

Isotope hydrology (^2H and ^{18}O) of water from the arctic Ikka Fjord, SW Greenland, and its relation to ikaite formation

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The small Ikka Fjord in arctic SW Greenland is home of more than a thousand submarine tufa columns originally composed of the metastable carbonate mineral ikaite ($\text{CaCO}_3 \cdot 6\text{H}_2\text{O}$, Buchardt et al. 1997). Several expeditions have visited the fjord between 1995 and 2021 with focus on geology, topography, biology, and hydrology of the columns. As part of the program more than 350 water samples have been collected over a period of 25 years from streams, springs, and lakes in the catchment areas of the fjord and from the fjord itself and analysed for ^{18}O - and ^2H -concentrations. This work presents the results from isotope studies of the different water types. The following conclusions can be made: 1) Seasonal effects of approx. 13‰ $\delta^2\text{H}$ and 2‰ $\delta^{18}\text{O}$ exist in isotopic composition of stream samples between early field campaigns (June and early July, depleted) and late field campaigns (late July and August, enriched). 2) A negative altitudinal effect (-12‰ $\delta^2\text{H}$ and -1.5‰ $\delta^{18}\text{O}$) can be seen in different stream waters sourced from close to sea level and up to 900 meters of elevation reflecting the precipitation at the source areas. 3) The freshwater samples define a local meteoric water line (LMWL: $\delta^2\text{H} = 6.4 \cdot \delta^{18}\text{O} - 11.6$, $R^2 = 0.97$) different from the general Global Meteoric Water Line. No significant secular changes in the isotopic compositions of the different freshwater systems have been noticed over the 25 years of sampling. 4) Samples from the fjord system exhibit a well-defined linear mixing between sea water from the Davis Strait ($\delta^2\text{H} \approx -9\text{‰}$, $\delta^{18}\text{O} \approx -1\text{‰}$) and stream water flowing into the fjord from the surrounding highlands ($\delta^2\text{H}$ between -100‰ and -115‰; $\delta^{18}\text{O}$ between -12‰ and -16‰). 5) The composition of submarine spring water sampled from the Ikka columns is strongly influenced by sampling method and reflects the degree of contamination from fjord water. The least contaminated samples (drawn by syringes embedded in the columns) have isotopic compositions ($\delta^2\text{H}$ between -88‰ and -95‰; $\delta^{18}\text{O}$ between -12.5‰ and -13.4‰) close to that of the most depleted stream waters and support the hypothesis that columns are fed from precipitation falling at elevated altitudes.

References

Buchardt, B., Seaman, P., Stockmann, G., Düwel, L., Jenner, C., Kristensen, R., Kristiansen, Å., Petersen, G[†], Thorbjørn, L. and Whiticar, M., 1997: Nature 390, 129-130.