Vol. 91 No. 1 pp. 363–364 ACTA GEOLOGICA SINICA (English Edition) Feb. 2017

Research Advances

Lithium Isotope Evidence for the Source of Potassium-Rich Brine Solutes in the Jiangling Depression of Central China

WANG Licheng[1, *], LIU Chenglin[1], WANG Chunlian[1], XU Haiming[1] and ZHANG Yongming[2]

1 *MLR Key Laboratory of Metallogeny and Mineral Assessment, Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing 100037, China*

2 *Qinghai Institute of Salt Lakes, Chinese Academy of Sciences, Xining 810008, China*

Objective

High-temperature and high-pressure brines have been discovered in the Jiangling Depression west of the Jianghan Basin, which contain K, Li, Rb and Cs of high economic grade. Till now, little attention has been paid to the potassium-rich brines, and it is uncertain to determine the source of solutes in the brines, such as K and Li. Previous studies have speculated that volcanism may attribute to the source of brine solutes. However, it is unclear whether basalt weathering or water-rock interaction is the main sources of potassium. This work conducted high-precision lithium isotope geochemical measurements on the newly discovered brines from drilled holes to reveal the relationship between high concentration of Li in the potassium-rich brines and basalts.

Methods

A total of nine brine samples were collected from the drilled holes GK-1 and GK-2 in the center of the Jiangling Depression. Lithium was separated from water samples by drying water samples in an oven for two hours and redissolving residue with Li diluent material. Samples were subsequently treated with 2 ml HCl and loaded into quartz columns packed with cation exchange resin. Lithium was eluted with 0.5 N HCl and Li fraction was allowed to dry on a hot plate and redissovled in 1N HCl. Lithium isotope analysis was performed using ICP-MS element 2/XR.

Results

The lithium isotopic compositions of nine brine samples lie between 15.87‰ and 30.98‰ with Li concentration ranging from 0.0513g/L to 0.0934 g/L. Samples from GK-2 have higher Li concentration with a more positive δ^7Li values. The δ^7Li values are generally lower than those of sea water (31‰) and higher than those of basalts and the Da Chaidam Lake (22‰) (Fig. 1). The highly variable Li isotopic compositions are similar to those of hydrologically closed large lakes, e.g., those of U.S. Great Basin (+16.7‰ to +23.7‰) and those of continental hot

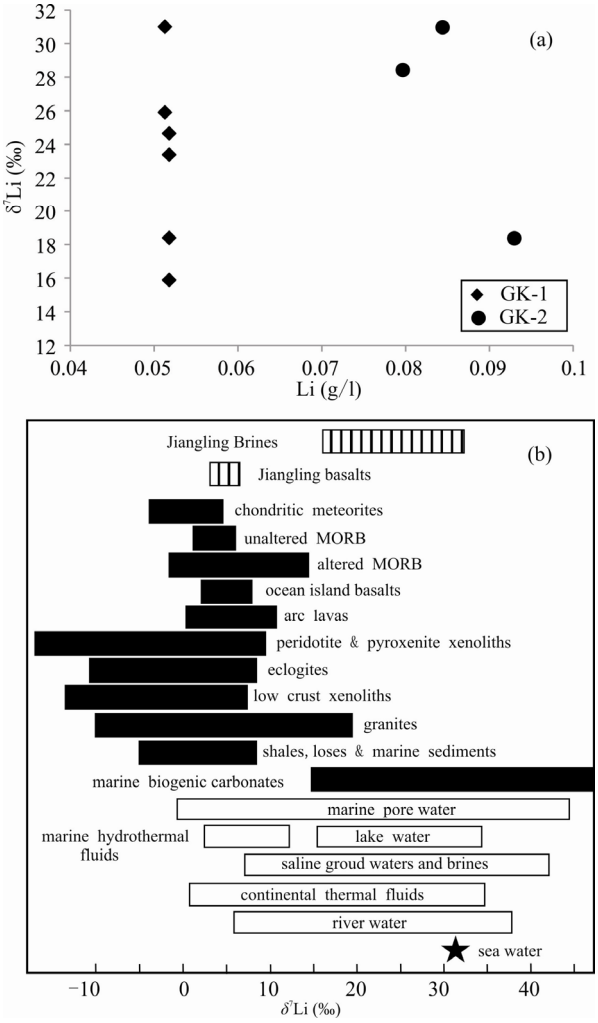

Fig. 1. (a) Plot of lithium isotope values vs. lithium concentrations from brines samples in the Jiangling Depression; (b) Comparison of Jiangling brines with typical basalts and water body in lithium isotopic compositions.

* Corresponding author. E-mail: wayne-wlc3@126.com

spring waters (+1.0‰ to +34.8‰). Saline ground waters (0.01 to 16 ppm Li) and oil filed brines (1.0 to 2.3 ppm) are common in many arid to semi-arid regions, which is much lower than the lithium concentrations of the Jiangling brines. High concentrations of lithium indicate that a large amount of lithium was leaching out from the Li-rich basalts. Generally, the water-rock interaction occurred at >200°C and ^{7}Li was preferentially removed from the rocks into solution. These hydrothermal alterations, which occurred at fracture zones with thermal fluids interaction directly with mantle rocks, made a higher concentration of lithium and δ^{7}Li value. Therefore, rock weathering is unlikely to be a source of solutes in the Jiangling brines.

Conclusions

(1) The potassium-rich brine solutes from the Jiangling Depression are possibly not of a marine origin.

(2) High concentrations of lithium and δ^{7}Li values indicate that weathering does not contribute to the solutes in the brines. The enrichment of lithium in the brines is likely from water-rock interaction which occurred between mantle basalts and high temperature fluids.

Acknowledgements

This study was financially supported by the National Nature Science Foundation of China (grants No. 41202059 and 41502089).