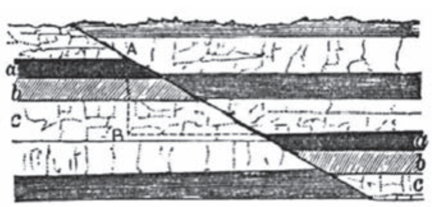
FOLDING AND FAULTING

The Earth is a dynamic planet and the enormous forces within the planet play a central role in forming the landscape we live in. Canada is home to spectacular land formations such as the Rocky Mountains and the Canadian Shield. In the last lesson we saw how tectonic activity (the movement of tectonic plates) can lead to violent upheavals in the form of mountains. In addition to this, as we have learned, tectonic forces deform rocks in the Earth's crust. The evidence for such activity is thousands of kilometres of rock layers that are bent, rumpled and fractured. The Earth's major mountain belts contain fossils of marine animals thousands of metres above sea level. Massive rock formations are folded as if they were made of modeling clay. These findings point to the tectonic activity forming the Earth's landscape. It is very important to study rock structures when we are selecting sites for bridges, hydroelectric dams, nuclear power plants and of course homes and communities. The knowledge of how a certain geographical area formed geologically – understanding the process of folding and faulting among others – allows us some understanding of the potential dangers of certain landforms.

Most rocks originally form in flat layers called **strata**. Some layers are **sedimentary**, which means they are created from rock particles (sand and mud) settling together. Others are volcanic, meaning there were formed due to volcanic processes. When these strata are compressed (squeezed), folding occurs. A **fold** is a bent layer, or series of layers, of rock that were originally horizontal and have become deformed (pushed out of shape). Folds come in different shapes and sizes from a few millimetres to tens of kilometres. The bending can be gentle or severe depending upon the amount of force. An arch shape fold is called an **anticline** and a down warp fold is called a **syncline**. Folding generally makes the rock units shorter and thicker.



Faults are fractures along which movement has occurred on either side of the crack. Faults can be caused by different forces such as *compression* (squeezing), *extension* (pulling) or *shearing* (tearing). Small faults consist of single breaks. Large faults, like the San Andreas fault in California, consist of many interconnecting faults. Sudden movements along faults are the cause of most earthquakes.

Faults in which the movement is mainly vertical are called *dip-slip faults* because the slip, or displacement, is parallel to the dip of the fault plane. The rock surface that is immediately above the fault is called the hanging wall and the rock surface below is called the footwall. These names have an interesting history, since they were given by miners who sometimes excavated tunnels along faults containing important minerals, such as gold. The miners would walk on the rocks below the fault (the *footwall*) and hang their lanterns on the rocks above (the *hanging wall*)! Dip-slip faults are classified as either *normal faults*, caused by pulling forces, where the hanging wall moves down relative to the footwall; or *reverse faults*, caused by squeezing forces, where the hanging wall moves up relative to the footwall.

Strike-slip faults are faults in which the movement along the fracture is horizontal, and parallel to the strike of the fault surface. Strike–slip faults result from tearing forces and generally consist of a zone of parallel fractures. The earliest records of strike-slip faulting were made after examining the surface ruptures produced by large earthquakes, such as the famous San Francisco Earthquake of 1906.

Folding and faulting have affected and continue to affect the landforms we find on Earth. Knowledge of folding and faulting has real importance for everyday life. It allows us to better understand the dynamic forces within the Earth that can be applied to decisions as to how and where we build our homes, communities, bridges and dams. It also helps us to know where to search for mineral and petroleum resources which sustain our economy.

A1: Folding and Faulting

Play-Doh Folds

1. Make a flattened pancake of each colour of Play-Doh (about 15 cm in diameter and 1 cm thick). The greater the diameter, the thinner the layers and the more easily the model can be folded.
2. Stack the layers on top of each other in any colour order to make a block.
3. Use colouring pencils that closely match the Play-Doh, sketch the side view of this model in the space labelled, **Diagram A**.
4. **To simulate compression -** place your hands, one on either end of the play dough block. Gently push your hands together so that you squeeze it along its longer axis. This will cause the play dough block to fold and buckle. Try to make at least one upward fold (anticline) and one downward fold (syncline)
5. Use colouring pencils that closely match the Play-Doh, sketch the side view of this model in the space labelled, **Diagram B**.
6. **To simulate surface erosion-**Take your cutting device (fishing line and washers) and cut the top off of your folded model.
7. Use colouring pencils that closely match the Play-Doh, sketch the side view of this model in the space labelled, **Diagram C**.
8. Discuss what you observe with your group members. Repeating bands of sedimentary layers, such as in this model, when found at the surface of the Earth tell a geologist that they have found an eroded fold.

Popsicle Stick Faults

1. Take one Popsicle stick. Hold it in both hands and bend it. What happens? Instead of folding, the Popsicle stick is brittle, and breaks. This is how a fault is produced in rocks.

A2: Play-Doh Faults

1. Cut your play dough block model in a vertical direction – add a little bit of an angle if you like.
2. Use this new model to demonstrate a normal fault, a reverse fault, and a strike-slip fault.
3. Use colouring pencils that closely match the Play-Doh, sketch the side view of this model in the space labelled, **Diagram D**.

Diagram A	Diagram B	Diagram C

Diagram D		
Normal Fault	Reverse Fault	Strike-Slip Fault

MATERIALS

- Transparent plastic box*
- Thick cardboard

Consumables:

A variety of substances of varying colour and similar particle sizes

- Sand
- Flour
- Chocolate powder

A3: Geological Squeeze Box: Folds and faults

1. Cut a piece of card to size to fit tightly and stand up in one end of the plastic container.
2. Pour in a thin (a few millimetres) layer of sand. Sprinkle a thin layer of flour on top of the sand. Continue to alternate layers of sand, flour, and chocolate powder until box is about one third full
3. Hold the piece of cardboard firmly and move it slowly and gently toward the opposite end of the box. Try to keep it vertical.
4. As the cardboard moves, watch the layers of sand and flour carefully to see what happens.
5. Stop moving the card when it is about halfway along the box.
6. Make a sketch of the side of the box identifying the folds and faults in the sand and flour layers.

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*For a visual reference visit:

https://www.earthlearningidea.com/PDF/Himalayas_in_30_seconds.pdf

Instructions to build a more sophisticated model can be found at:
http://www.di-mac.com/Peg1.JPG
https://www.boreal.com/ca/en/product/8867447/tectonics-model

Watch:
https://www.youtube.com/watch?v=t3T69vMK8OI

How to make :
http://www.exo.net/~emuller/activities/The_Squeeze_Box.pdf

Sketch

1. What causes similar compression to occur to the Earth's crust?

2. Where does this occur on the Earth's surface?

3. How does the model you made simulate the processes at work in the Earth?