Meteorite 6A: chemical, physical and petrological characterizations

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The meteorite 6A is a H-type chondrite found in the valley of the Draa river (Sahara desert, SW Morocco); the label follows the field-recovery grid scheme. It is spheroidal in shape (3x5x6 cm³) and wrapped by a melting crust (0.5 cm thick). Chondrules are well defined and form the 80% of the rock (Bonadiman et al., 2018). They are mainly composed of olivine, pyroxene, plagioclase, chromites, Fe-Ni metal, sulfides, and micro to crypto-crystalline mesostasis. The mesostasis and the homogeneity of feldspar suggest the petrological type 3-4. Fine grain matrix mainly consists of FeNi alloys, locally transformed in goethite as terrestrial product (weathering degree: W4). The chondrules have variable size, 200-600 μm on average, up to 1 mm; the great majority shows lower degree of weathering (W1-2).

EDS maps show that olivines and pyroxenes have variable size in different chondrules; they range from micro- to single-crystals of about 500 μm, by defining porphyritic olivine-pyroxene (POP), and radial pyroxene (RP) as most common textural types. An orthogonal distribution of bar olivine forms an unusual BO chondrula (Scott & Krot, 2014). The chemical composition of olivines is uniform in all grains and the average formula is $(Mg_{1.61}Fe_{0.37}Mn_{0.01}Ca_{0.01})SiO_4$. A single grain of Fe-rich olivine $(Fe_{1.52}Mg_{0.46}Ca_{0.12}Ni_{0.03}Cr_{0.01})[Si_{0.90}Al_{0.05}]O_4$, appearing as porphiric relict, was found as core of an enstatite bars series.

Likewise, ortho-pyroxenes have homogeneous enstatic contents, with small variations in the amounts of Ca, Mn, Cr, Al, Ti; the average formula is $(Mg_{1.62}Fe_{0.35}Mn_{0.02}Ca_{0.02}Ti_{0.02}Cr_{0.02})[Si_{1.97}Al_{0.03}]O_6$. Some pyroxene-bars show Ca enrichment in the core, until $(Mg_{0.93}Ca_{0.80}Fe_{0.11}Al_{0.05}Cr_{0.04})[Si_{2.02}]O_6$.

In all chondrules occur feldspathic mesostases, with on average high K content (Ab 73-85%, An 10-23% and Or 4-11%). The crypto-crystalline mesostases are a mixture of two distinct feldspars, albite and K-feldspar, both with small content of Ca. Anorthites has not been found. Compositional maps of mesostasis evidenced K-rich microzones (< 10 mm); point-analyses returned a composition corresponding to a K-feldspar: $(K_{0.80}Na_{0.09}Ca_{0.12})[Si_{2.91}Al_{1.07})O_8$. Porosity is important in meteorites and asteroids because affects density. The real density of this sample measured with He pycnometer is 3.56(1) g cm^{-3}, while the average intrinsic density estimated on the base of the occurring phases (X-ray microtomography) is 4.18 g cm^{-3}; the difference is related to the oxidation of Fe alloys with formation of goethite (7.9 and 4.3 g cm^{-3} for kamacite and goethite, respectively).

Primary porosity is estimated 10% by volume with average pore sizes of ≈300 μm. The observed dissolution of mesostasis glass with the formation of micro K-rich feldspars may be related to the porosity that facilitates the transport of fluid during aqueous alteration and metasomatism, accompaning thermal metamorphism of the parental body (Kovach & Jones, 2010; Lewis et al., 2018).

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