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New geochemical constraints on the multiphase ore formation in veins of the Armanis polymetallic deposit, Lori province, Armenia

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The Armanis polymetalic deposit (Cu, Zn, Pb, ±Ag, ±Au) is located in the Lesser Caucasus, which forms parts of the central segment of the Tethyan metallogenic belt. This segment is a prospective region, primarily for Cu-Mo-porphyry and epithermal Au and base metal deposits, with subsidiary VMS deposits associated with Jurassic island-arc and Cenozoic subduction and post-collisional magmatism. The Armanis deposit is situated in north-central Armenia and is spatially associated with the Amasia-Sevan-Akera ophiolite belt. The deposit consists of SW-NE and SE-NW trending, steeply dipping ore veins hosted in andesitic to tuffitic rocks, structurally controlled by strike-slip and thrust faults. Quartz is the main gangue mineral, with basaltic sills locally overprinting vein geometry, emphasizing the importance of geochemistry to decipher the ore-forming event. Armanis exhibits three ore types: (1) Cu-Fe, ±Zn, ±Pb, ±Ag assemblages with chalcopyrite and pyrite, plus minor sphalerite, galena, and acanthite. Pyrite shows idio- to hypidiomorphic crystals with sizes up to 1000 µm, whereas chalcopyrite exhibits predominantly more massive textures. (2) Fe-Zn ±Pb veins dominated by pyrite of the same size as in (1) and finer-grained vesicular sphalerite. (3) base metal-rich Cu-Zn ±Pb veins also with massive chalcopyrite and large (up to 2000 µm) sphalerite crystals. All stages contain small idio- to xenomorphic galena crystals with decreasing amounts from type (1) to type (3). Microprobe data already suggested a declining temperature regime from ore type (1) to (3), e.g. evidenced by high Co, Ni, Cu values and low Au, Ag values in pyrite (1) and vise-versa in pyrite (2) or high Se contents in chalcopyrite in (1) pointing towards higher temperatures compared to higher Au and Te in (3) which are commonly found in a more distal and colder regime. However, to understand the multiple mineralization phases, we used LA-ICP-MS analyses, which provide more detailed insights into element distribution. Spot analysis of all relevant ore minerals and elemental distribution maps reveal trace element contents and patterns that have helped to trace fluid evolution and overprinting events, contributing to establishing the link between ore deposition and the multiphase-hydrothermal processes.