THE EARLY CHRONOLOGY OF THE MOON AND METEORITES. G. Turner, P.H. Cadogan and C.J. Yonge, University of Sheffield, England.

$^{40}Ar-^{39}Ar$ ages of samples from Apollo 16 and 17 have been determined and in the case of highland material continue to be dominated by material from which ^{40}Ar was outgassed 3.95 Gy ago. An up to date summary of our data will be presented at Houston. We have earlier argued that much of this outgassing probably occurred when the highland breccias, or their precursors, were at some depth below the lunar surface(1). The lunar heat flow 4 Gy. ago coupled with the blanketing effect of a fragmented outer layer would be sufficient to maintain the ambient temperature at depths below a few km at a level sufficient to inhibit argon retention. On the assumption that the rocks examined are basin ejecta and not debris from smaller, more recent Archimedean age craters(2), we, and others, have argued that the highland ages indicate the times of formation of several of the large lunar impact basins; ^{40}Ar retention is presumed to commence when the present highland material was excavated from depth.

Whether these major impacts represent the final stages of lunar accretion or an episodic burst of bombardment is an open question. An episodic bombardment could have resulted from the debris of a major collision in the asteroid belt or alternatively if the moon was captured 4 Gy. ago by collision with a circumterrestrial debris swarm(3). The record prior to 4 Gy. appears to have been erased in most samples analysed and this has led us to institute a search for thermal effects in meteorites in the period 4.5 to 4.0 Gy. using the $^{40}Ar-^{39}Ar$ technique. Meteorites appear to have suffered less from outgassing events in this period and may therefore provide clues to the early collisional history of the solar system and, by inference, of the moon.

We have selected a number of meteorites having total fusion K-Ar ages around 4 Gy and high U, Th-He ages (in an attempt to avoid meteorites which may have been involved in the recent "500 my" event(4). This method of selection was not entirely successful in that we found several of the published total fusion ages to be inaccurate presumably due to the use of nominal K contents. A number of chondrites analysed showed minimal argon loss and "plateau" a es in the range 4.55 to 4.60 Gy., comparable to published Rb-Sr mineral isochron ages. In all cases the ($^{40}Ar/^{39}Ar$) release pattern showed the high temperature dip common in lunar samples. Until this decrease is fully understood the plateau ages must be regarded as tentative but the lunar experience suggests that they probably represent a meaningful age and are certainly quite adequate for a preliminary $^{40}Ar-^{39}Ar$ survey of meteorite ages.

Two of the samples analysed so far show rather clear evidence of outgassing around 3.9 - 4.1 Gy. ago, (Appley Bridge (LL6) and Mangwendi (LL6)). These low ages may represent collisional reheating or alternatively may be due to cooling of the parent body. ($^{40}Ar/^{39}Ar$) ratios increase with

EARLY CHRONOLOGY OF MOON AND METEORITES

Turner, G. et. al.

extraction temperature indicating the retention of argon from an earlier period and this may be easier to understand in terms of collisional reheating.

The number of samples analysed so far is too small to draw any major conclusions with regard to the lunar bombardment but it seems evident that, if we are dating collisional reheating, major collisions occurred elsewhere than on the surface of the moon 3.9 Gy ago.

In addition to the age determinations referred to above we have investigated the argon retention characteristics of grain size separates from irradiated and unirradiated samples of lunar anorthosite, 67075. Argon is released more easily from the unirradiated samples, the release pattern being shifted by about 200°C to lower temperatures. This contrasts with the opposite effect observed in other lunar samples[5]. These experiments indicate that anorthosite is less retentive than earlier assumed and reduces the depths previously calculated[1] for which argon retention is inhibited by the ambient temperature. In the course of this experiment we were able to determine the ^{37}Ar half live from a comparison of ($^{38}/^{37}Ar$) ratios in samples analysed 155 days apart. The value obtained (35.3 ± 0.2) days is in agreement with the value currently in use (35.14 ± 0.10) days[6].

We are also performing experiments aimed at understanding the systematics of ^{40}Ar – ^{39}Ar release patterns. The results of these will be briefly reported at Houston.

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