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Ultra-high precision $^{40}Ar/^{39}Ar$ geochronology of volcanic rocks, using an ARGUSVI multi-collector mass spectrometer

Phillips, D.[1] and Matchan, E.L.[1]

[1]School of Earth Sciences, The University of Melbourne, Parkville, 3010, VIC, Australia.

The new generation of multi-collector mass spectrometers for noble gas (including $^{40}Ar/^{39}Ar$) geochronology and geochemistry (e.g., Noblesse, ARGUSVI, HELIX-MC) offer unprecedented levels of analytical precision and have the potential to transform temporal constraints on volcanic events. In this presentation, we will document $^{40}Ar/^{39}Ar$ ARGUSVI geochronology results obtained on sanidine from selected tuffs (including those used as $^{40}Ar/^{39}Ar$ dating standards), anorthoclase megacrysts entrained in New Volcanic Province basalts (Victoria, Australia), as well as young (<0.5 Ma) basalts from the New Volcanic Province.

The $^{40}Ar/^{39}Ar$ ages have been standardised against the A1 Tephra unit from the Faneromeni section, Crete, which has an astronomically tuned age of 6.943 ± 0.005 Ma [1]. ARGUSVI $^{40}Ar/^{39}Ar$ analyses exhibit significantly enhanced precision levels (generally >10x), compared to previous mass spectrometer systems. The ultra-high precision capability of the ARGUSVI system is illustrated in Figure 1, where step-heating age spectra and laser fusion results are compared with previous data obtained using an older generation mass spectrometer.

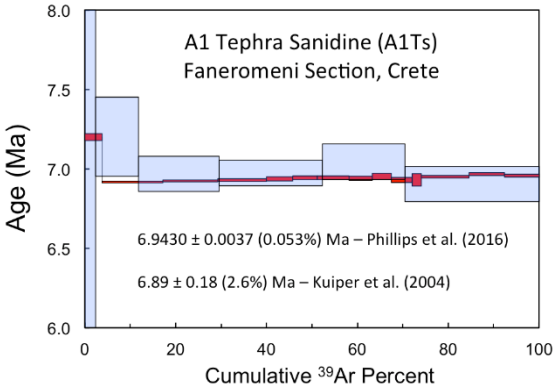

Figure 1: ARGUSVI $^{40}Ar/^{39}Ar$ step-heating and fusion data (red) vs previous results (blue) [4].

The high precision achievable using the ARGUSVI has permitted resolution of distinct age gradients in step-heating spectra for the sanidine standards [2], which are attributed to mass fractionation processes (Figure 1). This does not affect laser fusion results. For example, new $^{40}Ar/^{39}Ar$ ages calculated for the Fish Canyon Tuff sanidine (FTCs) and Alder Creek Rhyolite sanidine (ACRs) are: 28.126 ± 0.016 (0.057%) Ma (2σ) and 1.1811 ± 0.0011 (0.093%)(2σ), respectively.

The ARGUSVI system is particularly well suited to high precision $^{40}Ar/^{39}Ar$ dating of young (<100 kyr) basalts. Typically, such basalts yield ages with uncertainty levels of <1% 2σ). Higher precision ages are attainable from anorthoclase megacrysts in basalts, with new age data confirming these constituents as xenocrysts that formed just prior to basalt magmatism.

The significant improvement in analytical precision using the new multi-collector instruments presents new challenges, but also provides new insights into the chronology of volcanic rocks.

References:

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[4] Kuiper K et al (2004) Earth Planet Sci Lett 222: 583-597