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Moon Exploration – Part 1 (2A)

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IN-SITU AGE DETERMINATION OF PLANETARY SURFACE USING THE 40AR-39AR METHOD

Abstract

The time scale of any geologic process determines its very nature. Therefore, one of the highest-priority science goals of planetary exploration is elucidating the absolute chronology like internal differentiation processes or the surface evolution by volcanism and impact cratering. Radioisotope dating of the Apollo samples enabled to link impact crater counting to absolute chronology, not only for the moon but also for other terrestrial planets. In situ radiometric dating of rocks and coarse fines at landing sites on the moon could contribute to test the cataclysm hypothesis, to determine the age of the South Pole Aitken basin, or to date very young basalts (1.2Ga) south of the Aristarchus Plateau, which likely mark the end of active volcanism on the Moon. However, to date no autonomous instrument for the in-situ dating of planetary surfaces – though of vital scientific interest – has been developed. Particularly promising seems 40Ar-39Ar dating of neutron-activated samples, which is one of the most reliable radioisotope methods to date impact metamorphosed rocks and thus constrain lunar, asteroidal or terrestrial cratering histories. Dating basalt with the 40Ar-39Ar method generally is even more straightforward.

Based on a recent DLR funded study, the development of a compact in-situ radiometric dating instrument appears to be feasible. 252Cf (half live 2.6yr) would serve as a neutron source, while sample collection and transport between the neutron irradiation unit and the analysis unit would be performed robotically. Some ideas to optimize the configuration of the compact neutron source were investigated in order to increase the neutron flux and its homogeneity at the irradiation position. After irradiation, the noble gases He, Ne and Ar from samples would be extracted by stepwise heating in a furnace and analyzed

by mass spectrometry. The measurement of the isotopic compositions of argon (40Ar from in situ decay of 40K) will allow determining the impact metamorphism and crystallization ages and also the surface exposure ages. In addition, a potential γ-spectrometer to be attached will determine the concentrations of a number of minor (or trace) elements.

The paper will give an overview of the current status of the investigations of the concept design of Kayser-Threde's radiometric dating instrument.