

POLAR SCIENCE and ENGINEERING: DRILLING BACK THROUGH TIME

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POLAR SCIENCE and ENGINEERING: Drilling Back Through Time

Teacher Notes: This activity is offered as a means of introducing students to the Scientific and Engineering Practices, as outlined in the *Next Generation Science Standards* (NGSS). Rather than having students simply memorize the list, developers envisioned the need to engage students in *using* several different practices in order to develop and defend their understanding of disciplinary core ideas, and to successfully achieve the related performance expectations. To do this, students must first be able to identify what the types of practices are and to distinguish similarities and differences between the actions of scientists and those of engineers. The *Drilling Back Through Time* activity offers students an opportunity to reflect on what they've learned and test their understanding of the practices in the context of a real world polar research project.

Educational research has shown that encouraging metacognition, or thinking about one's own thinking, is effective at promoting student understanding. *A Framework for K-12 Science Education* reinforces this idea, stating, "Our view is that the opportunity for students to learn the basic set of practices outlined in this chapter is also an opportunity to have them stand back and reflect on how these practices contribute to the accumulation of scientific knowledge (NRC, 2012)."

Key Concept: Scientists and engineers employ similar but different actions to achieve their target goals. Scientists ask questions that seek to create new knowledge about our natural world, while engineers address problems that can be solved by designing new technologies to address a human need. Greater success can be achieved when scientists and engineers employ teamwork, problem-solving and communication during a project's design.

Target Grade Levels: Middle and High School

Background: The West Antarctic Ice Sheet (**WAIS**) **Divide** research project completed its goal of drilling to just above the Antarctic bedrock during the 2011-2012 field season. This accomplishment set a new United States record for drilling depth and enabled scientists to access important paleo-climate evidence trapped in ice cores during the past 62,000 years. None of this would have been possible without the development of the Deep Ice Sheet Coring (DISC) drill by engineers, working in sync with ice core researchers' parameters. After years of development, the successful completion of a new DISC drill "replicate coring" system made it possible to get duplicate ice core samples from strategic depths/times in order to validate previous research findings and to enable further discoveries. This engineering breakthrough design was successfully utilized in the 2012/2013 field season.

Guidelines: Allow one to two class periods to complete this activity.

Materials: One activity page per student, access to the movie, *Polar Science and Engineering: Drilling Back Through Time* (www.youtube.com/user/USIceDrillingVideos), computers or iPads (optional).

Procedure: If this is the class's first exposure, divide your class into 8 teams, each assigned to research one of the Science and Engineering Practices. Half of each team should be responsible for the scientific side of each practice and half for understanding the engineering aspect. Point them to print or web resources, such as Bozeman Science's videos online at http://www.youtube.com/playlist?list=PLlIVwaZQkS2rtZG_L7ho89oFsaYL3kUWq.



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Allow fifteen minutes for individual research, then convene individual teams together to discuss their findings and generate a few examples of their assigned practice to share with the class. Conduct an all group discussion, recording all team's examples of science and engineering practices by category. The goal is to record a generic list of ideas that illuminate the way scientists and engineers work.

Next, challenge them to apply what they've learned to a specific polar research project that is looking at mysterious data surrounding the end of the last ice age. Their goal is to recognize and provide evidence of some of the practices they have just researched, in the context of this ice core project. You may want to run the movie twice - first, letting them absorb the story and then recording their observations of the practices on the student worksheet during the second viewing.

Standards: Next Generation Science Standards

- Science and Engineering Practices
- ETS 1 Engineering Design

Evaluation: The last page of this packet contains optional questions that encourage reflection and offer students a chance to write a brief summary of what they learned.

Extensions:

Teacher feedback indicated strong responses to the dialog aspect of this 18K story, as outlined in the related background presentation, *Polar Science and Engineering*, at: <http://www.climate-expeditions.org/educators/activities.html> Consider having your students develop scripts for this, or other scientific projects to act out for analysis by their peers.

Information on ice core-related expeditions, people and tools can be found at <http://www.icedrill.org>.

For additional movies depicting the science and technologies at WAIS Divide and other sites, please visit: <http://www.waisdivide.unh.edu/multimedia/video.shtml> and www.youtube.com/user/USIceDrillingVideos

References:

Next Generation Science Standards (NGSS). Available at: <http://www.nextgenscience.org/next-generation-science-standards>

National Research Council (NRC). 2012. A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. Washington DC: National Academies Press. p. 78

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POLAR SCIENCE and ENGINEERING: Drilling Back Through Time

Student Name: _____ **Class/Period:** _____

Your teacher has familiarized you with the typical practices used by scientists and engineers as they conduct their work. As you listen to the movie, check off any of the practices you hear discussed by either a scientist or engineer. Make a mental note of the description she/he offers. The more practices you identify (i.e. the more steps that get checked off down the column), the deeper you will drill and the more climate evidence you can retrieve. How far back in time can you go?

Scientific and Engineering Practices

- 1) Ask a question or define a problem
- 2) Develop and use a model
- 3) Plan and carry out an investigation
- 4) Analyze and interpret data
- 5) Use mathematics and computational thinking
- 6) Construct an explanation or design a solution
- 7) Engage in argument, using evidence
- 8) Obtain, evaluate and communicate information

WAIS Ice Core





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Student Name: _____ **Class/Period:** _____

- 1) The diagram below outlines three categories of activities done by scientists and engineers. Think back over what you heard, then write one *specific* example of an action from each of these spheres under the appropriate column. Describe each example briefly.

Three Spheres of Activities for Scientists and Engineers		
Investigating	Evaluating	Developing Explanations and Solutions
Activities: Ask Questions Observe, Experiment, Measure, Collect Data, Test Solutions	Activities: Argue, Critique, Analyze	Activities: Imagine, Reason, Calculate, Predict, Formulate Hypotheses, Propose Solutions
Example:	Example:	Example:

**Adapted from A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*

- 2) What *differences* were apparent, if any, between what a scientist might do compared to an engineer's actions during a research project?

- 3) What *similarities* did you observe between the practices of scientists and engineers?

- 4) Did you hear any of the practices discussed more than once? If yes, which one(s):

- 5) What is the outcome of a scientist's practices?

- 6) What is the outcome of an engineer's practices?