東南極リュツォ・ホルム岩体北東部における新原生代の原岩形成と新原生代–カンブリア紀のグラニュライト相変成作用：ゴンドワナ地域の温度–圧力–時間的進化に対する示唆

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Neoproterozoic protolith forming and late Neoproterozoic-Cambrian granulite-facies metamorphism in the northeastern Lützow-Holm Complex, East Antarctica: Implications for *P-T-t* evolution of Gondwana fragments

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The Lützow-Holm Complex (LHC) of East Antarctica is regarded as one of the high-grade metamorphic terranes formed through collisional orogeny during late Neoproterozoic-Cambrian Gondwana amalgamation. Although previous studies inferred increasing metamorphic grade from the northeastern part (amphibolite facies) to the southwestern part (granulite facies) within the complex (Hiroi et al., 1991), recent studies reported ultrahigh-temperature (UHT) metamorphic condition from Akarui Point (900-920°C, 5-6 kbar; Iwamura et al., 2013, 825-900°C; Nakamura et al., 2013) in the lower-grade region. These results may suggest that the LHC could have been formed through multiple and complex collisions of several crustal blocks with different petrological and tectonic features. Tenmondai Rock area is one of exposures in the amphibolite-granulite transition zone in the complex, and dominantly composed of garnet-biotite gneisses and migmatites with layers of garnet-biottie gneisses and amphibolites and intruded granitoids. Some previous studies reported limited petrological and geochronological data from this region such as the peak *P-T* conditions of ca. 750°C and 7.2-7.5 kbar (Hiroi et al., 1983) and Rb-Sr whole rock isochron age of 780±70 Ma (Nakajima et al., 1988). In this study, we performed detailed investigations of various metabasites, garnet-biotite gneiss and garnet-biotite-sillimanite gneiss from this region to unravel *P-T-t* evolution and protolith of the low-grade part of the LHC.

The metabasites are dominantly composed of hornblende and/or orthopyroxene, plagioclase, garnet and biotite. Orthopyroxene + plagioclase symplectite surrounding garnet in one sample suggests isothermal-decompression probably along a clockwise P-T path. Whole rock geochemical data of the metabasites show characteristic Nb and Ti negative anomalies in spider diagrams, depletion of HREE, and Th-rich characters in some discrimination diagrams, suggesting magmatic arc-related setting. The garnet-biotite gneiss consists of garnet, biotite, plagioclase, quartz, muscovite and rutile. The garnet-biotite-sillimanite gneiss are composed of garnet, plagioclase, quartz, K-feldspar, biotite and sillimanite. This rock contains interlcalated kyanite-bearing quartzo-feldspathic leucosome, that suggest prograde partial melting in the stability field of kyanite.

The application of hornblende-plagioclase geothermometer and garnet-hornblende-plagioclase-quartz geobarometer for one metabasite (Ts11021001A) and garnet-orthopyroxene geothermometer and garnet-orthopyroxene-plagioclase-quartz geobarometer for other metabasite (Ts11021106A) yielded 747-855°C at 8kbar and 8.02-8.62 kbar at 800°C , and 805-847°C at 8kbar and 6.5-9.25 kbar at 800°C , respectively. The results of ternary feldspar geothermometer for garnet-biotite-sillimanite gneiss (Ts11021008B) and kyanite-bearing quartzo-feldspathic leucosome (Ts11021008A) show simmilar range of tenperature of ca. 700-850°C. These P-T cnditions are comparable to upper amphibolite to granulite facies, which are slightly higher than the results of previous studies (Hiroi et al., 1983).

U-Pb dating for zircon in metabasites with LA-ICP-MS yielded early to middle Neoproterozoic (ca. 900-750 Ma) ages from zircon cores and late Neoproterozoic-Cambrian (ca. 550-500 Ma) ages from homogeneous and rim of grains, which probably correspond to protolith and subsequent metamorphic ages, respectively. Some previous studies reported Neoproterozoic protolith ages with arc-related geochemical features and from orthogneisses in the northeastern LHC and have interpreted that these regions was Neoproterozoic arc (e.g., Kazami et al., 2016; Takahashi et al., 2017b; Tsunogae et al., 2014, 2015, 2016). Our results and these previous reports suggest that metabasites in Tenmondai Rock area was formed as part of Neoproterozoic arc. On the other hand, zircon ages in the garnet-biotite gneiss (Ts11021004C) show small amount of Paleoproterozoic (ca. 2000 Ma) and predominant Meso- to Neoproterozoic ages (ca. 1200-800 Ma), and late-Neoproterozoic-Cambrian (ca. 600-500 Ma) ages, which conist of detrital zircon ages and metamorphic ages, respectively, and the depositional age can be restricted as middle to late Neoproterozoic (ca. 800-600 Ma). These results are similar with those from other exposures on the northeastern LHC (Takamura et al., 2017) and suggest that protolith detritus of metasediments of these regions were dominantly derived from Meso- to Neoproterozoic provenances. The existance of small amount of Paleoproterozoic (ca. 2000 Ma) detrital zircon ages, however, potentially can be interpreted as sediment supply from older crust.

In summary, the metmaorphic rocks in Tenmondai Rock area can be considered to have been formed through early to middle Neoproterozoic arc magmatism, deposition of sediments dominantly derived from Meso- to Neoproterozoic provenances at middle to late Neoproterozoic, and upper amphibolote- to granulite-facies metamorphism with sebsequent isothermal decompression during Gondwana amalgamation.

References

Hiroi, Y., Shiraishi, K., Nakai, Y., Kano, T., Yoshikura, S., 1983. Geology and petrology of Prince Olav Coast, East Antarctica. In: Oliver, R.L., James, P.R., Jago, J.B. (Eds.), Antarctic Earth Science. Australian Academy of Science, Canberra, 32–35.

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., Thomson, J.W. (Eds.), Geological Evolution of Antarctica. Cambridge University Press, Cambridge, pp. 83–87.

Iwamura, S., Tsunogae, T., Kato, M., Koizumi, T., Dunkley, D.J., 2013. Petrology and phase equilibrium modeling of spinel-sapphirine-bearing mafic granulite from Akarui Point, Lützow-Holm Complex, East Antarctica: Implications for the P-T path. Journal of Mineralogical and Petrological Sciences 108, 345–350.

Kazami, S., Tsunogae, T., Santosh, M., Tsutsumi, Y., Takamura, Y., 2016. Petrology, geochemistry and zircon U–Pb geochronology of a layered igneous complex from Akarui Point in the Lützow-Holm Complex, East Antarctica: implications for Antarctica-Sri Lanka correlation. Journal of Asian Earth Sciences 130, 206–222.

Nakajima, T., Shibata, K., Shiraishi, K., Motoyoshi, Y., Hiroi, Y., 1988. Rb-Sr whole-rock ages of metamorphic rocks from Eastern Queen Maud Land, East Antarctica (2): Tenmondai Rock and Rundvågshetta. Proceedings of the NIPR Symposium on Antarctic Geosciences, 2, 172.

Nakamura, A., Kitamura, M., Kawakami, T., 2013. Microstructural records of multiple retrograde local H2O supplement in the pelitic gneiss, Lützow-Holm Complex at Akarui Point, East Antarctica. Mineralogy and Petrology 108, 177–186.

Takahashi, K., Tsunogae, T., Santosh, M., Takamura, Y., Tsutsumi, Y., 2017b. Paleoproterozoic (ca. 1.8 Ga) arc magmatism in the Lützow-Holm Complex, East Antarctica: Implications for crustal growth and terrane assembly in erstwhile Gondwana fragments. Journal of Asian Earth Sciences (In Press). doi: 10.1016/j.jseaes.2017.07.053

Takamura, Y., Tsunogae, T., Santosh, M., Tsutsumi, Y., 2017. Detrital zircon geochronology of the Lützow-Holm Complex, East Antarctica: Implications for Antarctica-Sri Lanka correlation. Geoscience Frontiers (In Press). doi: 10.1016/j.gsf.2017.08.006

Tsunogae, T., Dunkley, D.J., Horie, K., Endo, T., Miyamoto, T., Kato, M., 2014. Petrology and SHRIMP zircon geochronology of granulites from Vesleknausen, Lützow-Holm Complex, East Antarctica: Neoarchean magmatism and Neoproterozoic high-grade metamorphism. Geoscience Frontiers 5, 167–182.

Tsunogae, T., Yang, Q.Y., Santosh, M., 2015. Early Neoproterozoic arc magmatism in the Lützow-Holm Complex, East Antarctica: Petrology, geochemistry, zircon U–Pb geochronology and Lu–Hf isotopes and tectonic implications. Precambrian Research 266, 467–489.

Tsunogae, T., Yang, Q. Y., Santosh, M., 2016. Neoarchean–Early Paleoproterozoic and Early Neoproterozoic arc magmatism in the Lützow–Holm complex, East Antarctica: insights from petrology, geochemistry, zircon U–Pb geochronology and Lu–Hf isotopes. Lithos 263, 239–256.