

Mobility of halogen elements in ordinary chondrite breccias

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The behaviour of volatile elements in the early Solar System is of fundamental importance for considering the volatile inventory of the Earth and other terrestrial planets. Since ordinary and enstatite chondrites represent potential inner Solar System planetary source materials [e.g. 1], it is important to understand the abundances and distribution of volatiles in these meteorites. In ordinary chondrites (OCs), the halogen elements F and Cl are hosted in secondary apatite which was produced during metasomatism and thermal metamorphism on asteroid parent bodies [2-4]. In most OCs, apatite is Cl-rich [2-6]. However, the Cl/F ratio in two regolith breccias, Zag (H3-6) [5] and Kendleton (L3-5) [6], is extremely variable. To further investigate the relationship between apatite heterogeneity and regolith processes, we have studied apatite in 13 additional H group ordinary chondrites.

Among unbrecciated H chondrites, mean apatite compositions (measured by EPMA) differ slightly (mean Cl# [Cl/(Cl+F)] from 0.75 to 0.90), but display limited intra-sample variation, for example in H6 Benld (H6), mean Cl# = 0.86 ± 0.03 . In brecciated H chondrites defined as black (shock-darkened: [7]), apatite compositions are more heterogeneous e.g. in Cereseto (H5), Cl# = 0.83 ± 0.14 , with a range from 0.54 to 0.99. The highest Cl contents, Cl# > 0.95, occur in clasts of lower petrologic type. In gas-rich, H chondrite regolith breccias [7], apatite compositions are also heterogeneous. However, in Leighton (H5) (Cl# 0.79 to 1.00) and Cangas de Onis (H5) (Cl# 0.81 to 0.96), the range is not as extreme as in Zag (Cl# 0.45 to 0.99 [5]).

In general, it appears that H and L chondrite breccias are associated with significant halogen heterogeneity in apatite. We suggest that impacts could have resulted in prolonged, near-surface volatile mobility on OC parent bodies.

[1] Mezger K. et al. (2020) *Space Sci Rev* 216:27 [2] Jones R.H. et al. (2014) *GCA* 132:120 [3] McCubbin F.M. et al. (2023) *AmMin* 108:1185 [4] Che S. et al. (2023) *GCA* 348:85 [5] Jones R.H. et al. (2016) *AmMin* 101:2452 [6] Lewis J.A. and Jones R.H. (2016) *MAPS* 51:1886 [7] Britt D.T. and Pieters C.M. (1991) *MAPS* 26:279.