Climate bracelet

The Big Idea

- How do scientists know that the current global warming isn't just caused by the natural cycles of climate?
- Instrumental records are limited to ~150 years, but ocean sediment coring extends that record much further back, providing scientists with a long-term record of climate change
- This activity will simulate the sediment coring process. The students will make a bracelet with the beads they "cored," with their colors representing the long-term climate change of the past 250,000 years.

Materials

Discussion – Climate stripes	**Activity – Sediment coring (per group)**
• Figure of Santa Barbara temperature in color stripes for the past 128 years (digital if projector is available. Print if not)	• 4 dixie cups with period labels (half of the 8 in a "set" shown in the table below) • 2 mesh sieves • 2 extra dixie cups for sieving • Pre-cut bracelet string
Show & Tell – Foraminifera models	**(per room)**
• 3D-printed foraminifera models (at least 25)	• Bucket of sand • Four bags of pony beads in blue, yellow, orange, and red
There are enough supplies in the bin for 13 groups per rotation.	

Prep Work

Prepare before the session:

- Fill the dixie cups with period labels with sand and bury eight pony beads inside the sand. The color of the pony beads in each cup should be the same. The cup-bead color pairing is as follows:

Cup Label	**Bead Color**
250,000 years ago	Blue

200,000 years ago	Yellow
150,000 years ago	Blue
120,000 years ago	Yellow
20,000 years ago	Blue
2,000 years ago	Yellow
30 years ago	Orange
Present	Red

- As the table shows, eight labeled Dixie cups are in a "set." Each cup has sand representing a different time period. However, to reduce the prep work to a reasonable amount, each group or table will get half a "set" of four labeled cups. For example, if a table has cups labeled "250,000 years ago", "200,000 years ago", "150,000 years ago", and "120,000 years ago", the neighboring table will have "20,000 years ago", "2,000 years ago", "30 years ago", and "present". The groups can exchange their labeled cups once they have sieved out their share of the beads.
- The supply box should have small condiment cups that can help speed up the bead refill process. While the activity takes place, one person can fill condiment cups with eight beads so that once the activity finishes, the beads are counted out and ready to refill the labeled cups for the next session.

Procedure

During session:

Discussion – Climate stripes

- Display the climate stripe of Santa Barbara (attached at the end of the document) and ask the students what they think it is. Try not to let the students see the text on the lower left corner of the stripe (don't want to give away the answer).
    - If the students have trouble guessing, hint at the cold and warm colors as temperature.
- Once the answer is provided and the students understand that the stripes are the Santa Barbara yearly temperature record, ask them to describe any patterns they see (warming towards modern times).
- Comment on the fact that the climate stripe represents temperature going back to 1895, and ask students what they think the temperature was like before that.
- Inform the students that some people think the climate has always swung back and forth between cold and warm, and thus, they think the current warming is nothing out of the ordinary. Ask the students how we know what the climate was like a long, long time ago.

Show & Tell – Foraminifera 3D models

- Pass around the 3D foraminifera models. This shouldn't be done ahead of time in case students get distracted.
- Tell students that these are the 3D-printed shells of a type of marine zooplankton called foraminifera.
    - Pronunciation: *fə-RAM-ə-NIH-fə-rə*. Scientists call them forams for short.
    - Zooplankton means that they can't photosynthesize and need to eat other, smaller organisms to live.
    - Actual foraminifera are tiny – the size of a grain of sand.
    - Just like elephants live in the tropics and penguins in the poles, different species of foraminifera prefer different temperatures.
    - By knowing the species of the foraminifera shell, we can figure out the temperature of the Earth when that foraminifera lived.

Sediment coring

- This activity will let students make a long-term climate change record by sieving out foraminifera shells (beads) from deep-sea sediments (sands) of known ages.
- In the table attached at the end of the document, students will write down the color of the beads in each cup.
    - The colors represent the temperature preference of the foraminifera. Blue->cold. Yellow->temperate. Orange->warm. Red->hot.
- By taking two beads from each cup and lining them up in the time sequence on a bracelet string, the students will have a climate record on their wrist.
- At the end of the activity, ask students to describe the climate records they made.
    - The record should show cyclical swings of warm and cold in the beginning, representing the glacial cycles.
    - The most recent segment shows rapid warming unprecedented in the geologic history. This is caused by human activities that release large amounts of CO_2 and is evidence against the argument that global warming is natural.
    - The most effective solution to combat climate change is to reduce CO_2 emissions.

SAFETY / Troubleshooting / Notes

- The 3D-printed foraminifera are made with base support that was removed post-production. However, it is difficult to remove all the jagged edges. They should be handled with care.
- Don't let students take the 3D-printed foraminifera home. The only thing they can take is the bracelet string with beads.
- Ask the students to sieve out all the beads, even if they have more than they need. This will make it easier to clean up.

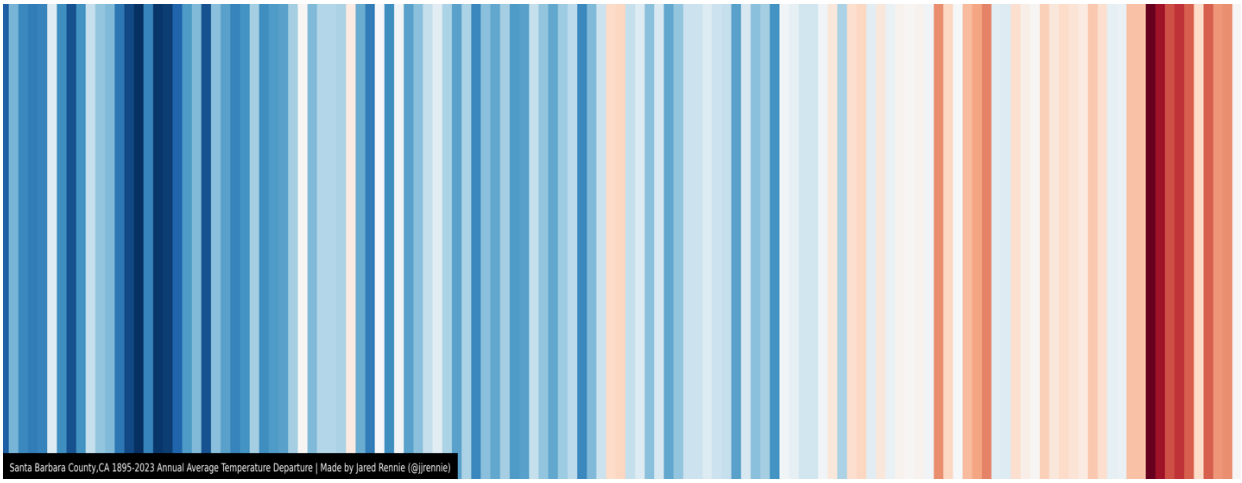
- During sieving, make sure the students hold the sieve to the rim of the receiving cup. It would be helpful to demonstrate sieving before letting the students do it.

Resources

Eco-Anxiety at University: Student Experiences and Academic Perspectives on Cultivating Healthy Emotional Responses to the Climate Crisis
https://digitalcollections.sit.edu/isp_collection/2642/
Past climates inform our future https://www.science.org/doi/10.1126/science.aay3701
Sediment Cores: What, How & Why
https://corerepository.ldeo.columbia.edu/content/sediment-cores-what-how-why

Background

- The sediment coring activity is a simplified version of paleo-sea surface temperature reconstruction. In the activity, only one species of foraminifera is found in each sediment sample. However, in practice, lots of foraminifera can usually be found in a sample, and a census is conducted to account for the number of each species encountered.
- While the species of foraminifera can inform us of the temperature of the seawater they lived in, this type of analysis is now supplemented by more sophisticated chemical analysis on the shells, including the ratio of Mg and Ca and other organic proxies (TEX_{86} and U^{k}_{37}).
- There are two types of foraminifera: benthic (bottom-living) and planktic (surface-living). The sediment coring activity focuses on the planktic foraminifera because the surface ocean temperature varies more than the deep ocean. Note that the 3-D printed foraminifera is a mix of planktic and benthic because benthic foraminifera have more interesting shapes.



Cup Label	**Bead Color**
250,000 years ago	
200,000 years ago	
150,000 years ago	
120,000 years ago	
20,000 years ago	
2000 years ago	
30 years ago	
Present	