Shaping the Landscape
WORKBOOK

Climate change, sea level rise, ice-ages, human evolution, the migration of peoples and cultures and of plants and animals, and the formation of the landscape and habitats of today are all subjects under the umbrella of the **'QUATERNARY'** a geological period, beginning 2.6 million years ago. This period is characterised by ice-ages with cycles of colder, glacial conditions in mid- to high-latitudes, interspersed with warmer 'interglacial' periods like that in which we live today. It is also the period in which humans evolved and includes the whole history of our species.

THE GEOLOGICAL COLUMN

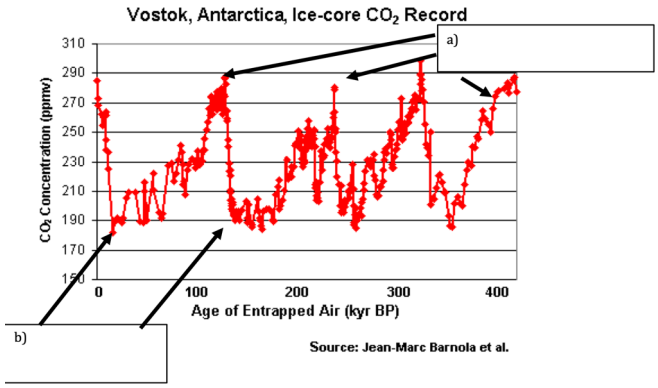
The Geological Column is a table that divides 4.6bn years of Earth's history into Eras and Periods/Systems. The former are large units of time divided upon the fossils found in the rock with each culminating in a mass extinction. The latter periods/systems are smaller units of time subdivided upon the rocks that are formed.

Era	Period		Age (mya)
Cenozoic	Quaternary	Anthropocene*	1950 CE
		Holocene	0.117
		Pleistocene	2.6
	Neogene		26
	Paleogene		65
Mesozoic	Cretaceous		145
	Jurassic		200
	Triassic		251
Paleoproterozoic	Permian		299
	Carboniferous		353
	Devonian		417
	Silurian		443
	Ordovician		490
	Cambrian		543
Neoproterozoic			1000

Using the Geological Column above complete the information box below:	
What is the age range of Quaternary	
List 2 geological periods within the Quaternary	
The Quaternary period represents what percentage of Earth History?	
What distinguishes the Quaternary from other geological periods?	

ICE CORES

The graph below is a record of the CO_2 concentration recorded from ice in the Vostok ice cores. Insert the terms **GLOBAL WARMING** or **GLOBAL COOLING** in either box a or box b.



Describe the CO_2 concentration from the graph above.

_____

_____

_____

Explain why scientists use CO_2 concentrations to determine climate change.

_____

_____

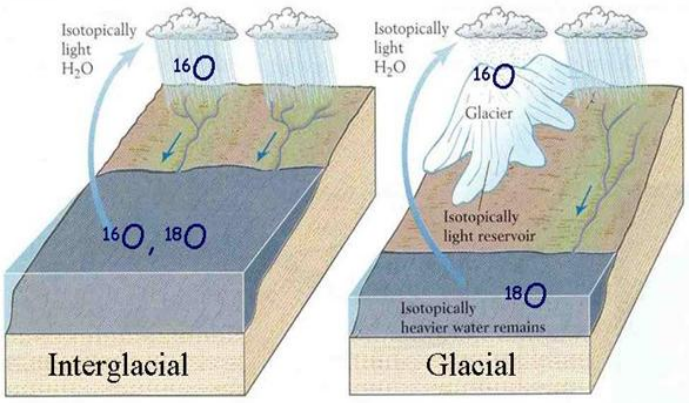
WEBQUEST

Log onto http://www.iqua.ie/ and answer the following questions:

- **When did the Quaternary begin?**
- **Describe the characteristics of the Quaternary?**
- **Define the term Anthropocene?**
- **Describe what a Quaternary Scientist does?**
- **Why is their work so important to our future?**
- **How is time determined using landscape deposits?**
- **Where did the first human settlers to Ireland come from?**
- **How did they cross the Irish Sea?**
- **What is the relationship between sea level and glacial periods?**

OXYGEN ISOTOPES

The diagram below illustrates how oxygen isotope ratios are altered during glacials and interglacials – write a sentence in each box to explain how and why the oxygen isotope ratio changes with climate change.



Evaluate the evidence for humans in Ireland 10, 000 years ago.

_____

_____

_____

_____

_____

Describe the following terms

PALAEOLITHIC

_____

MESOLITHIC

_____

NEOLITHIC

_____

Lith= *BC=*

POSTER

Create a poster that would describe the 'Quaternary' to an uninformed audience.

Success criteria:

- Must be informative (have dates)
- Visually stimulating and accurate
- Clearly show the climate, megafauna, flora and mankind

PAIR UP QUATERNARY

Instructions: pair up the keyword with their appropriate definitions.

QUATERNARY	Youngest time period in the Earth's history, beginning 2.6 mya and continuing to the present day. Within the Quaternary there are many epochs such as the Pleistocene, Holocene and the proposed Anthropocene
U-SHAPED VALLEY	A geological abbreviation for thousands of years ago
THE MALONE HOARD	A long, winding ridge of sand and gravel that was deposited during last ice age from glacial meltwater
POLLEN	A ratio of oxygen isotopes that signify a cooler climate
PLEISTOCENE	A geological abbreviation for Millions of Years
Mya	A geological epoch lasting between 2.6 Ma-11,700 years ago that incorporates the world's recent glacial events
MILANKOVITCH CYCLES	A remnant from the last ice age, a long, low oval mound shaped hill of sand and gravel deposits that were shaped by the ice
ESKER	Fine powdery plant material used to identify species of fauna and determine climate change
GIANT DEER	Large hollowed out depressions formed on the upper slopes of glaciated valleys, formed by abrasion
DRUMLIN	A proposed new geological period within the Quaternary defined as starting when humans had an impact on the climate, flora and fauna
ERRATICS	19 porcellanite axes found in Belfast, evidence of humans in Ireland pre 10,000 years ago
MORAINES	Megafauna that lived in Ireland toward the end of the last Ice Age, incorrectly called an Irish Elk
ANTHROPOCENE	A cause of climate change caused by cyclical changes in the Earth's orbit around the sun
CORRIES	Large, wide valleys shaped in a U that formed by abrasion as glaciers moved downhill
GLACIAL	A cool period in the Earth's history when the average temperature was lower than present with ice sheets and glaciers present
HIGHER O_{18}-0_{16}	A piece of rock that has a different geology to that on which it rests. These blocks were transported by glaciers from their place of origin to where they now rest
INTERGLACIAL	The most recent epoch, which is an interglacial period (warm period) beginning 11.7 kya.
Kya	A period between two glacial periods. The HOLOCENE is an example of an interglacial period and began 11,700 years ago
MICROFOSSIL	An accumulation of unconsolidated and unsorted glacial debris ranging in size from large boulders to the finest sand
HOLOCENE	Small organisms including plants and animals that can be used as indicators of climate change

QUATERNARY ODD ONE OUT

Instructions: Circle the odd word out from each row below and provide a reason for your choice. Row A has been completed as an example.

Row/ Word	Word 1	Word 2	Word 3	Word 4	Odd-one-out/Reason
Row A	Meteorite	Esker	Drumlin	Erratic	Word: **1** Reason: **2, 3, 4** are all glacial landforms
Row B	$O_{18}.O_{16}$ ratio	CO_2 levels	Mountains	Pollen	Word: Reason:
Row C	Holocene	Quaternary	Pleistocene	Anthropocene	Word: Reason:
Row D	Glacial ice	Lower SL	Lower $O^{18}:O^{16}$	Higher $O^{18}:O^{16}$	Word: Reason:
Row E	Land bridges	Corrie	Raised beaches	Drowned forests	Word: Reason:
Row F	Giant Deer	T-Rex	Cave bear	Woolly mammoth	Word: Reason:

QUATERNARY WORDBANK

TASK: Complete the paragraph below using the correct words from the Word bank below.

Oxygen has 3 stable isotopes, $\delta^{18}O$, $\delta^{17}O$ and $\delta^{16}O$. _____ is the most abundant oxygen isotope, totalling _____ %. The _____ between the two main isotopes can be used to give scientists information about the palaeoclimate (ancient climate). The _____ $\delta^{16}O$ isotope is more easily evaporated hence during _____ this isotope is locked up in the snow and changes the $\delta^{18}O$:$\delta^{16}O$ ratio making it _____ than during interglacials. Interglacial periods are dominated by _____ temperatures, so ice will _____, returning the $\delta^{16}O$ that was stored in glacial ice back to the sea, causing the $\delta^{18}O$:$\delta^{16}O$ ratio to lower.

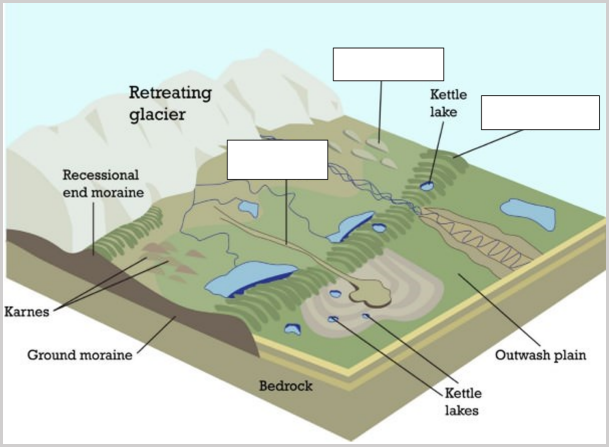
Word bank

lighter, **99.76%**, **glacial periods**, **higher** , **$\delta^{16}O$** , **warmer**, **ratio**, **melt**

GLACIAL LANDSCAPES

Identify the glacial landscapes in the sketches below. Add a description below each one and explain how it formed.

- Drumlin field
- Esker
- End moraine



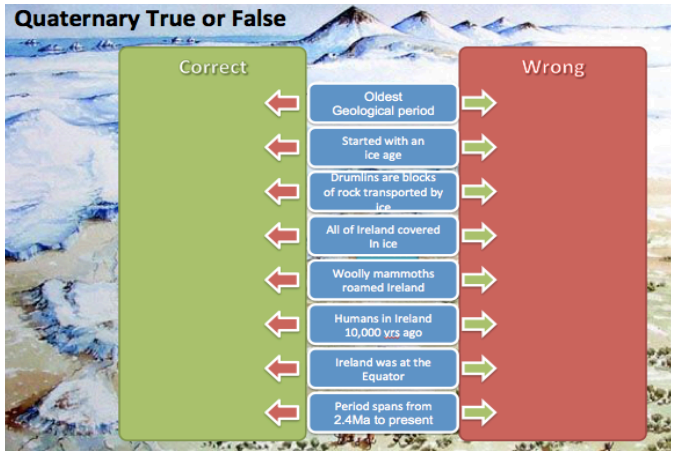
Describe how scientists can determine the direction that the glaciers advanced during the last ice age.

_____

_____

_____

_____



Irish Quaternary Map

Note layers for Quaternary Geomorphology and Quaternary Sediments. Click on at least 5 glacial geomorphological/sediment features in your local area. Record the following:

Note 5 features:

_____

Note dominant sediment type:

_____

Define new technical terms:

_____

Geological Heritage Mapviewer

Zoom to your local area. Locate your nearest Irish Geological Heritage (IGH) feature (look for Quaternary themes). Record the following:

Site name:

_____

Type of feature (e.g. moraine):

_____

Summary description (if present):

_____

_____

_____

www.gsi.ie/en-ie/data-and-maps/Pages/Geoheritage.aspx# for further info.

iMovie instructions: your report should be 2 mins long and have at least 10 slides. You should use the microphone function to create your narrative but can also use text.

- Introduce yourself as a Quaternary Geoscientist
- Describe the role of a Quaternary Geoscientists
- State the dates of the Quaternary
- Describe the climate at the start of the Quaternary
- Describe the latitude of present-day continents during the Quaternary
- Describe the climate fluctuations in the Quaternary
- Explain the causes for variations in Earth's Climate
- Define the terms Icehouse and Greenhouse
- State characteristics of Icehouse and greenhouse
- Describe and explain sea level during an ice age
- What happens sea level during a period of warming?
- What physical structure allowed animals to migrate between continents that we know today?
- Show 11 animals common in the Quaternary (Megafauna)
- Describe the impact of the human species on the flora and fauna in the Quaternary
- Describe the characteristics distinguish us from animals.
- Define the term Anthropocene and explain why it is being considered as a new Epoch

Research these Irish Quaternary Scientists

Sydney Mary Thompson _____

_____

Robert Lloyd Praeger_____

_____

Frank Mitchell _____

_____

Valerie Hall _____

_____

Useful Websites

Geological Survey Ireland Schools page: http://www.gsi.ie/education/
Quaternary Research Association
https://www.qra.org.uk/educational-resources/
British Geological Survey
https://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/iceAge/
Fossils www.fossils-facts-and-finds.com
Encyclopedia Britannica
www.britannica.com/science/Quaternary#ref260439
Geology for schools in Ireland
geoschol.com/ireland.html

Who wants to be millionaire?

Time dependent. Name:

- 5 animals present during the Quaternary
- 4 microfossils
- 3 landforms in Ireland associated with the glacial action of the Quaternary
- 2 causes of climate change
- 1 proposed name for new Epoch where humans have had major influence on the Earth

Revise the Terms

Can you recall the meaning of these terms?
Quaternary, Epoch, Milankovitch Cycles, Global warming, climate change, icehouse, greenhouse, drumlin, erratic, u-shaped valley, till, Anthropocene , esker, moraine, drumlin, pollen, oxygen isotope, interglacial

CURRICULUM LINKS

Junior Certificate

Strand 2: Exploring interaction with the physical world
2.6 Examine the causes & implications of climate change

Leaving Certificate

Core Unit 1: Patterns and Processes in the Physical Environment
1.5 Landform development (iii) (iv)

GCE (CCEA) Geography

AS 1: Physical Geography
AS 2: Physical Processes, Landforms and Management
Option D: Climate Change – Past and Present

A- Level (CCEA)

CORE UNIT 2: Regional Geography
2.2 The dynamics of regions

A-Level (WJEC)

Geology – Option T3 – Quaternary Geology, Core Unit 1: Patterns and Processes in The Physical Environment
Key Idea 1: Climate change, Key Idea 2: Quaternary deposits, Key Idea 3: Fossils

A-Level (OCR)

Module 7: Basin Evolution
7.1.1 (ii) Earth's climate and composition of the atmosphere, **7.1.1 (iii)** Long term changes in global sea level, **7.1.2** Long term changes interpreted from palaeoenvironments

Geographical information systems (GIS)
GIS, can be used in the teaching of Quaternary geology to

Irish Quaternary Association (Iqua.ie)

The Irish Quaternary Association (IQUA) is an all-Ireland voluntary organisation of academics, students, amateurs, governmental and industrial partners who are interested in studying and understanding the Irish landscape. IQUA members have diverse interests and expertise including archaeology, climatology, ecology, agriculture, engineering, geography, geomorphology, geology and hydrology.