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Permeability enhancement during gold mineralization: Evidences from Kestanelik epithermal vein system, NW Turkey

Nilay Gulyuz (1,2), Zoe Shipton (1), Ilkay Kuscu (3), Richard A. Lord (1), David R. Gladwell (4), and Nuretdin Kaymakci (5)

(1) Department of Civil and Environmental Engineering, University of Strathclyde, Glasgow, UK (nilay.gulyuz@strath.ac.uk), (2) Department of Geological Engineering, Yuzuncu Yil University, Van, Turkey , (3) Department of Geological Engineering, Mugla Sitki Kocman University, Mugla, Turkey , (4) Geochemico Consulting Inc., Canada, (5) Department of Geological Engineering, Middle East Technical University, Ankara, Turkey

The most favourable and principal mineral deposition mechanism in low sulphidation epithermal systems is boiling. Mineralization in these systems occurs dominantly as veins and stockworks; therefore, structures play major role in the localization of epithermal fluid flow. Epithermal fluids rise from depth along structural conduits at high temperatures under enough pressure to prevent boiling. When the pressure drops suddenly (for instance, through faulting or any fracturing), boiling occurs, and CO_2 and H2S are released to the vapour phase. Change in fluid chemistry due to the boiling causes first the base metals, and then the ore and gangue minerals to deposit in a well-recognized temporal and vertical sequence until all open spaces are filled. Vein infill in epithermal deposits indicate that mineralization is multiphase and associated with repeated and episodic fluid flow rather than a steady-state process. How can permeability enhancement be achieved after deposition of minerals in fractures and faults chokes permeable pathways and restrict fluid flow? Although geochemical aspects of LS epithermal systems are well known, limited studies exist on the permeability enhancement mechanisms in LS epithermal veins.

The main aim of the study is to understand the permeability enhancement mechanisms in epithermal gold deposits by focussing on the structures and quartz textures of a well-preserved low sulphidation epithermal quartz vein/breccia system in Lapseki, NW Turkey. We revealed the kinematics of the structure-vein network by mapping the geometries of epithermal quartz veins and associated structures and collecting detailed structural data from them. In addition, we determined the different phases of fluid flow and mineralization with the cross-cutting and structural relationships among them by examining the quartz textures and breccias and mapping their spatial distribution on vein outcrops and in drill cores with the help of thin section analyses. On-going work aims to construct the 3D geometry of the major veins to see how the geometries of the veins relate to host rocks and gold grades and to help understand the structural controls on the vein emplacement and the likely evolution of the vein system.

Our results suggest that after sealing of the veins due to the previous mineralization phases, permeability was created by earthquake rupturing event due to horizontal NE-SW-oriented compression dominant in the area during epithermal mineralization. Structures hosting the mineralized veins should have been activated along the vein-host rock contact in this compressional regime; E-W-oriented veins were opened as left lateral strike slip fault, N-S-oriented vein was opened as right lateral strike slip fault and NE-SW-oriented veins were opened as extensional fracture. Two phases of fluid flow and associated mineralization were picked up from E-W-oriented veins while four were determined from more dilatational NE-SW veins.

This study emphasizes the importance of understanding the structural controls on the multi-event history of vein emplacement for gold exploration on the mine and regional scales. In addition, the results will shed light on the behaviour of hydrothermal fluids at high crustal levels.