THE CHELYABINSK METEORITE: VARIABLE SHOCK EFFECTS RECORDED BY THE ^{40}AR-^{39}AR SYSTEM

E.V. Korochantseva[1,2], A.I. Buikin[1,2], J. Hopp[2], C.A. Lorenz[1] and M. Trieloff[2,3]. [1]Vernadsky Institute of Geochemistry, Kosygin St. 19, 119991 Moscow, Russia. [2]Institut für Geowissenschaften, Universität Heidelberg, Im Neuenheimer Feld 234-236, 69120 Heidelberg, Germany. [3]Klaus-Tschira-Labor für Kosmochemie, Universität Heidelberg, Im Neuenheimer Feld 234-236, 69120 Heidelberg, Germany (e-mail: Mario.Trieloff@geow.uni-heidelberg.de).

Introduction: The Chelyabinsk meteorite (LL5, S4, W0) is a genomict breccia [1,2] with complex impact and thermal history [e.g., 3]. Here we report the results of high-resolution ^{40}Ar-^{39}Ar dating of light and dark lithologies with different shock levels [4] and impact melt filling the shock veins which occasionally show segregation of metal-silicate layers [1], and were quenched rapidly after injection to the cold host meteorite matrix [5] during the late impact event [6].

Results and Discussion: While the light lithology releases K-derived ^{39}Ar at 800-900°C typically of unshocked chondritic plagioclase, the dark lithology degasses at 1300-1400°C, which is frequently observed for more strongly shocked chondritic lithologies [7,8]. The impact melt argon release patterns can be explained by a superposition of dark and light lithologies. Using 3-isotope plots, we identified extraterrestrial trapped argon (i.e. with ^{40}Ar/^{36}Ar ratios different from atmospheric composition) in all samples, likely incorporated during impact event(s) on the LL chondrite parent body. Correction of the age spectra for trapped Ar results in the age order dark>impact melt>light lithology, consistent with previous studies [9,10]. We interpret impact melt ages as chronologically meaningless resulting from a superposition of dark and light lithology ages. As the material of shock veins was quenched very fast [5,6], ^{40}Ar loss was likely not complete [11]. The age of 2.0±0.1 Ga detected from the dark lithology high temperature age plateau (60% of ^{39}Ar release) is probably related to a large impact event that caused darkening of the chondritic material and made the Ar system more retentive to subsequent impact event(s). The latter degassed the light lithology to a large extent, yielding an age plateau (95% of ^{39}Ar release) with an age close to 0 Ga within uncertainty, likely representing the ~28 Ma event identified by [9]. Diverse ages of Chelyabinsk ranging from 4558 Ga (Re-Os dating; [12]) to ≤28 Ma (Ar-Ar dating; this study, [9]) require careful interpretation, particularly if different chronometers date geologically meaningful events, or just experienced various degrees of isotopic resetting [11].

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