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Quaternary Volcanos of Shavnabada and Tavkvetili (Georgia): Hazards for the Azerbaijan-Turkey Oil and Gas Pipelines?

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Introduction

Georgia, situated in the central part of the Caucasian region, provides a natural pipeline corridor from Azerbaijan to the west and Turkey. The Baku-Supsa (BS) and the Baku-Tbilisi-Ceyhan oil pipelines (BTC), as well as the Baku-Tbilisi-Erzurum South Caucasian natural gas pipeline (SCP) traverse this corridor through Georgia. BTC is one of the longest oil pipelines in the world, with the length of 1768 km, while the length of SCP is 692 km and it is planned to be combined with the Trans-Anatolian gas pipeline (TANAP) in the future. They are parallel to each other and in Georgia run through Shavnabada and Tavkvetili areas - the youngest volcanoes of Quaternary Abul-Samsari volcanic ridge. This reality introduces legitimate doubts about the geological stability of the area. In this work, new information about Shavnabada and Tavkvetili volcanoes is analyzed and volcanic and tectonic hazards, threatening BTC and SCP, are assessed.

Geological framework of the region

The region represents a part of vast subaerial volcanic province, which started to emerge about 20 Ma, as a result of Arabia-Eurasia continental collision after the closure of Neotethys. These volcanics overlay all the rocks older than Middle Miocene, creating stratigraphic unconformity. This formation covers Eastern Anatolia and the central segment of the Lesser Caucasus and occupy about 20,000 km^2; in Georgia, Armenia and Turkey, it is known as Samtskhe-Javakheti, Armenian and Erzurum-Kars volcanic plateaus, respectively. Despite of its long research history, the genesis of the volcanic province is still a matter of discussion (Keskin, 2006; Okrostsvaridze et al., 2016. Nomade et al., 2016).

Three main stages of magmatic activity have contributed to the formation of the Samtskhe-Javakheti volcanic highland in Georgia: 1. Upper Miocene-Lower Pliocene, when huge, 700-1000 m thick dacite-andesitic volcanic tuffs and basaltic-andesitic lava flows were formed; 2. Upper Pliocene-Lower Pleistocene, when 120-270 m thick continental basalts were formed and 3. Middle-Upper Pleistocene volcanic activity, when Abul-Samsari volcanic ridge was formed (Okrostsvaridze et al., 2016). The latter is the youngest and northernmost part of Samtskhe-Javakheti volcanic plateau.

Abul-Samsari volcanic ridge

The Abul-Samsari volcanic ridge, of andesitic-dacitic composition, stretches to the S-N direction for 40 km with the 8-12 km width and contains more than 20 volcanic centers. According to the Sr and Nd isotopic parameters ($^{143}Nd/^{144}Nd$=+0.52504; $^{87}Sr/^{88}Sr$=0.0421) the magmatic source of this ridge was mantle reservoir. One of the obvious features of the ridge is the northward rejuvenation and simultaneous weakening of volcanic processes. To the south of the Abul-Samsari ridge the highest (3305 m a.s.l.) and oldest (K/Ar age 0.35-0.30 Ma) volcano Didi Abuli (Big Abuli) is located; further north the youngest and smaller volcano Tavkvetili is located (2583 m a.s.l.; K/Ar age 0.018- 025 Ma) (Okrostsvaridze et al., 2016).

The study area

Tavkvetili and Shavnabada volcanoes are located at the northernmost edge of the Abul-Samsari Ridge, extremely close to the pipeline corridor and are among the youngest volcanoes of this ridge (Fig. 1). Tavkvetili volcano is a scoria cone, up to 2582 m a.s.l. with a well-preserved summit crater, 200 m in diameter. Several lava flows were outpoured from the vent and flowed northward and southward 4 km away from it (see Fig. 1). Tavkvetili dacite is aphyric with a glassy black groundmass; the lava flows are a few decimeters to meters thick. These textural characteristics suggest that this lava had a low viscosity during emplacement. Shavnabada volcano is located 6 km south of Tavkvetili and shows two vents (see Fig. 1). The northern vent produced a scoria cone, up 2929 m a.s.l. in elevation. The southern vent is a small shield cone with a distinguishable summit crater and radial lava flow field. Shavnabada andesite is also aphyric with a glassy black groundmass.

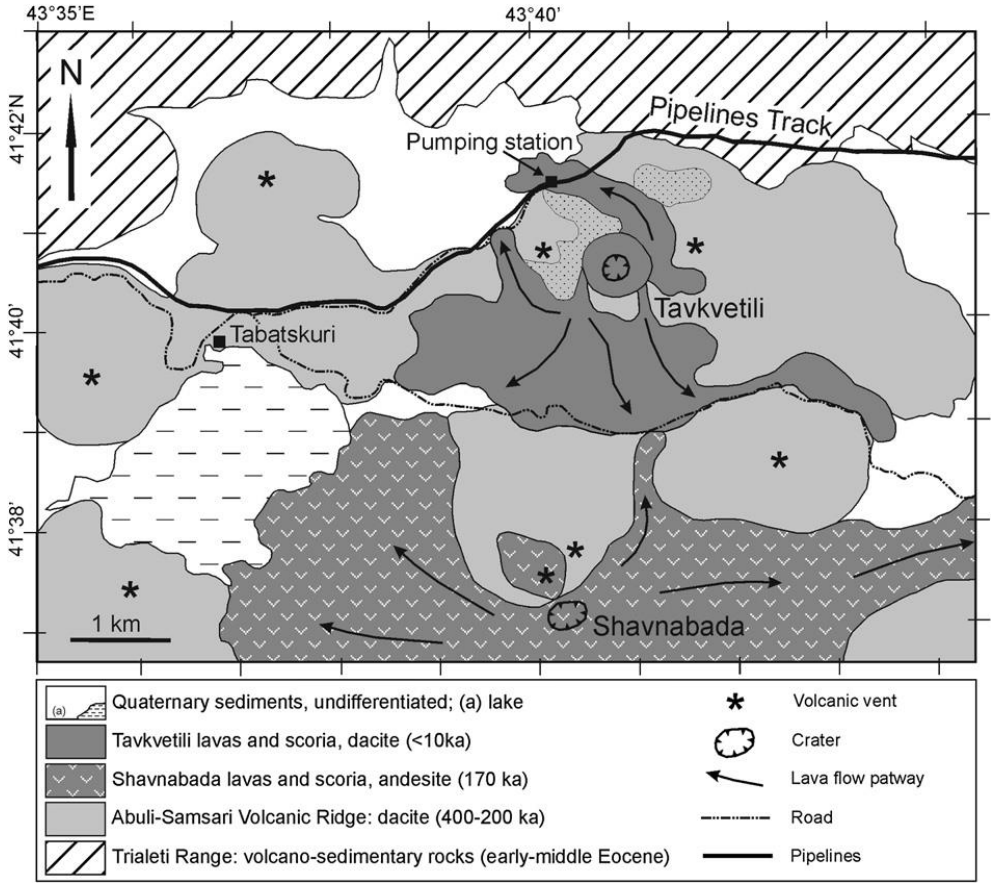

Fig. 1. Geologic map with local track of the pipelines, the $^{40}Ar/^{39}Ar$ ages of Tavkvetili and Shavnabada volcanos and its more recent lava flow.

Our geomorphologic observations indicate the absence of periglacial activity on Savnabada and Tavkvetili volcanoes. Well-preserved summit craters suggest that volcanic activity probably post-dates the last glacial retreat (<10,000 a BP). Nevertheless, the central and north segments of Abul-Samsari ridge carries obvious signs of ice age glacial activities (Akhalkacisvili, 2006). New K/Ar and $^{40}Ar/^{39}Ar$ radiometric data provides much younger dates (Nomade et al., 2016) than previous radio-metric analysis using the same methodology (Lebedev et al., 2003). For example, according to new study, the age of Tavkvetili volcano Ka 13 ± 5 Ka. (by Lebedev et al. is 30 Ka). If we rely on this data then this volcano is younger than the last glacial period and was unaffected by this process.

Conclusion

Based on the result of our study, we think that in case of reactivation of Shavnabada and Tavkvetili volcanoes BTC and SCP will face serious challenge, since these pipelines run over the slopes of these volcanoes. Seemingly, during the selection of pipeline routes this geological hazard was not taken into account, which should be considered as a serious mistake.

Especially hazardous area in this regard, is the northern dacitic flow of Tavkvetili, which is crossed by the aforementioned pipelines. Besides the fact that this segment will be very problematic in case of volcanic activity, the lava flow is inclined to the north by $8\text{-}11^0$ and its part consists of unconsolidated volcanic tuff, which causes its gravitational instability. If we also consider tectonic characteristics of the area, in particular, young faults with N-S strikes (Pasquare et al., 2011) and 1986 Faravani earthquake of magnitude 5.6, then we should suppose that areas of Shavnabada and Tavkvetili volcanoes represent geologically one of the most hazardous segments for BTC and SCP in Georgia.

Finally, our analysis is that the BTC and SCP were designed in such a way that the risk posed by the newly-identified geohazards in the vicinity of the Abul-Samsari Ridge were reduced significantly. The regionally significant BTC and SCP may warrant greater protections, since the consequences of longterm shut-down in the event of a lava flow or large landslide engulfing the valve station would be very damaging to the economies of western Europe and Turkay.

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