Core Understanding - Core Description and Lithostratigraphy
Teacher Guide

Background

The shipboard sedimentologists are responsible for describing the lithology and stratigraphy of sediments and sedimentary rocks that are recovered by scientific ocean drilling. Lithology is the set of physical characteristics of the rock or sediment. Stratigraphy is a term that refers to the classification, nomenclature (naming), and interpretation of layered rocks and sediment. The sedimentologists provide the first complete visual description of the cores. This is important because it will be used: (1) by shipboard and shore-based scientists as the basis for further sampling and study, and (2) for forming the first general conclusions about the geologic history of the drilling site. The shipboard sedimentologists have considerable responsibility to the scientific community at large, for they are commonly the only scientists who have the opportunity to see all the cores from each of the drilling sites. Thus, it is very important that they describe the lithology and stratigraphy of sediment and sedimentary rocks in a manner that is both complete and consistent from expedition to expedition.[1]

In this exercise you will be provided with a color print out of a split core photo. Photos such as this are taken of each core recovered on the drill ship. The photo itself is an important archive, as most scientists will not see the real split cores themselves. Rather, they rely on the core photos and the accompanying core description by the sedimentologist to learn about the nature of the sediment and rock recovered, and to sometimes make decisions on where in the core they want samples to be taken for their own research projects.

Objective

You will model the role of a shipboard sedimentologist and describe a split core. This is an inquiry-based activity and it will draw on and further develop your scientific skills of observation and description. You will also learn how important it is in science to be complete and consistent in recording your visual observations.

Procedures

You will be assigned one of the following cores to describe as a group:

130-807A-8H

3º 36.4'N, 156º 37.5'E

Water depth: 2804 mbsl

Cored interval:

64.40-73.90 mbsf

145-887C-6H

54º 21.9'N, 148º 26.8'W

Water depth: 3634 mbsl

Cored interval:

42.30-51.80 mbsf

206-1256B-2H

6º 44.2'N, 91º 56.1'W

Water depth: 3635 mbsl

Cored interval:

6.10-15.60 mbsf

Part I:

1. Specific terminology is used to precisely identify a core. See the attached *What is a Core?* worksheet to become familiar with this terminology. On what expedition (Leg) and at which Site was your core drilled?

   Leg = 130, Site = 807, Core = 8

   Leg = 145, Site = 887, Core = 6

   Leg = 206, Site = 1256, Core = 2

2. Where in the ocean was your assigned core recovered? Use the attached site map to determine the location.

   130-807-8H: SE Pacific

   145-887-6H: Gulf of Alaska

   206-1256B-2H: Eastern equatorial Pacific

3. Examine the photo of the split core that your group has been assigned to describe.

   a. What characteristics of this core should be described?

   Teacher: Answers will vary. May include characteristics of color, composition, grain size, disturbance features, fossils, etc. See the following "Guidelines for Core Description" to direct this initial discovery discussion.

   b. Is there any other visual information you would want to obtain that cannot be observed in the core photo?

   Teacher: Students may recognize that with core photos alone (rather than the real core) they cannot obtain all the information they desire. Composition and texture can't be easily identified from the core photo. This is why the photos are supplemented with smear slide data.

4. What do you think would be the best means of recording your observations? Discuss different options with your group. What did you decide?

   Teacher: Through discussion students should recognize the need for a common description format that includes both written and graphical information.

5. Now that you have had time to consider what should be described and how it should be recorded, let's compare that to what the sedimentologists do on the ship. Read the following to learn what instructions a new sedimentologist would get in preparation for describing cores.

   Teacher: It is important to go over this section with the students. Ask them to think about the core they are going to describe as you read the description guidelines.

Guidelines for Core Descriptions

What visual sedimentary features or characteristics of the split core should be recorded?

Visual description should include (but is not limited to):

1. Bedding thickness and attitude (orientation or angle)
2. Bedding contacts (sharp, gradational, scoured)
3. Sedimentary structures (e.g., graded bedding, laminated bedding, cross bedding, fluid escape structure, fractures or microfaults, bioturbation)
4. Accessory Components (e.g., concretions, isolated pebbles, macrofossils, wood fragments)
5. Composition
6. Texture (e.g., sand, silt, clay)
7. Sediment color
8. Induration (hardness)
9. Drilling disturbance

How can core description be accomplished in a complete and consistent way?

Standard forms, procedures, and lithologic nomenclature are used by the sedimentologists on each expedition. A description of the methods used in core description and sediment classification can be found in the "Explanatory Notes" chapter of each *Expedition Report* or *Initial Reports* volume.

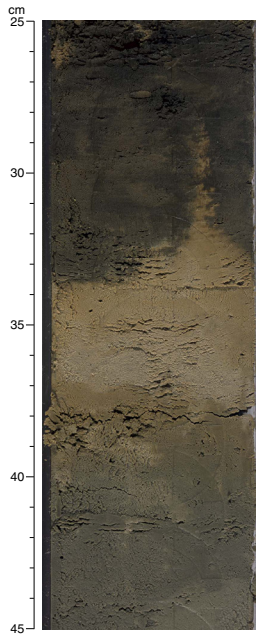
Visual Core Description (VCD) forms are completed for each section of core by the sedimentologists. The VCD is the most detailed summary of lithologic characteristics of the sediment or sedimentary rock. Standard symbols are used to graphically represent the lithologic features observed in the split core. Note that in addition to the lithologic characteristics noted above, there is also a column on the VCD form to indicate at what depth and for what purpose shipboard samples were taken. See attached copies of (1) a blank VCD form and (2) a figure summarizing the common lithologic symbols used in VCDs and barrel sheets. A copy of the handwritten, completed VCD forms for 130-807A-8H will also be distributed to you to compare with your completed core description.

Smear slides of unconsolidated sediment or thin sections of hard rock are prepared to help characterize the lithology. Smear slides are especially useful for characterizing the silt size fraction of sediment. These are examined under a petrographic microscope and estimates of the type and relative abundance of different sediment components are determined. A short video on how smear slides are made will be provided to you on CD and can also be downloaded at: *http://www.nisd.net/jay/joides/index.htm*. Attached are examples of (1) a smear slide/thin section data worksheet and (2) the smear slide results from the core you are describing.

Color of the sediment often is an indicator of composition. Color description is standardized by using Munsell Soil Color Charts to define the hue, value, and chroma of the freshly cut, wet sediment surface.

The descriptions recorded by hand on the VCD forms are compiled and summarized electronically as "barrel sheets." A single barrel sheet is completed for each core using the computer program AppleCore. The barrel sheets that the sedimentologists produced for 807A-8H, 887C-6H, and 1256B-2H will be distributed to you to compare with your completed core descriptions.

High-quality core photos are taken by the shipboard photographer, which are included in the *Expedition Report* accompanying the barrel sheets. You have printed color copies of core photos for 807A-8H, 887C-6H, and 1256B-2H. Close-up photos of particular intervals within a core can also be taken to illustrate characteristic or important lithologic features of the sedimentary sequence. For example, below is a close-up photograph of an ash layer in interval 206-1256B-3H-2, 25-45 cm.



Close-up photograph of ash layer at 34-36 cm (interval 206-1256B-3H-2, 25-45 cm). From: http://www-odp.tamu.edu/publications/206_IR/chap_03/chap_03.htm

How is a lithologic name determined?

Sedimentologists on board adopt or modify an existing sediment classification scheme that is appropriate for the lithology recovered, largely based on classification schemes used in previous DSDP and ODP expeditions recovering similar sedimentary sequences and Mazzullo et al. (1987). In nearly all cases the primary (dominant) sedimentary component is listed last, and may be preceded by secondary components (modifiers) or other descriptive modifiers. For example, a sediment sample (e.g., a smear slide sample) comprised of 20% terrigenous clay and 80% calcareous microfossils would be named: clay-bearing calcareous ooze. On the next page is one example of a classification scheme used by the Leg 199 sedimentologist on the *JOIDES Resolution* (From: *http://www-odp.tamu.edu/publications/199_IR/chap_02/c2_f5.htm*)

Part II:

6. Using the core photo, the smear-slide table and the photomicrographs provided, describe each section of your core. Record your descriptions on the VCD sheets. Note that microfossils shown in the photomicrographs can be identified using Deep Earth Academy's poster, *Microfossils: The Ocean's Storytellers*.

   Teacher: An example VCD for Core 130-807A-8H is provided for comparison.

7. Summarize the description of your core graphically and in words. This summary is analogous to a core barrel sheet. When you are done, compare your summary description to the core barrel sheet produced by sedimentologists.

   Teacher: The barrel sheets that the sedimentologists produced for 807A-9H, 887C-6H and 1256B-2H are provided for comparison. Review these together with your students.

Part III: Lithostratigraphy

After describing the sediment in each of the cores for a particular site, the next task is to define and categorize the sequence of sediment into particular lithostratigraphic units. Lithostratigraphy is the study of layered sedimentary layers based on physical characteristics.

Sedimentologists are responsible for writing the "Lithostratigraphy" section of each site chapter for the expedition proceedings volume (e.g., *Initial Report volumes of ODP*). Attached is the text from the Lithostratigraphy sections of the 807, 887, and 1256 Site chapters from *ODP Initial Reports* volumes 130, 145, and 206, respectively.

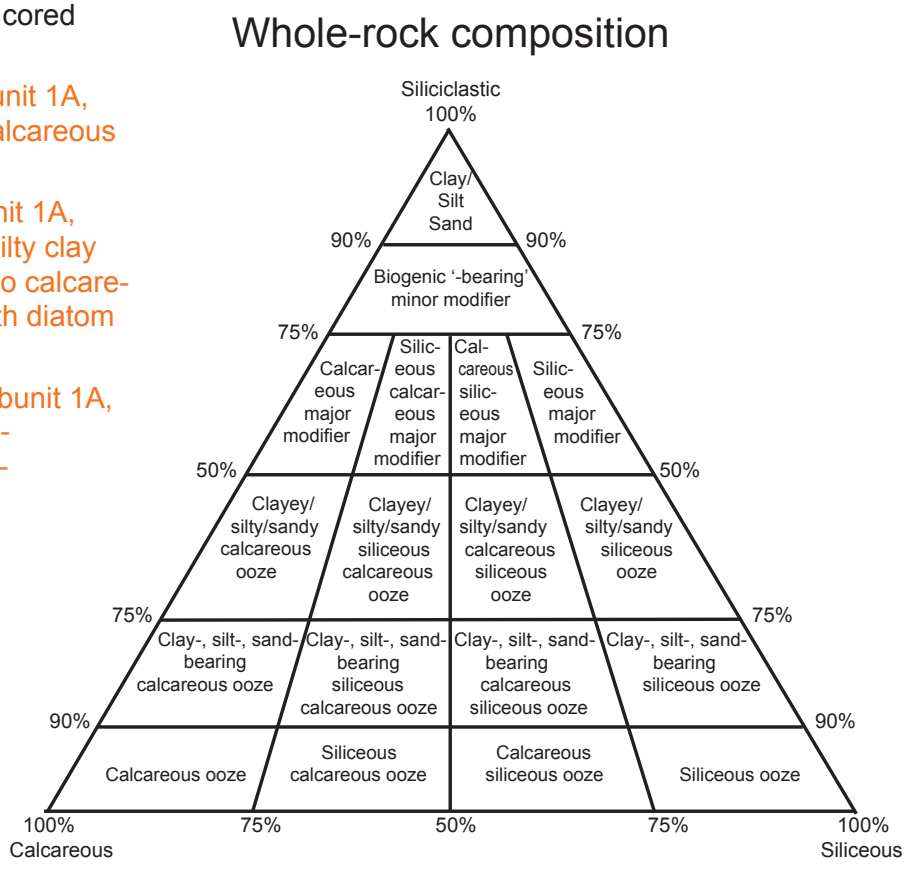
8. To which Lithologic Unit does the cored sediment you described belong?

   Core 130-807A-8H: Unit 1, Subunit 1A, Pleistocene-mid/late Miocene; calcareous ooze.

   Core 145-887-6H: Unit 1, Subunit 1A, Pleistocene-Pliocene; siliceous silty clay mixed sediment which grades into calcareous rich intervals interbedded with diatom ooze layers.

   Core 206-1256B-2H: Unit 1, Subunit 1A, Pleistocene-Miaocene; nannofossil silty clay and clayey nannofossil ooze.

   Teacher: Ask if this is the same lithologic unit from site to site. All of these examples are Unit 1, but Unit 1 at the different locations are different lithologies, which reflects different environments of deposition. Unit 1 simply refers to the top (uppermost) lithostratigraphic unit at any site. This Unit may not correlate from location to location.



Sediment classification scheme used on ODP Leg 199.

9. What interpretations are given regarding the environmental conditions at the time your lithologic unit was being deposited?

   Core 130-807A-8H: Long term changes in a depth-related carbonate dissolution gradient and to a latitude-related productivity gradient, as Site 807 experienced plate tectonic drift northward through the equatorial high productivity zone which is presently confined to within 1 degree of the equator.

   Core 145-887-6H: Lithology reflects hemipelagic sedimentation related to Northern Hemisphere glaciation which enhanced mechanical weathering. The diatom ooze layers may reflect the oceanic response to short term climate change.

   Core 206-1256B-2H: None are given. This may reflect the sedimentologists strict following of the lithostratigraphic section to be restricted to description and not interpretation.

Notes

1. Introductory text adapted from: Mazzullo and Graham, 1998. Handbook for *Shipboard Sedimentologist, ODP Technical Notes No. 8*, Texas A&M University.

References

Mazzullo, J., Meyer, A., and Kidd, R.B., 1987. A new sediment classification scheme for the Ocean Drilling Program. *ODP Technical Note, VIII*.

Shipboard Scientific Party, 1991. Site 807. In Kroenke, L.W., Berger, W.H., Janecek, T.R., et al., *Proceedings of the Ocean Drilling Program, Initial Reports*, *130*: ODP, College Station, TX.

Shipboard Scientific Party, 1993. Site 887. In Rea, D.K., Basov, I.A., Janecek, T.R., Palmer-Julson, A., et al., 1993. *Proceedings of the Ocean Drilling Program, Initial Reports*, *145*: ODP, College Station, TX.

Shipboard Scientific Party, 2003. Site 1256. In Wilson, D.S., Teagle, D.A.H., et al. *Proceedings of the Ocean Drilling Program, Initial Reports, Volume 206*: ODP, College Station, TX.