Fra Mauro Formation, Apollo 14: II. $^{40}$Ar-$^{39}$Ar Ages of Apollo 14 Rocks

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As a contribution to the Cone-Crater-Consortium $^{40}$Ar-$^{39}$Ar ages of 21 Apollo-14 samples were determined. Among these samples were 10 fragments from breccia 14063, which was collected only 20 m from the rim of Cone Crater. From impact mechanics it seems probable that this breccia is Cone Crater ejecta. This view is supported by the exposure ages of the fragments which range from 24 to 36 Ma which correspond to the assumed age of Cone Crater (25 Ma). The $^{40}$Ar-$^{39}$Ar age pattern show remarkable high apparent ages ($\geq 4$ Ga) in the high temperature fractions in three of the 10 fragments. Figure 1 shows the K/Ca and the age pattern of fragment 14063, 233. More than 50 % of $^{39}$Ar is released in temperature fractions with apparent ages above 4 Ga up to 4.11 Ga. The $^{40}$Ar-$^{39}$Ar age of 4.09 Ga is the highest so far found in the Apollo-14 rock-collection. The $^{40}$Ar-$^{39}$Ar ages of the other fragments from breccia 14063 are scattered over a broad range (Fig. 2). Apparently the fragment ages are mixing-ages between the age of crystallisation of the individual fragment and the age of the breccia forming event. Consequently the maximum of the age distribution curve is of no chronological significance, but the left edge of the peak is an upper limit to the time of the breccia forming event.

The other dated Apollo-14 rocks according to their $^{40}$Ar-$^{39}$Ar ages arrange themselves into three groups: Most samples have $^{40}$Ar-$^{39}$Ar ages between 3.80 and 3.85 Ga (samples no. 14068, 14069, 14074, 14079, 14311, and 14431). In most cases their $^{40}$Ar-$^{39}$Ar age pattern show well defined plateaux with the result that the errors are small (0.01 - 0.02 Ga). The samples 14179 and 14434 have higher ages, 3.97 and 3.92 Ga, respectively. And finally there are three samples with lower $^{40}$Ar-$^{39}$Ar ages. The ages of 14051 (3.77 ± 0.03 Ga), 14140 (3.76 ± 0.05 Ga), and 14070 (3.73 ± 0.02 Ga) are the lowest among the examined samples. Perhaps the low ages are due to argon loss during the samples' residence close to the lunar surface. There is no obvious correlation between the $^{40}$Ar-$^{39}$Ar ages and the mineralogy of the samples. Exposure ages vary from 18 to 528 Ma.

Fig. 1: $^{40}$Ar-$^{39}$Ar age pattern and K/Ca pattern of sample 14063, 233.

Fig. 2: $^{40}$Ar-$^{39}$Ar age distribution of 10 fragments from sample 14063.