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Original Article

AI- Based Geological Analysis of Kanakapura Taluk, Bengaluru South District, Karnataka State

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Abstract:
Geological analysis plays a crucial role in understanding the Earth's surface, mineral resources, groundwater potential and environmental sustainability. The integration of Artificial Intelligence (AI) with geological studies has revolutionized the collection, Intepretation and analysis of geological data. Kanakapura taluk is located in Bengaluru South district possesses diverse geological formations, rich mineral resources and significant groundwater potential. This study explores the application of AI techniques in geological analysis of Kankapura taluk using geospatial data, Remote sensing Imagery and machine learning algorithms. The findings demonstrate how AI enhances Geological Mapping, mineral identification, groundwater assessment and environmental monitoring thereby supporting sustainable resource management planning.
Keywords: *Artificial Intelligence, Geological Analysis, Remote Sensing, Machine Learning.*

Introduction:

Geology is the scientific study of the Earth's structure, composition and processes that shape its surface. Traditional geological investigations rely heavily on field surveys laboratory analysis and manual interpretation of maps. However, advancements in Artificial Intelligence (AI), Geographic Information system (GIS) and Remote Sensing technologies have transformed geological research by enabling faster and more accurate analysis. In order to put forward a planning for future of any area, it is very essential to understand the salient geographical features of the region. The regional setting is important in establishing the patterns of inter-regional and intra-regional space relations.[1] In view of this, in this sub-section an attempt has been made and dealt briefly on position, Physio-graphy, Geology, Mineral exploration, environmental conservation and sustainable land-use planning. The present study highlights the role of AI in analyzing geological features and resources of Kanakapura Taluk and demonstrates its applications in modern geo-scientific investigations.

Location and Extent of the Study Area

Kanakapura taluk is one of the forth taluk in Bangalore South district, situated in southern eastern part of the district. Kanakapura is located at 12° 33′ north - 12° 55′ North latitudes and 77° 25′ east ° 42′ East longitudes (Fig. 1). The total Geographical area of the taluk is 1594.00 sq. kms. It has an average elevation of 638 meters from MSL. Kanakapura is situated 56 km south to Bangalore and 26 kms from Ramanagara on the Arkavathi river bank. Kanakapura taluk takes its name from Kānikāranhalli, Kanakanahalli and Kanakapura. Kanakapura is a part of the Southern Karnataka Plateau, and is located in the South-easterncorner of Karnataka State. It has the greatest extent of 137 Kms. from North to South and 97 kms. From East to West, covering a total geographical area of 1594.00 Sq. km. The most conspicuous areas of very high and very low area of the taluk are located at 600 and 900 meters of contour lines above the mean sea level respectively.

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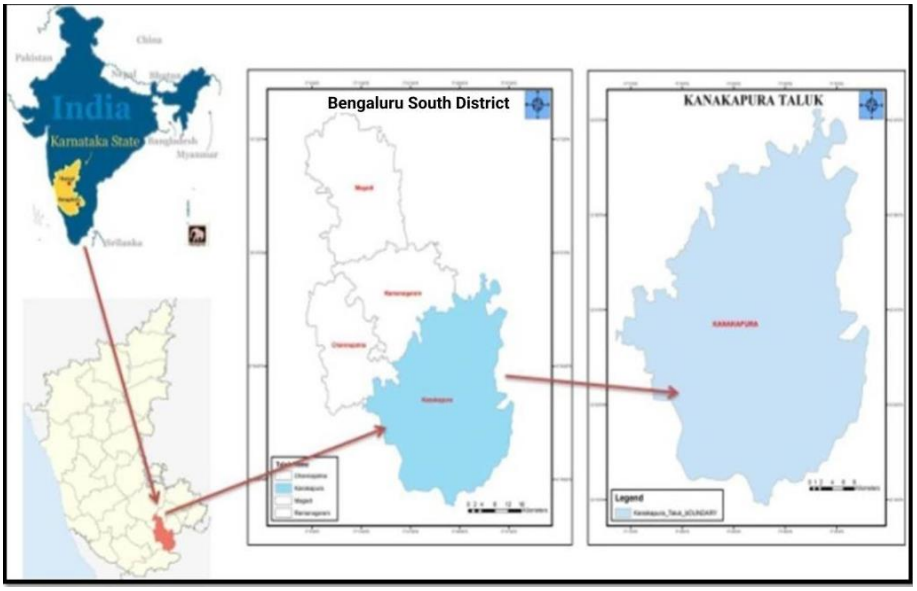

Fig-1: *Location Map of Study Area (Kanakapura Taluk)*

The geological setting is predominantly composed of peninsular gneissic complex, granitic formations, magnetizes, schist and amphibolites, Quartz veins and pegmatite. These formations indicate a complex geological history and provide valuable information regarding mineralization and groundwater occurrence.

Objectives of the Study:

The major objectives of the study are:

1. To examine the geological characteristics of Kanakapura Taluk
2. To explore the application of Artificial Intelligence in geological mapping
3. To identify mineral-bearing zones using AI techniques
4. To assess groundwater potential through AI, GIS in sustainable resource management

Methodology:

The study utilizes both primary data (field visit and observation and secondary data geological maps, satellite imagery, digital elevation models (DEM) and land-use and land-cover information. The maps gathered using AI and GIS technologies.

Geological characteristics of Kanakapura Taluk

A study of geographic features of Kanakapura taluk indicates that the nature of the slopes of the hillocks, the nature and the thickness of recent sediments over bed rock have brought to light features here typical of arid and semi-arid regions of the world[8]. There is diversified in undulating tracks, series of small hillocks, ditches, forests with irregular depressions here and there. The forests occupy about 28.39 percent and land not available for cultivation occupies about 14 percent of the taluk. The region is dominated by ancient Precambrian rocks belonging to the Dharwar craton and lithological units such as Granite gneiss, Biotite gneiss, Amphibolites, Quartzite and pegmatite etc,. In the *Fig-2.* shows different components of geological structure in the study area.

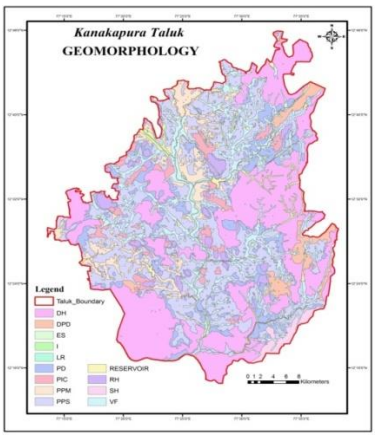

Fig-2. *Geomorphology of Kanakapura Taluk*

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Minerals

Kanakapura taluk forms part of the Deccan Plateau region but it is not rich in mineral resources. Major minerals are in the taluk is Corundum, Dyke. The important rocks/minerals which occur in the Taluk are peninsular gneiss, granites, basic Dykes, Quartz feldspar Limestone, Laterites, Ornamental and Building stones. The granites occur as intrusive in the gneiss complex and vary in colour, structure and texture.

The gneisses and granitic gneisses have under gone different degree of alteration and decomposition having thickness ranges from 30 to 70 meters. The depth of the weathered zone is Maximum in valleys and water bearing formation and is important from the point of view of groundwater storage. The Charnockites are exposed in the Southern parts of the taluk to the east of Hegnur, to the South-east of Sathur, and north-west of Ambadahalli. The range of hills running on the Western margin of the taluk is made up of coarse grained granites designated as close pet granites. The granites are hard, compact and massive and traversed by vertical and horizontal joints which split into huge blocks. The occurrence of garnet is also reported from the taluk. These are open joints and form rain water charges the groundwater reservoir.

The decomposition of granites is quite different from zone of the granite zone consists of broken portions of quartz feldspar with little or no clay. It is found near Salhunse, Neralmaradadoddi and Maralavadi in Kanakapura taluk. Nerelamarada doddi village near Harohalli has about 25,000 tonnes of Feldspar contains 11 to 16 percent alkalies (K_2O + Na_2O) and quantity of Quartz about 12,000 tonnes white Quartz analyzing 97 to 99 percent SiO_2, while the indicated reserves of Feldspar would be about 40,000 tonnes. Pink granites occur in some of the quartzite bonds and Micaceous Gneisses near Valgerehalli. As the weathered zone consists of irregular pieces of varying dimensions, the weathered rock is highly porous, holding substantial quantities of water. Wells excavated in the intermountain valleys have copious supply of water. The only recorded Occurrence of limestone in the Taluk is reported near Chunchi village. Corundum Granite has been traced in Kanakapura taluk. Ornamental Stone, Building stone, is abundantly available. Production of Ornamental stone depends upon demand and International Market.

Water Source

(A) Groundwater Potential Assessment: Groundwater in the taluk occurs in various geological formations, under water table conditions and the groundwater recharge is mainly through precipitation. The water bearing formations include the altered and weathered gneisses and laterite; the depth to the confined water in the taluk is related to the altitude of the land surface. Generally the depth is more where the land surface is high and shallow where the land surface is low. The depth of water ranges between one to three meters in Arkavathi basins. It is deeper in other parts and extends up to 12 meters depending on the topographic location of wells.

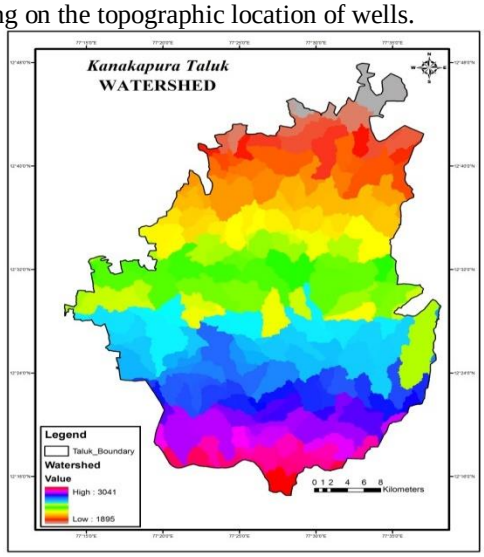

Fig-3: *Watershed of Kanakapura Taluk*

The wells normally range in diameter between two to ten meters and three twelve meters in depth. The fluctuation in water-table between summer and monsoon, water level ranges from one to four meters. The fluctuation can be seen in the low-lying basins. The Yields from wells range between 10 to 15,000 gallons per day. In exceptional cases where revitalization is done by sinking bores from the bottom, the wells are yielding between 25 to 30,000 gallons per day. The Yield from bore wells in the taluk range between 800 to 1,000 gallons per hour. The highly porous and sandy nature of the soil, weathered and jointed and fissured bed-rock permits increased percolation of meteoritic water underground (*Fig-3*). Smaller amount are derived by infiltration of assessed that about 90 percent of the rain that is precipitated, is lost evapo-trnspiration and remaining 10 percent eventually seeps through and reaches the groundwater reservoir. Groundwater utilization (as on 1-1-1987) in the taluk was 17603, 14963, 3797 and 2652 hectare meters, Gross annual recharge, Net annual recharge, Net annual discharge, and number of wells respectively.

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(B) Surface Water: Most of the study area depends upon surface water, is only from rainy season and very less area receives surface water from river Arkavathi. In the rainy season only small ponds will fill up because there are no large basins or lakes, the topography is looks like small valleys and not favorable for natural storage of surface water *Fig-4,* shows the flow direction of surface water in the study area.

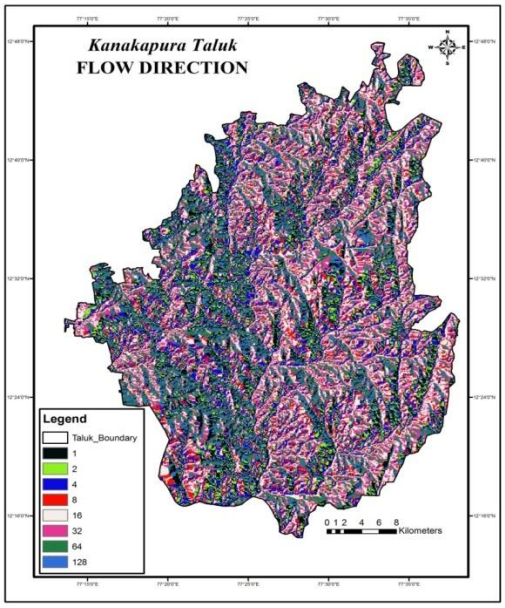

Fig-4: *Flow Direction surface water in Kanakapura Taluk*

Environment Monitoring and Hazard Assessment

Artificial Intelligence contributes significantly to environmental monitoring by analysis Land-use changes, deforestation pattern, soil degradation and water quality trends with the applications of monitoring activities, detects land degradation, assess erosion prone-areas and evaluate environmental impacts of mining

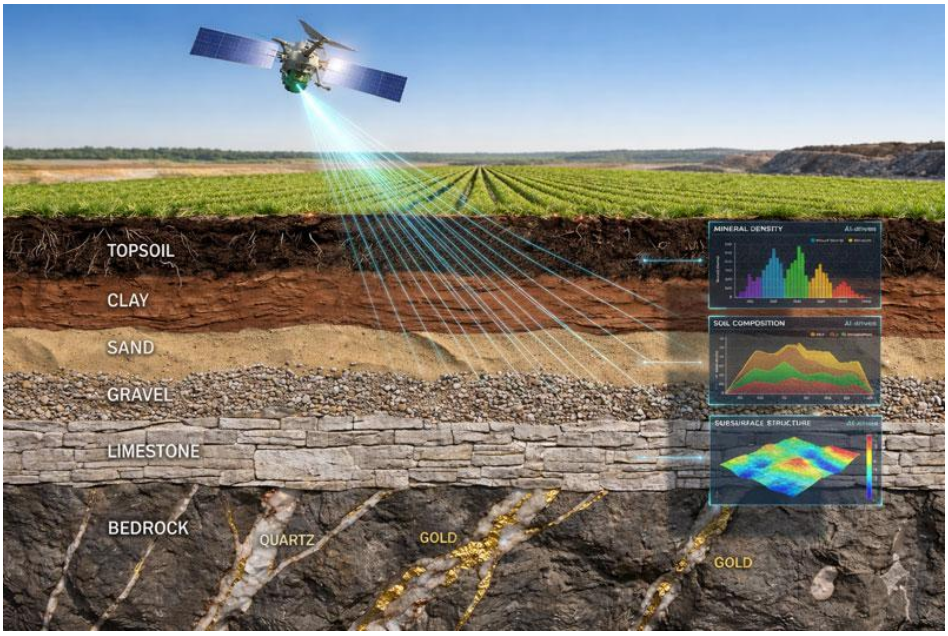

Fig-5: Application of Artificial Intelligence and GIS in geological analysis

The application of AI offers several advantages such as faster data processing and analysis, improved accuracy in geological interpretation, enhance groundwater predication capabilities, better environmental monitoring and management, support for evidence-based planning and decision making.

Challenges and limitations:

Despite its advantages, AI-based geological analysis faces several challenges.

1. Limited availability of high-quality geological data.
2. Requirement of advanced computational resources.

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3. Need for skilled personnel and technical expertise.
4. Complexity of geological system.
5. Model uncertainty and validation issues.

Conclusion and suggestions:

The geological diversity of Kanakapura Taluk provides an ideal setting for the application of AI-based analytical techniques. By integrating machine learning remote sensing and GIS technologies, geological mapping, mineral exploration, groundwater assessment and environmental monitoring can be conducted more efficiently and accurately. The study demonstrates that AI-driven geological analysis contributes significantly to sustainable development bu supporting informed decision making and resource conservation. Future research should focus on developing region-specific AI models and integrate real-time geospatial data for comprehensive geological assessments in Kanakapura Taluk and other regions of Karnataka.

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