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U–Pb baddeleyite and zircon ages of 2040 Ma, 1650 Ma and 885 Ma on dolerites in the West African Craton (Anti-Atlas inliers): Possible links to break-up of Precambrian supercontinents

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ABSTRACT

Precambrian inliers of the Anti-Atlas belt in the southern part of Morocco contain numerous dolerite dyke and sill swarms which were previously poorly dated. Four dykes and two sills dated by the U–Pb TIMS method on baddeleyite and zircon provide the first steps toward a magmatic 'barcode' for the West African Craton (WAC) and constraints on the timing of breakup of the WAC from Precambrian supercontinents. A 2040 ± 2 Ma (U–Pb zircon) age for a WNW dyke in the Zenaga inlier, matches the published age of a dyke in the Tagragra of Tata inlier, and also those of Eburnean granites observed in several inliers, which are collectively interpreted to represent ca. 2040 Ma bimodal magmatism due to a mantle plume. Based on the presence of matching 2040 Ma ages, the WAC may have been connected to the North Atlantic Craton at the initial stage of fragmentation of a late Archean continent. U–Pb baddeleyite ages of 1656 ± 9 Ma and ca. 1655 Ma from sills in the Zenaga inlier and 1654 ± 16 Ma from a NE-trending dyke in the Agadir Melloul inlier are similar to intraplate magmatic ages in eastern and northern Baltica, and support the SAMBA reconstruction (part of the Nuna supercontinent) of the WAC adjacent to Baltica. Approximate U–Pb ages of 885 Ma for two dykes in the Iguerda-Taïfast and Zenaga inliers date a NE trending swarm (named herein the Iguerda-Taïfast swarm) which is connected to the initial breakup of the supercontinent Rodinia, and a specific link with the São Francisco/Congo and North China craton is considered.

1. Introduction

The West African Craton hosts the remnants of extensive events of tholeiitic/alkaline magmatism represented by mafic sill and dyke swarms in most inliers of the Anti-Atlas chain of southern Morocco. These types of intrusive rocks are potentially important for the reconstruction of Precambrian continental blocks into their original relative positions using dyke swarm patterns, radiometric ages and palaeomagnetic signatures (e.g., Bleeker and Ernst, 2006; Buchan et al., 1998; Ernst and Buchan, 1997; Ernst and Bleeker, 2010; Fahrig, 1987; Halls, 1982; Li et al., 2008).

On the basis of geochronological data available prior to this study (e.g., Gasquet et al., 2004 and references therein), the Precambrian magmatism in the Anti-Atlas is represented by at least four generations of dykes: (i) tholeiitic dykes of Palaeoproterozoic age such as those in the Tagragra of Tata inlier which have been dated at 2040 ± 6 Ma using the SHRIMP U–Pb method on zircons (Walsh et al., 2002); (ii) microgranite dykes from the Kerdous inlier dated at 1760 ± 3 Ma (Pb–Pb evaporation on zircon, Gasquet et al., 2004), which are cartographically and structurally associated with the mafic dykes in this inlier and in the Tagragra of Akka inlier; (iii) Cryogenian mafic dykes with tholeiitic and alkaline affinities, coeval with the opening of a back-arc oceanic basin in the Central Anti-Atlas (Clauer et al., 1982). A U–Pb zircon age of 761 ± 2 Ma has been obtained for plagiogranites associated

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with the Siroua ophiolites (Samson et al., 2004); (iv) upper Neoproterozoic dykes corresponding to 575 ± 4 Ma mafic dykes intruding the Taourgha granite in the Bas Drâa inlier (U–Pb zircon, Aït Malek et al., 1998) and 600 ± 5 Ma dacitic dikes intruding the schists and the granite basement of the Tagragra of Akka inlier (U–Pb SHRIMP on zircon, Gasquet et al., 2004).

Here, we report zircon and baddeleyite U–Pb ages for four mafic dykes and two sills cross-cutting the Palaeoproterozoic basement of the Zenaga, Agadir Melloul and Iguerda-Taïfast inliers. These results contribute to the (i) refinement of the magmatic barcode for the West African Craton, (ii) reappraisal of the age of some of the lithological units of the central Anti-Atlas, (iii) comparison of dolerite ages between the three inliers, and (iv) discussion of the geodynamical evolution of the northern margin of the West African Craton during Proterozoic time and provisional suggestions for its position in Precambrian supercontinents.

2. Regional geological setting

2.1. The West African Craton

The West African Craton (WAC), stable since 2 Ga, is located on the northwestern margin of African continent (Fig. 1). The basement of the WAC is composed of three Archaean and Palaeoproterozoic shields: to the south is the Leo-Man shield, to which the smaller Kayes (Mali) and Kenieba (Senegal) inliers are associated; to the north is the Reguibat shield; and to the extreme north is the Anti-Atlas belt (studied area; Figs. 1 and 2). In between are the vast Taoudeni and Tindouf intra-cratonic basins covered by Neoproterozoic, Palaeozoic and more recent sedimentary rocks. The Reguibat Rise corresponds to the northern part of the Precambrian shield in the WAC. It is made up of Archaean blocks dating back to 3.5 Ga (Potrel et al., 1996, 1998) in the west and Palaeoproterozoic rocks in the east, where they make up the Yetti and Eglab massifs. The Leo-Man shield is composed of Archaean rocks in the west and Palaeoproterozoic rocks in the east and north. The basement of the Anti-Atlas belt comprises rocks entirely of Palaeoproterozoic age that outcrop mainly in the south part of the E–W-trending Anti-Atlas Major Fault (Fig. 2) (e.g., Gasquet et al., 2008; Thomas et al., 2004, and references therein).

The basement of the WAC was built through several major orogenic cycles: the Palaeoarchean–Leonian cycle (multiple episodes between 3.5 and 3.0 Ga) related to continental accretion and volcanosedimentary activity whose chronology remains uncertain (e.g. Potrel et al., 1996; Rocci et al., 1991), the Liberian cycle (2.95–2.75 Ga; Auvray et al., 1992; Potrel et al., 1998), the Eburnean–Birimian cycle (2.2–1.75 Ga; Abouchami et al., 1990; Aït Malek et al., 1998; Hirdes et al., 1992) and the Pan-African cycle (760–660 Ma; Gasquet et al., 2008; Leblanc and Lancelot, 1980; Samson et al., 2004; Thomas et al., 2002).

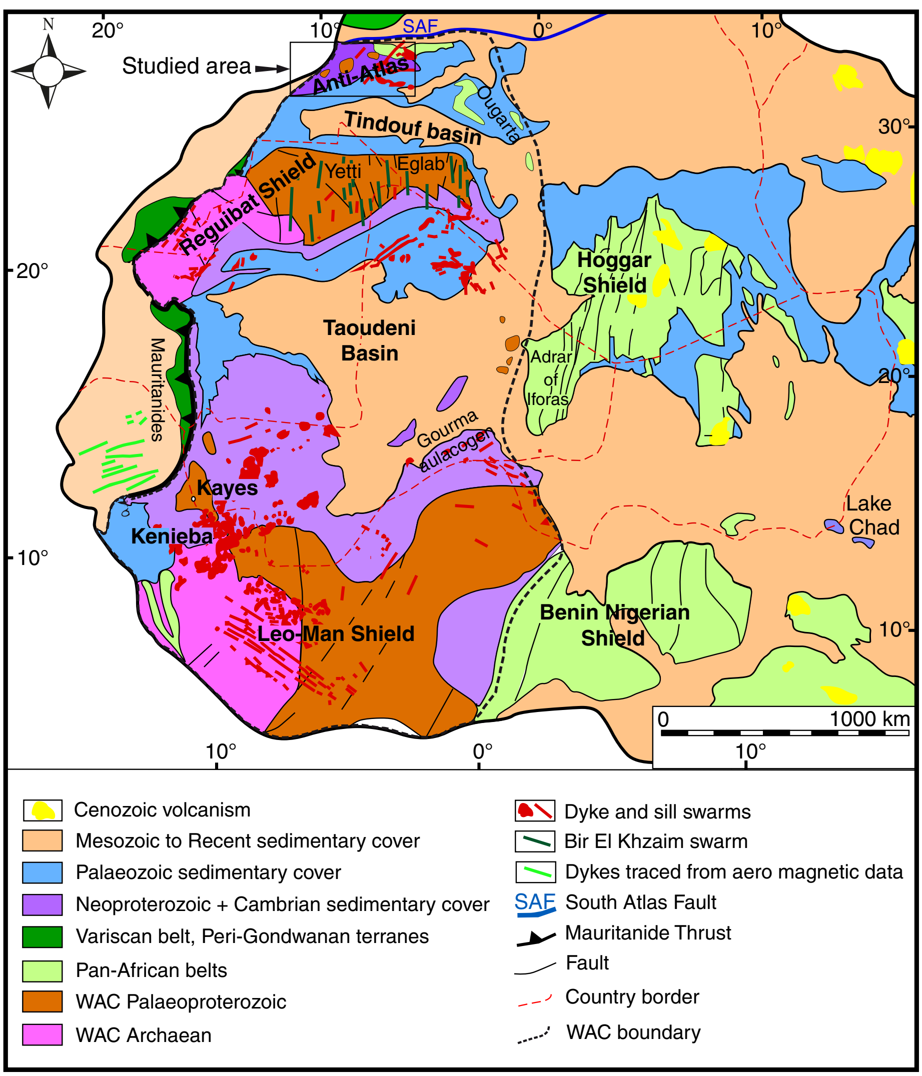

Fig. 1. General geological sketch map of the West African Craton. Modified after Fabre (2005) and Ennih and Liégeois (2008).