Studies on Geology And Mineral Resources of Mayurbhanj District, Odisha, India

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Abstract-*Mayurbhanj is an unique district in Odisha with rich and varied geology. Simlipal Complex being at its central part. The mountain ranges comprise mainly of highland plateau and valleys with intrusive running through them. The second physiographic unit 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 Granite Gneiss, Quartzite, Orthoquartzite, Arkose, Shale, Phyllite, Gabbro, Px-granite. The geology of the district is constituted by the Simlipal 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. Baripada Beds outcrops of tertiary formation occur around Baripada town. These comprise stratified clay and sand with marly clay or limestone interbands. Important mineral resources include iron, copper, itanium, vanadium, chinaclay ,nickel, kyanite ,quartz, talc, steatite ,soapstone and bauxite.*

Keywords-Geology, mineral, simlipal, vulcano sedimentary

I. INTRODUCTION

Mayurbhanj is an unique district in Odisha with rich and varied geology. It is a paradise for Geoscientists of India and aborad. It has preserved many important rock groups from earliest of crust formation to the geologically recent times. The landmass constituting the Mayurbhanj District, Odisha has attracted the attention of geoscientists, explorers and entrepreneurs on account of its diverse geological setting and rich and varied mineral resources. Many workers have carried out research work on various aspect of geology and mineral resources of odisha Ravindra, K. (2015) , Krishnan , M.S (2011) , Mahalik, N.K. (1994) Sarkar, A. and Paul, D.K (1998) , Mahalik, N.K. (1994) , Bose,M.K. (1979, Ramakrishnan ,M , Nanda JK, and Augustine,P. F. (1998) , Nanda, J, K.andPati, U.C. (1989) , Gupta , S.(2004), Mohapatra,S.K. andSarangi, S.K. (2006) Sahu ,C K ; Nandi ,D. and Kant ,J. (2014), GSI(2012). Lying to the north of Odisha and having its border with the states of Jharkhand and West Bengal, Mayurbhanj is the largest district in the state. It has an area of 10,418 sq km. and accounts for 6.69 % of the state's territory. It is the last princely state to be merged with the Indian Union in 1949. Before its merger Mayurbhanj had the distinction of being administered by a ruling family in unbroken continuity for over a thousand years. It has rich biodiversity as is known from the Similipal Biosphere Reserve and National Tiger Park. There are hill ranges at the centre with slopes gradually to east. It is endowed with rich mineral resources. With a tribal population of 1479576 (2011 census) which is 58.70% of the total population of the district, the area is also characterized by diversity of tribal cultures.

The district lies between 21°17' and 22°34' north latitude and between 85°40' and 87°10' east longitude. It is bounded on the north by the Singhbhum district of Jharkhand and Midnapore district of West Bengal, on the south by the districts of Balasore and Keonjhar, on the east by the Midnapore and Balasore districts and on the west by the districts of Keonjhar and Singhbhum. The district covers an area of 10,418 sqr.kms, with a population of 25,19,738 according to the 2011 Census. The district accounts for 6.69% of the state's territory and about 6% of state's population. The density of population of the district is 242 per square km as against 270 per square km of the state. As per 2011 census, the population of Scheduled Caste is 1,84,682 (7.30%), that of Scheduled Tribe is 14,79,576 (58.7%). The literacy percentage of the district covers 63.2 against 72.9 of the state. In order of size, the district is the largest among the thirty districts of Odisha and Baripada is the District head quarter. It has 3950 villages (including 202 uninhabited villages) covering 26 blocks, 26 tahasils and 4 sub-divisions.

II. METHODOLOGY

Topographic Maps of Survey of India were used during the study.Field Reconnaissance Survey has been conducted to generate the data related to lithology, Structure, Geomorphology and Mineral occurrences .Thematic maps of lithology, slope, lineament were prepared using Arc GIS .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 and available literatures.

III. RESULTS AND DISCUSSION

Physiography and Geomorphology : Physiographically the study area can be divided into 3 categories. The first physiographic unit of the district is high mountain ranges, Simlipal Complex being at its central part (Figure 1). The mountain ranges comprise mainly of highland plateau and valleys with intrusive running through them. The second physiographic unit is Tertiary Plain occurring in the eastern part of the district. The third physiographic unit is Alluvial Plain which lies partly in Rasgovindpur, Morada, Samakhunta, Betnoti, Baripada, Badasahi and Suliapada blocks. Geomorphologically the district is divided into 3 units:

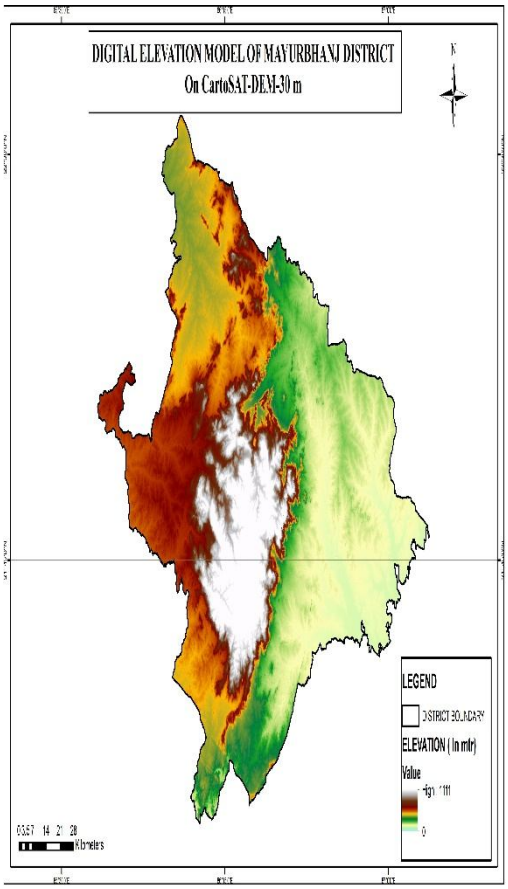

Figure 1: DEM of Mayurbhanj district

The denudational hills with moderate to high slope occurring in the western part of the district.

i) Dissected pediments having gentle slope.
ii) Pediplain having slope between 0^o to 5^o.

Drainage Pattern: The district is drained by a network of rivers and nallahs having flow in different directions. Budhabalang, Baitarani, Subarnarekha and Kharkhei are the principal rivers flowing through the district. The drainage density is observed to be fairly moderate and drainage pattern is dendritic in nature (Figure 2).

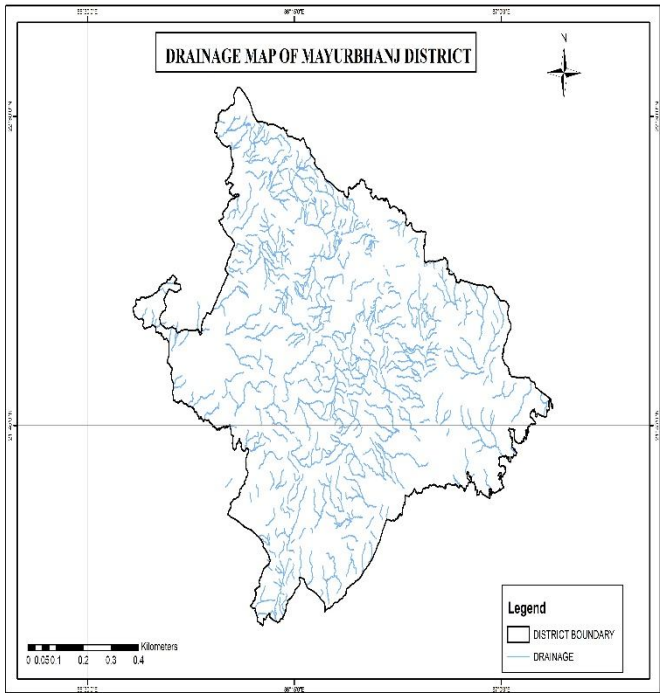

Figure 2 :Drainage map of Mayurbhanj district

Soil Type: The district comprises chiefly of lateritic, sandy loam and clayey loam type of soil (Figure 3). Laterite soil is mostly marked in the area occupied by crystalline rocks. The low lying valley fields are covered with clayey loam type of soil.

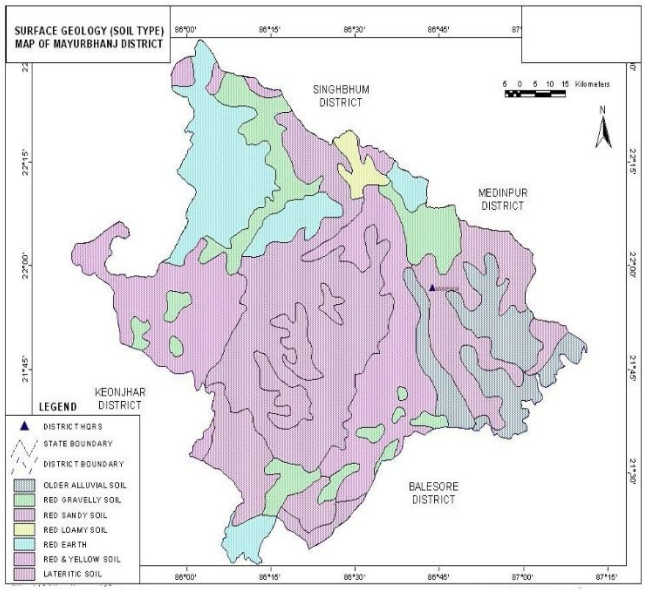

Figure 3 : Soil map of Mayurbhanj district

Geology: The major rock types encountered in the district are Granite Gneiss, Quartzite, Orthoquartzite, Arkose, Shale, Phyllite, Gabbro, Px-granite (Figure 4). The geology of the district is constituted by the Simlipal 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. The sedimentary of Simlipal mostly comprise of orthoquartzite, Arkoses and minor band of ferruginous shale and phyllite. The quartzites are devoid of any volcanic materials within it and exhibit well-preserved cross-bedding and palaeo-current structures indicating shallow water sub-marine origin. The dip of the quartzites towards the centre of the Similipal basin. The three consecutive bands of volcanic denotes 3 periods of quiescence. At the centre of Similipal lies the Amjori sill which covers an area of about 130 sq. kms. Following the volcanic phase, Gabbro, Granophyre and pyroxene granite were intruded along fractures in the periphery at Simlipal complex, Baripada bed of Mio-pliocene age occurs to the east of Simlipal built by marine deposits in the form of continental shelf. The laterite of Eocene age are found overlying the others. Some parts are covered by insitu and alluvial soil of recent age.Volcano-sedimentary rocks of the Simlipal basin forms a prominent circular feature in the geological map. This litho sequence of Simlipal group comprising basal conglomerate, phyllite, volcanic breccias, spilitic lavasand tuffs intercalated with quartzite overlies the Gorumahisani Badampahar group of rocks. In the type area, Gorumahisani-Badampahar group of rocks comprising pillow metabasatts with interbeded chert, quartzite, BMQ, hornblende schist, epidiorite, phyllite, acid volcanics and tuffs.

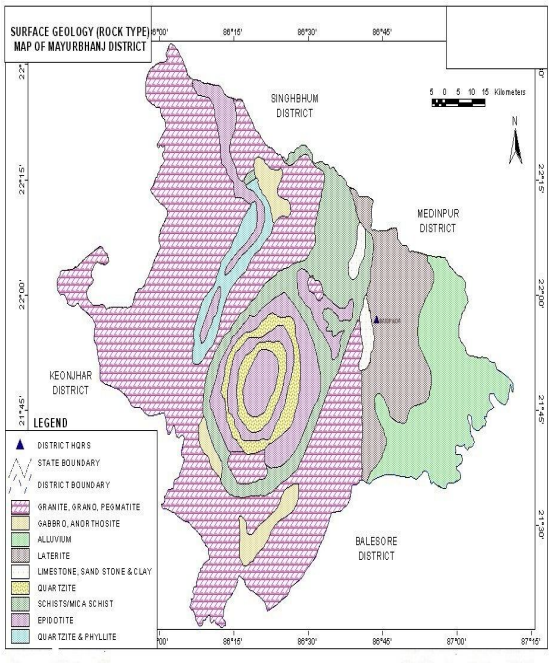

Figure 4: Geological map of Mayurbhanj district

Baripada Beds: Surface outcrops of sub-horizontal tertiary formation occur around Baripada town. These comprise stratified clay and sand with marly clay or limestone inter bands Significant fossil contents comprise *Ostrea sp* like *Crassostrea gajensis*, *Vredenburg*, fragments of *Palmoxylon* and *Shoreoxylon*. Vertebrate fossils like shark tooth and rodent remain have been recorded along the course of the river Budhabalanga. The occurrence of animal remains from Baripada beds throws some light on the palaeogeographical condition during mio-pliocene age. An arm of sea extended north-west along the course of present Budhabalanga river at least upto Baripada. Surface outcrops of sub-horizontal tertiary formation occur around Baripada town. These comprise stratified clay and sand with marly clay or limestone inter bands Significant fossil contents comprise *Ostrea sp* like *Crassostrea gajensis*, *Vredenburg*, fragments of *Palmoxylon* and *Shoreoxylon*. Vertebrate fossils like shark tooth and rodent remain have been recorded along the course of the river Budhabalanga. The occurrence of animal remains from Baripada beds throws some light on the palaeogeographical condition during mio-pliocene age. An arm of sea extended north-west along the course of present Budhabalanga river at least upto Baripada.

Generalised Stratigraphy

Geological Age		Geological Formation / Group
Quaternany	:	Recent Alluvium, Clays, silt, Sand, Gravel
Tertiary	:	Older Alluvium, Laterite, Baripada Beds.
Mesozoic/ Palaeozoic	:	Volcanics / Epidiorite
Precambrian	:	Slate/ Phyllite/ Schist / Gneiss
Archean	:	Granite/ Granite Gneiss

Mineral Resources : The earliest known geological survey in Mayurbhanj dates back to 1903, when P.N.Bose brought to light the extensive iron-ore deposits of high quantity on the Gorumahisani and Sulaipat hills in Bamanghaty sub-division. These deposits were considered to be almost inexhaustible and were pronounced to be of excellent quality, perhaps second to none in the whole of Asia by the famous American and English experts like M/s Perin, Weld and Colonel Staddart, who visited these deposits during 1905-06. This discovery was a momentous one as the steel plant of the Tata Iron & Steel Co. at Jamshedpur was entirely based on the exploitation of these deposits. By 1915, important discoveries of Steatite near Lulung and placer gold from the sands of Subarnarekha, Kharkhai and Barhai rivers had been made. The placer gold deposits were being worked by M/s J.B. Bettie of Calcutta, Mr. V.G. Piggot of Ghatsila and the Mayurbhanj Prospecting Concession Syndicate.

During 1936, a regular Department of Mining & Geology was started in Mayurbhanj. By 1940-41, the Mayurbhanj Mines Order and Mayurbhanj Workmen's Compensation Order had come into force and this regularized and controlled the procedure for granting Certificates of Approval, prospecting licences, mining leases, mining operations, inspection of mines, safeguard against accidents, etc. Several deposits of Vanadiferous and Titaniferous Magnetite, Kyanite, China Clay, Asbestos, Red Oxide, Quartzite and other minerals were brought to light and several mining leases granted. By 1945-46, occurrence of Galena, an ore of lead was discovered between Pithabata and Bangiriposi, in a belt extending over 30 kms. Prospecting operations had been taken up in this belt as well as in the Uperbhag area, the latter for exploring the possibility of striking workable loads of copper ore. During this period, the railway track between Tatanagar and Gorumahisani was extended upto Badampahad.

Kesharpur Copper Deposit: The villages Kesharpur, Dudhiasol and Madansahi encompassing the copper ore deposits are located between lat $22^o04'$ and $22^o07'$ and long. $86^o40'$ to $86^o42'$. The Kesharpur Cu deposits is located at the tail portion of the Singhbhum Thrust belt. Sheared metabasics belonging to proterozoic fold belt of Eastern Singhbhum constitute the host rocks for copper mineralization which occurs as a series of discontinuous lentricular bodies in an enechelon pattern. The ore mineral is mainly chalcopyrite with associated pyrite and pyrrhotite. Structurally, the shear zone has affected a major regional synformal structure and its core has been emplaced by a syntectonic granite.

Bauxite: In Simlipal complex (Mayurbhanj) aluminous laterite/ Bauxite are observed around 1000 m AMSL. The spongy aluminous laterite/bauxite occurs as sheets and boulders occupying the flat-topped hills made up of metavolcanics. Both ultramafics and metavolcanics are lateritised giving rise to nickeliferous laterite and aluminous laterite respectively.

China Clay is a clay like material approximating the mineral Kaolinite (Al_2O3, $2SIO_2$, $2H_2O$). China clay is found to occur in a long belt stretching from Singhbhum to Mayurbhanj. Badampahar-Joshipur- Karanjia – Ramachandrapur belt is the most important china-clay producing area of the state. The important deposits in Mayurbhanj district are found near Joshipur, Chanchbani, Dumuria, Jamoda, Kodadiha, Jamkeswar and Thakurmunda. China clay has many industrial application as filler in paper, textile, rubber, in the manufacture of potteries, ceramics, sanitary wares, glazed tiles, white cement, insecticides, paints, cosmetics, refractory bricks etc.Soap stone and Steatite Asbestos is mined from Mayurbhanj area.

Gold*:* The mid-Archaean Gorumahisani-Badampahar schist belt composed of basic ultrabasic, volcanic rocks and volcanogenic sediments. This belt has been prognosticated as a rift-type of volcanic dominated one and is highly potential for economic grade gold mineralization. Likely targets include: a) auriferous quartz veins close to the contact of sulphide chert volcanics, b) sheared and sulphidised Fe-rich tholeiite with anomalous copper, c) epigenetic vein type of mineralization and BIF volcanic association, and d) sulphidic conglomerate resting over the basic volcanics. Placer gold occurrence are known from rivers and stream of Mayurbhanj district. An area of about 5 square kilometers of alluvium at the headwaters of Sapgora and Borai rivers near Kudersai was indicated as promising.

Iron: Bose discovered iron ore deposits in Gorumahisani and Badampahar in the eastwhile princely state of Mayurbhanj (now Mayurbhanj District). Gorumahisani deposits were investigated by Perin & Weld (1905). Gorumahisani-Badampahar-Sulaipat deposits are associated with banded hematite / magnetite grunerite and BHJ.

Gorumahisani – Badampahar- Sulaipat (Broad geological sequence)

Laterite & Alluvium
Newer Dolerite
Gabhro-Anorthosite
Granite
____Unconformity____
Ultramafic dyke
Singhbhum Granite
Banded magnetite/ Martite quartzite with Fe-Ores
Quartzite
Basal Conglomerate
____Unconformity____
Older metamorphics

Vanadium Ores & Titanium*:* Vanadium is an important alloying element. Magnetite associated with gabbro-anorthosite suite of rocks contain vanadium and titanium. Deposits of vanadium-magnetite occur in association with gabbro-Anorthosite suite of rocks in the precambrian metamorphites. Vanadium bearing magnetite belts are :-

(a) Rairangpur – Bisoi belt (Kumardubi, Betjharan Amdabeda)
(b) Bisoi – Joshipur belt (Mayurbeka, Kesham, Sialnoi)
(c) Baripada – Podadiha belt (Andipur, Bahalda)

Pyrophyllite : is mainly used as a high grade ceramic product, electric insulator and refractory material. The comp. is $Al_2O_34SiO_2$ H_20. It is formed as an alteration product of feldspar. Pyrophyllite occurrences are reported at Kankrani,

Jashipur, Gorumahisani, Bangriposhi and Manada in Mayurbhnaj dist.

Talc, steatite and soapstone : Important localities of these deposits in Mayurbhanj dist are Tiring, Kendumundi and Kharidamak.

Kyanite: Kyanite deposits of refractory grade occur in Panijia area of Mayurbhanj dist, where it is associated with dumortierite bearing rocks, qtz-veins, quartz-mica-schists and talc-tremolite-schist. Other kyanite occurrence include Purnapani & Simlipal.

Quartz & Quartzite : Quartz and silica sand are mostly used in glass foundry, ferrosilicon alloy, ceramic industry, abrasive, paint, rubber, textile industries. Transparent varieties of quartz such as rock crystal, amethyst, citrine, Rosequartz and smoky quartz are used as semi-precious gemstone. Quartz is a piezoelectric material and is used in radio circuit, Radars and ultra-sonic devices. Quartzite is a monomineralic rock constituted predominantly of quartz. There are 6 mining leases for quartz and quartzite in Mayurbhanj dist.

High Magnesia rock: are found in Notapahar, Thakurmunda, Amjori and Badampahar of Mayurbhanj Dist.

Nickel: Nickel is concentrated within chemically weathered ultramafic rocks and found in the laterite and soil capping in Simlipal area. The mineral occurs in silicate form i.e. garnierite. The important patches of prospective ore zones are: Gurguria and Nawana.

IV. CONCLUSION

Mayurbhanj is an unique district in Odisha with rich and varied geology. The major rock types encountered in the district are Granite Gneiss, Quartzite, Orthoquartzite, Arkose, Shale, Phyllite, Gabbro, Px-granite. The geology of the district is constituted by the Simlipal 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. The sedimentary of Simlipal mostly comprise of orthoquartzite, Arkoses and minor band of ferruginous shale and phyllite. The quartzites are devoid of any volcanic materials within it and exhibit well-preserved cross-bedding and palaeo-current structures indicating shallow water sub-marine origin. Important mineral resources include iron, copper, itanium,vanadium, chinaclay,nickel,kyanite,quartz,talc,steatite ,soapstone and bauxite. Natural Emerald, green Beryl and opaque Beryl are reported to occur around Jaraguda, Pokharidiha, Bahadurpur, Ichinda, Khairakocha, Jamukunda, Nakulkocha, Kapadiha, Dunguridiha, Maheshpur, Kashidiha, Sagragora and Pokpoka. Dimension stone of the district are granite, granite-gneiss, migmatites, syenite, gabbro, anorthosite, charnockite, leptynite, pyroxene granulite, dolerite, pyroxinite and dunite etc.

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