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Proterozoic to Mesozoic evolution of North-West Africa and Peri-Gondwana microplates: Detrital zircon ages from Morocco and Canada

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ABSTRACT

The complex history of assemblage and disruption of continental plates surrounding the Atlantic Ocean is in part recorded by the distribution of detrital zircon ages entrained in continental sedimentary strata from Morocco (Central High Atlas and Argana basins) and Canada (Grand Manan Island, New Brunswick). Here we investigate detrital zircon from the latest Triassic (ca. 202 Ma) sedimentary strata directly underlying lava flows of the Central Atlantic magmatic province or interlayered within them. SHRIMP (Sensitive High-Resolution Ion Micro-Probe) and LA-ICP-MS (Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry) U–Pb ages for zircon range from Paleozoic to Archean with a dominant Neoproterozoic peak, and significant amounts of ca. 2 Ga zircon. These ages suggest a prevailing West African (Gondwanan) provenance at all sampling sites. Notably, the Paleoproterozoic zircon population is particularly abundant in central Morocco, north of the High Atlas chain, suggesting the presence of Eburnean-aged rocks in this part of the country, which is consistent with recent geochronologic data from outcropping rocks. Minor amounts of late Mesoproterozoic and early Neoproterozoic zircon ages (ca. 1.1–0.9 Ga) in Moroccan samples are more difficult to interpret. A provenance from Avalonia or Amazonia, as proposed by previous studies is not supported by the age distributions observed here. An involvement of more distal source regions, possibly located in north-eastern Africa (Arabian Nubian Shield) would instead be possible. Paleozoic zircon ages are abundant in the Canadian sample, pointing to a significant contribution from Hercynian aged source rocks. Such a signal is nearly absent in the Moroccan samples, suggesting that zircon-bearing Hercynian granitic rocks of the Moroccan Meseta block were not yet outcropping at ca. 200 Ma. The only Moroccan samples that yield Paleozoic zircon ages are those interlayered within the CAMP lavas, suggesting an increased dismantling (i.e. uplift) of the Hercynian chain during emplacement of CAMP lava flows, combined with subsidence of the volcanic grabens.

1. Introduction

Detrital zircon geochronology helps to unravel the complex history, displacement and assemblage of the Earth's continental plates (e.g., Linnemann et al., 2011; Murphy et al., 2004a; Nance et al., 2008). This applies in particular to areas that were located close to plate

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margins and underwent repeated phases of collision and separation from neighboring plates or micro-plates.

The terrains bordering the present-day Central Atlantic ocean, e.g. Morocco and Maritime Canada, were formed along the northern margin of the Archean West African Craton (WAC) during several orogenic events (e.g., Eburnean, Pan-African, Variscan–Alleghenian), alternating with rifting and plate separation events (e.g., opening of the Iapetus, Rheic, and Atlantic oceans; Michard et al., 2008; Nance et al., 2008). Such complexities leave space for debate on the origin, mutual position and time-related displacement of NW-Africa and the plates and micro-plates rimming the WAC during Paleozoic and Proterozoic times.

In this study we investigated the detrital zircon population of Late Triassic (ca. 202 Ma) sedimentary strata from Morocco and Canada (Fig. 1). These samples directly underlie or are interstratified with basaltic lava flows of the Central Atlantic magmatic province (CAMP), a large igneous province (LIP) emplaced just before the break-up of Pangea and the opening of the Atlantic Ocean (Marzoli et al., 1999). Age and trace element composition of zircon grains from Morocco and Canada were analyzed by means of SHRIMP and Laser Ablation ICP-MS. Combined with previously published data of detrital zircons from NW Africa (e.g., Avigad et al., 2012; Linnemann et al., 2011; Pratt et al., 2015) and Maritime Canada (e.g., Murphy et al., 2004a; Nance et al., 2008; Waldron et al., 2009), the investigated Moroccan and Canadian zircons shed light on the pre-Mesozoic geological history of NW-Gondwana and once contiguous Peri-Gondwanan terranes. A possible input from local (e.g. Anti-Atlas or Meseta) and distal source rocks (e.g., from Laurentia, Amazonia, or NE-Africa) is suggested for the Moroccan sedimentary rocks. Also, the zircon data for the sample from eastern Canada (New Brunswick, Gulf of Maine) contributes to the understanding of the origin of the Meguma terrane on the margins of NW-Africa. Finally, time-related variations in zircon age distribution between sedimentary rocks sampled at the base and in-between the CAMP lava pile constrain the tectonic evolution of the continental basins during emplacement of this LIP.

2. Geological background

The Moroccan samples were collected from Late Triassic sedimentary sequences of the Argana and Central High Atlas (CHA) basins (Fig. 1B, C). These basins were formed between the emerged units of the Western African Craton (WAC) and the Anti-Atlas in the South and the Meseta in the North, which thus represent the most proximal source areas of the studied sedimentary units. The WAC was assembled during the Archean, between ca. 3.5 and 2.8 Ga (Leonian and Liberian cycles; e.g., Key et al., 2008). Acid magmatic rocks in the Anti-Atlas were formed during two main orogenic cycles, i.e. the Eburnean (ca. 2.2–1.8 Ga; Abouchami et al., 1990; Boher et al., 1992; Egal et al., 2002; Schofield et al., 2006) and the Pan-African (at ca. 0.6 Ga; e.g., Gasquet et al., 2005,

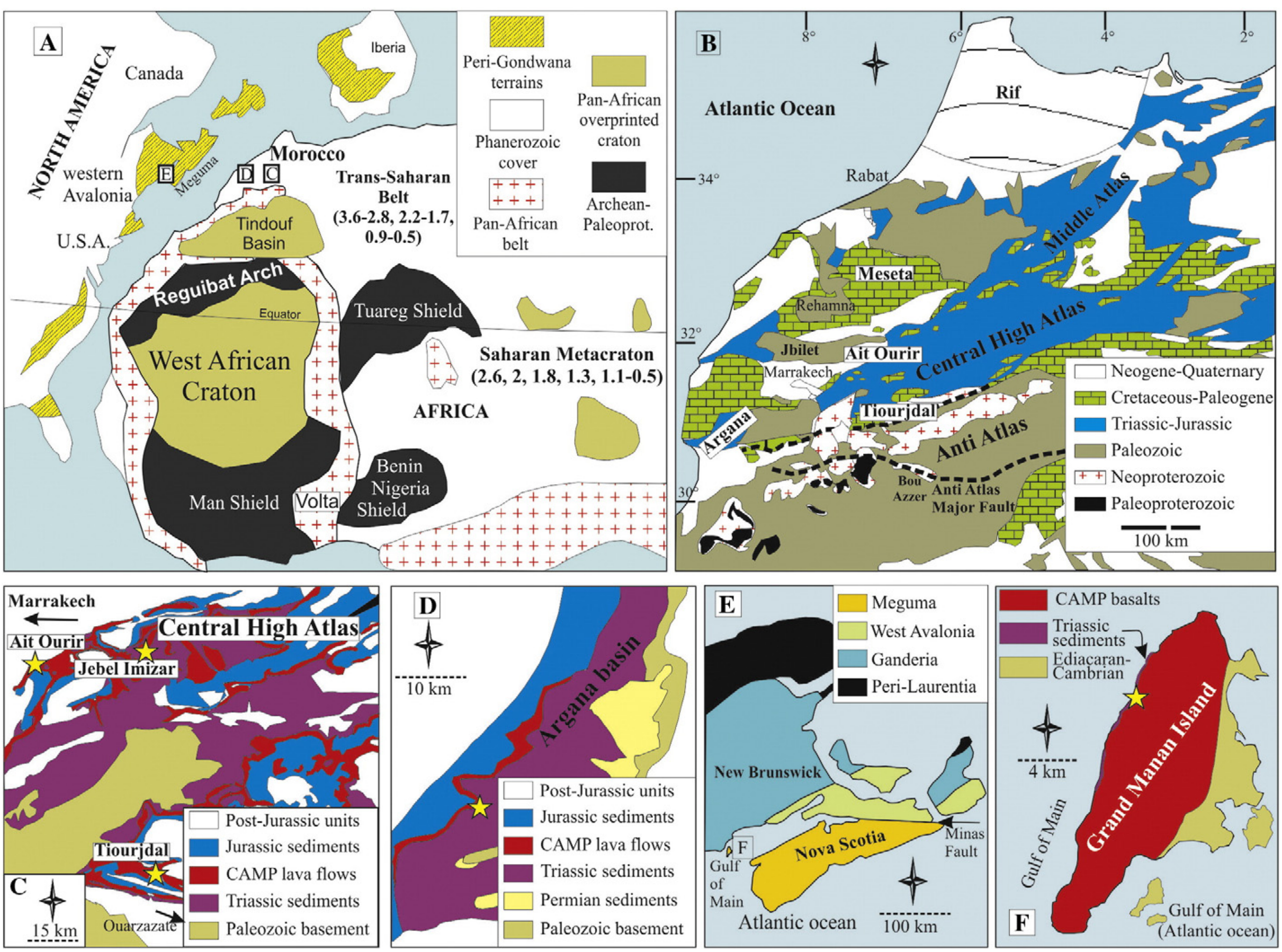

Fig. 1. A: Schematic geologic map of North-West Africa with adjacent North American and Iberian plates in a Late Triassic reconstruction. Peri-Gondwanan terranes are reported after Nance et al. (2008). Numbers in brackets refer to zircon age peaks, in Ga. B: Simplified geological map of Morocco from the Anti-Atlas to the Rif (after Michard et al., 2008). C–F: Schematic geological maps of the Central High Atlas, Morocco (after Verati et al., 2007), Argana basin, SE-Canada (after Waldron et al., 2009), and Grand Manan Island (after McHone, 2011), with sampling sites shown by yellow stars in C, D, and F. Locations of maps C, D, and E are shown in A, whereas location of F is shown in E.