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High-resolution marine Holocene record from an Arctic fjord of Svalbard: stable isotopes, micro- and macrofauna, geochemistry and lithology

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IMAGES core MD99-2305 retrieved in Von Mijen Fjord of Svalbard has penetrated a complete, uninterrupted package of Holocene sediments 16 m thick. The western coast of Svalbard, where the fjord opens to the Greenland Sea, meets a terminal branch of the Gulf Stream system and thus is potentially sensitive to the influx of Atlantic heat to the Arctic.

The fjord basin is 50 km long, 10 km wide and 115 m deep. Influx of the warm Atlantic Water from the adjacent sea is much reduced at present owing to a shallow (25 mwd) sill at the mouth. Seasonal ice stays 8 months a year. A low-salinity surface layer (some 30psu) develops in summer. A local water mass with negative temperatures and slightly reduced salinities (34.0-34.5psu), which forms in the fjord during the freeze-up, fills the basin and is partially removed during summer. A major tidewater outlet glacier feeds meltwater and small icebergs into the fjordhead, ca. 40 km upfjord from the coring location. The chronology is constrained by 23 AMS C-14 dates. Holocene sedimentation is uninterrupted. The accumulation rate is 3 to 4 m/kyr in the Early Holocene and steadily decreases to 1 m/kyr in the Middle and Late Holocene. The core top (perhaps, the last 300 yr) was destroyed during coring.

Deglaciation of the fjord took place at 11.2 cal. kyr BP. The ablation was dominated by iceberg calving, whereas meltwater production was small, as suggested by a moderate sedimentation rate, the absence of laminated deposits and a lack of the typical

meltwater-affected foraminiferal assemblages. Due to postglacial rebound, the depth of the sill was decreasing rapidly from plus 45-50 mwd at 11.2 kyr to plus 15 mwd at 8.8 kyr, as compared to the modern 25 mwd (the uplift dates are adapted from Landvik et al 1987), The decreasing sill depth resulted in progressive isolation of the fjord basin.

Seasonal ice, interpreted from the occurrence of winnowed subtidal foraminifera, nearly ceased forming at 10.7 kyr, resumed at ca. 9.0 kyr, and has been present in the fjord since. The cold, brine-injected local water probably started to accumulate in the deep basin since ca. 6 kyr, as suggested by the change of the dO-18 trend toward lighter values.

Productivity (inferred from calcareous benthic foram accumulation rate, mollusk occurrences, C/N ratio and dC-13) was generally high between 10.5 to 7.5 kyr, peaking at 9.5 kyr and being eventually interrupted by short declines, which are difficult to interpret. Productivity kept decreasing from 7.5 to 3.5 kyr and has stayed low afterwards. Our explanation of the increased productivity between 10.5 and 7.5 kyr is that the summer stratification of the water column in the fjord was maintained by temperature rather then by salinity, as it is today.

Temperature of the bottom water in the fjord seems to have been stable and low over the Holocene. There has been no invasion of boreal foraminiferal taxa into the fjord. Bivalves in the core occur predominantly in the early Holocene. Unlike the shallow-water thermophillous blue mussel of Svalbard (Salvingsen 2002), to which our bivalves are contemporaneous, they are not thermophillous and do not reveal any temperature increase in the basin ca.100 m deep. We infer that bottom temperature in the fjord even during the local climatic optimum at 9.5 kyr was only slightly higher than today, perhaps, 0°C to 2°C year-round. Planktonic foraminifera are predictably rare in this silled fjord. They occur throughout the Holocene but are most frequent between 10.3 and 8.7 kyr. This interval coincides with the Holocene temperature maximum in the SW Barents Sea of Sarnthein et al (2003). Probably, at this time the influx of warm water was largest and the surface temperature was at its maximum.

Overall, in the studied fjord of Svalbard, the Holocene climate change has been small and gradual. No 1000-yr or 100-yr harmonics is revealed. Soon after the deglaciation at 11.2 kyr BP, the temperature and, driven by it, productivity reached a maximum at ca. 9.5 kyr BP. After that, both temperature and productivity have been decreasing reaching minimal values in the Late Holocene.