

Tension, Shearing and Compression Stresses – Forming Metamorphic Rock

Objective:

To observe how pressure can change the structure of rock such as in the formation of metamorphic rock

Background:

There are many forces that act on the Earth's crust. For example compression forces push or squeeze rocks together. Tension forces pull rocks apart and shearing forces twist and tear rocks. These forces move the rocks in Earth's crust and change their shape and structure. Many of the Earth's major landforms are formed by these forces. Have the students practice the three forces on a piece of paper. Lay the paper flat on the desk and have the push the two ends together. Ask if this is the Earth's crust what have you made? Mountains Compression Stress. Then have them hold the paper above their desk and have them pull the two ends of the paper apart until it rips. Tension Stress- Rift Valley or Spreading Center or a fault. Then have them put one piece of the ripped paper back on the desk. Have them hold opposite diagonal corners and pull the top left corner towards the top of the desk and the bottom right corner towards the bottom of the desk. Not easy to coordinate. If the paper rips they have created Fault by Shearing stress.

Materials:

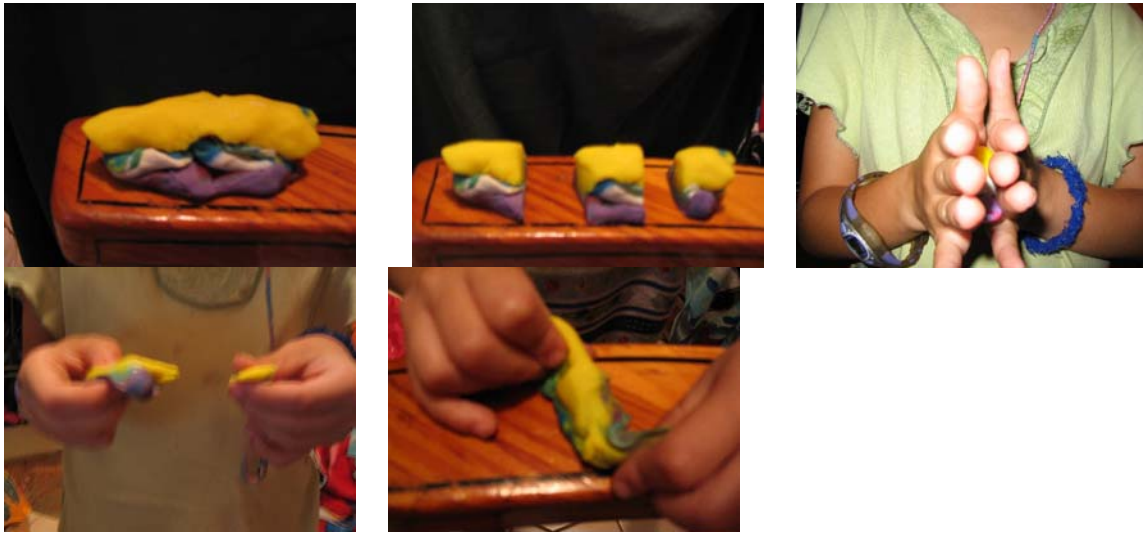
1. 3 or four different colors of play dough or clay. Some clay is very hard to push and pull
2. A plastic knife or scissors
3. Wax Paper or something to cover desk surface
4. Two hands
5. Paper and pencil for recording data

Procedure:

1. Put three or four layers of different colored play dough or clay flat on top of each other to form one long large block.
2. Cut (pushing down vertically) the multilayered block into three equal and similar looking parts.
3. Draw and describe the three undeformed blocks of multicolored play dough
4. Place the palms of your hands on either end of one block (one on the right side and one on the left side) of dough and slowly push.
5. Draw and describe the block of play dough after you pushed it inward.
6. Take a second block of multicolored play dough. Hold onto each end (one hand on the right side and one hand on the left side) and slowly pull the block outward.
7. Draw and describe the block of dough after you pulled it apart.
8. Take the third block of multicolored play dough and place the block on wax paper on your desk.
9. Hold onto the right side of the block with one hand and the left side with your other hand.
10. Push one end of the dough towards the top of your desk, while pushing the other end towards the bottom of your desk.

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11. Draw and describe this block of dough after you pushed and pulled the ends one towards the top of your desk and the other towards the bottom.



Observation Questions:

1. What type of force did you apply to the first block of dough? **Compression you pushed the layers together.**
2. What changes did you observe in the shape and structure of the first block of dough? **The layers swirled in an S shape or moved up in an upside down smile shape.**
3. What type of force did you apply to the second block of dough? **Tension stress-you pulled the dough in opposite directions.**
4. What changes did you observe in the second block of dough? **The middle of the block of dough got thinner and may be broke into two pieces**
5. What type of force did you apply to the third block of dough? **Shearing Stress-The block moved side to side**
6. What change did you observe in the third block of dough? **The dough move until it broke into two side by side pieces.**
7. Which blocks of clay produced foliation? **Any block that swirled in layers. Foliation means in ribbon like bands.**

Analysis Questions:

1. Which block of play dough resembles a metamorphic rock? Explain why. **The first and third block may show changes in the shape and structure of the clay like swirling, up warping, folding, over turning or bending.**
2. What is needed for metamorphic rocks to be formed in the Earth's crust? **Heat and pressure**
3. Describe how your hands modeled the metamorphic process with the three blocks of play dough. **The heat from my hands and the pressure of pushing the dough was like the forces and heat inside the earth that forms metamorphic rocks like Gneiss from granite of marble from limestone.**

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4. Where in nature would forces like the ones you applied to the play dough be applied to rocks in the Earth's crust? Give specific examples for support. **Inside mountains, along active transform faults and in deep regions near a magma source metamorphic rock is formed. For example inside the Rocky Mountains you can find folded rock or along the San Andreas Fault.**

Follow up:

Use clay and compare which required more force the play dough or the clay (or vice versa). Have the students explain why and relate it to grades of metamorphic rock. **Clay should take much more force or pressure and perhaps heat relating to higher grades of metamorphic rock.**

Have the students create a fourth multicolored block of play dough and apply forces from other angles like under or above the block and draw and describe the deformations. Have the students relate or compare them to samples of metamorphic rocks. **Students can push down to create a meteor crater or push up to create up warped Mountains. Just allow them to play with the dough and try to match up their creations with metamorphic rocks and landforms in nature. Let their imaginations go wild and play with the many colored doughs**