

Clues from the past

Introduction

One of the aims of research into climate change is to construct as detailed and continuous a record of climate and environmental change as possible. In recent years scientists have developed increasingly sophisticated ways of discovering what the climate of the Earth used to be like many thousands of years ago, based on investigations of ice cores, pollen grains, tree rings, coral reefs and ocean sediments. Data about more recent environmental conditions are available from instrumental and historical records.

Quantitative information about global change in the past can help scientists to understand the ways in which the Earth's climate system responds to the factors that drive change. Data from the past also allow scientists to test the validity of the mathematical models that they have developed to explain and predict changes to the climate.

This activity is adapted from an activity developed as part of the ICSU *Education in Global Change Project* published in 1994. The project was an international collaboration between global change scientists and curriculum developers from the UK, USA, India and France.

Commentary on the activity

The information needed to complete the table is provided in the notes which accompany the slides in the 'Clues from the Past' presentation and in the *A2 Science in Society* textbook, pages 110-117.

This activity is a good one for exploring the relationship between observations and explanations.

How Science Works

Cc An event is often explained by relating it to a particular scientific theory (or theories). A scientific theory proposes an underlying process that results in the observations we have made. Many scientific theories involve objects or properties that cannot be directly observed. Scientific theories do not 'emerge' from data by a process of logical deduction; proposing an explanation always involves imagination and conjecture. An explanation is not just a summary of the data, but is distinct from it.

Ce Scientists are more confident about theories that include a plausible mechanism for causing the events observed. It is also important that a new theory is consistent with existing theories that are well established and generally accepted.

Cf Comparing data with predictions is often not straightforward. It may be possible to interpret data from complex equipment in more than one way. Interpretations need to be checked and discussed with others working in the field. Lack of agreement may be because the data are incorrect, rather than because the theory is wrong.

Answers

Archive	Measurement (proxy data)	Information about the environment in the past	Approximate length of record
Documentary records	<p>Use of sources of climate data come from:</p> <ul style="list-style-type: none"> records of meteorological observations diaries with notes of unusual weather conditions paintings and photographs of natural features detailed records of events such as the time of grape harvests or wine production high water markers for rivers and tides. 	<p>The sources can be used to give information about:</p> <ul style="list-style-type: none"> temperature, hours of sunshine, rainfall and wind direction. occurrence of dramatic storms, extremes of cold and water levels. extent of glaciation, area covered by lakes, damage by high winds length and timing of seasons, areas where climate conditions are suited to particular crops extent of storms and flooding. 	Note more than 1000 years and mainly more recent
Sediments from deep oceans	Inorganic and organic composition, presence of fossils, ratios of stable isotopes of elements such as oxygen and hydrogen	Ice volume of earth, patterns of ocean currents as well as the mean sea surface temperature	Up to 20 million years ago
Ice cores	<p>The concentrations of trace gases such as carbon dioxide and methane in air bubbles.</p> <p>Oxygen isotope ratios in the ice</p>	<p>Composition of the atmosphere in the past</p> <p>Mean annual temperatures of the air.</p>	Back to about 800 000 years ago
Pollen grains	Identification of the number of grains of different species of plants in a sample.	Environmental conditions including levels of rainfall and range of temperatures.	Back to the last ice age, about 11 500 years ago
Tree rings	The density of width of the annual tree rings.	Conditions in which the tree grew at different times in the past.	Up to 10 000 years ago with the help of fossil wood.

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Scientists have discovered ingenious ways of finding out what conditions on Earth used to be like. The information comes from historical and natural 'archives'.

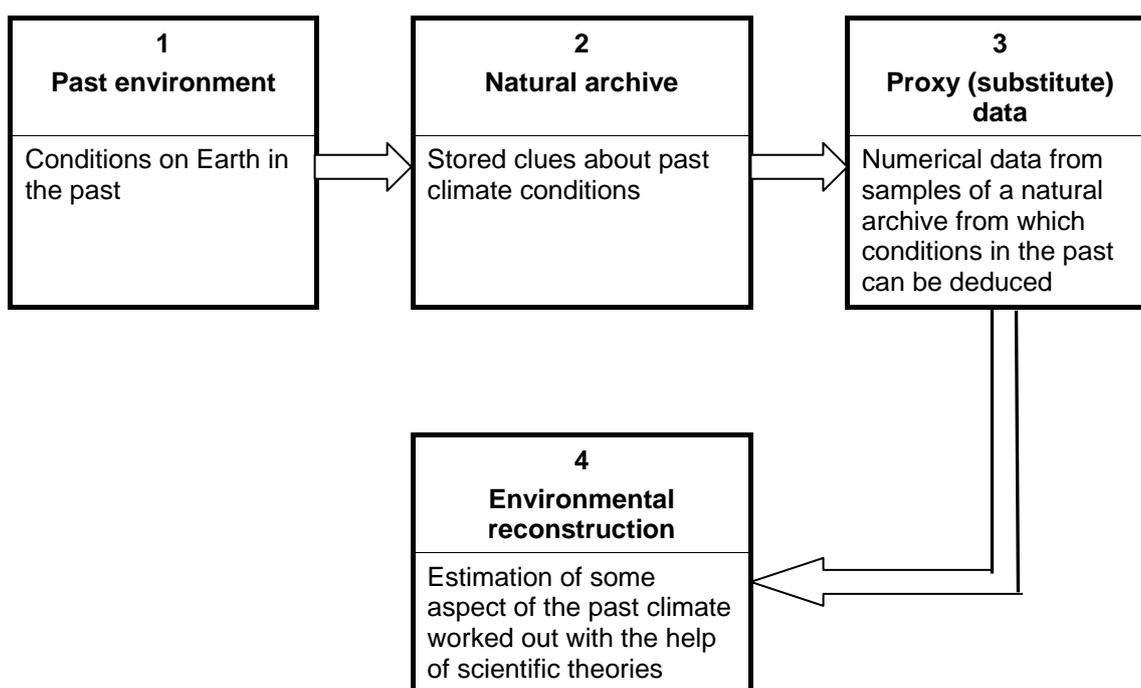
An archive is a collection of records. Historical archives, for example, often include books, papers and letters. Historians can study the information in these texts so long as they can read the language.

In a natural archive the records are 'written' in a variety of unexpected ways. Scientists have to discover how to read the records. They have found ways to decode the clues hidden in ice, in deposits under the sea, in patterns of pollen grains, in tree rings and in tropical corals.

The chart shows the stages involved in reading a natural archive. Box 1 represents conditions on earth hundreds, thousands or millions of years ago. Scientists want to find out more about these past environments: temperature, rainfall, sea level and so on.

Clues concerning past climatic conditions are recorded in natural archives (box 2). the thickness of tree rings, for example, depends on the growing conditions at the time the wood was formed.

Scientists make a series of measurements as they study the natural archives. As they look at cores drilled from tree trunks, for example, they measure the thickness of the rings. These data are one stage removed from the information that the scientists really want. They are a substitute (a proxy) as in box 3, from which past environmental characteristics can be deduced (box 4).



The activity

Watch a presentation by your teacher. Refer to pages 110 – 117 in your textbook. As you do so, complete the table below.

Archive	Measurement (proxy data)	Information about the environment in the past	Approximate length of record
Documentary records			
Sediments from deep oceans			
Ice cores			
Pollen grains			
Tree rings			