Geomorphology Capstone Research Paper

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Geomorphology: Four Processes of Landforms

As we look and feel around our natural environment, we can tell there are many different land formations. There are land formations such as hills, mountains, flat plains, deserts, sea beds, and river basins that cover our Earth's surface. We begin to wonder: what are the main processes that cause geologic land formations and how do they affect our environment?

Geologic processes or land formations include the uplift of mountain ranges, the growth of volcanoes, isostatic changes in land surface elevation, and the formation of deep sedimentary basins. The Earth's surface is modified by a combination of surface processes that sculpt landscapes such as water, wind, ice, fire, and living things on the Earth. Geological processes also cause the earth's surface and coastal geography to be changed such as tectonic uplift and subsidence. Surface processes along with chemical reactions that form soils and alter material properties, the stability and rate of change of topography under the force of gravity, and other factors, such as human alteration of the landscape also contribute to changes in geologic land formations.

Many of these geologic factors are strongly mediated by climate. Aeolian is the process in which wind is involved. This is also called "the wind process". It shows the process of how wind travels around the earth. "Wind travels using deflation, the action or process of deflating or being deflated. It also erodes by abrasion. Abrasion is the process of scraping or wearing. Regions which experience intense and sustained erosion are called deflation zones. Most Aeolian deflation zones are composed of desert pavement, a sheet-like surface of rock fragments that

remains after wind and water have removed the fine particles. Almost half of Earth's desert surfaces are stony deflation zones. The rock mantle in desert pavements protects the underlying material from deflation. A dark, shiny stain, called desert varnish or rock varnish, is often found on the surfaces of some desert rocks that have been exposed at the surface for a long period of time" (Lancaster).

In these conditions, the wind is saturated with respect to transport capacity. Very fine grains (silt and clay size) are inherently resistant to entrainment, yet are readily transported by the wind. "Recent studies have shown the critical role of impacting sand grains in the mobilization of silt- and clay-size particles and demonstrated the close relations between the horizontal flux of sand-size particles and the vertical flux of fine particles. In these situations, the horizontal mass transport rate is directly related to shear velocity, so dust emissions scale to the fourth power of wind shear velocity. Where there is a limited supply of particles able to abrade soil clods or playa crusts, dust emissions are limited by the supply of particles rather than the wind shear velocity, and the vertical flux of dust is almost independent of wind shear velocity" (Lancaster). Wind Erosion by wind involves two linked processes: abrasion (mechanical wearing of coherent materials, including playa crusts and clods created by tillage**)** and deflation (removal of loose material). Considerable attention has been devoted to the processes and rates of wind erosion because of their impact on agriculture, especially in semi-arid regions, and the implications of dust emissions for air quality (Lancaster). Wind erosion abrades crops, removes organic matter, nutrients and fertilizer, and changes soil texture. The products of wind erosion (especially dust particles) impact air quality, atmospheric radiative properties, and human health, causing respiratory illnesses. Rates of wind erosion vary widely and for a given wind shear velocity are

dependent on soil or sediment texture and the degree of crusting and cohesion. This is just one process that effects our Earth's crust the land formations it alters.

Igneous rocks are rocks formed from a volcano's molten magma. These rocks form when the magma cools and crystallizes. This can happen above ground with lava as well as it can also form below the surface when the molten rock rises in the crust but does not reach the surface. In essence, igneous rocks are formed through the cooling and solidification of magma (or lava). As hot, molten rock rises to the surface, it undergoes changes in temperature and pressure that cause it to cool, solidify, and crystallize (Williams).

"There are over 700 known types of igneous rock, the majority of which are formed beneath the surface of the Earth's crust" (Williams). These are known as intrusive or plutonic rocks. In order for an igneous rock to be considered intrusive it must undergo the change from a liquid to a solid state inside of the Earth. Due to the high temperatures inside the Earth, this process can take thousands or even millions of years. This type of igneous rock tends to be much larger and has a coarse texture. In addition to these, there is also hypabyssal a less common form of igneous rock that is formed within the Earth between plutonic and volcanic igneous rock cycle (Williams).

However, some igneous rocks are also formed on the surface as a result of volcanic activity. Basalt, granite, pumice, obsidian, tuff, diorite, gabbro, and andesite are just a few that are named igneous rock based on how they were formed (Madaan). These are known as extrusive rock. Extrusive rocks are usually found near volcanoes or fissures in the Earth's crust where magma has erupted (Madaan). These tend to be much smaller and have a very smooth texture. Obsidian is one of the most well-known, and also one of the most common of the extrusive igneous rocks.

All of the rocks on the surface of our planet were at one time molten rock. “Beneath the thin rocky crust of the earth is the inferno of the mantle. This is the origin of all igneous rocks. The mantle is the home of magma, the name of molten rock while it is still beneath the surface of the earth. Igneous rocks are formed from this molten magma. These rocks form when the magma cools and crystallizes” (Madaan). This can happen above ground as with lava. It can also form below the surface when the molten rock rises in the crust but does not reach the surface.

When the magma reaches the surface it cools quickly, taking a matter of days or weeks. When the magma forms pockets underground it cools much more slowly. This could take thousands or even millions of years. The rate at which the magma cools determines the kind of igneous rocks that are formed. Faster cooling surface lava creates rock that is fined grained or aphanitic (Madaan). The rapid cooling doesn’t allow large crystals to form. In addition most of the gasses are driven off into the atmosphere. The slower cooling that takes place underground allows larger crystal formation. After igneous rocks have been formed they can be transformed into metamorphic or sedimentary rocks (Madaan). They can even be re-melted to form new igneous rocks. “The upper section of the Earth's crust is made up of around 95% igneous rock. This is just one reason why we have so many variations of land formations“ (Williams).

Another geologic process that alters our Earth’s surface is the Hillslope Process. Hillslopes are an important part of the terrestrial landscape (Pidwirny). You can think of the Earth’s landscape as a composition of mosaic hillslope types being made and those ranged from steep mountains and cliffs to almost flat plains. On most hillslopes, large quantities of soil and sediment are moved over time via the medium of air, water, and ice often under the direct influence of gravity (Pidwirny). Also, the approximate length it takes to form a hillslope depends on the various geomorphic processes acting on it and their source of material that are used to

construct a number of depositional landforms. In practical terms, hillslopes have a direct and indirect influence on a number of human activities. The determination of agriculture, forestry, and human settlement was being made to steepness and structural stability (Pidwirny). Also, they can become a hazard to humans if their materials move rapidly through the process of mass wasting.

"According to the inputs and outputs of the hillslope system, we can begin our study of hillslopes by thinking of them as a process-response. Also, this system receives inputs of solar radiation, precipitation, solid and dissolved substances from the atmosphere, and unconsolidated sediment derived from the weathering of bedrock. The inputs of unconsolidated sediment are controlled by weathering rates and bedrock weathering. Also, rates are influenced by the presence of moisture" (Pidwirny).

"Outputs to hillslopes occur by evapotranspiration, by percolation of water, the movement of dissolved substances in to the bedrock, and by the removal of sediment by streams, glaciers, or by both ocean waves and currents. Also, outputs of debris and sediment from hillslope systems are controlled primarily by the availability of erosional mechanisms to transport material that accumulate at the slope's surface and face" (Pidwirny). For example, the presence of a stream at the face of a hillslope encourages removal of sediments. If the steams discharge is too small to handle the debris input, sediment will accumulate at the slope. The magnitude of hillslope inputs and outputs depends on a number of factors, including bedrock geology, climate, and the nature of the slope to the broader landscape. The balance between the inputs and outputs from the hillslope system exerts a major control over the form of the developing slope. In situations where inputs are the controlling factors, the slope is said to be weathering limited because outputs quickly remove and accumulating debris. Where the potential for weathering is high, but outputs

are restrained, and the hillslope system in classified as being transport limited. Landscapes that are transport limited are easily recognized by the presence of a deep soil profile (Pidwirny).

"Fluvial is a term used in geography and geology to refer to the processes associated with and having to do with rivers and streams and the deposits and landforms created by them. When streams or rivers are associated with glaciers, ice sheets, or ice caps, the term glacio-fluvial or fluvio-glacial is used" (Wikipedia).

The fluvial process mainly deals with the erosion of land forms to form rivers. Water flows over land and carves a channel for the river to follow. The fluvial process also deals with the things carried by a river, such as rocks, sticks, and dirt. Pretty much anything that can be dragged along by the current of a river is fluvial transportation. Typically heavier materials such as large rocks or logs are pushed by a river near its source where the current of the river is strongest. (S-cool the revision website) In the middle of the river the current lessens and larger materials are dropped out of the rivers current. The river picks up smaller materials like sticks and small rocks and carries them along the length of the middle of the river once more before dropping out of the current of the river. From that point on even smaller matter is carried by the river. These things include very small pebbles dirt particles and twigs.

A rivers bed or the channel is usually the product of strong water flow against carving its way through the earth and eroding away soil, rock, and other matter as it goes. (S-cool the revision website) Rivers always try to erode to their base level. A rivers base level is the lowest possible depth a river can go, typically around sea level. Sea level is the base level for measuring elevation and depth on Earth (Wikipedia). This is why you can almost always find a river in places such as valleys, gorges, and the like.

Now, as we look and feel around our natural environment, we know the many different land formations and geologic processes that alter our environment. Surface processes along with chemical reactions that form soils and alter material properties, the stability and rate of change of topography under the force of gravity, and other factors, such as human alteration of the landscape also contribute to changes in geologic land formations. Land formations such as hills, mountains, flat plains, deserts, sea beds, and river basins are modified by a combination of surface processes that sculpt landscapes such as water, wind, ice, fire, and living things on Earth. Our Earth is quite the unique place thanks to our ever changing land surfaces.

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