Journal of African Earth Sciences 114 (2016) 63–66

Contents lists available at ScienceDirect

Journal of African Earth Sciences

journal homepage: www.elsevier.com/locate/jafrearsci

New high-precision $^{40}Ar/^{39}Ar$ ages on Oligocene volcanic rocks of northwestern Kenya

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ARTICLE INFO

Article history:
Received 4 September 2015
Received in revised form
9 November 2015
Accepted 11 November 2015
Available online 19 November 2015

Keywords:
Kenya
Oligocene
Mogila
Songot
Lokwanamur
Gatome
Turkana
Volcanism

ABSTRACT

New, high-precision $^{40}Ar/^{39}Ar$ ages from volcanic rocks in northwestern Kenya are provided for some areas of exposure in this remote area. We report seven $^{40}Ar/^{39}Ar$ ages generated from single crystal total fusion experiments on alkali feldspar separated from volcanic rocks in the Mogila, Songot, and Lokwanamur Ranges and the Gatome valley. A rhyolite from the lower part of the sequence in the Mogila Range yielded ages of 32.31 ± 0.06 Ma and 32.33 ± 0.07 Ma, and a rhyolite near the top of that sequence yielded 31.67 ± 0.04 Ma. A single sample from the Songot Range yielded an age of 32.49 ± 0.07 Ma, slightly older than the rocks collected from Mogila. In both ranges the early Oligocene rhyolites are underlain by basalts, as is also the case in the Labur Range. Ages of 25.95 ± 0.03 Ma, 25.91 ± 0.04 Ma, and 27.15 ± 0.03 Ma were measured on alkali feldspar from rhyolites from the Lokwanamur Range, and the nearby Gatome valley. All of these rocks are part of an episode of widespread volcanism in northwestern Kenya in the mid-to late Oligocene that is not currently known from the Ethiopian Rift Valley.

1. Introduction

Volcanic rocks resting on Pre-Paleozoic basement rocks in the Turkana Depression of northwestern Kenya have been known for over 80 years (Arambourg, 1943; Champion, 1937), and were mapped by Walsh and Dodson (1969). The ages of these rocks at some localities are known from reconnaissance geochronology reported in Morley et al. (1999) and McDougall and Brown (2009), but several regions lack ages. Our objective in the present work is to provide ages for three mountain ranges for which no geochronological information has been available. Volcanic rocks in this region are amongst the oldest lavas and ash flows in Kenya, and may signal the beginning of rifting in the area (Davidson, 1983; McDougall and Brown, 2009). They are exposed in mountain ranges bounded by faults (Loima, Pelekech, Songot, Mogila, Lokwanamur (Lokwanamoru on some maps) and Lorienetom, from south to north; see Fig. 1), which stand 750–1700 m above broad areas of low relief and low elevation (400–500 m) that separate the ranges from one another. Here, we report ages on rocks from three of these mountain ranges (Songot, Mogila, and Lokwanamur), showing that they were erupted during the Oligocene Epoch. We sought, but did not find, suitable materials for dating in the Loima Range.

Songot (Zingout on old maps; e.g., Champion, 1937) and Mogila are two prominent mountainous areas near the town of Lokichogio, which are separated from the Pelekech Range and the Lokwanamur Range by the Lotikipi plain and its southern extension (Fig. 1). Rhyolitic lavas and ash flows in the Songot and Mogila ranges dip toward the east about 10°. Wescott et al. (1999) estimate that these rhyolites are ~900 m thick, underlain by 1800 m of basaltic lavas.

The volcanic sequences at Pelekech, northward to Lokwanamur and Lorienetom are estimated to be up to 3 km thick (McDougall and Brown, 2009; see also Wescott et al., 1999). At Lokwanamur, rhyolites dipping ~7° to the west are exposed over a vertical distance of 900 m, with the high point separated from the low point perpendicular to strike by ~8.5 km. From this we estimate that the rhyolitic rocks exposed in the Lokwanamur range are ~1900 m thick. Champion (1937) described a forest of fossil trees rooted in a red rhyolitic tuff exposed along the road to Kaimothia. We obtained an age from a rhyolite flow from Lokwanamur (KEM-1; Table 1), and we also dated a sample of the tuff in which the trees are embedded along the Kaiemothia road at 4.858° N, 35.373 E. Fuchs

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http://dx.doi.org/10.1016/j.jafrearsci.2015.11.012
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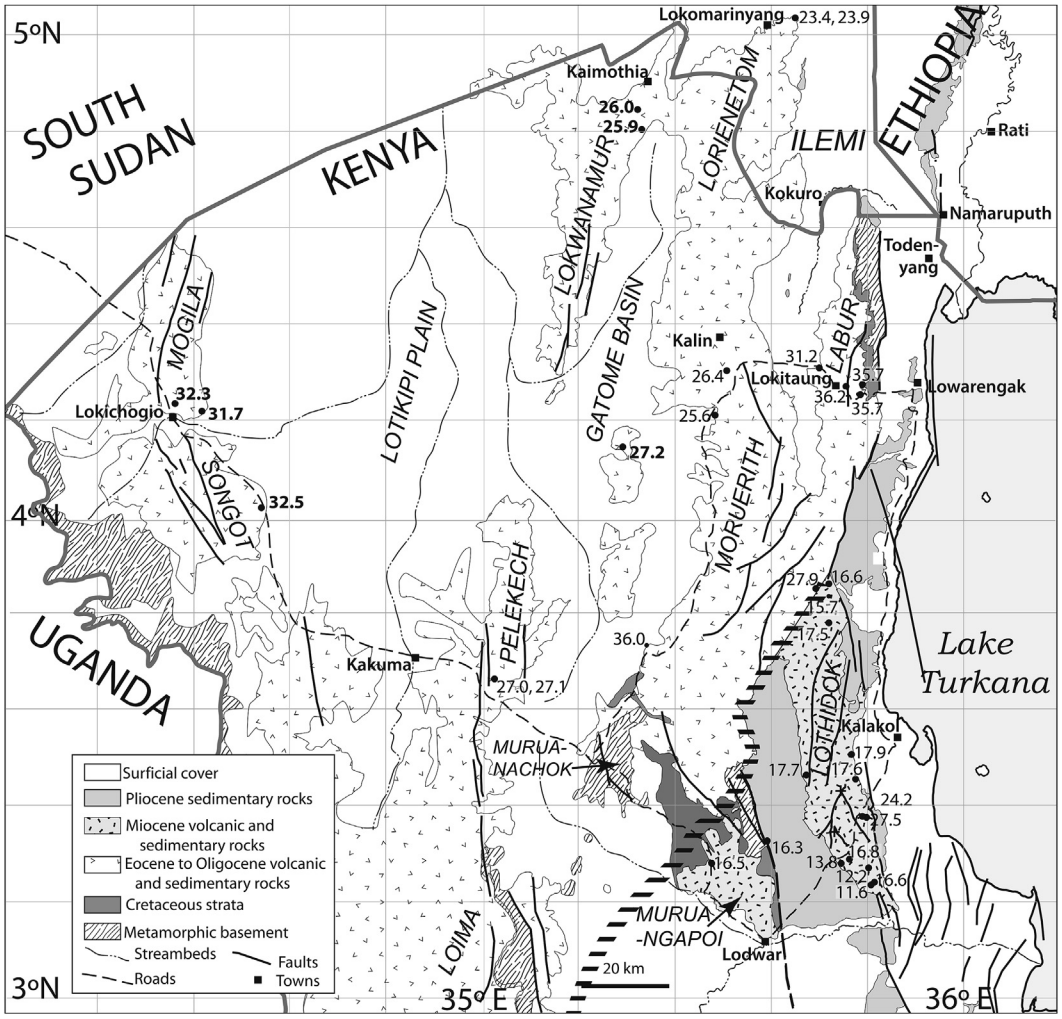

Fig. 1. Simplified geologic map of the northern part of Turkana, Kenya (largely after Walsh and Dodson (1969) with additions from Morley et al. (1999) and from field observations. Many faults are omitted for clarity. Dated units are shown as numbers without error (again with some omitted or averaged; those in normal font are reproduced from McDougall and Brown (2009); those in bold are reported in this paper. The broad horizontally dashed line separates Eocene-Oligocene volcanic and sedimentary rocks from Miocene volcanic and sedimentary rocks, but no single structure appears to account for the boundary. Areas mapped as Cretaceous strata are proven only east of Lokitaung; others are putative. Loima is shown as belonging to the older sequence because it appears to be continuous with the sequences at Pelekech, Songot, and Mogila, but this is not yet proven. This map is not an authority on international boundaries.

Table 1
Summary of $^{40}Ar/^{39}Ar$ single crystal alkali feldspar total fusion experiments.

Sample #	Location latitude, longitude	Range	K/Ca Total	N	MSWD	Weighted mean age (Ma) ± 2σ
K14-957	4.858°N, 35.373°E	Lokwanamur	34.8	15 of 20	0.98	25.95 ± 0.03
K14-983	4.224°N, 34.430°E	Mogila (top)	38.6	18 of 20	0.95	31.67 ± 0.04
K14-982A	4.214°N, 34.372°E	Mogila (bottom)	32.1	20 of 20	0.60	32.31 ± 0.06
K14-982B	4.214°N, 34.372°E	Mogila (bottom)	28.2	20 of 20	0.84	32.33 ± 0.07
K14-984	4.116°N, 34.453°E	Songot	37.2	24 of 24	0.84	32.49 ± 0.07
Gatome	4.145°N, 35.295°E	Gatome valley	64.6	9 of 14	0.84	27.15 ± 0.03
KEM-1	4.856°N, 35.372°E	Lokwanamur	66.5	13 of 14	0.84	25.91 ± 0.04

Fluence monitor is sanidine from the Fish Canyon Tuff; reference age 28.201 Ma from Kuiper et al. (2008). Decay constants: $\lambda_{40Ar} = 0.580 \pm 0.014 \times 10^{-10}$ a^{-1} and $\lambda_{B-} = 4.884 \pm 0.099 \times 10^{-10}$ a^{-1} from Min et al. (2000).

(1939) reported fossil wood in the same general region from imprecisely known locations near Naramum (a few km farther south) and near Lokitoi (a few km farther north).

The Gatome valley at ~600 m elevation between Lorienetom and Pelekech is floored with lavas and interbedded ash flow tuffs that dip gently (<10°) to the west or west-northwest, and are cut by many small faults. We determined the age of one rhyolite from these poorly exposed rocks in the Gatome valley (Gatome, Table 1). Wescott et al. (1999) described a faulted structure underlying the Gatome valley as the Gatome Basin.

2. Material and methods

Feldspar was separated from rocks collected from the Songot,