FORMATION MECHANISMS OF D-ENRICHED APATITES: CLUES FROM THE MARTIAN BASALTIC SHERGOTTITE NORTHWEST AFRICA 8657.

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Introduction: Apatite, a common hydrous mineral occurring in the Martian meteorites, can provide constraints on the water content of the Mars' interior [1-7]. All Martian apatites have significantly high δD values[1-5], which has been interpreted as either crystallization from a crustal assimilated magma or via the interaction between apatites and D-enriched fluids post crystallization [4]. In this study, we have systematically analyzed the water content, hydrogen and chlorine isotopic compositions of apatites in the basaltic shergottite Northwest Africa (NWA) 8657 in order to shed more light on the formation mechanisms of D-enriched Martian apatite.

Sample and Experiments: A polished section of NWA 8657was studied in this work. Petrography and mineral chemistry were carried by FE-SEM and EPMA, respectively, at the Institute of Geology and Geophysics, Chinese Academy of Sciences (IGGCAS). Water content and hydrogen isotopes of apatite were measured using the NanoSIMS 50L at IGGCAS, referring to methods in ref. [5, 8]. Chlorine isotopes of apatite were also measured with the NanoSIMS 50L. The Durango apatite was used as a reference material [9, 10].

Results and Discussions: NWA 8657 is mostly composed of zoned pyroxene and plagioclase with minor merrillite, apatite, magnetite, sulfide, ilmenite, quartz, and mesostasis - a typical basaltic shergottite texture. The modal of phosphate composition makes up approximately 1.5 vol. % of the sample. About 1/4 of phosphates are apatite, with large grain sizes (up to 150 μm in width) and smooth surfaces. EPMA analyses indicate that NWA 8657 apatite varies from F- to Cl-rich without any significant intra-grain zonation.

The water content and hydrogen isotopes of apatite from NWA 8657 measured by NanoSIMS vary from 112-2287 ppm and 2871-6398 ‰, respectively. They positively correlate logarithmically along a two end-member mixing trend as shown in melt inclusions from GRV 020090 [5]. The high δD values and the similar positive trend in apatite differ from the other data reported in Martian meteorites [1-4]. If the apatites record post-crystallization hydrothermal alteration, the chlorine isotopes would be similar to the regolith breccia NWA 7034 [11,12]. However, the chlorine isotopes in NWA 8657 apatite vary from -6.1‰ to -1.2 ‰, which are amongst the most negative values in Martian meteorites but similar to those found in olivne-phyric shergottites [11].The low δ^{37}Cl values in the NWA 8657 apatite suggests that the parent Martian mantle source was poorer in ^{37}Cl than the Earth, Moon and chondrites [11,13,14]. Furthermore, δ^{37}Cl does not correlate with water content and δD values, suggesting that NWA 8657 apatite crystallized from a D-enriched but ^{37}Cl-poor magma. A probable scenario is that the NWA 8657 parent magma melted a subsurface freshwater ice layer that equilibrated with the atmosphere, resulting in the extreme D-enrichments without significantly enriching ^{37}Cl in apatite. Some alternative scenarios will be discussed at the meeting.

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