NEUTRON CAPTURE EFFECTS IN ASTEROIDAL REGOLITHS

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It is well known that a variety of lunar soils and rocks exhibit neutron capture effects in the form of excesses in ^{158}Gd and ^{150}Sm (*e.g.*, 1,2). There is overwhelming evidence from the study of gas-rich meteorites, that they were compacted on the surface of asteroidal regoliths (*e.g.*, 3). It is the purpose of the present study to look for neutron capture effects in such samples. The effects in gas-rich meteorites are expected to be roughly an order of magnitude smaller than the lunar samples, based on a comparison of solar wind gas contents, solar flare tracks and other regolithic features. We have also performed Sm isotope studies on Shergotty, which is considered to have been derived from Martian regolith, based on a variety of geochemical evidence, (*e.g.*, 4). Because of the widely different dependences on shielding depths, a combined knowledge of solar wind, solar flare, cosmogenic neon and neutron capture effects should be extremely useful in deciphering the regolithic and brecciatian environments of gas-rich meteorites.

We have performed Samarium isotopic studies on two samples of Kapoeta, K-1 and K-2, as well as on a whole rock sample of Shergotty. K-1 is predominantly made of light colored material. It does have track-rich grains in it, as would be expected due to the intimate mixture of the irradiated and unirradiated material, documented from electron microscope studies. K-2 was chipped off from a large impact melt clast of ~3 *cm* (E. King, priv. comm). Based on past experience, the probability of such large clasts being irradiated by solar flares is very small, and our track studies confirmed that the clast was indeed unirradiated. Finally, the whole rock sample of Shergotty was analysed as a follow-up of our work on EETA79001(5).

The Samarium isotope measurements were performed using the VG-54E mass spectrometer at the Scripps Institute of Oceanography. The experimental techniques and chemical separation procedures are similar to that described in (2).

Table 1

Sample	Wt. (*mg*)	^{150}Sm/^{149}Sm	Relative Excess (in $\mathcal{E}$ units)*
Terrestrial Std	—	0.53402±4	≡0
Kapoeta (K-1)	67	0.53423±8	4±2
Kapoeta (K-2)	220	0.53401±3	0±1
Shergotty (Sh-1)	86	0.53395±5	-1±1

* One $\mathcal{E}$ unit refers to 1 part in 10^4.

It should be emphasized that our results (shown in Table 1) are preliminary in nature as they are based on only one set of runs. The weights given in the above table refer to the total amount of sample dissolved. The errors quoted refer to 2σ errors. Only about 30% of the above material has been used for the above analyses. Repeat analyses will be performed on the remaining material in order to establish the reproducibility of the above results before firm conclusions can be drawn.

From the above data, it is clear that there is no evidence for excess ^{150}Sm in the Shergotty whole rock (Sh-1) or in the impact melt clast from Kapoeta (K-2). In contrast, there is a suggestion of a neutron effect in the Kapoeta bulk sample K-1, which is predominantly made of light material. Following the line of reasoning described in (5), we infer upper limits to the neutron fluences $\left(\Phi(<0.2\text{eV})\right)$ experienced by samples K-2 and Sh-1 of 0.6 and $1.1 \times 10^{15}\ n/cm^2$ respectively.

The positive effect observed in K-1 corresponds to a neutron fluence of $2 \pm 1 \times 10^{15}\ n/cm^2$. Comparing the present result to that from lunar rock 75075(2), we infer a residence time for Kapoeta in its parent asteroid regolith of 33 ± 16 million years.

References

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