NORTHWEST AFRICA (NWA) 11119 – PROBING AN UNKNOWN EARLY PLANETARY BODY?

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Introduction: Northwest Africa 11119 represents a completely new and so far unknown type of meteorite which was classified as an Ungrouped Achondrite [1]. Petrographically NWA 11119 was described by the classification team as a porphyritic volcanic rock with an andesitic-dacitic bulk composition. A modal abundance of free silica polymorphs of about 22% was found (dominating tridymite and cristobalite, rarely quartz) which is significantly higher than in any other known meteorite [2-4].

In terms of oxygen-isotopy which plots in the ureilite field, similarities exist to the also unique achondrites NWA 7325/8409 (and pairs), petrologically classified as a plagioclase-rich cumulate olivine microgabbro [1,2] and the also unique Almahata Sitta individuals MS-MU 011 and 035, classified as plagioclase-enriched trachy-andesites [1,5-8]. These specific Almahata Sitta individuals are interpreted as being related very likely to the Ureilite Parent body crust.

Samples

The main mass of NWA 11119 which was found in Mauretania in 2016 consists of a large stone of a mass of 453 gr and several smaller fragments. The material is highly friable and partly covered with an unusual light green colored fusion crust. For our investigations we have obtained a set of samples which are typically representative for the meteorite as a whole, see figure 1 and table 1.

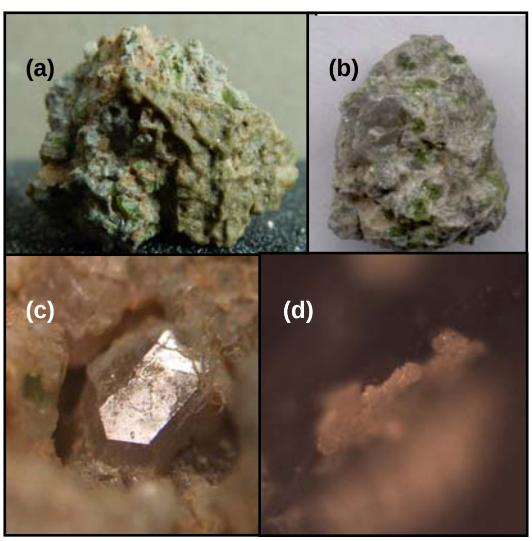

Figure 1: Some of the NWA 11119 samples under study: (a) 4.25 gr and (b) 0.90 gr fragments with dominating clinopyroxene (green, diopside) and SiO_2 phases (greyish, cristobalite-tridymite) and greenish-colored melt crust (in a). (c) An idiomorphic feldspar (anorthite-rich), a nearly mm–sized crystal in a small cavity is absolutely unique for any known meteorite. (d) Rarely quartz is found as radial prismatic, yellowish crystals in small cavities on the surface of cristobalite/tridymite or feldspar (anorthite) matrix.

Mineralogy and phase composition

The aim of these investigations is primarily on the mineralogy and phase composition, and on the magnetic classification based on Magnetic Susceptibility (MagSus X). LASER Micro Raman Spectroscopy is best suited for identifying and discriminating (extra-) terrestrial mineralogy in high-resolution mappings on natural, broken surfaces without any preparation in 2- or 3 D. Moreover, Raman Spectroscopy is the only available technique which allows to investigate and analyse samples like the new and unique NWA 11119, specifically to fully "catch" all present phases even in small vugs and little pockets (see figure 1). For us it was very important to fine-tune our Laser Raman System in a way that it would allow to access the real situation in any kind of rock/mineral sample in its original situation, excluding or avoiding any modification due to cutting/preparation etc. which would completely "destroy" reality.

We have used a Horiba Xplorer Raman System for our systematic mineralogical and shock investigations. High-resolution mapping (up to 15x15 points) was performed in partly less than 1 µm steps in order to control the real petrographical / mineralogical situation within this unique material. We also could investigate numerous inclusions within the dominating matrix phases (cristobalite-tridymite, diopside, anorthite) which is topic of a different contribution [11]:

(1) Dominating phases
- Clinopyroxene (CPX), diopside
- Silica – phases
  Cristobalite
  Tridymite (only intergrowth with Cri)
- Feldspar (anorthite-rich)

(2) Minor / rare phases
- Fe-Ti oxides
  Rutile, anatase
  Ilmenite ?
  Chromite ?
- Fe – sulfides: troilite
- Phosphates: apatite, merrilite
- OPX (orthopyroxene): enstatite, transparent, prismatic crystals in small cavities
- Ca-Mg carbonate (near calcite), terr.?
- Quartz SiO_2 (see fig. 1d)

Carbon – phases: a large spectrum of different carbon phases in significant amounts – amorphous and highly crystalline - could be detected, for example graphite. This topic is part of a different contribution [11].
Olivine or metal could not be found which confirms [1-4], we also could not detect zircon so far.

Summarizing, the unique NWA 11119 does not represent the first indication pointing towards extraterrestrial silica-rich volcanism: as mentioned above, Almahata Sitta individuals MS-MU 011 and 035 were the first samples of this kind [5-8], interpreted as crustal extrusive volcanism on the Ureilite parent body. Recently, also in lunar rocks (Apollo 12 samples) and on the Martian surface (Gale crater by Mars Science Laboratory rover Curiosity) low pressure, high temperature polymorphs of SiO_2 have been found [9,10].

Magnetic Classification
The uniqueness of NWA 11119 and related meteorites is also confirmed by their distinct magnetic signature. We can demonstrate this fact by classifying the meteorites using magnetic susceptibility (X, MagSus). Magnetic susceptibility was studied by the SM 30 and SM 100 instrumentation, ZH Instruments (Brno, CR). As mentioned above, due to the similarities in several properties, we decided to also include the 2 Almahata Sitta individuals, as well as NWA 7325 and pairs in our investigations.

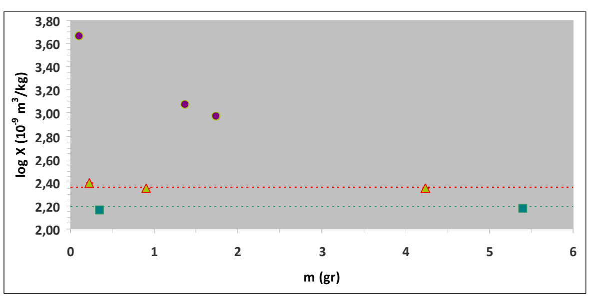

Figure 2: Magnetic susceptibility: (a) ▲ NWA 11119, (b) ■ NWA 7325 and pairs, (c) ● Almahata Sitta MS MU 011/035. For (a) and (b): the dotted lines indicate the average values, respectively.

MagSus values of NWA 11119 and NWA 7325 and pairs represent the lowest MagSus values which have been measured so far on any meteorites to our best knowledge, please note that both are finds. Therefore, one has to state that these values are not directly comparable with Almahata Sitta MS-MU 011/035 values which is a fall. Also in comparison with terrestrial equivalents, MagSus values are quite low, which means that the concentration of Fe-bearing phases is neglectible. This is confirmed by our mineralogy analyses data: no metals or strongly magnetic Fe-oxides.

The preliminary results could support a general conclusion that NWA 11119, eventually also NWA 7325 (and pairs), revealing oxygen isotopy data in the range of some ureilites, may probe a yet unknown planetary body which existed only in a very early period of time of our planetary system.

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