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On the origin of sellaite (MgF_2)-rich deposits in Mg-poor environments

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Abstract

Sellaite (MgF_2) forms from melts, fluids, and gases under variable temperature, pressure, f_{O2}, and fluid salinity conditions. It is typically associated with, but much rarer, than fluorite (CaF_2). The Clara mine near Oberwolfach (Schwarzwald, Germany) is an extensive hydrothermal vein-type deposit, where sellaite occurs in huge quantities (thousands of tons) in veins of mostly Jurassic/Cretaceous age. The sellaite mineralization, occurring in gneisses altered prior to and during sellaite mineralization, represents a stockwork-like network of veins and fissures, which is overlain and sealed by sediments, preventing the inflow of and fluid-mixing with sedimentary formation waters. The occurrence of sellaite is unique among the more than 1000 hydrothermal vein-type occurrences of the Schwarzwald ore district. The favored formation of sellaite compared to fluorite requires the initial Ca/Mg-ratio of the mineralizing fluid to be unusually low. These conditions are possible if fluids equilibrate with pre-altered rocks that lost some or much of their Ca during an earlier hydrothermal alteration event. Indeed, calculations demonstrate that rock-buffered fluids of pre-altered rocks (i.e., gneiss around the Clara mine altered during prior hydrothermal events) show significantly lower Ca/Mg-ratios than fluids equilibrated with unaltered gneisses, because Ca-phases (e.g., the anorthite component of plagioclase) are more prone to hydrothermal destruction. Due to the network-like structure of the sellaite-bearing portion of the Clara fluorite vein, the fluid is shielded from sedimentary formation water, resulting in fractionation processes of the repeatedly ascending mineralizing fluid. In addition, fluid cooling and formation of water-bearing phases like illite that consume fluids, favor sellaite, and later fluorite precipitation. The rarity of this combination of prerequisites explains the limited occurrence of sellaite in hydrothermal vein-type deposits.

Keywords: Sellaite, Clara mine, Schwarzwald, hydrothermal vein-type mineralization, fluid inclusion thermometry, fluid conditions