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Characterizing the Mineralogy and Weathering in Cosmic Spherules via Micro-Raman Spectroscopy

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Cosmic spherules (CSs) are widespread on Earth, recovered from urban settings, deserts, ocean floors and even across the geological record [1]. CS collections likely sample more small bodies than meteorites, as supported by oxygen (O) isotopic analysis [2,3]. Furthermore, as O-composition of CSs is affected by atmospheric interaction [2], fossil CSs may record Earth's past atmospheric composition. As such, CSs are particularly valuable and accessible tools for use in planetary science and potentially paleoclimatology. However, O-composition is strongly influenced by terrestrial alteration, and further controlled by location, terrestrial residency, and intrinsic CS mineralogy [4,5]. Consequently, quantitatively characterizing the mineralogy and degree of weathering of CSs (and how they differ among collections) is critical for reliably interpreting their "primary" O-isotopic signature. Although SEM/EDS is classically used for both mineralogical characterization and weathering assessment [5,6], this method requires significant sample preparation and is partially destructive for the samples. Moreover, current weathering schemes are only semi-quantitative and may not be applicable to all collections [5]. Here we assess Raman spectroscopy for these combined uses. This is invaluable as Raman is quantitative, requires no sample preparation, and is non-destructive. We will present Raman spectra of the exterior (and polished interiors) of thirty CSs from the AMGC (VUB) collections and compare these with compositional data obtained using SEM/EDS data. Our primary focus are iron (I-)type spherules as these are most resistant to survive in the geological record [1]. Overall this novel methodology lets us preserve these glimpses into the cosmos while still learning about Earth's changing relationship with the Solar System.

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