



Recurrent metalliferous fluid flow, Khetri Copper Belt, northern Rajasthan, NW India

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Proterozoic copper deposits in deformed sedimentary rocks present a challenging geologic environment for unraveling ore history. Typically, copper ores are broadly but not strictly stratabound and show deformed, less deformed and undeformed generations. A common observation is a late oxidation episode, unrelated to modern weathering, which affects primary sulfides. Thus, formation of Proterozoic copper deposits may span intervals of time within larger orogenic histories, with ores episodically upgraded or even downgraded by multiple generations of introduced fluids moving at regional scales.

U-Pb dating of standard minerals (monazite, titanite, zircon) in Proterozoic copper belts is challenging as the isotope systematics may respond unfavorably to post-depositional ingress of fluids. Re-Os dating, on the other hand, can be used to target specific generations of sulfide minerals, thereby directly dating fluid-flow events that move metals. Application of Re-Os dating in multiply-deformed Proterozoic terranes is not without challenge, however, especially when a record of oxidation is clearly visible in the ore-forming history. Utmost care in sampling within a well-defined paragenesis and regional geologic setting is essential.

Sulfide mineralization is well known from the Archean-Proterozoic Aravalli-Delhi fold belt in NW India. The northern Delhi fold belt contains the rich Khetri Cu belt, which is hosted in the Ajabgarh Group (quartz-biotite schists, retrograde chlorite-garnet-magnetite-hematite schists, banded amphibolite-quartzites, graphitic schists, calc-silicate units) within the Middle Proterozoic Delhi Supergroup. Recent U-Pb dating of key units in the southern Aravalli-Delhi fold belt reveals a complex history of Neoproterozoic magmatism (1 Ga and 850-750 Ma) along the western side. The northern Delhi fold belt, in contrast, has far fewer radiometric ages other than 1.8 to 1.7 Ga ages for basement granitoids. We provide some of the first geochronology for the north through Re-Os dating of sulfides from drill core covering three deposits in the >100 km-wide Khetri Cu belt.

In this study, we do not seek to isolate an event in time, but to integrate existing geochronologic data, together with our own, to illuminate the regional history that bears on ore formation in the Khetri Cu belt and adjacent areas. In our reconstruction, we use Re-Os ages for chalcopyrites and molybdenites from Khetri and Rohil, and the Baniwala Ki Dhani – Dokan area of the Sikar district (30 km SE of the Khetri Cu belt). We propose that fluids acquired from dehydration of paleoslabs hung beneath earlier Proterozoic back-arc basins in the Khetri region may be important players in the ore-forming process and key to interpreting the phenomenal albitization associated with the Cu belt. Prominent NE-trending shear zones, with subordinate N-S structures at the deposit scale gave fluids access and focus into sedimentary packages in earlier-formed rift basins. These Re-Os data, together with regional U-Pb data, show that the Neoproterozoic was an important time for development of ore deposits in the metasedimentary sequences of the Ajabgarh Group in the Khetri Cu belt, the greater Khetri region, and the Aravalli-Delhi fold belt as a whole.

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