Mapping geochemical variability across complex carbonate textures

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As the isotopic record of ancient oceanic conditions becomes better resolved, reports of coeval but discordant geochemical/isotopic proxies are becoming increasingly common. Bulk-rock geochemical fingerprints within carbonate minerals consist of a mixture of materials with different origins. Deciphering whether changes in stable isotope and trace elements derives from the relative contribution of secular change versus from variation in the origin of the components of bulk rock is critical in order to extract meaningful information about depositional and diagenetic environments.

We have collected samples from across 5 m laterally spaced carbonate samples within discrete beds from the Ordovician Decorah Formation (Missouri, USA). These samples have been analysed using cathodoluminesce allowing the visualization of the Mn^{2+} and Fe^{2+} contents of calcite cements. In addition, Laser Ablation Inductively Coupled Plasma Spectrometry (LA-ICP-MS) data have been collected, which is a powerful tool allowing the acquisition of high resolution trace element information but rarely used in carbonate rocks. We applied this technique to map the distribution of trace elements (Ca, S, Mg, Fe, Ba, Sr). The high-resolution maps of trace element variability show major differences between clasts and cement, as well as subtle variation in concentrations between fossil clades. Fossils showing different stages of micritization contained higher proportions of TEs and significant differences among fossil shells and background matrix were observed.

These preliminary data set the stage for further detailed analyses to assess the reproducibilty in stable isotopes across a discrete bed. Paired with secondary ion mass spectrometry (SIMS) measurements, this high-resolution approach can distinguish trace element and isotopic signatures between primary and diagenetic phases, enhancing our ability to interpret geochemical signatures and reconstruct biogeochemical cycling over Earth history.