SHEDDING LIGHT ON THE ORIGIN OF THE QUASICRYSTAL-BEARING KHATYRKA METEORITE

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Introduction: The CV_{ox}-type meteorite Khatyrka is the only known natural material to host Al-bearing alloys, including the two quasicrystals (QCs) icosahedrite [1] and decagonite [2]. Before their detection in what was later recognized to be meteoritic material [3], QCs had only been synthesized under highly controlled laboratory conditions. Icosahedrite was first found in samples of initially enigmatic origin, until an expedition to the Koryak mountains (Chukotka, Russia) succeeded in recovering new mm-sized grains of the Khatyrka meteorite, containing QCs, from a >7 ka old sediment bed [4]. A high-T, high-P, early solar system origin of the QCs has been suggested [5]. Here we constrain the pre-atmospheric size, cosmic-ray exposure and radiogenic ^{4}He retention age of Khatyrka, to shed more light on the history and origin of the only known natural QC-bearing material. We are currently doing He, Ne analysis also on Cu,Al-alloy samples from Khatyrka.

Methods: Six olivine grains from Khatyrka fragment #126 [2,5] were analyzed. Their forsteritic nature was confirmed by qualitative SEM-EDS analyses. Grain mass was calculated by multiplying the density of forsterite with volumes determined using a μCT scanner. After micromanipulator transfer, He, Ne was extracted by melting using an IR laser, and analyzed in a high-sensitivity, compressor-source noble gas mass spectrometer [6].

Results & Discussion: The He and Ne isotopic compositions of the grains plot on a mixing line between cosmogenic He, Ne and radiogenic ^{4}He (from U, Th decay) in a ^{20}Ne/^{4}He vs. ^{3}He/^{4}He diagram. As this suggests that no He has recently been lost relative to Ne, cosmogenic ^{3}He/^{21}Ne (3.5±0.4) can be used as a shielding indicator [7], resulting in an exposure age of 2-4 Ma in an asteroid of at least 1-10 m diameter (larger sizes resulting in longer exposure ages). The ^{4}He age (U=14-22 ppb; Th=49-77 ppb, from Allende chondrules [8]) is <200 Ma for three grains, 280±80 Ma for two grains and 2.2±0.6 Ga for one grain, suggesting that Khatyrka experienced a degassing event within the last 200 Ma. Such low U, Th-^{4}He ages are rare in CV chondrites, and suggest Khatyrka is derived from a different parent asteroid than most other CV chondrites. The K-type Eos and Eunomia asteroid families, possibly related to CV chondrites [9], are too old (at ~2 and ~2.5 Ga, respectively [10]) to have formed in the event that degassed Khatyrka.

References: [1]Bindi L. et al., 2009. *Science* 324:1306-1309. [2]Bindi L. et al., 2015. *Scientific Reports* 5:9111.[3]Bindi L. et al., 2012, *Proceedings of the National Academy of Sciences* 5:1396-1401.[4]MacPherson G. et al., 2013, *Meteoritics & Planetary Science* 48:1499-1514.[5]Hollister L. et al., 2014. *Nature Communications* 5:4040.[6]Heck P.R. et al., 2007, *Astrophysical Journal* 656:1208-1222.[7]Leya I. & Masarik J. 2009, *Meteoritics & Planetary Science* 44:1061-1086.[8]Amelin Y. and Krot A., 2007, Meteoritics & Planetary Science 42:1321-1335.[9]Burbine T., 2015, *Treatise on Cosmochemistry, 2nd edition*, pp.365-415. [10]Nesvorný D. et al., 2005, *Icarus* 173:132-152.