THE FLUX OF EXTRALUNAR MATERIALS ONTO THE LUNAR SURFACE AS A FUNCTION OF TIME

P.A. Baedecker, C.-L. Chou, E.B. Grudewicz and J.T. Wasson
University of California, Los Angeles, CA 90024

The extralunar component concentration is about 3.5% in Apollo-16 soils; this is the highest concentration observed in lunar samples--1.5 times higher than at the Apollo-14 landing site, and about 3 times higher than at mare landing sites (1). These concentration data can be converted to integrated flux ratios by means of the equation

$$\log\frac{\chi_2}{\chi_1} = 2.41 \log\frac{[x]_2}{[x]_1} \qquad (1)$$

where [x] is the concentration of the extralunar component, χ is the integrated flux, and the subscripts refer to different lunar locations (2). The extralunar component can be estimated from the net concentration in certain trace elements which are in high abundance in C1 chondrites, and in low abundance in lunar rocks (3). Although originally it was thought that both volatile and siderophilic elements were useful for estimating the magnitude of the extralunar component, a number of the volatile elements now appear to be mainly of lunar provenance; and the siderophilic elements are now agreed to give a more reliable basis for such estimates (2,4). We have restricted our estimates to the four siderophilic elements for which the most precise data are available--Ni, Ge, Ir and Au.

Fig. 1 shows integrated extralunar flux (normalized to Apollo 12 ≡ 1) plotted against the age of the regolith. The regolith age at mare sites appears well defined as the time elapsed since the last major lava flow. At the Fra Mauro site the regolith age is the time since the Imbrian event, here taken to be 3.91 Gyr, a mean Rb-Sr age (5). At Apollo 16 there may have been no single major, clock-starting event, although there is some tendency of Ar^{39}-Ar^{40} ages to cluster near 4.0 Gyr (L. Husain and O.A. Schaeffer, private communication). We have arbitrarily chosen 4.00 Gyr as the Apollo-16 regolith age.

Fig. 1 shows that the flux of extralunar materials was much higher 4.0 Gyr ago than it has been since the formation of the Apollo 11 site about 3.65 Gyr ago. This idea has previously been advanced on the basis of crater-count evidence (6,7). If our assumed regolith age for Apollo 16 is correct, we can fit the data with two populations of material, a nearly-constant flux which accounts for the bulk of the extralunar material at mare landing sites, and a population with a half-life of 45 ± 15 Myr which provided the bulk of the extralunar material

at the Apollo-16 site.

An alternative, limiting interpretation of the Apollo 14 and 16 data is the following: let us assume that the age of the Apollo-16 regolith is 4.60 Gyr, and that 28% of the extralunar material at the Apollo-11 site is attributable to the short-lived population. On this basis we estimate a half-life of 121 Myr for this component. If this is the correct interpretation, then 43% of the extralunar material at the Apollo 14 site is Preimbrian in origin, and this is the concentration to be expected in subregolith Fra Mauro materials, such as those excavated from Cone Crater.

A choice between these alternatives must await additional data on Apollo-14 and Apollo-16 rocks.

REFERENCES

(1) BAEDECKER P.A., CHOU C.-L., SUNDBERG L.L. and WASSON J.T. (1972) Earth Planet Sci. Lett. 17, 79-83.

(2) BAEDECKER P.A., SCHAUDY R., ELZIE J.L., KIMBERLIN J. and WASSON J.T. (1971) in Proc. Second Lunar Sci. Conf., Geochim. Cosmochim. Acta, Suppl. 2, pages 1037-1061.

(3) KEAYS R.R., GANAPATHY R., LAUL J.C. and ANDERS E. (1970) Science 167, 490-493.

(4) MORGAN J.W., KRÄHENBÜHL U., GANAPATHY R. and ANDERS E. (1972) in Proc. Third Lunar Sci. Conf., Geochim. Cosmochim. Acta, Suppl. 3, pages 1361-1376.

(5) PAPANASTASSIOU D.A. and WASSERBURG G.J. (1971) Earth Planet. Sci. Lett. 12, 36-48.

(6) HARTMANN W.K. (1970) Icarus 13, 299-301.

(7) BALDWIN R.B. (1971) Icarus 14, 36-52.

EXTRALUNAR FLUX VARIATION

Baedecker, P. A. et al.

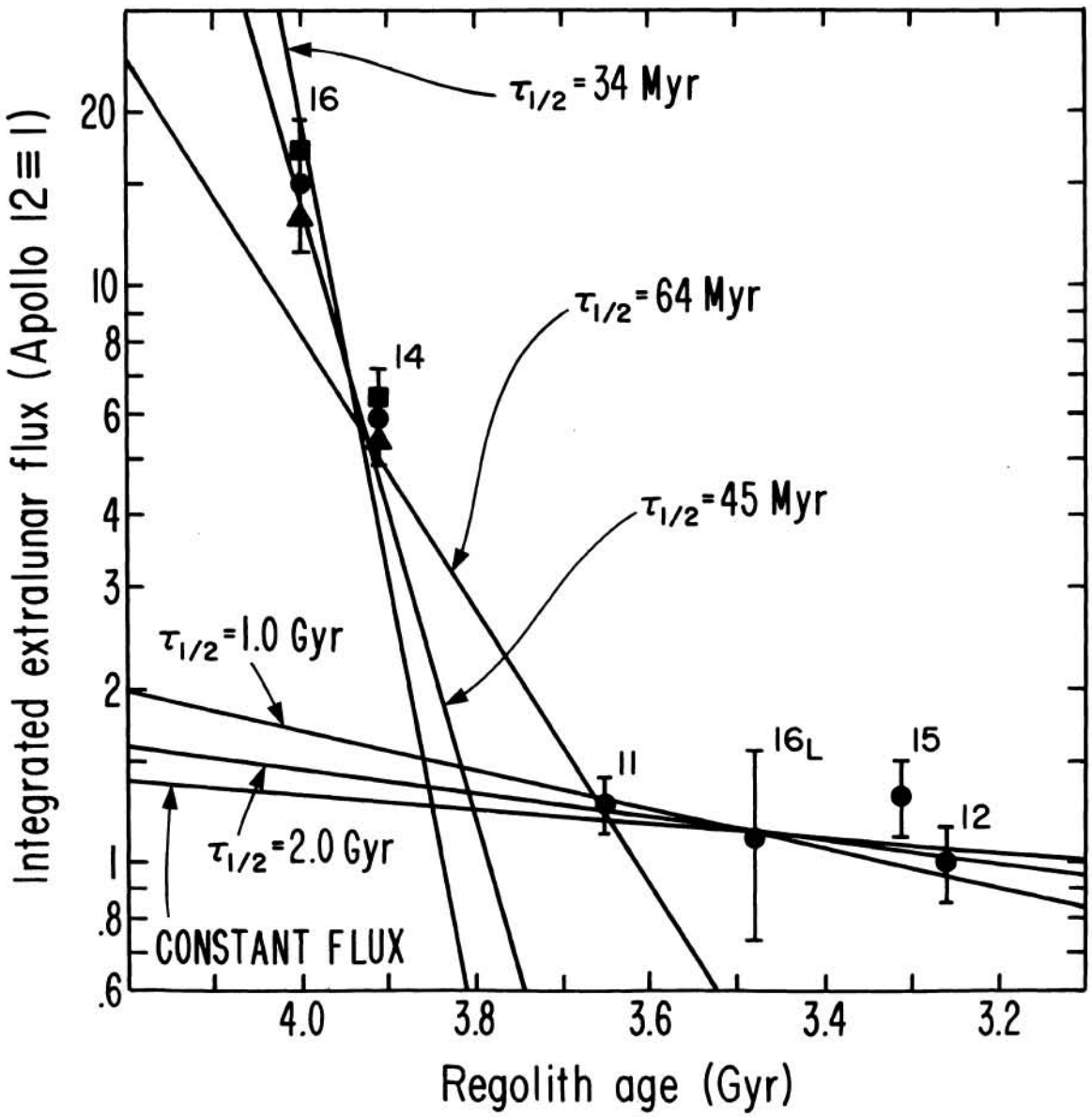

Fig. 1. Integrated flux of extralunar material estimated from regolith composition at Apollo 11-16 and Luna 16 landing sites is plotted against regolith age.