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A new age for $^{40}Ar/^{39}Ar$ geochronology – Out of Africa and beyond…

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Recent years have seen the development of a new generation of multi-collector mass spectrometers for noble gas (including $^{40}Ar/^{39}Ar$) geochronology and geochemistry (e.g., Noblesse, ARGUSVI, HELIX-MC, Isotopx NGX). These new instruments represent a major advance over traditional 'single-collector' noble gas mass spectrometers and provide significantly improved levels of analytical precision (>10x) and greatly expanded capabilities. In this presentation, I will outline some of these new developments and present recent $^{40}Ar/^{39}Ar$ geochronology results obtained on standard minerals and a variety of samples using a Thermo Fisher ARGUSVI multi-collector mass spectrometer system.

The ARGUSVI mass spectrometer has enabled ultra-precise, calibration of $^{40}Ar/^{39}Ar$ standards against the astronomically tuned A1 Tephra unit from the Faneromeni section, Crete (6.943 ± 0.005 Ma [1]). These analyses have yielded the most precise (and arguably accurate) determinations of standard ages ever recorded: e.g., Fish Canyon Tuff sanidine – 28.1232 ± 0.0136 (0.048%; 2σ) Ma; Alder Creek Rhyolite sanidine – 1.1811 ± 0.0015 (0.13%) Ma [2].

The ARGUSVI is particularly well suited to high precision geochronology of volcanic rocks, ranging from basalts to kimberlites. Before the advent of the new mass spectrometers, high precision $^{40}Ar/^{39}Ar$ dating of young basalts was challenging, due to low potassium contents, low radiogenic ^{40}Ar yields (<5%) and high atmospheric argon levels. The ARGUSVI system now permits $^{40}Ar/^{39}Ar$ dating of young (<500 ka) volcanic rocks at unprecedented levels of precision (<1%). For example, $^{40}Ar/^{39}Ar$ analyses of the Mt Rouse basalt (SE Australia) yielded an $^{40}Ar/^{39}Ar$ age of 284.4 ± 1.8 ka (2σ) compared to a value of 280 ± 19 ka (2σ) obtained using an older generation VG3600 mass spectrometer [3]. Current studies are focussed on Holocene basalts.

Aside from volcanic samples, the ARGUSVI is providing new constraints on the source(s) of detrital minerals, such as muscovite grains associated with Cape Fold Belt meta-sediments. One unusual example is $^{40}Ar/^{39}Ar$ dating of single clinopyroxene inclusions extracted from detrital diamond deposits along the west coast of Africa, which provide unique insights into source(s) of these deposits and the paleo-drainage patterns responsible for their dispersal.

The significant improvement in analytical precision from new multi-collector instrumentation is providing new insights into the intricacies of the $^{40}Ar/^{39}Ar$ method and sample characteristics that were unheralded previously. A new age beckons for an old method.

References:

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[3] Matchan E and Phillips D (2014) *Quat Geochron* 22:57-64