

Trace elements in sulfides from the Maozu Pb-Zn deposit, Yunnan Province, China: Implications for trace-element incorporation mechanisms and ore genesis

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ABSTRACT

The Sichuan-Yunnan-Guizhou Pb-Zn metallogenic province (SYGMP) is an important region for Pb-Zn resources in China. However, considerable controversy remains as to whether the Pb-Zn deposits are Mississippi Valley Type (MVT). The Maozu deposit, a typical example of the carbonate-hosted Pb-Zn deposits in the SYGMP, occurs in the late Ediacaran Dengying Formation and its ore bodies are divided into three types: lower layer (LL), vein layer (VL), and upper layer (UL) ore bodies based on their spatial relationship. In this study, laser ablation–inductively coupled plasma–mass spectrometry (LA-ICP-MS) was used to systematically analyze the trace-element compositions of sphalerite and galena in these three ore bodies. The results show that sphalerite is characterized by Cd and Ge enrichment; Fe, Mn, and Co depletion; and local In and Sn enrichment. Most of these elements likely appear as solid solutions in sphalerite and show a wide compositional variation, which is probably related to the medium- and low-temperature mixing of the ore-forming fluids. The local enrichment of In and Sn is likely attributed to the long-distance migration of ore-forming fluids through In-Sn-bearing volcaniclastic rocks. In vs. Sn and (Cu + Sb) vs. (Ag + Ge) show strong correlations and similar element distribution in the mapped images, indicating that these elements may be incorporated into sphalerite via a coupled substitution for Zn as $2\text{In}^{3+} + \text{Sn}^{4+} + 2\Box \leftrightarrow 5\text{Zn}^{2+}$ (\Box = vacancies) and $4(\text{Cu}^{+} + \text{Sb}^{3+}) + (\text{Ge}^{4+} + 2\text{Ag}^{+}) + 2\Box \leftrightarrow 13\text{Zn}^{2+}$. Galena is enriched in Ag and Sb with minor Cd and Se and depleted in Bi, and most of the elements may occur as solid solutions. Ag vs. Sb in galena displays a strong positive correlation, implying the coupled substitution of $\text{Ag}^{+} + \text{Sb}^{3+} \leftrightarrow 2\text{Pb}^{2+}$. Notably, the majority of the trace-element concentrations gradually decrease in the order LL → UL except Fe, Co, Cu, and Ge, while Fe, In, and Sn in sphalerite and Ag and Sb in galena have the highest concentration in the VL, indicating that the VL is a secondary migration channel for the ore-forming fluids. Furthermore, the trace-element compositions of the sulfides in the Maozu Pb-Zn deposit are consistent with the typical MVT deposit (hosted in the carbonate sequence) but are markedly different from sedimentary exhalative (SEDEX), volcanogenic massive sulfide (VMS) and skarn-type deposits. Based on these results, as well as the geological and geochemical characteristics of the deposit, the Maozu Pb-Zn deposit is an MVT deposit.

Keywords: Maozu Pb-Zn deposit, sulfides, trace elements, LA-ICP-MS, mapping, MVT