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Joints in a Cornstarch Analog

Type of activity: in-class exercise

Brief description: Desiccated cornstarch-water mixture provides an interactive introduction to joints and joint sets. Students interpret relative ages, examine intersection angles, use surface textures to determine propagation direction, and evaluate the role of flaws in joint initiation.

Context

Type and level of course in which I use this activity: undergraduate required course in structural geology. Typical enrollment: 20 students.

Skills and concepts that students must have mastered before beginning the activity: This exercise follows a brief introduction to joints, abutting relationships, and joint-surface textures.

How the activity is situated in my course: one of more than a dozen in-class and laboratory exercises

Goals of the Activity or Assignment

Content/concepts goals for this activity: Describing and interpreting joints: abutting relationships (relative age), intersection angles, surface textures, propagation direction, and initiation from flaws

Higher order thinking skills goals for this activity: Interpreting sequence of events

Other skills goals for this activity: Sketching and labeling accurate representations of structures

Description

Joints are very important to problems in applied geology (fluid flow, slope stability), but three-dimensional exposures of simple joint sets are not readily accessible from my campus. I developed this exercise based on the experiments of Müller (2001) to give students hands-on practice describing and interpreting joints.

For the exercise, I prepare a cornstarch-water mixture a few days in advance and pour it into plastic petri dishes. I add a "flaw" to each dish (typically a small pebble). As the cornstarch dries, vertical joints develop.

In class, each group of 3-4 students is provided a petri dish of desiccated cornstarch. Students are asked to draw a map of the joints, paying particular attention to intersection angles. (The joints curve to intersect at 90°.) They determine relative ages of the joints using abutting relationships. (Typically 3-6 generations of joints.) Students next dissect the sample and describe the surface textures of the larger joints and the location of the flaw. The cornstarch produces beautiful plumose structure (hackles). Students then interpret the joint propagation direction from the surface textures, and note the origin of the joint. (Typically, a first- or second-generation joint initiates at the flaw.) Students discuss the role of flaws in the initiation of joints in their groups.

Evaluation

At the end of the session, we review observations as a class, with each group reporting. I collect and review individual student maps, sketches and written responses.

Documentation:

Instructor's notes below; student handout attached.

See also: Müller, G., 2001, Experimental simulation of joint morphology, *Journal of Structural Geology,* v. 23, p. 45-49.

Instructor's notes:

Materials:

- cornstarch (available at any grocery store)
- water
- food coloring (optional)
- mixing bowl and spoon
- petri dishes (available from most biology depts.)
- small pebbles or granules (2-4 mm diameter)

Preparation: Mix cornstarch and water in approximately 1:1 proportion. Consistency should be of a stiff pancake batter. Add a few drops of food coloring to improve visibility of joint surface textures. Pour mixture into petri dishes, about 1 cm deep. I use plastic dishes, 9 cm diameter x 1.5 cm deep (3 1/2 x 1/2 in.), but any similar transparent container will work. Seed each dish with a small pebble. Set dishes aside to dry. Drying time will depend on local relative humidity. In a heated office, joints are fully developed in about two days. After 4 or more days, the cornstarch is too friable to be effectively dissected for observation of joint surface texture. Drying can be accelerated with heat lamps.

Student preparation: Students are asked to read the chapter on joints in their structural geology textbook.

In-class: Before the exercise, I give a short review, using photographs and illustrations, of joints, joint sets, joint surface textures, how to interpret propagation direction, and determining relative age.

I give students the lab hand-out, a blank sheet for sketching, and distribute a cornstarch "outcrop" to each group. The class spends about 20 minutes describing and interpreting the joint patterns and surface textures. This can be a good precursor to sketching and describing structures in the field.

After the groups are finished, I reconvene the class, and we review observations. How many joint sets? What is the intersection angle? Where did the joints initiate? How can you tell? We discuss the role of the flaw in the medium in the context of earlier discussions of deformation mechanisms. We end the class by discussing how joints might effect rock strength and permeability, and the practical applications of joint analysis.

Clean-up: Dry cornstarch is easily swept up, is not hazardous, and can be thrown away. Petri dishes can be rinsed and re-used.

Possible extensions of this exercise:

- Hypothesis testing: how does joint pattern (spacing, orientation, number of joint sets) vary with thickness of cornstarch layer, rate of desiccation, shape of container?
- Time-lapse photography for direct observation of joint propagation and joint-pattern development

Geology 318: Structural Geology

Western Washington University
Professor Juliet Crider

JOINT PATTERNS AND SURFACE TEXTURES

Objectives: to determine the relative ages of joints and to identify the origin of a joint from surface textures; to produce annotated sketches of geologic structures

<u>Materials you will need:</u>
pencil, eraser
un-lined paper
hand lens (optional)

<u>Materials provided:</u>
desiccated cornstarch-water mixture

Read through entire lab before acting!

A. Observe the map-pattern of the large joints.

1. Make a drawing of the sample showing the large joints. Include a scale.
2. What is the angle of intersection between most joints?
3. On your drawing, show how the joints curve to intersect each other and accurately show the angle.
4. Annotate your drawing to indicate the relative ages of the joints

B. Observe the role of a flaw in the material

5. Indicate the location of the flaw on your illustration in A.
6. What is the relationship of the flaw to the large joints?

C. Carefully dissect the sample so that you can see the surface of one of the large joints.

7. Sketch the fine structures visible on the surface of the joint. Include a scale.
8. From your sketch, determine the direction of joint propagation and, if possible, the origin of the joint. Note these on your drawing.
9. Can you relate the direction of propagation to the flaw or joint intersections? Explain this relationship in words.

<u>Turn in:</u>

- ❑ your sketches for A and C.
- ❑ your answers to questions 2, 6 and 9 typed or neatly written on a separate sheet