SIDEROPHILE, LITHOPHILE AND VOLATILE TRACE ELEMENTS IN ALLAN HILLS A81005

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From the time of its discovery in Antarctica, Allan Hills A81005 seemed a likely candidate for the first recognized lunar sample naturally transported to Earth. To study its meteoritic admixture and its geochemical and thermal histories, we requested material from ALH A81005 and were allocated 139 mg of matrix containing 30-40% mm-sized admixed clasts, which were too numerous and small to separate. We divided the sample into two nearly equal-sized portions to assess heterogeneity and analyzed each for 16 trace elements - siderophile As, Au, Co, Ga, Sb; volatile/mobile Ag, Bi, Cd, In, Se, Te, Tl, Zn; lithophile Cs, Rb, U - by radiochemical neutron activation analysis. These elements are known to yield important genetic information on lunar and meteoritic materials, e.g. [1-4].

Our duplicate results are entirely satisfactory considering sample heterogeneity and small size and the ppb levels of nearly every element we measured. These data are entirely consistent with a lunar origin for ALH A81005, based on comparison with prior results for similar lunar samples. Siderophile markers of meteoritic admixture (Ag, As, Au and Sb) indicate 0.015 ± 0.005 Cl-equivalent, in accord with the 1-2% admixture found in Apollo samples, e.g. [2,3]. Three more volatile (but not siderophile) elements - Se, Cd and Zn - are also in this range, indicating no measurable extraneous volatile admixture (Fig. 1). The Cd content (Fig. 1) and Cd/Zn ratio, 4.0×10^{-3}, are similar to those in numerous lunar samples [3]. The Cs/U ratio, 0.046, is unusually low compared with prior data [2] but Rb/Cs, 30, seems quite normal [4]; preliminary Tl results will be presented. Cobalt is slightly high, at 0.044 Cl-equivalents, hinting at admixture by siderophile-rich projectile debris. Part of the Ga excess (Fig. 1) could be attributable to this but most, if not all of it probably reflects an indigenous component, i.e. anorthosite. Slightly lowered contents of Bi and Te (0.0065-0.0039 Cl-equivalents) are similar to those in lunar highlands samples [2] and may reflect marginal shock-induced mobilization.

In summary, little in the trace element make-up of ALH A81005 distinquishes it from samples returned by the Apollo missions - a remarkable fact considering its unusual history: it is neither unusually rich nor poor in siderophiles and volatiles/mobiles. Thus, the impact that provided ≥ 2.4 km/sec to launch ALH A81005 on its journey to the Antarctic ice sheet left marks no more severe than those found in samples that did not escape the lunar gravitational field. This conclusion is entirely consistent with the 20 GPa shock pressure estimated mineralogically by Warren et al. [5]. A Martian origin for SNC meteorites, requiring ≥ 5.0 km/sec, now seems more likely in view of the results for ALH A81005. Just as Apollo had his twin (Artemis/Diana), the Apollo program had its natural twin that launched other lunar samples to Earth, now waiting to be hunted down on the Antarctic ice sheet.

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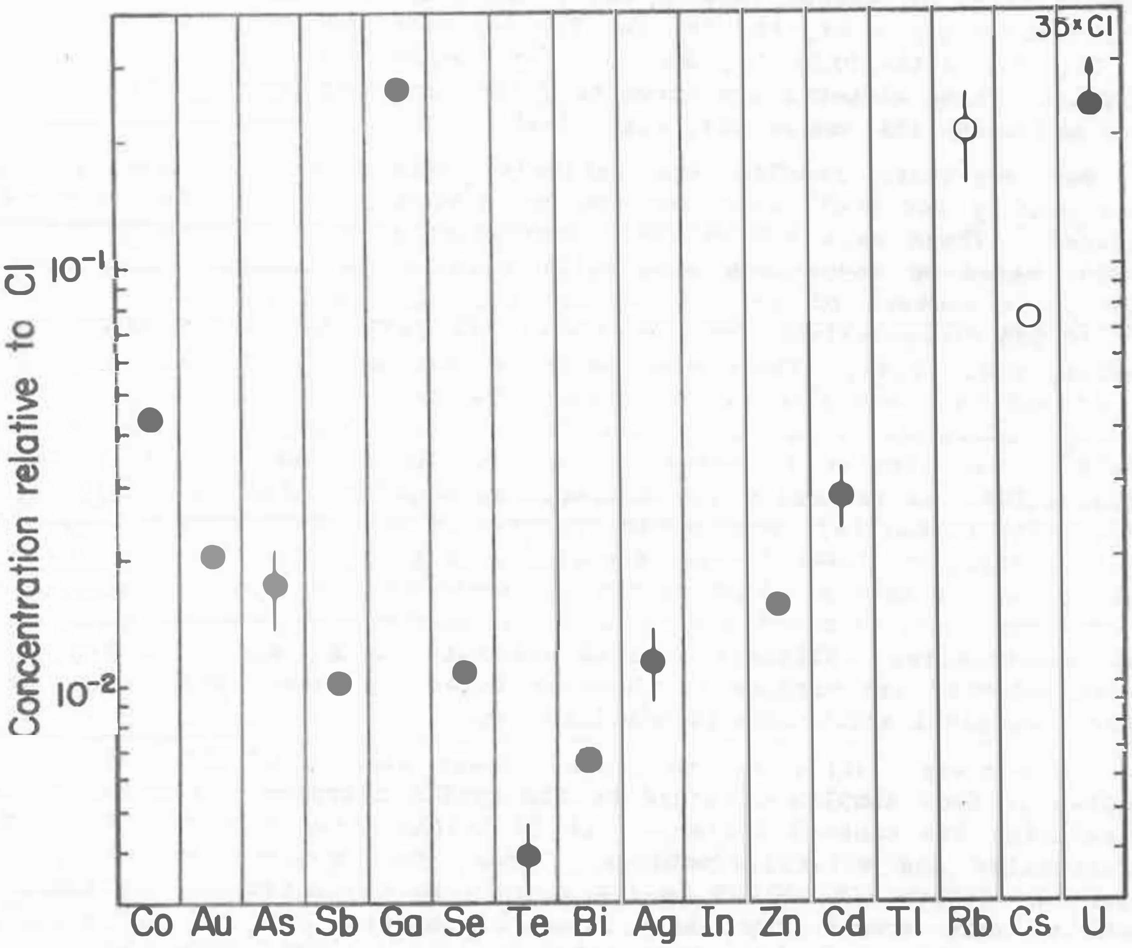

Fig. 1. Trace element contents of ALH A81005 normalized to those of Cl chondrites. Vertical lines indicate ±1 sample standard deviation derived from the duplicate analyses. Open symbols indicate provisional values. Gallium, lithophilic Cs, Rb and U and, perhaps, Co probably reflect anorthosite; other elements indicate 1-2% (Cl) admixture by meteoritic matter, possibly coupled with slight thermal redistribution of mobile elements. These are features often seen in Apollo lunar samples, indicating that ALH A81005 was compositionally unaffected during its transit to Earth.