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A new approach for electron microprobe zircon fission track thermochronology

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Fission track thermochronology (FTT) has been applied for decades to quantify rates and timing of processes in the shallow crust. The most widely used approach is the external detector method (EDM). In this conventional approach, an age is obtained by counting both the fossil (^{238}U spontaneous fission) and the induced (^{235}U induced fission) tracks using an optical microscope. The induced tracks are obtained through the irradiation of the sample with thermal neutrons in the nuclear reactor, which causes fission of ^{235}U. Based on the studies carried out by Gombosi et al. (2014), we present an alternative method of dating zircons using electron probe microprobe analysis (EPMA) to measure uranium concentration [U]. The electron microprobe analysis fission track (EPMA-FT) method was applied to three samples of rapidly cooled zircons: the Fish Canyon Tuff, Poços de Caldas (syenite) and Serra Geral zircons. The analyses were performed using two approaches: 1) Using the age equation described in Gombosi et al. (2014) and 2) Using a new age equation calibration developed for this work. The results using the Gombosi et al. (2014) age equation were 26.7 ± 4.1 Ma, 80.6 ± 12.8 Ma and 130.9 ± 20.1 Ma, respectively and the results using the age equation from this work were 27.8 ± 1.9 Ma, 83.8 ± 7.7 Ma and 136 ± 12 Ma, respectively (figure 1). The uncertainty of the age is affected mainly by ^{238}U concentration and ρS (the spontaneous fission track density) determinations. Other factors can affect the uncertainty of the age, but their contributions are smaller. For all samples, the yield ages found by the two methods are consistent and overlap within two standard deviations of published reference ages determined from other radiometric techniques (i.e., K/Ar, 40Ar/39Ar and/or U/Pb) and traditional FTT by the EDM.

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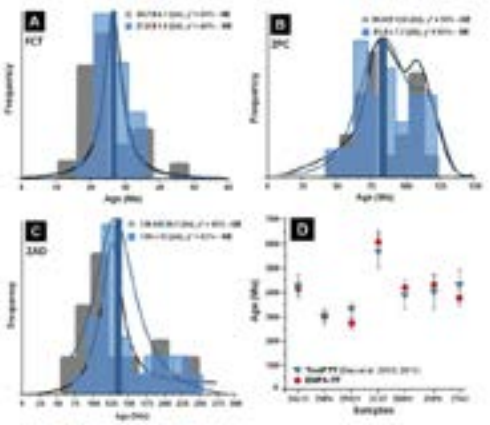

Figure 1. Histograms showing the age distribution of EPMA-FT single grain age determinations to FCT (A), ZPC (B) and ZAD (C) samples. Blue and gray lines denote the central age determination from the grain population. Blue and black lines show the probability density estimate. (D) Comparative analysis among ages obtained by Traditional FTT and EPMA-FT (Novel equation). GE means Gombosi's equation, and NE means Novel equation.