

Geomorphic Characteristics Of Myllem Flat Valley, Meghalaya

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Abstract: Myllem flat valley lies south of the Shillong Peak in East Khasi Hills district, Meghalaya. It is a structural valley formed due to widening of gaps between the ranges of the Meghalaya Plateau. Despite its location in a sub-tropical humid climate, the area does not represent a uniquely tropical type of relief. It is characterized by granite topography with broad flat valleys surrounded by rounded hills. Residual landforms such as granitic boulders are found in abundance. These boulders were originally part of the solid mass of coarse-grained granite which formed deep within the earth's surface (about 607 Ma). Erosion has stripped away the overlying material and weathering (spheroidal weathering) process has shaped them into the forms in which they appear today. This has resulted in widespread occurrence of boulders that indicates the presence of sub-surface weathering. The drainage is characterized by structure and follows almost straight courses. The entire topography gives the impression of a peneplained surface. Land-use practice in the study area is dominated by agricultural fields, quarries, settlements, forests, etc. This has resulted in several geo-environmental problems such as deforestation, siltation of rivers, soil erosion, etc.

Index Terms: flat valley, structural control, granite topography, land-use practices, geo-environmental problems.

I. INTRODUCTION

Meghalaya Plateau represents a Pre-Cambrian cratonic block of North-East India which is detached from the peninsular shield of India by the Garo-Rajmahal tectonic graben. This sector is at present tectonically sensitive and seismically very active. The Myllem flat valley lies just south of the Shillong Peak (1961m) in East Khasi Hills District. It has a unique geographical setting. The seismically active location, sub-tropical climate, lithology, structure, etc. and the resultant landform provide ample scope for intensive investigation and analysis of the area. A study of the area gives an understanding of the geomorphology of the Myllem flat valley, its evolution through time and the processes that have shaped it.

The Myllem flat valley with its unique geology, geomorphic features and economic activities, the utility of the subject is immense. The region is undergoing significant changes due to increased human activities such as agriculture, quarrying, etc. which in turn influences the geo-environment of the region. In addition, the geomorphological study may be applied in various fields such as topographic mapping, study

of natural hazard, agro-economic and socio-economic development. Thus there is need to study and analyse the geomorphic characteristics, processes and applied geomorphological implications in the flat valley. Amidst the hilly terrain- full of ridges and valleys- presence of flat valleys of various dimension attract attention of the geomorphologists not only to unravel their origin but also the means and ways of their utilisation for human needs, i.e., both fundamental and applied geomorphic aspects are worth investigating. It is under this context that the study "Geomorphic Characteristics of Myllem Flat Valley, Meghalaya" was taken up.

II. OBJECTIVES

The present study is based on the following objectives:

- ✓ to study the geomorphic characteristics of the flat valley; and
- ✓ to find out applied geomorphic implications in the flat valley.

III. THE STUDY AREA

The area under study is Myllem flat valley of East Khasi Hills District of Meghalaya. It extends between 25°32' N to 25°28' N latitude and 91°46' E to 91°54' E longitude (Fig. 1). It covers an area of approximately 98 sq km. Some of the important villages in the study area are Ladmawreng, Mawreng, Mawsawa, Mawpynthih, Mawkohngoh, Laitjem, Mawblah, Nongbet, Umthlong, etc. The area is characterized by granite topography and wide structural valleys. The area is drained by the rivers Umlieng, Wah Umtongsyiem, Um Baniam, Um Shawshaw, Umlew, Umiam and their tributaries.

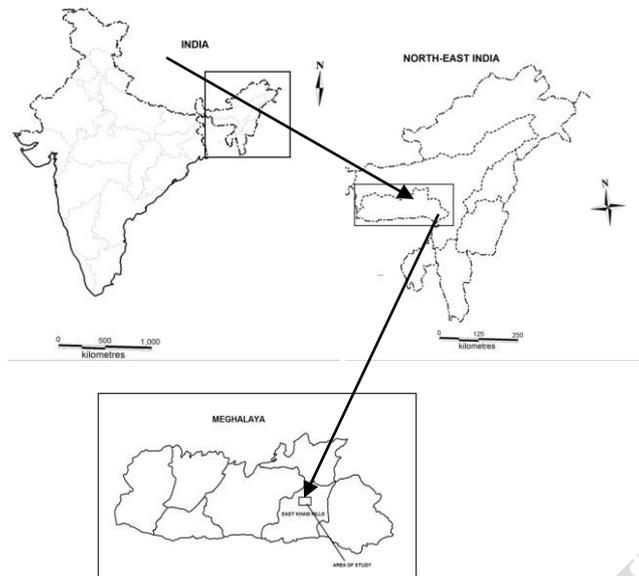


Figure 1: The Study Area

IV. DATABASE AND METHODOLOGY

The present study is based on both primary and secondary data. *Primary data* has been collected through the field work. Field work has been carried out to acquire first-hand information about geomorphological characteristics of the study area. Soil samples were collected from different sites in the study area to determine the soil type of the area. Photographs relevant to the study were also taken. *Secondary data* on geology, climate, vegetation, and land use/land cover have been culled from secondary sources like the Survey of India toposheets (scale of 1:50,000); published and unpublished literature, and web sites.

V. GEOLOGY

The study area lies in the central part of the Meghalaya Plateau which in fact is a detached part of the peninsular shield of India. The western and eastern sides of the Meghalaya Plateau are bordered by the North-South trending Jamuna fault system and the North-West to South-East trending Kopili fracture zone, respectively, the latter separates the Meghalaya Plateau from the Mikir Hills (Evans, 1964; Desikachar, 1974; Acharyya, et al., 1986; Nandy, 1986; Nandy, 2001). The bulk of the Meghalaya plateau is formed

by Archaean (Dharwarian) quartzites, slates, schists, with granitic intrusions and some basic sills and dykes, but in the south these are overlain by horizontal Cretaceous and Eocene sandstones, which on the outer flank dip steeply towards south-west. To the east, the plateau is linked to the Barail Group and so to the Tertiary formations Upper Assam

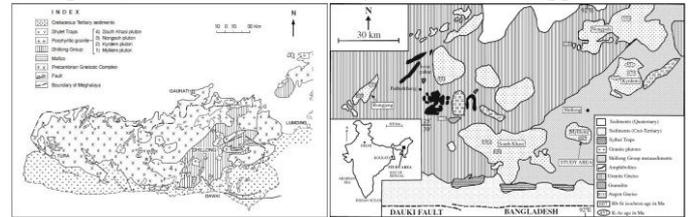


Figure 2: Geology of Meghalaya Plateau (after Mazumder, 1976; Ghosh, 1991)

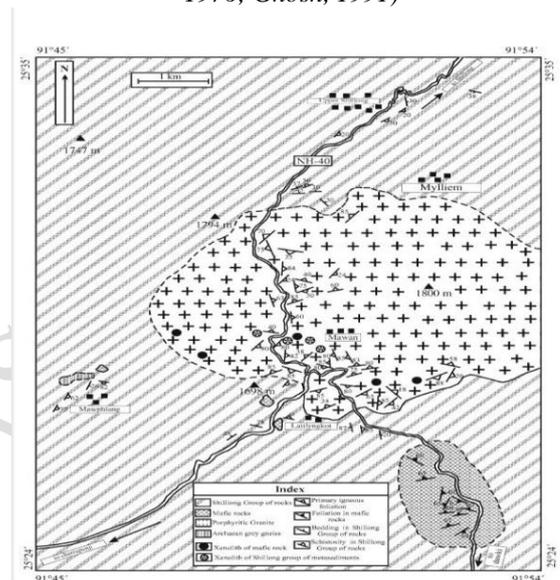


Figure 3: Geological Set Up of the Study Area (after Ray and Saha, 2011)

The area under study is a part of the Archaeans of Meghalaya Plateau and is included in the Shillong series marked by intrusion of granitic pluton. The structural grain in the Pre-Cambrian Gneissic Complex (Basement Gneiss) is different from that of the Shillong Group. Within the gneiss, on macroscopic scale, S-shaped folds and reclined folds superposed by more open pattern are predominant. Locally developed recumbent fold superposed by more open type later folds are also noticed. Murthy et al., (1967) described three generations of folds. According to them, the first one is an isoclinal to broad recumbent (or even reclined) folds having E-W trending axial plane. This older fold is superposed by a tight isoclinal fold having axial planes trending ENE to NE. The third phase is characterized by broad N-S warps.

The main structural trend in the Shillong Group is NE-SW, which is persistent all over the area and variation of this trend is discernible at places near the contact of intruded granite plutons. Folds in the Shillong series are not frequent and those that occur are in general open, asymmetrical folds with steep axial planes and gently plunging axes. The folds that occur in the rocks of the Shillong series surrounding the granite pluton commonly known as Myllem granite, have their axes as nearly as possible, towards the pluton. The trend of the rocks also veers round the pluton, becoming sub-

parallel and often parallel to the margins of the pluton. These structural relations between the rocks of the Shillong series and the Myllem granite are seen on the Shillong- Cherapunjee road on both the northern and southern margins of the pluton about 12 km and 24 km away from Shillong and Umtynger, respectively (Bhattacharjee, 1968). The study area is characterized by porphyritic coarse granite, pegmatite, aplite (quartz vein traversed by epidiorite, dolerite and basal dykes of the granite plutons and quartzite, phyllite, quartzitic schist, conglomerate of the Shillong Group.

As far as seismicity is concerned, the region is tectonically very active. It falls under zone V as per the seismic zoning map of India (Indian Meteorological Department). This zone expects the highest level of seismicity. The region is jawed between two arcs, the Himalayan arc to the north and the Indo-Burmese arc to the east. The Meghalaya plateau was the source area for the great 1897 earthquake. The area experiences frequent earthquakes and so it is said to be seismically very active.

VI. GEOMORPHOLOGY OF THE STUDY AREA

Origin and development of a landform is a very complex process and is the resultant product of many factors viz., rock types, structure, slope, drainage system, altitude, vegetation, climatic factors and spatial arrangement of some of the physiographic and geomorphic elements. As has been mentioned earlier, the study area is characterized by granitic intrusions within the quartzites of the Shillong Group. The timing of emplacement of Myllem granite is 607 Ma which is in age similar to other granite plutons of Meghalaya (881-479 Ma) and the Indian Peninsular Shield (740-395 Ma) (Ghosh, et al., 2004). The beds of the Shillong Group standing nearly vertical and are highly metamorphosed near the contact with granite. These granites have been considerably weathered. The agents of denudation like rain, surface water, and change of temperature have played a dominant role in the rock types in moulding the landscape of the area. The tropical monsoon humid climate exerts significant influence on the evolution of the topography.

Approaches to explain the variation in granite landforms appear to fall into two major categories: structural and environmental. Another explanation is process based and is championed by Twidale (1982) who emphasized the key role of deep sub-surface weathering in sculpting granite landforms. Lidmar-Bergstrom (1995) considered time as a principal factor in the evolution of granite landscapes. Depending on the duration of exposure of basement rocks, different types of relief developed. An apparent repetition of individual landforms in different morphoclimatic zone implies that geological factors acquire primacy in controlling the evolution of granite landscapes.

In fact, Myllem flat valley is a structural valley formed due to widening of gap between the ranges of the Meghalaya Plateau. Of course, The Myllem flat valley is characterized by typical granite topography with broad flat valleys surrounded by rounded hills. The granite hills rise to a general height of 1750-1850 m above mean sea level. These hills are weathered throughout. Residual landforms such as granitic boulders of

various shape and size are also found in abundance. The major and micro landforms of the study area are discussed as follows.

✓ **Flat Valleys:** The most important landform of the study area is its flat valley. In fact, it is a structural valley filled by the sediments brought from the nearby hills. Flat valleys are typical structural landforms drained by rivers. Such flat valleys develop when the space between two hill ranges is quite wider than the normal river valleys. The rivers in the flat valleys are not powerful enough to carve out such wide valleys. In fact, these are structural valleys, in due course of time, have been filled up with alluvium and colluvium. The cross sections of Myllem flat valley have been shown in Figure 4, which clearly depicts the broad and flat valley bottom.

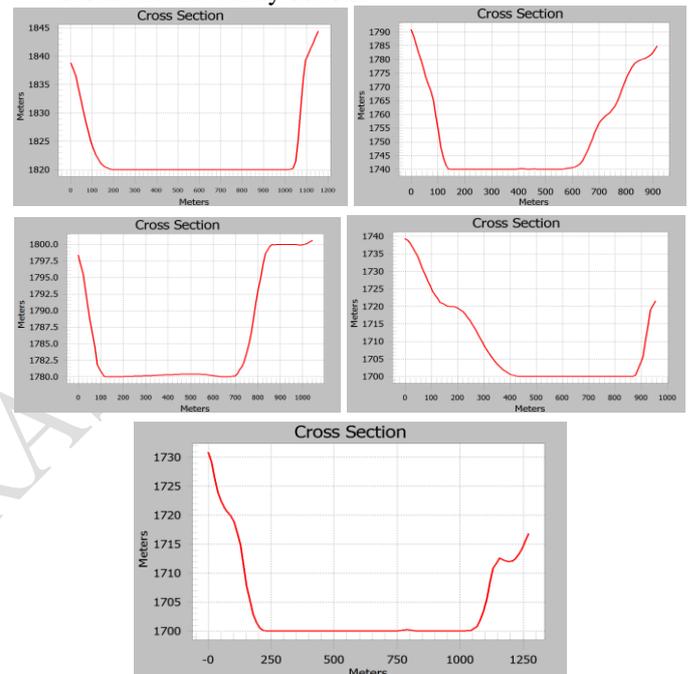


Figure 4: Cross Sections of the Flat Valley in the Study Area

In the given cross sections of the Myllem flat valley (Fig.4), it is seen that the width of the flat valleys ranges from 400m-600m and some of them are as wide as 800m. The height of the bordering hills ranges from 1750m-1850m. The valley gradually merges with the gentle slopes of the hills. The flat valley and hills are used for human settlement, pine, bamboo and agricultural fields. In some areas these are covered by huge boulders and core stones as outcrops.

✓ **Low Hills:** The study area is characterized by low hills which exhibit rounded forms with gentle slopes. The elevation of the hills ranges from 1750m to 1850m above mean sea level. These hills are covered by agricultural land and forests. Individual hills tend to be oval in plan and convex in shape. Many are crowned by tor groups which are actually clusters of boulders (Prokop and Migon, 2013). Sections in man-made excavations show that hills tend to be weathered throughout, although core stones are abundant both at the surface and in the subsurface.



Plate 1: Weathering of Granite Hills



Plate 4: Weathered hill



Plate 2: Corestones

- ✓ **Boulders:** One of the most characteristic landform of granitic landscape is the boulders or well-rounded groups of boulder. The Myllem flat valley is dotted with numerous boulders of different shapes and sizes (Plate 3). These boulders were originally part of the solid mass of coarse-grained granite which formed deep within the earth's surface (about 607 Ma). Erosion has stripped away the overlying material and weathering (spheroidal weathering) process has shaped them into the forms in which they appear today. This has resulted in widespread occurrence of boulders that indicates the presence of sub-surface weathering. The rivers of the flat valleys are also filled with such boulders.
- ✓ **Core stones:** Core stones are found in abundance in the study area. These core stones are the remnants of the initial granite rocks, around which weathering has taken place. When the weathered material is removed for sand and building stone the core is exposed to the surface. Sometimes, core stones appear to be like rock out crop as the weathered material enclosing them is removed by erosion or mining. These are formed as a result of spheroidal weathering of granites.



Plate 3: Boulders

VII. GEOMORPHIC PROCESSES

The geological factors play a primary role in controlling the evolution of the area. It is noted that the sculpture and evolution of the landform in the study area is very much associated with weathering in the area. As has been mentioned earlier, the study area is characterized by granitic intrusions within the quartzites of the Shillong Group. The timing of emplacement of Myllem granite is 607 Ma which is in age similar to other granite plutons of Meghalaya (881-479 Ma) and the Indian Peninsular Shield (740-395 Ma) (Ghosh, et al., 2004). The beds of the Shillong Group are standing nearly vertical and are highly metamorphosed near the contact with granite. These granites have been considerably weathered. Both physical and chemical weathering works in collaboration to shape the landforms of the area.

The area under study is characterized by sub-tropical monsoon climate. In warm and humid conditions, granitic rocks are prone to rapid, intense deep weathering. Due to high temperature and high rainfall the rate of chemical weathering is very high. The warm-rainy season spans from June-October and the dry season spans from November to May. In this region of seasonally humid tropics, regolith is less thick than in the humid tropics as during seasonal drought rainfall amount is reduced resulting in reduction in the rate of chemical weathering, and thus regolith formation, is retarded. A higher degree of surface run-off and erosion occurs during the wet season, leading to removal of the regolith layer, as at the end of the dry season, there is less dense vegetation and more exposed earth where rainwash process is more effective. The rate of regolith formation by chemical weathering therefore lags behind that of regolith removal by erosion processes. When surface erosion outpaces weathering, regolith layers decreases in thickness or removed altogether. Basal surface of weathering is also revealed (whole or part) at the land surface and contributes to landform development such as boulders, corestones, etc. Of particular importance in the study area is spheroidal weathering. It occurs as a result of the chemical alteration of the granite along intersecting joints. The differences in weathering rates between the corners, edges, and faces of bedrock block will result in the formation of spheroidal layers of altered rock that surround an unaltered rounded boulder- size core of relatively unaltered rock known as corestone. Erosion process then removes the layers of altered rocks and other saprolites surrounding corestones that were produced by spheroidal weathering. This leaves many corestones as freestanding boulders on the surface.

- ✓ *Fluvial Processes:* Fluvial processes are those relating surface runoff over landscapes, particularly in rivers. Surface runoff occurs as stream or river flow or overland flow. The area is drained by numerous rivers which have nearly straight courses. As such fluvial action plays a significant role in shaping the landform of the area. The valleys are filled with the alluvial deposits brought in by the rivers. The thickness of the infill may sometimes reach 10m (Prokop and Migon, 2013). The rate of erosion is increased by human use and poor management practices such as deforestation, overgrazing and unmanaged development. Rain-fall triggered runoff from inclined surfaces, thus, erodes weathered materials from the bare slopes and deposits in the valleys or the weathered materials are transported by the rivers and eventually moved away from the system. Core stones are left as residuals and, depending on their density, scattered boulders or bouldery tors originate.
- ✓ *Hill Slope Processes:* The study area is characterised by low and weathered hills. Rain splash is a micro-scale process that is quite effective in moving material on slopes. During rainy season, the weathering processes on the hill slopes are strengthened by the action of gullies and rills particularly along joint planes and fissures of rocks. Thus, the softer rocks have been worn away and resistant and hard rocks remained behind as hillocks.



Plate 5: Siltation of stream



Plate 6: Erosion of quarry wastes into agricultural fields



Plate 7: Quarrying along hill slopes

GEOHAZARDS/GEOENVIRONMENTAL PROBLEMS

Geohazards are all environmental instabilities including land degradation due to natural as well as man-made causative factors. It damages physical, chemical or biological status of a land (Chisholm and Dumsday, 1987). Geohazards are induced by unplanned, indiscriminate and unscientific land resource utilization in an area. In the study area, the impact of man on geo-environment is immensely felt. The hill slopes are deforested and overgrown by grass with scattered subtropical pines. Valley floors are occupied by paddy rice fields. Particle downwash during heavy rainfall and deposition of eroded material in the valley floors is facilitated by deforestation and crop cultivation. Quarrying, though done in a small scale, has affected the soil and water quality of the area. The major geohazards in the area are:

- ✓ Quarrying and landscape scarring
- ✓ Deforestation
- ✓ Soil erosion
- ✓ Siltation of rivers

The quarrying, processing and transport of minerals including hard rock aggregates and sand and gravel can have significant effects upon the environment. Quarrying carries the potential of destroying habitats and the species they support. Even if the habitats are not directly removed by excavation, they can be indirectly affected and damaged by environmental impacts – such as changes to ground water or surface water that causes some habitats to dry out or others to become flooded.

Quarrying involves the production of significant amounts of waste. Although the waste materials from quarries are generally inert and non-hazardous, there is still potential damage to the environment, particularly with water contamination. The quarry waste is often left over the land which gradually rolls down to the surrounding land disturbing man, material and land uses. The removal of topsoil, overburden and aggregates may affect the quality of water recharging of an aquifer. Quarrying destabilizes soil structure

and causes removal of top-soil and vegetation cover. The removal of trees, vegetation and slope material can have a cascading effect on the surrounding landscape. If too much is removed without restoration, the surrounding soil and bedrock will erode. This contributes to soil erosion. Agriculture, logging, mining and other human activities have been responsible for fragmentation, destruction and degradation of the forests in the study area. High rainfall and undulating topography have further accentuated the impact of human activities on the forest. As a result, the forests are getting fragmented into small patches. The pine forests are most disturbed and highly fragmented and supported by successional communities of vegetation. Human activity has led to the irreversible transformation in the landscapes and caused havoc to natural fragile ecosystems.

VIII. FINDINGS

The major findings of the present study are as follows:

- ✓ The flat valley is one of the most striking topographical features of Myllem area. These are structural valleys which have been filled up with alluvium and colluvium. The relief of the study area is closely associated with its geological structure. In other words, the structure of the study area plays a dominant role in shaping its geomorphic features.
- ✓ The study area is characterized by porphyritic coarse granites. The hill tops and valleys formed by these rocks indicate evidences of peneplanation. The micro-landforms of the study area include low residual hills, flat valley, boulders, core stones, etc. These landforms can be explained by selective erosion of the weathering mantle from moderately to gently inclined slopes.
- ✓ It is noted that deforestation, agricultural activities, quarrying, etc. have created several geo-environmental problems such as soil erosion, siltation of rivers, land degradation and pollution. These geo-environmental problems are result of several factors like surface-runoff, undulating topography, landuse pattern, etc.

IX. CONCLUSION

The geomorphology of Myllem flat valley is interesting in itself. Despite its location in a sub-tropical humid climate, the area does not represent a uniquely tropical type of relief. The landscape of the area under consideration is the product of a series of interactions between fluvial and denudational processes operating on underlying geology. Each landform signifies the processes operated in the evolution of the landforms. The geomorphology of the study area is marked by low, residual hills, denuded slopes and flat valleys and valley fills suggesting that considerable period has elapsed during the development of the landforms. The flat valleys are filled up

with alluvium. The valley is structural and valley-fills are depositional features. The drainage is guided by structure and follows almost straight courses. The study area is characterized by granitic intrusions which have been considerably weathered giving a distinct character to its topography. This has resulted in several geo-environmental problems such as deforestation, siltation of rivers, soil erosion, etc.

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