

Mineralogical and Chemical Characterization of Permian Fluorite Deposits in Trentino-Alto Adige: Insights into Fluid Inclusions and Economic Potential

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In recent years, the growing demand for critical materials for the energy transition has led to a renewed interest in old mining sites, especially in Europe, where many have been exploited since ancient times. The Trentino-Alto Adige region (Italy) hosts over 200 abandoned mines, primarily with polymetallic veins containing fluorite, barite, quartz, and carbonate gangue, along with minor pegmatites and magnetite ore bodies.

One of the most scientifically interesting types of deposits are the fluorite veins. While absolute age determination has not been performed, geological evidences suggest that the mineralizing events can be related to two main magmatic phases. The Permian ore bodies are related to post-Variscan magmatism and are mainly hosted in the lower part of the Athesian Volcanic Group (e.g., Zaccon and Roncegno mines) or at the contact between the igneous rocks and the metamorphic basement (e.g., Vignola and Cinquevalli mines). The Triassic deposits, which could be related to the Predazzo magmatism, are represented by veins that cut through Ladinian dykes and are hosted in the upper part of the Athesian Volcanic Group (e.g., Prestavel mine).

This contribution presents new data on the Permian deposit of Vignola, hosted in the pre-Variscan metamorphic basement, which consists of four veins predominantly composed of fluorite, quartz, and sulfides. The presence of accessory REE minerals is noteworthy. The mineralization process occurred in three phases: the first phase was dominated by fluorite and quartz deposition, the second phase saw the precipitation of mainly sulfides and sulfosalts, and in the third phase, barite, a small amount of fluorite, and calcite formed. Fluorite primarily appears as green to light blue veins, often crystallized in cubes, and transparent, light pink occurrences have also been reported. Cathodoluminescence analysis shows complex crystallization patterns, which makes the definition of fluid inclusion assemblages and their analysis particularly challenging.

Bulk and in-situ data on REE and trace element distributions will be presented, which allow a better understanding of the complex crystallization history of the fluorite and of the economic potential of the deposit. The new data will be compared with existing data on coeval and Triassic fluorite-bearing deposits in the region.