Excimer Laser Microprobe $^{40}Ar/^{39}Ar$ Chronology of Impact Melt Products

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Deep ultraviolet excimer laser microprobes have been employed for high spatial-resolution geochronology and thermochronology for two decades, but few of those applications involved extraterrestrial materials. At Arizona State, we are conducting a variety of laser microprobe studies of such materials with a special emphasis on the rock products of bolide impact. 'Impactites' are brecciated, poly-lithologic rocks that contain varying quantities of impact melt in the form of glass or its crystalline equivalent. Rarely are the melt domains in these rocks free from clasts of the target rocks, and this characteristic complexity frustrates attempts to acquire geologically meaningful $^{40}Ar/^{39}Ar$ ages. Ultraviolet laser microprobe ablation enables extremely precise targeting of melt domains in thin section at practical spatial resolutions (on the order of tens of microns for high-precision dating) unparalleled by other microanalytical techniques ranging from physical sampling to spot fusion with lasers of longer wavelength. In this contribution, we review our recent experiences thus far with *in situ* laser microprobe $^{40}Ar/^{39}Ar$ dating of impactites. Informed by work on samples from comparatively simple meteorite impact sites on Earth (e.g., Mistastin, Labrador, Canada), our studies of Apollo 17 impact breccias reveal a complex, polygenetic impact record spanning more than a billion years of lunar history. Thin sections of some lunar impactite samples contain a single, easily datable melt phase, while others contain multiple phases of melt with statistically distinguishable $^{40}Ar/^{39}Ar$ ages. In some cases, we find evidence for partial resetting of the argon isotopic systematics of an older melt component by subsequent impact events. Studies in progress are focussed on additional samples from the Apollo archive, as well as a variety of brecciated meteorites of varied provenance.