

Gold Fertility of the Inner Lesser Himalayas: Insights from Textural and Mineralogical Investigation of Pyritiferous Mandhali Black Shales, Uttarakhand, India

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Pyritiferous black shales are known to host several world-class orogenic/sediment-hosted gold deposits. Several research articles have also discussed the importance of pyritiferous black shales as a suitable source rock for orogenic gold formation, such as in the Sukhoi log, Bendigo, and majority Phanerozoic orogenic gold deposits. Notwithstanding, the gold fertility of laterally extensive pyritiferous black shales along the inner Lesser Himalayas (Mandhali Formation) have been overlooked. To this end, Neoproterozoic black shales of the inner Lesser Himalayas have been investigated here. Textural analysis reveals the presence of syngenetic, diagenetic, and metamorphic/hydrothermal pyrite, along with gold, either occurring as native grains or as micro-inclusions in pyrite. The sub-microscopic as well as native gold grains occur in texturally late paragenetic positions, thereby indicating a post-depositional hydrothermal control on mineralization. While this may be a sub-economic mineralization, previous studies recognizes that a threshold whole-rock content of 5 ppb Au and 250 ppb Au in diagenetic pyrite qualify a black shale as a suitable source rock for orogenic gold formation. Our results reveal whole-rock Au concentrations ranging between 6 and 66 ppb and Au content in pyrite ranging up to 4,300 ppm (mean 2,300 ppm, EPMA X-ray mapping) with As enrichment in diagenetic pyrite and depletion in later hydrothermal/metamorphic pyrite.

Further, the studied black shales exhibit effects of lower-greenschist facies metamorphism, contact metasomatism due to spatially associated sills, mild deformation, and are structurally overlain, at least in the studied area, by impermeable quartzites of the Berinag thrust sheet, thus satisfying the prerequisites for orogenic/sediment-hosted gold mineralization. Our findings, thus provide a starting point for; (a) studying the hitherto-unknown black shale-hosted gold mineralization in the inner Lesser Himalayas, and (b) assess the gold fertility of the inner Lesser Himalayas in context of a carbonaceous sedimentary gold reservoir.