Gold, Alteration and Sources of Sulfur: Insight from the world-class Bardoc Shear Zone

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Lithogeochemistry, mapping mineral zonation patterns and multiple S-isotope analysis were used to determine a new crustal architecture and a source of sulfur for the Zoroastrian gold deposit. The host-rock dolerite is separated into four groups (Low Ti-Th, Low-Th/High-Ti, Low Ti-Zr and Int.-Th/High-Zr) indicating different degrees of fractionation [1]. Dolerites of the Low-Th/High-Ti and Int.-Th/High-Zr groups are fractionated and commonly associated with high-grade Au zones. In the dolerite host-rock, a Ti-phase mineral zonation pattern is present with titanite in least altered wall-rocks, and ilmenite and rutile close to, or in high-grade gold zones. It is interpreted to be related to CO_2-rich fluids that can convert titanite to ilmenite and rutile [2]. Multiple S-isotope analysis yield four different populations: arsenopyrite (-1.84 to +0.28‰ δ^{34}S, +0.66 to +1.26‰ Δ^{33}S), pyrite (-0.2‰ δ^{34}, +0.14‰ Δ^{33}S), pyrrhotite1 (+1.23 to +1.5‰ δ^{34}, +0.2 to +0.39‰ Δ^{33}S) and pyrrhotite2 (+3.27 to +4.1‰ δ^{34}, +0.82 to +0.99‰ Δ^{33}S). The arsenopyrite population is paragenetically related to Au mineralization and shows MIF S (Δ^{33}S >0.2‰) [4]. Its signature could be explained by sedimentary S_8 deposited in shallow marine environments, mixed with S from magmatic or metamorphic fluids with no MIF [3, 4]. The pyrrhotite2 shows MIF S with the source of S likely to be shale underlying the dolerite host-rock [4]. The pyrite analysis shows MDF S, thus, a deeper mantle source seems likely, whereas the pyrrhotite1 population has positive δ^{34}S and slightly positive Δ^{33}S, explained by a deep mantle source mixed with a small amount of shallow MIF sulfur [3, 4].

[1] Barnes *et al.* (2012) *Aust J Earth Sci* **59**, 707-735. [2] Hunt & Kerrich (1977*) Geochim Cosmochim Ac* **412***,* 279-288. [3] Xue *et al*. (2013) *Geology* **41**, 791-794. [4] Farquhar & Wing (2003) *Earth Planet Sc Lett* **213**, 1-13