XENON ISOTOPES IN SHERGOTTITES RBT 04262, DAG 489, SHERGOTTY AND EET 79001. J. A. Cartwright, R. Burgess, and J. D. Gilmour. School of Earth, Atmospheric and Environmental Sciences, Williamson Building, Oxford Road, University of Manchester, M13 9PL, UK. (julia.cartwright@postgrad.manchester.ac.uk)

Introduction: Previous research on noble gases within Martian meteorites has identified numerous distinct trapped Xe components that have characteristic isotopic signatures. Three distinct reservoirs are needed to explain these components. One reservoir is the Martian atmosphere, containing an elevated $^{129}Xe/^{132}Xe$ of 2.4 [1], which has clearly contributed to the Xe budget in the Martian meteorites. Two distinct reservoirs in the Martian interior contribute to the Xe components. One reservoir, identified with the Martian mantle is indistinguishable from solar Xe with $^{129}Xe/^{132}Xe$ of 1.03 [2], whilst the second reservoir contains a solar xenon composition that has been modified by fission of ^{244}Pu.

The sources and trapping mechanisms of the components are controversial and poorly understood, and three mechanisms of incorporation have been proposed: dissolution in primary magma, aqueous alteration and shock incorporation. These three mechanisms would yield elevated noble gas concentrations in primary melt inclusions, alteration products and shock glasses (and, perhaps, close to grain boundaries where shock pressures are elevated) respectively.

To constrain the location and trapping mechanisms of noble gases, and help characterize parent reservoris of meteorites, we have analysed mineral separates of shergottites olivine-phyric RBT 04262, basaltic EET 79001 lithology B, basaltic Shergotty and olivine-orthopyroxene DaG 489. Comparison of shergottite type and the analysis of crystallization histories by investigation of melt inclusions may improve the understanding of meteorite formation and their relationship with each other, and increase understanding of the interior and atmospheric evolution processes on Mars. Our results will be compared to previous results by [3] on mineral separates of Shergotty.

Methodology: Following crushing in a clean laboratory, hand-picked mineral separates including aliquots of olivine, pyroxene, olivine/pyroxene, whole rock, iddingsite, maskelynite and opaques from the four meteorites were analysed on the RELAX instrument (Refrigerator Enhanced Laser Analyser for Xenon) using laser step-heating experiments to determine xenon isotopic ratios and concentrations [4-5]. It was impossible to distinguish between olivine and pyroxene in the crushed RBT 04262 fragments due to their similarity in colour, and small sample size. The aliquots were heated under vacuum until melting using an infrared Nd:YAG laser (λ = 1064 nm), and the gas emitted from each step was analysed and recorded using the data analysis programme associated with RELAX [4-5]. The temperature used in each step was controlled by varying the output power of the laser, using the laser lamp current – actual temperature readings are not available. The previous data for Shergotty was obtained in a similar way, as described by [3].

Results and Discussion: Step release diagrams for EET 79001, DaG 489 and RBT 04262 are shown in Figure 1.

Opaque minerals: The opaque aliquots from EET 79001, DaG 489 and RBT 04262 display a similar release pattern, with $^{129}Xe/^{132}Xe$ increasing with temperature until a large release at mid-high temperatures. Differences are seen in the maximum $^{129}Xe/^{132}Xe$ achieved, with EET 79001 maxima at ~1.69, DaG 489 maxima at ~1.56 and RBT 04262 reaching the lowest maxima of ~1.14. This increase in temperature in the opaque aliquots is consistent with previous data for Shergotty [3], where a $^{129}Xe/^{132}Xe$ maxima of ~1.61 was achieved.

Maskelynite: All maskelynite aliquots display an increase in $^{129}Xe/^{132}Xe$ with temperature. Again, differences are seen in the maximum $^{129}Xe/^{132}Xe$ achieved, with the highest seen in DaG 489 1.86, Shergotty at ~1.5, EET 79001 reaching ~1.35, and RBT 04262 again the lowest at ~1.05. This release pattern is consistent with previously observed Shergotty maskelynite samples, where 129Xe/132Xe maxima of 1.3 and 1.8 were reached [3].

Mafic minerals: The pyroxene aliquots for EET 79001, DaG 489 and RBT 04262 display similar release patterns, and $^{129}Xe/^{132}Xe$ plateaus between 0.98 and 1.03. The Shergotty pyroxene $^{129}Xe/^{132}Xe$ averaged 1.12. Our results are consistent with the release pattern seen in the pyroxene samples of Shergotty by [3], and the average $^{129}Xe/^{132}Xe$ is similar to our Shergotty at 1.16-1.29. The pyroxene aliquots suggest interaction with reservoirs Earth's atmosphere and Martian interior. This may be a result of weathering during residency time on Earth

Iddingsite: The DaG 489 iddingsite aliquot showed an increase with temperature, reaching a maximum $^{129}Xe/^{132}Xe$ of ~1.38 suggesting a Martian component, with the final step, responsible for 70% of the gas emitted for the sample with $^{129}Xe/^{132}Xe$ suggesting terrestrial contamination. No difference was seen between single or multiple grain olivine/pyroxene aliquots of RBT 04262.

Gas concentrations and bulk compositions: Of the four meteorites, RBT 04262 released the most gas, with ^{132}Xe concentrations approaching 10^{-10} STP cm^3 g^{-1}, and has the lowest ^{129}Xe/^{132}Xe ratios associated with compositions close to Earth's atmosphere. This may be due to a higher amount of terrestrial contamination by weathering during the meteorites residency time. DaG 489 released similar amounts of gas with concentrations reaching 6 x 10^{-11} STP cm^3 g^{-1}, whilst EET 79001 and Shergotty ^{132}Xe concentrations yielded the lowest, with concentrations similar to previous Shergotty data (10^{-11}-10^{-12} STP cm^{-3} g^{-1}) [3]. The RBT 04262 Xe isotopic data indicate the presence of three Xe components similar to reservoirs of terrestrial atmosphere, Martian atmosphere and Martian interior within the mineral separates. The high ^{129}Xe/^{132}Xe value obtained from the opaque mineral separate, suggests a large contribution from a Martian atmospheric reservoir (consistent with previous data for Shergotty [3]). The olivine and pyroxene separates for all meteorites exhibited Xe components similar to terrestrial atmosphere, with some slight input from Martian interior. By contrast, the remaining mineral separates for Shergotty, EET 79001 and DaG 489 all display high ^{136}Xe/^{132}Xe and ^{129}Xe/^{132}Xe values. This can be explained by the primary magmas of Shergotty, EET 79001 and DaG 489 interacting with a Martian interior reservoir that contained an excess fission component, subsequently acquiring a contribution from the Martian atmosphere. The absence of this high fission component in RBT 04262, may suggest that its original melt did not interact with the high fission reservoir possibly due to different formation conditions or environment, or, more likely that this component has been overprinted with a dominant terrestrial atmospheric signal.

Conclusions: All meteorites suggest similar distribution of Martian components among minerals, with variations caused by overprinting by terrestrial contamination. Martian atmosphere concentrations correlate with grain size, as the smaller grained aliquots like the opaques and maskelynite show increased influences from Martian atmosphere, consistent with a surface-area effect, as suggested by [3]. No difference is seen between the shergottite subgroups.

Acknowledgments: Thanks to ANSMET for supplying RBT 04262, and thanks to Sarah Crowther for RELAX instrument support.

References: [1] Swindle T. D., Caffee M. W., and Hohenberg C. M. (1986) *GCA* 50(6), 1001-1015. [2] Ott U. (1988) *GCA* 52, 1937 – 1948. [3] Ocker K. D. and Gilmour J. D. (2004) *Meteoritics & Planet. Sci.*, 39, 1967-1981. [4] Gilmour J. D., Lyon I. C., Johnston W. A., and Turner G. (1994) *Rev. of Scientific Instruments* 65(3), 617-625. [5] Crowther S. A., Mohapatra R. K., Turner G., Blagburn D. J., Kehm K., and Gilmour J. D. (2008) *JAAS,* 23, 938-947. [6] Mathew K. J. and Marti K. (2001) *JGR* 106(E1), 1401 – 1422 [7]Basford J. R., Dragon J. C., and Pepin R. O. (1973) 4th Lun. Sci. Conf.., 1915-1955.

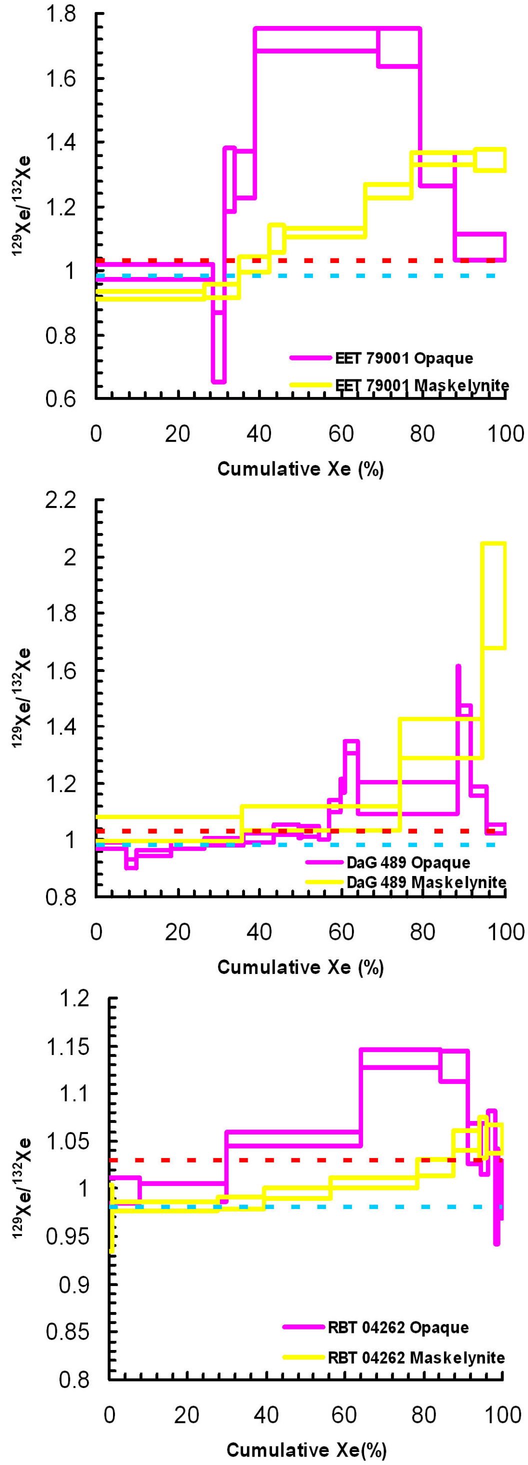

Figure 1: Step release diagrams of ^{129}Xe/^{132}Xe vs. cumulative Xe (equivalent to temperature). The dashed red and blue lines represent Martian interior [2] and Earth's atmosphere [7], respectively.