Proceedings of the IGCP-440 and LEGENDS International Symposium and Field Workshop on "The Role of Sri Lanka in Rodinia and Gondwana Assembly and Break-up", March-April 2003, Centenary Publication, Geological Survey & Mines Bureau, Sri Lanka, (K.V.W. Kehelpannala, Ed.) pp. 76-78

Retrograde Tectonothermal Events in the Napier Complex, East Antarctica: Correlation with the East Gondwana fragments

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The Napier Complex has an extended history of crust formation and tectonothermal activity from the early Archaean to the early Paleozoic (e.g., Sheraton et al., 1987; Harley and Black, 1997; Asami et al., 2002). Previous studies of Gondwana reconstruction implied that the Napier Complex juxtaposed with the Rayner Complex in Antarctica, and with the southern part of the Eastern Ghats Belt (EGB) in India (e.g., Sengupta et al., 1999).

The ultrahigh-temperature (UHT) metamorphic conditions of the rocks from the Napier Complex are estimated up to 11 kbar and 1150°C (e.g., Harley, 2003). UHT metamorphic rocks of the Napier Complex contain retrograde mineral reactions (e.g., Sandiford, 1985; Sheraton et al., 1987; Harley and Hensen, 1990; Hokada et al., 1999).

Owada et al. (2003) determined the time of the retrograde events using the internal isochron method involving the retrograde garnet in the Sm-Nd system from three kinds of UHT metamorphic rocks and discussed the relationship between the Napier Complex and the adjacent Gondwana fragments. Here we present the time of retrograde event of the Napier Complex following Owada et al. (2003), and discuss its retrograde tectonothermal events.

The peak metamorphism of the Napier Complex has been regarded to take place at the Late Archaean, although the exact age is still controversial (e.g., Harley and Black, 1997; Asami et al., 2002). Owada et al. (2003) examined the time of retrograde events. The dated samples were collected from Tonagh Island, the southern end of the Amundsen Bay. Three samples, namely, sapphirine-bearing aluminous gneiss, garnet-bearing felsic gneiss and iron-rich garnet-pyroxene gneiss, were analysed for age determination. Crustal residence time estimated from the Nd model age using the depleted mantle evolutional line (T_{DM}) of the dated samples gives a value of 3400 Ma to 4500 Ma, suggesting that these rocks experienced crustal evolution since early Archaean.

Internal isochron ages involving retrograde garnet for the sapphirine-bearing aluminous and the garnet-bearing felsic gneisses are of 1870±82 Ma and 1897±50 Ma,

respectively. On the other hand, the internal isochron for the Fe-rich garnet-pyroxene gneiss gives an age of 1557±35 Ma. These ages are fairly younger than the timing of UHT metamorphism.

Proterozoic igneous activities in the Napier Complex formed the so-called "Amundsen Dykes". The formation age of the dykes was regarded as ca 1200-1400 Ma (Sheraton and Black, 1981; Sheraton et al., 1987). Suzuki et al. (2000) performed Sm-Nd whole-rock isochron dating for meta-tholeiitic dykes and obtained an age of ca 1900 Ma in the Mt. Riiser-Larsen region, 40 km northeast of Tonagh Island. The dykes intruded into the middle to lower crustal level, and simultaneously underwent upper amphibolite to lower granulite facies metamorphism inferred from their mineral assemblages (Ishizuka and Suzuki, 2000). Although it is difficult to reset the Sm-Nd system in the whole-rock scale under the upper amphibolite to granulite facies metamorphism, the isochron age corresponds to the time of formation of the dykes after the UHT metamorphic event. The tectonothermal event of ca 1900 Ma would, therefore, include some magma activities in the Napier Complex.

The retrograde garnet from ca 1900 Ma samples occurs as coronas developed on the orthopyroxene. This texture indicates isobaric cooling (IBC), which is widely accepted by previous workers. The similar texture is extensively present throughout the Napier Complex (e.g., Sheraton et al., 1987). The retrograde P-T conditions of this event show 7-9 kbar and 750°-850°C (e.g., Sheraton et al., 1987). The estimated P-T values of the garnet-bearing felsic gneiss and also the sapphirine-bearing aluminous gneiss (Hokada et al., 1999) resemble those of the retrograde IBC reported from other part of the Napier Complex. In addition, 2000 Ma CHIME ages are obtained from the western part of the Napier Complex (Asami et al., 2002). Consequently, the tectonothermal events of ca 1900 Ma to 2000 Ma are one of the major retrograde events, which affected extensively the Napier Complex.

In the Fe-rich garnet-pyroxene gneiss, fine-grained augite and quartz coexisting with garnet interstitially occur in deformed inverted-pigeonite. There are no signs of deformation features on fine-grained augite and quartz. These textures imply that augite, quartz and garnet were formed through a relatively static thermal event after the deformation of inverted-pigeonite. Retrograde temperature conditions for ca 1900 Ma samples and ca 1550 Ma sample are different, suggesting that the age of ca 1550 Ma may reflect another tectonothermal event separated from the age of ca 1900 Ma.

East Gondwana fragments such as the Rayner Complex and the EGB record a tectono-thermal event at ca 1400 Ma to 1600 Ma ago. After this event, these three fragments (the Napier and the Rayner Complexes and the EGB) had been experienced tectono-thermal events at late Proterozoic and early Paleozoic.

Yoshida et al. (2000) argued that the ca 1900 Ma events in the EGB reflect convergent tectonothermal events, and the protolith ages indicate Early Proterozoic to late Archaean. Based on the Nd T_{DM} ages, Kelly et al. (2002) interpreted that the majority of the Rayner Complex is composed of a mixture of early Proterozoic and late Proterozoic orthogneisses underlain by early Proterozoic (~2100 Ma) lower crust, suggesting that the initial crust formation of the Rayner Complex has been dated back to early Proterozoic. The age of ca 1400-1900 Ma is known as the formation of the supercontinent "Columbia" (Rogers and Santosh, 2002). The time of the major retrograde event of the Napier Complex (ca 1900 Ma to 2000 Ma) is comparable to that of assembly of Columbia. The related East Gondwana fragments including the Napier

and Rayner Complexes in Antarctica and the EGB in India might, therefore, have juxtaposed with each other during the assembly of Columbia.

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