PROJECT 4
Earth Movers

Areas of Focus

- Physical Sciences: Changing landforms, geological processes, erosion
- Science (general): Experimental design, data gathering, model building
- Art: Design, working with materials

Target Grade Level: 6 - 8

The Science Behind the Project

Every time the earth shakes in southern California, we are reminded that the ground beneath our feet is constantly on the move. But you don't have to feel the ground shake to be convinced of that. Just look at the mountains that ring the Los Angeles basin. They are the result of titanic forces deep in the Earth that fold, crumble, and rip the Earth's crust like a sheet of paper.

We are all well aware that southern California is earthquake country, but did you know that region is also vulnerable to gigantic floods? It may not seem that way, as much of southern California is viewed as a semi-arid desert. But this part of the world has seen its share of massive floods, as torrents of rain fall onto the mountains and eventually flow into riverbeds that are usually very dry. But next time you drive east into places such as San Bernardino or up the Cajon Pass, take note of the huge car-sized boulders lying in the dried river bottom and ask yourself the question, "Now just how did that gigantic boulder get there?"

Much of the area we call the Los Angeles Basin, is a huge floodplain, a geological feature resulting from river water flowing over its banks and spreading across the ground. Before the development of Los Angeles, water flowed through the area north of and below the Baldwin Hills into nearby Ballona Creek. At times the Los Angeles River even shifted course to flow west from what is now downtown Los Angeles, to the Pacific Ocean through what is now Ballona Creek. Standing on top of the Baldwin Hills Scenic Overlook (see Station 6 on the Overlook Tour), you can see the current Ballona Creek contained within concrete channel walls. But imagine the power of the river moving through the flat floodplain below the hills before the houses and freeways were built.

And with all this water there are a lot of rocks, gravel, and sand. So much of the geography of southern California has been shaped by water. In this next set of activities, you will examine the dynamic consequences of moving water. Processes that shape the geography occur at such a gigantic scale that it is difficult to really appreciate these forces without getting into a car. So, instead, you will be constructing a model of a river floodplain that is no bigger than a small desktop.

Materials – What You Need (for all of the following activities)

- Wallpaper hanger tray (a paint roller tray will work as well)
- 5 lbs of diatomaceous earth (use food grade which can be purchased in health food stores or online for about $15)
- A bucket in which to hydrate the diatomaceous earth
- A dust mask
- Spray bottle containing water
- Empty food can (at least 12 ounces; a coffee can works well)
- Food coloring

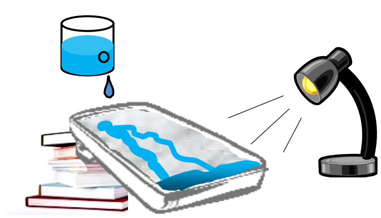
- Something to prop one side of the tray up and to support the can (plan on it getting a little wet)
- Paper cup
- Desk lamp
- Protractor

Activity 1: Building an (Almost) Pocket-sized River

In this first activity, you will create a dynamic river in your tray that will evolve in minutes what an actual river would achieve in many thousands of years. We think you will get the idea very quickly that there is nothing about flowing water that stays the same.

Procedures – What You Do

1. Using the desk lamp placed at an angle on the side of tray, illuminate the river system to reveal the many details of its structure (the low angle of the light creates a shadow effect). You should attempt to draw what you observe. Using a small nail, make a small hole on one side near the bottom of the water container. The hole should be small enough to only permit water drip out of the container at about 1 drip every 2 or so seconds. This may require trial and error to get the flow rate correct. If the water drains too quickly, you can use hot candle wax to plug a portion of the hole.
2. Carefully place the diatomaceous earth in the bucket. Be sure to wear the dust mask and spray water on the powder to minimize the amount of airborne particles (this is the only time the diatomaceous earth will be in a powder form).
3. Add enough water to the diatomaceous earth to give it the consistency of thick mud.
4. Place the material into about 2/3 of the tray, leaving the remaining 1/3 of the tray empty.
5. Tilt the tray by placing something to prop up the side with the diatomaceous earth (see the diagram). Some water may begin to drain out of the material into the lower portion of the tray. You may already see the river start to form at this time as the water drains downhill.
6. Place the empty water container at the upper end of the so that the hole is over the diatomaceous earth.
7. Add a few drops of food coloring to the container, and then fill the container with water. The water should begin to drain out of the container and down the diatomaceous earth.



8. Now is when you should take careful notes of what happens next. Watch for the following river features to form in only a few minutes:
    - Waterfalls and cascades (areas where the water flows quickly down steep inclines)
    - Braided water courses (as diatomaceous earth builds up on one side of the river causing it to shift to another path of less resistance)
    - Formation of canyons
    - Build-up of an alluvial fan that eventual forms a delta. How does the broad delta form from such a narrow river course?
    - Note how the lower edge of the diatomaceous earth forms a coastal region where a delta forms.

9. You can add a drop of food coloring to the river periodically to reveal the current flow of water.
10. After your river system has run for a while, shut down the flow of water and let the river dry for a short time (it will take on noticeably dryer appearance in less than an hour).
11. See, or even take a photo of the river system.
12. Using the Internet, search images of rivers and river features, such as deltas, alluvial fans, cascades, canyons, waterfalls, and braided watercourses. How many of these features do you see in your river?

Activity 2: How You Turn the Meandering Mississippi into the Deep-cutting Colorado

In this activity, you will see how the degree of tilt of the tray dramatically affects the characteristics of the river.

Procedures – What You Do

1. Run your river system with the tray at different tilts (Use books or pieces of wood to adjust the angle). Use a protractor to precisely set the angle (e.g., 10°, 20°, 30°, and 40°).
2. You can easily reset the river by tilting the tray in the opposite direction and re-piling material back at one end with your hand.
3. If you have the materials, you may run several rivers simultaneously and at different tilt angles.
4. Draw or photograph each river and describe the differences you see. Watch how the steeper the slope of the tray, the more quickly debris (aka, the diatomaceous earth) is carried downstream.
5. Go on the Internet and look up information and photos of the Mississippi and Colorado Rivers. How well to these actual images compare with your tabletop river system?

Going Further

- Cut out a dam from the lip of the paper cup (you will have to experiment with best shape to hold back the river water). Place the dam along the river course and observe what happens next. Do dams last forever? How did your dam eventually fail? What if you used multiple dams placed along the river?
- Create flood situations by dramatically increasing the flow of water down the river (this can be done by making several can reservoirs with different flow rates).
- Look up information on the Mississippi River Delta region and the City of New Orleans. Where does New Orleans lie relative to the river delta? Why do you think deltas are so important as agricultural areas?

Wrap It Up

This exercise is an excellent example of the role of physical models in science. The tiny tabletop river system will experience some - but not all - of the same forces that act on rivers that are hundreds of miles long. The models permit you to witness events that normally take many thousands of years to occur (such as the formation of a river delta) in just a few minutes. But be careful not to push the comparison between your tabletop river and the real thing too far. Remember it's not the real thing. Physical models of natural processes can only capture a small portion of the kinds of forces acting on a real river, but this is the case for models in general.