

## WELCOME TO THE SEA FLOOR EXPLORER SERIES PROGRAMS

These programs link middle school students directly to current research in oceanography and provide opportunities to use authentic scientific procedures and equipment. Students are put into challenging research simulations that focus on coring/micropaleontology, underwater seismology, and underwater archaeology.

Aboard the *R/V Sea Explorer*, students become familiar with deep-sea technology. Students conduct a Dana Point Oceanographic Survey through the use of Side-Scan SONAR, a gravity corer, and our SeaBotix ROV.

Please take a few moments to familiarize yourself with the materials we have included, and share them with other teachers and chaperones who will be joining you. These materials contain important information to prepare you, your chaperones, and your students for your visit. You will also find important forms that must be returned to the Ocean Institute in order for you and your students to participate.

If you have any questions about your visit to the Ocean Institute, please do not hesitate to contact our Director of Program Development, Shanette Grieve at 949-496-2274, extension 339. Again, welcome to the Sea Floor Explorer series of programs! We are looking forward to your visit.

Sincerely,  
Rick Baker  
Vice President, Education



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## A. ADMINISTRATIVE CHECKLIST FOR THE PROGRAM

### ***Immediately upon receiving this package...***

- Carefully review the Teacher Preparation Package
- Arrange your transportation

### ***Two months prior to your trip...***

- Arrange for parent chaperones—please limit the number to two adults for every 12 students
- Confirm student and adult numbers with the Ocean Institute

### ***One month prior to your trip...***

- Begin student preparation
- Copy and distribute Acknowledgement of Risk and Waiver to each student and adult
- Contact the Ocean Institute with any changes in student numbers
- Return the Special Information Form to the OEC Coordinator**

### ***Two weeks prior to your trip...***

- Mail program payment to the Ocean Institute—full payment must be received a minimum of 10 days before your program
- Collect Acknowledgement of Risk and Waiver from each student
- Contact parents to remind them to sign and return the Acknowledgement of Risk and Waiver

**Note:** We cannot guarantee that changes in numbers of students or adults can be accommodated if requested within two weeks of your program date

### ***One week prior to your trip...***

- Review behavioral expectations with students
- Contact the Ocean Institute with any last minute questions or changes

### ***24 hours to go!!!...***

- If inclement weather is expected, contact the Ocean Institute for status of the program
- Prepare nametags for students and adults

### ***When you arrive for the Sea Floor Explorer Program...***

- Unload the bus in front of the Ocean Institute
- Check in at the Student Services building with a final head count
- If necessary, students may use the restroom facilities—please limit use to 7 girls and 7 boys at a time



## B. DESCRIPTION OF THE PROGRAM

### ***Laboratory Stations:***

- **Underwater Archaeology**  
In this expedition students will investigate the underwater archaeology site of Port Royal. They will learn how to draw a map to scale as they survey the site, deal with the concept of buoyancy when using lift bags to excavate artifacts, and collect research to discover the answer to Port Royal's demise.
- **Sea Floor Seismology**  
After reviewing plate tectonic theory using our interactive globe, students familiarize themselves with technology used to study earthquakes. Students will conduct a simple experiment relating amplitude to the distance of a seismometer from an epicenter. The expedition will lead students through the process of finding the epicenter of an earthquake through triangulation.
- **Deep Sea Coring**  
In this expedition, students will observe foraminifera under microscopes and examine the layers of a core sample. As marine geologists and micropaleontologists, they will work to unlock the mysteries of Earth's climatic and tectonic past.

### ***R/V Sea Explorer Stations:***

- **Core sample/ Foram panning:** After a core sample is taken at the depth, students will examine the mud of the core, analyze layers, discuss sedimentation rates and look for different deposits. Students will then sieve the mud from the core. If foraminifera are isolated, they will be taken inside to the microscope station and identified. Students will also retrieve a live plankton sample and under the microscopes see if they can identify any live forams or radiolarians in the sample!
- **ROV:** Students will have an opportunity to drive an ROV off the bow of the ship in the harbor. A Remotely Operated Vehicle (ROV) is essentially an underwater robot that allows the vehicle's operator to remain in a comfortable environment while the ROV works in the hazardous environment below. ROVs are now used in many different fields of ocean science as well as commercial uses.
- **SONAR:** Students will discuss the use of SONAR and see live images of the seafloor as the Side Scan SONAR is towed through the harbor. They will use the images to determine the type of substrate and to identify any anomalies found.



## C. LINKS TO CALIFORNIA SCIENCE STANDARDS

### *Grade Six*

#### **Plate Tectonics and Earth's Structure**

- 1.a. Students know evidence of plate tectonics is derived from the fit of the continents; the location of earthquakes, volcanoes, and midocean ridges; the distribution of fossils, rock types, and ancient climate zones.
- 1.b. Students know Earth is composed of several layers: a cold, brittle lithosphere; a hot, convecting mantle; and a dense, metallic core.
- 1.c. Students know lithospheric plates the size of continents and oceans move at rates of centimeters per year in response to movements in the mantle.
- 1.d. Students know that earthquakes are sudden motions along breaks in the crust called faults and that volcanoes and fissures are locations where magma reaches the surface.
- 1.e. Students know major geologic events, such as earthquakes, volcanic eruptions, and mountain building, result from plate motions.
- 1.g. Students know how to determine the epicenter of an earthquake and know that the effects of an earthquake on any region vary, depending on the size of the earthquake, the distance of the region from the epicenter, the local geology, and the type of construction in the region.

#### **Shaping Earth's Surface**

- 2.d. Students know earthquakes, volcanic eruptions, landslides, and floods change human and wildlife habitats.

#### **Heat (Thermal Energy)**

- 3.a. Students know energy can be carried from one place to another by heat flow or by waves, including water, light and sound waves, or by moving objects.

#### **Investigation and Experimentation**

- 7.a. Students will develop a hypothesis.
- 7.b. Students will select and use appropriate tools and technology to perform tests, collect data, and display data.
- 7.c. Construct appropriate graphs from data and develop qualitative statements about the relationships between variables.
- 7.g. Students will interpret events by sequence and time from natural phenomena (e.g., the relative ages of rocks and intrusions).

### *Grade Seven*

#### **Earth and Life History (Earth Science)**

- 4.a. Students know Earth processes today are similar to those that occurred in the past and slow geologic processes have large cumulative effects over long periods of time.
- 4.b. Students know the history of life on Earth has been disrupted by major catastrophic events, such as major volcanic eruptions or the impact of asteroids.
- 4.c. Students know that the rock cycle includes the formation of new sediment and rocks and that rocks are often formed in layers, with the oldest generally on the bottom.
- 4.e. Students know fossils provide evidence of how life and environmental conditions have changed.
- 4.f. Students know how movements of Earth's continental and oceanic plates through time, with associated changes in climate and geographic connections, have affected the past and present distribution of organisms.

#### **Investigation and Experimentation**

- 7.a. Students will select and use appropriate tools and technology to perform tests, collect data, and display data.
- 7.c. Students will communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.
- 7.d. Students will construct scale models, maps, and appropriately labeled diagrams to communicate scientific knowledge (e.g., motion of Earth's plates).

**Grade Eight****Motion**

- 1.c. Students know how to solve problems involving distance, time, and average speed.
- 1.f. Students know how to interpret graphs of position versus time and graphs of speed versus time for motion in a single direction.

**Density and Buoyancy**

- 8.d. Students know how to predict whether an object will float or sink.

**Investigation and Experimentation**

- 9.a. Students will plan and conduct a scientific investigation to test a hypothesis.
- 9.c. Students will distinguish between variable and controlled parameters in a test.
- 9.e. Communicate the steps and results from an investigation in written reports and oral presentations.

**Grades Nine through Twelve****Physics**

- 5.f. Students know magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other charges.

**Earth Sciences**

- 1.c. Students know the evidence from geological studies of Earth and other planets suggest that the early Earth was very different from earth today.
- 3.a. Students know features of the ocean floor (magnetic patterns, age, and sea-floor topography) provide evidence of plate tectonics.
- 3.b. Students know the principal structures that form at the three different kinds of plate boundaries.
- 3.c. Students know how to explain the properties of rocks based on the physical and chemical conditions in which they formed, including plate tectonic processes.
- 3.d. Students know why and how earthquakes occur and the scales used to measure their intensity and magnitude.
- 6.c. Students know how Earth's climate has changed over time, corresponding to changes in Earth's geography, atmospheric composition, and other factors, such as solar radiation and plate movement.
- 9.b. Students know the principal natural hazards in different California regions and the geologic basis of those hazards.

**Investigation and Experimentation**

- 1.a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
- 1.d. Formulate explanations by using logic and evidence.
- 1.f. Distinguish between hypothesis and theory as scientific terms.
- 1.h. Read and interpret topographic and geologic maps.
- 1.l. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.



## D. ADMINISTRATIVE PREPARATION FOR THE DAY PROGRAM

### ADMINISTRATIVE CONTACT

For questions regarding the **Sea Floor Explorer Programs**, please contact:

Shanette Grieve, Director of Program Development  
Telephone Number: (949) 496-2274, extension 339  
E-mail: [srillorta@ocean-institute.org](mailto:srillorta@ocean-institute.org)

### INTRODUCTION

Thank you for choosing the Ocean Institute as your field trip destination. We appreciate the time and effort it takes to prepare your students for their program, and we will do everything we can to make their experience as rewarding as possible.

Please make sure that all of the participating teachers have a copy of these teacher materials. The information contained here can help you find answers to your questions, develop your preparation timeline, and prepare both your students and chaperones. This packet also contains directions to the Ocean Institute as well as contact telephone numbers—please call us at any time with questions you may have about your field trip.

### TEACHER INFORMATION: BEFORE YOUR PROGRAM

You can do several things before you arrive to help make your program run as smoothly as possible:

- **Complete and return the Program Information Form** to the program director. Notify the Ocean Institute staff of students with special health or behavioral considerations. **We must have the accurate number of students attending the program at least one month before your program in order to ensure proper staffing and equipment.**
- Review the program goals, station activities, and expected behaviors with the students before you arrive. Complete the classroom activity with your students, and make sure they have a clear understanding of the educational concepts they will explore during the program.
- Spend some time choosing and preparing your parent chaperones. Review the program goals, station activities, and expected student behaviors with them before you arrive. Make sure that they have a clear understanding of their role as a chaperone.
- Split students into three research teams and assign each team to a chaperone.
- Send program payment to the Ocean Institute at least 10 days before the scheduled date of your field trip.
- Have a signed Acknowledgement of Risk and Waiver for each participant before boarding the bus.
- Accurately complete the *R/V Sea Explorer* manifest before boarding the bus, noting the correct number of students and adults, and double-checking each name on the manifest.

### TEACHER INFORMATION: DURING YOUR PROGRAM

Ocean Institute instructors are all well trained to instruct students of different ages and abilities. You and the chaperones can help the instructors monitor student behavior and safety. There are several things you can do to facilitate the smooth running of your educational program:

- Work cooperatively with Ocean Institute instructors and parent chaperones to manage students during the program.
- Work cooperatively with Ocean Institute instructors and parent chaperones to solve student and chaperone management problems.

- Report any problems to the Ocean Institute staff as soon as possible.

### **CHAPERONE INTRODUCTION AND INFORMATION**

Adult chaperones play a significant role in safety and the educational quality of the program. We request that you bring no more than 2 adults per 12 students. We ask your chaperones to help us in the following ways:

- Work cooperatively with Ocean Institute instructors and classroom teacher to enforce all safety rules
- Work cooperatively with Ocean Institute instructors and classroom teacher to keep students on task at the stations
- Guide students to different stations throughout the program
- Act as a positive role-model for the students by exhibiting enthusiasm for learning without answering questions directed at students

### **PAYMENT**

**Payment must be received 10 days before your program date.** Please mail a **single check** for the total amount of the program minus the deposit you have already paid. Please make the check payable to **Ocean Institute**.

### **FINAL COUNT**

Call the Ocean Institute two days before your program if the number of students or adults changes. When you arrive at the Ocean Institute for your program, you must have an accurate count of total students and adults participating in the program. If the number of participants listed on your Program Agreement is not accurate, call the Ocean Institute immediately. **We cannot guarantee that changes in numbers of students or adults can be accommodated if requested within 2 weeks of your program date.**

### **STUDENT AID**

The Ocean Institute maintains a student aid fund for students who are unable to obtain sufficient funding to attend the program. Please call (949) 496-2274, extension 0 for more information and to receive the necessary forms for student aid.

### **TRANSPORTATION**

Student transportation should be arranged well in advance. It is important that you arrive on time. Please schedule yourself to arrive 15 minutes before your scheduled program start time. If you arrive late, your program time will be shortened.

Buses can unload in front of the Student Services building. After the students have unloaded, the drivers will be notified of where to park the buses.

### **FORMS**

The following forms can be found in the Appendix. Please make sure to have all the completed forms with you when you for your program.

#### **Acknowledgement of Risk and Waiver**

Each student must have this form signed by a parent or guardian to participate in any of the Sea Floor Explorer Series programs. Please make sure that you have one signed form for each student and adult chaperone when you check in with Student Services.

#### **R/V Sea Explorer Manifest**

Make sure each student and adult is accurately listed on the manifest.

#### **Program Information Form**

The program information form should be completed and mailed to the Ocean Institute at least one month prior to your program. Use this form to request your missions and inform us of any special needs. This information will help us prepare for your program.

### **STUDENT PREPARATION**

The more familiar the students are with program concepts and content before they arrive, the more they will benefit from and enjoy their experience. We have included background information and a classroom activity to introduce important concepts to your students before they arrive for their program.

### **STUDENT BEHAVIORAL EXPECTATIONS**

Please take time to discuss the academic nature of their field experience with your students before arriving at the Ocean Institute. When at the Ocean Institute, we expect your students to follow the same behavioral rules you have in your classroom.

### **STUDENT SAFETY RULES**

The students will use tools and equipment during the Sea Floor Explorer Day Program. They must wear proper safety gear and follow the instructor's safety guidelines.

### **STUDENT CLOTHING AND SUPPLY LIST**

For safety reasons, students participating in the program must have and/or wear the following clothing.

- Jacket
- Rubber-soled closed-toe shoes
- Hat
- Sunscreen

Optional Items:

- Camera with film
- Money for the gift and book store

### **LAURENA G. CHAMBERS GALLERY BOOK AND GIFT STORE**

*Chambers Gallery* Book and Gift Store is a fun and unique non-profit museum store open daily from 9:00 AM to 5:00 PM and definitely worth the visit. The revenue is directed toward lowering tuition for schools that participate in Ocean Institute programs.

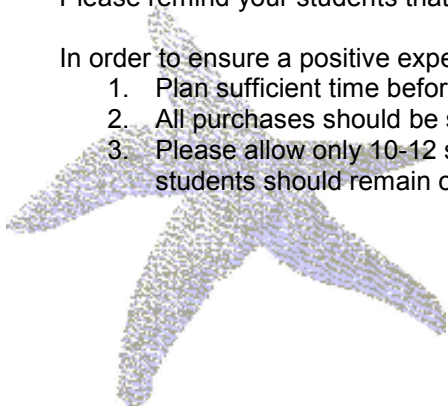
To help accommodate all of the schools that would like to shop each day, please have one teacher from your school check-in with a store staff member before your students begin shopping.

There will be a limit on the number of students allowed to shop at one time and we encourage you to organize them so that they all have time to enjoy the shop. Please have one or two adults in the store to help supervise your students. We ask that all food, drink, and backpacks be left outside while they are shopping. Teachers receive a 15% discount in the shop if members of the Teachers Club and 10% normally.

Please remind your students that sales tax will be added to their items.

In order to ensure a positive experience, we recommend the following:

1. Plan sufficient time before or after your program to shop.
2. All purchases should be stowed safely away and out of sight for the program.
3. Please allow only 10-12 students in *Chambers Gallery* Book and Gift Store at a time. Remaining students should remain outside in a manner that does not interfere with traffic in and out of the building.



**DIRECTIONS TO THE OCEAN INSTITUTE**

The address of Ocean Institute:  
24200 Dana Point Harbor Drive  
Dana Point, CA 92629  
(949) 496-2274

Directions from Los Angeles:

- Travel south on Interstate 5
- Exit on the Pacific Coast Highway Exit
- Stay in the right lane of the exit ramp and go north on P.C.H.
- Turn left onto Dana Point Harbor Drive
- The road ends in the Ocean Institute parking lot

Directions from San Diego:

- Travel north on Interstate 5
- Exit on the Beach Cities Exit
- Stay in the left lane of the ramp and go north on P.C.H.
- Turn left onto Dana Point Harbor Drive
- The road ends in the Ocean Institute parking lot



## E. BACKGROUND INFORMATION

**Seismology** is the study of earthquakes and the Earth using seismic waves. Seismology is a young science, only about 130 years old. Before scientific studies began, ideas about earthquakes were largely based on myth and superstition. However, information about an earthquake's source, magnitude, location, time of occurrence, and depth may be derived from recordings of earthquake-generated waves. Since nearly three-fourths of the earth is covered in water, many earthquakes occur in our oceans. At 9°50'N, ocean-bottom seismometers recently recorded the microearthquake of a mid-ocean ridge eruption. Activity at this site has increased gradually since seismic monitoring began in October 2003. This suggests that eruptions may be more common during the fast seafloor spreading movement.

**Coring** is the process of extracting long plugs of sediment and rock layers from the sea floor. This technology has been developed to descend through thousands of meters of water, drill deep into the Earth in very specific locations, and be retrieved so that the sediment can be analyzed. The seafloor is a good place to study the history of the planet, specifically the ocean basins, because the sea floor undergoes fewer disturbances than does land.

The seafloor receives a continuous supply of particles from many sources. Scientists study the distribution, rate of accumulation, and origins of sediment that has accumulated on the seafloor over millions of years. *Biogenous*, or organic sediment, forms almost entirely from the shells of single-celled organisms that deposit slowly over time. If the sediment is 30% or higher biogenous sediment by weight, it is known as *ooze*. *Calcareous ooze*, the most abundant of all biogenous sediments, comes from organisms whose shells (also called *tests*) are calcium-based, such as those of foraminifera, a type of zooplankton. *Foraminifera* are one of the most abundant types of zooplankton and are widely distributed throughout the surface of the world's oceans. *Siliceous oozes* are made up of the remains of *diatoms*, a microscopic phytoplankton, and *radiolaria*, a microscopic zooplankton. Because they are primary producers, diatoms are found in nutrient-rich areas of the ocean.

Sediment can also be of inorganic origin. Sediment derived from rock is called *lithogenous*. This is true of volcanic ash and basalt, which comes from igneous rock found deep in the Earth. If sediment comes from outer space, it is called *cosmogenous*. Sediment is also classified by the location of deposition and source. *Terrigenous* sediment is derived from land and found in the shallow water of the continental shelf. There are many different processes that control the rate and location of deposition including rivers, ocean currents, icebergs, water chemistry, and climate change.

**Archaeology** is the study of past human civilizations. Underwater archaeology is practiced in a submerged or underwater environment and includes survey, documentation and excavation. It appears underwater sites will yield the largest and greatest number of new finds over the next decades.

Only one percent of the world's oceans have been surveyed or explored. A site of extensive interest is Port Royal, Jamaica. Excavation at this site adds to the story of our human history as well as tectonic history. Port Royal, Jamaica was a significant port city of the New World and served as a major port in trade routes, particularly for slaves, sugar, and raw materials. It was a pirate city, run by privateers (pirates sanctioned by governments) and was known as the "wickedest city on Earth." On June 7, 1692 a massive underwater earthquake occurred causing 66% of the largest and wealthiest English settlement in the New World to slide into the harbor. It is estimated that 2,000 people were killed immediately by the earthquake and an additional 3,000 people died of injuries and disease in

the following weeks. Even after that catastrophic day, more sections of the town continually sank and shifted due to liquefaction caused by the disturbance from the original earthquake.

Port Royal is the only sunken city in the New World. Geologic setting played a major role in its development and eventual destruction and preservation. Jamaica sits on the edge of the Caribbean plate, which remains relatively stationary while the North American plate is being pushed westward. Earthquakes occur around the periphery of the entire plate. The town was also constructed on the widened end of a long, narrow sand spit. Buildings were constructed on unconsolidated, waterlogged sand making the area prone to liquefaction. This is a phenomenon in which an earthquake reduces the strength and the stiffness of a soil. When the earth is still, the water pressure in the soil is relatively low. When an earthquake occurs, the water pressure rises and fills the spaces between the soil particles. The soil particles are then able to move with respect to each other and objects sitting or built on top of the soil sink.

**Remotely Operated Vehicles** are unmanned submersibles that can be piloted by a distant operator. As no on-board crew is needed, there is no need for the extensive life support and safety systems necessary for a manned submersible. Nor is there any risk of taking a human being into the hostile depths of the sea.

ROVs have been used since the 1950s. Initially used as devices for recovery and manipulation by various navies, their advantages have more and more been utilized in the various fields of marine science. Since the cost of their creation, use and support is much less than that of a manned submersible, access and exploration of the deep ocean realm has been greatly expanded. ROVs are now commercially available and range from the size of a breadbox to the size of a large automobile and can be equipped for scientific, industrial and military uses.

## F. CLASSROOM ACTIVITY

*Introduce your students to vocabulary and background information before participating in the Ocean Institute field trip. Divide the class into three research teams to investigate and answer the following questions. You may wish to assign students to present their findings and information to the class, or come up with activities to illustrate these concepts.*

### CORING

1. Why are scientists interested in studying cores from the sea floor?
2. Why do cores have layers?
3. What are foraminifera? What can they tell us about the Earth?
4. List one type of sediment you may find on the sea floor near a tectonically active area.

### ROVS

1. What does ROV stand for?
2. What are some jobs ROVs can do for scientists in the field?

3. What is the average depth of the ocean? How deep can humans go on just scuba?

### **UNDERWATER SEISMOLOGY/PLATE TECTONICS**

1. List three geologic features found on the sea floor of the Pacific Ocean.
2. Why would a scientist be interested in looking at an underwater spreading center?
3. What plate boundaries affect California?
4. What does a seismometer do?
5. How does SONAR work?

### **UNDERWATER ARCHAEOLOGY**

1. Where is Port Royal and how is it historically significant?
2. What are the primary steps in archaeology and why is every step so important to follow?
3. How is SONAR used to help locate shipwrecks – what else can sonar detect underwater?
4. How do archaeologists find deep-water wrecks? Why are these wrecks usually found more intact than other wrecks found in shallower waters?

