COMPOSITION OF PHOSPHATES IN THE MARTIAN SHERGOTTITE NORTHWEST AFRICA 13581.

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Introduction: Apatite is a crucial phase in evaluating the volatile evolution and water contents of magmas. Shergottites crystallized from a mantle-derived magma and exhibit a great diversity of textures and compositions. Apatite in shergottites varies in composition which may record the volatile components of the martian mantle (e.g., [1]). Northwest Africa (NWA) 13581 was a newly found martian shergottite with a fresh fusion crust. Apatite often coexist with merrillite with uneven boundaries similar to those reported in NWA 7755 and NWA 6234 [1-2]. However, apatite in NWA 13581 contains more F but less OH compared to those of typical shergottites [3]. It mostly lie on the F-Cl join of the F-Cl-OH ternary plot. Here we report a mineralogical study of phosphate in NWA 13581 with an attempt to provide more constraints on the volatile evolution along with the formation of shergottite.

Sample and Methods: NWA 13581 is composed of pyroxene, olivine and maskelynite with minor spinel, ilmenite, phosphate and troilite. It has a poikilitic texture in which pyroxene encloses relatively fine-grained olivine. Major and minor element compositions of minerals were determined with a JEOL JXA-8230 electron microprobe. Raman spectra of minerals were acquired with a Thermo Scientific DXR Raman microscope. Both analyses were conducted at Purple Mountain Observatory, Chinese Academy of Sciences.

Results and Discussion: Apatite and merrillite often occurs as subhedral grains ranging up to ~ 300 μm. In many cases, these two phases coexist with straight or irregular boundaries associated with minor opaque minerals. Apatite often present within merrillite as irregular patches or at the rims of merrillite. Both apatite and merrillite may present as rims of the other. Some grains adjacent to shock melt pockets have been transformed to the high-pressure polymorphy tuite as indicated by the characteristic Raman peak around 977 cm^{-1}. Coexistence of phosphates and tuite in some cases suggests an incomplete transformation. Additionaly, stishovite has also been identified within NWA 13581. Merrillite is relatively homogeneous with more FeO (1.0 – 2.0 wt %), MgO (2.7 – 3.4 wt %) and Na_2O (1.4 – 1.9 wt %) than apatite. Apatite varies in F (0.8 – 4.4 wt%) and Cl (0.5 – 5.4 wt%). The X-site occupancy is calculated assuming F + Cl + OH = 1 (F = 0.2 – 0.9, Cl = 0.7 – 0.6, OH = 0 – 0.5). F/Cl ratios are mostly over 1. No evident systematic correlations of volatile content and occurrence are observed.

Martian apatite varies significantly in F, Cl and OH which may result from fractional crystallization and/or assimilation, degassing, fluid interaction or shock metamorphism [4]. The intergrowth of apatite and merrillite is suggested to from from reaction of merrillite and Cl-OH-rich fluids [1]. The calculated OH anions of NWA 13581 apatite are exclusively low compared to most other shergottites, and similar to the poikilitic shergottite NWA 1950 but with a higher F content [4]. The mineral-melt partition relationship exhibit that apatite prefers F over Cl, and Cl over OH [3, 5]. Therefore, the high F content may form under three scenarios: crystallization at the early stage of primary magmatic process [5]; under degassing during apatite crystallization because the strong partitioning of F into the melt [4]; and shock-induced mobilization of Cl [6-7]. The exlusively low OH contents may result from degassing or under a reasonable degree of fractional crystallization [4-5]. The parent melt may have exsolved Cl-rich melts that are subsequently migrating outward without interacting with NWA 13581 significantly. Nevertheless, more detailed calculation and modeling of the apatite evolutionary trends are required.

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