Palaeolithic Archaeology Teaching Resource Box

Pleistocene Climate, Flora and Fauna: Advanced

The Oxygen Isotope Record of Climate
Analysis of sediment cores from the floors of the deep oceans has provided a continuous record of climatic variability during the Pleistocene. The *deep sea cores* have documented the climatic cycles of the Pleistocene, with each climatic cycle consisting of a glacial and an interglacial. Since about 500,000 years ago these cycles have each lasted approximately 100,000 years. The climatic phases are often referred to by their oxygen isotope stage (OIS) numbers: warm interglacials have odd numbers while the cold glacials have even numbers.

The Ice Core Record of Climate
Recent research in the Arctic and the Antarctic has revealed new details about climatic change during the Pleistocene. Analysis of *ice cores* has indicated that alongside the major glacials and interglacials (lasting on average about 50,000 years each), there were also much shorter warm and cold periods. Some of the most important of these are known as stadials (a short cold period within an interglacial) and interstadials (a short warm period within a glacial). The ice core records have also indicated that significant temperature changes sometimes occurred over just a few decades, and it is likely that those changes would have been evident to the Pleistocene hominins who lived at that time.

Animals as Chronological Markers & Climatic Indicators
Research into the Pleistocene fauna (animals) of Britain has revealed that particular animal species are reliable chronological indicators. For example, the large fallow deer *Dama dama clactoniana* is only found in Britain during OIS-11 (*c*. 420–360,000 years ago). Small mammals are also very useful: changes in the teeth of the water vole during the early and middle parts of the Pleistocene enable archaeologists to use the presence of different vole species to date archaeological sites.

Insects such as beetles are also very useful as climatic indicators: this is because they are very sensitive to climatic changes, so if archaeologists find them then they can be fairly sure what the climatic conditions were like at that time. Large mammals such as woolly mammoths are much less useful as climatic indicators however, because they are tolerant of a much wider range of conditions.

Interglacial Vegetation:
During each of the Pleistocene interglacials many plant species (especially trees) returned to Britain from southern European *refugia* (where they had survived during the harsh, cold glacials) and re-colonised the country. However, while the pollen evidence from each interglacial is generally similar (increasing tree cover towards the peak of the interglacial, followed by a decline towards the start of the next glacial) they do also have distinctive elements (e.g. *pollen zone* III of the Ipswichian interglacial is distinguished by high proportions of hazel).

Terminology:
Deep sea cores (oxygen isotope record): sediment cores whose layers are made up of the skeletons of microscopic animals (known as foraminifera). The ratios of two oxygen isotopes (^{16}O and ^{18}O) in these skeletons indicate changes in global sea levels (and by inference global temperature) during the Pleistocene.
Ice cores: these are cores of ice which consist of individual ice layers, formed by the compaction of snowfall. The ratios of different hydrogen isotopes in the water that makes up the ice indicate variations in temperature (e.g. high proportions of the heavy hydrogen isotope Deuterium indicate a relatively warm climate). Air and gasses trapped in the ice

cores also enable climatologists (scientists specialising in the study of climate) to study changes in the world's atmospheric gasses.
Pollen zones: pollen zones are used to sub-divide Pleistocene palaeo-climate, using the data from pollen cores. When used for the climatic changes of the Late Pleistocene and the Holocene (the current geological period, which started at 10,000 years ago), the pollen zones run from I (tundra) to IX (grasses, and pine and beech woodland).
Refugia: isolated locations where plant and/or animal species survive during periods of unfavourable conditions elsewhere. These are typically related to climate, although more recently refugia have been created by human activities. In the Pleistocene such refugia are typically temporary, with plants and animals expanding out from the refugia in response to favourable changes in climate and environment.

Quiz Questions:
1. What are the benefits of the deep sea core and the ice core climatic records?
2. Were any mammal species driven to extinction by human over-hunting during the Palaeolithic?
3. Should we expect all the pollen diagrams from the *same* interglacial to look the same?

Further Resources:
http://news.bbc.co.uk/1/hi/sci/tech/3792209.stm [BBC news item describing one of the ice cores recently drilled in Antarctica]

http://www.staffs.ac.uk/schools/sciences/geography/staff/harrist/quatuk/links.htm (and click on the *Ice Age Mammals of London* Webcast link) [Dr Andy Currant from the Natural History Museum discusses the extinct Pleistocene animals from the London region]

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Geological Period	OIS	Climate	Start (kya)	End (kya)	Duration (kyr)	Archaeological Period
Holocene	1	Warm	10	Present	10	Mesolithic–present day
Late Pleistocene	2	Cold	24	10	14	Upper Palaeolithic
	3	Cold	57	24	33	
	4	Cold	71	57	14	Middle Palaeolithic
	5	Warm	127	71	56	
Middle Pleistocene	6	Cold	186	127	59	
	7	Warm	242	186	56	
	8	Cold	301	242	59	
	9	Warm	334	301	33	Lower Palaeolithic
	10	Cold	364	334	30	
	11	Warm	427	364	63	
	12	Cold	478	427	51	
	13	Warm	528	478	50	
	14	Cold	568	528	40	
	15	Warm	621	568	53	
	16	Cold	659	621	38	
	17	Warm	712	659	53	

Oxygen isotope stages (OIS) from OIS-17 to OIS-1 (present). Kya: thousands of years ago. Kyr: thousands of years. The Late Pleistocene (OIS-5 to OIS-2) is actually a single cycle (i.e. one warm stage (OIS-5) and one cold stage (OIS-4, 3 and 2 combined), but due to being better understood it is conventionally represented as shown here. The divisions between the archaeological periods are approximate for the Lower/Middle and Middle/Upper Palaeolithic transitions. After Gamble (1999: Figure 4.2).