

Geology and Mineral Resources of Orissa

Orissa, situated on the eastern seaboard of India is one of the gifted parts of the World, where a gamut of mineral resources exist in bounty. The state is endowed with large reserves of bauxite, chinaclay, chromite, coal, dolomite, fireclay, graphite, gemstones, iron ore, limestone, manganese ore, mineral sand, nickel ore, pyrophyllite and quartz. Recent discovery of diamond in the Dharambandha area of Nuapada district by the State Directorate of Geology has added a coloured feather in the cap of the state. Other minerals of the state include copper ore, lead ore, titanium bearing vanadiferous magnetite, talc/ soap stone and high magnesia igneous rocks. Recent boom of the mineral industry has turned the state in to a hotspot, with entrepreneurs from all over the World crowding the state for their share of fortune.

The rich mineral wealth of the state is attributed to its favourable Geological setup. Situated on the eastern fringe of the peninsular India, Orissa has about 72.5% of the area occupied by Precambrian metamorphic rocks (of Archaean and Proterozoic age) which hosts the majority of the minerals. The Gondwanas hosting the coal resources occur over about 8% of the landmass. The tertiary and quaternary formations, occupying rest of the area, provide avenues for aluminous/ nickeliferous laterite and heavy minerals (in beach sand).

The Archaean rocks in northern Orissa include the Supracrustal belts of metasedimentary rocks including Iron Ore Super Group having deposits of iron, manganese, gold and basemetals. These are also represented by the gneisses, granite, migmatite (Singhbhum, Bonai and Mayurbhanj Plutons) and mafic/ ultramafic intrusives. These intrusives are associated with the chromite, titaniferous vanadiferous magnetite and PGM. The Bastar cratonic complex of Archaean age in the Western Orissa includes gneisses, granite, migmatite and Strontium-Tantalum-Niobium bearing pegmatites.

Proterozoic rocks in the western Orissa exhibit platformal sedimentary formations and associated limestone deposits. In north-western Orissa they contain metasediments of low to medium metamorphic grade classified as the Gangpur Group, which host manganese, limestone and Lead-Zinc deposits. In central and southern Orissa, the Proterozoics are represented by the Easternghats granulite belt comprising of khondalite, charnockite, migmatite, anorthosite and alkaline rocks accounting for the mineralisation of bauxite, manganese, graphite and gemstones.

The Mesozoic rocks of Gondwana Super Group host the major coal resources of the state.

Formations of Cenozoic age occupy the eastern coastal plains in form of alluvial sediments, ash beds and low level laterite, providing avenues for occurrence of beach sand minerals and building materials. The deltaic fans extending into offshore regions play hosts for oil and gas.

Orissa has a lion share of the Country's mineral reserves. The chromite, nickel, bauxite, iron ore and coal resources of the state respectively stand at a staggering 83, 92, 55, 38 and 26 percent of India's total reserves. Some of these minerals also account for a visible spot in the world's mineral map. The state's mining revenue during 2008-09 amounted to approximately Rs 1380.59 crores.

Several mineral based industries have already come up in the state. The major ones include Rourkela Steel Plant, Alumina refinery and smelter of Nalco at Damanjodi and Anugul, Charge chrome plants at Baminipal, Bhadrak, Choudwar and Theruvali by OMC, FACOR, ICCL and IMFA respectively, Mineral sand separation unit at Chhatrapur by IRE. Many cement and sponge iron plants have been set up. Coal based thermal power plants have been set up at Talcher, Kanihan and Banaharpali. Captive thermal power plants have also been set up by NALCO, RSP, ICCL, INDAL etc. and many more are in the pipeline.

The dynamic State Government of Orissa has left no stone unturned in cashing in on the attention it has been getting from different business houses in recent times. The visionary Chief Minister with his view on the future development of the state has signed 79 MoUs with various companies to setup mineral based industries with a total proposed investment of Rs 3,65,327.20 crores, which is supposed to provide value addition to the mineral wealth thereby augmenting employment and enhancing the economic standard of the public. The huge mineral resources of the

state, 480 km long coastal stretch, the liberalised economic policy of Govt. of India, Industrial Policy 2007 and availability of infrastructural support makes the state an investor's paradise.

AN ACCOUNT OF INDIVIDUAL MINERAL RESOURCES OF THE STATE

BASE METAL

1	Chemical composition	PbS, ZnS, CuFeS ₂ (Lead, Zinc ore, Copper sulphide ore)
2	Types of Ores/Minerals	Galena, Sphalerite, Chalcopyrite as specks, stringers, pockets.
3	Distribution	
	Sundargarh District	Sargipalli – Galena, Chalcopyrite, Sphalerite, Cerussite, Azurite, Malachite, Covelite.
	Balangir District	Saintala Area – Galena, Malachite, Chrysocola & Pyrite.
	Bargarh District	Kermeli Area – Galena, Chalcopyrite. Malachite. Chrysocola, Pyrite.
	Kalahandi District	Sisakhal – Galena, Chalcopyrite, Malachite, Chrysocola, Pyrite.
	Deogarh District	Gangajal – Galena. Adas, Kesarpur – Chalcopyrite, Pyrrhotite
4	Reserve & Grade	Total resource of Orissa – 4.98 million tonnes Sargipalli deposit – 1.89 million tonnes between 220 m & 60 m with 6.73% Pb, 0.33% Cu and 51 PPM of Ag at 3% cut off.
5	Uses	Used in production of various alloys (brass, german silver & white metal), metallurgical industries, galvanization, pigments, dyeing, glue making etc. Lead is also used for construction of accumulators, cable covers, bronze, ammunition, and foil. Oxide of lead is used in glass making as flux, rubber industries. The nitrate of lead is employed in calico dyeing & printing. The acetate is used in medicine.
6	Mineral based industries in the State	
7	Remarks (Indicate Orissa position with respect to India)	The Sargipalli deposit – exploited by Hindustan Zinc Ltd., but mine was closed in 2001-02 due to depletion of resources & uneconomic production. Orissa has resource of about 4.98 million tones against country's resource of about 552 million tonnes

BAUXITE

1	Chemical composition	
2	Types of Ores/Minerals	Bauxite is a mixture of Gibbsite Al(OH) ₃ , Bohemite AlO(OH) and Diaspore (HAlO ₂)
3	Distribution	
	Koraput district	Panchpatmali, Pottangi, Maliparbat, Ballada, Kodingamali, Hatimali, Kakrimali, Chintamgundi, Kornapadikonda, Gurji, Medamgundi etc.
	Raygada district	Baphilimali, Sasubohumali, Pasangmali, Majhigaonmali, Sijimali, Tikrimali, Budharajamali, Taljhir, Dabuguda, Nunapaimali, Nangalghatmali.
	Kalahandi district	Karlapat-Pollingpadar, Kutrumali-Tangridongar, Lanjigarh Niyamgiri, Keluamali, Krishanmali.

	Kandhamal Dist.	Anamini Parbat, Rukunicuttack, Deomal, Ushabali.
	Keonjhar District	Dholkata pahar,
	Sundargarh Dist.	Tantra, Kodalia , Jaldihi, Kusumdihi etc.
	Malkangiri Dist.	Korkanda
4	Reserve/Grade	1797 Million tones with >40% Al ₂ O ₃ and <0.5% SiO ₂
5	Uses	For production of Alumina and as refractories, abrasives, minor quantities are used in ceramics, chemicals and ferroalloys industries.
6	Mineral based industries in the State	Alumina plant at Damanjodi and Angul of NALCO, HINDAL Co., L&T, Vedant, L&T, Utkal Alumina.
7	Remarks (Orissa position with respect to India)	Orissa has resource of about 1797 million tones against India's resource of about 3290 million tonnes

CHINA CLAY

1	Chemical composition	Al ₂ O ₃ 2SiO ₂ 2H ₂ O, Fusion point 1785 ^o c
2	Types of Ores/Minerals	Lenses & pocket type
3	Distribution	
	Mayurbhanj District	Joshipur, Chanchbani, Dumuria, Jamda, Kadodiha, Jamkeswar & Thakurmunda .Dhobadiha, Kalapathuria, Sorisbari, Jamkesar, Kalikapur,
	Keonjhar District	Ramchandrapur, Kathkaranjia, Nanua, Nijli, Mangalpur, Tikasil etc.
	Nawarangpur District	Unchheibera, Guras, Bholpara, Pradhanpara
	Rayagada District	Devdhara, Sorispadar, Ambagan
	Bargarh District	Kudingmali Khola
4	Reserve & Grade	Total resources of Orissa - 314 mt.
5	Uses	Ceramic, textile & paper coating, rubber, filler in paper, insecticide, calcinations industries
6	Mineral based industries in the State	
7	Remarks (Indicate Orissa position with respect to India)	

COAL

1	Chemical composition	Coal is composed of Carbon, Hydrogen, Oxygen, Nitrogen, Sulphur with some trace elements.
2	Types of Ores/Minerals	The Gondwana Coal of Orissa is non coking with grade varying from E to G.
3	Distribution	
	Angul - Dhenkanal District	Talcher Coalfield.
	Sambalpur-Jharsuguda District	Ib River coalfield
		Uneconomic coal occurrences are found in following basins- Athgarh basin, Gaisilat basin, Athmallick basin, Katrinjia Basin.
4	Reserve/Grade	65263.34 million tonnes non-coking coal.
5	Uses	Thermal Power Plants
6	Mineral based industries in the State	TTPS – NTPC, Talcher NTPC -Kaniha

7	Remarks (Indicate Orissa position with respect to India)	Indian resources of coal. 253.30 billion Tonnes.
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CHROMITE

1	Chemical composition	FeO Cr ₂ O ₃
2	Types of Ores/Minerals	Stratiform type – Occurs as Bands, Lenses & Xenoliths. Varieties are friable ore, lumpy and granular ore, ferruginous ore, banded ore, disseminated ore.
	Distribution	Confined to 3 belts such as (1) Sukinda Ultramafic complex. (2) Boula-Nuasahi Igneous complex. (3) Bhalukasuni Important deposits – Kamardah, Saruabil, Sukrangi, Kaliapani, Bhimtangar, Kalrangi, Chingripal, Gurjang, Kathpal, Birsal, Boula, Bangur, Nuasahi etc.
4	Reserve/Grade	177 million tones of all categories. Grade-10% to 45% Cr ₂ O ₃
5	Uses	Production of a variety of Steel and alloys , viz. Ferrochrome, charge chrome, ferro-silicon, chrome based refractory, chemical industries etc.
6	Mineral based industries in the State	Charge Chrome Plant – Bamnupal, Randia & Choudwar. Ferro Chrome Plant – Jajpur Road, Theruvali. Refractory Plant – Rajgangpur, Belpahar, Lathikata.
7	Remarks (Indicate Orissa position with respect to India)	Total resource of chromite of India is 213 million tones. Orissa ranks first in term of resource.

DIMENSION STONE

1	Chemical composition	
2	Types of Ores/Minerals	Hard rocks occurring as sheets or mounds mainly – Charnokite, Quartzofelspathic gneiss, Granite gneiss, Augen gneiss, Granulites, Dolerite, Gabbro & Stromatolitic limestone, Marble.
3	Distribution	
	i) Angul District	Gobinda Pana Sahi, Durgapur Panasahi
	ii) Dhenkanal District	Mahapada, Haripur, Radhadeipur.
	iii) Gajapati District	Raghunathpur, Sanadola, Sanatundi, Baguda, Lubarsingi, Sundaraba, Sabarapalli, Kankargurha, Taraba, Ranala, Nuasahi, Ragaisingi, Bhramarpur, Tundari & Sauri, Marlaba, Barahapadar, Mahulpadar, Kuddada, Jhingiriguda, Puigurha, Hatimunda, Kharia, Burhamali, Guruduma, Laxmipuram, Venkatpuram, Salkijeyepore, Addanguda, Appanayupeta, Antarba, Jamudiha, Poibandha, Khariguma, Bariabandha, Dengama, Kandha Adaba, Narayanpur, Khariaguda, Mandimera.
	iv) Ganjam District	Gudiapalli area, Dakhinpur, Lanja, Sukunda, Lathi, Bada Dumula, Kandasara, Dasipur, Mathura, Radhamohanpur, Gobinda nagar, Krushnanagar, Nuaparha, Baranga, Dutipur, Gopalpur, Sarahanaipalli, Manikyapur, Hinjlicut, Pathan Punji, Kirtipur, Sahaspur, Butasarsingi, Purusottampur, Khetapalli, Patapur, Gudiali, Mandalpur, Matisahi, Kohibiradi, Nuamundia, Bishnuchakra, Kanteipalli, Laxmipur, Jahada, Thurathora, Olamba, Chakunda, Baragarh, Badangi, Ekatapur, Matisahi etc.

	v) Nawarangpur District	Cheptiamb, Karlapada, Samarcharan, Hatibari, Tohra.
	vi) Nuapada District	Bhaira, Dalipathara, Damarkhol.
	vii) Cuttack District	Murdamekh, Paikregeda, Jagannath Prasad, Saradapur Patna, Jogibahali, Kakuria, Pancham, Sukad, Sitarampur, Ghantapara, Bhejiapara, Basantpur, Ramachandrapur, Mulikata, Tagila, Rusigara, Kanpur.
	Nayagarh District	Chuapalli, Mardarajpur, Khuntabandha, Singhapara, Khandapara, Sunamuhi, Kantilo, Laxmiprasad, Bebartapur, Malisahi, Bhandar Parbat, Damasahi, Madhyakhand, Koilama.
	Kandhamal District	Pandimaha, Nilungia, Gambuli, Kurmungia, Kulakanda, Tudipaji.
	Boudh District.	Bakapalli, Chhatrang, Baisparha, Madhapur
	Sambalpur District.	Badmal, Chhanchanpalli, Sahaspur, Salhesingha, Bhoipali.
	Subarnapur District	Goudgad, Mahukhandi, Saraspadar.
	Khurda District	Khuamundia, Hatia. Kalinga, Kaluchua, Dhobui, Dhania, Bhogpur,
4	Reserve & Grade	60 million cubic meters of all varieties.
5	Uses	As polished blocks & tiles for flooring Kitchen Platforms, Wall panels, Table tops, in commercial complexes, domestic houses, monuments, temples , platforms, tomb stones, land scaping etc. Many coloured varieties are used for flower vases, name plates. pen stands, paper weights, statues & modern sculptures.
6	Mineral based industries in the State	19 active industrial units in the district of Cuttack-4, Khurda-9, Koraput-2, Bolangir-2, Ganjam-1, Keonjhar-1, Major Entrepreneurs are – Laxmi Granites, Narayani Granites-Bhubaneswar, Minakshi Granites-Titlagarh, Vishnu Granites-Jeypore, Shekhawat Granites-Mahuda(Ganjam), Kalinga Granites-Cuttack.
7	Remarks (Indicate Orissa position with respect to India)	There is ample scope for development for dimension and decorative stone industries in the State. Besides, the wastes generated from mining have also end use as construction materials, filling materials, road materials, ballast for railways, manufacture of abrasives, stopes in coal mines to suppress coal dust, soil sweetener etc.

FIRE CLAY

1	Chemical composition	Basically Kaolinite with Pyrometric Cone Equivalent – 18.
2	Types of Ores/Minerals	Plastic, Semi-Plastic, Non-Plastic.
3	Distribution	Confined to 3 geographical belts Viz. (a) Talcher Coalfields, (b) Ib River Coalfield, (c) Upper Gondwana Athgarh Formation.
	Angul District	Jagannath Colliery, South Balanda Colliery, Kaniha, Telisinga.
	Cuttack District	Talbasta, Brahmabasta, Ghantikhal.
	Khurda District	Jagannath Prasad, Andharua, Bantala
	Bargarh District	Telipali, Buramunda, Gaisilat.
	Ib River Coalfield area	Belpahar, Jurabaga, Darlipali, Rampur, Kuropali, Baria pahar, Lukopoli, Khinda, Rail, Ainlapali, Kirwara, Belpur, Siarmal, Kulda, Ratansera, Lakhanpur, Bundia, Bholamal etc.
4	Reserve & Grade	176 million tonnes
8	Uses	The only application of fire clay is as refractories.
9	Mineral based industries in the State	Tata Refractories Ltd. – Belpahar. Orissa Cement Ltd. – Rajgangpur. Orissa Industries Ltd. – Lathikata. IPITATA Refractories Ltd. – Dhenkanal
10	Remarks (Indicate Orissa position with respect to India)	Resource of India 705 million tonnes

GRAPHITE

1	Mineral Composition:	Carbon 'C' (soft crystalline form of carbon) also known as plumbago, Black lead	
2	Type of Ore/Mineral :	Flaky (crystalline) graphite Amorphous (crypto crystalline) graphite	
3	Distribution :	Confined to Precambrian Eastern Ghat complex. Distributed as follows	
	West Zone	<i>Belt</i>	<i>Districts</i>
		i) Sargipali Belt ii) Titlagarh Belt	Bargarh, Nuapara Balangir
	South Zone	iii) Tumudibandh Belt	Kalahandi, Kandhamal, Rayagada, Gajapati
	East Zone	iv) Dandatopa Belt	Angul
	District	Important Location	
	Angul	Dandatopa, Akharkata, Adeswara, Kamalpur, Girida	
	Bargarh	Temrimal, Tentulikhunti, Hardatal, Ranjitpur, Dahigaon, Menaramunda	
	Balangir	Magur jungle, Gerdi, Fulmati, Ganjaudar, Rengali, Sargipalli-Golomunda, Dhandamunda, Godgadbahal, Mahulpati, Banjipali, Dukukamal, Beherapani, Beheramunda, Sappmunda, Mohanilaha, Malisira, Sargibahal	
	Kalahandi	Sargipada, Gaidar, Singjharan, Lamer, Badibahal	
	Kandhamal	Madagurha (Tumudibandh), Bargaon, Dhursi, Mahabali	
	Nuapada	Kirkita, Dharamsagar, Gandabahali	

	Rayagada	Lakhajharan, Bandhamandi, Sanamaturu, Malimunda, Kumbhibhata, Gundrugaon
	Nayagarh	Narajpada
4	Reserve/Grade:	Total resource 4 million tonnes
5	Uses:	Refractory industries – 45% Crucible industries – 30% Foundary – 9% Others (Dry cell battery, electrodes – 16% Pencil, paint paper Pesticides, asbestos products, graphite based sealing gasket graptitised greased etc.)
6	Mineral based industries in the State:	Clay bounded graphite crucibles are in Titilagarh (Bolangir Dist.) Sambalpur (Sambalpur Dist.)
7	Remarks:	Low grade graphite of the state are beneficiated and sold to different firms inside & outside the state to make graphite products. Resource of graphite in Orissa is very less as compared to that of India, Orissa (4.467 million tones) share only about 3% of total resource of India (169 million tonnes)

IRON ORE

1	Chemical composition	Haematite (Fe ₂ O ₃), Magnetite (Fe ₃ O ₄)
2	Types of Ores/Minerals	Haematite, Magnetite, Goethite, Siderite
3	Distribution	
	i) Keonjhar District	Roida-Bhadrasahi, Unchabali, Jajang, Jurudi, Belkundi, Bolani, Khandbandh, Katamati, Thakurani, Gandhamardan, Sakradihi, Joda-East, Haromoto, Guali, Kasia, Malangtoli etc.
	ii) Sundargarh District	Barsuan, Taldihi, Kalta, Khajuridihi, Palbeda, Ganua, Koira, Kurmitarpahar, Rantha, Mankarnacha, Baliapahar, Badamgarh pahar, Mithihurda-Basada etc.
	iii) Mayurbhanj District	Suleipat, Ghusura, Gorumahisani, Badampahar, etc.
	iv) Jajpur District	Daitari
4	Reserve/Grade	5231 million tonnes
5	Uses	Production of Iron and Steel & Sponge iron, Manufacture of Pigments used in drilling mud.
6	Mineral based industries in the State	Rourkela Steel Plant of SAIL. Kalinga Iron Works, Barbil, NINL(Dubri), MESCO(Jajpur Road)
7	Remarks (Indicate Orissa position with respect to India)	Orissa has a lion share in term of resources (5,231 million tonnes) against that of India (25,250 million tonnes)

LIMESTONE

1	Chemical composition	Calcium carbonate, CaCO ₃ : have some argillaceous/Siliceous material.
2	Types of Ores/Minerals	Bedded/crystalline
3	Distribution	

	Sundargarh District	Biramitrapur-Raibaga, Hatibari-Purnapani, Gatitangar, Lanjiberna, Khatkurbahal, Kiringsera, Bimta, Khairtola.
	Koraput District	Sunki, Dumajodi-Kundajodi, Parasagudi, Binsuli, Gupteswar.
	Malkangiri District	Kottametta, Nandiveda, Uskalvagu.
	Nuapada District	Chandpala, Sagundunguri, Deobahal, Rohapadar, Gorramura.
	Balangir District	Dhamandanga, Kuliadaha, Hial
	Bargarh District	Dungri, Banjipalli,-Jampalli
	Nuapada District	Putka-Saramsil
4	Reserve/Grade	1010.255 million tonnes
5	Uses	Cement industries, iron & steel industries including sponge iron & fertilizer industries, paper & pulp industries, water purification, alkali manufacturing etc.
6	Mineral based industries in the State	Bisra Stone Lime Company (BSL), IDCOL, Orissa Cement Ltd., Rourkela Steel Plant (RSP)
7	Remarks (Indicate Orissa position with respect to India)	Orissa has limestone resources of 1010 million tonnes against country's resource of 175345 million tonnes

DOLOMITE

1	Chemical composition	Carbonate of Calcium and Magnesium containing 30.4% CaO, 21.7% MgO and 47.9% CO ₂ in purest form with SiO ₂ , Al ₂ O ₃ , Fe ₂ O ₃ , Alkalies P & S etc.
2	Types of Ores/Minerals	Bedded type
3	Distribution	
	Sundargarh District	Biramitrapur-Raibaga, Gamardihi, Turmura, Lefripara, Dublabera, Sapai river section, Litibera.
	Bargarh District	Nuapara - Putka
4	Reserve/Grade	332 million tonnes.
5	Uses	Iron and Steel making, Ferroalloys, glass, foundary, cosmetics, refractory material.
6	Mineral based industries in the State	
7	Remarks (Indicate Orissa position with respect to India)	Orissa has dolomite resources of 332.457 million tonnes against country's resource of 7,533 million tonnes

MANGANESE

1	Mineral Composition:	Chief manganese ore of commercial importance are: Pyrolusite – MnO ₂ Psilomelane – MnO ₂ .n.H ₂ O (Hydrated manganese dioxide)
2	Type of Ore/Mineral :	Nodular, spherulitic, oolitic, laminated, soft, powdery
3	Distribution :	Manganese ore deposits of Orissa are associated with different Precambrian formations
		Iron Ore Group – Bonai-Keonjhar Belt
		Gangpur Group – Ghoriajor-Monmunda Area
		Eastern Ghat Super Group – In Koraput, Kalahandi, Bolangir, Rayagada Dist.
	Keonjhar	Joda, Chormalda, Katasahi, Jurudi, Parelipado, Roida, Sidhamata,

		Dubna, Jaribahal (Palsa), Katasahi-Kolha-Rudkela, Gurda
	Sundargarh	Orahari, Patamunda, Malda, Mahulsukha, Nuagaon, Teheral, Sarkundo, Kusumdihi, Gonua, Dendulo, Kanthor-Koira, Oraghat, Kolmong
	Rayagada	Nishikhal, Podakana, Khurigaon, Anajori, Liliguma, Ambadola, Rukunibari, Loharapara, Bhalumaska
	Balangir	Champasar, Bharatbahal, Rengali, Tamiya, Babja, Uchhabapali, Banipali, Biarpali, Gadashankar, Bhaludungri
4	Reserve/Grade :	Total resource: 120.763 million tonnes
5	Uses :	In iron & steel industries – 90 to 95% Ferromanganese industries Dry cell batteries Photography, leather, matchbox, paints textile, chemical industries
6	Mineral based industries in the State:	Tata Iron & Steel Co. Ltd. Joda dist. Keonjhar VBC Ferro Alloys Ltd.- Rayagada Balasore Alloys Ltd.- Balgopalpur, Balasore Rourkela Steel plant,- Rourkela Kalinga Iron Works (by IDC)- Barbil
7	Remarks:	Orissa -120.763 million tones- about 32% of the total resource of manganese ore in the country (India resources about 378.6 million tonnes)

MINERAL SAND

1	Mineral Composition:	A group of commercial minerals found in beaches are known as mineral sand i) Ilmenite (FeO TiO_2) ii) Rutile (TiO_2) iii) Zircon ($\text{ZrO}_2, \text{SiO}_2$) iv) Monazite Phosphate of rare earth with variable amount of thorium v) Garnet ($3\text{ROR}_2\text{O}_3, 3\text{SiO}_2$) vi) Sillimanite ($\text{Al}_2\text{O}_3, \text{SiO}_2$)
2	Type of Ore/Mineral :	Found as loose fragments (detrital grains)
3	Distribution :	Found all along Orissa coast as placer deposit
	Important location Ganjam Coast	All along Ganjam coast from A.P.-Orissa border to Ganjam-Puri border. Important Sector are: (i) Gopalpur Sector (ii) Chhatrapur Sector (iii) Prayagi Sector
	Puri Coast	On both side of Chilka lake (i) Paikrapur-Bajrakot Sector (ii) Brahmagiri Sector
4	Reserve/Grade :	Total resource of 82 million tonnes. 12% approximately.
5	Uses :	Ilmenite : Source of titanium, used for manufacture of titanium dioxide & ferro-titanium alloys Rutile: Source of titanium used for titanium dioxide pigment, welding electrodes production of titanium sponge & metal Zircon: Foundaries, ceramics, refractories Sillimanite: Manufacture of high temperature refractories Garnet: Used as abrasive Monazite: Production of Rare Earth Compounds – Thorium, Uranium & Helium

6	Mineral based industries in the State:	There is no industry in the state utilizing the mineral sand. All minerals after mineral separation are sold outside the state or export to other countries in raw state
7	Remarks:	Orissa is a leading producer of mineral sand. It (82 million) shares about 14% of country's (632 million tones) heavy mineral resource. Chhatrapur deposit along Ganjam coast is the largest & richest deposit along east coast of India. Indian Rare Earth Ltd. (IRE) – a unit of Atomic Mineral Division, Govt. of India has been exploiting the natural resource of Chhatrapur coast since 1986

NICKEL ORE

1	Chemical composition	Ni, Occurs in nature as Nickel Sulphide and Nickel Silicate/Nickel laterite.
2	Types of Ores/Minerals	Sulphidic ore and Oxidic ore as commonly associated with the weathered residium of ultramafic rocks in the lateritic profile.
3	Distribution	Confined to Sukinda valley :- Kansa, Saruabil-Sukrangi, Kamarda, Kaliapani, Bhintangar(TISCO) Simlipal Complex: - Bhilapoga Sector of Gurguria block.
4	Reserve/Grade	Total resource – 174.48 million tonnes In Sukinda valley with cut off of 0.5% Ni, Reserve - +120 MT. Avg. Grade-0.89%. In Kansa sector with cut off of 0.5% Ni Reserve- 40.88 MT Avg. grade-0.8%, others – 13.60 mt.
5	Uses	Wide application in metallurgical industries for production of Stainless steel, special alloys, coinage, electroplating, chemical & petroleum refining industries, production of nickel catalysts.
6	Mineral based industries in the State	Nickel Technology Proving Plant at IMMT, Bhubaneswar
7	Remarks (Indicate Orissa position with respect to India)	Orissa has resource of about 174 mt. against that of India about 189 mt.

PYROPHYLLITE

1	Chemical composition	Al ₂ O ₃ , 4 SiO ₂ , H ₂ O, (Al ₂ O ₃ = 28.3%, H ₂ O = 5%)
2	Types of Ores/Minerals	
3	Distribution	
	Keonjhar District	Rebra-Palaspal belt. Deposits are Dhobakuchuda, Balabhadrapur, Amjore, Baliadihi, Madrangajodi, Nitigothe, Sidhamath, Uchkabeda, Rodvan, Rebna, Palaspal etc.
	Mayurbhanj District	Joshipur, Gorumahisani.
4	Reserve/Grade	8.4 million tonne (Al ₂ O ₃ 20-23%, SiO ₂ 65-75%, Fe ₂ O ₃ – 0.77, LOI – 3-4%
5	Uses	Used as high grade ceramic product, electric insulator and refractory material. Also used as filler in rubber paint, cosmetic, soap, cotton, paper and plastic manufacturing.

6	Mineral based industries in the State	Four Crushing and Pulverizing Plants near Keonjhar and Joda.
7	Remarks (Indicate Orissa position with respect to India)	Indian resource 33.69 million tonnes

QUARTZ & QUARTZITE

1	Chemical composition	SiO ₂
2	Types of Ores/Minerals	Quartz is found as either quartz crystals or as crystalline to cryptocrystalline quartz or as granular form. Quartzite is monomineralic rock constituted predominantly of quartz.
3	Distribution	Quartz occurs in the form of veins and as a constituent of pegmatites. In Orissa, quartz and silica sand deposits are located in the Precambrian terrains occurring in the districts of Boudh, Bargarh, Kandhamal, Keonjhar, Jharsuguda, Kalahandi, Mayurbhanj, Nuapada, Sonapur, Nabarangpur, Rayagada & Koraput. Quartzite occurs as beds interstratified with other metasedimentaries. Quartzite deposits in Orissa are located in Bolangir, Kalahandi, Koraput, Mayurbhanj, Keonjhar, Sambalpur, Sundargarh, Kandhamal, Angul and Bargarh districts.
4	Reserve/Grade	Total resource about 70 million tonnes
5	Uses	Ceramic, fertilizers, abrasives, electrical, paint, rubber, chemical and textile industries with different specifications. Transparent varieties of quartz such as rock crystals, amethyst, citrine, rose quartz and smoky quartz are used as semiprecious gem stones. Quartz is a piezoelectric material and is used in radio circuit, radars, ultrasonic devices, chronometers etc. Quartzites are used in refractory, iron and steel making, ferro-silicon, glass & ceramics etc.
6	Mineral based industries in the State	Ferro silicon plant - Theruvalli
7	Remarks (Indicate Orissa position with respect to India)	Orissa has total resource of 70 mt. against that of India about 4383 mt.

TIN ORE (Cassiterite)

1	Chemical composition	SnO ₂ , sp.gr. - 7
2	Types of Ores/Minerals	Occurs in primary source i.e. hydrothermal/pegmatite veins as well as secondary source in the form of alluvial deposits. Secondary deposits are economical for mining purpose.
3	Distribution	
	Malkangiri District	Bijapadar, Vederupalli, Durmaguda, Mohapadar, Kurumpalli, Gurupada, Permanasu
4	Reserve & Grade	Total resource about 348 tonnes
5	Uses	Tin and terne plate, alloys (bronge & brass), solder, babbittmetal, tinning, bare tin, foil, chemicals, tubing.

6	Mineral based industries in the State	
7	Remarks (Indicate Orissa position with respect to India)	Orissa has resource of about 348 tonnes against that of India about 86 mt.

PLATINUM GROUP OF ELEMENTS

1	Chemical composition	Platinum Group of Elements (P.G.E) includes Platinum (Pt), Palladium (Pd), Rhodium (Rh), Ruthenium (Ru), Osmium (Os) & Iridium (Ir).
2	Types of Ores/Minerals	PGE are strongly Siderophile & combine with iron to form metal alloys. Occur as (i) Free independent minerals in size range of 10 μ -40 μ (ii) inclusion in sulphides with size range of 5 μ to 10 μ . (iii) Solid solution in sulphides, silicate sand oxides. (iv) very fine (5 μ or less) particles in silicate-oxide gangue.
3	Distribution	Confined to three Geological Provinces, viz. : Singhbhum – Orissa Craton Bastar Craton Eastern Ghats Granulitic terrain
		Deposits/Prospective areas- Balasore- Bhalukasuni, Jajpur- Sukinda valley, Keonjhar- Baula-Nuasahi complex, Dhenkanal- Bhuban, Asurbandha, Maulabhanj- Keonjhar- Amjori sill
4	Reserve & Grade	In Sukinda valley Pt values range between 2 to 400 ppb Pd values range between 1 to 500 ppb In Amjori sill Pt value – up to 200 ppb Pd value – up to 60 ppb
5	Uses	Auto catalyst, Jewellery, dentistry, industrial application.
6	Mineral based industries in the State	Nil
7	Remarks (Indicate Orissa position with respect to India)	

DIAMOND

1	Chemical composition	Carbon (C), S.G. 3.516 to 3.525, Hardness-10
2	Types of Ores/Minerals	Pure carbon in the form of Octahedral or Hexoctahedral or Dodecahedral occurs in colourless, pale
3	Distribution	Both primary and secondary diamond occurrences are reported in the State Primary – Kalamidadar valley in Nuapada district (64 L/5). It is under exploration by D.G. (O) Secondary – Rocky river bed of Mahanadi river particularly from Binika in Sonapur dist. to Madhapur in Boudh dist., is reported to contain good quality gem diamonds. Important locations are Binika, Sonapur, Amuda, Sahupada, Boudh, Ramgarh, Madhapur, Morjakud
4	Reserve & Grade	Not estimated

5	Uses	Jewellery, oil drilling, grinding, cutting & polishing,
6	Mineral based industries in the State	NIL
7	Remarks (Indicate Orissa position with respect to India)	Following the discovery of primary source of diamond, several prospective areas in the districts of Malkangiri, Kalahandi, Sambalpur, and Bargarh are under active R.P. by MNCs. All India reserve of diamond is placed at 4.582 million carats.

GEMSTONE

1	Chemical composition	Ruby – Aluminium oxide (Red/pink colour)
		Sapphire- Aluminium oxides (bluish colour)
		Aquamarine- Beryllium Aluminium Oxide (light blue)
		Chrysoberyl – Beryllium Aluminium Oxides (yellow, green, brown)
		Garnet – Magnesium, iron or calcium aluminium silicates
		(colour – garnet of different colour depends on composition pyrope & almandine – Red, spessartite & hessonite-orange, rhodolite - purple
2	Types of Ores/Minerals	Occurs as primary as well as secondary colluvial/alluvial deposit
3	Distribution	Ruby – Kalahandi dist. -Jhillingdhar, Hinjlibahal, Kerumurda
		Sapphire – Nuapara dist.- Katamal, Babebir, Amera
		Aquamarine - Sambalpur dist.- Charbati, Beldihi
		Bolangir dist -Saraibahal, Sakalimuri
		Subarnapur dist.- Badmal, Mursundi
		Chrysoberyl : Sambalpur dist. -Meghpal (Ranchipada)
		Rayagada dist.- Paikadakalguda, Hata-Muniguda, Karlaghati
		Koraput dist.- Turia
		Kandhamal dist. -Belghar
		Bolangir dist.- Ghumsar, Dehli
		Kalahandi dist.- Sirja, Tandla
		Garnet – Angul dist.- Magarmuhan-Jhili
		Deogarh dist. -Budido, Palsoma, Jharposi
		Subarnapur dist.- Siali, Nakatamunda, Binka, Sonapur
		Boudh dist.- Boudh, Ramgarh, Kantamal, Manamunda
		Kalahandi dist.- Banjipadar, Sargiguda
		Nuapara dist.- Sardhapur, Patialpara, Budhapara, Mantritaria
		Sambalpur dist.- Bagdhopa, Tabloi
4	Reserve/Grade	Not assessed
5	Uses	Ornamental stone, precious & semi-precious stone
6	Mineral based industries in the State	
7	Remarks	