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Research Advances

Apatite Fission Track Ages in the Duolong Ore District and the Uplift Time of the Qiangtang Terrrane, Tibet

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Objective

Fission track (FT) analysis has developed into one of the most useful techniques throughout the geologic community to reconstruct low-temperature thermal historyof rocks over geological time (Reiners et al., 2005). The FT method is based on the accumulation of narrow damage trails (i.e., fission tracks) in uranium-rich mineral grains (e.g., apatite, zircon, titanite) and natural glasses, which form as a result of spontaneous nuclear fission decay of ^{238}U in nature. Apatite Fission Track (AFT) has been used in many places in Tibet to study the Qinghai–Tibetan Plateauuplift-exhumation history. However, few AFT studies have been reported in the Duolong ore district. The Duolong ore district is one of the most important ore districts in the Bangong Co-Nujiang metallogenic belt, Tibet (Lin Bin et al., 2017) and the uplift-exhumation of the Duolong ore district is closely related to the evolution of the Qiangtang Basin. Therefore, AFT of the Duolong ore district will provide important information about the uplift-exhumation history of the Duolong ore district and the Qiangtang Basin.

Methods

Rock samples ranging in ages from the Late Cretaceous to the Late Jurassic were collected from the NW and SE of the Duolong ore district to pick out apatite crystals. The apatite crystals were separated from bulk rock samples following the standard procedures used for mineral separation. The apatite grains were glued with epoxy on the glass slides, grounded and polished to expose the maximum inner surface, and then etched in $5NHNO_3$ for 20s at room temperature, in order to reveal spontaneous fission tracks. Grain mounts and corning CN5 glass dosimeters were packed together with low-uranium muscovite external detectors and irradiated with thermal neutrons. After irradiation the mica external detectors were etched in 40% HF for 20 min at room temperature to reveal induced fission tracks. The ages were calculated using the zeta (ζ) calibration method recommended by the Fission Track Working Group of the International Union of Geological Sciences Subcommission on Geochronology (Hurford, 1990). The zeta value is 410±17.6.

Results

The $P(\chi^2)$ of all samples is greater than 5%, indicating that the single grain ages belong to the same age group. The sample mean age is expressed by the pooled age. The ages range from 7.8 to 72 Ma, and the mean track lengths range from 11.6 to 13.4μm, with standard deviations between 2.0 and 2.4μm. AFT single-grain ages are younger than the Early Jurassic to Early Cretaceous sample stratigraphic ages indicating the apatite was reset at least once after being deposited. The confine track lengths are shorter than the fission track initial length (16.3μm), showing a unimodal distribution. The characteristics of fission-track lengths indicate that the apatite samples had experienced significant annealing and the shortened track lengths suggest that the samples spent quite a long time in the partial annealing zone after reset. Mean track lengths in studied samples change depending on the elevation (Fig. 1a) increasing from low elevation to middle elevation, then decreases to highest elevation. The pooled ages also show a similar curve with the mean track lengths. The pooled ages of samples from the lowest elevation increases slightly from 63±5Ma to 72±5Ma at middle elevation, and decreases to 30±4Ma at the highest elevation (Fig. 1b).

Conclusions

The pooled ages of the samples from the NW of the Duolong ore district are almost the same which are around 63±5 Ma. In contrast, there is a wide range of the pooled ages of the samples from the SE of the Duolong ore

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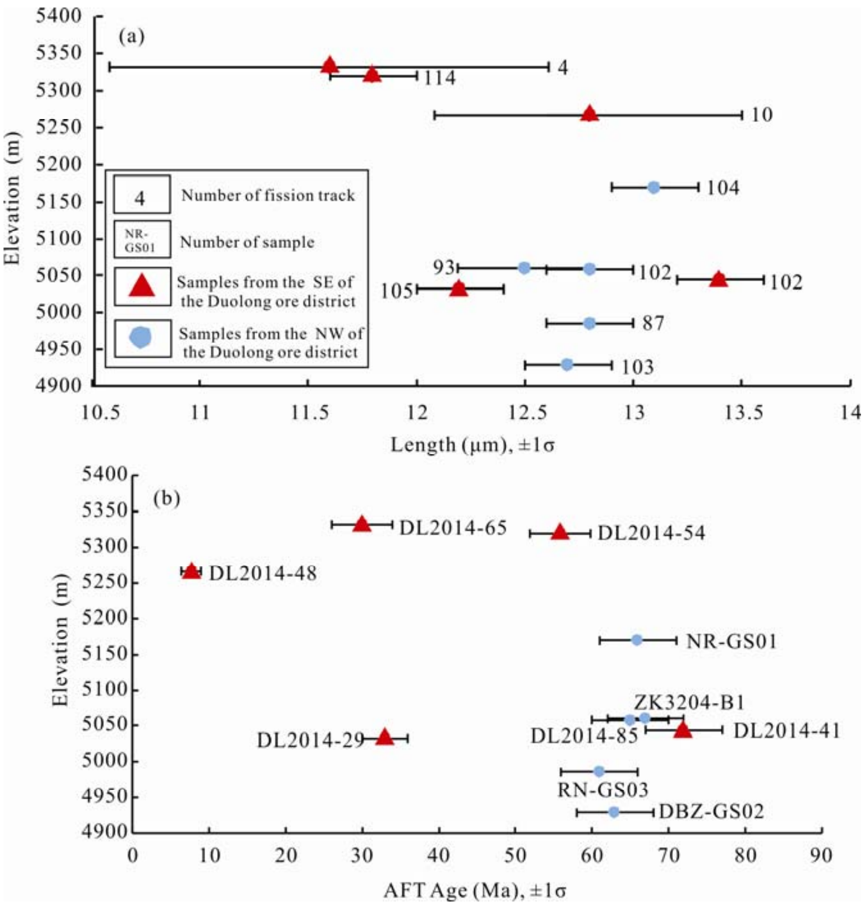

Fig. 1. Apatite dating results.
(a), Distribution of the mean track length with elevation; (b), Distribution of the AFT ages with elevation.

district which are between 7.8±1 Ma and 72±5 Ma. The AFT ages show that the NW of the Duolong ore district where the deposits (such as Tiegelongnan, Naruo, Duobuza) located experienced a cooling stage in the same period which was around 63Ma and the SE of the Duolong ore district experienced multiple cooling stages from 7.8 Ma to 72 Ma. The cooling after Late Eocene affected the SE part more intensively than the NW part of the Duolong ore district. The AFT ages also show that the Qiangtang terrane experienced cooling stage between late Cretaceous (72±5 Ma) and Late Miocene (7.8±1 Ma).

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