Nature and Source of Ore-Forming Fluid at Gadag Gold Field, Dharwar Craton, India

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We investigated the gold-forming processes at Gadag gold field (GGF) from the Gadag greenstone belt in India by integrating fluid inclusions, stable isotopes (S and C), and tourmaline chemistry. GGF has three auriferous lode systems with distinct lithology, namely western lode (WL): metabasalt-hosted; central lode (CL): argillite- and/or metabasalt-hosted; and eastern lode (EL): BIF-hosted. Three generations of carbonates were identified based on their individual textures and deformation fabrics in the mineralized zones. The third-generation vein carbonates are associated with progressive dextral shearing and major gold mineralization. Detailed fluid inclusion (FI) study of mineralized quartz-carbonate veins from both of the lodes reveals low- to medium-saline (WL: 1.8 to 9.6; CL: 0.04 to 7.8 wt% NaCl eq.) H_2O-NaCl-CO_2 ± CH_4 primary fluid, except for a few inclusions with relatively higher salinity in the western lode (20.1 to 21.8 wt% NaCl eq.), and fluid immiscibility. Estimated P-T conditions of alteration and mineralization (1.6-2.9 kbar; 296°-333°C), by combining the FI and chlorite and arsenopyrite thermometry, reflect greenschist facies conditions at GGF. Tourmalines, closely associated with sulfides in the alteration zones, belong to the dravite or oxy-dravite group with low to medium Na (avg: 0.68 apfu) and low Fe^{3+}/Fe^{2+} ratio. Ore fluid $\delta^{34}S$ values deduced from sulfides in the mineralized zone lie between 1.0 and 3.4‰. Overlapping $\delta^{34}S$ values from the mineralized (1.5 to 4.5‰) and host-rock (–1.0 to 7.5‰) sulfides indicate desulfidation and/or dissolution of the early pyrite during continuous fluid flux along the shear zone. However, relatively depleted $\delta^{13}C_{fluid}$ values (−4.2 to 1.9‰) reflect the insignificant role of fluid mixing and source of carbon in ore fluid corresponding to decarbonation of the organic sedimentary sequences during metamorphism of the Gadag greenstone belt. Thus, a metamorphic fluid source is postulated for the origin of the auriferous ore fluid at GGF.