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AR-AR AGE AND HALOGEN CHARACTERISTICS OF NAKHLITE MIL 03346: RECORDS OF CRUSTAL PROCESSES ON MARS

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Introduction: MIL 03346 is one of the 7 members of the nakhlite group of Martian meteorites. The texture and mineralogy of this rock distinguishes it from other nakhlites [1]. Almost complete absence of crystalline plagioclase and ferro-hedenbergitic rim on pyroxene phenocrysts are some of the unique characteristics of this sample. Previous Ar-Ar age study of MIL 03346 reported a total Ar-Ar age of 1.37 Ga [2]. Recent reports have also highlighted presence of exotic minerals such as K-Cl-rich amphibole in melt inclusions in pyroxenes and olivines in MIL 03346 [3]. The non-chondritic halogen ratios in nakhlites have been interpreted as a result of fluid activity on Mars [4]. In the present study we have combined measurements of step-heating Ar-Ar ages with that of halogen contents. The work was conducted on ~12 mg whole-rock sample, sliced out from 1g allocation of MIL 03346,37 from the MWG to the senior author.

Results: The total Ar-Ar age is 1360 ± 2 Ma, similar to that reported by [2]. The main release of K is between 600-900 °C and there is a clear decrease in age with temperature, most likely recoil-related. The major Cl release occurs at around 1000 °C, is therefore separate from K release, and accompanies the release of Ca from pyroxene. The measured halogen contents in MIL 03346 are high relative to other SNC meteorites, only lower than Nakhla [4]. The halogen data for MIL 03346 are: Cl = 156 ppm; Br = 0.41 ppm; I = 0.014 ppm. The halogen ratios of Nakhla are slightly higher than MIL (Br/Cl = 0.002; I/Cl = 6x10^-5) but this may be explained by high Br/Cl and I/Cl ratios of martian weathering components in alteration veins in Nakhla olivines [5]. For comparison the martian regolith Br/Cl = 0.007 and I/Cl = 16x10^-5 [6] while shergottites are more similar at Br/Cl = 0.005; I/Cl = 3x10^-5.
The presence of K-Cl-rich amphibole in melt inclusions in pyroxene could explain the major Cl release at high temperature and some of the recoil effect if 39ArK moves from the melt inclusions into the pyroxene. Alternatively, 39ArK may also be released from the mesostasis glass but then we would also expect to see major Cl release at the same time. Between 600-850 °C 73% of total K and 26% of total Cl are released; >900 °C the values are 21% and 67%; so the majority of halogen release presumably comes from the melt inclusions. This indicates that the Br/Cl and I/Cl are representative of the melt (although they may originate from a soil contaminated melt).