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Extent, kinematics and tectonic origin of the Precambrian Aswa Shear Zone in eastern Africa

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ABSTRACT

The Aswa Shear Zone (ASZ) is a fundamental Precambrian lithospheric structure that has been shaped by many tectonic events in eastern Africa. It separates the Saharan Metacraton in the northeast from the Northern Uganda terrane (which represents part of the Northeastern Congo block of the Congo craton) to the southwest. Nonetheless, its tectonic evolution is not fully understood. We used high-resolution airborne magnetic and radiometric data over Uganda integrated with Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) in South Sudan to assess the extent, kinematics and contribute to the understanding of the tectonic origin of the ASZ. (1) Our results showed that the ASZ extends in a NW–SE direction for ~550 km in Uganda and South Sudan. (2) The airborne magnetic and radiometric data revealed a much wider (~50 km) deformation belt than the 5-10 km of the exposed surface expression of the ASZ. The deformation belt is defined by three NW-trending sinistral strike-slip shear zones bounding structural domains with magnetic fabric showing splays of secondary shear zones and shear-related folds. These folds are tighter close to the discrete shear zones with their axial traces becoming sub-parallel to the shear zones. A similar fold pattern is observed in South Sudan from the SRTM DEM. We interpreted these folds as due to ENE–WSW contraction associated with the sinistral strike-slip movement. (3) To the northeast, the magnetic patterns and radiometric signatures suggest the presence of a series of W-verging nappes indicative of strong E–W to NE–SW contraction deformation. (4) We relate the evolution of the ASZ to E–W to NE–SW Neoproterozoic oblique collision between East and West Gondwana. The deformation related to this collision was partitioned into E–W to NE–SW contraction resulting in W-verging thrusts in the east and a sinistral strike-slip movement along the NW-trending ASZ with the strain localized at the boundary between the Saharan Metacraton and the Northern Uganda terrane.

1. Introduction

The Aswa Shear Zone (ASZ) is a fundamental NW-trending Precambrian structure in the central part of Gondwana (Fig. 1A). Traces of the shear zone have been mapped in eastern and central Africa extending in a NW–SE direction from South Sudan in the northwest through Uganda, Kenya and Tanzania to the southeast and possibly into Madagascar as the Ranotsara shear zone (Fig. 1A; Collins et al., 2003). It has been proposed that the ASZ extends further southeast into south India as the Achankovil shear zone in a Greater Gondwana reconstruction (Fig. 1A; Pradeepkumar and Krishnanath, 2000; Santosh and Collins, 2003). Until recently, only a few generalized studies have attempted to explain the Precambrian evolution of the ASZ and most of these attempts correlated the shear zone to other Neoproterozoic NW-trending strike-slip shear zones in the Arabian–Nubian Shield, the most prominent of which is the Najd fault system which is exposed in northwestern Saudi Arabian and the Eastern Desert of Egypt (Fig. 1A; Berhe, 1990; Stern, 1994). Both Berhe (1990) and Stern (1994) suggested that the development of the ASZ can be linked to the collision between East and West Gondwana similar to other NW-trending strike-slip shear zones in the Arabian–Nubian Shield.

Besides its importance in understanding the Precambrian evolution of East and West Gondwana and their lithospheric structure, the ASZ is also important for understanding the development of Mesozoic and Cenozoic rifts, seismicity distribution, and controls on the Nile drainage system in eastern Africa. Recent studies in Uganda (Nyakecho and Hagemann, 2014; Ruotoistenmäki, 2014; Westerhof et al., 2014) have highlighted the importance of the ASZ, especially as a major Precambrian structure. However, the lack of geological investigations in the better exposed part of the ASZ in South Sudan hinders full understanding of the geodynamic evolution of this structure.

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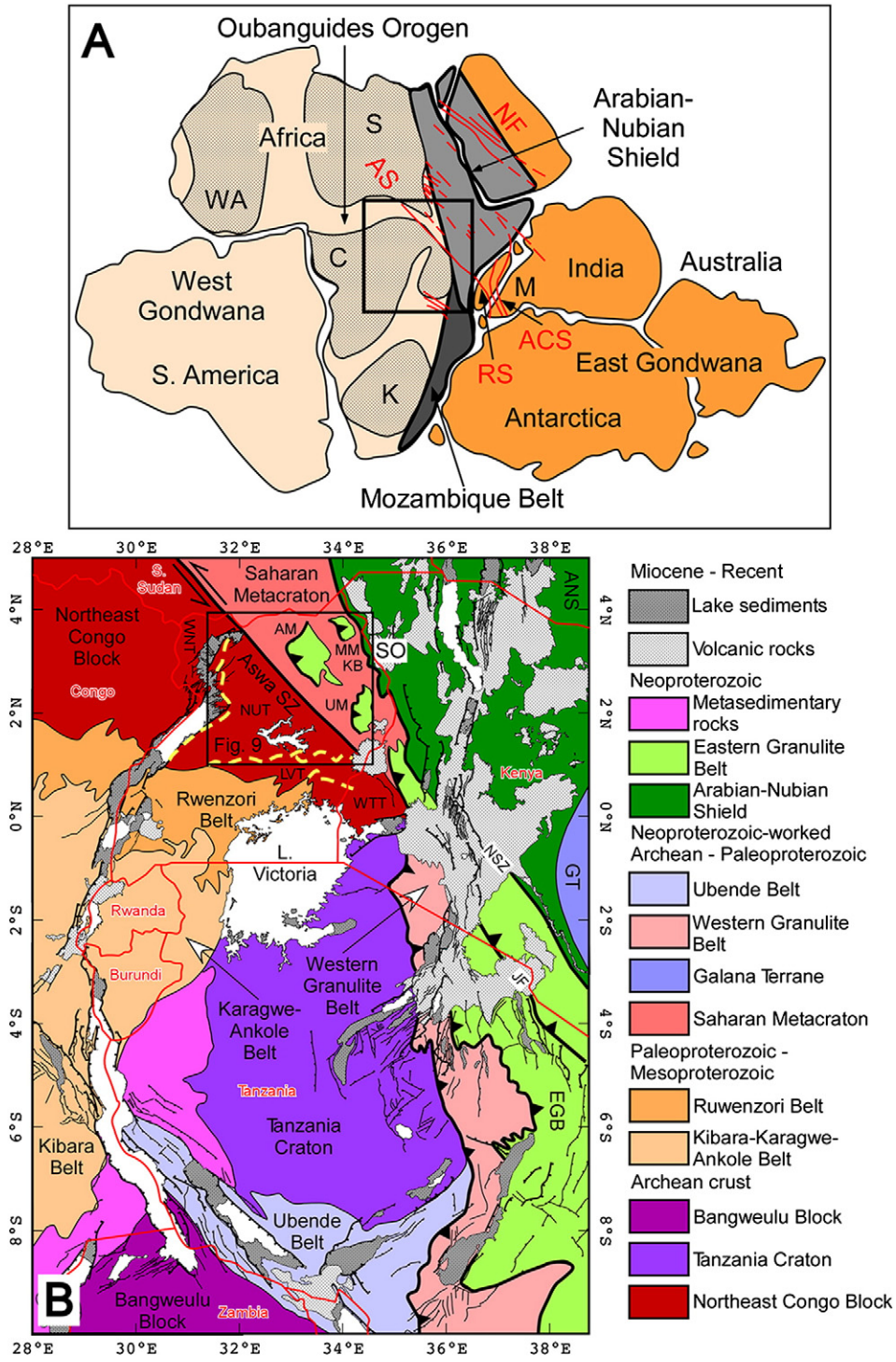

Fig. 1. (A) The Arabian–Nubian Shield and the Mozambique belt representing the East African Orogen between East and West Gondwana. Modified after Meert and Lieberman (2008). M = Madagascar. WA = West Africa Craton. S = Saharan Metacraton. C = Congo Craton. K = Kalahari Craton. AS = Aswa Shear Zone. NF = Najd Fault System. RS = Ranotsara shear zone. ACS = Achankovil shear zone. The NW-trending shear zones are from Berhe (1990) and Stern (1994). (B) Precambrian tectonic map of eastern Africa. Modified from a compilation by Katumwehe et al. (2015). Dotted yellow lines approximate the boundaries suggested by Westerhof et al. (2014) to divide the Northeastern Congo block in Uganda into the Western Nile terrane (WNT), Northern Uganda terrane (NUT), Lake Victoria terrane (LVT) and West Tanzania terrane (WTT). ANS = Arabian–Nubian Shield. GT = Galana terrane. EGB = Eastern Granulite belt. SO = Sekerr ophiolite. MM = Morungole massif. AM = Akur massif. UM = Ukutat massif. KB = Karamoja belt. NSZ = Nyangere shear zone. JF = Jailhouse rock fault.

In this work, we attempt to define the extent and explain the kinematics of the ASZ in Uganda and South Sudan benefiting from the availability of Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) and the newly acquired high resolution airborne geophysical data from Uganda. Additionally, we propose an origin for the ASZ within the context of East and West Gondwana tectonics.

1.1. The ASZ and Gondwana tectonics

Abdelsalam et al. (2002, 2011) suggested that the ASZ might represent the boundary between the Saharan Metacraton in the northeast and the Congo craton to the southwest (Fig. 1A). The extent of the Congo craton in northeastern Congo and northwestern Uganda is