

**PRIMORDIAL TERRESTRIAL XENON REVISITED.**

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Extensive studies were performed to determine the isotopic structure of a common ancestor for terrestrial and meteoritic Xe. Takaoka [1], Pepin and Phinney [2] and Igarashi [3], using different correlation analyses and a somewhat different meteoritic database, proposed similar isotopic compositions of primordial terrestrial Xe. Although none of these studies used solar xenon, the resulting primitive Xe turned out to be compositionally very close to the solar wind Xe found in lunar regolith, with the exception of the two heaviest isotopes. One of the explanations for the apparent  $^{134}\text{Xe}$  excess and twice larger  $^{136}\text{Xe}$  enrichment was a possible presence of unaccounted fission products on the moon. However, recent analyses of the solar wind Xe delivered by Genesis [4] dismissed this explanation and reconfirmed that all but the two heaviest primordial Xe isotopes are precisely solar.

This Xe puzzle could be approached either by introducing a new “sub-primordial” Xe component (extending already extensive noble gas “alphabet”) or by exploring how  $^{134}\text{Xe}$  and  $^{136}\text{Xe}$  could be selectively generated.

A nearly pure binary mixture of  $^{134}\text{Xe}$  and  $^{136}\text{Xe}$  was observed in gas released from the soil surrounding the liquid nuclear waste disposal facilities at Hanford Site [5]. Significant excesses in  $^{136}\text{Xe}$  and  $^{134}\text{Xe}$  isotopes were found in gas leaked from U-oxide powder during neutron irradiation [6]. In both cases  $^{136}\text{Xe}$  enrichment was twice of that of  $^{134}\text{Xe}$ , reproducing the isotopic pattern in mathematically constructed primordial Xe.

Apparently the observed effect in [5, 6] is due to fission in open systems where intermediate fission products (mainly iodine) could leak out from the host mineral, thereby producing isotope depletion in stable Xe isotopes remaining in the host, as well as complimentary enrichment in isotopes in the reservoir where the intermediate fission products had migrated. The following table shows some properties of fission iodine which could be responsible for separation of  $^{136}\text{Xe} + ^{134}\text{Xe}$  from  $^{132}\text{Xe} + ^{131}\text{Xe}$ :

Xe precursor	Q, MeV	Half-life	Max. recoil, eV
$^{131}\text{I}$	~ 0.97	8 days	8
$^{132}\text{I}$	~ 3.58	2.3 hours	67
$^{134}\text{I}$	~ 4.17	52 min	87
$^{136}\text{I}$	~ 6.93	86 sec	217

These properties are evidently the same for neutron-induced  $^{235}\text{U}$  and spontaneous fission of  $^{238}\text{U}$  or  $^{244}\text{Pu}$ . Therefore it seems plausible that the same effect may be responsible for apparent excess of  $^{134}\text{Xe}$  and  $^{136}\text{Xe}$  in terrestrial fission Xe.

More work is needed to understand the mechanism separating the two heaviest fission Xe isotopes. Grain size may play a critical role in this effect and the experiment to examine this is on the way. Modification of apparent fission yields in open systems is a real observable physical process seemingly capable of explaining isotopic structure of Xe in the terrestrial atmosphere.

[1] Takaoka N. 1972. *Mass Spectroscopy* **20**, 287-302. [2] Pepin R. & Phinney D. 1978. *Unpublished manuscript*. [3] Igarashi G. 1995. *AIP Conf. Proc.* **341**, 70-80. [4] Meshik A. et al. 2014. *Geochim. Cosmochim Acta* **127**, 326-347. [5] Dresel P. E. et al. 2007. *J. Radioanalytical & Nuclear Chem.* **276**, 763-769. [6] Meshik A. 1988. *PhD Thesis*, Vernadsky Institute, Moscow.