Interpret Earth temperatures from simulated deep-sea and ice cores
Using sweets to simulate oxygen isotope ratios in cores

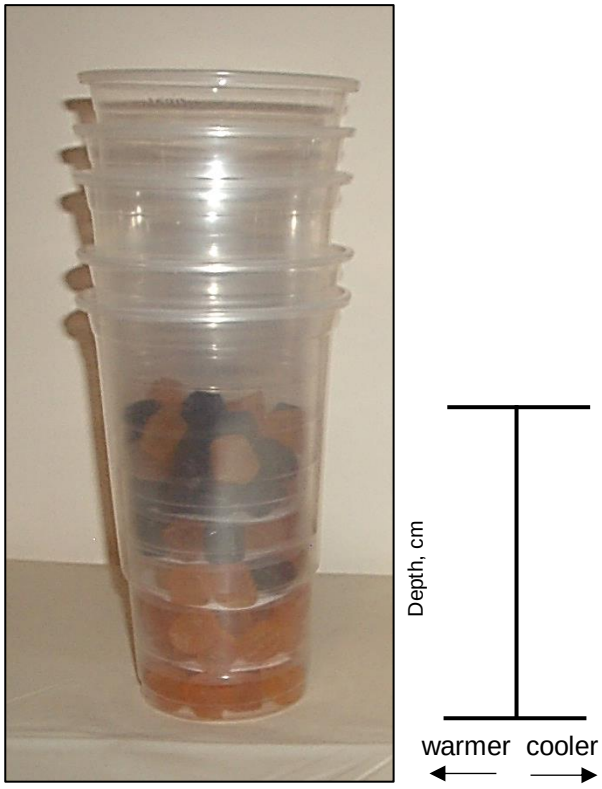
Demonstrate how the proportions of ^{18}O to ^{16}O in ice and deep-sea cores can be used to interpret past Earth temperatures with '*The oxygen isotope sweet simulation'* Earthlearningidea. This uses coloured sweets (e.g. Midget Gems™) which have been divided up into different colours. One set of pale-coloured sweets is put together with one set of darker coloured sweets to represent oxygen isotopes:

- darker-coloured sweets represent water with heavy oxygen – ^{18}O;
- paler-coloured sweets represent water with normal oxygen – ^{16}O.

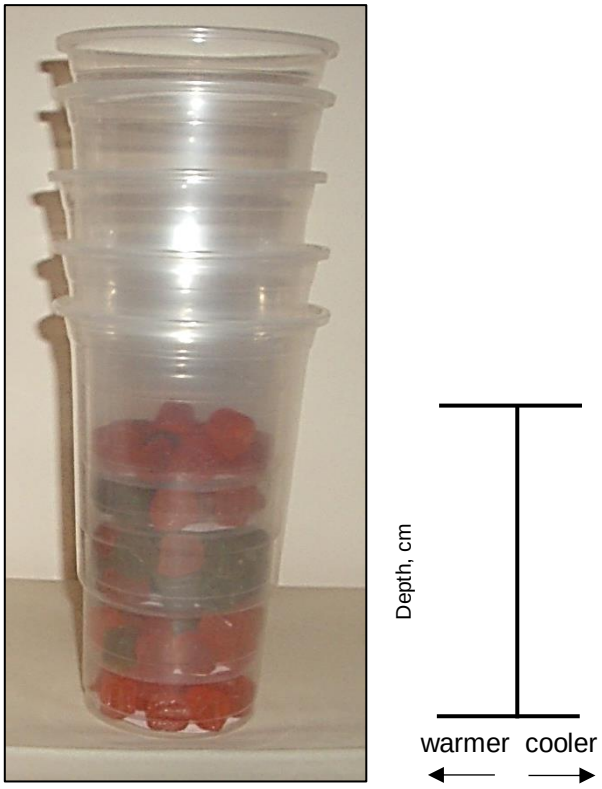
Cut out some circular disks of paper and put them in the bottom of a set of stacking plastic beakers. Then put a mixture of a few dark and pale-coloured sweets into a plastic beaker to represent one layer in a core. Repeat with a different dark/pale colour sweet ratio in another beaker and stack the two beakers. Do this several times with layers of different thicknesses, to represent a 'core' of different layers with different ratios, as in the photos.

Then ask the pupils to draw a graph of Earth temperature against core depth given that:

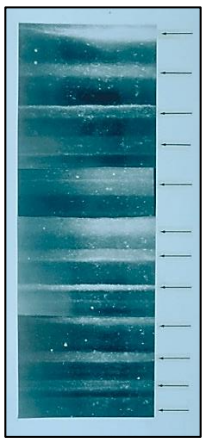
- if the core is a simulated **ice core** – the **less** ^{18}O it contains, the **colder** Earth's temperature will be, and *vice versa*;
- if the core is a simulated **deep-sea sediment core** – the **more** ^{18}O it contains, the **colder** Earth's temperature will be, and *vice versa*.



A mock ice core – dark sweets represent ^{18}O, paler sweets represent, ^{16}O. (*Chris King.)*



A mock deep-sea sediment core – dark sweets represent ^{18}O, paler sweets represent, ^{16}O. (*Chris King.)*



Ice core layers.

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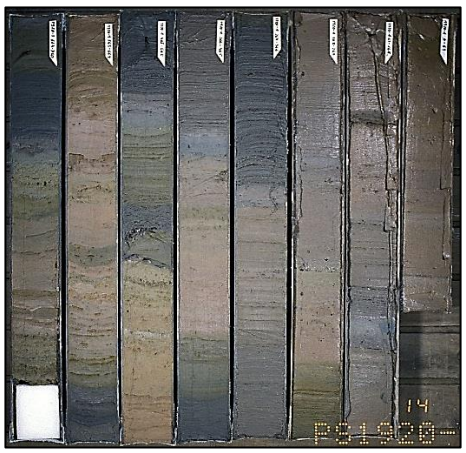

Deep sea sediment core from the south Atlantic Ocean – showing sediment layers.

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Notes:

1. *The paper circles in the bottoms of the beakers are used to separate the layers more clearly.*
2. *The students may find it easier to take the beakers apart to work out the dark sweet : pale sweet ratios – but if they do this, they should be sure to note the correct order of beakers.*

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The back up

Title: Interpret Earth temperatures from simulated deep-sea and ice cores.

Subtitle: Using sweets to simulate oxygen isotope ratios in cores.

Topic: An activity to plot Earth's temperature indications from mock ice and deep-sea sediment cores.

Age range of pupils: 16 years and above

Time needed to complete activity: 20 minutes

Pupil learning outcomes: Pupils can:

- describe that the **lower** the proportion of ^{18}O in an ice core layer, the **colder** the Earth was at the time the layer was laid down;
- describe that the **higher** the proportion of ^{18}O in a deep-sea sediment core layer, the **colder** the Earth was at the time the layer was laid down;
- plot a graph of warmer/cooler Earth temperatures from a mock core.

Context:

This activity consolidates understanding of how the ^{18}O:^{16}O ratios in ice cores and deep-sea cores respectively can be interpreted in terms of warmer (interglacial) or cooler (glacial) Earth temperatures. It also addresses potential misconceptions between oxygen ratios and ice cores; the correct conception is that **high** ^{18}O ratios in sediment cores indicate glacial periods, while **low** ^{18}O ratios in ice cores also show glacial periods.

Japan Agency for Marine-Earth Science and Technology's Deep-sea Drilling Vessel "CHIKYU".

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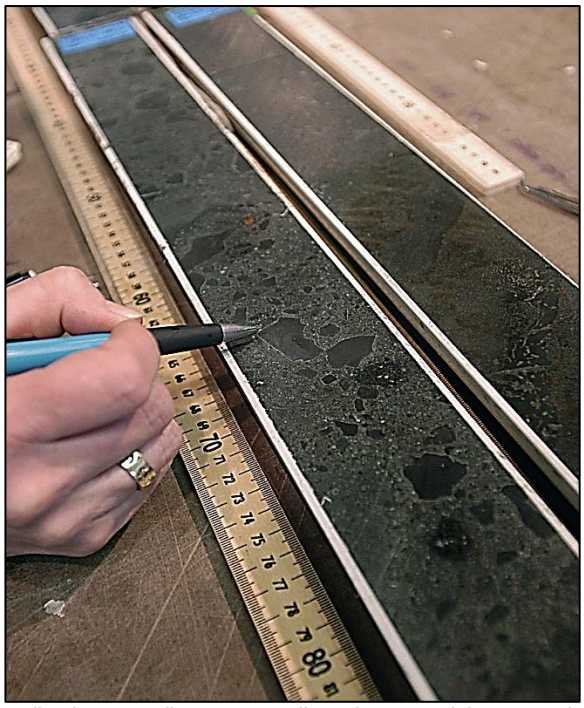
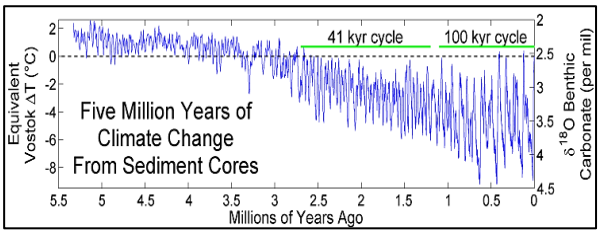


A sliced open sediment core collected as part of the ANtarctic geological DRILLing program, ANDRILL. The deep-sea sediment was analysed to study climate change.

Published by Peter West, a National Science Foundation employee. The image is in the public domain.



Temperature change over the past 5 million years, as indicated by the ^{18}O:^{16}O ratios in microscopic animal shells from deep sea sediment cores – cooler at the bottom, warmer at the top.

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Following up the activity:

Use the internet to find out how ice cores and deep sea sediment cores are drilled.

Underlying principles:

- Snow layers that accumulate on polar ice caps contain less ^{18}O during glacial times than in interglacials.
- Oceans, the shelly animals in them, and the deep sea cores they produce, contain more ^{18}O during glacial periods than in interglacials.
- The ^{18}O:^{16}O ratios in ice cores and deep-sea sediment cores can be used as a proxy for climate change, indicating when the Earth was subjected to glacial and interglacial periods in the past.

- In **ice cores** – the **less** ^{18}O a layer contains, the **colder** Earth's temperature was at that time, and *vice versa*.
- In **deep-sea sediment cores** – the **more** ^{18}O a layer contains, the **colder** Earth's temperature was, and *vice versa*.

Thinking skill development:
Pupils construct a pattern of dark to paler sweet proportions in the layers of the simulations and bridge their understanding to interpreting the temperature differences indicated by ^{18}O:^{16}O ratios in cores.

Resource list:
- several bags of sweets that can be divided into different colours (e.g. Midget Gems™)
- a stack of plastic stacking beakers
- paper and scissors to cut out paper disks

Useful links:
- *Global warming – the complete briefing*, by Sir John Houghton Cambridge University Press.
- ESTA's '*Science of the Earth'* '*Changes to the atmosphere'* at:http://www.esta-uk.net/pubarchive/index_htm_files/SoE1_Changes_to_the_Atmosphere.pdf

Source: Devised by Duncan Hawley.