Mapping mineral diversity in LL chondrite meteorites

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Abstract. Mineralogy within ordinary chondrite meteorites is known to be highly variable, dependent on petrologic type[1], and the result of differing parent body processes[2]. Quantifying representative mineralogy often involves destructive processes[3,4] which sacrifice petrographic context in the sample. We have combined the non-destructive methods of 3D computed tomography (CT) with 2D X-ray element intensity mapping of surfaces to quantitatively determine mineral modal abundances and variability across petrologic types of LL chondrite meteorites without losing petrographic context in each sample.

Bulk samples of the LL meteorites Semarkona (LL3.0), Parnallee (LL3.6), Soko-Banja (LL4), Savtchenskoje (LL4), Olivenza (LL5), Tuxtuac (LL5), Mangwendi (LL6), Ensisheim (LL6), and Kilabo (LL6) were first CT scanned to characterize their 3D structure and determine the abundance of opaque phases in ~1 cm^3 volumes. The samples were cut and polished to create thick or thin sections of the meteorites, which were mapped in X-ray emission for ten major elements over an area sufficient to characterize mineralogy in a 2D slice. Linear combinations of the element maps were used to determine the mineralogy of each pixel in every map, allowing for calculation of the relative mineral abundances in each meteorite. Opaque (metal) abundances determined from 3D data can be used to check that the 2D modal abundance maps are representative of trace phases.

Preliminary results are consistent with existing literature on ordinary chondrite mineral abundances[3-6]. This work is not only useful as a non-destructive method that preserves petrographic context, but also can be used to characterize laboratory spectroscopic measurements of the meteorite samples (work currently in progress) and help decipher parent-body asteroids[7].

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