The base metal sulfide and Ni-Co arsenide-bearing veins of Valsassina (Lombardy, Italy): a possible "five element vein-type" system?

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Valsassina (Lombardy, Northern Italy) represented a historically important mining district exploited since the Middle Ages for Fe, Pb, Cu, Ag and, in more recent times, barite extraction. This area is located in the Lombard southern Alps and it is characterized by the presence of metamorphic basement, by a major late-Variscan intrusive complex and by Carboniferous-Permian volcano-sedimentary cover units. These rocks host a pervasive system of poorly studied mineralized veins, in the past considered as directly related to the hydrothermal circuit of the Val Biandino intrusive complex.

Such veins are characterized by base metal (Pb, Zn, Cu, Fe) to complex polymetallic assemblages. None of these vein systems has been previously studied in detail, either for their geological setting, or for their mineralogical and geochemical features.

We investigated various vein deposits in terms of ore textures, mineral chemistry of sulfides and sulfosalts (EMPA-WDS and LA-ICP-MS analyses), stable isotopes (C and O) of carbonate gangue minerals, with the aim of obtaining clues about the conditions of deposition of these ore deposits.

Two different vein families can be recognized in Valsassina: NNW-SSE veins characterized by a complex polymetallic sulfide-sulfosalt assemblage, also with Ni-Co-Fe arsenides and other Ag-Bi-bearing minerals, and NE-SW veins with a simpler, base metal sulfide assemblage. In all the veins, gangue consists of variable amounts/fractions of quartz, siderite, dolomite and baryte.

The Ni-Co-bearing NNW-SSE veins show some distinctive features of the "five-element vein" type deposits, with the Ni-Co-Fe arsenide ore stage pre-dating a sulfide-tetrahedrite-dominated ore stage. LA-ICP-MS data on pyrite and sphalerite and stable isotopes (C and O) of the carbonate gangue minerals do not show clear differences between the two veins families, which are likely genetically linked. The isotopic compositions of the Valsassina vein carbonates are closely comparable with the signature of several major Five-element ore districts. Hence the mineralizing fluids could have been saline and mineral deposition might have been controlled by some reducing agents, either in the fluids (e.g., interaction with hydrocarbon components) or in the host rocks. In absence of fluid inclusion analyses, preliminary temperature estimates for the Valsassina vein systems were based on the sphalerite composition, applying the GIMFis geothermometer of Frenzel et al. (2016). The estimated temperatures for the sulfide-tetrahedrite-dominated ore stage range between 100 and 250°C.

The crosscutting relationships observed for all the veins with the host rocks, along with the results of recent and on-going studies on the pre-Alpine structural evolution of this sector of the Southern Alps, suggest a possible late Permian age, making these vein systems comparable with other late-post Variscan, polyphase hydrothermal events affecting large sectors of the Southern Alpine domain.

Frenzel M., Tamino H. & Gutzmer J. (2016) - Gallium, germanium, indium, and other trace and minor elements in sphalerite as a function of deposit type — A meta-analysis. Ore Geology Reviews, 76, 52-78. https://doi.org/10.1016/j.oregeorev.2015.12.017.