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The Tuareg shield terranes revisited and extended towards the northern Gondwana margin: Magnetic and gravimetric constraints

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ABSTRACT

The Trans-Saharan Belt is one of the most important orogenic systems constitutive of the Pan-African cycle, which, at the end of the Neoproterozoic, led to the formation of the Gondwana Supercontinent. It is marked by the opening and closing of oceanic domains, collision of continental blocks and the deformation of thick syn-orogenic sedimentary basins. It extends from north to south over a distance of 3000 km in Africa, including the Nigerian Shield and the Tuareg Shield as well as their counterparts beneath the Phanerozoic oil-rich North- and South-Saharan sedimentary basins. In this study, we take advantage of potential field methods (magnetism and gravity) to analyze the crustal-scale structures of the Tuareg Shield terranes and to track these Pan-African structures below the sedimentary basins, offering a new, > 1000 km extent. The map interpretations are based on the classical potential field transforms and two-dimensional forward modeling. We have identified geophysical units and first-order bounding lineaments essentially defined owing to magnetic and gravimetric anomaly signatures. In particular, we are able to highlight curved terminations, which in the Trans-Saharan context have been still poorly documented. We provide for the first time a rheological map showing a categorization of contrasted basement units from the south of the Tuareg Shield up to the Atlas Belt. These units highlight the contrasted rheological behavior of the Tuareg tectonostratigraphic terranes during (i) the northerly Pan-African tectonic escape characteristic of the Trans-Saharan Belt and (ii) the North Sahara basin development, especially during intraplate reworking tied to the Variscan event. The discovery of a relatively rigid E-W oriented unit to the south of the Atlas system, and on which the escaping Pan-African terranes were blocked, offers a new perspective on the structural framework of the north-Gondwana margin. It will help to understand how occurred the rendezvous of the N-S oriented Pan-African terranes and the E-W oriented Cadomian peri-Gondwanan terranes.

1. Introduction

The Trans-Saharan Belt is one of the most important orogenic system constitutive of the Pan-African orogenic cycle (Fig. 1), which, at the end of the Neoproterozoic (~540 Ma), led to the formation of the Gondwana Supercontinent (Bertrand and Caby, 1978; Black et al., 1979; Caby et al., 1981; Trompette, 1994; Kröner and Stern, 2005; Fritz et al., 2013; Oriolo et al., 2017). This belt represents a major crustal growth event, but also a major place where pre-existing cratons have been variably reactivated (metacraton sensu Liégeois et al., 2013).

The Trans-Saharan Belt formed in between the West African Craton (WAC) to the west, and the Saharan Metacraton (SmC) to the east (Fig. 1B). It extends from north to south over a distance of 3000 km, including the Nigerian Shield and the Tuareg Shield as well as their prolongations beneath the Phanerozoic North- and South-Saharan sedimentary basins (Coward and Ries, 2003). In this study, we focus more particularly on the crustal-scale structure of the Tuareg Shield and their oil-rich northern counterparts beneath the North Sahara basins (Beuf et al., 1971; Fabre, 1976; Black et al., 1994; Boote et al., 1998; Fekirine and Abdallah, 1998; Bumby and Guiraud, 2005; Guiraud et al., 2005; Craig et al., 2008; Eschard et al., 2010; Galeazzi et al., 2010).

Following several decades of geological studies (structural geology, geochronology, petrology), the overall Neoproterozoic development of the Trans-Saharan Belt is understood as resulting from the development

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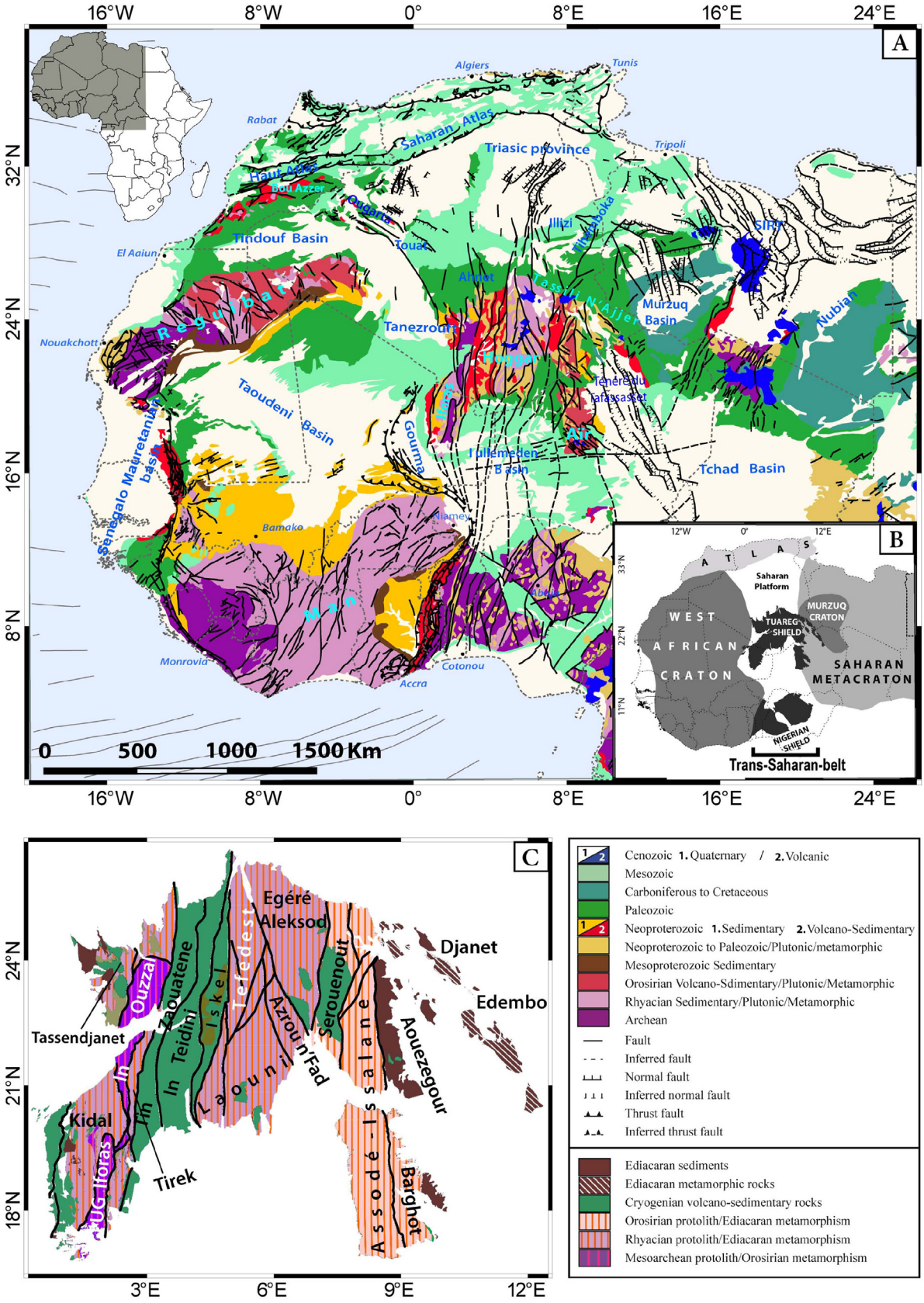

Fig. 1. (A) Geological map of North West Africa modified from BRGM (Milesi et al., 2004 and Thiéblemont, 2016); (B) Distribution of main geotectonic entities; (C) A focus on the Tuareg Shield showing terranes and their boundaries.