XENON IN YAMATO 000593 & NWA 817- NAKHLITES FROM TWO DIVERSE TERRESTRIAL ENVIRONMENTS. R. K. Mohapatra, S. Crowther and J. D. Gilmour, School of Earth, Atmospheric and Environmental Sciences, The University of Manchester, Manchester M13 9PL, U. K. ratan.mohapatra@manchester.ac.uk

Introduction: Yamato 000593 and NWA 817 are two martian meteorites collected respectively from Antarctic ice and Morocco [1, 2]. They are the first Nakhlites to be found in the (cold and hot) desert environments. We have analysed these meteorites for their xenon isotopes to understand the nature of volatile components, and present here preliminary data and results from the study.

Samples and Experimental: So far we have analyzed two bulk samples of NWA 817 and various mineral separates (Fig. 1) from both these meteorites. The mineral separates were prepared by visual identification under a binocular microscope. Xenon was extracted from the samples by laser stepwise heating and was analysed by RELAX [3] using standard procedures.

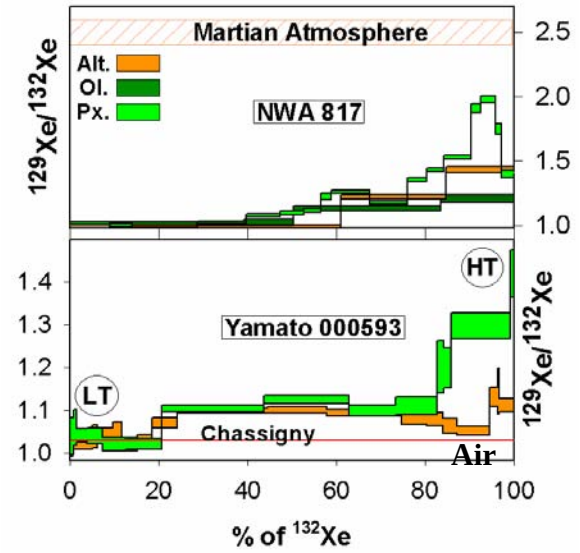

Fig. 1. Spallation corrected ^{129}Xe/^{132}Xe signature of gas released in the stepped heating experiment of Yamato 000593 and NWA 817 as a function of the % of ^{132}Xe (Alt. = Alteration product, Ol. = Olivine, Px. = Pyroxene, LT = low temperature, HT = High temperature). Also shown are the end-members: Martian atmosphere (the range from [6] and [17]) and Chassigny [4]. Air is represented by the lower horizontal scales in the plots. Data for NWA bulk samples follow a trend that is in between that of the Ol. and Alt. samples and are not shown in the plot to avoid clutter.

Results: Martian meteorites exhibit a wide variation in ^{129}Xe/^{132}Xe from 1.03 in Chassigny ([4], representing martian mantle) to 2.6 ([5], martian atmosphere). Total xenon measured in the present samples have ^{129}Xe/^{132}Xe signatures less than 1.2, which suggests dominating contribution from a Chassigny like component [e.g., [6], Yamato 000593). But the stepped temperature data show signatures as high as ~2 (NWA 817 Px. in Fig. 1). The highest ^{129}Xe/^{132}Xe in these meteorites are exhibited by the pyroxene samples while the bulk, alteration product and olivine samples show comparatively lower signatures. The same trend also applies to ^{136}Xe/^{132}Xe in these samples.

Discussion:

Terrestrial contamination: Low temperature (LT, data in the left hand side) xenon in NWA 817 samples have air-like ^{129}Xe/^{132}Xe indicating terrestrial contamination. The degree of terrestrial contamination in NWA 817 however appears less than that in martian meteorites (Shergottites) DaG 476 [7] or SaU 005 [8] also collected from the hot deserts. It may indicate a lower degree of desert weathering for NWA 817 or dominating release from a low retentive martian component (^{129}Xe/^{132}Xe: 1.03 to 2.6). On the other hand low temperature releases from Yamato 000593 samples have ^{129}Xe/^{132}Xe signatures similar to that of Chassigny (Fig. 1), suggesting very little effect of terrestrial contamination.

Martian atmosphere like xenon: The high temperature releases have ^{129}Xe/^{132}Xe signatures reaching ~2 in NWA 817 pyroxene, and ~1.4 in Yamato 000593 pyroxene. High ^{129}Xe/^{132}Xe, representing radiogenic ^{129}Xe from the decay of ^{129}I (active only in the first 100 Ma of the Solar System history; $t_{1/2}$ = 15.7 Ma), in Nakhlites is often attributed to martian atmosphere introduced into a meteorite by martian secondary processes [9]. But the maximum ^{129}Xe/^{132}Xe of 1.4 measured in the NWA alteration product may require an additional explanation for the signatures observed in pyroxene (Fig. 1). A similar inference may also be drawn from the step wise data for the Yamato samples. Shock is often suggested to have implanted martian atmospheric volatiles [10]. But the Nakhlites show very little effect shock pressures.

Crustal Assimilation? Considering their release in high temperatures, the elevated ^{129}Xe/^{132}Xe signatures may on the other hand represent magmatic signatures. Suggested ^{129}Xe/^{132}Xe for martian mantle vary from 1.03 [4] to 1.08 [11], which are much less than the above signatures. High temperature releases from olivine and alteration products have ^{129}Xe/^{132}Xe signa-

tures that are lower than that in the pyroxene samples, but are still above the martian mantle signatures. One plausible explanation would be incorporation of the radiogenic ^{129}Xe component in the parent magmas of the Nakhlites. For example, it has been suggested that the radiogenic xenon component in Nakhlites may have been acquired by assimilation of martian crustal materials into their parent magmas [12]. But the lower ^{129}Xe/^{132}Xe in olivine would require the assimilation to take place after (most of the) olivine has crystallized.

Fig. 2 is based on the stepped temperature data in Fig. 1, obtained by adding up consecutive temperature steps that are identical in terms of their ^{129}Xe/^{132}Xe and ^{136}Xe/^{132}Xe signatures. The low temperature data for the pyroxene samples and NWA olivine plot near Air, suggesting terrestrial contamination, while the high temperature releases move away from Air (as indicated by the line connecting the Yamato Px. data). As can be realized the NWA pyroxene and alteration product also (besides ^{129}Xe*) have more fission xenon (^{136}Xe). This may mean different degrees of crustal contamination of the parent magmas for these meteorites.

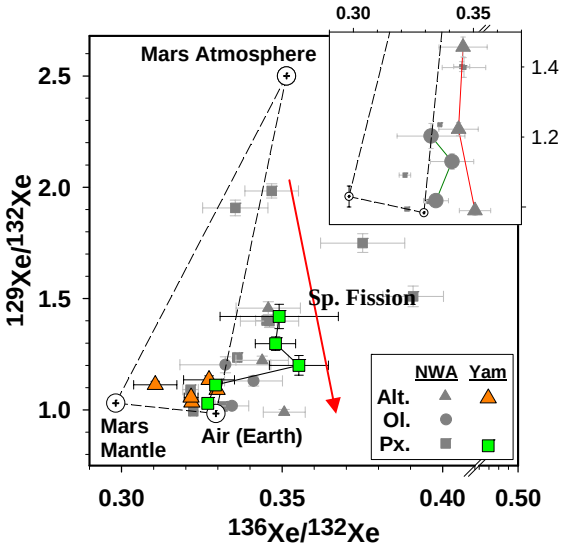

Fig. 2. A plot between ^{136}Xe/^{132}Xe and ^{129}Xe/^{132}Xe for the stepped temperature data from Yamato 000593 (Yam) and NWA 817 (NWA). Also shown are the end-members Air [18], Mars Mantle [4], Mars Atmosphere [5], the mixing lines and the trend for spontaneous fission of ^{238}U and ^{244}Pu (extinct).

Nature of secondary fluid: In NWA 817, secondary alteration (on Mars) of meteoritic olivine resulted in the alteration products. Our Alt. and Ol. samples actually represent fractions that are enriched (>90 volume %) respectively in the alteration products and unaltered (visually) olivine. In Fig. 2 (inset) the alteration product appears to have more fission and radiogenic xenon as compared to olivine (its precursor), suggesting that the fluid that was responsible for alteration was already enriched. It is however not clear if the fluid was also responsible for incorporation of the enriched component to pyroxene. It has been suggested that the fluid that caused secondary alteration in NWA 817 parent rock apparently had a Eu anomaly and perhaps was derived from martian interior rather than the surface waters [13]. Mantle xenoliths from Earth's sub-continental mantle show indications of secondary alteration by mantle-fluids, also known as metasomatic fluids, which also alter the trace element compositions of the host rock [14]. It is possible that such metasomatic events would also have been operative in Mars [15]. In Earth's mantle the metasomatic fluids are often enriched in trace elements from materials recycled at the subduction zones ([16], e.g., noble gases from Air, nitrogen from sediments). With the present understanding of martian tectonism it is however difficult assess such a possibility on Mars.

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