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The oldest rock of Ivory Coast

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ABSTRACT

The tonalitic gneiss of Balmer (TGB), in the SASCA area of south-western Ivory Coast, previously dated at 3141 ± 2 Ma using the single zircon evaporation method, is regarded as a relic of Archean rock within the Paleoproterozoic (Birimian) formation of the West African Craton (WAC). We present new geochronological data for the TGB using the laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) method. We obtain a U–Pb age of 3207 ± 7 Ma for abundant zircons extracted from the tonalitic gneiss, and interpret this age as that of the magmatic protolith because of the igneous-type homogeneous zircon population. Certain magmatic zircon edges and some round zircons define an upper intercept age of 3155 ± 17 Ma which could represent overgrowths during gneissification. It appears that the TGB was not affected by the events posterior to its genesis, i.e. the Liberian (2.9–2.7 Ga) and Eburnean (2.4–2.0 Ga) events. Additionally, the TGB proves to be a juvenile Leonian rock, as indicated by the Nd model age of 3456 Ma, and could also constitute the protolith of the granulitic grey gneisses and charnockites of the Man area, which are 150–400 Ma younger.

1. Introduction

The oldest continental history of the West African Craton (WAC) and particularly of the Man Rise is known until 3.6 Ga (Potrel et al., 1996; Thiéblemont et al., 2001, 2004; Gouédji et al., 2014). This oldest history is recorded by rocks located to the west of the Birimian terranes, in the Archean domains of the WAC (Fig. 1). This oldest history is also preserved in the Pan-African mobile zone of the Nigerian Shield (Kronër et al., 2001), to the east of the WAC.

In the Ivory Coast, investigations to identify the oldest formations were focused on the west and more precisely in the south-western SASCA domain. This domain is located to the south of the Kenema-Man domain and extends to the Atlantic coast (Fig. 2). The work completed in the SASCA domain (Papon, 1973) has highlighted the coexistence of high-grade metamorphic formations (assumed to be Archean in origin) and low-grade metamorphic formations, believed to be Birimian in origin (Lower Paleoproterozoic). Kouamelan et al. (1997a) found the oldest rocks of Ivory Coast by dating banded tonalitic gneisses recovered in the Balmer area (3.15 Ga), on the San-Pedro beach, using the single zircon evaporation TIMS method (Kober, 1987). In this paper, we present new zircon dates for the TGB using the LA-ICP-MS method.

2. Geological setting

Ivory Coast is located in the WAC also known as the Man-Leo Rise (Fig. 1). It mostly extends into the Birimian domain (Paleoproterozoic) with the rest in the Archean domain, which was affected by two main events: the Leonian (3.3–3.0 Ga) and the Liberian (2.9–2.7 Ga). The Kenema-Man domain in the Ivory Coast is mainly composed of granulitic formations, the oldest of which have an age of 3.05 Ga (Camil, 1981, 1984; Kouamelan et al., 1997b). These are the Leonian grey gneisses located in the north of the Man area. In the WAC, the oldest ages ca. 3.4–3.6 Ga, correspond to either relics of old crustal segments preserved within the Leonian, Liberian, Birimian and Pan-African formations, or to inherited zircons within the same formations (Potrel et al., 1996; Kouamelan et al., 1997b; Kronër et al., 2001; Thiéblemont et al., 2001; Gouédji et al., 2014). The youngest Archean ages correspond to the end of the Liberian granulitic event (Camil, 1984; Kouamelan et al., 1997b; Cocherie et al., 1998; Cocherie and Albarède, 2001; Thiéblemont et al., 2004). Subsequently, the Kenema-Man domain was severely reworked in some places during the Eburnean tectono-metamorphic event,

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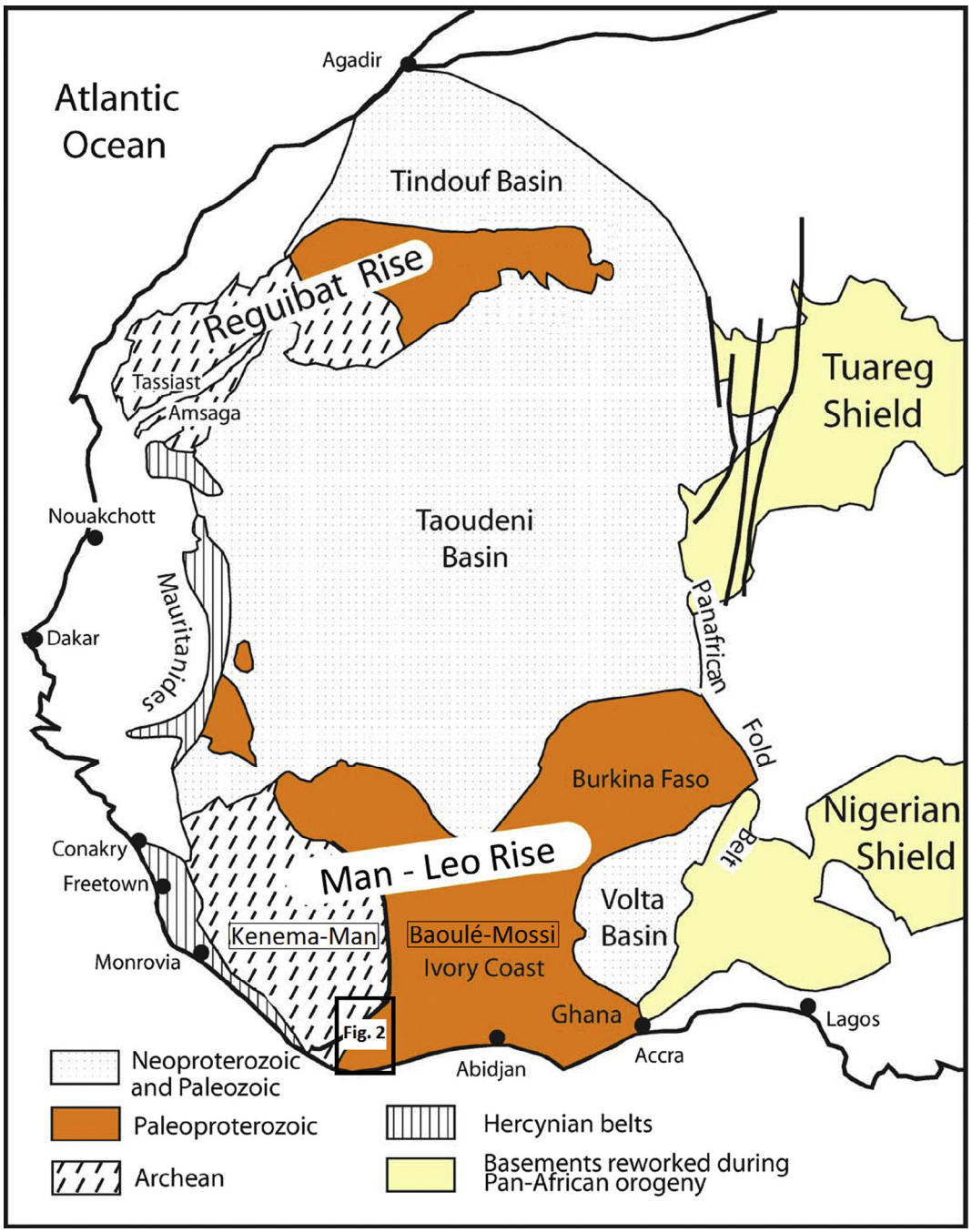

Fig. 1. Geological sketch map of western Africa (from Peucat et al., 2005).

contemporary with the genesis of the Birimian formations (Kouamelan et al., 1997b; Thiéblemont et al., 2004; Gouédji et al., 2014). The Birimian formations on the Baoulé-Mossi domain (Fig. 1) are juvenile rocks (Bessoles, 1977) that accreted around 2.1 Ga (Abouchami et al., 1990; Boher et al., 1992; Taylor et al., 1992; Pawlig et al., 2006). The Eburnean granitoids generally have TTG affinities (Casanova, 1973; Bassot, 1987; Kouamelan et al., 1997a; Doumbia et al., 1998; Gasquet et al., 2003; Tapsoba et al., 2013) and the basalts of the Birimian and Archean greenstone belts are quite often geochemical homologues (Zonou, 1987; Dia, 1988; Abouchami et al., 1990; Sylvester and Attoh, 1992). The tectonic structures within the various lithostratigraphical ensembles and the relationships between them are controlled by vertical crustal movements (Delor et al., 1995; Pons et al., 1995; Vidal et al., 1996, 2009; Lompo, 2010); these structures are globally oriented NE–SW, with no evidence for the existence of major thrusts indicating a "modern type" continental collision as postulated by some authors (Feybesse et al., 1989, 1990; Feybesse and Milési, 1994; Billa et al., 1999). The Birimian volcano-sedimentary terranes underwent greenschist-facies metamorphism (Arnould, 1961; Tagini, 1971) and amphibolite-facies conditions as reported in some areas, especially around the magmatic intrusions (Delor et al., 1995; Pons et al., 1995; John et al., 1999). Although Ganne et al. (2012, 2014) obtained mineral assemblages characteristic of high pressure conditions (HP greenschist and blueschist facies), these authors consider that the burial and exhumation of the greenstone belts were controlled by gravitational tectonics. Our study area is situated in the south-western part of the Baoulé-Mossi domain (Fig. 1). This