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SHORT NOTE – NOTA BREVE

A NEW OLIGO-MIOCENE MAMMAL-BEARING SITE FROM A SEDIMENTARY INTERCALATION IN THE TRAP BASALTS OF CENTRAL ERITREA

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Abstract. We report the findings of two proboscideans from a sedimentary intercalation within the Central Eritrea Tertiary Trap basalt succession. These intertrappean sediments can be traced continuously between Tera'emni and Adi Quala in the Mendefera region, and are interbedded between the underlying Asmara/Aiba-Alaji basalts and the overlying Adi Ugri basalt. This intercalation is up to 50 m thick and consists of a predominant intensely pedogenized red, green and gray mudstone and siltstone with subordinate channelized pebbly sandstone. The newly discovered mammal remains come from the coarse-grained deposits in the Mai Gobro section. Available radiometric datings of the host volcanic rocks constrain the age of the fossils between 24.6 and 22.1 Ma, i.e. at the transition between the Oligocene and the Miocene. The fossil vertebrate remains from Mai Gobro represent two proboscidean families, Deinotheriidae and Gomphotheriidae. The morphological grade of the two Mai Gobro proboscideans would suggest a more derived stage than that of representatives of the same families known from other Oligocene African sites (e.g. Chilga, Ethiopia), suggesting a possible Oligo-Miocene age.

Riassunto. Viene segnalato il ritrovamento di due proboscidati in una intercalazione sedimentaria presente nella successione trappica dei basalti terziari dell'Eritrea centrale. Questi sedimenti possono essere seguiti tra Tera'emni e Adi Quala nella regione di Mendefera, e risultano intercalati tra i sottostanti basalti di Asmara/Aiba-Alaji ed il sovrastante basalto di Adi Ugri. Questa intercalazione ha uno spessore massimo di 50 m ed è costituita prevalentemente da argilliti e siltiti rosse, verdi e grigie intensamente pedogenizzate con subordinate arenarie canalizzate con ciottoli. I fossili qui descritti provengono dal livello sedimentario grossolano della sezione di Mai Gobro. In base alle datazioni radiometriche disponibili relative alle rocce vulcaniche associate, i resti fossili hanno età compresa fra 24.6 e 22.1 Ma al passaggio tra l'Oligocene ed il Miocene. I resti fossili di vertebrati raccolti a Mai Gobro testimoniano la presenza di due famiglie di proboscidati, Deinotheriidae e Gomphotheriidae. Le morfologie presentate dai resti di Mai Gobro sembrerebbero suggerire un grado evolutivo leggermente più derivato rispetto ad altre forme delle stesse famiglie note in altri siti oligocenici del continente Africano (e.g. Chilga, in Etiopia), supportando una interpretazione cronologica oligo-miocenica.

Introduction

Eritrean and Italian researchers discovered new fossil mammals in the highlands of Eritrea (Mendefera area, ca. 50 km south of Asmara, Fig. 1). These new Oligo-Miocene fossils can be fruitfully matched with those previously found in the same area (Vialli 1966) and in the coastal belt near Massawa (Dogali, Sagri et al. 1998; Shoshani et al. 2006). The age of the fossil-bearing sediments represents a crucial time interval during which the African mammal community underwent a major faunal rearrangement, with the evolution of modern proboscidean groups (e.g. elephantoids) and the arrival of Eurasian migrants. The mode, path and time of this event is still poorly documented. The new Eritrean data are going to fill gaps in our understanding of the evolution of African mammals and associated paleontological and paleoecological context. In the literature the Afro-Arabian fossil record of the Paleogene mammalian

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evolution is scant when compared with those from northern continents (Seiffert 2010). Until the end of the Oligocene (23 Ma), the African continent was geologically isolated from Eurasia, so that the late Oligocene of Africa is characterized by endemic lineages. The finding of scanty remains referable to primitive elephantoids in the late Oligocene of Pakistan (Antoine et al. 2003), demonstrates, however, that early, possibly intermittent, dispersals between Africa and Southern Asia occurred before the Early Miocene.

African faunas were dominated by Afrothers, i.e. mammals that had evolved on an isolated African continent, including proboscideans, embrithopods and hyraxes as well as a few non-Afrotherian groups such as anthracothere artiodactyls, primates, and rodents (see, among others, Asher & Seiffert 2010; Holroyd et al. 2010; Sanders et al. 2010 a,b; Rasmussen & Gutièrrez 2010; Seiffert et al. 2010; Winkler et al. 2010). After Africa joined Eurasia, many of the taxa common in the late Oligocene disappeared and the early Miocene faunas mark a dramatic turnover, being dominated by northern Eurasian immigrants. Recent paleontological exploration in several parts of Africa (Egypt, Simons et al. 2008; Ethiopia, Kappelman et al. 2003; Tanzania, Stevens et al. 2008; Kenya, Leakey et al. 2011), has helped to make better known the Oligocene vertebrate faunas of Africa.

Mammalian evolution during the Late Oligocene is now documented in at least three areas, all in East Africa (in addition to Eritrea, Ethiopia and Tanzania).

In the highlands of Ethiopia, the Chilga beds have produced a diverse proboscidean and hyracoid fauna, as well as a large species of *Arsinoitherium* (Kappelman et al. 2003; Sanders et al. 2004). The Chilga localities have good chronological constraints between 27 and 28 Ma based on both radioisotopic and magnetostratigraphic data. A tuff with a $^{40}Ar/^{39}Ar$ date of 27.36 ± 0.11 Ma provides a maximum age for the youngest Chilga mammals, and all localities fall within normal polarity zone Chron C9n (Kappelman et al. 2003).

West of Lake Turkana in northern Kenya, at Lothidok Hill and in the Nakwai region, a diverse mammal fauna has been described. It includes proboscideans, hyracoids, *Arsinoitherium*, catarrhine primates, creodonts, anthracotheres, phiomorph rodents, and the northern immigrant carnivore *Mioprionodon* (Rasmussen & Gutiérrez 2009). K/Ar dates for basalts sandwiching the Lothidok mammals constrains their age in the interval between 24 and 27 Ma (Boschetto et al. 1992).

Isolated findings in Eritrea complete the scenario of African Oligo-Miocene mammal record. Dogali is known for the occurrence of *Deinotherium* remains and the primitive elephantoid *Eritreum* (Sagri et al. 1998; Shoshani et al. 2006), while a "*Deinotherium*" tooth was reported in early times from Adi Ugri (former name for a locality presently called Mendefera) (Vialli 1966).

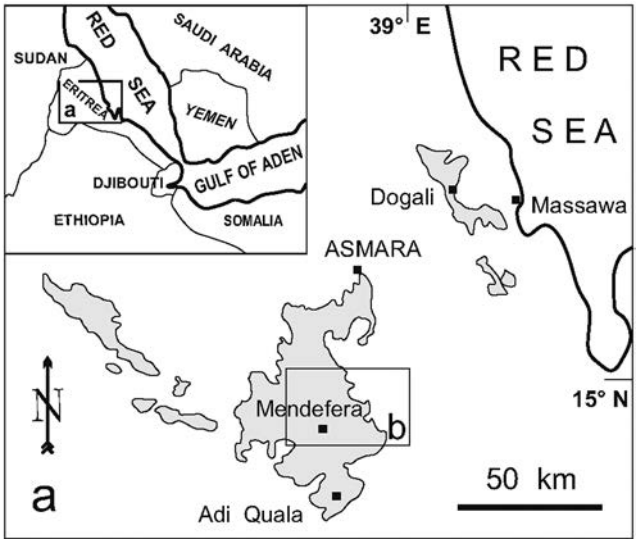

Fig. 1 - Schematic map showing the distribution of the Oligocene to Miocene Trap basalts in the Central Eritrea (a); location of the geological map of Fig. 3(b).

Geological setting

We report a new fossiliferous site in a sedimentary intertrappean level within the Oligo-Miocene Trap basalt succession in central Eritrea (Figs 1, 2). This volcanic pile is regarded as the northern extension of the well-known basalts outcropping in northern Ethiopia (Mohr 1962).

The basalts rest on a Neoproterozoic basement or on Paleozoic to Mesozoic sediments (Dainelli & Marinelli 1912; Merla et al. 1979). The volcanic rocks are not involved in the intense block faulting which, in contrast, characterizes the Eritrea plateau escarpment (Drury et al. 1994).

The basalts of the study area have been investigated and radiometrically dated by Zanettin et al. (1999), Teklay et al. (2005) and Zanettin et al. (2006). According to the latter authors the Asmara/Aiba-Alaji basalts represent the base of the succession and are overlain by the Adi Ugri basalt. The covered time interval of the whole succession is approximately from 30 to 22 Ma.

The Mai Gobro section

A preliminary survey in the highland basalts between Asmara and Adi Quala allowed to recognize the occurrence of a continuous level of fluviolacustrine deposits with lignite seams, interbedded between the Asmara/Aiba-Alaji basalts and the Adi Ugri basalt (Fig. 3). Its thickness is 50 m at maximum with an average of 20 m. Vialli (1966) described a tooth of "*Deinotherium*" cf.

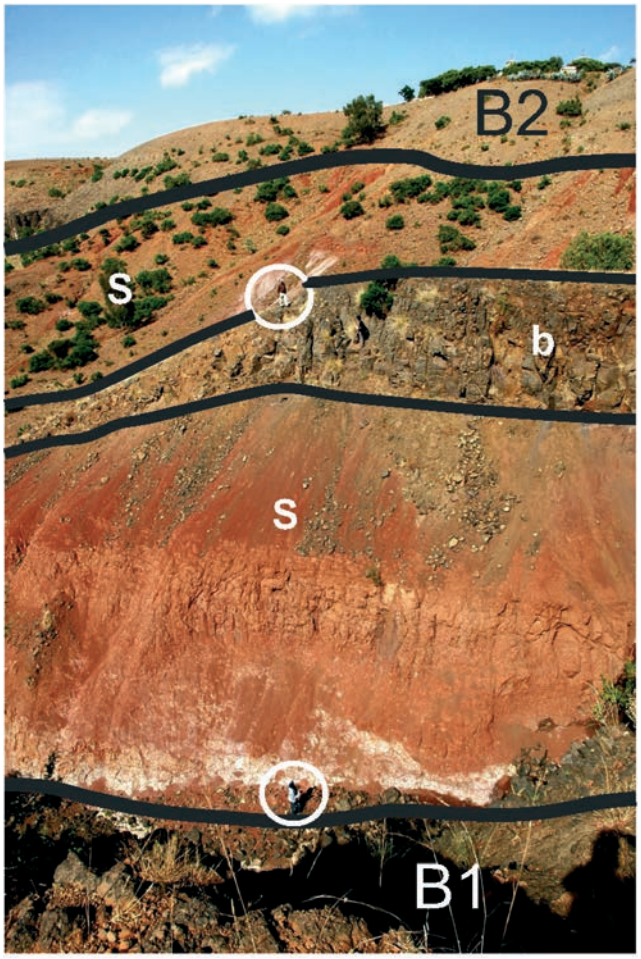

Fig. 2 - The sedimentary intercalation between the Asmara/Aiba-Alaji basalts (B1) and the Adi Ugri basalt (B2) 3 km north of Adi Zerna (site 1 in Fig. 3). The intertrappean sediments are predominantly reddish mudstones and siltstones and rare fine sandstones (S). A basalt flow (b) is interposed within the succession. Two encircled persons give the scale.

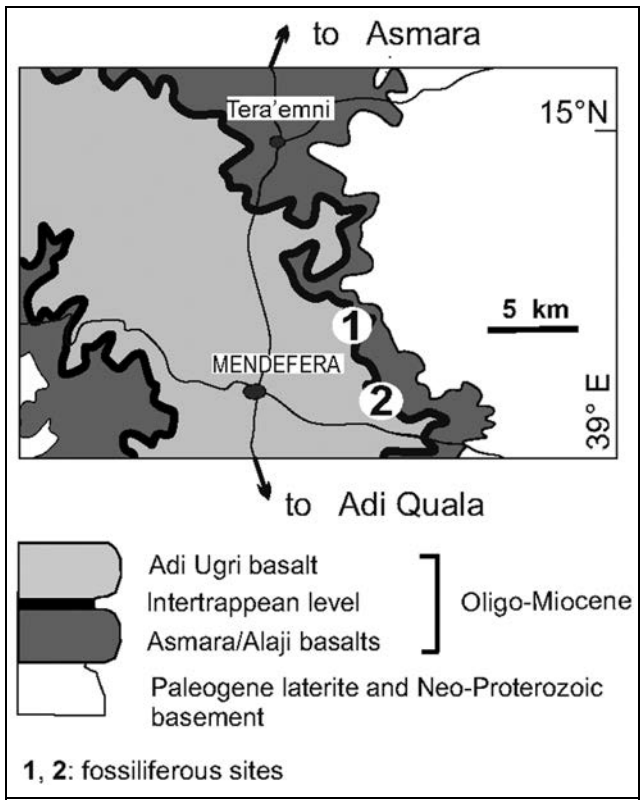

Fig. 3 - Schematic geological map of the Mendefera area with the location of the fossiliferous sites of Adi Zerna (1) and Mai Gobro (2).

hobley from a lignite-bearing intercalation of this level in the Adi Zerna mine, northeast of Mendefera.

At Mai Gobro, 5 km east of Mendefera, the same level has yielded dental and fragmentary cranial remains of two proboscideans**.** Locally the sedimentary interval contains basalt flows and rhyolites. A rhyolite lenticular bed sampled in the middle portion of the intercalation has given 24.6 ± 0.25 Ma (K/Ar, Zanettin et al. 2006).

The studied Mai Gobro section (Fig. 4) consists of intensely pedogenized, silty red mudstones resting on the Asmara basalt, followed by channelized bodies of pebbly sandstones and coarse sandstones with planar and trough-cross stratification (Fig. 5). The section continues with partially covered interval of silty mudstones capped by the Adi Ugri basalt. From the coarse-grained deposits, rich in fossil leaves, derive the determined mammal bones. These intertrappean sediments were laid down in an alluvial plain crossed by small rivers with some water pools, where the organic material was accumulated.

The volcanic activity was reduced during the deposition of the intertrappean sediments, only interrupted by rare basalt flows (Fig. 2) and a single rhyolite eruption. Correlated nearby outcrops (e.g. Adi Zerna) show that the rhyolite rests a few meters below the fossiliferous horizon.

We can rely on the Ar/Ar age of 28.5 ± 3.2 Ma given by Drury et al. (1994) for the upper portion of the Asmara basalt as the maximum age of the sedimentary intercalation. The latter cannot be younger than 22.1 Ma, that is the age of the lowermost overlying Adi Ugri basalt. More in detail, the dated rhyolite (24.6 Ma) provides the maximum age of the mammal bones.

The fossil remains

The mammalian remains from Mai Gobro represent two proboscidean families, Gomphotheriidae and Deinotheriidae, although the latter assignment is provisional, pending further study. An isolated, complete bilophodont M2 (upper second molar) is referred to a relatively small-sized deinothere (Fig. 6 A-D), more derived than *Chilgatherium* from the Late Oligocene of Ethiopia (Sanders et al. 2004), based on size. The occurrence of this taxon at Mai Gobro would support an Oligo-Miocene age of the Udi Agri "*Deinotherium*" described by Vialli (1966). A second proboscidean is

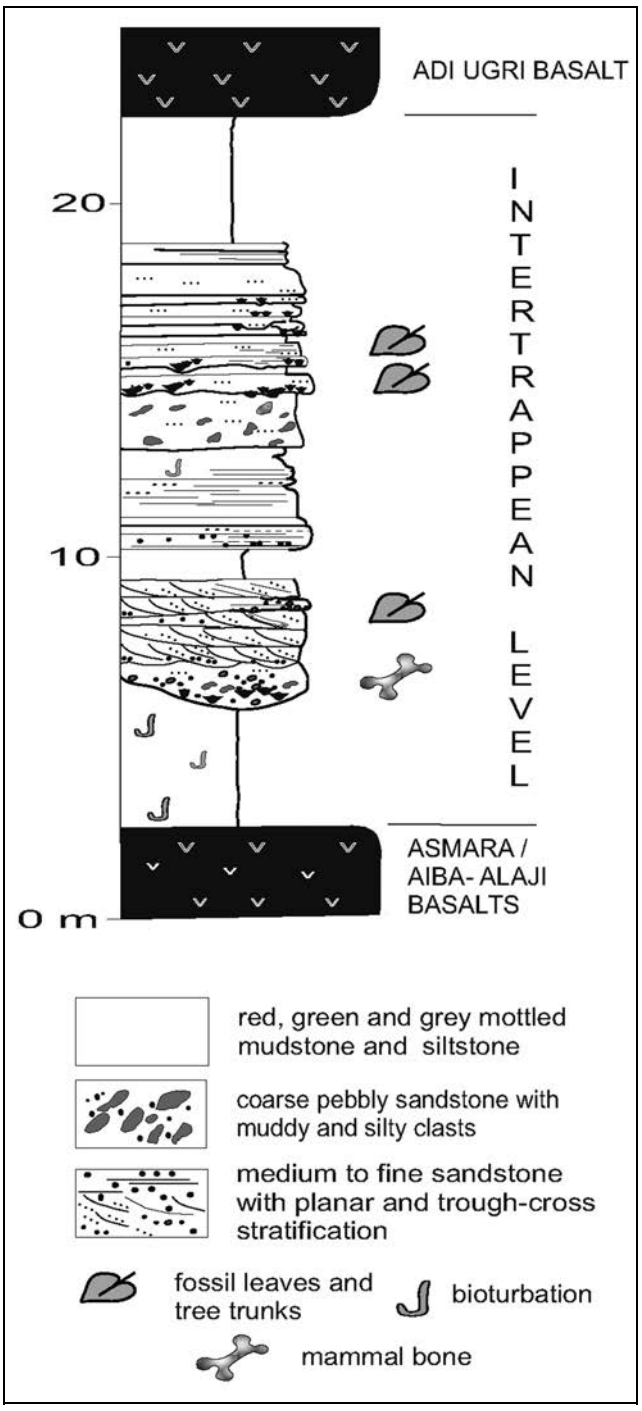

Fig. 4 - Stratigraphical log of the Mai Gobro fossiliferous site (site 2 in Fig. 3). The new fossils were found in the lower portion of this section.

documented at Mai Gobro by a fragmentary right maxillary bearing an M2 and M3 (Fig. 6 E) and by an isolated molar cone. The M3 is unworn and broken posteriorly. The M2 is well preserved, with three fully developed lophs. The tooth structure indicates a representative of the family Gomphotheriidae, more derived and sensibly larger than the late Oligocene *Eritreum* from Dogali (Shoshani et al. 2006). An early gomphotheriid was described by Sanders et al. (2004) from Chilga. The Mai

Fig. 5 - Lower portion of the Mai Gobro section; channel carved in the pedogenized red mudstone and filled by coarse sandstone and pebbles.

Gobro gomphotheriid is somewhat larger than the Chilga taxon, though smaller than typical Miocene forms.

The Mai Gobro proboscideans represent two families that originated in the late Oligocene of Africa and became widespread both in Africa and Eurasia during the Miocene. The morphological grade of the two Mai Gobro proboscideans appears more derived than that of representatives of the same families known from other Oligocene African sites (e.g. Chilga), suggesting a possible younger age.

Conclusion

The Trap basalt succession of the Eritrean plateau includes a continuous level of sediments in connection with a period of volcanic starvation. The sediments are referable to fluviolacustrine environment with lignite seams, and host mammal remains together with leaves and tree trunks. New fossil findings are referable to a small-sized deinothere and an early gomphotheriid, their chronology, on the base of radiometric datings, ranges from 24 to 22 Ma. The Mai Gobro findings documents an afrothere-dominated site in Eritrea still persisting at the Oligo-Miocene transition.

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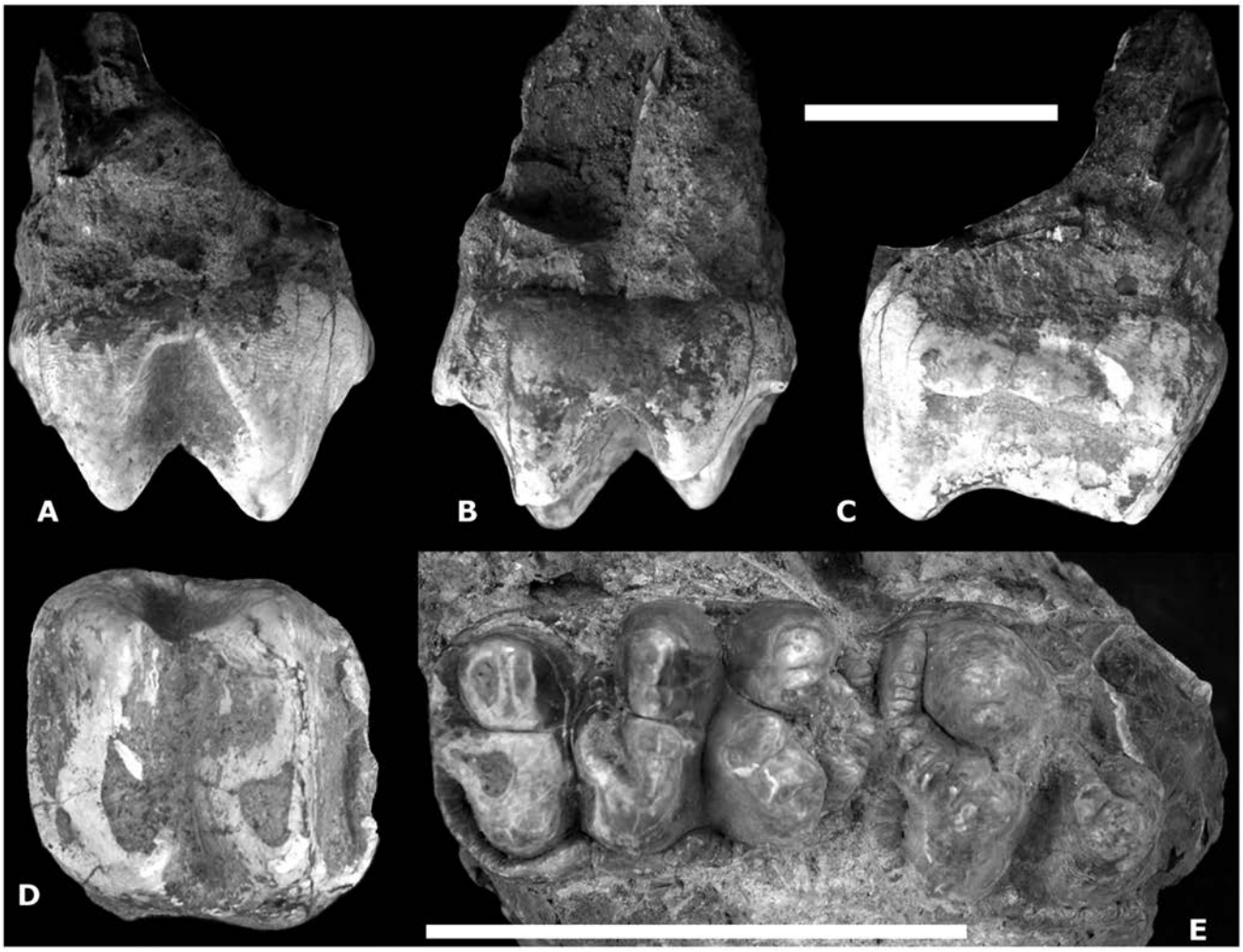

Fig. 6 - A-D: Upper M2 of the small-sized deinothere from Mai Gobro in labial (A), lingual (B), posterior (C) and occlusal (D) views (scale bar = 3 cm). E: Gomphotheriidae indet. from Mai Gobro. Occlusal view of the maxillary bone with M2 and M3 (scale bar = 10 cm).

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