LUNAR GRANULITIC IMPACTITES: CONSTRAINTS ON THEIR MINERALOGY, PETROLOGY, AND CHRONOLOGY.

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Introduction: Lunar granulitic impactites are complex rocks that are poorly understood. These coherent crystalline rocks were derived by the recrystallization of previously brecciated material. They contain clasts from both the ferroan anorthosite and Mg-suites. They are characterized by 70-80% modal plagioclase, are enriched in trace siderophile elements (indicative of meteoritic contamination), and contain virtually no KREEP component. Minerals lack zoning and their compositions are homogeneous. All minerals are assumed to have been re-equilibrated by a major thermal event, or events [1].

Few ages have been conclusively determined for this suite. These rocks are thought to have formed after the initial differentiation of the early lunar crust, yet before the final bombardment period that began around 4.0 Ga. We have performed ultra-violet and infra-red laser single shots and step-heating ³⁹Ar-⁴⁰Ar chronology on plagioclase grains from four Apollo samples (67955, 77017, 78155, and 79215). Although the ³⁹Ar-⁴⁰Ar systematics of the samples are highly disturbed, we interpret the ages obtained to date the age of the latest dominant metamorphic event [2].

An improved knowledge of the pressure and temperature at a certain depth within the Moon would help place valuable constraints on its thermal gradient and evolution. To this end, we have calculated equilibration pressures and temperatures for nine granulitic impactite samples on loan from NASA using equations based on the exchange of elements between co-existing minerals. Our results represent the suite’s last episode of re-equilibration, which corresponds to depths of burial of ~10 to 30 km (mid-crust of the Moon) [3]. This suggests that metamorphism was due to burial, rather than by juxtaposition at shallower levels with hot impact melt sheets. However, the applied thermobarometric equations were calibrated for terrestrial rocks and may not be appropriate for the lower pressure conditions of the lunar crust. In order to more accurately constrain equilibration conditions, low pressure piston cylinder experiments are being performed with the aim of simulating the formation conditions of the granulitic impactites. The information obtained from these experiments combined with other analyses will provide an understanding of how, when, and where these samples formed and evolved. By determining the age and composition of these samples, in addition to the temperature, pressure, and depth at which they formed, we hope to gain insight into the evolution of the thermal gradient of the Moon during pre-Nectarian times. In this work we report on the mineralogy, petrology, recent Ar-Ar research, and P-T constraints.