^{40}Ar-^{39}Ar DATING OF APOLLO IMPACT MELTS – SEARCHING FOR IMBRIUM. L. B. Seifert[1,2,3,4,5], D. A. Kring[3,6,7], and T. D. Swindle[1,2,3,4,8], [1]Lunar and Planetary Laboratory, University of Arizona, Tucson AZ 85721-0092, [2]Department of Geosciences, University of Arizona, Tucson AZ, [3]Solar System Exploration and Research Virtual Institute, Center for Lunar Science and Exploration, [4]Arizona Space Grant Consortium, [5]lseifert@email.arizona.edu, [6]Lunar and Planetary Institute, Houston TX, [7]kring@lpi.usra.edu, [8]tswindle@lpl.arizona.edu

Introduction: The Imbrium impact on the surface of the moon is one of the largest impacts seen and is therefore a key in studying the impact history of the Moon. Samples retrieved from both Apollo 15 and Apollo 17 missions were supposed to contain ejecta melt from this particular region, however, new data suugests that material originally thought to be Imbrium in nature might actually be something else.

Here, we seek to gain information about two things. First, to determine a more definitive age for classic samples of Imbrium melt from Apollo 15, samples 15445, and 15455. Second, we studied an Apollo 17 sample, 76055, to confirm whether or not this sample is Imbirum in nature as previously thought [1], or if its source is the from the nearby Sculptured Hills formation. This is under the assumption [1], that none of the impact melts at the Serenitatis site are in fact serenitatis melts and that the most likely source of melts is from Imbrium.

Methods: Analysis of these samples was completed using the ^{40}Ar-^{39}Ar technique, where the sample is irradiated with neutrons, then goes through a step heating process to release gas for analysis in a gas source mass spectrometer. Here, we focus on Argon isotopes 39 and 40. All samples have been corrected for a combination of solar wind ^{36}Ar and reimplanted parentless ^{40}Ar. For this correction, a $^{40}Ar/^{36}Ar$ values of 8±8 was used, which is based on the range of values expected through history for the lunar surface [2]. Through time, this value decreases because the supply of ^{40}Ar depends on the rate of production by radioactive decay.

Results: The addition of the correction for solar wind ^{36}Ar and reimplanted parentless ^{40}Ar does not seem to have much effect on the overall plateau plots for each sample, however, some of the errors on the plateaus could be the result of over correction. We know this because the uncertainty on some of the plateaus, specifically sample 76055,106 does not agree to the level uncertainty given by the standard deviation of the data set. Additionally, as a whole, only two samples, 76055,106,BS42/43 give reasonable plateau plots, where many steps agree within error.

Looking at sample 15445,300,BS36 (Fig. 1.), the lowest age recorded is ~1250Ma indicating the low temperature age of the last heating event, with an upper limit at ~3830. The lowest age should be close to the time of the late event, while the upper limit is the lower limit for the age of crystallization.

Similarly, 15445,300,BS37 (Fig. 1) follows a justified diffusion pattern starting with a low temperature age of 1250Ma and an upper limit at about 3727Ma. Similar to BS36, since there is not much of a plateau, the highest age found is probably lower than the age of crystallization.

Sample 15455,28,BS39 (Fig. 2.) looks quite similar to the 15445 samples and follows a similar diffusion pattern with low temperature ages starting at ~1250 with an upper limit of 3910Ma. Towards the end of this plateau plot, there are two steps that are much lower in age than the previous steps. There is a large increase in the overall Ca/K values for the last two steps, from ~10 to 50-70. This large jump could be the result of pyroxene degassing, meaning the lower age of the final steps could be because of recoil during irradiation or because of a short, high temperature event.

Sample 76055,BS42 (Fig. 3.) is a split of the same sample as 76055,BS43, but has a very different age. An average of the ages of a set of steps that contain 51.7% of the ^{39}Ar gives 3930 ±17Ma.

Sample 76055,106,BS43 (Fig. 3.) has a much higher age than 76055,106,BS42, but the plateau looks very similar in nature. A plateau containing 49.7%of the ^{39}Ar gives an age of 4003 ±5Ma.

Discussion: Both splits of sample 15445 contain distinctive diffusion patterns, with a large portion of gas being lost in the early steps. This suggests a single, prominent heating event at ~1250Ma for both splits. Since such a large portion of the gas is lost in the early steps, there is not much of a plateau to determine a solid age. For this reason, for these splits, it is evident that our ages shown in the plateau plot are underestimates of the actual formation age of the sample [3], which is probably consistent with the 3910-3940 Ma age of Imbrium[4,5,6]. We were not able to get any more definitive an age determination than [7], who dated the matrix and concluded the age was 3760Ma.

The other Apollo 15 sample, 15455,28,BS39, also displays substantial outgassing at ~1250Ma, but has a bit more of a plateau structure. However, due to the diffusion like pattern, we believe there is still an underestimate of the true age of the sample. This plot also displays a large decrease in age in the final steps, which is due to pyroxene outgassing. This same decrease was recorded for this sample in another study [8]. Although it is impossible to say whether the formation ages of 15445, and 15455 are the same, they are both consistent with formation in Imbrium followed by thermal resetting in a common event at ~1250 Ma.

Our 76055 splits BS42/43 give an encouraging plateau like structure. However, the ages for the two splits do not agree with one another. While 76055,106, BS42 seems to fall into the range of values of other Imbrium impact melts between 3910 and 3940Ma [4,5.6]. 76055,106,BS43 gives a distinctively higher age. This suggests that 76055 is not the product of the Imbrium impact that had been ejected to the Apollo 17 landing area in Serenitatis, but rather represents another impact event in the PKT region. However, the disagreement between the two splits makes it difficult to reach a firm conclusion.

Finally, none of our splits gives a plateau in which all steps agree within errors over 70%. While this distinction may be too restrictive [3], it is clear that these samples have suffered significant disturbances.

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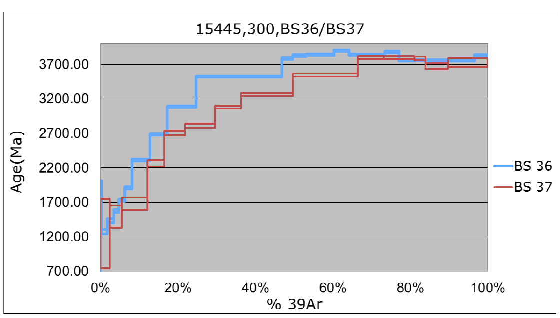

Fig. 1. Plateau plot of 15445,300,BS36/37.

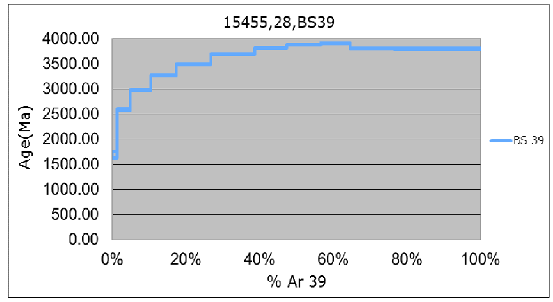

Fig. 2. Plateau plot of 15455,28, BS36.

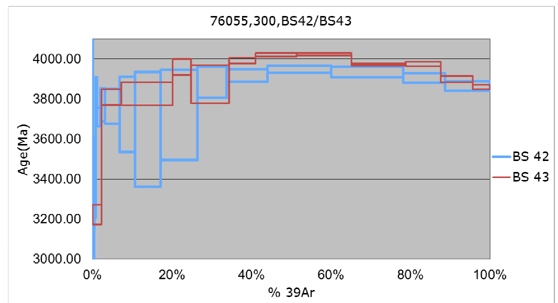

Fig. 3. Plateau plots of 76055,300,BS42/43.