El Médano 301: a New Forsterite Chondrite

Hamed Pourkhorsandi¹, Jérôme Gattacceca¹, Bertrand Devouard¹, Massimo D'Orazio⁲, Pierre Rochette¹, Pierre Beck³, Militara Valenzuela⁴, Corinne Sonnoli³

¹Aix-Marseille Université/CNRS/IRD/CEREGE UM34, Aix-en-Provence, France
²Dipartimento di Scienze della Terra, Università di Pisa, Pisa, Italy
³Institut de Planétologie et d'Astrophysique de Grenoble, Grenoble, France
⁴Instituto de Astrofísica, Pontificia Universidad Católica de Chile, Santiago, Chile

pourkhorsandi@cerge.fr

BACKGROUND & OBJECTIVE

Dark chondrule clasts with reduced olivine (FeO/FO₂ ) and pyroxene (FeO/F₂₇) compositions have been described inside Cumberland Falls aubrite [1] (Figure 1). It was suggested these clasts are fragments of an otherwise unsampled F-chondrite parent body which upon a collision with the aubrite parent body has led to the formation of Cumberland Falls breccia [1]. Another interpretation suggests that the reduction of a LL chondrite component in presence of highly reduced aubrite host could form clasts with the observed composition [2]. The latter model is supported by the occurrence of less reduced chondrules (defined as low-FoO ordinary chondrules) formed during thermal metamorphism and the reduction of chondrule clasts (defined as HH chondrites) inside IIE iron meteorites. Meteoritics and planetesimals 370 [1] and NWA 7135 [4] (Figure 2) are two recently described chondrules that show affinities with Cumberland Falls clasts. El Médano 301, an ungrouped chondrite that also shares characteristics with these two meteorites and with the Cumberland Falls chondrule clasts was found in 2013 by our team during a search for meteorites in the Atacama desert (Chile). Here we report the preliminary results on the petrography, mineral chemistry, trace element and oxygen isotopic compositions, and IR spectroscopy of this meteorite. Comparison of El Médano 301 with the previously known meteorites, can give insights into the existence and origin of F chondrites and their relationship with the ordinary chondrites and reduced ordinary chondrites.

El Médano 301 is composed of two pieces totaling ~17 g. There is no trace of fusion crust and cut surfaces show a dark brown interior. It presents a well-preserved and closely packed chondritic texture (Figure 3). Main minerals are Mg-rich olivine and Ca-poor pyroxene, diopside, chlorapatite, chromite, troilite, kamacite and taenite (Figure 4). Metal and sulfides have been extensively (>90%) replaced by weathering products. Different minerals (specially olivine) show sharp optical extinction and some random fractures, which indicates a low shock degree (S1-S2). Average apparent chondrule diameter is 800 ± 320 µm (n=99). Average olivine (n=10) and orthopyroxene (n=11) compositions are Fo39 ± 0.4 (PMD = 5.5%), and Fs13.5 ± 5.7 (PMD = 40%), respectively, which suggest a petrologic type of 3 (leaving to 4). Average Co content of kamacite is 0.13 ± 0.08. The magnetic susceptibility is log χ = 4.62 ± 10⁻¹¹ m³/kg. The infrared reflectance spectrum of El Médano 301 was obtained on a powdered sample leached with HCl to remove weathering products (oxyhydroxides) that otherwise dominate the spectrum. The IR spectrum reveals the presence of two strong absorption around 0.92 µm and 1.9 µm. The position of these bands as well as their relative intensity points toward the presence of an Mg-rich and Ca-poor pyroxene. From a spectral point of view, El Médano 301 is therefore closer to Vesta (V-type) than S-type asteroids.

The average apparent chondrule size of El Médano 301 and NWA 7135 is 480 ± 270 µm, n = 132), is intermediate between values for H [7] and L [8] chondrites, but significantly smaller than LL chondrites. This precludes a formation by reduction of a LL chondritic precursor as suggested for the chondrule clasts of Cumberland Falls [2]. Trace element composition shows the affinity of the meteorite with ordinary chondrites. However, the olivine and pyroxene compositions of El Médano 301 are far from the defined ranges for LL, H, L, and LL-FoO chondrules. Cobalt content of kamacite is also much lower than the reported amount for the ordinary chondrites [9]. Together with Cumberland Falls clasts, NWA 7135 and Acker 370, it forms a well-separated cluster. Similarly, the oxygen isotopic compositions of these meteorites form a cluster separated from other ordinary chondrites. El Médano 301 is a chondrite containing olivine and pyroxene with Mg-rich compositions of F₆₈.₂₄ and F₅₆.₂₄ that are intermediate between other ordinary and enstatite chondrites. Its oxygen isotope composition is different from other ordinary chondrites and it is similar to the chondrule clasts in Cumberland Falls. All these characteristics suggest that El Médano 301 has a close relationship to these clasts, NWA 7135, and Acker 370, strengthening the case for the occurrence of an “F chondrite” class of ordinary chondrite.

REFERENCES