Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.21908

Origin of high-temperature garnet granitoids: constraints from the phase equilibrium modelling

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In contrast to the S-type granites which contains hydrous minerals and form via low temperature anatexis, garnet granitoids usually form via ultra-high temperature anatexis of metapelites [1]. Current study reports the physico-chemical conditions suitable for formation of large-scale garnet granitoids in parts of the Eastern Ghats Province (EGP), India. The studied rock, containing large garnet grains and medium-sized quartz, K-feldspar and plagioclase feldspar grains, frequently hosts enclaves of metasedimentary rocks that were metamorphosed under UHT conditions (~1000ºC at 8-10 kbar [2]). The granitoids are siliceous (SiO_2 >70 wt %), peraluminous, calcic to alkali-calcic and show limited variation in maficity (FeO_t+ MgO~0.5 to 5 wt.%). Zircon saturation thermometry yield high magmatic temperature (830-900ºC [3]). Phase equilibrium modelling reveal that the compositions of the melt generated from two metasedimentary rocks (X_{Mg} ~0.27 and 0.65) [4] via isobaric heating corroborates well with the compositions of the studied garnet-granitoids. Most of the melt compositions matches well with the melts generated from more magnesian source. Entrainment of the peritectic phases in the melt produce more mafic and less siliceous melts compared to the studied garnet granitoids. Besides, the compositions of the garnet in the granitoids are uniform and more ferroan (X_{Mg} ~ 0.3) than the garnet (X_{Mg}~ 0.5) present in the metapelitic residue. This precludes the notion of extensive peritectic entrainment and points towards a magmatic origin of the garnet in the studied granitoids. Isobaric cooling models of the granitoid magma compositions suggest that garnet crystallizes as the dominant ferromagnesian phase only above 8 kbar. The process is further facilitated in low H_2O (<3 wt%) bearing ferroan melts. Fractionation of garnet along with quartz and feldspar produce the compositional variation observed in the rocks.

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