NORTHWEST AFRICA 6486 AND TSAREV: NEW INSIGHTS INTO THE CATASTROPHIC EVENT ON THE L-CHONDRITE PARENT BODY.

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Introduction: L chondrites are the major meteorite class that shows the most frequently disturbed radiometric clocks. Radiochronometry of L chondritic meteorites indicates a single asteroid breakup event at 470 ± 6 Ma [e.g., 1-3]. We performed high-resolution ^{40}Ar-^{39}Ar stepwise heating analyses on the whole rock samples of the meteorites Northwest Africa 6486 **(**NWA 6486, K-rich impact melt rock of L-chondrite composition; analysed by Ar-Ar dating for the first time) and Tsarev (L5, S4-5, W1). The latter contains numerous achondritic inclusions (AIs) of different texture and composition [4 and ref. therein]. Two samples (from inner light and outer darker zones) of a large unique light AI recently discovered in Tsarev were also studied by ^{40}Ar-^{39}Ar dating. The mineralogical and geochemical description of this AI likely representing L-chondrite impact melt is reported in [4; AI#1].

Results and discussion: In NWA 6486 the major Ar release occurs below 1000 °C. The three-isotope diagram $^{40}Ar/^{36}Ar_{trap}$ vs. $^{39}Ar/^{36}Ar_{trap}$ indicates the presence of excess Ar. The isochron for the temperature extractions 560-1100 °C reveals trapped Ar with $(^{40}Ar/^{36}Ar)_{trapped}$ ratio of 522 ± 59. The correction for this trapped argon composition results in a plateau age of 453 ± 8 Ma (1σ; ~87% ^{39}Ar release). The value of trapped argon composition and respectively corrected age depend on the selection of isochron data points. E.g., if the 1100 °C extraction is excluded, the temperature extractions 560-1070 °C yield $(^{40}Ar/^{36}Ar)_{trap}$ =488±69 and a plateau age of 477 ± 10 Ma (1σ; ~83% ^{39}Ar release). Both age values of NWA 6486 completely agree (within 2σ) with the time of the catastrophic event on the L-chondrite parent body 470 Ma ago. Later shock metamorphism (according to mineralogical and petrographic data) did not affect the K-Ar system of NWA 6486 because short-term heating was weak. The K concentration of 0.5217 wt% determined by Ar-Ar dating is identical to XRF K value.

In the Tsarev samples K contents are 0.0481 - 0.0751%. The Ar release patterns are complex. A significant fraction of Ar is degassed at high temperatures >1000 °C. The 3-isotope plots of $^{40}Ar/^{36}Ar_{trap}$ vs. $^{39}Ar/^{36}Ar_{trap}$ show the presence of trapped components in all samples. Age spectra uncorrected for trapped excess argon are saddle-shapped with minimum apparent ages of about 700 Ma for host and 500 Ma for the AI samples representing upper age limits of last impact resetting. Correcting the age spectrum of Tsarev host material for the trapped components identified with three-isotope diagram of $^{36}Ar_{tr.}/^{40}Ar$ vs. $^{39}Ar/^{40}Ar$ [$(^{40}Ar/^{36}Ar)_{tr.}$=469±15 for 700-860 °C, 247±18 for 1180-1260 °C, and ~1700 for 1360-1550 °C] doesn't result in a precise definition of the last total reset, but indicates a ~500 Ma age, relating the Tsarev meteorite age to the large-scale impact event on the L-chondrite asteroid at 470±6 Ma. A more accurate age estimate was obtained for two AI samples. The ages of low temperature extractions corrected for trapped components determined with isochron plots [$(^{40}Ar/^{36}Ar)_{tr.}$=287±11 for 720-880 °C of the AI inner zone sample and $(^{40}Ar/^{36}Ar)_{tr.}$ =424±23 for 700-950 °C of the AI outer zone sample] display partial plateaus with ages of 451±7 Ma (1σ; ~20% ^{39}Ar release) and 457±7 Ma (1σ; ~33% ^{39}Ar release), respectively. Consequently, the K-Ar system of the Tsarev meteorite as well as of most L-chondrites recorded the time of asteroid breakup event. The previous study on ^{40}Ar-^{39}Ar dating of Tsarev [5] reported a higher age of 650±50 Ma, likely due to age correction for atmospheric trapped Ar composition intead of presicely determined $(^{40}Ar/^{36}Ar)_{tr.}$.

The ages of high temperature extractions (>1240 °C) of the AIs, corrected for trapped Ar are about 3-3.5 Ga. Two scenarios are possible: 1) the melt inclusion was formed before the catastrophic event during which its K-Ar system was only partially reset (usually K-Ar systems of impact melt rocks are retentive to subsequent event [6]) or 2) it was formed during the catastrophic event but contains significant amount of inherited Ar. The first scenario is more likely as the crystallization rate of this melt inclusion was relatively slow (judging by the significant size of olivine grains and the fract that there was segregation of metal-troilite liquid) that implies an almost complete loss of radiogenic argon during the formation of the AI resulting in a broad age plateau.

Summary: ^{40}Ar-^{39}Ar dating of NWA 6486 and Tsarev allowed to reveal excess Ar compositions and link them to intense shock metamorphism 470 ± 6 Ma ago. The light AI of Tsarev was likely formed before this catastrophe.

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