^{40}AR-^{39}AR CHRONOLOGY OF NAKHLA AND LAFAYETTE: NEW ASPECTS

E. K. Korochantseva[1,2] , A. I. Buikin[1,2], J. Hopp[1], M. Trieloff[2]
[1]Institut für Geowissenschaften, Universität Heidelberg, Germany. E-mail: Mario.Trieloff@geow.uni-heidelberg.de. [2]Vernadsky Institute of Russian Academy of Sciences, Moscow, Russia.

Introduction: Nakhlites are usually considered to have a relatively simple geological history: igneous crystallization at ~1.3 Ga, aqueous alteration at <0.7 Ga, and ejection from Mars at ~11 Ma, possibly in a single impact event from a confined Martian surface terrain [1-4]. However, radiometric ages of individual nakhlites are not always concordant within uncertainties [1], and different petrogenetic scenarios have been suggested for the nakhlites [e.g. 5,6], which challenges the idea of a simple history. Here we present new Ar-Ar results for Nakhla and Lafayette, in particular the first Ar-Ar data on Lafayette mineral separates.

Results and Discussion: The ages of our Nakhla samples [bulk: 1418±18 Ma; CPx (a): 1399±28 Ma; CPx (b): 1389±35 Ma; mesostasis: 1364±54 Ma] are similar to the average Ar-Ar age of 1397±16 Ma by [7]. The low Ar-Ar age of Nakhla mesostasis of 1364±54 Ma is comparable within uncertainty to previously reported Ar-Ar ages [e.g., 8,9] which in turn are older than the age of 1270±10 Ma preferred by [1]. On the whole, our Nakhla samples show ages of ~ 1.4 Ga rather than ~ 1.3 Ga, similar to the Chassigny age by [10], to nakhlites MIL 03346 and Y-000593 [9] and to the high temperature extractions of Lafayette Px and bulk (this study). These ages are nevertheless consistent with close-in-time formation of nakhlites and Chassigny.

The ages of Lafayette clinopyroxene (1350±32 Ma) and whole rock (1306±7 Ma) are similar to previously reported Ar-Ar ages [8] and to the age of 1320±20 Ma compiled by [1]. However, our mesostasis age is quite different: 1093±22Ma (~8-97% of ^{39}Ar). The 200-300 Ma age difference implies that this meteorite was affected by a secondary thermal event: The age of the pyroxene dominated by glass-bearing magmatic inclusions represents the time of the entrapment of a magmatic liquid during early pyroxene crystallization. The mesostasis age of Lafayette has been reset during an unspecified secondary low grade, long lasting thermal event (e.g., impact melt sheet covering). Such an event admits the modification of mesostasis' isotopic characteristics, in particular the Ar-Ar system, while not affecting the K-Ar system of magmatic inclusions in Px and the original igneous texture of this rock. The age of the whole rock sample can be explained as superposition of mineral separate age spectra. This is the first evidence of a secondary thermal event in the history of Lafayette obtained from ^{40}Ar-^{39}Ar dating of mineral separates.

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