

GEO/OC 103

Exploring the Deep...

Lab 3

*From: Building Core Knowledge – Reconstructing Earth History’
Transforming Undergraduate Instruction by Bringing Ocean Drilling Science on
Earth History and Global Climate Change into the Classroom*

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Intro to Cores

Part 1. Earth History Archives

- What are **sediments**? Give two examples.
 - What are the **sources** of sediment? Make a list.

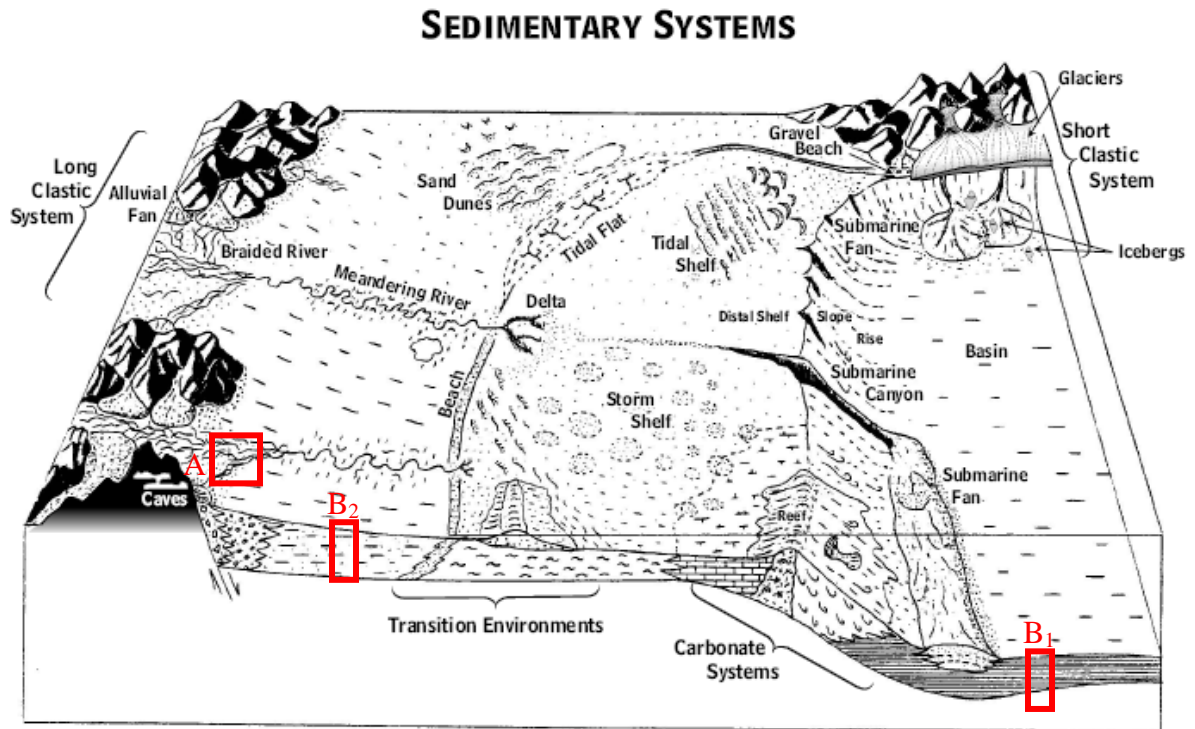


Figure 1.1. Major sedimentary depositional systems. Drawn by Lynn Fichter (James Madison Univ.). A = example outcrop setting, B₁ = example of a core in a marine (ocean) setting, B₂ = example of a core in a terrestrial (land) setting (see related Fig 1.2.).

- Examine the block diagram above (Figure 1.1). *Where do sediments accumulate? Why do they accumulate here?*

Examine the **outcrop** and **core** photos shown in Figure 1.2. These could have originated from locations A & B₁, respectively, in the block diagram (Figure 1.1.)

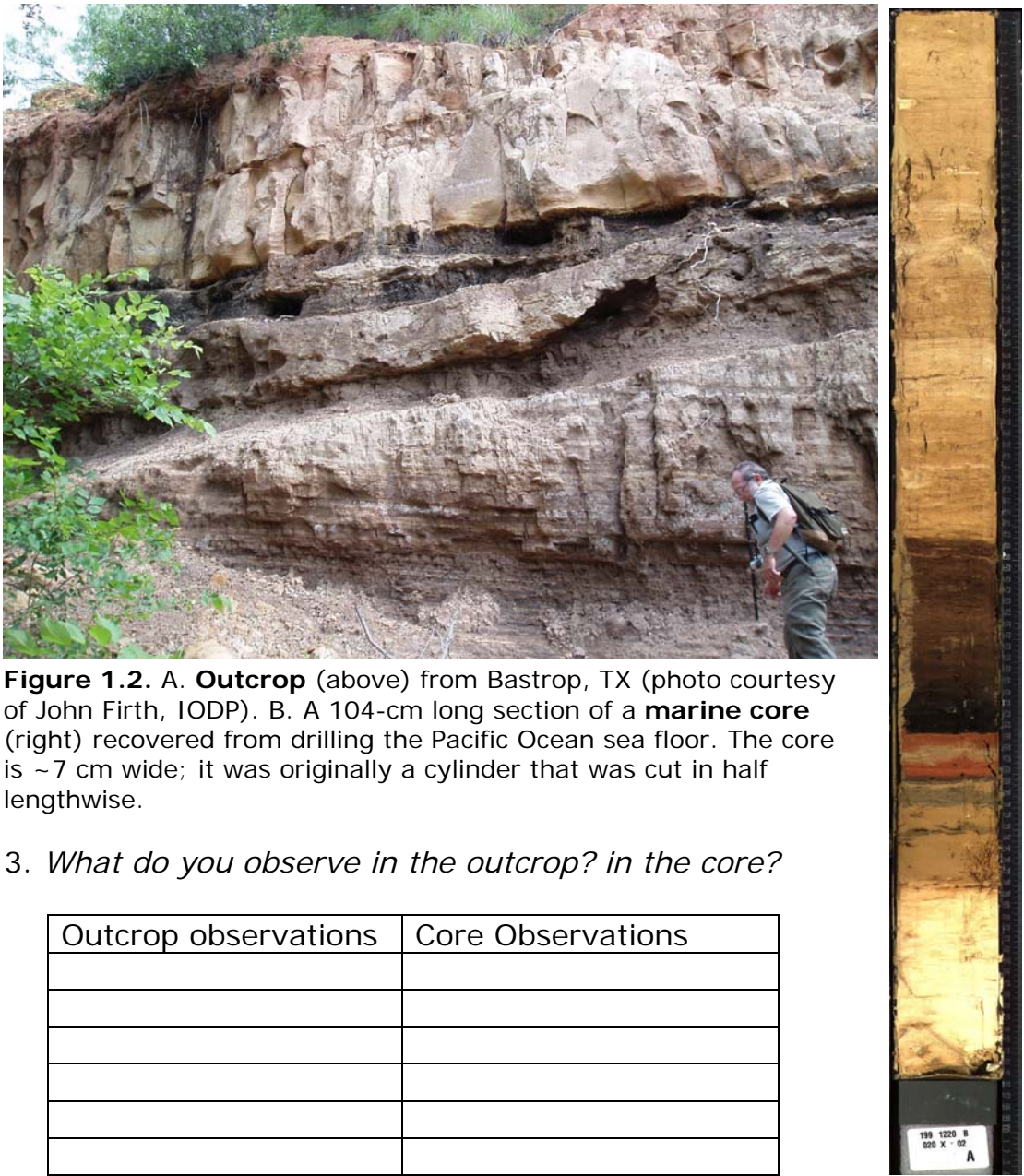


Figure 1.2. A. **Outcrop** (above) from Bastrop, TX (photo courtesy of John Firth, IODP). B. A 104-cm long section of a **marine core** (right) recovered from drilling the Pacific Ocean sea floor. The core is ~7 cm wide; it was originally a cylinder that was cut in half lengthwise.

3. *What do you observe in the outcrop? in the core?*

Outcrop observations	Core Observations

4. In 2 or 3 sentences explain how outcrops are similar to cores and how they are different:

5. *If you were asked to collect samples (get a piece or handful) of the oldest sediment in the outcrop and the oldest sediment in the core, where would you get it from? Place an "X" on the outcrop photo and a "Y" on the core photo indicating your selections (Fig. 1.2). Explain why you selected these locations.*

6. *What characteristics would make a **sedimentary sequence** useful as an archive (record) of Earth's past environmental and climatic change? Do outcrops have these characteristics? Do cores?*

7. Watch a 5 minute video on ocean drilling. Go to: <http://recordings.wun.ac.uk/conf/nwo/oceandrilling2006> and select "Why Ocean Drilling?". *Imagine you have to reconstruct Earth history for the last 5 million years as completely as possible. Which would you choose to use: an archive from the seafloor or an archive from land and why?*



Intro to Cores Part 2. How are ocean cores obtained?

1. *How might cores be obtained from below the seafloor? What types of technology might be necessary to accomplish this scientific task?*

2. Examine the photo below of the drill ship, *JOIDES Resolution* (Figure 2.1) and the diagram of the drill ship's coring system (Figure 2.2, next page). Watch the video "Modernization of the JOIDES Resolution Riserless Drilling Vessel" by going to <http://www.youtube.com/OceanDrilling>. *How are vessels used for scientific ocean drilling specially outfitted to enable them to recover cores from below the sea floor?*

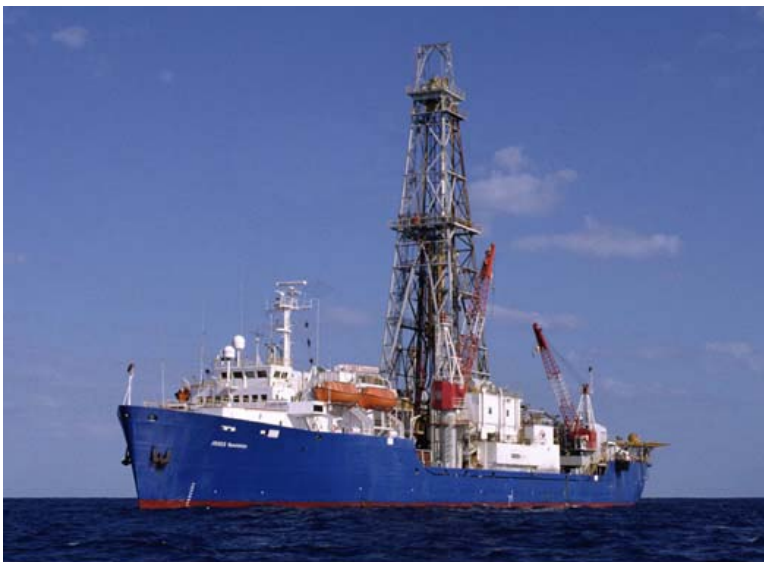


Figure 2.1. Scientific research vessel, *JOIDES Resolution*. For a history of the ship go to: http://iodp.tamu.edu/publicinfo/ship_history.html.

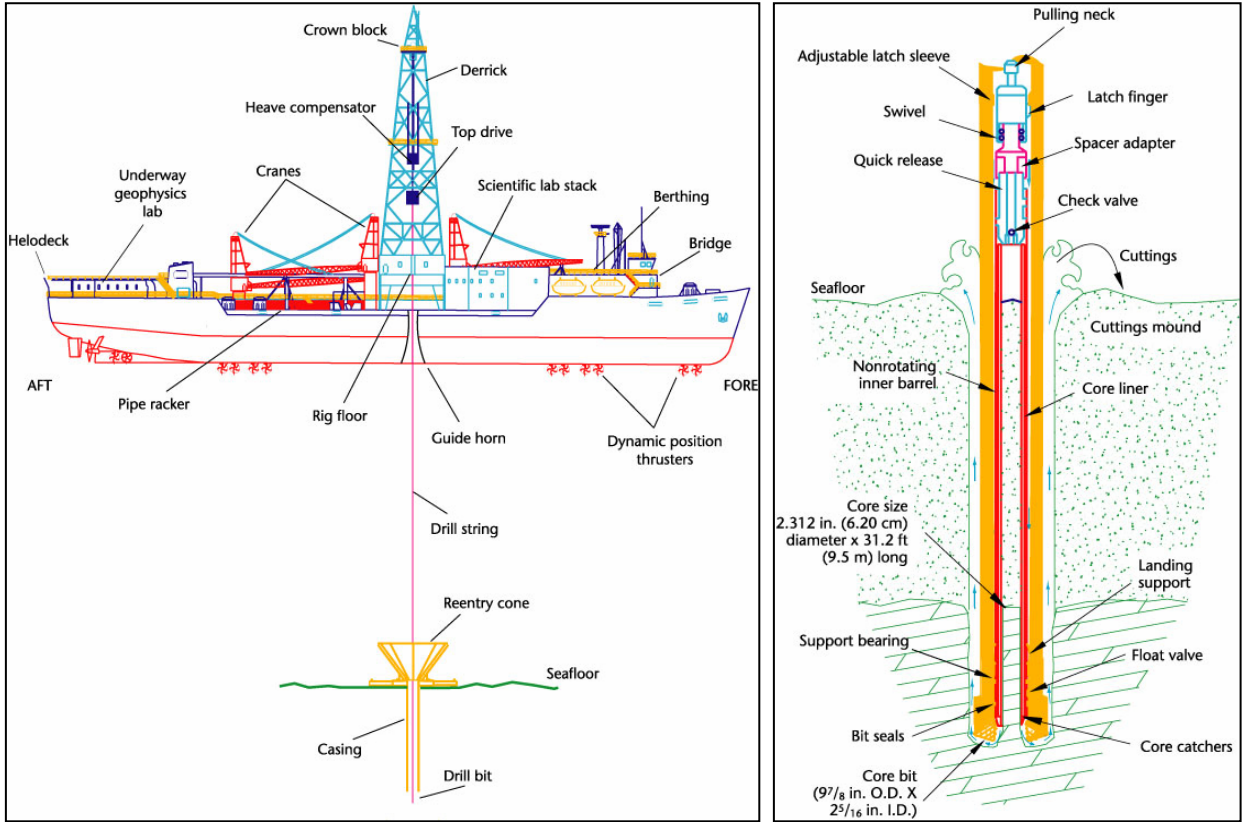


Figure 2.2. (A) Schematic drawing of (left) drilling equipment on the *JOIDES Resolution*. The drilling mode shown is with a reentry cone used to reenter a previously drilled hole. New holes are drilled in bare seafloor without a reentry structure. (B) Schematic of the rotary coring system drilling into bare seafloor. (From http://www-odp.tamu.edu/publications/tnotes/tn31/jr/fig_02.htm and http://www-odp.tamu.edu/publications/tnotes/tn31/rcb/fig_01.htm, respectively.)

3. Examine the map below (**Figure 2.3.**), which shows all of the drill **site** locations from the 40+ year history of scientific ocean drilling **expeditions**. At *each* of these drill site locations several **holes** may have been drilled and tens to hundreds of 9.5-m length **cores** recovered. To more easily carry and store the cores, each is cut into 1.5-meter **sections** (**Figure 2.4.**). The core sections are also split length-wise into a two halves – a **working half**, which is used in sampling, and an **archive half**, which is used for non-destructive analyses and for core photography (**Figure 2.5.**). In total there are currently >40,000 m of core recovered from below the seafloor, and >2.3 million **samples** taken of specific cm-intervals of the core sections. Those are a lot of cores and samples to keep organized! Librarians have much the same problem, so we will see how they keep their collections organized. Let's start by determining how geology resources are identified in a library.

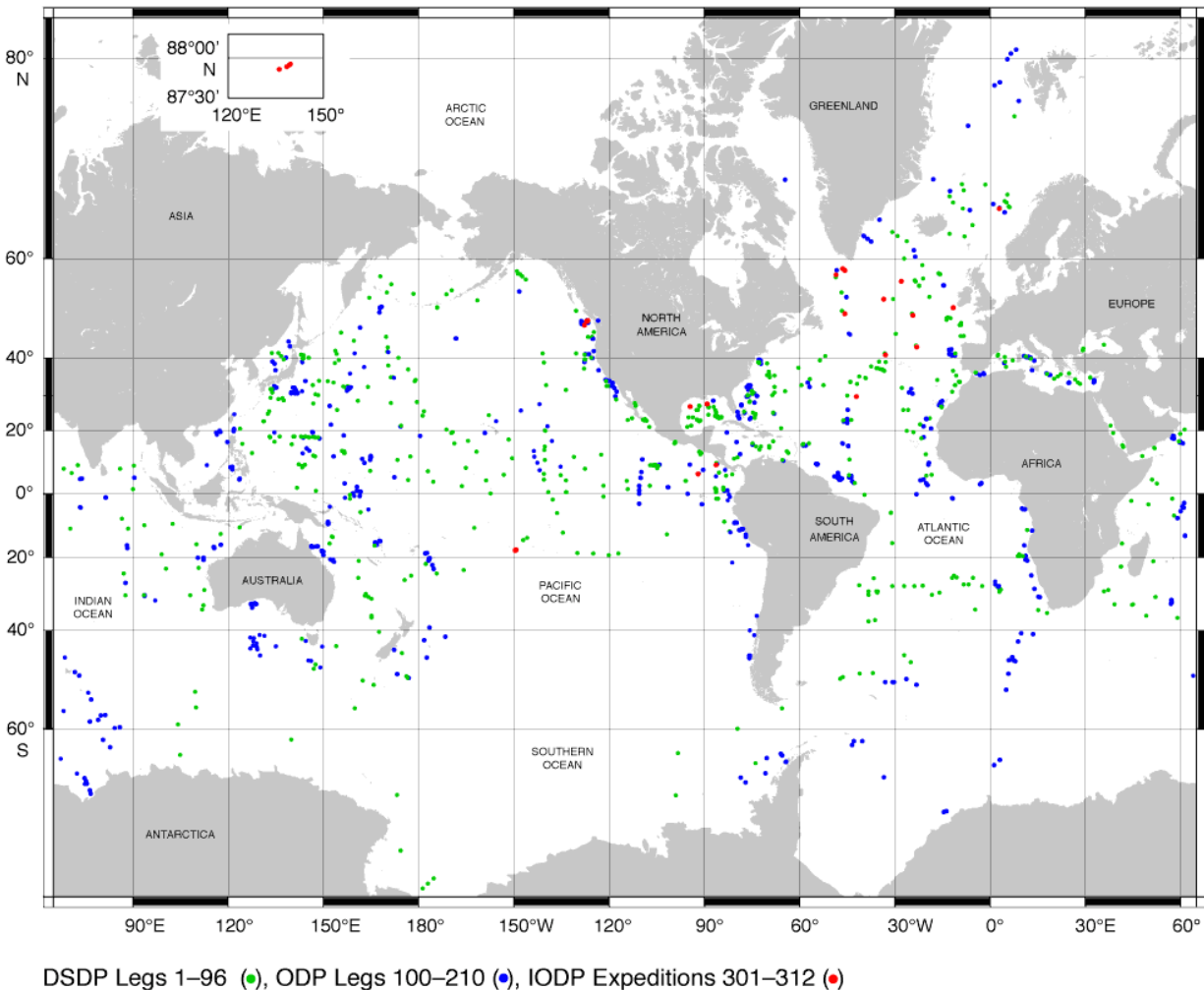


Figure 2.3. Scientific ocean drilling site locations of the Integrated Ocean Drilling Program (IODP; 2003-2013) and predecessor programs, the Ocean Drilling Program (ODP; 1983-2003) and the Deep Sea Drilling Project (DSDP; 1968-1983).

(a) Your job is to find the following in your university library system: the 1987 book Glossary of Geology by Bates & Jackson (editors). *How is this geology book uniquely identified?*

(b) Now go to the U.S. Library of Congress website (<http://catalog.loc.gov/>) and find this same resource. *How is it identified?*

(c) *Think about marine core samples - how could you ensure a unique identification for each sample so that you knew exactly where in the sub-seafloor it came from? List your ideas. Why is a unique identification of samples important?*

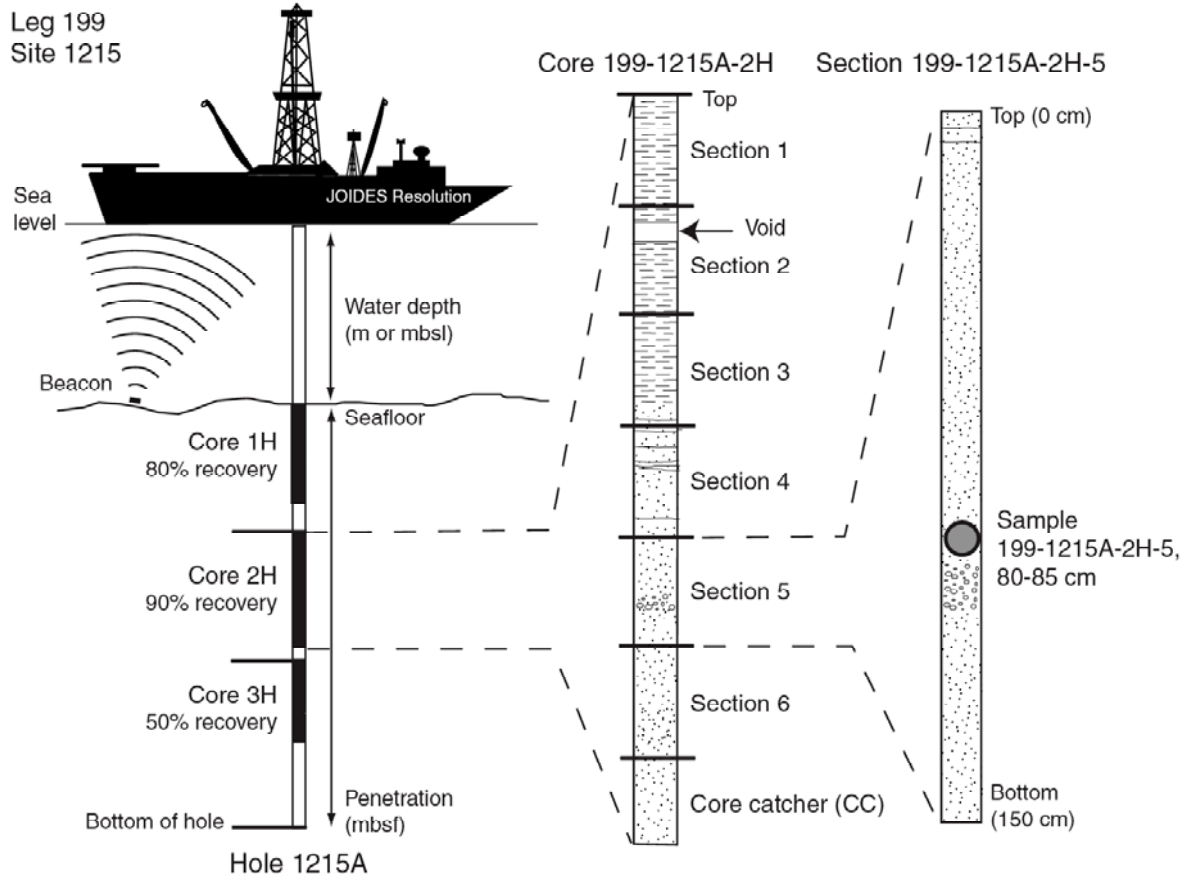


Figure 2.4. Example of coring and core terminology (from ODP Leg [i.e., Expedition] 199 Initial Reports Volume, Explanatory Notes: http://www-odp.tamu.edu/publications/199_IR/chap_02/chap_02.htm)

4. (a) Expedition (Leg) 199 began in Honolulu, Hawaii on October 28, 2001. The *JOIDES Resolution* left port at 0830 hr on 28 October and transited 1158 km to the first drilling location, Hole 1215A, arriving at 2100 hr on 30 October, 2001. Calculate the average rate of travel (i.e., speed) during transit in km/hr and mi/hr.

(b) Hole 1215A was planned for 57.5 hrs of drilling during Expedition 199. During this time they were able to drill 75.4 meters below the seafloor at this single location. *What was the average drilling rate for Hole 1215A?*

(c) While they drilled 75.4 meters below the seafloor at Hole 1215A, they recovered 68.27 meters of core. *What was the percent core recovery for Hole 1215A? Why might the core recovery be less than the maximum drill depth?*

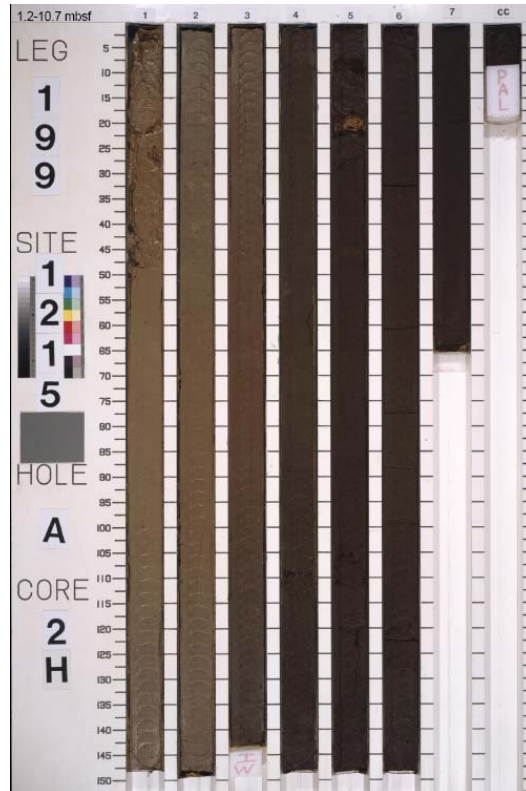


Figure 2.5. Photo of the archive-half of Core 2 from Hole 1215A, located in the central tropical Pacific Ocean. The sections of core are laid out next to each other, left to right. Section 1 of Core 2 is at the top of the drilled interval and the core catcher (CC) is at the bottom of the cored interval. The shipboard paleontologists took a sample (PAL) from the base of the core catcher to provide a preliminary age determination for Core 2. Site 1215 was cored during Ocean Drilling Program Leg (i.e., Expedition) 199. Note that an interstitial water sample (IW) was taken from the bottom of Section 3.

(d) A typical ocean drilling expedition lasts 2 months and costs ~\$6 million. At Hole 1215A on Expedition 199, 68.74 meters of core were obtained during the 57.5 hours of drilling. *What does 1 meter of core from Hole 1215A cost (i.e., what is its value)?*

(e) Sometimes scientific ocean drilling and space exploration (i.e., NASA) are compared because these are both large-scale, technologically dependent programs that are designed to help teams of scientists unravel the history of Earth by exploring in remote and challenging settings. Let's compare the cost of obtaining core from the seafloor to the cost of obtaining rocks from the moon.

The Apollo 11 mission cost \$355 million in 1969. Approximately 21.8 kg of moon rock were obtained on this successful and historic mission to the moon. *What does 1 kg of moon rock cost (i.e., what is the value of 1 kg of moon rock)?*

When you calculated the cost of a seafloor core in question 4d above it was the cost per meter of core. To make a comparison to the cost of the moon rock we need to determine the cost per kg of core (so we will need to convert units). Use your skills in geometry to figure this out: The average density of cores from Hole 1215A is $\sim 1.3 \text{ g/cm}^3$. A core is essentially a cylinder with a radius of 3.5 cm and a length (or height) of 1 meter (100 cm). The volume of a cylinder is equal to $\pi r^2 h$. As in question 4d, a scientific ocean drilling expedition is typically 60 days and costs $\sim \$6$ million. *What is the cost of a kg of core? How does this compare to the cost of 1 kg of moon rock?*

GEO/OC103 Laboratory 3: Marine Sediment Cores

Six examples of marine sediments are available for examination. These come from the eastern Pacific Ocean and are archived at the Northwest Core Repository at Oregon State University. Based on your knowledge of the distribution of major sediment types in the ocean, and some detective work, identify which of the core(s) are associated with which location on the map. Describe what the major sediment components are in the core and the processes responsible for its deposition.

Mystery Cores

