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**Article** · January 2023

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# GEOLOGY OF BALASORE DISTRICT, ODISHA, INDIA-A BIRD'S EYE VIEW

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**Abstract-**Balasore is a unique district in northeast coast of Odisha with rich and varied geology. The present study comprises of the complete geological survey of the district with an aim to highlight the varied topography, lithology, geomorphologyand vast mineral deposit of the area. Nilgirimountain is the chief central part. The mountain ranges comprise mainly of highland plateau and valleys with intrusive runningthrough them. The second physiographicunit is Tertiary Plain occurring in the eastern part of the district. The third physiographic unit is Alluvial Plain. The drainage density is observed to be fairly moderate and drainage pattern is dendritic in nature. The major rock types encountered in the district are NilgiriGranite Gneiss, Quartzite, Orthoquartzite, Arkose, Shale, Phyllite, Gabbro, Px-granite. The geology of the district is constituted by the Nilgiri granite complex at its central part belonging the Archaean age, unconformably lying over Singhbhum Granite and Banded Iron Formation (BIF). It consists of three alternate bands of volcano sedimentary units uniquely disposed in a ring like circular pattern formed under sub- marine conditions. Important mineral resources include iron, copper, titanium, vanadium, china clay, nickel, kyanite, quartz, talc, steatite, soapstone andbauxite.

***Keywords***-Geology, geomorphology, mineral, statigraphy, Balasore district

**Location and Geographical Area:**

Balasore is one of the coastal Districts of Odisha. Balasore is the District HeadQuarter, spreading over an area of 3634 sq.km lies between 20° 48' and 21°59' North latitudes and 86°16' and 87°29' East longitudes. The district is surroundedby Medinipur District of West Bengal in its northern side, Bay of Bengal in its East,Bhadrak District in its South and Mayurbhanj &Keonjhar Districts lie on its Westernside. It is best known for Chandipur beach. The Indian Ballistic Missile DefenseProgram's Integrated Test Range is located 18 km South of Balasore. It is the largestcity of North Odisha. This District consists of two subdivisions namely Balasore andNilgiri. There are 12 Tehsils for 12 Blocks in this district. Balasore is the main townof the district and is also its centre of economic growth. The district accounts for 5.53%of the State's territory and about 5.50% of State's population. The densityof population of the district is 532 per square km as against 610 per square km of theState.

It is in the coastal section of Odisha blessed with hot and humidcliamte, with alluvium soil and intersected by the perennial rivers, which collectivelyprovides conducive infrastructure for the growth of agriculture in the region. Rice,Pulses, oil seeds like Groundnut, Mustard, Castor and linseed are grown in theDistrict of Balasore. The district has a rich mineral base of

soft stones, limestone,stone chips are available in the district, which are mainly used in industrial units inthe district. The huge deposits of granite stones at Nilgiri, Khaira, Oupada regionsprovides tremendous scope for development of few more industries based on these resources. Except these, no minerals in large quantity which can be explored forcommercial purpose found in the district.

**Physiography:**

The District of Balasore is having unique physiographic setup. It is bounded by the Bay of Bengal in its southern part and in the north western part it is marked by a set of hillocks and mounds including a north east – south west trending hilly patch in the Nilgiri, Khaira&Oupada Blocks. The land elevation varies from as low as near mean sea level in the southern part to as high as about 600 m above mean sea level in the north western part. In between a major part covering more than 75% of the geographical area is having elevation within the range of 2 – 10 metres above mean sea level. In the extreme eastern part of the district, within the alluvial tracts of the river Subarnarekha &Burhabalang, the average elevation is within 1 – 2 metres above mean sea level.

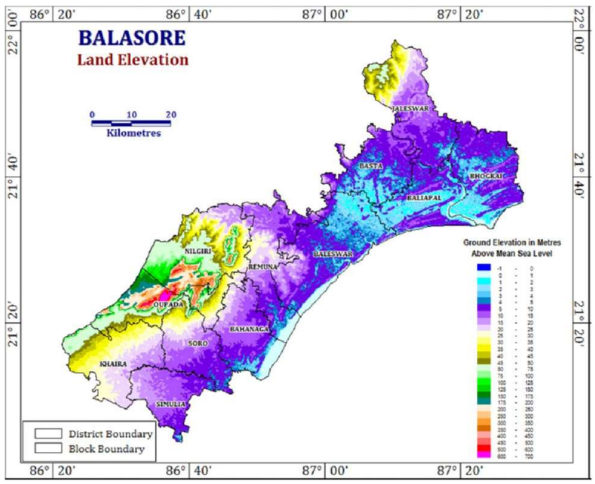


Figure 1: Land Elevation map of Balasore district.

**Drainage:**

The drainage in the area is controlled by Subarnarekha, Panchpara, Burhabalang, Jamira, Kansbans, Sono rivers and their tributaries and distributaries.All these rivers are havingsouth easterly flow direction.The rivers often meander giving rise to the occasional formation of oxbow lakes along their courses. The drainage patterns of the streams are dendritic nearby the foothills. Due to flattening of topography nearby the coast, drainage congestion takes place along the mouth of the river. During high tide often the tidal water ingress quite a long distance into the mainland. During heavy downpour also, the runoff water inundates the low-lying areas due to very low capacity of the rivers and the streams. Figure 2 represents the drainage map of Balasore district.

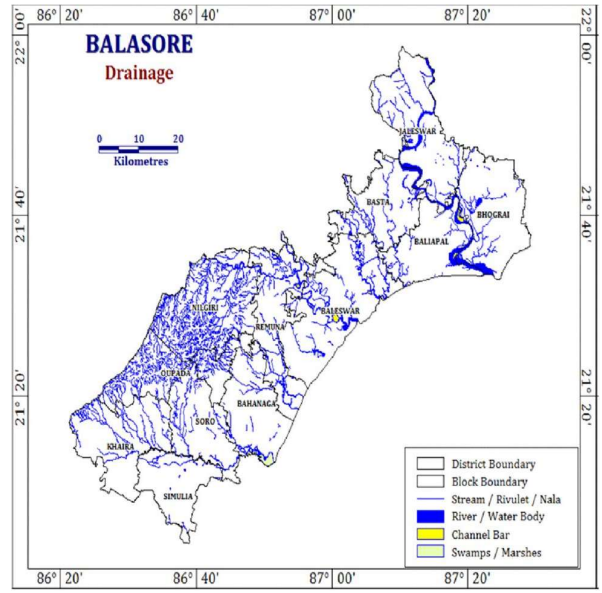


Figure 2: Drainage map of Balasore District.

**Geomorphology:**

Hydrogeomorphological features of Balasore district are mainly attributed to fluviomarine, erosional, denudational and depositional processes. The coastal plain has been developed due to fluviomarine processes. The alluvial plains owe their origin due to various fluviatile actions of major rivers. The details of the geomorphic unit as identified are as below:

i. **Coastal Plain:** Coastal plain predominantly consist of sand silt and clay is developed allalong the coast of Balasore district. It is gently sloping plain occurring parallel to the coast. The saline marshy tract with shrubby vegetation comes under this coastal plain. Tidal streams are very

active during high tide time. Ground water prospect is good but salinity is a major problem in this tract.

ii. **Beach:** Beach is mainlyformed bymarine action. Beach ridges are very common and these are formed due to sea waves. They are mainly consisting of sand mixed with silt etc. Ground water prospect is good within a depth of 30 40 m, where fresh ground water pockets are available. Deep tube wells in these areas maylead to sea water ingress.

iii. **Mud flat:** This is a relatively marshy area covered with fine silt and mud along the shore. Mangrove's vegetation is verycommon along the coastal tract. Ground water quality is mostly saline.

iv. **Paleo mud flat:** These are the ancient mud flat consisting of fine sand and mud. These are mostly converted to agricultural land in due course of time. Due to marine regression ground water quality is saline.

v. **Off shore Bar:** Off shore bar is an elongated bar of sand occurring in the sea more or less parallel with the coast line. These comprises of sand. Ground water quality is saline.

vi. **Channel Bar:** It is adepositional fluvial land form developed inside the channel due to the recession of the velocity of water. It is mainly consisted of alluvial deposits. Ground water prospect is good.

vii. **Meander Deposits:** This is an abandoned river course mostlyfilled with alluvial deposits. Ground water prospects are good to excellent.

viii. **Oxbow Lake:** This is a cut off meander filled with alluvial material. The shape of the land form looks like an oxbow. Ground water prospect is excellent.

ix. **Paleo Channel:** This includes buried as well as abandoned channels. These are mostlycomprised of fluvial deposits of varying grain size. Ground water prospect is good to excellent. **x. Flood Plain:** This is an area adjacent to the river and mostly built up by river

This is an area adjacent to the river and mostly built up byriver borne deposits during high floods. Flood plains primarily consist of unconsolidated materials like sand, gravel and silt. Groundwater prospect is good to very good.

xi. **Younger Alluvial Plain:** This is a flat to gently undulating plain of large extent formed by river action. The area encompasses various fluvial landforms in the latter stage of deposition in the fluvial cycle. This constitutes unconsolidatedmaterials like gravel, sand and clay of varying size and forms prolific aquifers.

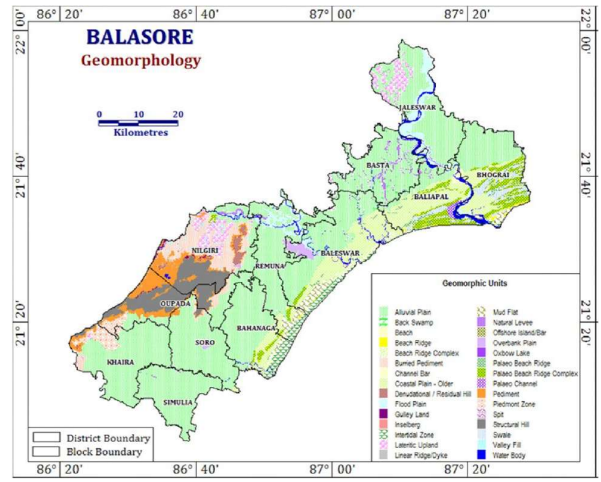

Figure 3: Geomorphology of Balasore District

**Pedology:**

Four main types of soil groups (USDA Soil Classification System) can be observed in the Balasore District. These are Alfisols, Aridisols, Entisols and Ultisols. Alfisols are the dominant soil groups in the district, occupying approximately 55% of the geographical area.They have a clay enriched subsoil and relatively high native fertility. "Alf" refers to aluminium (Al) and iron (Fe). They can be further sub divided into Older Alluvial Soils, Red Gravelly Soils and Red Sandy Soils.They are widely used both in agriculture and forestry, and are generally easier to

keep fertile than other humid climate soils. Alfisols have undergone only moderate leaching and have at least 35% base saturation, meaning calcium, magnesium, and potassium are relatively abundant.

**Geology:**

The major parts of the district are underlain by Tertiary &Quarternary Alluvium (including recent alluvium). The north western part is underlain by the Archaeo Proterozoic Basement Granites and Granite Gneisses with minor Pegmatites and vein Quartz. The recent alluvium occurs in limited patches along the river courses. The Tertiary deposits comprise of lower marine fossiliferous sequence of Miocene' age and an upper estuarine sequence of Mio Pliocene age. Small outcrops of ultramafic rocks are exposed in and around Balukasoni area under Nilgiri subdivision. The ultramafic comprises serpentiniseddunite, peridotite and pyroxenite under soil and laterite cover, over an area of 1.8m * 800m. A 100m long E-W trench has exposed two chromite ore bodies on its both end with dimension of 500m*3.5m*4.5m and 5.5m*2m*3.3m. A chromite occurance associated with ultramafic rocks are traced and considered to be xenolithic bodies lying within a plutonic mass of gabbroic rock. The generalized stratigraphic sequence of Balasore district is given below.

**Stratigraphy:**

Holocene: Sand dune, newer alluvium
Older alluvium

Laterite

Quaternary: Recent to sub Recent Laterites and lateritic gravels

~~~~~~~~~~ Unconformity ~~~~~~~~~~

Tertiary: Mio Pliocene Brown, yellowish and grey sand, gravel and clays, gritty sandstones.

Miocene: Grey Clays, sand, Lime stones with molluscan shells

~~~~~~~~~~ Unconformity ~~~~~~~~~~

Archaean to Proterozoic:Associated intrusives, Nilgiri granites, Quartzite and phyllite, amphibolites, unclassified gneisses.

**Archeans and Pre-Cambrians**: The Archean formation comprises of amphibolites, quartzite, phyllite, unclassified gneisses and the pluton of Nilgiri granites. The unclassified gneisses are biotite bearing and both fine to coarse grained. The coarse types are known as Nilgiri granites. The hornblende granites occur as intrusives into this Nilgiri granites. The young dolerites are found as intrusives into the countryrocks.

**Tertiary Formations:** The tertiary sediment occurring in the district comprise of lower marine fossiliferous sequence of Miocene age, overlain by estuarine sequence of Mio Pliocene age. The fossiliferous marine formations are metwithin the exploratory boreholes at different depths ranging from 69.8 to 273 metres below ground level. The younger unfossiliferous estuarine sediments are encountered from almost ground level down to about 307 m depth in different boreholes.

**Quaternaries:** The older alluvium of Pleistocene age overlies the tertiary formations. The sediments are grey to brown colour, unfossiliferous but possesses plenty of calcareous concretion. Laterites commonly occur on the hill tops, flaks of hills and occasionally in the undulating plains in the north, a topping the tertiary sediments. Theyare also encouraged at depth ranging from almost ground level to 35 m or more.

**Recent to SubRecent:** The laterites occur extensively as capping over the Khondalite in topographic lows as also over granite gneiss. These are ferruginous in nature and highly porous having a spongy look and at places form a nodular mass. The recent to sub recent alluvium occurs as flood plains and channel deposits of the Subernarekha, Burhabalng, Jamira River and its tributaries. It comprises of sand, gravel, silt and clay. Dune sand occurs along the sea coast.

**Structure**: The granites forming the Nilgiri hills are affected by orogenic movements. The granites and gneisses which occur as intrusives into quartzites and phyllites rocks show sub vertical joints trending NE SW and NW SE. Quartzite also exhibit similar type of joint system. Ptygmatic folds in pegmatite and quartz veins are also seen within granite gneisses have differing trends varying from N S to NW SE with foliation dips varying from 60 75° in the Nilgiri granites.

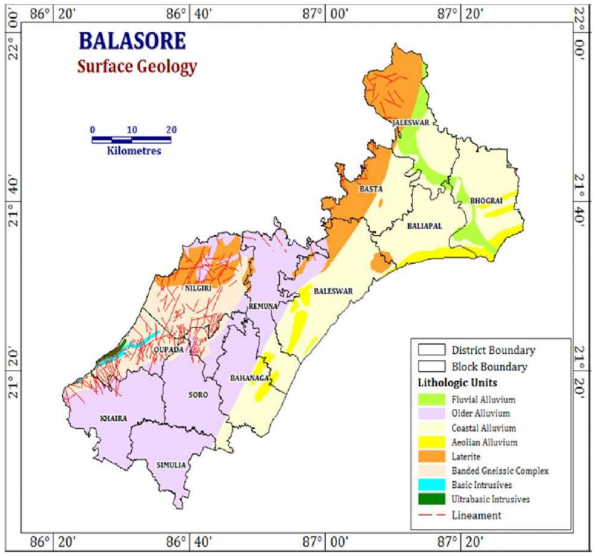


Figure 4: Surface Geological Map of Balasore District

## MINERAL RESOURCES:

**Vanadiferous Magnetite:** These deposits occur near Betei and Rangamatia in Nilgiri sub-division. The Rangamatia deposit has a total resource of 21,120 tonnes with a $V_2O_5$% varying from0.38% to 1.238%. Whereas, the Betei deposit is insignificant with $V_2O_5$% varying from0.044% to 1.446%. Besides this, several other vanadiferous magnetite deposits are also located in Godasahi, Dwarkasuni, south of Takabandha and Khandihudi areas constituting a total inferred reserve of 42,000 tonnes.

**Chromite:** Incidence of Chromite was reported south of Bhalukasuni village. Two parallel chromite loads striking approximately N-S have been exposed in the area. The strike length of the western and eastern loads is of 90m and 60m respectively. The average width of western and eastern laods is proved to be 5.5 m and 1.5m respectively. Both the chromite ore loads are continuing beyond 4m depth. Atotal reserve of 0.003 million tonnes of medium to high grade Chromite has been estimated around Bhalukasuni. Besides the Bhalukasunicromite deposit, chromite loads are also noticed in the plains on either side of the magnetite deposit near Rangamtia and northern part of Astopahad (Δ436m) 10km south-west of Rangamatia. In Rangamatia area chromite is of high grade and contain 44.57% to 54.27% $Cr_2O_3$. In Atopahad area $Cr_2O_3$ content varies from 47% to 48%.

**Soapstone** (Steatite): Soapstone is reported from Hatikholia, Gopalpur, Sikidia, Mukundpur, Rahighari and Baulagadia of Nilagiri sub-division. The deposits were exploited by Boulagadia stone industry for making potteries and statues. Heavy minerals: The beach and sand dune deposits contain heavy minerals like monazite, rutile, illemenite, zircon etc. Such deposits are seen around Udayapur, Bindha-Padampur, Khadibil etc. over a coastal length of 5.80km

**Vein Quartz and Quartzite**: Vein quartz occurs towards south of village Gotira on the northern flanks of the hill range of Nohada and Rangamatia area. In Rangmatia the vein quartz is about 20m long. Besides, vein quartz bodies are also located near Dwarakasuni, Tiakata, Juruki, Gaipani and Patasahi area. Out of these occurrences Dwarakasuni occurrence is significant. It is milky white in nature and appears to contain >99% of $SiO_2$. The quartzites of Devgiri and KotilaParvat joining with Similipal hill ranges are noteworthy. Analysis of respective samples reveal $SiO_2$ content as 97**%.**

**Laterite:** Laterites are found around Bhalukasuni, Rangamatia, Kusundaspur, Khaira and Kupari areas. Thickness of laterite in these areas vary from 10m to 12m and used for laterite brick purpose. Dimension stone (Dolerite): Dolerites of the district are important for dimension stone. These occur as intrusive dykes within Nilgiri granite around Barakhada, Tiakata,

Khandihuda, Betei, Morichua, Basanga, Padmapokhari, Barikdhara and Raipal village. These are used as polished blocks and tiles for flooring, kitchen platforms and wall panels etc. China Clay: White plastic gritty china clay deposit occur to the north ofArbanda hosted in highlydecomposed gneiss. Though the deposit is extensive, the clay content is only about 10%. About 23m thick white clay deposit occurs to the north of Garidihi concealed underaterite capping. The clay is banded in appearance and is slightlygritty

**River Sand deposits**: River sand deposits occur around Hatiagand, Mukundapur, Kasaba, Dahapada, Benapada, Makramapur, Mahammad Nagar, Patana, Chalanti, Seksarai, Kantapal, Sikharpur, Balikbad, Praharajpur, Gambharia, Rudrogopalpur, Samil-Naharpatna etc. villages of the district and used as construction material for buildings and roads. Road materials: quarries are established around Kanjamahal and Mahumuhan villages of the district for production of road materials. A few occurrences of asbestos associated with steatite are reported.

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