Ikaite column formation explained by secondary alteration of a syenite-carbonatite complex

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Hundreds of tufa columns composed of ikaite ($CaCO_3 \cdot 6H_2O$) stand at the bottom of Ikka Fjord in SW Greenland. Why these cold water tufa columns form only at this site is not known. Nepheline-syenite and carbonatite rocks, part of the Grønnedal-Ika igneous complex, surround the fjord and an association with the columns has been suggested. Sodium-carbonate rich spring water emerges from the bottom of the fjord and mixes with seawater. Ikaite precipitates from this mixture at a high rate; the columns can grow up to 0.5 m per year. In this study we show that low temperature alteration in the complex provides the sodium and carbonate in the spring water. Sodium ions are released when nepheline is replaced by illite and analcime in the nepheline-syenite rocks and carbonate ions are released when siderite is oxidised to goethite in the carbonatite rocks.

With a mass balance calculation we show that the volume of carbonate in the complex is more than sufficient to produce the necessary amount of carbonate for the columns to form and an estimated time frame for the production is ~600 years. More than 500 carbonatite complex have been located world-wide, but only the Grønnedal-Ika complex meets the requirements for ikaite column formation: 1) the presence of both nepheline and siderite, 2) high latitude location and 3) a marine setting.