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Petrology and mineral equilibrium modeling of incipient charnockite from the Lützow-Holm Complex, East Antarctica: implications for granulite formation in a Gondwana fragment

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Charnockite (orthopyroxene-bearing granitoid) is regarded as one of the fundamental lithologies in many high-grade metamorphic terranes including Neoproterozoic collisional orogen formed during the amalgamation of Gondwana supercontinent. Although both magmatic (massive) and metamorphic charnockites have been reported, several classic examples for the spectacular development of 'incipient charnockites' within orthopyroxene-free felsic gneisses are exposed in several quarry sections in Neoproterozoic granulite terrenes in southern India (e.g., Trivandrum Block) and Sri Lanka. (e.g., Wanni Complex). The charnockite-forming process in these localities is considered to have been triggered by the infiltration of CO_2-rich anhydrous fluids along structural pathways within upper amphibolite facies gneisses, resulting in the lowering of water activity and stabilization of orthopyroxene through the breakdown of biotite. However, no detailed study of incipient charnockites in the Lützow-Holm Complex of East Antarctica, which is regarded as an extension of Neoproterozoic to Cambrian orogeny in India and Sri Lanka, has been reported so far. This study thus reports new petrological data of incipient charnockite patches in orthopyroxene-free felsic gneiss from Skallevikshalsen in the granulite-facies region of the Lützow-Holm Complex, East Antarctica, and discuss the timing and process of charnockite formation. Incipient charnockite (Opx + Qtz + Pl + Kfs + Grt) occurs as dark brownish patches of several cm in length within coarse-grained leucocratic gneiss (Qtz + Pl + Kfs + Grt) interlayered with various supracrustal lithologies such as mafic granulite, pelitic granulite, and marble. Orthopyroxene, which occurs only in garnet-bearing portion of the rock, probably formed by a FMAS continuous reaction: Grt + Qtz => Opx + Pl. Phase equilibrium modeling in the system NCKFMASH suggests a wide range of P-T stability (>780 C, >6 kbar), although the condition is broadly consistent with retrograde P-T conditions of the region. The texture and estimated P-T range suggest that the incipient charnockite formation in Skallevikshalsen is a post-peak event probably related to decompression after the peak event possibly without the effect of infiltration of low H_2O activity fluids.