

Geochronology of the metamorphic rocks from the Masora, Antananarivo and Betsimisaraka domains, east-central Madagascar

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In a previous reconstruction of Gondwana supercontinent, Madagascar is located within the interior of the supercontinent (e.g. Jacobs and Thomas, 2004). Therefore, Madagascar is one of the most significant areas to understand the process of Gondwana supercontinent formation. However, it is still controversial whether the central part of Gondwana supercontinent was formed by young arc-arc collision and amalgamation (Stern, 1994), or was reworked of old continent (e.g. Collins and Pisarevsky, 2005; Tucker et al., 2012). In this study we estimated the age of protolith formation by applying LA-ICP-MS zircon dating method to metaigneous rocks and the age of metamorphism by applying EPMA monazite dating method to metasedimentary rocks, to understand the geochronological characteristics of the composed domains in east-central Madagascar.

East-central Madagascar is divided into Masora, Betsimisaraka and Antananarivo domains from east to west based on the geology and geochronology (Tucker et al., 2011). The Masora domain is mainly composed of the felsic metamorphic rocks with subordinate amounts of the metasedimentary rocks. Two metasedimentary rocks gave ages ranging from ca. 520 to 510 Ma. This age range is consistent with the age obtained from the meta-granitoid (ca. 530 to 510 Ma, Smith et al., 2008) and from quartzite (ca. 540 to 520 Ma, De Waele et al., 2011) by U-Pb zircon dating method. The felsic metamorphic rock gave igneous age at ca. 3300 Ma. This age is consistent with the age obtained from the migmatized gneiss (Tucker et al., 2011).

The Antananarivo domain is mainly composed of the felsic metamorphic rocks with subordinate amounts of the metasedimentary rocks. This domain is divided into east and west on the basis of the metamorphic condition and structural geology. The east and west areas are bounded by the low-angle ductile shear zone of top-to-west sense. Monazites from the metasedimentary rock in the east gave ages ranging from ca. 500 to 480 Ma. In the west monazites from the two types of the metasedimentary rocks gave ages ranging from ca. 540 to 500 Ma (Martelat et al., 2000) and ca. 630 to 540 Ma (Jöns and Schenk, 2011) and from the meta-granitoid gave age ranging from ca. 560 to 540 Ma (Grégoire et al., 2009). Therefore, the metamorphic age in the east is relatively younger than in the west. The felsic metamorphic rocks are geochemically classified into two types, which gave individual igneous ages of ca. 2700 Ma in the east and ca. 760 Ma in the west, respectively. The intermediate metamorphic rocks are exposed in the west and gave igneous age at ca. 550 Ma.

The Betsimisaraka domain is mainly composed of the metasedimentary rocks. Monazites from the metasedimentary rocks gave ages of ca. 500 Ma. This age is younger than the ages reported from the quartzite at ca. 550-520 Ma (Tucker et al., 2011) and rim ages from the metasedimentary rock at ca. 550 Ma (Collins et al., 2003) by U-Pb zircon dating method.

As a consequence east-central Madagascar was metamorphosed between ca. 550 and 500 Ma. Both the east of the Antananarivo and Betsimisaraka domains was metamorphosed at the youngest age around ca. 500 Ma. In previously reported geochronological results the oldest igneous activity was at ca. 2500 Ma in the Antananarivo domain (e.g. Kröner et al., 2000). Therefore the ca. 2700 Ma igneous age is new and the oldest igneous age in this domain. The east of the Antananarivo domain was older than the west and the oldest part of this domain. The age transition zone was possibly exposed between the Masora, Betsimisaraka and the west of the Antananarivo domains. The age and geological relationship in Archean domain was recently reported from the Dhawar Craton in southern India (Peucat et al., 2013). The existence of the ca. 2700 Ma igneous activity in the east of the Antananarivo domain could be the significant evidence of the continuity between India and Madagascar since Archean.

Keywords: Gondwana supercontinent, east-central Madagascar, LA-ICP-MS U-Pb zircon dating, EPMA monazite dating