Origin of rare metal resources in geothermal fields of southern Tibet, China

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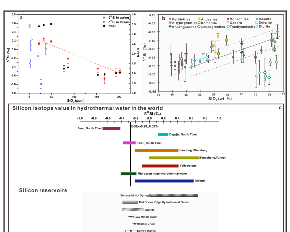
A unique enrichment of rare metals (Cs, Rb, Li) occurs in geothermal water along the south-north direction of the Shiquanhe-Yarlung Zangbo geothermal area, near the Yarlung Zangbo Suture Zone, southern Tibet, China (e.g. Li of 5-30 ppm; Cs of 6-50 ppm). In geothermal water, the Na/Cl ratios show to be around unity, and the Cl/Br molar ratios are from 400 to 1400. The isotopic compositions of hydrogen and oxygen are from -153 ‰ to -169 ‰ and from -13.2 ‰ to -19.72 ‰, respectively. The $\delta^{30}Si$ ranges from -0.67 ‰ to +0.25 ‰ in geothermal water in study areas, which are more negative than other geothermal water elsewhere in the world. Compared to geothermal water, the $\delta^{30}Si$ values of stream show a wider variation, from -0.79 ‰ to +0.54 ‰ (Fig. 1).



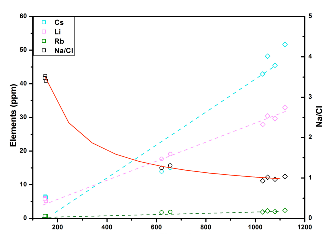


Fig. 1 (a) Variations of $\delta^{30}Si$ geothermal springs in studied areas; (b) correlations of SiO_2 vs. $\delta^{30}Si$, (c) distribution of $\delta^{30}Si$ compositions in various hydrothermal water in the world.
Fig. 2 Correlations of Cl content, Na/Cl molar ratio and cations.

The Cl/Br molar ratios, δD, $\delta^{18}O$ values and the correlations of Cl content with Na/Cl molar ratios and cations indicated the accumulation of rare metals from residual magmatic degassing, dissolution of halite (Fig. 2). The relationships of $\delta^{30}Si$ with SiO_2 and other elemental contents fairly reflect strong water-rock interactions during groundwater circulation in the geothermal systems. As typical incompatible elements of Cs, it is not only easily enriched in residual magmatic fluids but also transmitted into water from rocks during water-rock interactions. Therefore, both residual magmatic fluids mixing and secondary stronger water-rock interactions can make rare metals unusually enrich in the high temperature geothermal water in the Tibet.