CHAPTER - VII

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In areas like the Karbi Anglong District where 62% of the total area is covered by hard rocks, surface water is generally not easily available, except along the perennial river courses. This too decreases during the dry period of the year. As a result, groundwater becomes the only source of water. Accurate prediction and visualisation of groundwater conditions of the area is beset with several uncertainties. A search for ground water and its development in hard rock areas need specific strategy and methodologies. In these contexts, remote sensing techniques have opened up a new vista for mapping potential areas for groundwater targeting.

The present study covers the whole of the Karbi Anglong District of Assam. The use of remote sensing in the study of the geological, structural, hydrological and geomorphological characteristics ultimately helps in delineating the groundwater potential zones of the district. The conventional methods of investigation is expensive and time consuming in view of the difficult nature of the terrain and lack of accessibility in the district.

Karbi Anglong is an underdeveloped hill district of Assam with a population of about 6,62,723. Therefore, it is essential to study the district very critically so as to help in its future development.

The present work has been taken up with an objective to identify and map groundwater potential zones of the area and to high
light the role of satellite imagery and aerial photographs in supplementing the information required for resource estimation, evaluation of potential and prospects, identification of target zones for groundwater exploration, augmentation and conservation. Efforts are also made to generate a database using both remote sensing techniques and conventional methods for the development of groundwater in the area.

For hydrogeomorphological study two types of data products are generally used. These are satellite imagery and aerial photographs. The application of aerial photographs has the advantage of getting three dimensional view of the area, which helps in studying the area in detail.

The study reveals that the major parts of the district are covered by Precambrian gneisses. Rocks of the Shillong Group occur on the gneisses in the northern and western parts. Both these groups, intruded by granitic rocks belonging to the Cretaceous age, occur in the central part of the district. Covering all the older rocks, the sedimentary rocks belonging to the Tertiary period occur along the southern and south-eastern borders of the district. The whole district is covered discontinuously by a thin veneer of older and younger alluviums. These broad group of rocks can easily be delineated with the help of remote sensing techniques even on the thickly forest covered areas.

The region has experienced several geological events and the present day landscape is the result of complex geological, tectonic and
climatic processes which have operated in it over the years. As the study area is mainly hilly, most of the area falls under run off zone.

The tectonic evolution of the area is studied which helps not only to delineate the phases of deformation but also to understand the lineament pattern in it. A minimum of three phases of deformation could be recognised in each of the Precambrian Group of rocks, namely the Gneissic Group and the Shillong Group. Moreover, some post Precambrian structural elements resulting from the intrusions of circular and semicircular igneous rock bodies were identified as depressions that are inverted conical in shape. These areas are important from mineralogical point of view. From the study, several unconformities were also recognised within the Shillong Group and the Tertiary Group of rocks.

The study reveals a number of lineaments which include joints, faults, fractures and shear zone. These are not confined only to any particular lithounit of the area. Their numbers, lengths and direction were counted and measured. Statistical analyses were also carried out for individual categories of the lithounits and it is noted that different lithounits have different types of lineament concentration. In the Gneissic Complex the concentration of lineaments is higher in comparison to the Shillong Group or the Tertiary Group of rocks. In the Tertiary rocks their concentration is moderately higher than the Shillong Group of rocks. Four main sets of lineaments are observed in the study area. These trend NNE-SSW, NE-SW, E-W and NW-SE. The NW-SE lineaments are limited in number. In the Gneissic Complex of
both Diphu and Hamren sub-divisions, the maximum length of the lineaments occurs in the NE-SW direction and the number gradually decreases in the N-S and E-W directions. In the Shillong Group the maximum length occurs in the ENE-WSW direction in Diphu sub-division, but in Hamren sub-division the maximum length is in the N-S direction. In the Tertiary Group the maximum length occurs in NNE-SSW direction. These variations indicate variations in the flow direction of groundwater in the different lithounits. High density of lineament indicates high secondary porosity and intersecting nature of lineaments indicates high permeability.

Fault plane analysis of the conjugate fracture systems in the area indicates that the stress field under which the fractures were developed had the following orientation: The maximum principal stress was oriented in the NE-SW direction, while the intermediate principal stress was steeply inclined and the least principal stress was oriented in the SE-NW direction. It is suggested that the stress field as indicated above was related to a domal structure elongated in a general NW-SE direction. The structure influences not only the development but also the orientation of the lineaments in the rocks of the area.

From geomorphological studies, the entire area has been grouped into three broad landform units and these are the depositional, denudational and denudostructural units. The depositional landforms were formed by the fluvial actions in different periods of time under different environment. These are mostly
semiconsolidated to unconsolidated in nature and are flat topped. The constituent materials consist mainly of boulders, gravel, pebble, sand, silt and clays in varying proportions. This unit represents a high recharge zone and has good aquifer zones at different levels. For extraction of groundwater various types of methods are applicable in this unit depending upon the requirement of groundwater quantity. In the natural levees and palaeo-channels as shown on the map (Fig. 21) shallow depth tubewell may be executed for good quantity of water.

In the case of the denudational hills of different lithological units, the water holding capacity is different depending upon the presence of primary or secondary porosity in them. Generally, in the unweathered igneous rocks like granite, dolorite and veins the primary porosity is almost nil. No recharge could take place in these rocks except in the weathered zone. In the Shillong Group of rocks though the rocks are less metamorphosed, still the primary porosity in them is low. In the Gnessic Complex the primary porosity is provided by the foliation plane where very limited recharge may take place. In the Tertiary sedimentary groups of rocks, primary porosities are higher than in the metamorphic rocks but less than the fluvial landforms. In the loose sandstone and medium hard sandstones, sufficient primary porosities exist along the bedding plane and the unconformities, wherefrom moderate quantity of groundwater may be extracted. In the loose, coarse grained Tipam rock of the Tertiary group, moderate quantity of groundwater may be extracted in suitably located areas.
In the hard rock areas of the district, secondary porosity is developed due to the weathering effects, joints, faults and shear zones of which the latter appear as prominent lineaments on the imagery and aerial photographs. These features, which act as conduits and aquifers in the hard rocks, are well recognised from this study. The highly weathered zones on the hard rock areas covered by granite, quartzite and gneisses and occurring as pockets in the gentle slope areas are good sites for groundwater occurrences. Groundwater occurs under water table condition only in the weathered mantle, along major joints and fractures. Moderate quantity of groundwater may be developed in these zones depending upon the location which is influenced by the degree of weathering, degree of concentration of intersecting joints and fractures and lithological character of the rocks.

The denudostructural hills, which occur mostly in the areas of the Shillong Group of rocks, represent a high run off zone. Partial recharge may take place in this unit only along the bedding plane and the lineaments. Therefore, aquifer zones are poor in this unit. Development of groundwater in this unit is restricted to the dug wells and that too only in the weathered surface materials.

The study suggests that the landforms and lineaments have considerable influence on the aquifer characteristics like transmissivity as well as discharge. The wells which are located in the valley - fill areas and along the lineaments, faults and shear zones concealed under the alluvium provide higher discharge, whereas
less water yielding wells are located in hard rock areas devoid of joints, fractures, and faults. For example, a bore hole falling on the Kaliyani-Dikharu-Barpani shear zone covered by a thick blanket of alluvium, provide artesian condition. The valley fills and major lineaments covered by alluvium are the most promising sites for groundwater development in the Karbi Anglong district.

Drainage analysis of the study area has shown that six major types of drainage patterns can be identified in it and these are dentritic, trellis, rectangular, sub-parallel, annular and radial pattern. Each pattern of drainage depends mainly on the lithological character of the rocks on which it is developed and the structures present in them. A correlation of the drainage and the lineaments pattern indicates that streams of higher order coincides with the lineament trending NE and ENE in the central part of Diphu sub-division. In the Hamren sub-division about three fourth of the perennial streams flow along the lineaments. This is indicative of infiltration of water into the deepest fractured zones along the streams which is tappable through bore wells but at the down stream side.

Some of the structures identified from remote sensing techniques are important from mineralogical point of view. These include the syenite rocks (containing Niobium, Zirconium, Strontium) of Chamchampi area, the basic intrusives around Luhajuri and Bajajuri and southwest of the Hima Parbat (containing Uranium, Niobium, Chromium, iron etc.). The coal and limestone quarries, which are
presently being mined, can be identified both on the imagery and aerial photographs. These quarries also provide fresh rock surfaces for detail investigation in the area. Some of the lineament intersections in the Gneissic Complex are ideal locations from mineralogical point of view.

It is ascertained that the water harvesting structures and recharge zones in the study area can be delineated from the study of survey of India toposheets, satellite imagery and aerial photographs. It is also found from the study that the sites for minihydel projects can also be identified in it.

Based on the present study, the following conclusions may be drawn.

(i) Space borne remote sensing data (Landsat and IRS) are very useful for regional study and to map broad geological and hydrogeomorphological units and to infer structural deformities in the rocks of the area under investigation. These data are also very useful in the study of landuse and landcover pattern of the area.

(ii) Aerial photographs, due to its three dimensional effect, are useful for detailed hydrogeomorphological mapping on a larger scale.

(iii) Conventional groundwater data are necessary for properly interpreting the remote sensing data.

(iv) The pre-monsoon satellite data are useful for the above studies as during this period the vegetation cover is thin and the cloud
cover is minimum.

(v) The results and experiences from the present hydrogeomorphological study based on remote sensing data for targeting groundwater potential zones can be further used for exploration in similar hard rock terrains elsewhere.

It may be concluded that an integrated approach, using both the remote sensing and the ground data, can help in groundwater exploration in larger areas within a relatively short period of time.

Based on the present study, the following suggestions are made:

(i) Though the alluvium cover in the study area is limited in extent, yet it should be explored systematically because, the alluvium terrain is found to represent a highly promising area for groundwater exploration.

(ii) For limited and shallow groundwater extraction, the small valleyfill areas should be targeted first.

(iii) The Tipam sandstones should be studied in detail by drilling test wells to explore their aquifer conditions.

(iv) Lineaments represent the zones of high secondary porosity and they cut across different lithological formations in the area. These zones should be considered as potential ground-water yielding zones.

(v) Geophysical investigation should be carried out on a priority basis along the lineaments of the area.

(vi) As a test case, the lineament along the Kaliyani-Dikharu-Barpani may be taken up for detailed investigation and exploration.
(vii) The combination of lineament and valley fills should be considered as zones with excellent groundwater potential. One such combination located on the Kaliyani should be explored.

(viii) Palaeochannels and valley-fills should be exploited further to locate potential shallow aquifers.

(ix) Deep borewells may be used in the alluvial region.

(x) The alluvial plains are the potential zones of groundwater. Geophysical survey should be carried out in these plains to assess the thickness of the alluvial deposit in them.