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The Mississippi Valley-type Lead-zinc Deposits along the Southwest Margin of the Yangtze Block, China

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The Mississippi Valley-type (MVT) lead–zinc deposits account for about 27% of the world's Zn+Pb resources (Paradis et al., 2006) and usually contain important by-product metals like Ag, Cd, Ga, and Ge. In the southwest margin of the Yangtze Block, the Sichuan–Yunnan–Guizhou (S–Y–G) triangle area has been famously known as the major base of Zn and Pb in China. Approximately 408 Zn–Pb deposits with >26 million tons of Zn+Pb had been reported in this Zn–Pb triangle (Liu and Lin, 1999). Although the magmatic–hydrothermal origin and syngenetic type (SEDEX) were proposed for these Zn–Pb deposits (Xie, 1963; Zhang, 1984; Li et al., 2004), the recent studies revealed that most of these Zn–Pb deposits had the common characteristics of the MVT deposits (Zhang, 2008; Wu et al., 2013). In present paper, we summarize the ore geology, geochemistry and ore-forming fluids of these Zn–Pb deposits. Moreover, the geodynamic setting of the Zn–Pb deposits is also discussed.

The Zn–Pb deposits are epigenetic and hosted by the carbonates that range in age from Sinian to Permian, while the dolostone of Sinian Formation and Early Carboniferous Formation are the two major ore-bearing rocks accounting for more than 60% of the Zn–Pb deposits and 70% of the Pb+Zn reserves (Wu et al., 2013). These deposits are significantly controlled by thrust-fold systems which are related to the regional compressive deformation (Liu and Lin, 1999). Moreover, the orebodies generally occur in the bedding-parallel fractures as the stratabound lenses or in high-angle thrust faults as the pipe-type. Sphalerite, galena and pyrite are the most abundant metallic minerals, whereas chalcopyrite is rare. Dolomite, calcite and quartz are the major gangue minerals, while fluorite, barite and bitumen occur in some deposits. The low-temperature hydrothermal alterations such as carbonatization, silicification and fluoritization are closely

associated with Zn–Pb mineralization. The sulfides of most MVT deposits have the large positive $\delta^{34}\text{S}$ values (+11 to +19‰), which indicates that the reduced S is probably derived from the thermochemical sulfate reduction (TSR) of seawater sulfates (Zhang, 2008). In addition, H_2S originated from biological sulfate reduction (BSR) and H_2S -bearing gas reservoir were employed to explain the sulfides with negative $\delta^{34}\text{S}$ values in the Wuyi MVT deposit and Chipu MVT deposit respectively (Guan and Li, 1999; Wu et al., 2013). The Pb–Sr isotopic studies suggested that basement rocks and sedimentary strata could be the two main metal sources for ore-forming (Zhang, 2008), while the erupted Permian Emeishan basalt may provide a part of Zn and Pb for mineralization in some deposits (Zhou et al., 2013). Most of the Zn–Pb deposits in this area formed from the mineralizing fluids with low-to-moderate temperatures (170 to 270 °C) and moderate salinity (8.0 to 17 wt% NaCl) (Zhang, 2008). The ore-forming fluids could be originated from the high-salinity basinal brines (evaporated seawater) and mixed with the oilfield water (Wu et al., 2013) or low-salinity meteoric fluid during the ore-forming stages (Li et al., 2002). Li et al. (2004) firstly used the Sm–Nd isotope dating of calcites from the Huize giant Zn–Pb deposit to successfully obtain the mineralization age of 222 ± 14 Ma. Then, several Late Triassic ages (~200 Ma) for the other MVT deposits in the S–Y–G Zn–Pb triangle were got by the Rb–Sr dating of sphalerites and Sm–Nd dating of hydrothermal calcites (Lin et al., 2010; Zhou et al., 2013; Wu et al., 2013). These data do not support the Emeishan mantle plume-related hypothesis for these Zn–Pb deposits but suggest the large-scale MVT mineralization could be attributed to the regional-scale migration of basinal fluids which is probably triggered by the late Indosinian orogeny in response to the closure of the Paleo-Tethys Ocean around the study area.

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