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New geochronological and thermobarometric data for revisiting Alpine Pb-Ag ore deposit genesis (Macôt-La Plagne and Peisey-Nancroix)

MR. MAXIME BERTAUTS[1], EMILIE JANOTS[2], MAGALI ROSSI[3], ISABELLE DUHAMEL-ACHIN[4], PHILIPPE LACH[4], BLANDINE GOURCEROL[4] AND VALERIE MAGNIN[5]

[1]ISTerre, Université Grenoble Alpes
[2]ISTerre-UGA
[3]EDYTEM, Université Savoie Mont-Blanc
[4]BRGM
[5]ISTerre, University Grenoble Alpes

Presenting Author: maxime.bertauts@univ-grenoble-alpes.fr

The Pb-Zn-Ag occurrences are the most abundant polymetallic mineralization-type in the Northern French Alps. Ore genetic model and metal sources in these deposits are still controversial and remain unclear, mainly due to the lack of reliable geochronologic, thermobarometric and mineralizing fluid data in the complex Alpine tectonic setting. In the external Briançonnais zone of the internal Alps, the two deposits of Macôt-La Plagne and Peisey-Nancroix were the most productive during the 19th and 20th centuries. Ore bodies are mainly represented by deformed discontinuous stratiform lodes and lenses dominated by massive galena and minor (Ag)-tetrahedrite, within Permo-Triassic schists and quartzite. Both deposits are part of a syncline structure within a complex tectonic zone characterized by major thrusts and related faults. In this study, new thermobarometric and geochronological data were obtained using modern in-situ analytical techniques to unravel the complexity of this open and multi-stage environments.

Two stages of sulfide precipitations were determined from detailed paragenetic sequences using SEM. Accordingly, elemental mapping of chlorite and phengite obtained by EPMA and treated using XMap Tools 3.4 presents a compositional zoning coherent with two successive crystallisalisation stages. Chlorite thermometry combined with phengite barometry indicate a significant pressure increase between the two mineralization episodes from 4.5-6.5 kbar to 7-9 kbar at around 340°C. Hydrothermal monazite and sulfides are syngenetic, with intergrowths and similar microinclusions of phengite, quartz and florencite (REE aluminophosphate). Monazite compositions by EPMA indicate: (i) high concentrations of non-radiogenic Pb (ii) high U content (1.2 wt%UO2) and (iii) exceptionally high Eu content (>5 wt%) in the core of Peisey-Nancroix monazite. This high Eu reflects Eu-enrichment in the mineralization fluid independently indicated by whole-rock composition. I*n-situ* U-Pb monazite dating using LA-ICP-MS proves to be a reliable geochronometer despite of high Pb common contribution and two-stages mineralization. The U-Pb datasets align well in Tera-Wasserburg diagrams to yield singles ages of 34.9±0.5 Ma (n=38, MSWD=2.1) for Peisey-Nancroix and 33.1±3.25 Ma (n=17, MSWD=1.3) for Macôt-La Plagne. Thermobarometric and geochronological data indicate coeval mineralization for the two Pb-Zn-Ag ores during Alpine accretionary processes and collisional thrust wedges associated with the Penninic front and sedimentary rocks nappe stacking.