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Structural evolution of Iwaraja shear zone, southwestern Nigeria

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ABSTRACT

The Iwaraja shear zone is an easterly splay to the Ifewara shear zone in the eastern part of Ilesha schist belt, southwestern Nigeria. Results of field and microstructural investigations reveal that the Iwaraja shear zone was developed during the second deformation phase that affected the region under retrograde metamorphic conditions. Deformation within the shear zone involved the mylonitisation of the granitic gneiss generating rocks ranging from weakly deformed granitic gneiss to ultramylonite under amphibolite to greenschist facies, respectively. The shear zone is characterized by NNE-SSW trending, sub-vertical mylonitic foliation (ca. 022°/79°) with shallowly dipping stretching lineations (ca. 021°/10°). Minor folds in the shear zone include early and late folds of pegmatite dykes in the granitic gneiss mylonite. The early folds are typically open to close folds but the late folds show typical geometry of synthetic folds characterized by thinned short limbs. Kinematic indicators in the granitic gneiss mylonite include sigma-type (σ-type) porphyroclasts and displaced fractured feldspar porphyroclasts indicate dextral shear sense. These features show that dextral, transcurrent displacement was important in the final amalgamation of different crustal blocks during the closing stages of the Pan-African Orogeny.

1. Introduction

Major crustal-scale transcurrent shear zones occur in many tectonic settings around the world. These major shear zones have been recognized as important elements of crustal deformation during orogenesis involving collisional, transcurrent or oblique (transpressive) displacements. The nature of activity along these shear zones may evolve with orogenic development going from dominantly convergent to dominantly transcurrent at a later period like the evolution of transcurrent shear zones in the Kaoko belt, northwestern Namibia (Konopasek et al., 2005) and the deformation along the inner fore-arc of the obliquely convergent Hikurangi margin, southeastern North Island, New Zealand (e.g. Kelsey et al., 1995). Several Neoproterozoic orogenic belts are characterized by several of such shear zones trending generally parallel to the elongation of the belt, such as the Borborema, Dahomeyides-Nigeria and the Hoggar provinces where the shear zones are roughly parallel to the suture (Fig. 1a) linking the provinces to the West African craton (Vauchez et al., 1995; Attoh et al., 1997; Arthaud et al., 2008; Caby, 2003), the Mozambique belt of East Africa (e.g. Ring et al., 2002). Considerable strike-slip movements were observed to have taken place along these major shear zones.

Detailed analyses of mesoscopic and microscopic structures towards understanding the deformation associated with these shear zones as well as models for their evolution have been are well documented (e.g. Alsop and Holdsworth, 2004; Carreras et al., 2005; Schmid, 1982; Simpson and Schmid, 1983; Holdsworth, 1989; Oyhantcabal et al., 2010; Banerjee and Matin, 2013).

The tectonics of the western Nigerian belt, particularly the evolution of the major transcurrent shear zone structures have not been investigated in detailed and are such poorly understood. Only regional studies (e.g. Caby, 2003; Caby and Boesse, 2001) that are relevant to the structural evolution of the study area and also references (e.g. Arthaud et al., 2008; Viegas et al., 2014) that document continent-scale relationship of the shear zones of the Nigeria shield with other Neoproterozoic shear zones in North Africa and NE Brazil are available.

The width of the Iwaraja shear zone is ~700 m. Since the recognition of this shear zone (Hubbard 1975; Folami, 1992; Odeyemi, 1993; Caby and Boesse, 2001; Anifowose et al., 2006; Kayode et al., 2010; Adelusi et al., 2013), the structural evolution and nature of displacement in this shear zone has been the subject of different interpretations. Some workers have inferred a wholly transcurrent motion while others have suggested a thrust displacement. These interpretations were largely based on geophysical and remote sensing observations with little

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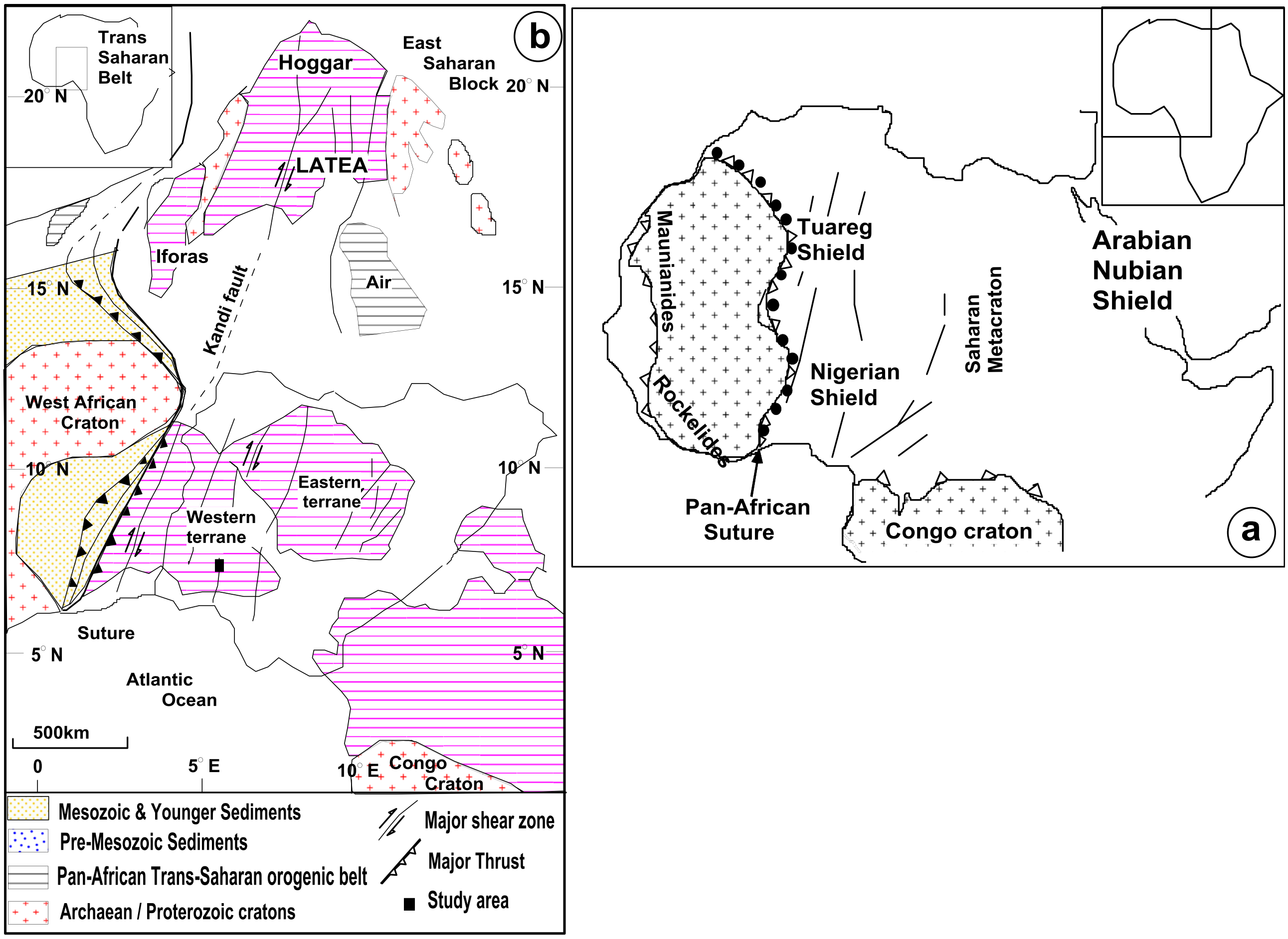

Fig. 1. Regional geological sketch map of (a) Pan-African belt showing the Tuareg shield and Nigerian Shield (modified after Caby, 2003) (b) Trans-Sharan belt showing Hoggar-Air-Nigeria province (modified after Ferré et al., 2002).

petrostructural input.

We present here field as well as laboratory-based petrological and microstructural study in order to comprehensively characterize the Iwaraja shear zone and place it in the context of the overall structural evolution of the area.

2. Geological setting of Nigeria

The Nigerian shield belongs to the southern part of the Neoproterozoic (750 - 500 Ma) Trans-Saharan belt (Fig. 1), which was formed by continental collision between the converging Archaean blocks of West African craton, Congo craton and Saharan Metacraton (Caby, 1989, 2003; Black et al., 1994; Ferré et al., 2002). The main Pan-African suture is buried under Phanerozoic cover in southwest Algeria but is exposed in northern Mali, Togo, Benin and Ghana (Caby, 1989). The Trans-Saharan belt is a complex assemblage of N–S trending geological terranes which have evolved differently (Boullier, 1991). According to Kroner and Stern (2005), this belt consists of pre-Neoproterozoic basement strongly reworked during Pan-African event and Neoproterozoic oceanic assemblages. It is characterized by high-grade metamorphism, early thrust-nappe development, numerous granite intrusions and late orogen-parallel tectonics (e.g. Black and Liégeois, 1993). During the late Pan-African, shield-scale strike-slip ductile shear zones and brittle faults were produced which were long considered as the main tectonic manifestations of Pan-African event in the Trans-Saharan belt (Boullier, 1991). According to Boullier (1991), the shear zones did not operate at the same time; some of them have been related to the early thrust-nappes, such as the Tin Di-Tin Eifei lineament in western Hoggar (Lapique et al., 1986), while others have been shown to clearly postdate this event, such as the 4°50′ fault, where considerable dextral strike-slip movement took place also along the 4°50′ fault (Caby, 1989). These strike-slip faults are important in the correlation of the Trans-Saharan belt with northeast Brazil in relation to the pre-Mesozoic fit of the West Africa and northeast Brazil (Viegas et al., 2014).

The Nigerian shield is believed to represent in part the southern extension of the Laouni-Tefedest-Azrou-n-fad (LATEA) terrane (Caby and Boesse, 2001) distinguished by Liegeois et al. (2000) in the Tuareg shield. The terrane includes large volume of polycyclic migmatitic gneisses of assumed Palaeoproterozoic and/or Archaean age and abundant late-kinematic Pan-African granitoids (Liegeois et al., 2003). In the Nigerian shield, the existence of two main terranes (Fig. 1b); western and eastern Nigeria, proposed by Ferré et al. (1996) have been recognized. The eastern Nigerian terrane forms a separate Neoproterozoic terrane exhibiting significant lithological differences with the western Nigeria terrane (Ferré et al. (2002). It consists of mainly a migmatite-gneiss complex intruded by larger volumes of Pan-African granites and the Mesozoic ring of the Central Nigeria (Ajibade et al., 1987). No basement-cover relationship was identified in the gneisses and migmatites of Eastern Nigeria. Nd model ages and Pb upper intercept ages suggest that the migmatites were derived from 2.0 to 1.8 Ga metasediments (Ferré et al., 2002). The Neoproterozoic tectono-metamorphic