

# REMOTE SENSING AND GIS TECHNIQUES FOR URBAN GEOLOGY & HYDRO GEOLOGICAL STUDY

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## Abstract:

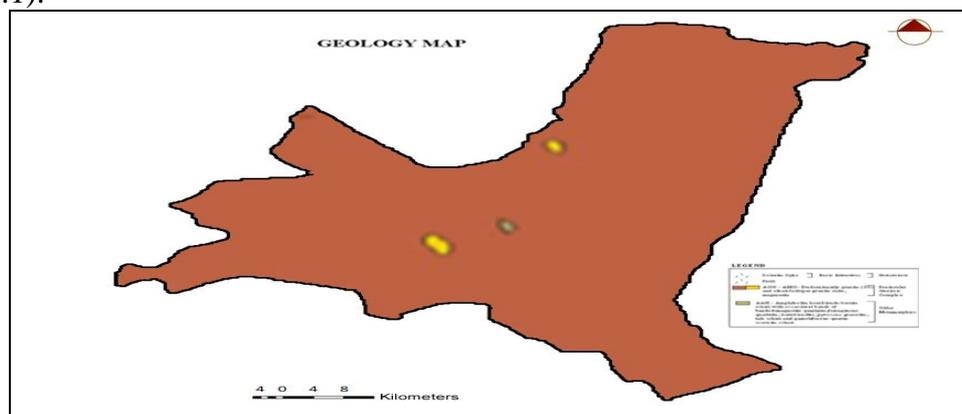
*Geologically the study area forms a part of the Indian peninsular shield and comprises Archaean and Proterozoic formations, characterized by igneous rocks, sedimentary rocks and their variants. The peninsular shield has been stable for the last 1000 m.y. However, during mountain building activity in the early Precambrian orogeny, the rocks have been subjected to folding, faulting, uplifting, metamorphism, intrusion and extrusion. Followed by this activity Proterozoic basins were initiated. The uplifted highlands of Precambrian and associated intrusives have been the source for these sediments. In this way the Precambrian shield and the Proterozoic sedimentary complex have formed a complex geological set-up, providing a unique geology in the study area.*

**Keywords:** Granites, Gneisses, Geology, Hydrogeology, Pegmatite, Aplites, Quartz Veins

## 1. INTRODUCTION

Hyderabad forms part of the Pre-Cambrian peninsular shield and is underlain by the Archaean crystalline complex, comprising Pink and grey granites and granite gneisses. A thin veneer of alluvium of recent age occurs along the Musi River. This undulating terrain is punctuated by granite hillocks and mounds. Several dykes intrude the granite, and some of these dykes form linear ridges. Many of these hills and ridges (for example in Banjara Hills, Shaikpet, Malkajgiri and Addagutta areas) are intervened by low-lying areas and drained by minor streams. The Granites exhibit structural features such as fractures, joints, faults and fissures. WNW - ESE and ENE-WSW, NE-SW trending structures are tensional in nature while NW-SW & NW-SE structures are shears in type.

Different geological features of the study area have been delineated by using standard visual interpretation method on IRS-1D PAN and LISS IV Imagery satellite data. In the present study geological features of the study area have been prepared from existing geological survey India and modified by satellite data. Different geological features are information presented below (Ritchce, 2000)(Fig. 1.1).



**Fig. 1.1** Geology Map of Study Area

### 1.1 GRANITES AND GNEISSES

The granitic rocks of the world are the subject of intense investigation regarding their origin and as read as put it "There are granites and granites".

The study of Precambrian shield granites present many problems as they are subjected to many phases of deformation, metamorphism and igneous activity. The granites of Hyderabad belong to the Precambrian shield type and consist of many rock types from syenites to Alaskites.

Precambrian rocks, such as Granite, Adamellite, Tonalite, Amphibolites, Hornblende biotite schist occupy a major part of the area. These formations were subjected to tectonic and green schist facies metamorphism. Except for portion in the western part of the district to understand its geological significance most of the area is occupied by granites. Based on mineral composition they were further classified as alkali feldspar granite, Magmatite granite gneiss, Adamellite, Granodiorite, Tonalite and Trondjinite.

Granites and gneissic complexes, occupy vast expenses of Peninsular India. Granitic rocks of the Hyderabad form part of the Peninsular Gneissic Complex. Pink and Grey granites are the major rock types occurring in and around Greater Hyderabad. Dolerite dykes, basic enclaves, aplites, pegmatite, quartz veins, migmatites and alaskite traverse these granites. At places alaskites and leucogranites are emplaced within the pink and grey granites (Krishna, 2004). Mineralogy, textures, structure and major intrusive of these areas are

The major units are:

- Grey series: coarse porphyritic grey granites, biotite granites and pyroxene granite.
- Pink series: coarse porphyritic pink granite, fine to medium grained pink granite, coarse porphyrite pink alaskite, fine grained pink alaskite, white alaskite.
- Dykes and veins: Dolerite dykes (both fine and coarse grained) Quartz veins and epidote veins
- Enclaves: Fine grained
- Migmatitic zone: Inter mingling zones of pink and grey granites. Investigated study area and it covers the cluster of Mandals i.e. Ibrahimpatnam, Keesara, Ghatkesar and Maheshwaram Greater Hyderabad and Ranga Reddy district. Almost all the Mandals are covered with Peninsular granites. The Granites of Hyderabad have been extensively studied during last three decades by a number of researchers, (Balakrishna, 1964; Janardhan Rao, 1965 and Sitaramayya, 1968). The rock types covered in the area are classified as grey and pink granites and they are intruded by younger formation i.e. dolerite dyke, quartz, epidote and Pegmatite veins.

Raja (1959) attempted systematic studies on the petrography of the granites occurring in and around the twin cities of Hyderabad & Secunderabad. According to him, soda metasomatism of pre-existing hornblende – biotite schist gave rise to grey granites. The parental rock occurs as enclaves and the pink granites were derived from the granites by potash metasomatism. Rao (1963) suggested that there might not be any age difference between grey granites and pink granites. He opined that the difference in the colour of the two granites could be due to the difference in the parental material, which was subjected to process of granitization. Rao (1965) opined that both grey and pink granites are metasomatic in origin. The grey granites were formed by granitization of parental metasediments like quartz mica schists and related rocks. The pink granites were supposed to have formed along shear zones in grey granites by potash metasomatism.

There are several researchers who have expressed different opinions regarding their origin. Geological Survey of India, Hyderabad has concluded that the granites of Hyderabad are of magmatic origin.

Balakrishna, (1964) studied in detail the Petrology and Petrogenesis of these granites. They came to the opinion that the granites have formed due to metasomatism of the country rock.

According to (Balakrishna, 1964) granitic rocks predominate the peninsular complex and are represented in the city of Hyderabad. He studied the granitic rocks of Hyderabad with special reference to tectonics, petrography and textural features. He noticed two types of granites, pink and grey, and said that it has been found difficult to demarcate them separately. On the basis of his studies he concluded that the pink could be a derivative from the grey series of granites and gneisses. He also concluded that the pyroxene bearing granites seem to have all characteristics of the conventional Charnokites and they appear to be a sort of basis front formed due to late stage of potash feldspar. He further said that, the pink granites are found to be rich in perthite and myrmekitic structure and are seen in all types of granites particularly in hybrid or magmatic zone. He also studied the elastic constants pointed out that the pink granites are younger than the grey granites.

Janardhan Rao and Sitaramayya, (1968) has extensively studied the Geological features like structures, the petrology and geochemistry of granites of These rock types in this region is characteristic of the Archaean granite terrain. Due to similar rock type mineralogy of both are described together. The rocks of the areas in grain size from medium to coarse grained. Feldspar is the predominant mineral and occurs as phenocrysts. These rocks are essentially composed of quartz, potash feldspar, plagioclase hornblend and biotite and accessory minerals as magmatite, epidote and sphene. Few specks of pyrite and chalcopyrite are noticed in the rock samples of the area.

Gnaneshwar (1986) concluded in his litho geochemical surveys of Hyderabad granites that porphyritic granites, white alaskite and pink alaskite are potentially theore-bearing rock types. The porphyritic granites contain higher amount of U, Th and Mo. In the vicinity of pink alaskite and these elements were mobilized and emplaced in fracture systems at higher structural levels

The geological Survey of India (2006) have investigated this area and suggested that these granite rocks are of magmatic origin and pink series are intrusive into grey series. A very large area of the investigation is underlain by Peninsular gneissic complex of Achaean's age, consisting of pink and grey granites, granitic, magmatites, Pegmatites, quartz veins and dolerite dykes, occurring in the forms of domes, scaps, massive columnar blocks and 'tor' scattered over a partly undulating country.

## **1.2 PORPHYRITIC GRANITE**

These are the dominant rock type of pink and grey color in this area. Grey porphyritic granite is predominating in the area of investigation. They are mainly comprised of microcline perthite, plagioclase and biotite. At some places hornblend occurs in addition to biotite. Magmatite, sphene, zircon and pyrite are the important accessories in these granites. The variation in texture and composition is attributed due to the assimilation of the pre-existing rocks of porphyritic granite. Band of composite gneiss occurring at places in the porphyritic granite might have formed earlier than the porphyritic granite though injection of granitic fluids along the foliation planes of the pre-existing schist and reaction with them.

The structure of the porphyritic granite is generally massive, but where it is composite in character it shows foliation. The foliation is derived from the pre-existing schist's which are granitic. This has a NW-SE strike and vertical dips. The porphyritic granite is traversed by many joints. They generally belong to NE-SW and NW-SE set, and the dip of the joints is vertical. Apart from these are sheet joints, curved and low dipping in the porphyritic granite.

### **1.3 PEGMATITE, APLITES AND QUARTZ VEINS**

Porphyritic granites are traversed by numerous veins of pegmatites with different trends. The common trends are NE-SW, NNE-SSW, NNW-SSE and NWSE. They are found in white, grey, pink and milk white colours. Feldspar is generally microcline perthite. Apart from feldspar and quartz the other constituents are biotite, magnetite, muscovite, sphene and zircon. Among the sulphides are pyrite, chalcopyrite and molybdenite. The molybdenite bearing pegmatites traversing the porphyritic granites are older than the medium grained granites (Kittu, 1968). Aplites which are exposed in a few places occur either as narrow veins or small lenses.

The trend of the quartz veins is NE-SW. These veins are found in the porphyritic granite and at some places quartz veins pass into pegmatites. Generally they are entirely made up of quartz. The pegmatites contain mostly feldspar and quartz and quartz veins traversing these granites occasionally contain pyrite, chalcopyrite and malachite. These are minor intrusions & traversing the host rocks granites. They are a few centimeters to few meters wide and run over a few hundreds of meters of distance.

### **1.4 GABBROS**

Gabbro is a coarse-grained, dark-colored, intrusive igneous rock. It is usually black or dark green in color and composed mainly of the minerals plagioclase and augite. It is the most abundant rock in the deep oceanic crust.

Gabbro is composed mainly of calcium-rich plagioclase feldspar and clinopyroxene (augite). Minor amounts of olivine and orthopyroxene might also be present in the rock.

This mineral composition usually gives gabbro a black to very dark green color. A minor amount of light-colored mineral grains may be present. Unlike many other igneous rocks, gabbro usually contains very little quartz.

### **1.5 EPIDIORITE**

Epidiorite dykes are noticed in this area. They are mostly in NE-SW direction they are generally composed of amphibolites and andesine. Hornblende generally occurs as pseudo-morph of pyroxene. The feldspar is very much altered.

Fluorite, Epidote, Calcite, Feldspar, Quartz and Jasper veins are traversing the porphyritic granites, numerous veins of epidote, calcite, feldspar; quartz and jasper are noticed with less than a centimeter in width. In few cases pyrite, chalcopyrite, biotite and sphene are present. Epidote veins traverse the epidiorite, pegmatites and quartz veins. The veins in general have NE-SW strike and steep dips.

The structure of the porphyritic granite is generally massive, but where it is composite in character it shows foliation. The foliation is derived from the pre-existing schists which are granitised. This has a NW-SE strike and vertical dips. The porphyritic granite is traversed by many joints. They generally belong to NE-SW and NW-SE set, and the dip of the joints is vertical. Apart from these are sheet joints, curved and low dipping in the porphyritic granite.

### **1.6 HYDRO GEOLOGICAL STUDY**

Ground water occurs under phreatic conditions in weathered zone and under semi-confined to confined conditions in the fractured zones. The piezometric elevations in northern part vary from 500 to 563 m amsl with steep gradient in NE direction. In southern part, the piezometric elevation is between 470 and 520 m amsl with gentle gradient towards Musi River. Ground water was exploited

through shallow, large diameter dug wells until 1970 to meet domestic and irrigation requirements. Presently ground water is being exploited through shallow and deep bore wells with depth ranging from 100-300 m.

More than 97% of the area is underlain by the Archaean group of rocks consisting of mostly pink and grey granites and the remaining 3% of the area is underlain by the Alluvium. Accordingly two aquifer systems exist in the area, i.e Aquifers of the granites and Aquifers of Alluvium, though alluvial aquifers are insignificant.

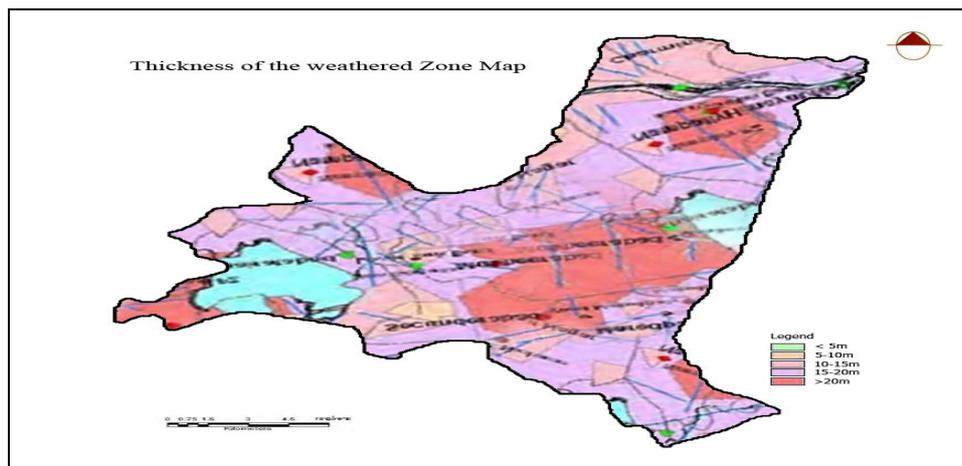
Hussain Sagar Lake was built in 1562 A.D. during the reign of Quli Qutub Shah (1550-1580) the fourth ruler of Qutub Shahi dynasty. The lake water was utilized for irrigation and drinking water needs upto 1930. The lake joins the twin cities of Hyderabad and Secunderabad and adds historical aesthetic dimension to the twin cities. Gradually the lake became receptacle of sewage and industrial effluents from the catchment areas. Due to eutrophication, algal bloom, growth of water weeds and bad odour the water body became redundant for recreation & pisci-culture. Hyderabad Urban Development Authority (HUDA) is making efforts to restore Hussain Sagar Lake to its past glory in all respects including ecological, economical and cultural aspects by appropriate technological interventions. The project titled "Hussain Sagar Lake and Catchment Area Improvement Project" is funded by Japan Bank for International Cooperation (JBIC) under ODA assistance with objectives, to improve the lake water quality by preventing pollutants entering into the lake both point source & non-point sources of pollution, besides removal of nutrient rich sediments. Interception & Diversion of dry weather flows, improvement of Nalas in catchment area.

The following components of work is undertaken to improve the lake water quality and to maintain the hydrology of the lake (Taubenhock, et. al., 2009). Construction of New Sewerage Treatment Plant at Picket Nalla, Upgradation of Existing Hussain Sagar Sewerage Treatment Plant, Construction of Trunk Sewers, Construction of Small Sewerage Treatment Plants, Construction of Ring Sewers around the Hussain Sagar Lake, Capacity Enhancement of Interception and Diversion Works, Recycled Water Supply Facilities, Lake and Nalla Environment Improvement, Desilting / Dredging and Disposal of Sediments, Construction of Alternative Idol Immersion Places, Repair of Surplus Weir, Installation of Aeration Equipment, Shoreline Improvement, Nalla Improvement, Slum Improvement, Public Awareness and Community Participation.

### **1.7 CRYSTALLINE AQUIFERS**

The aquifers are of anisotropic and non-homogenous type resulting in different hydrogeological conditions within the shorter distances depending upon degree and intensity of fracture and recharge conditions. The thickness of the weathered zone varies from 5-25 m (Fig. 2.2) and yield ranges from negligible to 5 lps.

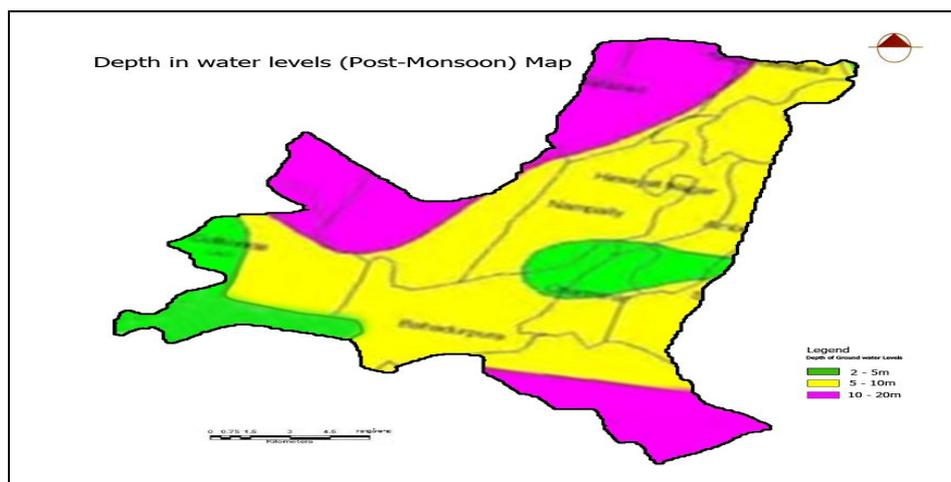
The depth to water level ranges from 3.30 m (Manikeswarinagar) to 56.3 m in (Film nagar). The yield of wells varies from 0.21 to 6.9 lps with drawdown of 6 to 20.6 m. The specific capacities of the bore wells range between 10.0 lpm/m (New Boiguda) to 72 lpm/m (Borabanda) and the Trans emissivity of the aquifers ranges between 0.48 and 202 sq.m/day.



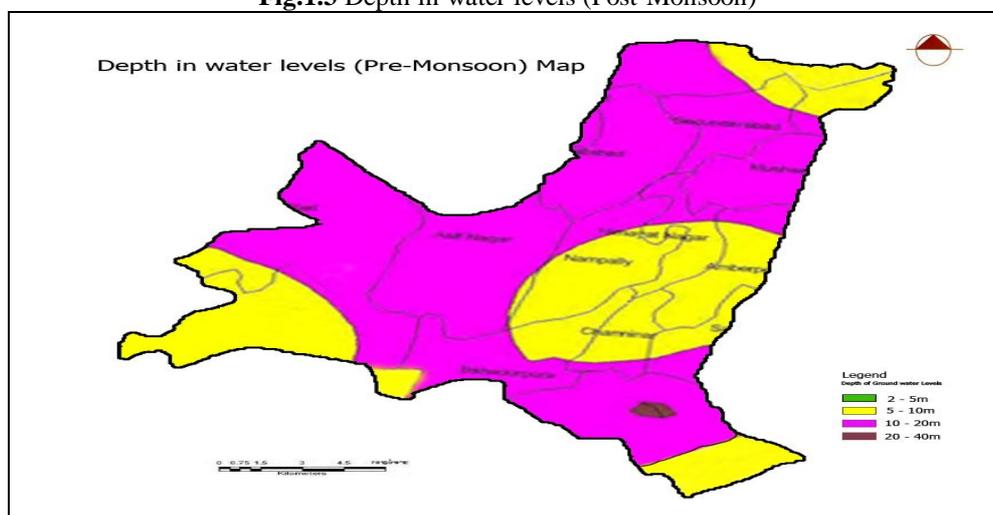
**Fig.1.2** Thickness of the weathered Zone

### 1.8 ALLUVIAL AQUIFERS

The alluvial formations occur as isolated patches along the Musi River. It consists of medium to fine grained sand, silt with thickness varies from few meters to about 5 meters. Ground Water occurs under phreatic conditions. The ground water used to be developed through large diameter dug wells, but presently not in practice due to the contamination of the pollutants from the Musi effluents.



**Fig.1.3** Depth in water levels (Post-Monsoon)



**Fig.1.4** Depth in water levels (Pre-Monsoon)

### **CONCLUSION:**

It is evident that the ground water resources are precious and valuable to sustain human civilization. Further, the problem, challenges, issues raised in respect of ground water resources is diminished rapidly and in turn contribute to disastrous situation raised in socio-economic and living conditions of the population particularly in urban areas of the country. Hence, the study has selected Hyderabad city for detailed study to improve the status of ground water resources and its quality in short and long term perspectives. Hence, the study assessed the physical, socio-economic and living conditions exist in the study area. The details are presented in the future research..

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