The West African Craton and its margins. Foreword

Isabelle Manighetti, André Michard, Omar Saddiqi

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The West African Craton and its margins. Foreword

The present thematic issue is dedicated to the West African Craton (WAC) and its margins (Fig. 1). The project was launched during the "First West African Craton and Margins International Workshop", which took place in Dakhla (Morocco) on 24–29th April 2017. The aim of this meeting was to confront the results of different teams working on various topics, mainly in the northwestern parts of the WAC and their Pan-African to Present margins. The workshop, organized basically by one of us (O. S.) and the University Hassan II of Casablanca, met with great success. Indeed, the Moroccan part of the WAC and the adjoining Oulad Dlim massif (aka Adrar Souttouf) are under the spotlights. Mapping programs, metallogenic prospection, and academic research backed on petrological and geochronological analyses have been intensely focused on the formerly Spanish Rio de Oro, which became Moroccan in 1975. These recent (and ongoing) studies have greatly improved our understanding of the geological structure and tectonic-stratigraphic evolution of the area.

In this volume are gathered nine contributions with various approaches and methods focusing on nearly all the facets of the WAC and its margins (Fig. 1). The articles are presented below according to the geological time scale, i.e. from the oldest periods to Present (Fig. 1). The first three articles concern the Oulad Dlim allochthonous units, which were thrust over the northern WAC Archean nucleus (Reguibat Shield) during the Alleghanian–Variscan collision. The fourth paper brings us to the Burkina Faso-Niger confines at the southeastern margin of the WAC. Contributions # 5 to # 7 deal with the northern margin of the WAC, more and more reworked going from the Anti-Atlas to the Atlas-Meseta, and to the Rif domains. Finally, paper # 8 is a paleontological study dealing with Eocene vertebrates of the former Atlantic margin, while paper # 9 is a methodological study dealing with the prehistoric funeral mounds of the Dakhla region.

Haissen et al. (2018) (paper # 1 in Fig. 1) present Hf and O isotopic data of the Derraman granite, which is a deformed, aegirine/riebeckite-bearing A-type granite emplaced in the Archean rocks of the easternmost Oulad Dlim unit. The protolith age was previously dated by U–Pb in zircon at *ca.* 525 Ma, which is much younger that the Nd and Hf model ages of *ca.* 1.8 Ga. The authors use Hf and O isotopic information to discuss the possible mantle *vs.* crustal origin of the granitic melts. They propose that the Derraman granitic melts formed in the Cambrian by partial melting of 1.8-Ga crustal fenites formed during Paleoproterozoic refertilization of crustal granulites.

The core of the Oulad Dlim Massif comprises the Adrar Souttouf complex, made of high-grade mafic rocks (amphibolites and charnockites). This tectonic unit has been interpreted as an obducted island arc that was active at *ca.* 635 Ma, and which underwent high-grade metamorphic conditions at about 605 Ma, but a suspicion of superimposed Variscan metamorphism made sense. Molina et al. (2018) (paper # 2 in Fig. 1) present the first analyses and calibration of metamorphism from the northern part of the complex. They show that the main mineral assemblage of garnet + low-Ti pargasite + oligoclase + phengite + epidote + quartz + rutile ± paragonite ± K-feldspar was formed at high-P amphibolite-facies conditions at 650–700 °C and 10–13 kbar. The observed stability of paragonite and phengite reveals fluid-absent conditions or the presence of a fluid phase with reduced H_2O activity during the peak of metamorphism. No relict of eclogite-facies mineral assemblage was found in the garnet amphibolites, contrary to the southernmost, Mauritanian part of the complex, thus suggesting a shallower burial of the northern part of the complex, probably during the Variscan orogeny.

In their contribution, Gärtner et al. (2018) (paper # 3 in Fig. 1) target the metasedimentary rocks (quartzites) that occur in the Sebkha Gezmayet unit west of the Adrar Souttouf complex, otherwise mostly consisting of meta-igneous felsic rocks. The detrital zircon barcode of the Sebkha Gezmayet unit resembles that of the previously dated underlying igneous rocks. These zircon data point

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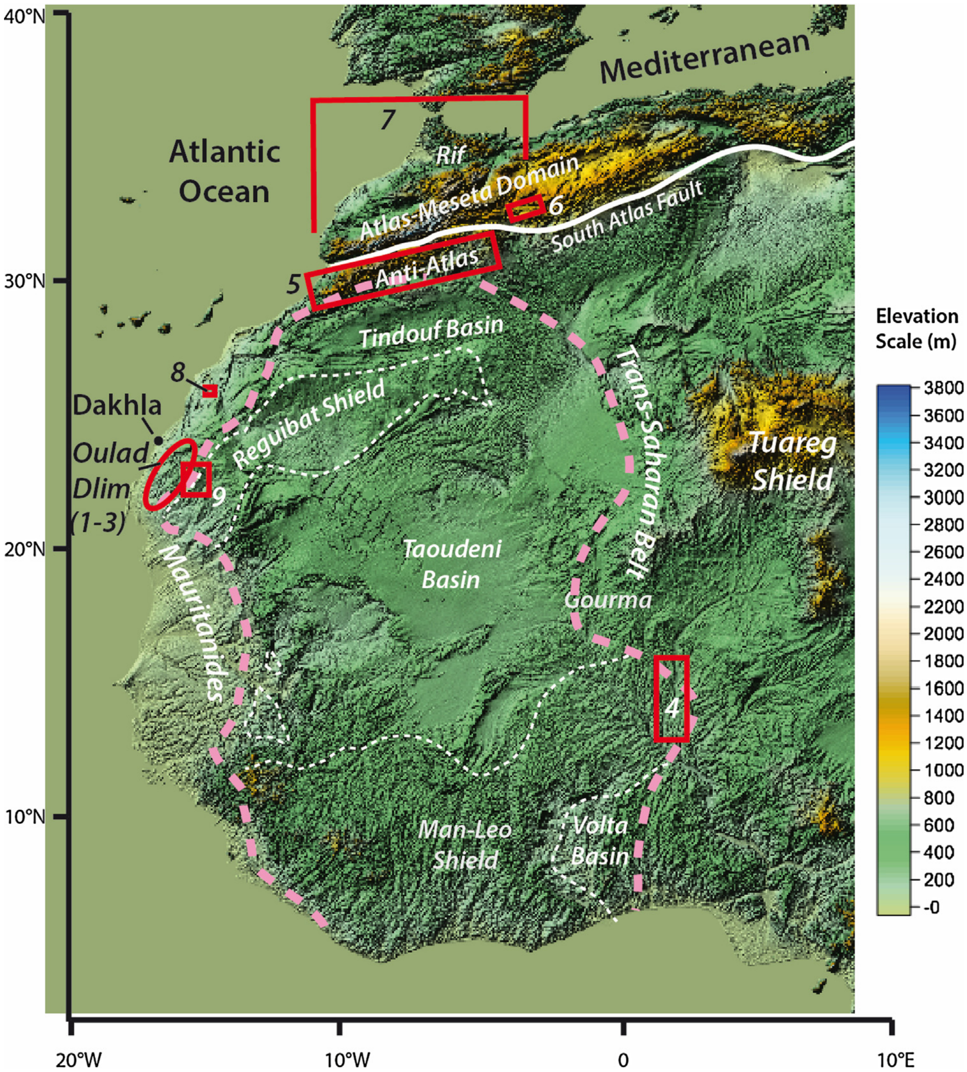

Fig. 1. Location of the studies #1–9 presented in this foreword (see text for references). Thick, pink dashed line: WAC contour. Thin, white dashed lines: contours of the Archean–Palaeoproterozoic. Figure kindly provided by Rémi Leprêtre, University of Cergy-Pontoise, France.

out a relation with a WAC source in general. However, occurrences of Early Devonian detrital zircon ages are at odds with the magmatic history of the WAC. The scarcity of Mesoproterozoic detrital zircon grains therefore corroborates the Meguma terrane affinity of that part of the Oulad Dlim massif.

Change of scenery with Konaté et al. (2018) paper (paper # 4 in Fig. 1), which brings us at the eastern margin of the Man-Leo Shield. There, the Liptako basement is overlain by detrital sequences topped by a "triad" diamictites-cap carbonate-silexite seemingly homolog of that of the Taoudeni basin, which is regarded as Ediacaran. The zircon barcodes of the lowermost detrital deposits provide dominant Paleoproterozoic, and very few Archaean ages, thus suggesting sources in southwestern areas of the Man–Leo Shield, as the bordering units to the east correspond to the Neo-Proterozoic Trans-Saharan domain.

We come back to Morocco with the Anti-Atlas review proposed by Soulaimani et al. (2018) (paper # 5 in Fig. 1). The Anti-Atlas Precambrian inliers expose both the Pan-African belt and its WAC foreland. Our knowledge about these inliers greatly improved during the last couple of decades, so a review paper is particularly welcome. Pending questions are still numerous. Were there one or two intraoceanic arcs during the closure of the Tonian–Cryogenian Ocean? During the Early Ediacaran period, i.e. after the obduction phase of the Pan-African orogeny, where was built the magmatic arc that yielded abundant clasts in the late orogenic basins? How to account for the surprising arc affinity of the Late Ediacaran post-collisional magmatism? The authors also make a point on the far-field deformation of the Paleoproterozoic platform cover south of the Pan-African suture zone.

A bit further to the northeast, Ouanaimi et al. (2018) (paper # 6 in Fig. 1) question the Mougueur Palaeozoic massif that cores a faulted anticline of the eastern High Atlas. This massif belongs to the South Meseta Zone and exposes mostly azoic, low-grade metasediments poorly described so far. Detail mapping allowed the authors to unravel the Mougueur stratigraphy, which appears strikingly transitional between that of the Anti-Atlas and the Atlas–Meseta domains. This reinforces the idea that the Atlas–Meseta basement represents the distal Palaeozoic margin of the WAC, whose proximal margin corresponds to the Anti-Atlas.

Still further to the north, Michard et al. (2018) (paper # 7 in Fig. 1) examine the Mesozoic limits of the Atlas–Meseta WAC-dependent domain. The western limit is identified: it corresponds to the Central Atlantic continental margin, formed from the Middle Liassic onward. On the other hand, the position of the northern limit is poorly defined along the North African Alpine belts. In the Rif belt, the limit could be localized along the gabbro and serpentinites lineament labelled Mesorif Suture Zone, which is closely associated with a Basalt-Breccia lineament. Based on a 190 Ma date obtained from one of the Mesorif gabbros, the authors suggest that these twin lineaments might represent the former North African transform fault that was linking the Central Atlantic and the Alpine Tethys during the Jurassic.

Coming back to the Dakhla region, Zouhri et al. (2018) (paper # 8 in Fig. 1) propose a paleontological study. They have been collecting vertebrate remains for long in a natural section of the Eocene beds belonging to the Atlantic coastal basin. The fossiliferous beds include the world's richest Bartonian-age archaeocete assemblage. Here the authors present the rich and varied rest of the vertebrate fauna, which makes possible palaeoenvironmental and paleogeographic considerations. A kind of mangrove environment may be evoked, and striking correlations are observed with the coeval Libyan and Egyptian sites along the South Tethyan margin.

Eventually, Nsanziyera et al. (2018) (paper # 9 in Fig. 1) present a remote sensing and GIS model developed to remotely identify the areas with high potential of archaeological sites in the Awserd region. Such sites are numerous in this desert area, especially scenic funerary mounds or tumuli, sometimes with erected stones several meters-high, rock engravings and ceramics artefacts from the pre-5000 BC times, when the Sahara was still wet. The presented Archaeological Predictive Model has been tested successfully in a large desert area straddling the Oulad Dlim and the Reguibat Shield geological domains, and can be scaled to larger and varied geographic settings.

We would like to draw attention on the importance of the Electronic Supplementary Material associated with several of the contributions. They most often present, besides the usual data tables, complementary data of great interest (e.g., the reconstructed continent configuration around the WAC at 310 Ma, the compiled U–Pb zircon dates from the Anti-Atlas inliers, the systematic palaeontology of the Eocene vertebrates of the Gueran sites, etc.).

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Isabelle Manighetti[a,*], André Michard[b], Omar Saddiqi[c]
[a]*Université Côte d'Azur, OCA, IRD, CNRS, Géoazur, Valbonne, 06560 Sophia Antipolis, France*
[b]*Université Paris-Sud, Département des sciences de la Terre, 91405 Orsay cedex, France*
[c]*Geosciences Laboratory, Faculty of Sciences Aïn Chock, Hassan II University, Casablanca, Morocco*

[*]Corresponding author. manighetti@geoazur.unice.fr (I. Manighetti)

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