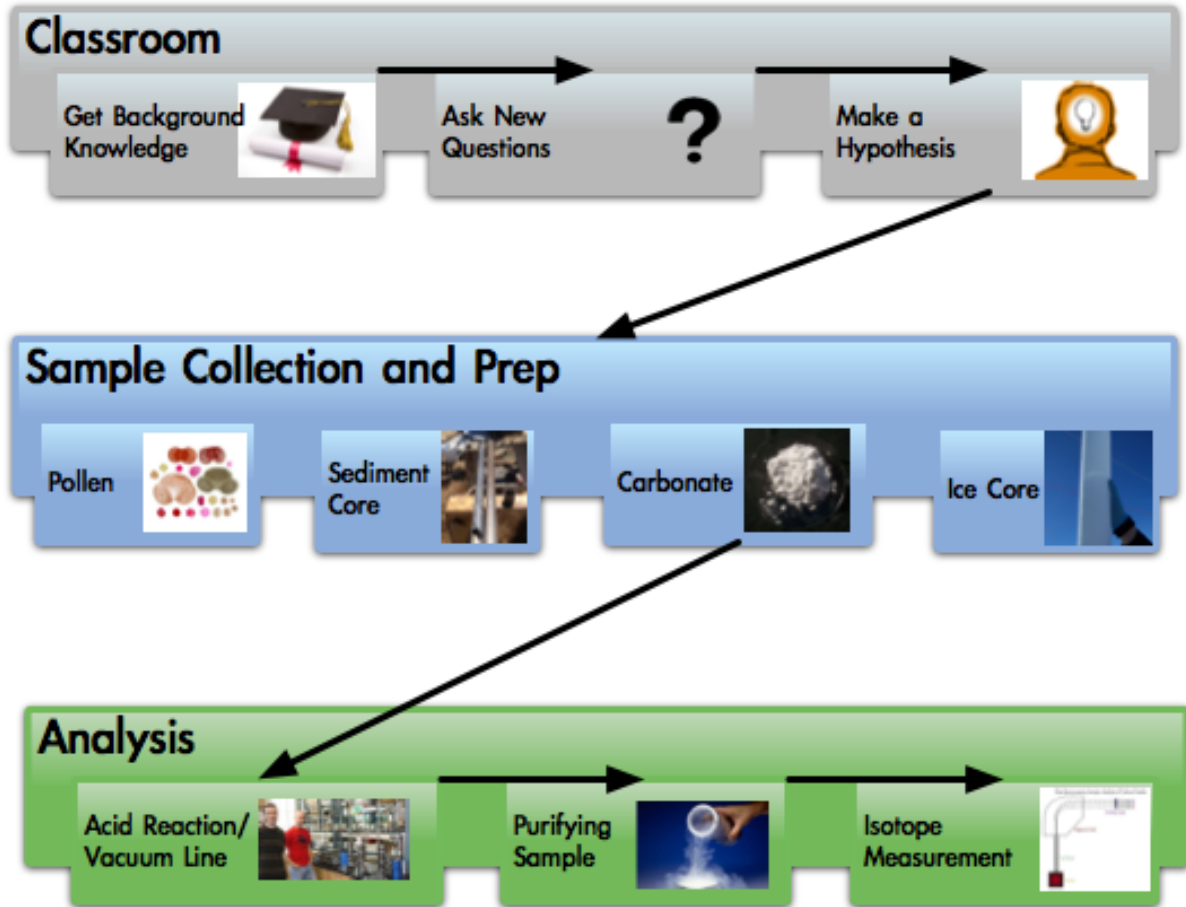

Paleoclimate Research

Field Trip to the Stable Isotopes Laboratory at University



of Washington

Workbook • Hosted by Dr. Katharine Huntington • December 2015

Classroom

Questions to consider before arrival:

1. What is the greenhouse effect?
2. What causes climate change (natural and human)?
3. Why is the study of paleoclimatology important?
4. Compare the Earth's age to the number of years of paleoclimate data on the Earth. What percent of the Earth's past climate has been studied or documented using proxies?
5. How are proxies used to reconstruct records of the past climate?
6. Why is climate change so controversial?
7. How has our local climate changed?
8. How does the rate of climate change vary with time?
9. Is there more climate change in some regions than others? Note a specific example.
10. What is the difference between climate and weather?

Classroom

Get Background Knowledge and perform the following activities:

Visit the NASA/UWHS Climate Science Page

<http://www.uwpcc.washington.edu/outreach/tertiary.jsp?entity=NASA&action=GetEntity&title=NASA/UWHS%20Climate%20Science>

and especially...Do the ICE CORE LAB!

<http://uwpcc.washington.edu/documents/PCC/uwhsicorelablessonplan.pdf>

Do the Volcano résumé writing and research activity:

<http://images.schoolinsites.com/SiSFiles/Schools/AL/LeeCountySchools/SanfordMiddle/Uploads/Forms/VolcanoResume%5B1%5D.pdf>

Do the Tree Rings: Living Records of Climate Activity:

<http://www3.epa.gov/climatechange/kids/documents/tree-rings.pdf>

http://eo.ucar.edu/educators/ClimateDiscovery/LIA_lesson5_9.28.05.pdf

Answer questions and read the article: **The Use of Carbonate
'Clumped Isotope' Thermometry to Quantify
Temperatures of Burial and Diagenesis from 0-200C**

<https://acswebcontent.acs.org/prfar/2011/media/huntington.html>

1. Who sponsored the article and research?
2. In paragraph one, what are the “sedimentary basins”? Explain sedimentary basins using your knowledge of the rock cycle. Draw a possible rock cycle to support your description of “sedimentary Basins”.
3. In paragraph two, shallow faults produce zones of crushed rock that cause fluids to do what?
4. What are quartz or calcite cements (described in paragraph two)?
5. In paragraph three, consider the sponsor of the article and explain why the author describes the Moab fault as a “productive basin in Utah”.
6. What causes isotopes to clump and what does the analysis of clumped isotopes reveal to researchers (described in paragraph three)?
7. Why do you think the author included the fourth paragraph in this article? Without the fourth paragraph, what information would be lost?
8. In paragraph six, what discovery is made using clumped isotope thermometry?
9. Who probably made the quote in paragraph seven?
10. What does it mean to “efficiently extract hydrocarbons”?
11. Describe in three sentences Dr. Katharine W. Huntington’s research.
12. Draw a flow-chart diagram from beginning to end of Dr. Katharine W. Huntington’s research.
13. What do you think would be a next step for her research?

Table of Contents



Planning

My Itinerary

Campus Map

College Tour

Lab Demonstration: Volcanoes and Climate

Question and Answer with college students

Sample Collection and Prep

Pollen Analysis

Ice Core

Sediment Core

Carbonate

Carbonate Analysis

Acid Reaction and CO₂ Transfer

Purifying Sample

Isotope Measurement

Planning

How will I know where to go?

MY ITINERARY★

Time	9:00	9:20	9:40	10:00	10:20	10:40	11:00	11:20	11:40	12:00
Activity										lunch
Room										HUB

Back on the bus at 12:50!!!



CAMPUS MAP

College Tour

Lab Demonstration: Volcanoes and Climate

What is it like to be a student here?

LAB DEMONSTRATION: VOLCANOES AND CLIMATE

1. What types of volcanoes tend to be the most explosive and why?

2. How do volcanoes increase and decrease temperature on earth? Give two examples.

College Tour

Lab Demonstration: Volcanoes and Climate
What is it like to be a student here?

QUESTION AND ANSWER WITH COLLEGE STUDENTS

1. Looking back, what were some of the greatest mistakes that you have been able to learn from?

2. What are similarities between high school and college?

Sample Collection and Prep

Where do the samples come from? What do they look like?



POLLEN ANALYSIS

221 Johnson Pollen Lab

Questions

1. What are two other types of proxy data used to reconstruct past climate conditions?
2. What are some of the limits to pollen analyses and understanding the past climate?



ICE CORE

303C Johnson, hallway outside freezer

In places where it stays cold all year round and the snow never gets a chance to melt, large glaciers and ice sheets form over time. We know that the deeper down in the ice you go, the older the ice is, and we can analyze the gas trapped in the little air bubbles and the ice itself to get information about climate.

Questions

1. What are sources of uncertainty in ice core data?
2. How do scientists work together in studying data from ice cores?
3. How do ice cores capture climate change?



SEDIMENT CORE

318 Johnson Erosion Lab

Sediment Cores are collected from the bottoms of lakes or oceans to analyze the information stored in the sediment. We know that the further down we go the older the material is, so we can use that to make a timeline and form conclusions about the data we collect, be that pollen data, carbonate data, or something different we find in the sediment.

Questions

1. What are some of the errors associated with using sediment cored to understand paleoclimate?
2. What depth were these sediments from? What was above this sediment?

CARBONATE

318 Johnson Erosion Lab

Carbonate can be collected in many ways because it is found in many things in the environment. Carbonate is in shells, can form on the bottoms of rocks, and can be collected from soils. No matter the source, you still need to collect enough sample for the next step, which is the acid reaction.

Questions

1. How are carbon isotopes used to deduce past climates?
2. How are oxygen isotopes used to deduce past climates?
3. What is the chemical name and symbols used for the white powder you were collecting?

Carbonate Analysis

How do we get data from dirt?

ACID REACTION AND CO₂ TRANSFER

303 Johnson, Stable Isotopes - Sample Prep Lab

Carbonate minerals grow in the environment, and their isotopes record climate. Our instruments can't measure isotopes in solid carbonate, so we have to turn samples into CO₂ gas to analyze. To do this, we react the carbonate with acid to release CO₂ that we can analyze on a mass spectrometer.

Vocabulary To Define and Draw

	Definition	Drawing
Vacuum:		
Air:		
Carbon Dioxide:		
Mass Spectrometer:		
Stable Isotopes:		
Carbonate Mineral:		
Dry Ice:		

Goal 1: React carbonate with acid to release the CO₂ gas

Draw the chemical reaction here:

Goal 2: Get the CO₂ out of the reaction vessel without contaminating it with air.

Goal 3: Transfer the CO₂ gas to a small tube that fits on the mass spectrometer to be measured for its stable isotopes.

Draw the atom and its stable isotope here:

Questions:

- I. How do you turn your carbonate mineral sample into CO₂ gas that you can measure?
- I. How do you make sure your sample of gas doesn't get mixed with the atmosphere gas?
2. What are the four most abundant atmospheric gases?

PURIFYING SAMPLE

317 Johnson

Tube	Did it freeze in:		What is the substance?
	Dry Ice	Liquid N ₂	
A			
B			
C			

Moving around Carbon Dioxide gas without letting it escape or get contaminated with air is not easy. We use the different freezing points of the materials to move and purify our samples. This activity is designed to help you understand how we do that.

Substance	Freezing Point
H ₂ O	0°C
CO ₂	-78.5°C



Liquid	Temperature	What would freeze at this temp?
ethanol/Dry Ice Slush (CO ₂)		
Liquid Nitrogen (N ₂)		

You will have 3 tubes. One is a tube of CO₂, one is water vapor, and the third is vacuumed empty. Use the information about freezing temperature below to deduce which tube contains which gas

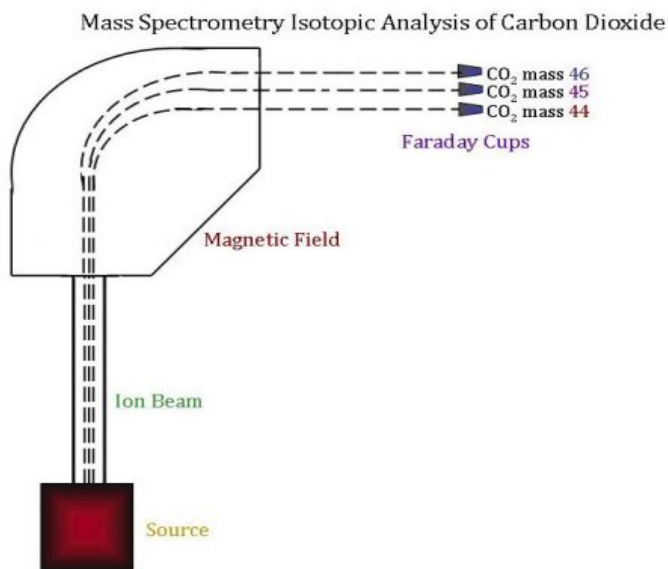
Questions

1. How did you know which tube was the CO₂?

ISOTOPE MEASUREMENT

302A Johnson, Stable Isotopes- Spectrometer Lab

This piece of equipment analyzes the gas we have collected to give us information about the isotopes. There is a direct relationship between isotopic levels and the temperature, so we can use the data from this machine to make conclusions about what the temperature was while each sample was forming. This combined with the knowledge of when the sample formed can allow us to build a picture of changes in climate over time.



Question

1. Draw Carbon Dioxide showing the electrons, bonds, and shape of the molecule.
2. Where did you obtain carbon dioxide for this sample?