NORTHWEST AFRICA 12774 – A NEW BASALTIC/QUENCHED ANGRITE.

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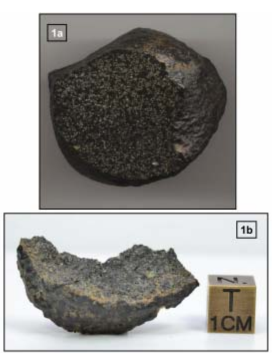
Introduction

A new angrite, NWA 12774, was reported in Meteoritical Bulletin 108 [1]. The meteorite, a single stone with a weight of 454gr, represents the 18th unpaired angrite, quite a rare group of meteorites. A very limited number of finds (20) and only one reported fall, Angra dos Reis (1869, Brasil) are known [1,2]. Four groups of angrites can be discriminated presently in terms of petrogenesis: (1) quenched-basaltic-diabasic (fine-grained), (2) plutonic-subvol-canic (coarse-grained), (3) NWA 2999 and pairs – possibly a regolith breccia and (4) NWA 8535, the first dunitic angrite (deep mantle) [1-4].

NWA 12774 is characterized by a very fresh-looking interior without fusion crust and is classified as a quenched olivine-phyric angrite (so belonging to group 1) with large phenocrysts of olivine and Al-Ti augite arranged in a dark-black, fine-grained groundmass [4].

In our poster contribution we will present results of investigations by magnetic and mineralogical means, and by Raman spectroscopy (phase composition). The data will be compiled with results of our systematic studies performed on a larger set of angrites (Angra dos Reis, d'Orbigny, Sahara 99555, NWA 2999, 4590 and 7203).



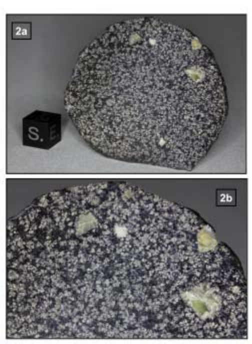


Fig. 1 (a): Main mass of NWA 12774 [© K. Wimmer], (b) interior view [© www.saharagems.com].
Fig. 2 (a): Full slice of the main mass, cut and polished, (b) upper right part showing up to > 5mm sized olivine megacrysts (xenocrysts).
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Results

There are several common and specific features and characteristics of angrites, for example: (a) very low or no shock, (b) presence of a large variety of silico-phosphate phases and (c) significant contents of partly large-sized spinels of various compositions (see also magnetic signature) [4-7]. The latter con-cerns hercynite (Fe and Al rich), chromite and Ti-Al-Mg substituted magnetite but also stoichiometric magnetite which is quite rare in achondrites.

The following phases have been identified by Raman Spectroscopy on NWA 12774 (see also figs. 3,4):

Olivine, fassaite (CPX), troilite, feldspar (anorthite), Fe-sulfide (pyrrhotite?), silico-phosphates, amorphous carbon and graphite, kamacite, numerous inclusions in olivine and CPX, a range of opaque phases. No indications for shock or terrestrial alterations have been found so far.

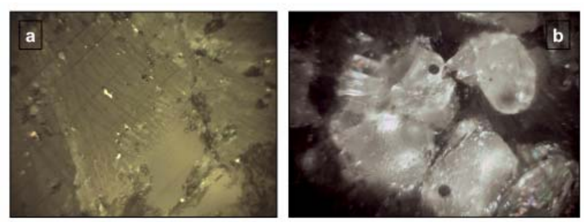

Fig. 3a,b: Optical microscopy images of NWA 12774: (a) Olivine and fassaite with numerous opaque inclusions (eg Fe-oxides, Fe-sulfides, Fe-Ni metal), magn. 500x. (b) Kamacite (Fe-Ni metal) droplets in olivine (magn. 200x).

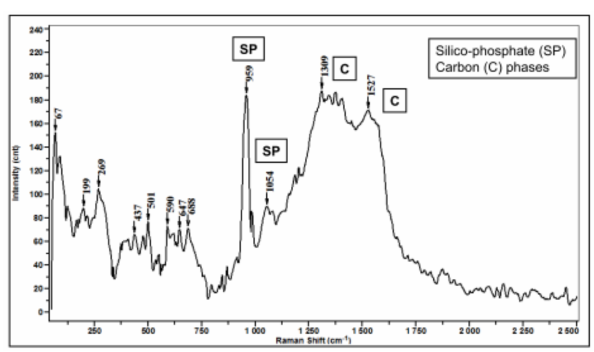

Fig. 4: Typical Raman spectrum of NWA 12774 phases: Silico-phosphate and amorphous carbon.

The magnetic signature and paleomagnetic signal of the angrites was topic of only a very few investigations. The general magnetic signature was studied by [8-10]. On several investigated angrites a strong and stable magnetic remanence was detected which was interpreted as an original thermomagnetic remanence. The record points to a paleomagnetic field intensity of about 10 µT on the angrite parent body (4564-4558 Mill. years ago, formation of the lava flows) of which the origin is still under debate: core-dynamo or solar nebula field? [10].

The dominating magnetic recorders were found to be low-Ti titanomagnetite (Fe-Ti spinel), but also kamacite (Fe-Ni) and pyrrhotite (Fe-sulfide) may play a significant role (depending on the kind of angrite, see above [2,3,10]).

Within our project we also will compile the general magnetic signature of a set of angrites (magnetic susceptibility and remanence parameters, low and high temperature magnetic properties such as magnetic transition temperatures). As a first step we focus on the compilation of the magnetic susceptibility values which represent independent classification parameters [8,9].

Magnetic susceptibility (MS) of the new quenched angrite NWA 12774 gave a value of

2.98 +/- 0.03 (log MS [10^{-9} m^3/kg])

The result was obtained by measuring MS with the SM30 (Hulka Comp., Czech Republic): the main mass as well as several full slices of the main mass have been investigated and a mean value was calculated. Generally, only falls are useful for a well constrained magnetic classification, however in the case of angrites we have only one fall. Therefore we have to focus in detail on the terrestrial weathering effects of the individual angrite finds.

The MS database of the various angrite groups (see above, and details in our poster) presently lack on sufficient data and, of course, group members (group 3 and 4). Further, only one average MS value was reported for LEW 86010 and LEW 87051 but the two meteorites are not paired and belong to different groups. The basaltic angrite's MS is relatively homogenous with an average value of 2.92 (log MS [10^{-9} m^3/kg]), the NWA 12774 MS fits well into this group. The MS distribution of the plutonic angrites group is more complex with a lower average value of 2.79 as compared to group 1. MS of NWA 2999 and pairs – possibly a regolith breccia with a component from an Iron-Meteorite - is significantly higher with a log value of 4.54. No magnetic data have been reported from the dunitic angrite NWA 8535 so far. However, a well constrained interpretation of the MS data would require more unpaired angrite falls/finds, additionally we can expect a major influence to MS from effects of terrestrial alteration.

Systematic low and high temperature magnetic experiments and detailed paleomagnetic studies on a set of different angrite samples indicate in all cases near stoichiometric magnetite (Fe_3O_4) as the dominating and stable magnetic recorder with minor contributions from Al, Mg, Cr substituted magnetite, Fe-sulfide and possibly kamacite.

Summary and conclusions

Presently 21 unpaired angrites have been published in Meteoritical Bulletin (1/2020). NWA 12774 is a typical member of the quenched angrite group. The stone is characterized by a very fresh interior, lacking any terrestrial alterations or shock features.

Already our pilot study brought fascinating insights concerning the complexity of the phase composition and texture. For example, the quite large-sized inclusions of silico-phosphates will certainly allow much more detailed structural and mineral-chemical investigations on this very rare components.

References

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