

Studies on Geology and Mineral Resources of Ganjam District, Orissa, India

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Available online at: www.isca.in, www.isca.me

Received 20th April 2016, revised 9th June 2016, accepted 22nd June 2016

Abstract

Ganjam district is located in the southern part of the Odisha state. The main geomorphic units valleys, buried pediplain, flood plain, coastal plain and sand dunes. The important structural features are various types of folds, joints, foliation, lineations etc. The important litho types are Khondalite, Charnockite, Gneiss and Granulite. Chhatrapur deposit along Ganjam coast is the largest and richest deposit along East Coast of India. The important heavy minerals are Ilmenite, Garnet, Sillimanite, Rutile, Zircon and Monazite. The commercial type Dimension and Decorative Stones of in Ganjam district include Berhampur Blue, Grey Granite and Pink Granite. The various rocks which are quarried in Ganjam dist. as dimension stones include Granite, Khondalite, Charnockite, granulite, leptynite, granitic gneiss laterite and Augen gneiss. The prospect a beach sand deposit in Ganjam Coast can lead to increasing mining and industrial activities in future the future growth of this industry is lucrative and prospective.

Keywords: Granulite, Khondalite, Charnockit, Heavy Minerals, Dimension Stone.

Introduction

Ganjam district is located in the southern part of the Odisha state. It lies between North Latitudes 18° 59' 30'' and 20° 16' 40'' and East Longitudes 84° 08' and 85° 10' 40''; falling in the Survey of India Toposheet Nos 74 A/5, 74 A/6, 74 A/7, 74A/8, 74 A/9, 74 A/10, 74 A/11, 74 A/12, 74 A/13, 74 A/14, 74 A/15, 74 A/16, 73 D/12, 73 D/16, 74 E/2 and 74 E/3. It is bounded by Phulbani, Nayagarh, Khurda districts in the North; Gajapati and Srikakulam district of Andhra Pradesh in the South, Rayagada and Phulbani districts in the West and delimited by the Bay of Bengal and Puri district in the East. The district spans an area of about 9474 sq. km. with a population of approximately 40 lakhs. The district enjoys a humid, sub-tropical climate characterized by cold winter and hot summer. South West monsoon is the Principal source of rainfall in the area. The average annual rainfall is 1271 mm. About 86% of the geographical area constitutes cultivated lands. Paddy is the Principal crop in Kharif, while pulses are the main crops in Rabi. Red sandy soils, red loamy soils, lateritic soils, coastal alluvial soils and coastal sandy soils, are the main soil types occurring in the district. The litho types have undergone and are product of intense polyphase deformation and granulite facies metamorphism during Proterozoic. Many workers have carried out research work on various aspects of geology and hydrogeology in Easternghats belt¹⁻⁶.

Methodology

Topographic Maps bearing numbers 74 A-6, A-7, A-8, 74 A-9, A-13, A-14, A-15, A-16, 73D-12, D-16 of Survey of India were used during the study. Field Reconnaissance Survey has to

been conducted to generate the data related to lithology, Structure, Geomorphology and Mineral occurrences. Thematic maps of lithology, slope, lineament were prepared using ArcGIS. Digital Elevation model were prepared using ERDAS. Satellite data of LISS-IV and LISS-III, CARTOSAT –DEM data also used for preparation of DEM. Secondary data were collected from different agencies.

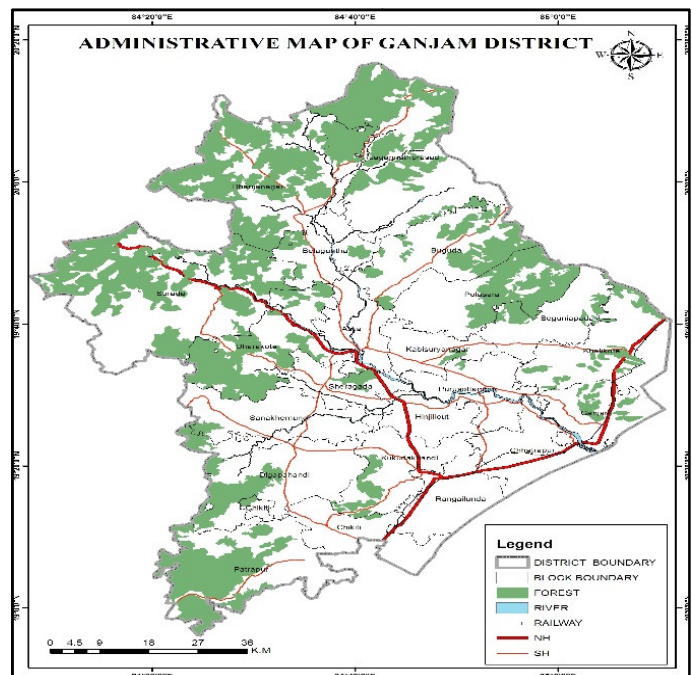


Figure-1
Location map of Ganjam District

Results and Discussion

Geomorphology: The main geomorphic units are structural hills, denudation hills, residual hills, inselberg, linear ridge, intermontane valleys, buried pediplain, flood plain, coastal plain and sand dunes.

The river Rushikulya, Bahuda and their tributaries constitute the main drainage system in the district. The major part of Ganjam district are drained by the Rushikulya river and its tributaries. The Bahudariver controls the drainage of a small area in the southeastern part of the district. The Mahanadi, Baghua, Ghodahada etc. are important tributaries of Rushikulya. The general drainage pattern of the district is dendritic to sub-parallel. The sea coastline and part of the Chilika lagoon are the source of marine products.

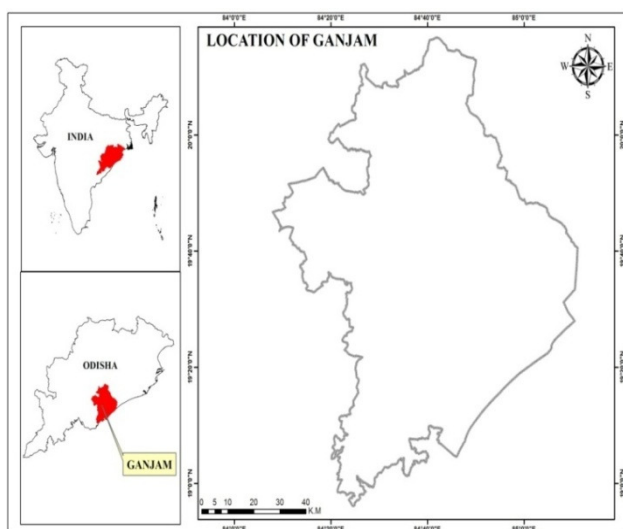


Figure-2
 Administrative map of Ganjam

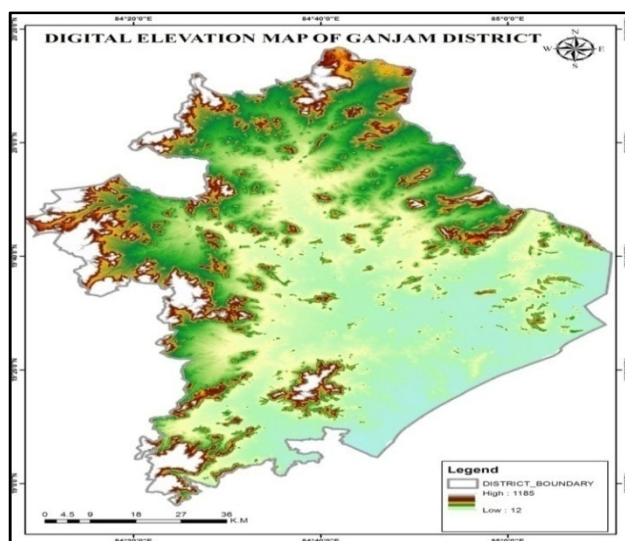


Figure-3
 DEM map of Ganjam District

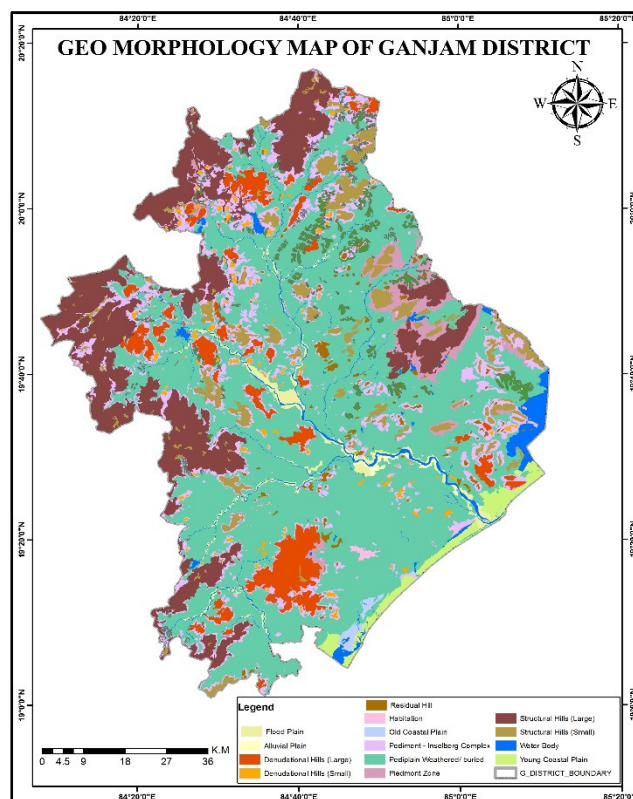


Figure-4
 Geomorphology map

Stratigraphy: Generalized stratigraphic sequence of Ganjam district is given in Table-1.

Table-1
 Stratigraphic Sequence of the study area

Recent to Sub-Recent	Alluvium	Sand, Silt, clays in varying Proportion
	Laterite	
	Unconformity	
	Eastern Ghat Granitic suite	Pegmatite and Quartz Veins Porphyritic and Non-Porphyritic granites, Granite gneiss Garnetiferous granite gneiss
Archaean		
	Charnockite suite	Hypersthene granite gneiss Basic pyroxene granulite Quartz-feldspar-garnet-sillimanite schist and gneiss Quartzites Calc-silicate rocks

Lithology: The Eastern Ghats Group comprises of granite and granite gneiss, Khondalite suite, charnockite suite, pegmatites and quartz vein.

Granite and Granite Gneisses: Granite, Granite Gneisses and their variants constitute the most predominant rock types in the district. These are porphyritic and non porphyritic in nature. Nice exposures of porphyritic Granites are found at Aska, Bhanjanagar, Hinjilicut etc. Their intrusive nature is evidenced by the contact effects, injection of quartzofeldspathic materials and apophyses, tongues along the foliation planes of older rocks. These rocks are usually grey to light gray in colour and fine to medium grained.

Khondalite Suite: This is a meta sedimentary group consisting of interbedded sequence of quartz- feldspar- garnet-sillimanite schist /gneiss, quartzite and calc silicate gneisses and granulites which represent the metamorphosed argillaceous, arenaceous and calcareous sediments respectively. The primary non-diatrophic sedimentary structure have been completely obliterated due to high grade metamorphism, migmatization and multiple deformation suffered by them. Intimate interbanding and lack of any top bottom criteria preclude the possibility of establishing the precise stratigraphic order among the different member of the para metamorphites. The majority of the workers have expressed the view that Khondalite group represent the oldest among the rock. It is found associated with hypersthene granite gneiss and porphyritic granite gneiss. These are usually grayish brown to reddish brown in colour and show well developed foliation and gneissosity. Sometimes outcrops are simply weathered, Kaolinised and covered by the laterites capping. Occurrence of quartzites, calc silicate rocks are very limited and sporadic. These are light gray to white in colour, fine grained.

Charnockite Suite: This suite of rocks includes hypersthene bearing rocks of granodiorite and Granite composition and Pyroxene Granulites (basic). These are fine to coarse grained hard and recognised by its greyish black colour and greasy lustre. The acid and intermediate Charnockites usually form large bodies. These are sometimes Garnetiferous also. The pyroxene granulites usually occur as small lenticular bodies and bands parallel to the foliation of Khondalite. Depending on the mode of occurrence, the pyroxene Granulites are younger than Khondalite and older than the acid and intermediate Charnockites.

Pegmatites and Quartz veins: The country rocks are traversed by numerous veins of pegmatites and quartz pegmatites by numerous veins of pegmatites and quartzs. Quartz vein generally traverse the older formation along the shear zones.

Laterite and lateritic Gravels: These are reddish, porous, concretionary material occurring as capping over the older formation. The composition varies greatly. The colour is yellowish to whitish when the aluminium constituents predominate. Laterites appear to be due to intensive weathering under extreme oxidising condition in tropical to sub tropical

climate characterised by strongly contrasted wet and dry seasons. The thickness of laterite usually varies from 3 to 20m.

Alluvium: Recent to sub recent alluvium occurs as thin (10 to 45m) discontinuous patches along the main drainage channel i.e the Rushikulya and Bahuda and their major tributaries. Also along narrow strip of alluvium occurs along the coast. The alluvium comprises fine to coarse grained sands, gravels and brownish grey sticky clay. The thickness of alluvium is maximum in the vicinity of the river course and it gradually dwindles away from it.

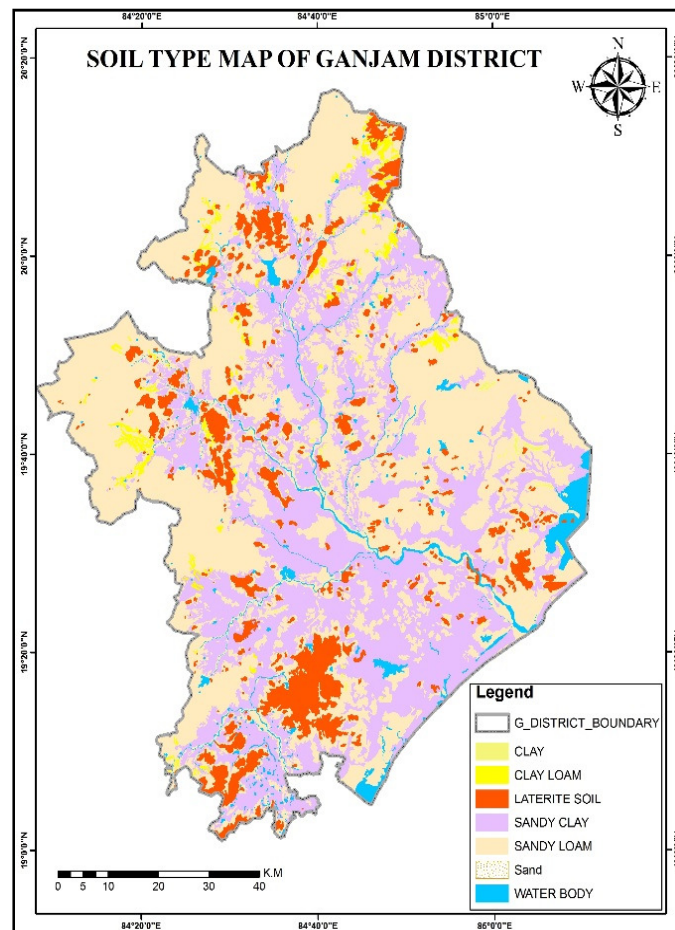


Figure-5
Soil map of Ganjam District

Structure: The rocks have undergone deformation many times as revealed by structural characters like folds (Figure 7 and 10) faults, joints, foliation, lineations etc.⁷⁻¹⁰. Gneissosity and foliation are well developed in Khondalite and granitic rocks. The major NE-SW, N-S and E-W lineament are closely related to the fold movements. Calc-granulite exhibits various types of folding (Chevron fold, Ptygmatic fold, Isoclinal). Charnockite dykes are intruded into the Gneiss in Athagarhpatna area (Figure-3).

Mineral Resources: Beach Minerals: The resources of beach

sand minerals (Heavy minerals) of Orissa is confined to the Ganjam dist. Ganjam coast is most important from the point of view of reserve and grade of heavy minerals (Table-2). Chhatrapur deposit along Ganjam coast is the largest and richest deposit along East Coast of India¹¹. It extends for a length of 18 km along Chhatrapur coast between Rushikulya river confluence in the NE and Gopalpur on the SW. The average width is 1.5 km. The important heavy minerals are Ilmenite, Garnet, Sillimanite, Rutile, Zircon and Monazite. These heavy minerals are important input in refractory, ceramic, abrasive and electronics manufacturing industries. Mining carried out in IREL.

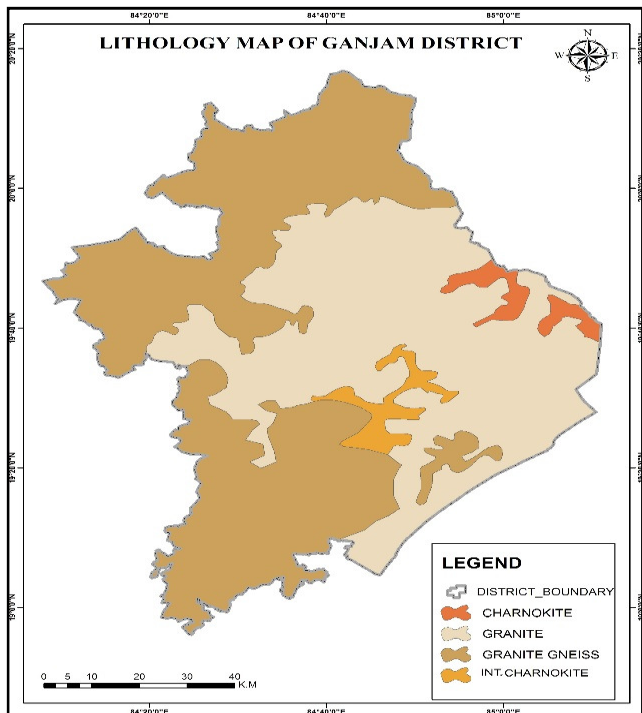


Figure-6
 Lithology map of Ganjam dist



Figure-7
 Folded Calc- Granulite in Bhabandh area, Ganjam

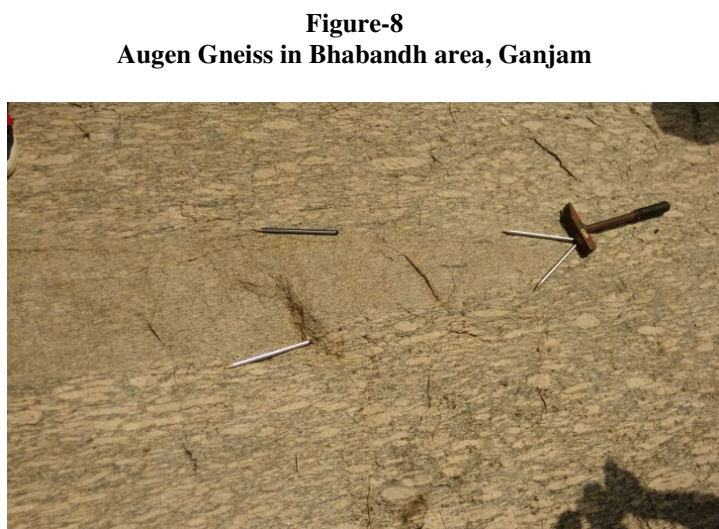


Figure-8
 Augen Gneiss in Bhabandh area, Ganjam

Figure-9
 Charnokite Dyke intruded into Augen Gneiss



Figure-10
 Chevron folding in Khondalite, Bhabandh area



Table-2
Heavy Mineral Reserves of Odisha (in million metric tonnes and grade in wt. %)

Deposit	Coastal length in Km	Grade%		Llmenite	Rutile	Leucoxene	Monazite	Ziron	Garnet	Sillimanite	Others	THM	Category
Gopalpur (AP Odisha border to Gopalpur)	24.50	9.44	1 2	5.357 3.45	0.295 0.19	0.043 0.03	0.127 0.08	0.189 0.12	4.393 2.83	3.812 2.45	0.468 0.30	14.684 9.44	Indicated
Chhatrapur (Gopalpur to Chhatrapur)	18.00	20.51	1 2	20.285 8.80	0.882 0.38	Ne Ne	0.616 0.27	0.705 0.31	15.445 6.70	7.845 3.40	1.492 0.65	47.268 20.51	Indicated
Chhatrapur	18.00	18.50	1 2	26.720 7.79	1.150 0.34	Ne Ne	0.820 0.24	0.940 0.28	20.350 6.07	10.330 3.08	1.750 0.52	62.060 18.50	Indicated
Rushikulya-Prayagi	11.55	12.52	1 2	4.637 4.58	0.139 0.14	0.076 0.08	0.020 0.02	0.041 0.05	4.603 4.60	2.932 2.93	0.116 0.11	12.654 12.52	Indicated

The Easternghat Group of rocks, e.g. Khondalite, Leptynite, Charnockite and their associates like granulite, migmatite and gneisses form the source rocks for the coastal placer deposits. These rocks on weathering release the heavy minerals which are carried into sea by many rivers draining the Eastern Ghat terrain. Tidal waves, littoral drift, fluctuation of the sea level and wind action have played their part in the concentration of heavy minerals along the coast. By far, Khondalite constitutes the principal source rock of the heavy minerals. The geomorphology of the Ganjam coast is characterized by two sub-parallel dune systems frontal and rear separated by intermediate low-lying areas. Higher concentration is observed in the frontal dunes.

Gemstone: The gemstone occurrence of Ganjam district is localized in the Easternghat granulite belt. The Easternghat granulite belt comprising mainly khondalite, charnockite suites of rocks and their variants and intruded by potassic granites, pegmatites and quartz veins host most of the gemstone occurrence of Ganjam district. Important varieties are tourmaline, topaz, amethyst, aquamarine, moonstone etc.

Dimension and Decorative Stones: Stones have been in use by human beings since the Palaeolithic time^{12,13}. The commercial type Dimension and Decorative Stones of in Ganjam district include Berhampur Blue, Grey Granite and Pink Granite. Any natural stone which can be cut, sized, shaped and polished to suit the fancy and specification of the builders, designers and architects are marketed as Dimension stones. The various rocks which are quarried in Ganjam dist. as dimension stones include Granite, Khondalite, Charnockite, granulite, leptynite, granitic gneiss laterite and augen gneiss (Field photo : 2). The important places are Sripur, Bhaduka, Digapahandi, Mahuguna, Soroda, Chikiti and Ramgurha.

Graphite: Minor pockets of graphite within the Khondalitic suite of rocks occur in Ganjam district.

Mica: Mica occurs within the pegmatite veins at some places in the Ganjam district, but not in sizable quantity.

Sand: Large reserve of good quality sands used as construction material found in the river courses of Rushikulya, Bahuda and Mahanadi.

Kaolin: Kaolin deposit are found in Satarpally, Gillinda and Sarangoda. Kaolin resulting from alteration of Granulitic rock and Gneiss are reported¹⁴.

Conclusion

Chhatrapur deposit along Gnam coast is the largest and richest deposit along East Coast of India. The important Heavy mineral are ilmenite, Rutile, Zircon, Garnet, Sillimanite, Monazite and Leucoxene. The prospect a beach sand deposit in Ganjam Coast can lead to increasing mining and industrial activities in future. The dimension and decorative stone of Ganjam includes Granite, Augen Gneiss, Khondalite, Charnockite and laterite. The future growth of this industry is lucrative and prospective. The rock wastes derived from quarries and processing plants can be used for road materials, construction materials, and fertilizers, manufacture of Synthetic slabs and preparation of tiles.

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