

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

Demonstrate how the proportions of  $^{18}\text{O}$  to  $^{16}\text{O}$  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:

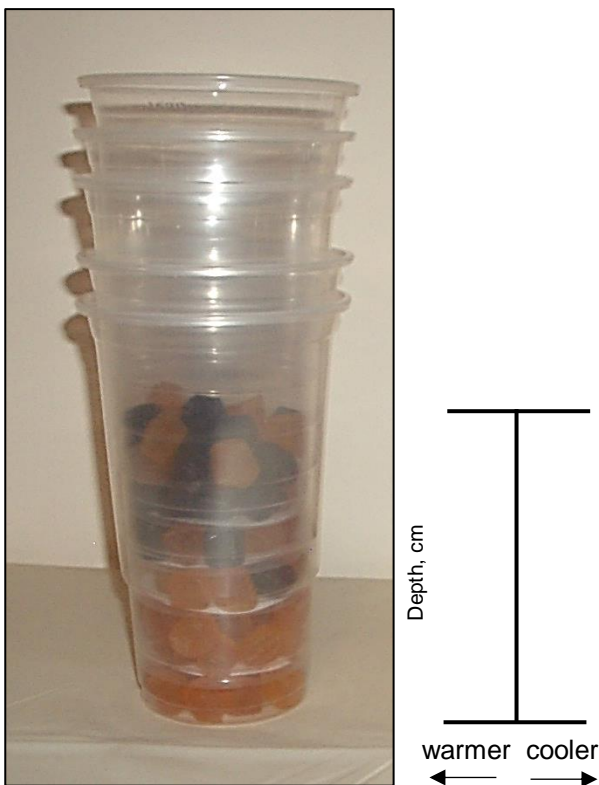
- darker-coloured sweets represent water with heavy oxygen –  $^{18}\text{O}$ ;
- paler-coloured sweets represent water with normal oxygen –  $^{16}\text{O}$ .

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-

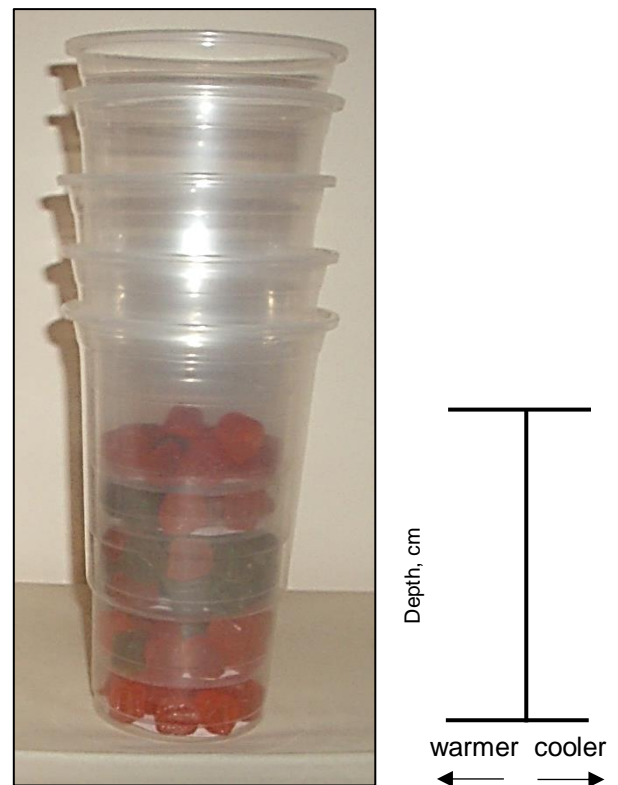
coloured sweets into a plastic beaker to represent one layer in a core. Repeat with a different dark/pale colour sweet ratio in another beaker and stack the two beakers. Do this several times with layers of different thicknesses, to represent a 'core' of different layers with different ratios, as in the photos.

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

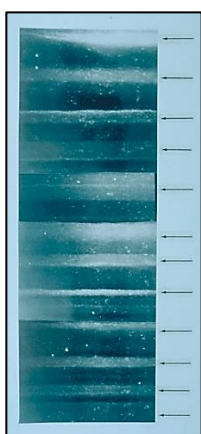
- if the core is a simulated **ice core** – the **less**  $^{18}\text{O}$  it contains, the **colder** Earth's temperature will be, and *vice versa*;
- if the core is a simulated **deep-sea sediment core** – the **more**  $^{18}\text{O}$  it contains, the **colder** Earth's temperature will be, and *vice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



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

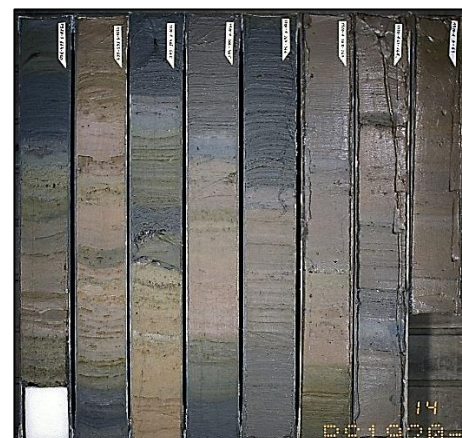


A mock deep-sea sediment core – dark sweets represent  $^{18}\text{O}$ , paler sweets represent,  $^{16}\text{O}$ . (Chris King.)



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.

## 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  $^{18}\text{O}$  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  $^{18}\text{O}$  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.

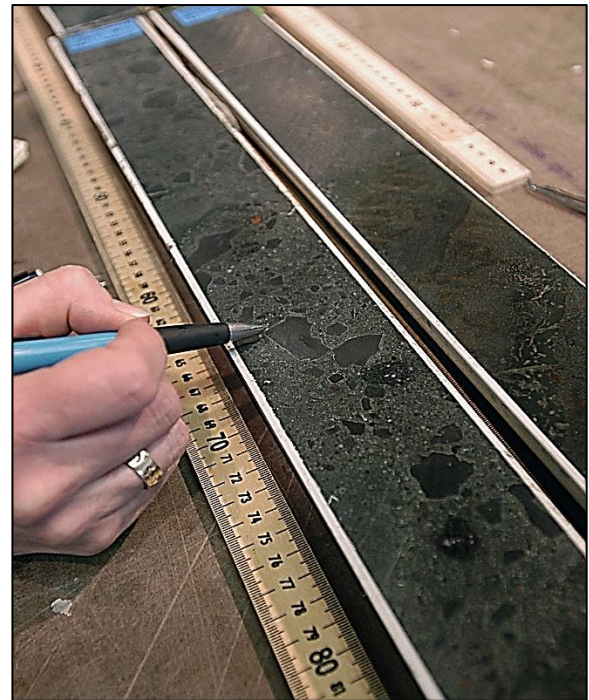
## Context:

This activity consolidates understanding of how the  $^{18}\text{O}:^{16}\text{O}$  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**  $^{18}\text{O}$  ratios in sediment cores indicate glacial periods, while **low**  $^{18}\text{O}$  ratios in ice cores also show glacial periods.



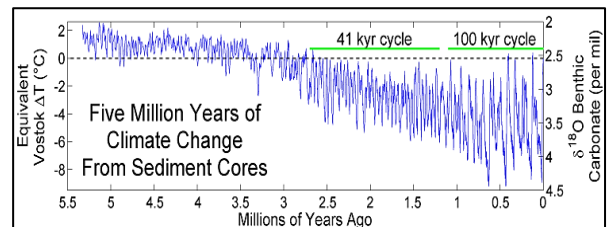
Japan Agency for Marine-Earth Science and Technology's Deep-sea Drilling Vessel "CHIKYU".

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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  $^{18}\text{O}:^{16}\text{O}$  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  $^{18}\text{O}$  during glacial times than in interglacials.
- Oceans, the shelly animals in them, and the deep sea cores they produce, contain more  $^{18}\text{O}$  during glacial periods than in interglacials.
- The  $^{18}\text{O}:^{16}\text{O}$  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**  $^{18}\text{O}$  a layer contains, the **colder** Earth's temperature was at that time, and *vice versa*.
- In **deep-sea sediment cores** – the **more**  $^{18}\text{O}$  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  $^{18}\text{O}$ : $^{16}\text{O}$  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](http://www.esta-uk.net/pubarchive/index_htm_files/SoE1_Changes_to_the_Atmosphere.pdf)

**Source:** Devised by Duncan Hawley.

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