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Approaches to Vínland

A conference on the written and archaeological sources
for the Norse settlements in the North-Atlantic region
and exploration of America

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North Atlantic Climate *c.* A.D. 1000: Millennial Reflections on the Viking Discoveries of Iceland, Greenland and North America*

I. Introduction

> The country seemed to them so kind that no winter fodder would be needed for the livestock: There was never any frost all winter and the grass hardly withered at all. (A description of Vínland from Grœnlendinga saga)

It has been suggested that the North Atlantic region experienced a relatively mild climate around the time of Viking expansion (*c.* A.D. 800–1100), and thus during the Norse settlement of Iceland (*c.* A.D. 870) and Greenland (*c.* A.D. 985) and also during the voyages of the Norse to North America (*c.* A.D. 1000). According to the eminent climatologists C.E.P. Brooks (1949), Herman Flohn (1950), Hubert Lamb (1977), and other researchers, this expansion occurred during the so-called 'Medieval Warm Period', the existence and extent of which have been the subject of much debate (see, for example, Ogilvie 1991, 1998; Hughes and Diaz 1994; Ogilvie and Farmer 1997). This debate is not entered into here; instead, current knowledge regarding environmental and climatic conditions of the North Atlantic region in the present and in the past is outlined. In particular, the times of exploration and settlement for Iceland, Greenland, and 'Vínland' are considered. The main focus will be on three separate lines of evidence: documentary written records, mainly from Iceland; isotopic ice-core records from the Greenland ice sheet; and marine sediment cores from Nansen Fjord, Greenland. These proxy climate records provide information about important factors such as relative temperature and sea ice in the years around A.D. 800–1100 and thereafter.

II. Historical Background

The Viking Age

The 'Viking Age' traditionally refers to the period from around *c.* A.D. 800–1100, when people of Scandinavian origin, primarily from modern-day

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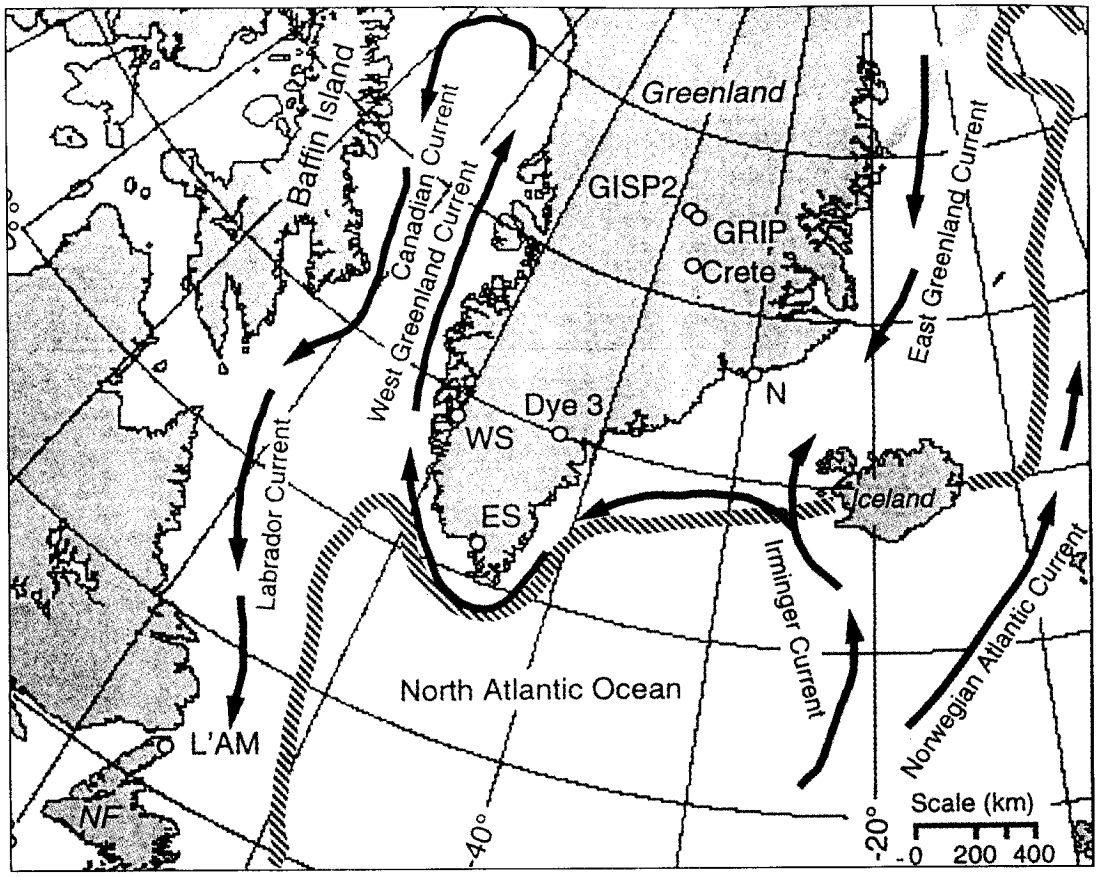

Fig. 1. Map showing location of areas mentioned including L'Anse aux Meadows site (L'AM); Nansen Fjord (N) and sites of ice cores (GISP2, GRIP, Crête, Dye 3); and the Greenland Norse Eastern (ES) and Western Settlements (WS). Also shown are principal ocean currents and sea-ice limits.

Norway, Sweden and Denmark, left their homes and travelled far to raid and plunder, but also to trade and to settle. From Sweden they tended to go east, across the Baltic to Finland, to the Slav territory around Novgorod, through Poland, Russia, and as far as Constantinople in the Byzantine Empire. From Denmark, the Vikings went to England, particularly the east and north-east, as well as to Normandy in France. From Norway they mainly went to the west, to the Atlantic islands of Shetland, Orkney, the Faroes and the Hebrides. They also settled in Ireland, the Isle of Man, large areas of Scotland, and north-west England. They colonised the island of Iceland, and the Icelanders in turn established colonies in Greenland. According to the written records, it was the Norse Greenlanders who later explored the eastern shores of North America. See Fig. 1 for a location map of the North Atlantic regions.

The Settlement of Iceland and Greenland

The settlement and colonisation of Iceland is believed to have occurred during the ninth to tenth centuries A.D.—more precisely from *c.* A.D. 870–930. Although recent archaeological and historical research has focused on the re-

evaluation of this traditional view (see, for example, Margrét Hermanns-Auðardóttir 1989) the most likely year for the beginning of the settlement of Iceland still remains *c.* A.D. 871 (Orri Vésteinsson 1998). The main documentary sources for the settlement of Iceland and Greenland are *Íslendingabók*, and *Landnámabók* (1968). The reliability of these sources is discussed, for example, by Jón Jóhannesson (1974) and Orri Vésteinsson (1998). These and other sources, in particular *Grœnlendinga saga* and *Eiríks saga rauða* (see, for example, *The Vinland Sagas* 1965; Ólafur Halldórsson 1978; Jónas Kristjánsson 1993) tell how, around 985 or 986, a group of people under the leadership of Eiríkr Þorvaldsson (Eiríkr rauði or Eiríkr the Red) set off for Greenland from Iceland. Eiríkr the Red and his companions took land in the so-called 'Eastern Settlement', on the south coast. Others made their home in the 'Western Settlement', situated near modern-day Nuuk (Godthåb). These settlements are shown in Fig. 1 as 'ES' and 'WS'. It is likely that the colony of the Western Settlement foundered some time around the mid-fourteenth century. By the end of the fifteenth century the colonists of the Eastern Settlement were also gone. The exact fate of the Norse Greenlanders has excited much speculation from the sixteenth century onwards. For a discussion of what may have occurred see, for example, Buckland et al. (1996), Barlow et al. (1997), Ogilvie (1998).

The Exploration of 'Vínland'

Grœnlendinga saga and *Eiríks saga rauða* are known collectively as the 'Vínland sagas' because, in addition to referring to the settlement of Greenland, they also describe the discovery and exploration of a land which was named by the Norse visitors 'Vínland'. In these sagas it is stated that the expeditions to Vínland were organised by members or affiliates of the family of Eiríkr the Red. In particular, Eiríkr's son Leifr Eiríksson, who became known as 'Leif the Lucky', was stated to be one of the principal organisers of the expeditions. As pointed out by Wallace (1991), the purpose of the Vínland expeditions was three-fold: exploration for new resources, exploitation of resources found, and exploration of the potential for settlement. That the Norse Greenlanders did indeed reach North America as stated in these sagas is supported by firm archaeological evidence at the site of L'Anse aux Meadows on the north shore of what is now Newfoundland. The strange name of this site, a mixture of French and English, probably derives from the seventeenth-century French name L'Anse aux Medées—'Medea Bay' from Medée (Medea), a common name for a ship (Wallace, personal communication, 1999). Although others had suggested that a Norse site might be found here, it was discovered by the Norwegian Helge Ingstad, and subsequently excavated by Ingstad and his wife, the archaeologist Anne Stine Ingstad, from 1961 to 1968. From 1973 to 1976 additional excavations were made by Parks Canada.

III North Atlantic Climate and Environment c. A.D. 2000: Evidence from Systematic Observations

Climate Variability

Because of the interplay of a number of highly variable elements associated with both air and ocean, the north-western Atlantic, from Newfoundland and Baffin Island eastward to Iceland, exhibits marked fluctuations in climate. In order to illustrate the magnitude of variability that may have been experienced in the past, Fig. 2 shows annual mean temperature variations over a section of the North Atlantic (50–80°N, 0–60°W) compared with global mean variations. The interdecadal variability of this region during the past century is characterised by initially colder conditions between 1880 and the 1910s, a very large and abrupt warming during the 1920s, a warm period into the 1960s, a much colder period in the 1970s and 1980s, and a subsequent warming trend. Changes in this region show no clear relationship with global mean changes. An interesting feature to note is that although the recent years in the North Atlantic have yet to reach the warmth of the 1930s and early 1940s, on an individual year basis, 1998 was the eighth warmest year in the 140-year record, which extends back to 1860. Of course, there is also significant variability from one specific location to another; in Iceland, for example, 1998 was the forty-seventh warmest year of the century, in other words, very close to the average (Trausti Jónsson, personal communication 1999). A number of the features which contribute to climate variability in the North Atlantic are discussed below.

Atmospheric Pressure Systems

The features of the general atmospheric circulation that influence the region include the Iceland Low, an area of frequent storms and intensification of storm systems, and the upper air Baffin Island trough. The Iceland Low results from the topography of the North American continent, land-sea temperature contrasts, and the presence of the high, cold, Greenland ice sheet. It is the northern centre of action of a primary atmospheric teleconnection, the North Atlantic/Arctic Oscillation (NAO/AO), that partially links the regional air pressure, winds, climate, sea ice and sea-surface temperature distribution (van Loon and Rogers, 1978). The upper air Baffin trough (a highly variable feature) tends to extend southward along eastern North America and is a response to the winter cold pool over the region around Baffin Island. Although it weakens in summer, the region around Baffin Island is still affected by large numbers of cyclonic storms (Serreze et al. 1997).

Surface Ocean Circulation

The surface ocean circulation in the North Atlantic is dominated by the southward movement of cold Polar Water out of the Arctic Ocean via the Fram Strait and the Canadian High Arctic channels; a flow referred to as the Eastern Greenland Current and the Canadian or Labrador Current (see Fig. 1). These

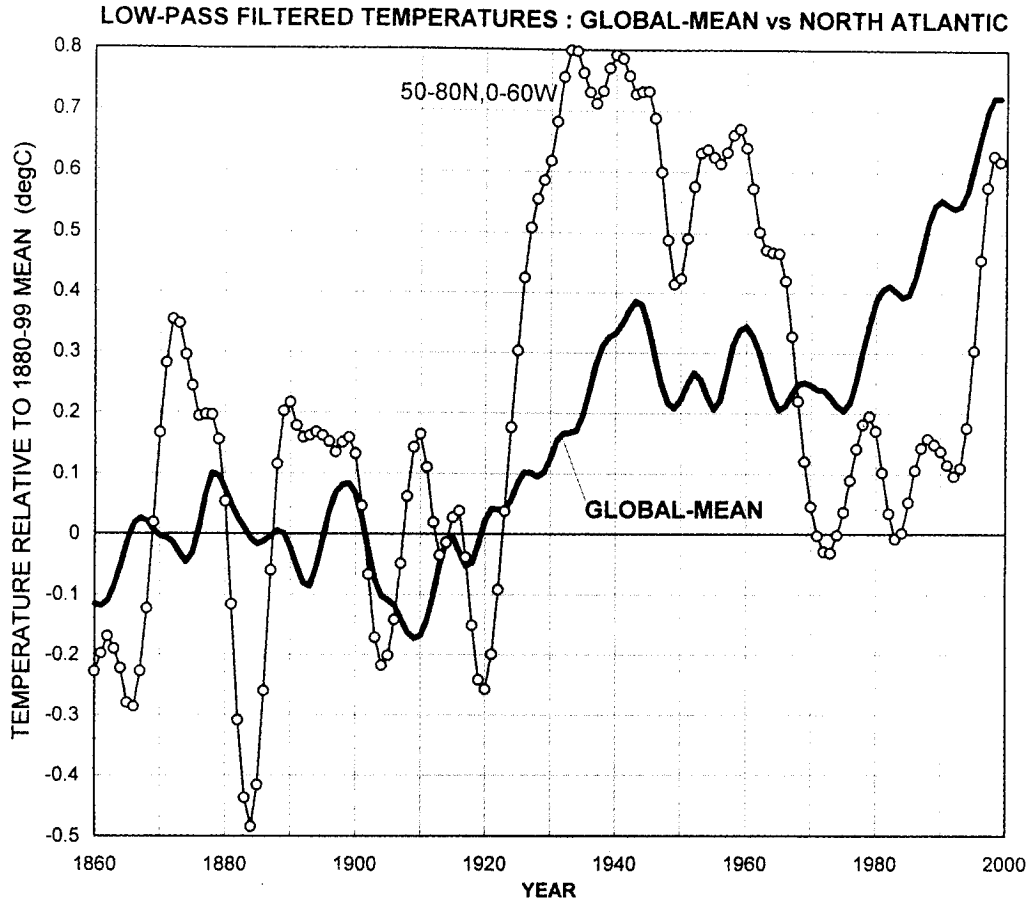

Fig. 2. Annual-mean temperature variations over the North Atlantic around Iceland (50–80°N, 0–60°W) compared with global-mean variations. The data have been filtered with a low-pass filter to highlight changes on decadal and longer time scales. The data used come from the gridded land-plus-marine data set used by Intergovernmental Panel on Climate Change (Nicholls et al. 1996) and were provided by P.D. Jones.

surface currents carry fresh water out of the Arctic Ocean in the form of sea ice and diluted surface waters, and create cooler coastal temperatures on East Greenland and Baffin Island (Aagaard and Carmack 1989). To the south-east of Greenland, warmer, saltier Atlantic Water branches off from the main North Atlantic Drift (that is, the extension of the Gulf Stream) and tracks northward along the western Iceland shelf as the Irminger Current. This proximity of the Irminger current to Iceland ameliorates conditions for human settlement. It is deflected into the Denmark Strait and runs southwards near the shelf break, thence west and north with the East Greenland Current into the Labrador Sea and Baffin Bay as the West Greenland Current (Fig. 1). In most years the warm waters of the Irminger Current are also carried eastward as a surface current along the north coast of Iceland, but in years such as 1993, cold, low salinity waters of the East Iceland Current advance, and sea surface temperatures (SSTs) can be lowered by as much as 8°C (published by Hafrannsóknastofnun Íslands [Marine Research Institute, Iceland] SST Maps, Sept./Oct. 1993).

Sea Ice

Sea ice is a dominant feature of the shelf along both the East Greenland and Eastern Canadian margins and its extent and duration is fundamental in determining aspects of the near-shore terrestrial climate (Sturla Friðriksson 1969). Sea ice forms easily on low salinity Polar Water, which comes from the Arctic Ocean and contributes to the East Greenland Current. Expansion of Polar Water leads to greater sea ice. Positive sea-ice anomalies in the Greenland Sea and Denmark Strait are generally in phase with negative sea-surface salinity and sea-surface temperature anomalies of the East Greenland Current, which are in turn driven by changes in the near-surface salinity of the Arctic Ocean (Malmberg and Geir Magnússon 1982). The close proximity of sea ice to Iceland lowers temperatures and has a detrimental effect on grass growth. In the past it often disrupted ocean travel, trade and fishing (Ogilvie 1982).

North Atlantic Deep Water

The formation of North Atlantic Deep Water (NADW) is another factor in the climate of the North Atlantic. A major mechanism for this involves the cooling of warm Atlantic Water to create Deep Water. This acts as a heat source for the atmosphere, and changes in the rate of Deep Water formation can affect the climate system locally as well as on a hemispheric scale (Wigley and Raper 1987; see also Aagard and Carmack 1989). The movement of fresher Polar Water over Atlantic Water can inhibit heat exchange to the atmosphere, and thereby reduce both Deep Water production and surface air temperature. Although this is an important local and hemispheric feature, there is no proxy record for Deep Water production at this time, so the history of its changes is unknown.

IV. North Atlantic Climate and Environment c. A.D. 1000: Evidence from Proxy Climate Data Interdisciplinary Linkages: Present and Past

Modern systematic observations of climatic parameters such as temperature, pressure, ocean currents, sea ice and so on provide a firm basis from which to increase knowledge and understanding of not only present atmospheric and oceanic conditions, but also of past climates and environments. Knowledge concerning twentieth-century variations in temperatures and sea ice, for example, makes it evident that variations on similar scales may have occurred in the past. This linkage from present to past also works in reverse, from past to present. Systematic observations of the environment only exist for a limited extent back in time. Proxy data must therefore be used in order to consider climatic and environmental changes on longer time scales. The information thus gathered can give a perspective on present and also possible future changes. Proxy data available for the North Atlantic region include documentary records from Iceland, marine sediment cores from east Greenland and ice-

core records from the Greenland ice sheet. Evidence from these is discussed below.

Marine Sediment-Core Records (Nansen Fjord, Greenland)

Two high-resolution marine sediment cores from Nansen Fjord (marked as N on the location map) off eastern Greenland were collected in 1991 (Jennings and Weiner 1996). This site was chosen because the location of Nansen Fjord makes it particularly sensitive to changes in the relative strengths of water masses in the East Greenland Current. This current carries cold Polar Water (PW) and warmer Atlantic Intermediate Water (AIW) as well as sea ice into the area. Analyses of the cores taken show evidence of changes in these oceanographic and sea-ice conditions from A.D. 730 to the present. The changes are inferred primarily from two independent lines of proxy evidence for environmental change. These are variations in lithofacies (types of marine sediments) and *foraminifera* (microscopic fauna with shells). The *foraminifera* are composed of two major types. One is 'agglutinated' *foraminifera* (with shells formed from detritus present in the ocean) and the other consists predominantly of 'calcareous' species (with shells produced by the fauna themselves from calcium carbonate). The presence of these two different groups of *foraminifera* corresponds closely to the different water masses found at varying times at the sea bed, with PW associated with agglutinated *foraminifera* and AIW with the calcareous species. For the period A.D. 730–1100 the foraminiferal evidence suggests that AIW was the predominant water mass on the Nansen Fjord floor. The lithofacies record in the cores consists of variations between two main sediment types: 'diamicton' or pebbly muds without stratification (i.e. layering) and stratified (layered) fine mud and diamicton (see Jennings and Weiner 1996, for details). As the presence of sea ice tends to result in the deposition of certain sediments, and the presence of icebergs (found in open water) results in different sediments, the presence or absence of specific sediment types can indicate whether there was heavy sea-ice cover or mainly open water at any given time represented by the core. In brief, it may be stated here that layers where diamicton predominates represent times of more open sea-ice conditions with iceberg rafting. It is this type which prevails during the period A.D. 730–1100. The foraminiferal and lithofacies data from this site therefore both suggest that the interval from *c.* A.D. 730–1100 was one of relatively warm and stable conditions. The evidence suggests further that there were two cold intervals that culminated in *c.* A.D. 1150 and *c.* A.D. 1370. This research is continuing with cores collected from sites around the coast of Iceland.

The settlers who travelled from Iceland to Greenland in the late tenth century probably first journeyed west from Iceland, then south along the Greenland coast. The route runs across the Denmark Strait, an area known for variability in sea-ice extent. Clearly the presence of the ice could be a potential hazard to travellers and traders. The evidence from Nansen Fjord outlined

above does suggest a low sea-ice interval with prevailing relatively warmer AIW from *c.* A.D. 730–1100, with relatively less chance that sea ice would adversely affect travel in the area around this time. This record thus supports the possibility that Norse expansion to Iceland and Greenland occurred during an interval when North Atlantic climate was similar to the warmest years of the twentieth century. It may also be inferred that such a climatic regime could have facilitated the exploration further west, to Vínland. The record from Nansen Fjord suggests a colder climatic regime around the time of the loss of the Norse Western settlement in Greenland.

Documentary Records (Iceland and the North Atlantic)

For much of its thousand-year long history, Iceland is unusually rich in both the quality and quantity of its documentary information on climate (Sigurður Þórarinsson 1956; Ogilvie 1982, 1991, 1992; Trausti Jónsson and Hilmar Garðarsson 2001). Some relevant information also exists for Greenland (Ólafur Halldórsson 1978; Ogilvie 1998). Of particular interest are descriptive accounts which may give an indicator of temperature and also descriptions of the Arctic sea ice which is brought by the East Greenland Current (mentioned above) and which reaches the coasts of Iceland in severe sea-ice years (see Fig. 1). However, it should be noted that historical writing in Iceland does not become contemporaneous with the events described until the twelfth century at the earliest. For this reason, accounts of the environment and climate and weather events before this time must be treated with extreme caution (Ogilvie 1982, 1991, 1992, 1998). Nonetheless, it is possible to infer how Iceland may have appeared to the early settlers. It is likely to have seemed fertile, attractive and eminently suitable for settlement. There were no native peoples on Iceland when the Norse arrived, and no grazing animals (the only land mammal was the Arctic fox) and vegetation had thus remained undisturbed for centuries. There seems little reason, therefore, to disbelieve the early written accounts that there was extensive vegetation, including trees, when the settlers first arrived. (Erosion soon set in, however, and remains a serious problem.) The lack of descriptions of sea ice prior to 1145 (the first unquestionable reference to sea ice) may indeed reflect a lack of ice as suggested by the marine records. A number of sources give interesting descriptions of famine and severe seasons around A.D. 975 and 1056–1058. Rather than pointing to a severe climate at this time, however, it may be that they were recorded because such events were unusual. If so, they would provide further evidence for a relatively mild climate in the tenth and eleventh centuries. There is certainly circumstantial evidence that such a climatic regime did prevail from the early years of settlement to *c.* A.D. 1180. (The 1180s and 1190s are characterised by severe seasons). Most important, perhaps, is the fact that the settlers did travel to Iceland and managed to maintain a reasonable lifestyle for several centuries (Ogilvie 1991). The location of settlement sites in Iceland may also reveal something about the climate. Thus, for example, at least two

farms, prosperous in medieval times, were eventually engulfed by glaciers in the late seventeenth and early eighteenth centuries (Ogilvie 1991). Fig. 3 shows occurrences of mild and cold seasons and sea ice reported in documents covering the period *c.* A.D. 865–1598 (from Ogilvie 1991).

Ice-core Records (Greenland)

Ice-core isotopic records are available from a number of sites in Greenland. (These include the GISP2, GRIP, Dye 3 and Crête cores—see Fig. 1). By analysing chemical composition (especially the changes in oxygen isotope ratios), frequency of air-borne inclusions like volcanic dust and sea salt, and by dating the cores by their annual layers in conjunction with other means, it is possible to build up a detailed record of environmental change that extends thousands of years into the past. Oxygen isotopic records suggest a warmer time period variously interpreted as between A.D. 700–1100 (Crête: Dansgaard et al. 1975) and A.D. 900–1350 (GISP2: Stuiver et al. 1995), depending on smoothing and averaging techniques applied to the data. Borehole temperatures from central Greenland ice cores show a period warmer than today between A.D. 900 and 1200 (Dahl-Jensen et al. 1998). All three intervals contain the period of Norse expansion to Iceland, Greenland and Vínland. According to the ice-core evidence, the founding of the Eastern and Western Settlements in Greenland in the late tenth century may also have been favoured by mild climate. Although the record is open to interpretation, the Crête and Dye 3 ice-core isotopic records suggest that the settlers experienced above average mean annual temperatures for the first crucial years after arriving in Greenland—enough time to give them confidence to set about establishing their farming sites (see Fig. 4). The loss of the Norse Greenland settlements (dated by historical documents to *c.* 1360 for the Western Settlement

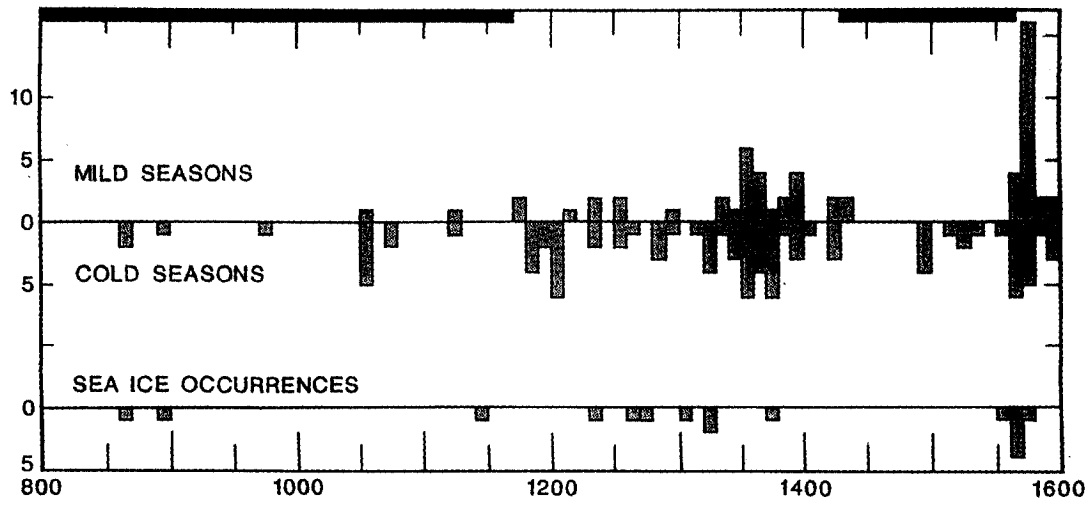

Fig. 3. Historical data from Iceland (Ogilvie 1991). This shows occurrences of mild and cold seasons and sea ice reported in reliable historical documents covering the period c. A.D. 865–1598. The dark lines at the top of the diagram show periods of poor data coverage.

and perhaps *c.* 1450 for the Eastern Settlement) was due to a combination of factors but there seems little doubt that the climate of that time played a part (Buckland et al. 1996; Barlow et al. 1997). High-resolution isotopic data suggest a period of relatively lower temperatures (when normalised to a 700-year mean) *c.* 1343–1362 (Barlow 1994).

Records from L'Anse aux Meadows (Newfoundland)

The name Vínland, literally, 'Wineland', has caused considerable discussion and speculation. In the sagas, much is made of the discovery of wild grapes. For this reason alone and because wild grapes do, in fact, grow in certain parts of north-eastern North America, it seems likely that the meaning really does refer to wine and not to 'pasture land' as was suggested, for example, by Ingstad (1986:307–313; see also the discussion by Magnús Stefánsson 1997 and Crozier 1998). Referring to 'pasture land', the name would be 'Vinland', a short 'i' with no accent. Wallace (p. 141–142, in the present volume) has also pointed out that fresh pastures would not have been needed at that time (excellent pastures were available then in Greenland and Iceland) and would not have been likely to cause excitement. The prospect of producing wine, however, was another matter. In both the Scandinavian homelands, and the North Atlantic settlements, this was a costly and highly-prized item that any chief might covet. Furthermore, it was a vital ingredient in the Eucharist, an important element of the Christian religion, now making rapid strides in these areas. Other names given by the Norse to the places they visited on the North American continent included 'Helluland' (presumed to be Baffin Island) and 'Markland' (presumed to be Labrador). The meanings correspond to 'slab'- or 'rock-land' and 'forest-land', respectively: see Fig. 5 for a map of the North Atlantic dating from *c.* 1590 showing these regions as well as 'Skrælinge Land' (see below) and 'Promontorium Winlandiæ' in addition to Iceland and Greenland. The Vínland sagas also refer to rolling grasslands, rich hunting and fishing, and a climate so mild that winter frosts were hardly known. Also mentioned is 'self-sown wheat'. This is most likely to be wild rye, *Elymus virginicus,* which does look like old-type wheat (Wallace, personal communication 1999). The native inhabitants (referred to in the sagas by the derogatory name *Skræling,* meaning 'wretch') who ultimately drove away the Norse would-be settlers also figure in the sagas.

It may be noted, however, that grapes do not grow in the region of the L'Anse aux Meadows site. This region was almost certainly not 'Vínland', but rather the 'gateway to Vínland', and the archaeological and written evidence points to its use as base camp for exploration (Wallace 1991). The date of the Norse occupation of L'Anse aux Meadows lies close to the decade before or after A.D. 1000. This date has been arrived at by the use of architecture, artefacts, and radiocarbon dates (Wallace 1991). This dating accords well with the written evidence for the 'Vínland' explorations. However, it is likely that the Norse occupation of the site lasted no more than a few years (Wallace 1991).

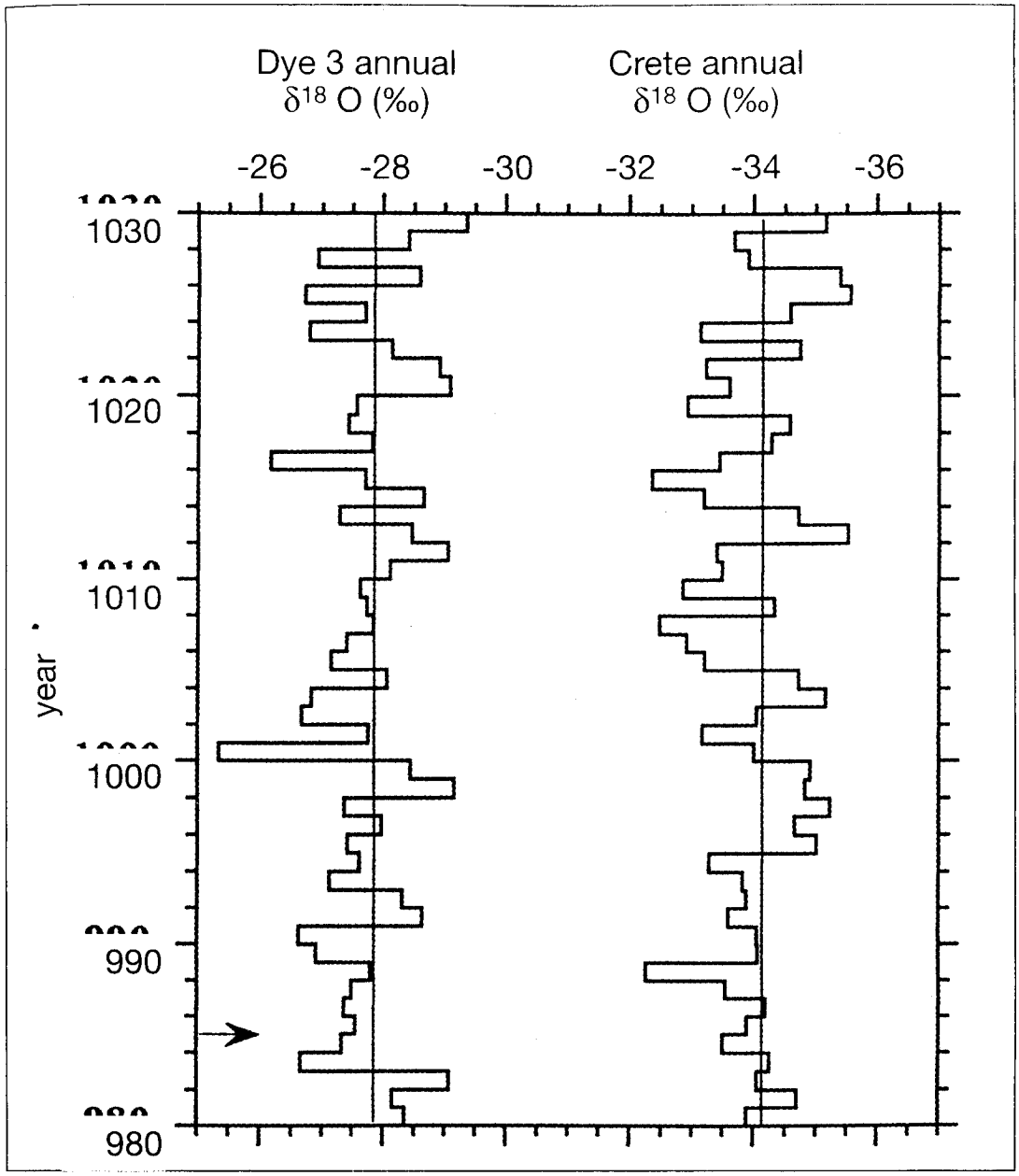

Fig. 4. Average annual oxygen isotopic ratio (d18O) for A.D. 980–1030 from Dye 3 and Crête ice-cores (see Fig. 1 for locations). Less negative values suggest relatively higher temperatures, and more negative values suggest relatively lower temperatures. Mean reference is A.D. 800–1400. The arrow at A.D. 985 indicates probable initial Norse settlement of Greenland. (Data are courtesy of S.J. Johnsen via D. Fisher).

Many suggestions have been made regarding the exact whereabouts of Vínland. Thus, for example, Páll Bergþórsson (1997) has recently suggested that it may have been in the region of New York. Wallace has made the point that the region of New Brunswick is a likely candidate; it has the wild grapes and 'self-sown wheat' mentioned in the sagas (Wallace 141, in the present volume).

Fig. 5. Map of the North Atlantic drawn in Iceland by Sigurður Stefánsson c. 1590. The original of this map is lost but later copies are preserved in the Royal Library in Copenhagen (GKS 997 fol; 2877 4to and 2881 4to). Pictures of the map are also to be found in Þormóður Torfason, Gronlandia antiqva, *Hafniæ 1706, table I–V; and* Det gamle Grønland, *Oslo 1927. The photograph reproduced here is from the latter work. The map is discussed in Haraldur Sigurðsson (1978:85–86).*

The documentary evidence for the exploration of Vínland by the Norse underscores the impact made on them by a place where the livestock did not need to be given winter fodder. (See the description of Vínland from *Grœnlendinga saga* at the start of this article.) This was very different from the situation in Greenland and Iceland where lack of sufficient fodder for the live-

stock could have perilous consequences with deaths of livestock and subsequent loss of human life. In later times, northern Newfoundland has by no means been snow-free in the winters. However, in the winter of 1998, Wallace noted that there was no snow, and the livestock could indeed have fed outside (Wallace, personal communication 1999). For the L'Anse aux Meadows site, pollen analyses (McAndrews and Davis 1978; Davis et al. 1988), chemical analyses of peat (Robertson 1978), and wood and radiocarbon analyses (Wallace, personal communication 1999) suggest that the climate at L'Anse aux Meadows was slightly warmer at the time of the Vínland voyages in comparison with subsequent relatively cold periods. Wallace (1991) also notes that the ice-free navigation season between L'Anse aux Meadows and Greenland would have been limited to two months of the year. It is possible to speculate that once the areas termed 'Markland', 'Helluland' and 'Vínland' by the Norse were well known to them, probably many voyages were made in search of precious commodities such as timber. In years of heavy sea ice, however, travel from Greenland or Iceland could clearly have been perilous, and it is of course also possible to speculate that sea ice did at times hinder navigation. However, Wallace (1991) emphasises that, on the whole, for L'Anse aux Meadows and Vínland, conflicts with indigenous peoples and difficulty in maintaining this remote site, rather than weather conditions in those regions, were the most likely reasons for abandonment.

Conclusions

The twentieth-century development of the sciences of climatology, oceanography, and related fields, as well as the study of paleoclimates, has demonstrated the variability of climate on all time scales. The period we have been considering, *c.* A.D. 800–1100, almost certainly was no exception. Nonetheless, proxy climate evidence does suggest that the climate of the North Atlantic at this time was favourable for exploration and expansion to Iceland, Greenland, and Newfoundland. Marine-core evidence and historical documents suggest that sea ice, which caused difficulties for Icelanders in later centuries and could have hindered travel between Iceland and Greenland, and Greenland and Newfoundland, was not prominent during Norse expansion to Iceland and beyond. Indeed, this was possibly a stable time of comparatively less Polar Water variability. Documentary and ice-core evidence indicates that temperatures were generally higher than in later centuries (although by no more than 1 or 2°C). Pollen, peat and wood from L'Anse aux Meadows show that this opportune warmth extended to Newfoundland, and probably aided in the successful, albeit brief, Norse exploration of this area. In short, it is perhaps likely that North Atlantic temperatures were similar to the warmer years of the twentieth century. The Viking settlers who travelled to Iceland a millennium ago prospered, but over the subsequent thousand years often suffered hardship, due at least in part to a difficult climate. The Norse Greenlanders did not survive beyond the end of the fifteenth century, and the Vínland voyages became

no more than the stuff of stories and legends. As we look back to the beginning of the last millennium and forward to the next, perhaps we may speculate, as global warming takes effect—will Vínland, with its winters without frost, rise again from these stories and sagas, not on the North American continent but in Iceland or Greenland?

Acknowledgements

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