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MINERAL RESOURCES

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MINERAL RESOURCES

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A naturally occurring substance that has a definite chemical composition is a mineral. Minerals are not evenly distributed over space. They are concentrated in a particular area or rock formations. Minerals are formed in different types of geological environments, under varying conditions. They are created by natural processes without any human interference.

Mineral resources range from the soils that support agriculture to metals such as silicon, which is used in high-technology applications such as computers. Though technically not minerals, oil, natural gas, coal, and some other sources of energy are also included as mineral resources because they are extracted from Earth. Mining worldwide produces about $500 billion worth of metallic ore each year; another $700 billion of energy minerals are produced.

Types of Minerals

There are over three thousand different minerals. On the basis of composition, minerals are classified mainly as metallic and non-metallic minerals.

Metallic Minerals: The metallic minerals contain metal in raw form. Metals are hard substances that conduct heat and electricity and have a characteristic luster or shine. Iron ore, bauxite, manganese ore are some examples. Metallic minerals may be ferrous or non-ferrous.

Ferrous Minerals: Ferrous minerals like iron ore, manganese and chromites contain iron. A non ferrous mineral does not contain iron but may contain some other metal such as gold, silver, copper or lead.

Non-Metallic Minerals: The non-metallic minerals do not contain metals. Limestone, mica and gypsum are examples of such minerals. The mineral fuels like coal and petroleum are also non-metallic minerals.

Processes that form mineral deposits

The origin of most ore deposits is related to fundamental geologic processes. These are: (1) igneous processes, (2) metamorphic processes, (3) sedimentary processes, and (4) weathering and groundwater processes.

1. Igneous processes:

Many mineral resources are formed by magmatic processes. Prime examples are the exotic ultramafic volcanic rocks that host diamonds. Diamond crystals were probably ripped from diamond-bearing wall rocks by magma rising through the deep. Laboratory experiments show that diamond is stable at depths of at least 150 to 200 km. At low pressure, the stable form of carbon is the soft mineral graphite, but the reaction of diamond to form graphite proceeds very slowly at the low temperatures found at Earth's surface. Besides its use as a gem, diamonds have found industrial uses as abrasives and as strong coatings. Diamond deposits are limited to regions underlain by Precambrian crust. The richest deposits are found in South Africa and Australia.

Concentrations of other ores result, when minerals forming in magma have different temperatures of crystallization and density. Some ores are formed when molten rock cools to form igneous rock. This process forms building stone such as granite, a variety of gemstones, sulfur ore, and metallic ores, which involve dense chromium or platinum minerals that sink to the bottom of liquid magma.

Further during fractional crystallization, water and elements that do not enter the minerals separated from the magma by crystallization will end up as the last residue of the original magma. This residue is rich in silica and water along with elements like the Rare Earth Elements (many of which are important for making phosphors in color television picture tubes), Lithium, Tantalum, Niobium, Boron, Beryllium, Gold, and Uranium. This residue is often injected into fractures surrounding the igneous intrusion and crystallizes as a rock called a pegmatite that characteristically consists of large crystals.

2. Metamorphic processes:

Metamorphism occurs deep in the earth under very high temperature and pressure and produces several building stones, including marble and slate, as well as some nonmetallic ore, including asbestos, talc, and graphite. Metamorphism changes the texture and mineralogy of rocks and in the process can form important new mineral resources.

Further Hot hydrothermal fluids circulating through the oceanic crust cause seafloor metamorphism. These fluids leach metals (such as manganese, iron, copper, zinc, lead) and sulfur from the crust and transport these elements to hot spring vents on the ocean floor. Minerals precipitate when the hydrothermal fluids mix with seawater and cool. Mounds of sulfide ores collect on the seafloor where the hot waters are released

3. Sedimentary Processes:

Sedimentary processes occur in rivers that concentrate sand and gravel (used in construction), as well as dense gold particles and diamonds that weathered away from bedrock. These gold and diamond ore bodies are called placer deposits. Other sedimentary ore deposits include the deep ocean floor, which contains manganese and cobalt ore deposits and evaporated lakes or seawater, which produce halite and a variety of other salts.

Examples:

- **Evaporite Deposits**-Evaporation of lake water or sea water results in the loss of water and thus concentrates dissolved substances in the remaining water. When the water becomes saturated in such dissolved substance they precipitate from the water. Deposits of halite (table salt), gypsum (used in plaster and wall board), borax (used in soap), and sylvite (potassium chloride, from which potassium is extracted to use in fertilizers) result from this process.
- **Iron Formations-** These deposits are of iron rich chert and a number of other iron bearing minerals that were deposited in basins within continental crust during the Proterozoic (2 billion years or older). They appear to be evaporite type deposits, but if so, the composition of sea water must have been drastically different than it is today.
- **Placer Ore Deposits-** substances are concentrated by flowing surface waters either in streams or along coastlines.

The velocity of flowing water determines whether minerals are carried in suspension or deposited. When the velocity of the water slows, large minerals or minerals with a higher density are deposited. Heavy minerals like gold, diamond, and magnetite of the same size as a low density mineral like quartz will be deposited at a higher velocity than the quartz, thus the heavy minerals will be concentrated in areas where water current velocity is low. Mineral deposits formed in this way are called placer deposits. They occur in any area where current velocity is low, such as in point bar deposits, between ripple marks, behind submerged bars, or in holes on the bottom of a stream.

4. Hydrothermal Ore Deposits

Hydrothermal is the most common ore-forming process. It involves hot, salty water that dissolves metallic elements from a large area and then precipitates ore minerals in a smaller area, commonly along rock fractures and faults. Molten rock commonly provides the heat and the water is from groundwater, the ocean, or the magma itself. The ore minerals usually contain sulfide (S2-) bonded to metals such as copper, lead, zinc, mercury, and silver. Actively forming hydrothermal ore deposits occur at undersea mountain ranges, called oceanic ridges, where new ocean crust is produced. Here, mineral-rich waters up to 350°C sometimes discharge from cracks in the crust and precipitate a variety of metallic sulfide minerals that make the water appear black; they are called black smokers

Hydrothermal deposits are produced when groundwater circulates to depth and heats up either by coming near a hot igneous body at depth or by circulating to great depth along the geothermal gradient. Such hot water can dissolve valuable substances throughout a large volume of rock. As the hot water moves into cooler areas of the crust, the dissolved substances are precipitated from the hot water solution. If the cooling takes place rapidly, such as might occur in open fractures or upon reaching a body of cool surface water, then precipitation will take place over a limited area, resulting in a concentration of the substance attaining a higher

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value than was originally present in the rocks through which the water passed.

5. Residual Ore Deposits

During chemical weathering and original body of rock is greatly reduced in volume by the process of leaching, which removes ions from the original rock. Elements that are not leached form the rock thus occur in higher concentration in the residual rock. The most important ore of Aluminum, bauxite, forms in tropical climates where high temperatures and high water throughput during chemical weathering produces highly leached lateritic soils rich in both iron and aluminum. Most bauxite deposits are relatively young because they form near the surface of the Earth and are easily removed by erosion acting over long periods of time.

Mineral Survey

The important minerals of the world and their major producers along with India's position are surveyed here.

IRON ORE :

One of the most widely distributed elements of the earth's crust, iron rarely occurs in free state.

The finest ore is magnetite with nearly 70 per cent iron content. These ore deposits are in igneous or metamorphic rocks. The banded type is considered to be the most important due to extensive occurrence, easy amenability to benefication by crushing and magnetic separation and agglomeration. Its colour ranges from dark brown to black. Sweden, Russia and Liberia have magnetite deposits. In India, deposits occur in Dharwar and Cuddapah systems in the peninsula, in Karnataka (Kudremukh), Andhra Pradesh, Tamil Nadu and Kerala.

The important iron ore deposits in **Karnataka** include the Kudremukh deposits where the percentage of iron ore varies from 30 to 40. Other deposits in the state are Hariyur, Kunigal, Siddarhali, Shankaraguddu, Ubrani, Maddur-Malvalli, and Sargur in the Archi, Gangamula and Gangrikal hill ranges.

The important deposits in **Tamil Nadu** are at Chettari, Belukkurrichi, Namagiri, Pan-chalais, Sittinglinge, Kanjamalai, Tirthamalai, and Mahadev hills in the Salem district, Kelur, Malnad and Devala and Nilgiri district are also areas with ore deposits. The iron content is anything between 35 and 50 per cent.

In **Andhra Pradesh,** the Chityal, Dasturabad, Kalleda, Rabanpalli and Amberpeta deposits and those south of the coalfields at Singreni have an iron content ranging from 35 to 45 per cent. Only 20 to 28 per cent of iron is found in the Gopalpur, Utla, Tatrariyepalli, Kottagudem and Cheruvapuram deposits.

In **Kerala,** magnetite ore reserves are mostly in the Kozhikode district and in Cherupa, Eliyettimala, Nauminda, Naduvallur and Allampara.

Haemetite with about 65 per cent iron is hard, bumpy, compact and reddish in colour. It occurs in sedimentary rocks in crystalline or powdery forms. The Lake Superior areas in USA, Qebec in Canada, Brazil, Russia, Liberia, China and Spain have the ore.

Haemetite ores contribute to more than three-fourths of India's total production of iron ores. They are found in the Cuddapah and Dharwar systems of the peninsular Deccan. They mostly occur as laminated hematite, micaceous haematite, hematite breecia and haematite quartz schist.

In **Jharkhand and Orissa**, the two important belts are the Gurumahisani - Badampahar belt and the Barajamda group. In the former the iron ore occurs in metamorphosed banded iron formations in Mayurbhanj district in which the iron content is low, i.e., 58 to 60 per cent, and of siliceous nature. The latter covers parts of Singhbhum district in Jharkhand and the adjoining districts of Keonjhar and Sundergarh in Orissa. This group contains the largest ore reserves in the country. The massive ores where the iron content ranges from 66 to 70 per cent occur on top of hill ranges. The shaly ore may be rich or as low as 50 per cent or less in iron. Blue dust ore which is an extremely friable and micaceous haematite powder containing about 68 per cent of iron is formed by leaching process. There also occurs lateritic ore. The important mining centres of Orissa and Jharkhand are Barbil, Gua, Bonai, Joda, Kiriburu, Suleipat, Gorumahisani, Noamundi, Barajamda, etc.

In **Madhya Pradesh and Chattisgarh,** the areas where iron ores are common include the

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Bailadilla, Raughat and Aridongri group in Bastar district; Dalli-Rajhara group in the Durg district; and the deposits in Jabalpur district.

In **Maharashtra** the ore deposits are found in the Chandrapura district. Here the important deposits are located in Lohara, Pipalgaon, Asola, Dewalgaon and Surajgarh. The Chandrapura deposits have iron content between 55 to 60 per cent. Even in Bailadilla and Durg districts, the iron content ranges from 60 to 65 per cent.

Babubudan hills in Chikmaglur district, Sandur, Bellary and Hospet districts as well as Shimoga and Chitradurg districts in **Karnataka** are important producers of iron ores. The canoe-shaped Sandur ranges of the Bellary Hospet area contain large reserves of iron ore. The important deposits of this area are NEB range, Ramandurg, Abbalaguni, Rajpura, Donamalai, Devadri, Kumaraswamy, Kammadheruvid and Belgal. The iron content of the ores in the area is around 64 per cent.

In **Goa,** the deposits are mostly blue dust with 60 per cent of iron. These ores are easily amenable to pelletization, and include both lumpy and fine varieties. In Goa the richer and larger deposits are confined to north Goa (between Adualpale and Usgaon). The important deposits which contain more than 10 million tonnes of reserves are Bicholim-Sirigao deposits, Gudnem-Dignem-Surle deposits, Velgnem-Pale deposits and Arwalem deposits. In Ratnagiri district, the areas where iron ores are mostly prevalent include Vengurla, Guldure and Aroes areas. The percentage of iron content varies from 55 to 58.

In **Andhra Pradesh** the iron ore producing areas are scattered through Anantpur, Khamman, Krishna, Kurnool, Cuddapah and Nellore districts where the main producing centres are Jaggayapeta, Ramallakota, Veldurti, Nayudupetta and Bayyaram. The iron content varies from 55 to 66 per cent.

In Bhilwara district of Rajasthan, the ore deposits are in Moriza and in the Udaipur district, in Nathrakipal. The iron content varies from 55 to 62 per cent.

The other areas where minor deposits of iron ore are prevalent include **Assam, West Bengal, the Himalayan region, Uttar Pradesh, Madhya Pradesh, Punjab, and Jammu and Kashmir.**

Limonite (bog iron) is a brown ore occurring in sedimentary formations. Its iron content is less than 50 per cent and it has many impurities.

It occurs in Alabama, USA. ***Siderite*** is a carbonate of iron and is found near coal fields. It is also a residual ore and has an iron content of 20 to 30 per cent. Deposits of the Jurassic Age are found in Lincolnshire, England, in France and Luxembourg.

These ores are found in India in Garhwal (Uttaranchal) and Mirzapur district (Uttar Pradesh) and the Kangra Valley (Himachal Pradesh).

The total recoverable reserves of iron ore in India are about 10,052 million tonnes of haematite and 3,408 million tonnes of magnetite. The resources of very high grade ore are limited and are restricted in Bailadila sector of Chhattisgarh and to a lesser extent in Bellary-Hospet area of Karnata and Barajamda sector in Jharkhand and Orissa. Indian ore has low sulphur content which never goes above 0.6 per cent.

MANGANESE ORE

In terms of composition of the manganiferrous ores with regard to the proportion of manganese to iron, It is customary to use the term manganese ore for those containing over 40 per cent of manganese. The most common minerals are braunite, pyrolusite, psilomelane and manganite. The ore contains impurities like silica, lime, alumina, magnesia and phosphorus.

Manganese is used as a ferro alloy; it removes gases and acts as a cleanser in the manufacture of steel. Manganese is also used as a decoloriser in glass, and in the manufacture of bleaching powder and electric batteries.

Georgia has huge deposits of maganese ore.

India is the third largest producer of manganese ore in the world. The country's most important ore deposits occur in the form of sedimentary stratified metamorphic deposits in the Dharwar system.

In India, extensive and rich manganese deposits occur in Madhya Pradesh, Orissa, Jharkhand, Andhra Pradesh, Maharashtra and

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Karnataka. Indian manganese deposits display some distinct geological formations, which are:

(a) deposits associated with the khondalite rocks (garnet, sillimanite, gneisses) found in the Srikakulam district of Andhra Pradesh and in the Kalahandi and Koraput districts in Orissa;

(b) deposits associated with the iron ore bearing rocks (schists) found in Karnataka state in the Sandur hills, as the Bisgold-Yellapur deposits in North Kanara, and in the Chitradurg and Shimoga belt, and the Supa-Dandeli area of North Kanara;

(c) deposits associated with limestone and dolomite which occur in the Sausar-Manganese-Marble province of Madhya Pradesh, Jharkhand and Gangpur (Orissa), Ratnagiri in Maharashtra, and Panch Mahal and Vadodara districts of Gujarat, The deposits of the group are generally small and often have high phosphorus as in the case of ores from Srikakulam districts. Manganiferous shales and banded manganiferous rocks with friable layers of quartz are found associated with iron ore group of rocks in Karnataka and Goa - Ratnagiri. In Jharkhand and Orissa the ore is low in phosphorous and high in iron.

The important areas in **Madhya Pradesh** are Balaghat, Chindwara, Jabalpur, and Jhabhua districts. The deposits occur in a westerly direction for about 200 km for a width of 25 km. Braunite, pyrolusite and psilomelane are the important minerals. The ore is hard, lumpy and compact in nature. The manganese content is about 46 per cent. There is high silica content but very low amount of phosphorus. This belt is the major producer of ferro-manganese grade ore in India. In Balaghat, the principal mining areas are Katgaria, Langur, Varwali, Netra, Tirodi, Batjari, Salwa, Jani, Sukali, Mirangpur, Ukwa, Kochawahi and Chikpara. In Chindwara district, the areas are in Godawari and Wardha river valleys at Butkum, Goti, Sitapur, Kachidhana and Machiwana. In Jhabua, deposits occur in Thandala tehsil at Rampura, Mandhi, Tumdia-Bandiwar and Amlaimal. Small deposits occur in Jabalpur, Dewas, Sehore and Nimar districts.

In Maharashtra, the manganese ore is of low grade and is mainly mined in Nagpur district and Bhandara district. In Nagpur district, the manganese ore is mined in Ramdongri, Kodergaon, Gumgaon, Satak, Kandia, Mansar, Lohardongri, Morgaon, Manigaon, Gondadob, Parsoda, Baldongri, Bhandarkhori. In Bhandara district, the main mining areas are Kusumbah, Pachala-Chilka, Bujrum, Asolpem, Sangi Kargi and Sitasaongi. This ore occur in the South Ratnagiri district also.

The deposits are associated with khondalite rocks in Srikakulam district where Kodur Devada, Sonpuram, Maudipilli, Batuva, Garividi, Sivrem and Garbhan are chief centres. Small deposits also occur at Sankarapolem and Kothavalasa in Visakapatnam. Mineral content is about 25 to 30 per cent. Phosphorus is high and iron content is also fairly high.

In **Jharkhand and Orissa,** the deposits are associated with Precambrian iron ore and also with quartzites, garnets and schists. The mineral content varies from 40 to 55 per cent. In Jharkhand, the important producing areas are in Singhbhum, Hazaribagh, Dhanbad, Gaya and Monghyr districts. The important areas in Singhbhum district are Birmitrapur, Kalenda and near Chaibasa, Mirgitnaur, Basadera and Pahadpur and other localities where ore of low grade is mined. In Orissa, the important producers are Bhutura, patmuda, Naktipalli and Jamunkria in Sundergarh district, Nishikhal in Kalahandi district, Baijolla and Kutinga in Koraput district, Jamda, Koira, Bambari, Bhadrasabi and Dhubna in Keonjhar district. Deposits are also found in Dhenkanal, Ganjam, Cuttack and Mayurbhanj districts.

In **Gujarat,** the mineral content is around 45 per cent. Inferior quality of deposits also occur at many places in important producers are in the district of Panchmahal near Jatvad, Shivrajpur, Dohad, Bhat and Bamankua and in Vadodara district near Pani and between Khandi and Unadharia.

In **Karnataka** manganese is raised in Sandur, North Kanara, Tumkur and Shimoga district which are associated with the Dharwar rocks. The phosphorus and silica content is low, but iron is high (5 to 19 per cent) and the mineral content varies from 30 to 50 per cent.

Other areas where minor deposits are prevalent include **Goa and Rajasthan.**

CHROMITE:

Chromite is the only ore mineral of chromium and is an important alloying element in the manufacture of steel. The world's leading producer is South Africa Zimbabwe, Russia and Kazakhstan are other producers.

In India the chromite deposits occur as the following Precambrian formations of peninsular India.

(a) Deposits associated with the Dharwar metamorphic rocks in Karnataka and Maharashtra.

(b) Deposits associated with the metamorphic rocks of iron ore in Bihar, Jharkhand and Orissa.

1. Fracture lineament emplacements in gneissic terrain in Tamil Nadu.

(d) Younger deposits of the Himalayan-Arakan belt.

(e) Deposits of Andhra and those at Bembat and Tashgaon (Ladakh), near Moreah (Manipur), near Kokapu and Vartha in Sabarkanta district (Gujarat) and at Chakargaon (Andamans).

In **Karnataka,** good grade of chromite occurs in Hassan district in an area of 89 sq km. The main chromite bearing belt is the Nuggchalli belt which extends over a distance of 125 km and carries the important deposits of Byrapur, Chikonhalli, Pensamudra, Bhaktarahalli, Jambur and Tagadur. In the Byrapur area, chrome is traced up to 180 m length with a width of 9 m. In Mysore district minor bodies of chromite occur in Kadkola, Talur, Gorur, Dodkanya, Sindhuvalli and Dodkattur areas. In Sindhuvalli area, the mineral content ranges from 48 to 56 pe cent. Chitradurg, Shimoga and Kadur also contain few deposits of chromite. Low grade chromite is also found near Tarikere in Chikmaglur district is also found near Tarikere in Chikmaglur district and near Krishnarajpat and Kabbal in Mandhya district.

In **Maharashtra** chromite occurs around Kankauli and Wagda areas in Ratnagiri district. The mineral content is 31 to 38 per cent. In Bhandara district, it is found around Taka, Balgatta and Pauni with a mineral content of 31 to 38 per cent.

Orissa is considered as the largest chromite deposit in the country. The deposits are mainly located in the Sukinda ultrabasic belt of Cuttack, Dhenkanal district and in the Keonjhar district of the state. The belt extends over a distance of about 20 km and the width of the belt is about 2 km. The ore bodies are venticular in shape and occur as lenses and patches within the laterised ultrabasic rocks. The types of ores found to occur are massive ores, banded ores, disseminated ores, ferruginous lateritic ores, powdery or friable ores, conglomeratic ores and placer ores.

In **Jharkhand** chromite is found is Singhbhum district in the hills of Rorburu, Kiriburu, Kittaburu and Chittangburu around Jojohatu area. The mineral content is 53 per cent on an average.

In **Tamil Nadu,** chromite occurs in Sittampundi in Salem district. Bands of chromite represent a lineament intrustion in the genetic genesis. The mineral content is low it about 21 per cent.

TUNGSTEN:

Tungsten is a heavy metal used in steel alloys, its chief alloys, is chief ore is wolfram. It is found in large amounts in China. USA, Russia, Portugal Australia and South Africa also have the metal.

NICKEL:

The main ore is pentlaudite, a complex mixture of nickel, iron and sulphur. Nickel is also often found in association with copper. It is used for plating purposes as it does not rust. It is also less magnetic than iron, so it can be used in metal parts located near compasses. Canada produces the largest amount of the world's nickel. Russia and Australia have large resources.

COBALT:

A hard blue metal with properties similar to iron, cobalt is used in making cobalt steel and in radio-therapy. More than half of the world production comes from Zaire. Zambia, Morocco, Canada and Finland also produce cobalt.

VANADIUM:

The ores are carnotite, desdoisite, rescoelite and patronite. It helps to remove non-metallic impurities form steel; it is used in paints and dyes. Major producers are South Africa, Russia and USA.

MOLYBDENUM:

Molybdenite and wulfenite are the main ores occurring in quartz veins in granitic rocks. It is used in making alloy steel and in valves, electric lamps, and permanent magnets, among other things. Major producers are USA, Canada, Russia and Chile.

GOLD:

Gold may occur in alluvial or in placer deposits, as in California and Alaska. Or it may occur as reefs or lodes underground, as in South Africa. The greatest producer is South Africa, with major mines in the Witwatersrand, Odendaalrus and Lydenburg. Canada, Japan, the USA, Zimbabwe and Ghana also produce gold.

In India, the vein gold deposits are found in Karnataka, Andhra Pradesh, Assam, Bihar, Madhya Pradesh and Tamil Nadu while alluvial gold is mainly found in Bihar, Assam, Uttar Pradesh, Madhya Pradesh, Kerala, Punjab and Meghalaya.

The Kolar gold field has been the principal source of gold production in India since 1871 when mining first started. It has four productive mines—Nandydroog, Champion Reef, Mysore and Ooregaum. The Champion Reef mine is the deepest mine in the world. The Dharwar schists on which the Kolar gold fields are situated run in a north-south direction for 80 km. However, the quartz veins bearing gold are confined to only a 6-7 km section near Marikuppan. The mineralising solutions responsible for the development of the auriferous veins of South India were probably derived from the magma which gave rise to champion genesses. The Kolar field mined by the Bharat Gold Mines Limited has always had the highest output in India, but it now faces closure.

In the Raichur district, the auriferous veins occur within the schistose rocks of Dharwarian age. There are six auriferous quartz reefs of which the Oakley reef is the main producer. It is worked by Hutti gold Mines Company of Karnataka state. According to the Geological Survey of India, the reserves in both these fields are estimated at about 4.5 million tonnes with a total gold content of about 45,000 kg. In addition ore reserves of about 60,000 tonnes with 8.5 gm per tonne have been indicated in Budini area.

New fields have been found at Kempinkote (Hassan district), Honnali (Shimoga district), Siddarahalli (Chikmaglur district), Bellara (Chitradurg district) and Munglur (Gulbarga district).

In Andhra Pradesh the Ramgiri field of Anantapur district is the main source of gold. Other areas are Chittoor, East Godavari, Kurnool and Warangal districts. In Ramgiri field, the mineralisation extends for 19 km from north to south from Kankapuram to Jibutil.

SILVER:

The ore minerals are stephanite, agentite, proustite and pyrargyrite. Silver is found in the galena ores that may have up to one per cent of this metallic mineral. Mexico is the chief producer of silver; other producers are Russia, Canada, peru and Australia.

In India, the lead-zinc ores of Zawar in Rajasthan yield silver. Silver is derived as a by-product in the Karnataka gold fields. The lead ores in Andhra Pradesh (Guntur, Cuddapah, Kurnool districts), Jharkhand (Santhal Parganas, Singhbhum), Bihar (Bhagalpur), Gujarat (Vadodara district), Karnataka (the district of Bellary), Uttaranchal (Almora district), Karnataka (the district of Bellary), Uttaranchal (Almora district) and Jammu and Kashmir (Baramula district) are also expected to yield some silver.

PLATINUM:

Platinum is a rare metal, which is always found with other rare metals allied to the platinum group such as osmium (the heaviest metal), palladium (of great medical importance), iridium (used in fountain pen nibs) and rhodium (used for plating silver to avoid tarnishing). Canada and South Africa lead in the production of platinum and its allied metals, followed by Russia.

COPPER:

Copper is the most important non-ferrous metal and was the earliest metal used by man. In nature, copper occurs in pure form but mostly as sulphides, oxides and carbonates. To be economically exploitable, copper ores should contain at least 2.5 per cent of copper. The world's largest producers are the USA, Russia, Chile, Zambia, Canada and Zaire.

India is deficient in copper ores and thus depends to a large extent on imports. In India, copper ores occur as sulphides. They occur both in ancient crystalline and younger rock formations including the Cuddapahs, Bijawars and Aravallis.

Copper is mined at the Khetri complex in Rajasthan, in which state important deposits are found in Kho-Dhariba area. Jharkhand (Singhbhum) and Andhra Pradesh (Agnigundala) have some deposits.

In Andhra Pradesh, the important copper belt lies in Agnigundala in the Guntur district. The mineral here is associated with quartzites and dolomites interbanded with phyllites and shales. The principal deposits are around Bondalamottu, Nallankonda and Dhukonda. Copper ore also occurs in Ganikalava, Gumankonda and Somalapilli areas (Kurnool district), Garimanipenta (Nellore district) and Zangamraju Varikunta-Chelima areas.

In Jharkhand, in the Singhbhum district, a copper-bearing belt of about 140 km occurs. Here the copper ore occurs as veins in the country rock consisting of micaschists, quartz schists, chlorite schists, biotite schists, granite and granite gneisses. The veins are best developed along a zone of overthrust where they form well-defined lodes as seen at Rakha mines, Mosabani and Dhobani. Individual lodes normally consist of one or more veins one inch to two feet thick, the average being 5 to 7 inches.

In Rajasthan, the Khetri copper deposit is one of the important copper deposits in the country. This belt has richly mineralised sections. Important deposits are in the Khi-Dhariba area (Alwar district), and the Khetri-Singhana (Jhujhunu district)--specifically at Kolihan and Mandhan, Berkhara mines and Akhwali mines. The copper ore bodies occur in phyllites, states and schists of the Ajabgarh series (Delhi system) as irregular stringers, fillings of schistose planes and fractures and disseminations in the host rock. The mineralisation in Rajasthan copper belt is epigenetic and seems to have occurred under belt is epigenetic and seems to have occurred under mesothermal conditions from post-Delhi (erinpura) granite magma.

Other important copper deposits of the country are in Himachal Pradesh—Kangra-Kulu valley; Mysore—Chittaldrug, Hassan, Bellary districts; West Bengal—Darjeeling, Jalpaiguri districts; Sikkim—Rangpo and Dickchu deposits which are found to occur in association with metamorphic rocks.

TIN:

The main ore of tin is cassiterite or tinstore with about 75 per cent of tin. It occurs in igneous and metamorphic rocks. Nearly 80 per cent of the world's supplies come from alluvial deposits. Malaysia is the world's leading producer and exporter of tin. Other producers are China, Indonesia, Thailand, Nigeria, Zaire, Bolivia and Australia.

LEAD AND ZINC:

The two metals, lead and zinc, rarely occur in native state. They generally occur in combination with other elements. Galena is the chief ore of lead while sphalerite or zinc blende is the chief ore of zinc. These sulphide ore minerals of lead and zinc are formed due to contact metasomatism, replacement by hydrothermal solutions. Galena is found in veins in limestones, calcareous slates and sandstones and occasionally in metamorphic rocks or in association with volcanic rocks, while zinc blende or sphalerite is found in veins in associaiton with galena, chalcopyrites, iron pyrites and other sulphide ores. The chief rock types associated with the sulphide ores of lead and zinc are pyrite, slate, dolomite and quartz.

Major producers of lead are the USA, Russia, Australia, Canada, Peru and Bulgaria. Leading producers of zinc are Canada, Russia, Peru, Australia and the USA.

The most important of the lead-zinc deposits of economic value in India is the Zawar deposit of Udaipur district of Rajasthan. In the Zawar area, the Mochia Magra, Baroi Magra and Zawar-Mala hills contain most extensive deposits. The Zawar mine is located in Mochia Magra hills Lead and zinc occur at these places. Mineralisations of lead and zinc occur at these places. Mineralisations of lead and thin and parallel tabular masses. Galena is generally concentrated in some particular portions of the deposits but the sphalerite is more or less evenly distributed. Lead-copper ore deposits occur in Agnigundala area of Guntur district of Andhra Pradesh. There is a lead-zinc-copper belt in Ambamata Devi area of Gujarat and Rajasthan. The Sargipalli area in the district of Sundergarh (Orissa) has deposits of these metals.

BAUXITE:

The only ore from which aluminium is extracted is called 'bauxite', which is not a mineral but and aggregate chiefly of gibbsite, boehmite and a little of kaolinite. The largest quantities of bauxite are found in the tropical

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and sub-tropical latitudes. Australia, Jamaica and Guinea are the major suppliers. India is fifth in world bauxite resources.

Bauxite is associated with laterite rocks occurring extensively as blankets or cappings either on the plateau or hill ranges of peninsular India or in certain low level laterites in the inland area or in coastal tracts of the country. It is a result of the residual weathering process which leads to leaching of the silica.

In **Jharkhand,** extensive deposits occur in Khuria highlands in Ranchi and Palamau districts. The important deposits are located at Bagrupahar, Seradang, Pabhrapat Jardapahar, Maidanpat and Manduapat. In the Palamau district, the Netrahat plateau is important. Here the important deposits are located at Jamiropat, Ranchonghat, Orsapat and Joradumar.

In **Madhya Pradesh and Chhatisgarh,** there are three important areas: (a) the Amarkantak plateau region comprising Sarguja, Raigarh and Bilaspur districts; (b) the Maikal range of hills in the Bilaspur, Shahdol, Durg Mandla and Balaghat districts; (c) the Katni area of Jabalput district.

In Bilaspur district bauxite deposits are located on Phutka Pahar, Laddhi Pahar, Mahadeo Pahar and several other hilltops. In Shahdol and Mandla districts bauxite is found in Umergaon, Jamuna Dadar, Dadar, Rukti Dadar and Nanku Dadar areas. Bauxite deposits segregated in the laterite cappings are located in Jashpur in Khuria highlands north of Kurki, Kesmanda, Chandra and Rahbon Danwahi.

In **Gujarat,** important deposits occur in laterite cappings in plateau basalts, lying between the Deccan Traps and the Gaj beds for about 48 km between Gulf of Kutch and the Arabian Sea through Bhavnagar, Junagarh districts and around Bhatla, Nandana, Rann, Mewasa, Habardi, Kenedi, Lamba and Virpur. Occurrences have also been reported in Mandvi, Lakhpat, Nakharana and Bhujr, and Anjar talukas of Kutch district.

In **Maharashtra,** some of the deposits are found in plateaus such as Udgiri, Dhangarvadi, Radhanagri and Iderganj in Kolahpur district.

In **Tamil Nadu,** bauxite deposits are found in four areas, namely, Kotagiri and Curzon valley areas and near Ootacamund in the eastern portion of the Nilgiri hills; plateau region of the Palni and Kodaikanal hills in he Madurai district; Shevaroy hills near Yarcand in the Salem district; and in parts of the Kollaimalai hill.

In **Karnataka** the principal deposits occur in the Belgaum district near Sidhpahar, Jamboti and Betul and in the Magalgad plateau, near Kasarsoda range of hills, Kalanandigarh area and the Boknur-Navge ridge.

In **Orissa,** bauxite deposits occur in Panchpatmalli hills in Koraput. Other deposits are Bahlimali Parbat, Kalkahal, Kutrumali, etc. Large deposits are also found in the Eastern Ghat tract in Koraput district. Bauxite reserves have also been discovered in Gandhamardhan plateau of Sambalpur and Bolangir districts.

In **Andhra Pradesh,** bauxite has been discovered in the Anantgiri plateau. There are 12 such blocks in the area. The Gallikonda area in Visakhapatnam district has also shown a reserve.

Other areas of occurrences are in **Jammu and Kashmir and Uttar Pradesh.**

URANIUM:

The main ores are uranite and pitchblende. A Geiger counter, which measures radioactivity, is used to locate deposits. Occurrences of uranium ores are rare and localised. Concentrations are generally low, so that extraction is both difficult and costly.

Canada, the USA and South Africa are major producers.

In India, uranium occurs at Pichli near Abrakipahar in Gaya district (Bihar), near Sunrgai and Dalbhum area of Singhbhum district (Jharkhand). Jaduguda is the only mine worked at present. In Rajasthan, it is found in Bisundi area of Ajmer district and Umra near Udaipur. In Andhra Pradesh it occurs in Nellore district in Sankara mine. In Karnataka it is found at Yedyur near Bangalore. Uranium has also been found at Domiasat.

MICA:

The term 'mica' covers a large group of rock-forming minerals. Natural mica forms hexagonal crystals of varying size. Owing to its excellent dielectric strength, low loss power factor and insulating properties, mica is one of the indispensable minerals used in electrical and electronics industries. The main mica minerals are muscovite, biotite, phlogopite. Mica minerals occur in igneous, sedimentary and metamorphic rocks formed under different geological conditions. While muscovite occurs in pegmatites of acidic nature, phlogopite mica is restricted to basic pegmatite. Commercial biotite is found to occur mostly in biotite schists. India is the most important mica producing country in the world and it supplies 80 per cent of the world requirements of block mica. The occurrence of muscovite mica is associated with the rocks of the Archaean age. It occurs in the Koderma mica belt in Jharkhand, the Nellore mica belt in Andhra Pradesh, and the Rajastan mica belt.

The Koderma mica belt stretches from the Gaya district through Hazaribagh and Monghyr to the Bhagalpur district. In this mica belt, the deposits of mica are associated with the pegmatite veins which traverse through the schistose and gneissose country rocks. The blocks of muscovite which occur within the Bihar mica belt are generally reddish in colour and are therefore known as 'Ruby mica'.

The Nellore mica belt stretches between Gudur and Sangam. The country rocks are Archaean mica schist and hornblende schist which are intruded by pegmatite veins. Here muscovites are light green in colour.

Nearly 20 per cent of the Indian production comes from the Rajasthan belt. Here the mica-bearing pegmatites are intrusive mainly into rocks of the gneissic complex and the Aravalli schists.

In Karnataka the deposits occur mainly in Mysore and Hassan districts, at Tagdur, Vadesamudra, Undavadi and Mundoor. The quality of the mica is poor.

In Tamil Nadu few occurrences that have been re-corded are in Tirunelveli district near Kovilpatti in Coimbatore district (in Vairemanlam, Munampalli, Sevattampalaiyam), in Tiruchirappalli district (in Kurumbapatti, Pallipati Kadavur and Mungilmalai) and also in Madurai and Kanyakumari districts.

Kerala too accounts for mica occurrences in Alleppey district at Maulhupa and Kulanda and in Quilion district around Ranni. The important producers are Punalur and Nayyur.

Other places where mica is found are in Madhya Pradesh, Mimachal Pradesh, Assam and West Bengal.

DIAMOND:

Diamond is not a metal, but a precious stone. Diamonds occur as scattered crystals in an igneous rock called kimberlite which forms pipes, dykes or volcanic plugs deep underground. Diamonds also come from alluvial sources, e.g. in Brazil or Zaire. Zaire is the leading producer (by quantity) but mostly produces bort. Botswana and South Africa are leading gemstone producers. The world's greatest diamond cutting centres are Antwerp, Amsterdam and The Hague.

In India, the main diamond bearing areas are Panna belt in Madhya Pradesh, Raipur in Chhattisgarh, Munimadugu-Banganapalle conglomerate in Kurnool district, Wajrakarur kimberlite pipe in Anantapur district and the gravels of Krishna river basic in Andhra Pradesh.

Reserves have been estimated only in Panna belt and Krishna gravels.

ASBESTOS:

Its main ore is chryoslite. France and Russia are major producers.

SULPHUR:

Gases emitted from volcanoes are highly sulphuruous and sulphur is thus deposited in volcanic regions. It is also obtained from iron pyrites (iron sulphide). Sulphur comes mainly from Poland, the USA and Mexico.

SALT:

Halite or sodium chloride is common salt. It occurs as a sedimentary rock as a result of evaporation of sea-water or lakes in the past. Major producers of rock salt are USA and China.

In India three-fourths of salt production comes from the sea. Mithapur, Chharvada, Jamnagar, Dharsana, Bulsar and other areas in the Gujarat region produce more than half of the country's total salt every year. The salt-producing centres in Maharashtra include Uran, Bhayandar and Bhandup. Salt is also obtained from coastal tracts in Goa; Kerala; Karnataka; Cuddalore, Adrampatnam, Madras and Tuticorin in Tamil Nadu, which produces about 16 per cent of the country's total annual

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production; Pennuguduru and Nanpadu in Andhra; and Kolkata.

In the north-western region, Rajasthan is the main salt-producing state. The Sambhar lake (Jaipur district) is the largest and the most important salt-producing area in India. Areas in the district of Jodhpur (Didwana, Pachbhadra and Phalodi) and Bikaner district (Lonkarasar) also yield salt.

Drang, Guma and other parts of Mandi (Himachal Pradesh) are centres where rock salt is mined.

POTASH:

Main sources of potash are Canada, Germany, USA.

PHOSPHATES:

Phosphates occur as rocks in sedimentary sequences or as phosphatic nodules. Another source is bird droppings or guano. Main sources of phosphate rock is the USA and the main source of guano is the coast of Peru.

KAOLIN:

Kaolin or china clay is a fine clay formed by the alteration of granite by metamorphism. Kaolin is produced for local use in many parts of the world. USA leads in production.

COAL:

A principal mineral fuel, coal is a combustible, solid stratified rock of organic and mineral matter. The organic matter constitutes carbon (60 to 90 per cent), hydrogen (one to 12 per cent) and also small amounts of phosphorus and sulphur. Coal occurs as a sedimentary rock in association with carbonaceous shale, sandstone and even fireclay in a regular succession and in repetitions. Gondwana coal is found as drifted deposits and tertiary coal occurs as in situ deposits.

Coal originates from the accumulation of vegetable matter in swampy areas on broad delta, coastal plains and basin lowlands. The vegetable matter is subjected to geological processes that effect physical and chemical changes. The changes can be seen in the darkening of colour, increase in compactness, hardness and carbon content, and decrease in volatility and moisture. The growth in situ and drift theories explain the origin of coal. The complex process of coal formation involves physical and bacteriological agencies. Favourable climatic conditions for coal formation are mild temperature to sub-tropical climate with well-distributed moderate to heavy rainfall.

Peat is the first stage of coal formation and varies considerably in extent and thickness. It has a high percentage of moisture and volatile matter. Carbon makes up only about one-third of its bulk. Fenno - Scandinavia is the site of the world's main deposits of peat.

Lignite is considered to be the second stage of coal formation after peat. Its moisture content is high (over 35 per cent), as a result of which it gives out much smoke but little heat. It breaks up easily when exposed to air. About 15 per cent of the world's coal output is from lignite.

Bituminous coal is hard, black and compact. It makes up most of the world's total coal output. It varies in composition, in carbon content (from 40 per cent to 80 per cent), and in moisture and volatile content (from 15 per cent to 40 per cent). Generally, steam coal with a fixed carbon content of more than 80 per cent, is the best of bituminous group. The widest domestic use is of coal with a fixed carbon content varying from 50 to 80 per cent. Coking coal is high-grade bituminous coal with a special value because when it is heated in coke ovens it fuses into coke, an important ingredient in iron and steel smelting in blast furnaces. Gas coal with a high content of gaseous and volatile matter is best suited for the production of coal-gas and other chemical products.

The most extensive deposits of bituminous coal occur in the Appalachians and the central continental areas of the USA, the Donbas and Kuzbas regions of the Ukraine and Russia, the Shanxi-Shaanxi and Sichuan coalfields of China.

Anthracite, the hardest variety, ranks highest amongst the coals. It has a carbon content of almost 95 per cent with practically no volatile matter. Only about 5 per cent of the world's coal is anthracite and 50 per cent of this comes from the Pennsylvanian fields of the USA. Russia, Ukraine, Kirghizia, Kazakhstan account for another 25 per cent.

In India, coal belongs to two principal geological periods, i.e., the lower Gondwana coals of Permian age and Tertiary coals of Eocene to Miocene age. The greatest period of coal

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formation in India is the Permian. The important coal bearing formations are collectively known as Damudas and belong to the lower Gondwana system. The series of coal formations are Peat-lignite-bituminous Anthracite. The lower Gondwana coals account for more then 90 per cent of the annual production of coal which is generally of bituminous rank. In Tertiary coalfields lignite predominates.

The Gondwana coals are largely confined to the river valleys like those of the Damodar, Mahanadi, Godavari, etc. Tertiary coals principally occur in Assam, in the Himalayan foothills of Kashmir and in Rajasthan (Palna in Bikaner) in Eocene strata. Besides these, lignite deposits are found to occur in the South Arcot district of Tamil Nadu, in Kutch of Gujarat and also in the state of Kerala. The Neyveli lignite field of Tamil Nadu (which is of the Miocene Age) is the largest lignite deposit in South India.

Coalfields engaged in mining Gondwana coal are to be found in the following states.

In **West Bengal,** the Burdwan, Bankura, Purulia, Birbhum, Darjeeling and Jalpaiguri districts account for large coal deposits. The state accounts for one-fourth of the country's production and an equal proportion of its reserves. The chief and the largest coalfield in India is the Raniganj coalfield.

In **Jharkhand,** there are several promising coalfields in Dhanbad, Hazaribagh, Palamau and Santhal Pargana districts. Of these, Jharia, East and West Bokaro, Giridih, North and South Karanpura, Ramgarh, Auranga, Hutar and Daltonganj are the most important. Jharia coalfield in the Dhanbad district has coals of low volatile coking quality. That is why it has been recognised as the "store house of best metallurgical coals in India." An average analysis of Jharia coal shows moisture content to be 1.38 per cent, volatile matter, 21.5 per cent, fixed carbon, 60.4 per cent and ash, 14.95 per cent.

The Bokara coalfield lies within 32 km of the western end of the Jharia coalfield. It comprises two parts separated by the Bokarao River—East Bokaro and the West Bokaro field. The east Bokaro coalfield coves abut 207 sq km and has 29 seams, while the west Bokaro coalfield covers about 167 sq km and has 23 major seams. The average sample of coal analysis shows moisture, 0-82 per cent; volatile matter, 25.56 per cent; ash, 19.38 per cent; and fixed carbon, 54.24 per cent.

The Giridih or Karharbari coalfield lies to the south-west of Giridih in Hazaribagh district. Its area is 28.5 sq km and there are three main seams of varying thickness—lower Karharbari, upper Karharbari and the Badhua seams. The lower Karharbari provides the finest coking coal.

Karanpura coalfield is separated into north and south Karanpura. The coal seams occur in both the Barakar and Raniganj measures, the seams being about 22 m thick.

The Ramgarh coalfield lies about 9 km of the Bokaro field covering an area of about 98 sq km mostly with Barakar measures. There are 22 seams of which four major seams have an average thickness of 8 m each. The coal is dull in appearance and high in ash content—30.7 to 31.8 per cent.

Auranga, Hutar and Daltonganj coalfields are of minor importance in Palamau district. Auranga extends over 240 sq km with a seam of 13 m thickness. The coal analysis shows moisture, 10.35 per cent; volatile matter, 26.81 per cent; fixed carbon, 26.43 per cent; and ash, 35.81 per cent. Hutar covers an area of 200 sq km with five seams. Daltonganj field contains Talchir seams.

In Sambalpur and Sundargarh districts of Orissa lies the 1B river coalfield where coal occurs in middle and lower Barakar seams of which Rampur, Lajkuria and Gamhaera are important. The Talcher coalfield extends from Talchir to Rairkhol in Dhenkanal and Sambalpur districts.

In Madhya Pradesh, coal is generally found associated with Barakar measures. The important fields are Tatapani-Ramkola with five main seams of inferior quality coal; Jhimilli with five main seams of moderate coking type coal; Pench valley with four main seams of high volatile non-coking coal; Karhan valley with a seam of high volatile coking coal. The Korba field with several seams is in Chhattisgarh.

Important coal deposits in Maharashtra are in Nagpur district at Kamptee; Chandrapur district in Wardha valley, Warora and Ghugus; and at Ballarpur in Yavatmal district. The Wardha coalfield alone contains a little over 2000 million tonnes.

Warangal Khammamet, East Godavari and West Godavari districts are the main coal-bearing areas in Andhra Pradesh.

Of the Tertiary variety, Makum coalfield in Assam is the most profitable and workable region. Workable seams are exposed along the northern flank of the Naga-Patkoi ranges facing Sibsagar (at Nazira) and Lakhimpur district (at Jeypore). Other fields are Dolgrung and Nambor. Assam coal has very low ash and high coking qualities but the sulphur content is high and therefore it is unsuitable for metallurgical purposes.

In the closely associated Balyong, Doigring and Waimong fields of Meghalaya, coal seams are high. In Balphakram-Pendeng area eight seams have been recorded in the Chatmang and Balphakram hills with a reserve of 32 million tonnes of good quality coal.

The upper Assam belt extends into the Namchick-Namphuk coalfields of Tirap district of Arunachal Pradesh. In this coalfield, coal is generally high in volatility and in sulphur content. The Jhanzi-Disai coal belt and Barjan coalfield of Nagaland and Dilli-Jaipur of upper Assam also belong to the same belt.

India at present is the fifth largest producer of coal in the world. Coal is also India's largest mineral resource.

PETROLEUM:

The word 'petroleum' has been derived from the world 'petra', which means rock, and 'oleum' which means oil. Thus 'petroleum' means 'rock, and 'oleum' which means oil. Thus 'petroleum' means rock, and 'oleum' which means oil. Thus 'petroleum' means 'rock-oil'. It is one of the important mineral fuels and is a complex mixture of hydrocarbon compounds with minor amounts of impurities like nitrogen, sulphur and oxygen. The liquid petroleum is called crude oil, petroleum gas is called natural gas and the semi-solid to solid forms of petroleum are known as asphalt, tar, pitch, bitumen, etc.

For petroleum to accumulate in commercial quantities in an area, the oil must originate in a source bed. A marine shale, once a black mud rich in organic compound, is thought to be a common source rock. The oil then migrates to permeable reservoir rocks after travelling for long distances both vertically and horizontally. Te source beds tend to lack the permeability necessary for profitable extraction of the oil. A non-permeable layer must occur above the reservoir bed. A non-permeable layer must occur above the reservoir bed. A non-permeable layer must occur above the servoir bed. A favourable structure must exist.

Three principal grades of crude oil are considered important, ***Paraffin-Base Oil*** with a high percentage of the lighter hydrocarbons such as methane gives products, such as petrol, paraffin and high grade lubricating oils which are commercially more valued. ***Asphalt-Base Oil*** consists mainly of the heavier hydrocarbons with a viscous, asphaltic base. ***Mixed-Based Oil*** is an intermediate group with mixed properties of the lighter and heavier oils. It has use in lubricants and fuel oils.

Over 75 per cent of the world's supply of crude oil comes from three major areas: North America, the West Asian states, Russia and Azerbaijan.

Saudi Arabia has the largest reserves followed by Iraq and the United Arab Emirates. Saudi Arabia is the leading producer followed by the Commonwealth of Independent States and USA.

India's most important oil-bearing area in the eastern part of the Himalayas is Assam. The oil-bearing belt runs from extreme north-east of Assam to the eastern border of the Brahmaputra and Surma valley. The existence of oil in the hills of upper Assam was known as early as 1825, but drilling of oil started only in 1866 following the recommendations of the Geological Survey of India (GSI) in 1865. During 1866-68 several shallow wells were drilled near Makum by Mckellop Stewart and Company. It was the discovery of the Digboi oilfields, however, which marks a landmark in the development of India's sources of oil.

In India, the Digboi oilfield, situated in Lakhimpur district of upper Assam, it is the biggest oilfield in India. Digboi area raises about 4 lakh tonnes of crude annually. Tipam sandstone of Miopliocene age is the oil bearing formation.

Naharkatiya oilfield is situated 32 km away from Digboi. This field was discovered in 1955 by Assam Oil Company. Its reserve is estimated to be about 5 million tonnes. Naharkatiya is the second largest oilfield in India. The oil bearing formation is the Barail series of Oligocene age. Moran, about 40 km south-west of Digboi, Bappapung, Hausanpung, Hugirijang also have oilfields. The search for oil in the Surma valley (Cachar district) dates back to 1910. In 1910 the Badarpur Oil Company was formed to work the Badarpur oilfield. In Surma valley, some oil of poor quality is found in Badarpur, Masimpur and Patharia. In 1961 oil was discovered at Rudrasgar near Nunmati.

In Gujarat, the Cambay basin is the site of the main oil bearing sands of Oligocene age. Here a majority of the wells are only gas-producing. The other oilfields of importance are Kalol oilfield, Nawagam and Sanand oilfield.

The Ankaleshwar oilfield is the most important oilfield discovered so far in Gujarat. The producing sands are of Eocene age. This field was discovered in 1961.

In Maharashtra, about 184 km off Mumbai in the Arabian Sea, a huge oil deposit, known as Bombay High, was struck (in 1974) in limestone rocks of Miocene age. Bombay High (Ratnagiri district) is the most productive oilfield and has a reserve of 5 crore tonnes of oil. It has an area of 2 thousand sq km. While the output of conventional oilfields has increased only marginally over the past 14 years, Bombay High has accounted for the bulk of the higher production. During 1978-79, the work on the laying of sub-sect pipeline from Bombay High to Uran and transfer line from Uran to Trombay was completed. Since 1978, oil and gas have started to flow through these pipelines.

In the south, the Cauvery, the Krishna and the Godavari basins have oil reserves.

A number of potential oil bearing fields have been discovered in the states of Tripura, Punjab, Nagaland, Gujarat, West Bengal, and Jammu and Kashmir.

NATURAL GAS:

Most of the natural gas is found in association with crude oil. It is obtained as a by-product from petroleum refineries. The gasfield at Cambay (Gujarat) as the only non-associated source of natural gas. The Ankleshwar gasfield, Bombay High—a comparatively new source, and Morah and Naharkatiya gasfields in Assam are among the main sources. It is available as seepages in Nom-Chick, Miao Punga and Laptang Pung in Arunachal Pradesh, areas of the Baramura range in Tripura, and Jwalamukhi and Kangra in Himachal Pradesh. Natural gas as also been discovered in Punjab (Ferozepur district), West Bengal (Midnapore district), Jammu and Kashmir (in parts of Mausar-Maradpur) and Tamil Nadu (Thanjavur and Chinglepet districts).

Some Other Minerals of India:

Dolomite:

Dolomite is a double carbonate of magnesium and calcium found in Bihar and Jharkhand (Singhbhum and Shahabad districts); Tamil Nadu (Trinelveli, Salem districts and in coastal areas near Tuticorin); Orissa (Birmatrapur, Bildih, Khatepur and Hathibri in Sundargarh district, Sulai and other areas in Sambalpur district and Koraput district); Chhattisgarh Kodwa-Mohbatta in Durg district and Hirri, Chatane, Dhurarbhatta, Baraduar and Atta in Bilaspupr); some hills in Himachal Pradesh; and Vadodara and Bhavnagar districts in Gujarat.

Steatite:

Steatite (also sandstone or talc), a hydrous silicate of magnesium, is found in association with dolomitic lime-stone and basic igneous rock material. Rajasthan has the largest steatite reserves.

Bhilwara, Jaipur and Udaipur districts yield more than four-fifths of the state's total production. Other districts living steatite reserves are Alwar, Sawai Madhopur and Dungarpur.

The steatite reserves in Andhra Pradesh are associated with metamorphosed magnesium limestone. They are found in the districts of Kurnool, Cuddapah, Anantapur, Chittoor.

In Jharkhand, steatite is found in the districts of Singhbum, Hazaribagh, Dhanbad and Ranchi.

Other states possessing reserves of steatite are: Madhya Pradesh (mainly Jabalpur and Jhabua districts); Karnataka Bellary, Shimoga, Hassan, Bijapur, Tumkur, Mysore and South Kanara districts); Orissa (near Tiring, Kendumundi and Kharidamak in Mayurbhanj district, Balasore district, and Sundargarh and Cuttack districts); Tamil Nadu (Saleum, Combatore, North and South Arcot, and Tiruchirapalli districts); Gujarat (at Vartha, Bhanta and Thuravas); Maharashtra (parts of Ratnagiri, Bhandara and Chandrapur districts);

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West Bengal (purulia, Darjeeling and Midnapur districts).

Limestone:

The sedimentary despoits of limestone occur with rocks constituting calcium carbonate or double carbonate of magnesium and calcium, or both. Phosphorous, sulphur, alumina and silica may also be found.

In Madhya Pradesh and Chhattisgarh, limestone deposits are found in Katni and Jukehi-Keymore in the district of Jabalpur, Alaktara in Bilaspur district, and in Raipur, Rajgarh, Bastar, Durg, Betul and Sagar districts. Deposits of cement and flux grade are found in the district of Rewa. Damoh district has deposits of blast furnace grade.

In Andhra Pradesh the districts of Guntur, Krishna, Cuddapah, Khammam, Kurnool, Nalgonda and Godavari possess some of the major deposits.

In Tamil Nadu, important reserves of mainly cement grade limestone are found in Tiruchirapalli, Coimbatore, Madurai, and Ramnathapuram districts. Salem district has flux grade deposits as well. Lime can be obtained from the limestone reserves in Tirunelveli, South Arcot and Thanjavur.

In Karnataka flux grade limestone deposits are dispersed in the districts of Shimga, Belgaum and Bijapur. Mysore, Gulbarga, Tumkur and chitradurg districts have also some deposits.

In Orissa important deposits of mainly flux grade limestone occur at Hathbari, Birmitrapur, Amghat, Pagposh, Purnapani and Katopuryheria in Sundargarh district. Areas of Kalahandi and Sambalpur districts also yield limestone.

In Gujarat the districts of Junagarh (near Dari, Veraval, Patan, Grokhundi, Savni and Sutrapara), Banaskanta (near Pasuval, Khunia and Diwania), Sabarkanta (near Posina), and Khera (near Balasinar) have high grade limestone reserves. Much of this limestone can be used for manufacturing cement.

In Rajasthan, cement grade limestone occurs in Jaipur, Ajmer, Sawai Madhopur, Pali, Jodhpur, Jhunjhunu, Sirohi, Bundi and Banswara districts.

The Khasi and Jaintia hills in Meghalaya, Nowgong and Sibsagar districts in Assam, Shahabad, Palamau, Ranchi, Hazaribagh and Singhbhum districts in Bihar, Ahmednagar, Yavatmal, Chandrapur and Nanded districts in Maharastra are other important areas bearing limestone deposits.

Magnesite:

It is an important ore mineral of magnesium. It is a refractory mineral. About two-thirds of India's total magnesite reserves are located in Salem district of Tamil Nadu and over a quarter in Almora district of Uttaranchal. Karnataka, Bihar and Rajasthan have small reserves.

The principal magnesite deposits in Tamil Nadu are found in the chalk hills area in Salem district. The deposits occur in regular veins in intrusive ultrabasic rocks. In Almora district of Uttaranchal good quality magnesite occurs in narrow bands of variable thickness in massive dolomite between Someshwar and Bageshwar near Agar, Chahana, Dewaldhar and Nail. Occurrences of magnesite have also been reported from Jhiroli, Pagankhol, Ariapani, Bhurgaon, Changdog, Boragar, Gahar Rithait, Satislang, Phadiari Jakhera, Tachhiri, Tanga Durai, Salia, Rafalkhet and Chamagaon, all situated in Chamoli district.

Kyanite :

It is a member of the aluminium-silicate group of minerals which includes andalusite, sillimanie and kyanite—all refractory minerals. They are all metamorphic minerals. India has the richest deposits of kyanite in the world. Important deposits of kyanite occur in the Singhbhum district of Jharkhand along a belt 80 miles in length, stretching east along the western part of Seraikela through parts of northern Singhbhum and Kharasawan and into Dhalbhum. The Lapsa Buru kyanite deposits, the largest kyanite deposits in the world, are situated in this belt.

In Maharashtra large deposits occur in Bhandara district in Pipalgaon-Dahegaon-Padri area where the estimated reserves are about 100 million tonnes.

In Karnataka it occurs in Hassan, Mysore and Chitradurg districts. TIF important producers are Kudinirkatte, Dodderi, Kamasa-Mudram, Melkoppa and Kadmane localities, etc.

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Some pockets of kyanite also occur in Ajmer, Bhilwara, Dungarpura and Banswara districts of Rajasthan, in Darjeeling and Purulia districts (West Bengal), Mahasu district (Himachal Pradesh), Coimbatore district (Tamil Nadu) and Mahendragarh district (Haryana).

Graphite:

Graphite (also black lead or plumbago) is composed of mainly carbon. It has impurities—silica and silicates—as well. It occurs along with metamorphic rocks which abound in garnets and sillimanite. Andhra Pradesh, Orissa and Bihar have good deposits.

In Andhra Pradesh deposits around Peddanakonda have a fixed carbon content of 40 to 65 per cent. Important areas include east Godavari and west Godavari districts (areas like Rampa Chodavaram, Reddi Bodiar and Haripuram), Krishna district, Khamamet district, Visakhapatnam, Guntur, Buderu and Srikakulam.

In Orissa, graphite deposits of 55-60 per cent carbon occur at Babupali, Dengsurgi, Biliangora, Bughmunda, Komna and other parts of Kalahandi district; Titilagarh, Darpagarh, Munbahal, Belagaon, Patnagarh and other areas of Bolangir district; near Sargipalli, Padampur and Rampur in Sambalpur district; Majikelam arugali, Karrigudda and other parts of Koraput; and in Phulbani district.

In Jharkhand, deposits with a carbon content of about 50 per cent occur around Rajhara and Khandih.

In Tamil Nadu, graphite reserves are located in Tirunelveli district, Madurai district, Arumanallur, Todagamalai and Kandawawamipuram in Kanyakumari district and near Poovandi, Arsanur and Kirnur in Ramanathapuram.

In Karnataka, deposits occur in Chikbanavur, Arsikere and Holavanballi areas and in the Kolar belt in Bangarpet.

Gypsum:

It is a hydrated calcium sulphate which is usually found in beds or banks in the sedimentary rocks such as limestones, sandstones and shales.

The most important sources of gypsum are located in the state of Rajasthan and are confined to the Tertiary rock formations in the Jodhpur region. Beds of gypsum half-to-two metres thick occur at several places around the great Indian desert of Rajasthan, particularly in the districts of Bikaner, Jodhpur, Barmar, Churu, Nagaur, Pali, Jaisalmer and Shri Ganganagar.

Important deposits of gypsum are found in Tamil Nadu in Coimbatore near Annuppapatti, Andiyur, Venkatapuram, Pusaripatti, etc., where the percentage grade is 88 to 92 per cent. In Tiruchirapalli district, gypsum occurs as thin irregular veins in the clays and limestones of the Uttatur and Trichinopoly stages of the Createaceous system.

In Uttaranchal, gypsum occurs in several localities as at Lachmanijhula, around Kharari Chatti, Sera Narendranagar and Gughthani in Garhwal district and near Dhapila, Bhatta, Khalagaon, Sahashradhara, Nainital posits have been reported near Gonti and Parsua in Jhansi district of Uttar Pradesh and near Purune in Hamirpur district of Himachal Pradesh.

In the district of Barmula and Doda of Jammu and Kashmir, rich deposits occur as lenticular bands in the Precambrian Salakhal schists or with nummulitic lime stones of Eocene age.

In Himachal Pradesh, deposits associated with known limestone and dolomite and also with the Subathu series have been reported from Chamba, Mahasu and Sirmur districts.

In Gujarat, gypsum occurs in the Saurashtra area especially in Halar and districts of Bhavanagar, Gohilwad, Jamnagar, Jungadh and Kutch covering an area of 518sq km. Important occurrences are in Jamnagar district at Rana Virpur and Bhatis.

Thorium:

Thorium minerals consists of thorianite(38-8) per cent of thorium), allanite (3 per cent of thorium) and monazite (up to 18 per cent of thorium).

In India thorium minerals are found mostly in Tamil Nadu, Andhra Pradesh, Jharkhand, Rajasthan, Orissa and Kerala.

India possesses the greatest reserves of monazite known in the world. The monazite reserves of Kerala have been estimated at 2.5 million tonnes from which 1.5 lakh tonnes of thorium are available.

Beryllium: Beryllium is obtained from beryl, which is found in association with felspar and mica in pegmatities. It occurs in Rajasthan, Andhra Pradesh, Karnataka, Sikkim and Kashmir. Beryllium is very useful as a moderator in atomic reactors.

Norms Related To Trade in Mineral

To the extent that mineral resources may be traded is covered by the obligations contained in the WTO agreements relating to trade in goods. WTO rules generally do not regulate natural resources before they are extracted or harvested.

WTO rules related to Mineral trade:

- Article I of the GATT sets out the most-favoured-nation principle, one of the fundamental obligations of the multilateral trading system. This provision prohibits a WTO member from treating the products originating in or destined for another member less favourably than the "like" products originating in or destined for any other country (including non-WTO members). Thus, WTO member A cannot subject imports of coal from WTO member B to a higher tariff than imports of coal from WTO member C. Export taxes and other export regulations are also subject to the obligations in Article I, even if such measures are not prohibited under Article XI. This means that WTO member A cannot subject its exports to WTO member B to a higher export tax than it applies to exports to WTO member C.
- Article II of the GATT 1994 prohibits WTO members from applying "ordinary customs duties" on the importation of a product that are higher than the rate specified in their schedules of commitments. Through successive rounds of trade negotiations, the number of products subject to tariff bindings has increased and the levels at which tariffs are bound have been progressively brought down. Members are also prohibited from applying any other duties or charges on the importation of a product, unless specified in the schedule of commitments.
- Article XI of the GATT 1994 provides that no prohibitions or restrictions, other than duties, taxes or other charges, shall be applied by any WTO member on the importation of any product or on the exportation or sale for export of any product. This provision covers quotas and other similar measures that establish quantitative limitations on imports or exports.
- Article XIII of the GATT states that no prohibition or restriction shall be applied by any WTO member on the importation of any product of the territory of any other member or on the exportation of any product destined for the territory of any other member, unless the importation of the like product of all third countries or the exportation of the like product to all third countries is similarly prohibited or restricted.
- In some circumstances, subsidies can exacerbate the over-exploitation of scarce natural resources. The WTO includes important disciplines on the use of subsidies by WTO members. Subsidies to non-agricultural goods are regulated under the SCM Agreement. The SCM Agreement defines a "subsidy" as a financial contribution by a government or any public body within the territory of a member that confers a benefit. A financial contribution is deemed to exist where (i) a government practice involves a direct transfer of funds; (ii) government revenue that is otherwise due is foregone; (iii) a government provides goods or services other than general infrastructure; or (iv) a government entrusts or directs a private body to carry out one or more of the types of functions listed in (i) to (iii). A WTO member that is affected by subsidies granted by another member can challenge those subsidies in the WTO dispute settlement mechanism. Alternatively, the affected member can apply countervailing duties to the subsidized imports if it shows that they cause or threaten to cause injury to its domestic industry.

Trade in natural resources can support economic development, as it enables resource-rich countries to export resources and raise revenues. If done to high environmental and social standards, trade can thereby contribute to sustainable development of poor countries. But the current trade system reinforces unequal levels of resource consumption by shifting resources from poorer low consuming countries to richer, high consuming countries.

Industrialised countries in Europe and North America, but also in Asia, largely export manufactured products with a high value added. Many developing countries, on the other hand, continue to rely strongly on the export of raw materials such as agricultural products, minerals and fossil fuels. Exporting manufactured products usually generates higher profits compared to export of commodities. Furthermore, environmental pressures related to extraction and processing of resources are high

One of the major challenges that are crucial in the context of relatively backward economies is that the macroeconomic policies of these countries are not always proportionate to utilize the gains from world trade. International trade can be beneficial if the gains derived from it can be distributed evenly across the different layers of the society. Here lies the importance of "trickle-down" effect.

Domestic trade involves exchange of factors of production at the regional level; whereas international trade ensures greater mobility of latest technology and goods and services across the nations. World trade helps the developing countries to have ready access to the modern techniques of production. However, the challenge here is to use these techniques in an efficient manner. The industrial setup and social infrastructure need to be developed as per the global standard to optimize the benefits from international trade.

There are instances of African nations, which have failed to utilize the gains from trade due to inappropriate macroeconomic setups. Before opening up the economy, the backward nations need to safeguard the interests of the domestic entrepreneurs. The liberalization policies need to be taken up gradually so as to help the infant industries face the challenges of the changing economic scenario.

So the challenges before international trade may arise from different fronts. The countries involved in world trade need to adopt proportionate policy measures to make use of the gains from trade for the overall development of their economies.

Case study: India launches WTO case against U.S. steel duties

Countries impose countervailing duties - punitively high import tariffs - when they suspect another country of gaining an unfair trade advantage through subsidies. The United States Commerce Department has set a preliminary import duty of nearly 286 percent on a circular welded carbon-quality steel pipe from India to offset government subsidies. India had "requested consultations" with the United States over U.S. countervailing duties.

India claimed that Washington had imposed the countervailing duty because a portion of the iron ore used to produce the pipes came from India's top iron ore miner NMDC (NMDC.NS), a state-run firm that supplies steelmakers such as Tata (TISC.NS), Jindal (JNSP.NS) and Essar. But the U.S. argument was that "because NMDC is a public sector undertaking and therefore implicitly subsidising a private-sector enterprise. However to counter it, Indian side replied that Indian iron ore prices were determined by the domestic market so, there is no subsidy.

Last October the United States sent the WTO a list of 50 Indian government measures that it said amounted to unfair subsidies that had not been notified, as required by the WTO, and threatened to slap duties on them if India did not notify them promptly. Included on the list were loans from India's Steel Development Fund (SDF), with the 2010-2011 annual report of the Indian Ministry of Steel cited as evidence. The ministry's report said the SDF was providing financial assistance for research and development and 64 projects had been approved in 2010, at a cost of 4.42 billion Indian rupees, including 2.78 billion rupees from the fund. The SDF had already paid out 1.39 billion rupees.

US files dispute against India on solar panel products

The United States, on February 6, 2013, notified the WTO Secretariat of a request for consultations with India on certain measures of India relating to domestic content requirements under the Jawaharlal Nehru National Solar Mission (NSM) for solar cells and solar modules. The United States claims that India requires solar power developers to buy and use domestic solar cells and solar modules in order to benefit from participating in the Jawaharlal Nehru NSM programme and to enter into contracts under the NSM programme or with the National Power Company. According to the United States, the benefits for solar power developers, contingent on their purchase and use of domestic solar cells

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and solar modules, would include subsidies through guaranteed, long-term electricity rates. The request for consultations formally initiates a dispute in the WTO. Consultations give the parties an opportunity to discuss the matter and to find a satisfactory solution without proceeding further with litigation. After 60 days, if consultations have failed to resolve the dispute, the complainant may request adjudication by a panel.

Issue of overconsumption of resources

The amount of natural resources extracted for the production of goods and services is steadily increasing. Almost half of global resource extraction takes place in Asia, followed by North America with almost 20% and Europe and Latin America with 13% each. However, large variations exist in natural resources extraction per capita: on average, an inhabitant of Australia extracts around 10 times more resources than inhabitants of Asia or Africa. Increasing resource extraction leads to growing environmental and social problems, often worst in poor countries in Africa, Latin America and Asia. In 1980, the world economy extracted almost 40 billion tonnes. Up to 2005, this number grew to 58 billion tonnes, an increase of almost 50%.

Resource extraction has increased in all major categories: biomass, fossil fuels, metal ores and industrial and construction minerals. Between 1980 and 2005, the extraction of gas, sand and gravel almost doubled, and nickel ore extraction tripled. For some of the biotic resources, such as fish, the signs of overuse can already be observed – catch rates have been declining over the past 10 years.

The extraction and processing of natural resources is often very intensive in the use of materials, energy, water and land. These activities therefore often entail environmental problems, such as the destruction of fertile land, water shortages or toxic pollution. Social problems are also often linked to extraction activities, including human rights violations, poor working conditions and low wages.

Case study on oil extraction in Nigeria

Shell has been operating in Nigeria's Niger delta since the 1930s. Nigeria is now a democracy, but has a long and brutal history of military dictatorships. The Niger delta was once considered the breadbasket of Nigeria because of its rich ecosystems, a place where people cultivated fertile farmlands and benefitted from abundant fisheries. In the southern part of the delta lies Ogoniland, where half a million Ogoni people live.

Nigeria is the largest oil producer in africa and 11thlargest in the world. In 2004, 17% of all Nigerian oilexports - more than two million tonnes - went to the European Union. Crude oil production in 2004 was 2.5 million barrels per day, of which an average of one million barrels per day were produced by shell, making shell by far the biggest oil company in Nigeria. The country has significant oil reserves and even greater gas reserves. However, most Nigerians have not benefited from these resources and Nigeria is now one of the poorest countries in the world.

Shell operates in Nigeria through the shell petroleum development company, a joint venture between shell and the Nigerian government. SPDC has more than 90 oil and gas fields spread over some 30,000 square kilometres of oil mining leases in the Niger delta. It is a massive operation involving a network of more than 6,000 kilometres of flow lines and pipelines, seven gas plants, 86 flow stations and other facilities. Shell and other oil companies have transformed the Niger delta into a virtual wasteland, bearing deep scars from gas flaring and oil spills. The population in the Niger delta suffers from multiple health problems and the land is heavily polluted. Gas flaring has severe health consequences. Many scientific studies have linked breathing particulate matter to a series of significant health problems, including aggravated asthma, increases in respiratory symptoms like coughing and difficult or painful breathing, chronic bronchitis, decreased lung function, and premature death. This is due to the fact that flaring emits a cocktail of toxic substances (including sulphur dioxide, nitrogen dioxides), carcinogenic substances (such as benz[a]pyreneand dioxin) and unburned fuel components (including benzene, toluene, xylene and hydrogen sulphide).

One example of the environmental consequences of gas flaring in the Niger delta is acid rain. Delta residents have long complained that their roofs have been corroded by the composition of the rain that falls as a result of the flaring. The primary causes of acid rain are emissions of sulphur dioxide (sO2) and nitrogen oxides (nOx), which combine with atmospheric moisture to form sulphuric acid and nitric acid, respectively. Acid rain acidifies lakes and streams and damages vegetation. In addition, acid rain accelerates the decay of building materials and paints. According to the World Bank, emissions during flaring are the major source of greenhouse gases in Sub-Saharan Africa.

In November 2005, the federal high court of Nigeria ordered shell to immediately stop flaring gas, in iwherekan community, delta state. The court found gas flaring to be a 'gross violation' of the rights to life and dignity. Nevertheless, shell continues the flaring.

There have been major human rights abuses as well. On June 8 2009, shell was forced to pay us$15.5 million to settle an embarrassing lawsuit in the US for human rights abuses in Nigeria. The company is also facing legal action in The Hague concerning repeated oil spills which have damaged the livelihoods of Nigerian fisher folk and farmers.

Issue of denial of property rights to local people

Tribals have paid the highest price of national development because their regions are resource rich: 90 percent of all coal and around 50 percent of the remaining minerals are in their regions. Also the forest, water and other sources abound in their habitat. But lakhs of tribals have been displaced from 1990 onwards (due to the so-called economic liberalization policies of the Center under pressure from the Westernlenders) without proper rehabilitation.

International conventions adopted by the United Nations as well as the International Labour Organisation have recognized the rights of tribal communities on land and surface and sub-surface resources. Many countries including Canada, Brazil, South Africa and Australia have been forced to at least acknowledge in different ways the rights of indigenous communities on mineral wealth in their respective countries.

But in India, where an overwhelming majority of mines are located in adivasi areas, the tribals have not only been denied these rights but have been driven out of their lands through forcible acquisition or denied access. The spirit of the Samatha judgement of the Supreme Court to recognize tribal ownership rights has been ignored. The legal requirement under PESAA (Panchayat Extension to Scheduled Areas Act 1996) and the Forest Rights Act for consent of the Gram Sabha is blatantly violated. On the contrary even where the gram Sabha has opposed a particular project, the land is forcibly acquired as for example in the bauxite rich tribal areas in Vishakhapatnam district in Andhra Pradesh and Kalahandi in Orissa.

Further the Central Government while granting mining leases has fixed extremely low royalty rates. The mining companies have made huge profits. For example the Central Government has recently fixed the royalty for iron ore at just 10 per cent of the value of the mined iron ore after supposedly discussing with the so-called stakeholders, namely the big mining companies. Royalty is equally low for other major minerals.

In the face of growing resistance by tribal communities, the Central Government is proposing an amendment to the Mines and Minerals (Development and Regulation Act) 2011, to make it mandatory for companies to give funds for tribal development in districts where they have mining leases. The funds are to be put in a District Mineral Foundation Fund which will be under the control of the administration. Coal companies are to give 26 per cent of their profits to the Fund.

The International Labour Organisation (ILO)- funded report on India's indigenous population also claims that more than half the country's mineral wealth is obtained by violating the rights of tribals. The report states that minerals found in adivasi or tribal areas reportedly contribute to more than half of the national mining production. Yet, mining policies in India have overlooked the existence of adivasi communities and the constitutional provision for the protection of their land and resources.

"There is no mention of adivasis ' rights or protection in any of the procedures. Though a disaggregated data on the number of mines operating in the country or the number of people displaced by such projects does not officially exist as the information is deemed to be " politically sensitive," the report estimates that an overwhelming majority of mines are located in the adivasi areas. In 1991, out of the 4,175 mines in the country, 3,500 were in tribal areas. Another estimate states that between 1950 and

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1991 at least 2,600,000 people were displaced by mining projects of which only 25 per cent received any resettlement. Among those displaced 52 per cent belonged to the Scheduled Tribes, the report notes. In the case of private lands, proceedings under the Land Acquisition Act 1894 are initiated in order to acquire the land. The legislation also allows the government to acquire lands upon payment of cash compensation for any public purpose, including mining. The report is also stridently critical of Jharkhand. The new state, instead of enforcing constitutional and protective rights of the indigenous communities and restoring their alienated lands and resources, has signed over 100 memorandums of understanding with the private industry.

Further the economic liberalization, privatization and globalization (LPG) model of development in India is virtually depriving the tribal people and other agriculture dependent poor people of their traditional means of sustainable livelihood by promoting the unregulated growth of mineral-based industries in the tribal regions of India. In the name of modernization and the country's economic development, the elites in India are taking over the life sustaining resources of the poor and pushing them into a further marginalized state of living as a result of displacing them from their land and homes. Such development serves the interests of these elites while it impoverishes the tribal people and poor peasants in these regions who are dependent on the life sustaining resources of the ecosystems in which they live. The mining and other industries that are taking over the resources of the ecosystems of these tribal people and poor peasants fail to provide them with an improved and sustainable means of making a living. The very nature of the present development paradigm does not provide for the absorption of these poor people into the organized non-farm sector economy.

Case Study of Impact of Development Project on Displaced Tribals in Orissa

Orissa's coal deposits are mostly concentrated in two regions - Talcher Belt in Angul District and the lb Valley Area in Jharsuguda District and in the State and mining is carried out by the Mahanadi Coal Fields Limited (MCL), a subsidiary of Coal India Limited (CIL). The lb Valley Project has affected 19 villages involving a total number of 1306 families. A total of 90 families were displaced (homestead oustees), who were resettled in Madhuban Nagar. Of them 52 belonged to Scheduled Tribes, 2 to Scheduled Castes and 36 belonged to other castes.

On the basis of the empirical study conducted on the displaced families of lb Valley Coal Mines, the following are some of the important impacts that have been revealed from the analysis of data by the researcher:

- The general socio-economic condition of the oustees has deteriorated significantly.
- Socio-economic inequalities have widened.
- The cropping pattern has changed drastically
- Dependence on trees and livestock has reduced substantially.
- Increase in the proportion of agricultural labourers.
- Increasing trend towards nuclear family.
- Poor dwelling conditions of the oustees.
- Improper use of compensation money
- Rise in the incidence of indebtedness.
- Drastic reduction in the socio-economic condition of women.

Issues relate to development and exploitation of mineral resources:

Mining, world over, has now become an important input in the economic development a mineral rich country. In addition to the general value-adding benefits of mining, a quality which it shares with many other businesses, mining has some special qualities which enable it to serve as a springboard for countries seeking to industrialise. Mining is at the beginning of the value chain and has a capacity to kick start economic development that few other businesses offer. It does not require a sophisticated supply chain in the country in which it takes place, as manufacturing so often does, and it does not require developed local markets.

Also, minerals are indispensable when producing manufactured goods of all kinds and in providing most services, even at a basic level. Furthermore, all 'renewable' forms of energy generation, including solar, wind, bio-energy, and forestry and agricultural production, are ultimately dependent on utilizing minerals and metals in some form.

Off late two very significant developments are occurring in the mining industry and related government resource programs worldwide. One is positive, the other problematic. Working together, these two trends have the potential to change dramatically the way in which mineral resource companies, the Governments of resource-based economies, and indeed the world function in the 21st century.

The first trend is the greatly expanding international opportunities for mineral resource development. On the supply side, industrial development in general and mining in particular have been accelerated by a number of factors, including the end of the Cold War, the emergence of new market economies in Asia, Latin America, Africa and Eastern Europe, the move toward privatization of state mining assets, and increasing fiscal liberalization in developing and emerging economies.

On the demand side, consumption of the majority of minerals continues to increase, particularly in developing countries and emerging economies. The second trend, however, consists of the growing challenges to mining development, production, and products. Mining, by its very nature, causes significant environmental, social, cultural and economic disruption. As it has expanded globally particularly in the resource based economies of many developing countries - international awareness and concern about its negative effects has heightened, and this heightened concern is fueling a significant increase in both national and international laws regulating mining.

To maintain equilibrium sustainable development gained wide credibility as the centre piece of the 1987 report of the United Nations World Commission on Environment and Development

For development in general, sustainability mandates three things: preservation of options for future generations, nurturing of social and community stability, and maintenance and restoration of environmental quality. For mining in particular, this requires poverty alleviation, meeting of basic human needs, environmental impact assessment, pollution abatement, minimization of environmental impact, resource conservation, adequate worker health and safety standards, community betterment, and protection and restoration of the environment.

In short, the concept of sustainable development requires a complete paradigmatic shift in national and international thinking, because making economic and ecological concerns work together is its controlling objective. To have sustainability, nations, industries, companies and individuals can no longer seek merely to maximize material gains but must maximize the nonmaterial quality of life, can no longer rely on technology to make possible infinite development and population growth, and can no longer maximize present-generation benefits at the expense of future generations' well-being.

Issue related to corporate corruption

Governments are dependent upon individual officials and ministers to negotiate deals. Companies can gain immensely by bribing these individuals. This gives rise to an ‘agency problem’ for LDCs. While widely recognised, to date it has been addressed by a variety of ad hoc international initiatives.

One such is the Extractive Industries Transparency Initiative, started in 2003 and now with over thirty signatories among the governments of resource-rich countries, indicating recognition of concern for the problem. It aims to counter corruption in contracts by requiring companies engaged in resource extraction to report all their payments, country-by-country, forcing illicit payments into the open.

Another initiative has been the pan-OECD anti-bribery legislation which has made it a criminal offence for an OECD-based company to bribe government officials anywhere in the world in order to win a contract. One consequence of this OECD legislation has been the rapid emergence of a two-stage system of negotiations for the rights to resource extraction. In the first stage a company which is either too small to face scrutiny, or not OECD-based, negotiates with government. In the second stage, this company onsells the rights to a major OECD company that has the technology and finance to undertake exploitation.

A third and related international initiative has been to co-ordinate the laws relating to money laundering.

A fourth initiative has been the Kimberley Process which has curtailed illegal international transactions in diamonds through certification of the source of origin. The Government of Nigeria has recently proposed that an equivalent system of certification be put into place to curtail the large-scale theft of crude oil from the Niger Delta. The latest initiative is the Lugar-Cardin Amendment, now enacted into US law, whereby all companies listed on the New York stock market engaged in resource extraction must report all payments made associated with contracts in considerable detail. Potentially, such legislation could so discourage the major companies from entering into prospecting contracts with the governments of LDCs that the only companies left as partners for governments would be cowboy operations.

But it is not a matter of adopting new standards, but simply of enforcing standards which are already incorporated into legal systems globally.

Issue related to nexus between government and private sector:

In India, ownership of minerals lies with the State. However, the Central government which has control over all major minerals like iron ore, bauxite, copper, coal and most State governments which have control over minor minerals like sand, stone, granite, etc., have promoted privatisation through leasing mines to private companies apart from handing over captive mines of iron ore and bauxite to steel and aluminium corporates like the Tatas and Birlas. According to a recent report compiled for the industry by Ernst and Young, of the 4.9 lakh hectares of land given out in mining leases in 23 States by the end of 2009, 95 per cent of the leases comprising 70 per cent of the land were given to private companies.

The MMRDA Bill aims to further deregularise and liberalise the mining sector and encourage privatisation based on the recommendations of the Hoda Committee. It introduces the concept of high technology reconnaissance, prospecting and exploration licences, and easy terms of conversion to mining leases to encourage the entry of FDI and foreign companies. It also gives weightage, in the allocation of leases, to a set of criteria which favour such companies and also allows them activity on much larger tracts of land than previously. This has adverse implications for equity, the environment and growth.

The Bill also gives legal sanction to the arbitrary rights of governments, both at the Centre and the States, to give different types of licences and leases from reconnaissance to exploration, prospecting and finally extraction without any procedure for even consulting, leave alone taking the consent of tribal communities. The only reference to "consultation" (not consent), is for the grant of licences for minor minerals (but not major) in Fifth and Sixth Schedule areas where "the gram sabha or the District council, as the case may be shall be consulted." Thus even the provisions under other laws such as the Panchayat Extension (to Schedule Areas) Act (PESAA), which mandates consultation with the gram sabhas, are violated by the complete absence of any consultative process prior to the granting of lease for major minerals, which are the main sites of tribal deprivation. In another provision for notification of giving leases in forest areas and wildlife areas, the State government has to "take all necessary permissions from the owners of the land and those having occupation rights." Thus an unwarranted differentiation is made between the rights of tribal communities in Fifth Schedule non-forest areas and forest areas. However even in the case of forest areas there is no provision for what would happen in case the owner does not give permission.

Issue related to mineral exploitation and women sufferings

The displacement of people due to mining has only multiplied the exploitation and degradation of women's rights with regard to land and livelihoods. Historically and also in the existing legal framework, women have no legal rights over lands or natural resources. There is an invisible distinction between rural and tribal women with regard to control over lands in traditional land based situations in mainstream India. Tribal women enjoy a greater social status with regard to control over resources. This ensures their active participation and decision-making with regard to land utilization, agriculture and powers over cash flow in a tribal economy. This is enjoyed to a lesser extent by rural women in India. Yet, they have a distinct role in the agrarian society with regard to participation in agricultural work, livestock management, and access to common properties.

However, both rural and tribal women are completely alienated from these accesses and rights when the mines come. Testimonies of women from coal mining areas of Orissa (Talcher) show that displacement and loss of land were the most serious problems affecting their lives, as their link to livelihood, economic and social status, health and security all depended on land and forests.

Whenever villages have been displaced or affected, women have been forced out of their land based work and pushed into menial and marginalised forms of labour as maids and servants, as construction labourers or into prostitution, which are highly unorganised and socially humiliating.

Women displaced by mining, have lost the rights to cultivate their traditional crops, and forests being cut down for mining, they are unable to collect forest produce for consumption (food, fodder, medicines or ceremonial needs) or for sale. The cash flow that tribal and rural women have access to, by sale of forest produce and by breeding livestock, has disappeared. They are forced to walk miles away from their villages leaving behind their children, either to collect forest produce or find wage labour and have had to sell away all their cattle. In many situations there is seasonal migration leading to work insecurity, breaking up of family relations and exposing them to various social hazards.

To curb the social and cultural impact of mining local communities are organizing protests against the government and companies.

Frequent public health problems related to mining activities include:

- **Water:** Surface and ground water contamination with metals and elements; microbiological contamination from sewage and wastes in campsites and mine worker residential areas;
- **Air:** Exposure to high concentrations of sulfur dioxide, particulate matter, heavy metals, including lead, mercury and cadmium; and
- **Soil:** Deposition of toxic elements from air emissions.

Mining activities can suddenly affect quality of life and the physical, mental, and social well-being of local communities. Improvised mining towns and camps often threaten food availability and safety, increasing the risk of malnourishment. Indirect effects of mining on public health can include increased incidence of tuberculosis, asthma, chronic bronchitis, and gastrointestinal diseases.

Issues related to Mining and Environment

Environmental impacts of mining and mineral processing includes:

1. Surface water pollution

- Soluble contaminants in domestic or agricultural use waters from release of mine and processing water or leakage from waste deposits
- Deposition of solids on agricultural land and in shallow sea zones
- Withdrawal of water for industrial purposes
- Alteration of aquatic flora and fauna, including\ destruction of fish species and accumulation of toxic elements in fish
- Sand deposition in river channels and shallow sea zones

2. Underground water pollution

Soluble contaminants in wells, springs etc. resulting from leakage from waste heaps and mine water

Natural water sources drying up as a consequence of water table lowering

3. Air pollution

- Dust blown on inhabited, agricultural lands
- Accumulation in plants of toxic elements carried by dust
- Acidification of water bodies and soil resulting from SO emissions 2
- Damage to buildings from SO emissions 2

4. Solid waste

- Hazards related to lack of stability of waste deposits
- Land disturbance
- Withdrawal of agricultural land

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5. Excavation

- Loss of fauna and flora habitats.
- Land subsidence due to underground mining.

Methods for reducing the environmental impact of mining and metallurgical operations have improved considerably over the last couple of decades. At the mining stage, methods for rehabilitating mined-out areas to the original or new land uses have been developed and are applied in most new mining projects. Similarly, releases of effluents to surface water bodies or to groundwater are controlled and reduced through judicious planning at the very beginning of mining projects.

There are several reasons for the change in attitudes. The most important may be the pressure of public opinion. Second, conditionalities aimed at ensuring good environmental practices are increasingly being required by international financial institutions and by commercial banks. Third, environmental control measures in new projects usually do not entail major cost increases and may even improve production economies.

Most governments have made the "Polluter Pays Principle" (PPP) an integral part of their environmental policies. According to this principle "the polluter should bear the expenses of carrying out pollution prevention and control measures decided by public authorities to ensure that the environment is in an acceptable state. In other words, the cost of these measures should be reflected in the cost of goods and services which cause pollution in production and/or consumption". The PPP aims to improve economic efficiency.

There are some examples of economic instruments not directly aimed at internalizing environmental costs but rather at promoting pollution control measures. These include tax incentives such as accelerated depreciation for pollution control equipment. While these instruments are likely to contribute to reductions in pollution, they are not very cost-effective from the government's point of view. Furthermore, they may provide an incentive to companies to invest in "end-of-pipe" technology, that is, to treat emissions rather than to prevent pollution from occurring in the first place through appropriate process design. The latter would be preferable from the point of view of maximizing pollution reduction in relation to cost, but would provide no tax advantage.

Case study of Gobi Desert

- **Gobi Desert**

This resource – thought to be the biggest deposit of coking coal on the planet – is chewed out and transported away to China by a seemingly endless line of trucks that rumble across the plains in a convoy of dust. Until recently, this area of southern Mongolia was one of the world's last great wildernesses – a cold desert that is home to gazelle, wild ass and herders living a traditional nomadic existence.

Today, however, it is the centre of the planet's greatest resource boom. Some are calling it "the last frontier", others "Minegolia". Whatever the name, this impoverished but remarkable nation in east Asia is on the brink of one of the most dramatic transformations in human history.

The vast opencast pit at Tevan Tolgoi is just the start. Its 6bn tonnes of coal are being partly developed by a local mining firm. Extraction rights will also be auctioned off to overseas bidders, likely to include China's Shenhua, Peabody of the US and a Russian consortium. Whoever does the digging, the ultimate buyer of the fuel is likely to be China, which accounts for 85% of Mongolia's exports. The extraction is expected to triple the national economy by 2020 and propel the living standards of the small, impoverished 2.6 million population into the global middle class, but locals fear it will also devastate an arid environment as the mines suck up scarce water resources, damage the grasslands and necessitate roads and electricity grids that disrupt the migration patterns of local species.

The damage is already evident in the cross-Gobi traffic, where drivers churn up so much dust that some use their headlights in the middle of the day to pierce the gloom.

Nomad families in the area blame the mines for dried up wells, shrinking watering holes and clouds of dust that blacken the lungs and stomachs of their animals.

Two-thirds of the state's Human Development Fund – which has come from mining revenues – has been spent on monthly cash payments to the population to secure electoral votes. Environmental worries also loom large, particularly with regard to water usage rights.

The mines are good for Mongolia, but bad for residents of the southern Gobi. "They take too much water. There is not enough left so the herders have to move or sell their animals."

The operators of Oyu Tolgoi acknowledge they have taken surface water until now, which has made them a competitor with the nomads for scarce resources. But from next year, the mine will extract and treat saline water from a fossil aquifer 45km away. Operators say this is not linked to any lakes or watering holes.

Rio Tinto has pledged to set the highest international standards in minimising the impact on the environment. They plan to build an asphalt road to reduce dust, with underpasses for migrating animals. They have also promised to recycle much of their water.

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