

**Chromites in ordinary chondrite fusion crusts** . M. Bellesi<sup>1</sup>, G. Pratesi<sup>2</sup>, A. Di Michele<sup>3</sup>, S. Nazzareni<sup>3</sup>, L. Pittarello<sup>4</sup>, S. Goderis<sup>5</sup>, C. Santini<sup>1</sup>, G. Giuli<sup>6</sup>., <sup>1</sup>School of Science and Technology-chemistry division, University of Camerino, Piazza dei Costanti, 4, I-62032 Camerino, Italy. manliobellesi@gmail.com, <sup>2</sup>Dipartimento di Scienze della Terra, Università di Firenze, Via G. La Pira 4, 50121 Firenze, Italy; E-Mails: [g.pratesi@unifi.it](mailto:g.pratesi@unifi.it), <sup>3</sup>Dipartimento di Fisica e Geologia, Università di Perugia, Via G. La Pira 4, 50121 Firenze, Italy; E-Mails: [alessandro.dimichele@unipg.it](mailto:alessandro.dimichele@unipg.it), <sup>4</sup>Naturhistorisches Museum (NHM), Mineralogisch-Petrographische Abteilung, Burgring 7, A-1010, Vienna, Austria, [Lidia.Pittarello@nhm-wien.ac.at](mailto:Lidia.Pittarello@nhm-wien.ac.at), <sup>5</sup>Analytical, Environmental, and Geo-Chemistry (AMGC), Vrije Universiteit Brussel (VUB), Pleinlaan 2, B-1050 Brussels, Belgium, [Steven.Goderis@vub.be](mailto:Steven.Goderis@vub.be), <sup>6</sup>School of Science and Technology-geology division, University of Camerino, Via Gentile III da Varano, 7, I-62032 Camerino, Italy, [gabriele.giuli@unicam.it](mailto:gabriele.giuli@unicam.it).

The goal of our study was to investigate possible compositional differences between the chromites present in the interior of a meteorite and the chromites formed within the fusion crust. We report here the composition of 150 chromites measured within the bulk and 159 chromites found in the crust of 9 ordinary chondrites of different groups: 8 fall (H4, three H5, LL5, LL6, L3.6, L6) and 1 find (L3-6, H5 – the latter processed by Plasmatron in order to create a synthetic analog of a fusion crust, to be compared with the rest of the sample[1]).

Petrographic observations and chemical analysis have been performed with various scanning electron microscopes, a field-emission microprobe, LA-ICP-MS, synchrotron-based XANES...

Chromites found in the interior of the meteorite are usually anhedral and relatively large in size (several tens of micrometers), whereas chromites formed within the crust are consistently smaller (few micrometers in size) and can display anhedral, or subhedral to euhedral habit.

The Mg# and Al# determined for all the chromites found in the interior show a fair agreement with data reported in the literature for chromite compositions in ordinary chondrites [2-5], which display a small scatter of the Al# (ca.0.13±0.025) and a large variation of the Mg# (from 0.05 to 0.30).

When compared with the ones found in the bulk, chromites found within the fusion crusts generally exhibit similar values of the Al#; however, they display a much larger scatter of the Mg# and, usually, also larger average Mg# (up to 0.65) than their counterparts in the interior.

Chromites in the fusion crusts are often associated to magnetite dendrites made up by magnetite octahedral crystals 200-400 nanometers wide; occasionally, other spinel group minerals can be found, as magnesi-ochromites and magnesioferrites. In most of the samples studied, several chromite crystals are mantled by magnetite crystals, but the reverse has never been observed throughout our study: no magnetite crystal has ever been found mantled by chromites. Textural data

so far collected suggest a crystallization sequence in the fusion crust: olivine, chromite, magnetite.

A small but significant fraction (~14%) of chromites grown in the fusion crust display a detectable Ni content, in marked contrast with those found in the bulk (where only ca. 2% of the analysed chromites display Ni contents above the detection limit).

The meteorite sample (El Hammami, H5) processed with a plasmatron to create a synthetic fusion crust [1] has been analysed as well in order to ascertain if, under controlled temperature conditions, chromites could be formed within the surficial melt and to compare the composition of the newly formed chromites with those present in the interior of the meteorite. Also in this case, chromites found within the fusion crust formed at controlled conditions (Temperature measured at the sample surface at 2400-2200 K for 20 seconds) display similar Al# and sensibly higher Mg# compared to those in the bulk.

In conclusion, our study supports the crystallization sequence proposed for the fusion crust of ordinary chondrites, with chromite crystallizing in the melt immediately after olivine and before magnetite, possibly incorporating Ni from the melt and displaying significant variations in Mg#, likely as result of local temperature and oxygen fugacity conditions upon melting and cooling.

**References:** [1] Pittarello et al. (2019) *Icarus*, 331, 170-178. [2] Bunch, T. E., Keil, K. and Snetsinger, K. G. (1967) *Geochimica et Cosmochimica Acta*, 31, 1569- 1582. [3] Ramdohr p. (1967) *Geochimica et Cosmochimica Acta*, 31, 1961-1967 [4] Rubin, A.E. (2003) *Geochimica et Cosmochimica Acta*, 67, 2695-2709. [5] Wlotzka, F. (2005) *Meteoritics & Planetary Science*, 40, 1673–1702. .