

Education on Climate Archives

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Background Information



- Goal: teach k-12 students about climate change and computational thinking synergistically
- This activity teaches kids about climate archives
 - Records which scientists look at to understand the past climate
- Students do a case study on speleothems, which are found in caves and are used to show precipitation levels
 - Case study is of the precipitation levels at the end of the Maya classic period

- Learned: important to think of creative, interdisciplinary ways to teach students and present information
- Challenges: coding the game, making the website instructions clear to student and in an order that makes sense
- Went well: creating the design for the website and game





ARCHIVE INTRODUCTION

Introduction to Climate Archives

We will be using climate archives here to investigate what the climate was like for the Maya at the end of the Classic period. Why the Maya Classic period ended has been debated a lot by archaeologists and earth scientists. To introduce yourself to climate archives and learn more about what they are and what types of questions they can help scientists answer, click the button below and play the climate game. Following playing the game, answer the questions below.

CLIMATE ARCHIVE GAME

Discussion Questions:

1. What are climate archives?
2. What is a speleothem and how do they grow?
3. What are two other examples of climate archives and how do they work?
4. Optional: Make a flow chart of the code for the coding game by analyzing how you think it works.

1. Climate Archive Matching Game

- Students are introduced to the concept of climate archives
- Matching game contains information on some of the most common archives
- Students answer questions following the game and can also choose to make a flow chart of the game code



Tree Rings

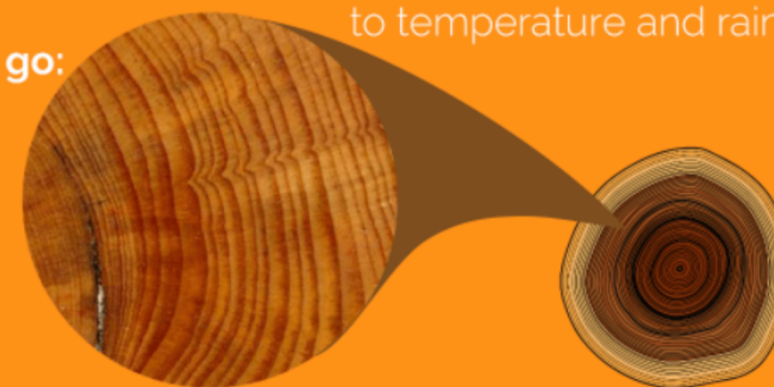
What they reveal:

Droughts
Volcanic eruptions
Hurricanes
Changing temperature
Rainfall

How far back they go: Up to 10,000 years

How they show it:

Examine the relative width of tree rings, each representing one year. Ring width shows how fast the tree grew, which is related to temperature and rainfall.



Click anywhere to continue

Code of the Game

- Game was made in NetsBlox with block-based coding
- Each tile is cloned then assigned a number which determines its state as it goes through
 - i.e. been flipped over once, never flipped, already matched
- Each tile also has a number indicating what its identity is
- The background changing is what shows and reveals facts

```
when clicked
  stop all but this script
  broadcast Welcome

when I receive Start!
  show
  if id > 1
    delete this clone
  set flips to 0
  set endgame to list 0 0 0 0 0 0
  initialize variables
  create a clone of myself

when I start as a clone
  change ind by 1
  set id to ind
  if id < 12
    create a clone of myself

go to x: (id - 1 mod 4) * size - 1.5 * size y:
  round (id - 1 / 4 - .3) * size - 1 * size

when I am clicked
  for i = 1 to length of matchedCostumeIDs
    if item i of matchedCostumeIDs contains costumeID
      set state to 1

  if state = 1
    set fact to costumeID
    broadcast Show Fact
  else
    if not item 1 of costumeList = costumeID and
       not length of costumeList = 2
      if costumeNo = 0
        switch to costume costumeID
        if length of costumeList < 2
          add costumeID to costumeList
          broadcast Match? and wait
      if costumeNo = 1
        script variables random location
        set location to pick random 1 to length of costumeNums
        set random to item location of costumeNums
        set costumeNo to random
        switch to costume costumeNo
        delete location of costumeNums
        if length of costumeList < 2
          add random to costumeList
          broadcast Match? and wait

  set flips to round flips
```

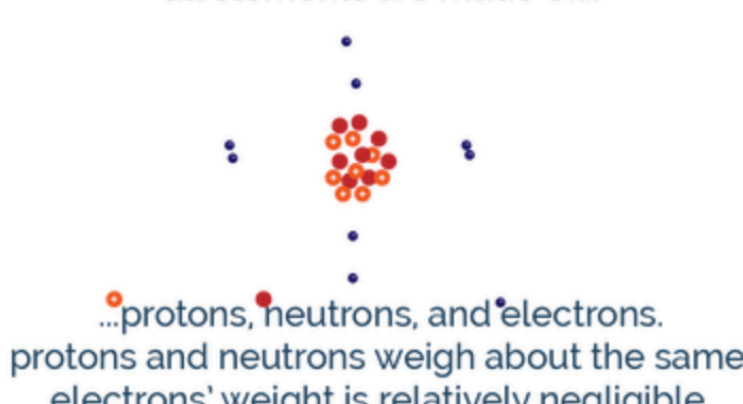
2. Students graph and analyze

- The students start out by reading background information
- They go through an activity where they graph data from a past study in excel
- In groups or individually they answer discussion questions

What is an oxygen isotope and why do they matter?

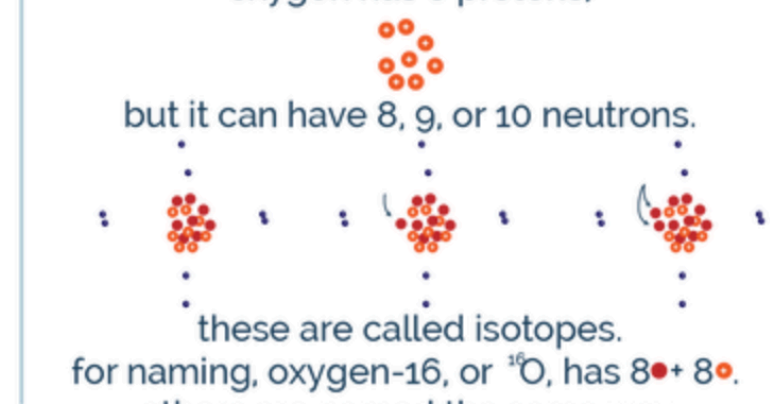
The two stable oxygen isotopes found in water are ^{18}O and ^{16}O . What this means is that they have 18 and 16 neutrons, respectively. Neutrons are relatively heavy in an atom, so the ^{18}O isotope is heavier than the ^{16}O isotope. It takes energy to energize water molecules to convert them from the liquid state to the vapor state. Because the ^{18}O isotopes are heavier, it takes more energy to convert them to the vapor state. So, when the $^{18}\text{O}/^{16}\text{O}$ ratio is high, there is more ^{18}O . This means that the precipitation is relatively higher because more ^{16}O would have gone away easier. See the graphic below for further explanation.

all elements are made of...




...protons, neutrons, and electrons.
protons and neutrons weigh about the same.
electrons' weight is relatively negligible.

oxygen has 8 protons,
but it can have 8, 9, or 10 neutrons.



these are called isotopes.
for naming, oxygen-16, or ^{16}O , has 8 + 8.
others are named the same way.

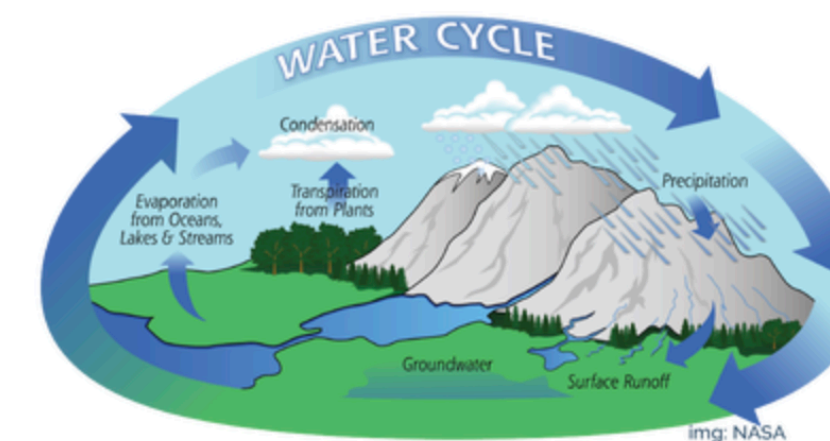
oxygen-16 is lighter than oxygen-18...



...because it has more neutrons.

evaporation and condensation affect oxygen-18:oxygen-16

evaporation:
oxygen-16 evaporates easier
because it is lighter, leaving
oxygen-18 on the ground. this
increases the ratio.

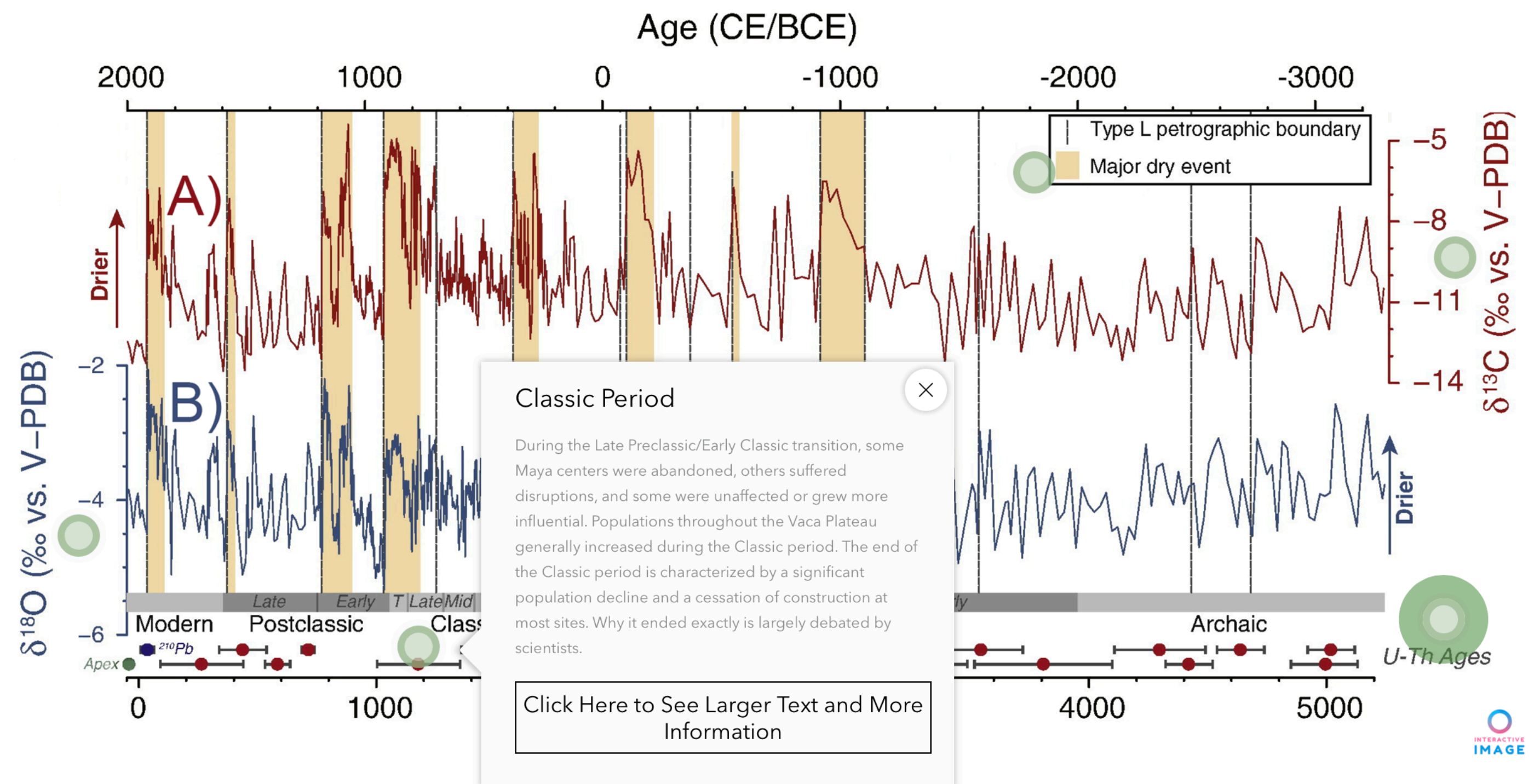


precipitation/condensation:
oxygen-18 condenses and falls
more readily, so when oxygen-18 is
all gone, the rain is oxygen-16 and
the clouds move. so, in the end
more oxygen-16 is on the ground,
and the ratio decreases.

3. Students compare to “another scientist”

- Begin by examining a graph from another study by reading annotations
- Students then graph both the data from their study and this one to examine for overlap
- Discussion questions from this section include ones leading to applications of how archives can be used to identify other climate events

Climate Proxy Records from the MCo1 Stalagmite



questions?