^{40}AR/^{39}AR STUDIES OF MARTIAN METEORITE RBT 04262 AND TERRESTRIAL STANDARDS.

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Introduction: Park et al. [1] recently presented an ^{40}Ar/^{39}Ar dating study of maskelynite separated from the martian meteorite RBT 04262. Here we report an additional study of ^{40}Ar/^{39}Ar patterns for smaller samples, each consisting of only a few maskelynite grains. Considered as a material for ^{40}Ar/^{39}Ar dating, the shock-produced glass maskelynite has both an important strength (relatively high K concentration compared to other mineral phases) and some potentially problematic weaknesses. At Rutgers, we have been analyzing small grains consisting of a single phase to explore local effects that might be averaged and remain hidden in larger samples. Thus, to assess the homogeneity of the RBT maskelynite and for comparison with the results of [1], we analyzed six ~30 µg samples of the same maskelynite separate they studied [1]. Furthermore, because most ^{40}Ar/^{39}Ar ages are calculated relative to the age of a standard, we present new ^{40}Ar/^{39}Ar age data for six standards. Among the most widely used standards are sanidine from Fish Canyon (FCs) and various hornblendes (hb3gr, MMhb-1, NL-25), which are taken as primary standards because their ages have been determined by independent, direct measurements of K and ^{40}Ar (*e.g.*, [2-4]).

Experimental Methods: The maskelynite grains from RBT 04262 and samples from the standards (HB NL-25, MMhb-1, Hb3gr, Bern 4M, and JG1) were irradiated for about 80 hours at the USGS TRIGA reactor in Denver along with multiple samples of the Fish Canyon sanidine. Argon extraction was by heating with a CO_2 laser and the argon isotopes so released were analyzed in a MAP 215-50 noble gas mass spectrometer [5-6]. Ages are calculated assuming a FCs age of 28.2 Ma [7] and the decay constants of [8].

Results & Discussion:

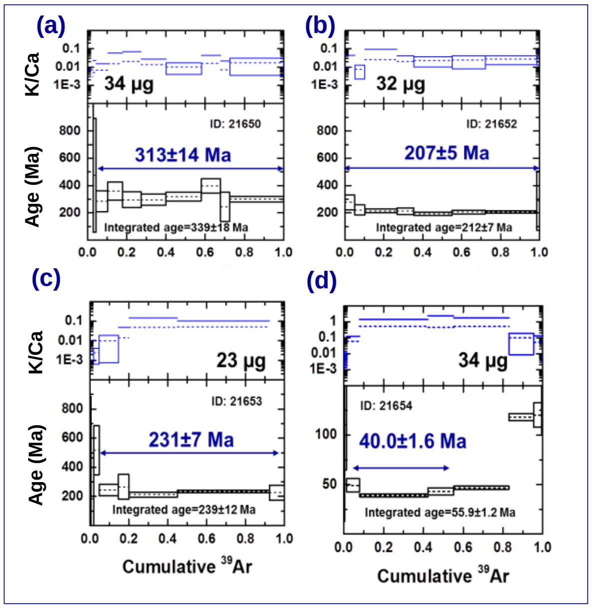

Figure 1. ^{40}Ar/^{39}Ar age spectra of RBT04262 maskelynites.

RBT 04262 maskelynites. Results were obtained for six maskelynite samples with masses from ~23-42 µg, each consisting of either a single grain or a few grains. In five of them, measured ^{40}Ar/^{39}Ar ages range from 207±5 Ma to 313±14 Ma; the sixth, 21654, gives a very young age of 40±2 Ma. ^{40}Ar/^{39}Ar age spectra for four of the samples are shown in Figure 1. Sample 21654 contains a much higher K concentration, ~1.3 wt %, than do the others, ~0.2-0.3 wt%. The weighted averaged plateau Ar age, 236±3 Ma (excluding 21654), matches the result of [1], 228±7 Ma based on the standard HB NL-25 (2650±9 Ma). The Martian shergottite RBT 04261 was dated by total fusion, ~253 Ma for interior samples relative to the biotite monitor standard GA1550 (98.8 Ma) [9]. The ^{238}U-^{206}Pb age of baddeleyite in RBT 04261 was also reported as ~200 Ma [10]. (RBT 04261 may [11] or may not [12-13] be paired with RBT 04262.)

A combined isochron for all maskelynites (Figure 2) yields an intercept indistinguishable from zero, and an apparent age of 244±37 Ma, about 70 Ma older than the Sm/Nd age of 174±14 Ma [14]. Ar release data for

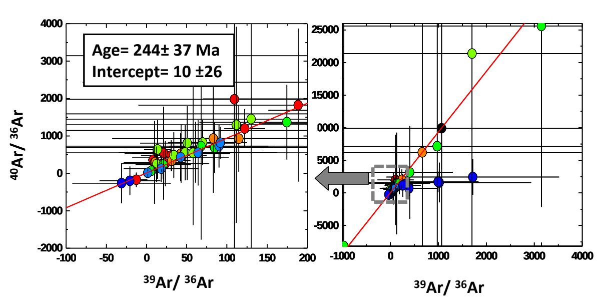

Figure 2. Isochron plot for RBT maskelynites (no cosmogenic corrections.) Data within the dashed square on the right are zoomed to higher resolution on the left.

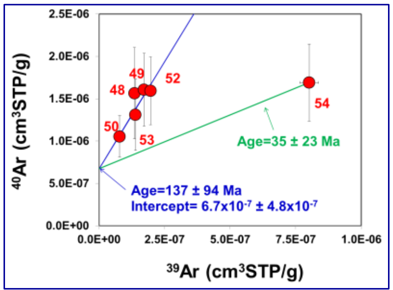

Figure 3. Plot of ^{39}Ar vs. ^{40}Ar of RBT 04262 maskelynites. Numbers are from id 216xx.

the bulk (10 mg) maskelynite [1] gave a somewhat disturbed plateau with an apparent age of 262±8 Ma over 22-78% of the ^{39}Ar release. An ioschron fit to all the data of [1] gave an apparent age of 227±4 Ma and an intercept of 263±20 after correction for cosmogenic ^{36}Ar. An isochron fit to the 850-1050 ^{o}C data of [1] corresponding to the "best" portion of the age plateau gave an apparent age of 171±8 Ma and an intercept of 676±54 indicating the presence of trapped Ar components, both terrestrial and Martian [1]. These non-zero intercepts raise the possibility that our smaller samples also contain trapped Ar, but at levels below our ability to detect trapped ^{36}Ar.

In Figure 3 we plot the total concentrations of ^{40}Ar and ^{39}Ar released from each of the RBT maskelynites. The data will define a straight line if the samples have a common age implied by the slope of the best-fit line and an additional, fixed concentration of ^{40}Ar that is not due to *in situ* ^{40}K decay and is given by the intercept. The best fit intercept of (6.7±4.8) $\times 10^{-7}$ cc/g, is similar to previously inferred values of initial excess ^{40}Ar in several shergottites [15-16]. The age of 137±94 Ma is rather uncertain, but agrees with the age of 171±8 Ma preferred by [1]. The characterization of trapped Ar in individual maskelynite grains will require more work.

One sample especially (id: 21654), shows the utility of the small-sample approach. It has an extraordinarily young age of 40±2 Ma but "normal" ^{40}Ar and roughly the expected concentration of cosmogenic ^{38}Ar, as do the other maskelynite samples. It also has a high K concentration of ~1.3 wt%. K-rich (K~7 wt %) glass exists in association with maskelynite in RBT 04262 [1]. ^{40}Ar loss from such glass due to post-shock heating on ejection from the Martian surface may account for the young age. A comparably young age (~<22±2 Ma) for a small baddeleyite in another shergottite, NWA5298 was reported by [17], and also was attributed to re-setting that occurred on launch of RBT from Mars.

<u>*Terrestrial standards.*</u> The average Ar/Ar ages for MMhb-1, Bern 4M, JG-1, HB NL-25 and Hb3gr are 525.6±2.2 Ma, 18.4±0.3Ma, 94.1±0.3 Ma, 2666±16 Ma and 1080.0±0.9 Ma. To compare our results with published ^{40}Ar/^{39}Ar and K-Ar ages (Figure 4), where appropriate, we re-calculated the published values [18-19] using the the decay constant of [8]. Where possible we also corrected for differences in monitor age [19]; for some standards we lacked sufficient information to make these adjustments. With these qualifications, the results for MMhb-1, Hb3gr, JG-1, and Bern 4M are concordant (Figure 4).

Conclusion: ^{40}Ar/^{39}Ar ages of six ~30-µg RBT 04262 maskelynites range from 40 to 313 Ma. A combined Ar/Ar isochron gives an age of 244 Ma, which gives similar values to those of [1]. Our study demonstrates good reproducibility in the standard analyses and complexities in the ^{40}Ar/^{39}Ar systematics of shergottites even at the micro-sample level.

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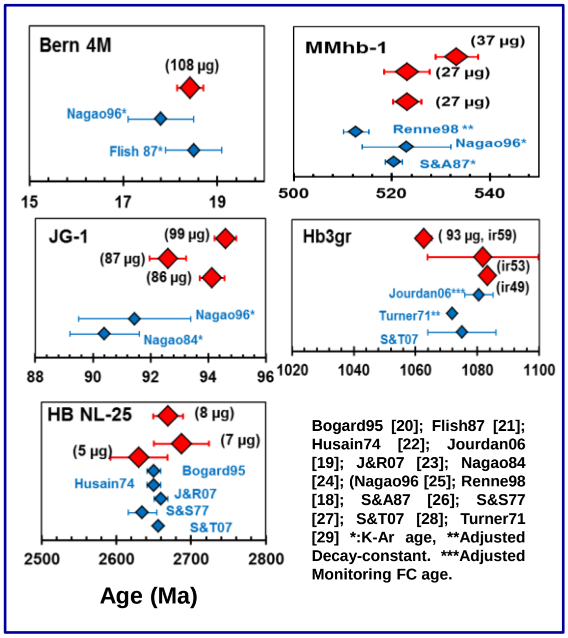

Bogard95 [20]; Flish87 [21]; Husain74 [22]; Jourdan06 [19]; J&R07 [23]; Nagao84 [24]; (Nagao96 [25]; Renne98 [18]; S&A87 [26]; S&S77 [27]; S&T07 [28]; Turner71 [29] *:K-Ar age, **Adjusted Decay-constant. ***Adjusted Monitoring FC age.

Figure 4. Terrestrial standards age comparison.