Clay Lava Flows

Purpose

To understand some of the geological processes and the structures that form as lava flows across planetary landscapes by using mud as an analog for lava.

Background [also see "Teacher's Guide" Pages 3, 4, 12, 13]

In this activity students will use mud to simulate surface **lava** flows. The experiment demonstrates many of the key features of **a'a** flows, though not of whole **pahoehoe** flow fields, which are fed by lava tubes.

Real a'a lava flows are complicated. They are characterized by a prominent lava **channel** confined between levees. Shear zones, places where one portion of the flow is moving faster than an adjacent portion, usually occur. Small flows of pahoehoe lava also become channelized, but on a much smaller scale than a'a flows.

As mud is poured onto an inclined surface, the first and foremost thing to do is to observe the formation of distinct features in the flow. **Levees** form on the outer part of the flow. These are not quite the same as levees on lava flows because the latter build up levees by overflowing the banks, but nevertheless, mud flows do form levees. Inside the levees the mud moves downhill. **Ridges** might develop in the flowing portions, analogous to large ridges in lava flows. The thickness of the flow varies with slope, time, position in the flow, and amount of mud poured. These variables can be tested by measuring width and thickness as functions of time, as described in the procedure.

Preparation

Review and prepare materials listed on the student sheet.
Mix clay and water in a bucket: 5 pounds of wet clay with 4 cups of water. To mix easily, break clay into half-inch pieces and allow to dry. The mixing process should be started at least 2 days before you intend to use the clay. Cover the bucket to keep the clay mixture from hardening.

The final clay-water mixture should be fairly uniform, with only a few lumps. Smooth the mixture with a wire whisk to the consistency of thick cream. If the mixture is too runny, then it will pour like water. If it is too thick, then it will mound up (though that is interesting and somewhat resembles some very viscous lava flows).

Plexiglas is an excellent surface to use for the experiment, though any nonporous surface will do fine, such as a wooden drawing board covered with plastic wrap. If the surface is too porous, then the mud loses moisture to it, changing flow characteristics.

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Draw a grid with 10 cm spacing onto the Plexiglas using a permanent marker pen. Or draw a grid onto paper taped to the wooden board, then cover with plastic wrap.

In Class

Using a protractor and plumb line, the Plexiglas is propped up to an angle of 15^{o} for the procedure, then to an angle of 25^{o} for a repeat of the procedure.

Students should pour the clay slowly and at a constant rate down the inclined Plexiglas. The bucket should be held about 10 cm from the high end of the Plexiglas.

At each 10 cm mark, the students will:

1. record the time the flow front passes the mark,

2. measure the length of the flow,

3. measure the width of the flow,

4. measure the center depth of the flow.

“Data Tables” are provided for recording these values. Space is provided for sketches of the flow outline.

When the clay is flowing down the Plexiglas, look for areas near the edges where the flow rate is low or zero; these are the levees of the channel. The part in the middle that is moving faster is called the channel interior.

Wrap-up

How do the two flows compare?
Is the ratio of channel width to flow width the same?
Presumably the clay volumes were the same for both slopes, but the flow areas could be determined and multiplied by the average depths as an exercise just to check.

Extensions

1. Use a ruler with a grid to slice into the flow at each 10 cm mark to get cross sections.
2. Can you see the levee margins in the cross sections?
3. How do the cross sections change down the length of the flow?
4. Videotape the activity.
5. Use this clay in the “Impact Craters” activity on Page 61.

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Key Words

lava flows

channels and levees

pressure ridges

Materials

clay mixture

bucket, preferably with pouring spout

wire whisk

large spatula

Plexiglas or other nonporous surface (~1/2 by 1 meter, and preferably with a grid)

protractor with plumb line

stopwatch

"DataTables"

tape measure or ruler

Procedure

1. Stir your mixture of **clay** and **water** in the **bucket.** A few lumps are acceptable.

2. Prop up one end of the **Plexiglas** at an angle of about 15° (use the **protractor** and **plumb line** to determine the angle). A board under the Plexiglas helps prevent sagging.

3. Hold the bucket of clay mixture about 10 cm downslope from the high end of the Plexiglas. Keep the bucket about 10 cm above the Plexiglas surface. Pour the clay slowly. It is important to keep the pour rate as constant as possible. Start the **stopwatch** when the flow front passes the zero line.

4. Watch the flow as it goes downhill and spreads out, and record the time it reaches each 10 cm mark. How far behind the flow front does the distinct channel become apparent?

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5. Record the time when you stopped pouring (the flow will continue to move). Fill in the "**Data Tables**."

6. Note the channel and levees as well as shear zones within the levees. Does the channel extend the entire length of the flow?

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7. Using the **tape measure**, measure the length, width, and center depth of the flow and the channel width at each 10 cm mark. Fill in the "Data Tables."

8. Draw the outline of the flow using the grid as a guide.

9. Now prop the Plexiglas up higher to an angle of about 25° and repeat the procedure. The clay may flow off the end of the ramp onto the flat underlying surface. How do the structures in this flat part compare to those on the slope?

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10. Repeat all the measurements and fill in the "Data Tables."

11. How do the two experimental flows compare? Is the ratio of channel width to flow width the same?

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Data Tables

Angle	Time at 0	10	20	30	40	50	60	70	80	90	Time stopped pouring
15°											
25°											

Angle	Width at 0	10	20	30	40	50	60	70	80	90	Total length
15°											
25°											

Angle	Center-line depth at 0	10	20	30	40	50	60	70	80	90
15°										
25°										

Angle	Channel width at 0	10	20	30	40	50	60	70	80	90
15°										
25°										

Sketch of flow at 15°

Sketch of flow at 25°