A GRIDDLE EARTH:
culinary genesis in the classroom

You take four teaspoons of pancake flour, place them in a glass beaker, and stir. Then transfer the ingredients to a metal tray, apply heat, and -- a pancake develops, right? **Wrong!**

You get a blob of dough representing earth in its molten state approximately 4.5 billion years ago.

Allow your imagination to travel back in time to when the earth was a steaming, hissing mass. As your doughy earth warms up, rapid changes occur. Miniature earth structures spring up throughout the paste; mountains, plains, and plateaus poke out in every direction. Volcanoes pinpoint the surfaces.

Later, upon cooling, deep valleys, ocean basins, and jagged fault lines appear. Several million years pass quickly before your eyes.

This simple experiment suggests that the internal forces of the earth result from its unequal heating and cooling. Scientists offer the following hypotheses:

Contraction theory. The earth is gradually shrinking. This may be due to gradual cooling in the mantle of the earth. As a result of cooling, earth structures thrust and buckle like the skin of a drying apple.

Convection theory. Convection currents are set up in liquids and gases by heating. The cooler portion, being denser, sinks. This pushes up the heated portion. The rising liquid comes to the surface, loses heat, then moves down again. This happens under the crust of the earth. Disintegrating radioactive elements may provide the heat source. The downward pull between two convection currents (A and B) could account for subsiding, or sinking land.

Continental drift. One large continent formed when the earth's crust (mostly granite) cooled. The underlying material (basalt) is heavier than granite, therefore, granite "floats" over basaltic material. This single continent eventually broke up and various sections drifted apart.

Expansion theory. The earth is neither shrinking nor remaining at the same size. It is expanding. The mid-oceanic rift zone has been cited as evidence for the expanding earth theory and for the shrinking earth theory.

It's easy to bog students down with technical terms and confusing explanations for the origin of the earth. However, confusion is minimized when students receive information sheets describing each theory. Geologic terms - i.e., volcanoes, faults, plateaus, etc., and definitions pave the way for easy understanding.

How can these theories be demonstrated in the classroom? Simply, give each student a procedure outline and an observation sheet with guide questions.

The following is the procedure for the two-part experiment.

A. Part I - The Effect of Heat on Cooler Substances

Materials:

Pancake flour or Bisquick
Pyrex or metal tray
teaspoon
water
thermometer (F°)
hot plate
magnifier
metric ruler
beaker (100 ml)

Procedure:

Mix flour teaspoonfuls of pancake with water in a 100-ml beaker. Add enough water to get a gooey substance. Stir until the flour mixes thoroughly with the water. Pour the mixture into a Pyrex dish or a metal tray. Spread around in a circle. Place a thermometer in the mixture and record the temperature. Measure (mm) and record the diameter of the mixture. Place these recordings in the spaces provided on the observation sheet. Transfer the tray of doughy substance to a hot plate. Set the temperature dial at 350°F.

Observation

Students observe the changes that take place as the dough heats up. They record the changes in dough temperature and surface texture every two minutes for ten minutes. Many holes appear as gas comes to the surface and dough lumps rise and fall throughout the mixture. During this time, numerous cracks form near the outer edge of the mixture. A magnifier helps the student make accurate observations.

Part II - The Effect of Cooling on Warmer Substances

Procedure

After ten minutes, remove the mixture from the hot plate. Students continue to observe dough temperature and texture changes every two minutes for twenty minutes. Again, all observations are recorded on the observation sheet. Allow mixture to stand overnight. The next day students make a final observation of structural and temperature changes. The diameter of the mixture is measured and recorded on the observation sheet.

The following are guide questions:

Part I

1. How does heat affect the mixture?
2. What was the temperature of the mixture after ten minutes of heating? How much did it increase over the starting temperature?
3. When do bubbles appear in the mixture?
4. When does the surface begin to dry?
5. Explain how the following structures form in the mixture:
   - Plateaus
   - Plains
   - ocean basins
   - mountains
   - volcanoes
   - faults
6. When do each of the above structures appear (minutes)?
7. Does this experiment provide evidence supporting the convection, continental drift, or expansion theory? Explain.

Part II

1. How does cooling affect the mixture?
2. When did cracking occur in the mixture? Measure (mm) the length and width of the largest cracks. Sketch their approximate position.
3. When did the surface of the mixture appear dry?
4. How much did the temperature decrease after 20 minutes of cooling?
5. Does this experiment provide evidence supporting the contraction theory? Explain.

Part III - After 24 hours

1. Once more measure (mm) the length and width of the cracks previously measured in Part II. Have they changed in size? If so, how?
2. Does this experiment provide evidence supporting the contraction theory? Explain.
3. Has the diameter of the mixture changed over the past 24 hours? If so, what does this indicate?

Do these experiments support the theories of earth origin? Hardly. But evidence of land rising and falling cannot be denied. Fossil seashells buried in rocks thousands of feet above sea level indicate that great upheavals of the earth's crust have taken place. All landforms are thought to be a combination of processes that continually work against each other. Although the effect of the various forces on the position of rocks is evident, their exact origin of the forces is not known. Scientists may never uncover all the earth's secrets. They may disagree on several points, but one thing remains clear - the landform processes will continue to do their work for some time to come.

References

Bishop, Lewis, Bronaugh; Focus on Earth Science, Charles E. Merrill Publishing Co., Columbus, Ohio, 1969.
Earth Science Curriculum Project, Investigating the Earth, Houghton Mifflin Co., Boston, Mass., 1967.
Ramsey & Burckley, Modern Earth Science, Holt, Rinehart and Winston, Inc., 1965.

Physics and pancakes

In a recent session of our graduate-level physics education class, even our adult classmates enjoyed this new look at the lowly pancake, so your students probably will too. The lab is simple to run, there's no math in it, and cleanup is easy; just eat your product.

You will need plenty of pancake mix, bowls, spoons, spatulas, an electric mixer, and a griddle or two.

- Why do the edges get done before the middle?
- Which cools off the fastest, the middle or the edges? Why?
- If you pour first one spoon of batter and then another on the same pancake and then flip it over when ready, you will see concentric circles, or rings. Why?
- When the batter first hits the griddle, it sizzles. Why?
- When you mix up the batter, try several methods of mixing. Stir with a spoon, an eggbeater, a spatula, an electric mixer, and shake up the batter in a jar. Some of these methods are harder than others, they require more time or effort. Why is that?

Your questions can lead into discussions of many physical concepts. How deeply you will be able to go into these ideas is, of course, limited by the level of your students. Some of the basic concepts you can bring up for discussion are gravity and its effect on shape; viscosity and its effect on thickness and cooking rates; how heat transfer and thickness are related to cooking and cooling rates in the middle versus at the edges of the pancakes; bubble formation due to boiling; and basic ideas about work as related to the mixing methods.

Try this novel lab. It can be a lot of fun, and it should stimulate students to take a look at science in ordinary, daily activities. Good eating!

Observation Chart - Part 1- The effect of heat on cooler substances
STRUCTURAL CHANGES IN MIXTURE (check the appropriate spaces)

Time (min)	Temp. (ºC)	Gas bubbles present	Surface becoming dry	Cracks forming	Folds developing	Rapid rising and falling of dough	Rapid hardening of surface	Very little change
0								
2								
4								
6								
8								
10								

Diameter of mixture before heating _____ mm

Observation Chart - Part 2- The effect of cooling on warmer substances
STRUCTURAL CHANGES IN MIXTURE (check the appropriate spaces)

Time (min)	Temp. (ºC)	Gas bubbles present	Surface becoming dry	Cracks forming	Folds developing	Rapid rising and falling of dough	Rapid hardening of surface	Very little change
12								
14								
16								
18								
20								
22								
24								
26								
28								
30								

Diameter of mixture after heating and cooling _____ mm

Observation Chart – Overnight

Time (hrs)	Temp. (ºC)	Holes grew larger	Shrinking occurred	Cracks increased in width and length
24				

Diameter of mixture after 24 hours _____ mm