

The scope of Strategic Environmental Assessment of North Sea areas SEA3 and SEA2 in regard to prehistoric archaeological remains



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Executive Summary

Prehistoric submarine archaeological remains back to a date of the order of 100,000 years can occur over the whole floor of the North Sea, excluding only the coastal waters of Scotland, and possibly a strip offshore Yorkshire. South of 52° 30' human artefacts as old as 500,000-700,000 years BP could survive on the sea floor, as also in the English Channel. In practice, artefacts dating from the last 10,000-12,000 years have been found in sites scattered from Viking Bank, to Denmark, Hartlepool, Dogger Bank, Brown Ridge, the Yorkshire coast, East Anglia, Isle of Wight, Cherbourg, and other locations. Mammal bones from 500,000 years BP have been found on the floor of the southern North Sea. Analysis of seabed sedimentology, the geophysical modelling of glacial-eustatic marine transgressions, predicted locality of prehistoric occupation sites, and the taphonomy of archaeological deposits result in a consistent picture. Pipe entrenching is the process in the oil and gas industry most likely to disturb prehistoric archaeological deposits, although dredging for marine aggregates is much more invasive. Commercial site investigation and sediment coring could provide beneficial new archaeological data. The paper concludes with tentative suggestions for discussion of protocols and a reporting regime.

Contents

1. Overview of legislation and agreements (UK, EU and international) that apply to UK marine and maritime prehistoric and archaeological remains.
2. Overview of known and likely areas with prehistoric and archaeological remains, with mapped indications of relative likelihood of the presence of remains (sensitivity mapping) and with hotspots identified.
3. Human occupation of the North Sea Continental Shelf and adjacent regions, a brief history of the last half million years.
4. Coastal and submarine prehistoric archaeological sites already discovered, surveyed, or excavated in the North Sea Region.
5. Consideration of the potential impacts of oil field operations on submarine prehistoric and archaeological remains.
6. Consideration of the opportunities presented by oil and gas operations in an area for site/artefact identification e.g. seismic survey, sub-bottom profiling, coring, ROV.
7. A summary of existing practices regarding the reporting, investigation and protection of prehistoric and archaeological remains.
8. Recommended mitigation measures to prevent damage to prehistoric and archaeological remains from oil and gas activities. These recommendations should draw on, and where appropriate be concordant with, draft guidance produced for BMAPA and RCHME.

1. Overview of the legislation and agreements (UK, EU and international) that apply to UK marine and maritime prehistoric and archaeological remains

1.1 UN Conventions, European laws and directives, national legislation, and non-statutory codes and procedures all apply to coastal and offshore marine, maritime and submarine archaeology.

1.2 In this report there will be no analysis or discussion of the state of shipwreck archaeology. There are an estimated 26,500 historic losses over 100 years old and 13,500 known wreck sites in UK Territorial Waters (English Heritage 2002, para. 4.3). There are many more in deeper water further offshore in the North Sea and other adjacent seas. Many of the same international legislative documents apply to all types of marine archaeology, whether of shipwrecks, abandoned single artefacts, or submerged sites of previous human occupation. However, the emphasis of the present report is entirely on the subject of submerged sites where human beings and early hominids previously lived or hunted on terrain which was at that time dry land, or where they exploited fish and shellfish on the coast. Sites discussed are all older than 3,000 years, and mostly older than 5,000 years. It must not be assumed that the comments made or conclusions reached in this paper would apply in exactly the same way to shipwrecks on the sea bed.

1.3 Legal regimes will be reviewed from the global and UN level successively downwards in scale to the regional and local, and non-statutory agreements or codes. When reporting the status of legislative documents which may or may not have been signed on behalf of the UK Government or UK agencies I will not comment as to the reasons, nor as to likely changes in policy. All terms such as "underwater cultural heritage", "maritime archaeology", "marine archaeology", "submarine archaeology", "nautical archaeology" etc., will be deemed to have equivalent meaning. Nothing stated in the following discussion should be interpreted as an attempt to define strict legal obligations. It is an attempt to show by analogy, and in plain language, how prudent anticipation of future events leads to a consistent view of the responsibilities of regulatory authorities and operators.

1.4 The United Nations Convention on the Law of the Sea (UNCLOS) was negotiated continuously from 1968 through to 1982 when the Convention document itself was agreed. The Convention became recognised international law when it had been ratified at national level by 65 states, and was ratified by UK on 25 July 1997. Although UNCLOS entitles the coastal state to declare an Exclusive Economic Zone out to about 200 nautical miles from a coastal baseline, and to declare an extra 12 nautical mile Contiguous Zone outside the traditional 12 mile Territorial Sea, the UK has decided not to opt for either of these legal rights.

1.5 The Articles of UNCLOS directly concerned with marine archaeology are 149 and 303 (See Annex 1). Article 149 applies only to archaeology in the International Area outside national jurisdiction. These circumstances do not apply anywhere in the North Sea. Article 303(1) stipulates that all states have the duty and right to protect archaeological resources found at sea "and shall cooperate for this purpose". This Article is completely open-ended, with no geographical boundaries or distinctions between different economic or jurisdictional zones. Since the UK has signed UNCLOS, and has a designated Continental Shelf in the North Sea which is periodically licensed for the exploitation of both hydrocarbons and aggregates, it follows that Article 303 applies in a general sense to the UK sector of the North Sea.

1.6 The UNESCO Convention on the Protection of the Underwater Cultural Heritage (UCPUCH) (UNESCO, 2001) is an international and globally applicable document which has been passed by UNESCO General Conference, but has not been ratified by sufficient countries to become international law. It has not been ratified by the UK. It is probable that the necessary number of signatories to make the Convention into agreed International law may never be obtained.

1.7 There is considerable tradition, at least in the field of international legal conventions concerning the sea, for complex documents to be discussed for many years, and for those clauses or principles which have consensus acceptance to become the guidelines by which people act, while other principles are neglected, ignored, or rejected, long before agreement or ratification of the final document. Thus the UNESCO Convention should prudently be considered in terms of the "going rate" for the levels of national regulatory control which the coastal state might be obliged to assert on its Continental Shelf, and similarly for the obligations of operators exploiting or utilising the resources of the Continental Shelf.

1.8 The Preamble to UCPUCH states that UNESCO is conscious "of the need to respond appropriately to the possible negative impact on underwater cultural heritage of legitimate activities that may incidentally affect it". This is the situation which concerns SEA3, and this Report. Underwater cultural heritage is defined, as in most other documents, as traces of human existence which have been partially or totally underwater for at least 100 years. UCPUCH is designed to be compatible with UNCLOS (UCPUCH, Article 3)

1.9 UCPUCH (Article 4) states that underwater cultural heritage shall not be subject to the law of salvage, unless this is authorised by the competent authorities, and the cultural heritage materials have maximum protection. As noted below (para.1.15) , UK Salvage Law only applies to shipwreck, and so salvage law does not apply to prehistoric material on the UK Continental Shelf, outside Territorial Waters, even if the raised material is landed at a British port.

1.10 UCPUCH (Article 5) states that signatories should use the "best practicable means" to prevent or mitigate adverse effects to underwater cultural heritage caused by legitimate activities under their jurisdiction. Again, although UK has not signed, the general indication of this Article is clear. A point of uncertainty and ambiguity regarding this clause is the extent to which it is completely open-ended, requiring apparently unlimited commitment to ensure that no damage is done, and to what extent a common-sense judgement should be applied regarding the chances of an unknown site lying in the path of some legitimate commercial activity. This obligation is dealt with more specifically in UCPUCH (Article 10.4) which applies directly to the Continental Shelf

1.11 The UNESCO Convention concludes with a set of Rules Concerning Activities Directed at Underwater Cultural Heritage. The preferred means of protecting cultural heritage sites is protection *in situ*. For prehistoric sites this is sensible, provided there is no erosion, since only a few sites need to be excavated, the materials on the seabed have negligible commercial value so that they are not subject to looting, and it is sufficient in most cases to document the type of site for research purposes. Most of the remaining Rules refer to the planning and conduct of projects conducted by specialist archaeologists to study or excavate sites of underwater cultural heritage.

1.12 The European Convention on the Protection of the Archaeological Heritage (Revised) (The Valetta Convention) was agreed by the Member States of the Council of Europe in 1992, and became law on 20 March 1992. It has been ratified by the UK, and the responsible agency is English Heritage. Most of the Articles concern archaeology on land, control of the trade in antiquities and the prevention of looting. The Valetta Convention (VC) applies "underwater" (Article 2.ii). Since English Heritage is the relevant responsible UK agency the application of the Valetta Convention (VC) only extends within the 12 mile limit in the UK sector of the North Sea.

1.13 In VC the archaeological cultural heritage is also linked with the concept of "historical and scientific study" (Article 1.1) and "research into mankind and the related environment" (Article 1.2.i). This suggests an analogy with the many Articles of UNCLOS relating to scientific research. Article 1.3 of VC states that it applies whether on land or under water.

1.14 VC (Article 2) provides for "archaeological reserves" on land or under water. VC (Article 5) spells out at length the consultation which should take place between planning authorities and developers to avoid damage to archaeological remains. The implications are relevant, by analogy, to procedures which may be recommended on the UK Continental Shelf in SEA 3.

1.15 Three components of UK law apply directly to marine archaeology. The first is the National Heritage Act 2002 (NHA); the second is the authority of the Receiver of Wrecks, which applies only to shipwreck (Coastguard and Maritime Agency, Department of Trade, Merchant Shipping Act (1995)); and the third is the Protection of Wrecks Act (1973) presently administered by the Department of Culture, Media and Sport. In this report we will discuss only the NHA. Article 1 of NHA modifies the National Heritage Act 1983 to include "ancient monuments in, on, or under the seabed within the seaward limits of the UK territorial waters adjacent to England". SEA3 and SEA2 are partly within the adjacent English waters, and therefore we do not need to consider the legal situation in Scotland in this report. The rest of NHA consists of a list of clauses in the 1983 Act which have to be modified to recognise antiquities on the seabed.

1.16 NHA (Article 3) appoints the Historic Buildings and Monuments Commission for England to exercise the functions implied by the Act. Ancient monument is defined as "any structure, work, site

(including any site comprising, or comprising the remains of, any vehicle, vessel, aircraft or other moveable structure or part thereof) or area which in the opinion of the Secretary of State is, or may be, of historic, architectural, traditional, artistic or archaeological interest".

1.17 Article 6 of NHA 2002 defines the responsibilities of the Commission for assistance in relation to shipwrecks protected by the Protection of Wrecks Act 1973. Again, this is not directly relevant to the present report, but illustrates by analogy the concern for and obligation towards shipwreck archaeological materials within Territorial Limits which is accepted by the UK.

1.18 In May 2002 English Heritage responded to its new responsibilities charged by NHA 2002 by publishing a policy document entitled "Taking to the Water: English Heritage's Initial Policy for the Management of Maritime Archaeology in England." This document (TttW) defines the maritime archaeological resources in English Territorial Waters, and supports the central role played by the National Monuments Record (NMR) in the management of maritime archaeology.

1.19 TttW is a policy discussion document, and contains some suggestions which would require further legislation for implementation, if they were supported by Government. The policy document is intended primarily for the archaeological community, amateur archaeologists and divers. Although there are references to the need for consultation and collaboration with many stakeholders, there is no reference to working with industry or commercial operators at sea. Presumably there is an assumption that the regulations in this respect are a direct extension of those which apply on land in England. TttW (Article 2.1) includes "extensive submerged landscapes, primarily relating to the earlier prehistoric period during which Britain was divorced from mainland Europe by rising sea levels."

1.20 TttW (Article 3.3) states "... it is clear that marine archaeological sites should enjoy parity of esteem and treatment with their terrestrial counterparts". England already has an inventory of maritime archaeological sites located within Territorial Waters in its NMR, which contains over 40,000 marine sites. Three specialist staff are employed to maintain the maritime record. The remit of NMR has been expanded to include submerged terrestrial sites and landscapes. The meaning and significance of the term "landscape" is not always clear, although it is presumably linked to prehistoric significance.

1.21 TttW refers to three active diving organisations which work on, and can provide advice on, marine archaeological projects. These are the Archaeological Diving Unit at the University of St Andrews, which is the current contractor responsible for the field work in administration of the Protection of Wrecks Act (1973); the Hampshire and Wight Trust for Maritime Archaeology, which is a charitable trust with experience both in shipwreck archaeology, and a wide range of prehistoric site investigation throughout the Solent area; and Wessex Archaeology, which is a professional archaeological unit with capability to undertake marine fieldwork. Most organisations concerned with marine archaeology in the UK meet through the activities, conferences, workshops, and projects of the Nautical Archaeology Society (NAS). The contracting of the responsibility for supervising the Protection of Wrecks Act (1973) lies with the Department of Culture, Media and Sport (DCMS).

1.22 TttW (Article 7.3) states that English Heritage approves of virtually all the substance of the UNESCO Convention on Protection of the Underwater Cultural Heritage (2001). Reservations are expressed concerning the requirement for authorisation of all activities directed at underwater archaeological sites, regardless of their importance.

1.23 The Protection of Military Remains Act (1986) has the principal concern to protect the sanctity of vessels and aircraft that are military maritime graves. In 2001 the Secretary of State for Defence announced that 16 vessels within UK jurisdiction would be designated as Controlled Sites, and 5 vessels in international waters would be designated as Protected Places. The purpose of this safeguard is not primarily archaeological, but MoD liase closely with DCMS and English Heritage in the process of site designation.

1.24 The remaining clauses of TttW discuss the future role of English Heritage in marine archaeology, and the role of Local Authority archaeologists. The latter are particularly important where sites are found close to the shore, in mudflats, and within coastal waters. Article 11.7 states "We expect to engage with other legitimate users of the sea, such as fishermen, developers, port and harbour authorities, salvors and marine-tourism operators, in a pragmatic and constructive way in the discharge of our duties..." This list is illustrative, but it is odd that there is no direct reference to the aggregates industry, or offshore hydrocarbons, or pipe or cable laying.

1.25 Under the heading of Future Priorities the TttW text discusses the importance of "drowned coastal landscapes". This discussion states "Such landscapes have tremendous potential for the preservation of archaeological evidence of the exploitation of coastal and marine resources and for use in predicting the nature, scale, and pace of coastal change." The first part of this phrase seems to be referring to prehistoric dwellings, shell middens, tools of flint or wood, debitage, debris, and other remains where early peoples were exploiting marine food sources, but the second part seems to be describing the geomorphological value to understanding how rising sea level interacts with previous coastlines. This could be of scientific interest, but, in the view of the writer of this report, the concept is so broad that almost the whole floor of the North Sea might be regarded as of research interest. If English Heritage has the responsibility on land to conserve landscape and landforms for research purposes, the analogy offshore needs to be very carefully assessed.

1.26 The previous paragraphs have reviewed a range of international and national documents which pertain to UK Territorial Sea and Continental Shelf. Since the North Sea is bordered by states which may have signed and ratified the same documents, or documents which the UK has not ratified, collaborative projects in the North Sea should be based on adequate preliminary consultation on these matters.

1.27 It is good practice for government agencies, planning authorities, and industry representatives to develop non-statutory guidance, recommendations, or codes of practice for the protection of archaeological sites which may be disturbed. Consultation may take place through scholarly organisations such the Council for British Archaeology (CBA), or the Nautical Archaeology Society. For example the consultation phase of the Mineral Planning Guidance for On-Shore Oil and Gas and Coalbed Methane Development included circulation of the relevant archaeological paragraphs to the CBA in 1999-2000. Discussion of the draft specifically referred to the importance of wetland and inter-tidal archaeology, and the importance of Mesolithic activity on the Dogger Bank. The British Marine Aggregate Producers Association (BMAPA) has collaborated with the Royal Commission on the Historical Monuments of England (RCHME) to produce a Consultation Draft (October 2001) entitled "Marine Aggregate Dredging and the Historic Environment". This draws attention to Planning and Policy Guidance note 16 (PPG 16) which states that the first preference is that archaeological remains should be preserved *in situ* without disturbance. If that is not possible, it is reasonable to require the developer to make appropriate and satisfactory provision for excavation and recording. This is followed by a practical and balanced set of recommendations for preparing Applications to DTLR, and the advice that contractors should obtain support from an archaeological consultant.

1.28 BMAPA/RCHME code discusses Environmental Impact Assessment (EIA) which should include a description of the measures envisaged in order to avoid, reduce, and if possible remedy significant adverse effects on the historic environment. There is reference to prehistoric sites from Palaeolithic to Mesolithic. Pre-dredge surveys and evaluation may be needed. Dredging exclusion zones can be implemented around areas where the presence of prehistoric assemblages has been confirmed. Although it may be possible for a suitably experienced archaeologist to visit onshore screening plants periodically to carry out a visual search for stone tools and other human artefacts, such procedures appear unlikely to be productive. Copies of reports on any sites located and the measures taken should be lodged with the appropriate Curators and the NMR.

1.29 Summary of legal situation and the prudent practices to adopt in the UK sector

No Government agency in the UK has been allocated the responsibility to monitor, manage, or protect the prehistoric cultural heritage on the UK Continental Shelf outside Territorial Waters. Within Territorial Waters off England the responsibility rests with English Heritage. Through signing UNCLOS, the UK is duty bound to observe the stipulations of UNCLOS Article 303, while the draft UNESCO Convention indicates the responsibilities which are, by general consensus, deemed to be reasonable in regard to prehistoric cultural heritage on the Continental Shelf. Similarly, a pro-rata extension of the relevant clauses of NHA to the Continental Shelf, or extension of the policies suggested by TttW for within Territorial Limits, would all lead to the same conclusions. The principles of the Valetta Convention, broadly interpreted, might apply on the Continental Shelf since it does apply underwater, but no UK agency has been designated to implement it outside Territorial Limits. It is therefore prudent, though not legally binding, for all parties, government agencies, regulatory authorities, commercial operators, and voluntary bodies to act as if their standards of conduct were to be judged, in broad measure, by the standards of those documents.

2. Overview of known likely areas with prehistoric remains, with mapped indications of relative likelihood of the presence of remains, sensitivity mapping, and with hotspots identified

2.1 The earliest occupation of the British mainland by hominids, *Homo heidelbergensis*, occurred about 500,000 years Before Present (BP) (Pitts and Roberts, 1997). Human and proto-human artefacts may therefore have been deposited in sediments on the continental shelf at any time in the last half million years whenever the glacial control of world sea level caused the floor of North Sea or English Channel to be dry, and outside the limits of the ice.

2.2 The six major glaciations of the last million years had different extent on land, and extended differently into the North Sea. It is assumed that any deposit which was subsequently covered by a later ice sheet would be completely destroyed and scattered, with artefacts or shaped stones irretrievable broken or altered. The extent of the different ice sheets into the area of the North Sea therefore must be taken into account (Siebert, 2001; Woodcock, 2000) (see Figures 1 and 2).

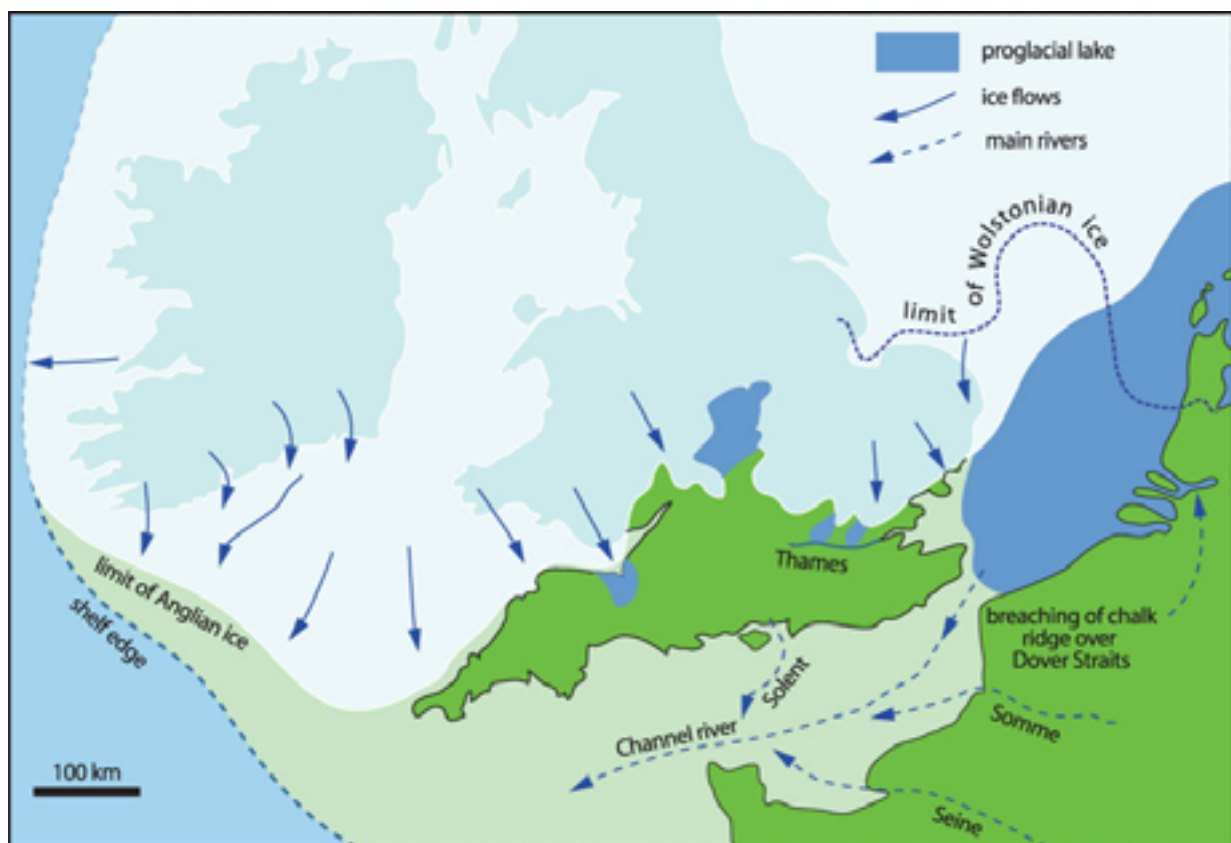


Figure 1 Palaeogeographic map showing features at the southern margins of the Anglian and Wolstonian ice sheets (based on Gibbard 1988, with permission from the British Geological Survey 2000)(Woodcock; in: Woodcock and Strachan 2000).

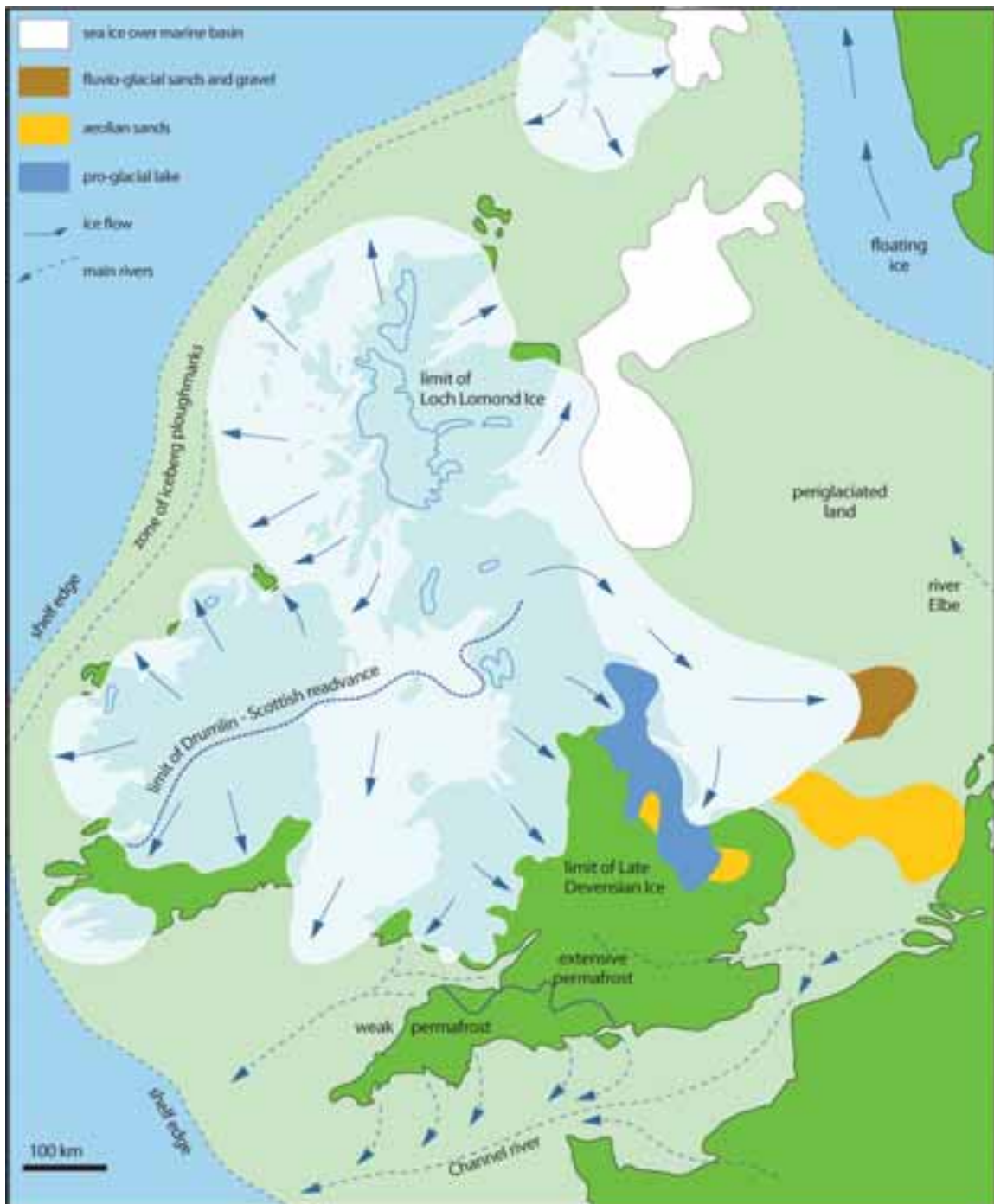


Figure 2 Palaeogeography during the Devensian glaciation (After Woodcock and Strachan 2000)

2.3 In northern peri-glacial conditions the availability of protein for prehistoric peoples close to the shore was higher than in the hinterland (Momber, 2000, 2001; Fischer, 1995). At glacial maximum when the sea did not penetrate into the North Sea area any inhabitants would have depended on large mammals such as mammoth and reindeer. Later, Mesolithic peoples would have benefited from the resources of wetlands and estuaries. Flemming (1996) summarises the reasons for prehistoric peoples being attracted to the coast, and estimates that, as sea level fell, vegetation and fauna would colonise the exposed land close to the shoreline within a few decades. Human remains in south Wales have been found a few km from the ice front (Woodcock, 2000, p.404), so cold itself was not a deterrent. Primitive hunters required fresh water, food supplies, a supply of flints, some timber, shelter, and a secure position which might have to be defended, with good routes of access, and the option to move or migrate with the seasons, or with changing supplies of fish, shellfish, or mammals. Mesolithic settlements were often positioned so as to be convenient to fish traps and fish weirs on the coast.

These requirements have been used with great success by archaeologists in the UK and Denmark to predict and interpret submerged Mesolithic sites (Andersen, 1980; Pedersen *et al.* 1997; Momber, 2001; Coles 1998, 1999, 2000). Hunting kill sites, flint quarries, flint-knapping sites, settlements, camps, shell middens, charcoal from fires, and shelters, tend to cluster round shorelines, estuaries, lagoons, headlands and promontories.

2.4 This places a premium on identifying accurately the shorelines and rivers at each date, and especially those shorelines where the sea level was locally constant for hundreds or thousands of years, relative to the local land. Under these conditions rivers would tend to create stable estuaries, and perhaps barrier bars or lagoons and wetlands. Coles (1998, p.50-68) collates the extensive literature on the precise ice limits at different dates, the possible courses of the river valleys, estuaries, and shorelines. The numerous publications on the details of topography, dating, soil types, pollen, palaeo-climates, pro-glacial lakes, etc., cannot be discussed in the present paper, and are, as yet, not entirely consistent in detail. A great deal of work still needs to be carried out to reconstruct the terrestrial conditions at each location and date. To a first approximation it would seem that, given a reliable assessment of the global sea level for any date, it would be a simple matter to reconstruct the palaeo-shorelines. However, because of the proximity of the ice caps to the North Sea, the crust of the earth was regionally depressed by hundreds of metres under the weight of the ice, while the unloaded crust beyond the limits of the ice cap bulged upwards. Since the North Sea was bordered by the ice cap on Scotland-plus-northern-England and the ice cap on Scandinavia, and since these sometimes merged across the North Sea, quantification of this factor is essential to predicting habitable shore zones for a given date.

2.5 Figures 3 and 4 (based on Lambeck 1995 and Shennan *et al.* 2000b) show the estimated position of the shore lines during the rise of sea level for the last 22,000 years. Other models have been prepared by Ben Horton *et al.* Durham, with similar results (web site). Before analysing the last rise of sea level in detail, I want to consider briefly the possible occurrence and survival of deposits from earlier glacial periods and glacial stadials.

2.6 The three last glacial peaks, the greatest extent of the land-based ice caps, are known in UK as Devensian (start about 100,000, and maximum extent about 22,000 years BP); Wolstonian (start 250,000 years BP, maximum 150,000 years BP); and Anglian (start about 350,000 years BP, maximum about 280,000 years BP). The Anglian and Wolstonian ice sheets joined with the Scandinavian ice across the northern North Sea, so that only the sea floor south of an arc approximately from Southwold to Scheveningen was not covered by ice (Figure 1). The last glaciation, the Devensian consisted of separate ice sheets which never joined across the North Sea (Figure 2) exposing almost the whole floor of the North Sea to periglacial vegetation, tundra, large mammals, and possible human movements or occupation. At various stages of each glaciation large lakes of meltwater were trapped between the ice and the peri-glacial bulge of the earth's crust. At the peak of the Devensian glaciation there were some large shallow embayments in the northern North Sea which were covered in floating sea ice.

2.7 Other things being equal, the oldest material that it should be potentially possible to find would be in the southern and central North Sea well away from the coast, as old as about 100,000 years, soon after the start of the Devensian glaciation, and similarly of course in the English Channel. No material much older than about 100,000 years would survive the Wolstonian glaciation in the central and northern North Sea, although a few sites might have been formed in the wake of the retreating ice of the Wolstonian. Even older material should survive in the English Channel. The discussion so far has ignored the question of whether artefacts would survive one or more marine transgressions. This will be discussed later (paras. 2.11 and 2.15). In practice there seems to have been a gap in site evidence for human occupation of southern England from 180,000 to 60,000 years BP, but this may be due to a failure to discover materials of this age on land. After 120,000 years BP people may have moved onto the low-lying shelf lands as the Devensian ice expanded over northern Britain.

2.8 The topography of the coastline at the peak of the Devensian glaciation 22,000 years ago is shown in Figure 2 (Woodcock and Strachan 2000, p. 405) for peak glacial limits. Lambeck (1995) and Shennan *et al.* (2000a, 2000b) have produced models which combine the compensation for the addition and removal of the weight of ice (Glacial isostatic correction) and for the removal and addition of weight of water (Hydro-isostatic correction) during the rising sea level (see Figures 3 and 4). In Figures 3(a)-3(d) we see the north British ice cap melting rapidly from 22,000 to 14,000 years ago. As the weight of ice is removed the land rises faster than the global sea level, so that the area of dry land increases throughout this period, both northwards and south-westwards. By 12,000 years BP the sea is

beginning to overflow the land (Figure 3(e)) and, although a small ice cap forms briefly around 10,000 years BP, the sea continues to rise faster than the land, forming deep bays and gulfs penetrating into the North Sea, isolating Dogger Bank, and separating the Straits of Dover about 7,000 years BP (Figure 3(h)). Figure 4 ((a) to(h)) provides an overlapping sequence from 10,000 years BP to 4,500 years BP showing the progressive flooding of Dogger Bank, and the shoals around East Anglia, and the German Bight. By 4,500 years BP the sea level became approximately stable, although isostatic adjustment of the land continues, with Scotland doming upwards in the centre, and south-east England subsiding slowly. The central land mass around Dogger Bank has been called "Doggerland" by Coles in a series of research papers (Coles, 1998; 1999; 2000). It should be born in mind that the tidal range and tidal currents during the periods of changed topography were quite different from today, and models of these have been generated by Shennan *et al* (2000 a & b).

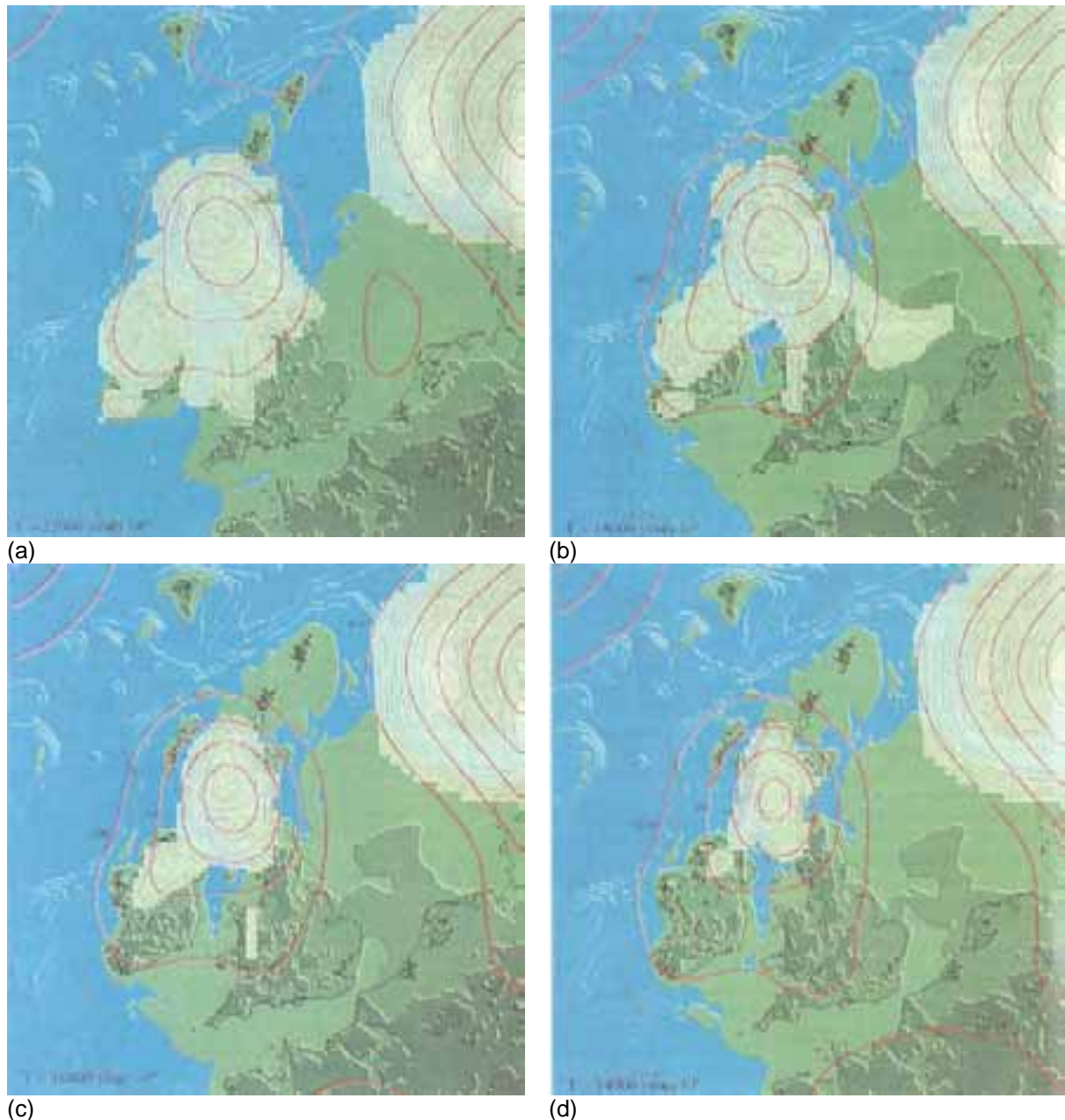


Figure 3 *Isobase maps of predicted shorelines, shoreline locations and ice sheet limits for selected epochs. (a) 22,000 years BP corresponding to the adopted time of maximum glaciation over the British Isles, (b) 18,000 years BP corresponding to the time of the onset of deglaciation of the large ice sheets, (c) 16,000 years BP, (d) 14,000 years BP.*

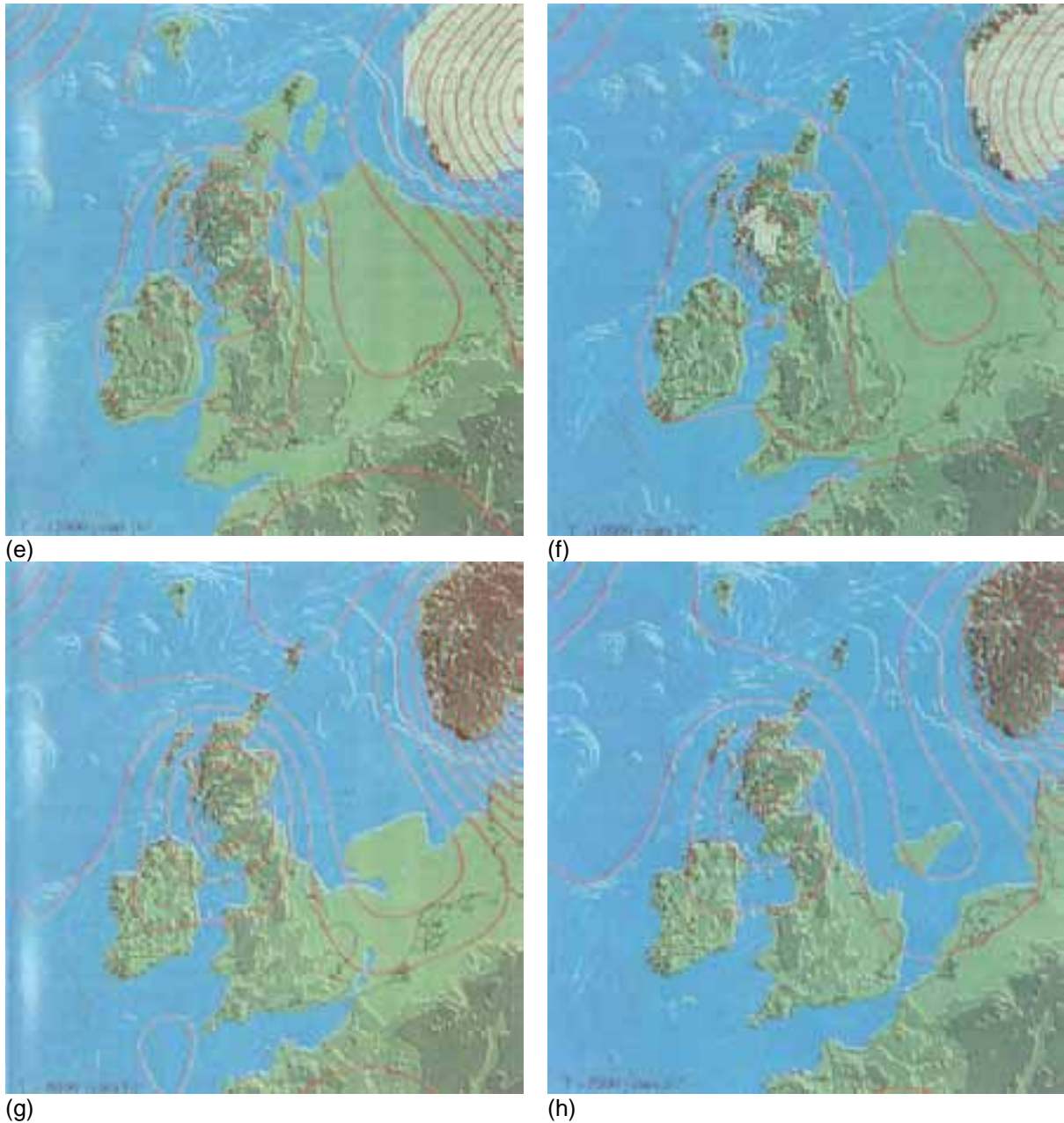


Figure 3 continued (e) 12,000 years BP, (f) 10,000 years BP, (g) 8,000 years BP, (h) 7,000 years BP. The maximum ice heights for these epochs are: 1,500m at the time of the glacial maximum at 22,000 years BP, 1,400m at 18,000 years BP, 1,300m at 16,000 years BP, 1,000m at 14,000 years BP and 400m at 10,000 years BP. Palaeowater depths are also indicated with contours at 50, 100, 150 and 200m. Isobase contour intervals are 50m for (a) to (d), 25m for (e) and (f) and 10m for (g) and (h). (After Lambeck, 1995).

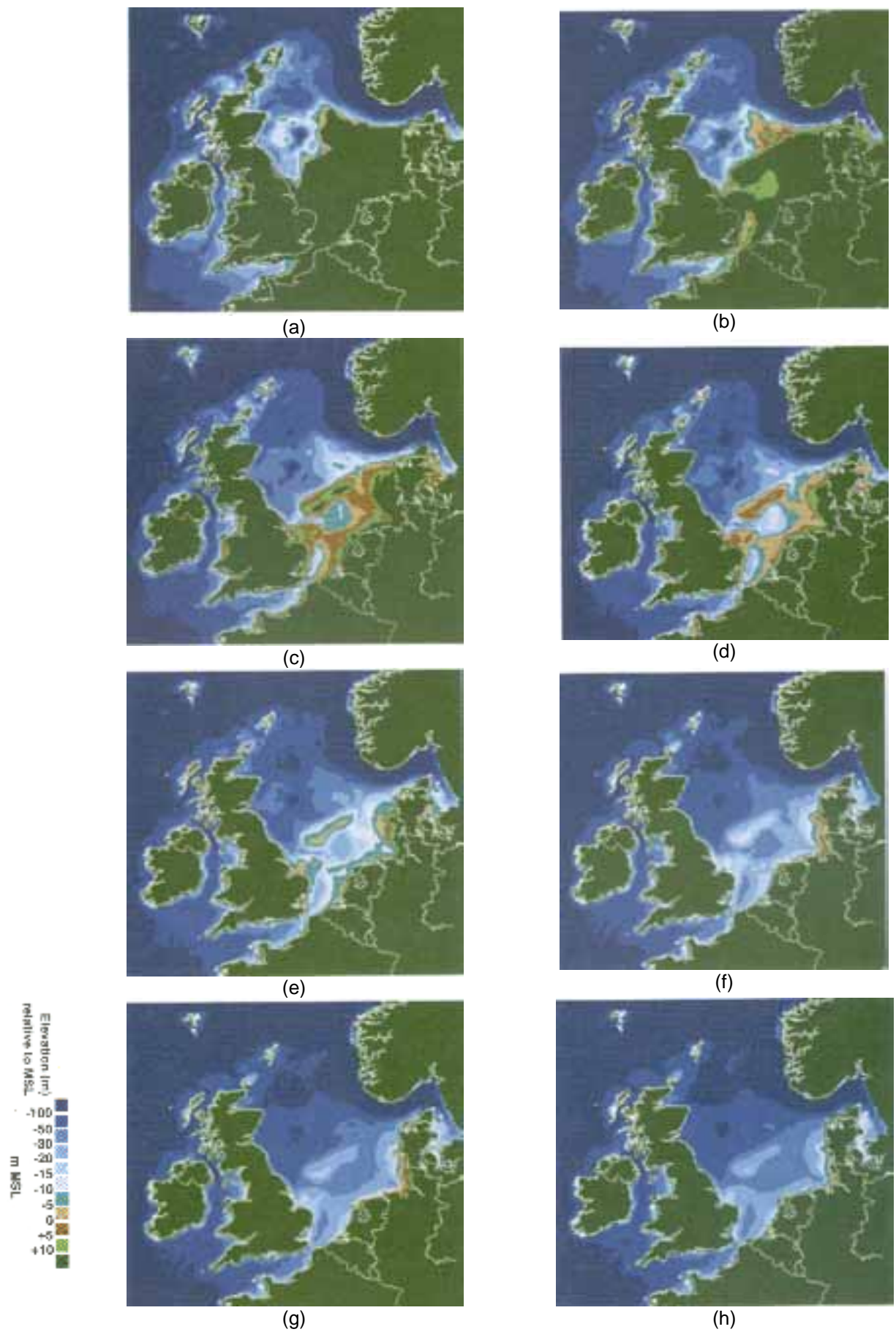


Figure 4 Palaeogeographic reconstructions of Northwest Europe (a) 10,000 years BP, (b) 9,000 years BP, (c) 8,000 years BP, (d) 7,500 years BP, (e) 7,000 years BP, (f) 6,000 years BP, (g) 5,000 years BP, (h) 4,000 years BP. Elevations (metres) relative to MSL, depths below MSL are given as negative. (After Shennan et al, 2000b)

2.9 Considering the detail of topography, the search for coastal sites, and the local complexity of glacial isostasy and hydro-isostasy reveals a factor which, so far as I know, has not yet been fully analysed by the modellers. The numerical models of the process of the last melting of the ice and transgression of the sea water represent a period when the uplifting of the off-loaded land in the area of the North Sea was lagging by centuries or millenia behind the equilibrium position which would apply as a result of the previously removed mass of ice. The evidence for this is with us today, since the land in Scotland and Scandinavia is still rising. Conversely, when the ice caps were growing, the depression of the land would lag behind the equilibrium position after the ice mass had been added. Between 120,000 years BP and 20,000 years BP the ice caps were, in general, increasing in size. However, there were periods such as sub-stage 5e about 85,000 years ago, or sub-stage 3 about 30,000 years BP, when, on a global scale, ice melted for a few thousand years, and the sea rose by a few tens of metres, and then descended again. These inter-stadial events will have produced substantial shoreline features especially when the sea level was at a turning point. However, a minimum sea level turning point at the end of a period of increasing ice volume and falling sea level would be contemporaneous with a sinking land mass lagging behind the ice volume, while a maximum sea level turning point would be contemporaneous with off-loaded crust which was starting to rise, with a lag factor. This means that the maps shown in Figures 3 and 4 cannot be transposed exactly to other parts of the last glacial cycle when the sea level or ice volumes appear at first sight to be similar. Since each glacial cycle is in general a series of increasingly cold stadials over about 100,000 years followed by relatively rapid deglaciation over about 20,000 years, this final phase can be modelled in the same way each time, and Figures 3 and 4 should be approximately applicable to the final marine transgressive phase of each of the last 3 glaciations.

2.10 We now consider the question of how and when human artefacts deposited in beach gravels, river beds, or lagoonal sediments or peat, would survive either one sea level transgression, or even multiple marine transgressions.

2.11 Taphonomy is the study of the changes which occur to deposits after primary deposition. Archaeological materials may be covered by metres of sediments which protect them indefinitely, or eroded by ice, eroded by rivers, eroded and scattered by surf action on a beach, eroded by bottom action of storm waves in shallow water, eroded by tidal currents, chemically altered, or disturbed by trawling, dredging, entrenching, or drilling. There is insufficient space in this report to discuss all the processes, conditions, and topography which are most favourable in every combination of circumstances for the survival of an archaeological artefact *in situ* which is submerged for at least part of its existence. The typical conditions for the survival of known submerged archaeological prehistoric sites are presented in a table by Flemming (1983a, p.161-163) classified as Ria, Lagoon, Estuary, Sheltered alluvial coast, Exposed accumulating beach, Submerged sea caves, Karstic caves, and Islands and archipelagos. Each site is classified in terms of depth, age, tidal range, current, wind fetch, and estimated wave action. Peat and submerged forests are important indicators, and Figures 19 and 20 in Louwe Kooijmans (1970/1), illustrate in the widespread occurrence of peat on the floor of the North Sea. Earlier analysis of North Sea peat is provided by Jelgersma (1961).

2.12 Although other factors also apply, for example normal subaerial erosion processes, the critical period for survival is the time when the surf zone starts to impact on the site, and the ensuing few hundred years as the sea level rises over the site, and coastal shallow water waves are breaking over the site. Favourable factors for survival in the deposit area include:

- ❑ Very low beach gradient and offshore gradient so that wave action is attenuated and is constructional in the surf zone.
- ❑ Minimum fetch so that wave amplitude is minimum, wavelength is short, and wave action on the seabed is minimum.
- ❑ Original deposit to be embedded in peat or packed lagoonal deposits to give resistance and cohesion during marine transgression. Drowned forests and peat are good indicator environments.
- ❑ Where deposits are in a cave or rock shelter, roof falls, accumulated debris, concretions, breccia, conglomerate formation, indurated wind-blown sand, all help to secure the archaeological strata.
- ❑ Local topography contains indentations, re-entrants, bays, estuaries, beach-bars, lagoons, near-shore islands, or other localised shelter from dominant wind fetch and currents at the time of transgression of the surf zone.

2.13 This brief analysis demonstrates that survival or destruction of an archaeological deposit, whether originally inland or on the coast, depends acutely upon the local topography within a few

hundred metres or a few km of the site. Generalised coarse resolution maps tend to omit the details which show the necessary local topographic clues. It is no coincidence that the most prolific area of proven submerged Mesolithic sites is between the islands of the Danish archipelago, where many hundreds of sites have been mapped and sampled by the National Museum Maritime Archaeological Institute, and the National Forest and Nature Agency, assisted by amateur divers. The Bouldnor Cliff site in the lee of the Isle of Wight on the Solent is protected in the same way.

2.14 The factors in the previous paragraphs are those which promote survival of the original deposit *in situ*. However, if an archaeological deposit is buried under 5-10m of mud or sand it will not be discovered, except in very unusual circumstances. Thus the final requirements for survival and discovery are:-

- ❑ Low net modern sediment accumulation rate so that the artefacts are not buried too deeply.
- ❑ No fields of sand waves or megaripples over the site.
- ❑ Ideally, a slight change in oceanographic conditions so that the site is being gently eroded to expose deposits when visited by archaeologists. (This factor is sufficiently common in known sites to be a serious factor, and should not be regarded as an unlikely fluke).

2.15 The previous paragraphs describe how prehistoric archaeological remains can be deposited and preserved as the sea level rises once over the site; how the remains can survive on the seabed; and how they may subsequently be sufficiently exposed or eroded to permit discovery. The great majority of known submerged prehistoric sites globally fall in the age range of 5,000-45,000 years old (Flemming 1998), and thus, even if they were formed before the last glacial maximum at 22,000 years BP, the sea level was falling at the time, and they only experienced one subsequent marine transgression during the Flandrian rise of sea level. Only one submarine prehistoric site has been reported with an age which implies multiple marine transgressions. Werz and Flemming (2001) describe 3 Acheulean hand-axes found at a depth of 8m offshore Table Bay, South Africa, covered by several metres of marine sand, and embedded in red earth on bedrock. The offshore gradient seaward of the site is 1:400, which is extremely low, and so the Atlantic swell was both attenuated and constructional in action when breaking. The tools are of a type which was in use between 300,000 and 1.2 million years BP. The report analyses the stability of the coast to check whether the land may have subsided since the tools were deposited. The conclusion is that the tools have survived *in situ* and have experienced between 3 and 8 marine transgressions of glacio-eustatic origin. The hand-axes each weigh just over 1kg, and are about 21cms long. This example, which is unique so far, demonstrates that, given suitable oceanographic conditions, hominid and human artefacts can survive multiple marine transgressions over many hundreds of thousands of years.

2.16 Potential discovery "hot-spots" in the North Sea cannot be listed exhaustively at this stage. The steps needed to create high resolution local sensitivity maps can be identified, and are discussed later in this section. In principle the key factors are:-

- ❑ "Fossil" estuaries and river valleys.
- ❑ The flanks of banks and ridges which have been proven to have peat layers, or which are likely to have peat layers.
- ❑ Valleys, depressions, or basins with wetland or marsh deposits.
- ❑ Nearshore creeks, mudflats, and peat deposits (e.g. Essex coast).
- ❑ "Fossil" archipelago topographies where sites would have been sheltered by low-lying islands as the sea level rose.
- ❑ Niche environments in present coastal zones, wetlands, intertidal mudflats, and estuaries.

2.17 Basic topography can be obtained from hydrographic charts.

Charts 2182A & B show the detailed topography of the southern North Sea Banks, Shoals, and Ridges very clearly, and both these sheets, and the BGS Sheets discussed in para.2.18, show the positions of production platforms and pipelines. Figure 5 shows the topography of the North Sea at 10m vertical resolution and with high horizontal resolution. At first sight there are many features which provide locations comparable with the features required in previous paragraphs. However, actual interpretation depends on separating modern ridges and banks of mobile sand from earlier Devensian gravel, clay, or peat.

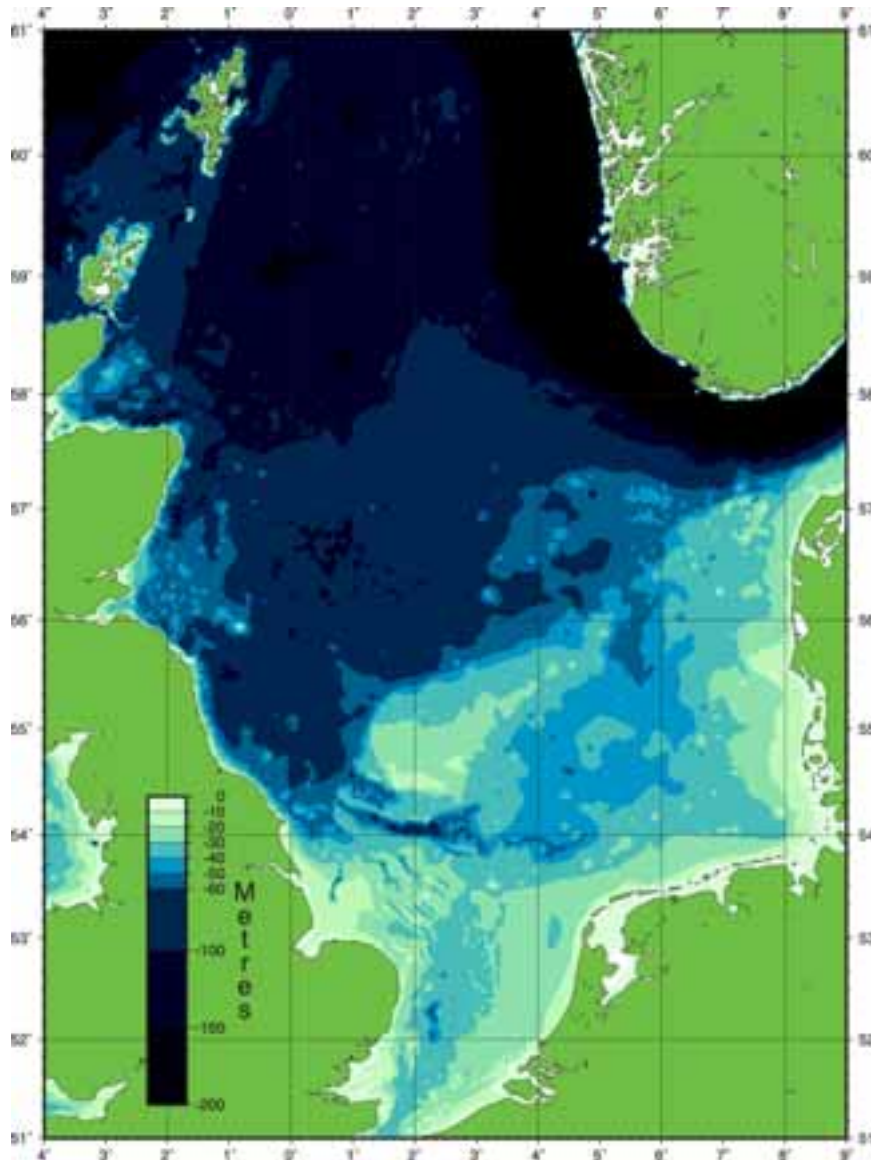


Figure 5 *North Sea bathymetry at 10m depth intervals for 0-60m. The Dogger Bank dominates the central basin from 54°-56° N, and the deep channel of Outer Silver Pit cuts across south of the Bank. Active sand banks trend NW-SE off the Norfolk coast, with Brown Ridge trending N-S in the centre of the southern basin. Devensian ice age terrestrial topography has been partly concealed by Holocene infilling of river valleys, lakes, and glacial tunnels, combined with the superposition of longitudinal banks of moving sand maintained by the tidal currents, and fields of sand waves.*

2.18 The British Geological Survey (BGS) collaborated with its opposite numbers in Netherlands and Norway during the 1980s to produce a series of seabed sediment maps for the North Sea at a scale of 1:250,000. These maps, and the associated cores, are an essential tool for assessing the archaeological potential and sensitivity of areas of the sea floor, providing classification of surface sediments by grain size, thickness of active marine sediments, thickness of Holocene deposits, standard cross-sections, information on tidal currents, sand waves and sand ripples, carbonate percentage, and other items of information which vary from sheet to sheet. Some sheets, but not all, include copious technical notes, sections, core profiles, and analysis of sources, references, and comments on the various facies. All sheets show positions of platforms and pipelines at date of publication. Notes on some of the most relevant sheets follow (from north to south):

Cormorant: 61-62° N, 0-2° E. Massive gravel ridge trends NW-SE at a depth of 170-180m. Core logs show clay and sand with shells. Shelf edge and fossil beaches. Extreme northern margin of land at maximum extent.

Halibut Bank: 60-61°N, 0-2° E. Patches of sandy-gravel at 130m, sloping gently westwards towards a depression at 150m depth, consisting of muddy-sand. A worked flint was found in a core taken on this slope (See section 4. 2 below).

Bressay Bank: 59-60°N, 0-2°E. High ground of Bressay Shoal, and widespread distribution of modern sands a few cms thick over older Quaternary deposits. Potentially interesting with more data.

Bosies Bank: 58-59°N, 2°W-0°. Local high grounds of gravelly-sand with flanks of sand with some gravel, and extensive flats of sand. Gravel deposits could be source of flints.

Devil's Hole: 56-57°N, 0-2°E. A series of N-S trending depressions with the break of slope at 90m, and 20-30 miles long. Depth at southern end 140-200m. Typical tunnel valleys. Accumulation of fine sediments within the basins would make retrieval of any existing artefacts very difficult.

Swallow Hole: 55-56°N, 0-2°E. The Swallow Pit drops from 90 to 160m resulting from glacial scour or sub-glacial tunnelling. As with the adjacent Gorsthorpe Deep at 90m the accumulation of fine sediments and mud in the depression would tend to make the recovery of artefacts very difficult. There is a broad bank of gravel 5 x 10 miles forming the NW Rough, on the edge of the Dogger Bank. This could be source of artefacts, though it is uncertain whether sites would occur on such exposed high ground.

Dogger: 55-56°N, 2-4°E. Dogger Bank consists of morainic and pro-glacial lake deposits, with Elbow formation of calcareous sands and peaty organic detritus infilling glacial depressions, and overlying Pleistocene sediments. Upper surface is Holocene sediments 5-20m thick on the SE flank. Mostly gravelly-sand with patches of gravel. In Mesolithic period occupation more likely in the lower valleys, but hunting could have taken place on the high ground.

California: 54-55°N, 0-2°E. This area close to the Yorkshire coast was subjected to ice erosion by a tongue of the ice cap during the Devensian, and there are few thick sediment layers which might contain archaeological materials.

Silver Well: 54-55°N, 2-4°E. The Outer Silver Pit is bordered along its SE margin by Indefatigable Bank, Cleaver Bank, and South Rough, all of which are sandy-gravel. There are gradients of the order of 1/25 to 1/10 down into Markham's Hole, Botney Cut, and Silver Pit itself. Artefacts might occur in valley or beach structures on the slopes.

Indefatigable: 53-54°N, 2-4°E. Seabed between the banks from Ower to Swarte is gravelly-sand, while north of the Indefatigable Banks towards Markham's Hole, sandy-gravel. Paths of sandy-gravel between Outer Silver Pit and Botney Cut. These coarse grain sizes are natural retainers of lag materials such as flints and bones. The SE half of the sheet shows the Elbow formation from 5-20m thick. This is early Holocene clay and peat, associated with tidal mudflats and wetlands. The Indefatigable Beds are 30% gravel, early Holocene, lag deposits with molluscs.

Flemish Bight: 52-53°N, 2-4°E. NW part of the sheet dominated by tidal sand ridges up to 25m thick, including Winterton, Hewitt, Smith's Knoll, etc. Gravelly-sand in the troughs, and some sandy-gravel. If the ridges have any earlier core, the low ground would have been coastal inlets as the sea rose, and hence archaeologically interesting. Beds of the Elbow formation contain the coastal bivalve *Spisula subtruncata* overlying a basal peat. An interesting area away from the sand ridges.

2.19 The discussion throughout this section on site occurrence, preservation, and discovery is based on the analysis of known prehistoric submerged sites off the coasts of many countries. It is not a speculative theory without field evidence. A selection of the key sites providing the basis for this analysis are described by the following documents: Godwin (1941); Blanc (1940); Fischer(1995); Galili and Nir(1993); Galili *et al.* (1993); Momber (2000, 2001); Flemming (1983a; 1983b; and 1998); Prigent *et al.* (1983); Hayashida (1993); Harding *et al.* (1969); Cockrell and Murphy (1978); Wreschner (1977, 1983); Clottes and Courtin (1996); Wilkinson and Murphy (1995); Andersen (1980); Scuvée and Verague (1978); Werz and Flemming (2001); Josenhans *et al.* (1997); Stright (1990); Louwe Kooijman (1970-71).

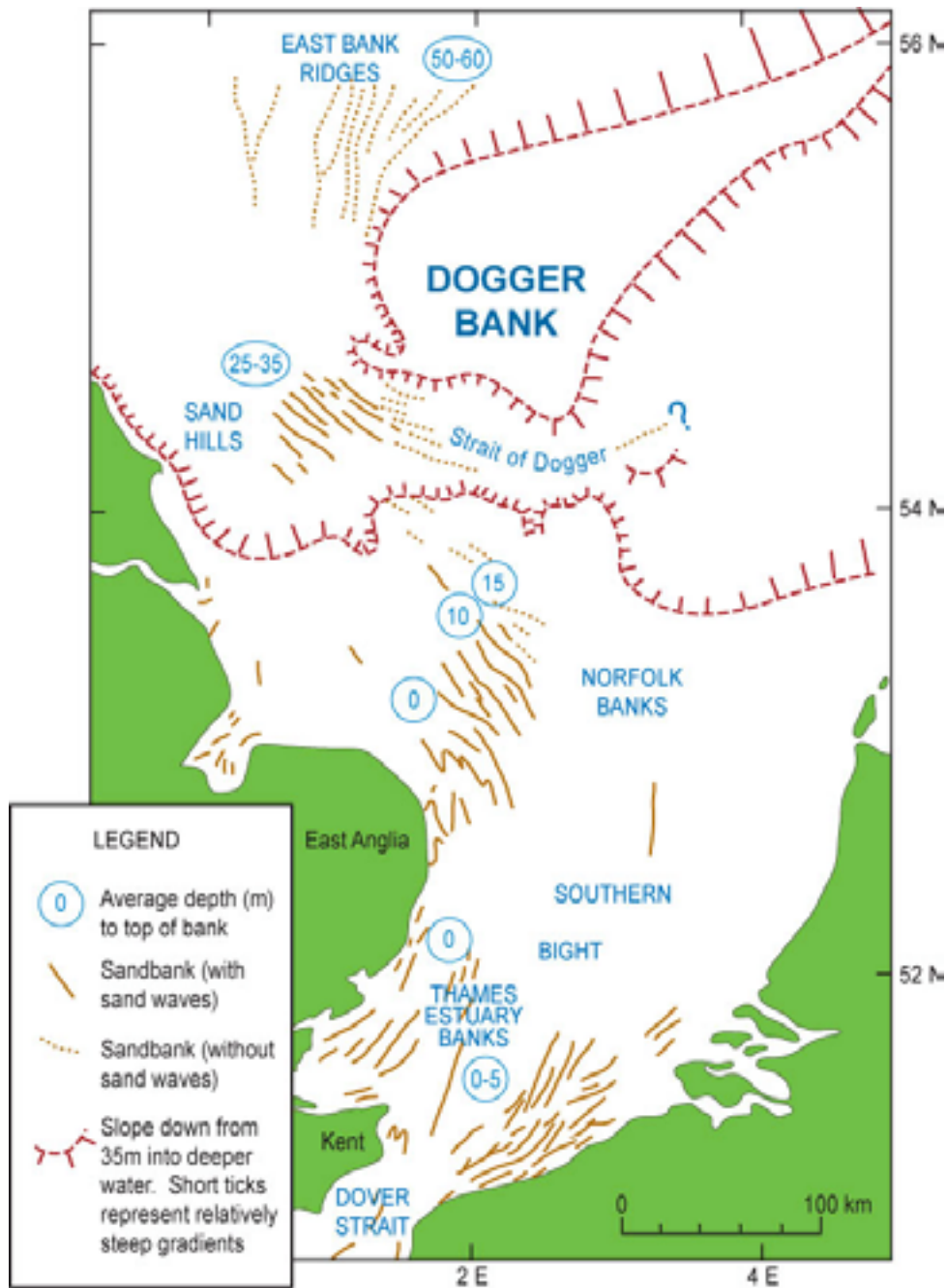


Figure 6 Offshore tidal sand-banks of the south-western part of the North Sea. The East Bank group, the Sand Hills group and the outermost of the Norfolk Banks are considered to be moribund. However, the sand-waves on much of the Sand Hills group suggest that they are still subject to some constructional activity by modern currents. (From Kenyon *et al* 1981)

2.20 The known banks and shoals in the North Sea are one starting point, since prehistoric artefacts have been dredged adjacent to several of them (see next section). It is necessary to separate those banks which have a core of Pleistocene or early Holocene terrestrial material from those which are purely hydrodynamic bedforms of unconsolidated sand responding to modern tidal currents (See-Kenyon *et al.*, 1981; D'Olier 1981) and Figure 6. A good introduction to this problem is provided by Pantin *et al.* (1991). In some cases the sand may have accumulated round a previous high in the topography, but even if this is the case, the thick cover of recent marine sand can make the bank an unattractive search area for prehistoric artefacts. D'Olier presents data to show that some of the banks close to the Kentish coast and Thames estuary may have formed initially as beach ridges during the rising sea level. For completeness, banks are listed from north to south as follows (see Figure 6):

Bank Name	Depth range, m	Probable composition
Viking, Bergen	90-110	
Halibut, Little Halibut	75-90	
Little Fisher	40-50	
Jutland	16-30	
Dogger	20-60	Pleistocene, Holocene Elbow
Outer Well	20-30	
Outer Dowsing	<10	
Indefatigable	<10	
Swarte	<10	
Broken	<10	
Well	<10	
Ower	<10	Sand on London Clay ridge
Leman	<10	Sand on London Clay ridge
Brown Ridge	16-40	Eroded Pleistocene clay
Smith's Knoll		Modern sands
Shipwash		
Galloper	<10	Sand on London Clay ridge
Hinder		
Goodwin Sands		
West Dyck	<10	Active tidal sand bank
Outer Ruytingen	<10	Active tidal sand bank
Fairy Bank	<10	
West Hinder		
North Hinder		
Bligh	<10	
Buertebanken	<10	
Middle Bank	<10	
South Falls	<10	Active tidal sand bank
North Falls	<10	
Outer Gabbard	<10	Sand on London Clay
Sandettie		Active tidal sand bank

In general, banks which have a core which is earlier than Holocene or modern marine sands could have formed headlands, promontories, or sheltering islands on the coast at some stage during the Flandrian. Closely spaced banks would have narrow channels between, providing both shelter and good fishing. Depending upon the precise gradients and topography of the neighbouring sea floor, one would expect the low ground adjacent to the ridge to be a prospective area. The chance of discovery would depend upon the thickness of recent mobile sands, or recent scour.

2.21 Possible null zones and prospective submerged archaeological sites

Null zones

Some areas can be ruled out immediately. The coast of Scotland is uplifted substantially, (Flemming 1982; Lambeck 1995), so that all Holocene and Devensian shorelines are above present sea level. There are no submerged artefacts or occupied shoreline sites within several km offshore from the Scottish coast. Some distance offshore there will be a hinge-line, and the seabed will be depressed, so that coastal lands from the past will still be underwater.

Fischer (1991) shows a series of plots of the ice front retreating from the north of Denmark, and the positions of the northernmost prehistoric sites at the same dates. The correlation suggests that there were no permanent settlements within about 100km of the ice front. Settlements do move north continuously following the ice, and there may have been hunting or fishing excursions closer to the ice front.

The deepest ice-scour valleys and the deep valleys of the major rivers crossing the central floor of the southern North Sea probably provided attractive habitation areas after the retreat of the ice, but these valleys are now usually filled with thick Holocene deposits and modern marine sands. Further archaeological and sedimentological research on this problem using sub-bottom profiling might be worthwhile, but there is little chance of artefacts being exposed on or near the surface.

The tops of banks and ridges would usually not have been inhabited, and would tend to be scoured by wave and current action during inundation, if not under present conditions. Late Palaeolithic and Mesolithic people were not stupid, and probably had the same IQ as modern humans, combined with the migrant hunter's understanding of the landscape and weather. In near Arctic conditions settlements would have been in the lee or shelter of ridges and headlands, not on top. The ice caps had melted completely by 9,000 years BP, but even as the climate ameliorated and vegetation and forests covered the land, the attraction of the coast would persist into the Mesolithic.

Prospective sites, to be considered for high resolution sensitivity mapping

Depressions, large lagoons, channels

All recorded sites of retrieved prehistoric artefacts in the North Sea so far are in some form of depression or low ground, where scour has removed the usual presence of mobile marine sands.

Sites of continuing or prospective interest are:

- Depressions to the west of Viking and Bergen Banks
- The extensive depression south of Dogger Bank, and through the Outer Silver Pit.
- The depression south and west of Brown Ridge, including deep gulleys down to 50m in this area.
- Depressions and gulleys between the banks and ridges north east of the Essex coast, from Leman and Ower to Swarte Bank.

Palaeo-coastlines, headlands, bays, coastal lagoons

This category overlaps with the previous paragraph, but is intended to describe small sheltered coves, and back-beach lagoons, wetlands and pools of a few km extent, rather than the semi-enclosed seas or gulfs.

This is more difficult to pin down, since the features would tend to emerge briefly when the water level reached a particular contour of the topography, and disappear a few hundred years later as the sea level changed. The topography would be the late Devensian landscape before it was covered with Holocene alluvium and marine sands, so that the contours are not easily identified from present charts. Detailed study of the Holocene thickness from the sediment maps of BGS might provide sufficient data.

Modern coastlines

Artefacts have been found on modern coastlines in Denmark, Netherlands, Yorkshire, East Anglia, and the southern coast of England. The UK NMR is developing a full catalogue of prehistoric sites, including coastal and shallow water. These zones indicate the likely occurrence of future finds.

Present intertidal mudflats and wetlands

This is a very rich area, and a great deal of work has been done in this environment in the last 20 years. All mudflats and marshes and wetlands of the east coast of England should be regarded as potential archaeological sites. Hotspots would be in precise type localities already demonstrated by previous work. A complete register is being built up by the National Monuments Record (NMR) and English Heritage is developing a coastal and nearshore programme.

Lee of islands and archipelagos

Close scrutiny of the sediment maps of the North Sea at the base of the Holocene will reveal locations where isobath gradients reverse to indicate channels between islands. Nearshore islands provide tempting sites, not because the island would necessarily have been occupied, but because of the sheltered water.

Estuaries, wetlands, marshes, peat

Figure 7 is adapted from work by Coles (1998) and is a tentative reconstruction of the most probable courses of rivers and locations of lakes at the maximum extent of land at about 12-14,000 years BP. From this reconstruction, and from the detailed regional papers, the position of wetlands, estuaries, and

peat environments could be reconstructed for different dates. These environments have frequently been associated with Mesolithic artefacts in sheltered modern locations (see Section 4). The absolute chronology of peat deposits in the North Sea, and the relation of peats to age and sea level was first evaluated in detail by Jelgersma (1961), and the subject has been steadily developed since.

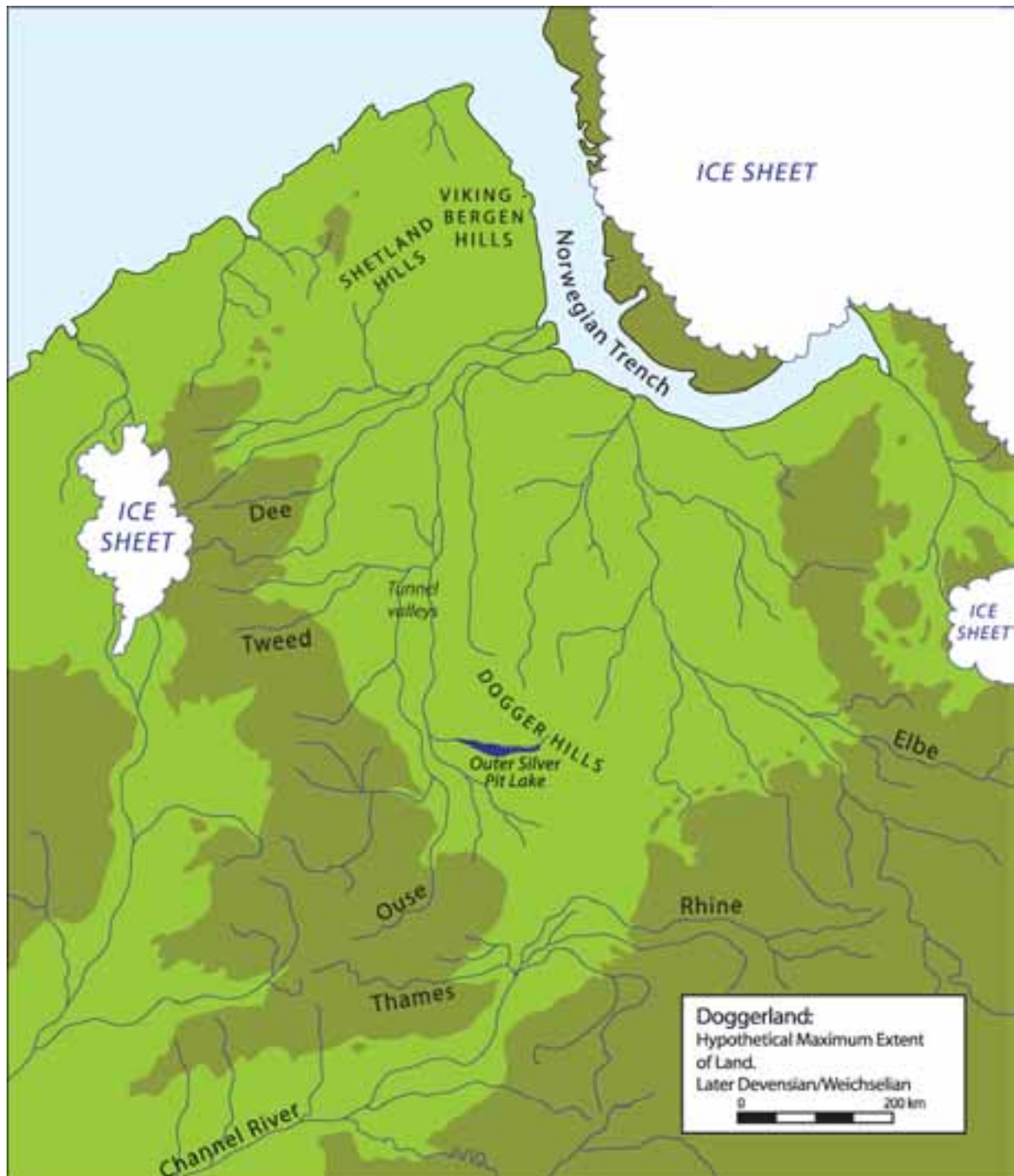


Figure 7 This map is a speculative reconstruction of the river courses across the North Sea floor, the Channel, and the Irish Sea at the Late Glacial cold stadial when the area of dry land was a maximum. Map devised by B.J.Coles and S.E. Rouillard. Copyright.

Caves and cliffs

This environment is of proven potential in many parts of the world, including underwater, but no likely areas are known to exist submerged in the North Sea. The Yorkshire cliffs, and other cliff coasts of Northumberland and East Anglia are important erosional features with artefacts occasionally being revealed. Outside the area of SEA3 and SEA2 there are obviously interesting areas around Orkney and Shetland where there are extensive rocky surfaces and known archaeological sites on land dating back at least 5,000 years.

2.22 Conclusions of this Section

Distinct areas of the North Sea can be ruled out as not archaeologically prospective for prehistoric sites. (Note: there may of course be many shipwrecks in these areas).

Although human artefacts in the North Sea have only been found for dates as far back as about 11,000-12,000 years BP, it is theoretically possible that settlements or occupation sites existed on the sea floor at any time back as far as 100,000, and the possibility of discovery should not be rejected.

Two large areas of the central North Sea, west and south of Dogger Bank and south west of Brown Bank are of high potential, and should be monitored and studied further.

Smaller zones in the lee of banks and islands on palaeo-shorelines are potential hotspots.

Intertidal mudflats and wetlands on the east coast of England should be reviewed by the standards of the East Anglian survey by Wilkinson and Murphy (1995).

English cliff coasts of unconsolidated glacial drift contain artefacts which are eroded out onto the shore. These features should be monitored.

British archaeologists should work closely with colleagues in mainland Europe, especially Denmark and the Netherlands to compare site interpretation and detection methods.

The rocky coasts off Yorkshire present a potential, and around the Orkneys and Shetlands there is a potential which has not been assessed in this report.

3. Human occupation of the North Sea continental shelf and adjacent regions, a brief history of the last half million years

3.1 Hominids (*Homo heidelbergensis*, *H. neanderthal*) have lived in Britain since about 500,000 years BP, with occasional gaps. On 4 June 2002 Chris Stringer announced that the AHOB programme had confirmed some UK sites as early as 700,000 years BP (Times, 4.6.02). *Homo sapiens* arrived in about 60,000 years BP. Since hominids could walk from mainland Europe for much of this time, there is no mystery as to how they reached southern England. Figure 8 illustrates the distribution of early hominid sites in Europe (From Stringer and Gamble 1993). During these very early times hominids could not make boats, but they had a sophisticated stone tool kit, and used these to cut wooden tools such as spears and boomerangs. Thousands of flint tools have survived, but only a few of the wooden artefacts. Analysis of the edges of stone tools can show which ones were used for cutting wood, cleaning bones, cutting meat, scraping skins, etc. Stone tools, the residual flint cores, and the chips of debris scattered off them have been re-assembled into the original lump of stone, showing exactly the technique and sequence adopted by the people making them. The earliest proven date for major sea crossing by early man is the occupation of Australia in about 50,000 years BP which necessarily required the use of floating craft capable of crossing tens of km of open sea. People may have been able to cross wide channels before that, but we have no evidence of it. Many small and medium sized mammals can swim well, as can humans, and it is probable that people could cross channels of a few km, when it was important to do so, well before 50,000 years BP. Mesolithic people from about 10,000 years BP onwards were able to build and use sophisticated log boats, and hence travel between islands, and to catch fish in open water.



Figure 8 Well dated pre-neanderthal fossils are rare in Europe. Sites of finds are here divided into those older than 400,000 years (red circles) and more recent, up to about 125,000 years ago (red dots). Also marked is Paviland, a cave in Wales where the first fossil skeleton was excavated in 1823 (it was a modern human, or 'Cro-Magnon'). The shaded areas represent the approximate maximum extent of the sheet ice during the severest cold periods of the ice ages. At the time of Boxgrove a land bridge joined England and France at their closest points. (Map based on Stringer and Gamble 1993).

3.2 Figure 9 shows the chronology and correlations which enable archaeologists to fit human artefacts, climate, vegetation, and sea level into an integrated pattern. From about 1850-1950 strata of Pleistocene sediments, fossils, and organic remains could only be identified by the fauna and pollen, and hence were given type names, without absolute ages or exact inter-correlation. Since the use of ^{14}C dating and other absolute methods, most of the glacial phases and sediments have been correlated, but names still vary from one author or region to another, and some correlations are genuinely doubtful. The $^{18}\text{O}/^{16}\text{O}$ system for dating volume of ice from ocean cores is probably the most consistent and reliable dating baseline which serves as a uniform reference for the other factors over the last 1 million years. The first column in Figure 9 shows maximum ice volumes, and hence minimum sea levels, at 22, 140, and 345 thousand years BP. This correlates well with previous discussion, although the name Wolstonian does not appear on this diagram.

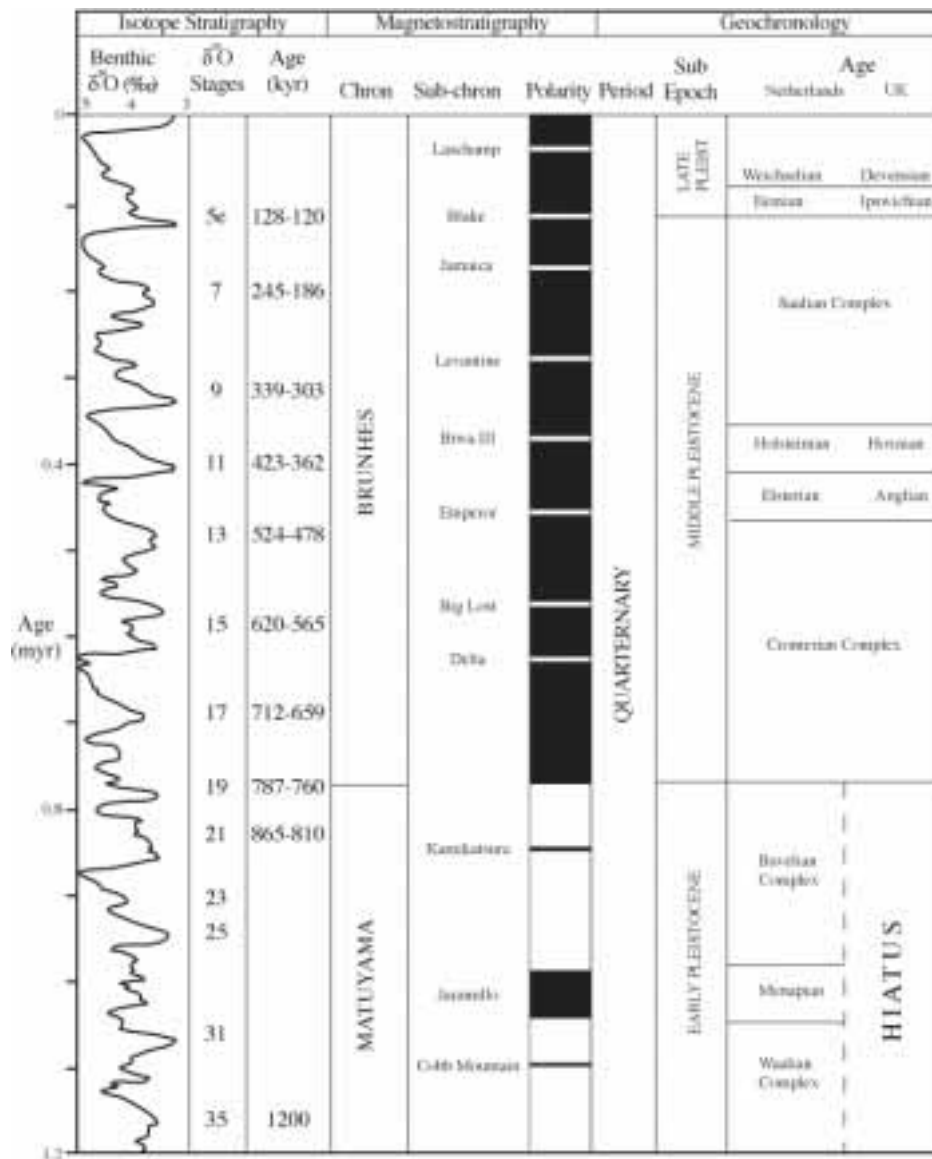


Figure 9 This diagram links the key dating schemes for the past 1,000,000 years of the ice age. On the left is the Oxygen Isotope sequence, with the warm (odd numbered) Stages indicated. The calendar dates (in thousands of years before the present) are derived from 'magnetic reversals' identified in the deep sea cores from which the isotope curve has been constructed. These reversals (centre columns) are independently dated. By convention, 'normal polarity' when magnetic north corresponds to map north, is shown shaded and 'reversed polarity' (magnetic 'north' is to the south) shown white. The former named stages of the ice age in Britain (far right) cannot be matched precisely with the Oxygen Isotope Stages. (Diagram from Pitts and Roberts, 1997).

3.3 The glacial-sea level record shows peak ice volumes and interglacials alternating with a period of about 100,000 years, with some subsidiary stadials, for the last million years. Oxygen isotope stages are numbered even for cold and odd for warm and are shown in the second column. From this we can see that the earliest hominid occupation of Britain, which occurred about 500-700 thousand years ago, has been followed by 5-7 glacial peaks covering most of the northern British Isles and North Sea. Archaeological sites from this early period are found scattered across southern England from Somerset to East Anglia, and the hominid is known as *Homo heidelbergensis*. A project funded by English Heritage and led by Dr Chris Stringer is studying the phases of occupation of the British Isles, and is called "Ancient Human Occupation of Britain" (AHOB), with a budget of £1.2 million. The AHOB outline states that "Uniquely in western Europe, East Anglia appears to contain an ancient landscape preserved, rather than destroyed, by glacial action." AHOB combines re-analysis of artefacts already curated in collections, application of new dating and radionuclide isotope studies, and some new excavations.

3.4 The most readable description of an early human occupation site in Britain is the popular book entitled "Fairweather Eden" (Pitts and Roberts, 1997), describing the Boxgrove excavation. A flint handaxe of surprising sophistication from Boxgrove is shown in Figure 10. From the extensive records of diet, hunting techniques, social structures, flint technology, and seasonal changes which define this community, a key factor from the point of view of SEA3 is that the settlement was on a coastal plain, backed by a cliff, and quite close to the sea. Bones of trout and salmon were found in the deposits, but there was no indication whether they had been part of the occupants' diet. AHOB will investigate the sites which indicate the first evidence of possible control of fire around 400,000 years BP, and examine the 15 known British assemblages of the later Levallois flint technology between 300,000 and 180,000 years BP.

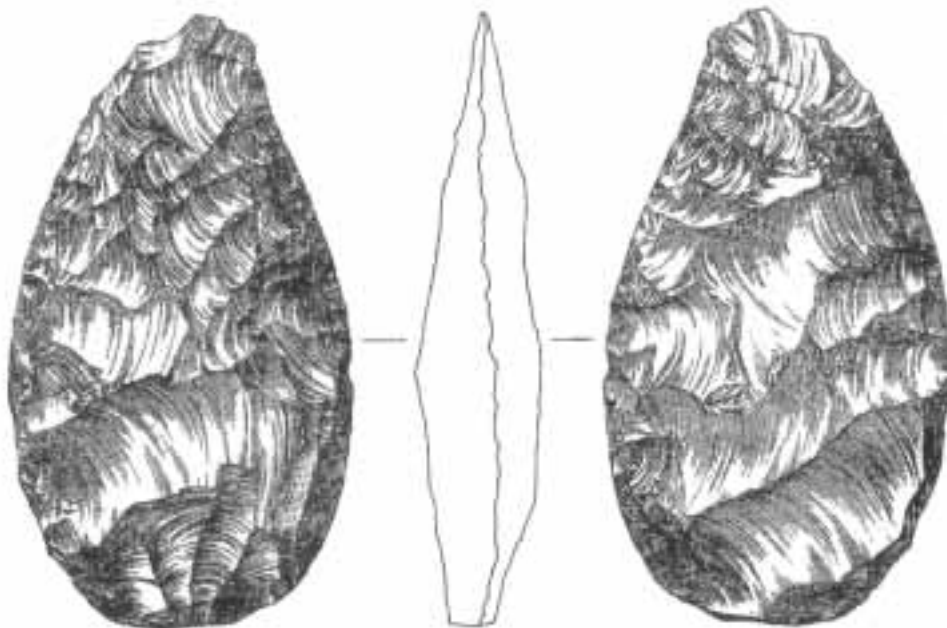


Figure 10 A flint handaxe from Boxgrove, with a 'tranchet' edge at the tip formed by the intersection of large flake scars. It is about 500,000 years old. Apart from at the base, the whole edge of this axe could have been used for cutting: the tip is razor sharp, the serrated sides are tougher but still very sharp. This is a fine example of the flint worker's art. Note the long diagonal scars in the right view, created by flakes that ran from the edge to more than half way across the axe (concentric ripples radiate from points of impact). Removing such long shallow flakes is an efficient way of thinning an axe, requiring skilful use of a soft hammer. Length 16cm (drawn by Julian Cross). (From Pitts and Roberts, 1997).

The sites analysed up to this phase are indisputable evidence of hominid occupation of southern England, and can be compared with similar sites in mainland Europe. There is no evidence of population breaks or declines in glacial times, although the population seems to have survived of the order of 5 glaciations in northern Britain. Submarine sites of all these periods could, in principle, be found on the floor of the southern North Sea and English Channel.

3.5 AHOB confronts the problem that there seems to be a break in human occupation of Britain from about 180,000-60,000 years BP, that is from Oxygen Isotope stages 6 to 4 (see Figure 11). Since this spans the last interglacial, the Eemian Ipswichian, when conditions were mild and the sea level possibly a few metres higher than at present, this is curious. Some archaeological sites might be underwater in the Channel and southern North Sea, while others may be further north, and were then obliterated by the ice of the Devensian glaciation. Chris Stringer has recently announced excavation of a Neanderthal site dating from about 70,000 years BP near Thetford, and this may begin to close the gap. Modern humans, *Homo sapiens*, seem to have arrived during OI stage 3, a mild interstadial about 60,000 years BP. A range of sites provide continuous evidence for occupation of southern England until the Devensian glacial maximum at 22,000 years BP. The Fermanville site at a depth of 25m on the French coast near Cherbourg (see below) fits into this period with a date of 45,000 years BP (Scuvée and Verague, 1978). There is then a curious gap, when the ice caps are already melting, and the next dated sites are at 13,000 years BP. AHOB proposes to examine relevant collections existing in museums to check whether this gap is genuine, or whether accurate modern dating would show continuity.

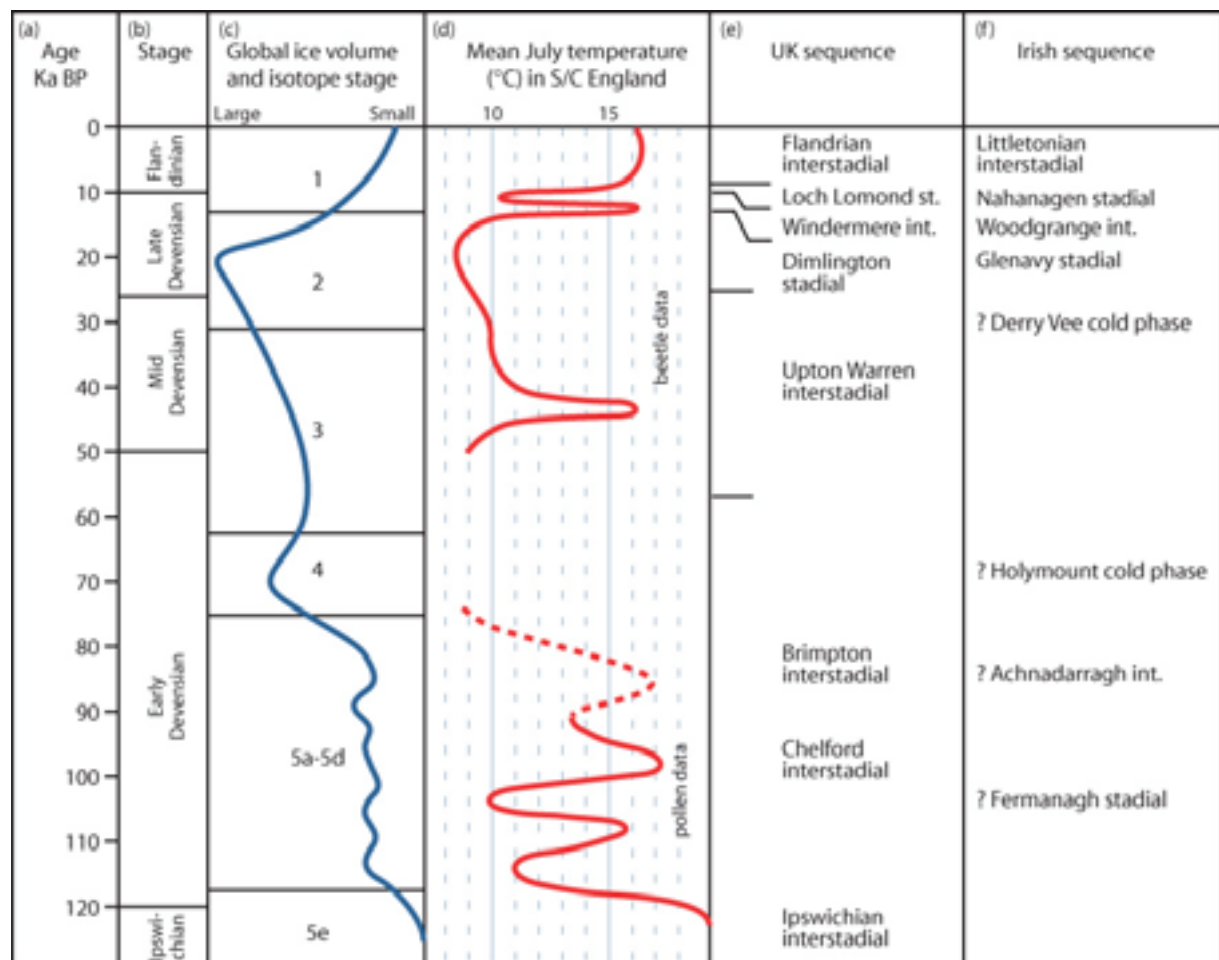


Figure 11 Estimates of temperature and ice volume through the Devensian and Flandrian, correlated with stadial and interstadial period temperature data from Coope (1977) and West (1977); ice volumes from Shackleton and Opdyke (1973). (After Woodcock and Strachan 2000).

3.6 After 13,000 years BP, the Late Upper Palaeolithic, numerous sites are known on land and underwater (see next Section). AHOB states that the environments preferred by Mesolithic tribes are poorly understood, but data in the next section will suggest that they had a strong preference for the coast, and that, at least in the early stages of northward migration, the peoples moving first and fastest were those exploiting a wide range of marine resources, and using log boats. From the knowledge of the Mesolithic in Denmark the occupied sites inland were only a few tens of km apart, and on the coast only a few km. The marine resources supported a surprisingly high population density, which in turn was conducive to the adoption of cultivation and agriculture at a later date.

3.7 Figure 11, in column (d), shows an estimate of the summer temperature in south-central England during the last 120,000 years (Coope 1977; Woodcock, 2000). Interglacials are generally as warm as the present climate, with similar vegetation, while glacials are 7-8 °C colder. This report cannot digress in detail into the methods for estimating climate and vegetation, but strata containing pollen naturally provide an accurate indicator of the flora at any time. Fossil beetles are another sensitive climate indicator. Apart from the abrupt cold snap known as the Loch Lomond stadial around 10,000 years BP, the ice had all melted by about 12,000 years BP, and the air temperature for about half of the Mesolithic was, to all intents and purposes, the same as now. Forests and vegetation were spreading northwards, and the sea level was rising continuously. At glacial maximum the ground close to the ice front was frozen permafrost, but mammoths, reindeer, and other large fauna found sufficient to eat in the periglacial terrain, and these megafauna attracted human hunters. Megafauna bones are found regularly in the North Sea. Because of the low latitude, sun angle was relatively high, there was no Arctic night, and vegetation would have been somewhat richer than modern tundra.

3.8 Conclusions from Section 3

Humans and their precursors have left signs of their activity widely across southern England and the mainland of Europe for at least the last 500,000 years, and possibly 700,000. For all glacial periods archaeological materials could survive on the sea floor of the southern North Sea and the English Channel. For the last 100,000 years sites of any age could be found in the whole North Sea. These data are important for defining the process of early occupation of Britain. Without proposing any sensational revision of the existing understanding of early humans, it is still a fact that archaeologists are continuously discovering evidence that people were cleverer than we thought, earlier than we thought, and were exploiting tools and resources in more ingenious ways than we thought. If one imagines technological capability plotted as an exponential decay curve with time going backwards, successive discoveries do not change the shape of the curve as a whole, or introduce maxima or minima, but the constants are gradually adjusted so that the curve is lifted slightly off the zero line, and the earliest date for a given level of technology moves rapidly backwards. Future discoveries on the floor of the North Sea and coastal waters are a vital part of the information needed to understand this process. They are also relevant to the origins of Neolithic agriculture in north-west Europe, and to the origins of human seafaring.

4. Coastal and submarine prehistoric archaeological sites already discovered, surveyed, or excavated in the North Sea region

4.1 This section reviews all known submarine prehistoric sites in the North Sea, with an emphasis on the British sector. The sites known within SEA3 and SEA2 are important but limited, so that relatively little can be learnt from considering them alone. By looking more widely at known sites in the rest of the North Sea it is possible to see what kinds of future discoveries might be made around the Dogger Bank, in submerged estuarine environments, and palaeo-wetlands. It is of particular interest that preserved bodies in submerged peat bogs might be discovered. The analysis of sites also serves as a set of case histories for testing the conditions of deposition and survival outlined in Section 2.

There are many hundreds of Palaeolithic and Mesolithic sites onshore within a few tens of km of the coast on all sides of the North Sea, some of which contain log boats and other evidence of seafaring. However, the total number of sites on the sea floor is sufficient to give a fully representative sample, and no onshore sites are listed in this section. Sites which are intertidal are included. The distribution of submarine prehistoric sites in the North Sea is shown in Figure 12.

Sites are listed approximately north to south.

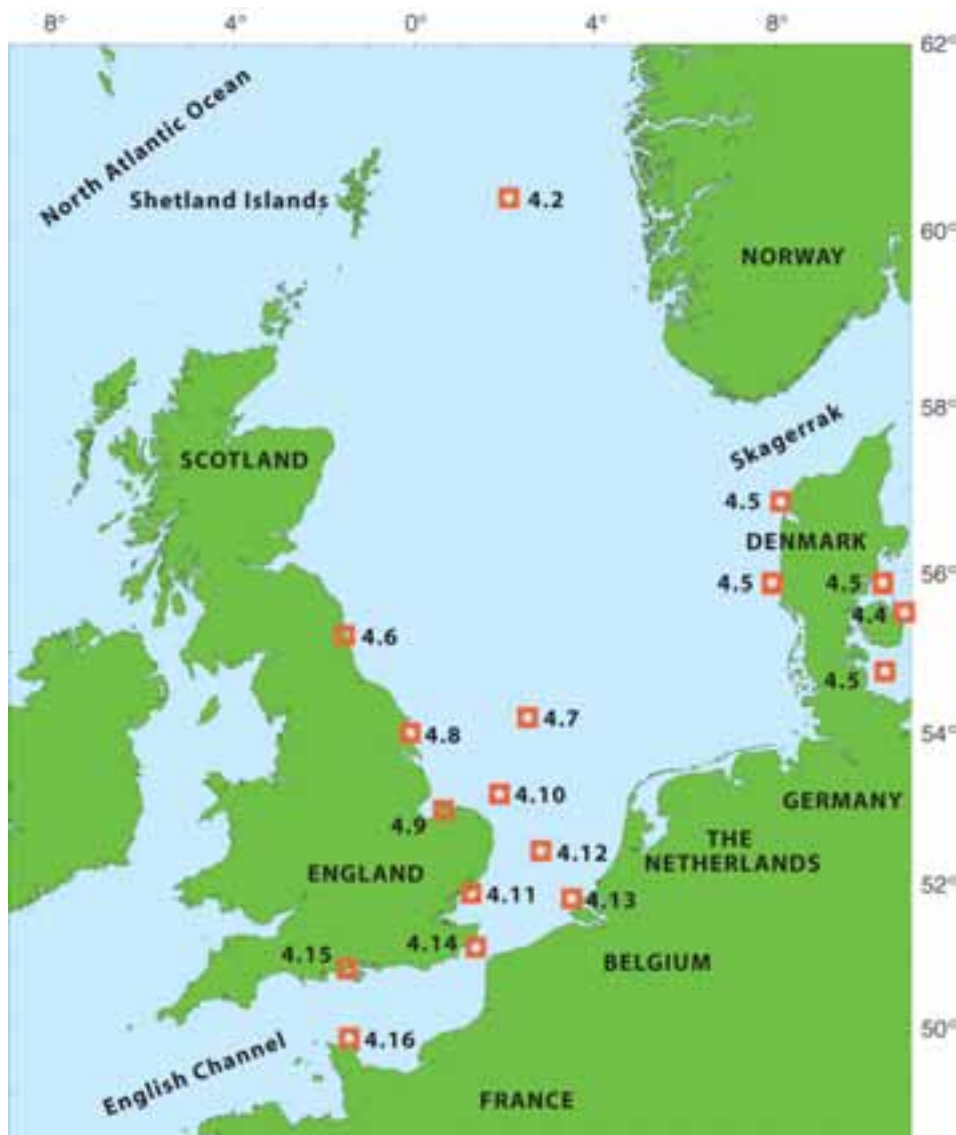


Figure 12 Sketch map showing the locations of submarine prehistoric sites and artefacts described in this section. Numbers refer to the sub-paragraph numbers in the text.

4.2 West of Viking Bank

Vibrocore number 60+01/46 obtained as part of a BGS programme in the UK shelf produced a worked flint from a point 150km north-east of Lerwick, near Viking bank, in a water depth of 143m (Long *et al.*, 1986) (Figure 13). It is inside the UK sector. The artefact has been submitted to the National Museum of Antiquities of Scotland. This artefact is unique on a global scale, both in terms of its water depth, and its distance from the present shore. The unusual statistical chance of its discovery arises because the BGS programme required many hundreds of cores to be taken over a wide area of the continental shelf at standardised spacing, and the laboratory analysis of the core revealed the flint. Out of the hundreds of cores examined, no other flints were detected.

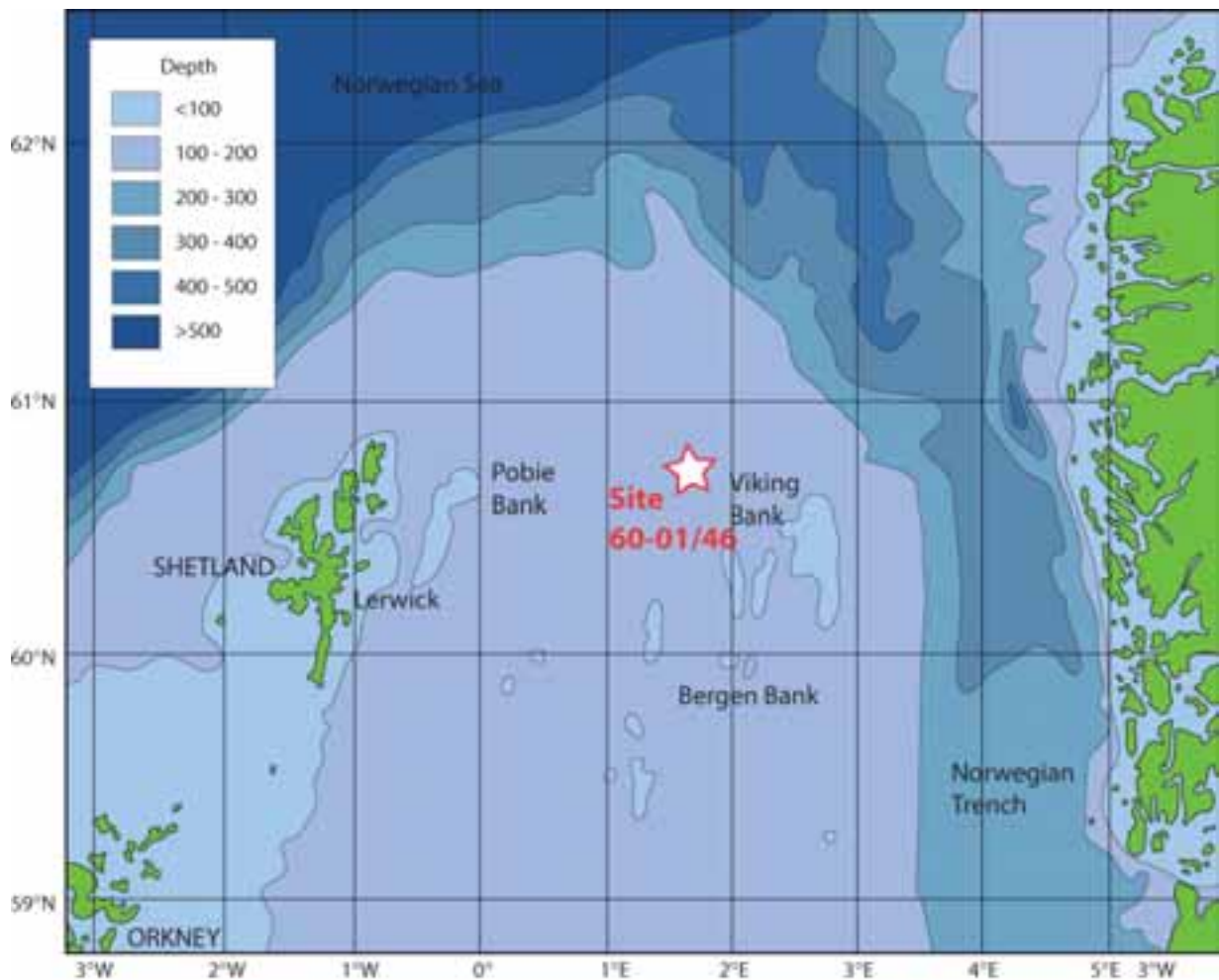


Figure 13a Bathymetric map of the Northern North Sea showing site 60+01/46 and localities referred to in the text. (Contours in metres below sea level). (From Long *et al.* 1986).

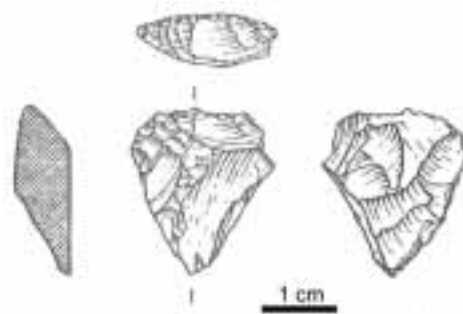


Figure 13b The flint artefact (From Long *et al.* 1986).

The location of the core was 60° 42.3' N, 1° 40.3'E. The core location appears on the BGS sediment map for Halibut Bank. The artefact is made of fine, dark grey patinated flint, and is 21mm long, weighing only 2.6g. It has been retouched to make a steep face, and may also have been broken by accident. Scrapers of this kind exist at a number of sites, and it can be attributed to the Upper Palaeolithic (Long *et al.* 1986, p.59). The core was 1.7m long, and consisted of 50cm of silty sand overlying 10cm of pebbly muddy sand with many shell fragments and frequent whole shells. Beneath this is 1.0m of clay with shell fragments, and a basal layer of poorly sorted pebbly sand. The flint was found 28cm below the surface in the Holocene silty sand. Long *et al.* (*op.cit.*p.57) conclude that the layer is a lag deposit formed when the marine transgression reworked sediments in shallow water, and the flint comes from a nearby archaeological site on land exposed prior to the transgression.

The lowest indicators of sea level on the present seabed are at depths of the order of 180-190m, dating from approximately 15-16,000 years BP (Carlsen *et al.* 1984). Ice caps from Norway and Shetlands did not meet across the North Sea. The model of Lambeck (1995) provides a set of plots showing the limits of the ice caps and the shorelines from 22,000 years BP onwards (see Figures 3 and 4). As the local ice caps retreat the land comes up faster than the global sea level so that the dry land area is at a maximum around 16,000 to 14,000 years BP. Peacock (1995, p.1040) dates the gravel and shell-hash layer below the Holocene sands in the core to about 11,000 years BP. Around this time band the flint tool could have been lost on the continental shelf at the observed location. The isobases on the Lambeck figures indicate the depth of the contemporary shoreline as it would be found now. The flint lay in the depression about half way between the two isobases showing -100m, suggesting that it should be found now at about 150m. The actual depth at the find site was 143m. The BGS map shows a gentle east-west gradient of the present seabed at the core site, suggesting that the source could be to the east.

By 11,500 years BP a sea level stand caused a wave-cut platform to the north of the sample area, and the Viking and Bergen Banks existed as islands (Rise and Rokoengen, 1984). The sea level subsequently rose rapidly, and there was little subsequent deposition, although there was reworking of shallow sediments. Popular discussion often focuses on cut off islands, and imagines massive disasters, floods, and many deaths. More realistically people living in a near arctic environment, fishing and hunting, would avoid wind-swept high ground and thus the location of the tool close to a palaeo-shoreline is to be expected.

4.3 Oresund

Lars Larson (1983) describes work in 1979-80 during which submarine Mesolithic settlement sites were found on the seafloor of the narrow strait between Denmark and Sweden known as the Oresund. This paper documents a wide range of submarine archaeological finds in the area dating from 1891 onwards. Submarine finds include peat, and flint core axes, blade scrapers, and a large amount of flint waste, that is the debitage from making flint tools. Some bones and a slotted bone point were found. These finds were attributed to the period 7,000-8,000 years BP.

Knowledge that sites were usually clustered round narrow bays and river mouths facilitated a search by divers. The results of these explorations included flint blades, scrapers, microblades, and flakes with retouching from depths of 6-8m in a submerged river channel 1km offshore.

4.4 Denmark, Storebaelt

Since the late 1970's several groups of divers have been finding Mesolithic settlement sites in the waters of the Danish archipelago (see below) and so it was natural, when planning the Fixed Link Bridge-Tunnel joining the islands of Fyn and Sjælland, to survey the route of the bridge very carefully first for archaeological relics. The Fixed Link across the Storebaelt is about 15km long, from Nyborg to Korsor. The decision to build the Link was taken in 1987, and, since the route of the various bridges, cuttings, and tunnels had not yet been fixed, the divers searched a much wider area than was finally influenced by the construction. In 1997 a massively complete survey and analysis of the archaeological results was published under the editorship of Pedersen, Fischer and Aaby (Pedersen *et al.* 1997). The report is probably the most thorough and complex document available on all aspects of a submerged prehistoric site, or rather area of sites. As the introduction says (Pedersen *et al.* 1997, p.62) "The contributions to this chapter may therefore be taken as inspiring examples of the world-wide archaeological potential of the sea-bed".

It is almost impossible to summarise here the scope of this work, which revealed a range of Mesolithic and Neolithic sites, skeletons and skulls, extensive submerged forests with the trunks of oak trees from 9100 years BP, and a pine forest at a depth of 30m dating to 10,100 years BP. There were sufficient tree trunks to construct a local dendrochronology. Worked flints, organic materials, fish-traps, fish weirs, wattle fencing, fence stakes, arrowheads, ornaments of carved antlers, and trade-goods from central Europe, all provided testimony to the vigorous settlements which resided on the ancient coast from about 8,000-4,000 years BP. Archaeologists have concluded that the coastal sites contained many families living together, and that the sites already known inland were only the outposts where small groups foraged the hinterland, and then returned to the shore. The probable location of sites was predicted in advance using a model based on the best sites for the construction of fixed fishing traps made of long wattle fences. The predicted sites often turned out to be so rich that divers found worked flints within minutes of reaching the seabed, and on average would find 41 flints per hour at these sites (Figure 14).



Figure 14 Divers inspect fresh flints raised from the submerged Mesolithic site at Stavreshoved, during the Danish Storebaelt project. (From Pedersen et al. 1997).

During the Mesolithic, the surrounding land was covered in dense forest of lime, oak, elm and ash, with an under-forest of hazel. Fireplaces and charcoal were found, as well as dugout boats. From the skeletons the health and age structure of the population can be assessed, and the diet. Sea food, not surprisingly, was the dominant component.

4.5 Denmark archipelago

Skaarup (1980, 1983), Fischer (1989, 1991, 1993, 1995, 1997), Fischer and Sorensen (1983), Fischer and Thomsen (1987, 1988), and Andersen (1980) through a wide range of publications give an overview of the many hundreds of Upper Palaeolithic, Mesolithic, and Neolithic sites found underwater amongst the islands of the Danish archipelago. It is undoubtedly the richest and most extensive continuous area of underwater prehistoric archaeology in the world. Sites have been found at predicted locations using environmental models. Deepest sites so far are at 21m, with an expected maximum of 60m. The analysis of the complex cultures which evolved on the coast has changed the whole picture of how people moved northwards from about 14,000 years BP onwards, following the retreating ice front. It is now obvious that the basic source of food, health, comfort, and prosperity was the sea, and that the combination of seafaring with coastal foraging and fish trapping indicates a sophisticated community with skills to cope with all the risks and dangers of the seafarer's life. The density of sites is shown by Figure 15, taken from an early survey by Skaarup. Typical tools found in the Danish sites are shown in Figure 16.

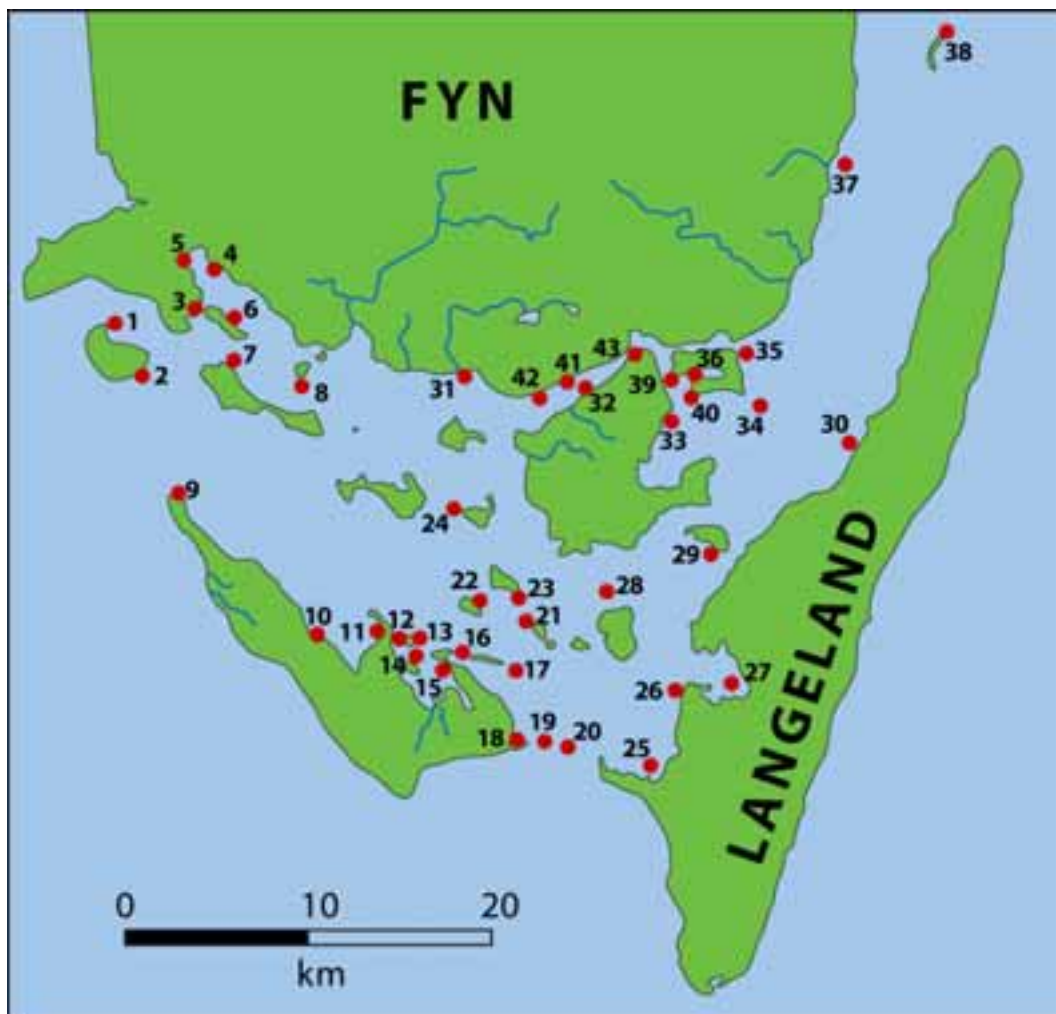


Figure 15 Plot showing the submarine stone age sites found south of the island of Fyn, Denmark. Note that many sites are often bunched within 2-5 km of each other. The maximum distance between nearest sites is 10 km. (After Jørgen Skaarup 1983).

A seminal excavation which attracted much interest in the early stages of Danish underwater prehistoric archaeology was that by Andersen (1980) describing a submerged settlement discovered in 1978 at Tybrind Vig. The water depth was 2-3m, and finds occurred in a strip about 50m long and 10m wide along the original shoreline. Finds included fish traps, stakes, food waste, bones of mammals and fish, and many small fur-bearing animals. Seals and porpoises were caught at sea. Fifteen oars for canoes were found, and bows for shooting arrows. In 1980 a dugout canoe was

found, cut from a lime tree trunk, 9m long and 65cm wide. The boat included a small fireplace, possibly to create flares to attract fish or eels, but also suggesting that sea trips may have lasted more than a few hours. The remains have been dated to 6,000-5,700 years BP.

A unique factor in the Danish situation is that the land masses making up the archipelago are all small, compared with the UK or the main European continental area, and are very low lying. The greatest altitude is of the order of 300m, and most of the land is below 100m. The result is that the sediment load transported by rivers or direct coastal runoff is very limited. Sea currents then winnow away the finer sediments, leaving the archaeological material as surface lag deposits.

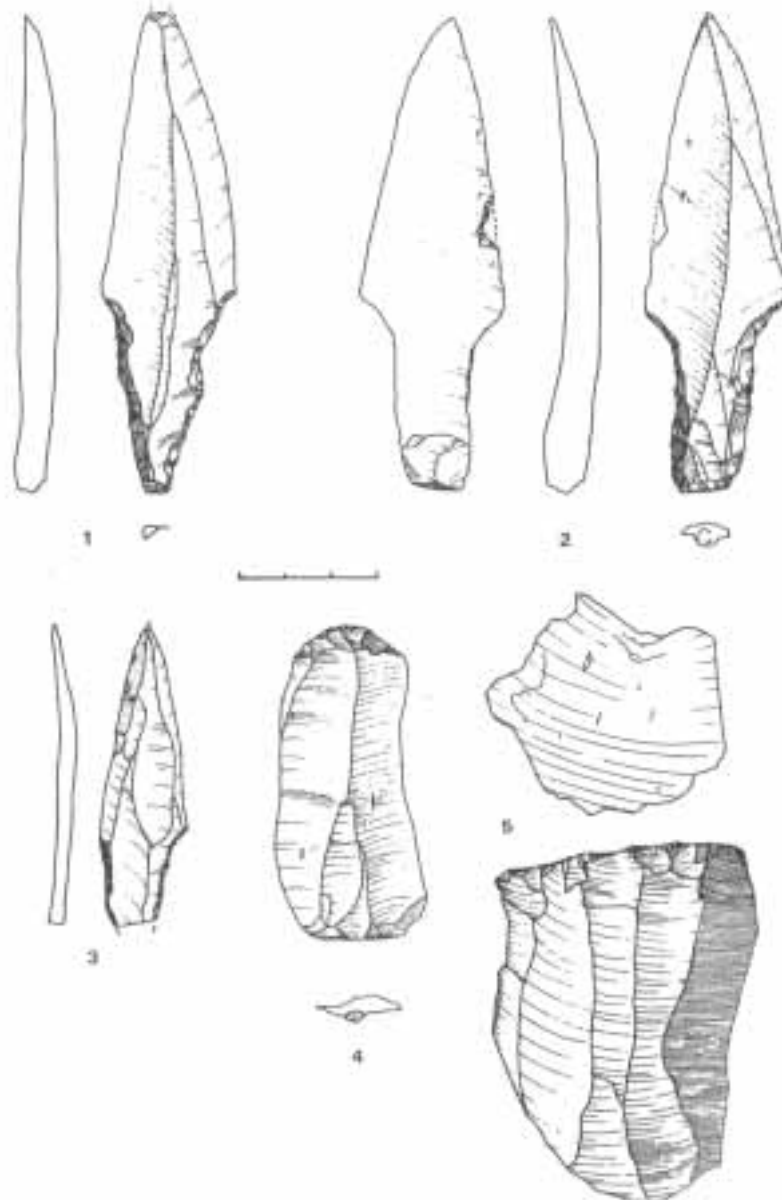


Figure 16a Characteristic artefacts from the Brommian site of Ellensbanke, southern Zealand. 1-3, tanged points; 4 blade-end scraper; 5 blade core. Scale 3cm. (From Fischer 1991).

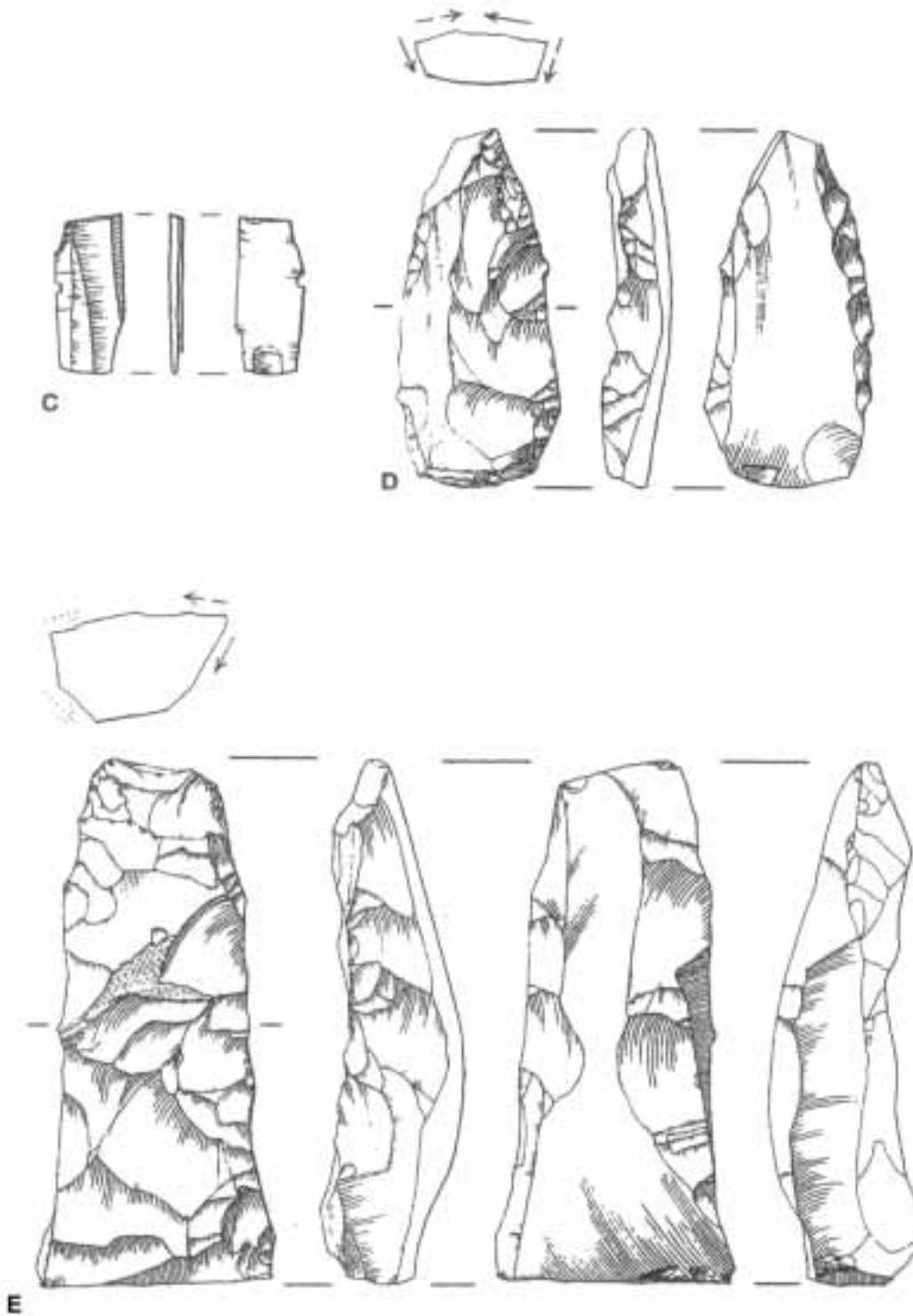


Figure 16b Examples of flint tools from Skottemarke, Denmark. C: simple lanceolate microlith; D: small, irregular flake axe; E: flake axe, the edge of which has been reworked in a burin-like way. NB: C is shown in scale 1:1 while D-E are in scale 3:4. K Petersen and A Fischer del. (From Fischer, 1997).

The winter storms of 1999-2000 caused damage to many underwater prehistoric sites. Amateur divers gave reports to the National Museum's Institute of Maritime Archaeology. While damage and loss undoubtedly occurred, the storms also revealed many new artefacts, many kilograms of flints, bones, antlers, a harpoon, and one human skull.

The extraordinary complexity and density of Mesolithic sites in the Danish archipelago prompts the supposition that other parts of the North Sea coast at the same date would have had similar human occupation, provided that similar indented coastlines existed. As we shall see below, this seems to be the situation south of Dogger Bank, and south west from Brown Ridge, and possible other sites.

4.6 Cleveland shore

Storms and tidal currents have recently exposed a prehistoric wattle screen or panel on the beach at Seaton Carew, just south of Hartlepool, Cleveland (Buglass, 1994). The wattle was embedded in peat and drowned forest materials which are extensive in the region. Artefacts of flint, wood, and bone have been collected from the beach for many years, and in 1971 a skeleton was uncovered after a storm had eroded the peat. Finds have been transferred to the Cleveland County Archaeological Section, and the wattle was conserved by the University of Durham. ¹⁴C dating of the peat gives an age of 4,200-5,000 years BP.

4.7 Dogger Bank

The Dogger Bank is a large raised platform consisting of Devensian pro-glacial lake deposits, and glacial moraine resting on earlier Pleistocene deposits. (refs. BGS, 1990; Godwin, 1941; Stride, 1959; Haugwitz and Wong, 1988). Figures 3 and 4 show the sequence of its inundation from 10,000 to 6,000 years BP. The bulk of the bank is a glacial till, from the Cromer glaciation and late Devensian. There are calcareous sands of the Elbow with peat formation, and overlying Holocene sands and modern sandwaves. There are distinct patches of surface gravel. Aggregate prospecting is already taking place on the gravels of the West Rough.

Human artefacts, flints, spear-heads, and mammal remains have been dredged from locations reported as the Dogger Bank, and it is always assumed that the finds have been retrieved from the upper surface of the Bank. This may indeed be so, but closer analysis suggests that a richer environment for the origin and preservation of archaeological materials would be the vast lagoon which existed to the south of Dogger Bank from 8,000-7,000 years BP (see Figures. 3 and 4). Around 7,500 BP there was a shallow sea basin approximately 5m deep, and 90 nautical miles in diameter. This basin was connected to the open North Sea to the north-west by a narrow channel which is now the Outer Silver Pit. Louwe Kooijmans (1970/71) states that fishermen now say that bones and tools are not found on Dogger Bank itself. Coles (1998, 1999, 2000) has proposed reconstructions of the prehistoric environment of Dogger Bank and the wider North Sea floor at different dates based on extensive experience of wetland archaeology.

The known Pleistocene fauna reported to have been trawled from Dogger Bank consist of mammoth and rhinoceros teeth, and are in the Hunterian Museum, Scotland: *Mammuthus primigenius*, V 5153, V 5572, and V 5577; also *Rhinus (Coelodonte) antiquitatis*, V 5600.

While tools and archaeological deposits left on the upper surface of Dogger Bank are likely to be exposed by modern currents and wave action (very severe, breaking waves in 10m), as well as being periodically covered by sand waves, it is probable that there are far more relicts originally abandoned on the shore of this vast gulf, in the region which is now at a depth of about 40m, and the edge of Silver Pit itself. The discoverability of such artefacts depends upon modern marine sediment thickness. BGS (1990) sediment map and notes thereon describes Holocene sediments 5-20m thick on the SE flank of Dogger Bank, while most of the surface of the Bank is covered by 1m thick Holocene deposits. Whitehead and Goodchild (1909) describe the recovery of peat deposits or "moorlog" by fishermen working the Dogger Bank, and Louwe Kooijmans (see Fig 19) shows extensive peat or moorlog at exactly this location, especially on the north side of the basin, on the flanks of Dogger Bank itself.

4.8 Yorkshire coast

Sheppard (1912) provides geographical, historical, and antiquarian data on 25 towns on the Yorkshire coast between Flamborough Head and Spurn Head which have been eroded into the sea in the last 1,000 years. Numerous prehistoric artefacts were washed out of the cliffs during the late 19th century, including a Neolithic polished axe at Grimston Garth, and another at Withensea. Faunal remains include a mammoth tooth at Withensea and a Rhinoceros tooth at Dimlington. The width of coast lost

in the last 1,000 years is of the order of 3-5km. The rate of loss presumably was similar in preceding millenia, and therefore both prehistoric Mesolithic and Neolithic artefacts, and historical debris from mediaeval towns should be scattered on the seabed. These processes are discussed in more technical detail by Steers (1946, p.409-419) who concludes that recent erosion, in spite of modern engineering works to protect the shore, has been of the order of 3-5m per year, which is the same average rate of erosion.

4.9 Sea Henge, Holme next the Sea, Norfolk

In early 1999 a circle of 56 wooden posts surrounding an up-turned oak tree stump was exposed by beach erosion at Holme next the Sea, Norfolk. The site was dubbed "seahenge" by the press. Carbon dating and dendrochronology showed the wood to be 4100 years old. The posts are thought to have been 3m tall originally. English Heritage arranged for the excavation of the site to prevent further damage from waves. Analysis of the axe cut-marks on the timber shows that they were shaped with bronze axes.

4.10 Leman and Ower Banks

Evidence that the submerged peat landscape, probably of Mesolithic age, was occupied by humans was confirmed by the discovery in 1931 of a barbed pointed weapon trawled up by the *Colinda* in a lump of "moorlog", the fishermen's name for peat from the seabed (Figure 17). It was dredged from between the Leman and Ower banks from a depth of about 36m (Louwe Kooijmans, 1970/71, p.32). More recent ¹⁴C dating of the peat gave a date of 8,500 years BP, while the tool itself has been dated by AMS to 11,740 +/- 150 years BP (OXA-1950) (Housely, 1991). The implement is made of bone or antler, and carved with numerous notches and some decorations. It was in 1971 still in Norwich Castle Museum. Judging from Figure 3(c) the find location would have been very close to the shore of the gulf forming in the southern North Sea.

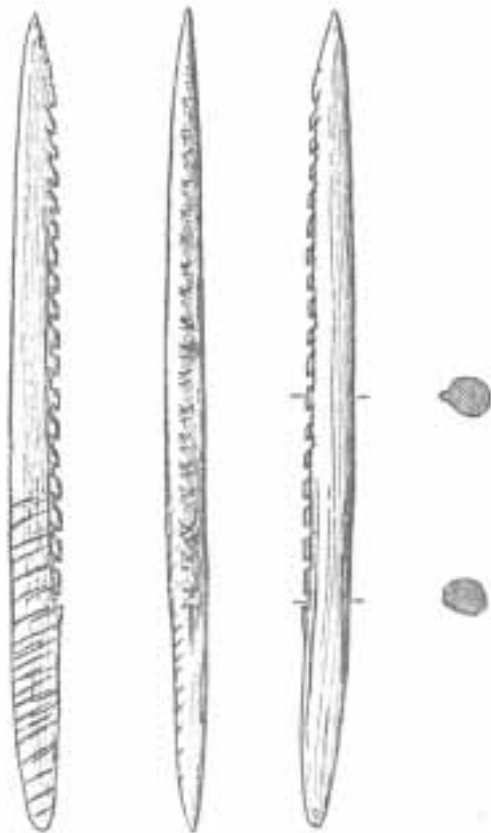


Figure 17 The barbed point from Leman and Ower Banks, (from Lowe Kooijmans 1970/71). Scale 1:2.

4.11 East Anglian coast wetlands and intertidal sites

Wilkinson and Murphy (1995) describe numerous sites in the marshlands, creeks, and tidal mudflats of the Essex coast dating from 7600-3500 years BP. Surveys and excavations relate to Mesolithic and Neolithic sites in tidal conditions. Finds include wooden structures in intertidal mud and many stone artefacts.



Figure 18 Sites containing artefacts of Mesolithic date in the wetlands and shoreline sediments of the Essex coast. A similar plot could be shown for the distribution of Neolithic sites. (From Wilkinson and Murphy, 1995).

Stuart Bacon has for many years led diving teams surveying the extensive remains of the medieval town of Dunwich, which has collapsed into coastal waters because of the erosion of the soft cliffs of unconsolidated drift. Heavy parts of buildings can still be found in spite of the appalling underwater working conditions.

In 1998 a trawler dragged up a complete dugout canoe in the vicinity of Southwold. It is about 5m long, but has not yet been carbon dated.

4.12 Brown Ridge

Since 1964 Dutch fishermen working in the southern North Sea have dredged up thousands of fossil mammal bones, some of which have been worked or carved to make human artefacts (Louwe Kooijmans, 1970/1, p.27; (to be referred to as LK1)). According to the fishermen the bones are dredged up in the gullies around the ridge within 25km to the west and south west (Figures 19 and 20).

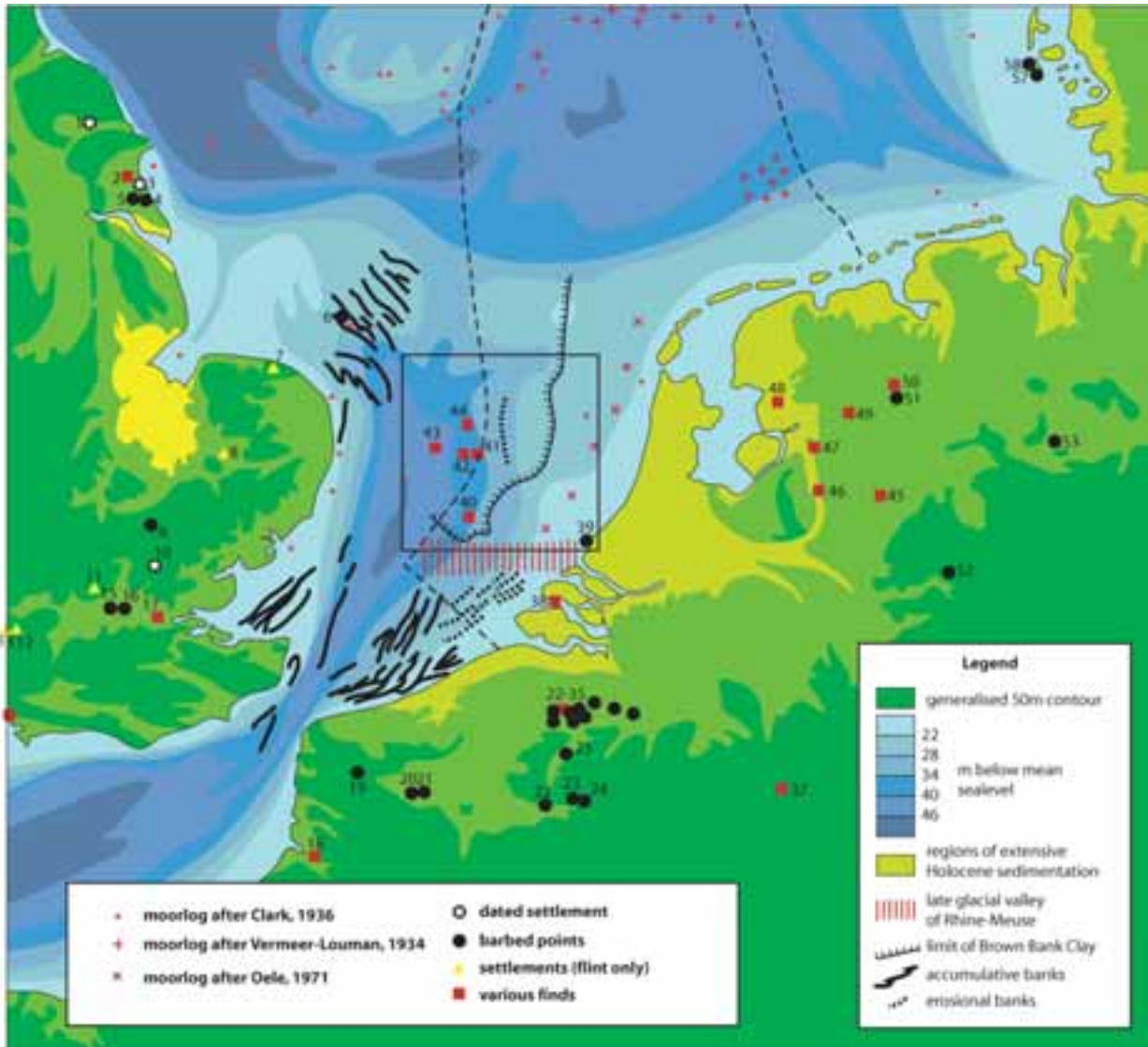


Figure 19 The southern part of the North Sea and its surroundings, illustrating some features of importance in the study of the fished-up implements. The big square encloses the area of Figure 20. (From Louwe Kooijmans 1971/72).

The mammalian fauna bones do not come from Brown Ridge itself (van der Sluis, in LK1, p.69). Bones are very seldom found between Brown Ridge and the coast of Belgium and the Netherlands, and, according to fishermen, bones have not been found recently on the Dogger Bank. Many of the bones are in a bad state of preservation, and this seems to be due to prolonged subaerial exposure before inundation by the Flandrian transgression. The bones are of mixed origin and dates. Some are early Pleistocene, for example the elephant *Mammathus (archidiskodon) meridionalis*, while others are late Pleistocene or Devensian in type. Most bones are of this period. Sluis (*op. cit.*) reports further finds which include *Dicerorhinus etruscus*, and *Equus cf. robustus* from the early Pleistocene; *Panthera spelea*, *Crocota crocota spelea*, *Ursus speleaeus Rosenm.*, *Rangifer tarandus*, and *Bison priscus*, amongst others, from the Devensian.

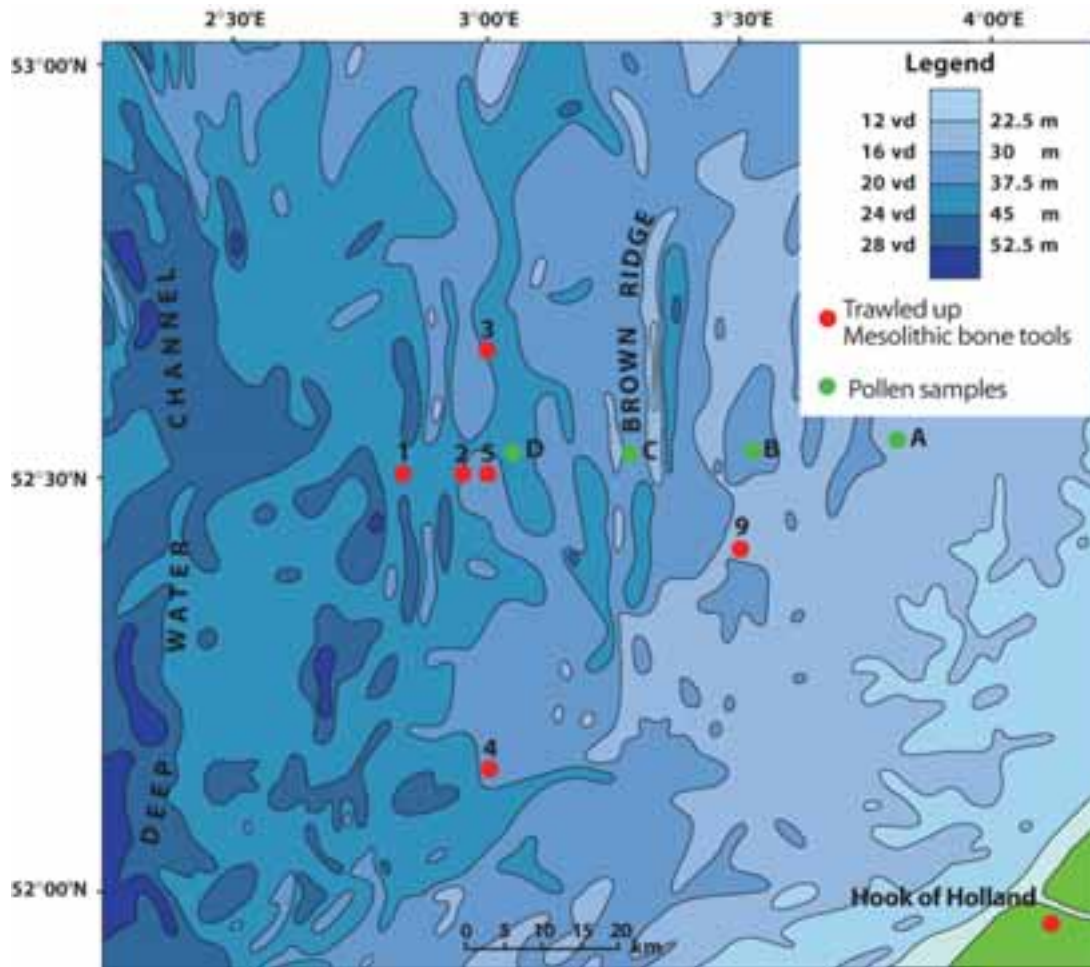


Figure 20 Contour map of the surroundings of the Brown Ridge (after Houbolt 1968) with the position of the fished-up implements and of the pollen samples A-D of Jelgersma 1961. Scale 1:1 million. For the situation see Figure 19. (From Louwe Kooijmans 1970/71).

The recovery of pre-Devensian, Vilefranchian, faunal remains from the Brown Ridge basin is consistent with the prediction of paragraphs 2.6 and 2.7 above that such bones or artefacts could only survive south of the line from Southwold to Sheveningen (52°30'N). *Elephas (archidiskodon) meridionalis* is described by Clark (1969, p.16) as typical of Lower Pleistocene, approximately 400-500,000 years BP. Pitts and Roberts (1997, p.98) point out that *Dicerorhinus etruscus*, now known as *Stephanorhinus hundsheimensis*, died out around 480,000 years BP, well before the Anglian glaciation. Thus these early faunal remains reported by LK1 are more or less contemporary with the Boxgrove hominid site described by Pitts and Roberts. The implication is that other archaeological sites of any date in the last half million years could survive in the southern North Sea or English Channel. The population density and frequency of sites of this age was very low, but the potential should not be excluded. The fact that bones of this age have survived multiple marine transgression is consistent also with the findings of Werz and Flemming (2001).

Lambeck (1995) and Shennan *et al.* (2000a, 2000b) show that from about 8,000 years BP to 7,500 years BP a shallow lagoon developed in the western half of the southern North Sea, fed with fresh water by the Rhine and the Thames, and connected to the open sea through the Straits of Dover at a sill which would only have been a few metres deep (see Figure 4). A cursory inspection shows that the water would have been brackish; the waves and currents minimal. Eisma *et al.* (1981) collected *Cardium edule* shells from the southern bight of the North Sea which gave ¹⁴C dates in the range 9,000-7,000 years BP, and had shell characteristics corresponding to a salinity about 13. These factors all suggest the perfect environment for shelter, combined with access to fish, shellfish and mammalian fauna.

This site will be analysed further because it lies within SEA3, and the characteristics of the location and the finds constitute a test of the model for deposition, survival, and discovery established in Section 2.

Brown Ridge is an erosional remnant of freshwater clays formed during a stage of the Devensian glaciation (Houboldt 1968, and LK1, p.29). There is about 6m of modern marine sand over the clay in most places. The simplest assumption is that the bones and artefacts occur predominantly in the clay, and were washed out, though not necessarily from Brown Ridge itself, during the Holocene transgression so that they now lie on the clay surface under a moving covering of sand (LK1.p.30). The gullies appear to be depressions in the sand that reach down to the surface of the clay.

Louwe Kooijmans compares the conditions of the Brown Ridge site with similar known lagoonal sites around Denmark, the Danish Maglemose sites, where Mesolithic hunter-fishers caught game. He imagines an extensive swamp as the sea level rises, and this fits exactly the model by Lambeck. Nine separate Mesolithic artefacts of bone are reported by LK1 (p.35), including the Leman and Owers tool mentioned above. Heavy bones of Aurochs were shaped into axes and tools, sometimes with a bored transverse hole. The bones had no peat attached, but were slightly encrusted with marine growth, indicating that they had been eroded free on the seabed for some time. LK speculates that smaller tools, barbed points, and flint implements would have slipped through fishing nets. He then compares the finds at length with similar tools found onshore in the Netherlands.

The final distribution of tools considered by LK1 is shown in Figure 20. One conclusion is that the technology of the submerged North Sea is similar to that found in Denmark, and the people seem to have migrated northwards along the shore, bypassing different land-locked cultures further to the east in the Netherlands and Germany.

The Brown Ridge reveals some valuable points about the objective of defining archaeologically prospective sites. Although people commonly refer to finds being associated with a bank, they are usually found in troughs or hollows nearby. Again, publicity tends to refer to islands, like Dogger, being cut off, but population density would have been greater on low ground. The model proposed by Lambeck and others provides a landscape with marshes and coastal wetlands which is exactly what Mesolithic people preferred. The gulf or bay was about 100 miles long by 30 miles wide, with many large rivers flowing into it, and the climate was warming rapidly. Peat was forming, or had already formed in adjacent wetlands. The rising sea would have had very little destructive force until the water was tens of metres deep, and strong tidal currents were developing. (See Horton, web site). Modern marine sands, sand waves, and sand sheets, cloak many of the archaeological strata, but movement of these deposits, or periodic erosion, exposes the archaeological sites.

4.13 Dutch and Belgian flints

Dutch and Belgian archaeologists have for many years collected occasional flint tools and artefacts from coastal sites, from dredging operations during harbour construction, from fishermen, and sports divers. These are usually retained at local and regional museums, and described in local and regional historical guides (Jongepier, 1995). In 1951 a dredger recovered Late Palaeolithic tools about 10,000 years BP from the coast at Sloegebied. Other sites have revealed Mesolithic and Neolithic tools on the beaches, or just offshore. There are active groups collecting information from fishermen.

4.14 Dover boats, and Moor Sand boat

Two Bronze Age dugout canoes have been salvaged at Dover, one offshore by the East breakwater, and one inshore during road repairs. A third Bronze Age boat was found offshore Moor Sand, Salcombe, Devon. The submarine finds have been described by Muckelroy (1981), and indicate an active cross-Channel trade with substantial cargoes of bronze artefacts. The materials are about 3300 years old.

4.15 Bouldnor cliff

Momber (2000, 2001) describes a Mesolithic site from 8,500 years BP at a depth of 11-12m on a peat platform north east of Yarmouth off the Isle of Wight. The submerged forest at the west end of the

Solent has been known for many years, since fishermen recovered timbers and peat in 1976. Worked flints were discovered by a diving team in 1999, and diving survey and excavation has continued for several seasons, supported by the Hampshire and Wight Trust for Maritime Archaeology. Over 300 humanly worked flints have now been recovered, some about 4-5cms long. Diving surveys demonstrated that the worked lithics were stratified within the seabed.

This site has important lessons for the North Sea, although it is out of area. The circumstances of peat beds, embedded tree trunks, flints, charcoal, seeds, fishbones, and other food remains are closely similar to the conditions within the Danish archipelago, as is the Mesolithic date. The sheltered location on the lee side of the Isle of Wight, and the small land area creating minimal runoff and sediment are also similar, combined with the strong tidal currents up to 2 knots to erode the site and prevent build up of modern sediments.

Sites that are 1-2 thousand years older would be about 20m deeper, and this would be the environment of the central North Sea, around Brown Ridge or Dogger.

The severe seabed wave action and strong currents in the North Sea, combined with the mobile bedload create a radically different taphonomy and modern working conditions, but the larger items and denser materials from Mesolithic sites should still be there, either embedded in peat, or recently eroded from peat as lag deposits.

4.16 Fermanville

Scuvée and Verague (1978) describe a peat deposit at a depth of 25m at Fermanville, near Cap Levi, Cherbourg, where construction of a small pipe outfall revealed flint artefacts. Divers made further research, and found that natural erosion was causing the flints to fall away from the peat into a gully, which was a submerged stream bed. Numerous tools of a Levallois-Mousterian assemblage were recovered, dating from about 45,000 years BP. From Figure 11. this places the occupation date in Oxygen Isotope Stage 3, with a warm climatic spell and intermediate sea level, before the peak of the Devensian glaciation. Similar materials should exist anywhere in the central and southern North Sea, and, again, could be associated with peat beds.

4.17 Conclusions from Section 4

- i) Artefacts of all dates back to 45,000 years BP do survive in the environmental and taphonomic conditions predicted in Section 2.
- ii) Natural erosion is often a key factor in exposing materials prior to discovery.
- iii) Natural erosion often proceeds at a pace which is damaging, and will scatter archaeological items on the seabed, leaving them prone to abrasion, fouling, borers, and other hazards.
- iv) The arguments of Section 2 are closely compatible with the catalogue of sites in Section 4. While the sample is too small to analyse on a statistical basis, there are no contradictions and many correlations which fit the models, including the predicted dry land areas at each date; the predicted sea areas; the predicted ice areas; and the preferred coastal zones.
- v) Commercial operators offshore, fishing, dredging, etc., are important sources of information for archaeologists.
- vi) The North Sea environment is exceptionally hostile in terms of waves, wind, currents, and poor underwater visibility. Academic institutions would find it very difficult to justify searches for prehistoric materials without a great deal of advance information on known finds of artefacts.
- vii) The timing and nature of the first hominid occupation of Britain, and subsequent incoming of more advanced evolutionary species of *Homo* cannot be understood without understanding the process of migration across the English Channel, across the North Sea into Britain, and northwards through the North Sea to Scandinavia.
- viii) There are active groups of prehistorians in Denmark, Netherlands and Belgium with whom British archaeologists should collaborate.

5. Consideration of the potential impacts of oil field operations on submarine prehistoric archaeological remains

5.1 SEA3 and SEA2 contain two of the most archaeologically prospective sectors of the North Sea, that is the region of Dogger Bank, particularly the southern slopes and slopes down from the banks surrounding the Outer Silver Pit; and the scattered sand and gravel patches south west of Brown Ridge over a distance of 20-30 miles or more.

Offshore hydrocarbon prospecting and exploitation have several phases of activity which could impact on submarine prehistoric archaeology.

- i) Coring of seabed to investigate pipe routes and foundation engineering for platforms.
- ii) Emplacement of platforms, concrete gravity, jacket or jack-up. Consider the total footprint of the platform, and associated support systems.
- iii) Permanent anchors for semi-submersible platforms.
- iv) Pile driving.
- v) Drilling and running casing.
- vi) Pipe entrenching.
- vii) Coastal entrenching, terminals, docks, shoreside structures, jetties.

5.2 The total area of sea floor disturbed, excavated, or drilled in the course of these activities is small compared with aggregate dredging or beach replenishment, but there is always a chance that a single core may penetrate a prehistoric site, as in the case of the Viking Bank core, or that a trench for a pipeline will intersect one or more prehistoric sites over the tens or hundreds of km of burial. The proposed new Symphony gas pipeline from Heimdal to Brae, and then south to Bacton (Offshore Engineer, June 2002, p.21) will be potentially interesting. All shallow sediment cores sampling the top 1-10m of sediment in sensitive areas should be checked routinely for prehistoric materials.

5.3 The excavated sediment from pipe entrenching machines is not brought to the surface, but is ploughed or jetted to the side of the trench, there is thus no chance at present to investigate the occurrence of prehistoric artefacts in the sediments. Consideration should be given to some way of monitoring this process, either by recovering sediment, or close video inspection by ROV. Prehistoric artefacts have been retrieved from 50m depth by ROV (Josenhans *et al.*, 1997) off British Columbia.

5.4 Trawling and dredging both disturb the upper 0.5-1.0 metre of sediments over enormous areas, but are outwith this report. The offshore aggregate industry already has a very healthy collaborative relationship with the academic archaeological community, and indeed funds from the industry provide support for some very important excavations. Many land excavations have been started by good observations from industry workers. Louwe Kooijmans has shown that fishermen also can become prolific sources of information and assistance in retrieving subsea archaeological materials. The Solent fishery demonstrates the same point, with some of the local fishermen having collections of flint tools which are catalogued by the County archaeologist, but left in the possession of the finders.

6. Consideration of the opportunities presented by oil and gas operations in an area for site/artefact identification, e.g. seismic survey, sub-bottom profiling, coring, ROV

6.1 The previous discussion shows that, given sensible preparation, briefing, and mutual understanding offshore industries can actually serve the archaeological community. It is not within the terms of this report to make specific proposals of this nature, especially since the cost implications and time lost (if any) are not immediately apparent. However, on the assumption that some staff time, funds, and assistance might be available, the following paragraphs show that activities of the offshore oil and gas industry could be positively helpful, with appropriate monitoring.

6.2 Acoustics

Acoustic surveys of various kinds can contribute to the discovery of submarine prehistoric sites, but, to date, only through circumstantial identification of likely topographic and stratigraphic conditions. No acoustic system has yet been used successfully to demonstrate that a particular structure or surface feature contains worked flints, shell midden deposits, charcoal, carved wood, or bones. Swath bathymetry, side-scan sonar, and conventional shallow sub-bottom profiling can identify a drowned beach ridge or river valley, or similar features of archaeological relevance beneath a few metres of modern sediments. The ability to resolve the sub-millimetre characteristics of stones a few cms across that would tell the human eye that they are man-made cannot be achieved at present by acoustics. Similarly it is difficult, perhaps impossible, with acoustics to detect tree-trunks or other organics in peat, or to distinguish a humanly-biased selection of shells, that is a midden, from natural shell gravel. More research is needed on this problem.

6.3 Limitations of acoustic imaging

Chirp technology can show fine-scale stratification which gives strong clues, but physical sampling by core, grab, or diving, or ROV has always proved essential to establish existence of a submerged prehistoric site. No cross-correlation check has been carried out using high frequency, high resolution acoustics over known submarine prehistoric sites to test signatures of anthropogenic materials. The Danish experience, where acoustics are used routinely to select optimal diving sites on the basis of topography suggests that no such direct signature yet exists. Consideration of the wavelength of high frequency sound, which is of the order of 4 -15 mm in the frequency range 400-100 kHz, suggests that the resolution could not distinguish shapes at the level required. Medical type acoustics at 4 MHz has a penetration of only 20-30cm. Given the present state of knowledge and acoustic signal interpretation, commercially obtained records could be used to improve site identification on the basis of topographic and sedimentary criteria.

6.4 Coring, grab samples, and site investigation

Coring and sampling of seabed sediments can identify sedimentary facies, and detect material such as peat, beach gravels, clay, deltaic muds, and organic materials indicating age, and pollen indicating vegetation, temperature, and shells indicating salinity. BGS cores and commercial cores which have been archived provide a massive body of data which has not been exploited archaeologically. In future, any planned core or grab sample investigation by offshore operators should be checked against the list of archaeologically sensitive areas, and in the high-probability archaeological zones the cores must be examined for archaeological signals.

6.5 Dredging and pipe entrenching

Bulk movement of seabed sediments has the potential to damage prehistoric sites in the North Sea very seriously. Paradoxically, in the North Sea, this may be the only way that archaeologists could ever discover sites. As mentioned in para. 5.3 such operations should be monitored or sampled at intervals to check for artefacts or designated indicators.

6.6 Avoidance

Acoustic systems and seabed sampling create the potential to gain advance warning of the probable presence of prehistoric sites, and hence to plan avoidance of intervention. Avoidance would usually increase costs for the operator. Repeated instructions to avoid newly indicated potential sites would complicate logistics and add more to costs. Over-sensitive thresholds for site avoidance would ensure that no artefacts were recovered, and no sites discovered for archaeological research. It follows that avoidance criteria should be set at a coarse, non-sensitive level. Mandatory instructions to divert or delay operations should only be considered after human artefacts or mammal bones have been recovered. Even then it is possible that the decision would be to monitor operations and the sediments disturbed on a 100% basis, rather than avoid the site.

6.7 Preservation in situ

The legally preferred method of preserving submarine archaeological sites is *in situ* (See Section 1.11). Strictly speaking this means no disturbance at all, but discovery and research does involve disturbance, unless the artefact is on the surface. The objective is to balance over time the sum total of acquired and published knowledge and the sum total of preserved artefacts left *in situ* for future generations. Research excavation increases knowledge but destroys sites. Undiscovered sites represent future knowledge, but present ignorance. Since the North Sea is an exceptionally hostile environment, and waves and currents erode sites constantly, there is a powerful argument to discover and excavate sites, monitored under academic supervision. This approach differs from the management protocols of the Danish archipelago, where hundreds of submerged sites are known, and the great majority are preserved *in situ*. Preservation *in situ* in the North Sea is indistinguishable from deliberate neglect.

6.8 Conclusion to section 6

Offshore oil and gas operations, and the sub-contracted services, present a good opportunity to discover and record submarine prehistoric sites in the North Sea, outside Territorial Limits. Regulations and Avoidance criteria should be set a level such that acoustic surveys and sampling systems have the maximum chance of physically proving the existence of archaeological sites.

7. Summary of existing practices regarding the reporting, investigations and protection of prehistoric and archaeological remains

7.1 The Outer Continental Shelf legislation in the USA requires offshore operators to conduct extensive pre-disturbance and avoidance surveys before starting operations, so as to protect prehistoric archaeological sites, as well as shipwrecks. By the early 1980s the situation was attracting severe criticism because hundreds of millions of dollars had been spent, and no prehistoric artefacts had ever been found on the outer shelf, and no academic search was being conducted for remains. During the same period American marine archaeologists working on minuscule budgets, and usually assisted by large teams of volunteers, were studying palaeo-indian prehistoric sites in water depths up to 10-20m at many locations on all sides of the USA (e.g., Stright, 1990; Cockrell and Murphy, 1978; Ruppé, 1981). Flemming (1981) wrote to comment on the absurdity of this position. UK regulations should avoid repeating this mistake.

7.2 The assumption behind a strict code of *in situ* preservation is that academic institutions will both discover, classify, and excavate sites, and have sufficient funds to prove or disprove the existence of artefacts in high-potential areas. For the North Sea outside Territorial waters this is incorrect. Only commercial companies can justify the cost of seabed work in these conditions. It is therefore preferable to allow commercial companies to proceed in the manner which is technically and economically the most efficient, and to monitor the archaeological impact. When the existence of a site is certain, then academic resources should be deployed to monitor, and, if suitable, excavate.

7.3 The BMAPA is working with English Heritage to develop a detailed protocol for the management of archaeological sites impacted by aggregate dredging, and the principles developed in that document could be adapted to the offshore sector. Expert groups such as the ADU, the Hants and Wight Trust for Maritime Archaeology, and the Nautical Archaeology Society, should be consulted. Sites need to be reported and studied whenever possible. Procedures will be recommended consistent with BMAPA and RCHME schemes to encourage and promote the reporting of sites with a minimum interference with work schedules. Notice of intention to carry out operations or to disturb the surface sediments in key areas is the major step.

7.4 It is obvious that the work of Louwe Kooijmans and van der Sluis produced hundreds of finds in less than 10 years by collecting materials reported by Dutch fishermen who were fishing on the UK side of the median line. A few finds (Dogger, 1832, Leman/Ower 1932) were also reported by UK fishermen. But the discrepancy is not really explicable, in spite of the active sediment movements in much of the UK sector. There must be material in many other areas, especially south of Dogger. A programme to alert operators to the potential and a scheme amongst archaeologists to monitor the work, should produce many more finds.

8. Recommended mitigation measures to prevent damage to prehistoric and archaeological remains from oil and gas activities. These should draw on, and where appropriate be concordant with, draft guidance produced by BMAPA and RCHME

8.1 The objective is to achieve a constructive and positively beneficial relationship between the offshore oil and gas activities in sectors SEA3 and 2, and the archaeological research community, and associated legislation, both national and international.

8.2 The following comments are intended to suggest the areas of discussion which might promote and maintain such a relationship. None of these comments should be regarded as assuming any particular outcome of that discussion process.

8.3 The first question to consider is whether any known areas within SEA3 and 2 should, on the present evidence, be restricted in such a way that offshore hydrocarbon activity of any kind should be curtailed or banned. Notwithstanding possible legal arguments which could suggest that such pre-emptive restrictions might be desirable, we need to consider the practical effects for archaeology, in addition to the economic and industrial impacts. The experience with the OCS legislation on archaeology in the USA shows that when such regulations are rigidly enforced, large sums of company money are spent in pre-disturbance and avoidance surveys, and no archaeological artefacts are ever discovered. Meanwhile cash-strapped archaeological teams struggle to recover deposits of prehistoric artefacts found in the coastal zone, usually assisted by sports divers. Since so many known artefacts have been retrieved in European waters by commercial activities from at least three major industries, an overly restrictive policy would be self-defeating for archaeology, as well as expensive for industry.

8.4 The legal point of view might be that commercial exploitation of resources will disturb unknown archaeological sites, and may do damage before work is halted or diverted. Therefore exploitation should be restricted, or subject to exhaustive pre-disturbance surveys. While this may prevent commercial damage to sites, it also ensures that no sites will be discovered by archaeologists, while natural wave and current erosion will progressively destroy deposits anyway. In the high energy hydraulic regime of the North Sea, the archaeological resource is continuously declining.

8.5 It is therefore in the interests of long term preservation of the archaeological sites, and in the interests of acquisition of archaeological knowledge, that we use industrial and commercial activities as a means of identifying archaeological prehistoric sites in the offshore area. On the coast and in shallow water sites will usually be known to the local authorities. The approach suggested here would only apply offshore, perhaps outside Territorial Waters. But there should be a continuity of the protocols at the Territorial Limit.

8.6 The ideal structure would require or encourage the industry and its sub-contractors to check whether their activities are in archaeological prospective zones, and to identify, and report, when their activities positively detect prehistoric artefacts, or, in the case of acoustic surveys, provide very strong evidence. If this can be achieved at minimal or acceptable cost/delay to industry, then there is a positive advantage in allowing operators to start activities in zones of archaeological potential, while avoiding positively identified sites, if any.

8.7 This may sound heretical, but the conditions and circumstance in the North Sea need to be treated realistically. Even thousands of bones or artefacts scattered over an area of, say, 50km square, represents about 1-2 artefacts per km². Since the examples given above refer to finds over decades, and since the movement of modern sediments implies that artefacts are exposed or eroded, and then covered again sporadically, the chances of any systematic search by professional archaeologists finding artefacts from a cold start are almost zero.

8.8 There is no comparison with the Danish situation where complex and relatively undisturbed sites, each with thousands of artefacts, are known to occur with a spacing of the order of 1km. Even if the original North Sea site spacing was comparable to the Danish discoveries, there is no means now of finding the sites in the much more sediment rich and active marine environment of the southern North Sea by surface observation. Extensive disturbance, dragging, or coring or excavation

are essential if we are to find anything at this stage. In coming years, if and when we know much more, this situation may alter, and limited areas could be strictly protected.

8.9 The guidance for BMAPA (BMAPA and RCHME, 2001) is reasonable, as a consultation draft Guidance Note. The Guidance Note provides for Site Assessment, (desk-based studies of existing knowledge); Archaeological Field Evaluation (a limited programme of non-intrusive or intrusive fieldwork); Avoidance, Reduction, and Remedying or Offsetting. There are recommended protocols for monitoring commercial dredging. An equivalent document for the offshore oil and gas industry should address the equivalent issues.

8.10 In North Sea open waters it would be extremely difficult to mount a major excavation with strict site stratigraphy, and it is probable that, in the near future, academic activity would be limited to analysis of finds by commercial operators, and occasional dives to check for surface finds, possibly by the ADU. When more sites are located and understood, excavation might become advisable, especially if a site revealed a major item such as a bog body in peat.

8.11 The success of this approach depends upon many more people in the commercial sector being aware that prehistoric artefacts could be present in almost any sediment recovered from the floor of the North Sea, and learning to recognise artefacts of flint, bone, and antler. It has been suggested that stone tools are so obscure that non-experts would never learn to recognise them. I doubt if this is true, and recognition kits or guidance notes could be distributed or posted as notices at very little cost. Since the older tools tend to be larger, there is a greater chance of recognising those artefacts which are the least likely to be found.

8.12 Excavation procedure: The responsibility for excavation of offshore sites rests with the archaeological authorities and the university research community. Any plans for excavation or submarine survey for archaeological purposes would be conducted in accordance with the standards of safety normal for offshore operations, and diving would be conducted in accordance with HSE regulations. This paper cannot comment on funding in regard to offshore archaeological projects.

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Annexes

1. Articles 149 and 303 of UNCLOS
2. Acronyms

1. Articles 149 and 303 of UNCLOS

Article 149. Archaeological and historical objects

All objects of an archaeological and historical nature found in the Area shall be preserved or disposed of for the benefit of mankind as a whole, particular regard being paid to the preferential rights of the State or country of origin, or the State of cultural origin, or the State of historical and archaeological origin.

Article 303. Archaeological and historical objects found at sea

1. States have the duty to protect objects of an archaeological and historical nature found at sea and shall co-operate for this purpose.
2. In order to control traffic in such objects, the coastal State may, in applying article 33, presume that their removal from the sea-bed in the zone referred to in that article without its approval would result in an infringement within its territory or territorial sea of the laws and regulations referred to in that article.
3. Nothing in this article affects the rights of identifiable owners, the law of salvage or other rules of admiralty, or laws and practices with respect to cultural exchanges.
4. This article is without prejudice to other international agreements and rules of international law regarding the protection of objects of an archaeological and historical nature.

2. Acronyms

ADU	Archaeological Diving Unit, University of St Andrews
AMS	Accelerator Mass Spectroscopy
AHOB	"Ancient Human Occupation of Britain" project
BMAPA	British Marine Aggregates Producers Association
BGS	British Geological Survey
CBA	Council for British Archaeology
DCMS	Department of Culture, Media, and Sport
DTLR	Department of Transport, Local Government, and the Regions
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EU	European Union
MoD	Ministry of Defence
NAS	Nautical Archaeology Society
NHA	National Heritage Act 2002
NMR	National Monuments Record
OCS	Outer Continental Shelf, (legislation, USA)
RCHME	Royal Commission on the Historical Monuments of England
ROV	Remote Operated Vehicle
TttW	"Taking to the Water". Policy statement of English Heritage, 2002
UCPUCH	UNESCO Convention on Preservation of the Underwater Cultural Heritage
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea 1982
UNESCO	United Nations Educational, Scientific and Cultural Organisation.
VC	Valetta Convention, European Convention on the Protection of the Archaeological Heritage (Revised) 1992