

## **Multiple fluid sources in skarn systems: Oxygen isotopic evidence from the Haobugao Zn-Fe-Sn deposit in the southern Great Xing'an Range, NE China**

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### **ABSTRACT**

Diverse fluid sources and complex fluid flow paths in skarn systems appear to be well documented. Nevertheless, in situ microanalysis of oxygen isotopes by secondary ion microprobe (SIMS) in skarn minerals can provide further high spatial resolution information on this complexity and the formation of skarns and associated ore deposits. In this study, we investigated the Haobugao skarn Zn-Fe-Sn deposit (0.36 M tonnes Zn) in the southern Great Xing'an Range, northeast (NE) China, and the associated Early Cretaceous Wulanba biotite granite. Based on drill hole logging, four early skarn phases are recognized: proximal red-brown garnet-hedenbergite exoskarn, central green garnet exoskarn, light brown garnet-diopside exoskarn, and distal pyroxene skarn. Oxygen isotope analyses of garnet, pyroxene, and other minerals from skarn, oxide, and quartz-sulfide stages were carried out using SIMS to determine the origin and evolution of the skarn-forming hydrothermal system. Garnet from exoskarn has a much wider range in  $\delta^{18}\text{O}_{\text{VSMOW}}$ , between  $-8.1$  and  $+6.0\%$ , than other stages and minerals. The estimated  $\delta^{18}\text{O}$  values of fluids in equilibrium with the Haobugao skarn vary widely from  $-5.1\%$  to  $+8.9\%$ , suggesting that the skarn formed via episodic flux of magmatic fluid and meteoric water. Low  $\delta^{18}\text{O}$  values of cassiterite and quartz from quartz-sulfide stage rocks are  $+1.2$  to  $+3.6\%$ , and  $+5.7$  to  $+5.9\%$ , respectively, indicating significant contributions of meteoric water during deposition of Pb-Zn sulphides. Therefore, meteoric fluids were periodically present throughout most of the stages of skarn formation at Haobugao.

**Keywords:** Oxygen isotopes, skarn, meteoric water, magmatic fluid, fluid source, Haobugao