Introduction: Martian meteorite, Dhofar 378 (Dho378) is a basaltic shergottite from Oman, weighing 15 g, and possessing a black fusion crust [1]. Chemical similarities between Dho378 and the Los Angeles 001 shergottite suggests that they might have derived from the same Mars locale. The plagioclase in other shergottites has been converted to maskelinite by shock, but Dho378 apparently experienced even more intense shock heating, estimated at 55-75 GPa [2]. Dho378 feldspar (~43 modal %) melted, partially flowed and vesiculated, and then partially recrystallized [3]. Areas of feldspathic glass are appreciably enriched in K, whereas individual plagioclases show a range in the Or/An ratio of ~0.18-0.017 [2], [3].

Radiometric dating of martian shergottites indicate variable formation times of ~160-475 Myr, whereas cosmic ray exposure (CRE) ages of ~162-165 Myr observed at ~28-40% of ~160-475 Myr (where the CRE age) are not directly dated. The youngest Ar-Ar age, ~162-165 Myr, has derived from the same Mars locale. The characteristics in martian meteorites were produced (both part of the mesostasis), and plagioclase glass generally assumed that the shock-texture initiated the CRE age.

Fig. 1, as a function of cumulative release of K Ar from in situ decay and a trapped Ar component, cosmogenic Ar must be subtracted from the total 36 Ar. To do this we use the measured 36 Ar/37 Ar ratio and assume specific values of this ratio produced by nuclear processes. (37 Ar is produced in the reactor from Ca; cos36 Ar is produced in space from Ca; and this nuclear ratio is expected to remain approximately constant during Ar extraction.) Trapped 36 Ar for each extraction is obtained by subtracting the abundance of 36 Ar from total 36 Ar. We adopted three values of nuclear-(36 Ar/37 Ar) to make this correction. First the minimum measured 36 Ar/37 Ar is taken as an upper limit to (36 Ar/37 Ar)\text{nuclear}. Secondly, we used the abundance of 36 Ar measured in an unirradiated sample of Dho378 plag. [7] to determine (36 Ar/37 Ar)\text{nuclear}. Thirdly, we assumed a 36 Ar\text{cos} only one-half as large as that directly measured.

The isochron plot for 8 extractions, releasing 3-45% of the 39 Ar and corrected for 36 Ar\text{cos} using directly measured 36 Ar\text{cos}, is shown in Fig. 2. The Ar-Ar age corresponding to this isochron is 143±4 Myr (where the ± ignores the uncertainty in applying a correction for 36 Ar\text{cos}). Applying a
correction assuming only one-half of the measured $^{36}$Ar$_{cos}$ gives an age of 159 ±2 Myr. Using the minimum measured $^{36}$Ar/$^{37}$Ar to apply the correction gives a minimum possible age of 138±5 Myr. All of these ages are within combined uncertainties of the Sm-Nd age [6]. The trapped $^{40}$Ar/$^{36}$Ar ratio obtained from the isochron is largely defined by the highest [K] data. The intercepts corresponding to these three $^{36}$Ar$_{cos}$ corrections are 146 ±16, 150±15, and 119±21, respectively.

**Ar-Ar Age Interpretation:** To interpret the Ar-Ar age results for Dho378 plag. we must consider differences in Ar diffusion characteristics of the two Ar “components” discussed above (<45% and >45% $^{39}$Ar). From the release of $^{39}$Ar as a function of temperature we calculated the diffusion parameter D/a$^2$, and examined these in an Arrhenius plot (Fig. 3). The first ~45% of the $^{39}$Ar released shows much greater ease of diffusion loss compared to the last ~55% of the $^{39}$Ar released, and the first ~13% of the $^{39}$Ar release, which occurred from the high-K glass phase, appears to diffuse even more readily. This finding is consistent, during shock heating, with much greater retention of trapped martian $^{40}$Ar in the plagioclase releasing at highest temperature, where Ar diffusion is more difficult, compared to the melted mesostasis material.

We used these diffusion data in a thermal model that compares the cooling rate of bodies of given sizes with various fractional losses of Ar by diffusion [8]. The Ar-Ar isochron (Fig. 2) suggests that no more than ~10% of the $^{40}$Ar that accumulated after the degassing event ~143 Myr ago could have been lost in the ~3 Myr CRE initiation event. If we assume Dho378 was 10 cm in diameter when ejected into space, this thermal model and Fig. 3 imply that the low-temperature “phases” (those releasing <45% of the $^{39}$Ar) could not have been heated above ~500°C. Yet, the plagioclase texture implies heating to 1000-1100°C, and the mesostasis apparently melted [2, 3, 9]. If we use the value of Da$^2$ at a temperature of 1000°C implied by Fig. 3 (~2x10$^{-8}$) and examine this in our thermal model, we conclude that to retain ~90% of the $^{40}$Ar in the low-temperature phase during heating to 1000°C ~3 Myr ago, Dho378 would have to substantially cool in a time of seconds.

**Conclusion:** We suggest that the ~143 Myr Ar-Ar age determined from the Dho378 isochron may not date the impact that ejected the meteorite into space ~3 Myr ago, but a much earlier impact at ~143 Myr. The relationship between the similar Ar-Ar and Sm-Nd ages is not clear. For the Ar-Ar isochron not to have been reset ~3 Myr ago would require one of two conditions. Either the mesostasis yielding the Ar-Ar age was not heated above ~500°C, in spite of the observation that plagioclase was melted, or alternatively, those K-rich phases heated to melting cooled so rapidly, on the order of seconds over distances of mm, such that $^{40}$Ar diffusive loss did not occur. This last explanation would require that pyroxene was not significantly shock-heated.

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