A review of the environmental history of Iceland, 13 000–9000 yr BP

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ABSTRACT: A synthesis of the main environmental changes that are interpreted to have occurred in Iceland during the period 13–9 ka BP is presented. Most of the evidence available relates to variations in the position of ice margins, although some limited information on vegetation history and soil stability is also referred to. Only qualitative and limited climatic inferences can be made for this period because of the lack of detailed evidence. A summary curve of the relative extent of ice cover is presented.

KEYWORDS: Ice-margin variations, radiocarbon-dated mollusc assemblages, pollen records, tephra layers.

A contribution to IGCP-253

Introduction

One of the problems of reviewing the environmental history of Iceland at the termination of the Pleistocene is the poor resolution of the data available, mainly resulting from the lack of good chronological control of the event stratigraphies (Inglófsson, 1991; Norddahl, 1991). The late Weichselian and early Holocene strata hitherto studied in Iceland are usually incomplete and often lack datable material. The chronology of late Weichselian–early Holocene environmental changes is based on relatively few 14C dated samples of subfossil marine molluscs found in deglaciation sequences in the coastal areas, and a very limited number of radiocarbon-dated lacustrine sediments. Chronological determinations, in areas where datable material has yet to be recovered, are based mainly on stratigraphical and geomorphological correlations and on an apparent parallelism between the course of events in separate areas. Tephra layers are rarely found in inorganic subsoil profiles, and the utilisation of tephrochronology for dating late Weichselian and early Holocene environmental changes is limited because Iceland, except for some peninsulas and elevated coastal mountains, was almost completely ice-covered until the early Holocene. The most important tephra material from the time prior to the final deglaciation of Iceland is the Skógar tephra in northern Iceland, which has been correlated with the Vedde Ash Bed, ca. 10 600 yr BP (Norddahl and Halldíason, 1992). The occurrence of the Skógar tephra, both in inorganic and organic sediment sequences, offers a unique opportunity for distant stratigraphical correlations.

Only two biostratigraphical sequences that extend beyond 9000 yr BP have been investigated (Hallsdóttir, 1991; Björck et al., 1992). Thus the environmental history of Iceland during the period 13000–9000 yr BP is based mainly on geomorphological and lithostratigraphical studies, which have focused on glacial oscillations and sea-level changes. The climatic reconstruction (Fig. 1) for the period 13000–10000 yr BP is based on biostratigraphical information from subfossil molluscs in glaciomarine deposits in western Iceland, and for the period 10 400–9000 yr BP on biostratigraphical information from a pollen-analysed lake sediment sequence in northern Iceland. Owing to its position in the middle of the North Atlantic Ocean, at the boundary between Arctic and Boreal domains, the climate and, consequently, the extent of glaciers in Iceland was highly sensitive to changes in oceanic and atmospheric circulation. Therefore, the history of glacial oscillations in Iceland primarily reflects regional North Atlantic climatic variations.

Environmental trends and their 14C ages

Glacial events in a period of very dynamic environmental changes are not always interpreted easily in terms of climate. During the past few years, however, more high-resolution data have been produced and more detailed event stratigraphies with good chronological control are arriving by the day. As yet we find it impossible to quantify climate reconstructions (Fig. 1) beyond relative terms of ‘cold’, ‘cool’ and ‘warming’, and the resolution of the data does not allow for a tighter interval than 1000-yr time-slices in our review. Apart from briefly reviewing the environmental history of Iceland at the termination of the Pleistocene, this report tries...
ICELAND

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Figure 1 A summary of Late Weichselian and early Holocene environmental changes in Iceland.

Iceland. A marine transgression in northeast Iceland was probably accompanied by a glacier readvance at about 12700 yr BP (Pétursson, 1991). By 12300 yr BP the ice margin was inland of the present coast, at least in western and northeastern Iceland (Ingólfsson, 1991; Norddahl, 1991). Towards the end of the period, relative sea-level was higher than during the Holocene (10000 yr BP) marine limit. The ocean was relatively warm, as indicated by a boreal–arctic Macoma calcarea mollusc community described from glaciomarine sediments in western Iceland (Ingólfsson, 1991).

12 000–11 000 yr BP

The available data provide a low to medium resolution of the stratigraphical and geomorphological evidence. Relative sea-level was somewhat higher than today's throughout the period. A glacier readvance, which culminated at about 11800 yr BP in western Iceland (Fig. 2), reached a position seawards of the present coast (Ingólfsson, 1991). The climatic significance of this readvance is not clear. Glaciers in fjords and valleys in other parts of the island probably terminated close to the present coast (Norddahl, 1991). Relatively large ice-free areas were present on peninsulas and in elevated coastal mountains, especially in northern Iceland. Glaciomarine sequences in western Iceland, carrying arctic faunal species (Portlandia arctica, Buccinum groenlandicum), have been dated to about 11 000 yr BP. These could indicate a southward displacement of the marine polar front.

11 000–10 000 yr BP

For the period 11000–10000 yr BP there is low to medium resolution of the lithostratigraphical and geomorphological data, but medium to high resolution for biostratigraphical data dated to later than 10400 yr BP. During a glacier readvance, which most likely culminated at about 10600 yr BP in western and central northern Iceland (Fig. 2), the continuous inland ice reached to or beyond the present coastline around the whole island, except for some of its most peripheral parts in western, northern and northeastern Iceland (Ingólfsson, 1991; Norddahl, 1991). The Reykjafjark area in southwest Iceland was probably also overridden by glaciers sometime during this period (Hjartarson, 1989).

10 000–9000 yr BP

There is a medium to high resolution of available stratigraphical and geomorphological data. Early Preboreal (9800–9600 yr

>13 000 yr BP

Extensive glaciation characterised the period between the Weichselian maximum and 13 000 yr BP, with the inland ice reaching off-shore around the whole island. The initiation of ice retreat, which occurred sometime before 13 000 yr BP may have been due to climatic amelioration or alternatively to a rise in global sea-level.

13 000–12 000 yr BP

Available data provides only a poor to medium resolution of the geomorphological, litho- and biostratigraphical evidence from coastal areas in western Iceland and northeastern

10 000–9000 yr BP

There is a medium to high resolution of available stratigraphical and geomorphological data. Early Preboreal (9800–9600 yr

Weichselian maximum

This is inadequately defined both in space and time, because ice margins were off-shore, around the island. In general, erosion prevailed inland from the present coast while extensive sedimentation occurred on the shelf or at shelf margins. Ice thickness over central Iceland was more than 1000 m, leading to heavy glacio-isostatic down-warping. Ice-free enclaves occurred in coastal areas (Fig. 2). A full glacial climate prevailed.
BP) glacier readvances and/or ice-marginal still-stands have now been recorded from southwestern, central northern and central southern Iceland (Fig. 2), and probably also in central eastern Iceland (Hjartarson and Ingólfsson, 1988; Ingólfsson, 1991; Norddahl, 1991). After about 9600 yr BP, rapid deglaciation occurred and a pollen record from central northern Iceland indicates a transition from a cold climate by 10400 yr BP to interglacial subpolar maritime climate, characterised by birch–juniper heathlands, by ca. 9200 yr BP (Björck et al., 1992). There was a very rapid glacioisostatic rebound, with relative sea-level below present sea-level by 9400 yr BP in southwestern Iceland (Thors and Helgadóttir, 1991). Intense volcanic activity in Iceland produced extensive tephra layers, which give good possibilities for tephostratigraphical dating and correlations (Björck et al., 1992).

Concluding remarks

The late Weichselian–early Holocene deglaciation history of Iceland now contains four plausible glacier readvances in the period between 12700 yr BP and 9700 yr BP. Two of these episodes, at about 10600 yr BP and 9700 yr BP were marked by widespread, probably synchronous readvances in several areas. These concurrent changes in the extent of the Icelandic ice sheet probably reflect regional climatological changes in the North Atlantic region and an altered mass-balance of the inland ice sheet. The environmental history of Iceland at the termination of the Pleistocene reflects climatic changes associated with oscillations of the North Atlantic marine polar front during deglaciation. It is possible to monitor these changes as reflected in terrestrial sequences, and via correlations with deep-sea data and Greenland ice-cores (Sveinbjörnsdóttir and Johnsen (1991), which indicate a dynamic picture of the North Atlantic environmental history at the last glacial–interglacial transition. Current research is aimed at obtaining higher resolution stratigraphical data from Iceland, and special efforts are directed at high-resolution lake sediment sequences covering the last glacial-interglacial transition. More detailed sea-level displacement curves constitute another important research objective.

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References


