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Calibrating U-Pb and Ar/Ar Ages Using Carboniferous Volcanic Rocks from Scotland

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Arguably the most significant first order problem in modern geochronology is the up to 3% apparent bias in absolute ages between high precision U-Pb and Ar/Ar analyses on samples from the same rock. The final goal would be to reduce this bias to near the analytical precision of the most modern techniques, approaching 0.1%. The ultimate source of discrepency will almost certainly remain the analytical inaccuracies in the various radioactive decay constants and isotope dilution standards. However, a significant source of the present uncertainty is the possible protracted crystallization history of the large, complex magma chambers in which the most commonly-used Ar/Ar and U-Pb mineral standards formed. We address this later problem by studying older, rapidly-cooled, homogeneous extrusive rocks with fresh minerals phases suitable for both Ar/Ar and U-Pb techniques.

Relatively small volume, differentiated alkalic lavas from Scottish Carboniferous volcanic centres appear to be ideal candidates, both with respect to age and suitable petrography. Initial U-Pb ID-TIMS and Ar/Ar dating studies on rocks from the Midland Valley of Scotland show that U-Pb ages are systematically 0.77 $\pm$0.44% (2σ) older than Ar/Ar ages from samples at equivalent positions in the same stratigraphic succession. This bias is similar to, but at the lower range of, those documented in the most recently published studies. Our current focus is searching for individual flows with phases suitable for both Ar/Ar and U-Pb techniques, with the ultimate goal of choosing one or two rocks from which a sufficient amount and variety of mineral phases could be separated for international inter-laboratory calibration studies.

A further goal is to find new Paleozoic age Ar/Ar standards which would suitable for

both single-crystal laser-fusion analyses and larger bulk-fusion analyses such as K-Ar isotope dilution and absolute air calibration studies. One such set of phases has been well-characterized to date: anorthoclase (K/Ca c. 1.4) and hornblende (K/Ca c. 0.10) from the High Alderstocks benmoreite are 332.03 $\pm$0.32 Ma and 332.24 $\pm$0.30 Ma, respectively, vs Taylor Creek sanidine at 28.34 Ma. The anorthoclase has been further dated at 331.62 $\pm$0.46 vs GA1550 biotite at 98.79 Ma. The precision of these analyses, as well as the concordance between the hornblende and anorthoclase results, suggest that this or a similar sample would indeed make an ideal Paleozoic age Ar/Ar standard.