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Partial melting of HP mafic granulites and tectonic evolutions of the Himalayan orogen

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The Himalayan orogen, which resulted from the collision of the Indian and Asian continents, exposes a set of high-grade metamorphic rocks in its core. Intensive anatexis of metapelitic and felsic granulites during the Himalayan orogeny has been well demonstrated, whereas the partial melting of mafic granulites remains controversial. In the Eastern Himalayan Syntaxis, the mafic granulites show stromatic structure, consisting of alternating layers of leucosome and melanosome. The former is composes of abundant garnet, plagioclase and quartz with minor amphibole and titanite, whereas the later consists mainly of garnet and amphibole with minor plagioclase, quartz and biotite. Clinopyroxene only occurs as inclusion within garnet. The porphyroblastic garnet shows distinct growth compositional zoning with increasing Mg and decreasing Mn, Fe and Ca from core to rim, and has symplectitic corona of amphibole and plagioclase. The mafic granulites have a peak assemblage of garnet + clinopyroxene + biotite + quartz + rutile + melt ± plagioclase, and a retrograde assemblage of garnet + amphibole + biotite + quartz + plagioclase + ilmenite. Phase equilibria modeling and conventional thermobarometry show that peak metamorphism of the mafic granulite reached high-pressure (HP) granulite-facies conditions of 16–18 kbar and 750–800°C. The partial melting of the mafic granulites occurred by dehydration melting of both amphibole and biotite, with melt mode of up to 10–14 vol.% and granitic composition. Based on zircon U–Pb dating, the mafic granulites witnessed a protracted metamorphic and anatectic process lasting at least 30 Myr, with a peak metamorphic age of ca. 25 Ma. The present study provides robust evidence for partial melting of the mafic granulites in the thickened lower crust of the south Tibet and new insights into the tectonic evolution of the Himalayan orogen.