Read-Write Earth History

Use magnetic tape to learn about the ocean floor

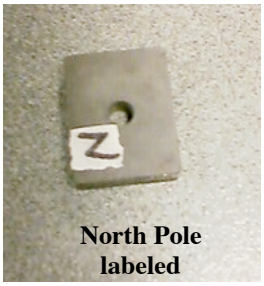
Introduction:

Use magnetic audiotape to simulate how geologists pieced together the theory of seafloor spreading and magnetic striping.

This activity is an expanded version of Paul Doherty's "Magnetic Tape" activity [1] and "Bits and Bytes" in the Exploratorium "Square Wheels" Science Snackbook.[2]

Materials:

- Register tape (cash register tape) or any long piece of paper (see option with masking tape too)
- Sticky tape
- Scissors
- Magnetic tape – Audio Cassette tape
- A permanent magnet – refrigerator magnet, cow magnet almost any small ceramic magnet

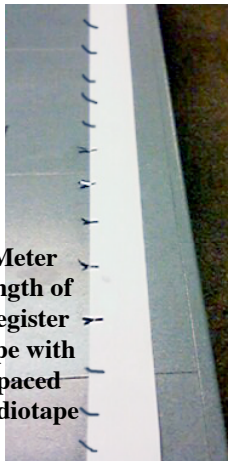


North Pole labeled

Assembly:

1. You will need to find "north" on your permanent magnet. This can be done in several ways.
   a. Hang the magnet by a string and see which way it points. [3]
   b. Use a known pole from a magnet.
   c. Use a compass
2. Label the north and south side of your magnet.
3. Unroll and cut off about a meter of register tape.
4. Pull out about 50 cm of audiotape from the audiocassette.
5. Cut the audiotape into about 16 to 20 piece, each 2 to 3 centimeters long.
6. The audiotape should have a preferential curve. Orient the pieces along the edge of the register tape with the curve going up.
7. Using sticky tape, secure one end of the audiotape to the paper register tape. The other end should hang over the edge of the register tape.
8. Space the pieces of audiotape about 5 or 6 centimeters apart. This will help reduce errors when working with neighboring audiotape.

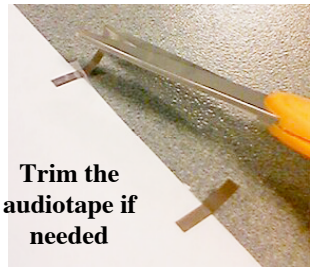
Cut tape from a cassette



Meter length of Register tape with spaced audiotape

9. If needed, trim the ends of tape. You might find that some pieces are too long. Try to make the unattached ends of the audiotape extend equal distance, about 1 to 1.5 cm from the edge of the register tape.

10. To help with this activity, you might also add to the upward curve of the tape by bending or creasing the unattached portion of audiotape upward.



Trim the audiotape if needed

11. The register tape and audiotape together represent a model of the ocean floor.

Optional:

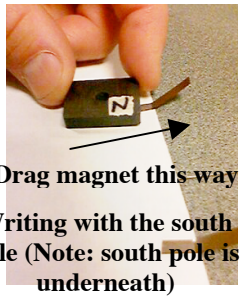
If you don't have register tape, you can use sticky tape to attach your magnetic audiotape to (like in the picture to the right).

You can use sticky tape instead of register tape

To Do and Notice:

Getting ready-

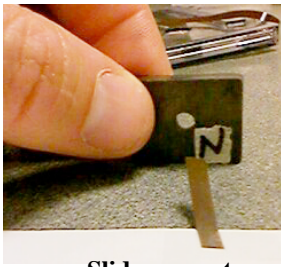
1. Experiment to see what happens:
    a. Write your magnet direction:
        i. With its north side facing upward, (so that the south side is in contact with the tape), drag the south pole of the magnet along the top surface of a piece of audiotape (see photo to the right). Only drag it once. Drag it from the taped portion towards the curved tip of the audiotape.
        ii. On a difference piece of audiotape, flip your magnet over. Now, with its south side facing upward, (so that the north side is in contact with the tape), drag the north pole of the magnet along the top surface of a piece of audiotape (see photo to the right). Only drag it once. Drag it from the taped portion towards the curved tip of the audiotape.



Drag magnet this way

Writing with the south pole (Note: south pole is underneath)

    b. Read your magnetic direction:
        i. Slowly slide the magnet, with the north side facing the curled audiotape, slowly toward the end of the audiotape (see photo). However, do not touch the audiotape with the magnet (this may ruin your results).
        ii. This is subtle, but notice which way the audiotape reacts. Is it attracted or repelled by the magnet?
        iii. Do the same for the second piece of audiotape; again, keeping the north side of the magnet facing the audiotape.

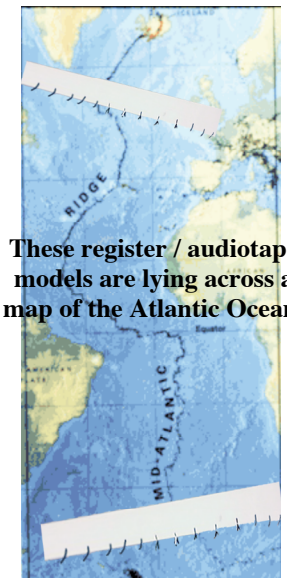


Slide magnet toward the audiotape. Always use the north end.

2. So, you can magnetize your audiotape to attract or repel.
    If it attracts, you magnetized your audiotape "South."
    If it repels, you magnetized your audiotape "North."

Here are some simple rules for reading and writing your audiotape.

Writing: Polarity of permanent magnet	Reading: Only read with the North polarity of the permanent magnet	Effect on the audiotape	Polarity of the loose end of Audiotape
North	North	Attract	North
South	North	Repel	South



These register / audiotape models are lying across a map of the Atlantic Ocean.

The Earth Science link and activity-

You can make a pattern of magnetic striping on your ocean floor model just like on the real ocean floor. Your model represents a cross-section of the sea bottom across a mid-ocean ridge.

Students can make their own magnetic patterns and other students can discover the pattern:

For students making the pattern:

1. Make a magnetic pattern on your ocean floor model. However, don't put any visible markings on your register tape.
2. The pattern should be symmetric with a chosen "line of symmetry." This line should be located somewhere near, but not necessarily at the middle of the register tape.
3. Single and multiple neighboring magnet tapes can be magnetized in the same direction, but this pattern must be mirrored.

N N N S N N S S S N N S S S N N S N N N

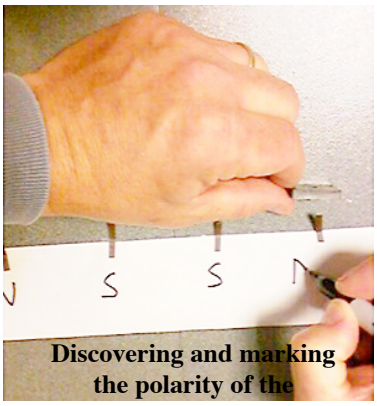
Here's a possible magnetic pattern, showing its line of symmetry

For students discovering the pattern:

1. Record the direction of each magnetic audiotape (don't write on your register tape if you want to use this set-up again.).

2. Look at the pattern created and see where the line of symmetry is located.

3. Check with the creators of the pattern to see if yours is correct.


Discovering and marking the polarity of the audiotape.

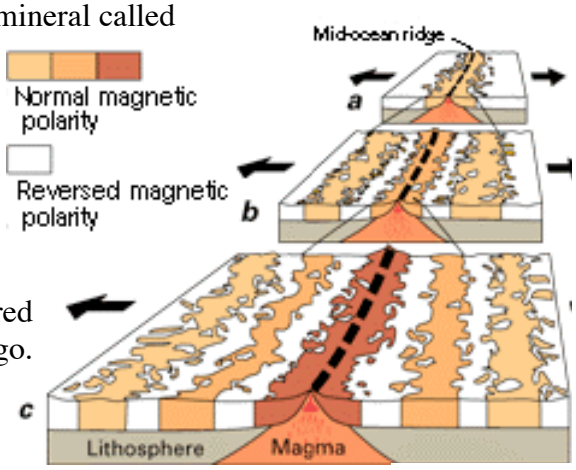
What's going on?:

Audiotape contains tiny magnetic particles. These particles become magnetized when exposed to a strong magnetic field. This "magnetic memory" can be read at a future time.

Your audiotape can be used to model the magnetic features of the ocean floor!
In the 1950's, research ships sailed across the oceans and discovered strange magnetic patterns imprinted in the rocks below. These patterns were discovered all over the globe underwater. It wasn't until the mid-1960's that geologist had a good working theory to explain what was going on. One of the most important theories in earth science was developed, Sea floor spreading.

The rock at the bottom of the ocean is quite different than rock on the continents. One important feature preserved in the ocean floor is a "Zebra-like" striping of magnetic directions in the rocks. Alternating bands of North –South magnetized rock form patterns that are symmetric with the associated mid-ocean ridges, also known as spreading centers.

At these spreading centers, molten material wells up and cools. Oceanic rock is made of basalt. Basalt is iron-rich and contains a strongly magnetic mineral called magnetite. As the rock cools, the iron in the rock "captures " the magnetic history of the earth.
Over time, the sea floor spreads away from these ridges in both directions carrying this magnetized rock with it (at a rate of a few centimeters a year). As the sea floor spreads, new rock is created.



From the USGS

It is known that Earth's magnetic field flips every few hundred thousand years. Our last reversal was about 780,000 years ago. Since crust is created and moves away from the mid-ocean ridge symmetrically, the acquired magnetic pattern is symmetric too. Beside the symmetric magnetic pattern, the ocean floor is also roughly topographically, chronologically (the rock's age is roughly the same, the same distance away from the ridge), temperature and density symmetric.

Optional:
The picture on the right shows another model one can do with this set-up. Using this model, two strips of register tape are drawn out slowly and in equal increments from in between two tables. The audiotape can be magnetized in a symmetric pattern as it "pops" out from between the table.


Another model of the sea-floor

Going further: The north end of a compass points north. However, did you know- what we call the earth's magnet pole in the north (around Baffin Island Canada at this writing), is really a south of pole of a magnetic. Opposite poles of magnets attract!

Resources:
[1] http://www.exo.net/~pauld/activities/magnetism/magnetictape.html
[2] http://www.exploratorium.edu/square_wheels/index.html
[3] http://www.exo.net/~pauld/summer_institute/summer_day16magnetism/Where's_North.html
This Dynamic Planet by the USGS
http://pubs.usgs.gov/gip/dynamic/ (the ocean floor graphics are from this website)