

New high precision zircon ages from the Carboniferous of Scotland and their implications for the systematic bias between U-Pb and $^{40}\text{Ar}/^{39}\text{Ar}$ dating techniques

R.R. PARRISH¹, A.A. MONAGHAN², AND M.S. PRINGLE³

¹Dept of Geology, University of Leicester & NERC Isotope Geosciences Laboratory, British Geological Survey, Keyworth, Notts, NG12 5GG, UK
(r.parrish@nigl.nerc.ac.uk)

²British Geological Survey, Murchison House, West Mains Road, Edinburgh, EH9 3LA, UK (als@bgs.ac.uk)

³Department of Earth Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139, USA (m.pringle@mit.edu)

Several samples have been precisely dated by using either U-Pb or $^{40}\text{Ar}/^{39}\text{Ar}$ methods in the Midland Valley of Scotland. While high quality sanidine and zircon have not yet been dated from the same sample, we have dated samples in close proximity where the stratigraphic relationships are well established. The U-Pb results on concordant abraded zircons range in age from 335 to 344 Ma with 2σ uncertainties of ± 0.7 to ± 0.9 Ma. $^{40}\text{Ar}/^{39}\text{Ar}$ ages from related samples have uncertainties of approximately ± 1.5 Ma but are systematically younger. The minimum bias between the dating techniques can be quantified because the U-Pb ages from stratigraphically higher samples are between $0.50 \pm 0.33\%$ and $1.34 \pm 0.48\%$ older at the 95 % confidence level than $^{40}\text{Ar}/^{39}\text{Ar}$ ages from samples lower down in the same succession. The U-Pb and $^{40}\text{Ar}/^{39}\text{Ar}$ ages are relative to ages of 418.2 Ma for Temora zircon and 98.79 Ma for GA1550 biotite using well characterised mineral standards and U-Th-Pb metal reference solutions. Magma chamber residence time between dated crystal separates is unlikely to explain a bias of this size, given the Carboniferous absolute age. The amount of systematic bias is smaller than that documented from some other studies yet important when using the dates for numerical timescales or regional correlations. Together the data suggest that the minimum bias between the two methods is between 0.5%-1.0%. The results support the need for further work on fundamental argon concentration measurements that underpin K-Ar and $^{40}\text{Ar}/^{39}\text{Ar}$ age determinations and/or the ^{40}K decay constant, and to a lesser extent refinements in the U decay constants and U-Pb intercalibration experiments.

Paleocene timescale miscalibration: Fact or fiction?

MALCOLM S. PRINGLE¹ AND LYNNE M. CHAMBERS²

¹EAPS MIT, Cambridge MA 02139, USA
(mpringle@mit.edu)

²NIGL, BGS, Keyworth NG12 5GG, UK (lmch@bgs.ac.uk)

In the absence of an accepted global stratigraphic section, the Paleocene/Eocene (P/E) boundary is currently a c. 1 m.y. interval within magnetic polarity chron C24r which includes the NP9/NP10 nannofossil boundary, the planktonic foraminifera P5/P6a boundary, a seawater carbon isotope excursion, and the -17 through +19 ash layers in Denmark. Early, unpublished Ar/Ar ages suggested that the -17 ash was c. 55 Ma. The late Paleocene thermal maximum [LPTM] is older than the -17 ash, but younger than the base of C24r.

Based on a correlation of the palynoflora found within the base of the Mull Plateau Group lavas with the LPTM, Jolley et al [2002, 2003] suggested that there is a previously undetected problem with the Paleogene time scale, concluded that the LPTM is older than the Mull lavas, placed the LPTM within the early phase of widespread North Atlantic igneous province volcanism, and even suggested that the onset this volcanism at 60 Ma was the cause of ocean-floor methane hydrate release thought to be responsible for the LPTM.

Below we present new Ar/Ar ages on the +19 and -17 ashes which, combined with our previous results constraining the duration of British Tertiary volcanism, conclusively show that the Danish ashes and P/E boundary are indeed 55-56 Ma, there is no general problem with P/E time as previously calibrated, and the LPTM is no older than 56-57 Ma. As the main extrusive phase of British Tertiary volcanism was complete by 59 Ma, the thermophilic palynoflora found within the base of the Mull lava pile simply cannot be correlated with late Paleocene thermal maximum time.

Paleocene/Eocene Ashes:

+19, Denmark	55.26 ± 0.24 Ma ¹
-17, Denmark	55.44 ± 0.08 Ma ¹

Late Stage British Tertiary Volcanism:

Mull, Late Stage dikes	58.99 ± 0.26 Ma ²
Mull, Loch Ba Ring dike	59.35 ± 0.36 Ma ²
Skye, Loch Ainort granite	59.45 ± 0.26 Ma ²
Eigg, Sgurr of Eigg rhyolite	59.61 ± 0.16 Ma ²

Early Stage British Tertiary Volcanism:

Mull, basal lava	61.46 ± 0.58 Ma ²
Muck, basal tuff, zircon U-Pb	61.15 ± 0.26 Ma ²
Muck, basal tuff, sanidine	61.55 ± 0.14 Ma ²

Cretaceous/Tertiary Boundary

Beloc, Haiti, tektite	65.78 ± 0.06 Ma ¹
-----------------------	----------------------------------

Ages relative to FCs @ 28.02 Ma¹ or TCs @ 28.34 Ma²