

^{126}Xe EXCESSES: MONOISOTOPIC ANOMALIES IN REGOLITH SAMPLES ?

K. J. Mathew¹, K. Marti¹ and L. K. Levskii², ¹ Department of Chemistry and Biochemistry, University of California, San Diego, CA 92093-0317, USA. ² Institute of Precambrian Geology and Isotope Geochemistry, Makarova 2, IPGG, St. Petersburg 199034, Russia

We present new Xe isotopic signatures of Pesyanoe regolith samples which document excesses of ^{126}Xe and we explore the possibility that it formed by low-energy reactions on transient Te-rich coatings.

Introduction: Lunar and asteroidal regoliths provide important information on the composition of solar wind (SW) gases. Pesyanoe is uniquely suited for a study of SW Xe in an asteroidal regolith, since its signatures are not masked by indigenous components. Possible excesses on ^{126}Xe were first recognized in Pesyanoe when the Xe composition was compared to implanted solar wind Xe in lunar regolith samples [1, 2]. These excesses, in principle, could be explained by solar proton irradiation of surface-correlated iodine or tellurium [3, 4], but also, (α, n)-reactions on ^{123}Sb , followed by β -decay may contribute to the excesses.

The new Pesyanoe data with larger ^{126}Xe isotopic excesses show an increase with increasing SW concentrations, indicating that ^{126}Xe excesses together with solar Xe are acquired during residence on the topmost layer of the regolith and thus give a measure of the residence time in the top SW loading zone of the lunar/asteroidal regoliths. An approximate correlation with lunar grain-size data is suggestive of a surface enrichment of responsible target elements and also rules out the possibility that the ^{126}Xe excesses are due to an underestimation of the spallation Xe corrections, since in this case low SW Xe abundances would show larger anomalies, contrary to observed trends.

For the lunar grain size separates of 10084 [5] the spallation contribution to ^{124}Xe , which is used for the calculation of spallation yields at other Xe isotopes, are ~25% for <100 μm size fractions (also bulk) and only ~3% for several small grain size fractions. ^{126}Xe excesses are also observed in the first etch steps of lunar ilmenites [6] and in the intermediate (~800° - 1000°C) pyrolysis steps (only minor spallation Xe components are released in these steps) of Pesyanoe as well as in lunar soils and breccias [2, 7]. Furthermore, there are grain populations which carry no ^{126}Xe excesses. Pesyanoe regolith samples have two orders of magnitude lower solar Xe abundances than lunar soils and breccias of different antiquities [2, 3], and in lunar regolith samples ^{126}Xe excesses are often enriched in mineral separates and in grain size separates. The ^{126}Xe excesses can not be explained by observed Te or I abundances, which would produce only percent effects of the observed excesses. In order to establish whether ^{126}Xe excesses are in fact monoisotopic or if co-produced effects on other isotopes can not be recognized, we investigate the option of correlated effects, such as due to a temporary coating of Te, onto regolith materials from volcanic vents, or from re-implantation of volatile Te-compounds (e.g. TeH_2 , a product of SW reactions). Reactions of low-energy protons on Te would cogenerate anomalies on ^{128}Xe and ^{130}Xe and 46% of the produced ^{126}I will β -decay into ^{126}Xe .

Considering the production of ^{126}Xe excesses by the proton reaction $^{126}\text{Te}(p, n)^{126}\text{I}$ ($t_{1/2} = 13$ d) followed by β -decay to ^{126}Xe , we note that proton reactions could be limited to timescales of retention of Te on grain sur-

faces. It is not clear whether the Pesyanoë regolith during its early history had higher Te abundances, since the observed Te abundance in enstatite achondrites is only ~1% of Te in the enstatite chondrites [8].

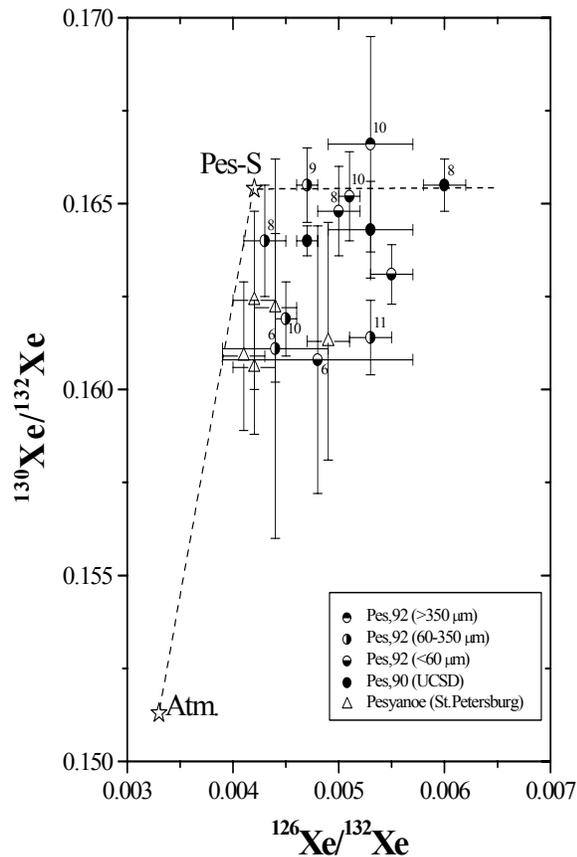


Figure 1. The Figure shows the spallation-corrected ratios $^{130}\text{Xe}/^{132}\text{Xe}$ vs. $^{126}\text{Xe}/^{132}\text{Xe}$ for studied Pesyanoë samples (UCSD and St. Petersburg samples). Only the Pesyanoë,90 measurements were made on an uncrushed fragment of the dark lithology. Pes-S represents an average for the solar wind Xe signature in Pesyanoë (UCSD data). The UCSD data below 600°C (<5% of the total Xe in the sample) are not shown, because of atmospheric contamination. Data collected at 1100°C (all St. Petersburg samples) are shifted below the Pes-S $^{130}\text{Xe}/^{132}\text{Xe}$

reference line due to the presence of either terrestrial contamination or of fission Xe. Temperatures (in hundreds of degrees) are given for the UCSD data only. Note that all samples show ^{126}Xe excesses.

The low-energy ^{126}Xe production cross-sections from Te relative to those of the co-produced isotopes, $^{128}\text{Xe}/^{126}\text{Xe}$ and $^{130}\text{Xe}/^{126}\text{Xe}$ were studied by [4]. For protons with a differential rigidity spectrum corresponding to SW protons, as recorded in lunar samples [9], a $^{130}\text{Xe}/^{126}\text{Xe}$ production rate ratio of 0.33 ± 0.05 was determined [4]. Since current uncertainties in spallation corrected ^{130}Xe data are $\geq 1\%$, excesses at ^{126}Xe from such reactions would have to be $\geq 100\%$ in order to be recognized as anomalies at ^{130}Xe . Such excesses are at the limit of currently available data, as shown in Figure 1. The presence of either fission components or of terrestrial atmospheric Xe components further complicates this search since the reference Xe isotopes are affected.

References: [1] Podosek F. A. et al. (1971) EPSL 10, 199-216. [2] Marti K. (1969) Science 166, 1263-1265. [3] Pepin R. O. et al. (1995) GCA 59, 4997-5022. [4] Be-gemann F. and Mathew K. J. (1996) GCA 60, 4593-4597. [5] Basford J. R. et al. (1973) Proc. LSC 4th, 1915-1955. [6] Wieler R. and Baur H. (1994) Meteoritics 29, 570-580. [7] Kim J. S. and Marti K. (1992) Proc. LPS 22, 145-151. [8] Biswas et al. (1980) GCA 44, 2097-2110. [9] Rao M. N. et al. (1994) GCA 58, 4231-4245. Research supported by NASA.