THE I-Xe SYSTEM AND THE EARLY HISTORY OF THE LL CHONDRITE PARENT BODY. M. J. Filtness, S. A. Crowther and J. D. Gilmour, , School of Earth, Atmospheric and Environmental Sciences, The University of Manchester, Oxford Road, Manchester, United Kingdom, M13 9PL. Michal.filtness@postgrad.manchester.ac.uk.

Introduction: The 16 Ma half life of ^{129}I makes the I-Xe chronometer ideal for investigating the evolution of planetesimals over the first 50-100 Ma of solar system history. Several previous studies have examined the I-Xe record of the primitive LL chondrites; results from Semarkona [1], Chainpur [2,3] and Parnallee [4] are available in the literature. In this study, we have focused on two other primitive LL chondrites, Bishunpur and Krymka. One goal of our study was to examine whether the I-Xe record of Bishunpur was consistent with the widespread evidence of extinct ^{26}Al in its chondrules [5], or if the I-Xe system has been reset. We also examined a clast from Krymka that may represent a fragment of a previous generation of planetesimals [6]. Overall, by extending the database of analyses we hope to better understand the evolution of the LL chondrite parent body.

LL chondrites: The LL chondrites Semarkona (3.0), Krymka (3.0/3.1), Bishunpur (3.1) and Chainpur (3.4) are among the most primitive ordinary chondrites [7]. Both Semarkona and Bishunpur appear to have suffered *in situ* hydrous alteration – this has resulted in the destruction of all but the most magnesian mafic minerals in Semarkona [7]. Primary sulphides such as troilite have been partially changed into phyllosilicates and Ni-rich pyrrhotite. The matrix of Krymka is primarily made of opaque silicates and its composition is uniform and significantly more oxidized than that of Bishunpur and Chainpur [8]. Chainpur is the most equilibrated of the four samples [8]. Based on thermoluminescence sensitivity, it was reported that Bishunpur is less primitive and unequilibrated than Krymka [9]. However, it was also noted that Krymka and Bishunpur contained some recrystallized matrix, but Chainpur did not [8]. It seems that classifying the samples according to a trend of increasing processing is non-trivial.

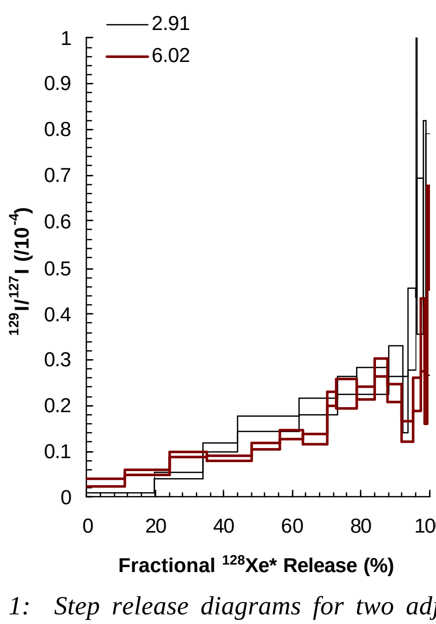

Fig. 1: Step release diagrams for two adjacent chondrules from a section of Bishunpur. Consistent ratios obtained after ~80% release of ^{128}Xe correspond to ages 40 Ma after Shallowater. Both show marginal evidence of an earlier event at higher release temperatures.*

Method: The principles of I/Xe analysis have been recently described [10]. Our samples (3 Bishunpur chondrules, 4 Krymka chondrules and 2 fragments of the Krymka clast) were loaded into a sealed tube alongside aliquots of the irradiation standard, Shallowater enstatite, and exposed to a thermal neutron fluence. Xenon was extracted using laser step heating [3] and isotopic analysis performed using the resonance ionization mass spectometer RELAX (Refrigerator Enhanced Laser Analyser for Xenon) at the Univeristy of Manchester [11]. Data analysis revealed some variation with tube location in the ^{128}Xe*/^{129}Xe* determined for Shallowater enstatite, so results reported here should be considered provisional within ~3 Ma pending analysis of the remaining aliquots of the Shallowater standard.

Results: All samples yielded a consistent ^{129}Xe*/^{128}Xe* ratios over a range of consecutive, high temperature releases that can be interpreted as corresponding to an initial iodine ratio.

Two Bishunpur chondrules exhibited a trend of increasing ^{129}Xe*/^{128}Xe* with temperature, ultimately converging on the same value. These samples were in close proximity in a parent section, suggesting that this records a parent-body process (Fig. 1). The third chondrule, from the same section, yielded no clear isochron, but reached a maximum ^{129}Xe*/^{128}Xe* ratio equivalent to an age ~8 Ma after Shallowater..

Krymka chondrules all yielded isochrons corresponding to -9.0 ± 1.6, -11.1 ± 3.0, -14.2 ± 0.9 and -27.7 ± 2.3 Ma (negative numbers denote ages later than Shallowater). One fragment of the clast yielded an isochron corresponding to resetting at -22.6 ± 3.2 Ma.

Discussion: In contrast to clear evidence for live ^{26}Al in LL chondrite chondrules, our data suggest that the I-Xe system has been reset relatively late in the history of the early solar system. In Fig 2, we summarise I-Xe data for the most primitive LL chondrites showing consistent evidence for late processing on this parent body. There is little evidence of a trend with increasing petrologic type, though such a trend may become more apparent if and when a wider range of samples have been analysed. In the light of the close agreement observed for our Bishunpur samples, it is possible that such variation as is apparent may reflect different sampling strategies, although 2 separate studies of Chainpur obtained similar results [2,3].

In Figure 3 we present accumulated data for the LL chondrites mapped against an absolute timescale based on assigning an age of 4563.3 Ma to closure of the I-Xe system in Shallowater [12]. It seems that 80% of the events recorded by the I-Xe system on the LL chondrite parent body occurred within the first 20-25 Ma of solar system evolution, with a declining rate over the ensuing 10s of Ma. This contrasts with the relatively sharp isochronism among chondrules of the enstatite [12] and ordinary [13] chondrites. In addition, it postdates the reasonable timescales over which radioactive decay can cause thermal resetting. We speculate that these primitive meteorites retained sufficient volatiles to remobilise iodine host phases during impact events, and that this figure may serve as a proxy for the declining frequency of impact events in the early solar system.

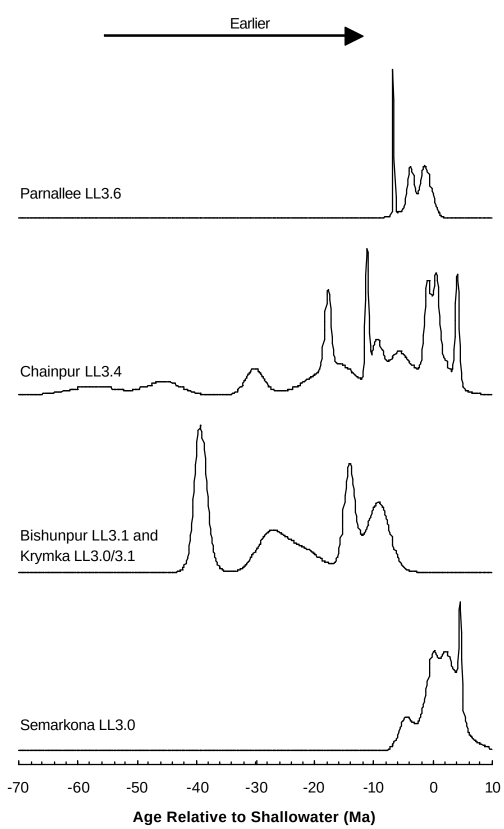

Fig. 2. Summary diagram of LL chondrite I-Xe data. Each age and associated error has been used to create a unit-area Gaussian, these have been summed together for each meteorite (curves are normalised to produce the same maximum value). Data from this work and refs [1] (Semarkona), [2,3] (Chainpur) and [4] (Parnallee).

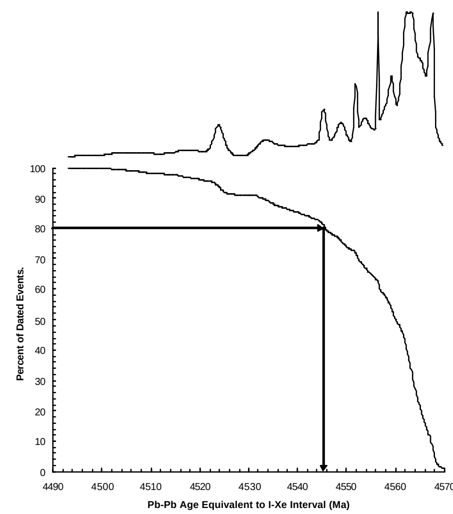

Fig.3. Summary diagram of equivalent Pb-Pb ages derived from I-Xe intervals for 5 separate studies of LL chondrites (top), and cumulative fraction of dated entities (bottom). The procedure adopted is as for Fig. 2, and each date has been assigned equal weight.

References: [1] Swindle T. D. *et al.* (1991) *GCA 55*, 3723- 3734. [2] Swindle T. D. *et al.* (1991) *GCA 55*, 861-880. [3] Holland G. *et al.* (2005) *GCA 69*, 189-200. [4] Gilmour *et al.* (2000) *MAPS 35*, 445-455. [5] Mostefaoui S. *et al.* (2000). *GCA 64*, 1945-1964. [6] Sokol A. K. *et al.* (2006) *MAPS 41*, A164 [7] Alexander, C, M, O'D. *et al.* (1989). *GCA 55*, 3045-3057. [8] Rambaldi, E. R. *et al*. (1984). *GCA 48*, 1885-1897. [9] Sears, D, W. *et al*. (1980). *Nature 287*, 791-795. [10] Gilmour J. D. *et al.* (2006) *MAPS 41*, 19-31. [11] Gilmour et al. (1994) *Rev. Sci. Instrum. 65*, 617-625. [12] Whitby J. A. *et al*. (2002) *GCA 66*, 347-359. [13] Gilmour J. D. *et al.* (1994) *MAPS 30*, 405-411.