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High-resolution 1000-year sediment records from the North Iceland shelf: temperature reconstructions and marine reservoir ages

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Palaeoceanographic and climatic high-resolution archives for the last millennium are preserved in several sedimentary basins on the North Icelandic shelf. The present position of the oceanographic Polar Front across the North Icelandic shelf separates Polar and Arctic surface waters of the East Greenland and East Icelandic currents from branches of the North Atlantic Current. The sedimentary and fossil record, which is extremely sensitive to past oceanographic and climatic changes in a boundary region like that, has shown that the position of the Polar Front has been very dynamic through the last millennium.

Our study is based on material from the IMAGES piston cores MD99-2275 and MD99-2273, located at 440 and 600 m water depths, respectively, combined with lead-dated multicores from the same sites off North Iceland. The mean sedimentation rate at the core sites is about 300 and 600 cm per 1000 years in respective cores. The presence of historically and terrestrially dated air-fall tephra markers from Icelandic volcanoes makes it possible to construct a reliable tephrochronological age model for the marine cores, minimizing the problem of variable marine radiocarbon reservoir ages.

A 1000-year sea surface and bottom water temperature record has been reconstructed for each site based on stable isotopes, as well as on planktonic and benthic foraminiferal and diatom transfer function calculations. A comparison between our proxy results for the last 130 years with instrumental data from the North Icelandic shelf shows a strong connection between atmospheric and oceanic changes. For instance, there is a clear change in the faunal distribution and the reconstructed sea-surface temperature at around AD 1910-1920, a general cooling trend towards the top of the record, and a slight warming again in the 1990s. Instrumental data from the last 60 years are used for calibration of the 1000-year temperature record. A weakening of the North Atlantic Current and penetration of cold Polar and Arctic water masses and sea-ice to the North Icelandic shelf occurred during the Little Ice Age, which in our record is characterized by low reconstructed sea surface and bottom water temperatures. The Maunder Minimum (around AD 1700) appears to have been the coldest interval during the last millennium.

Changes in the marine radiocarbon reservoir ages through time on the North Icelandic shelf appear to be related to the inflow of Polar waters to the area. This enables us to use the deviation in reservoir age as a palaeoceanographic tool for tracing changes in the position of the oceanographic Polar Front. The modern (pre-bomb) reservoir age of the coastal water masses off Iceland, which are dominated by the Atlantic Water of the Irminger Current, is generally assumed to be about 400 years, and this correction is conventionally applied to marine radiocarbon ages from Iceland. The modern reservoir age of the Polar Water of the East Greenland Current north of the Polar Front is relatively high, about 550 years, indicating that the recent, pre-bomb apparent age difference across the Polar Front is about 150 years.

Age models developed for the shelf sediments north of Iceland, based on offshore tephrochronology on one hand and on calibrated AMS radiocarbon age determinations of marine molluscs on the other, display major deviations through the last 1000 years. The discrepancies between the two age models show that there was an

average reservoir age of about 550 years, which is suggested to be related to a generally high, but fluctuating, inflow of Polar waters to the area through the last millennium.