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Boron Isotopic Composition of Halite from 46-m-long Sediment Core in the Qarhan Salt Lake, Western China

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Previous studies have investigated the boron isotopic composition of salt lake brines in the Qaidam Basin, western China. However, the research on boron isotopic composition of halite is very limited due to halite's low boron concentration. In this study, a 46-m-long drilling core (ISL1A) was recovered from the Qarhan Salt Lake in the eastern Qaidam Basin (Fig. 1). Fifty halite samples in ISL1A were collected and analyzed for B, Mg and Ca concentrations and isotopic composition of boron in order to investigate the relationships between these elemental concentrations and isotopic compositions and their fractionation between halite and brine in the study area. Therefore, this abstract will discuss the following two issues.

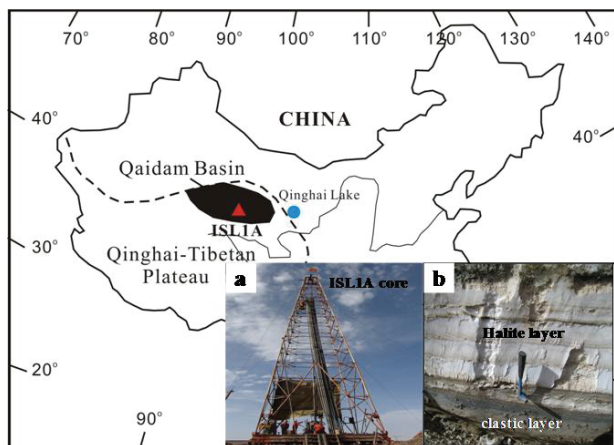


Fig. 1. Map showing the location of Qarhan Salt Lake in the eastern Qaidam Basin, western China.

(1) the mechanism of boron removal from brine into halite has not yet been determined (Dong, 1984; Vengosh et al., 1992; Liu et al., 2000). Dong (1984) investigated the composition of trace elements in an evaporite halite sequence and argued that boron could be present in the

form of parent fluid inclusions. Meanwhile, the evaporation experiment on the salt lake brines in the Qaidam Basin indicates that boron in halite is mainly from fluid inclusions (Liu et al., 2000). An evaporation experiments on seawater showed that the $\delta^{11}\text{B}$ values of halite are lower than those of the parent seawater, suggesting that the boron is incorporated into the mineral lattice (Vengosh et al., 1992). In the Qarhan Salt Lake, the mineral components are relatively simple (Zhang, 1987; Zhang et al., 1993), and halite layers mainly contained halite and poor gypsum minerals (Li, 1987; Gao, 1987). Mg salt mineral is not almost existed in ISL1A. Meanwhile, Mg salt is the late stage precipitating salt mineral, and it is not coprecipitated with halite mineral (early stage precipitating salt mineral). Therefore, Mg concentrations in halite might be not come from salt mineral. By comparison B, Mg and Ca concentrations in halite in ISL1A (Fig. 2), we found that B concentrations are in positive correlation ($R=87\%$) with Mg concentrations in halite, while Ca concentrations are uncorrelated ($R=25\%$) with B concentrations in halite, suggesting that B in halite is not coprecipitated with Ca mineral but same source with Mg in halite. This result demonstrates that B in halite is mainly from fluid inclusions.

(2) B isotopic fractionation between halite and brine in inner salt lakes, western China: an evaporation experiment on seawater indicated that the coexisting salt deposits may be depleted in ^{11}B by 20‰ to 30‰ relative to their parent brines, and a 25‰ fractionation of boron isotopes between brine and gypsum and/or halite was observed (Vengosh et al., 1992). However, an evaporation experiment by Liu et al. (2000) indicates that the $\delta^{11}\text{B}$ value of halites crystallized from pure NaCl solutions does not vary (ranging from 10.7 to 10.8‰), while the $\delta^{11}\text{B}$ values of halites crystallized from Na-Ca-Cl-SO₄ solutions (7.1 to 10.7‰) are lower than those of the parent solutions. This result indicates ~4‰ fractionation of boron isotopes during crystallization of halites from brines containing

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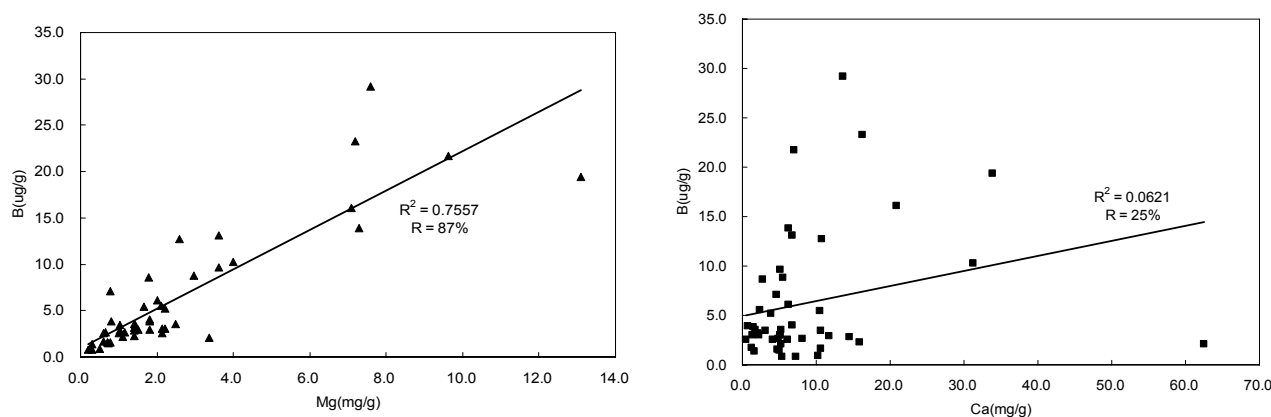


Fig. 2. The comparison among B, Ca and Mg concentration of halite in ISL1A.

Ca^{2+} , SO_4^{2-} , Na^+ , and Cl^- (Liu et al., 2000). Likewise, the boron isotopic compositions of the seven samples of halite and coexisting brine from the Qaidam Basin imply the occurrence of 1–5‰ fractionation of boron isotopes between the two phases (Liu et al., 2000). In a recent study, the boron isotopic compositions of modern halite samples from salt marshes along Atlantic and Sicilian coasts are comparable to that of modern seawater (Paris et al., 2010). This finding suggests that seawater evaporation and halite formation induce only a slight fractionation of boron isotopes (Paris et al., 2010).

In this work, the $\delta^{11}\text{B}$ values of the halites in ISL1A range from -0.35 to $+5.84\text{‰}$, and those of brines in the Qarhan Salt Lake range from $+2.9$ to $+6.2\text{‰}$. By comparing the $\delta^{11}\text{B}$ values of the halites in ISL1A with those of the brines in the Qarhan Salt Lake, we found that the former values are obviously lower than the latter. The variation in the $\delta^{11}\text{B}$ values can reach 3–4‰. These results demonstrate that the magnitude of boron isotopic fractionation between the halites in ISL1A and the brines in the Qarhan Salt Lake is basically consistent with that in the evaporation experiment and of the salt lake brines in the Qaidam Basin. This suggests that the boron isotopic fractionation between halite and brine is minor. Such a conclusion is in agreement with the observations of Liu et al. (2000) and Paris et al. (2010).

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References

- Dong, J.H., 1984. Mineralogical chemistry of halite in modern salt lakes of China. *Acta Mineral Sinica*, 1: 29–34(in Chinese).
- Gao, Z.H., 1987. Preliminary study on carbonates in clastic sedimentary layers of some salt lakes in Qaidam Basin. In: *Proceedings of the Sino-Australian Quaternary Meeting*, pp. 142–152(in Chinese with English abstract).
- Li, B.X., 1987. Salt minerals and their sedimentary conditions of salt lakes in the Qaidam Basin. In: *Proceedings of the Sino-Australian Quaternary Meeting*, pp. 133–141(in Chinese with English abstract).
- Liu, W.G., Xiao, Y.K., Peng, Z.C., An, Z.S., and He, X.X., 2000. Boron concentration and isotopic composition of halite from experiments and salt lakes in the Qaidam Basin. *Geochimica et Cosmochimica Acta* 64(13): 2177–2183.
- Paris, G., Gaillardet, J., and Louvat, P., 2010. Geological evolution of seawater boron isotopic composition recorded in evaporites. *Geology*, 38: 1035–1038.
- Vengosh, A., Chivas, A.R., Kolodny, Y., Zhang, B.Z., and Zhang, P.X., 1995. Chemical and boron isotope compositions of non-marine brines from the Qaidam Basin, Qinghai, China. *Chemical Geology*, 120: 135–154.
- Zhang, P.X., 1987. *Salt Lake in Qaidam Basin*. Beijing: Science Press, 1–235 (in Chinese).
- Zhang, P.X., Zhang, B.Z., Lowenstein, T.K., and Pancer, R.J., 1993. *Origin of ancient potash evaporites: examples from the formation of potash of Qarhan Salt Lake in Qaidam Basin*. Beijing: Science Press, 27–121 (in Chinese).