A COORDINATED 40Ar/39Ar THERMOCHRONOLOGY AND SHOCK STUDY FROM THE KAMESTASTIN LAKE IMPACT STRUCTURE. J. R. Davis[1], C. A. Crow[1], G. R. Osinski[2] [1]Department of Geological Sciences, University of Colorado Boulder, Boulder, CO 80309 (jennifer.davis-4@colorado.edu) (carolyn.crow@colorado.edu), [2]Department of Earth Sciences, University of Western Ontario, London, Ontario, Canada, N6A 5B7.

Introduction: Impact cratering is a widespread geologic process that occurs across all rocky and icy bodies in our solar system. In planetary science, impacts serve as benchmarks for determining the ages of surfaces, constrain the timing of geologic events, and serve as a connection between remote sensing and returned sample data [1, 2, 3]. As such determining the ages of impacts is important for many areas of planetary science. Impact events can produce high temperature and extremely high-pressure conditions that can partially or fully reset geochronometers in returned samples. In terrestrial impact structures, samples exhibit a wide range of shock pressures and temperatures resulting in heterogeneous age resetting on the outcrop to hand sample scale [4]. Due in part to the complex nature of age resetting, the majority of terrestrial impact craters have no age constraints [4]. To better interpret the ages of both terrestrial and planetary impactites (samples produced by impacts), it is imperative to better understand correlations between the level of physical and chemical alteration and the resulting effects on geochronometers.

Experimental studies have demonstrated that a hypervelocity impact produces varied age resetting for geochronologic systems such as Rb-Sr, Sm-Nd, and Pb-Pb [e.g. 5]. Analyses of planetary materials have also shown that shock heating can produce unique age resetting patterns, such as high-temperature Ar-loss in ^{40}Ar/^{39}Ar age spectra [e.g., 6]. Partial isotopic resetting makes interpreting geochronologic data difficult unless there is context to the isotopic resetting, such as the extent of shock damage and heating [7].

^{40}Ar/^{39}Ar thermochronology is one method that can be used to constrain both age and context by gaining insight into a sample's thermal history through multiple diffusion domain modeling (MDD) [6, 8, 9]. Paired with physical characterization of samples to identify shock defects indicative of temperature and pressure conditions, ^{40}Ar/^{39}Ar could be an effective method to place constraints on the ages of impacts. While there have been studies that investigated the correlation between the extent of ^{40}Ar/^{39}Ar age resetting and the level of shock in the mineral plagioclase feldspar [e.g., 10], these studies have mainly focused on end member samples – e.g., crystalline unshocked and maskelynite (diaplectic glass) – and have not investigated the full range of shock conditions typically observed in impact structures and planetary materials.

To better understand the effects of impact conditions on ^{40}Ar/^{39}Ar thermochronology, we have analyzed samples from the Kamestastin (Mistastin) Lake impact structure in Newfoundland and Labrador, Canada, that exhibit a wide range of peak shock pressures and thermal histories. The Kamestastin Lake crater, a complex impact crater of about ~28 km in diameter, was chosen for this study because of the wide variety of impactites found at the structure [11] and the dominantly anorthositic target rock (~54-71%) making it a good lunar analog [12].

Samples: The six samples analyzed in this study include target rock material, moderately-to-heavily altered target rock material, and impact glass. These samples were collected by GRO from various localities within the Kamestastin Lake impact structure.

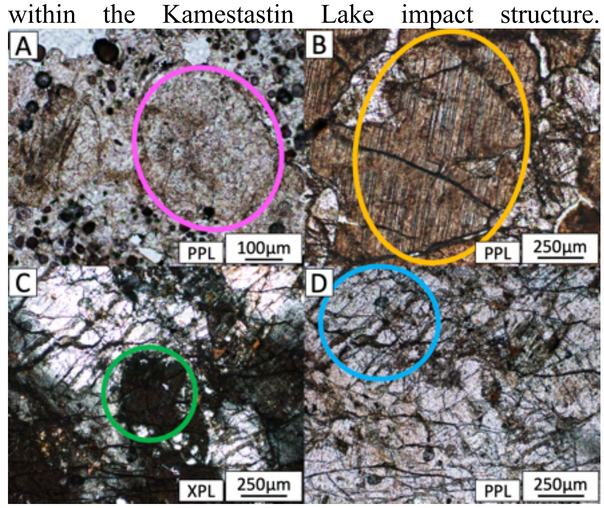

Figure 1: *Thin sections depicting various shock features that indicate different degrees of metamorphism experienced by these samples seen in plain polarized light (PPL) or cross polarized light (XPL): (A) Ballen silica, (B) toasted quartz, (C) maskelynite, (D) heavily fractured plagioclase.*

The unaltered target rock is classified as a mangerite sampled near the west rim of the impact structure and displays no shock metamorphic effects. Four anorthositic and granitic samples displaying varying degrees of impact alteration were collected from different localities around the inner terraces and from the central uplift. These samples display a range of shocked and baked characteristics such as fracturing, undulose extinction in K-spar, ballen silica, "toasted" quartz (an impact induced alteration of quartz crystals), planar deformation features (PDFs) in quartz, and maskelynite (Figure 1). The one impact glass in this study was collected from an inner terrace and consists primarily of melt glass with clasts ranging from 150 µm-1 mm in size.

Methods: Samples were initially characterized using a petrologic microscope and then dated via $^{40}Ar/^{39}Ar$ thermochronology and analyzed using Raman spectroscopy to quantify shock degree within each sample.

$^{40}Ar/^{39}Ar$ Thermochronology: A fraction of each rock was irradiated, and bulk $^{40}Ar/^{39}Ar$ step heating experiments were conducted at New Mexico Institute of Mining and Technology (Figure 2). MDD modeling is ongoing for each sample using a new MDD modeling program developed at the University of Colorado Boulder [13]. This modeling will be used in constraining and hypothesis testing the thermal histories of reset samples.

Raman Spectroscopy: Thin sections of each sample were analyzed via Raman spectroscopy at the University of Colorado Boulder. The level of shock induced crystal lattice damage in plagioclase can be quantified using Raman spectroscopy [14, 15, 16]. Individual grains of plagioclase feldspar displaying various degrees of shock textures were analyzed across all thin sections.

Results, Discussion, and Future Work: $^{40}Ar/^{39}Ar$ age spectra display a variety of resetting behavior from non-reset ages, partially reset, and fully reset ages (Figure 2). The unshocked sample does not appear to be reset from the impact event, while the moderately to highly metamorphosed samples display partial resetting to full resetting to the age of the impact. Interestingly, the impact glass does not give the impact age, which we suggest is likely due to the presence of microscopic clasts within the glass.

Preliminary Raman spectroscopy results suggest a wide range of shock deformation in feldspar crystals from crystalline to glass. The shock deformation within feldspar crystals from the same sample suggest heterogeneity in shock within a sample.

The results of Raman spectroscopy and ongoing MDD modeling will be used to help constrain how impact pressure-temperature conditions influence $^{40}Ar/^{39}Ar$ age spectra and to help determine which impactites record reliable impact ages.

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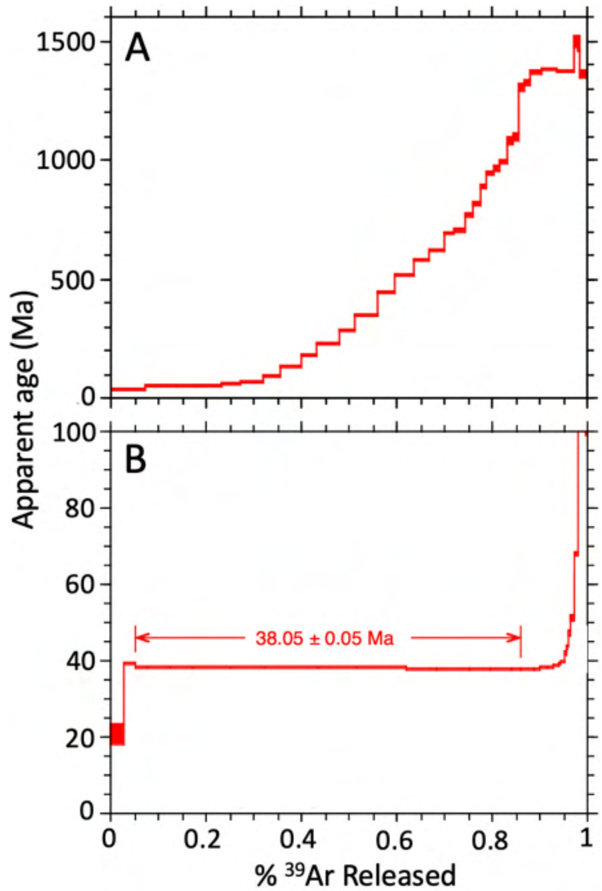

Figure 2: *Age spectra diagrams of showing the range of age resetting (A) partially reset age from minimally altered anorthosite and (B) reset age from highly shocked and thermally altered granite.*

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