

THE GEOCHEMICAL FRACTIONATION RECORDED BY CHONDRITIC GLASS COSMIC SPHERULES DURING ATMOSPHERIC ENTRY.

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Introduction: Cosmic spherules (CSs) are extraterrestrial particles < 2 mm in size, captured by the Earth's gravitational field and melted while penetrating through the atmosphere. The diversity in quench textures and chemistry among stony CSs has been ascribed to variable peak temperatures and evaporative loss during atmospheric entry [1], with glass CSs forming under very high temperature regimes. Here, we combine the major (n=187, EPMA) and trace element (n=76, LA-ICP-MS) and oxygen isotope (n=6, IRMS) compositions obtained on glass CSs from the Transantarctic Mountains [2] with literature data [1, 3-6] to discuss the processes occurring during their atmospheric entry.

Results: 31 CSs closely resemble the FeO-poor (Fe/Si < 0.06), Mg-rich (Mg/Si > 0.9), colorless, glass CAT-like spherules [3]. 45 "high Ca-Al" CSs have high CaO, Al₂O₃ and TiO₂ contents (CaO + Al₂O₃ > 9 wt.%, Ti/Si = 0.005 ± 0.002), but higher FeO (Fe/Si > 0.6) and lesser MgO contents (Mg/Si < 0.9) than CAT-like CSs. The 393 other chondritic CSs form the normal group. From normal group to high Ca-Al group, through CAT-like group, CaO, Al₂O₃, TiO₂ and REE contents increase, whereas SiO₂, MgO and volatile element contents decrease. Siderophile and chalcophile elements show a different behavior: their depletion increases from the normal group, to the high CAT-like group, through the high Ca-Al group.

Atmospheric entry processes: Chemical differences between the three groups of CSs record variations in the degree of heating and evaporation. Based on progressive enrichment in major (Ca, Al, Ti) and trace (Zr, REEs) refractory elements relative to moderately refractory elements (Mg, Si) and volatile elements (Rb, Na, Zn, Pb), we propose that the mass lost by evaporation increases from the normal group (40-50 wt.% mass loss), through the CAT-like group (50-60 wt.%), to the high Ca-Al group (80-90 wt.%). However, siderophile and chalcophile elements in CSs appear to be not governed only by evaporation process. As there is no correlation between siderophile and chalcophile element contents, the processes governing their abundances during melting and melt evolution are, however, different. Siderophile elements probably record the mechanical extraction of metal (plus sulfide) beads resulting from immiscibility between metallic and silicate liquids under reducing conditions [7]. Chalcophile elements may record the extraction of chromite relict grains. The relative importance of evaporation vs. segregation is controlled by interdependent factors: parent body, precursor mineralogy and thermal and redox conditions during atmospheric entry.

References: [1] Taylor S. et al. 2000. *Meteoritics & Planetary Science* 35:651-666. [2] Rochette P. et al. 2008. *Proceedings of the National Academy of Sciences* 105:18206-18211. [3] Alexander C.M.O. et al. 2002. *Geochimica et Cosmochimica Acta* 66:173-183. [4] Taylor S. et al. 2005. *Geochimica et Cosmochimica Acta* 69:2647-2662. [5] Yada T. et al. 2005. *Geochimica et Cosmochimica Acta* 69:5789-5804. [6] Cordier C. et al. 2011. *Geochimica et Cosmochimica Acta* 75:1199-1215. [7] Brownlee D.E. et al. 1997. *Meteoritics & Planetary Science* 32:157-175.

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