VESTOID ASTEROIDS AS A SOURCE FOR DIFFERENTIATED COSMIC SPHERULES

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Introduction: Previous studies on melted micrometeorites (i.e., cosmic spherules, CS) revealed that differentiated compositions are present in very low proportions in Antarctic collections when compared to meteorites [1]. Here, we report the major and trace element compositions of 10 differentiated CS (V-type) obtained by means of EPMA and LA-ICP-MS. The dataset provides us robust criteria for the discrimination of differentiated versus chondritic CS, for coherent comparison and identification of their parent bodies.

Basaltic precursors for the differentiated CS: Differentiated CS can be identified from their Fe-Mn-Mg relationship [2], their high incompatible element contents (e.g. REE), and their siderophile depletions relative to chondritic CS. Ca and Al contents in differentiated CS show large variations (Ca/Si = 0.06-0.34 and Al/Si = 0.02-0.72) but tend to be higher than in chondritic CS. These ratios are highly sensitive to the relative abundance of the different mineral phases in the precursor, namely to the plagioclase to pyroxene ratio. Conversely, refractory incompatible trace elements are not sensitive to the precursor mineralogy and their abundances in differentiated CS are similar to those in planet/asteroid basalts. Based on the Fe/Mg atomic ratios (1.2 ± 0.1), the inferred plagioclase-pyroxene-rich mineralogy of the precursor and the incompatible trace element distribution, we propose that differentiated CS originate from basaltic precursors.

Parent body of the differentiated CS: The narrow range of Fe/Mg and Fe/Mn (30 ± 4) of the differentiated CS is consistent with a common origin either from a Vesta-like asteroid or from Mars [2]. The Vesta-like source is supported by major element composition of spherules deriving from an anorthite-rich precursor as this calcium-rich plagioclase composition is not reported in martian basalts [3]. The Vestoid source is also established by the contents of trace elements whose behaviors are dependent on redox conditions. Indeed, the oxygen fugacity (fO_2) values proposed for the mantle of 4 Vesta are significantly lower than for the martian mantle [4]. The studied differentiated CS share a number of features with eucrites [5]: their low volatile element contents (e.g., Zn), their low chalcophile/slightly siderophile element contents (e.g., V), and their contents in siderophile elements that are easily oxidized (e.g., Co). We thus suggest that the differentiated CS could originate from the regolith of large asteroids, lithologically and geologically similar to 4 Vesta (Vestoids). High-precision oxygen isotope measurements [6] are desirable to conclusively attribute the studied differentiated CS to 4 Vesta or to other Vestoids. Our work stresses the importance of future systematic studies of the large cosmic spherule collections to estimate accurately the relative proportion of the micrometeorite sources over the recent geological past.

References: [1] Taylor S. et al. 2007. *Meteoritics & Planetary Science* 42: 223-233. [2] Goodrich C. A. and Delaney J. S. 2000. *Geochimica et Cosmochimica Acta* 64: 149-160. [3] Papike J. J. et al. 2009. *Geochimica et Cosmochimica Acta* 73: 7443-7485. [4] Righter K. and Drake M. J. 1996. *Icarus* 24: 513-529. [5] Ruzicka A. et al. 2001. *Geochimica et Cosmochimica Acta* 65: 979-997. [6] Suavet C. et al. 2010. Earth and Planetary Science Letter 293: 313-320.