Iron-Oxide-Copper-Gold (IOCG) Type Hydrothermal-Alteration Recorded in the Lawa Gold Deposit: North Singhbhum Mobile Belt, Eastern India

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The Lawa gold deposit in the Proterozoic North Singhbhum Mobile Belt (NSMB) is the only active gold mine in eastern India. There, mineralization is confined to a ~1000 m-long, NW-SE-trending shear zone along the contact between ferruginous quartzite and phyllite of the ~1600 Ma Chandil Formation. A pervasive Fe-K-(Na-Ca) alteration assemblage, rather than discrete quart-veins, exerts primary control on mineralization. Stage-I alteration comprises albite + actinolite + pyrite-I + chalcopyrite ± magnetite and reflects infiltration of oxidized and acidic magmatic-hydrothermal fluids (>350°C). This is supported by Py-I geochemistry (Co/Ni = 1–1.5; mean Se ~300 ppm; below detection As) and in-situ $\delta^{34}S$ values of Py-I ranging from +1.0 ‰ to +6.6 ‰ (LA-QQQ-ICP-MS). These fluids induced extensive brecciation of the host lithology. Stilpnomelane + magnetite + chalcopyrite + carbonates ± native gold (Stage-II alteration) overprints the Stage-I assemblage and occupies pre-existing breccias. This Fe-K dominated assemblage and a lack of gold-sulfide association suggest transport of gold as $AuCl_2^-$ complexes. Fluid decompression along the preexisting breccias and H_2O-CO_2 unmixing raised fluid alkalinity and triggered native gold precipitation. Dolomite associated with native gold along brittle fractures and coeval stilpnomelane + magnetite (pH >7) supports this inference.

The Stage-III alteration comprises abundant pyrite-II + chlorite + hematite ± chalcopyrite indicative of increasing $a\sum S$. Gold, exclusively occurring as Pb-Bi-Te-Au polymetallic inclusions along pyrite-II rims reflects remobilization of the pre-existing native gold as $AuHS^-$ complexes. Subsequent mixing of this fluid with meteoric water led to an increase in fO_2 and consequent deposition of Pb-Bi-Te-Au polymetallic inclusions. This contention is supported by the variable Co/Ni ratios, mean Se ~550 ppm, mean As ~100 ppm in Py-II and progressively lighter $\delta^{34}S$ values (-4.0 ‰ to +6.5 ‰) relative to Py-I. We infer that the Lawa deposit likely represents a hitherto unknown IOCG-type mineralizing system in the NSMB.