Examples of Lesson Plans to Meet NGSS and Common Core Challenges in Earth Science Education

Dr. Michael J Passow
Dwight Morrow High School
Englewood, NJ
michael@earth2class.org

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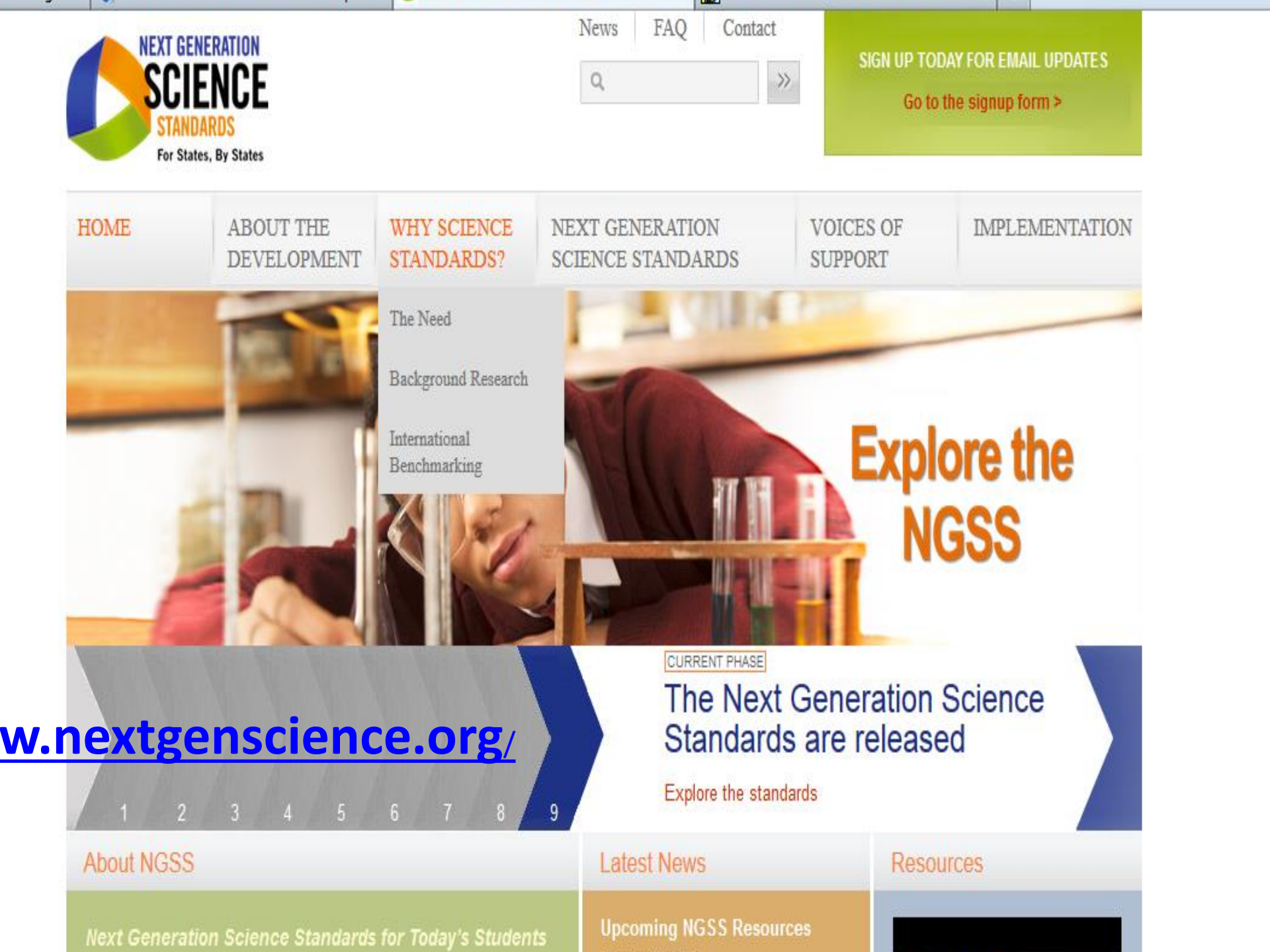
Next Generation Science Standards

- Based on National Research Council Framework for K-12 Science Education
- Joint effort between NRC, NSTA, AAAS, and Achieve to 'create the foundation for all students to have a solid K-12 science education'
- Created through collaborative, state-led process



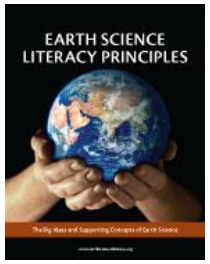
www.nextgenscience.org/

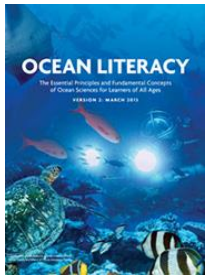
Implementing NGSS offers

Best opportunity to enhance ES instruction by focusing on “Big Ideas”

- Earth Science Literacy Principles
- Ocean Literacy
- Atmosphere Science Literacy
- Climate Literacy

Renewed focus on smaller set of key “Disciplinary Core Ideas”





NGSS also encourages

- integrating **Technology & Engineering Practices** into science courses
- emphasizing **crosscutting patterns**
- spotlighting the **Nature of Science**

- BUT curriculum choices must also take into account **State and Local Standards & Goals**
- and **teacher knowledge, skills, and interests**

Common Core ELA and Math

School districts in most states now focused on implementing "**Common Core Standards**"

ELA (English Language Arts)

Grades 6 – 12 Literacy in Science & Technical Subjects

http://www.corestandards.org/ELA-Literacy

Math

http://www.corestandards.org/Math

State standardized testing often based on these

Can be component of teacher evaluation system

Challenge for K – 12 Educators

Teachers are asking, "What do I have to do now?"

Is this a

Revolution/paradigm shift from current practice?

or an

Evolution to more effective practices?

Depends in part on where teacher is in the "**career continuum**" and **district PD support**

Proactive—What Could NGSS/Common Core Implemented Curriculum Materials Be?

- 3 'Prototypes' for Common Core/NGSS-based Curriculum Activities
- Supported by grant by Consortium for Ocean Leadership/International Ocean Discover Program (IODP)

- Developed through Earth2Class Workshops at the Lamont-Doherty Earth Observatory of Columbia University

www.earth2class.org

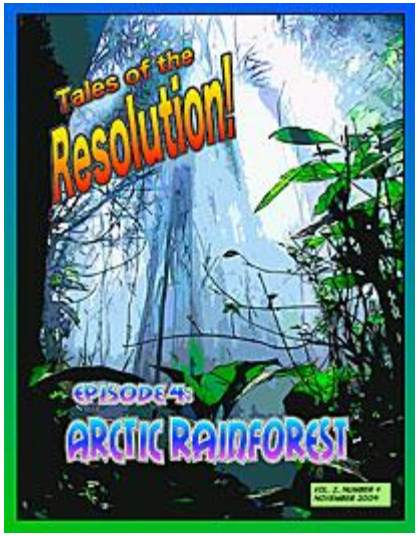
Addressing NGSS+ in curriculum design

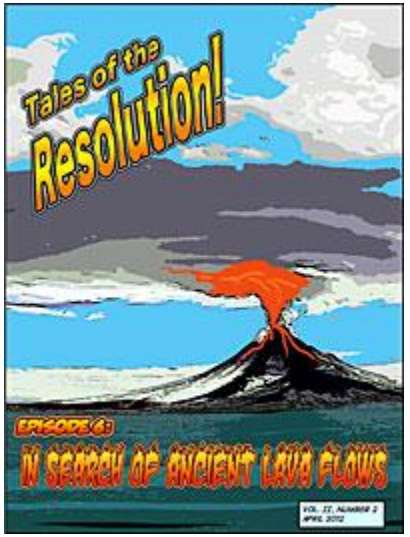
- Disciplinary Core Ideas
- Science and Engineering Practices
- Crosscutting Patterns
- Understanding the Nature of Science
- ELA and Math Common Core
- State Standards
- Local district needs
- Personal knowledge and teaching experience

Designed for Middle and High School

- Primarily aimed at Earth Science courses
- Could also be incorporated into Physics, Physical Science, Technology, English, Social Studies, or other classes
- Adaptable for 2- and 4-year college courses
- Draft versions available for comment

“Tales of the Resolution”





- TotR are a series of graphic novels created by Carl Brenner of the LDEO Borehole Group
  http://joidesresolution.org/node/263
- Integrates excitement of scientific discoveries and problem-solving in engineering practices with enjoyable reading style
- Less ‘threatening’ than traditional textbooks
- Activities support mastery of “College and Career Readiness Anchor Standards” identified in the Common Core ELA Standards in Science

Examples of Student Activities

- During its first 20 years of exploration, the JR made many discoveries. Some of these are described in "Treasure Chest of Cores" (http://joidesresolution.org/node/273).

Select one or more of these cores and explain their importance in deciphering Earth's history.

“Prepping for the Test” (especially for the NYS Regents Exam)

- Four steps in collecting seafloor materials include:

  (A) A mud or rock cylinder (core) fills the drill pipe in 9.5 m (30-ft.) sections
  (B) Cores are brought up to the ship and prepared for study.
  (C) Rotating cones on the bit rotate as the drill string rotates
  (D) The drill bit is lowered to the seafloor on the end of a drill string

  What sequence of letters represent the correct order of these steps?

  _____

- What kind of information can be discovered by borehole logging that adds to what is learned from the cores?

  (A) Identification of fish and other seafloor organisms
  (B) Measurements of earthquakes on the ocean floor
  (C) Physical characteristics of the sediments or rocks that were cored
  (D) Samples of the seawater for chemical testing in shipboard laboratories

Writing Across the Curriculum

- What are the three most important new scientific ideas you learned through these activities?

- Imagine you are writing a message to your Congressional Representative or Senator to explain the importance of funding scientific ocean drilling. What would be two essential points you would make?

Understanding the Nature of Science

- Imagine you have been selected to write blogs about the expedition.

A. What would you blog about the scientific activities taking place during this expedition?

B. What would you include in a blog about life aboard the “JR” during your non-working shift?

Episode 5 “Choose Your Own TotR! Jobs on the JR”

Imagine you are one of the people from the JR featured in this episode and have been invited to talk at a school like yours. Based on what you read in this episode and other knowledge, what would be your answers to these questions?

- Questions for the Scientist:
  What is your area of scientific expertise?
  Why is it helpful to have knowledge from many different subjects?

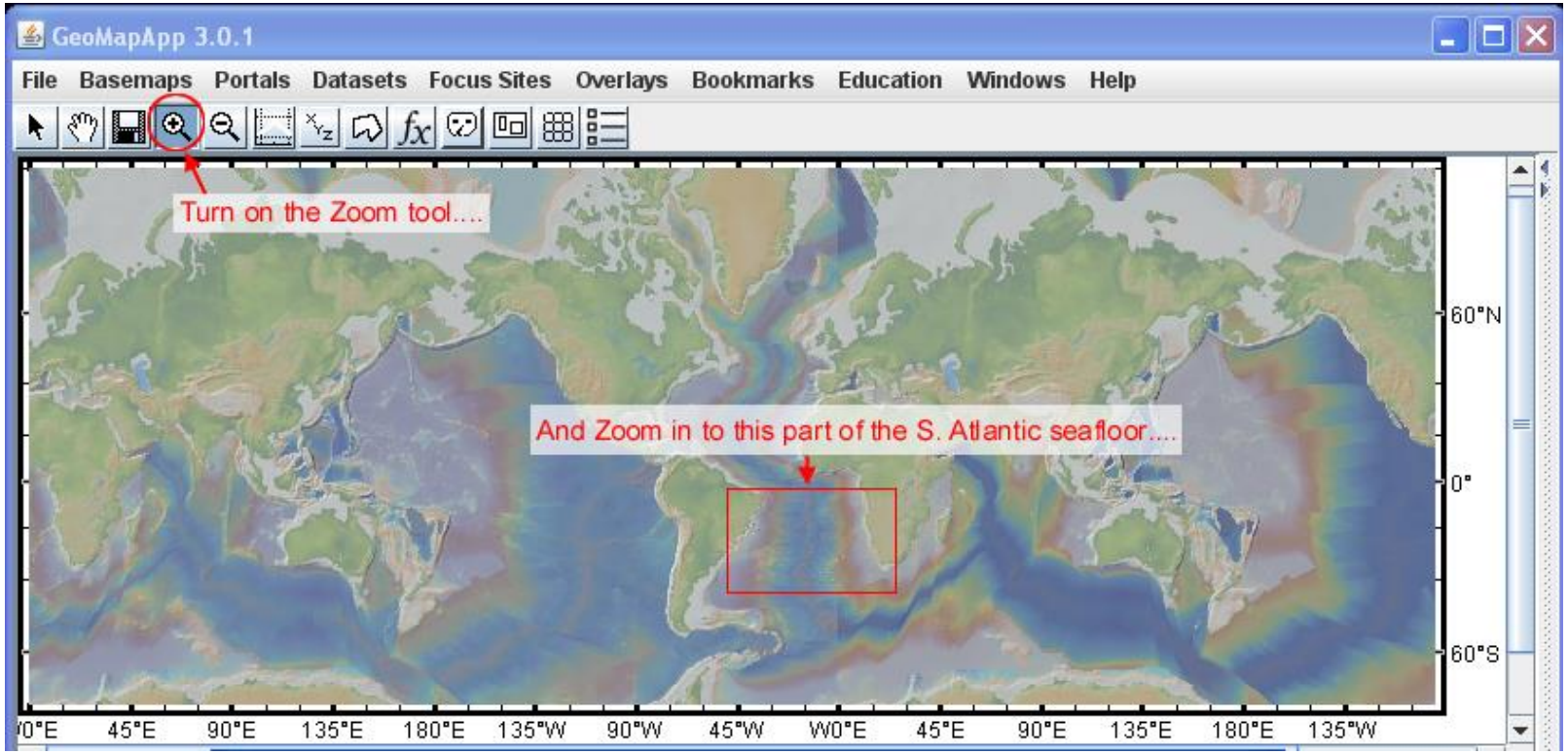
- Questions for the Welder:
  Where did you get the experience needed to land this job?
  How do you keep yourself safe when you are welding?

- Questions for the Engineer:
  What did you do before this that helped you do your job on the JR well?
  Why is it important to be very precise in your work?

“How Old Is the Ocean Floor? Discoveries from Scientific Ocean Drilling”

- Activities focus on observations and conclusions based on scientific ocean drilling
- Utilizes GeoMapApp (www.geomapapp.org)

Example of a GeoMapApp screen



Show Your Understanding

“Pre-” and “Post-test”

- What methods can we use to determine the age of rocks and sediments on the ocean floor?
- In general, which is older, the ocean floors or the continents ?
- How old are the oldest parts of the oceans, and where are they?
- Do all ocean regions have the same age and patterns?

Activity 1: What Age Patterns Are Observed in the Ocean Floors?

- Open GeoMapApp
- On the top menu bar, select “Basemaps” → “Global Grids” →“Seafloor Bedrock Age.”
- Explore the image by moving your mouse. On the top bar, numbers will show you the latitude, longitude, and age of the rocks at that location.

Activity 2: How Does Sea Floor Age Vary at Ocean Drilling Locations?

- Open “Portals” → “Ocean Floor Drilling.”
- Data layer shows locations (dots) where scientific drilling has taken place
- Also opens table with information about each drilling site
- Students select and compare locations in different parts of the ocean

Activity 3: How Old Are the Rocks in Your Hometown?

- Locate geologic maps to identify rock ages in your home area

- How old are the rocks where you live? Give both the geologic period and the approximate age (m.y.a. , millions of years ago).

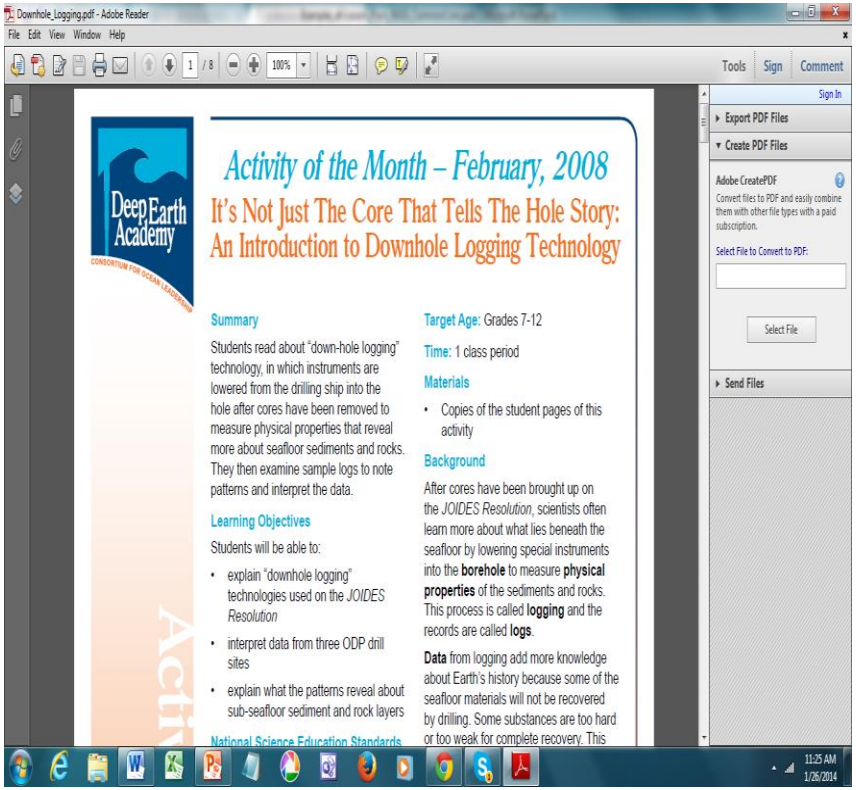
  Compare the age of the bedrocks where you live compare with the age of oldest and youngest sea floor rocks and sediments.

- Briefly describe the **range** of ages of the bedrocks in your state. That is, what are the oldest and youngest rocks?
  Compare the range of bedrock age in your state with the age range in the ocean floors.

"It's Not Just the Core that Tells the Hole Story: An Introduction to Downhole Logging Technology"

- Deep Earth Academy "Activity of the Month" (Feb 2008)
  Developed by Dr. Gilles Guerin and MJP

- Now incorporates NGSS-inspired enhancements



Science and Engineering Practices

- **Developing and Using Models**
- Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS1-1)

Student Page

Background

After cores have been brought up on the *JOIDES Resolution*, scientists often learn more about what lies beneath the seafloor by lowering special instruments into the **borehole** to measure **physical properties** of the sediments and rocks. This process is called **logging** and the records are called **logs**.

Data from logging add more knowledge about Earth's history because some of the seafloor materials will not be recovered by drilling. Some substances are too hard or too weak for complete recovery. This creates gaps in the core. But logs provide continuous records that give information about the missing layers.

Also, when the cores are brought to the surface, temperature and pressure conditions are very different from where materials originally lay, and so the cores may expand or be altered in the process. Logging measurements, by contrast, are made **in situ** (in the place where the layers are located), so they help correct core properties that were disturbed or changed.

Strings of instruments attached together are lowered by a wireline into the borehole to measure sediment and rock properties, as represented by Figure 1. This operation allows scientists to study such variables as **stratigraphy** (what kinds of rock

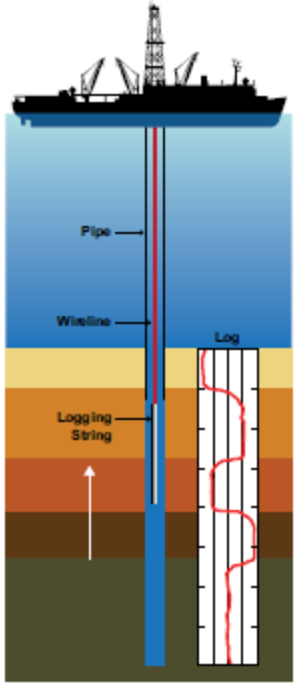


Figure 1. The "JOIDES Resolution" lowers a string of instruments to learn more about the sediment and rock layers of the ocean floor. As the instruments go across different layers, the physical properties measured (logs) change.

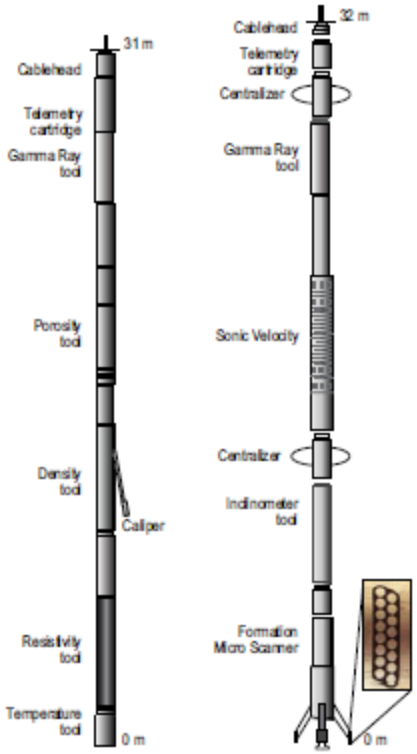


Figure 2. Logging string configurations.

You can not really make models of the instruments used to make the borehole geophysical measurements, but you can make a model to represent the string of instruments sent down.

- View the slideshow available at:

http://www.ldeo.columbia.edu/BRG/outreach/projects/index.html

(Scroll down to the "Logging 101" presentation.)

- After viewing the show, makes notes to answer the questions below:

What material(s) will you use to make your model? (Hints: cardboard, wood, plastic)
Which instruments are you going to include? How will you represent them?
How will you explain your model to others?

After final approval, teacher & student guides will be disseminated through

- Deep Earth Academy Educational Resources http://joidesresolution.org/
- Earth2Class workshops and website http://earth2class.org/site
- State, regional, and national science education conferences
- print and dvds

IODP
INTERNATIONAL OCEAN DISCOVERY PROGRAM

Conclusions

- Designing curriculum materials to address the power of the NGSS & Common Core will require considerable thought and effort
- Must satisfy many competing demands placed on 21st Century educators
- No “one-size-fits-all”
- Potential benefits to students and teachers will be worth it!

michael@earth2class.org