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Students will be able to identify and explain types of evidence and expertise that can help verify the nature and historical content of artifacts recovered from shipwrecks.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.
cu/activity/bubbles/ for more background informa-
tion 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 arti-
facts found.

6. Have each group present their findings and
analytical story. Based on this story, discuss
what kinds of additional evidence and profes-
sional 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 recog-
nize 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
(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.htm – Timeline for last 10,000 years from NOAA’s Paleoclimatology Web site


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

http://projectx.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


**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.
Send Us Your Feedback
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Acknowledgements
This lesson plan was produced by Mel Goodwin, PhD, The Harmony Project, Charleston, SC for the National Oceanic and Atmospheric Administration. If reproducing this lesson, please cite NOAA as the source, and provide the following URL: http://oceanexplorer.noaa.gov