Abstract

Ada Tepe is a low-sulfidation epithermal gold deposit located in the Krumovgrad district of the Eastern Rhodopes, southern Bulgaria. In 2000, the Dundee Precious Metals company acquired the license area and the exploitation started in February 2019. The resources calculated are of 6.9 Mt at 3.86 g/t Au and 2.15 g/t Ag (Dundee Precious Metals Inc., Technical report R135.2014; 2017). Locally, gold reaches bonanza grades.

The Rhodopes tectonic zone belongs to the Eurasian plate within the Aegan region. It is part of the Alpine-Himalayan orogenic belt. The lower Eocene - Miocene syn/post-orogenic stage of extension was initiated by low-angle detachment faulting. The Ada Tepe deposit is hosted by sedimentary rocks (Shavar Formation) in a half-graben associated with a metamorphic dome (Kessebir-Kardamos dome) formed during the extension.

As a first observation, the gold precipitates only in the veins. The gangue mineralization has been dated at 35.36±0.21 to 34.71±0.16 m.y. (Ar-Ar on hydrothermal adularia; Márton et al., 2010). It shows a multiphase history of formation with several breccia and vein-forming events resulting in complex overprinting infill stages and cross-cutting relationships between the veins.

Like in other epithermal deposits, the gold is typically restricted to very narrow bands in the veins corresponding to one event which displays a particular mineral assemblage with specific textural features.

During this research project, thirty-three samples coming from four drill holes, and seventeen surface samples were investigated. Three types of veins have been structurally defined: a sub-horizontal, a sub-vertical and a 60° dipping vein. The study was focus on: i) the relative timing of the gold precipitation in the veins; ii) the mineral associations of gold, and iii) the quantitative mineralogy of the veins, in order to establish the vein stratigraphy and study the major controls on gold precipitation. Various analytical techniques have been used: detailed petrography combining structural and vein density study, optical and cathodoluminescence (CL and SEM) microscopy, Qemscan analysis, portable XRF, electron microprobe and LA-ICP-MS. The similarities and the differences between the sub-vertical and the sub-horizontal veins and their mineral assemblage associated with gold were characterized. Ore-forming fluid properties (P-T-X) were studied through fluid inclusions analysis (microthermometry and LA-ICP-MS of individual fluid inclusions).

The structural study implies that the three types of veins could have occurred under similar tectonic conditions. Indeed, their gangue mineralogy is similar, consisting mainly of carbonate, silica, adularia, and minor kaolinite, pyrite, chalcopyrite, and marcasite. Gold seems to occur as native gold and electrum. Other gold-bearing mineral

phases have not been identified in this study. The sub-horizontal and sub-vertical veins display quasi the same textures but with different abundance. All veins show boiling textures (bladed calcite, abundant adularia), but in the sub-horizontal veins these textures are much more common. So, it has been assumed that the four horizons that have been delineated by vein density distribution in the drill holes represent four boiling horizons. The shift of the horizons could be explained by silicification of the host rock or differences in permeability of the different lithologies. Another difference between the veins studied concerns the adularia composition - adularia is depleted in REEs in the sub-horizontal veins. The chemo-stratigraphy of the veins, based on pXRF analyses and LA-ICP-MS of gangue minerals highlights that their element concentration does not vary dramatically through time but presents periodicity every 10-20 mm (2-3 bands) alternating the precipitation of carbonate and silica. The characterization of a clear chemical signal associated with gold presence was not observed. However, gold precipitation seems to be mostly related to an increase in Sr and K. The element Sr is associated to boiling texture such as bladed calcite and in less concentration adularia. Potassium (K) is only relative to the K-feldspars.

Gold has also been detected by LA-ICP-MS in hydrothermal breccia that occur at the end of the formation of the main mineralized vein. These hydrothermal breccias are composed of clasts coming from veins and from the host rock. It could be possible that when the hydrothermal breccias cross-cutted the main mineralized veins, they carry away some pieces and re-mobilized the gold.

Finally, the ore-forming fluid was of low-salinity (0 to 1wt. % NaCl equivalent) and a moderate temperature of entrapment (160° to 289 °C) which infer a paleodepth of entrapment of about 280 m (sample from present day surface outcrop) at pressure of about 30 bars.

Key words: Ada Tepe, epithermal deposit, gold, vein, texture.