NEW I-Xe AGES OF CHONDRULES FRON THE ORDINARY L4 CHONDRITE SARATOV.

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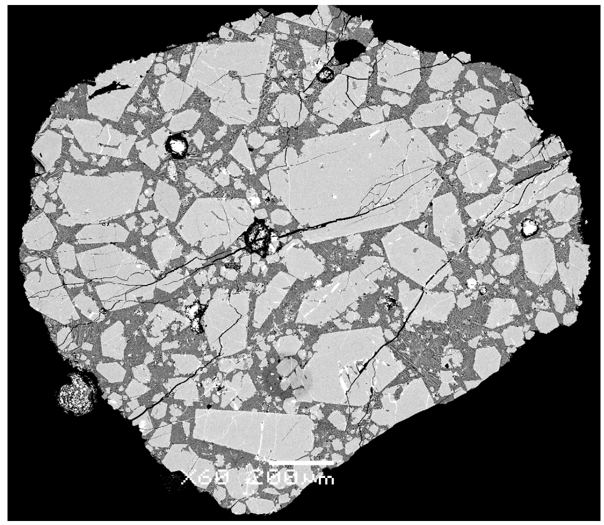
Chondrules from the ordinary chondrite Saratov (L4), were studied as a part of the ongoing investigation of I-Xe and Pb-Pb systems in chondrules from the ordinary chondrites covering different types and methamorphic grades. In the course of this work we analyze and report I-Xe ages for chondrules from Unnamed Antarctic LL3.6 [1, 2], Elenovka L5 [3], NWA 267 H4 [4], and Richardton H5 [5]. Considered together with the previously reported I-Xe ages for Bjurbole L4 [6], Semarkona LL3.0 [7], Chainpur LL3.4 [8, 9], Parnallee [10] these collectively form a consistent picture for each type of ordinary chondrites.

The I-Xe ages of NWA267 (H4) and Richardton (H5) chondrules are in good agreement, with the lower metamorphic grade NWA267, slightly older. Ordinary L chondrites Bjurbole (L4) and Elenovka (L5) follow the same trend: I-Xe ages of the lower methamorphic grade Bjurbole (L4) chondrules cluster within 1.5 Ma interval while the I-Xe ages of individual Elenovka (L5) chondrules differ by 27 ± 10 Ma. A similar trend in the I-Xe ages is observed in the LL3.0 – LL3.6 meteorites, with chondrules of higher metamorphic grade being younger and characterized by apparently longer evolution times between closure in high- and low-temperature iodine host phases (Figure 1).

With a new calibration for the absolute age of the Shallowater reference based on experimental observations [5] and a broad range of comparisons of I-Xe ages with those provided by other chronometers [11, 12], the absolute I-Xe ages of the oldest chondrules (Semarkona) fall into the time interval for CAI formation 4567.2 ± 0.6 Ma [13], and could reflect chondrule formation, as was suggested by Swindle [7], rather than alteration. In this case the chondrules formed simultaneously with CAI's or shortly thereafter (uncertainties for old Semarkona ages are rather high). Krot et al. [14] argued the entire range of I-Xe ages in the type 3 ordinary chondrites reflects long aqueous alteration.

Clearly, chondrule type should be considered when question of primary or secondary origin of I-Xe ages is addressed. With this in mind, each chondrule intended for the comparison I-Xe – Pb-Pb study was separated into a few fragments. Thus, different fragments from the same chondrule could be analyzed by I-Xe and Pb-Pb chronometers, with one fragment saved for the mineralogical studies and identification of iodine host phases by *in situ* laser extraction. Fragments designated for I-Xe analyses were irradiated by thermal neutrons in evacuated quartz ampoules. The Xe isotopic composition in each chondrule was measured in step-wise extractions following the same protocol to ensure proper comparison of the results.

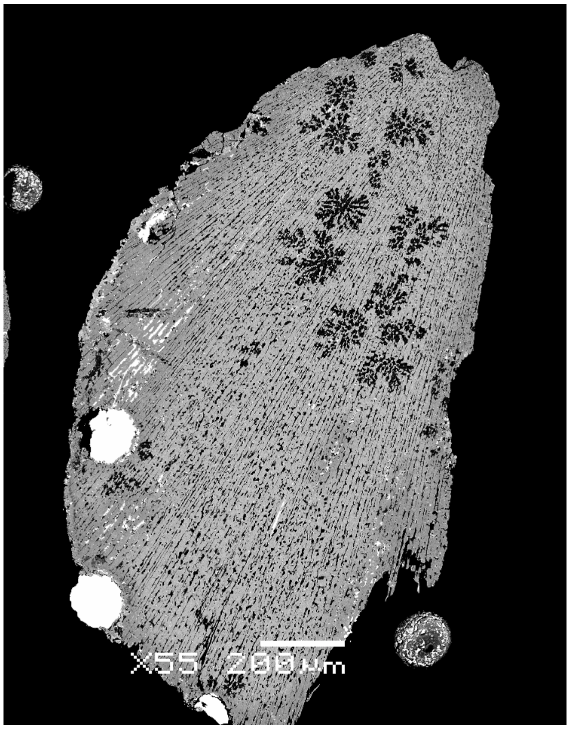


Saratov chondrule #1

Saratov #1 is a porphyritic chondrule, with euhedral olivine phenocrysts, surrounded by microcrystalline mesostasis. The apparent isochron corresponds to an age 4551.0 Ma, –12.2 ± 0.9 Ma younger than the Shallowater standard. Since olivines do not contain radiogenic xenon, the apparent I-Xe age of this Saratov chondrule probably reflects a secondary event, recorded in mesostasis. The I-Xe isochron begins at 1300 °C. Most of the iodine, converted into radiogenic ^{128}Xe after nutron irradiation, is released in the low temperature extraction steps, suggesting redistribution of iodine during secondary methamorphic events.

Saratov #2 is a nonporphyritic radial pyroxene chondrule. According to Gooding and Keil [15] this type most clearly preserves the original tensional surface of the molten chondrule. The apparent isochron corresponds to an age 4563.2 ± 0.9 Ma, same as the Shallowater standard. Most of the radiogenic ^{128}Xe and ^{129}Xe are correlated, apparent isochron formed by extraction temperature steps starting from 1300 °C.

	weight, mg	age, Ma	^{*129}Xe 10^{-12} cm^3STP/g
#1	1.08	-12.2 ± 0.9	61.9
#2	1.54	0.02 ± 0.9	39.9



Saratov chondrule #2

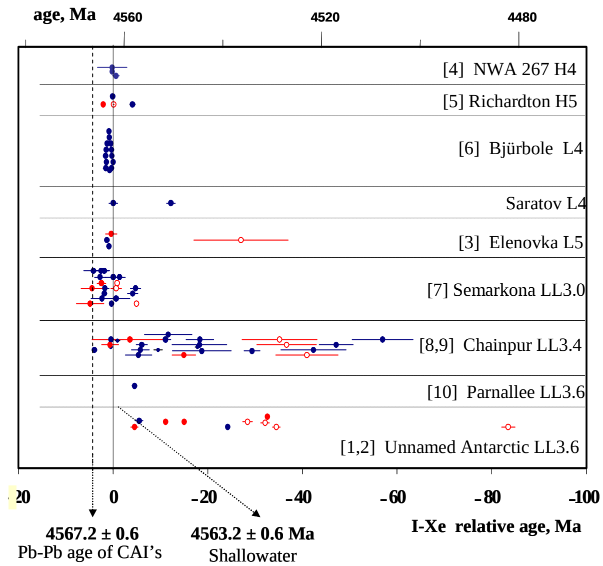


Fig.1. The I-Xe ages of chondrules from ordinary chondrites. In red is shown ages from chondrules with two iodine-carrier phases. Solid red symbols represent high temperature apparent isochron ages, open red symbols – low temperature ages.

The I-Xe ages of Saratov chondrules form a consistent picture when considered together with the I-Xe ages of Elenovka L5 and Bjurbole L4 (Fig.1). The more pristine Saratov chondrule #2 is older than chondrule #1 and in good agreement with the older ages of Bjurbole and Elenovka.

The I-Xe chronometer mostly reflects secondary processes. If so, I-Xe ages of chondrules indicate longer or multiple secondary procceses for higher methamorphic grade meteorites. Older chondrule ages cluster tightly at 1.8 ± 1.8 Ma after CAIs and are consistent with Pb-Pb and Al-Mg estimations of the time of chondrule forming event. For the Pb-Pb chronometer, this conclusion is based on the high-precision Pb-Pb ages but for CAI's and chondrules from different meteorites [13]. Recent $^{26}Al/^{26}Mg$ data indicate possible simultaneous formation of CAI's and chondrules in Allende [16].

The cluster of older I-Xe ages indicates that these may well provide the chondrule formation time, but exact knowledge of the iodine carrier phase is required.

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