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Research Progress of the Mineralization of Carbonate-Hosted Pb-Zn Deposits in the Sichuan-Yunnan-Guizhou Pb-Zn Metallogenic Province, Southwest China

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The Sichuan-Yunnan-Guizhou (SYG) Pb-Zn metallogenic province in the western Yangtze Block, is a key component of the low-temperature metallogenic domain in South China. In this area, more than 400 Pb-Zn deposits have been discovered, and the total proven reserves are up to 260 million tons with lead and zinc grade reaching 10%, even up to 30%. Another important aspect is that they are commonly associated a variety of other metals, such as Ge, Cd, Ga and Ag. The orebodies are hosted in the Sinian to Lower Permian carbonate rocks, and occur as veins, lentoid and bedding parallel layers. They show a significant control by the thrust-fold structure, and are spatially associated with the Emeishan basalts. Primary ores in these deposits are simply composed of sphalerite, galena, pyrite, calcite and dolomite with a small amount of fluorite, barite and quartz. It is thus indicated that these Pb-Zn deposits in the SYG province are of an epigenetic origin. They possess unique metallogenic setting, special ore-forming environments, and have undergone complicated ore-forming processes. Thus, there has long been considerable debate about the genesis of these deposits. This study analyzed the geological, geochemical and geochronological features of some typical deposits in the SYG province, and conducted mathematical simulation, supported by the National 973 project (No. 2014CB440905). The major progress are summarized as follows.

① Rb-Sr and Sm-Nd isotopic data indicate that the Pb-Zn mineralization in the SYG province occurred in the Late Triassic to Early Jurassic (226–192 Ma) with a peak age at ~200 Ma (Zhou et al., 2013a; 2013b; 2015). This time is significantly later than the Emeishan mantle plume activity (~260 Ma), and corresponds to the closure of the Paleo-Tethys Ocean. It is therefore suggested that the Pb-Zn metallogenic processes was under a compressional setting, which is in close agreement with the tectonic control of these deposits by the thrust-fold structures in the region.

② C-H-O-S and Sr-Nd-Pb isotope data demonstrate that the ore-forming elements and fluids were derived from mixed sources. They are mostly originated from the Emeishan basalt, sedimentary rocks and basement volcano-sedimentary low-grade metamorphic rocks (Zhou et al., 2014a; 2014b; 2015).

③ Thermodynamic simulation shows that the temperature was still high at 30 myr after the Emeishan mantle plume activity. This may contribute to the thermal driving of ore-forming fluids from the SYG Pb-Zn deposits (Xu et al., 2014). However, the Middle Permian flood basalts mainly acted as an impermeable layer for the Pb-Zn mineralization (Zhou et al., 2014b; 2015).

④ Variations of zinc isotopes in the carbonate-hosted Pb-Zn deposits have been reported. The Emeishan basalts have $\delta^{66}Zn_{JMC}$ values ranging from +0.30‰ to +0.44‰, and the $\delta^{66}Zn_{JMC}$ values of the Sinian to Lower Permian sedimentary rocks vary between −0.24‰ and +0.17‰, respectively. Sphalerite selected from the Shanshulin, Tianqiao, and Banbanqiao Pb-Zn deposits in the southeast SYG province have $\delta^{66}Zn_{JMC}$ values ranging from 0‰ to +0.55‰, −0.26‰ to +0.58‰ and +0.07‰ to +0.71‰ respectively, suggesting that the $\delta^{66}Zn_{JMC}$ values of sphalerite increased from the early to late mineralization stages (Zhou et al., 2014a; 2014b). Such a change indicates that the zinc isotope fractionation between crystalline phase and fluid phase may be due to dynamic Raleigh fractional crystallization, and that zinc isotopes

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can be used to trace the direction of ore-forming fluids (Zhou et al., 2014a; 2014b).

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