THE INTEGRATED OCEAN DRILLING PROGRAM BEGINS!

EARTH2CLASS WORKSHOPS FOR TEACHERS at LAMONT-DOHERTY EARTH OBSERVATORY

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During Summer 2004, Gerry Iturrino and Jonathan Rice participated in the first leg of the Integrated Ocean Drilling Program (IODP.) In this part of today’s program, I will provide some general background information about ocean drilling, and the IODP in particular. They will tell you more and describe their experiences.
• Early sailors had little interest in the sea floor as long as it was deep enough for their vessel to “swim.”

• To measure depth, they dropped lead-weighted lines overboard to determine how many fathoms (6 feet) or other depths of water lay beneath the keel.

• Side note: Sam Clemens took his pen name—Mark Twain—in part from the leadsman cry meaning 12 feet deep
• The first real need for more detailed knowledge about the deep ocean floors came with attempts to lay telegraph cables across the oceans.

• First efforts before the Civil War were unsuccessful, but in 1869, the first trans-Atlantic telegraph cable linked North America and Europe, opening a new age in communication.
HMS Challenger circumnavigated the world from 1872 - 72 in the first major scientific study of the oceans.

• http://www.wshs.fcps.k12.va.us/academic/science/bjewell/ocean/hhocean/final/chall.htm
One of the main reasons for this voyage was to learn more about the sea floors so other cables could be laid down. Like all vessels up till then, HMS Challenger determined depth by dropping a weighted line. Her approximate measurements permitted the first general understanding of the topography of the ocean bottoms.

In this way, we learned that there are great mountain ranges, deep trenches, flat abyssal plains, volcanoes, and many other features hidden beneath the waves. .
SONAR

• In the 1920s, a new technique—SONAR--was developed.

• **Sound Navigation and Ranging** provided a rapid method of looking through water to identify features in the water beneath a vessel and on the sea floor.

• The next slide represents how a ship can send down a signal and detect the echo.
P(ic)assow
So what do we know in general about the ocean floors

There are several basic “zones”:

• **Continental margins** (continental shelves, continental slopes, and continental rises)

• **Abyssal plains** (which may contain abyssal hills, sea mounts, and guyots)

• **Mid-Oceanic ridge system** (largest mountain range in the world, with central rift valley)

• **Deep-sea trenches, island arcs**, and other marginal features
Heezen and Tharp's "physiographic maps"

- SONAR was widely employed in WW II, and many records became available after the war.
- Dr. Bruce Heezen and Marie Tharp here at Lamont developed techniques beginning in the 1950s to change these 2-D records into 3-D physiographic charts, a drawing technique developed by their Columbia professors E. Raisz and A. K. Lobeck.
Making the Sea Floor Visible

- Marie Tharp often commented that she was part of the only effort that could start with blank paper and make the hidden features of the sea floor known to the world.
- Their first effort—the North Atlantic—was published as a Geological Society of America “Special Paper” in the late ’50s.
- The National Geographic Society contracted to have this and later efforts published as featured maps (and, later, globes).
Atlantic Ocean

- Symmetrical—continental margin/abyssal plains/MOR/abyssal plains/continental margin
- Formed by spreading of Americas away from Europe and Africa
- Relatively few trenches and island arcs (Caribbean)
- Marginal seas (Gulf of Mexico)
Pacific Ocean

- Largest and oldest ocean basin (but younger than continents)
- Asymmetrical—East Pacific Rise and Pacific-Antarctic Ridge
- “Ring of Fire”—trenches, island arcs, and volcanic mountain ranges, such as Andes
- Many sea mounts and guyots
Indian Ocean

- Similar to Atlantic, but symmetrical about an “upside-down Y” created by a “triple junction”
- Mostly in southern hemisphere; Antarctic, African, Australian, Indian, and Asia plate movements
- Java and other trench-island arc systems (Krakatoa)
The Arctic Ocean

• Smallest of the ocean basins
• Almost entirely land-locked except for its connection with the North Atlantic
• Very wide continental shelves
• Lomonosov Ridge divides the North American (Canadian) Basin from the Eurasian (Nansen) Basin
You can learn more about the ocean features through “The Warfighter’s Encyclopedia” of the US Navy

- **Atlantic:** [http://wrc.chinalake.navy.mil/warfighter_enc/oceans/Atlantic/atlfloor.htm](http://wrc.chinalake.navy.mil/warfighter_enc/oceans/Atlantic/atlfloor.htm)
- **Pacific:** [http://wrc.chinalake.navy.mil/warfighter_enc/oceans/Pacific/pacfloor.htm](http://wrc.chinalake.navy.mil/warfighter_enc/oceans/Pacific/pacfloor.htm)
- **Indian:** [http://wrc.chinalake.navy.mil/warfighter_enc/oceans/Indian/indfloor.htm](http://wrc.chinalake.navy.mil/warfighter_enc/oceans/Indian/indfloor.htm)
- **Arctic:** [http://wrc.chinalake.navy.mil/warfighter_enc/oceans/arctic/arcfloor.htm](http://wrc.chinalake.navy.mil/warfighter_enc/oceans/arctic/arcfloor.htm)
- **More about the oceans:** [http://wrc.chinalake.navy.mil/warfighter_enc/oceans/oceansmn.htm](http://wrc.chinalake.navy.mil/warfighter_enc/oceans/oceansmn.htm)
In the 1940s, Jacques-Yves Cousteau and colleagues in the French Navy invented SCUBA (Self-Contained Underwater Breathing Apparatus.) This allowed people to study the shallow floors more efficiently than snorkel or “hard hat” divers.

http://www.cousteausociety.org/people.htm
In the 1960s, Cousteau developed habitats in which “aquanauts” could stay underwater for weeks. His 1964 film “World Without Sun” won an Academy Award.

Shortly afterwards, the U. S. Navy carried out two successful underwater living experiments called “SEALAB.” A third attempt failed, and interest waned.
Piccard’s “Trieste”

In 1960, the U. S. Navy and Swiss inventor Auguste Piccard completed development of the bathyscaphe “Trieste.” This “underwater balloon” took Jacques Piccard and Lt. Donald Walsh to the bottom of the Mariannas Trench. In their 20 minutes there, they proved that life can exist even in the greatest depths of the oceans.
Small manoeuverable research submersibles, such as the “ALVIN” operated by Woods Hole Oceanographic Institution, provide access to deep-sea features not otherwise accessible.

In the late ’70s, Alvin Discovered Hydrothermal Vents in the MOR

- These previously unknown and unimagined features provided new understandings about the very nature of Life

http://www.pmel.noaa.gov/vents/PlumeStudies/BlackSmokers.html
• Modern shipboard and airborne techniques for mapping the ocean floors include “side scan sonar” and high-resolution seismic profiling.

• The next slide provides examples of such images, which are great advances over the 2-D images from the original echo-sounders.
Magnetometers provide another important technique for understanding seafloor geology

- Since iron-rich basalts form the oceanic crust, magnetometers can reveal the paleomagnetic patterns that allow studies of when the seafloor formed.

- Magnetometers revealed that the oceanic basalts erupted at different times, in patterns that preserve a record of magnetic reversals.
Lamont vessels have been collecting samples from the ocean floor for more than half a century. The Deep-Sea Sample Repository houses the greatest collection of materials retrieved from the ocean floors.

The gravity piston corer has long been one of the basic tools used to collect samples of the sediments covering the sea bottom.

“Doc” Ewing began the practice required all Lamont vessels to collect at least one core each day back in the late ’40s.
The Glomar Challenger was the first successful deep-sea drilling ship.

The JOIDES Resolution carries on today with an ambitious deep-sea drilling program.

LDEO houses the East Coast Core Repository. We will visit this and the LDEO Sample Repository in our next E2C Workshop.

- http://www.odp.tamu.edu/resolutn.html
The IODP

• International research program that explores the history and structure of the Earth as recorded in seafloor sediments and rocks

http://www.iodp.org/
• Builds upon the earlier successes of the Deep Sea Drilling Project (DSDP) and Ocean Drilling Program (ODP)

• Expands the reach of these previous programs by using multiple drilling vessels, including riser, riserless, and mission-specific platforms, to achieve its scientific goals

• IODP Teacher at Sea initiative was kicked off when Dr. Jonathan Rice was selected to sail on Expedition 301.
• Jon kept an **on-line journal** during the 25 June – 21 August 2004 cruise.
• Also planned are “Laboratory Briefs” that can be used by teachers and students to learn more about the many activities aboard the JOIDES Resolution
• Learn more in Gerry and Jon’s sections of this workshop.