CHARACTERIZING IMPACTOR SIGNATURES OF APOLLO 16 IMPACT MELT ROCKS. M. Sharp[1], I. S. Puchtel[1] and R. J. Walker[1]. [1]Department of Geology, University of Maryland, College Park, MD 20742 (mgalenas@umd.edu)

Introduction: Highly siderophile elements (HSE: including Re, Os, Ir, Ru, Pt, and Pd) can be used to fingerprint the chemical nature of large impactors. This is particulary viable for lunar impactors because the relative abundances of HSE are four to five orders of magnitude higher concentrations of HSE in impactors with chondritic bulk compositions, in comparison to lunar target rocks [1-2]. Ratios of the HSE present in the impactor can be ascertained by measuring concentrations of multiple impact melt subsamples and taking the slope of the linear regression (e.g., Ir vs. Ru). The HSE ratios can be diagnostic with regard to the broad category of impactor, given the variance of these ratios among the various meteorite classes.

The Apollo 16 impact melt breccias were collected in the lunar highlands northwest of the Nectaris Basin. Previous studies [3,4] show that impact melt rocks from Apollo 16 are characterized by a wide range of $^{187}Os/^{188}Os$, Ru/Ir, and Pd/Ir. These ranges encompass the compositions for impact melts from Apollo 14, 15 and 17. Some of these ratios are elevated in comparison to chondrites. By contrast, granulitic rocks associated with impacts found at the Apollo 16 site show signatures that overlap with carbonaceous chondrites [3].

Here we present new HSE concentration and $^{187}Os/^{188}Os$ data for four Apollo 16 impact melt rocks. We use these data in comparison with previous data to postulate on possible impactors and incorporation processes at the Apollo 16 site.

Samples: Four samples from three stations have been analyzed. The samples were 60235, 60635, 62295, and 63549.

All of these rocks appear to be basaltic textured impact melts. Samples 60635 and 63549 have two lithologies of different grain size. Both 60235 and 60635 were collected near the lunar module. Sample 62295 was collected near Buster Crater at Station 2. Sample 63549 was a rake sample from Station 3.

Analytical Methods: Multiple 40-100 mg chunks of samples were comminuted with an alumina mortar and pestle. Chemical separation methods used in this study are described in [5]. Osmium was analyzed by negative thermal ionization mass spectrometry using a *VG Sector 54* in electron multiplier mode. A *Nu Plasma* inductively-coupled plasma mass spectrometer with triple electron multipliers was used to analyze Re, Ir, Ru, Pt, and Pd. Total analytical blanks were measured for each sample set. The overall precisions for HSE concentrations are 0.5% for Os, Ir, and Ru, 5% for Re and Pt, and 2.5% for Pd.

Results: The Apollo 16 impact melts we analyzed are within the range of previous studies of these rocks [3,4] (Figure 1). All of the linear regression derived y-intercepts are indistinguishable from zero.

Our four samples can be split into two groups: those with suprachondritic $^{187}Os/^{188}Os$, and those with chondritic $^{187}Os/^{188}Os$. The $^{187}Os/^{188}Os$ for 60235 is the highest of our measured samples with an average ratio of 0.1362±6. Sample 62295 also has a suprachondritic ratio with an average of 0.1343±10. Sample 60635 is characterized by a chondritic range for $^{187}Os/^{188}Os$ with an average ratio of 0.1297±9. Similarly, Sample 63549 has a ratio of 0.1300±9. This isotopic composition of the latter two samples overlap with the range defined by ordinary and enstatite chondrites.

Samples 60235, 60635, and 63549 have Ru/Ir ratios that are within the chondritic range. Sample 62295 has a suprachondritic Ru/Ir ratio.

The chondrite normalized HSE patterns are shown in Figure 2. Samples 60235 and 62295 have similar patterns. Samples 60635 and 63549 are characterized by patterns that are generally flat. Sample 60635 has one subsample that is considerably different from subsamples of any other Apollo 16 rock Most notably, this subsample is characterized by low Re/Ir and Os/Ir.

Discussion: In comparison to the dominant Apollo 17 impactor signature [6], there are some similarities. The composition of Apollo 17 impact melt rocks fall into two narrow ranges. The majority of Apollo 17 impact melts have a composition with slightly elevated Ru/Ir, Pd/Ir, and $^{187}Os/^{188}Os$. Some Apollo 17 rocks (e.g., 76055, 72315-55) have chondritic compositions that have been attributed to the presence of granulitic clasts [5,6].

The HSE fractionation patterns of samples 60235 and 62295 are generally similar to those found in the majority of Apollo 17 impact melt rocks. This suggests that the impact being sampled could be the Serenitatis Basin-forming event, or another impact basin that had an impactor with a similar composition to the one responsible for the generation of the Apollo 17 impact melt rocks.

The HSE patterns of 60635 and 63549 are similar to carbonaceous chondrites. The different pattern observed in one subsample of 60635 does not resemble the patterns of any type of chondrite. It shows some similarities to IIAB or IIIAB meteorites.

While 60635 and 63549 show fractionation patterns similar to carbonaceous chondrites, their average $^{187}Os/^{188}Os$ is higher than the average for carbonaceous chondrites and instead overlaps with ordinary chondrites. This signature is distinct from the granulitic signature that is represented by 67915 and 67955 reported by [4].

Our samples appear to show a variety of impactor compositons. This is consistent with conclusions of previous studies [3,4]. The distribution of the impactor signatures does not appear to be related to sample collection sites, as 60235 and 60635 were collected at the same location but have very different signatures. It is possible that the highlands Apollo 16 location is sampling multiple basin-forming impact events.

Alternatively, the range of compositions of all the Apollo impact melts could be consistent with a mixing line [4]. The mixing could be represented by endmembers of granulitic material, which is shown to have a composition similar to carbonaceous chondrites, and one or more components with compositions characterized by elevated $^{187}Os/^{188}Os$, Ru/Ir and Pd/Ir relative to most chondrites. These two components could have been dispersed at the Apollo 16 site in varying proportions, which could then produce the range observed.

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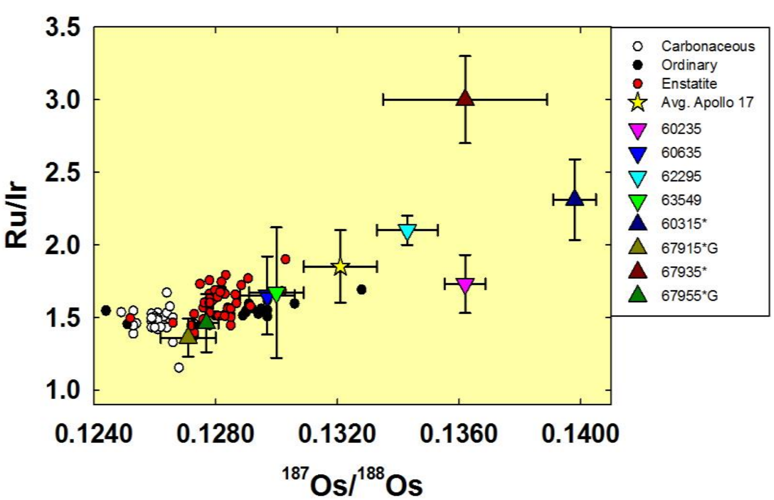

Figure 1. Plot of $^{187}Os/^{188}Os$ *vs.* Ru/Ir. On this diagram, our data are inverted triangles. The upward facing triangles with asterisks are from [4]. The G qualifier on two of the literature values indicates that those were granulitic samples. We also present bulk chondrite data from [2, 7-9] for comparison.Error bars in y-axis represent uncertainty from linear regressions. Error bars in x-axis reflect the absolute range of $^{187}Os/^{188}Os$ ratios for each sample.

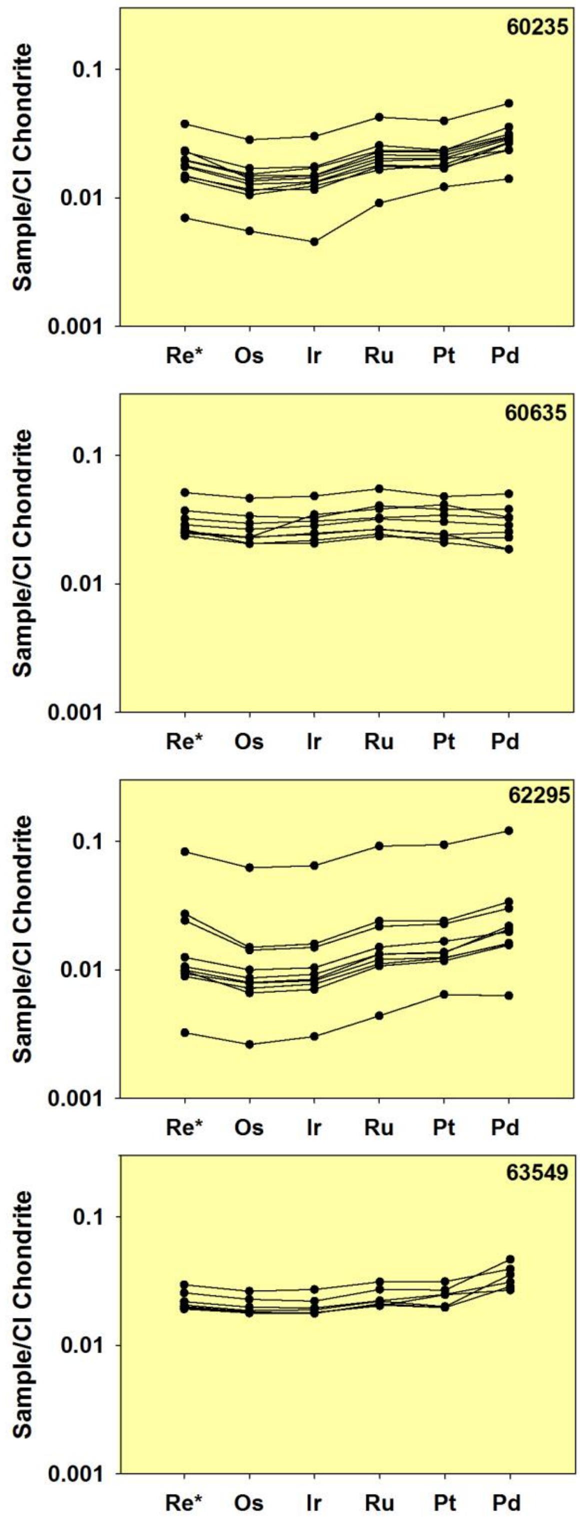

Figure 2. Chondrite normalized HSE fractionation patterns for samples 60235, 60635, 62295, and 63549. Re* is calculated from measured $^{187}Os/^{188}Os$ and Os concentration

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