Quaternary International 395 (2016) 45–59

Contents lists available at ScienceDirect

Quaternary International

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

New $^{40}Ar/^{39}Ar$, unspiked K/Ar and geochemical constraints on the Pleistocene magmatism of the Samtskhe-Javakheti highlands (Republic of Georgia)

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A R T I C L E I N F O

Article history:
Available online 22 July 2015

Keywords:
Georgia
Samtskhe-Javakheti
Pleistocene
Lithospheric mantle source
Ar/Ar
K/Ar

A B S T R A C T

The Samtskhe-Javakheti volcanic plateau (Republic of Georgia) is the northernmost and youngest expression of the magmatism following the Arabia-Eurasia collision. Here, we present whole rock elemental and twenty-one new unspiked K/Ar and $^{40}Ar/^{39}Ar$ ages for the volcanic sequence well exposed east of the plateau. Based on our new radio-isotopic ages, we have identified three magmatic episodes. The oldest one (2.84–1.08 Ma), corresponding to the "Javakheti plateau *s.s.*", is mainly constituted of medium-K alkaline mafic lavas (basalt, basaltic trachyandesite) and of intermediate composition domes (dacite). The more recent volcanic activity has constructed an impressive N–S trending volcanic ridge (Samsari *s.s.*) composed of evolved rocks (medium-K dacite to rhyolite). Within this ridge, two main periods of activity could be depicted: Middle Pleistocene (439–189 ka) and Late Pleistocene (90–13 ka). The youngest activity is restricted to the northern edge of this prominent magmatic structure and linked to the Tavkvetili volcano activity. According to these young ages, this area can be considered as a potential zone of volcanic hazards. The oldest volcanic activity shaping the Javakheti plateau is distributed between major strike slip faults in pull-apart position. The emplacement of the volcanism is controlled by a localized upper crustal extension. This is particularly outlined by the N–S linear array of domes that constitutes the Samsari ridge. This volcanic structure emplaced indeed on top of two major N–S faults that have probably played a key role to control the Middle to Late Pleistocene volcanism. The new $^{40}Ar/^{39}Ar$ ages date between 2.32 and 1.54 Ma the fauna assemblage of the Tsalka paleontological site. Rocks from the Samtskhe-Javakheti volcanic plateau derived from a low degree of melting of a metasomatized lithospheric mantle source (spinel facies). Except the obsidians from the Chickiani dome, they all derived from this source and evolved following a crystallization sequence involving mainly clinopyroxene, garnet, and/or amphibole. A crustal contamination component modified the composition of the youngest products (Samsari ridge rocks). According to the geochemical signature of these rocks, it seems that the magmatism does not fit with models involving asthenospheric upwelling in this region.

1. Introduction

The mountain range of the Lesser Caucasus and associated volcanic plateaus are part of the Alpine fold belt (Fig. 1). Their formation is related to the convergence between the Arabian and

DOI of original article: http://dx.doi.org/10.1016/j.quaint.2015.07.042.
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http://dx.doi.org/10.1016/j.quaint.2015.05.049
1040-6182/

Eurasian plates, which results in compression of the region located between the northern edge of the Arabian block and the Eurasian shelf, with lateral ejection of the Anatolian block westward and the Iranian block eastward (Jackson and McKenzie, 1984). The Caucasian region is characterized by the complexity of its active tectonic, due to N–S compressive accommodated by major E–W thrusts and folds as well as E–W extensional structures (Rebaï et al., 1993). Another characteristic of the Lesser Caucasus is the volcanic activity, which started during the Middle Miocene and extended through historical times (e.g., Aydar et al., 2003). The work of Milanovskii and Koronovskii (1973) depicted three stages in the evolution of the late magmatism in this extended area: (1) Late Miocene to Early Pliocene, (2) Middle Pliocene to Early Pleistocene (3) Middle Pleistocene to Holocene. Evidence of this long lasting volcanic activity is found all along the volcanic belt extending from Iran, Armenia, Georgia to eastern Turkey (Lesser Caucasus mountains) (Fig. 1). Erupted products range from mafic to felsic, and sodic to ultrapotassic composition (e.g. Karapetian et al., 2001; Keskin et al., 2008; Dilek et al., 2010; Allen et al., 2013; Neill et al., 2013). Several geodynamical mechanisms are usually advocated to interpret such intraplate mantle-derived post collisional volcanism: 1) an asthenospheric upwelling following the break-off of the subducted oceanic slab (e.g. Keskin, 2003; Keskin et al., 2008); 2) the delamination of the lithosphere inboard of the plate suture (e.g. Kay and Kay, 1993). However, a recent study questioned these models in the northern part of the Lesser Caucasus because of the lack of asthenospheric components in the volcanic products (Neill et al., 2013). 3). A more recent model involving small-scale convection at the lithosphere-astenosphere boundary and melting due to the breakdown of hydrous phases in context of thick mantle lithosphere may explained the long lived volcanism found over the Turhish-Iranian plateau and the lack of clear temporal as well as spatial patterns (Kaislaniemi et al., 2014).

The northernmost expression of this magmatic activity linked to the Arabian-Eurasian collision marks the junction between Turkey, Georgia and Armenia in the Samtskhe-Javakheti highland region (Lebedev et al., 2008a,b; Neill et al., 2013) (Figs. 1 and 2). The Plio-Pleistocene volcanic succession in this region represents a major topographic feature and displays lavas piles with thickness that exceeds 1 km locally along the Kura River (Figs. 1 and 2). The Samtskhe-Javakheti highlands magmatic plateau is mainly constituted of subalkaline basalts with only minor occurrences of dacite and rhyolite (Lebedev et al., 2008b). This thick sequence spreads over Cretaceous and Paleocene volcanogenic and sedimentary rocks well exposed west and east of the plateau (Fig. 2). Previous K–Ar and $^{40}Ar/^{39}Ar$ ages (Maisuradze et al., 1991; Camps et al., 1996; Gabunia et al., 2000; Lebedev et al., 2006, 2008a,b; Messager et al., 2011 suggest that the Javakheti plateau was built between 3.75 and 1.60 Ma (Chernyshev et al., 2002; Lebedev et al., 2008a,b)). One of the most important and prominent geological features of the Samtskhe-Javakheti highland is the N–S trending 30 km long Samsari ridge. This volcanic ridge of Middle Pleistocene age (Messager et al., 2013) is constituted of more than 20 volcanic domes and reaches 3301 m a.s.l. (Didi-Abuli, Fig. 2). In the central part of this ridge, a 3 km diameter depression (2400 m a.s.l.), currently interpreted as a caldera, was recently dated at 189 ± 20 ka (Messager et al., 2013). The most recent activity has not been precisely dated. According to Chernyshev et al. (2006) it might be as young as 30 ka or even Holocene (Skhirtladze, 1958). The highest parts of the Samsari ridge were covered by an ice cap (50–100 m) during the last two glacial periods as attested by the presence of glacier deposits (Messager et al., 2013).

To further constrain the origin and timing of the volcanic activity of the Samtskhe-Javakheti highlands, we report twenty-one new unspiked K/Ar and $^{40}Ar/^{39}Ar$ ages as well as seventeen whole rock elemental analyses covering the eastern side of the

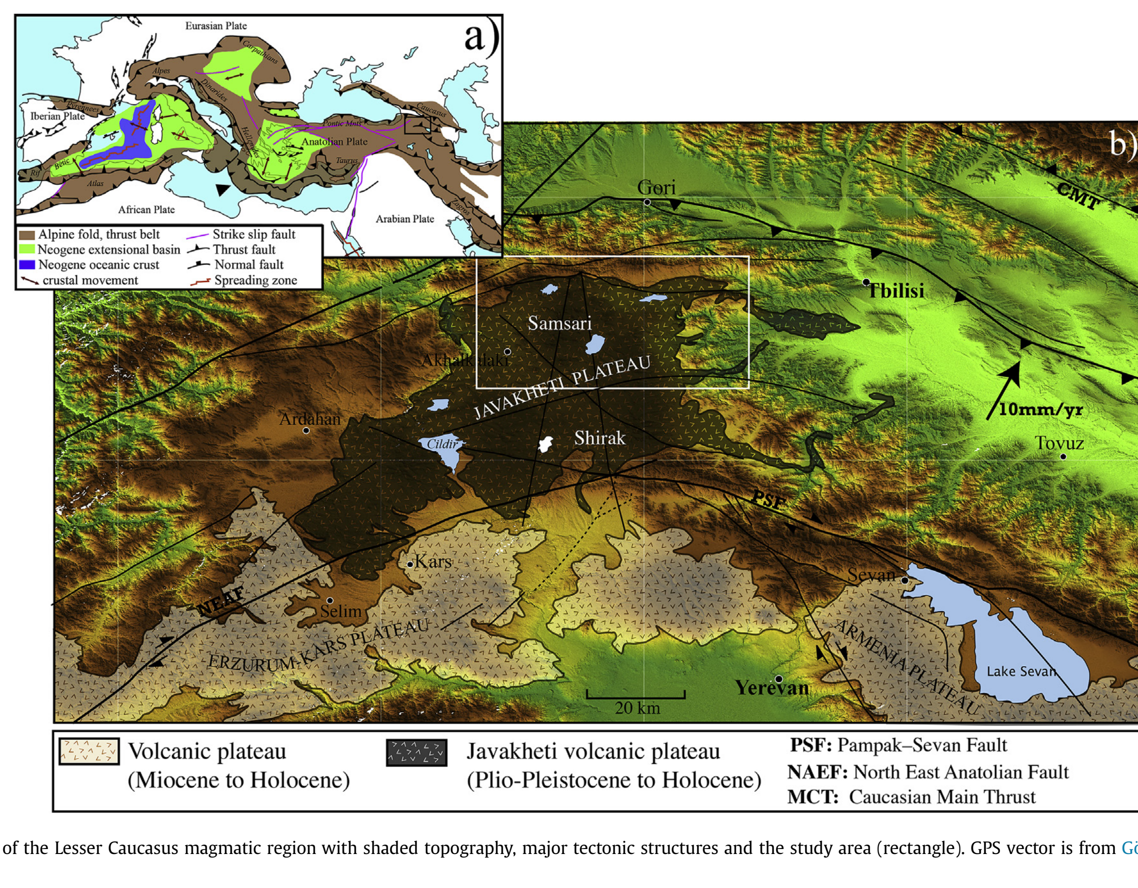

Fig. 1. Map of the Lesser Caucasus magmatic region with shaded topography, major tectonic structures and the study area (rectangle). GPS vector is from Gök et al. (2011).