AGE OF LUNAR METEORITE LAP02205 AND IMPLICATIONS FOR IMPACT-SAMPLING OF PLANETARY SURFACES. L. E. Nyquist1, C.-Y. Shih2, Y. Reese3, and D. D. Bogard1, 1Mail Code KR, NASA Johnson Space Center, Houston, TX 77058, laurence.e.nyquist1@nasa.gov, 2Mail Code C23, Lockheed-Martin Space Operations, Houston, TX 77058, 3Hernandez Engineering Inc., Houston, TX 77058.

Introduction: We have measured the age of lunar meteorite LAP02205 by the Rb-Sr and Ar-Ar methods. Sm-Nd analyses are in progress. The Rb-Sr and Ar-Ar ages indicate a crystallization age of ~3 Ga. Comparing the ages of LAP02205 and other lunar mare basaltic meteorites to mare surface ages based on the density of impact craters shows no significant bias in impact-sampling of lunar mare surfaces. Comparing the isotopic and geochemical data for LAP02205 to those for other lunar mare basalts suggests that it is a younger variant of the type of volcanism that produced the Apollo 12 basalts.

Representative impact-sampling of the lunar surface contrasts to apparently unrepresentative impact-sampling of the Martian surface by Martian meteorites. We consider possibilities to explain this paradox.

Rb-Sr Age and Initial $^{87}\text{Sr}/^{86}\text{Sr}$: The Rb-Sr data are shown in Fig. 1. Pyroxene separates were leached in 2 N HCl and the residues analysed (Px1(r), Px2(r)). The leachates were combined (Leach). Plag(r) was leached in 1 N HCl. Plag, Ilm, and WR (bulk) were not leached.

Rb-Sr Age and Initial $^{87}\text{Sr}/^{86}\text{Sr}$: The Rb-Sr data are shown in Fig. 1. Mineral separates obtained by density separations were hand-picked for purity prior to analysis. For pyroxene the densities were chosen to correspond to Ca-rich- (augite) and Fe-rich- (pigeonite) pyroxenes, respectively. Data for all the samples define an internal isochron age of 3.02±0.03 Ga (2σ). Because (a) this age relies heavily on Ilm and Px2(r), (b) Sm-Nd analyses now in progress indicate the possibility of an older age, and (c) the Ar-Ar age spectrum (below) shows some disturbance, the final error on the crystallization age of LAP02205 may be larger than given by the Rb-Sr isochron.

The initial $^{87}\text{Sr}/^{86}\text{Sr}$ (I(Sr)) is 0.699844±13 and is insensitive to the age uncertainty. Fig. 2 shows the (T, I(Sr)) parameters for LAP02205 compared to ilmenite basalt 12056 and averages for Apollo 12 olivine-, pigeonite-, ilmenite-, and feldspathic basalts [1]. It has been suggested that LAP02205 resembles Apollo 12 ilmenite basalts [2,3], but this suggestion is not supported by the Sr isotopic data. Rather, (T, I(Sr)) parameters for LAP02205 most closely resemble those for Apollo 12 olivine basalts. The Sr-isotopic data suggest that LAP02205 represents younger volcanism from a lunar mantle source region resembling that of the A12 olivine basalts, but having a slightly higher time-averaged $^{87}\text{Rb}/^{86}\text{Sr}$ ~0.038 compared to $^{87}\text{Rb}/^{86}\text{Sr}$ ~ 0.031 in the A12 basalt source region.

Ar-Ar Age: Fig. 3 gives the $^{39}\text{Ar}/^{40}\text{Ar}$ age spectrum for LAP02205. The alkali-rich mesostasis released ~45% of the $^{39}\text{Ar}$ (K/Ca ~0.2-0.3) around 500°C. For the mesostasis, Jolliff et al. [4] reported [K]= 3.5% and K/Ca =0.26, whereas Mikouchi et al. [2] reported [K]=5.8%. Twelve extractions of this mesostasis phase define a flat Ar-Ar age plateau with an average value of 2.955±0.010 Ga (1σ). Six extractions above 1000°C released the last ~15% of the $^{39}\text{Ar}$, probably from plagioclase, and suggest a similar age plateau of 2.936±0.017 Ga. Plagioclase comprises ~30% of LAP02205 and contains 12.3% Ca and ~0.07% K, with K/Ca ~0.005 [4], similar to K/Ca ratios of 0.001-0.006 we observed in the high temperature release.
Younger Ar-Ar ages are observed over ~45-86% of the 39Ar release for K/Ca ratios intermediate between those of mesostasis and plagioclase. Possibly this argon was released from the ~20-µm-sized blebs of alkali-rich glass in fayalite [2]. Then the higher temperature release of argon compared to that from mesostasis might be the result of slower Ar diffusion in fayalite, and the younger ages might be the result of slower Ar diffusion in fayalite, and the younger ages might be the result of slower Ar diffusion in fayalite, and the younger ages might be the result of slower Ar diffusion in fayalite.

**Comparison to Apollo 12 Basalts:** Although the Ar-Ar age and the Rb-Sr internal isochron age agree closely, a preliminary Sm-Nd internal isochron age of ~3.15 Ga for LAP02205 would place its (T, I(Sr)) parameters into close agreement with those of the Apollo 12 olivine basalts; i.e., I(Sr)~0.6997. However, REE abundances in LAP02205 are about twice as high as in the Apollo 12 basalts, and LREE are more enriched relative to HREE resembling a KREEP pattern, as in the Apollo 12 basalts, and LREE are more enriched relative to HREE resembling a KREEP pattern.

**Figure 3.** Ar-Ar age spectrum for LAP02205. Variation in the K/Ca ratio by ~200X indicates the existence of K in two or more phases. [K] and [Ca] were 410 ppm and 7.5%, respectively, in this 29.5 mg sample.

**Figure 4.** Lunar basaltic meteorite ages ([6,10,11,12], this investigation) compared to lunar mare surface ages [7,8]. Ages range ~2.8-3.8 Ga, approximately the same as for Apollo and Luna samples, except aluminous mare basalt clasts in the Apollo 14 breccias [9].

**Meteorite and Mare Surface Ages**

<table>
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<tr>
<th>Age (Ga)</th>
<th>Total mare surfaces</th>
<th>Western mare surfaces</th>
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**Lunar Meteorites:**

- LAP-02205
- A881757
- Dho287A
- NWA032
- NWA773
- NWA1205

- **Figure 4.** Lunar basaltic meteorite ages ([6,10,11,12], this investigation) compared to lunar mare surface ages [7,8]. Ages range ~2.8-3.8 Ga, approximately the same as for Apollo and Luna samples, except aluminous mare basalt clasts in the Apollo 14 breccias [9].

**References:**