Beyond the Surface: Earth's Magnetic Memory Revealed in Seafloor Cores

STUDENT NAME: .....

STUDENT ACTIVITY

SCIENTIFIC OCEAN DRILLING

Objective(s)/Outcome(s)

Students will be able to analyze data on the magnetic orientation of sediment and rocks within ocean cores to determine when shifts in polarity occurred throughout Earth's history.

Materials

- Geomagnetic Polarity Time Scale (GPTS) handout
- Paleomagnetic Data for Site 1208 handout

Background

Stratigraphy is studied by geologists who want to understand the relative positions of rock strata and the ages of each layer. Biostratigraphy requires the use of fossil evidence to determine rock ages and to correlate layers from different areas. Similarly, the stratigraphic record of the episodic reversals of Earth's magnetic field can be used to establish the age of rocks and make correlations between rock layers that contain sedimentary or igneous rocks that contain magnetic minerals, such as magnetite. The basaltic crust on the seafloor can provide evidence of magnetic reversals, as can the ocean sediment that settles on top of this crust.

The magnetic signal that geoscientists measure is called natural remanent magnetization (NMR), which can be determined for both igneous and sedimentary rocks containing magnetic minerals. As both these rock types form, the magnetic minerals within them become aligned with the Earth's magnetic field as they either crystallize (igneous) or are deposited (sedimentary). Not all rocks and sediment can provide magnetic data, which requires scientists to sample multiple areas and make correlations to determine periods of "normal polarity" (with Magnetic North located near the geographic north pole) versus times of polarity reversal.

Activity

1. Make observations of the Paleomagnetic Data for Site 1208. This data was taken from cores of the floor of the northwest Pacific Ocean.
   a. What do you think the axes mean?
   b. What do you notice about the data? Do you see any trends?
   c. Do some parts of the data seem easier or harder to read? Why do you think this?
   d. Compare the Paleomagnetic Data to the Geomagnetic Polarity Time Scale (GPTS). How do these two images relate?
2. Use the Geomagnetic Polarity Time Scale (GPTS) to fill in the polarity column next to the paleomagnetic data.

Analysis

1. What do you notice about the periods of normal versus reversed polarity?

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a. What was the longest period of normal polarity? When did it occur?

b. What was the longest period of reversed polarity? When did it occur?

c. Are there any patterns in the data or does it appear random?

d. Circle 1–2 polarity reversals shown in the paleomagnetic data that were difficult to determine. What made the data difficult to interpret? In these cases, how did you make a conclusion as to when the actual polarity reversal occurred?

2. What other data might you collect to:

a. Learn more about the area in which cores taken at Site 1208 were taken?

b. The time periods in which polarity reversals occurred?

c. The length of the reversals?

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Synthesis

1. Why do you think it is it important to have a record of past polarity reversals? Use at least one piece of data (from this activity or from research) to support your argument.

2. The core data used during this activity was taken at Site 1208, located on the Shatsky Rise, which is a plateau in the northwestern Pacific Ocean that is associated with an area of seafloor spreading. Similarly, the data below were taken from cores collected along the Mid-Atlantic Ridge.

a. Study the bottom row, which shows the polarity of seafloor crust. Circle the part of the ridge that is being formed today. Use details about the diagram as well as your knowledge of seafloor spreading to explain how you determined this location.

b. The top row of data shows paleomagnetic data. Compare this to the bottom row showing the polarity of the crust on either side of the ridge. Which part of the data represents normal polarity—the peaks or the valleys? How do you know?

c. In 1966, this exact data was used to confirm the theory of seafloor spreading. Researcher Walter Pitman took the paleomagnetic data shown in the top row and reversed it (flipped 180 degrees), which is shown in the middle row. Compare the two sets of data. What do you notice? Why do you think Walter Pitman flipped the data? Make an argument for how this confirms the theory of seafloor spreading.

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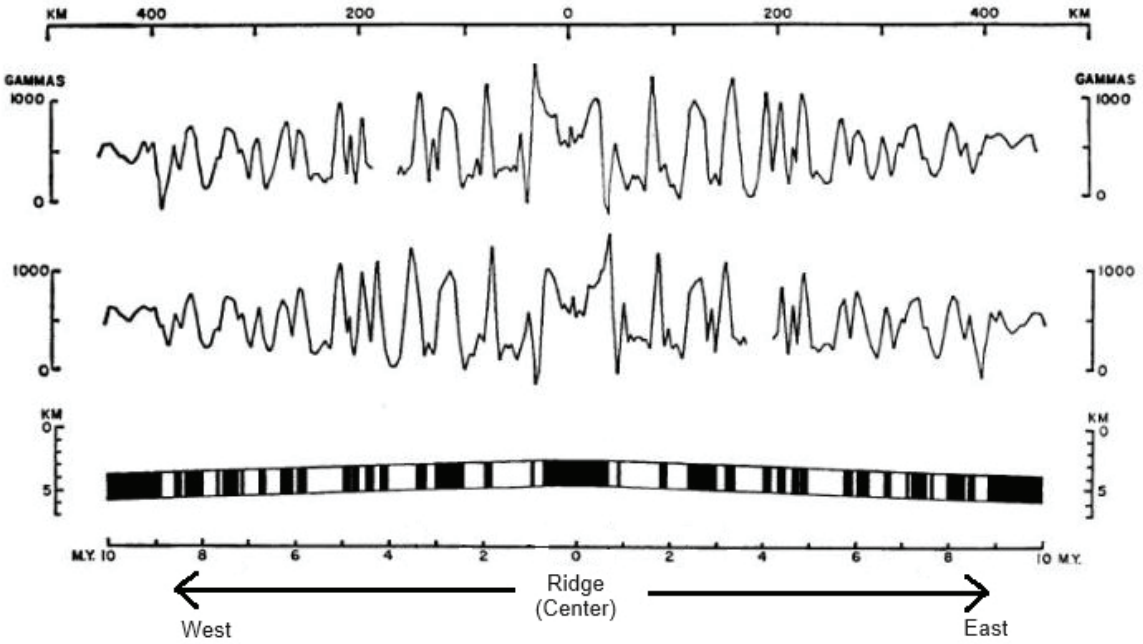
FIGURE 1. DATA COLLECTED BY PITMAN AND HEIRTZLER IN 1966 SHOWING THE PALEOMAGNETIC ANOMALIES AROUND THE MID-ATLANTIC RIDGE.



Source: Morford, Columbia Climate School, 2016.

Extensions

Research why it is important for Earth to have a magnetic field. Other than polarity reversals, what can affect the magnetic field and how?

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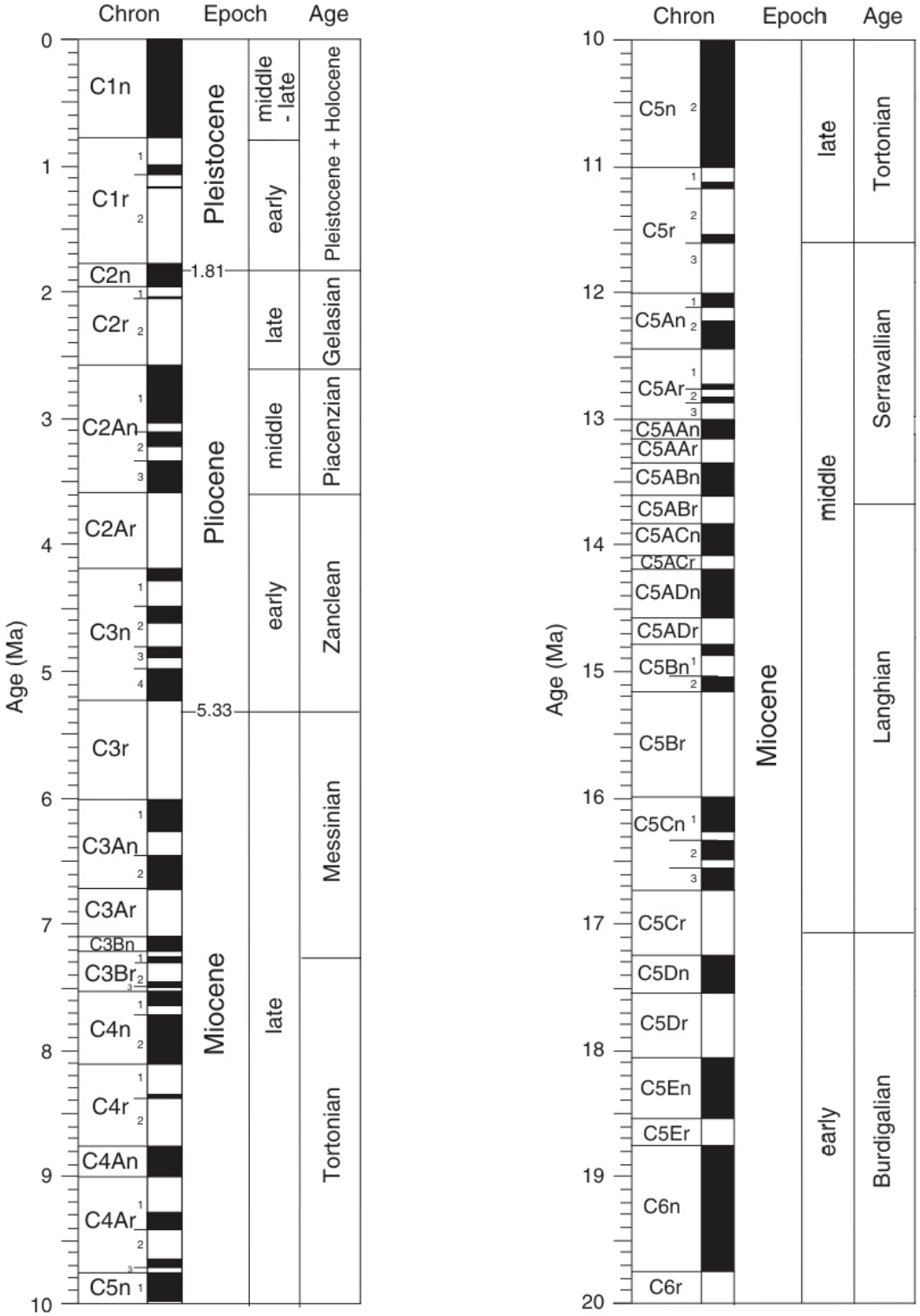
HANDOUTS

GEOMAGNETIC POLARITY TIME SCALE (GPTS)



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PALEOMAGNETIC DATA FOR SITE 1208