

## GEOMORPHOLOGY: LANDFORMS

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**Abstract:** Geomorphology is the study of landforms and landform evolution. The topic traditionally has been studied both qualitatively, which is the description of landforms, and quantitatively, which is process-based and describes forces acting on Earth's surface to produce landforms and landform change. The shift to a more quantitative approach was largely based on the work of Horton, Strahler, and Leopold in the 1940's and 50's who advocated a physically-based assessment of landforms. Today, the quantitative approach is widely utilized, demonstrated by modern 'process geomorphology' textbooks (see Further Reading list). There are many sub disciplines in geomorphology including tectonic, fluvial, storm, aeolian, floodplain, glacial, groundwater, climate, tsunami, and many others. These sub disciplines are mainly driven by distinctions in the mechanics and dynamics involved in the processes. Engineering geomorphology is the study of how geomorphology and geomorphic processes have and may impact sites of engineered works and typically is additional to the physical processes acting at a site. Human geomorphology studies impacts humans have worldwide on reshaping landforms. Thus, it is difficult to imagine a location or circumstance that has not been impacted by geomorphic processes. This article emphasizes geomorphologic processes as a balance of forces that result in the varied landforms observed across Earth's surface. For this paper, these processes can be considered by the following sequence of events: tectonic forces, fluvial processes, mass wasting, glaciation, and human activity.

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### Introduction

Geomorphology (the study of shape of Earth's surface and the processes that have shaped it) is more challenging beneath than above sea level, because visual observations are limited by water turbidity. The development of the subject of submarine geomorphology has therefore more closely followed the development and deployment of new technology than subaerial geomorphology. Thus, whereas in subaerial geomorphology, hypothesis and inquiry have been prompted by structures that have always been visible, in submarine geomorphology, advances of understanding have tended to occur when new features have been discovered or imaged with instruments at higher resolution. Also, because of the limited accessibility, our knowledge of the marine geologic processes creating these morphological features has relied mostly on a forensic type of analysis (reconstructing events based on analyses of samples or other geophysical data) rather than by monitoring of processes more directly, although monitoring has been possible in some instances, in particular in the more accessible shelf seas.

Beneath the oceans, erosion can be important locally such as in submarine canyons but is not as important as generally as it is in subaerial geomorphology where rainwater runoff and

glaciation can cause radical changes in landscapes. Some features created by flows (of lava, debris, evaporites, etc.) and tectonics can therefore remain unmodified for long periods, making interpretation of process in some respects and in some locations easier than on land.

Geomorphology has been defined as the study of terrestrial geomorphology and the forms and features that result from it (Peel, 1967). Geo scientist treat it as a bridge between geology and geography as a matter of fact it harmonises the basic concepts which constitute the philosophical and methodological bases of these sister disciplines and offers a convincing and logically sustainable interpretation of geomorphic processes, forms and associated features. Some Geo scientists considered geomorphology as a study of forms of the earth's surface and their origin and effects. This has led to the form process approach. Another group of geoscientists considered it as the study of processes and resultant forms and features. As a result process-form approach emerged. These development created a dichotomy. Thus a vexed controversy analogous to chicken and egg persists in geomorphology methodology. As a matter of fact the geomorphic reality is a unified whole whose appreciation essentially requires the interpretations from both the points of view.

Similarly a group of geo-scientists treated geomorphic units in a cycle manner whereby they originate, grow and decay. This was elucidated in terms of a trinity principle and expressed that landscape is a function of structure, process and stage. This school was developed by Devis (1899, 1909) and supported by a host of others. This facilitated not only the forms existed in the past on the basis of the preset geomorphic forms and processes but also helped in visualizing the feature geomorphic pattern. Penck (1924) marked a departure from the cyclic model and treated the land scape as a manifestation of interaction between tectonic forces and denudation processes occurring simultaneously.

#### **Review of literature**

The science of geomorphology as a discipline can be defined as the study of terrestrial denudation and the forms and features that result from it. A great deal of new research development in geomorphology has taken place recently. Applications of space photograph, remote sensing and computers have widened the scope of this subject in solving environmental problems. The American and European Scientists have done considerable amount of work in geomorphology. In the field of quantitative geomorphology the contributions of Horton (1945) Strahler (1950, 1952, 1954, 1956, 1958) Milor (1953) Schumom (1956) Melton (1957, 1958) Smith (1958) Morisawa (1959) Abrahams (1972) Gardiner (1977) Douglas (1976) Embleton and King (1980) Sugden and John (1968) Eyles (1983) are worth mentioning. In India too, considerable work has now been done in the field of geomorphology by geographers and geologists. Early studies have been conducted by Chatterji (1975) Verma (1957) Singh (1968) Bose (1961) West (1962) Sen (1965) and Choubey (1966). Besides these senior geologists and geographers significant contribution to this field has been made by Vaidyanadhan (1964). His work is mainly concentrated on various aspects of Cuddapah basin and coastal form and process of the Krishna and Mahanadi deltas (Rao and Vaidyanadhan 1974). After 1970, substantial contributions in this field have been made by younger scholars like Pal (1972) Sings (1982) Sharma H.S. (1972, 1976, 1980, 1982) and De N.K. (1982) Bandhopadhyay (1972) Rao, Padamja (1976) Dhinwa (1981) Sharma M.L. (1986) Mukhophadhyay (1969) and Rai (1970-71).

#### **LANDFORMS AND THEIR EVOLUTION**

**RUNNING WATER** In humid regions, which receive heavy rainfall running water is considered the most important of the geomorphic agents in bringing about the degradation of the land surface.

There are two components of running water. One is overland flow on general land surface as a sheet. Another is linear flow as streams and rivers in valleys. Most of the erosional landforms made by running water are associated with vigorous and youthful rivers flowing over steep gradients. With time, stream channels over steep gradients turn gentler due to continued erosion, and as a consequence, lose their velocity, facilitating active deposition. There may be depositional forms associated with streams flowing over steep slopes. But these phenomena will be on a small scale compared to those associated with rivers flowing over medium to gentle slopes. The gentler the river channels in gradient or slope, the greater is the deposition.

Overland flow causes sheet erosion. Depending upon irregularities of the land surface, the overland flow may concentrate into narrow to wide paths. Because of the sheer friction of the column of flowing water, minor or major quantities of materials from the surface of the land are removed in the direction of flow and gradually small and narrow rills will form. These rills will gradually develop into long and wide gullies; the gullies will further deepen, widen, lengthen and unite to give rise to a network of valleys. In the early stages, down-cutting dominates during which irregularities such as waterfalls and cascades will be removed. In the middle stages, streams cut their beds slower, and lateral erosion of valley sides becomes severe. Gradually, the valley sides are reduced to lower and lower slopes. The divides between drainage basins are likewise lowered until they are almost completely flattened leaving finally, a lowland of faint relief with some low resistant remnants called monadnocks standing out here and there. This type of plain forming as a result of stream erosion is called a peneplain (an almost plain). The characteristics of each of the stages of landscapes developing in running water regimes may be summarised as follows:

#### **Valleys**

Valleys start as small and narrow rills; the rills will gradually develop into long and wide gullies; the gullies will further deepen, widen and lengthen to give rise to valleys. Depending upon dimensions and shape, many types of valleys like V-shaped valley, gorge, canyon, etc. can be recognised. A gorge is a deep valley with very steep to straight sides (Figure 6.1) and a canyon is characterised by steep step-like side slopes (Figure 6.2) and may be as deep as a gorge. A gorge is almost equal in width at its top as well as its bottom. In contrast, a canyon is wider at its top than at its bottom. In fact, a canyon is a variant of gorge. Valley types depend

upon the type and structure of rocks in which they form. For example, canyons commonly form in horizontal bedded sedimentary rocks and gorges form in hard rocks.

#### **Potholes and Plunge Pools**

Over the rocky beds of hill-streams more or less circular depressions called potholes form because of stream erosion aided by the abrasion of rock fragments.

#### **Floodplains, Natural Levees and Point Bars**

Deposition develops a floodplain just as erosion makes valleys. Floodplain is a major landform of river deposition. Large sized materials are deposited first when stream channel breaks into a gentle slope. Thus, normally, fine sized materials like sand, silt and clay are carried by relatively slow moving waters in gentler channels usually found in the plains and deposited over the bed and when the waters spill over the banks during flooding above the bed. A river bed made of river deposits is the active floodplain. The floodplain above the bank is inactive floodplain. Inactive floodplain above the banks basically contain two types of deposits — flood deposits and channel deposits. In plains, channels shift laterally and change their courses occasionally leaving cut-off courses which get filled up gradually. Such areas over flood plains built up by abandoned or cut-off channels contain coarse deposits. The flood deposits of spilled waters carry relatively finer materials like silt and clay. The flood plains in a delta are called delta plains.

#### **GROUNDWATER**

Here the interest is not on groundwater as a resource. Our focus is on the work of groundwater in the erosion of landmasses and evolution of landforms. The surface water percolates well when the rocks are permeable, thinly bedded and highly jointed and cracked. After vertically going down to some depth, the water under the ground flows horizontally through the bedding planes, joints or through the materials themselves. It is this downward and horizontal movement of water which causes the rocks to erode. Physical or mechanical removal of materials by moving groundwater is insignificant in developing landforms. That is why, the results of the work of groundwater cannot be seen in all types of rocks. But in rocks like limestones or dolomites rich in calcium carbonate, the surface water as well as groundwater through the chemical process of solution and precipitation deposition develop varieties of landforms. These two processes of solution and precipitation are active in limestones or dolomites occurring either exclusively or interbedded with other rocks. Any limestone or

dolomitic region showing typical landforms produced by the action of groundwater through the processes of solution and deposition is called Karst topography after the typical topography developed in limestone rocks of Karst region in the Balkans adjacent to Adriatic sea. The karst topography is also characterised by erosional and depositional landforms.

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