ABSTRACT

Rajasthan hosts eighty-five percent of the Pb-Zn deposits of India. Silver is produced as a by-product from Pb-Zn smelting. The Sindesar Khurd deposit exhibits the highest silver content of all Pb-Zn deposits in Rajasthan. The other deposits of Rajasthan viz. Rampura Agucha and Rajpura-Dariba are known to have undergone melt-assisted remobilization of sulfide ores. As the Sindesar Khurd deposit lies six kilometers to the northeast of the Rajpura-Dariba deposit, similar ore remobilization processes may have been operated at Sindesar Khurd. In this study, samples of host rocks, country rocks, and ores were collected from Sindesar Khurd, to characterize the remobilization processes, if any, that may have been operative at Sindesar Khurd.

The near absence of pyrite at Sindesar Khurd differentiates it from Rajpura-Dariba which is pyrite dominant. Petrographic studies indicate that pyrite was transformed to pyrrhotite at Sindesar Khurd. Similar to Rajpura-Dariba, two ore and host assemblages are observed at Sindesar Khurd. The graphitic-mica-schist, which is the dominant host rock contains stratiform, deformed, and banded ores rich in sphalerite and pyrrhotite. In contrast, calc-silicate marbles contain veins of sphalerite and galena enriched in sulfosalts. The graphitic-mica-schist mainly comprises rutile- and ilmenite-bearing garnet-biotite-schist while the calc-silicate marbles are diopside and actinolite-bearing.

Galena from the vein ore assemblage contains exsolutions of Ag and Sb-rich sulfosalts. Ag concentration in galena varies between 200 and 6100 ppm. The sphalerite-galena-sphalerite interfacial angles are significantly lower than the value of 102°, typically seen when the minerals are in textural equilibrium in the solid state. This indicates that galena has crystallized from a melt phase. The ores show evidence of melt fractionation as sulfide, sulfosalt and alloy phases are observed to coexist. The sulfosalt phases consist of Ag-rich tetrahedrites, diaphorite, and freieslebenite. The alloy phases comprise dyscrasite, breithauptite, nisbite and other Sb-Ni phases.

Garnet porphyroblasts in the schists of Sindesar Khurd are spessartine-rich and exhibit characteristic textural sector zoning. These porphyroblasts also contain oriented rod- and needle-shaped inclusions of sulfides, quartz, apatite, and Mn-rich calcite. Electron backscatter diffraction analysis reveals that there is no misorientation between the garnet sectors which host mineral inclusions oriented in different directions. Analysis of adjacent carbonates and inclusions of Mn-rich calcite within garnet suggests that the garnet-in reaction might have involved calcite.

Application of garnet-biotite and Ti-in-biotite geothermometers and sphalerite geobarometer shows that the Sindesar Khurd deposit experienced metamorphic P-T conditions of 6 kbar and 590°C, similar to that of Rajpura-Dariba.

For understanding the temporal relationship of deposition and remobilization of ores in the Rajpura-Dariba-Bethumni belt, detrital zircon grains from metasediments of Sindesar Khurd were dated using U-Pb isotope system. The detrital zircon ages indicate deposition of the sediments at about 1.8 Ga and two later closely spaced tectono-thermal overprints at 1.7 and 1.6 Ga, which may have been responsible for sulfide partial melting and remobilization at Sindesar Khurd.

Keywords: sulfide partial melting; ore remobilization; garnet zoning; melt fractionation; detrital zircon geochronology