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HT-LP Metamorphism within the Palaeo-Proterozoic Basement of the Kabul Block, Afghanistan

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The Kabul Block is situated within a tectonic collage of Gondwanan crustal terranes that separates the Indian and Eurasian continents. It consists of a highly deformed Proterozoic basement comprising of a rhythmic succession of gneiss, schist, migmatite, amphibolite marble & quartzite, overlain by weakly deformed Phanerozoic sedimentary rocks and bounded on all sides by ultra-mafic complexes. Amphibolite facies metamorphism is widespread throughout the basement rocks, although granulite grade metamorphic rocks crop-out locally north of Kabul. Granulite grade rocks comprise quartz-feldspathic lithologies, which contain lenses of marble and metabasite. Based on textural relations and mineral compositions, at least two distinct metamorphic events can be recognized. The older (M1) event is a granulite facies metamorphism, and the younger (M2) event is represented by the amphibolite facies overprint. Mineral assemblages defining the granulite facies event are orthopyroxene + plagioclase + biotite + quartz + ilmenite in felsic (gneiss) and mafic (metabasite) granulites and calcite + dolomite + olivine + phlogopite + amphibole in impure marble. In addition the felsic granulite contains K-feldspar, and hornblende is present in mafic granulite. The younger amphibolite facies metamorphism is characterized by formation of garnet and recrystallization of biotite and plagioclase within the gneisses.

In spite of the amphibolite facies overprint, the mafic granulite preserves prograde history, which is characterized by the presence of amphibole inclusions in orthopyroxene. During the retrograde stage of metamorphism, cummingtonite forms by a reaction between orthopyroxene and hornblende. Orthopyroxene in mafic variety has X_{Mg} = 0.57, Al_2O_3 = 1.3 wt % and it is close to that in the gneiss X_{Mg} = 0.4 and Al_2O_3 = 1.5 wt %. Biotite is rich in Ti having 4 wt % TiO_2 with X_{Mg} = 0.63 in mafic and 5.5 wt % TiO_2 with X_{Mg} = 0.36 in felsic granulite. Plagioclase in the mafic granulites is anorthite rich ($An_{0.87}$) whereas in the felsic rocks, plagioclase is more albite rich ($An_{0.35}$). Marbles contain a groundmass of mostly pure calcite as well as minor amounts of dolomite with both phlogopite (X_{Mg} = 0.98) and pargasite (X_{Mg} = 0.95) forming as porphyroblastic grains. Highly fractured relict olivine crystals are observed forming predominantly as inclusions within the amphibole. These rocks pose a challenge due to the absence of garnet and clinopyroxene from the granulite facies assemblage thereby precluding traditional geothermobarometry. For that reason we combine the granulite facies mineral assemblages in different lithologies and focus on a detailed micro-structural analysis of the samples along with P-T equilibrium phase diagrams and mineral isopleths to constrain and evaluate the granulite facies event within these rocks.