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ELEMENT DISTRIBUTION AND NOBLE GAS ISOTOPIC ABUNDANCES IN LUNAR METEORITE ALLAN HILLS A81005

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Antarctic meteorite ALLAN HILLS A81005, an anorthositic breccia, is recognized to be of lunar origin [1]. Bogard and Johnson [2] analyzed the noble gases in this meteorite and found solar-wind implanted gases, whose absolute and relative concentrations are quite similar to those in lunar regolith samples.

We obtained an 0.279 g sample (A81005,51) of this meteorite for the analysis of the noble gas isotopes, including ^{81}Kr, and for the determination of the elemental abundances. In order to better determine the volume derived from the surface correlated gases, grain size fractions were prepared. After crushing the sample using a stainless steel mortar 0.022 g material was used for bulk analyses. The remaining mass was separated by sieving in acetone into the following grain size fractions: <15µm(0.0031g), 15-35µm(0.0048g), 35-74µm(0,010g), 74-149µm (0.0216g) and >149µm(0.1925g).

Chemistry. About 20% of each size fraction was irradiated in suprasil quartz vials for 4 days at 10^{14} n cm^{-2}s^{-1}. The results of the instrumental measurements of the gamma radiation are given in Table 1.

Table 1. Major and trace elements in grain size fractions of A81005,51. One sigma errors are ± 5% for Na, Fe, Cr, Co and Sc; ±5-10 % for Ca, La, Eu and Hf.

fraction	sample weight mg	Na %	Ca %	Fe %	Cr ppm	Co ppm	Sc ppm	La ppm	Eu ppm	Hf ppm
<15μm	0.91	0.24	10.5	-	780	18	9.2	-	0.50	0.60
15-35μm	1.21	0.24	11.8	3.95	800	18	9.4	1.90	0.53	0.55
35-74μm	2.48	0.27	12.4	4.75	770	17	10.3	1.60	0.61	1.05
74-149μm	5.22	0.22	11.6	3.25	750	19	8.5	1.70	0.63	0.60
>149μm	50.14	0.22	10.5	3.60	710	17	8.8	2.2	0.61	0.60

Concentrations were calculated relative to those in the reference sample IAEA soil-5 and in USGS standard BHVO-1. Our data agree well with those reported by Laul et al. [3] and by Palme et al. [4]. The anorthositic composition of this Antarctic meteorite is indicated by the high Ca value, the rather low Fe concentration and the typical values for La and Eu compared with the ones found in chondrites. All the five fractions show essentialy the same distribution pattern. That means we have not produced a major mineral fractionation by the grain size separation. In order to determine the blank levels a sample of suprasil quartz powder was subjected to the same grinding and sieving scheme as the meteorite sample. High contamination was observed for Ba and Br; therefore, no values are reported for these two elements. Blanks for Na, Fe, Co, Sc, Cr and La amount to less than 3% in the 35-74μm fraction. Blank corrections for the <15μm fraction are about 10 times larger than for the 35-74μm fraction (smaller sample weight, longer and more thorough contact with sieving apparatus and acetone).

For Fe and La, blank corrections for the finest material are larger than 60%; therefore, no values are reported. For Ca, Eu and Hf blank corrections are negligibly small.

Production rates for cosmogenic noble gas nuclei

Because this meteorite spent less than 1 my in space as a small body [5] it must have resided in the lunar regolith during most of its cosmic ray exposure time. The shielding depth within the lunar regolith was determined from the ratio of cosmogenic $^{131}Xe/^{126}Xe = 4 \pm 1$, which corresponds to an average shielding depth of $<50\ g/cm^2$. Production rates for cosmogenic noble gases were calculated from the data given by Regnier et al. [6] and Hohenberg et al. [7] for 2π irradiation at a shielding depth of 40 g/cm^2 using the target element abundances given in Table 1. For Mg, Al, Si, K and Ti values reported by Plame et al. [4] were used. Zirconium concentrations were calculated from Hf values using a ratio Zr/Hf of 31.8. The resulting production rates are given in Table 2.

Table 2. Concentrations of cosmogenic noble gases, production rates and exposure age of A81005.51 (preliminary data).

	^{3}He	^{21}Ne	^{38}Ar	^{83}Kr	^{126}Xe
Concentration ($10^{-8} cm^3$ STP/g) av. for bulk and grain size fractions	18	36	66	1.5×10^{-2}	1.55×10^{-3}
Production rate ($10^{-8} cm^3$ STP/g, my)	1.24	0.118	0.113	2.8×10^{-5}	2.8×10^{-6}
Exposure age (10^6 y)	15	305	584	536	554

Lunar surface residence time.

From the amounts of cosmic ray produced noble gases and respective production rates, the lunar surface residence times were calculated (Table 2). The ^{21}Ne exposure age and, in particular, the ^{3}He

exposure age are erroneously low due to diffusion loss of these noble gases, as typically observed for lunar rocks and soils. From the fact that a plateau is obtained for three heavier noble gases we conclude that the lunar surface residence time is about half a billion years. More detailed results, including the terrestrial age of A81005 calculated from the ^{81}Kr concentration, will be given in a later publication.

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