QEMSCAN chemical imaging of textures and structures within carbonaceous chondrites and iron meteorites

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A new non-destructive method applying a QEMSCAN instrument fitted with four x-ray detectors for the determination of the mineralogy and for the imaging of chemically distinctive textures and structures within carbonaceous chondrites and iron meteorites has been developed and applied to investigate the genesis of CAI and chondrule inclusions that may have formed within the solar nebula and matrix minerals that may have formed within disrupted differentiated planetesimals.

Preliminary results from the application of this new analytical technique at a resolution of ≤10 μm have been obtained from CAI's and chondrules within the Allende meteorite. Analysis of an Allende CAI a few mm in diameter has distinguished ca. 10μm-sized hibonite dust grains and metallic iron fragments embedded in one of two Ca/Al phases that are heterogeneously distributed and incompletely mixed, possibly as a result of thermal metamorphism. The low Ca/Al phase also forms a thin rim around the exterior of the CAI. Detailed mineral textures and intergrowths, including textures that might have arisen as a result of quenching and impacts, have also been distinguished in a number of Allende chondrules.

Radiogenic decay products of more than 12 short-lived radionuclides have been identified within primitive meteorites, affirming that a stellar nucleosynthesis event occurred within 2 Ma of the onset of formation of our solar system and may have triggered its formation. The nature of the last stellar source that contaminated our solar system's precursor molecular cloud with freshly synthesized elements may be inferred from determination of the relative abundance of short-lived nuclides in the earliest-formed and best-preserved inclusions identified within meteorites. The newly developed QEMSCAN imaging technique will provide not only information directly regarding the evolution of differentiated planetesimals, but also facilitate identification of minerals within inclusions of interest for future isotopic analysis.

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