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Gold grade distribution within an epithermal quartz vein system, Kestanelik, NW Turkey: implications for gold exploration

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Vein-hosted gold deposits contribute a large part to the global gold production. Discovery of these deposits mainly include drilling of hundreds of holes, collecting thousands of soil and rock samples and some geophysical surveys which are expensive and time consuming. Understanding the structures hosting the veins and the variations in gold concentrations within the veins is crucial to constrain a more economic exploration program.
The main aim of this study is to investigate the gold grade distribution in the mineralized quartz veins of a well exposed epithermal gold deposit hosted by Paleozoic schist and Eocene quartz-feldspar-hornblende porphyry in Lapseki, NW Turkey. We have constructed 3D architecture of the vein surfaces by mapping their outcrop geometries using a highly sensitive Trimble GPS, collecting detailed field data, well-logs and geochemistry data from 396 drill holes (255 diamond cut and 141 reverse circulation holes). Modelling was performed in MOVE Structural Modelling and Analysis software granted by Midland Valley's Academic Software Initiative, and GIS application softwares Global Mapper and Esri-ArcGIS.
We envisaged that while fluid entering the conduit ascents, a sudden thickness increase in the conduit would lead to a drop in the fluid pressure causing boiling (the most dominant gold precipitation mechanism) and associated gold precipitation. Regression analysis was performed between the orthogonal thickness values and gold grades of each vein, and statistical analyses were performed to see if the gold is concentrated at specific structural positions along dip. Gold grades in the alteration zones were compared to those in the adjacent veins to understand the degree of mineralization in alteration zones. A possible correlation was also examined between the host rock type and the gold grades in the veins. These studies indicated that gold grades are elevated in the adjacent alteration zones where high gold grades exist in the veins. Schist-hosted veins host the majority of gold mineralization (94.39%). While there is almost no correlation between the true vein thickness and the gold grade, 77.65% of high gold grades are located where the veins bend along dip. These results suggest that multiple gold precipitation mechanisms may have been active and boiling mechanism responsible for gold precipitation along the structural pathways was more effective than possible fluid-rock interaction or throttling mechanisms which will precipitate gold at adjacent alteration zones around the pathways at Kestanelik. In addition, specific structural locations such as vein bends are favorable for gold precipitation.
This study emphasizes that structural architecture of the veins is one of the key controls on the location of high gold grades. In addition, adding structural data collection and mapping specific structural locations such as bends to the exploration program could permit the key locations of high gold grade to be identified faster, and to focus further drilling and assays.