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First investigations of fine-grained cryogenic cave carbonates from a High-Arctic permafrost karst system in Greenland

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In recent years, cryogenic cave carbonates (CCC) have become the focus of studies tracking past climate change in periglacial environments. Two types of these speleothems occur, fine-grained CCC (CCC_{fine}), which form due to the rapid freezing of a thin water film on ice, and coarse-grained CCC whose origin is related to the slow freezing of water pockets inside cave ice. Here, we report for the first time the occurrence of CCC_{fine} from a cave in northeast Greenland, presently situated in continuous permafrost.

Eqik Qaarusussuaq (Cove Cave), located at 80.2° N, is a 103 m long, gently-dipping phreatic passage that was discovered during the 2019 Greenland Caves Project Expedition (www.greenlandcavesproject.org). CCC_{fine} were found in a dry chamber 65 m behind the entrance. The cave air temperature at the CCC site of -14.7 °C contrasts with outside air temperatures of up to +18.0 °C in July 2019. This, together with current dry conditions at the sampling site, indicates that water infiltration, necessary for CCC formation, is not possible under present-day climate conditions. This is further supported by a lack of ice found within the cave.

Stable isotope analyses of CCC show $\delta^{18}O$ values ranging from -21.9 to -16.0 ‰ and $\delta^{13}C$ values between 8.4 and 11.7 ‰ VPDB. While the $\delta^{13}C$ values are consistent with published data of CCC_{fine} from caves at lower latitudes, the $\delta^{18}O$ values are significantly lower and plot in the field of CCC_{coarse} (cf. Žák et al., 2018). This shift reflects the much lower $\delta^{18}O$ values of meteoric precipitation in northeast Greenland compared to lower latitude sites.

Exploratory radiocarbon dating suggests that CCC_{fine} formed in this High Arctic cave as recent as during the end of the Little Ice Age.

Reference

Žák, K., Onac, B.P., Kadebskaya, O.I., Filippi, M., Dublyansky, Y., Luetscher, M., 2018. Cryogenic mineral formation in caves. In: Perşoiu, A., Lauritzen, S.-E. (Eds.), Ice caves. Elsevier, Amsterdam, Netherlands, pp. 123–162.