First fission-track dating experiments performed in Bulgaria

Първи опити за провеждане на датиране по метода на следите в България

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Fission-track (FT) dating is one of the methods of the low-temperature geochronology widely used to constrain the thermal histories of various rocks in different geological settings (orogenic belts, sedimentary basins, mineral deposits, faults, etc). Some of the most used applications of FT dating include reconstruction of time-temperature history of rocks, estimation of denudation/exhumation rates of mountain chains, dating of faults and ore mineralizations, deciphering sedimentary basin evolution as well as dating volcanic deposits. One of the most used minerals in FT dating is apatite (Donelick et al., 2005) for dating events at about 110±10 °C (effective retention temperature).

Here we present the first attempts to prepare and process apatite samples in Bulgaria. The experiments have been performed on standards (Durango apatite) with well-known FT age in order to check the efficiency of the method. Sample preparation was processed in the Chemical laboratory of the Geological Institute of BAS. The laboratory procedures follow to a considerable degree the described methodology by Tagami et al. (1988). Fragments of the jewellery Durango apatite were arranged in arrays of 5 × 5 grains of almost same size (Fig. 1a) on a glass covered by bifacial tape and mounted in epoxy resin where adhesive and hardener were mixed. The mounts were dried for more than 24 hours at room temperature and then easily detached from the tape. After mounting, pre-grinding, grinding and polishing of mounts was performed in order to remove a certain thickness to observe the tracks in the whole volume of the crystal. For pre-grinding and grinding 1500 grit silicon carbide paper was used. Mounts were pre-ground gently in one direction at least 20 times in order to observe grinding scratches on most of the grains. After that the mounts were ground perpendicular to the direction of pre-grinding

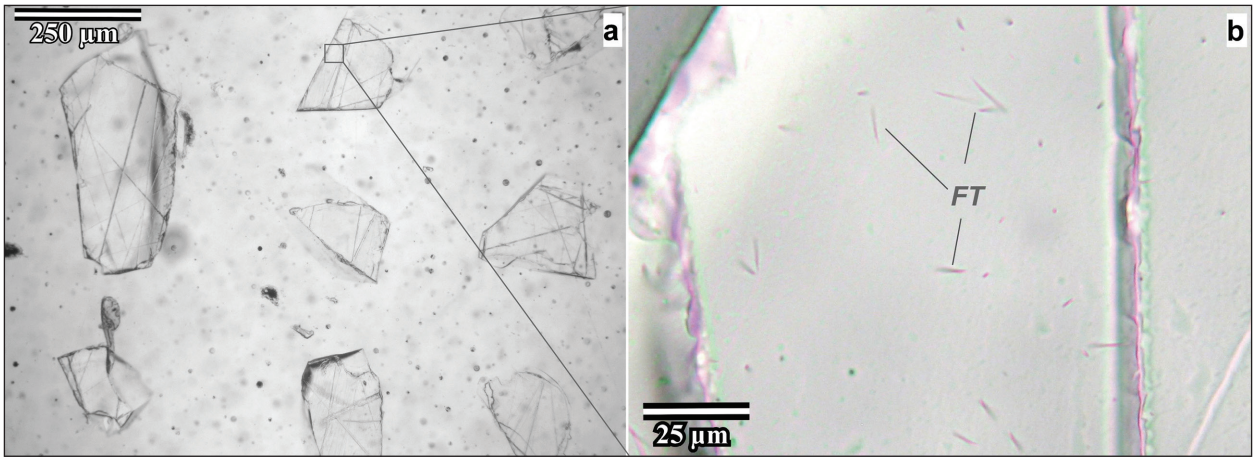

Fig. 1. *a*, fragments of Durango apatite arranged in arrays; *b*, spontaneous fission tracks (FT) in a fragment of Durango apatite

until all the previous scratches disappeared. This was repeated 8 times in order to remove at least 8 μm from the surface of the crystals (half of the etchable track length) as the depth of the grinding scratch is found to be at least 1 μm for 1500 grit silicon carbide paper.

Polishing was done using 6, 3 and 1 μm diamond pastes. For every step of polishing the direction was changed by 90° from that of the preceding polishing. After polishing the mounts were washed in ultrasonic cleaner for 5 minutes. In order to reveal the fission tracks and made them visible under optical microscope chemical etching of the samples was performed. Apatite mounts were etched in 5.5 N HNO_3 for 20 s at temperature of 21 °C (Donelick et al., 2005).

Spontaneous tracks (Fig. 1b) were counted under a Leica DM 2 500 POL optical microscope in the Department of Geology, Paleontology and Fossil Fuels, Sofia University. 100x dry and immersion objective lens were used for observation and counting.

After counting of fission tracks in the Durango grains, uranium concentration is needed to be directly measured on the same grains using laser ablation system in order to be used in the formulas for calculation of FT ages. This stage is ongoing in the Laboratory of laser ablation in the Geological Institute, BAS where ^{238}U concentrations are calibrated against NIST 610 and NIST 612 standard glasses.

The accomplishment of consistent results with the Durango apatite will give good premise for measuring and obtaining reliable results of the natural samples in the new laboratory.

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