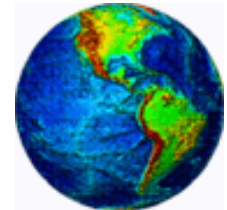


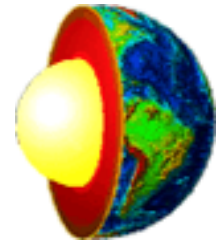


TEACHER BACKGROUND: EARTH'S SPHERES

Everything in Earth's system can be placed into one of four major subsystems: land, water, living things, or air. These four subsystems are called "spheres." Specifically, they are the "lithosphere" (land), "hydrosphere" (water), "biosphere" (living things), and "atmosphere" (air). Each of these four spheres can be further divided into sub-spheres.

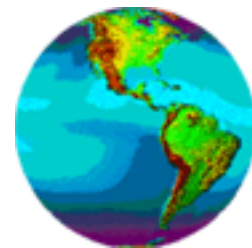


The **Lithosphere** -- contains all of the cold, hard solid land of the planet's crust (surface), the semi-solid land underneath the crust, and the liquid land near the center of the planet. The surface of the lithosphere is very uneven. There are high mountain ranges like the Rockies and Andes, huge plains or flat areas like those in Texas, Iowa, and Brazil and deep valleys along the ocean floor.



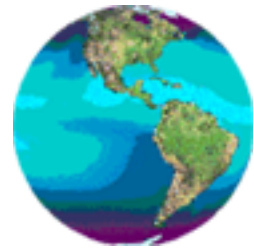
The solid, semi-solid, and liquid land of the lithosphere form layers that are physically and chemically different. If someone were to cut through Earth to its center, these layers would be revealed like the layers of an onion. The outermost layer of the lithosphere consists of loose soil rich in nutrients, oxygen, and silicon. Beneath that layer lies a very thin, solid crust of oxygen and silicon. Next is a thick, semi-solid mantle of oxygen, silicon, iron, and magnesium. Below that is a liquid outer core of nickel and iron. At the center of Earth is a solid inner core of nickel and iron.

The **Hydrosphere** -- contains all the solid, liquid, and gaseous water of the planet. It ranges from 10 to 20 kilometers in thickness. The hydrosphere extends from Earth's surface downward several kilometers into the lithosphere and upward about 12 kilometers into the atmosphere. A small portion of the water in the hydrosphere is fresh (non-salty). This water flows as precipitation from the atmosphere down to Earth's surface, as rivers and streams along Earth's surface, and as groundwater beneath Earth's surface. Most of Earth's fresh water, however, is frozen.



Ninety-seven percent of Earth's water is salty. The salty water collects in deep valleys along Earth's surface. These large collections of salty water are referred to as oceans. The image above depicts the different temperatures one would find on oceans' surfaces. Water near the poles is very cold while water near the equator is very warm. The differences in temperature cause water to change physical states. Extremely low temperatures like those found at the poles cause water to freeze into a solid such as a polar icecap, a glacier, or an iceberg. Extremely high temperatures like those found at the equator cause water to evaporate into a gas.

The **Biosphere** --contains all the planet's living things. This sphere includes all of the microorganisms, plants, and animals of Earth. Within the biosphere, living things form ecological communities based on the physical surroundings of an area. These communities are referred to as **biomes**. Deserts, grasslands, and tropical rainforests are three of the many types of biomes that exist within the biosphere.



The **Atmosphere**--contains all the air in Earth's system. It extends from less than 1 m below the planet's surface to more than 10,000 km above the planet's surface. The upper portion of the atmosphere protects the organisms of the biosphere from the sun's ultraviolet radiation. It also absorbs and emits heat. When air temperature in the lower portion of this sphere changes, weather occurs. As air in the lower atmosphere is heated or cooled, it moves around the planet. The result can be as simple as a breeze or as complex as a tornado.



Figure 1

INTERACTIONS BETWEEN THE 4 SPHERES

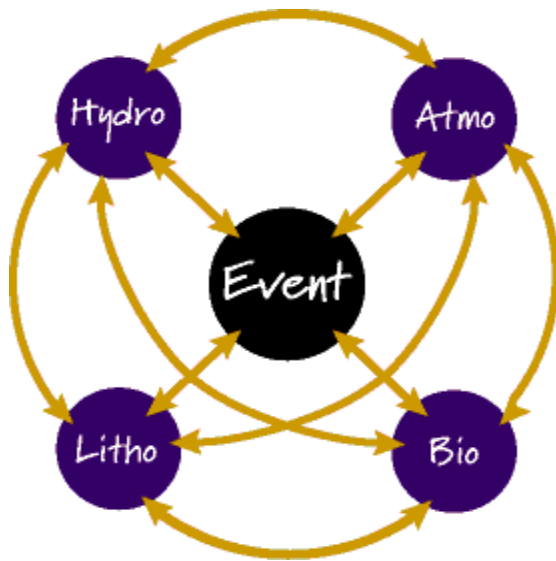
Although the four systems have their individual identities, there is important interaction between them. Environmental scientists study the effects of events in one sphere on the other spheres. There are ten possible types of interactions that could occur within the earth system. Four of these interactions are between the event and each of the



earth's spheres. The double-headed arrows indicate that the cause and effect relationships of these interactions go in both directions. These four types of interactions can be illustrated in **Figure #1**. The "*event < > hydrosphere*" refers to the effects of the event on the hydrosphere, as well as the effects of the hydrosphere on the event. For example, a volcanic eruption in the geosphere may cause profound direct and indirect effects on the hydrosphere, atmosphere and biosphere as follows.

Example: (Volcano) On May 18, 1980, Mount Saint Helens, in the state of Washington, erupted. This *event* altered the surrounding environment, and provided scientists with an opportunity to study the effects of volcanic eruptions on the lithosphere, hydrosphere, atmosphere and biosphere. Such studies are important because volcanic eruptions will continue to occur, and will have increasing impact on humans as people continue to settle lands closer to dormant volcanoes.

Figure 2



In addition to the above four event-sphere interactions, there are six interactions that occur among the spheres themselves. **Figure 2** illustrates a few of the many interactions resulting from a volcanic eruption. The ten types of interactions that can occur within the earth system often occur as a series of *chain reactions*. This means one interaction leads to another interaction, which leads to yet another interaction--it is a ripple effect through the earth's spheres.

Volcano >> lithosphere >> atmosphere >> hydrosphere >> biosphere

Volcanoes (an event in the lithosphere) release a large amount of particulate matter into the atmosphere. These particles serve as nuclei for the formation of water droplets (hydrosphere). Rainfall (hydrosphere) often increases following an eruption, stimulating plant growth (biosphere). Particulate matter in the air (atmosphere) falls out, initially smothering plants (biosphere), but ultimately enriching the soil (lithosphere) and

thereby stimulating plant growth (biosphere).

Volcano >> lithosphere >> hydrosphere >> biosphere

Volcanoes (events in the lithosphere) may release a substantial amount of hot lava (lithosphere), which causes mountain glaciers (hydrosphere) to melt. Mudflows (lithosphere) and flooding may occur downstream from volcanoes and may inundate streamside communities (biosphere).

Volcano >> lithosphere >> atmosphere >> biosphere >> lithosphere

Volcanoes (events of the lithosphere) release a large amount of carbon dioxide (atmosphere), the raw material for sugar production in plants (biosphere). This may increase photosynthetic production and eventually increase the amount of biomass, which, after a very long time, forms coal and oil deposits (lithosphere).

Volcano >> complex interactions

- ❖ Volcanoes (lithosphere) may emit large quantities of sulfur dioxide (atmosphere).
- ❖ When atmospheric sulfur dioxide combines with water (hydrosphere), sulfuric and sulfurous acid form.
- ❖ Rain (hydrosphere) may bring these acids to the Earth, acidifying soils (lithosphere), lakes and rivers (hydrosphere).
- ❖ Acidic water leaches nutrients from the soil (lithosphere) into the water table (hydrosphere), making the soil less fertile for plants (biosphere), and the subterranean water supply (hydrosphere) less potable for humans (biosphere).
- ❖ Acid rain falling on lakes and streams reduces the pH of the water (hydrosphere), which may result in a decrease in phytoplankton and zooplankton growth (biosphere).
- ❖ If photosynthesis is reduced, atmospheric concentrations of carbon dioxide can build up and stimulate global warming (atmosphere) which may contribute to increased melting of glaciers (hydrosphere).