Breeching the Holocene: Advances in single crystal $^{40}Ar/^{39}Ar$ dating using the ARGUS VI Mass Spectrometer

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$^{40}Ar/^{39}Ar$ geochronology of 0-20 ka alkali-feldspar from Changbaishan volcano along the China/North Korea border is challenging due to incorporation of xenocrysts and melt inclusion hosted excess argon. Published studies with well-behaved, plateau style spectra on multi-grain aliquots are shown to be inaccurate by as much as 100% of the eruption age when single crystals are step-heated with moderate resolution. Despite perception that exceedingly small (5e-17 moles) amounts of radiogenic ^{40}Ar cannot be measured accurately using Faraday amplification, we show that Faraday noise is not rate-limiting in conducting high precision – high accuracy geochronology of Holocene single crystals. Most important to successful dating is the high-sensitivity of the ARGUS VI, coupled with low-background and blanks for the mass spectrometer, and accurate ^{36}Ar measurement afforded by multi-collection on an ion counter. Although 10^{13} Ohm resisters are desirable at ^{40}Ar, ^{39}Ar and ^{37}Ar, use of 10^{12} Ohm resistors do not dramatically impact geochronology precision. Single crystal dating of a known ca. 1000 CE eruption at Changbaishan resolved ages of crystals at this age and also confirmed significant contamination by discrete xenocryst populations of 3 ka, 6 ka and 10 ka. These xenocrysts prohibit multigrain analysis and demonstrate that earlier eruptive sequences are being recycled through multiple magmatic episodes. The Qixiangshan eruption is dated at 10.5±0.2 ka (1σ) that is concordant with U-series zircon results. Xenocrysts are present and range up to 140 ka. The phenocryst population demonstrates variable concentrations of melt inclusion hosted excess argon that degasses during initial heating steps. This further demonstrates the requirement to step-heat single grains as total fusion experiments and/or total gas ages are inaccurately too old. Variable alkali-feldspar ages from these near zero age eruptions may provide clues as to why sanidine ages scatter well beyond analytical precision for deep time samples. If xenocrysts occur that are nearly equal to true eruptions ages and/or if unidentified excess argon is ubiquitous in ancient sanidines it maybe that the youngest population best approximates the actual eruption age.