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Integrating AMS, rock mechanics, vein statistics and numerical modeling results to understand fluid flow and gold mineralization in Dharwar Craton (South India)

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It is well established that remobilized metamorphic fluid is the source of different mineral deposits (e.g. gold). Also, it is known that fluid flow and deposition of metamorphic fluid is governed by regional stress field, state of stress and variation in rock mechanical strength. In the present study relationship between fluid flow, rock mechanical strength, variation of state of stress and gold mineralization is evaluated in rocks of the Gadag region (Dharwar Craton, South India). This is achieved by integrating anisotropy of magnetic susceptibility (AMS) and rock mechanics tests of host rock (metabasalt), statistical analysis of quartz veins, and numerical modeling. Gadag region in Dharwar Craton is a well-known province of gold mineralization, where gold occurs in quartz lodes having dominantly NW-SE orientation. Host rocks are mainly massive metabasalt and gold deposition is known to have occurred during D3 deformation at ca. 2.5 Ga. For the present investigation (a) rock samples from mineralized zone have been collected for AMS and rock mechanical strength tests viz. ultrasonic P-wave velocity (Vp), uniaxial compressive strength (UCS) and point load strength (Is(50) (b) five transects each from mineralized and non-mineralized zone have been considered for statistical and palaeostress analysis and (c) numerical modeling is carried out to understand variation in regional stress field. Rock mechanics tests demonstrate that the metabasalt has strength anisotropy. The metabasalts are weaker along magnetic fabric (NW-SE direction). It is inferred that rocks dilate in this orientation to accommodate fluid during D3 deformation (NW-SE compression). Statistical analysis of vein orientations, paleostress and vein intensities in the mineralized and non-mineralized zones of Gadag region is carried out. Relatively higher vein intensity and evidence of high fluid pressure fluctuation from palaeostress analysis confirm massive fluid influx in the mineralized zone. Vein thickness data are used to determine Weibull modulus (k), which is representative measure of tensile strength of the host rock metabasalt. Value of k is less in the mineralized zone, as compared to the non-mineralized zone. This implies that the tensile strength of the host rock in mineralized zone is lower than the non-mineralized domain.. Numerical modeling (FEM) is done to highlight the role of Mulgund Granite in strain partitioning and its importance in channelizing fluid and gold deposition.