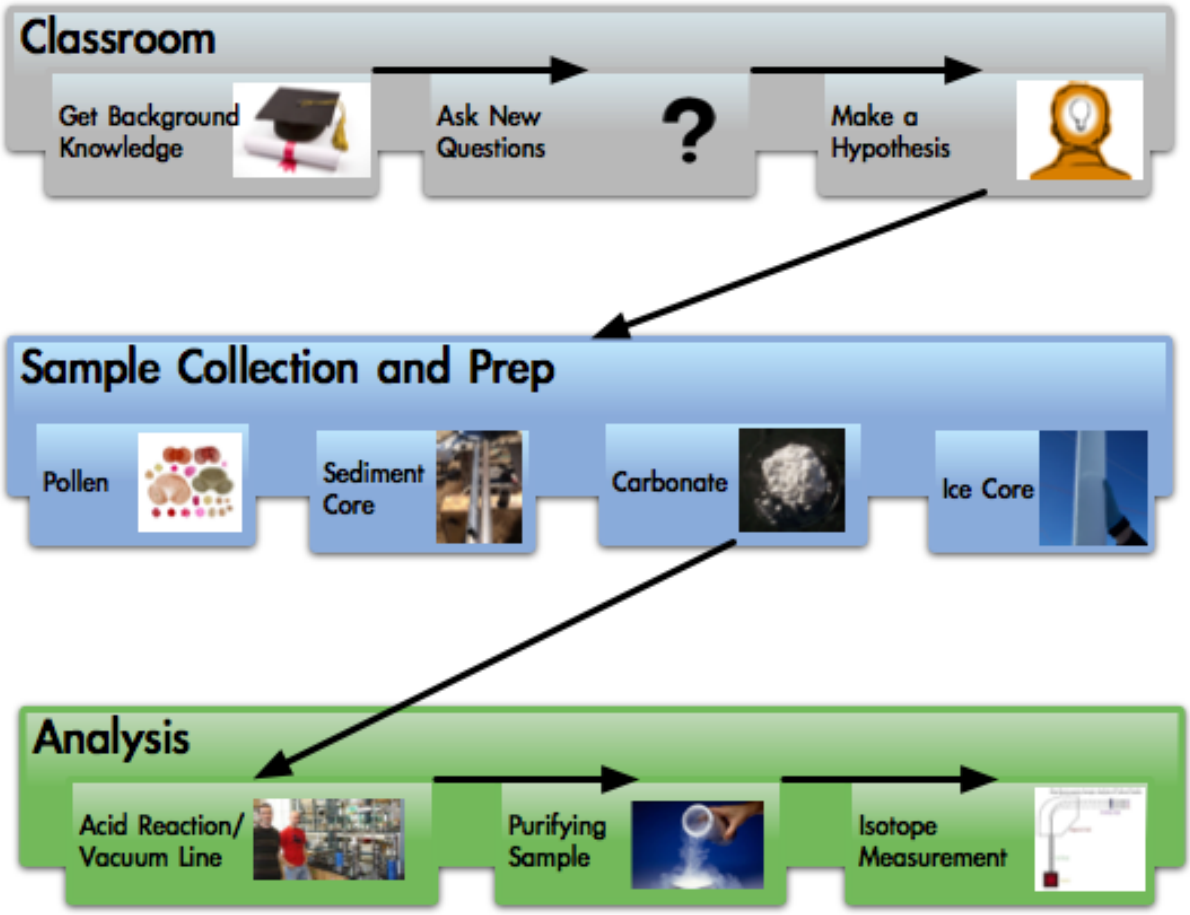
Paleoclimate Research

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/uwhsicecorelablessonplan.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?

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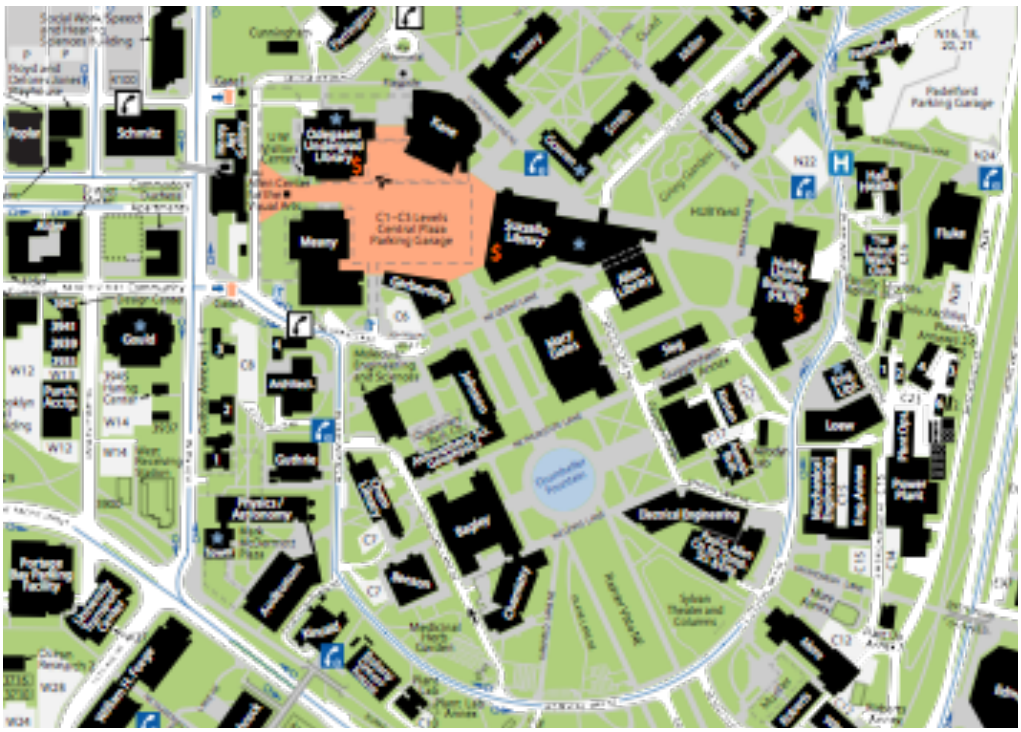
Planning

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!!!


Schmitz
Odegaard Undergraduate Library
C1–C3 Levels Central Plaza Parking Garage
Suzzallo Library
Allen Library
Mercer
Gerberding
Gould
Architecture
Physics / Astronomy
Electrical Engineering
Loew
Fluke
Padelford Parking Garage
Medicinal Herb Garden
Sylvan Theater and Columns
Drumheller Fountain

CAMPUS MAP

College Tour

Lab Demonstration: Volcanoes and Climate

What is it like to be a student here?

Lab Demonstration: Volcanoes and Climate

1. List three gasses given off by volcanoes and describe one effect of each gas.

2. What type of volcano is being modeled and list two real world examples of this volcano type?

College Tour

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

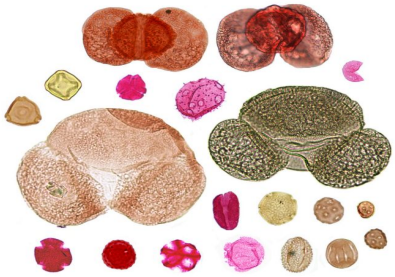
Question and Answer with college students

1. What are some of the newest ways of studying paleoclimate?

2. What was one struggle faced so far with college?

Sample Collection and Prep

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



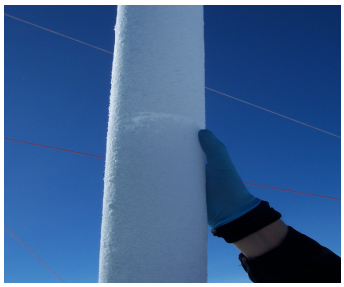
Pollen Analysis

221 Johnson Pollen Lab

Questions

1. What are proxy data?

2. How do scientists studying pollen from the past work together?



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 the bubbles in the core and how are the bubbles used?

2.What information do ice cores provide to scientists?

3. Draw a diagram showing the process of scientists extracting air from ice cores.

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.

1. Compare the ice core data to the sediment core data and explain specifically how far back in time both can be used as proxy data.

2. Is seismic data evident?

3. Are organisms present and what are they?

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 organisms used as proxies to understand the Earth's previous climate?

2. Summarize the variety of data and techniques used to reconstruct over two billion years of the Earth's climate.

3. Looking back over those two billion years was the Earth's climate warmer or colder than it is now?

Carbonate Analysis

How do we get data from dirt?

Acid Reaction and CO_2 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 CO_2 gas to analyze. To do this, we react the carbonate with acid to release CO_2 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 CO_2 gas

Draw the chemical reaction here:

Goal 2: Get the CO_2 out of the reaction vessel without contaminating it with air.

Goal 3: Transfer the CO_2 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:

1. How do you turn your carbonate mineral sample into CO_2 gas that you can measure?

2. How do you make sure your sample of gas doesn't get mixed with the atmosphere gas?

3. 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_2O	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 CO_2, one is water vapor, and the third is vacuumed empty. Use the information about freezing temperature below to deduce which tube contains which gas

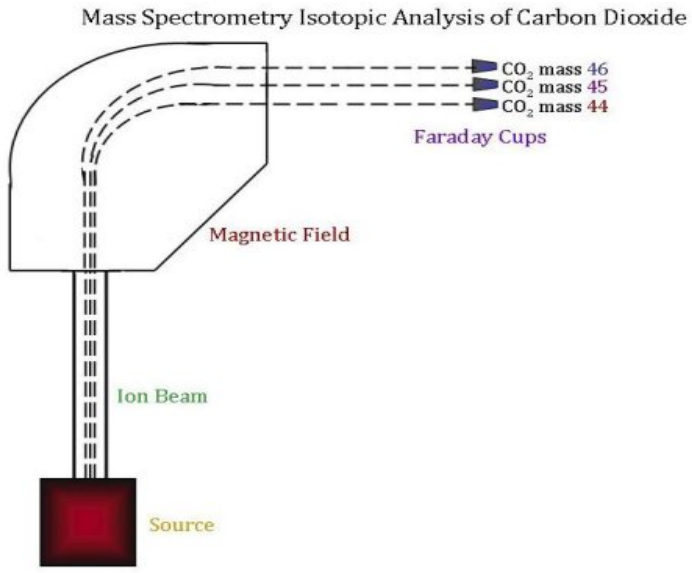
Questions

1. How did you know which tube was the CO_2?

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 whatt 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.



Questions

1. What was the instrument you used to measure isotopes?

2. Draw CO_2 46, CO_2 45, and CO_2 44.