

## 2004 Return to *Titanic* Expedition

# Looking for Clues



Image captions/credits on Page 2.

# lesson plan

### Focus

Marine Archaeology of *Titanic*

### Grade Level

5-6 (Social Studies)

### Focus Question

How can marine archaeologists use historical and archaeological data to draw inferences about shipwrecks?

### Learning Objectives

- Students will be able to draw inferences about a shipwreck given information on the location and characteristics of artifacts from the wreck.
- Students will be able to list three processes that contribute to the deterioration of the *Titanic*.

### Materials

- Copies of *Inventory of Artifacts Recovered from Three Sites in the Titanic Debris Field*, one copy for each student group
- (Optional; see Learning Procedure, Step 1) One or more copies of *Return to Titanic Mission to Document Wreck's Destruction* by Brian Handwerk ([http://news.nationalgeographic.com/news/2004/04/0423\\_040423\\_titanicscience.html](http://news.nationalgeographic.com/news/2004/04/0423_040423_titanicscience.html)); and/or *Rusticles Thrive on the Titanic* by Dr. Roy Cullimore (<http://oceanexplorer.noaa.gov/explorations/03titanic/rusticles/rusticles.html>); and/or images of Titanic exterior (<http://oceanexplorer.noaa.gov/gallery/cultural/cultural.html#titanic>)

### Audio-Visual Materials

- None

### Teaching Time

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

### Seating Arrangement

Groups of three to four students

### Maximum Number of Students

30

## Key Words

*Titanic*

Debris field

Artifact

Rusticle

Galvanic coupling

## 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.*

At 11:40 pm on April 14, 1912, RMS *Titanic* struck an iceberg off the coast of Newfoundland. Two hours and 40 minutes later, the great liner sank 3,900 meters to the bottom of the North Atlantic Ocean. Thought to be unsinkable, *Titanic* had not survived her maiden voyage. Neither did 1,522 passengers and crew members who also perished on that cold April morning.

In 1985, *Titanic* was seen again by explorers from the Woods Hole Oceanographic Institution and the Institut Français de Recherches pour l'Exploitation des Mers. Using the remotely operated vehicle (ROV) *Argo*, the explorers made dramatic video recordings showing changes brought about by 73 years in the deep ocean. One of the most conspicuous changes is caused by complex communities of bacteria and fungi that produce structures called "rusticles" that superficially resemble icicles or stalactites. Rusticles are built up in ring structures and are highly porous with channels and reservoirs that allow water to flow through. Up to 35% of rusticles' mass consists of iron compounds (iron oxides, iron carbonates, and iron hydroxides). The remainder is biomass of bacteria and fungi. Rusticles grown in laboratories have been found to continuously release a red, powder-like material as well as a yellowish slime. The iron content of these materials is  $20 \pm 5\%$  and  $8 \pm 3\%$ , respectively. These releases total between 0.02% and 0.03% of the rusticles' biomass per day. Based on these observations, it has been estimated that all of the iron in *Titanic*'s bow section could be removed in approximately 280 to 420 years. Experiments are underway at the *Titanic* site to measure the actual rate of iron removal from the ship due to rusticles. Whatever the rate, it is clear that *Titanic* is slowly being recycled back to nature.

Another natural degradation process known as "galvanic exchange" (or "galvanic coupling" or "galvanic corrosion") is also at work on *Titanic*. This process results from different metals in electrical contact with each other in seawater. Metals can be classified into an "Electromotive Series" according to the strength with which they "hold on" to their electrons. Metals lower in the Series tend to give up their electrons

### Images from Page 1 top to bottom:

A view of the bow of the RMS *Titanic*. Image copyright Emory Kristof/National Geographic.  
[http://oceanexplorer.noaa.gov/explorations/04titanic/media/hirez/titanic\\_bow\\_hirez.jpg](http://oceanexplorer.noaa.gov/explorations/04titanic/media/hirez/titanic_bow_hirez.jpg)

This mosaic of the *Titanic*'s bow section was originally published in the October 1987 issue of *National Geographic Magazine*. An updated mosaic will be made from images collected by the *Hercules* ROV during this expedition. Image courtesy of Bert Fox © National Geographic Society.

<http://oceanexplorer.noaa.gov/explorations/04titanic/slideshows/june02/slideshow.html#>

Institute for Exploration (IFE) engineer Dave Lavalvo (in red) removes a rusticle experiment station from the *Hercules* "bio box" and hands it to microbiologist Dr. Roy Cullimore, who placed it on the *Titanic*'s bow in 1998 for future rusticle analysis. It was retrieved from the depths on June 2, 2004. Image courtesy of Mike Sweeney © National Geographic Society.

<http://oceanexplorer.noaa.gov/explorations/04titanic/slideshows/june03/slideshow.html#>

A view of the steering motor on the bridge of the *Titanic*. Image copyright Emory Kristof/National Geographic.

[http://oceanexplorer.noaa.gov/explorations/04titanic/media/hirez/steering\\_motor\\_bridge\\_hirez.jpg](http://oceanexplorer.noaa.gov/explorations/04titanic/media/hirez/steering_motor_bridge_hirez.jpg)

more readily than metals that are higher in the Series. When two metals with different electromotive strengths are electrically connected and submerged in an electrolyte (such as seawater), electrons will flow from the metal lower in the Electromotive Series, causing this metal to form oxides or other compounds in a process we know as corrosion (this is also the process through which batteries produce an electric current). Besides the iron in its hull, *Titanic* contains many other metals such as lead, bronze, copper, and brass that are higher in the Electromotive Series than iron. As a result, the steel in *Titanic*'s hull is degraded as iron is replaced by other compounds formed through galvanic exchange.

It has been suggested that galvanic exchange was the real reason *Titanic* sank in the first place. Since the ship was held together by 3 million rivets made with wrought iron (which is a different material than the hull plates), galvanic exchange could have taken place between the dissimilar metals of the hull and rivets causing the rivets to weaken. In fact, *Titanic* sat in seawater for a year after her hull was launched while the interior was furnished. One of the last photos taken before the ship's maiden voyage shows a pattern that may suggest the rivets were rusting faster than the hull plates. When *Titanic* collided with the iceberg, the weakened rivets could have popped (which would account for a clinking sound reported by some survivors). An opening just an inch wide between the hull plates would have been enough to sink the ship...and video images of the wreckage show a narrow opening in the unburied part of the bow, as well as preferential corrosion of the rivets in some areas. For more information on this theory, visit <http://www.corrosion-doctors.org/Landmarks/titan-sinking.htm>.

Since the initial discovery in 1985, *Titanic* has been visited by numerous other expeditions, many of which have taken away considerably more than video images. At the end of 2002, an estimated 6,000 artifacts had been removed from the *Titanic* wreck site. These activities have stirred controversy, since the *Titanic* shipwreck is unquestionably a gravesite as well. This fact is underscored by video images of paired shoes (for example, at <http://www.titanic-facts.com/titanic-artifacts.html>) lying on the ocean floor in positions that suggest the shoes have not moved since the person wearing them landed on the bottom.

The mission of the 2004 Ocean Exploration Return to *Titanic* Expedition was to assess changes that occurred at the RMS *Titanic* wreck site since 1985, and to investigate natural degradation processes as well as changes caused by human activity.

In this lesson, students will analyze historical and archaeological data to draw inferences about the remains of *Titanic*.

## Learning Procedure

To prepare for this lesson, review *Return to Titanic Mission to Document Wreck's Destruction* by Brian Handwerk ([http://news.nationalgeographic.com/news/2004/04/0423\\_040423\\_titanicscience.html](http://news.nationalgeographic.com/news/2004/04/0423_040423_titanicscience.html)), *Rusticles Thrive on the Titanic* by Dr. Roy Cullimore (<http://oceanexplorer.noaa.gov/explorations/03titanic/rusticles/rusticles.html>), and images of *Titanic* exterior (<http://oceanexplorer.noaa.gov/gallery/cultural/cultural.html#titanic>); decide which of these you want to use as part of Step 1.

1. Briefly review the history of *Titanic*, its sinking, discovery of the shipwreck in 1985, and human activities at the site following this discovery. Show students one or more images of the ship's exterior, and ask what processes might be responsible for the "alarming and possibly increasing rate of deterioration. You may want to assign one or both of the essays referenced above for student reading and reports. Students should recognize that both natural and human-induced processes may be involved with the ship's deterioration, and may distinguish between galvanic action and "rusting." If you have serious *Titanic* fans in your class, they may also know about rusticles. If not, provide a brief summary, highlighting the fact that this is a biologically-mediated oxidation process, in contrast to the more familiar form of "rusting."
2. Tell students that they are going to assume the role of consulting marine archaeologists investigating the wreck of *Titanic*. Their assignment is to analyze artifacts collected from three sites near the ship, and determine their probable location on the ship before *Titanic* sank. These analyses can be used to focus additional explorations on sites in the debris field that are most likely to contain artifacts from areas of the ship that are of particular interest.
3. Provide each student group with copies of *Inventory of Artifacts Recovered from Three Sites in the Titanic Debris Field*. Note that these are actual entries from the inventory of artifacts collected in 2000 by RMST, Inc with the exception of the initials on the leather briefcase (the briefcase is part of the inventory; the initials are fictitious). Students should first group the artifacts according to the site from which they were recovered.

Next, have students review deck plans of *Titanic* at <http://www.encyclopedia-titanica.org/deckplan/index/> and <http://www.copperas.com/titanic/> (the latter site also has a link to a detailed description of *Titanic* published in the May 26, 1911 issue of the British journal *Engineering*). Students should study the artifacts found at each of the three sites, and develop inferences about the areas on the ship from which these artifacts originated. Have each

student group prepare a short report on their analyses, stating which areas of the ship are represented in each site, and evidence to support their conclusions.

4. Lead a discussion of students' results. Many of the artifacts from Site 00-12 appear to be associated with dining areas, and seem to include a mixture of items from First, Second, and Third Class areas. Examination of deck plans shows that although the First and Second Class dining saloons, galleys, and pantries on C-Deck were separate from the Third Class dining facilities on F-Deck, they were all near the center of the ship. Damage to the hull in this area could reasonably be expected to result in the mixture of artifacts found at this site.

Artifacts from Site 00-23 include items that might have belonged to wealthy passengers as well as items that might have been associated with the ship's navigation (speaking tube, binoculars, etc.). The briefcase with initials "JCS" is a valuable clue, since the location of many First Class passengers' cabins is known. If students search the A-Deck cabins on <http://www.encyclopedia-titanica.org/deckplan/index/>, they will find the cabin assigned to James Clinch Smith near the forward end of the ship on the starboard side. This cabin is relatively close to the wheelhouse on the deck above which was damaged when the foremast collapsed. These observations support the inference that these artifacts originated from this general area.

A great deal of clothing is mingled with mechanical artifacts at Site 00-27. The staircase portion and pieces of reciprocating engine suggest that many artifacts at this site may have originated from areas of the ship beneath the First Class Lounge (A-Deck). A reciprocating engine room was located on the Orlop deck in this area, as well as many Third Class cabins on E-Deck.

Ask students to speculate about why clothing and personal items are scattered throughout all of the collections. Based on their examination of deck plans, students should realize that passenger and crew accommodations were distributed over almost the entire length of the ship on multiple decks. Since the collections probably include artifacts from several decks, some of these artifacts are likely to have originated in accommodation areas.

### The BRIDGE Connection

[www.vims.edu/bridge/](http://www.vims.edu/bridge/) – In the Navigation toolbar, click on "Ocean Science Topics," then "Human Activities," then "Heritage," then "Archeology". Also, search keyword "*Titanic*" in the "Search" box for more locations on the BRIDGE site dealing with *Titanic* topics.

### The “Me” Connection

Have students write a brief essay describing why investigations of wrecks such as that of *Titanic* are (or are not) worth the time, money, and risk involved, and how such investigations might affect their lives personally.

### Connections to Other Subjects

English/Language Arts

### Assessment

Student analyses and report prepared in Step 3 offer opportunities for assessment.

### Extensions

1. Have students visit <http://oceanexplorer.noaa.gov/explorations/04titanic/welcome.html> to find out more about the 2004 Return to *Titanic* Expedition.
2. Have students investigate the controversy surrounding recovery of artifacts from *Titanic*. You may want to have student groups debate both sides of the argument, or write an essay supporting one view or analyzing both views. The Encyclopedia *Titanica* web site is a useful starting point for this activity.
3. Have students investigate one or more persons who were aboard *Titanic* when the ship sank, and prepare a report on their activities on April 14 and 15, 1912.

### 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://www.corrosion-doctors.org/> – A web site about corrosion causes and solutions, with modules designed for training in corrosion science and engineering

<http://www.encyclopedia-titanica.org/> – Encyclopedia *Titanica* web site with biographies, research articles and ongoing discussions about the *Titanic*

<http://www.titanic-nautical.com/RMS-Titanic.html> – Titanic Web page from the Titanic and Nautical Resource Center

<http://score.rims.k12.ca.us/activity/bubbles/> – Marine archaeology activity guide based on investigations of the wreck of a Spanish



galleon; from the Schools of California Online Resources for Education website

<http://www.titanic1.org/> – *Titanic* Historical Society

<http://www.titanicinquiry.org/> – *Titanic* Inquiry Project

<http://www.skarr.com/titanic/> – The *Titanic* Information Site

<http://www.titanicscience.com/TSci-ActivityGuideFinal.pdf> – Maryland Science Center’s *Titanic* Science Teacher Activity Guide

<http://www.encyclopedia-titanica.org/deckplan/index/> – Deck plans for *Titanic*

also <http://www.copperas.com/titanic/> – Deck plans for *Titanic*, as well as a link to a detailed description of *Titanic* published in the May 26, 1911 issue of the British journal “Engineering”

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### National Science Education Standards

#### Content Standard A: Science As Inquiry

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

#### Content Standard B: Physical Science

- Properties and changes of properties in matter

### **Send Us Your Feedback**

In addition to consultation with expedition scientists, the development of lesson plans and other education products is guided by comments and suggestions from educators and others who use these materials. Please send questions and comments about these materials to:

[oceaneducation@noaa.gov](mailto:oceaneducation@noaa.gov).

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### **Acknowledgements**

This lesson was developed and written for NOAA's Office of Ocean Exploration and Research (OER) by Dr. Mel Goodwin, Science and Technology Consultant to OER's Education Team.

Design/layout: Coastal Images Graphic Design, Mt. Pleasant, SC.

### **Credit**

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Inventory of Artifacts Recovered from Three Sites in the *Titanic* Debris Field

Item	Material	Site
pair of wool socks	textile (wool)	00-27
pair of wool socks	textile (wool)	00-27
pair of wool socks	textile (wool)	00-27
pair of wool socks	textile (wool)	00-27
pair of wool socks	textile (wool)	00-27
five linen handkerchiefs	textile (linen)	00-23
silk necktie	textile (silk)	00-23
pair of silk socks	textile (silk)	00-23
cravat	textile (silk)	00-23
four London omnibus tickets	paper	00-27
polka dotted handkerchief	textile (silk)	00-12
red box containing a dropper and a pen	paper, glass, metal	00-27
red box containing a dropper and a pen	paper, glass, metal	00-27
two cotton rags	textile (cotton)	00-12
long john pants	textile (cotton)	00-12
cambray blue work shirt	textile (cotton)	00-27
white cotton work shirt	textile (cotton)	00-27
dress bibb	textile (cotton)	00-23
white cotton long sleeve work shirt	textile (cotton)	00-27
white cotton work shirt with red stripes	textile (cotton)	00-27
man's shirt collar	textile (cotton)	00-23
man's shirt collar	textile (cotton)	00-12
man's shirt collar	textile (cotton)	00-12
three man's shirt collar	textile (cotton)	00-23
man's shirt cuff	textile (cotton)	00-23
four leather suspender brace ends	leather	00-12
silver match box	metal (silver)	00-23
folding pocket knife	metal (brass), wood	00-12
eraser	rubber	00-23
miniature imitation pistol	metal (brass)	00-23
milk warmer with White Star Line logo	metal (brass, copper)	00-23
swivel loupe	leather, glass, metal	00-27
pencil	graphite	00-12
First Class silver plated tureen	metal (copper, silver)	00-12
Second Class soup tureen	metal (copper, silver)	00-12
Second Class blue and white plate	ceramic (earthen ware)	00-12
sink splash with decanter holder	metal (silver), stone	00-23
Third Class sink with drain plug	metal (brass), ceramic	00-27
brown ceramic jug	ceramic (earthen ware)	00-12
brown ceramic jug	ceramic (earthen ware)	00-12
screw down window	metal (bronze), glass	00-23
coal	coal	00-27
lavatory slate	stone	00-12

Inventory of Artifacts Recovered from Three Sites in the *Titanic* Debris Field - page 2

Item	Material	Site
oval port hole with glass	metal (brass), glass	00-12
ventilating port hole	metal (cast iron, bronze)	00-23
ventilating port hole	metal (cast iron, bronze)	00-23
leather travel bag	leather, paper	00-23
dome metal object	metal	00-12
turnbuckle	metal (brass)	00-23
table base	metal (cast iron, brass)	00-12
leather bag	leather, paper	00-23
deck bench armrest	metal (bronze)	00-12
deck bench end	metal (cast iron)	00-12
boiler access plate	metal (bronze)	00-27
bearing liner	metal (babbet metal)	00-27
water boiler	metal (brass, copper)	00-27
large wrench	metal (wrought steel)	00-27
over port hole frame	metal (brass)	00-12
bearing liner	metal (babbet metal)	00-27
watertight shaft	metal (bronze, steel)	00-27
deck light	metal (brass), glass	00-23
glass bottle with contents	glass, paper, cork	00-12
floor tile	textile (linoleum)	00-12
floor tile	textile (linoleum)	00-12
door knob with eschutcheon & hardware	metal (brass)	00-12
floor drain	metal (cast iron)	00-12
lead crystal bead	glass	00-12
gong	metal (brass)	00-12
spigot from folding lavatory tilt sink	metal (brass)	00-12
toilet	ceramic, metal (iron)	00-23
window from officers quarters	metal (brass), glass	00-23
taffeta bag with contents	textile	00-23
leather satchel with initials "JCS"	leather	00-23
pair of leather work boots	leather, metal	00-27
wool jacket	textile (wool)	00-27
wool vest	textile (wool)	00-27
wool suit pants with suspenders	textile (wool)	00-27
white cotton dress shirt	textile (cotton)	00-23
short sleeve wool smock	textile (wool)	00-12
man's left shoe	leather	00-12
gold plated cylindrical tin	metal	00-23
speaking tube	metal	00-23
two large ceramic fuse holders	ceramic, metal (copper)	00-27
large pieces of wood	wood	00-27
glass dish with White Star Line logo	glass	00-23
steering wheel stand	metal (bronze, iron)	00-23

**Inventory of Artifacts Recovered from Three Sites in the *Titanic* Debris Field - page 3**

<b>Item</b>	<b>Material</b>	<b>Site</b>
beveled gear with shaft	metal (bronze, steel)	00-23
crystal candy dish with White Star Line logo	glass	00-12
Third Class cup with White Star Line logo	ceramic	00-12
Third Class mug with White Star Line logo	ceramic	00-12
bronze base for First Class staircase	metal (bronze)	00-27
wash basin	ceramic	00-12
mustard bottle	glass, cork	00-12
First Class demitasse cup	ceramic	00-12
binoculars	metal, glass	00-23
Second Glass soap dish	ceramic	00-27
Third Class soup bowl with White Star Line logo	ceramic	00-27
cherry toothpaste jar with lid	ceramic	00-12
three silver plated porrigers	metal	00-12
spittoon	metal (copper)	00-12
bath tub hot and cold water fixture	metal (brass)	00-12
small hot and hold water fixture	metal (brass)	00-23
three First Class chamber pots	ceramic	00-23