

**INSIGHTS INTO EVOLUTION OF VOLATILES IN MARTIAN MAGMA BASED ON A RECONSTRUCTION OF NWA 2975 PHOSPHATE CRYSTALLIZATION PROCESS – A COMBINED TEM, SYNCHROTRON FTIR- AND RAMAN-SPECTROSCOPIC STUDY.** E. Słaby<sup>1</sup>, M. Koch-Müller<sup>2</sup>, R. Wirth<sup>2</sup>, H.-J. Förster<sup>2</sup>, A. Schreiber<sup>2</sup>, U. Schade<sup>3</sup>, D. Rhede<sup>2</sup>, K. Lisowiec<sup>1</sup>, <sup>1</sup>Institute of Geological Sciences, Polish Academy of Sciences, Research Centre in Warsaw, Twarda 51/55, 00-818 Warsaw, Poland, \*e-mail [e.slaby@twarda.pan.pl](mailto:e.slaby@twarda.pan.pl), <sup>2</sup>Deutsches GeoForschungsZentrum, Telegrafenberg, 14473 Potsdam, Germany, <sup>3</sup>Helmholtz-Zentrum Berlin, Elektronenspeicherring BESSY II, Albert-Einstein-Str. 15, 12489 Berlin, Germany

Phosphates, such as volatile-bearing apatite and anhydrous merrillite, are frequently used to decipher magma composition. In NWA 2975, merrillite represents intermediate merrillite–ferromerrillite solid solutions and fluorapatite is rich in Cl and water. We combined the focused ion beam sample preparation technique with polarized synchrotron-based FTIR- and Laser-Raman-spectroscopy to determine structurally bounded OH, F, Cl and CO<sub>3</sub>-groups in apatite from NWA 2975 shergottite. These are the first FTIR spectra in the OH-stretching region from a Martian apatite showing the characteristic OH-bands of a F-rich, Cl- and H<sub>2</sub>O-bearing apatite. The FTIR-based quantification of the incorporated H<sub>2</sub>O is in good agreement with the H<sub>2</sub>O concentration estimated by combining electron-microprobe analyses of F and Cl with mineral stoichiometry. The process of crystallization of apatite and coexisting with merrillite is reconstructed from TEM and geochemical analyses. Both phosphates have been indexed (HR TEM study). They reveal planar deformations or mosaicism of several, variably distorted and undistorted sub-domains reflecting shock induced deformation, suggesting that both species precipitated from residual magma prior to the shock event. Quenched, very porous melt drops of phosphate composition, containing silica and volatiles (with F predominating over Cl) occur in merrillite, but not in apatite. In apatite cracks, crystallization of residual, F-enriched and Cl-free melt is observed. Tiny, tile-shaped crystals (indexed as apatite) nucleated on the crack's walls and grow in parallel-oriented piles. The composition of host apatite shows the presence of both F and Cl in parental magma. Two apatite generations support the occurrence of volatiles in the melt during phosphate formation. Geochemical modelling shows that the parental magma was volatile poor. Volatile concentrations considerably increased during progressive fractional crystallization, however, Cl is mostly exhausted before its termination. The analyses show that the volatiles budget recognized in apatite can be related with high probability to magmatic origin, and was not altered during post-magmatic events. The proportions between halogen and water in apatite indicates

high-temperature parental magma with high F activity and comparatively low Cl and water activity (F>>Cl~H<sub>2</sub>O). The model supposed for Amazonian magmatism (the age of NWA 2975 is 304 ± 29 Ma; [1]) by [2] assumes dry upper mantle with occasional entrainment of hydrous material from wet lower mantle. Thus volatiles-enriched reservoirs may contribute to shergottite magma generation. Volatiles budget estimated for NWA 2975 apatite rather points to volatiles poor mantle as a shergottite magma source.

#### References:

- [1] Lindsay F.N., Osmond J., Delaney J.S., Herzog G.F., Turrin B., Park J., and Swisher C.C. III (2013) *44th Lunar and Planetary Science Conference*, 2911 pdf. [2] Balta J.B., and McSween Jr., H.Y. (2013) *Geology*, 41, 1115-1118.

The study was financed by NCN 2011/01/B/ST10/04541.