Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.29350

Halogen distribution in ordinary and carbonaceous chondrites

DR. JULIA NEUKAMPF[1], RHIAN H. JONES[1], LAURETTE PIANI[2] AND ETIENNE DELOULE[3]

[1]University of Manchester
[2]CRPG-CNRS, Université de Lorraine
[3]CRPG, CNRS - Université de Lorraine, F-54000 Nancy

Halogens (fluorine [F], chlorine [Cl], bromine [Br], iodine [I]) serve as tracers for processes that took place within the solar nebula and during the accretion of the Solar System's inner planets. Understanding halogen abundances and distributions in chondrites is crucial for deciphering the volatile evolution of Earth and other terrestrial planets.

To assess what halogen concentrations in chondrules tell us about protoplanetary disk processes, we are investigating the behaviour of halogens in chondrule mesostasis glass. During chondrule crystallisation, halogens become concentrated in the melt due to their incompatibility with most silicate phases. Additionally, they may diffuse out into the vapor phase or condense back into the melt as the chondrule cools.

To explore halogen behaviour in detail, we measured abundances of F, Cl, Br, and I, as well as sulphur (S) and major elements, in the mesostasis of 46 chondrules from Antarctic carbonaceous chondrites (Dominion Range [DOM] 08006, Elephant Moraine [EET] 92105) and primitive ordinary chondrites (EET 90628, Grosvenor Mountains [GRO] 06054, Meteorite Hills [MET] 00452, MET 96503) using secondary ion mass spectrometry (SIMS) and an electron probe microanalyser (EPMA). Concentrations of halogens in mesostasis in the carbonaceous chondrites are F: 0.37-12.2 ppm, Cl: 0.22-290 ppm, Br: 0.002-0.83 ppm I: 30-432 ppb. For the ordinary chondrites, the concentrations are F: 0.2-118 ppm, Cl: 0.3-2255 ppm, Br: 0.001-2.5 ppm, I: 2.0-273 ppb. In the L group ordinary chondrites, we observe a correlation between metamorphic grade and Br and I concentrations from subtype 3.05 to 3.6, Br concentrations increase whereas I concentrations decrease.

This correlation between metamorphic grade and Br/I ratio suggests a potential influence of fluid mobility. Halogen abundances in chondrule mesostasis in ordinary and carbonaceous chondrites are more than an order of magnitude lower than abundances in enstatite chondrites [1]. This may reflect variations in cooling and crystallisation processes, potentially indicating exchange between a vapor phase and chondrule melt, or it may reflect a difference in the main carriers of halogens in chondrule precursors, in different regions of the solar nebula.

References:

[1] Baker, E., Jones, R. H., & Villeneuve, J. (2023).