CHAPTER - 5

GEOMORPHOLGY
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5.0.0. General:

Geomorphology is the study of landforms. Various geological agents, like, wind, water and glaciers etc, which are external agents, carve out landforms. In addition to these, there are two important internal parameters, which control the evolution of landforms. They are the lithology and structure. The geomorphic expression can be considered as the reflection of lithology to a great extent. Though all the Nagari outliers are separated, interestingly, their geomorphic expression is similar. This again points to the influence of lithology in the formation of the order of topography. The use of Remote Sensing in the study of Geomorphology of the Cuddapah Basin was elucidated (Divi & Vaidyanadhan, 1995).

5.1.0. The use of Remote Sensing technique in respect of Geomorphology is as follows:

The basic geomorphic units in the granitoid country are:

5.1.1. Denudational Hills (DH):

As the name implies the denudational hills are group of hills, which are the resultant feature of denudation, which have formed due to differential erosion and weathering and cover large areas. This is an erosional landform.

5.1.1a. Distribution and Character:

In the Nagari outlier area, the denudational hills are more...
Conspicuous in the plains. These are not conspicuous in the area where it is covered by quartzite. The geomorphic expression of these hills is uniformly in the form of exfoliation domes.

5. 1. 1b. *Spectral Signatures*:

The spectral signatures are:

Tone: Dark to medium at a few places
Texture: Fine to coarse.
Pattern: Blocky in the form of continuous hills.
Shape: In the form of exfoliation domes when they occur in isolation.
Colour: Greenish black, when there is no vegetation and reddish, when there is dense vegetation.

The basic Geomorphic units in the Sedimentary terrain are:

5. 1. 2. *Escarpmament*:

The quartzite being very resistant stands out like a wall on the granitic terrain with a height of 3m to 15m. It forms a major escarpment. This is a structural landform.

5. 1. 2a. *Distribution and Character*:

Escarpmament is seen in almost all the outliers. This runs in a sinuous way as the units involved are dipping at a very shallow angle of $10^0$ to $15^0$ towards east and west. This form comes down the hill to the ground level in the twin outliers of Narayanavanam. Escarpments
are seen as wall like features in almost all the outliers. The units in the outliers standout, being very resistant to weathering.

5 1. 2b. Spectral Signatures

The spectral signatures are:
Tone : Dark.
Texture : Smooth.
Pattern : Linear.
Shape : Sinuous.
Color : Dark grey. This due to the shadow effect. This helps in identifying the escarpment easily.

5 1. 3a. Distribution and Character

This is seen in as a majestic wall on the obsequent slope and gentle consequent slope, which also forms the gentle dip slope of $10^0$ to $15^0$.

The entire unit constituting the escarpment exhibits the cuesta type of landform. This is a structural landform.

5 1. 3b. Spectral Signatures

The spectral signatures are:
Tone : Dark.
Texture : Smooth.
Pattrem : Blanket type.
Shape : Steep obsequent slope and gentle consequent slope.
Colour : Reddish, because of vegetation.

5. 1. 4. Residual Hill (RH):

Residual hill is the left over of the effect of weathering and erosion. In fact, it can also be considered as Denudational hill, but the isolated occurrence qualifies it to be a 'Residual Hill'. This is an erosional landform.

5. 1. 4a. Distribution and Character:

A few isolated hills like Perundesam outlier, (Fig 5 -1), can be considered as Residual Hill. The formation of these hills is mostly controlled by lithology. In the present situation the lithology as stated earlier is quartzite, which is resistant to weathering.

5. 1. 4b. Spectral Signatures:

The spectral signatures are:

Tone : Dark to medium.
Texture : Fine to coarse.
Pattrem : Blocky in the form of geometrical forms.. 
Shape : Domal and linear.
Color : Blackish green.
5. 2. 0.  Geomorphic Expression:

All the outliers structurally represent synformal hills separated by anticlinal valleys. This is an interesting feature, which needs a detailed study. The synclinal hills and anticlinal valleys generally represent second order or mature topography. This is also designated as reversal in topography.

The first order topography represented by the anticlinal hills and synclinal valleys, is a common feature in the Cuddapah Basin, especially in the Nallamalai Fold Belt (NMFB). In the said situation quartzite, which is hard and resistant forms the core of an anticline and the softer rocks, like shale, carbonates and phyllite occur in the synclinal valleys. This type of setup is best observed, north of the river Cheyyeru, in the Nandalur area. The lithologies involved in the said area are quartzite in the core of anticlinal hills and phyllite in the synclinal valleys. South of the river, the topography is of the second order, i.e, the hills reflect synclinal structure and the valleys, the anticlinal structure. The former is constituted by quartzite and the latter by carbonate rocks. The distinction in lithology is vividly seen on the slopes of the hills. The slope portion of quartzite is marked by the absence of vegetation, whereas the carbonate part of the slope supports bushy vegetation. This difference in the degree of vegetation can be identified even from a distance. The texture of the quartzite is smooth and that of dolomite is rugged, which can be appreciated even without approaching the outcrop area. But in the area under study the lithologies involved in the synclinal hills and the anticlinal valleys are both hard and
resistant. Quartzite occurs in the synclinal hills and the basement granitoid occupies the anticlinal valleys. The granitoid also stands out as hills of considerable magnitude. This makes the problem of geomorphic analysis a little more interesting.

5. 3. 0.  Geomorphology of the outliers:

All the outliers have triple division stratigraphy, viz., the basal conglomerate, the middle grit and upper quartzite. The details of the units are detailed in the chapter on 'Geology'. The field study has revealed that all the said lithological units form scarps of different magnitude, (Fig. 5 - 1), because of the variation in their lithological composition.

The major geomorphic land forms that are visibly clear are, the scarps and the cuesta. The information on these is detailed below.

5. 3. 1.  Scarps:

These are seen all around the hills of the Nagari outliers. The degree of development varies from place to place, (Fig. 5 - 1). The development of scarp is controlled by the lithology. As the units involved are rudaceous and arenaceous that are resistant to weathering are standing out as majestic scarps. However, the nature of the litho unit, viz., conglomerate, grit and quartz arenite has a say in the final formation of scarp. The following figures reflect the nature of expression by various units mentioned above.
FIG. 5-1: GEOMORPHOLOGICAL MAP OF THE NAGARI OUTLIERS
The conglomerate beds form scarps of lesser magnitude, due to the coarseness of the rock. Further, the pebbles can be easily removed by the weathering of the matrix, (Fig. 5-2a).

The grit is more compact and stands up as scarps of considerable magnitude, (Fig. 5-2b).

It is the quartzite, which stands up as high scarps (like majestic walls), due to fineness, cherty and compact nature of the unit, (Fig. 5-2c).

5.3.2. Cuesta:

This has an obsequent slope that is normally steep or near vertical and a gentle consequent slope. All the outliers in fact have cuesta type of land form, where in, the obsequent slope is represented by the scarp and the consequent slope by the gentle dip - slope, (Fig. 5-3).
Development of 2\textsuperscript{nd} order topography:

Wooldridge, (1937) concept (Fig.5 - 4), authoritatively advocated the development of 2\textsuperscript{nd} order topography.

The critical scrutiny of the said figure, (Fig.5 - 4), points to the following basic assumptions that are required for the development of the 2\textsuperscript{nd} order topography. The assumptions in the opinion of the author of the thesis are, (1). The rocks in the anticlinal area should be generally softer, so that it can be easily brought down to the ground level by pediplanation or peneplanation. (2). The rocks in the synclinal portion should be harder and resistant to weathering, so that they can stand out as hills. The net result will be the rocks in the synclinal areas will be standing out as hills and the rocks in the anticlinal areas will be valleys. Similar set up can be observed in the case of the topography south of the river Cheyair, in the Nandalur area, where carbonate and quartzite are involved in the formation of 2\textsuperscript{nd} order topography.

The nature of the rocks in the synclinal hills and the anticlinal valleys of the Nagari outliers are both hard rocks, i.e., quartzite and
FIG. 5-4: STAGES IN THE DEVELOPMENT OF RESEQUENT DRAINAGE

a. Anticlinal hills and synclinal valleys
b. Anticlinal hills and synclinal valleys
c. Anticlinal hill is lowered and formation of valley and drainage takes place in the anticlinal area. But the base level of the newly formed valley is slightly above the base level of earlier valleys located on either side
d. Further lowering takes place in the newly formed valley. This results in the gain of elevation on either side
e. Final refinement makes the adjacent areas as hills. Structurally these are synclinal

WOOLDRIDGE CONCEPT
This has similarity in the stages of the development of resurgent drainage
The explanation given in the figure 5-4a is that of the author of the thesis

FIG. 5-4a STAGES IN THE DEVELOPMENT OF INVERTED RELIEF (SYNCLINAL RIDGES)
granite respectively. The geomorphology of the Nagari outliers is analysed with reference to geology (lithology) and structure in the following paragraphs.

The moot point is that, whether the present geomorphic disposition of the outliers is due to the development of the 2nd order topography or due to the geological set-up i.e., the resistant quartzite is resting in synclinal basins over the granitic basement.

5.5.0. Geology versus Geomorphology:

An analysis has been made to find the possible reason for the formation of 2nd order topography by considering the geomorphic disposition of the outliers. If the 1st order topography, i.e., anticlines represented by hills and synclines by valleys, has to get reversed, to form the 2nd order topography, the positive land form has to be brought down either by peneplanation or pediplanation. Granite being an igneous rock is hard and generally stands out as major hills, as seen in and around the area under study. In the present set-up, granite is noticed in the anticlinal valley portion and the hardest quartzite in the synclinal hill. Though both the rocks involved are hard and compact, the relative competency has played a major role in carving out the mature topography. The granite being relatively softer was brought down in relief. This is in agreement with the concept of Wooldridge, (1937). Structure has also played its role in the process of bringing down the relief.
The evolution of the 2nd order topography is explained indicating different stages, (Fig. 5 - 5).

5.6.0 Structure versus Geomorphology

Structurally all the outliers reflect doubly plunging synclines. The moot question is that, whether the 2nd order topography is due to the structure or due to the geomorphic imprint. In the earlier paragraphs, it was stated that the quartzite being very resistant to weathering is standing out majestically. An attempt has been made to consider the role of structure in carving out the 2nd order topography.

The figure (Fig.5 - 5A), clearly explains that the foundering of earth's crust at different places, has given rise to minor individual basins. These were separated by the inter-basinal basement highs. From the above consideration, it is evident that the synclinal Structure was inherent to the outliers, because of the basinal character. The beds in the outliers could have had qua qua inverse dips due to the basinal feature of the site of deposition. This set up due to subsequent compression has gained height perpendicular to the direction of compression refining the structure, (Fig.5 - 5B). The compression involved helped in shortening of the crust and raising the elevation of the sediments and the granitoid basement. The fracture system resulted due to the tectonism has effected the basement as well as the sediments. This fabric has quickened the work of geomorphic processes in bringing down the relief of the granitic basement, which is relatively softer especially in the inter
A. INITIAL STAGE - BASIN FORMATION AND DEPOSITION OF SEDIMENTS

B. SEQUEL TO COMPRESSION

C. REFINEMENT OF TOPOGRAPHY - PRESENT STATUS

FIG. 5-5: GENERALISED STAGES OF EVOLUTION OF THE NAGARI OUTLIERS
outlier areas, (Fig.5 – 5C). In the outlier zone, the basement is protected by the ultra resistant quartzite. The quartzite thus gained the higher relief reflecting the present configuration.

The said analysis clearly points to the fact that the concept of Wool dridge (1937) is applicable to the formation of 2nd order topography of the Nagari outliers.

Majority of the Nagari outliers show curved fold axes, unlike the fold structures in the main basin, where the fold axes are straight at a given place. The curving of the fold axes has modified the morphology/configuration of the outliers. This is very conspicuous in the Virapaka Kota - Nagalapuram outlier (Fig.5 - 1). The sigmoidal nature of the axis could be attributed to the movement along the Karakamabadi fault in the north and the river Arani fault in the south, (Fig.5 -1).

Thus, the entire set up of the Nagari outliers, is yet another evidence supporting the theory, that the evolution of landforms is controlled by two endogenic factors, i.e., the lithology and structure. This fact is well presented and preserved by Nature in the form of Nagari outliers.