Advances in glendonite understanding despite precursor ikaite remaining enigmatic

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Geologists have long debated the relationship between the metastable ikaite mineral ($CaCO_3$*$6H_2O$), found today in various polar and cool-water environments, and the calcitic glendonites, found in many intervals of the Phanerozoic sedimentary record (e.g., Rogov et al., 2023). Although the large sub-merged ikaite tufa pillars of Ikka Fjord bear no resemblance to glendonite, large yellow/orange euhedral ikaite crystals resembling glendonite morphology were first found in the Bransfield Strait, offshore Antarctica (Suess et al., 1982), represented in high detail in (Whiticar et al., 2022). Ikaite rapidly breaks down above ~7 °C into less or non-hydrated polymorphs of $CaCO_3$, which has hindered traditional crystallographic investigations. These calcite granules form a mesh of mm-large grains, coined as "guttalatic" texture (Scheller et al., 2022). The guttulatic structure is present in many different aquatic and terrestrial systems and yet appears a defining and common feature of glendonites from marine settings (Scheller et al., 2022; Schultz et al., 2023a). Marine sediment-formed euhedral ikaite is now unequivocally identified as the parent mineral to glendonite, whereby guttulatic microstructure is observed in recrystallized ikaite (Schultz et al., 2023b). The Eocene-aged Fur Formation mega-glendonites, Paleocene and Eocene glendonites of Svalbard, and, more recently, those of the Paleocene-Eocene Thermal Maximum interval retrieved during IODP Expedition 396 (summarized in Rogov et al., 2023), appear inconsistent with cold temperature formation of ikaite; supporting findings from laboratory studies that ikaite may precipitate at warmer temperatures under certain chemical conditions (Tollefsen et al., 2020). Ikaite might also lead to new possibilities for carbon storage. Indeed, ikaite might be used as a catalytic precursor for subsequent precipitation of stable calcite. However, this requires better understanding of the catalysing agents that favour the formation of ikaite, a problem that has so far remained unsolved.

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