APPLICATIONS OF RELAX TO XENON MEASUREMENTS IN GENESIS SAMPLES. S. A. Crowther, M. J. Filtness and J. D. Gilmour, School of Earth, Atmospheric and Environmental Sciences, University of Manchester, Manchester, M13 9PL, UK. (sarah.crowther@manchester.ac.uk)

Introduction: A very high level of precision and accuracy is demanded for analysis of samples from NASA's Genesis mission. Noble gases are of particular interest but, since they are heavily depleted in natural reservoirs, the most sensitive techniques and instruments must be used to make precise and accurate measurements. The wealth of information available is limited only by our ability to measure the minute quantities of these elements.

The RELAX mass spectrometer in Manchester is capable of determining Xe isotope ratios from samples containing just a few thousand atoms of Xe. However, at peak sensitivity sample sizes are restricted to less than ~10^6 atoms. Thus to achieve precise measurements of isotope ratios it is necessary to take an average from multiple analyses. Here we demonstrate that RELAX is capable of the required reproducibility, and report the results of initial measurements of solar-wind Xe from analysis of one Genesis sample.

RELAX: RELAX (Refrigerator Enhanced Laser Analyser for Xenon) is an ultra sensitive, time of flight, resonance ionization mass spectrometer specifically for measuring Xe isotope ratios [1]. Over the past few years a number of upgrades have been made to RELAX, including installation of a new ionization laser system, installation of new microchannel plate (MCP) detectors, and development of new software for both data collection and reduction.

In its current configuration, the blank of the spectrometer is about 1000 atoms ^{132}Xe (3.7×10^{-17} cc STP ^{132}Xe). Before recent installation of a new detector, a detection limit of about 950 atoms of ^{132}Xe was estimated [2], based on 3 times the standard deviation of the blank. The lifetime against ionization is currently about 120 s.

Reproducibility: A 200 μg sample of Allan Hills 77307, which had been neutron irradiated for I-Xe dating, proved to be an ideal sample to investigate the reproducibility of RELAX. Large amounts of ^{128}Xe and ^{129}Xe were released at low temperatures when this sample was step-heated, but once this had been liberated, the higher temperature heating steps released large amounts of a trapped component. Analyses were consistent with a uniform composition. The mean isotope ratios of ~60 consecutive analyses of this component yielded delta values in excellent agreement with, and more precise than, the corresponding values for Q-Xe reported by Busemann *et al.* [3] (Fig.1).
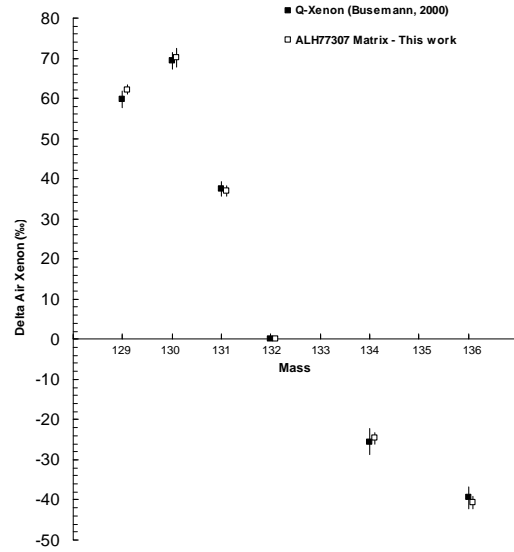

Figure 1: Mean delta values from ~60 analyses of the trapped component in a sample of irradiated ALH77307. For the major isotopes precision is better than 1 permil.

Genesis Sample: Initial measurements have been made on one Si sample, JSC 60052, an almost square piece about 34.5 mm^2 (~6mm × ~ 6mm).

Gas was extracted from the sample by step-heating using a CW IR laser ($\lambda = 1064$ nm). Initially the beam was defocused to cover the whole target, and the sample was heated for 1 minute at each step. Once the maximum current setting of the laser had been reached the beam was focused and rastered over the target during the 1 minute heating. This gives a higher power density while ensuring the whole sample is heated. It did not prove possible to melt the Si targets with the maximum power available from the IR laser, however we are confident that all the gas was extracted from the samples as the maximum temperature heating step was repeated with the focused beam for longer times until no further gas was released. In total, 11 step heating steps yielded significant quantities of gas, which was consistent with a uniform composition.

Initial calculations of the mean ratios are given in Table 1, and the mean delta values are shown in Fig 2. Isotopes ^{126}Xe and ^{128}Xe are affected by an interference caused by non-resonant photo-ionization of a hydrocarbon that has not been corrected for in the data as yet.

While these data are preliminary and should be approached cautiously, it is intriguing that Fig 2B suggests a linear mass fractionation of solar Xe to produce the isotopic ratios of the terrestrial atmosphere when isotopes of mass 130 to 136 are considered. This is in contrast to the non-linear fractionation implied by the accepted composition of the solar wind [4].

3.85×10^5 atoms ^{132}Xe (1.47×10^6 atoms total Xe) were released from the sample, which corresponds to about 1.12×10^6 atoms ^{132}Xe cm^{-2} (4.26×10^6 atoms total Xe cm^{-2}). The blank incorporated in the Si was determined to be about 3.03×10^5 atoms ^{132}Xe cm^{-2} (1.13×10^5 atoms total Xe cm^{-2}) from the analysis of a piece of non-flight CZ-Si of comparable size to the flight sample analysed here. From this we calculate that 8.13×10^5 atoms ^{132}Xe cm^{-2} or 3.13×10^6 atoms total Xe cm^{-2} are due to solar wind implanted in the Si. This agrees well with the predicted 2 year fluence value of 3×10^6 atoms total Xe cm^{-2} [5].

Further work is required to tailor the methods of data reduction to this particular dataset, and many more analyses hold the possibility of sub-permil determinations of the isotopic composition and will allow the reproducibility of the distinction between these data and the accepted solar wind composition to be investigated.

Table 1: Preliminary mean ratios to ^{132}Xe for the major Xe isotopes for Genesis sample JSC60052. Numbers in parentheses represent the uncertainties in the last significant figure.

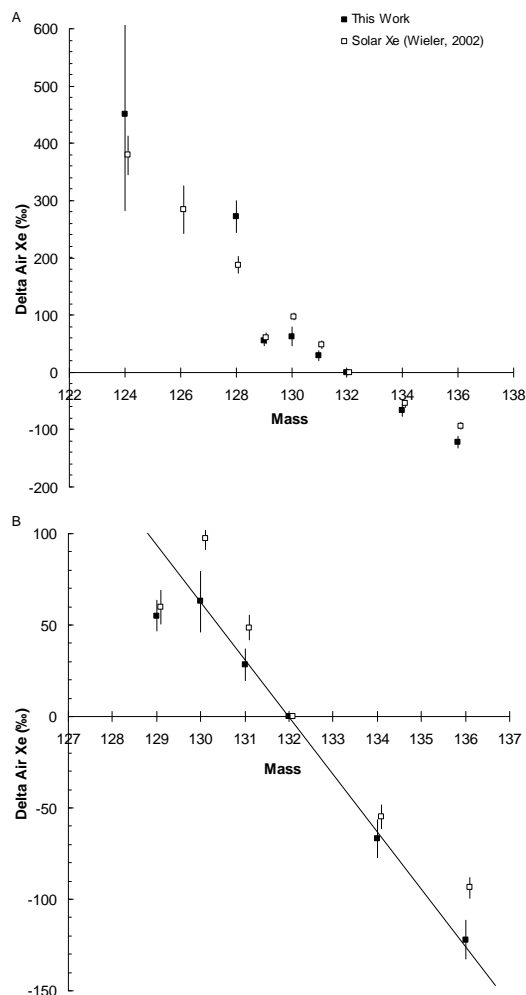| Isotope	Ratios to ^{132}Xe	
	This work	Solar wind [5]
^{129}Xe	1.055 (8)	1.042 (9)
^{130}Xe	0.160 (2)	0.166 (1)
^{131}Xe	0.813 (6)	0.827 (5)
^{134}Xe	0.355 (4)	0.367 (3)
^{136}Xe	0.272 (3)	0.299 (2)

Figure 2: Preliminary delta values for the Genesis sample JSC60052 illustrating consistency with linear mass fractionation.

References: [1] Gilmour, J. D. et al., (1994) *Rev. Sc. Instrum., 65,* 617-625. [2] Crowther, S. A. et al., (2006), *LPSC XXXVII*, Abstract # 1942. [3] Busemann, H. et al., (2000) *MAPS, 35,* 949-973. [4] Wieler, R., (2002) *Rev. Mineral. & Geochem., 47*, 21-70. [5] Burnett, D. S. et al., (2003) *Space Sci. Rev., 105,* 509-534.