CALIBRATION OF THE I-XE SYSTEM AND APPLICATION TO IMPACT PROCESSING RATES.
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Introduction: The iodine-xenon dating system relies on the decay of short-lived $^{129}$I in the early solar system [1]. $^{129}$I/$^{127}$I ratios are determined from $^{129}$Xe/$^{128}$Xe ratios after samples have been neutron irradiated (to convert $^{127}$I to $^{128}$Xe). To allow calculation of formation intervals between samples subjected to different neutron fluences in different irradiations, the conversion efficiency must be monitored. To this end, samples of the anomalous aubrite Shallowater are included in each irradiation, and I-Xe ages are reported relative to closure of the system in this sample [2]. Absolute calibration of the system (against the Pb-Pb system) thus corresponds to determining an absolute age for closure of Shallowater enstatite.

Calibration: It has not yet proved possible to determine a Pb-Pb age for Shallowater enstatite itself. Initial proposed calibrations relied on analyses of phosphate grains in both systems [2, 3]. Subsequently, calibrations have been based on comparison of a range of samples in which both Pb-Pb and I-Xe data are available, latterly with outlier rejection [4,5]. Most recently, Pravdivtseva et al. contributed a precise I-Xe age for a chondrule from the CB chondrite HaH 237 [6]. They combined this with literature data, updating Pb-Pb ages for the effects of uranium isotope variation, and proposed a new Shallowater closure age of 4562.4 ± 0.2 Ma.

Two further samples are now available to contribute to this calibration. I-Xe data from the anomalous eucrite Ibitira [7] and from the ungrouped acondhrite NWA 7325 [8] can be combined with literature Pb-Pb data [9, 10, respectively]. In addition, we update the Pb-Pb age for the earliest chondrules [11] (which can be compared to the earliest chondrule I-Xe age). These additions to the dataset of Pravdivtseva et al. [6] allow identification of one outlier – a datum relying on the association of a Ste Marguerite (H4) feldspar I-Xe age and phosphate Pb-Pb age. Elimination of this point leads to an MSWD for the fit to 9 data points of 1.5 and a Shallowater closure age of 4562.7 ± 0.3 Ma (1 σ, the error has been scaled by the MSWD to acknowledge the scatter of the data around the line).

Application: As noted above, the earliest chondrule I-Xe ages are consistent with the earliest reported Pb-Pb ages and, therefore, contemporaneous with CAI formation [11]. Literature bulk $^{129}$Xe*/I ratios from whole-rock samples of type 6 chondrites are lower than those for petrologic types 4 and 5, suggesting resetting of the system during high temperature metamorphism in at least some minerals [8]. In addition, the I-Xe ages of mineral separates from type 4/5 H chondrites indicate that resetting of the chronometer in magmatic phases occurs close to the peak metamorphic temperature [12]. However, I-Xe ages from adjacent chondrules in the most primitive meteorites range over the first ~80 MyR of solar system history (and include the earliest I-Xe chondrule ages, as well as the latest) [13] and the I-Xe system in low closure temperature sites in nanodiamonds appears to have closed relatively late [14]. These observations suggest a distinct mechanism affected the I-Xe system in Type 3 material.

On the basis that setting/resetting the system requires an input of energy, we propose that impact processes is the most likely cause of events that set the I-Xe chronometer in these primitive samples, and attempt to constrain how the rate at which this process occurred varied with time. Models of data from the Chainpur (LL3.4) [15,16] chondrite where events that can set the I-Xe system occur at a constant rate are a poor match to the data. In contrast the data can be modeled when the rate of such events declines exponentially with a half life of 15-20 Myr, and with a power law (n°) decline. In the latter case, good matches to the data require the possibility that an early event can be overprinted by a later event, and the best fits are achieved when 1.5 < n < 2.0. We propose that the mechanism involved may be associated with compaction as modeled by Bland et al. [17].

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