Rb - Sr Ages, Chemical Abundance Patterns and History of Lunar Rocks

Lunatic Asylum*

Division of Geological Sciences
California Institute of Technology
Pasadena, California 91109

Abstract

Rb-Sr ages and initial (I) $^{87}Sr/^{86}Sr$ values have been obtained on eight basalts from the Sea of Storms. The ages of all samples lie between 3.15 and 3.35 x 10^9 yrs. Some evidence exists for this spread in age being real. Typical errors (2σ) in the initial values are 5 x 10^{-5}. The spread in initial values clearly shows that the basaltic rocks must represent several different magma reservoirs as opposed to the two magma types found at the Apollo 11 site. The Apollo 12 basalts usually show a significantly higher $(^{87}Sr/^{86}Sr)_I$ compared to the Apollo 11 rocks, reflecting their younger age. An A-11 basalt #10024 reported by other workers to show an age of 4.1 x 10^9 yrs. was analyzed by us and gives an age of 3.61 ± 0.07 x 10^9 yrs. and is indistinguishable from the other high-K rocks of A-11. Two soil samples (#12042 and #12070) from A-12 give model ages of T_{BABI} = 4.6 x 10^9 yrs. and 4.4 x 10^9 yrs., respectively. The soil has a high Rb/Sr ratio in comparison to the rocks and once again shows the universal necessity of adding magic component to a mixture of the local basalts in order to produce the soil. From the Rb-Sr data, the basaltic rocks cannot be the result of melting and differentiation of the soil.

Chemical abundance measurements for Li, Na, K, Rb, Cs, Ca, Sr and Ba on Apollo 12 basalts and soils show that, with respect to these elements, the rocks are very similar to the low-K A-11 rocks. Rb and Cs concentrations are slightly higher and Ba is slightly depleted. The 12070 soil is highly enriched in alkalis and Ba compared to the basalts and must contain a magic component, possibly similar to 12013. The basaltic rocks from both A-11

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* In alphabetical order, the aging inmates are A. L. Albee, D. S. Burnett, A. A. Chodos, E. L. Haines, J. C. Huneke, D. A. Papanastassiou, F. A. Podosek, G. Price, F. Tera and G. J. Wasserburg**.

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and A-12 are clearly evolved from a magmatic reservoir depleted in Rb relative to Sr.

Rock 13 shows a "mixing" age of $4.00 \pm 0.02 \times 10^9$ yrs., and an $(^{87}Sr/^{86}Sr)_I > 0.7085$ for the granitic component. This clearly demonstrates the existence of granitic magmatic reservoirs which were produced during the early differentiation (near 4.6×10^9 yrs.) of the moon. They must be either totally separate or negligible in mass compared to the basaltic reservoirs in order to preserve the immense differences observed in $(^{87}Sr/^{86}Sr)_I$. The formation of the early lunar crust must have involved the rapid transport of K, U, and Th to the lunar surface. A major remaining problem is whether the outer part of the moon is a reflection of shallow, compositional layering (modified by differentiation) or if the outer parts are the product of differentiation of the much deeper interior.

Rock 13 shows an extremely heterogeneous non-equilibrium distribution of U. The principal distinguishable phases containing U are apatite, whitlockite, zircon (all showing highly variable U contents) and a Zr-Ti phase containing up to 1% U. The residual phase of 12040 has been separated and shows K contents ranging up to 11%.