American Mineralogist, Volume 94, pages 535–545, 2009

Stability of pargasite during ultrahigh-temperature metamorphism: A consequence of titanium and REE partitioning?

K. Sajeev,[1,*] Y. Osanai,[2] Y. Kon,[3] and T. Itaya[4]

[1]Centre for Earth Sciences, Indian Institute of Science, Bangalore 560012, India
[2]Division of Evolution of Earth Environments, Graduate School of Social and Cultural Studies, Kyushu University, Ropponmatsu, Fukuoka, 810-8560 Japan
[3]Department of Earth and Planetary Sciences, Tokyo Institute of Technology, O-Okayama 2-12-1, Meguro, Tokyo 152-8551, Japan
[4]Research Institute of Natural Sciences, 1-1 Ridai-cho, Okayama University of Science, Okayama 700-0005, Japan

Abstract

Orthopyroxene-clinopyroxene-plagioclase needles and symplectite along the cleavage planes and grain boundaries of fluorine-bearing titanian-ferroan pargasite from the Highland Complex, Sri Lanka, are interpreted as evidence for dehydration melting at ultrahigh-temperature conditions. High Ti (up to 0.4 pfu) and F (X_F up to 0.56) content in pargasite extends its stability to higher temperatures, and the composition indicates the dehydration melting reaction may take place at ultrahigh-temperatures (~950 °C) at a pressure around 10 kbar, close to peak metamorphic conditions. The increase of Ti content close to the grain boundaries and cleavage planes in pargasite indicates titanium partitioning from the melt during dehydration melting enhanced the stability of the mineral toward ultrahigh-temperature conditions. The REE content in the pargasite shows a similar behavior to that of titanium. The cores with no breakdown assemblage consist of low and flat REE concentrations with respect to the high and Eu-depleted rim. Clinopyroxene in symplectite and needle-shaped lamellae within the pargasite porphyroblasts have similar REE patterns with slightly low-concentrations relative to that of pargasite. In the breakdown assemblage, LREEs are partitioned mainly into plagioclase while the HREEs are partitioned into orthopyroxene. The REE enrichment in the pargasite rims signals their relative partitioning between pargasite rims and melt. Modeling of the partitioning of Ti and REEs associated with pargasite breakdown demonstrates that its stability is greatly enhanced at UHT conditions. This investigation implies that the stability of hydrous minerals such as amphibole can be extended to UHT conditions, and expands our knowledge of metamorphism in the lower crust.

Keywords: Pargasite, ultrahigh-temperature UHT, dehydration melting, titanium partitioning, fluorine, mineral REE, Highland Complex, Sri Lanka