

Paleo-Diving

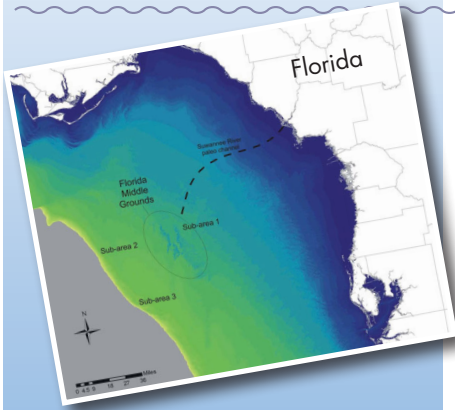


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Lesson Plan

Focus

Underwater archaeology of sinkholes

Grade Level

7-8 (Earth Science/Archaeology)

Focus Question

Why are sinkholes in Florida often associated with paleoamerican settlements, and how are they studied by archaeologists?

Learning Objectives

- Students will be able to explain how sinkholes are formed.
- Students will be able to infer and explain why sinkholes may be associated with paleoamerican settlements.
- Students will be able to describe how artifacts retrieved from sinkholes may be interpreted.

Materials

- Copies of *Paleoamerica Archaeology Inquiry Guide*, one copy for each student or student group

Audio-Visual Materials

- None

Teaching Time

One or two 45-minute class periods, plus time for student research

Seating Arrangement

Classroom style, or groups of 2-4 students

Maximum Number of Students

32

Key Words

Paleoamerican
Sinkhole
Pleistocene Epoch
Sloth Hole
Little Salt Spring
Page-Ladson

Background Information

NOTE: Explanations and procedures in this lesson are written at a level appropriate to professional educators. In presenting and discussing this material with students, educators may need to adapt the language and instructional approach to styles that are best suited to specific student groups.

Recent archaeological and molecular genetic evidence (Goebel, *et al.*, 2008) indicates that the first humans to inhabit North America migrated from Siberia around 15,000 years ago, near the end of the Pleistocene Epoch. These migrants are believed to have crossed a land bridge to the Pacific coast of North America, and continued southward, possibly using boats. Some of their descendants spread across what is today the United States, while others continued southward into South America. An important characteristic of these first Americans is that they used thrusting spears tipped with specialized stone points, and were very successful hunters. At this time, North America was inhabited by many large mammals that are now extinct, including mammoths, bison, short-faced bears, giant sloths, and sabre-toothed cats.

Some of the oldest archaeological sites discovered in North America are in the eastern United States, and there are numerous quarry-campsites in the southeastern states. Quarries are locations where raw rock material was mined and processed to make tools. If a reliable source of water is nearby (or was nearby during late Pleistocene times), residential sites are often found near the quarry. When the first humans arrived in Florida, sea level was much lower and there was more than twice as much dry land as exists today. The climate was considerably drier, and water was scarce. Not surprisingly, early American settlements that have been discovered in the state are almost always associated with a reliable water supply such as rivers and springs. These areas would also have been attractive to animals, increasing the likelihood that human hunters would be able to find food.

Limestone bedrock that underlies the Florida peninsula strongly influences the state's landscape. Limestone dissolves in acidic solutions, and over time has been sculpted by rainwater which is weakly acidic. This sculpting includes the formation of underground caves. When the roof of a cave becomes unstable, it collapses to form a hole in the ground called a sinkhole. Florida has hundreds of sinkholes, some of which became natural reservoirs for fresh water. Not surprisingly, some of the most artifact-rich paleoamerican sites are located near sinkholes.

Coastal areas inhabited by early Americans are difficult to explore because the coastlines of 15,000 years ago are now under more than 300 feet of water! As the last ice age drew to a close, melting ice sheets caused a rapid rise in sea level just as the first Americans were entering the New World. Drowned settlements may contain well-preserved

Images from Page 1 top to bottom:

The eastern Gulf of Mexico showing the three sub-areas examined in 2008, the Florida Middle Grounds, and the Suwanee River paleo channel.
http://oceanexplorer.noaa.gov/explorations/09newworld/background/plan/media/fmg_surveyareas.html

During the Late Pleistocene Florida's shoreline extended much farther offshore than the present coast. The Florida Middle Grounds were part of the exposed coastal margin.
<http://oceanexplorer.noaa.gov/explorations/09newworld/background/climatechange/media/pleistocene.html>

Map of the Bering land bridge during the late Wisconsin glaciation, when global sea level dropped to about 120 meters or more below its present position.
http://oceanexplorer.noaa.gov/explorations/09newworld/background/occupation/media/beringia_late_wisconsin.html

This image portrays a more accurate reconstruction of Ice Age human behavior with a focus on small familial groups and the processing and use of plants as opposed to athletically fit young men attacking large, dangerous animals.
<http://oceanexplorer.noaa.gov/explorations/09newworld/background/beliefs/media/correctpaleobehavior.html>

All images courtesy NOAA.

artifacts that can provide important new information about how the first Americans lived and when they arrived at various locations in North and South America. The eastern Gulf of Mexico in the vicinity of the Ocala Uplift Zone (Florida) is particularly promising as a potential location for drowned coastal settlements because:

- There are numerous onshore archaeological sites along the same zone that are more than 13,000 years old;
- Clusters of similar sites have been identified along drowned shorelines in the northern Gulf of Mexico;
- Rivers that discharge into this part of the Gulf do not carry large quantities of sediment, so sites should not be deeply buried;
- The coastal shelf is gently sloped which would reduce the impact of waves and storms; and
- Rapid sea level rise would have reduced the impact of waves as coastal settlements were inundated.

The Northeastern Gulf of Mexico 2008 Expedition focused on ancient river channels in the vicinity of the Florida Middle Grounds, which are now several hundred feet below the Gulf's surface. Major accomplishments included:

- Locating and high resolution mapping of a large, essentially intact, and infilled ancient river channel several kilometers long east of the Florida Middle Grounds;
- Identifying additional stream and river channels, some with clearly visible deposits along the banks;
- Locating and identifying more than 100 sinkhole features filled with material in stratified layers that may contain human artifacts as well as plant and animal material from early American times; and
- Mapping nearly 10 square kilometers of intact, shallow-water, near-shore sand ripples/ridges adjacent to an area that would have been Florida's shoreline when sea level was at its lowest point during the last glacial period.

The latter achievement is particularly important because it shows that the oldest shoreline is extraordinarily well preserved. Most interesting, though, are the infilled sinkholes with multiple layers of distinct strata. These sinkholes are a potential treasure trove of new information about the late Pleistocene landscape and environment, as well as about the humans who lived there.

This lesson guides a student inquiry into the archaeology of sinkholes as applied to the study of the first Americans.

Learning Procedure

1. To prepare for this lesson:
 - (a) Review introductory essays for the Exploring the Submerged New World 2009 Expedition at <http://oceanexplorer.noaa.gov/explorations/09newworld/welcome.html>; and

(b) Review questions on the *Paleoamerican Archaeology Inquiry Guide*.

2. Lead a brief discussion about the arrival of the first humans in North America. Mention the approximate timing of the first migrations from Siberia (about 15,000 years ago), and the fact that a land bridge existed between Siberia and North America at this time. Do not discuss details of paleoamerican technologies (i.e., thrusting spears tipped with specialized stone points) or the presence of now-extinct mammals at this point.

3. Distribute copies of the *Paleoamerican Archaeology Inquiry Guide* to each student group. Have each group brainstorm their answers to the Prediction section of the Guide, then discuss their ideas with the rest of the class. Students should infer that food and water would have been basic needs that might have influenced the location of paleoamerican settlements. If they know that paleoamericans used stone tools, they may also infer that appropriate supplies of raw materials (quarries) might also have been important. Other key questions may include:

- What did paleoamericans eat?
- How did paleoamericans obtain their food?
- What was the Florida climate like 10,000 years ago?
- Where have paleoamerican settlements actually been found?

4. Have students complete the Research and Analysis section of the *Inquiry Guide*. Describe the background and mission of the Exploring the Submerged New World 2009 Expedition, highlighting the discovery of infilled sinkholes along drowned shorelines. Ask students why these features might be important, and lead a discussion of their research results. The following points should be included:

- In the late Pleistocene, Florida's climate was considerably more arid than at present, so a reliable source of fresh water would have been an important factor in the location of paleoamerican settlements.
- Florida's limestone bedrock is prone to the formation of sinkholes that can become filled with rainwater or water from subterranean springs, providing a water source for humans and other animals. The presence of fresh water as well as a concentration of game probably made sinkholes attractive locations for paleoamerican settlements.
- Large mammals, many of which are now extinct, were abundant in Florida in late Pleistocene times, and could have provided a major food source for paleoamerican hunters.

- Many sinkholes, including Little Salt Spring, Sloth Hole, and the Page-Ladson site have yielded large collections of artifacts that provide strong evidence of habitation by paleoamericans.
- Artifacts from paleoamerican settlement sites typically include tools, remains of butchered animals, and human remains. Sloth Hole, near the northeastern Florida Gulf coast, has produced what may be the largest collection of paleoamerican bone and ivory tools in North America, and contains remains of 27 extinct Pleistocene species including horses, camels, mastodons, mammoths, and sloths. Little Salt Spring has produced the second-oldest dated artifact ever found in the southeast United States—a sharpened wooden stake some 14,000 years old. Animal remains from Little Salt Spring include mastodons and a ground sloth.
- Water in sinkholes may have very low dissolved oxygen content, which slows decomposition processes and thus preserves artifacts composed of organic materials. Artifacts from Little Salt Spring include wood, textile fragments, hair, skin and brain tissue dating to about 8,000 — 11,000 years ago.
- The Little Salt Spring settlement might have been abandoned because of climate change that caused the area to become more arid; or because water supplies in other areas improved as glaciers melted; or because rising sea levels caused salt water to intrude into the spring, making it unusable as a source of fresh water. Environmental conditions also changed dramatically about 10,000 years ago, as sea level rose and large mammals became extinct. The Page-Ladson site on the Aucilla River (near Tallahassee on the Florida panhandle) contains evidence of a transition from big game hunting to a less nomadic lifestyle that depended upon smaller animals for food.

The BRIDGE Connection

www.vims.edu/bridge/archeology.html

The “Me” Connection

Have students write a brief essay about how knowledge of paleoamerican settlements might be of personal importance or benefit.

Connections to Other Subjects

English/Language Arts, Geography

Evaluation

Students’ research reports and class discussions provide opportunities for assessment.

Extensions

1. Visit <http://oceanexplorer.noaa.gov/explorations/09newworld/welcome.html> for more about the Submerged New World 2009 Expedition.
2. Visit <http://www.pbs.org/wgbh/nova/first/> for information and resources about the discovery and controversy surrounding a well-preserved, 9,000-year-old human skeleton called Kennewick Man.
3. Have students investigate techniques for producing atlatls and flint tools, and use these to create examples of tools that might have been used by paleoamericans. Be careful with flint knapping—wear gloves, because these tools really are very sharp!

Other Relevant Lesson Plans from NOAA's Ocean Exploration Program

(The following Lesson Plans are targeted toward grades 7-8)

Shipwreck Mystery (10 pages, 322k) (from AUVfest 2008)
<http://oceanexplorer.noaa.gov/explorations/08auvfest/background/edu/media/shipwreck.pdf>

Focus: Marine Archaeology (Earth Science/Physical Science/Social Science)

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; use a grid system to document the location of artifacts recovered from a model shipwreck site; and identify and explain types of evidence and expertise that can help verify the nature and historical content of artifacts recovered from shipwrecks.

Sonar Simulation (10 pgs, 308kb) (from the Bonaire 2008: Exploring Coral Reef Sustainability with New Technologies Expedition)
<http://oceanexplorer.noaa.gov/explorations/08bonaire/background/edu/media/sonarsim.pdf>

Focus: Side-Scan Sonar (Earth Science/Physical Science)

In this activity, students will describe side-scan sonar, compare and contrast side-scan sonar with other methods used to search for underwater objects, and make inferences about the topography of an unknown and invisible landscape based on systematic discontinuous measurements of surface relief.

This Old Ship (9 pages, 272 kb) (from the 2006 Phaedra Expedition)
http://oceanexplorer.noaa.gov/explorations/06greece/background/edu/media/old_ship.pdf

Focus: Ancient and Prehistoric Shipwrecks (Earth Science/Social Studies)

In this activity, students will be able to describe at least three types of artifacts that are typically recovered from ancient shipwrecks, explain the types of information that may be obtained from at least three types of artifacts that are typically recovered from ancient shipwrecks, and compare and contrast, in general terms, technological features of Neolithic, Bronze Age, Hellenistic, and Byzantine period ships.

Mapping the Aegean Seafloor (8 pages, 288 kb) (from the 2006 Phaedra Expedition)
http://oceanexplorer.noaa.gov/explorations/06greece/background/edu/media/seafloor_mapping.pdf

Focus: Bathymetric Mapping of Deep-sea Habitats (Earth Science)

In this activity, students will be able to create a two-dimensional topographic map given bathymetric survey data, create a three-dimensional model of landforms from a two-dimensional topographic map, and interpret two- and three-dimensional topographic maps.

Other Resources

The Web links below are provided for informational purposes only. Links outside of Ocean Explorer have been checked at the time of this page's publication, but the linking sites may become outdated or non-operational over time.

<http://oceanexplorer.noaa.gov> – NOAA's Ocean Explorer Web site

<http://oceanexplorer.noaa.gov/explorations/09newworld/welcome.html> – Web site for the Submerged New World 2009 Expedition

<http://celebrating200years.noaa.gov/edufun/book/welcome.html#book> – A free printable book for home and school use introduced in 2004 to celebrate the 200th anniversary of NOAA; nearly 200 pages of lessons focusing on the exploration, understanding, and protection of Earth as a whole system

<http://www.kumeyaay.com> – Web site dedicated to the promotion and preservation of the Kumeyaay culture, with extensive information presented from the Kumeyaay perspective

<http://centerfirstamericans.org/index.php> – Web site for the Center for the Study of the First Americans

<http://www.jqjacobs.net/anthro/paleoamericans.html> – Online article on issues and evidence relating to peopling of the New World

<http://www.pbs.org/wgbh/nova/first/> – Web site to accompany the NOVA presentation, “Mystery of the First Americans” (originally broadcast on February 15, 2000) documenting the discovery and controversy surrounding a well-preserved, 9,000-year-old human skeleton called Kennewick Man; includes “Does Race Exist?,” “Meet Kennewick Man,” “Claims for the Remains,” “The Dating Game” (about carbon-14 analysis), and links to resources

<http://www.nps.gov/history/aad/eam/index.htm> – National Park Service Archaeology and Ethnography Program’s Web site, The Earliest Americans

Goebel, T., M. R. Waters, and D. H. O’Rourke. 2008. The Late Pleistocene Dispersal of Modern Humans in the Americas. *Science* 319:1497-1502. <http://centerfirstamericans.org/cfsa-publications/Science2008.pdf>

Clausen, C. J., A. D. Cohen , C. Emiliani, J. A. Holman, and J. J. Stipp. Little Salt Spring, Florida: A Unique Underwater Site. *Science* 203(4381):609 - 614.

Holman, J. A. and C. J. Clausen. 1984. Fossil Vertebrates Associate with Paleo-Indian Artifact at Little Salt Spring, Florida. *J. Vertebrate Paleontology* 4(1):146-154.

Largent, F. B. 2004. Diving into Florida Prehistory. Mammoth Trumpet 19(4):18-20; http://csfa.tamu.edu/mammoth/issues/Volume-19/vol19_num4.pdf

Wisner, G. 1997. Underwater Site Opens Window on Big Environmental Change. Mammoth Trumpet 12(2):9-10; http://csfa.tamu.edu/mammoth/issues/Volume-12/vol12_num2.pdf

National Science Education Standards

Content Standard A: Science As Inquiry

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

Content Standard C: Life Science

- Populations and ecosystems
- Diversity and adaptations of organisms

Content Standard D: Earth and Space Science

- Earth’s history

Content Standard E: Science and Technology

- Understandings about science and technology

Content Standard F: Science in Personal and Social Perspectives

- Populations, resources, and environments
- Natural hazards
- Science and technology in society

Ocean Literacy Essential Principles and Fundamental Concepts

Essential Principle 1.

The Earth has one big ocean with many features.

Fundamental Concept d. Sea level is the average height of the ocean relative to the land, taking into account the differences caused by tides. Sea level changes as plate tectonics cause the volume of ocean basins and the height of the land to change. It changes as ice caps on land melt or grow. It also changes as sea water expands and contracts when ocean water warms and cools.

Essential Principle 2.

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

Fundamental Concept a. Many earth materials and geochemical cycles originate in the ocean. Many of the sedimentary rocks now exposed on land were formed in the ocean. Ocean life laid down the vast volume of siliceous and carbonate rocks.

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.

Essential Principle 6.

The ocean and humans are inextricably interconnected.

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).

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 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

We value your feedback on this lesson.
Please send your comments to:
oceaneducation@noaa.gov

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Paleo-Diving Paleoamerican Archaeology Inquiry Guide

Prediction

Imagine you are an archaeologist who is interested in the first people to inhabit North America, and are applying for a small grant to fund a field expedition to Florida. The grant application requires you to identify places where you will be most likely to find remains of paleoamerican settlements, and explain why these are promising sites for exploration and investigation. You have decided that the most convincing way to present this information is by describing the basic needs of paleoamerican people, and then identifying locations where people had the best chances for meeting these needs. You are about to begin Internet research to gather information that will help you write the grant proposal. What questions do you want to answer? Remember to consider the geography of Florida as well as characteristics of paleoamericans. Hint: you will probably want to bring SCUBA diving equipment.

Research and Analysis

Use your own Internet research to answer the following questions...and good luck with your grant!

1. What were important basic needs of paleoamericans that might have influenced their choice of locations for settlements?

2. What aspects of Florida's geography (including geology, climate, and ecology) are relevant to your search for paleoamerican settlements? Why are these relevant?

3. What locations do you predict would be promising sites for finding remains of paleoamerican settlements? What evidence exists to support your predictions?

Paleo-Diving Paleoamerican Archaeology Inquiry Guide – 2

4. What sort of artifacts would you expect to find in sites that were inhabited by paleoamericans? Have any of these artifacts actually been found in paleoamerican settlement sites?

5. Why might paleoamerican artifacts be particularly well-preserved in sites that require exploration with SCUBA equipment?

6. The youngest artifacts from Little Salt Spring are about 5,500 years old. What might have happened to cause paleoamericans to abandon a settlement that had been inhabited for at least 5,000 years?
