Graduating Thesis.

Geological Actions of Water.

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Geological Actions of Water.

I Destructive.

1 By chemical changes.
(a) Weathering.

2 By physical agents.
(a) Rivers (erosion).
(b) Oceans (waves).
(c) Ice (snow, glaciers).

II Constructive.

1 By physical agents.
(a) Rivers (deltas)

2 By chemical changes.
(a) Precipitation.

Geological Actions of Water.

Of all the agents that geologically modify the surface of the earth, water is the most important. It exists in the three following well known forms: (1) as invisible vapor; (2) as water; and (3) as ice.

By the heat of the sun vast quantities of water vapor are raised from rivers, lakes and seas, all over the world. This vapor rises into the atmosphere and when it is cooled below its point of saturation, it falls to the earth again in the form of rain, hail or snow. It either percolates thru the soil to feed

springs & flows over slopes of land to enter a brook or torrent and at last returns to the sea. When the water vapor first rises, it is nearly chemically pure, but after it has again fallen to the earth and worked its way over or under the surface of the earth, and when it again reaches the sea, it is no longer pure, but loaded more or less with the material it has taken up in the air, rocks or soil thru which it has passed.

Chemical & Destructive Changes.

Chemical Action of Rain. - This depends on the amount of gases in the air thru which the rain passes. This amount varies in different localities. Around volcanos and large cities where manufacturing is extensively carried on, gases in the air are most plentiful. As the rain falls it washes the air and holds the gases in solution. This accounts for the

fact that rain makes such marked chemical changes on soil and rocks. As far as is known, Oxygen, carbonic acid and organic material are the most important substances washed from the air.

Weathering.—This is destructive changes that are continually taking place thru the agency of chemical and physical agents. "Constant dropping as the old proverb runs, wears away stones." Rain, by its chemical and mechanical action leaves its mark everywhere. In the course of time, the polish is removed from marble and even granite. In large cities where the rain becomes acidulated as it falls thru the air, columns of polished marble and granite soon become dim. In the country the same effect is produced, only more slowly, due to the fact that the atmosphere does not contain so much smoke. Inferior varieties of stone such as we have in this vicinity are constantly crumbling away.

Nothing can wholly withstand the action of the atmosphere and of the rain (aided no doubt, by changes of temperature, especially by frost). Mere hardness or softness, forms no index to the comparative power of a rock to resist weathering. Rocks least liable to be acted on chemically, resist weathering best, provided the particles have sufficient cohesion to withstand mechanical disintegration.

Probably no other rock is weathered in a greater variety of ways than is granite. It weathers and disintegrates from all exposed surfaces. Thus a rectangular mass, weathering more rapidly on the edges and corners than elsewhere, loses its regularity and finally becomes a shapeless mass. As granite becomes decomposed as such, it forms kaolin, a kind of white mud, used quite extensively in making pottery.

"The weathered surfaces of rocks as they are called, afford endless

proofs of the same common action. Obscure structure scarcely perceptible on freshly broken faces are developed by the quick increasing, yet deliberate process of etching out which Nature's hand is ever engaged." Weathering of hills is especially marked when the strata offer different resistance to the destructive agents and when the slopes are such as to allow the removal of the debris. Probably no place in the world offers a better example of weathering than is found in Colorado. Here rocks have weathered readily and are formed into towers, spires and terraces.

"For some distance along the South River, hundreds of monuments rise from 60 to 80 feet and some are even 400 feet high, and on the top of each is a large boulder". The surface waters and rain are checked from the apex of these monuments by large boulders, but as it drops and runs down the sides, they

are gradually worn away and finally topple and fall.

Erosion. The extent of erosive action of rivers and smaller streams depends on their gradient and the amount of rocks and sand carried by the stream. If the gradient is steep, the stream runs rapidly and the erosive action is much greater than it is in a stream of less velocity, other things being equal. A stream with high velocity has a deep channel and seldom overflows, while the sluggish in some cases has its bed higher than the surrounding country (P.o.).

The Canon of the Colorado River affords a good illustration of the erosive action of water where the gradient is steep. Its channel is a mile or more deep, the walls being composed of limestone and sandstone. The rainfall in the immediate vicinity is slight, and this together with the fact that the strata are parallel, gives ample reason for its walls

being so nearly perpendicular. If the strata were oblique, the walls would not stand perpendicularly. Freezing and thawing and thawing would sooner or later loosen the ledges of rock and they would slide into the water below. There is a tendency of rapid streams to run in a straight direction, and consequently the erosive action is much greater on the convex than on the concave side of the channel.

Waves. - The waves of the ocean are a powerful agent. They are continually wearing away hills and elevations that fringe on the coast. These hills are worn away near their bases and when they are sufficiently undermined, large masses break off and slide into the sea. This never ceasing action, in time wears away cliffs, tho they be of the hardest rock. The rapidity with which cliffs are worn away, depends on the hardness of their rocks and the angle they present to the waves.

A good illustration of rapid wear is afforded by the soft chalk hills of Kent and Sussex. In some places the sea advances on the land from one to two feet a year. At Easton – Bavent, near Southwold a breadth of 350 yards is said to have been washed away by the sea in 35 years.

Ice. – Water as it freezes expands and is a very powerful and destructive. By its expansion, water pipes are burated and rocks cracked and sealed off. Stone avalanches that thunder down mountain slopes are started by frost and consist of large masses detached by the action of ice. In arctic regions rocks are often completely shattered by frost. Huge masses are detached and burst asunder and fall into the valley below.

Frozen water also appears in the form of snow and glaciers. If snow falls on the side of a mountain it slides away in the form of an avalanche. The snow

may be dry, such as has lately fallen, or it may consist of snow that has lain on the ground for some time. When spring comes, these masses slide down the mountain and are destructive to both animal and vegetable life.

When large masses of ice collect and move down the mountain side very slowly, they are known as glaciers. "The rock fragments, some of them many tons in weight, carried down on the surface of the medial and lateral moraines, undergo no friction and retain all their original shapeness and angularity; but those which travel under the glacier, where the friction is great are generally small, worn and scored on all sides. These latter consist in greater part of the stones which have fallen from the surface into crevices and gradually work their way to the bottom, where held and pressed down by the overlying ice, they have rasped with it over the rocky glacier-bed." The edges of these

loose fragments have been ground away by the powerful abrasion. There are also many rocks embedded in the ice, and these with loose sand and stone press scratches and polishes the stationary rocks over which they pass, in a remarkable manner. As a result of this action, angular rocks are made smooth, and where the resistance is irregular, smooth dome shaped eminences are formed, striated in the direction of the moving ice. These present a continuous slope, and at the highest end a deposit of debris has taken place. This form of structure is known as 'crag and tail' and serves to indicate the direction of the ice movement on all glaciated surfaces.

The erosive power of glaciers depends on the gradient, its weight and the channel. The narrower the channel, the greater is the erosive action and plowing force. When the glacier enters a broader valley, it expands in fan shape and the erosive and plowing action are

greatly diminished. When the glacier reaches the ocean, it projects into the water and breaks off in large masses, which float in the water and are known as icebergs.

Physical Constructive Changes

The quantity of silt mud or sand carried by a river, depends on its velocity, and also on the country thru which it flows. The higher the velocity, the greater the transporting power. The constructive action of the Mississippi river is quite important. It has at its mouth a delta whose area is 12,300 square miles, 630 feet thick and is advancing rapidly. Thus we see while the ocean is becoming filled, the land mass is being torn down and carried away. Consequently the ocean is growing shallower and the hills are lower. It would

seem that the ratio between the depth of the ocean and the height of the land mass would remain nearly the same.

The point of deposition of a river as it enters the ocean, depends on its velocity and also on the absence or presence of currents or tides. If the stream is sluggish, the deposit is made near its mouth, but if its velocity is high, the suspended material is carried a long distance into the ocean before it is deposited. The heavier materials are thrown down first, while the lighter may be carried many miles into the ocean. If the river water as it enters the ocean, comes into contact with an ocean current, it is quite likely that a very small delta or none at all will be formed. To a great extent, tides have the same effect. As they advance they sweep the deposit towards the shore and carry it far into the ocean as they return.

As the river removes soluble material from the soil thru which it passes, so does it form marine calcareous strata. Calcareous beds are also formed under the ground by subterranean waters. There is also another kind of sedimentary strata, such as is deposited in fresh water lakes. New deltas are formed by in-flowing streams, but not to such a great extent as is the case in the ocean. In some of the American lakes, myriads of decomposing shells have formed thick beds of white marl. Should this become hardened, it would form limestone

Besides the strata already named, there are still others formed by chemical changes. These changes arise from changes in organic matter. "The more important of these substances are Gypsum, Rocksalt, Dolomite and Coal."

"By far the most important among chemical deposits, is Calcium Carbonate". The manner. The manner in which this substance is removed

and redeposited by permeating water can be easily seen in the case of stalactites and stalagmites, beneath the damp arches of limestone caves. They are caused by water coming in from above in drops. These drops evaporate and leave rings of carbonate. These rings continue to grow, and form tubes. These tubes finally fill up and thicken into massive pillars. Calcareous springs deposit in large quantities a precipitate of carbonate of lime on twigs, stones and other objects over which it flows. The precipitation takes place when the water from any cause looses carbonic acid.

All these changes have been going on no doubt, ever since the world was created. As striking as all these changes are, they are so slow and so gradual, that we hardly notice what changes are going on about us from one year to another, but nevertheless, construction and destruction are continually going on.

As erosion and disintegration takes place on one hand, construction takes place on the other, hence we have another evidence of the law of indestructibility of matter.