, it is shown that during the mineralization there was the organic-fluid in the ore-fluid. In some samples, there are marine vitrinite with low reflectance, and they are duck-gray under oil-immersed reflected light. The organic matter is abundant and most are bitumen with vesicles on the surface, suggesting that they are high thermal maturation. The organic matter and metal minerals (pyrite, galena and blende) are well paragenous, which directly shows a close relationship between the organic matter and metal minerals. Pyrite of granular and strawberry form indicates the effect of bacteria and micro-alga. In addition, fluid inclusions are found under the microscope, with the size from 6 μm to 10 μm , and the modalities of which are oval, orbicular triangle and anomalistic. The most are G-L phase inclusions. On the basis of the preliminary organic petrologic observation, fluid inclusions in some ores are CH₄-rich, even organic-rich (or bitumen-rich) polyphase inclusions. We can, therefore, infer that the organic matter of the host rocks plays an important role during the zinc-lead mineralization.