Plunging Plates

STUDENT NAME: .....

STUDENT ACTIVITY

SCIENTIFIC OCEAN DRILLING

Objective(s)/Outcome(s)

Students will be able to:

1. Use a model to qualitatively predict the conditions and geometry of a subduction zone.
2. Analyze maps and ocean coring data to make an argument as to whether there is a subduction zone off the west coast of Costa Rica.

Materials

- color copies of Figures 1–4 (or access electronically)
- computer with internet access (optional)

Background

Subduction Zones are a specific type of convergent plate boundary where two tectonic plates collide, and one is forced (subducted) beneath the other. At a subduction zone, rocks in the subducting plate can undergo changes due to heat and pressure. These changes are broadly called metamorphism. Furthermore, sediment can be deposited in unique ways at these boundaries. In this activity, you will model the physical geometry of a subduction zone, make predictions about what features you might see in rocks and sediment at a subduction zone, and investigate real data from three locations sampled from the ocean floor west of Costa Rica to determine if this is a subduction zone.

The images and data you will use were collected by the *JOIDES Resolution* (*JR*), a scientific ocean drilling ship. Over a two-month expedition, the *JR* collected cores from the seafloor near Costa Rica. These cylindrical cores of rock and sediment can be analyzed to tell how the area has changed over time. Scientists aboard the *JR* (and in labs for many months or years after an expedition) use many types of evidence to reconstruct the tectonic, climatic, and environmental conditions of areas around the world.

Activity

1. You will examine a series of figures to assess an area as a possible subduction zone. Annotate each figure, noting evidence that is consistent with geologic features and activity at subduction zones.

   a. Obtain Figure 1, which shows the general region being studied, the bathymetry (water depth to the seafloor) along Costa Rica, and three sites where ocean sediment cores were taken.

   - Make general observations of each map. Indicate specific features that might indicate this is a subduction zone.
   - Also, note features that could indicate this area might not be a subduction zone or about which you have questions.
   - What additional data would you want from this area to be able to determine whether or not it is a subduction zone?

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b. Follow your teacher's directions to obtain Figure 2, which shows a seismic profile of the area where the cores indicated on Figure 1 were taken. Seismic profiles are collected before an expedition begins to help scientists determine where to take cores from the seafloor. Energy waves are transmitted into the water, and instruments collect information about the reflection of these waves by the layers of sediment and rock under the seafloor.

- Watch a video that gives some insight into how **seismic profiles are read**. Keep in mind that each profile is unique but can reveal certain patterns that tell about the layers of sediment and rock below the Earth's surface.
- Make general observations of the seismic profile. Annotate the image to indicate significant features or events that have occurred in this area.
- Based on the core sites, what would you expect the cores to have in common and why? What would you expect to be different and why?
- What questions do you have about the seismic profile?
- What additional data do you want or need to determine whether or not this is a subduction zone?

c. Follow your teacher's directions to obtain Figure 3, which shows the map of coring locations (same as Figure 1) with interpretations of the sediment and rock types in the three cores. The interpretations were completed by techs aboard the *JOIDES Resolution* during coring expeditions. A key has been provided that identifies each sediment and rock type.

- Make general observations of the core interpretations, comparing them to each other and considering what you have learned about each coring site from Figures 2 and 3.
- Note features that would support this area as being part of a subduction zone.
- Note features about which you have questions or that might refute the idea that this area is a subduction zone.

d. Follow your teacher's directions for obtaining Figure 4, which shows the core interpretations as shown in Figure 3, along with actual images of cores (corresponding to the indicated sections of the interpretations).

- Make general observations of the core images. How do their appearances match the interpretations?
- What additional information would you want to know about the cores that could help in your interpretation?

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Analysis

1. Describe how the three cores compare to each other.

   a. What do the types of rocks and sediments found within the cores tell you about the environment in which these cores formed?

   b. Why are the layers different thicknesses? What might a thin layer tell you about the geologic event that caused it to form?

   c. Figure 3 contains core photographs from specific locations near the bottom of each of the three interpretations. Each image shows a section approximately 10 cm in length. What does the differing depth of the basement rock at Sites 1039 and 1040 tell you?

2. Recall that the frosting/"spread" layer in your model was meant to represent sediments. Does what happened in your model look at all like what you observe in these sections?

Synthesis

1. Return to Figure 2. A fourth coring site is shown on the image (unlabeled, between cores 1039 and 1043). How would you expect this core to be similar to and different from the cores you analyzed here? Explain your reasoning.

2. Using all of the evidence gathered so far, make a claim about the area that answers the question: "Is this area a subduction zone?" In a paragraph length response, defend your claim with evidence and good scientific reasoning.

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Extensions

1. What features of a subduction zone might change the shape and size of the accretionary wedge? Example: “What might happen to the accretionary wedge if the plate plunged at a steeper/shallower angle?”

2. Research: questions about subduction zones:

   a. Once a plate gets subducted, where does it go? What happens to it?

   b. How could a subduction zone create a volcano (or a chain of volcanoes?)

   c. What might happen when two plates of the same density and thickness collide?

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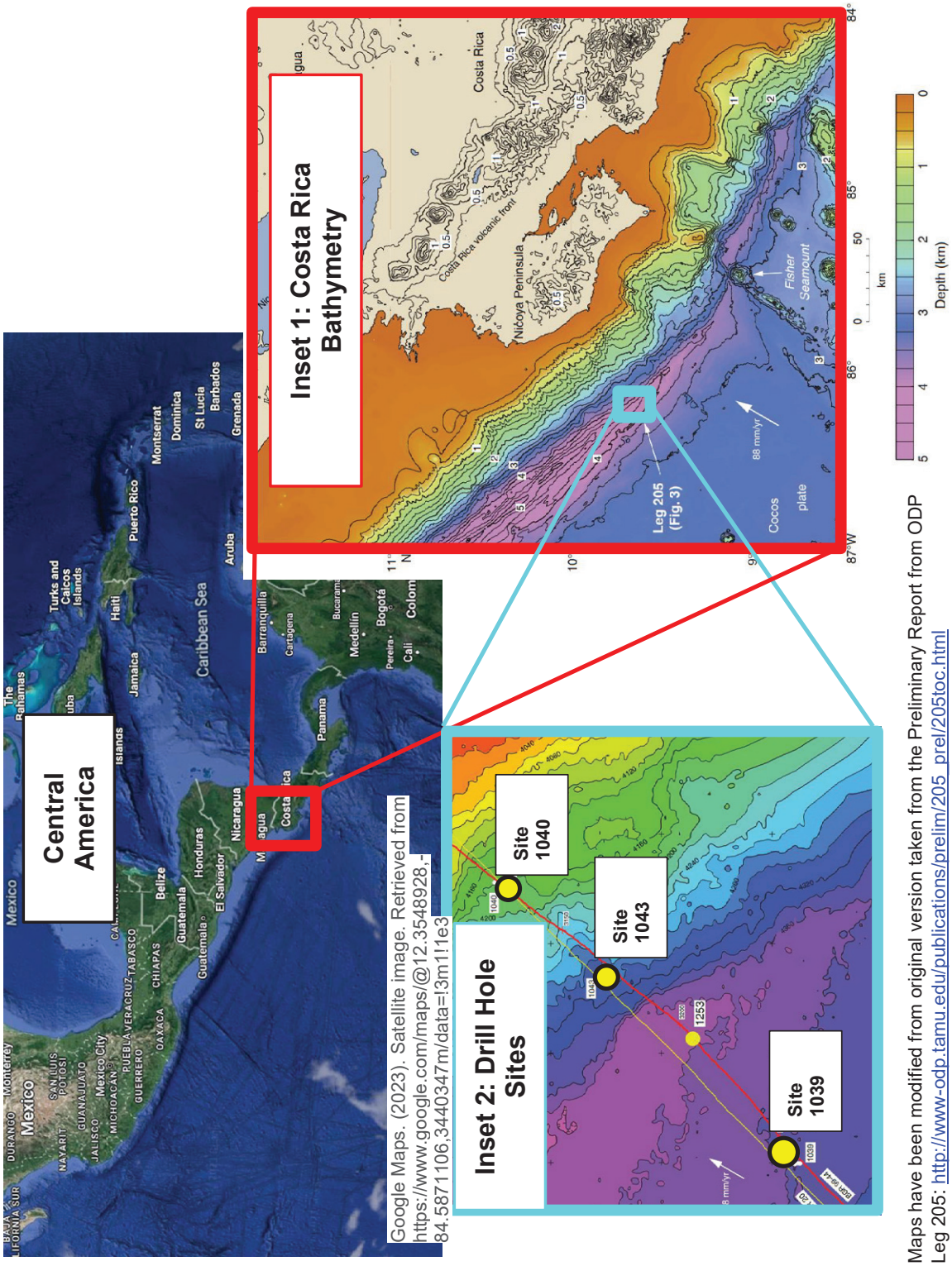
HANDOUTS

FIGURE 1. MAPS OF A POSSIBLE SUBDUCTION ZONE OFF THE WEST COAST OF COSTA RICA.



Maps have been modified from original version taken from the Preliminary Report from ODP Leg 205: http://www-odp.tamu.edu/publications/prelim/205_prel/205toc.html

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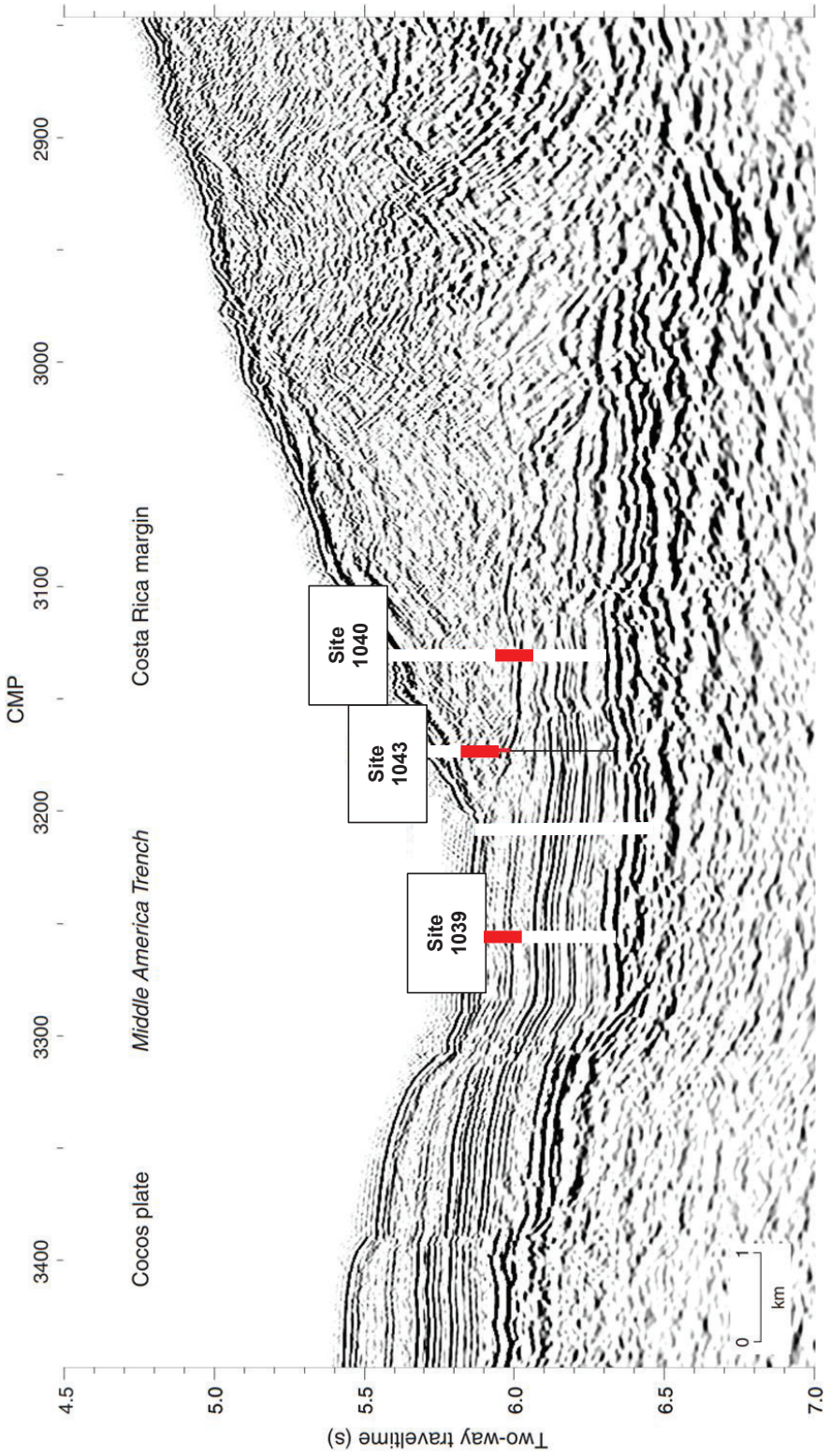
FIGURE 2. SEISMIC PROFILE OF A POSSIBLE SUBDUCTION ZONE OFF THE WEST COAST OF COSTA RICA.



This Seismic Profile has been modified from original version taken from the Preliminary Report from ODP Leg 205
Original version can be found at: http://www-odp.tamu.edu/publications/prelim/205_prel/205toc.html

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FIGURE 3. CORE INTERPRETATIONS FOR THREE DRILLING SITES.

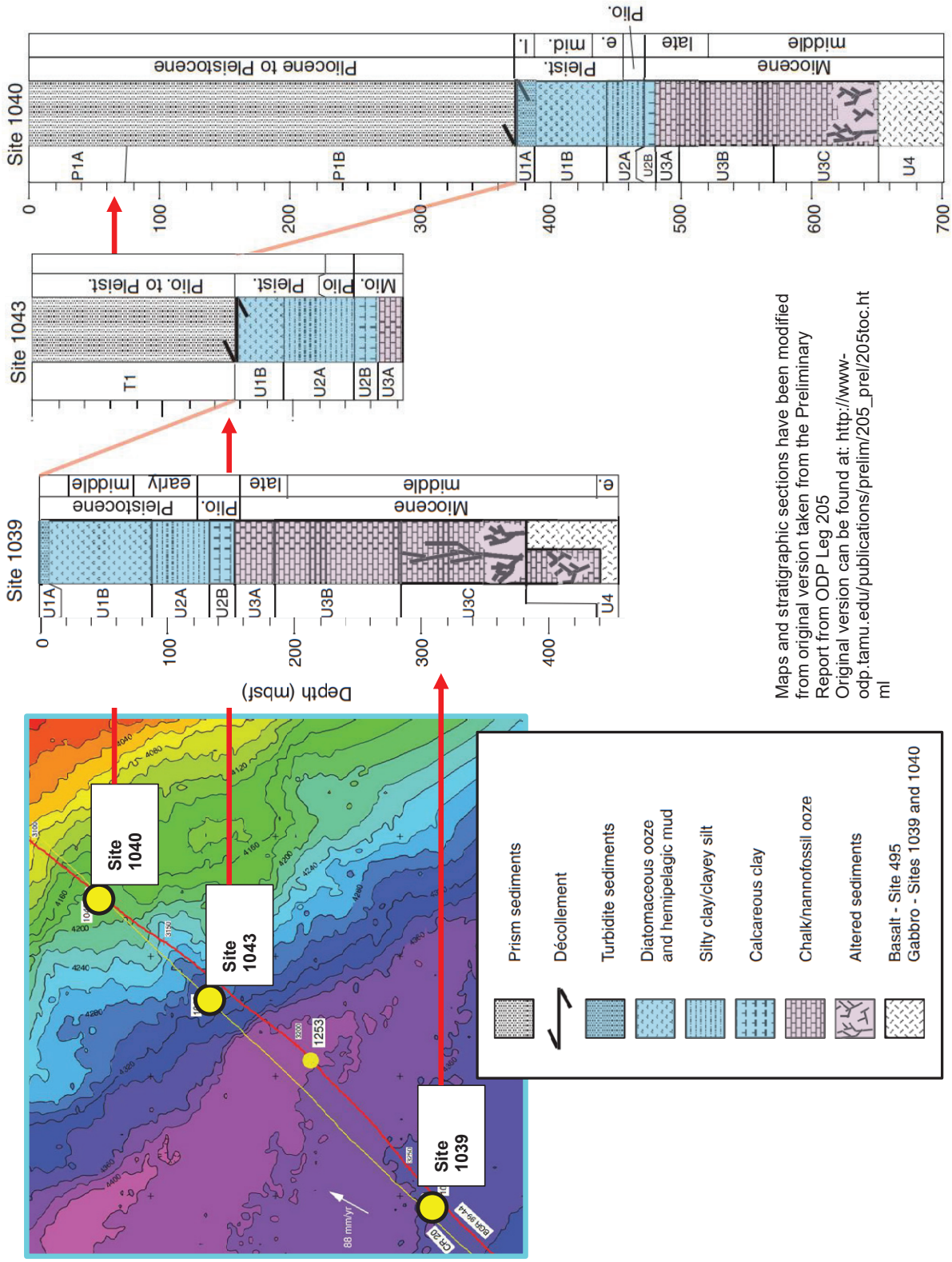

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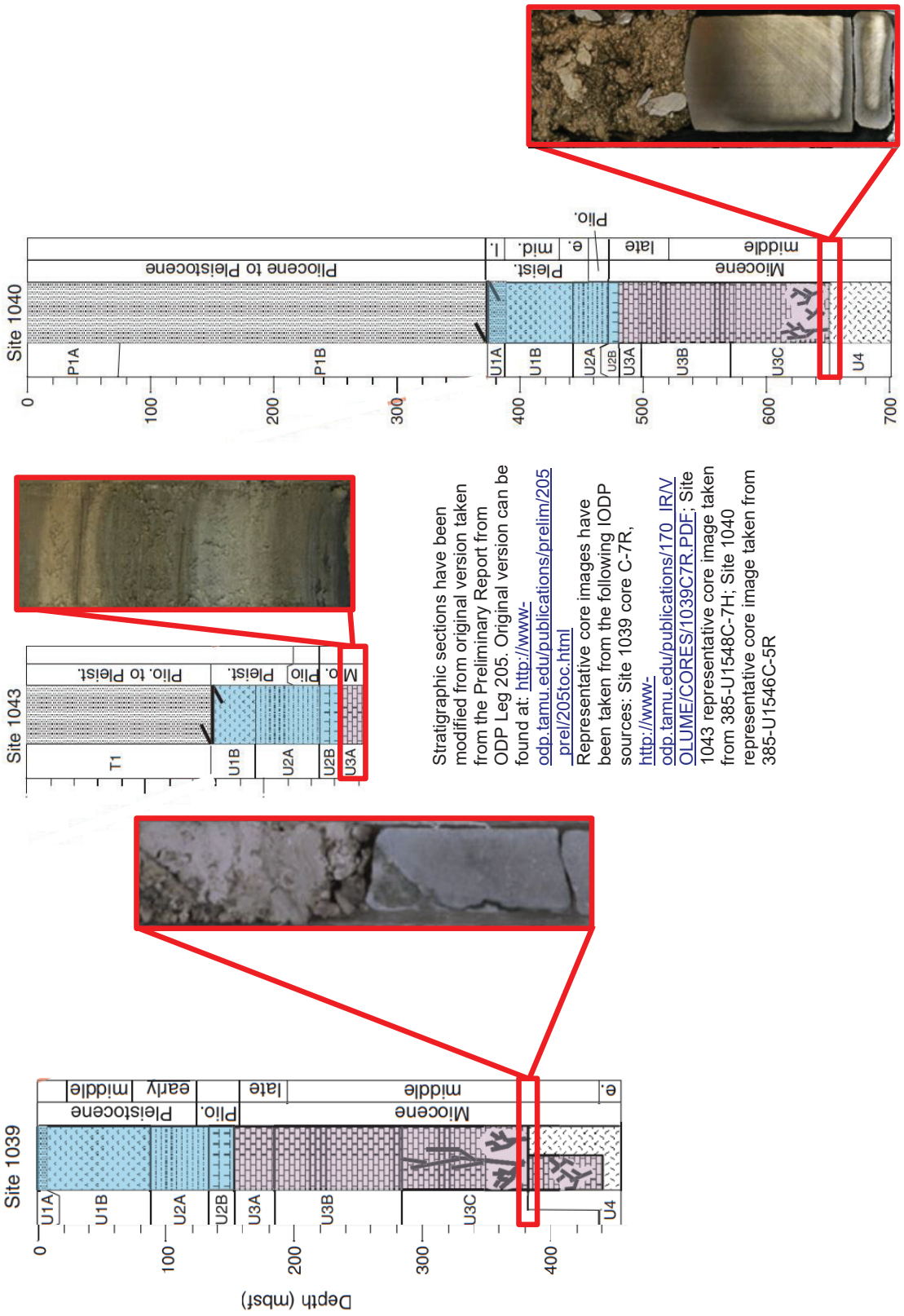
FIGURE 4. IMAGES OF SEDIMENT AND ROCK FOUND WITHIN THE BOTTOM LAYERS OF THREE CORES.



Stratigraphic sections have been modified from original version taken from the Preliminary Report from ODP Leg 205. Original version can be found at: http://www-odp.tamu.edu/publications/prelim/205_prel/205toc.html
Representative core images have been taken from the following IODP sources: Site 1039 core C-7R, http://www-odp.tamu.edu/publications/170_IR/VOLUME/CORES/1039C7R.PDF; Site 1043 representative core image taken from 385-U1548C-7H; Site 1040 representative core image taken from 385-U1546C-5R