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Emplacement of silica veins at a brittle shear zone in the Ahar region, NW Iran: insights from structural analysis, analogue and numerical modeling

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Abstract

Post Eocene silica vein emplacement at a brittle shear zone in NW Iran is associated with Au, Cu and Mo mineralization. The orientation and abundance of veins are dominantly controlled by the fault and fracture pattern. Within this context, we have analyze the spatial and geometrical properties of the faults and fractures affecting vein emplacement and compare the results with analogue and numerical models to distinguish the proper area for the emplacement of ore bearing silica veins in the evolution of a brittle shear zone. For this purpose regional lineament trends have been extracted from Aster satellite image. The trends of this lineament are between N80˚W to N60˚W. Field observations revealed two dominant fracture sets with strike of N40˚E and N20˚W; as well as the silica veins general trend is N15˚W. The brittle shear zone analogue model indicated that the first structure to appear in the D1 stage of deformation were the shear fracture. With the progress of deformation in D2 stage, shear fractures eventually grew, rotated and were connected to each other, which created surface ruptures in the models. The main surface rupture displays a misalignment with the basement shear zone. In the D3 stage, fractures rotated with increasing displacement along the strike slip faults. The numerical stress analysis model shows that in the D1 stage, compressive stress is localized in the central part of the shear zone, and the rupture developed. In D2 stage, stress in the central part significantly decreased from 0.14 to 0.09 MPa (67% of maximum value) and an extensional regime was dominant. In the D3 stage, the tips of the model were primarily influenced by extensional stress, whereas the central part was subdivided into two zones: one is high stress and compressive and the other is low stress and extensional. Shearing along strike slip faults led to subsequent deformation in D4. Our modeling data indicate that heterogonous stress distribution along the shear zone instigated the frequent inversion of the extensional basins to compressional and vice versa. The D2 stage of evolution of the shear zone was favorable time for the emplacement of ore bearing veins, because of open fractures and the prevailing extensional regime in the central part. Thus the young shear zone open fractures of the central part and the mature shear zone tension fractures in the tips are appropriate areas for emplacement of veins.

Key Words: brittle shear zone**,** Analogue model, numerical model, vein emplacement, shear fracture, NW Iran

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