CONTINUED STUDY OF HIGHLY SIDEROPHILE ELEMENT CHARACTERISTICS OF APOLLO 17 IMPACT MELT BRECCIAS. M. G. Galenas[1], I. Gerasimenko[1], O. B. James[2], I. S. Puchtel[1] and R. J. Walker[1]. [1]Department of Geology, University of Maryland, College Park, MD 20742 (mgalenas@umd.edu), [2]U.S.Geological Survey, Reston, VA 20192

Introduction: The bulk of the highly siderophile elements (HSE: including Re, Os, Ir, Ru, Pt, and Pd) in lunar impact-melt breccias are derived from meteoritic material incorporated in the impact-melt fraction of these rocks during the impacts that formed the melts. Many such rocks most likely formed in basin-forming impacts related to the postulated late heavy bombardment at ~3.9 Ga [1-3]. The relative abundances of the HSE in these rocks can provide diagnostic chemical fingerprints of the impactors because pristine lunar crustal rocks have extremely low concentrations [4], and chondritic materials have relatively high abundances [5] of these elements. Previous studies have utilized the slopes of linear trends generated from plots of Ir versus other HSE and $^{187}Os/^{188}Os$ to define relative abundances of HSE and long-term Re/Os in the impactors [6-7], thus, allowing comparisons to various primitive and differentiated meteorites.

In this and previous studies, we have been attempting to determine the nature of the impactors that formed Apollo 17 impact melt breccias. These breccias are divided into two petrographically and chemically distinct groups: poikilitic and aphanitic. The melt fractions of both rock types are broadly similar in major- and minor-element compositions, except that Al_2O_3 is higher in the melt in the aphanitic breccias and TiO_2 is higher in the melt in the poikilitic breccias. The melt fraction is coarser grained in the poikilitic rocks than in the aphanitic rocks. Aphanitic melt rocks generally contain more abundant clasts than the poikilitic melt rocks, and the clasts on average come from higher levels in the target crust. The poikilitic rocks have generally been interpreted as formed in the Serenitatis basin-forming event [1]. The source of the aphanitic rocks is less clear. Some evidence suggests they were generated in the same impact as the poikilitic rocks [2], but other characteristics suggest a different impactor [3].

Our prior work on Apollo 17 poikilitic melt rock 76215, collected from the North Massif, and 72395, collected from the South Massif, showed that their HSE characteristics were indistinguishable [6]. Aphanitic melt rocks 73215 and 73255, both from Station 3 of the South Massif, were chemically and isotopically indistinguishable from each other but characterized by lower average $^{187}Os/^{188}Os$, Pd/Ir and Ru/Ir compared to the poikilitic melt rocks. Here we report results for three additional Apollo 17 melt rocks. Our objective is to further assess the variance of the HSE signatures among rock types, and sample locations at the Apollo 17 site.

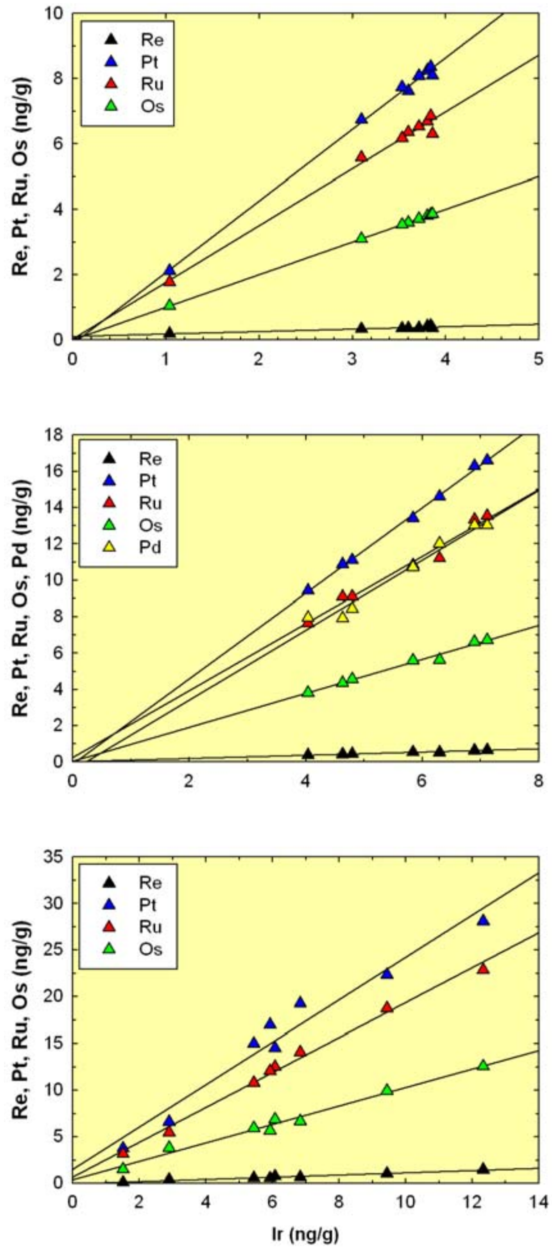

Figure 1. *Iridum concentrations vs. Re, Pt, Ru, Os, and Pd in multiple chunks of 73235 (top) (aphanitic), and 72535 (center), and 72435 (bottom) (both poikilitic).*

Samples: Multiple subsamples of Apollo 17 melt breccias 72435, 72535 and 73235 were analyzed for this study. Samples 72435 and 72535 are poikilitic melt rocks collected at Station 2 on the lower slope of South Massif. Sample 72435 was chipped from a large melt-rock boulder [8] and 72535 was found in the regolith at the station. Sample 73235 is an aphanitic melt breccia collected from the regolith at Station 3 on the light mantle (interpreted as a landslide deposit) at the base of South Massif.

Analytical Methods: Multiple 40-100 mg chunks of samples were gently comminuted but not ground with an alumina mortar and pestle. Exterior surfaces of some samples (72435, 73235) exhibited micrometeorite pits and exposure patina. Subsamples that showed these characteristics were considered separately from the subsamples that showed no exposed lunar surface, as a means of assessing effects on HSE characteristics.

Samples were spiked and then digested using 5ml of a 2:1 mixture of concentrated HNO_3 and HCl in sealed Pyrex Carius tubes at 260^{o}C for 72 hours. Osmium was separated via solvent extraction and measured by N-TIMS using a *Thermo Triton* at the UMd. The remaining liquid was processed via anion exchange chromatography to separate Re, Ir, Ru, and Pt. Pd was also collected for 72535. Further details about the chemical separations are provided in [9]. These fractions were analyzed via ICP-MS using a *Nu Plasma* MC-ICP-MS. Average blanks (in pg) were: Pt 5.2, Ru 6.1, Ir 0.73, Re 2.0, Os 1.5, Pd 8.2.

Results: As with previous studies, plots of Ir versus other HSE defined linear trends of varying precision (**Fig. 1**). Regression lines and uncertainties were calculated using *Isoplot 4*. All trends for 72435, 72535 and 73235 have Y intercepts that are statistically indistinguishable from zero at the 95% confidence level, consistent with two-component mixing where the lunar component has extremely low HSE. The fit of data to the Ir-Pt trend for sample 72435 is notably poor. The poor fit to the data does not, however, correlate with evidence for surface modifications.

Our new $^{187}Os/^{188}Os$ *vs.* Ru/Ir (obtained by regression) data for 72435, 72535 and 73235 are plotted with previously published Apollo 17 data (**Fig. 2**). Data for the new poikilitic samples plot with very similar relative abundances of HSE to the previously published data for poikilitic melt rocks. As previously noted, the impactor source that dominates the HSE signature of these rocks has generally higher $^{187}Os/^{188}Os$ (long-term Re/Os), Ru/Ir and Pd/Ir ratios than bulk chondrites. Of note, in contrast with the earlier results for aphanitic samples 73215 and 73255, 73235 plots among the poikilitic samples with respect to $^{187}Os/^{188}Os$ and Ru/Ir.

Conclusions: HSE data for poikilitic samples at the Apollo 17 site are quite similar and continue to suggest a source with $^{187}Os/^{188}Os$, Ru/Ir, and Pd/Ir somewhat higher than the range of bulk chondrites. The HSE data for aphanite 73235 are similar to the data for the poikilitic rocks, in contrast to previous results for aphanites 73215 and 73255. This result may support the previous suggestion [6] that the HSE in 73215 and 73255 are dominated by the HSE-rich granulitic-breccia clasts they contain, rather than by the HSE derived from the impactor in the melt fraction. The similarities of HSE characteristics in many of these melt breccias is consistent with the interpretation that most melt rocks at the Apollo 17 site are dominated by a single, Serenitatis impactor signature.

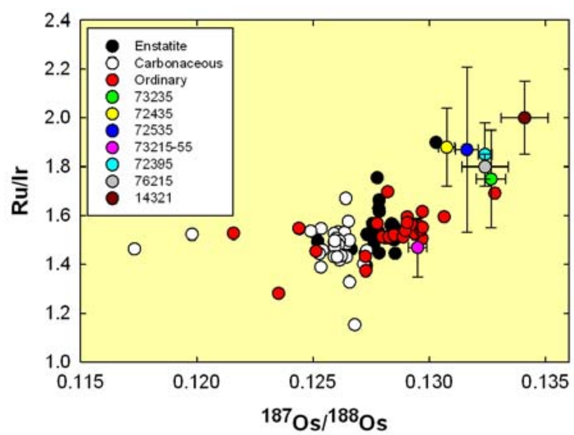

Figure 2. $^{187}Os/^{188}Os$ *vs.* Ru/Ir. Error bars show regression uncertainties. For comparison, bulk chondrite data from [5,9,10,11] are also plotted.

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