I-Xe dating of mineral separates and integration with the Mn-Cr timescale. A. Busfield and J. D. Gilmour, SEAES, University of Manchester, Oxford Road, Manchester, M13 9PL, UK (a.busfield@manchester.ac.uk).

Introduction: The ^{129}I-^{129}Xe dating technique has recently been successfully applied to dating of mineral separates and individual mineral grains [1], where it has been shown to correlate with results from other dating techniques (e.g. [2]). The mineral separate approach to I-Xe dating allows the development of a more detailed understanding of the distribution and evolution of iodine and xenon in the early solar system than is possible from whole rock studies. This work extends the database of mineral separates dated by the I-Xe technique and incorporates these data into a combined chronology of the early solar system.

Experimental: The iodine-xenon technique involves irradiation of the sample to convert a proportion of ^{127}I to ^{128}Xe*. During subsequent noble gas analyses the ^{128}Xe*/^{129}Xe* ratio is obtained and can be converted to ^{129}Xe*/^{127}I by reference to the irradiation monitor Shallowater. This value is equivalent to the initial ^{129}I/^{127}I ratio at the time of last isotopic closure because all ^{129}I has decayed to ^{129}Xe over the timescale of the solar system. In this work negative ages indicate time after Shallowater.

Samples were irradiated at the Penubaba Reactor, South Africa and analyses of Shallowater aliquots revealed that the ^{127}I to ^{128}Xe* conversion factor was 6.3×10^{-5}. Xenon measurements were made using the RELAX (Refrigerator Enhanced Laser Analyser for Xenon) time-of-flight mass spectrometer in which gas is released by laser stepped-heating [3].

The meteorites studied in this work were Indarch (EH4), Khairpur (EL6), Khor Temiki (aubrite), Itqiy (enstatite achondrite) and Asuka 881394 (eucrite). Separates were obtained by crushing and hand-picking under a microscope in clean conditions. Phase identification and abundances were determined by electron probe and SEM analyses.

Mineral Separates:

Indarch. Three separates were obtained from Indarch. IndB was dominated by enstatite, IndC contained enstatite and metal and IndD represented the bulk rock. I-Xe data are shown in Figure 1a. Each separate displays scatter in the data and no single age is defined. However, when the data are combined a maximum, corresponding to an I-Xe age of 0.2 Ma (before Shallowater) is seen (Figure 1a), assuming the trapped ^{129}Xe/^{132}Xe = Q-Xe (1.04). The scatter in the data is observed within a single phase (pyroxene) and may represent the range in chondrule ages, either of formation or of alteration before incorporation into the most recent parent body.

Khairpur. I-Xe data are displayed in Figure 1b. KPA contained more metal than KPB and again no single age is defined. The data do not lie along a single mixing line if the trapped component is assumed to be Q-Xe. However, a maximum is defined, corresponding to an age of -4.2 Ma, if the composition of the trapped component is taken as 1.12. Unlike Indarch examination of the ^{131}Xe*-^{127}I release pattern suggests that scatter in the data is associated with the presence of secondary phases which may be responsible for disturbing the age spectrum.

The ages obtained here for enstatite chondrites are in good agreement with those of [4] who found a difference in whole rock ages of 3.89 Ma. [5] also observed a Mn-Cr age difference of ~4 Ma between these meteorites.

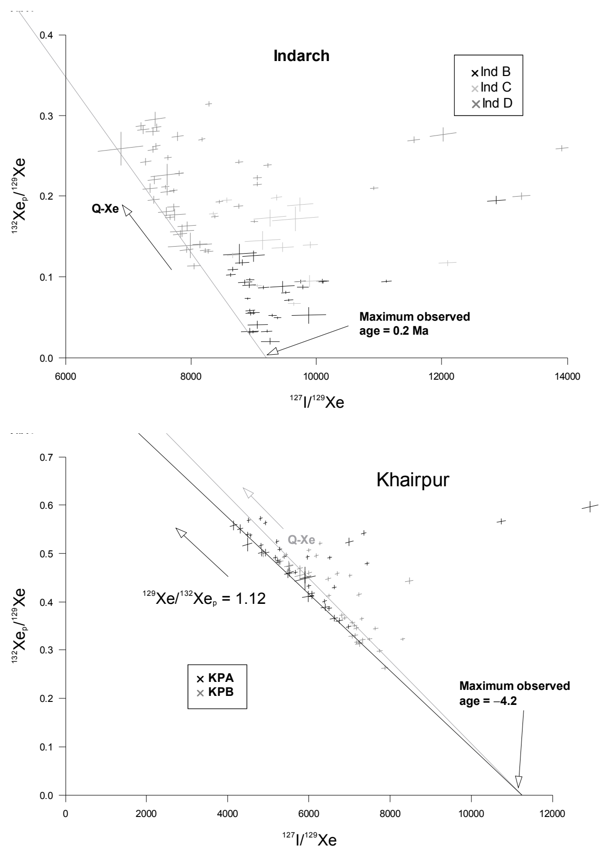

***Figure 1.** 3-isotope plots of Indarch and Khairpur data*

Khor Temiki. Only one separate was obtained from this meteorite which consisted of very pure enstatite chips. The inferred trapped ^{129}Xe/^{132}Xe ratio is exceptionally low suggesting that the I-Xe system has been disturbed by shock. This is not unexpected as Khor Temiki is known to contain clasts which have been darkened by extreme shock. It may still be possible to obtain some chronological information from these data. If it is assumed that the enstatite formed in the presence of Q-Xe then a model age of -0.06 Ma is obtained. Alternatively, if it is considered that the release with the highest initial $^{129}I/^{127}I$ ratio has been least disturbed by shock then an age of -1.5 Ma is calculated.

Itqiy. This metal-rich, enstatite achondrite was split into three separates, ItA (metal), ItB (enstatite+metal) and ItC (enstatite). No $^{129}Xe^*$ excess was observed in ItA. High temperature releases from ItB and ItC are dominated by trapped xenon but imply an age of -2.6±2.6 Ma (Figure 2). This age is associated with extensive recrystallisation and equilibration of enstatite observed by [6].

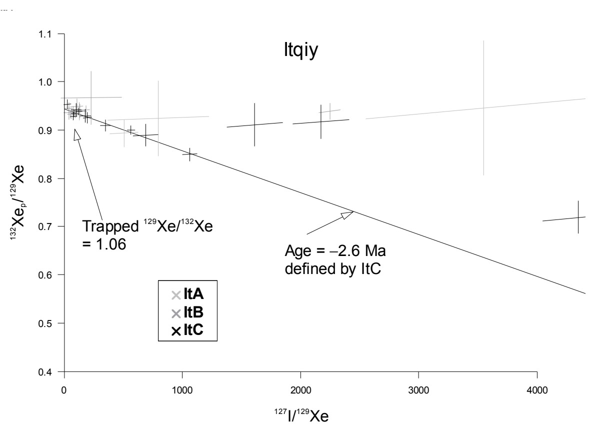

Figure 2. *3-isotope plot of high temperature Itqiy data*

Asuka-881394. The coarse grain size of this eucrite meant that the two separates obtained by hand-picking were relatively pure. They consisted of AsA (feldspar) and AsB (pyroxene). Both separates had much lower iodine concentrations than in the enstatite meteorites. There was no $^{129}Xe^*$ observed in AsB. Although no $^{129}Xe^*/^{127}I$ correlation was seen in AsA some $^{129}Xe^*$ was released in the highest temperature steps. The release pattern is indicative of $^{129}Xe^*$ loss by thermal metamorphism and the maximum $^{129}Xe^*/^{127}I$ ratio of 3.8×10^{-5} provides a time for onset of closure to Xe before −25 Ma.

^{53}Mn, ^{26}Al and ^{146}Sm record very early ages for this meteorite of 4563 Ma, 4564 Ma and 4562 Ma respectively, corresponding to formation or very early metamorphism [7]. I-Xe was clearly more susceptible to resetting and indicates the long timescale over which the eucrite parent body was evolving.

Combining ^{129}I and ^{53}Mn chronometers: Ages obtained from the I-Xe dating technique are calculated relative to a standard (Shallowater). For robust interpretation of the I-Xe chronometer it would be advantageous to be able to compare it with results from another chronometer with similar precision, such as the ^{53}Mn-^{53}Cr technique. Various calibrations have previously been suggested to achieve this [8], which rely on calibrating the chronometers in a single object such as the H-chondrite Ste. Marguerite. Recently an alternative technique has been proposed in which a least squares regression was used to calculate the age of Shallowater relative to the ^{53}Mn standard LEW86010 to be 6.7 Ma [9]. This calibration allows all I-Xe and Mn-Cr ages to be compared. Figure 3 shows the I-Xe and Mn-Cr ages of 'asteroid belt' meteorites, relative to LEW86010. Also shown is a slope 1 line which passes through these meteorites, indicating that in the asteroid belt region these chronometers behaved coherently. In contrast the enstatite chondrites Indarch and Khairpur are significantly offset from this line. It has been proposed that ^{53}Mn was radially heterogeneous in the early solar system [5] and application of a correction for this heterogeneity causes the E-chondrite ages to move onto the slope 1 line (Figure 3). This result firstly lends support to the radial heterogeneity model and, secondly, demonstrates how combining chronometers can lead to an improved understanding of the distribution and behaviour of chronometers in the early solar system.

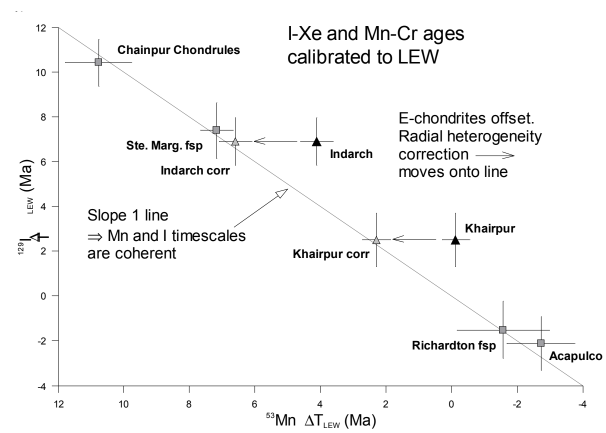

Figure 3. *Comparison of I-Xe and Mn-Cr ages relative to LEW86010*

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Acknowledgements: Thanks to Sara Russell at the Natural History Museum, London for provision of samples. This work was funded by PPARC.