JOIDES Resolution Outreach Network Hands-on activities descriptions and talking points

This guidebook provides information on how to prepare for, set-up and facilitate each of the hands-on activities included in the JRON event kit. Each of these activities will ideally have a facilitator nearby to encourage visitors to check out the activity, answer their questions and engage the visitors in conversation.

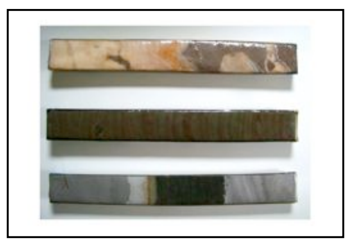
For each activity you will find:

- A brief description of the activity
- A list of all materials needed for each activity
- A description of what needs to be done to facilitate the activities
- A list of the main talking points to convey to the visitors, as well as links to sites with more comprehensive background information for each activity.

What is a core?

Core replicas

Visitors can examine actual-sized, ceramic core replicas and engage in a discussion with the *JR* facilitators about what cores are and how the *JR* collects them.



Materials:

- 1 or more ceramic core replicas

Talking points / Background information

- Cores are scientific samples that are collected as long tubes of material. They are a way to examine the physical and chemical properties of the layers buried underneath a surface. On the *JR*, cores are collected through drilling the sea floor. Other scientists collect cores from dry land, the bottom of aquatic environments, ice sheets and glaciers.

- For more background information specific to *JR* cores, visit http://joidesresolution.org/node/266 & http://joidesresolution.org/node/267 & http://joidesresolution.org/node/272
- The *JR* contains a variety of sophisticated equipment, including the eyes and minds of about 30 scientists per science team, to describe the physical and chemical properties of each core. They will later use the data from core description to help answer a variety of scientific questions. For more information on the scientific use of cores from the *JR,* visit: http://joidesresolution.org/node/1751
- For specific background on each of the core replicas that may be used during a JRON event, visit http://joidesresolution.org/node/3297

What is the *JOIDES Resolution*?

JR papercraft models

Visitors can make their own *JR* papercraft model to take home with them. Visitors cut out the pieces they need from a model sheet and follow the directions to assemble. Tape can be used to ensure pieces hold together.

Materials:

- 50 or more copies of the *JR* papercraft model sheet
- 2 or more pairs of child safety scissors
- 2 or more rolls of transparent tape

Talking points / Background information

- The papercraft model is a simplified model of the *JR* that allows you to discuss some of the key features of the ship**.**
  - The Bridge/Berthing/Scientific Lab Stack: This includes the living spaces, the lab spaces and the bridge where the captain and crew navigate the ship. Point out that, though this makes up less than half of the ship, it is the place most of the people live and work while they are at sea.
  - The Derrick: Is 202 feet above the waterline.
  - The Crane: Loads all needed items on the *JR* before it departs on the expedition.
  - The Helideck: Does not normally have a helicopter on it, but provides a landing place for a helicopter if one ever has to fly to the ship while it is at sea.
  - Detailed info about some of the features of the JR can be found here: http://www-odp.tamu.edu/publications/tnotes/tn31/jr/jr.htm

JR Drill Sites Inflatable Globe and floor mat

Visitors can examine an inflatable globe and a floor mat that depicts many of the *JR* drilling sites, allowing people to see that the *JR* is a global operation that has traveled and drilled the seafloor all over the world.

Materials:

- 1 or 2 *JR* Drill Site inflatable globes

Talking points / Background information

- The *JOIDES Resolution* conducts expeditions in the ocean all over the world. It is not specifically US based, but is an international collaboration of scientists.

- For a detailed list of past expeditions: http://iodp.tamu.edu/scienceops/expeditions.html
- For printable maps of past expeditions:
- http://iodp.tamu.edu/scienceops/maps.html
- For upcoming schedule of expeditions: http://iodp.tamu.edu/scienceops/

Drill bit cutting shoe
Visitors can examine a drill bit cutting shoe that was used on the *JR*. This can be used to answer questions and start discussions about how the JR drills the ocean floor.

Materials:

- 1 drill bit cutting shoe
- Laminated image of drill bit with cutting shoe identified

Talking points / Background information

- The cutting shoe is part of the drill bit. The drill bit is about the size of a not-exactly-round basketball made of metal. The cutting shoe is like a cookie cutter within the drill bit that cuts out the seafloor in the shape of a long cylindrical core.
- As the drillbit drills down into the seafloor, the cutting shoe eventually becomes worn down and ineffectual and has to be replaced in order for drilling to continue. This is one of the cutting shoes that was used on the *JR* during an expedition (though we don't know where).
- Drillbits recover 9.5 m long core samples at a time.
- Specifics of this particular cutting shoe (if someone is curious): It is a XCB cutting shoe used primarily in sediments to recover core samples from soft to moderately hard formations. It will retract once it hits igneous basement, as hard rock will destroy

this cutting shoe. It is used ~400 to 700 m deep and typically drills 30 to 12 m/hr.

- More detailed info on drill bits: http://joidesresolution.org/node/1706

Dynamic Positioning activity

To give an idea of how difficult it is for the *JR* to lower drill pipe with pinpoint accuracy into a drill site on the seafloor while being pushed around by currents, waves and wind, visitors attempt to lower a thread into a film canister while a small fan blows the thread around. Visitors can then learn why the *JR* needs dynamic positioning and thrusters to hold the ship in place while drilling.

Materials:

- Spool of thread
- Cordless, portable fan
- Film canister
- Laminated graphic of diagram of JR that shows thrusters

Facilitating tips

Whenever someone wants to participate in the activity, place the film canister on the floor near the fan, and just be careful it doesn't get stepped on. Have the visitor stand over the film canister and slowly unroll the thread to try to get the end into the film canister while adjusting to the breeze from the fan.

Talking points / Background information

- The *JR* is able to stay on location at a drill site despite sitting atop the moving ocean. This is because of the dynamic positioning system that uses GPS and thrusters

to hold the *JR* in place, despite the wind, waves and currents moving it around.
  - Detailed info about dynamic positioning: http://joidesresolution.org/node/7 & http://joidesresolution.org/node/1824

JR Length & Depth activity

To give visitors an idea of the scale of both the *JR* and of ocean drilling, help them measure themselves in centimeters with a tape measure, then use their height as a unit of measure to figure out how many of themselves would have to be stacked on top of each other to be as tall as the derrick, as deep as the deepest drilling site, or other lengths and distances related to the *JR*.

Materials:

- Calculator
- Metric tape measure
- Scrap paper
- Pencils
- Laminated sheet with JR lengths and distances in centimeters and feet as well as conversion formula

Talking points / Background information

- This activity is just to give visitors a sense of the scale of the *JR* in an interactive way. Distances will be listed on the laminated sheet, as well as instructions on how to do this activity.
- Detailed ship specifications: http://www-odp.tamu.edu/publications/tnotes/tn31/pdf/jr_ship.pdf

Survival Suit

Visitors can see and even try on a survival suit from the *JR*. Visitors will be most likely to try if there is a volunteer there to encourage them. A volunteer can also wear the survival suit to bring visitors attention to the activities.

Materials:
- Survival suit

Talking points / Background information
- Survival suits are one of the safety precautions to protect everyone during an expedition on the *JR*. Everyone onboard is issued a survival suit, which is a waterproof drysuit to prevent hypothermia and provide flotation in case of the need to abandon ship. Each one also has a strobe light and radio beacon, to help find the person if they are in the water.
- Video about safety on the *JR*: http://vimeo.com/29849739

What are microfossils?

Microfossils under the microscope
As an introduction to microfossils and their importance to the research of scientists on the *JR,* visitors can view under a microscope prepared slides of microfossils collected by the *JR*. They can also look at seafloor sediment samples containing microfossils, view "stuffed animal" enlarged models of microfossil species, and look at a sieve from the *JR* used by scientists to separate out fossils from a sediment sample.

Materials:
- Microscope
- Extension cord
- Prepared slides of microfossils collected on the *JR*

- Sediment samples collected on the *JR*
- Stuffed models of microfossils (species: *Pulleniatina primalis*, *Globigerinoides ruber*, and *Triactinosphaera sp.*)
- Sieve from *JR*

Talking Points/Background Information

- Every expedition's science team includes paleontologists whose job is to identify any fossils found in the cores. Most fossils are microfossils. However, *JR* scientists do occasionally find larger fossils such as bivalve shells or shark teeth.
- Microfossils come from the hard, shell-like structures of microscopic organisms such foraminifera, diatoms, radiolarians, and discoasters. These shell-like structures are so durable they will stay intact millions of years after the organism that created them has died.
- There are so many foraminifera, diatoms, radiolarians, and discoasters in the ocean that most deepsea sediments are made-up of microfossils. Continental shelf sediments have more sands and clays in the sediments, because they are close enough to the coast to receive the eroded sediments that rivers continuously discharge into the ocean.
- In cores, microfossils are primarily found in the sediment layers, or in the limestone layers of solidified calciferous sediment.
- *JR* scientists separate out microfossils from other sediment by washing sediment samples in very fine-holed sieves. This washes away clays in the sediment samples, while leaving the microfossils in the sieve so they can then be place upon microscope slides and observed and identified under a microscope.
- Much can be learned by identifying microfossils in the cores. For example, index fossils can be used to quickly determine a date range for the core being observed. By knowing the temperature range a microorganism species can survive in, scientists can also use the microfossils of those species to determine the climate of the ocean at the

time that layer was deposited. This can be used to help determine past climate change.
- For more detailed information about microfossils and how JR scientists use them:
  - http://joidesresolution.org/node/794
  - http://joidesresolution.org/node/290
  - http://odplegacy.org/PDF/Outreach/Brochures/Greatest_Hits/Rhythms/Katz.pdf
  - http://odplegacy.org/PDF/Outreach/Brochures/Greatest_Hits/Rhythms/Barron.pdf
  - http://odplegacy.org/PDF/Outreach/Brochures/Greatest_Hits2/Thomas.pdf

How has the *JOIDES Resolution* helped us better understand volcanoes, seafloor spreading and plate tectonics?

Mini-Mount St Helens activity

To get visitors' attention, we'll use the popular hands-on science museum activity of having visitors put effervescent tablets in water to blow the lid off a film canister. We'll explain the pressure that blows the lid off the film canister is similar to the pressure that builds up under subduction volcanoes, such as Mount St Helens, that eventually causes these volcanoes to blow their tops. They can visualize what causes subduction volcanoes by looking at the 3-D Ocean Geology model and also see where the Ring of Fire is located by looking at the plate tectonics map/puzzle.

Materials

- At least 10 film canisters with tight seals
- At least 25 effervescent tablet packages
- Water bottle with narrow mouth for easy pouring
- Water

- Plastic container for collecting water after eruption
- Laminated photos of 1980 Mount St Helens eruption
- Safety goggles
- Paper towels

Facilitating Tips

You can think of this activity as bait. It will get people's attention, particularly kids, and make them want to come over and hopefully interact with the rest of the *JR* activities.

To start presenting this activity to visitors, ask them if they know how an eruption can blow the top off a volcano. Tell them they can do an activity to see how that can happen. Have the visitor put on the safety goggles. Fill a film canister about half to ¾ full with water from the water bottle. Give about ¼ of an effervescent tablet to the visitor to drop in the film canister. Put the lid on tightly and have the visitor hold the canister straight up so the lid is facing the ceiling and definitely not at any people. Hold the plastic container for collecting water under the canister to minimize spillage. Tell the visitor they will have to wait about 30 seconds before anything will happen, then the lid will pop off and go about 10 to 20 feet in the air. Have visitor pour water in the film canister into the plastic container for collecting water. Retrieve the lid. If the lid is not blown off, it may no longer have a tight enough seal and gas is escaping rather than building up pressure, so set it aside and start using a new canister.

Talking Points/Background Info

- The exploding film canister and an exploding volcano both blow their top because of excessive pressure that builds inside. The film canister explodes because of the air pressure from the gas released by the effervescent tablet/water reaction. The volcano explodes because of the pressure from the rising magma and gases inside it.
- Mount St. Helens is most famous for blowing its top in a catastrophic eruption on May 18, 1980. It was the deadliest

and most economically destructive volcanic event in the history of the United States.

- Mount St Helens is part of the Cascades Range, which is part of the Pacific Ring of Fire, the ring of volcanoes and associated mountains around the Pacific Ocean. These volcanoes are created by subduction zones, where the oceanic plates associated with the Pacific Ocean sink underneath the continental or other oceanic plates. As these plates sink into the hot interior, the seafloor rock melts into magma, rising up to form volcanoes.
- Our understanding of how subduction works has been greatly increased because of ocean drilling. The *JOIDES Resolution* has had a number of expeditions that specifically study subduction zones.
- If anyone asks how the effervescent tablets create pressure:
    - Effervescent tablets contain both acids (aspirin) and bases (baking powder). When acids and bases come in contact with each other, they always produce a reaction. When the effervescent tablets are solid, the molecules of the acids and bases cannot move to interact with each other, so no reaction occurs. When added to water, the water dissolves the tablet, releasing the molecules. This allows the acids and bases to come in contact with each other, which leads to the reaction that releases the carbon dioxide gas that creates pressure.
- For more detailed info on Mount St Helens and subduction volcanoes:
    - http://www.geology.sdsu.edu/how_volcanoes_work/Sthelens.html
    - http://volcanoes.usgs.gov/volcanoes/st_helens/st_helens_geo_hist_101.html

Visualizing Subduction and Seafloor Spreading
A 3-D model of ocean geology helps visitors visualize and understand the processes of subduction and seafloor spreading. It can be used to further explain both the Mini Mount St Helens activity and the Seafloor Spreading activity.

Materials:
- 3-D Ocean Geology Model

Facilitating Tips
One side of this model shows the interior processes associated with seafloor spreading and the other side shows the processes associated with subduction, so you will need to turn the model around regularly to make sure the visitor can see the side displaying the process being discussed.

Talking Points / Background Info
- The *JOIDES Resolution* has greatly expanded our knowledge of ocean floor geology and the interior processes that create seafloor and coastal geologic features. Much of the confirmation of plate tectonics theory has come from ocean drilling.
- Seafloor spreading occurs where plates diverge creating rift in the seafloor, where magma from the Earth's interior then rises and solidifies into new seafloor. The seafloor spreads in two opposite directions. See Seafloor Spreading Activity Talking Points for more background on seafloor spreading.
- Subduction occurs where the dense ocean plate sinks beneath a less dense continental plate (or in some place a less dense seafloor plate). As the ocean plate sinks into the hot interior of the Earth, the seafloor rocks melt quickly, because they are saturated with water, which lowers the melting temperature of rock. This quickly melting rock rises up parallel to the subduction zone, creating chains of volcanoes, such

as the Cascade Range in yhe Pacific Northwest of North America.
- For more detailed info:
    - http://www.platetectonics.com/book/page_12.asp
    - http://volcano.oregonstate.edu/subduction-zone-volcanism
    - http://www.pmel.noaa.gov/eoi/nemo/explorer/concepts/mor.html

Seafloor Spreading Activity

This activity will show how seafloor becomes older the farther away you measure from a spreading center. Visitors spread paper out from the paper rolls a little on both sides and then draw close to the spreading center a line on both pieces of paper with a crayon and write the time down. They can then compare the time of their lines to the times of the lines drawn earlier by other visitors to see how it gets older the farther one is from the center. Visitors can then look at a Google Earth overlay on the iPad that shows actual cores from *JOIDES Resolution* drill sites that revealed the age increases of seafloor as you get farther from the spreading center. They also can look at a Google Earth overlay showing lithosphere ages around the world. They can further visualize how seafloor spreading works by looking at the 3-D Ocean Geology model.

Materials:

- Seafloor spreading model
- Two rolls of black paper, fitted for model
- Box of light colored crayons to write on black paper
- Small battery powered clock.
- Basalt rocks from the seafloor
- iPad with Google Earth and these Google Earth overlays (http://nachon.free.fr/GE/Welcome.html & http://oceanleadership.org/education/deep-earth-

academy/educators/classroom-activities/grades-5-8/an-expedition-to-the-seafloor/)

Talking Points/ Background Information

- The seafloor of the world's ocean contain numerous spreading centers, places where the seafloor splits apart, and magma rises up to cool, solidify and create new seafloor rock.
- Because of seafloor spreading, the farther you travel from a spreading center the older the rock becomes.
- Scientists were first able to conclusively prove seafloor spreading is occurring because of ocean drilling. On its third expedition, the JR's predecessor, the Glomar Challenger, drilled a series of holes in the seafloor in a line moving away from spreading center. They radiometrically dated the cores and saw it did indeed get older the farther you traveled from the spreading centers. The cores can be seen in the Google Earth overlay.
- Ocean rock is much younger than the vast majority of continental rock. Rarely does oceanic crust get over 150 million years old, while some continental crust is over 4 billion years. This is because seafloor spreading continuously (though slowly to our perspective) creates new ocean rock, while subduction zones recycle the old ocean rock.
- More detailed info:
    - Seafloor spreading is the result of convection currents of molten material within the asthenosphere (because of pressure, the molten material within the asthensphere is about the consistency of silly putty, but it still can flow). The molten material down near the core becomes really hot and rises up to the lithosphere. The lithosphere then becomes weaker in the places where all that hot, molten rock is pushing up against it. The lithosphere is like a ceiling, though, that stops the current of asthenosphere from completely breaking through. Instead, the current is forced to flow along underneath the lithosphere. As the current flows

under the lithosphere, it actually drags the lithosphere with it. When the lithosphere is dragged, it cannot stretch, so it ends up breaking open in the same weak spot where the asthenosphere current first rises up to meet it. Some of the asthenosphere magma then fills the gap in the lithosphere as lava. When the lava comes in contact with ocean water it immediately cools into rock, adding to the seafloor and causing it to spread out.

- http://oceanleadership.org/education/deep-earth-academy/educators/classroom-activities/grades-5-8/an-expedition-to-the-seafloor/

Plate Tectonics Map

A laminated plate tectonics map will allow visitors to see where plate boundaries are located in the Earth's lithosphere. Use this to help visitors visualize where the spreading centers, subduction zones and the volcanoes of the Ring of Fire (discussed in the other activities) are located.

Materials:

- Laminated plate tectonics map

Talking Points/ Background Information

- Introduce visitors to the fact that the Earth's lithosphere (the crunchy part of the Crust) is broken up into numerous plates. The boundaries tend to be the spreading centers and subduction zones discussed in the accompanying activities. (Some boundaries also create mountains, such as the boundary under the Himalayas).
- There are ocean plates and continental plates. One of our geographic oceans is usually underlain by more than one plate.

- Ocean plates are less dense than ocean plates, which is why they will subduct under continental plates. This is happening all around the Pacific Ocean, creating the Ring of Fire.
- For more detailed info:
    - http://pubs.usgs.gov/gip/dynamic/dynamic.html