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## High resolution marine records of the last glacial/interglacial transition from the Hebridean margin, N.W. Scotland

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It is increasingly apparent that the last glacial-interglacial transition (the Lateglacial period) may provide insights into the underlying processes acting within our planet's ocean-climate system. Short-lived, but severe climatic anomalies, such as the Younger Dryas cold phase (ca. 11–10 ka BP), indicate the importance of oceanic circulation and particularly changes in the rate or style of thermo haline overturn in the North Atlantic during deglaciation. Such anomalies, which can only be resolved from high sedimentation rate sites, challenge our perceptions of long-term changes in incident solar radiation forcing climate change and illustrate the internal discontinuities to which the system is prone.

We present data from two short cores recovered at a water depth of 156 m from the St.Kilda Basin of the Hebridean Shelf, N.W. Scotland (fig. 1). The records are supported by AMS radiocarbon chronologies measured upon marine molluscs, details of which are given by Peacock et al. (1992). The benthic foraminifera are discussed by Austin (1991); here we summarise the major faunal assemblage changes from British Geological Survey (B.G.S.) vibrocore 57/-09/89 (fig. 2). Immediately, as the local foraminiferal assemblage zonation illustrates, the benthic foraminifera allow a climatostratigraphic subdivision of the sequence; these are also supported by grain size, calcium carbonate, organic carbon and other proxy records (Austin and Kroon, submitted). A second core, B.G.S. vibrocore 57/-09/46, contains an expanded Younger Dryas – early Holocene record (fig. 3). The transition at a core depth of about 100 cm, although not entirely unidirectional, represents a sudden shift from cold, arctic-dominated to warm, boreal-dominated faunas. This amelioration begins at  $10\,175 \pm 110$  radiocarbon years BP<sup>Y</sup>. A precursor to this main amelioration, centred at about 10 200 radiocarbon years BP<sup>Y</sup>, is clearly seen at a core depth of

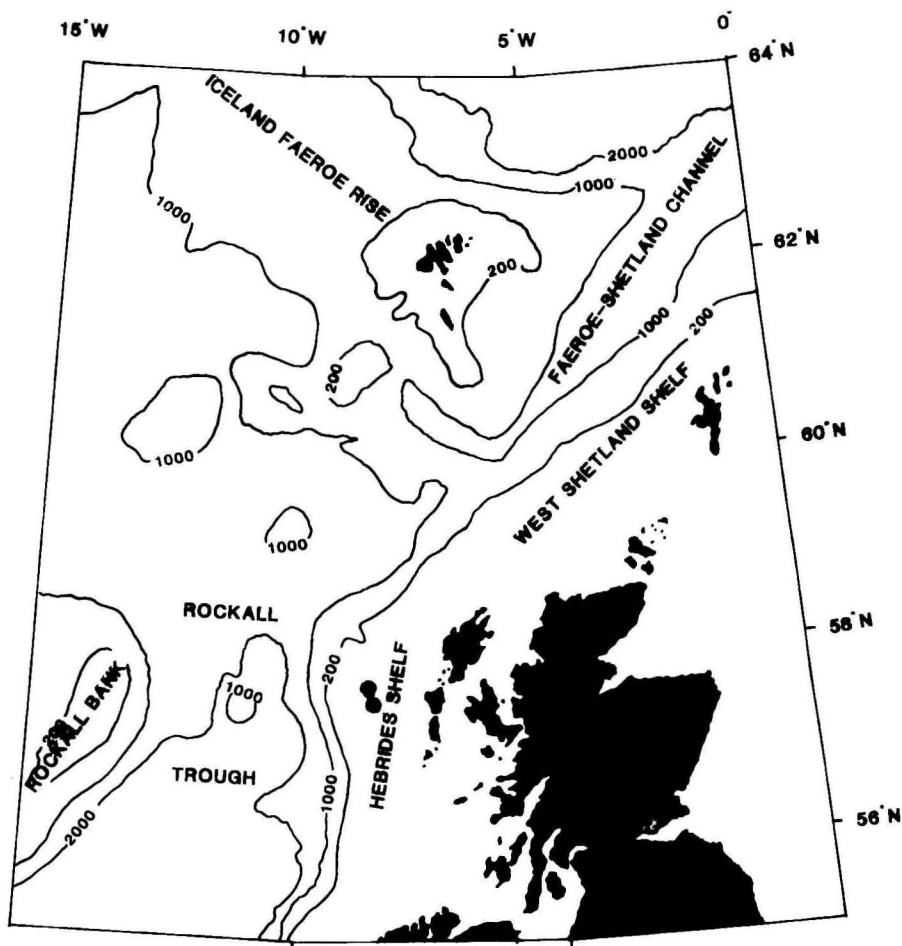


Fig. 1. Location of the cores on the Hebridean Shelf indicated by closed circles.

180 cm and indicates hitherto unresolved climatic structure within the marine Younger Dryas record (Austin and Kroon, submitted).

The benthic foraminifera respond in a complex manner to the changing environmental conditions which have acted upon this margin during the last glacial/interglacial transition. However, we believe that the overriding environmental factor which explains most of the variation within the assemblage data is summer water temperature. The first principal components, based upon a principal components analysis (PCA) of the distribution of the dominant species from both cores, explain 44.3% and 49.3% of the variation for cores 57/-09/89 and 57/-09/46 respectively. For example, the Younger Dryas – early Holocene transition within core 57/-09/46 shows a rapid shift from negative first axis scores to highly positive first axis scores which can be directly related to a changeover from arctic dominated to boreal dominated assemblages, since

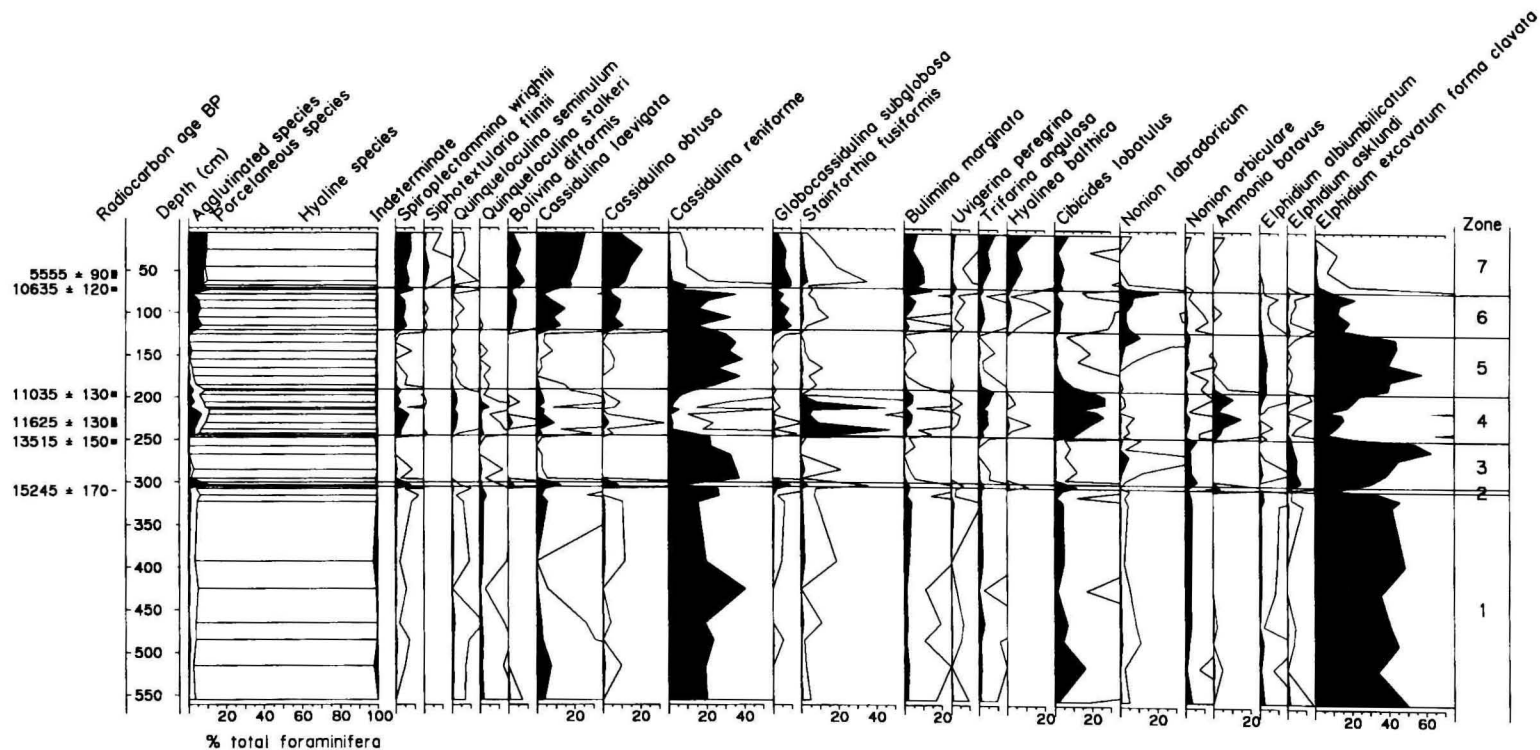


Fig. 2. Summary benthic foraminiferal diagram for vibrocore 57/-09/89. Reservoir age correction of  $405 \pm 40$  applied.

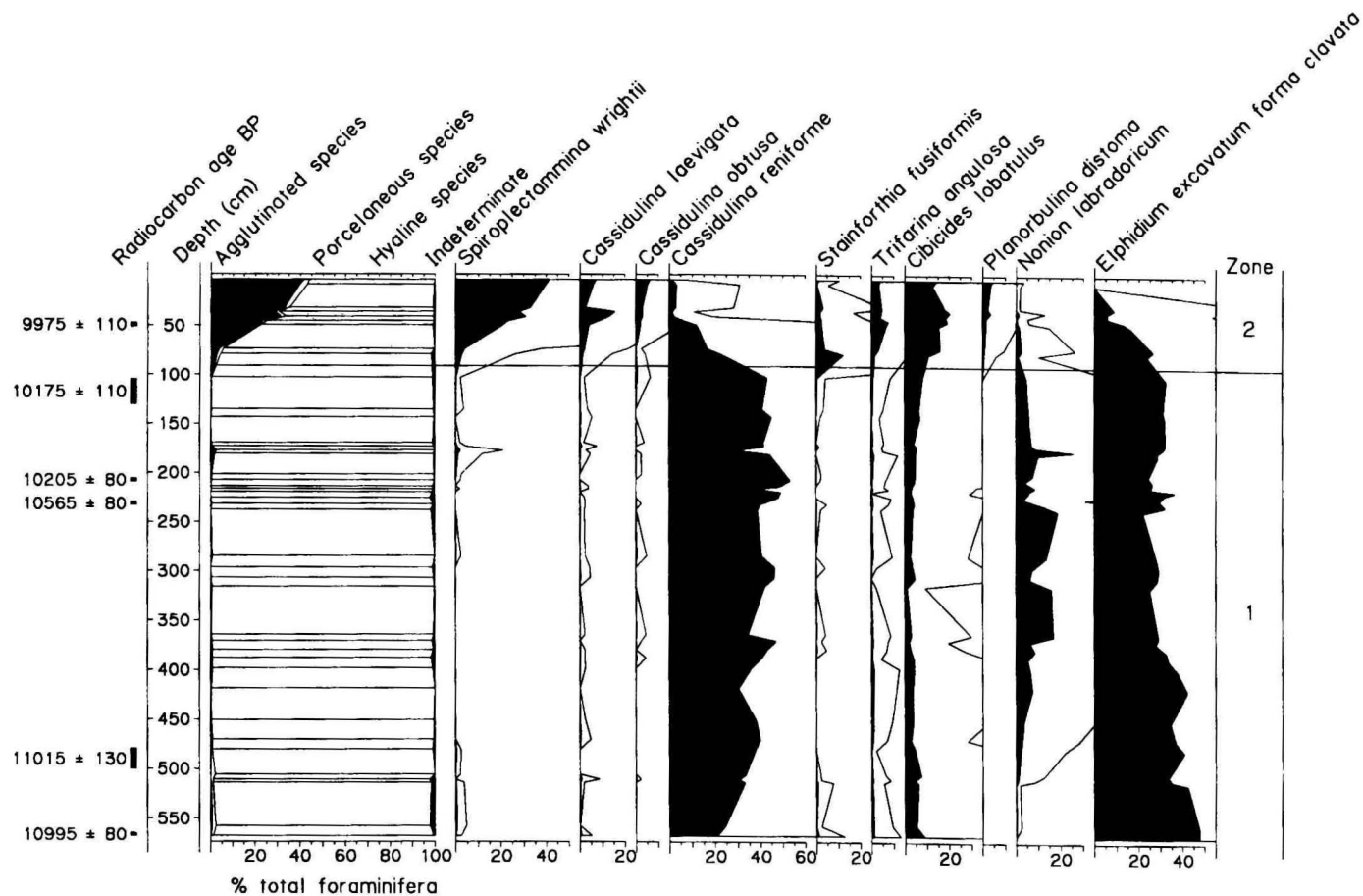


Fig. 3. Summary benthic foraminiferal diagram for vibrocore 57/-09/46. Reservoir age correction of  $405 \pm 40$  applied.

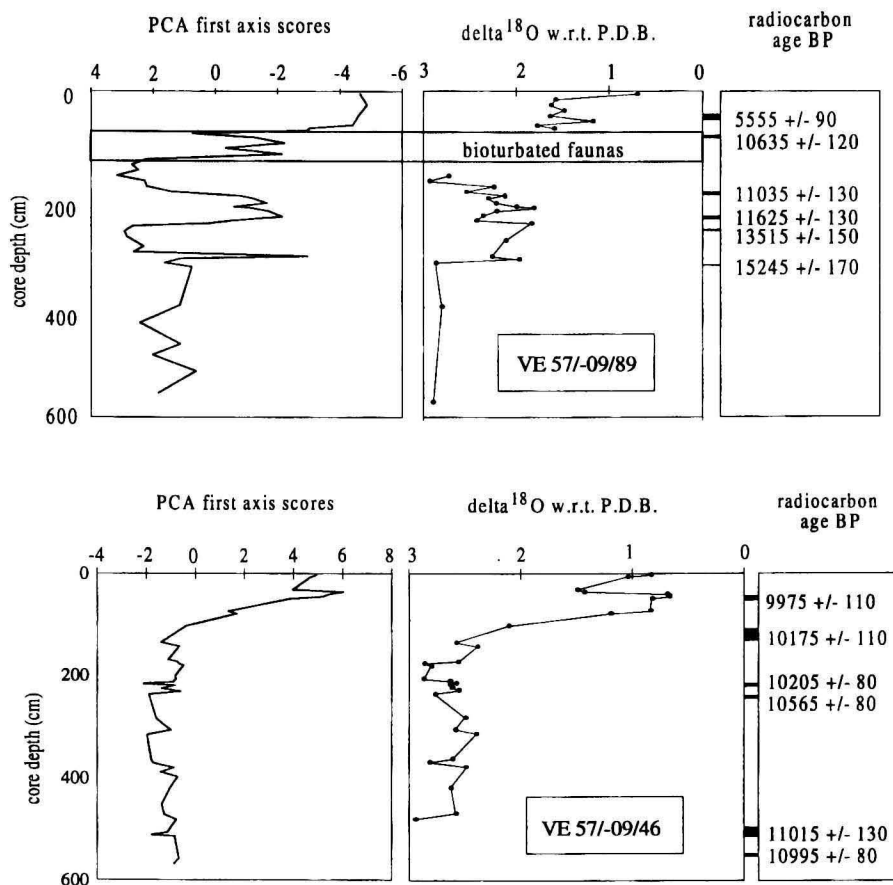


Fig. 4. First principal component scores and oxygen isotope values for *Cibicides lobatulus*.

these two groups dominate the species contribution to this component. A similarly rapid, possibly faster shift is observed in the stable oxygen isotope record of *Cibicides lobatulus* (Walker and Jacob) (fig. 4). The correspondence between the shift to lower oxygen isotope values and the first principal component scores suggest that this is a temperature effect and that the rapid warming through this interval is of the order of 8°C.

However, shifts to lower oxygen isotope values need not always correspond to increasing water temperatures, but can also be explained by low salinity. Preliminary results indicate that during the interval of assemblage zone 3, core 57/-09/89, low oxygen isotope values occur. This assemblage contains cold water indicator species, as expressed by the first principal component scores, and also contains species such as *Elphidium asklundi* Brotzen which is thought to tolerate low salinity waters. Thus, zone 3, dated at its base to 15245  $\pm$  170 radiocarbon years BP<sup>✱</sup> and giving way to warm Lateglacial interstadial assemblages at about 13515  $\pm$  150 radiocarbon years BP<sup>✱</sup> represents the main

phase of deglaciation of the British ice sheet. This period of deglaciation represents a significant meltwater release onto the Hebridean Shelf and into the N.E. Atlantic and may contribute to the meltwater record which Duplessy et al. (1993) have attributed to the melting of the Scandinavian ice sheet during the same interval.

We conclude that the oxygen isotope records of benthic foraminifera in continental shelf sediments provide a record of temperature and salinity variations. Faunal changes, quantified by principal component analysis, help us to distinguish the periods of climatic amelioration. Stable isotope measurements of the eurythermal, epi-lithic, benthic species *C. lobatulus*, which spans the entire Lateglacial period from the continental margin of N.W. Scotland, are largely coincident with changes in the first principal component scores related to the faunal assemblage data. We interpret this faunal and isotopic record as reflecting water temperature variation immediately adjacent to the Atlantic seaboard of N.W. Scotland. Water temperature variation from the shelf records confirm the pattern and timing of North Atlantic Polar Front movement as seen in the open ocean records (Duplessy et al., 1993).

✧(reservoir age correction of  $405 \pm 40$  applied)

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