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New radiometric age of volcanic rocks in the central Eritrean plateau (from Asmara to Adi Quala): Considerations on stratigraphy and correlations

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Abstract

New radiometric data have recently been acquired on basalt and rhyolite sampled at various levels of the volcanic sequence occurring in the central Eritrean plateau, confirming the stratigraphic reconstruction suggested in a previous paper [Zanettin, B., Bellieni, G., Justin Visentin, E., Haile, T., 1999. The volcanic rocks of the Eritrean plateau: stratigraphy and evolution. Acta Volcanologica 11(1), 183–193]. New considerations indicate the tholeiitic, not alkaline, nature of the Asmara basalt. Doubts about the relative age of the Aiba/Alaji and Asmara basalts have now been clarified: they are, at least partly, coeval (about 30 Ma old).

The Serae rhyolite intercalated in the Adi Ugri basalt turns out to be about 24 Ma old, like the more abundant ignimbrite outcropping in the Senafe area, of which it is the westernmost extension. Its age confirms that it does not correspond to the trachyte intercalated in the Oligocene stratoid basalt of the Adwa-Axum area (where the Adi Ugri basalt probably also occurs, intercalated with the Serae trachyte and rhyolite).

The upper part of the Adi Ugri basalt is 22 Ma old (an age consistent with the finding of a *Deinotherium* tooth).

The radiometric age of these rocks also confirms already indicated correlations between Eritrean and Ethiopian volcanic formations.

Keywords: Eritrea; Volcanism; Stratigraphy; Age

1. Introduction

We recently published the first data dealing with the volcanic rocks outcropping in the central Eritrean plateau (Amasien and Serae regions), along the road from Asmara to the Ethiopian border, via Adi Ugri (Mendefera) and Adi Quala (Fig. 1) (Zanettin et al., 1999). The paper provided bulk chemical compositions, petrographic descriptions, and the mineral chemistry of the main coexisting phases. At that time, radiometric data were not yet available, but correlations with some chemically and petrographically similar Ethiopian volcanic formations, of known age and stratigraphic position, allowed a provisional stratigraphic reconstruction of the Eritrean volcanics.

Summarizing, the previous paper suggested the following volcanic succession: (i) south of Adi Ugri, Mesozoic sandstone is covered by fissural transitional-tholeiitic flood basalt, linked with the Aiba or Oligocene Alaji basalt of Ethiopia (32–26 Ma; Zanettin, 1992; Zanettin and Justin Visentin, 1974; Zanettin et al., 1980); (ii) north of Adi Ugri, the laterite of the metamorphic basement (sandstone is absent) is covered by alkaline basalt, called Asmara basalt and dubitatively linked with the Termaber basalt of Ethiopia.

Due to the lack of clear stratigraphic relations between these two formations, it was arbitrarily decided to consider the Aiba/Alaji flood basalt as older than the Asmara basalt.

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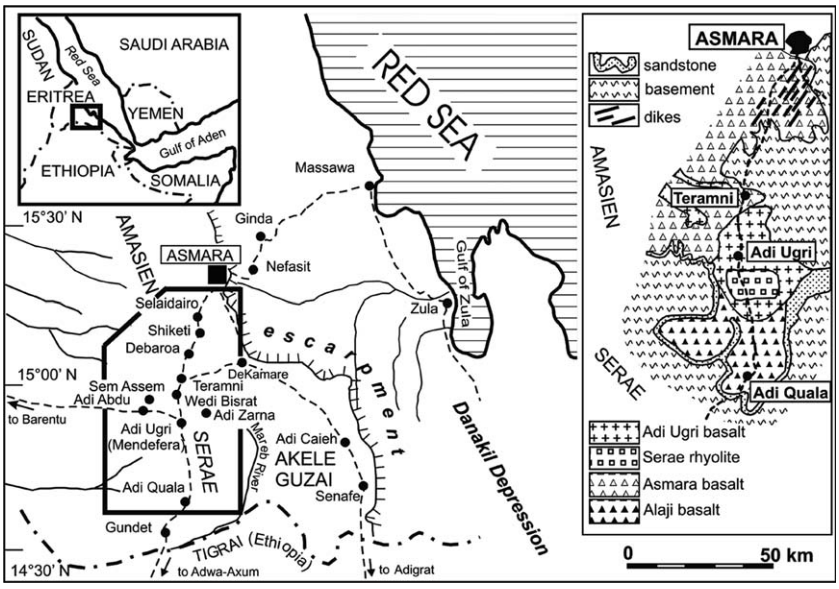

Fig. 1. Simplified map of central Eritrea. Continuous line: area of plateau between Asmara and Adi Quala (Amasien and Serae regions). Inset: geological sketch-map of study area, from Zanettin et al. (1999).

The Adi Ugri alkaline basalt was emitted on the erosion surface of these two volcanic formations, fed by thick dykes trending N20°E.

A relatively thin ignimbritic flow (Serae rhyolite) is intercalated between the lower and upper parts of the Adi Ugri basalt.

The finding of a *Deinotherium* tooth (Vialli, 1966) in the upper part of the basaltic pile points to an age lower than 24 Ma.

2. Radiometric dating and correlations

The new radiometric data are shown in Table 1 and Fig. 2. They do not substantially change the above-mentioned stratigraphic sequence. The main contradictory result is that one sample (ER 49) of the fissural Aiba/Alaji basalt turns out to be substantially coeval with a sample (ER 52) of the Asmara basalt, instead of being older. The chemical composition and mineral chemistry of the dated rocks are shown in Table 2.

2.1. Aiba/Alaji basalt

The sample found in the Adi Quala area gave a K/Ar age of 28.6 ± 0.3 Ma.

It must be recalled that this sample is the youngest so far yielded by the Aiba/Alaji Eritrean basalt. In fact, as already reported in our previous paper, Drury et al. (1994) supplied higher $^{40}Ar/^{39}Ar$ ages (32 ± 3 Ma and 29.4 Ma) for two basaltic samples "outcropping on the lateritic and metamorphic basement on the banks of the tributary of Barka river, in the western Eritrean plain 23 km beyond Adigrat in the direction of Barentu, 5 and 25 m respectively above the laterite".

The radiometric age of the Eritrean flood basalt turns out to span from 32 to 28 Ma, thus clearly confirming its correlation with the Aiba/Alaji basalt of the Ethiopian plateau.

Some doubt exists about the correlation of the Eritrean fissural basalt with both the Aiba and Alaji Ethiopian flood basalts, because we can neither confirm nor exclude the presence of acidic layers within the basaltic flows. In any case, the intercalation mentioned by previous authors (Dainelli, 1943; Merla and Minucci, 1938) does correspond to the Serae rhyolite, which is interposed in the pile of the Adi Ugri alkaline basalt instead of the Aiba/Alaji basalt. If more accurate future research confirms the absence of acidic layers, it would be more correct to correlate the Eritrean flood basalt with the Aiba than with the Alaji basalt.

The dating of the Asmara basalt was difficult, because it is quite severely weathered. Only on one sample (ER 52) from a basaltic flow directly covering the laterite of the basement, near the village of Teramni, was it possible to carry out some measurements ($^{40}Ar/^{39}Ar$ 29.6 ± 0.6 Ma), as already mentioned. If these data are correct, we can state that, about 30 Ma ago, central vent volcanoes began to form in Amasien, while slightly further south, in the Adi Quala area, the fissural Aiba volcanism still continued.

In a previous work (Zanettin et al., 1999), the Asmara basalt was classified, albeit doubtfully, as alkaline, although the low values of TiO_2 and K_2O, beyond the projection in the TAS diagram (Le Maitre et al., 2002), indicated their tholeiitic nature. This appeared to be explained by the fact that the pyroxene analysed by microprobe revealed an alkaline, or transitional-alkaline character, similar to that of the pyroxene from the moderately alkaline or transitional-alkaline Adi Ugri basalt and the Termaber alkaline basalt in the Ethiopian plateau. The