Lead isotope constraints on the affinities among four giant massive sulfide deposits from the Langshan-Zhaertai ore belt, northern China

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The Langshan-Zhaertai ore belt, northern China, hosts four representative sediment-hosted massive Zn-Pb(-Cu) deposits (Dongshengmiao, Tanyaokou, Jiashengpan and Huogeqi). These deposits are traditionally considered as formed as a result of ongoing hydrothrmal activity in the same marginal rift system, whereas recent geochronologic and Hf isotope studies suggest they may belong to different tectonic belts, resulting in the ambiguous relationships among themselves. Here we assess their sources of metal by analysis and comparsion of Pb isotope data, aiming to decipher their affinities. The Pb isotope signatures of above deposits are heterogeneous and do not lie along similar secondary or anomalous lead evolution lines, suggesting derivation of Pb from distinct reservoirs: (1) Massive ore sulfides at Dongshengmiao and Tanyaokou show very similar and exceedingly unradiogenic isotope compositions (DSM-TYK array) grouped around 15.2 ($^{206}Pb/^{204}Pb$), indicating that they were formed from a common mineralizing fluid. The general mantle affinity of these ore leads argues for deep-penetrative circulation of hydrothermal fluids and leaching of juvenile Pb from mafic igneous rocks in the Archean basement ($^{206}Pb/^{204}Pb$ = 14.2~15.3). (2) The Jiashengpan massive sulfides have higher $^{206}Pb/^{204}Pb$ ratios (~16.0) and steeper array than DSM-TYK array, suggesting mixing of much more radiogenic crust-soured leads. Meanwhile, age-corrected data of intercalated metavolcanic rock display apparent overlap and matching trend with the Jiashengpan array, thus it could be the less radiogenic end-member component. (3) Various sulfide minerals at Huogeqi have a very radiogenic lead signature ($^{206}Pb/^{204}Pb$>17.0) mainly consistent with associated Indosinian magmatic rocks ($^{206}Pb/^{204}Pb$~17.3). This characteristic indicates it of a volcanogenic origin, mimicking the Zhulazhaga Cu-Au deposits in the adjacent area and differing from other three giant massive Zn-Pb(-Cu) deposits in the Langshan-Zhaertai district.