Geoscience Frontiers xxx (2017) 1–21

HOSTED BY

ELSEVIER

Contents lists available at ScienceDirect

China University of Geosciences (Beijing)

Geoscience Frontiers

journal homepage: www.elsevier.com/locate/gsf

Research paper

Detrital zircon geochronology of the Lützow-Holm Complex, East Antarctica: Implications for Antarctica–Sri Lanka correlation

Yusuke Takamura[a], Toshiaki Tsunogae[a,b,*], M. Santosh[c,d], Yukiyasu Tsutsumi[e]

[a] Graduate School of Life and Environmental Sciences, University of Tsukuba, Ibaraki 305-8572, Japan
[b] Department of Geology, University of Johannesburg, Auckland Park 2006, South Africa
[c] School of Earth Sciences and Resources, China University of Geosciences Beijing, 29 Xueyuan Road, Beijing 100083, China
[d] Centre for Tectonics Resources and Exploration, Department of Earth Sciences, University of Adelaide, SA 5005, Australia
[e] Department of Geology and Paleontology, National Museum of Nature and Science, Ibaraki 305-0005, Japan

ARTICLE INFO

Article history:
Received 1 May 2017
Received in revised form
24 July 2017
Accepted 29 August 2017
Available online xxx

Keywords:
The northern Lützow-Holm–Vijayan Complex
Zircon U–Pb geochronology
Crustal evolution
Tectonic correlations
Gondwana supercontinent

ABSTRACT

The Lützow-Holm Complex (LHC) of East Antarctica has been regarded as a collage of Neoarchean (ca. 2.5 Ga), Paleoproterozoic (ca. 1.8 Ga), and Neoproterozoic (ca. 1.0 Ga) magmatic arcs which were amalgamated through the latest Neoproterozoic collisional events during the assembly of Gondwana supercontinent. Here, we report new geochronological data on detrital zircons in metasediments associated with the magmatic rocks from the LHC, and compare the age spectra with those in the adjacent terranes for evaluating the tectonic correlation of East Antarctica and Sri Lanka. Cores of detrital zircon grains with high Th/U ratio in eight metasediment samples can be subdivided into two dominant groups: (1) late Meso- to Neoproterozoic (1.1–0.63 Ga) zircons from the northeastern part of the LHC in Prince Olav Coast and northern Sôya Coast areas, and (2) dominantly Neoarchean to Paleoproterozoic (2.8–2.4 Ga) zircons from the southwestern part of the LHC in southern Lützow-Holm Bay area. The ca. 1.0 Ga and ca. 2.5 Ga magmatic suites in the LHC could be proximal provenances of the detrital zircons in the northeastern and southwestern LHC, respectively. Subordinate middle to late Mesoproterozoic (1.3–1.2 Ga) detrital zircons obtained from Akarui Point and Langhovde could have been derived from adjacent Gondwana fragments (e.g., Rayner Complex, Eastern Ghats Belt). Meso- to Neoproterozoic domains such as Vijayan and Wanni Complexes of Sri Lanka, the southern Madurai Block of southern India, and the central-western Madagascar could be alternative distal sources of the late Meso- to Neoproterozoic zircons. Paleo- to Mesoarchean domains in India, Africa, and Antarctica might also be distal sources for the minor ∼2.8 Ga detrital zircons from Skallevikshalsen. The detrital zircons from the Highland Complex of Sri Lanka show similar Neoarchean to Paleoproterozoic (ca. 2.5 Ga) and Neoproterozoic (ca. 1.0 Ga) ages, which are comparable with those of the LHC, suggesting that the two complexes might have formed under similar tectonic regimes. We consider that the Highland Complex and metasedimentary unit of the LHC formed a unified latest Neoproterozoic suture zone with a large block of northern LH–Vijayan Complex caught up as remnant of the ca. 1.0 Ga magmatic arc.

1. Introduction

Previous petrological, geochemical and geochronological studies on East Africa–India–Sri Lanka–East Antarctica region, which corresponds to the central part of the East African–Antarctic Orogen, suggest that the region was formed through a sequence of complex subduction–accretion–collision processes of various arc and continental components during the latest Neoproterozoic to Cambrian Gondwana amalgamation (e.g., Meert, 2003; Jacobs and Thomas, 2004; Collins and Pisarevsky, 2005; Collins et al., 2007a,b, 2014; Meert and Lieberman, 2008; Santosh et al., 2009, 2014, 2015, 2016, 2017, and reference therein). The Lützow-Holm Complex (LHC) of East Antarctica has been regarded as one of the examples of Neoproterozoic to Cambrian high-grade metamorphic terranes

* Corresponding author. Graduate School of Life and Environmental Sciences, University of Tsukuba, Ibaraki 305-8572, Japan.
E-mail address: tsunogae@geol.tsukuba.ac.jp (T. Tsunogae).
Peer-review under responsibility of China University of Geosciences (Beijing).

http://dx.doi.org/10.1016/j.gsf.2017.08.006

formed during this orogenic event (e.g., Hiroi et al., 1991; Shiraishi et al., 1994). Recent geochemical and geochronological studies proposed that the LHC is composed of at least three Neoarchean (ca. 2.5 Ga), Paleoproterozoic (ca. 1.8 Ga), and Neoproterozoic (ca. 1.0 Ga) magmatic arcs and was formed by collision of these terranes (e.g., Dunkley et al., 2014; Takahashi et al., 2017). The LHC has been correlated with other Gondwana fragments, particularly the Sri Lankan basement which is composed of two Neoproterozoic magmatic arcs (Wanni and Vijayan Complexes) and a suture zone (Highland Complex) between them. Yoshida et al. (1992) proposed that the sedimentary units of the LHC along the Lützow-Holm Bay (LHB) region (Ongul and Skallen Groups) could be correlated to those of the Highland Complex based on structural patterns and lithological similarities. Shiraishi et al. (1994) also regarded the LHC as a supracrustal basin developed in a suture zone with the Highland Complex during the final phase of Gondwana assembly. Kazami et al. (2016) discussed geochemical and geochronological similarities of meta-igneous rocks from the LHC and the Kadugannawa Complex of Sri Lanka. Similar metamorphic P–T conditions from the two regions are also discussed (e.g., Yoshida et al., 1992; Takamura et al., 2015; Osanai et al., 2016a,b). In contrast, there are also some major differences between the two regions, particularly with regard to geochronology. For example, the LHC contains remnants of Neoarchean (ca. 2.5 Ga) magmatic arcs (e.g., Shiraishi et al., 1994, 2008; Dunkley et al., 2014; Tsunogae et al., 2014, 2016), which have not been reported from Sri Lanka. In this study, we will therefore compare geological, petrological, and geochronological features of the LHC and Sri Lanka and evaluate the correlation of the two regions for further unraveling the tectonic evolution and terrane assembly during Gondwana amalgamation.

Zircon is a common accessory mineral in crustal rocks, and possesses the properties of physical and chemical durability against weathering and metamorphism. Therefore, geochronological investigations of detrital zircon and comparison of their age spectra with those of adjacent terranes are common approaches to understand the evolution of orogens and reconstruction of continental fragments (e.g., Gebauer et al., 1989; Cawood et al., 2003; Tsutsumi et al., 2009; Kuznetsov et al., 2014). The detrital zircon ages from the Highland Complex have been well studied. For example, dominant Paleoarchean to Paleoproterozoic (ca. 3.5–1.7 Ga) detrital zircons have been obtained from the Highland Complex (Kröner et al., 1987; Hölzl et al., 1994; Dharmapriya et al., 2016; Takamura et al., 2016). Recent studies also reported early to middle Neoproterozoic (ca. 1.0–0.7 Ga) ages for detrital zircons from the complex (Sajeev et al., 2010; Dharmapriya et al., 2015, 2016). Kitano et al. (2015a,b) argued the difference of dominant detrital zircon ages between the eastern (ca. 2.0–1.5 Ga) and western (ca. 1.0–0.7 Ga) parts of the Highland Complex. In contrast, only a few report of Neoarchean to Neoproterozoic detrital zircon ages have been presented from the LHC (e.g., Shiraishi et al., 1994, 2003; Dunkley et al., 2014), and they are restricted only from the LHB region. No data are available from the region along Price Olav Coast in the eastern part of the complex. Systematic correlation of age spectra of the LHC with those from other Gondwana fragments has not been done so far.

This study reports new geochronological data on detrital zircon grains in metasediments from eight localities in the LHC, compares their age spectra with available geochronological data from other Gondwana fragments such as Sri Lanka, southern India, and Madagascar, and evaluates their implications on paleogeographic correlations.

2. Geological background

2.1. General geology and metamorphism

The Lützow-Holm Complex is located from southwest to northeast along the Prince Harald and Sôya Coasts of Lützow-Holm Bay, and Prince Olav Coasts of East Antarctica (Fig. 1). It is bordered with the western Rayner Complex to the east, and the Yamato–Belgica Complex and the Sør Rondane Mountains to the west and south, although the boundaries are not exposed. The LHC is dominantly composed of felsic to intermediate orthogneisses (e.g., charnockite, biotite-hornblende gneiss) with various metasedimentary rocks (pelitic and psammitic rocks, quartzite, and marble) and metabasites (mafic to ultramafic granulites and amphibolite) (e.g., Shiraishi et al., 1989). Metamorphic grade of the complex increases from amphibolite-facies in the northeast to granulite-facies in the southwest (e.g., Hiroi et al., 1991) (Fig. 1). The highest-grade metamorphic rocks are exposed at Rundvågshetta in the southernmost part of the complex where peak P–T condition is as high as 1040 °C and 13–15 kbar (e.g., Kawasaki et al., 2011). Similar ultrahigh-temperature (UHT) metamorphic conditions have been reported from granulites in adjacent localities, such as Skallen and Skallevikshalsen (Osanai et al., 2004; Yoshimura et al., 2008). In contrast, Tsunogae et al. (2014) estimated peak P–T condition for charnockites from Rundvågshetta and adjacent Vesleknausen as 800–850 °C, and suggested that the UHT event is a local and only recorded in dry Mg–Al-rich pelitic rocks in this region. Lower peak metamorphic P–T conditions have been estimated for the transition zone between granulite- and amphibolite-facies zones such as 750 °C at 7.2–7.5 kbar for Tenmondai Rock (Hiroi et al., 1983), and 770–790 °C at 7.7–9.8 kbar for Akarui Point (Kawakami et al., 2008). In Akarui Point, however, higher temperatures of 825–900 °C were obtained by the application of ternary-feldspar geothermometry (Nakamura et al., 2013). Iwamura et al. (2013) reported peak UHT metamorphism (900–920 °C at 5–6 kbar) and clockwise P–T path from sapphirine- and spinel-bearing metagabbro from Akarui Point, and proposed that the LHC might be separated into several crustal blocks by shear zones as inferred from geophysical data of Nogi et al. (2013).

2.2. Geochronology

Available geochronological data from the LHC suggest late Neoproterozoic to early Cambrian (600–520 Ma) high-grade metamorphism (e.g., Shiraishi et al., 1994, 2003, 2008; Asami et al., 1997; Hokada and Motoyoshi, 2006; Tsunogae et al., 2014, 2015, 2016). Shiraishi et al. (1994) performed systematic SHRIMP zircon U–Pb dating for ortho- and paragneisses from several localities in the LHC (e.g., Austhovde, Rundvågshetta, Telen, Ongul, Akarui Point) and obtained peak metamorphic ages as 550–520 Ma. Asami et al. (1997) reported CHIME ages for monazite in biotite gneiss from East Ongul and Mt. Vechernyaya as 537–533 Ma. Hokada and Motoyoshi (2006) also performed CHIME monazite age dating for pelitic granulites from Skallen and obtained two age groups; 650–580 Ma of prograde metamorphic age and 560–500 Ma of peak metamorphic age. Dunkley (2007) reported a spread of SHRIMP zircon age from ca. 600 to 500 Ma in the LHC, and concluded that the 550–530 Ma event corresponds to retrograde metamorphism of the LHC after the peak metamorphism at >550 Ma. Tsunogae et al. (2014) obtained 591 ± 3 Ma and 548 ± 7 Ma SHRIMP zircon ages from partially molten feldspathic rock from Vesleknausen, and interpreted the ages corresponding to prograde partial-melting stage and retrograde metamorphic stage, respectively, suggesting that the peak