東南極 Lützow-Holm 岩体に産出するグラニュライト中に見られる結晶化したメルト包有物と CO_2 に富む流体包有物共存の意義

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Significance of coexistence of crystalized melt inclusions and primary CO_2 -rich fluid inclusions in granulites from the Neoproterozoic - Cambrian Lützow-Holm Complex, East Antarctica

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We report here new petrological date of the coexistence of crystalized melt inclusions (CMIs) and CO_2-rich primary fluid inclusions from partially melted granulite to evaluate the fluid activity and partial melting processes from the Neoproterozoic - Cambrian Lützow-Holm Complex (LHC), East Antarctica (Shiraishi et al., 1992). Previous petrological studies of the LHC suggest an increase in the metamorphic grade from northeast (amphibolite facies) to southwest (granulite facies) (Hiroi et al., 1991). CMIs are often reported from several lithologies and their petrogenesis have been well discussed (e.g. Cesare et al., 2009). However relationships between CMIs and fluid inclusions in metamorphic rocks have been poorly investigated, although Hidas et al. (2010) reported coexistence of silicate melt inclusions and CO_2-rich fluid inclusions from mantle peridotite, and they pointed out that the coexistence is rare. We thus attempt to investigate the relationships of fluid inclusions and CMIs in the granulites to discuss the deep crustal process.

Based on detailed microscopic observations, we found coexistence of CMIs and CO_2-rich fluid inclusions from mafic and pelitic granulites from the LHC. Mafic granulites discussed here occur as small block surrounded by felsic orthogneiss. Pelitic granulites occur as thin layer with psammitic granulites, and they contain leucocratic texture which could imply the presence of partial melting. The representative samples of mafic granulite are composed mainly of coarse-grained garnet, hornblende, orthopyroxene, clinopyroxene, plagioclase, and ilmenite. The garnet often contains CMIs. The CMIs consist of fine-grained quartz, biotite, K-feldspar, plagioclase, ilmenite, orthopyroxene, and rutile which size varies from 1 to 50 μm. The size of CMI grains is up to 100 μm, and they show negative crystal shapes of the host garnet. Pelitic granulite contains garnet, K-feldspar, spinel, quartz, biotite, rutile, and ilmenite. CMIs are often observed in coarse-grained garnet. The CMIs within pelitic granulite contain quartz, biotite, K-feldspar, plagioclase, ilmenite, and muscovite.

The garnet in both mafic and pelitic granulites contains CO_2-rich fluid inclusions as confirmed by Raman spectroscopy analysis. Some of the CO_2-rich fluid inclusions are close to the CMIs, which distances are less than 20-30 μm. We thus consider that CO_2-rich fluid inclusions and CMIs were trapped together. The CO_2-rich fluid inclusions show negative crystal shapes of garnet, and they are isolated, suggesting that the inclusions are primary origin. We subsequently calculated composition of the CMIs based on modal abundance and chemistry of the minerals for each CMI within mafic granulites. The results are nearly equivalent to the compositions of andesitic to dacitic melt. Occurrence of hornblende and biotite within garnet in the CMI-bearing samples suggests dehydration melting of the hydrous minerals and formation of andesitic to dacitic melt possibly during prograde stage.

Previous study revealed that coexistence of silicate melt and CO_2-rich fluid inclusions is a result of immiscibility from

CO_2-bearing silicate melt (Hidas et al., 2010). According to their sample description, CO_2-rich fluid inclusions occur as primary, and they show negative crystal shapes of host minerals. CO_2-rich fluid inclusions and silicate melt inclusions occur in same grain (e.g., orthopyroxene and clinopyroxene). These petrographic features are similar to the samples discussed here. We thus consider that coexistence of silicate melt and CO_2-rich fluid inclusions in our samples could be explained by immiscibility from CO_2-bearing silicate melt during decompression, because solubility of CO_2 within silicate melt strongly depends on pressure.

Widespread occurrence of CO_2-rich fluid inclusions within granulites is also important factor to discuss the evolution of granulite terrains. Some authors argued that they are infiltrated from mantle beneath high-grade terrain or released from calc-silicate rock or marble through de-carbonate reaction. (e.g., Santosh and Omori 2008). Here we present that the possibility of immiscibility from CO_2-bearing silicate melt as a source of CO_2-rich fluid inclusions. If it is the case, the scenario is different from previous studies, and implies that CO_2 was originated from source melt which formed CMIs.

In conclusion, coexistence of CMIs and CO_2-rich primary fluid inclusions is important to discuss the origin of CO_2 within high-grade metamorphic rocks.

References

Cesare, B., Ferreol, S., Salvioli, M.E., Pedron, D., Cacallo, A., 2009. “Nanogranite” and glassy inclusions: The anatectic melt in migmatites and granulites. Geology 37, 627-630.

Hidas, K., Guzmics, T., Szabó, C., Kovács, I., Bodnar, R.J., Zajacz, Z., Nédli, Z., Vaccari, L., Perucchi, A., 2010. Coexisting silicate melt inclusions and H_2O-bearing, CO_2-rich fluid inclusions in mantle peridotite xenoliths from the Carpathian–Pannonian region (central Hungary). Chemical Geology 274, 1-18.

Hiroi, Y., Shiraishi, K., Motoyoshi, Y., 1991. Late Proterozoic paired metamorphic complexes in East Antarctica, with special reference to the tectonic significance of ultramafic rocks. In: Thomson, M.R.A., Crame, J.A., and Thomson, J.W. (eds) Geological Evolution of Antarctica, Cambridge University Press, Cambridge, 83-87.

Santosh, M., Omori, S., 2008. CO_2 flushing: a plate tectonic perspective. Gondwana Research. 13, 86-102.

Shiraishi, K., Hiroi, Y., Ellis, D.J., Fanning, C.M., Motoyoshi, Y., Nakai, Y., 1992. The first report of a Cambrian orogenic belt in East Antarctica – An ion microprobe study of the Lützow-Holm Complex. In: M. Yoshida, K. Kaminuma, and K. Shiraishi (eds.) Recent Progress in Antarctic Earth Science. Terra, Tokyo, 67-73.