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Rapid changes in ocean circulation and climate along the north Icelandic shelf: a multiproxy perspective from the last millennium

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Here we provide radiocarbon data for the north Icelandic shelf waters during the last millennium based on annually-banded molluscs and high-resolution sediment archives. Additionally, we provide a shell growth record that has been calibrated and validated with a nearby instrumental series, which allows us to estimate past summer seawater temperatures. The master shell chronology is based on long-lived bivalves (Arctica islandica L.), which were live-caught in 2006 in a relatively shallow shelf setting (80 m) near the island of Grimsey. Using the dendrochronological technique of cross-dating, we have successfully linked dead-collected A. islandica shells with the modern master chronology and established a continuous shell chronology for most of the last millennium. The nearby sediment archives are from relatively deep sites (400 – 600 m) along the shelf. These sediment records utilize tephrochronological age/depth models, which provide a unique opportunity to accurately constrain the age of fossils contained within these cores. Using the radiocarbon data from selected A. islandica shells and carbonate-based fossils in the sediment cores, we calculate Delta R values (deviation from the modelled global mean surface ocean reservoir age of about 405 14C years) to infer the relative position of the Polar Front. The oceanic Polar Front is now situated in the Denmark Strait between Greenland and Iceland where the relatively warm and saline waters from the North Atlantic flow clockwise around Iceland as the Irminger Current and mix with the relatively cold and low saline waters of the East Icelandic Current. Because the Irminger and East Icelandic currents have distinctly different physical properties and radiocarbon reservoir ages, biogenic archives that calcify in these waters reflect the dominant water mass present during biomineralization. Our combined dataset suggests that the Polar Front location was near its present day location from AD 1000 – 1300 and since AD 1850. From AD 1300 – 1850, during the Little Ice Age, the mean Delta R values reached a maximum, suggesting that the Polar Front location moved southward of the north Icelandic shelf during this interval; the onset and termination of the Little Ice Age for the north Icelandic shelf waters occurred rather abruptly (<20 years). The implications of these findings are discussed with respect to the interpreted palaeoceanographic evolution of the north Icelandic shelf during the last millennium.