Geologic Time

**Purpose:** To use relative dating techniques to interpret geological cross sections.

**Materials:** colored pencils

**Procedure:** Today we will be interpreting geologic history from geologic cross-sections. Geologic history is a series of events that resulted in the current distribution and geometry of the rock units in a cross-section. Evidence for these geologic events is in the rocks themselves. Each type of rock formed in a different way, and thus tells you something about the geologic history.

**Sedimentary rocks** - these rocks form at the surface of the Earth when sediment is deposited and lithified to form rock. Therefore, if you found sandstone in your cross-section, you could describe the geologic event that formed the sandstone thus, "Sand was deposited and lithified to form sandstone." Descriptions of sedimentary rock forming events take the general form "<sediment> was deposited and lithified to form <sedimentary rock>."

**Metamorphic rocks -** these rocks form deep within the Earth's crust when rocks are exposed to heat and pressure and undergo physical and chemical changes. The rock is called a "protolith" before metamorphism, and given a metamorphic rock name after it has been metamorphosed. For instance, a quartz sandstone protolith that is exposed to these conditions will form the metamorphic rock quartzite. Descriptions of metamorphic rock forming events take the form "<protolith> was metamorphosed to form <metamorphic rock>."

**Protoliths of Common Metamorphic Rocks**

|  |  |
| --- | --- |
| **Protolith** | **Metamorphic Rock** |
| quartz sandstone | *quartzite* |
| limestone | *marble* |
| coal | *anthracite* |
| shale | *slate* |
| slate | *schist* |
| schist, granite | *gneiss* |

To be exposed on the surface of the Earth, all of the rock above the metamorphic rock must be removed by erosion, which requires uplift like what you find in mountain building events.

**Igneous Rocks -** these rocks are formed when magma (molten rock) cools to form rock. Igneous rocks are divided into plutonic (formed from magmas intruded deep within the Earth's crust) and volcanic (formed from magmas that extruded onto the surface of the Earth). These distinctions are very important when reconstructing geologic history. Like metamorphic rocks, plutonic igneous rocks can only be f on the surface of the Earth if all of the rocks above them have been removed by erosion. Plutonic magmas intrude into the rocks in an area without being exposed on the surface. Determining the relative age of plutonic magmas is further complicated when magma has intruded the rocks in an area at different times. Plutonic rock structures are given names based on their size and shape, e.g., *pluton* (any plutonic rock body), *lacolith* (dome-shaped pluton), *batholith* (very large pluton), *dikes* (primarily vertical plutons) and *sills* (primarily horizontal plutons). Descriptions of plutonic igneous rock forming events take the form "Magma intruded into <names of all rocks the magma cut across> then cooled to form <igneous rock>."

Volcanic igneous rocks generally form from lava, which is magma extruded on the surface of the Earth. These types of igneous rocks can be interbedded with sedimentary rocks, forming layers just like sedimentary rocks. Not all extrusive igneous rocks are formed directly from lava, volcanic eruptions frequently throw enormous amounts of debris into the air that can fall as volcanic ash hundreds of miles from the eruption. Descriptions of volcanic igneous rock forming events take the form "A volcanic eruption occurred in the area, forming <igneous rock>."

**Common Igneous Rocks**

|  |  |
| --- | --- |
| granite | obsidian |
| diorite | tuff |
| gabbro | pumice |
| rhyolite | scoria |
| andesite |  |
| basalt |  |

Rocks are subject to forces that result from the active nature of the Earth's surface. These include:

**Erosion** - the removal of material from a portion of the Earth's surface due to the actions of wind, water, glaciers and/or mass wasting. Any rock on the surface of the Earth that is not being constantly covered with material can be assumed to be undergoing erosion.

**Tectonic Stress** - forces within the body of the Earth that, fold, spindle and occasionally mutilate the contained rock bodies. Also causes **faults** (fractures within a body of rock along which movement occurs). Tectonic stresses can force rock bodies to move in any direction, including up.

**Uplift and Erosion** - exactly as it sounds, rock body move upward toward the Earth's surface as the overlying body of rock is eroded away. The rock body eventually becomes exposed at the surface of the Earth. Uplift is usually caused by tectonic stress, but that stress may be gentle enough not to severely deform the rocks.

You have been given two cross-sections to decipher.

**Cross Section One:**

Complete the chart based on the geological cross-section. The oldest event should be on the bottom of the chart just as the oldest rock in a cross-section is usually (but not always) on the bottom. The most recent event should be on the top of the chart. It almost always involves the formation of the present surface of the Earth at that locality. Each time you add an event (e.g., deposition of a sedimentary rock), For each rock unit or feature write which correlation principle(s) you used to determine its age relative to the other rocks and features in the cross section.

**Cross Section Two:**

The instructions for this cross-section are the same as for the other cross section, except for the last column. For each rock unit or feature, write a short description of how that feature formed. Make sure that you choose appropriate verbs for each type of rock or feature (e.g., "Tectonic stress deformed the older rocks, which were then uplifted to the surface of the Earth and the rocks above them eroded away, forming an angular unconformity.").