# Developing Interactive Lectures

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# What Are “Interactive Lectures?”

## Traditional Class

- Passive students
- Quiet
- Instructor-focused
- Information from instructor-to-student
- Students work as individuals
- Competitive learning environment
- Limited assessment opportunities

## Active Learning Class

- Active students
- Noisy
- Student-focused
- Information from instructor-to-student, student-to-student, student-to-instructor
- Student collaboration
- Supportive learning environment
- Multiple assessment opportunities

http://serc.carleton.edu/introgeo/interactive/howto.html

# The Value of Interactive Lectures

Students taught key concepts using one of four methods.
Student learning assessed by proportion of correct answers to open ended questions on same concepts on final exam

| Teaching method | % correct answers |
|---|---|
| No demonstration | 61 |
| Observation of demonstration w/explanation | 70* |
| Prediction prior to demo with a conceptest | 77* |
| Prediction prior to demonstration using discussion & a later conceptest | 82* |

**n = 158-297; * = statistically significant result vs. no demonstration**

Crouch, C.H., Fagen, A.P., Callan, J.P., & Mazur, E., 2004. American Journal of Physics, v.72 #6, p. 835-838.

# Appropriate Learning Environment

## Interactive Lectures

- Pre-class preparation as homework or for reading quizzes
- Lecture broken into short segments, separated by assessments (called Interactive Lectures)
- Students work together in groups
- Formative exercises during class used to assess student understanding and progress

http://serc.carleton.edu/introgeo/interactive/whatis.html

McConnell, D.A., Steer, D.N., & Owens, K., 2003, Journal of Geoscience Education, v. 51, #2, p. 174-183.

# Interactive Lectures: A Caveat

- Interactive lectures can consume large amounts of class time (more than you might expect….)
- As a result, you might not be able to cover as much material
- Suggestion: Strive for less content but deeper understanding of the topics that are covered

# Interactive Lecture Techniques

- Think-pair-share/small group work
- Conceptests
- Predictive demonstrations
- Wall walk
- Working with real data
- Muddiest point exercise
- Other

Fill your toolbox!

# Think-Pair-Share

**Open-ended questions intended for small group discussion**

- Students individually consider a question related to a prediction, image or graph.
- Students write a response
- Short group discussion provides “low stakes” learning environment
- Instructor can listen to discussions and use to guide instruction

McConnell, D.A., Steer, D.N., & Owens, K., 2003, Journal of Geoscience Education, v. 51, #2, p. 174-183.

# Think-Pair-Share: An Example

Place the following events that were described in the earlier chapters of the book in the correct relative chronological order, from earliest to most recent.

A. Tsunami struck Japan.
B. Ice sheet was present in India (Pangaea).
C. Asteroid collided with Earth (Chicxulub).
D. Mount Pinatubo erupted in the Philippines.
E. Wegener developed the continental drift hypothesis.

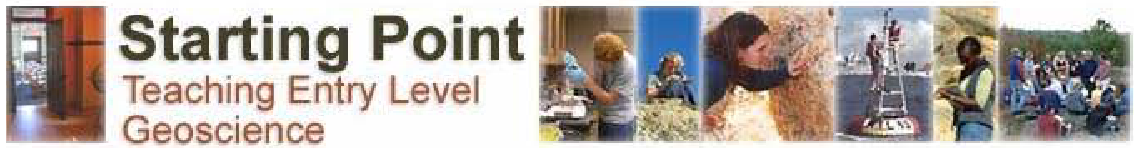
**Think-Pair Share:** http://serc.carleton.edu/introgeo/interactive/tpshare.html

# Think-Pair-Share: Try It

With a partner, construct a think-pair-share question covering one key concept in each of your disciplines that could be used in an introductory class.

# More Think-Pair-Share Info

[http://serc.carleton.edu/introgeo/interactive/tpshare.html](http://serc.carleton.edu/introgeo/interactive/tpshare.html)






## Think-Pair-Share

Ask your students to get together in pairs. If need be, have some of the students move. If you have an odd number of students, allow one group of three. It's important to have small groups so that each student can talk. Open-ended questions are more likely to generate more discussion.

1. Ask a question.
2. Give students a minute to two (longer for more complicated questions) to discuss the question and work out an answer.
3. Ask for responses from some or all of the pairs.

Examples of think-pair-share questions include:

- Describe and interpret the image.
- Before we start talking about global warming, have there been periods warmer than the present in the past? If so, when did such periods occur and what is the evidence? *After responses are collected, and possibly a short lecture on climate history:* How do we know what the climate was like before people started keeping track?
- From the data provided, what was the rate of the chemical reaction?
- What kinds of jobs do you think require people with knowledge of Calculus?

# Conceptests

## Multiple choice questions embedded in the lecture

- Focus attention on key concepts
- Frequently include peer instruction
- Formative exercises during class used to assess student <u>understanding and progress</u>

Frequently used with an electronic Personal Response System (PRS) “clicker”

http://serc.carleton.edu/sp/library/interactive/conctest.html

McConnell, D.A., Steer, D.N., & Owens, K., 2003, Journal of Geoscience Education, v. 51, #2, p. 174-183.

# Good Conceptests

- Focus on a single concept
- Do not require calculations
- Have good multiple-choice answers that include misconceptions
- Are clearly worded (short on text)
- Recast concept in a way not covered directly in lecture

**http://serc.carleton.edu/sp/library/interactive/conctest.html**

McConnell, D.A., Steer, D.N., & Owens, K., 2003, Journal of Geoscience Education, v. 51, #2, p. 174-183.

# Conceptests: An Example

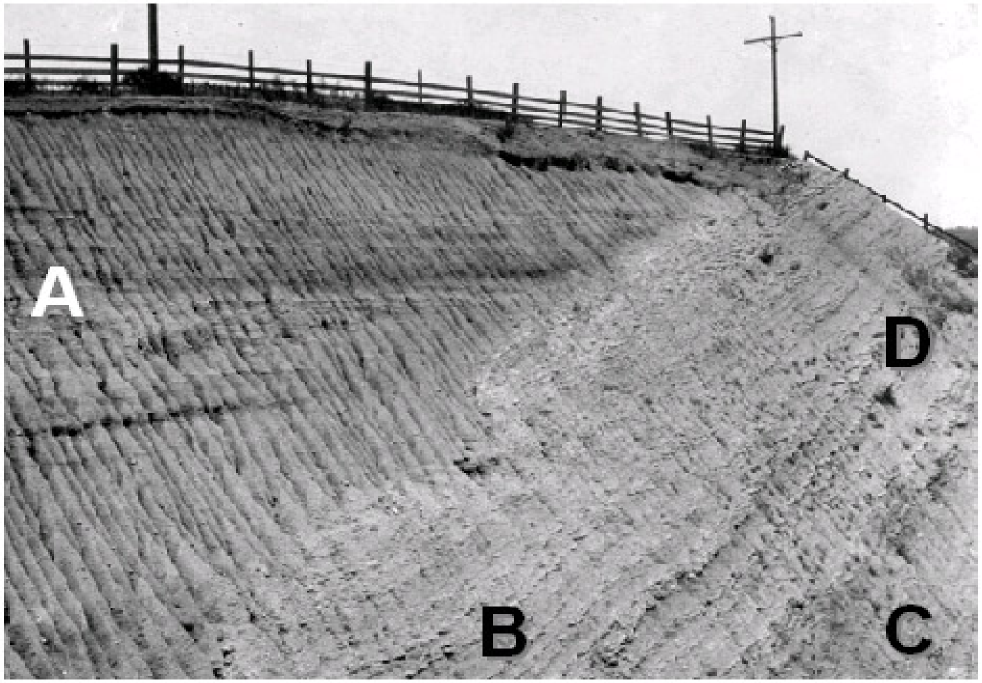
In what order were the layers formed (from oldest to youngest)?

A. C,D,B,A

B. C,B,D,A

C. B,C,D,A

D. B,C,D,A




Conceptest

http://serc.carleton.edu/introgeo/interactive/conctest.html

# Conceptests: Try it

With a partner, construct a conceptest covering one key concept in each of your disciplines that could be used in teaching an introductory class.

# More Conceptest Info

http://serc.carleton.edu/introgeo/interactive/conctest.html




## ConcepTests

ConcepTests are conceptual multiple-choice questions that were originally designed by Eric Mazur at Harvard University for students in large physics classes (Mazur, 1997 ; NSF, 1996 ). They:

- Focus on a single concept
- Can't be solved using equations
- Have good multiple-choice answers
- Are clearly worded
- Are of intermediate difficulty

Watch a 2-minute video clip of Eric Mazur using and discussing ConcepTests.

### Assessment with ConcepTests

ConcepTests are generally short, and as they are multiple-choice, they are useful for immediate quantitative assessment of student understanding. It may be useful to the instructor to know how many correct responses there are to a question both before and after peer instruction to better gauge student understanding. Read about different methods of collecting this feedback.

### Enhancing ConcepTests with Peer Instruction

ConcepTests can also be the basis of a group-reflective activity (especially if the students have trouble answering the initial ConcepTest).

Mazur, 1997 follows up every ConcepTest question with a think-pair-share activity (he refers to it as peer instruction) in which students then try and explain to a neighbor why they think that the answer they just gave is the correct one.

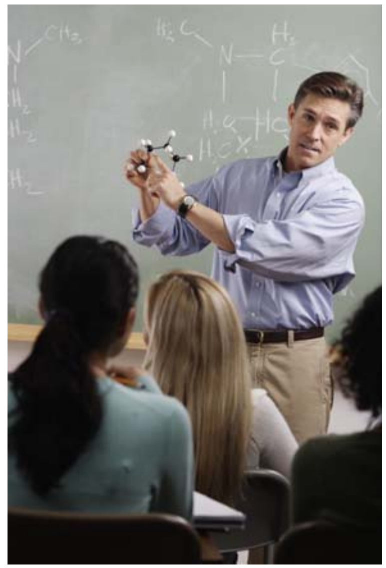
### Adjusting ConcepTests for Levels of Comprehension

Introductory science students may attempt to deal with the material by trying to simply memorize it. McConnell et al. (2003) suggest that ConcepTests should be additionally restricted to the level of comprehension or application in Bloom's taxonomy.

# Predictive Demonstrations

Normal demo:

- Show and tell
- Students observing but not necessarily engaged



Predictive demo:

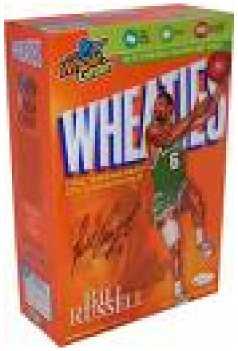
- Show don't tell, - students predict results
- Students active
- Student responses help address misconceptions

# Predictive Demos: Best Practices

- Relate to class topics
- Use common items to enhance student interest (esp. food)
- Can be used in large or small classes
- Can be used with think-pair-share
- Can be enlarged as a guided discovery lab
- "Showmanship" encouraged!

# Predictive Demos: An Example

- Iron in your cereal – see for yourself!



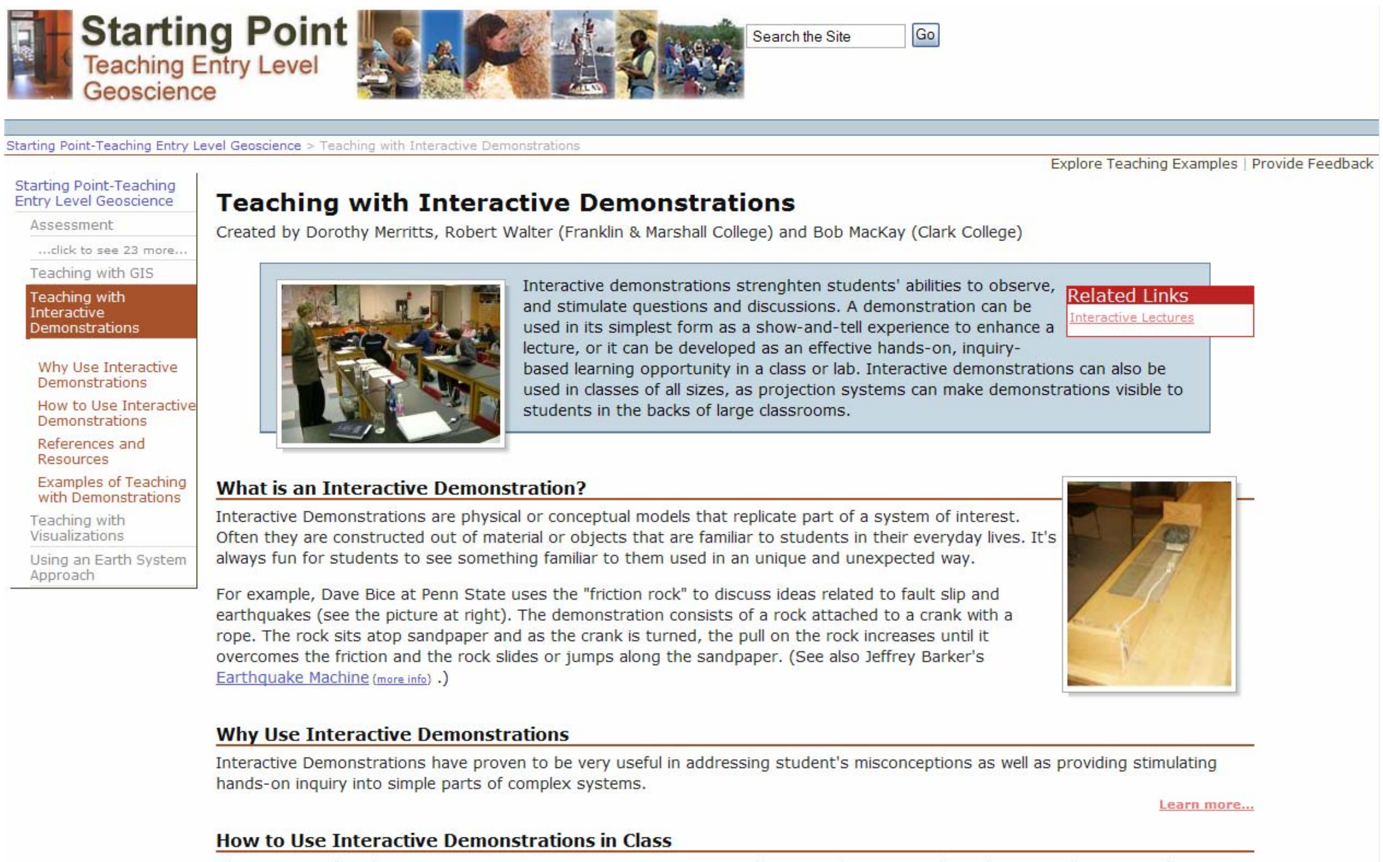

- Relates to acidity of your stomach and our crazy food system!

# Predictive Demo: Try it

With a partner, outline one predictive demonstration in each of your disciplines that could be used in an introductory class. Also, make a list of the equipment you would need.

# Predictive/Interactive Demo Info

http://serc.carleton.edu/introgeo/demonstrations/index.html



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Using an Earth System Approach

## Teaching with Interactive Demonstrations

Created by Dorothy Merritts, Robert Walter (Franklin & Marshall College) and Bob MacKay (Clark College)

Interactive demonstrations strenghten students' abilities to observe, and stimulate questions and discussions. A demonstration can be used in its simplest form as a show-and-tell experience to enhance a lecture, or it can be developed as an effective hands-on, inquiry-based learning opportunity in a class or lab. Interactive demonstrations can also be used in classes of all sizes, as projection systems can make demonstrations visible to students in the backs of large classrooms.

Related Links
Interactive Lectures

### What is an Interactive Demonstration?

Interactive Demonstrations are physical or conceptual models that replicate part of a system of interest. Often they are constructed out of material or objects that are familiar to students in their everyday lives. It's always fun for students to see something familiar to them used in an unique and unexpected way.

For example, Dave Bice at Penn State uses the "friction rock" to discuss ideas related to fault slip and earthquakes (see the picture at right). The demonstration consists of a rock attached to a crank with a rope. The rock sits atop sandpaper and as the crank is turned, the pull on the rock increases until it overcomes the friction and the rock slides or jumps along the sandpaper. (See also Jeffrey Barker's Earthquake Machine (more info) .)

### Why Use Interactive Demonstrations

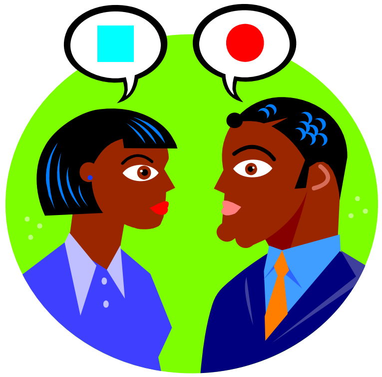
Interactive Demonstrations have proven to be very useful in addressing student's misconceptions as well as providing stimulating hands-on inquiry into simple parts of complex systems.

Learn more...

### How to Use Interactive Demonstrations in Class

# Wall Walk

- Used to stimulate class discussions
- On 4 walls of the class, place signs: Agree, Disagree, Strongly Agree, Strongly Disagree
- Establish rules (can change where you are standing, be courteous, raise hand, will be called upon, etc…)
- Project a (controversial) statement about a class topic



# Wall Walk: Best Practices

- Assign background readings about the topic beforehand
- Do not let students stand in the middle (make them "take a stand")
- Students will make assumptions about the statement
- Instructor serves only as moderator or to clarify misconceptions

# Wall Walk: Some Examples

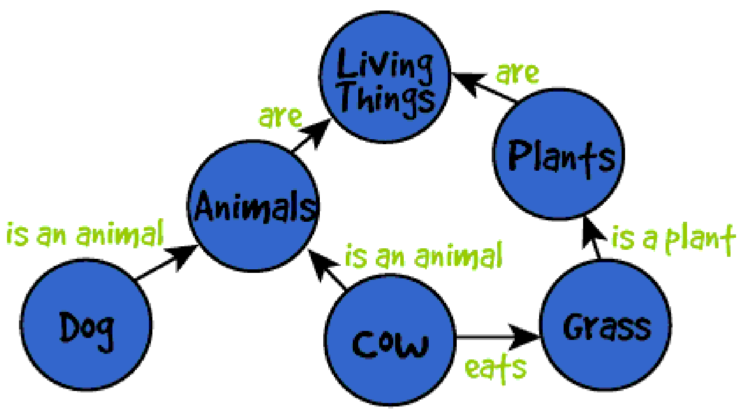
- It is a good idea to add iron to the ocean (or to our cereal) to reduce the atmosphere's greenhouse effect.
- Scientific theories are never that certain and so they should not be believed.
- We must limit the taking of fish from the ocean.
- Instead of dumping harmful pollution in the ocean, we should dump it on land.

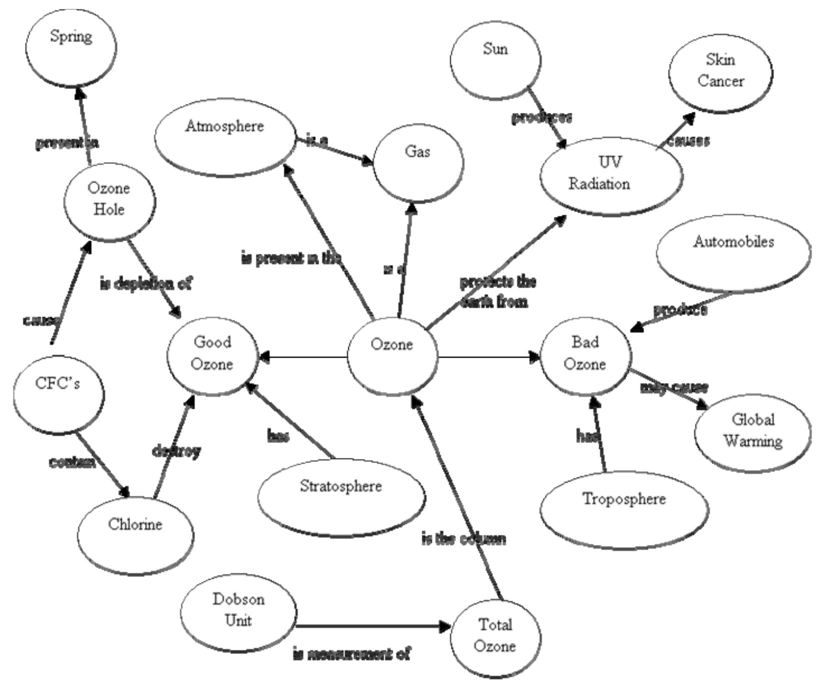
# Wall Walk: Try It

With a partner, outline one wall walk topic in each of your disciplines that could be used in an introductory class.

# Other: Concept Maps

•Show students an example of a concept map
•Have them develop their own for a particular topic
•Ask other students to grade them



# Working with Real Data

- Brings realism to your classroom
- Allows students to make their own observations and notice trends
- Make sure the data ties into classroom topics but isn't too complex
- Students have difficulty filtering data as scientists do

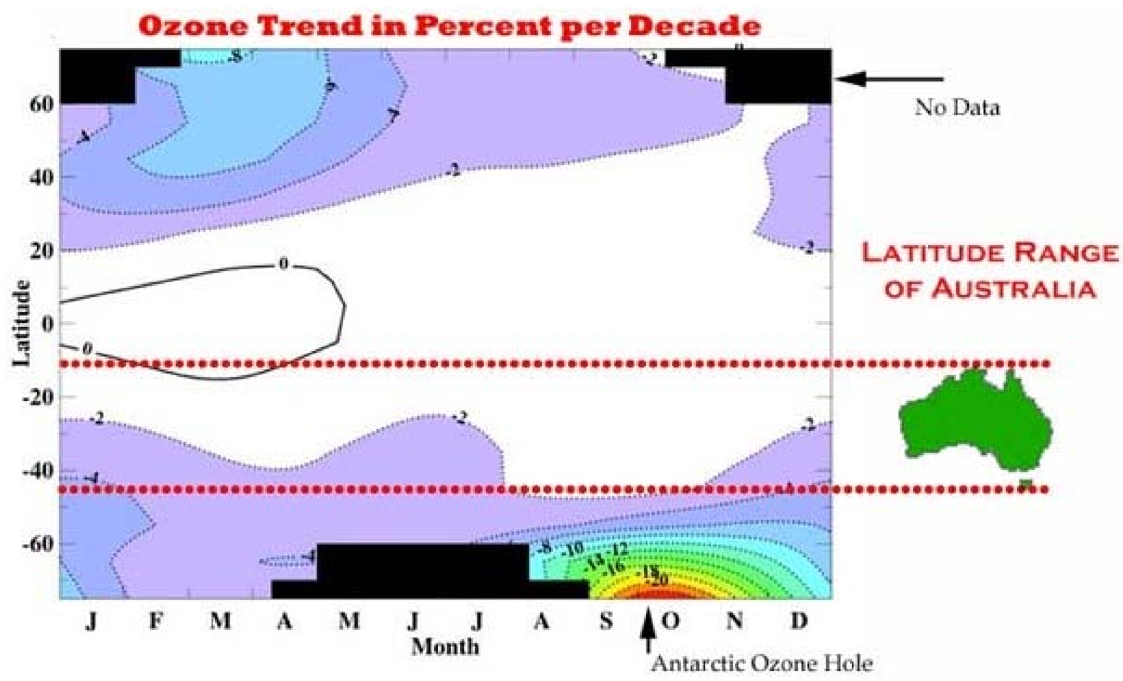
# Working with Real Data: An Example

## Q: Is the ozone hole really over Australia?

Satellite measurements

Trend calculation

Let's look at some real data and do real science…




Ref: Learning modules on ozone depletion: www.met.sjsu.edu/~cordero/education/

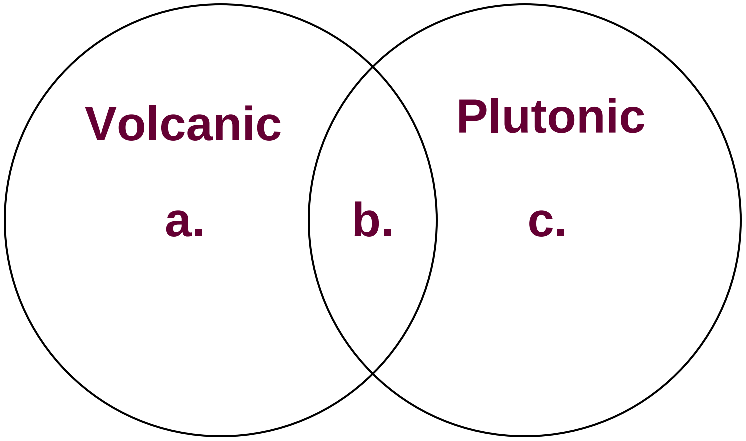
# Muddiest Point Exercise

**"What aspect of today's reading/class did you <u>least</u> understand?"**

- Promotes metacognition
- Involves students in their own learning
- Provides a low-stakes method of interacting with instructor
- Can show class-wide trends
- Makes a natural starting point for the next lecture

# Other: Venn Diagrams

Use the Venn diagram to answer the questions that follow.




| | | | |
|---|---|---|---|
| High silica rocks. | a. | b. | c. |
| Low silica rocks. | a. | b. | c. |
| Form deep in the earth. | a. | b. | c. |
| Form at the surface. | a. | b. | c. |
| Large-grained. | a. | b. | c. |
| Small-grained. | a. | b. | c. |

# Other: Question of the Day

Short activities for the beginning of class that engage students with the lecture material

- You are at the beach and notice that the tide has come in. Is this an observation, law, theory, or hypothesis?
- What would you do if you saw somebody throwing their cigarette our the window of a car in front of you?
- What are difference<u>s</u> between an island arc and a hotspot?

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END

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# Predictive Demos: An Example

- "Floatability" of diet Coke/regular Coke

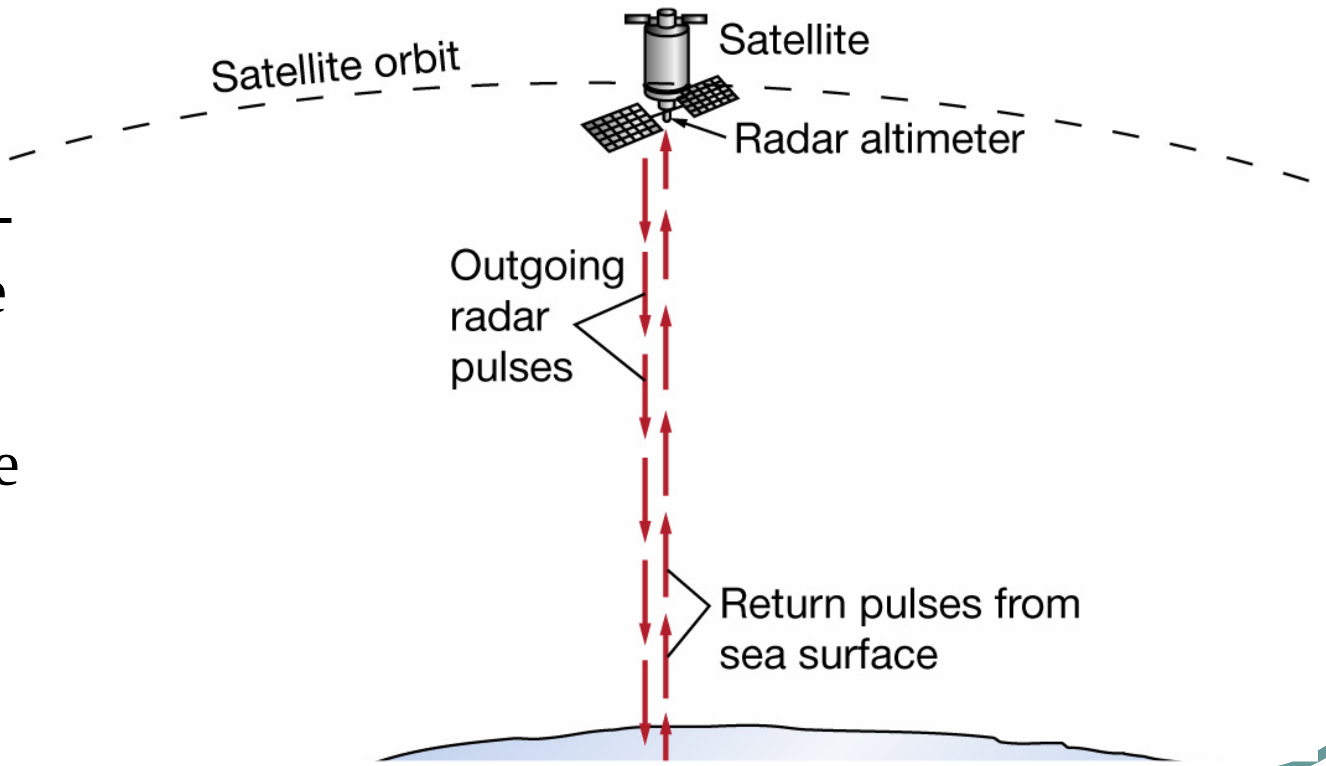

- Relates to how water masses are formed in the ocean

# Working with Real Data: An Example

## Q: Is sea level really level?

Measuring sea level from space: How the TOPEX-Poseidon satellite works ➔

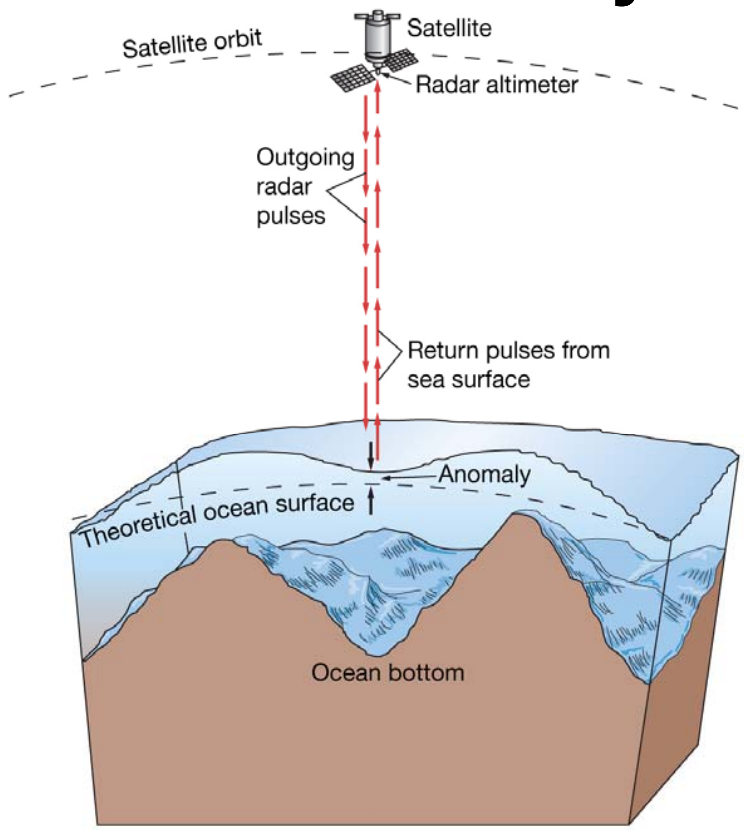
Let's look at some real data and do real science…




Ref: Maury Project: Sea Level Measurement, © American Meteorological Society

# Working with Real Data: An Example

**Q: Is sea level really level? NO!**




Note: it's the shape of the sea floor that affects sea level

Here's why:
**More mass = more gravity**

Shallow areas = more rock (less water) = more mass beneath = more gravity, so seawater piles up there

Ref: Trujillo and Thurman, *Essentials of Oceanography* 9E, © Pearson Ed., Fig. 3A, pg. 76

# Other: Evaluation Rubrics

Students analyze scenarios and recommend specific courses of action.

Q: Who gets earthquake preparedness funding?