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Aegean and Black Sea 2006 Expedition

Wreck Dectectives

(adapted from the 2003 Steamship* Portland *Expedition)

Focus
Marine archaeology

Grade Level
5-6 (Physical Science)

Focus Question
How can marine archaeologists use archaeological data to draw inferences about shipwrecks?

Learning Objectives
Students will be able to use a grid system to document the location of artifacts recovered from a model shipwreck site.

Students will be able to use data about the location and types of artifacts recovered from a model shipwreck site to draw inferences about the sunken ship and the people who were aboard.

Students will be able to identify and explain types of evidence and expertise that can help verify the nature and historical content of artifacts recovered from shipwrecks.

Materials
- ❒ Modeling clay
- ❒ A variety of small objects with different shapes, including marbles, coins, metal washers, beads, cheap jewelry, etc.
- ❒ 40 cm x 80 cm plastic tub, disposable aluminum roasting pan, plastic shoe box, or aquarium; one for each student group
- ❒ Sand to make a 5 cm to 8 cm layer on the bottom of each container
- ❒ Water to fill containers
- ❒ Plastic knives, spoons, forks
- ❒ Graph paper
- ❒ Toothpicks
- ❒ String
- ❒ Pencil and paper

Audio/Visual Materials
- ❒ Marker board and markers or overhead projector and transparencies for group discussions

Teaching Time
One or two 45-minute class periods

Seating Arrangement
Groups of 2-4 students

Maximum Number of Students
30

Key Words
Marine archaeology
Shipwreck
Artifact
Bronze Age

Background Information
The geographic region surrounding the Aegean and Black Seas has been the stage for many spectacular performances in Earth's geologic and human history. Human activities on the region's stage began during Paleolithic times; artifacts discovered near Istanbul are believed to be at least 100,000 years old. Well-known Aegean cultures

include the Minoans (ca 2,600 – 1,450 BC), Mycenaeans (ca 1,600 – 1,100 BC), Ancient Greeks (776 – 323 BC), and Hellenistic Greeks (323 – 146 BC). Istanbul—"the only city that spans two continents"—has been a crossroads of travel and trade for more than 26 centuries. Mariners have traveled the Aegean and Black Seas since Neolithic ("Stone Age" times; 6,500 – 3,200 BC), probably for a combination of purposes, including trading, exploration, and warfare.

Interactions between these cultures and many others were often violent and destructive. So, too, were interactions with geological processes. One of the most dramatic and destructive events was the eruption of a volcano near a small Aegean island called Thera (also known as Santorini), sometime between 1,650 and 1,450 BC. Estimated to be four times more powerful than the Krakatoa volcano of 1883, the eruption left a crater 18 miles in diameter, spewed volcanic ash throughout the Eastern Mediterranean, and may have resulted in global climactic impacts. Accompanied by earthquakes and a tsunami, the volcano destroyed human settlements, fleets of ships, and may have contributed to the collapse of the Minoan civilization on the island of Crete, 110 km to the south.

Interactions with other geological processes may have been equally disastrous. In 1997, geologists William Ryan and Walter Pitman published a theory in which the Black Sea was inundated around 5,600 BC by flood waters from the Mediterranean passing through the Straits of Bosporus at Istanbul. Such a deluge, if it occurred, would have been disastrous for human settlements along the Black Sea shoreline and might have provided an origin for accounts of cataclysmic floods in Christianity and other cultures. Subsequent research has neither proved nor disproved the "Black Sea deluge theory," but in 2000, Robert Ballard discovered remains of a wooden structure that may have been part of an ancient seaport 95 meters below the surface of the Black Sea. This may be one of the best places in the world to look for remains of ancient civilizations, because the deep waters of the Black Sea contain almost no oxygen, so the biological organisms that normally attack such relicts cannot live in this environment. Additional support for the idea comes from radiocarbon dating of the shells of freshwater molluscs sampled at the "ancient shoreline" site. These analyses show the age of the freshwater molluscs to be about 7,500 years, while saltwater species from the same area appeared about 6,900 years ago. In other words, the transition from fresh to saline conditions was fairly rapid. More recent analyses of other data conclude that while this flood did occur, it was not as catastrophic as suggested by Ryan and Pitman, and a more severe flooding event took place 16,000 - 13,000 years ago (see http://gsa.confex.com/gsa/2003AM/finalprogram/abstract_58733.htm). Notwithstanding debate about the relative significance of ancient floods, the anoxic waters of the Black Sea may still reveal a great deal about seafaring activities of "Stone Age" peoples. Finding well-preserved marine archaeological sites, studying ancient maritime trade, and exploring the history of the Theran volcano are the primary goals of the Aegean and Black Sea 2006 Expedition.

In this activity, students will create their own versions of a Bronze Age shipwreck, explore and document each other's wreck site, and present their findings to other archaeological teams.

Learning Procedure

[Note: This activity is based in part on the "Lost at Sea: Sunken Slave Ship" activity from Newton's Apple episode 1502. You can access this activity from http://www.ktca.org/newtons/15/sunken.html.]

1. To prepare for this lesson, review the background essays for the Aegean and Black Sea 2006 Expedition at http://oceanexplorer.noaa.gov/explorations/06blacksea/. If students will not have

access to the internet for research, you will also need to download suitable materials, or confirm that such materials are available in libraries to which students have access.

2. Introduce the Aegean and Black Sea 2006 Expedition, emphasizing some of the reasons that scientists are interested in the Black Sea, and the probable existence of undiscovered marine archeological sites that could reveal a great deal about the history of the Aegean/ Black Sea area.

3. Tell students that their assignment is to create the story of a Bronze Age shipwreck that might be found in the Aegean or Black Sea. To do this, their first task is to learn about the types of artifacts that might be found on and around the site of such a shipwreck. There are many Web sites with information on Bronze Age society in the Aegean region, as well as on shipwrecks from the area (e.g., http://ina.tamu.edu/ub_main.htm, which documents the excavation of a Bronze Age shipwreck at Uluburun in southern Turkey). Potential artifacts that might be found include ship's equipment (anchors, oars, hull materials), beads, ceramics, ornaments, weapons, jewelry, tools, precious metals, cups, bowls, scarabs, and seals. Encourage students to think about the purpose of the ship's final voyage (trade, warfare, passenger transport, etc.) and about the lifestyles of the people who were on board.

4. Next, each student group should write a short (one to five paragraphs) story about the final voyage of their ship, describing at least five individuals who were on board, and what kinds of objects would have been associated with these people. Each group should collect a variety of objects to represent things that might have been aboard the ship and make a detailed list of their "artifacts," including size, shape, and material. Students should cover each of their artifacts with clay to model the encrustations marine archaeologists typically find on artifacts. Next, have each group cover the bottom of their container with a layer of sand, fill the container with water, and then arrange their artifacts in and under the sand. This arrangement should be based on some of the information included in their story.

   Remind students that the position of artifacts relative to each other often gives archaeologists important clues. For this reason, archaeologists investigating shipwreck sites often use a grid to help document where various artifacts are found. You may want to visit http://score.rims.k12.ca.us/activity/bubbles/ for more background information about archaeological investigations.

5. Have each group move to another team's site to explore and excavate their artifacts. At this point, be sure each team keeps their short story a secret. Students should use string tied to toothpicks to set up a grid in the sand around the site, diagram the grid on graph paper, and then record the location where each artifact is discovered. Students should also use a data log to record the location and description of each object as it is found. Using plastic utensils and water, encrustations should be carefully removed, and the results recorded in the data log. Each group should analyze their data and write a short (up to five paragraphs) story that is consistent with the location and types of artifacts found.

6. Have each group present their findings and analytical story. Based on this story, discuss what kinds of additional evidence and professional expertise might be useful to verify the nature and historical content of the artifacts found at the model shipwreck site. Then have the group that created the site read their own story. Discuss similarities and differences between the two stories. Would the additional evidence and expertise discussed earlier have led to the "true" story? Students should recognize that a variety of interpretations are often

possible for archaeological and other scientific data. Sometimes, even when a hypothesis, theory, or story fits all of the available facts, it can still fail to accurately tell what actually happened.

The Bridge Connection

http://www.vims.edu/bridge/archive1200.html/

The "Me" Connection

Have students write a short essay about how marine archaeological investigations might be important to their own lives.

Connections to Other Subjects

English/Language Arts, Social Studies

Assessment

Written reports and presentations prepared in Steps 4 and 6 provide opportunities for assessment.

Extensions

Have students visit http://oceanexplorer.noaa.gov/explorations/06blacksea to keep up to date with the latest Aegean and Black Sea 2006 Expedition discoveries.

Resources

NOAA Learning Objects

http://www.learningdemo.com/noaa/ – Click on the links to Lessons 1, 2, and 4 for interactive multimedia presentations and Learning Activities on Plate Tectonics, Mid-Ocean Ridges, and Subduction Zones.

Other Relevant Lessons from the Ocean Exploration Program

Looking for Clues

http://oceanexplorer.noaa.gov/explorations/04titanic/edu/media/Titanic04.Clues.pdf
(8 pages, 556k) (from the Titanic 2004 Expedition)

Focus: Marine archaeology of the Titanic

In this activity, students will be able to draw inferences about a shipwreck given information on the location and characteristics of artifacts from the wreck, and will list three processes that contribute to the Titanic's deterioration.

The Biggest Plates on Earth

http://www.oceanexplorer.noaa.gov/explorations/02fire/background/education/media/ring_big_plates_5_6.pdf (7 pages, 192k) (from the 2002 Submarine Ring of Fire Expedition)

Focus: Plate tectonics – movement of plates, results of plate movement, and magnetic anomalies at spreading centers.

In this activity, students will be able to describe the motion of tectonic plates and differentiate between three typical boundary types that occur between tectonic plates, infer what type of boundary exists between two tectonic plates, understand how magnetic anomalies provide a record of geologic history around spreading centers, infer the direction of motion between two tectonic plates given information on magnetic anomalies surrounding the spreading ridge between the plates, and describe plate boundaries and tectonic activity in the vicinity of the Juan de Fuca plate.

Unexplored!

http://www.oceanexplorer.noaa.gov/explorations/05fire/background/edu/media/rof05_unexplored.pdf
(7 pages, 724k) (from the New Zealand American Submarine Ring of Fire 2005 Expedition)

Focus: Scientific exploration of deep-sea volcanoes (Life Science/Physical Science/Earth Science)

Students will be able to compare and contrast submarine volcanoes at convergent and divergent plate boundaries; infer the kinds of living organisms that may be found around hydrothermal vents; describe three ways in which scientists may prepare

to explore areas that are practically unknown; and explain two types of primary production that may be important to biological communities around hydrothermal vents in the Mariana Arc.

Other Resources and Links

http://oceanexplorer.noaa.gov/explorations/06blacksea – Web site for the Aegean and Black Sea 2006 Expedition

http://www.immersionpresents.org/ – Immersion Presents Web site; click on "Ancient Eruptions!" for more information about the Aegean and Black Sea 2006 Expedition, images, and educational activities

http://www.ngdc.noaa.gov/paleo/ctl/clihis10k.html –Timeline for last 10,000 years from NOAA's Paleoclimatology Web site

http://pubs.usgs.gov/pdf/planet.html – "This Dynamic Planet," map and explanatory text showing Earth's physiographic features, plate movements, and locations of volcanoes, earthquakes, and impact craters

http://disc.gsfc.nasa.gov/oceancolor/scifocus/oceanColor/dead_zones.shtml – Web page from NASA about "Creeping Dead Zones," including SeaWIFS satellite imagery

http://news.nationalgeographic.com/news/2000/12/122800blacksea.html – National Geographic Web site, "Ballard Finds Traces of Ancient Habitation Beneath Black Sea"

http://blacksea.orlyonok.ru/blacksea.shtml – Web site of the Living Black Sea Marine Environmental Education Program in the Russian Federal Children Center Orlyonok

Friedrich, W. L.. 2000. Fire in the Sea. The Santorini Volcano: Natural History and the Legend of Atlantis. Translated by Alexander R. McBirney. Cambridge University Press. 258 pp.

Ryan, W. and W. Pitman. 1999. Noah's Flood: The New Scientific Discoveries About the Event That Changed History. Simon and Schuster. New York.

Yanko-Hombach, V. 2003. "Noah's Flood" and the late quaternary history of the Black Sea and its adjacent basins: A critical overview of the flood hypotheses. Paper presented at the Geological Society of America Annual Meeting, November 2–5, 2003, Seattle, WA (abstract available online at http://gsa.confex.com/gsa/2003AM/finalprogram/abstract_58733.htm).

http://ina.tamu.edu/ub_main.htm – Web site with information about the excavation of a Bronze Age shipwreck at Uluburun, Turkey

http://projectsx.dartmouth.edu/history/bronze_age/ – Dartmouth University Web site, "Prehistoric Archaeology of the Aegean," with texts, links to other online resources, and numerous bibliographic references

http://www.gomr.mms.gov/homepg/lagniapp/shipwreck/ – US Department of the Interior Minerals Management Service publication, "Historic Shipwrecks of the Gulf of Mexico: A Teacher's Resource"

National Science Education Standards

Content Standard A: Science As Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Content Standard B: Physical Science

- Properties and changes of properties in matter
- Motions and forces
- Transfer of energy

Content Standard D: Earth and Space Science

- Energy in the Earth system

Content Standard E: Science and Technology

- Abilities of technological design
- Understandings about science and technology

Content Standard F: Science in Personal and Social Perspectives

- Natural hazards
- Risks and benefits
- Science and technology in society

Content Standard G: History and Nature of Science

- Nature of science

Ocean Literacy Essential Principles and Fundamental Concepts

Essential Principle 2.

The ocean and life in the ocean shape the features of the Earth.

- *Fundamental Concept b.* Sea level changes over time have expanded and contracted continental shelves, created and destroyed inland seas, and shaped the surface of land.
- *Fundamental Concept e.* Tectonic activity, sea level changes, and force of waves influence the physical structure and landforms of the coast.

Essential Principle 6.

The ocean and humans are inextricably interconnected.

- *Fundamental Concept a.* The ocean affects every human life. It supplies freshwater (most rain comes from the ocean) and nearly all Earth's oxygen. It moderates the Earth's climate, influences our weather, and affects human health.
- *Fundamental Concept b.* From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation's economy, serves as a highway for transportation of goods and people, and plays a role in national security.
- *Fundamental Concept c.* The ocean is a source of inspiration, recreation, rejuvenation and discovery. It is also an important element in the heritage of many cultures.
- *Fundamental Concept f.* Coastal regions are susceptible to natural hazards (such as tsunamis, hurricanes, cyclones, sea level change, and storm surges).
- *Fundamental Concept g.* Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Essential Principle 7.

The ocean is largely unexplored.

- *Fundamental Concept a.* The ocean is the last and largest unexplored place on Earth—less than 5% of it has been explored. This is the great frontier for the next generation's explorers and researchers, where they will find great opportunities for inquiry and investigation.
- *Fundamental Concept b.* Understanding the ocean is more than a matter of curiosity. Exploration, inquiry and study are required to better understand ocean systems and processes.
- *Fundamental Concept d.* New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.
- *Fundamental Concept f.* Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, and physicists, and new ways of thinking.

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