Precambrian Research 234 (2013) 30–46

Contents lists available at ScienceDirect

Precambrian Research

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

Sinistral transpressional and extensional tectonics in Dronning Maud Land, East Antarctica, including the Sør Rondane Mountains

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ARTICLE INFO

Article history:
Received 9 April 2012
Received in revised form 15 April 2013
Accepted 18 May 2013
Available online 2 June 2013

Keywords:
Sør Rondane Mountains
East Antarctica
Pre-Pan-African extension
Sinistral transpression
Dextral shearing
Gondwana

ABSTRACT

In this paper we clarify the history of deformation in the Sør Rondane Mountains (SRMs), eastern Dronning Maud Land (DML), East Antarctica, and construct a form-line contour map of the metamorphic and plutonic rocks in order to comprehend their structural features and provide constraints on the collisional tectonics of East and West Gondwana. We divide the deformational history in the SRMs into 13 stages (D1–D13). The tectonic regime varied frequently from extension (D3–D4) to layer-normal compression and layer-parallel extension (D5), to compression (D6), extension (D7), sinistral transtension and sinistral strike-slip (D8), compression (D9–D11), and finally extension related to dextral shearing (D12–D13). D7 and D8 indicate major extensional tectonic activity in the southern part of the East African and Antarctic Orogen (EAAO) before the Pan-African compressional event, and after the c. 600 Ma peak of metamorphism. The Pan-African compressional event resulted in the formation of upright folds with horizontal axes that curve along the coastline in central to eastern DML during the D9 deformation that took place between 600 and 560 Ma. The coastline-parallel fold axes and subvertical axial-planes correspond to the *X*-axes and the *XY*-planes, respectively, of strain ellipsoids that were progressively rotated counterclockwise toward the central parts of a sinistral shear zone. Therefore, the curved fold axes and axial-planes suggest the EAAO acted as a zone of sinistral transpression during the collision of parts of East and West Gondwana. Around 560–550 Ma, during D12, parallel dyke swarms of granitic pegmatite were intruded along normal faults under a regime of NNE–SSW horizontal extensional stress. The extensional paleo-stress and its related structures suggest dextral rather than sinistral shearing took place along the north-trending EAAO during this late Pan-African event. There is the possibility of a reversal of trans-orogen asymmetry from sinistral to dextral in the southern part of the EAAO. The dyke swarms are considered to have been the heralds of the voluminous 530–500 Ma A-type granite intrusions in DML. At the same time, the Lützow–Holm Complex was under a non-extensional tectonic regime, and may have been situated in a different orogen from the EAAO.

1. Introduction

Dronning Maud Land (DML), including the Sør Rondane Mountains (SRMs), in East Antarctica (Fig. 1), is a key region for understanding Pan-African tectonothermal events and Neoproterozoic to Early Palaeozoic continental collisions that resulted in the formation of the Gondwana supercontinent (e.g. Jacobs et al., 1998; Jacobs and Thomas, 2002, 2004; Bauer et al., 2003).

Jacobs and Thomas (2002, 2004) indicated that the SRMs were situated in the 650–500 Ma East African and Antarctic Orogen (EAAO) and Meert (2003) indicated that the SRMs were located in the 570–530 Ma Kuunga Orogen (Fig. 2a and b). The EAAO resulted from a sinistral transpressional collision between East Gondwana

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http://dx.doi.org/10.1016/j.precamres.2013.05.010

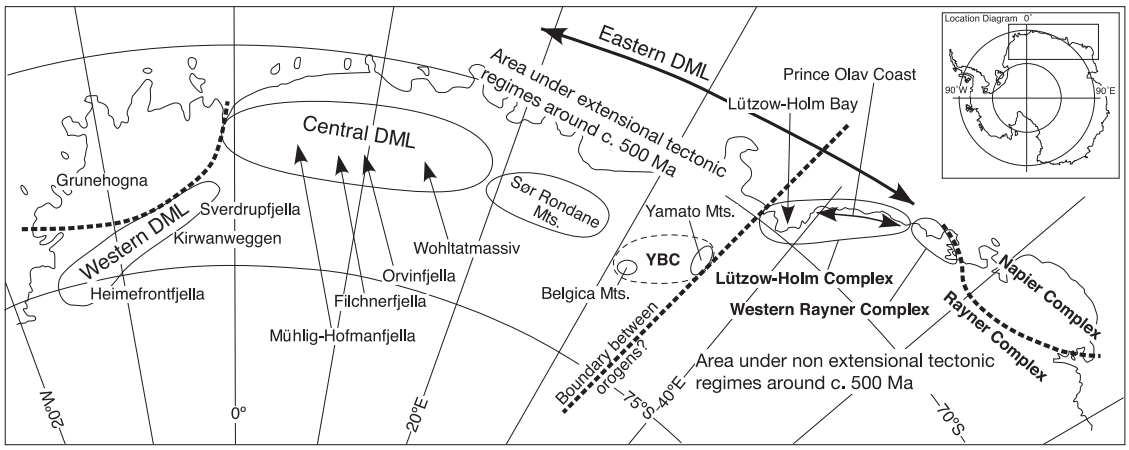

Fig. 1. Map that gives an overview of geographical names and geological terranes in western to eastern Dronning Maud Land and Enderby Land, East Antarctica. YBC, Yamato–Belgica Complex.

(including parts of India and East Antarctica) and West Gondwana (including the Congo and Kalahari cratons) (Jacobs et al., 1998, 2003a,b, 2008; Jacobs and Thomas, 2002, 2004). In the Kuunga Orogen, the East Antarctic, Australian, and Kalahari cratons collided with the Indian Craton and eastern Africa (including the Congo Craton) (Meert, 2003). The EAAO includes the westernmost part of the Lützow–Holm Complex (LHC) (Fig. 2a), which crops out along Lützow–Holm Bay (LHB) and the Prince Olav Coast (POC) (Fig. 3). The Kuunga Orogen includes the entire LHC and the western Rayner Complex (wRC) (Fig. 2b). Boger (2011) also put together some paleo-geodynamic maps for East Antarctica. According to Boger (2011), metamorphic and igneous rocks in DML occur in three belts: the 990–900 Ma Rayner Belt in the Indo-Antarctic Craton, the 550–520 Ma Ediacaran–Cambrian collisional belt in the Pan-African Orogenic Belt, and the 1130–1060 Ma Maud–Natal Belt in the Kalahari Craton. Rocks of the three belts are exposed in the areas from the western DML to the SRMs, from the Belgica Mountains (BMs) to the western coast of the LHB, and from the eastern coast of the LHB to the boundary between the Rayner and Napier Complexes, respectively. Grantham et al. (2008) further proposed that the East African–East Dronning Maud Land Orogen formed a mega-nappe, and they considered that the basal thrust of the mega-nappe was in the SRMs. It is still unclear which of these various orogenic models is the more realistic. The SRMs, located in the westernmost part of eastern DML (Fig. 1), have been recognized as the key to clarifying the reconstruction of the supercontinent and for developing a model of the Neoproterozoic–Cambrian orogen.

Jacobs et al. (2008) divided the Late Neoproterozoic–Early Palaeozoic collisional history of DML into three major phases, mainly on the basis of numerous U–Pb SHRIMP zircon analyses. The first phase is characterized by a granulite facies metamorphism at c. 670 Ma and a period of anorthosite magmatism at c. 600 Ma (Jacobs et al., 2008). Evidence for the second phase is the intense deformation and metamorphism between c. 590 and 550 Ma that is interpreted to represent a period of collision (Jacobs et al., 1998, 2003b, 2008); it produced E- to ESE-trending upright folds that are postdated by major sinistral shearing and transpression (Bauer et al., 2003, 2004). The third phase is associated with extensional tectonics, voluminous A2-type granitic intrusions, tectonic exhumation, and S-directed crustal extrusion between c. 530

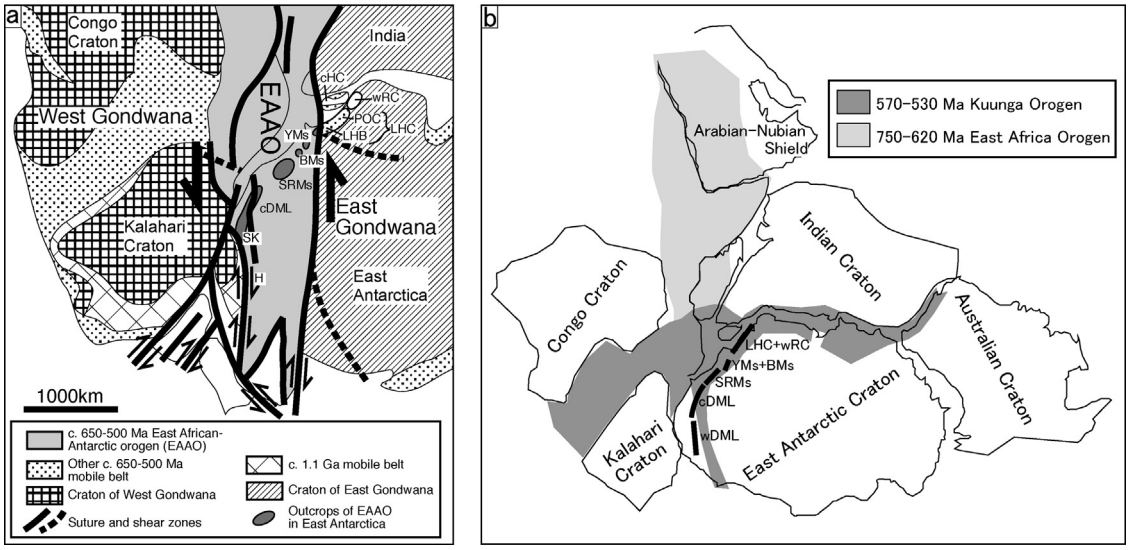

Fig. 2. Geological setting around East Antarctica during the Neoproterozoic to Early Palaeozoic continental collision. SK, H.U. Sverdrupfjella and Kirwanveggen; H, Heimefrontfjella; wDML, western Dronning Maud Land; cDML, central Dronning Maud Land; SRMs, Sør Rondane Mountains; BMs, Belgica Mountains; YMs, Yamato Mountains; LHB, Lützow–Holm Bay; POC, Prince Olav Coast; LHC, Lützow–Holm Complex; wRC, western Rayner Complex; cHC, central Highland Complex. (a) Geological setting of the southern part of the East African–Antarctic Orogen (EAAO) modified after Jacobs and Thomas (2004) and Jacobs et al. (2008). (b) Geological setting of the East Africa and Kuunga orogens modified after Meert (2003). The Kuunga Orogen includes cDML, eastern DML (including the SRMs to POC), and Enderby Land (wRC).