SEQUENCE OF TERRA ROCK FORMATION AND BASALTIC LAVA FLOWS ON THE MOON. A. Stettler, P. Eberhardt, J. Geiss, N. Grögler and P. Maurer, Physikalisches Institut, University of Bern, Sidlerstrasse 5, 3012 Bern, Switzerland.

A general time-scale of lunar rock formation has been established by radiometric dating. In broad terms there are two immediate problems concerning this time-scale which are still largely unresolved:
(a) Does the clustering of terra rock ages reflect a lunar cataclysm (1) in the sense that a substantial fraction of the maria was excavated in a relatively short time interval $\sim$ 3.95 AE ago, or is the clustering observed because the last 2 large impacts (by the Oriental and Imbrian projectiles) have obliterated the record of earlier events at the lunar surface near the Apollo landing sites (2), leaving only very few traces of older rock formation (3)?
(b) Was the filling of a mare basin accomplished within a relatively short period, or did the filling by successive lava flows last over times comparable to the interval between excavation and filling.

This paper is meant as a contribution to answering these two questions.

All highland rocks investigated in the past in our laboratory have yielded Ar^{39}-Ar^{40} ages near 3.95 AE (4), whenever a high or intermediate temperature plateau was found. Encouraged by the report of higher ages of small rock fragments from the neighbourhood of the Apollo 16 North Ray Crater (3) we have begun a study of rock fragments in the 2 - 4 mm size range collected at station 13, about 800 m from the rim of this crater. The results obtained so far from 4 fragments are shown in figure 1. The data were corrected for trapped Ar^{40} which was determined from Ar^{40}/Ar^{36} - Ar^{39}/Ar^{36} plots. A small piece of each fragment was set aside for petrologic classification. The ages of 3 fragments lie between 3.95 and 4.00 AE, but one gives an age of 4.19 $\pm$ .06 AE. This age is based on a well defined plateau (Figure 1), and therefore it is not simply some relict from the early history of this rock, but should represent a definite period of rock formation or at least a severe metamorphic event. The exposure age of 55 m.y. for this fragment indicates a North Ray Crater origin (cf. 5). This crater may have excavated older material from below the Cayley layer (cf. 2). Age determinations on additional fragments from station 13 are in progress.

The exposure age of 1.8 m.y. of rock 65315, a B_2 breccia with anorthositic composition, indicates excavation from South Ray Crater. Taken at face value the Ar^{40}/Ar^{39} release curve implies a 2-stage metamorphism in the history of this rock (Figure 2). This would be in agreement with the

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postulate that the B_2 rocks have been brecciated and rebrecciated (6). The low temperature part of the release curve ($\sim$2 AE) would then correspond to the rebrecciation caused during formation of older craters, whereas the primary brecciation took place between 3 and 4 AE. If we assume that this event was accompanied by a very high Ar loss, then the apparent age of the last temperature step of 4.30 ± .26 AE could be an indication of anorthosite formation early in the history of the moon (7).

Turner (8) found a systematic difference between the Ar^{39}-Ar^{40} ages of the low-K and high-K Apollo 11 basalts. Our data confirm this (Figure 3). It is not clear yet whether there is a quasi continuous sequence of ages or whether there are three age groups. In either case the age pattern implies that the lava flows in Mare Tranquillitatis lasted at least 400 million years. Models of Apollo 11 rock stratigraphy have been deduced from the exposure age distribution and the contents of slow neutron products (9). In one model the high-K basalts overlie the low-K rocks. This would fit the Ar^{39}-Ar^{40} age relation. The highest age (3.92 ± .03 AE, rock 10003) is very well established by measurements on whole rock and separated feldspar samples. Considering the large spread of Apollo 11 basalt ages, the fact that a rock of such a high age was found near the surface of the lava filled Tranquillity basin suggests that the latter was excavated appreciably earlier than the cataclysmic period mentioned above.

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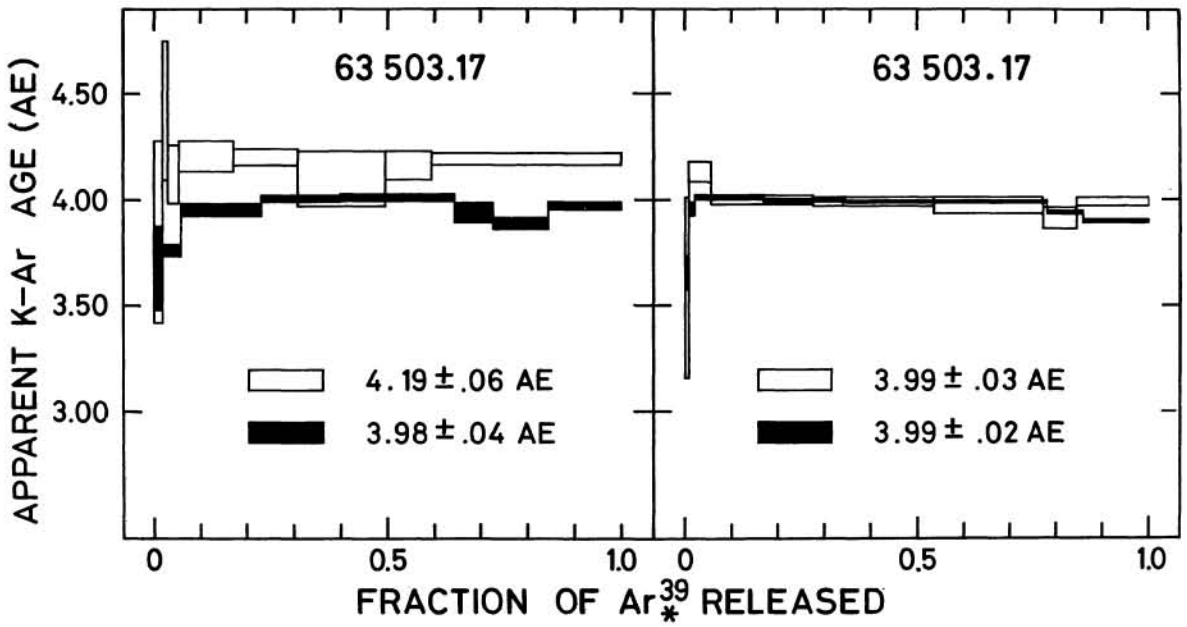

Figure 1

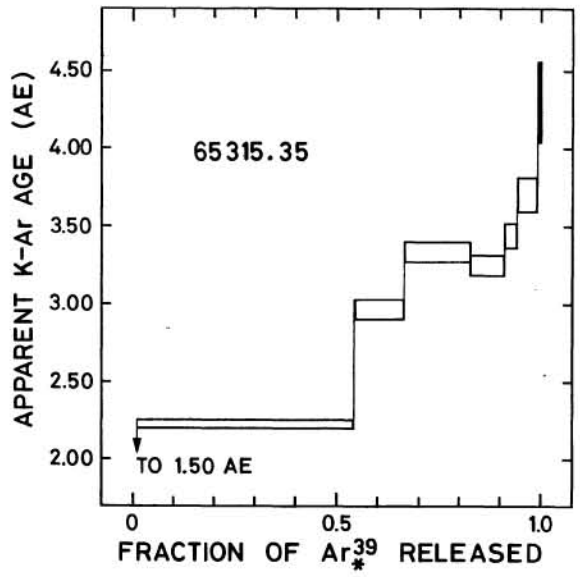

Figure 2

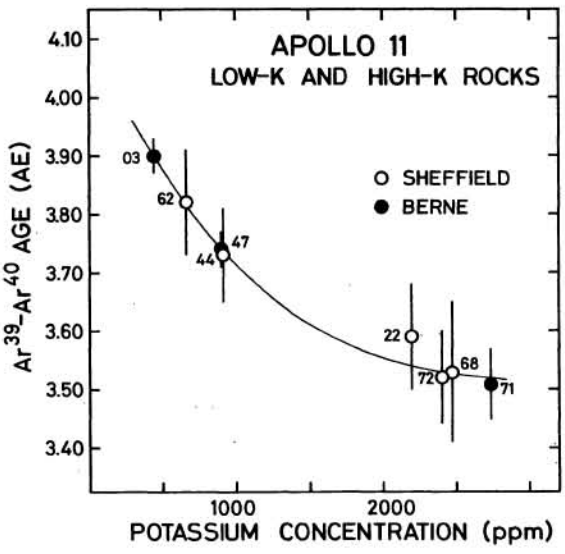

Figure 3