**Research Advances**

# The Discovery of Deep Potassium and Lithium Resources in the Huangjinkou Anticline, Northeast of Sichuan

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## Objectives

Important clues have been found for potassium prospecting in the Huangjinkou anticline of the northeast Sichuan Basin in the 1970s (Zheng et al., 2015; Lin et al., 2004). In 2008, China Geological Survey launched a prospective investigation of potash resources in the western region of China, and the local governments and private-owned enterprises also responded positively. Then, during 2015−2016, the Land and Resources Department of Sichuan Province deployed potash prospecting drilling (borehole ZK601) in the Huangjinkou anticline, and obtained deep potassium and lithium resources. These results may give a direction of marine potash prospecting in the Sichuan Basin.

## Methods

Detailed geological documentation of the drilling core and comprehensive logging have been made for this potash well in the Huangjinkou anticline. Evaporites, e.g. polyhalite, halite and karstenite, which were systematically sampled at strata deeper than 3500 m. The samples were studied comprehensively with methods including wet-chemical analysis, powder X-ray diffraction, thin section and scanning electron microscopy observation, trace elements and Sr isotope analysis. We paid special attention to the samples from salt-bearing series, especially to polyhalite-bearing samples. Meanwhile, hydrochemical analysis and chemical investigations were carried out on brine samples.

## Results

(1) Lithologically, the salt-bearing strata from the first member of the Leikoupo Formation to the fifth member of the Jialingjiang Formation of the potash well ZK601 can be divided into four polyhalite mineralization periods (Fig. 1).

(2) There are eight layers of polyhalite, which are often associated with gypsum and halite in the borehole. The thickness of a single polyhalite layer varies from 1.11 to 12.13 m, and the cumulative thickness is 33.5 m, with the K content of 3.83wt%−7.34wt%, averaging 6.02wt%.

(3) The brine, with a specific gravity of 1.21−1.24, salinity of 330−362 g/l, pH value of 7.6, belongs to chloride type brine. The $K^+$ content of the brine is 34.84 g/L, equaling to a KCl content of 66.55 g/L.

The contents of LiCl and $B_2O_3$ in the brine are much higher than the industrial grade. Besides, the magnesium and lithium ratio (the lower, the easier for industrial extraction of lithium from brine) for the brine in Triassic strata in northeastern Sichuan is lower than that of the brine of Zabuye Lake, and is similar to the Yiliping brine and belongs to high quality lithium-rich brines (Table 1), profitable for industrial production of lithium.

The $^{87}Sr/^{86}Sr$ of 28 whole-rock core samples is between 0.70816−0.70837, with an average of 0.70824, which is in consistent with that of the Triassic sea water. Meanwhile, the patterns of REE is similar to that of the sea water, i.e., enriched in LREE and depleted in HREE. The Sr isotope values and REE patterns indicate a marine origin for the potassium-bearing evaporites in this area.

## Conclusions

This paper discovered large-scale thick bed marine polyhalite and brines rich in potassium, lithium and boron from evaporites buried at a depth of 3500 m, which has guiding significance for the prospecting of deep-buried marine potash and brine type lithium resources in China. The thick layer of polyhalite-bearing rock salt in this well is relatively easier for solution mining compared with

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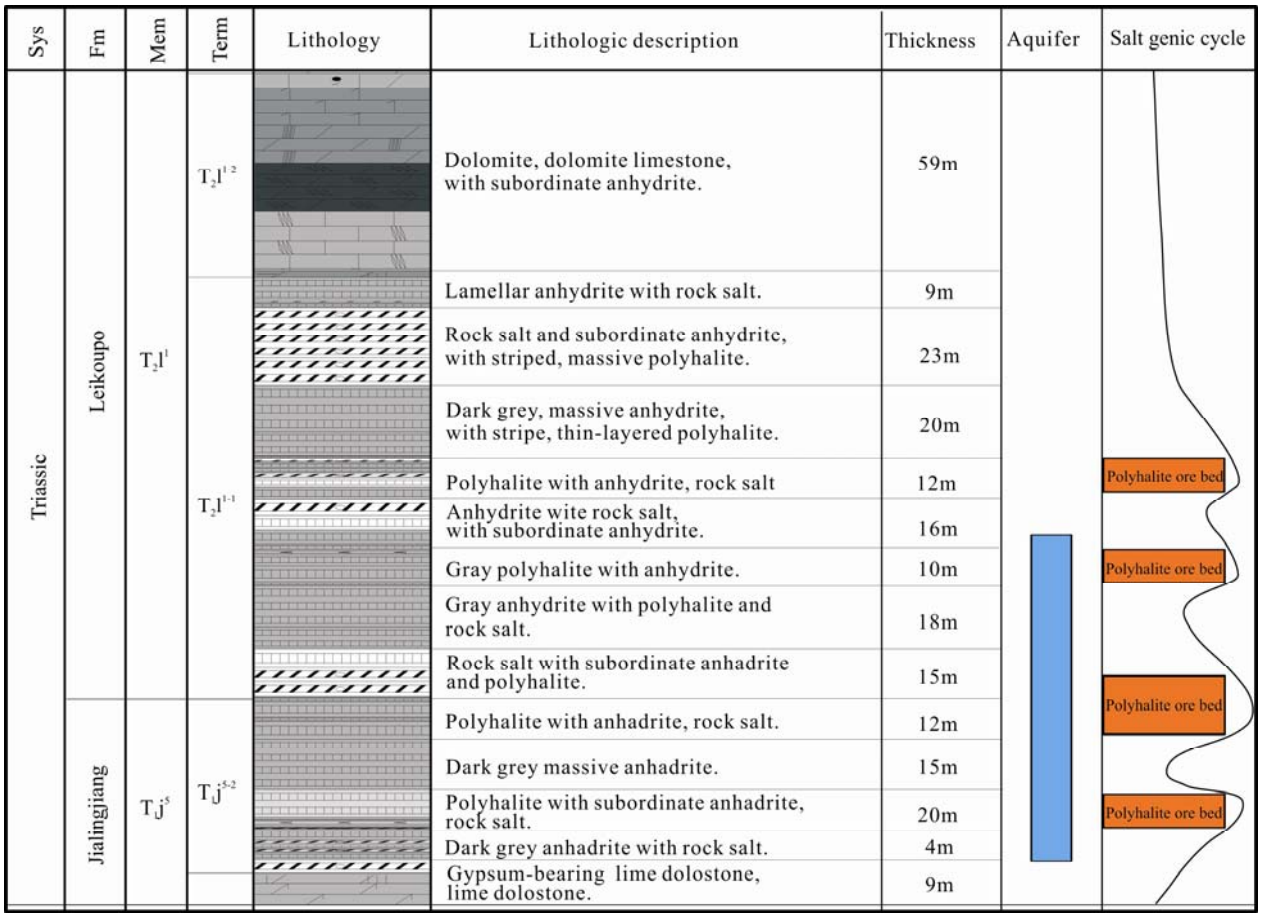


Fig. 1. The borehole log of saliferous strata and divides of salification cycles.

thick layers of polyhalite co-occur with anhydrite. Furthermore, our work indicates wide distribution of this type polyhalite beds, which has instructive meaning to achieve a breakthrough in the prospecting of polyhalite type potash beds in the Sichuan Basin (Wang and Zheng, 2014).

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**Appendix 1 Drilling lithium concentration and ratio of magnesium to lithium with the domestic main salt lake brines**

| | $Li^+$ (mg/L) | LiCl (mg/L) | $Mg^{2+}$ (mg/L) | $Mg^{2+}/Li^+$ |
|---|---|---|---|---|
| Yiliping | 262 | 1812.2 | 24181 | 92 |
| East Taijinaier | 141 | 975.3 | 5686 | 40 |
| West Taijinaier | 202 | 1397.2 | 13650 | 68 |
| Lake Se Nie | 15.8 | 109.3 | 28667 | 1814 |
| Zabuye | 879 | 6079.8 | 21 | 0.02 |
| Northeast Sichuan | 240.1 | 1660.7 | 1015 | 4 |