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Liassic age of an oceanic gabbro of the External Rif (Morocco): Implications for the Jurassic continent–ocean boundary of Northwest Africa

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ABSTRACT

This work concerns the northernmost limit of the West African Craton (WAC) and Variscan WAC-related terranes of NW Africa. Based on newly obtained radiometric age of an oceanic gabbro from the "Mesorif Suture Zone" of the External Rif Belt, we propose a revised interpretation of this puzzling lineament. We report on a 190 ± 2 Ma LA–ICP–MS U–Pb zircon age of a trondhjemite vein cross-cutting the Bou Adel gabbro, which is one of the largest oceanic units of the quoted suture zone. We previously interpreted the arcuate MSZ in terms of transported, hyper-extended margin of the Alpine Tethys, based on a K–Ar 166 ± 3 Ma age ascribed to the Bou Adel gabbro in the literature. The new, Early/Middle Liassic age coincides instead with the onset of oceanic floor formation in the Central Atlantic. We hypothesize that the Mesorif suture zone corresponds to the transported trace of the West African Atlantic margin surrounding the northwestern Moroccan Meseta promontory and connecting with the ENE-trending North African Transform North African transform. The latter zone sharply bounded the North Africa margin and connected the Central Atlantic with the Alpine Tethys. We propose that transported elements from the North African transform constitute the "Mesorif Basalt–Breccias" lineament parallel to and more external than the Mesorif suture zone. If correct, this new interpretation provides an opportunity to develop detailed field and laboratory studies of an exhumed segment of the up-to-now conceptual Jurassic North African transform.
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1. Introduction

The 2-Ga-old West African Craton (WAC) is surrounded by deformed margins of different types and ages (Fig. 1). Limiting our study to the northern half of the craton, we find to the east the Pan-African Trans-Saharan collisional belt, formed around 620–600 Ma (Bosch et al., 2016; Caby, 2003). To the west, the Pan-African units are incorporated in the Variscan Mauritanide Belt, built around 300 Ma during the Pangean collision (Bea et al., 2016; Gärtner et al., 2014; Le Goff et al., 2001; Montero et al., 2017;

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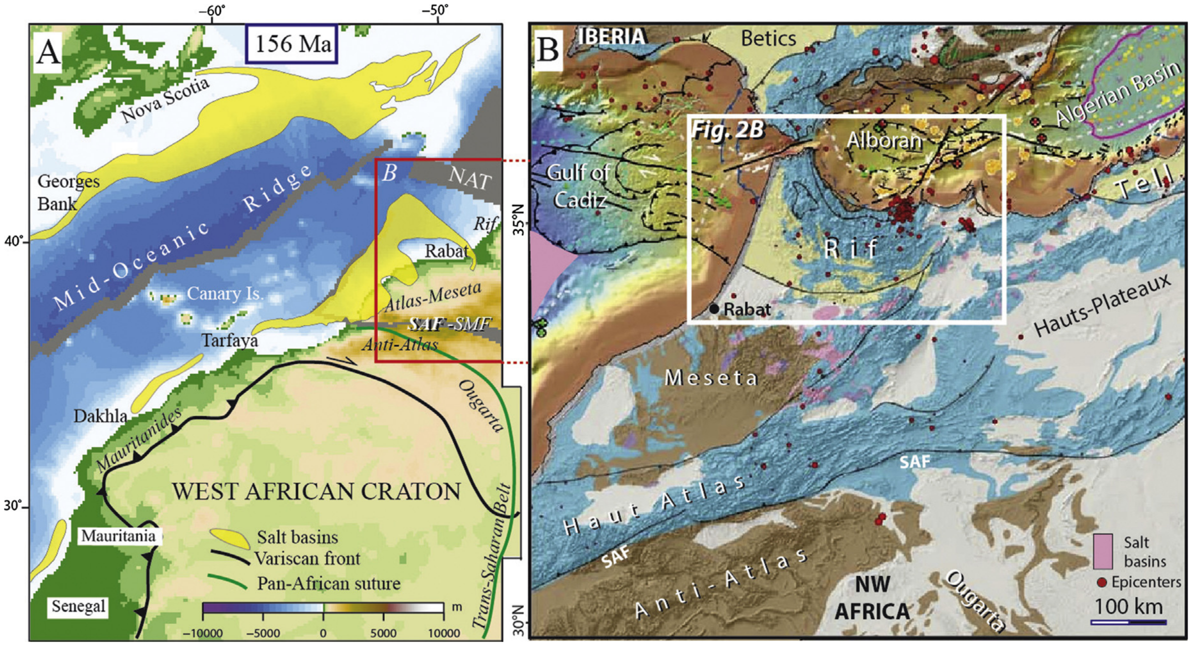

Fig. 1. The northwestern limits of WAC and WAC-related Variscan terranes. A. Atlantic margin geomorphology and salt basins, after Biari et al. (2017), modified. Salt basin from Tarfaya to Dakhla, after Davison and Dailly (2010). Main geological boundaries around the WAC after Michard et al. (2010). B. Geotectonic map of the northwestern Africa–Iberia contact zone, showing the relationships of the Atlantic margin with the Azores–Gibraltar–West Mediterranean transform zone. Background map after Mascle and Mascle (2012). Triassic evaporite basins in pink. Offshore Triassic basin after Hafid et al. (2008).

Villeneuve et al., 2006) and extending northward up to latitude 28°N. This poly-orogenic border has been partly superimposed by the structures of the West African passive margin, formed basically during the Triassic–Liassic breakup of Pangea at *ca.* 190 Ma (Labails et al., 2010).

The northern border of the WAC is currently defined by the South Atlas Fault (SAF, Fig. 1), i.e. the southern limit of the High Atlas intracontinental Alpine belt at some distance north of the Pan-African suture zone of the central Anti-Atlas (Ennih and Liégeois, 2001, 2008; Frizon de Lamotte et al., 2008). However, the SAF is mostly inherited from the Variscan South Meseta Fault (SMF; Michard et al., 2010), which limits the Meseta orogen from its Anti-Atlas foreland. A Paleoproterozoic and Neoproterozoic crust of Gondwanan affinity has been recently recognized in the Meseta domain (El Houicha et al., 2018; Letsch et al., 2017; Ouabid et al., 2017; Pereira et al., 2015). The Meseta Paleoproterozoic crust was rifted off the WAC before colliding against it during the Neoproterozoic "WAC-Cadomian" event of the Pan-African cycle (Hefferan et al., 2014). During the Paleozoic, the Meseta domain formed the distal passive margin of northwestern Gondwana before being amalgamated along the WAC Anti-Atlas border during the Variscan collision (Hoepffner et al., 2017; Michard et al., 2010). Thus, the most distal margin of the WAC-related terranes corresponds to the northern limit of the Atlas–Meseta domain beneath the thrust units of the ENE-trending Rif–Tell Alpine orogen.

The present paper aims at defining the east-trending limit of northwestern Africa inside the Rif domain and to recognize its connection with the northeast-trending Atlantic margin. The Moroccan Atlantic margin is currently described as preserving its overall northeast trend up to latitude 35°N (Biari et al., 2017; Hafid et al., 2008; Klingelhoefer et al., 2016), where it disappears beneath the accretionary prism of the Gulf of Cadiz (Crutchley et al., 2011; Gutscher et al., 2009). The implicit suggestion is that the Moroccan Atlantic margin should be crosscut there by the Newfoundland–Azores–Gibraltar fracture zone (Olivet et al., 1984; Sallarès et al., 2011), which broadens and coincides farther to the east with the Tell–Rif orogen (Galindo-Zaldívar et al., 2003; Meghraoui and Pondrelli, 2012). In contrast, we argue in the following that the Liassic Atlantic margin curved eastward at about latitude 35°N, entered the future Rif domain and connected there with the ENE-striking North African Transform (NAT) fault south of the Alpine Tethys domain (Frizon de Lamotte et al., 2011; Lemoine et al., 1987). This argument is based on a new, robust U–Pb zircon age obtained from an oceanic gabbro massif that crops out in the External Rif belt. This massif belongs to the so-called "Mesorif Suture Zone" (MSZ; Fig. 2; (Benzaggagh et al., 2014; Michard et al., 2007, 2014). Based on the new radiometric date, we propose the working hypothesis that rock material from the Atlantic margin could in fact constitutes most of, if not all, the oceanic elements of the Mesorif suture tectonic lineament. Moreover, we emphasize that the Kimmeridgian–Berriasian tholeiites and carbonates breccias described in the Mesorif (Ben Yaïch et al., 1989; Benzaggagh, 2011; Michard et al., 2007, 2014) define a second lineament,

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