On the Nickel-Sulfide Potential of Late-Archean Komatiites from the Dharwar Craton: A Case Study from the Shankaraghatta Complex (Southern India)

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The Shankaraghatta Complex (12 km × 0.3 km) is located within a Late Archean greenstone belt in the Western Dharwar Craton (WDC) and hosts komatiites that are now entirely serpentinized. These ultramafic rocks represent adcumulate to mesocumulate flow facies and are surrounded by komatiitic basalts, now altered to talc-tremolite-chlorite schists. The komatiitic rocks contain currently uneconomic disseminated sulfide blebs (3–8 modal %), comprising millerite, pyrite, violarite, and minor chalcopyrite.

For the first time, these ultramafic rocks have been dated in this study, yielding a Sm-Nd errorchron age of 2718 ± 107 Ma (MSWD = 2.4), which demonstrates contemporaneity with late-Archean komatiites from the Kalgoorlie Terrane of the Yilgarn Craton (Australia), which are notably mineralized. However, the Dharwar Craton lacks significant endowment. This study therefore further explores the reasons behind this disparity.

Multiple sulfur isotope analyses ($\delta^{34}S$ = -0.8 to +2.5‰; $\Delta^{33}S$ = -0.6 to +0.2‰) from this study reveal a predominantly mantle-like signature with no evidence for mass-independent fractionation, suggesting the absence of any significant crustal sulfur contribution, which is an essential component for economic mineralization, as seen in the Kalgoorlie Terrane. In addition, several factors appear to have inhibited the development of large-scale, komatiite-hosted nickel sulfide mineralization in the Dharwar Craton. Chief among them are the absence of a suitable crustal substrate, the lack of contemporaneous or pre-existing crustal-scale structures (e.g., faults or shear zones), and, most critically, the tectonic setting.

We put forward the hypothesis that in the Late Archean the WDC had already evolved into a mature and stabilized continental crust supporting convergent tectonics, in contrast to the intraoceanic rift environment prevailing in the Kalgoorlie Terrane. It is argued that this fundamental difference in tectonic setting likely played the decisive role in controlling the mineralization potential of the two terranes.