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Wüstite in a hydrothermal silver-lead-zinc vein, Lucky Friday mine, Coeur d'Alene mining district, U.S.A.

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Abstract

The Coeur d'Alene mining district of northern Idaho is one of the major Ag-Pb-Zn producers in the world; it contains Ag-Pb-Zn replacement veins in clastic burial metamorphic rocks of the Middle Proterozoic Belt Supergroup. Electron microprobe analyses and Raman spectroscopy of samples from the Gold Hunter vein of the Lucky Friday mine revealed the presence of the rare iron oxide wüstite ($Fe_{1-x}O$) coexisting with stable magnetite. An assemblage of galena, pyrite, and siderite is associated with the two iron oxides although these minerals do not share phase boundaries with wüstite and their coexistence is, therefore, thermodynamically precluded.

Wüstite is stable under high-temperature conditions (above 570 °C at 1 bar). Increasing pressure can lower this temperature significantly. However, the veins in the Coeur d'Alene district formed well outside the wüstite stability field and represent a low-temperature (250–350 °C), low-pressure (1–3 kbars), and low-f_{O_2} environment. To form wüstite at temperatures around 250–350 °C a pressure increase of at least 70 kbars would be required. This corresponds to burial of around 250 km, which is geologically unrealistic. Similarly, to form wüstite, the temperature must have exceeded 570 °C, which exceeds the maximum temperatures of vein formation by at least 200 °C. A temperature increase of that scale is not reflected in the mineral assemblage of the veins or the host rocks, which both contain siderite. We conclude that wüstite formed as a metastable phase at 250–350 °C and pressures below 100 bars because of the low-f_{O_2} conditions in the Coeur d'Alene district.

Keywords: Coeur d'Alene district, Belt Supergroup, Lucky Friday, Gold Hunter, Ag-Pb-Zn veins, magnetite, wüstite