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Quantification of Physio-chemical environment, nature of magmatism and mineralization of Paleoproterozoic Malanjkhand Cu-deposit, Central India: Constraints from Phase Petrology of barren and mineralized granitoids

DR. DR. DEEPA ARYA, PHD, DR. SAURABH GUPTA, PHD AND SANTOSH KUMAR

Kumaun University

Presenting Author: arya.earth11@gmail.com

The early Paleoproterozoic Malanjkhand granitoids (2.45–2.5Ga) host Cu (±Mo ± Au) deposit. The MG lie in the south of Central Indian Tectonic Zone (CITZ), forming an integral part of the Bastar Craton. The MG bear moderately high Sr/Y and $(La/Yb)_N$ similar to as adakite-like melt which is supposed to be peculiar for Phanerozoic Porphyry style Cu-deposits. It is unique in a sense that it holds Precambrian Cu-deposit which somewhat a rare occurrence. Numerous attempts have been done so far to decode the Physio-chemical environment of its mineralization. However, less known for Physio-chemical environment and nature of magmatism of host MG. The present work is an comprehensive attempt to quantification of Physio-chemical environment, nature of magmatism and mineralization of Paleoproterozoic Malanjkhand Cu-deposit. Electron probe micro analysis (EPMA) of major and accessory minerals constituting the mineralized and unmineralized MG has been carried out. The chemistry of amphiboles, plagioclase, biotite, sphene, magnetite and chlorite has been done to deduce the chemical evolution, elemental substitution, nature and physical condition of evolving host magma and mineralization fluid.

The mineralized MG exhibit coarse-grained hypidiomorphic textures with abundant secondary minerals. They bear rock-forming Pl-Kfs + Qz + Bt + Hbl ± Ap ± Zrn ± Mag ± Spn ± Chl and ore-forming Ccp+Py±Sp±Cv±Po assemblages. The unmineralized MG are relatively fresh, unaltered, and bear Pl-Kfs + Qz + Bt+ Hbl ± Ap± Zrn ± Mag ± Spn assemblage. The hydrous ferromagnesian minerals (Hbl-Bt) from MG are altered to chlorite. Fe-Ti oxides (Mag-Ilm) are commonly found associated with biotite and amphiboles.

The results suggest that MG crystallized at very high ‘O’ fugacity condition with $\log fO_2$ ranges from -12 to -13 at narrow temperature range (700-850 ^{0}C) and emplaced at shallow level (1.5-3kb). However, ‘O’ fugacity decreases with decrease of temperature. The magma contains very high amount of water (4.5-7 wt. %) which supress the crystallisation of plagioclase relative to amphibole and provide peculiar adakitic character to MG. The later produce hydrothermal system marks the ore precipitation. The ores were precipitated by CO_2-bearing H_2O rich brine hydrothermal solutions at low to high temperatures (93-342 ^{0}C).