XENON ISOTOPIC COMPONENTS IN NWA 2737– A CHASSIGNITE FROM THE HOT DESERT. R. K. Mohapatra [1], S. A. Crowther [1], J. D. Gilmour [1] and B. Marty [2]; [1] School of Earth, Atmospheric and Environmental Sciences, The University of Manchester, Manchester M13 9PL, U. K. (ratan.mohapatra@manchester.ac.uk); [2] Centre de Recherches Petrographiques et Geochimiques, 54501 Vandoeuvre-lès-Nancy Cedex, France.

Introduction: NWA 2737 recently recovered from the Moroccan sahara is a martian dunite. Based on mineralogy (e.g., 89.6 % olivine), major (Fe/Mn) and trace element chemistry as well as oxygen isotopic signature ($\Delta^{17}O = 0.305$), it has been identified as the second Chassignite [1, 2]. The meteorite however has a few differences from Chassigny pointing to differences in petrogenesis and martian evolution. A remarkable feature of NWA 2737 is the unusually strong shock metamorphism that has modified the crystal lattice and changed the valency of Fe. This has been suggested as responsible for the observed black colour of olivine. Noble gas data have been presented by Marty et al. [3], who derive a cosmic ray exposure age (~10 Ma) similar to that of Chassigny but a lower (U-Th/He and K/Ar) crystallisation age (<0.5 Ga) in the range of that observed in the shergottites [4].

We present here preliminary xenon isotopic data from mineral separates from a 10 mg sample of NWA 2737, and discuss their implications for the volatile components in this meteorite.

Samples and Experimental: About 4.6 mg of black grains and a few pale blue to colourless grains weighing 0.095 mg were picked from a mildly disaggregated piece (5 mg) of the meteorite. From the petrography of NWA 2737, the black colour grains are assumed to be olivine, while the other separate (pale blue to colourless) is assumed to be sanidine (feldsfar). While in the rest of the discussion we adopt this crude mineralogical identification, we will check this by future SEM EDS examination. Xenon isotopic measurements were carried out on gases released by stepwise heating by RELAX using standard procedures [5].

Results: In general, the concentration of ^{132}Xe (~3 × 10^{-12} ccSTP/g) xenon in the present NWA 2737 samples are about an order of magnitude lower than that in Chassigny [6, 7]. The measured $^{129}Xe/^{132}Xe$ ~ 1.5 in olivine and 2.0 in sanidine, on the other hand, are much higher than the signatures measured in Chassigny (1.03 to 1.07). The low temperature data are dominated by (terrestrial) air-like xenon isotopic signatures. The high temperature extractions have $^{129}Xe/^{132}Xe$ up to 1.8 in olivine and 2.1 in sanidine and represent the meteoritic signatures.

Considering the fairly large cosmic ray exposure age (~10 Ma) of this meteorite and low abundances of xenon in the present samples, significant contributions from spallation are expected in the measured data. The effect of spallation is much pronounced in the sanidine xenon data. It has an order of magnitude higher spallation Xe compared to olivine, indicating a Ba, LREE rich phase (supporting its preliminary identification as sanidine).

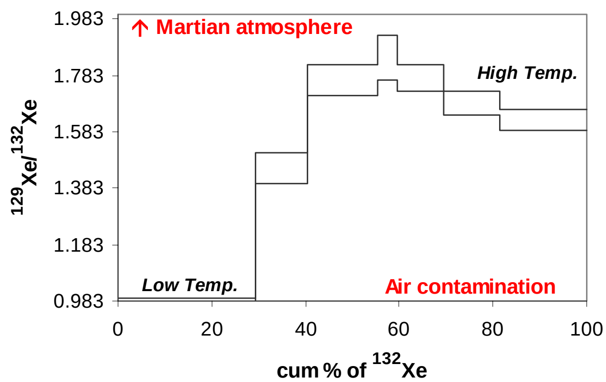

Fig. 1. Spallation corrected $^{129}Xe/^{132}Xe$ in the stepped heating releases, represented by the cumumlative % of ^{132}Xe, in NWA 2737–olivine. $^{129}Xe/^{132}Xe$ signature of terrestrial contamination (Air) is represented by the abscissa, while that of martian atmosphere lies beyond the upper limit of the ordinate. * Spallation contributions at ^{132}Xe are < 9 % for the stepped heating data.*

Discussion:

Terrestrial contamination: Air-like $^{129}Xe/^{132}Xe$ in the low-temperature steps indicate significant terrestrial contamination, which for example accounts for ~30% of the total ^{132}Xe in olivine (Fig. 1). NWA 2737 has probably spent a significant time in the desert sands and is composed of ~90 % olivine [1] - an easy victim of desert aqueous processes. The degree of air contamination in the present olivine sample is however lower than that in the mineral separates and bulk samples of other martian meteorites from the hot deserts- NWA 817 [8], DaG 476 [9] and SaU 005 [10]. This suggests lower desert weathering as compared to that in the other meteorites that are mineralogically more resistant to such processes. A low desert weathering of NWA 2737 is also inferred from the trace element data [1].

Martian xenon: In Fig. 1, spallation corrected $^{129}Xe/^{132}Xe$ for the high temperature data in olivine show clear contributions from martian atmospheric xenon ($^{129}Xe/^{132}Xe$ ~2.4 to 2.6 [11]). The high temperature data from sanidine also exhibit comparable $^{129}Xe/^{132}Xe$ signatures. While this provides a strong case for its martian origin, the presence of significant contributions from martian atmospheric xenon in NWA 2737 presents a new insight into the volatile evolution of Chassignites.

Solar like xenon in Chassigny (Chassigny "S") is considered a representative of xenon in martian mantle [6]. Mathew et al., [7] have reported a second mantle component (Chassigny "E") that is somewhat enriched in fission xenon compared to the Chassigny "S" (Fig. 2). Stepped heating xenon data in the present samples however do not reveal any such signatures. We believe that such signatures are probably obscured/dominated by air contamination in the low temperature steps and the martian atmosphere like signatures in the high temperature data. Mathew et al. [7] have shown that the solar like xenon component in Chassigny is released in low temperature steps, indicating possible residence in fluid inclusions. Such a low temperature component in NWA 2737 would be very difficult to resolve from a mixture of air and martian atmosphere like signatures. Although $^{129}Xe/^{132}Xe$ in the high temperature data show martian atmospheric contributions, they are significantly lower than the martian atmospheric signature (2.4 to 2.6 e.g., [11]). This indicates the presence of a component with lower $^{129}Xe/^{132}Xe$.

Further features of the trapped xenon in NWA 2737 are understood in Fig. 2. While the low temperature datum for olivine plots on the air point (indicating air contamination), the high temperature data plot along the mixing line between Chassigny "S" and martian atmosphere (MA). Assuming the high temperature data to be a two component mixture of MA ($^{129}Xe/^{132}Xe$ = 2.5) and Chassigny "S" ($^{129}Xe/^{132}Xe$ = 1.03) we derive a mantle contribution of 57 % in olivine and 44 % in sanidine (not plotted in the figure).

If NWA 2737 crystallised from a martian magma trapping the mantle xenon (similar to Chassigny), the observed two-component mixing in Fig. 2 may be explained by implantation of the martian atmospheric xenon by shock. However, the order of magnitude lower ^{132}Xe concentration observed in NWA 2737 compared to Chassigny requires additional explanation. Similarly, the effect of shock on the pre-existing xenon from the mantle is also not fully understood. Considering the intensity of the shock, such a process would destroy much of the pre-existing fluid inclusions that are believed to host the mantle derived xenon in Chassigny [7]. Further, the observation that shock has even affected the crystal lattice in NWA 2737 suggests that a part of xenon in the lattice voids would also have been vulnerable. Together, these two may explain the comparatively low xenon content of NWA 2737.

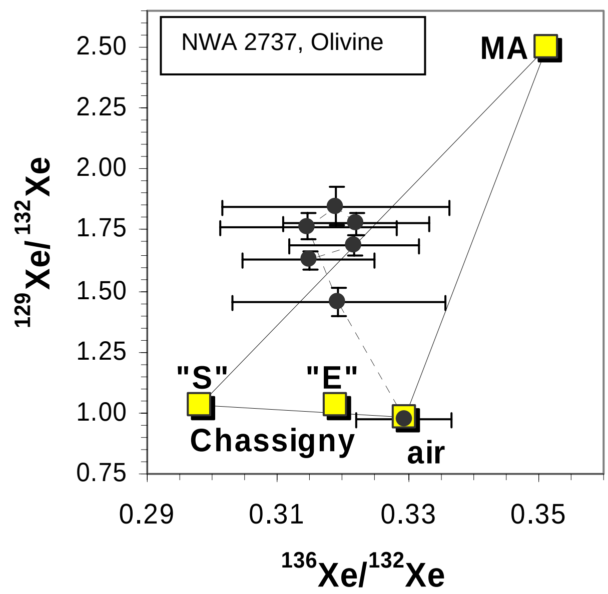

Fig. 2. A plot between $^{136}Xe/^{132}Xe$ and $^{129}Xe/^{132}Xe$ for the spallation corrected stepped heating data from NWA 2737–olivine. Also shown are the end-members Air [12], Chassigny [6, 7], Mars Atmosphere (MA) [11] and the binary mixing lines. Chassigny "S" and "E" refer to solar and evolved components in the mantle [7].

References:

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