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Petrology and geodynamic significance of the post-collisional Pan-African magmatism in the Eastern Saghro area (Anti-Atlas, Morocco)

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ABSTRACT

The Saghro Group consists of a thick volcanic-sedimentary sequence with intercalated basaltic lavas, the first magmatic event in eastern Saghro area. Nd isotopes of basaltic pillow lavas show T_{DM} model ages ranging from 640 to 580 Ma, which represent a maximum age for basalt eruption.

Granitoids within the Saghro Group consist of a charnockitic suite, tonalites, granodiorites and monzogranites. They are high-K calc-alkaline (HKCA) with a post-collisional character, and were emplaced at high-levels in the crust. Their ages of emplacement are within the 580–560 Ma bracket, implying that the entire Saghro Group is slightly older than or partly coeval to granitoid emplacement and implying a common geodynamical setting. Sr–Nd isotopic compositions and Nd T_{DM} model ages point to a mixed origin, combining a juvenile mantle source and an Eburnean crustal component, which could be the West African Craton (WAC). The juvenile component in the Saghro granitoids could be the depleted upper mantle that has sourced the earlier basalts.

Field observations, geochemical and geochronological data together support that, during the Pan-African orogeny, the Anti-Atlas was subjected to a regional transpressional to transtensional event. This event would have been responsible for the dissection of the northern margin of the WAC into several blocks, the development of deep sedimentary basins and the emplacement of HKCA magmas.

1. Introduction

The Gondwana mega-continent is made up of several old (>1.5 Ga) cratons, surrounded by Neoproterozoic to Phanerozoic mobile belts. Neoproterozoic crustal accretion has been documented around the western, northern and eastern boundaries of the West African Craton (WAC). A key area for understanding the late Proterozoic accretional and break-up events along the margins of the WAC is the Anti-Atlas of Morocco (Fig. 1A), where a large Pan-African segment is well exposed. The Anti-Atlas is currently regarded as part of a 6000 km-long Neoproterozoic 'ring of fire' along the northern promontory of the WAC (Hefferan et al., 2000) (Fig. 1A). The Anti-Atlas is one of the most important segments of the Pan-African belt of North Africa. It is exposed in a series of near-continuous, SW-NE trending inliers that stretch over 700 km across southern Morocco (Fig. 1B).

Details of crustal accretion, suturing age(s) and subduction zone polarities, however, remain a matter of debate due to the fairly small number of reliable structural and geochronological constraints (Aït Malek et al., 1998; Barbey et al., 2004; Hefferan et al., 2000; Thomas et al., 2000).

Two main periods of tectono-thermal activity, both associated with crustal accretion, have been recognised so far: (i) a Palaeoproterozoic episode, corresponding to the Eburnean (Birimian) orogeny, (ii) a Neoproterozoic episode, corresponding to the Pan-African orogeny. Most authors (Leblanc and Lancelot, 1980; Bassias et al., 1988; Leblanc and Moussine-Pouchkine, 1994; Villeneuve and Cornée, 1994; El Aouli et al., 2001; Ennih and Liégeois, 2001; Thomas et al., 2002, 2004; Gasquet et al., 2005) consider that the development of the Pan-African orogen can be explained by three successive stages of (1) crustal extension, (2) shortening and compression, then (3) transtension–extension. The first stage was related to rifting and break-up of the WAC, illustrated by continental tholeiitic dyke swarms, passive margin sedimentary series and oceanic crust identified by ophiolites. Ophiolites (ca 800–690 Ma; Clauer, 1974; Hefferan et al., 2000) are exposed in Bou-Azzer and Siroua inliers along the major Anti-Atlas Fault and signify a Neoproterozoic paleosuture. The second stage (c. 690–605 Ma) (Leblanc and Lancelot, 1980; Gasquet et al., 2005) was characterised by basin closure and arc accretion by subduction,

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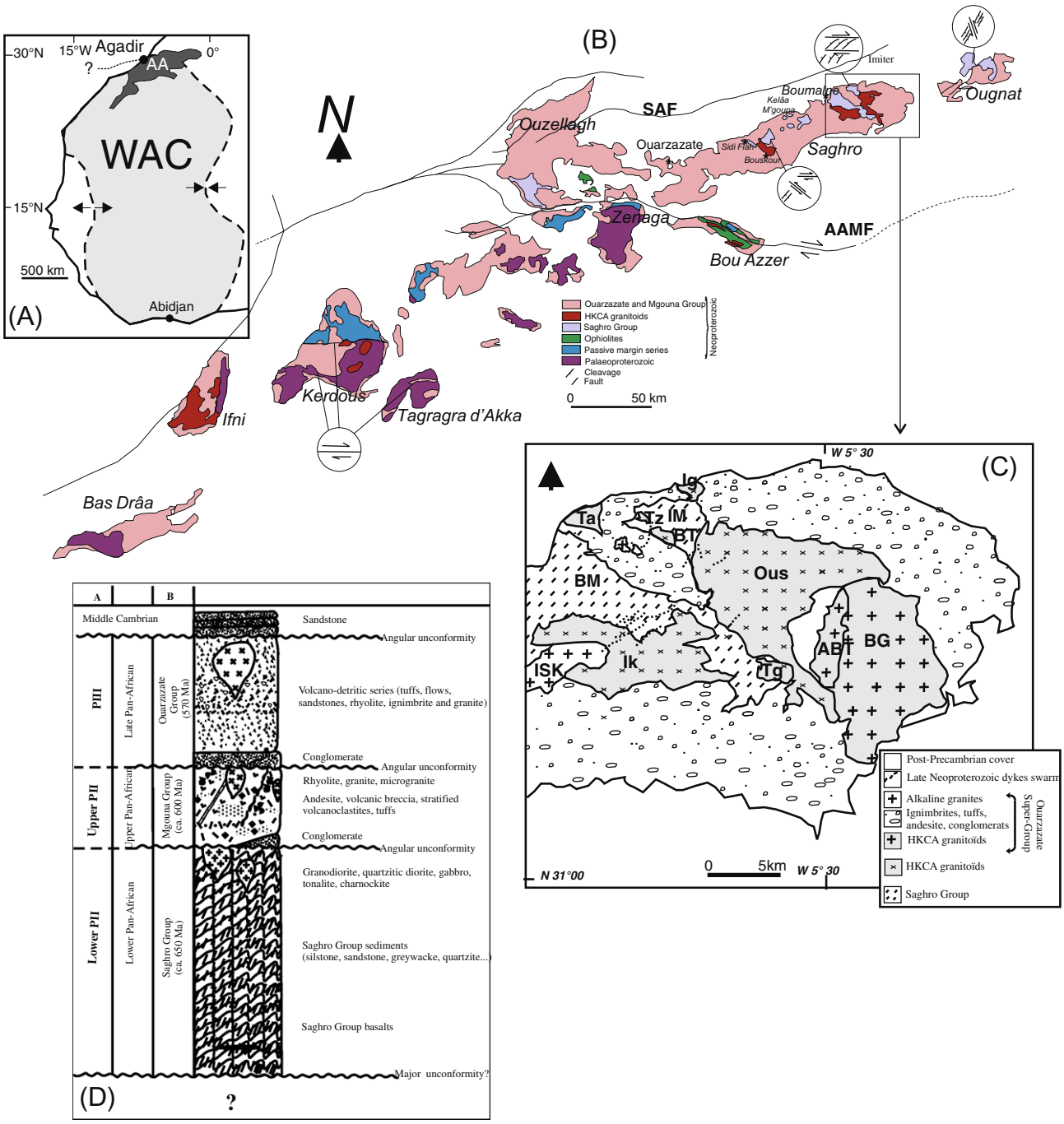

Fig. 1. (A) Position of the Anti-Atlas belt (AA) at the northern limit of the West African craton (Gasquet et al., 2005). (B) Geological sketch map of the AA of Morocco with the main inliers and the main structures (Gasquet et al., 2005). SAF: South Atlas Fault. MAAF: Major Anti-Atlas Fault. (C) Geological sketch map of the eastern Saghro with Boumalne (BM) and Imiter (IM) inliers [Iknioun (Ik), Tagmout (Tg), Oussilkane (Ous), Bou Teglimt (Bt), Igoudrane (Ig), Taouzzakt (Tz), Ta (Taouia), Akka Bou Tiouit (ABT), Bou Gaffer (BG), Isk n'Allah (Isk). D) Synthetic stratigraphic log of the Saghro Inlier (Eastern Anti-Atlas).

ophiolite obduction, deformation, metamorphic and igneous events. Whether the subduction zone associated with island-arc development was dipping northward or southward is still unclear. The final, post-collision, extensional stage (605–530 Ma) was marked by molassic sedimentation and igneous events, followed by Cambrian transgression.

New mapping and zircon dating (Thomas et al., 2002, 2004) led to a new lithostratigraphic framework for the Anti-Atlas orogen. The older Zenaga and Kerdous complexes contain Paleoproterozoic (c. 2035 Ma) granitoids and correspond to the northern part of the WAC. The earlier Neoproterozoic formations comprise a passive margin unit (Taghdout and Jbel Lkst Groups; 800 Ma?) and an island-arc volcano-sedimentary ophiolitic series (743 Ma Iriri and Bou Azzer Groups), bounded by tectonic contacts and affected by SW-verging thrusting and accretion at c. 660 Ma. The stratigraphic position of the c. 6000 m-thick sedimentary, with volcanic intercalations, Saghro Group is still controversial. It has been interpreted either as an island-arc assemblage (Saquaque et al., 1989; Thomas et al., 2004), back arc basins (Marini and Ouguir, 1990; Ouguir et al., 1996) or as a passive margin sequence (Fekkak et al., 2000; Ennih and Liégeois, 2001). It was initially considered older than the accretion period dated at c. 660 Ma (Thomas et al.,