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Zircons U-Pb Dating of Mtkvari Canyon Volcanic Flow (Georgia) and Destructive Processes of Vardzia Cave City Hewn into this Flow

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INTRUDUCTION

Georgia is situated in the central part of the Caucasus, which represents Phanerozoic collision orogen formed along the Eurasian North continental margin and is stretched on 1200 km, from the Caspian to Black sea (Fig. 1). Currently, it is an expression of continental collision between the Arabian and Eurasian plates. Three major units are distinguished in the Caucasus construction: the Greater and Lesser Caucasian mobile belts and Inner Caucasian microplate.

Fig. 1. Physical map of the Caucasus, in the central part Samtskhe-Javakheti Volcanic Province.

REGIONAL GEOLOGY

At Late Cenozoic in the central part of the Lesser Caucasus Samtskhe-Javakheti volcanic highland was formed (Skhirtladze, 1958) (Fig. 2). It has an area of more than 4500 km2 (1300-2200 m asl), however its large part is located in the South of Turkey and Armenia territories. In the formation of the highland three main magmatic activity should be marked:

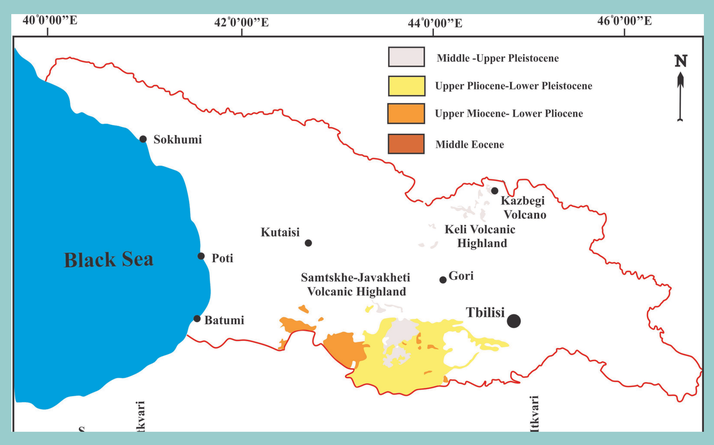

Fig. 2. Schematic map of the Late Cenozoic volcanic activity of Georgia

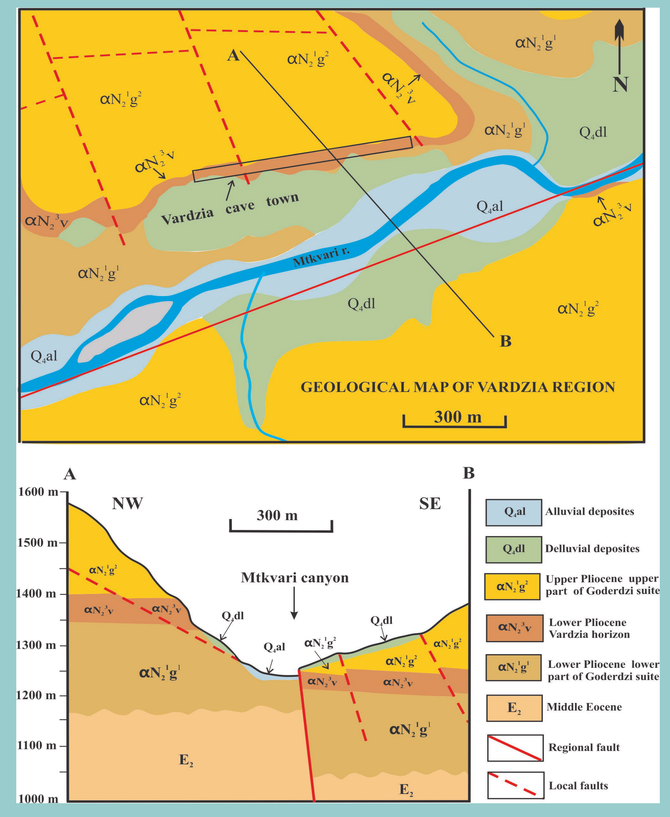

Fig. 9. The geological map and cross section (A-B) of the Vardzia area (Okrostsvaridze et al. 2016).

MTKVARI CANYON VOLCANIC FLOW

In the lower part of the Goderdzi formation, which is represented by volcanic lava-breccias, pyroclastic rocks, tuffs and ash fall deposits of andesitic-dacitic composition, along a Mtkvari river canyon outcrops fine-grained volcanic pyroclastic flow (Fig. 3). Thickness of this flow varies between 30-80 m length 35 km, width 2-3km (Fig. 4) and is described as slightly welded tuffs (ignimbrites) of andesitic-dacitic composition (Ustiev, Djigauri, 1971). Its isotope data confirms a mantle source of magma chamber (143Nd/144Nd = +0,51703 - +0,52304; 87Sr/88Sr = 0.7036 - 0.7042). Based on our investigations we suppose that the magmatic center of this flow was a megacaldera, which nowadays is represented as Niala's Fields (Okrostsvaridze, Popkhadze, 2016).

Fig. 3. Panoramic view of the right side of Mtkvari canyon. White color- Mtkvari volcanic flow, black color-upper part of the Goderdzi formation. Right– the Vardzia cave city.

ZIRCONS U-Pb DATING RESULTS

The dating the zircons of Mtkvari volcanic pyroclastic flow was done at National Taiwan University, by U-Pb method, using LA-ICP–MS equipment. The samples were taken from three main parts of the flow: in the end of the flow (at 35 km), near the Khertvisi castle (13GEO-04), in the central part of the flow (at 15 km) near the Vardzia cave city (13GEO-05) and at the beginning of the flow (at 2 km) near the Arzameti castle (13GEO-06). It was dated 72 of zircon grains (Fig.5 and 7). The results are as follows: 13GEO-04 = 7.500,42 Ma; 13GEO-05 = 7,540,21 Ma; 13GEO-06 = 7,52 0,21 Ma (Fig.7). Thus, according to this dating, the Mtkvari volcanic flow represents the Late Miocene formation (av. 7.52 Ma)

VARDZIA CAVE CITY

Cave city of Vardzia is in carved in the central part of the Mtkvari volcanic flow, in the 12th century. It combines urban, defensive and monastic functions and is one of the most important monuments of Georgia cultural heritage. Vardzia had 13 floors and more than 500 cave rooms (Fig. 8). In 1283, after a strong earthquake, the cave city was severely damaged, but did not cease its operation. In 1999, Vaddzia was included in the UNESCO World Heritage list together with Khertvisi castle.

Fig. 8. View of the Central part of Vadzia cave city; is hewn into the weakly welded ignimbrite flow.

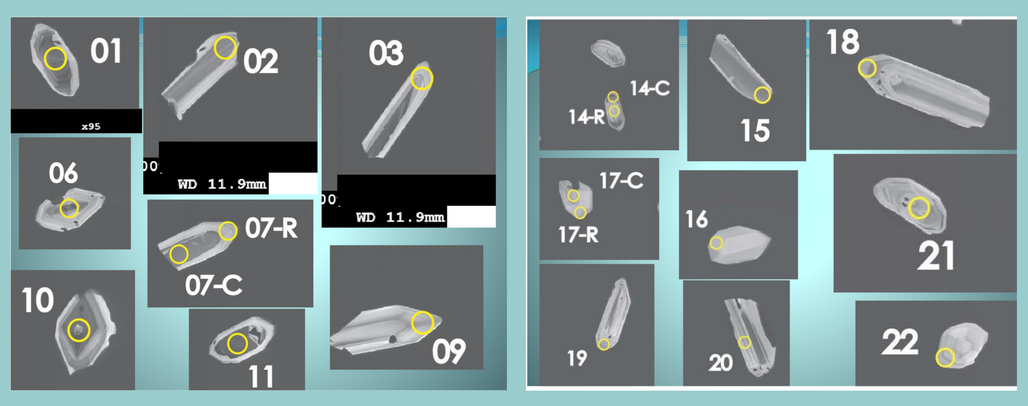

Fig. 6. Part of zircon grains of the 13GEO-06 sample.

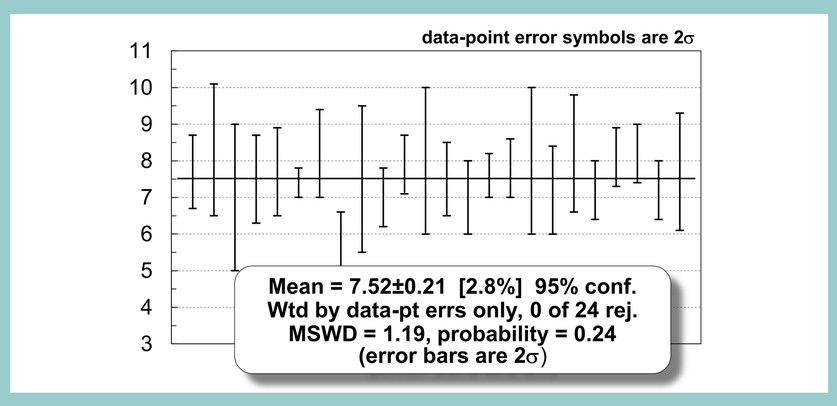

Fig. 7. Statistical result of the 13GEO-06 sample zircons U-Pb dating.

DESTRUCTIVE PROCESSES OF VARDZIA CAVE CITY

The results of the geological investigation which was conducted by us [5], showed that the Vardzia area has a complex geological structure (Fig. 9). It is situated on the eastern slopes of the Erusheti ridge and is hewn into the 900 m long tectonic block, which is detached from the main rocks and is gradually subsiding towards the Mtkvari gorge (Fig.10). In addition, the Vardzia block is split into several microblocks by a joint set and thereby its stability lessens (Fig. 11 and Fig. 12). The matter is made worse by the fact that the active deep fault runs along the Vardzia city in the Mtkvari gorge and presents a potential earthquake source. It is clear that the important monument of the World cultural heritage is in danger of natural gradual destruction and earthquake hazards.

Fig. 10. A general view of the Southern tectonic contact of Vardzia segment.

Fig. 11. View of the northern part of the Vardzia cave city;

Fig. 12. Fragment of Collapsed facade part; result of the 1283 year Vardzia earthquake .

REFERENCES

Okrostsvaridze A., Popkhadze N., 2016. Abst. 6th Intern. workshop on collapse calderas. Hokkaido, Japan. 42 p.
Okrostsvaridze A., Elashvili M., Popkhadze N., G. Kirkitadze G., 2016. Bull. Georg. Nat. Acad. Sci., vol. 10, no. 3. pp. 98-105.
Skhirtladze N., 1958. Post-Paleogeneic volcanism of Georgia. Tbilisi, "Metsniereba" 165 p.
Ustiev E. K., Jigauri D. I., 1971. The velded tuffs from Vardzia formation. Izvestia. AN SSSR, , vol. 4. pp.3-16.