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A microscopy study of the NWA2086 and NWA7043 meteorites

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Abstract

In this work a study of the NWA2086 and NWA7043 meteorites based on microscopy analysis is presented. These meteorites are carbonaceous chondrites whose meteoritic matrix has micro-sized elongated bodies. Additionally, the NWA2086 and NWA7043 contains many chondrules rich in olivine and clinopyroxene. According to the Scott-Taylor-Jones classification, these chondrules are type I. Many of these chondrules have thin rims probably created by heating events in the solar nebula.

1. Introduction

The meteorites NWA2086 and NWA7043 were collected in the Sahara desert of Northwestern Africa and have been classified as carbonaceous chondrites by the Meteoritical Society. One main characteristic of carbonaceous chondrites is that they contain millimeter sized quasi-spherical objects called chondrules whose mineralogy and specific characteristics where produced during their formation in the proto-planetary accretion disc when planets have not been yet accreted. The chemical abundances in carbonaceous chondrites are very similar to those in the solar photosphere except by the hydrogen and helium abundances [1]. Carbonaceous chondrites also have the oldest calcium-aluminum rich inclusions (CAI´s) bodies with 4,567.2 My of antiquity [2] which corresponds to the solar system age. This is why the chondrule textures are related with the processes in the early stages of the planetary solar system [3].

In this work we present a study of the NWA2086 and NWA7043 meteorites under the Scott-Taylor-Jones scheme [4,5,6,7]. The study is based on the analysis of their matrices and chondrules using Scanning Electron Microscopy (SEM), Energy Dispersive X-Ray Spectroscopy (EDS), Wave Dispersive X- Ray Spectroscopy (WDS) and X-Ray Diffraction (XRD) techniques.

2. Experimental procedures

Prior to the SEM analysis, the meteorites samples were cut and mirror-polished, and were cleaned for 10 minutes in an ultrasonic bath using ethyl alcohol.

Samples of the NWA2086 and NWA7043 meteorites were analyzed primarily by light microscopy using a Carl Zeiss Axiotech microscope at 10X and 20X. In order to study in detail the differences and similarities between the two meteorites, the samples were analyzed by Low Vacuum Scanning Electron Microscope JSM-5600LV equipment with a Noran X-ray microanalysis detector. The SEM analysis was performed at 20 kV acceleration voltage and at 12 Pa of pressure in the specimen chamber. SEM images were obtained with backscattered electrons (BSE).

A chemical analysis of minerals was also done using a JEOL scanning electron microprobe JXA8900-R, equipped with EDS and WDS analysis.

The quantitative analysis by WDS was performed at 20 KeV acceleration voltage, probe current of 2.0×10^{-8} A, with a beam diameter (P Dia) of 1 µm and an acquisition time of 40 seconds for each element except for K and Na. For these last elements the time was 10 seconds.

The more abundant crystalline phases present in the samples were identified by X-Ray Diffraction analysis (XRD) using an equipment SHIMADZU with Cu-Kα radiation (λ=0.15405 nm) in the interval 2θ of 4 to 70°, steps of 2°/s.

3. Results

The matrices of both meteorites are mineralogically similar, but present a small difference in the bulk elemental composition which is probably related to the aqueous alteration and/or to the processes experienced in the meteorite formation. On the other hand, the NWA2086 matrix is richer on chemical compounds than the one of the NWA7043, indicating that the former could probably come from C-type and D-type asteroids located around 3 AU and beyond 4 AU, respectively.

The chondrules present different appearances which could be produced by collisions and remelting processes if considering that collisions are associated with the coagulation of dust particles or with very small bodies in the solar nebula and the remelting processes modify the chemical, mineralogical and oxygen isotopic compositions as a result of gas-melt reactions as in the case of chondrules type I found in both meteorites (Scott-Taylor-Jones scheme*)* (Figure1).

Since there is a multiplicity of chondrules in both meteorites, the associated matrix could be thermally modified during transient heating events in which thick and fine-grained rim chondrules were probably created. Whereas the fine-grained rim could be built by regolith breccia that in turn result from multiple collisions between the embryos in the solar nebula; the thick rim could be formed by brecciation or accretion of mineralogical and/or compositional distinct materials in the solar nebula. Otherwise, the thick rim could be created during the growing and evolution of major bodies.

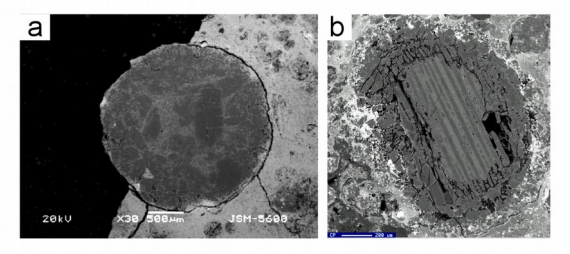

Figure 1. Type I chondrules in (a) NWA2086 and (b) MWA7043 meteorites.

4. Conclusions

1. The matrices of both meteorites have similar features and are formed by irregular and elongated grains. The NWA7043 meteorite has grain sizes <10 μm, while the NWA2086 has grains ≤ 2 μm. Both matrices are Fe, Si and Mg rich. The mackinawite and crystalline phases of clinopyroxene were identified in the NWA2086 matrix, meanwhile clinopyroxene, magnetite and magnesioferrite were identified in the NWA7043 by XRD analysis.

2. Both meteorites contain chondrules <2.5 mm in diameter. The chondrules surface number density is 1.94×10^{-3} chondrules/μm^2 for the NWA7043 and 1.93×10^{-3} chondrules/μm^2 for the NWA2086 meteorite.

3. Significant similarities were found in the chondrules: both are chondrules type I (according to the classification of Scott-Taylor-Jones) mainly compound by olivine and clinopyroxene. Additionally, some chondrules have Fe-rich inclusions.

4. The majority of the chondrules here studied have a thin rim probably formed by heating events in the solar nebula.

5. The thick rims in some chondrules could be formed by accreted breccia in the solar nebula. This process was perhaps a first step in the formation of major-sized bodies.

Acknowledgements

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References

[1] Amelin Y., Krot A. N., Hutcheon I. D. and Ulyanovet A. A.: Lead isotopic ages of chondrules and calcium-aluminum-rich inclusions, Science, Vol. 297, no. 5587, pp. 1678-1683, 2002.

[2] Bernatowicz T. J., Croat T. K. and Daulton, T. L.: Origin and Evolution of Carbonaceous Presolar Grains in Stellar Environments. In Meteorites and the Early Solar System II, Dante S. Lauretta and Harold Y. McSween Jr. (Eds.), University of Arizona Press, Tucson, AZ, USA, pp. 109-126, 2006.

[3] Kerridge J. F. and Matthews M. Sh.: Meteorites and the early solar system, University of Arizona Press, Tucson, AZ, USA, pp. 1286, 1988.

[4] Jones, R. H. : Petrology and mineralogy of type II chondrules in Semarkona (LL3.0): Origin of closed-system fractional crystallization, with evidence for supercooling. Geochim.Cosmochim. Acta, 54: 1785–802, 1990.

[5] Jones, R. H. : Petrology of FeO-poor, porphyritic pyroxene chondrules in the Semarkona chondrite. Geochim.Cosmochim. Acta, 58: 5325–40, 1994.

[6] Jones, R. H. & Scott, E. R. D. : Petrology and thermal history of type IA chondrules in the Semarkona (LL3.0) chondrite. Proc. 19Th Lunar Planet. Sci. Conf. Lunar and Planetary Institute, 523–36, 1989.

[7] Scott, E. R. D. & Taylor, G. J. : Chondrules and other components in C, O, and E chondrites; Similarities in their properties and origins. Proc. 14th Lunar Planet. Sci. Conf. J.Geophys. Res. 88, B275–B286, 1983.