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Control of a calcite inhibitor (phosphate) and temperature on ikaite precipitation in Ikka Fjord, southwest Greenland

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#### ACCEPTED MANUSCRIPT

- 1 Control of a Calcite inhibitor (phosphate) and Temperature
- on Ikaite precipitation in Ikka Fjord, Southwest Greenland
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## 13 Keywords

14 Ikaite, Ikka Fjord, seawater, orthophosphate, calcite inhibitors, precipitation

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- 16 Abstract
- 17 Ikaite (CaCO<sub>3</sub>·6H<sub>2</sub>O) forms submarine tufa columns in Ikka Fjord, SW Greenland.
- 18 This unique occurrence is thought to relate to aqueous phosphate concentration and
- 19 low water temperatures (< 6 °C). Phosphate ions are well-known inhibitors of calcite
- precipitation and Ikka Fjord has a naturally high-phosphate groundwater system that
- 21 when mixing with seawater leads to the precipitation of ikaite. In the study presented
- here, experiments simulating conditions of Ikka Fjord show that a) the formation of
- ikaite is unrelated to the aqueous phosphate concentration (0–263 µmol/kg PO<sub>4</sub><sup>3-</sup>) in
- 24 0.1 M NaHCO<sub>3</sub>/0.1 M Na<sub>2</sub>CO<sub>3</sub> solutions mixing with seawater at 5 °C and pH 9.6–
- 25 10.6, and b) ikaite forms at temperatures up to 15 °C without phosphate and in open
- beakers exposed to air. Instead, supersaturation of ikaite and the seawater composition
- are the likely factors causing ikaite to precipitate in Ikka Fjord. This study shows that
- adding Mg<sup>2+</sup> to a NaHCO<sub>3</sub>/Na<sub>2</sub>CO<sub>3</sub> CaCl<sub>2</sub> mixed solution leads to the formation of
- 29 ikaite along with hydrated Mg carbonates, which points to the high Mg<sup>2+</sup>
- 30 concentration of seawater, another known inhibitor of calcite, as a key factor
- 31 promoting ikaite formation. In experiments at 10 and 15 °C, increasing amounts of
- either nesquehonite (Mg(HCO<sub>3</sub>)(OH)·2H<sub>2</sub>O) or an amorphous phase co-precipitate
- 33 with ikaite. At 20 °C, only the amorphous phase is formed. In warming Arctic
- seawater, this suggests Mg carbonate precipitation could become dominant over ikaite

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