

# How Do Scientists Conduct Research on Ancient Environments?

## Overview

In this activity, students sequence a series of captioned photographs to determine the scientific process of one scientist, Dr. Tracy Quan, as she uses deep sea core data obtained by the JOIDES Resolution research vessel to investigate the climate during the mass extinction that took place 66 million years ago. During the activity, students learn about specific data, tools, and techniques used to study the past. Then by comparing their pathway with others, they learn that science is a dynamic, non-linear, and creative process that can be conducted in different ways.



## Learning Objectives

1. Students will be able to explain one way in which deep sea cores are used in scientific investigations.
2. Students will be able to justify how scientific endeavors are dynamic, nonlinear, and based on the individual needs of the scientist and investigation.
3. Students will be able to explain how science is a human endeavor.
4. Students will be able to explain that science is tentative in nature and our knowledge changes as new information and processes are created.
5. Students will be able to explain that science is conducted various ways including testing of ideas, exploration and discovery, and community analysis and feedback.

## Science Standards:

- NGSS Earth and Space Science Disciplinary Core – touches on:
  - ESS2.A (Earth Materials and Systems), ESS2.D (Weather and Climate), ESS2.E (Biogeology): HS-ESS2-4, HS-ESS2-6, HS-ESS2-7
- NGSS Science and Engineering Practices:
  - Planning and Carrying Out Investigations; Obtaining, Evaluating, and Communicating Information
- NGSS Crosscutting Concepts:
  - Systems and System Models
- Connections to Engineering, Technology and Applications of Science:
  - Interdependence of Science, Engineering, and Technology
- Common Core Standards: RST.11-12.2, SL.11-12.5, MP.2
- National Science Education Content Standards:
  - Standard A: Science as Inquiry
  - Standard D: Earth and Space Science
- Ocean Literacy Essential Principles:
  - 3. The ocean is a major influence on weather and climate
  - 7. The ocean is largely unexplored



### Target Ages

Grades 9-12 and undergraduate

### Time

40-80 minutes

### Prerequisites

A prior knowledge of basic isotope chemistry or the nitrogen cycle may be beneficial for this lesson, but the lesson objectives can be accomplished without this background understanding.

### Materials

- A computer and projector to view the introductory video clip:  
[http://www.youtube.com/watch?v=eudbroUnSPs&list=UUomf\\_JKZQKV71PQBU3ODsQw&index=2&feature=plcp](http://www.youtube.com/watch?v=eudbroUnSPs&list=UUomf_JKZQKV71PQBU3ODsQw&index=2&feature=plcp)
- Pen or Pencil
- Writing paper
- A set of “How Do Scientists Conduct Research on Ancient Environments” printed cards and a large work surface or
- “How Do Scientists Conduct Research on Ancient Environments” digital file viewed on computer, tablet or other device. Note: One version of the slides is available in the correct order for the teacher labeled *Teacher-Ordered Slides*.
- The slide-description document for students
- A projector for students to present results of reordered slides in PowerPoint

### Background

The scientific process is often depicted and described as a linear set of steps. Somewhere on a wall in at least one of your classrooms was a colorful or dull poster of what scientists do, but is that what they really do? Do they really start with a problem or question to be answered? Do all scientists form a hypothesis, experiment with a control and variable, make observations, get data and write a nice conclusion? How scientists conduct their work has been labeled the process and nature of science. For more information on the how science works visit Understanding Science <http://undsci.berkeley.edu/>.

Science is a human endeavor, done by creative and hard working problem solvers. During this activity students “meet” Dr. Tracy Quan, who is a professor at Oklahoma State University studying paleoenvironment using deep sea ocean cores obtained through the International Ocean Discovery Program. Dr. Quan uses nitrogen isotope measurements from the cores to estimate the oxygen levels of past environments. One of her areas of research is to investigate how the nitrogen cycle changed as a result of the meteor impact 66 million years ago, at the end of the Cretaceous Period. This impact killed not only the dinosaurs, but 85% of all species that were alive in the Cretaceous period. These data points will help Dr. Quan make inferences about the environmental changes that took place during the mass extinction.

### Core Information

Take a look at the red arrow. It is pointing at the site where the *JOIDES Resolution* drilled a famous core off the coast of Northern Florida, the Blake Nose Core.

*How do the scientists choose where to drill?*

It takes teams of experts to select locations that are likely to have sediments that help to address scientific questions. Because the ocean floor changes with time, the current sea floor environment may have been different millions of years ago. Just think, around 200 million years ago there was one large land mass (Pangaea) and a very different ocean.

These cores are the archives halves from off the Southeast coast of the United States.

The purple arrow points at the section of the core that contains evidence of the bolide impact, an impact made by a 1-10km solid mass traveling faster than a speeding bullet. This is the classic Blake Nose Core. Finding this 66 million year old deposit serves as a 'book mark' for the end of the Cretaceous period, providing explicit evidence for the claim that a meteorite impact occurred at this time.



The time period when this event took place is called the Cretaceous-Paleogene (K-Pg) boundary. The sediment above and below the dark "glass bead" layer contain ocean sediment that existed before and after the impact. THIS IS THE CORE THAT MANY SCIENTISTS WANT TO RESEARCH TO INVESTIGATE THIS BIG MYSTERY!!

### Directions

1. Pre-activity: Introduce students to the *JOIDES Resolution* and ocean sediment cores using the *Core Information* and the introductory video clip: [http://www.youtube.com/watch?v=eudbroUnSPs&list=UUomf\\_JKZQKV71PQBU3ODsQw&index=2&feature=plcp](http://www.youtube.com/watch?v=eudbroUnSPs&list=UUomf_JKZQKV71PQBU3ODsQw&index=2&feature=plcp)
2. Organize students into 2 or 3 person groups.
3. Give each group a slide-description document and a set of either *ship* or *land* "How Do Scientists Conduct Research on Ancient Environments" cards or PowerPoint file. \*(Rearrange the cards/slides before you provide them to the students)\*
4. Groups examine each picture and corresponding description then sequence them to reflect how Dr. Tracy Quan conducted her work. Students record logical explanations for how they ordered Dr. Quan's work and explain how and why she conducted her work in the order proposed.
5. Have groups write and/or present their sequence and explanation to the class.

6. As a class, discuss the similarities and differences in the way the different groups interpreted how Dr. Quan conducted her research, and then discuss how science is a dynamic and non-linear process that involves creativity.

#### Ways to differentiate the lesson:

1. Have students put the pictures in order without the slide descriptions. Merge multiple (or all) *land* or *ship* groups together for comparison and discussion. If student groups are presenting the order of the slides, the differences and similarities between the groups can be shared with the class.
2. Merge one *land* with one *ship* group to view the entire process and share information in a small-group format.
3. If an interactive board is available, students can manipulate the slides in front of the classroom on the screen. Each group of students can move the slides and provide justifications for that ordering. Pictures can also be used in a four corner or carousel type of activity where the pictures are posted around the room on large pieces of white paper. Students can write their opinion about what and/or why the scientist is doing what they are doing in the picture. Students can walk around individually, in pairs or in groups. Each student/group can be given a different marker color so ideas can be easily represented for discussion and assessment purposes.

#### Useful links

Understanding Science- <http://undsci.berkeley.edu/>

JOIDES Resolution- <http://joidesresolution.org/>

For further learning, students can examine these informational videos:

<http://joidesresolution.org/node/777>

What happens to a core when it is on the ship floor?-<http://joidesresolution.org/node/777>

Animated overview of the deep sea drilling process -<http://joidesresolution.org/node/218>

What is life like living on board the deep sea drilling vessel, JOIDES Resolution?-

<http://joidesresolution.org/node/775>

#### Extensions

1. Dr. Quan says, "Science is like untying a knot, you have to work your way back from the present day data in order to find solutions to your problem." Give students a knot to untie and ask how this is similar to scientific processes.
2. The International Commission on Stratigraphy recently changed the age of the K-Pg boundary from 65.5 Million years ago to 66 Million years ago. Discuss how advances in analyses and the collection of new data lead to the refinement of geological ages.
3. Students can analyze the scientific processes that go into collection of radioactive carbon isotope data. They can compare the similarities and differences between the two processes- radioactive carbon isotope vs. Dr. Quan's nitrogen isotope collection methods.
4. Students can analyze how nitrogen isotope data may be collected from land sediments or ice cores.
5. Students can take pictures of their own scientific process in their science class, and explain why they did various processes in the order in which they did.

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