Role of pre-existing fabric in abetting fracture formation, fluid flow and vein emplacement in the metavolcanics: a domain for shallow crustal gold mineralization in the Archean greenstone belt, India

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Archean greenstone belts gained prominence for its gold mineralization. Gold bearing vein infillings within fracture systems are significant for its economic utility. Fracture formation is often associated with reactivation of the pre-existing host rock fabric under a compatible stress field. Upper crustal fluids are mostly channelized through these fracture systems under variable fluid pressure conditions generating a widespread network of veins. A wide range of vein infilled crosscutting fractures of variable thicknesses, are investigated from the gold-bearing massive metabasalts (supracrustals) of the Chitradurga Schist Belt (CSB) adjacent to the Chitradurga Shear Zone (CSZ), Western Dharwar Craton, southern India. Anisotropy of magnetic susceptibility (AMS) studies are adopted for determining the internal anisotropy of the apparently massive metabasalt hosts. The study involves tensile strength determination of the metabasalts, deciphering the paleostress condition using fault-slip analysis and propensity of fracture/fault reactivation under the prevailing stress field. Parameters like stress ratio ($\phi$) and driving pressure ratio ($R'$) are evaluated for understanding the conditions of fluid induced fracture opening/reactivation. Change in the opening angle ($\mu$) of fractures with fluid pressure ($P_f$) variation, $\phi$ and $R'$ variations with the range of fracture orientations are also ventured upon.

We conclude ~NW-SE oriented (mean 337°/69° NE) magnetic fabric in the metabasalts are a product of regional D1/D2 deformation on an account of NE–SW shortening. This was followed by the D3 deformation with NW–SE to E–W shortening that led to the sinistral movement along CSZ. Thus, prominent fracture orientations representing riedel shear components were formed as a consequence of this sinistral shearing. Under compatible fluid pressure conditions, all such cohesionless pre-existing pathways were reactivated. Schematic models help to understand the mechanism of vein emplacement under episodic fluid pressure fluctuations from high to low $P_f$ at shallow crustal depth (~2.4 km). With respect to the prevailing stress field, fracture orientations coinciding with the host rock fabric show higher values of slip/dilatation tendencies justifying maximum vein thickness along this orientation. Multiple methods were integrated to develop a better understanding of the fracture networking system, channelizing fluids and assisting gold mineralization in the greenstone belt.