Electron backscatter diffraction (EBSD) as a tool for evaluating fossil preservation for carbonate clumped isotope paleothermometry

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Carbonate clumped isotope thermometry is being widely applied for paleotemperature reconstructions throughout the Phanerozoic. Accurate temperature estimates rely on fossil preservation; thus imaging and chemical techniques are routinely used for sample screening. While conventional textural, chemical, and isotopic techniques are effective at detecting open-system recrystallization, they are not always effective at detecting the closed-system recrystallization or isotopic reordering that can influence clumped isotope compositions. For example, Paleozoic brachiopod shells that appear to exhibit good preservation can have unreasonably high clumped isotope temperatures (D_{47} > 100°C), reflecting burial rather than environmental temperatures. To better identify diagenesis of clumped isotope samples, novel techniques must be employed.

EBSD is an *in situ* microscopy technique providing high-resolution crystallographic information at nano- to micro-scales which can identify modifications to the calcite lattice. Our studies show that Carboniferous brachiopod shells from the USA (NV, IL) and Russia (Urals) appear preserved yet have unusually high temperature values. EBSD reveals poorly ordered lattices ("ghost diffraction") and/or loss of original crystal orientation consistent with recrystallization. In contrast, specimens exhibiting preservation of original crystallographic orientation typically preserve lower temperature values. Thus, EBSD data can provide evidence for fossil preservation, distinguishing between original crystal structure, closed-system recrystallization, and open-system recrystallization.