Remnant impactor traces in micro-scale deposition layers in Australasian microtektites

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Large-scale terrestrial meteorite impacts have significant effects on Earth systems, altering landscapes and changing the evolutionary history of life. They produce large volumes of impact melt and vaporized material. The vaporized impactor condenses and mixes with the molten ejecta, forming mm- to cm-scale distal impact glasses known as tektites. Tektites (and µm-scale microtektites) are found over large geographic regions (strewnfields), such as the Australasian strewnfield, covering ~15% of Earth's surface. The bulk composition of these tektites is representative of upper continental crust, however, the nature and origin of the impactor remains unconstrained.

Fallout glasses, which are formed in near-surface nuclear explosions, share certain physicochemical similarities to tektites. Our recent studies have shown that glassy fallout agglomerates preserve layers of condensed nuclear device material on their surfaces, particularly obvious at the interfaces between two fused objects. We postulate that tektites may similarly preserve condensed impactor material. To this end we investigated microtektites from the Australasian strewn field, using EPMA and NanoSIMS analyses. We identified two microtektites containing multiple µm-scale, high-Z bands similar in size and appearance to the condensation features observed at the interfaces of fused fallout glasses. The microtektites are felsic (SiO_2 ~63 wt.%) in composition, with relatively high MgO and FeO concentrations (>1.5% and >4% wt%). Compositional analysis of the high-Z bands revealed relative enrichments in the abundances of Fe, Mg, Ca, Cr, Ni, and Co, and depletion in Si, Al, Na, and K. We interpret the relative enrichment of Co and Ni in the bands as indicative of condensed impactor contribution. The Co/Ni and Cr/Ni variations across the samples are consistent with recent studies suggesting a basaltic source for this vapor component, such as an achondritic impactor.