A “new” irradiation facility for FT applications at the Belgian Nuclear Research Centre: the BR1 reactor

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Thermal neutron irradiation to induce ^{235}U fission in geological samples remains a vital step in the application of fission-track (FT) dating. However, suitable facilities with well-thermalized irradiation channels are sparse. Recent advances and attempts to introduce LA-ICP-MS as an alternative [1] have as of yet not been widely adopted. Here we present the possibility to use the irradiation facilities of the BR1 (Belgian Reactor 1) at the Belgian Nuclear Research Centre.

Since late 2009, calibration procedures have been conducted successfully, and from early 2010 onwards, routine irradiations for FT purposes are being performed. At the time of writing 21 apatite age standard mounts (ED), 108 apatite samples, 7 sphene standards and 25 sphene samples have already been irradiated.

BR1 is in fact the world’s oldest running non-military reactor, and first became critical on May 11 1956. It is a 4 MW graphite-moderated, air-cooled reactor, which offers flexible irradiation and calibration services and in principle runs on a daily basis on the experimenters’ request (at most 7-8 hours/day at a maximum power of 700 kW). The reactor fuel is loaded in 569 channels between 14,500 graphite blocks, in a 2 m thick concrete shell, allowing experiments around the reactor without contracting any dose. For experimental purposes, 70 channels of different dimensions, equipped with pneumatic sample dispensers, are reserved. Various standard and reference neutron fields under a thermal as well as fast fission flux are available.

Channel X26 is a well-thermalized channel in BR1 that was found to serve FT applications the best. Using several techniques, a thermal/epithermal fluence ratio of 98 ± 3 was established. Based on γ-dosimetry of IRMM-530 Al-Au foil, a thermal (sub-Cd) fluence rate ratio (Høgdahl convention) of 6.12E10 n/cm²s was calculated. This yields and integrated one-day irradiation flux (7hrs) of 1.54E15 n/cm² or up to 2.42E15 n/cm² for a 1.5 day (7+4 hrs) irradiation. Due to the reactor’s large dimensions, axial flux gradients are less than 1% over the irradiation container (Au monitors) and radial gradients (Cu wires) less than 1.5%. Axial gradients based on FT counting in muscovite ED from U-doped glass dosimeters (IRMM-540, [2]) are somewhat higher, but less than 1.8%. Samples can be loaded as required with maximum container dimensions of 7cm and 3cm (diameter). Absolute calibration with metal activation monitors (Au, Co) can be performed on site. Ages based on absolute flux calibration are within analytical uncertainty consistently identical to conventional ζ ages. Prices vary according to sample loading, irradiation time and γ-dosimetry (if required). Shipping is not included. After a cool-down period of 6-8 weeks (depending on residual activity) samples can be signed off in a straightforward way. Irradiation at this time is usually performed within the week of sample delivery.

References

[1] Hasebe N. et al. (2004). Apatite fission-track chronometry using laser ablation ICP-MS. *Chemical Geology*. **207**. 135-145.
[2] De Corte F. et al. (1998). A new U doped glass certified by the European Commission for the calibration of fission-track dating. *In*: Van den haute P. & De Corte F. *Advances in fission-track geochronology.* Kluwer Academic Publ., Dordrecht, 67-78.