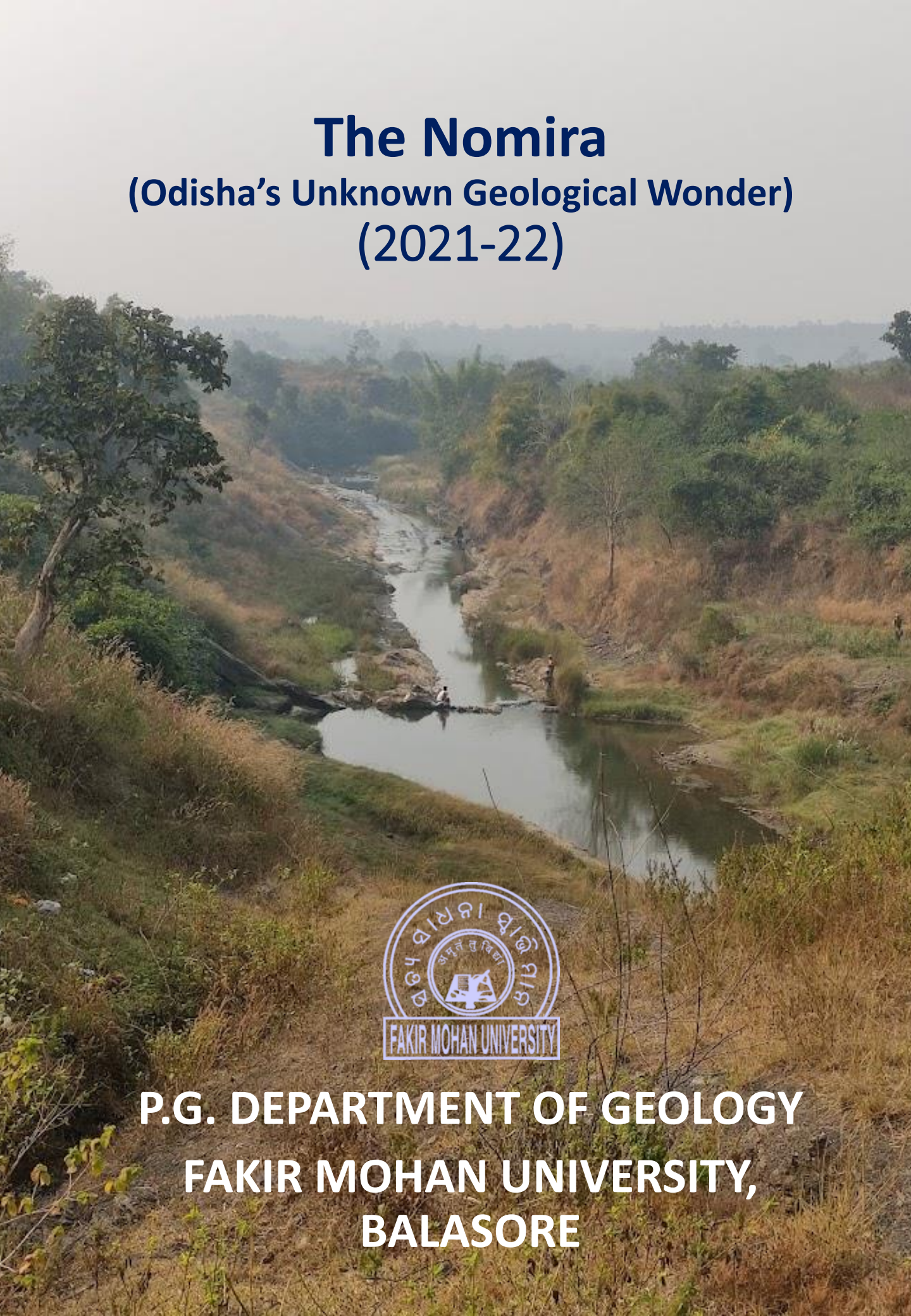
The Nomira

(Odisha's Unknown Geological Wonder)

(2021-22)



FAKIR MOHAN UNIVERSITY

P.G. DEPARTMENT OF GEOLOGY

FAKIR MOHAN UNIVERSITY, BALASORE

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Published by
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Fakir Mohan University

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MESSAGE

I am very happy to know that the Departmental magazine "The Nomira" is being published for 2021-22. I expect a lot of creative articles will feature in the said magazine contributed by the stakeholders of the Department.

I wish all the very best for all the stakeholders to flourish in future.

(Prof. Santosh Kumar Tripathy)

Flt. Lt. Prof. Munesh Chandra Adhikary
Chairman, Post Graduate Council

Fakir Mohan University,
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MESSAGE

It gives me immense pleasure to know that the P.G. Department of Geology is coming up with the Department annual magazine "The Nomira" on the occasion of the Annual function of their Department. It reflects all the curriculum and co-curricular activities of the Geology Department showcasing the achievement of the faculties as well as students. Hope all the stakeholder will take advantages of this publication for getting information. I am very much happy with all students of Geology that in addition to their classroom study, they could manage to participate in a number of field visits and adding the rare materials / minerals to strengthen their Department Museum. I also congratulate the Head as well as all the faculty members for their interest and effort for development. I wish all success of students and faculty members.

(Prof. Munesh Chandra Adhikary)

Prof. Madhumita Das (Retd.)
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(Former Vice Chancellor,
F.M. University, Balasore)

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MESSAGE

I am extremely pleased to learn that the Department of Geology , Fakir Mohan University is going to release the Magazine "THE NOMIRA" for the session 2021-22.

As Odisha is rich in both metallic and non-metallic minerals along with vast potential for coal, and water resources there is a huge scope for Geology students to utilize these resources by adopting innovative technological inputs. So, geology students have a great responsibility for strengthening the economic growth of Odisha as well as India.

Albert Einstein has said, "Education is not about learning of facts but training young minds to think." Learning is not confined to the four walls of Classroom rather it is beyond that. It is also not confined to a prescribed curriculum. This magazine is the best platform for students and staff to unfold their creativity, imagination and express their divergent thinking.

I congratulate the editorial team and all the authors for this great endeavour. I wish the young and talented students to come out with path –breaking scientific findings and discoveries in Geology.

MDas

(Prof. Madhumita Das)

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MESSAGE

It gives me immense pleasure in publishing first departmental magazine "THE NOMIRA", the unknown wonder of geology, on the eve of Annual day celebration.

THE NOMIRA is not only a publication, but a catalyst for students to explore their inherent literary talent. In fact, young talent finds its first exposure to show their extra-curricular enthusiasm as well as their academic venture through this medium. The magazine also records the achievements and various activities of the department. I sincerely wish that the magazine will serve a great purpose for exploration of newer avenues of knowledge.

I would like to thank everyone involved in this publication and nurturing department and our young talents.

My best wishes for continuing success.

Dr. Rosalin Das
Associate Professor & Head

Contents

Nomira: Odisha's Unknown Geological Wonder

Asim Amitabh Pradhan, Assistant Professor

The connection between people, landscape and the earth's history forms the foundation of the concept of geological heritage. The Geological Survey of India has identified 26 sites as National Geological Monuments, most of which are located in geologically-rich States like Rajasthan, Odisha, Karnataka, Andhra, Telangana and Tamil Nadu.

In Odisha, the pillow lava formations found in Nomira in Keonjhar is one of the designated geo-heritage sites. These unique geological features are embodied with significant scientific, cultural, educational or historical value and reconnect humans to the remarkable planet we call home.

In many countries, the concept of geo-heritage and geo-parks has found much traction with sites being properly protected as part of larger bio-diverse.

Geo-tourism is an integral part of these geo-parks which encompasses both landforms like outcrops and rock types and geological processes such as volcanism or glaciations. Unfortunately, in India, beyond declaring the sites as geological monuments, little else has been done to protect these marvels of the nature. Most of the sites are lying forlorn and desolate and may well be lost to the country during the course of 'development' activities. Nomira too is an unknown wonder, which lies in one corner of Odisha and which hardly anybody knows about. The Geological Survey of India, during its 125 years celebrations in 1976, had declared Nomira as a National Geological Monument.

The Tata Iron and Steel Company had even put up a marble plaque at the site but then forgot all about it. The pillow lava site was discovered by British geologists Jones and Dunne in 1942. It was the second site in the country where such formations were found, the other being near Maradihalli, a small village situated in Chitradurga district of Karnataka.

Nomira is located about 18 km south of Joda town on the Barbil-Lahunipada State Highway. The monument can be approached from Joda by following the Joda-Nayagarh road up to Bamebari village and then trekking two km eastward to Nomira.

The pillow lava outcrops look like small buns or pillows, a feature formed when hot molten basaltic magma slowly erupted under water and solidified rapidly to form roughly spherical or rounded pillow shapes. This happened 2.8 billion years ago when the area was covered by oceans and provides an important clue to the evolution of Precambrian peninsular India. The well-preserved pillow structures are roughly ellipsoidal and closely packed.

Because of its remote location, nestled in an unapproachable area which was thick jungle till a few decades ago, Nomira is one of the best preserved pillow lava sites of the world. Such pillow basalts can be seen forming even today along the mid-oceanic ridges or where sub-marine volcano erupts in the ocean. It is happening in the Hawaiian volcano eruption recently. The flowing lava, when it reaches the sea, gets chilled so fast that part of the flow separates into discrete rounded bodies a few feet or less in size.

It is now heavily wooded with shrubs and small trees. By taking the help of GPS you can locate the place. Most of the local people also not aware about Nomira. The plaque that had been put up nearly 45 years ago was found with a lot of difficulty. The site now adjoins the railway line; and any expansion will spell doom of this natural heritage. With hectic mining and blasting going on in the vicinity, both legal and illegal, Nomira needs to be protected. It is indeed a pity that both we and the Government are not aware of this geological wonder.

There are at least two dozen unique geological sites in Odisha which should be declared as National Geological Monuments. Lava ash beds, sand dunes, petrified forest zones, monolith stone formations, caves, waterfalls, etc.. have been discovered but not listed.

Pillow lava

Source: https://www.dailypioneer.com/2021/state-editions/nomira--odisha---s-unknown-geological-heritage.html

INDUSTRIAL MINERAL – AN OVERVIEW

Sayan Kumar Manna

Industrial minerals are mined from recent past and plays a key role in human civilization. It plays a predominant role in developing country's economy. For a developed and sustained country use of industrial mineral is to be prime. Industrial minerals are the raw material directly taken to processing unit from the field of extraction. Industrial minerals are denoted by means of place, unit value, specification standard and value for economy. Many industrial minerals are found in India which has a great usage followed by their physical properties and usage. For a country's development it is very necessary to mine and processing of large amount of this industrial mineral as they must be act as a good substitute of other minerals.

Introduction:

Industrial minerals are exploited by man for many thousands year and contributed to some of the major cultural development to the society. But in recent periods people use pigments and hard stones for grinding and cutting. As technology have advanced and improved in major ways so similar materials are still not use for similar applications. Nowadays, Industrial minerals are the prime key for industrialisation as they used as raw materials. To establish out adequate definition for industrial mineral is difficult but several have proposed some important description about Industrial mineral likewise (Bates, 1994) defines that "An Industrial mineral is any rock, mineral fuels and gemstones; one of the nonmetals". Like industrial minerals have been used in past as a synonym to non- metallic materials (Harben & Bates, 1990). Besides this a more useful and complete definition was given by (Scott, 2009) where as "Industrial Minerals are a loose grouping of products made from Earth materials that are not source of energy or a metal".

So, in general Industrial minerals are naturally occurring substance which are exploited for industrial value other than for a source of metal, precious stone, fuel or water. It is used to define a wide range of Individual and rocks containing minerals, which get exploited for their non- metallurgical value. These minerals possess a good physical and chemical properties which make good their use in a wide variety of domestic and Industrial uses. Without industrial minerals, most of human's material achievements and products, involving the easiest to the most sophisticated methods, would not be possible. In general, Industrial minerals are large in volume, low value commodities and are extracted from surface and underground mines. The characteristics of industrial is that they possesses good physical and chemical properties. Industrial possesses five major groups of raw materials. These are

- Raw materials used by the industry as minerals or buck rocks because of their physical and chemical properties like colour, viscosity, strength etc.
- Raw materials are the source of non-metals like pyrite for sulphur, apatite for phosphorous etc.
- Raw materials which may be source for metals such as bauxite for Al, Chromite for Cr or ilmenite for Ti , but also used in certain Industrial application because of their characteristics physical and chemical properties.

- Natural construction materials including building and ornamental stones and aggregates. (Marble, limestone, granite)
- Other materials, such as glass or cement are made up of industrial mineral but must be considered as manufactured industrial products, not real industrial minerals. Geopolymer is a new type of materials which can be taken in to this group (Xu & van Deventer 2002; Komnitsas & Zaharki, 2007).

Hence, the term industrial mineral minerals includes a large number of raw materials and synthetic products. There are a series of terms are defines deposits of industrial minerals. They are mainly ore, gangue, tenor, grade etc. The term ore can not be used for raw materials, which are utilized in bulk from without separation of the gangue through processing. This is usually the case for industrial rocks such as limestone, benitonite etc. In general, kaolin may undergo significant processing to increase the concentration of kaolin minerals can be considered as ores. Other than two additional term which differentiate industrial mineral from ore deposits are evaluation and assessment. Assessment includes geological, petrographical and mineralogical study of the deposit. Assessment also includes examination of factors that are likely to affect mining, processing and maintenance and transportation cost and markets (Scott, 1987). On the other hand evaluation includes estimation of reserves, examination of suitable mining and processing methods as well reappraisal of markets.

Special Characteristics of Industrial Mineral:

Place and Unit Value:

It is an important term used in Industrial mineral. It represents the geographic area in which an industrial mineral is mined or quarried on its market value and reflects the importance of the product in relation to its market (Scott, 1987). But the unit value is the real market value of the product and depends on the development of a market for this mineral and the ability of the mining companies to add value on their end product. Moreover, for a good market value the raw material should be of high grade and have a great deposit followed by production. Example like the acid activated bentonites which find application as bleaching earths for decolourising edible oils (Christidis et al., 1997), or the organophilic bentonites, which are utilized in the formulation of nanocomposites (de Paiva et al., 2008). Usually, industrial mineral products with high place value have low unit values.

Variable functions in industry:

The products derived from industrial minerals are interrelated with industrial process and function. Some industrial minerals can act as a good substitute for other but have less grade value followed by less quality. Use of raw materials or their products for the production of another industrial mineral is followed by a synergetic action of different industrial mineral of variable industrial procedure.

Specifications and standard:

After industrial processing the properties of industrial mineral follows some national and international standards which have been issued by various national or international institutions. They are namely ASTM, BSI, DIN, API, OCMA etc.

Industrial mineral types:

Asbestos:

Asbestos is a naturally occurring fibrous silicate mineral. It can easily split into fibre. It has a high tensile strength, resistant to heat and chemical reactions and have good flexibility. Because of these all specific properties asbestos plays an important role in commerce and industry. It has various varieties. These are Chrysotile Asbestos :(3MgO, 2SiO2, 2H2O)

Amphibole Asbestos: Tremolite, Actinolite, Anthophyllite, Amosite, Crocidolite

Origin:

Asbestos formed by regional metamorphism. Chrysotile asbestos occurs in serpentine bearing rocks such as dunites, peridots etc. Amphibole asbestos occurs as slip-fibre or mass fibre associated with schist and gneisses and other basic and ultrabasic rocks.

Physical properties:

Colour- Green/red/yellow, Streak- white, Luster- silky, Cleavage- Prismatic, Hardness- 2.0- 6, Sp. Gravity- low, Crystal system- Orthorhombic, Monoclinic

Uses:

It has a great usage in manufacturing roofing materials, floor tiles, asbestos cement products, friction products, insulating equipment, gaskets etc.

Indian Distribution:

It is mainly found in Andhra Pradesh, Jharkhand, Chhattisgarh, Tamil Nadu, Karnataka, Odisha etc.

Gypsum:

Gypsum ($CaSO_4$. $2H_2O$) is a hydrated calcium sulphate. It is soft and white when it is found in pure form. Its commercial importance depends upon on its ability after calcination. It occurs as fibrous and massive mineral. Gypsum occurs as five verities. These are Selenite, Alabaster, Rock gypsum, Gypsite and Satin spar.

Origin:

In dry region, gypsum deposits are found in the surface with other earth materials. Due to evaporation of sea water gypsum deposited as small crystal. During production of salt gypsum obtained as by product.

Physical properties:

Colour- Colourless to white, Streak- white, Luster- Vitreous to silky, Hardness- 2, Sp. Gravity- low, Crystal system- Monoclinic

Uses:

Gypsum used in fertilizer industry, manufacture of cement, production of Plaster of Paris, paint industry followed by rubber and Paper industry.

Indian Distribution:

Gypsum deposits are found in various states of India. They are Rajasthan, Tamil Nadu, Himachal Pradesh, Gujrat, Jammu & Kashmir, Andhra Pradesh etc.

Clays:

Clay has a complex composition. But clays are mainly natural substance consisting chiefly of hydrous alumino silicic acid with colloidal material and impurities like rock fragments. Clay is an aggregate of minerals and colloidal material. Properties of clay varies from place to place. It has many varieties. They are mainly chia clay, fire clay, ball clay etc.

Origin:

It is formed due to continuous weathering on earth surface. It can be occurred as transported clay, residual clay, colluvial clay etc.

Properties:

Clay minerals occur as very minute lath like, flaky like crystal. Due to its low double refraction kit is very difficult to differentiate clay minerals. They are mainly recognised by X-ray. Other clay minerals are Kaolinite, Montmorillonite, pyrophyllite etc.

Uses:

It is used in textile, paper, rubber industries. It is used for the manufacture of medicine, cosmetics, alum and ultramarine. It is also used in refractory industry.

Indian Distribution:

It is found in Jharkhand, Kerala, Odisha, West Bengal, Haryana, Himachal Pradesh, Bihar, Jharkhand States of India.

Conclusion:

From the ancient times raw materials are used to improve and develop the human civilization. The relative metallic or industrial minerals to the economy of the various countries reflects the economic maturity of the country. Industrial minerals act as back bone some country's economy. It boosts the economy with a great affect. So the, both developed and developing country's trying their best to utmost utilize their industrial minerals. So, technologies should be improved and to be implemented on mining and extraction of Industrial mineral. By this sustainable development of some strategic and critical minerals can be done in a possessive manner. Due to urbanisation and population explosion the ore minerals present are no sufficient to meet the people's usage for such more and more extraction and processing of Industrial mineral should be done for most sure to resolve the future problem.

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KEONJHAR: *The Storehouse of Ore Minerals*

Biswanath Sahoo

Keonjhar, a major district of Odisha has enormous mineral potential and is rich in mineral resources. Geographically Keonjhar district is located in the northern regions of Odisha. It is a small and landlocked district with an area of 8303 sq. km. The district is surrounded by the Singhbhum district of Jharkhand in the North, Jajpur in the South Dhenkanal and Sundargarh in the west, and Mayurbhanj and Bhadrak in the East. It lies between 21°1′ N to 21°10′ N latitude and between 85°11′ E to 86°22′ E longitude. The Keonjhar area forms a part of the southwestern Singhbhum- Orissa Craton of India's oldest Eastern Indian Shield and belongs to part of Singhbhum Granite, OMG, OMTG IOG, Malangtoli Lava, Dhanjori, and Kholan group. The area extends from Barbil in the North to Uchkabeda in the South and Mankarchua in the west to Bhimkunda in the east.

Singhbhum - Orissa craton is a polycyclic Archaean crustal block of the Indian Shield. The supracrustals of the Older Metamorphic Group (OMG) are considered to be the oldest rocks (3.5 - 3.6 Ga) in the Singhbhum craton (Saha, 1994; Mukhopadhyay, 2001; Misra et al., 1999; Misra, 2006) and comprise mainly para-and ortho-amphibolites, pelitic and psammo-pelitic schist, and meta-arenite. The OMG rocks are intruded by the TTG gneisses (biotite-hornblende-tonalite gneiss) which are termed Older Metamorphic Tonalite Gneiss (OMTG) and represent the first stable continental crust dated at 3.44 Ga. Tait et al., (2011), Upadhyay et al., (2014), and Nelson et al., (2014) offer new-age data on various litho-components of the Singhbhum craton. Supracrustals of the IOG comprising bimodal volcanic rocks, ultramafic rocks, banded iron formation (BIF), chert, shale, and minor carbonates occur as three detached belts along the periphery of the nucleus viz. the NE-SW trending Noamundi-Jamda-Koira belt, the western IOG; the E-W trending Tomka-Daitari belt (TD basin), the southern IOG and the N-S trending curvilinear Badampahar-Gorumahisani belt (BG basin), the eastern IOG. The Iron Ore Group of the Bonai-Keonjhar belt is exposed in the form of a 'Horse shoe' shaped syncline (Jones, 1934, Dunn and Dey, 1942).

Iron ore, Manganese ore, Chromite, Quartzite, Bauxite, Gold, and Pyrophyllite are the major minerals found in this district.

Iron Ore:

The main iron ore deposits are found along with the classic Bonai-Keonjhar Horse Shoe-shaped synclinorium. Hematite is the chief mineral resource of this district. Important deposits were found in Thakurani, Bolani, Joda east, Khandbhanda, Sidhmath, Belkundi, Kasia-Barapada, Bolani, Kiriburu, Gurudia, Jharibahal, Dubuna, Bamebari, Murga, Palsa, Jajang, Malangtoli, Chamakpura, Gandhamardhan, Daitari, Tomka, Guali and Uliburu. Iron ore bands occur in layered BIF bands along with volcano-sedimentary rock piles known as Iron Ore Super Group. Usually, four types of ore are seen i.e., hard massive, laminated, lateritic, and blue dust. A total of 3142.70 million tonnes (DSR 2018) of iron ore resources of all categories have been assessed with 64-68% Fe in massive, 62-65% Fe in laminated, and 65-68% Fe in powdery blue dust type of ore.

Manganese:

The Keonjhar manganese belt is a part and parcel of the Singhbhum Bonai belt and one of India's most important manganese ore-producing regions. This is confined to shale formation of Pre-Cambrian Iron Ore Super Group as stratiform, stratabound, and lateritoid types.

Important deposits in the Keonjhar district are located in the areas of Roida- Bhadrasahi, Silijhora-Kalimati, Guruda, Chormalda, Sarkunda, Dubna Kolarudkela, Podadihi Langini-Jharan, Lasarda, Pacheri, Balani, Baneikala, Kendudihi-Purulipada, Horomoto-Jajang, Katasahi, Joribahal, Joda west and Belkundi etc. The grade of the ore is variable from deposit to deposit as also from body to body within the same deposit. out of the total production, about 10% to 15% forms the High Grade (more than 46% Mn), 25% to 30% Medium Grade (36-45% Mn), and the rest Low (less than 30-35% Mn) and still lower (less than 30% on Mn)

Chromite:

The chromite deposits of the district are associated with the ultramafic rocks of the Nuasahi, Boula, and Phuinjhorhuli areas. The body extends for about 3 km in an N-S direction. It is a dyke like body dipping steeply to the east and is widest in the center and gradually tapering towards north and south. The ultrabasic occurs as intrusive in Precambrian metamorphites as well as differentiated layered igneous complex. It has a peridotite core with a subordinate amount of chromite, peripheral pyroxenite, and enstatite. the ultramafites include enstatite, bronzite, pyroxenite, serpentinized dunites, talc schist, silicified dunites, and chromitites with chromite loads. The chrome ore available is mostly of lumpy type.

Pyrophyllite:

The occurrences of pyrophyllite are stretched over a 90Km long belt extending from Rebna-Palasbahal in the south to Dhobakuchuda-Balabhadrapurr in the north. These are associated with the border area of Singhbhum Granite and quartzite hills such as Madrangajori, Macchakandana, Jodiaghat, and south of Uchakabeda, eastern slope of Chantrabhangapahar, Dalimpur, and Sidhamath area. The Pyrophyllite occurrences mentioned above are in the form of very fine flakes, typically soapy feel and associated with pyrophyllite quartz schist, quartz tourmaline pyrophyllite rocks, and quartz tourmaline pyrophyllite schist as irregular patches.

China Clay:

Pockets of china clay are near Judiapahar, Tarreni pokhari, Aupura, Fakirpur, Padmakesharpur, Jaypur, Kankadajodi, Adakata, and Govindpur area of the district. The clay is yellowish-white, gritty, and occurs as a pocket type.

Bauxite:

Industrial and chemical grade Bauxite occurs in the Dholkata Pahar area of the district. The area is represented by metavolcanic characterized by metatholeiitic basalt. The different flows are separated by tuffaceous shale. Outcrops of metagabbro have been noticed to the east and southeast of Dholkatapahar. Apart from these minor occurrences of bauxite in a pocket or poddy nature has been reported along the Keonjhar-Banai belt. The occurrences have been located around Kodalia, Khajurdi Pahar, east of Kasiara, and the Jaladihi area. The Dholkata Bauxite is of high alumina, high iron, low silica, and low titanium grade having 60 to 70% tri-hydrated as gibbsite and rest boehmite. the predominant iron minerals are goethite and hematite occurring as colloidal bands.

Quartzite:

High-grade quartzite mining activities continue near the district's Barapada, Barang, Paharpur, and Marsala areas. Besides, cherty and massive quartzite with 99% SiO_2 is marked intermittently in the iron ore series near Rebna-Palaspal, Magarmuhan, Jaypur, Dalmaposi, Chauthia, and Nawabeda areas.

Talc- Soapstone:

This is reported from the northern slope of hill ranges immediately south and west of Keonjhar and Dalimpur. The talc-schist occurs as gently undulating slabby layers underlying the Kolhan sandstone. The highly foliated talc schist is traversed by veins of quartz as impurities. Besides these, soapstone occurrence is encountered near Dholkata, Dalangpur, NE of Sayedmulia, Suramundi, Kuladhamkuni, Sapghosara, Pithagola, and Alanga area. These are locally utilized for the preparation of stoneware and statues.

Glass Sand:

Some of the Kolhan sandstones in the northern portion of the district (near Barangam) are suitable for the glass industry.

Gold:

The occurrence of gold is reported in Telkoi and Banspal block of Keonjhar district. Several old workings of the gold in the shape of elongated trenches, deep circular pits, wells, and tunnels have been recognized around Saleikena, Sirisbahal, Dublapal, Bangadiha, Odal, Gopur, Gajipur, Kusuguda, etc. The area covering the gold deposits constitutes the rock units belonging to the Iron Ore Super Group comprising basic lava, tuffites, basic intrusive, metagabbro, metadiorite, amphibolites, quartzite, and chlorite schist. The granitic suites of rocks are intrusive into the above rock types and are represented by micro granites, fracture, shear zone, and faults that might have acted both as channel ways and receptacles for gold deposition in the vein quartz bodies.

Dimension Stone:

Singhbhum granite, dolerite dykes, and ultrabasic rocks of the district are suitable for dimension stone or decorative stones. The 150Km long Palaspanga dyke from Keonjhar to Chainbasa, the longest dyke in Asia is being used for the above purpose because of its color, texture, composition, and hardness. These are quarried at several places around Dhurpada and Keonjhar.

Pyrite:

Pyrite crystals have been recorded in dark grey shaly formation underlying the Kolhan sandstone west of Balibandha on the Keonjhar-Chainbasa road.

Building Stone & Road Material:

Granite gneisses, aplites, dolerites, and quartzite are being used as road metal and in concrete mixtures. Laterite blocks are extensively used as a very common building material and are found in plenty.

Other Minerals:

A few occurrences of asbestos are encountered near Gopalpur. Thin bands of slip fibres were marked in the peridotite body, but the economic aspect of this occurrence appears not to be viable. A patch of travertine limestone is also encountered near the Asurkhol area.

Keonjhar district produces enormous minerals including non-metallic, metallic, and fuel minerals. It is the major producer of iron and manganese ore in the state. Other than the above-mentioned minerals, minor minerals such as river sand, laterite slabs, black stone, road metals, morrum, brick earth, etc. are also available in the district. So Keonjhar district can be considered the storehouse of ore minerals in Odisha.

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TECHNIQUES OF X-RAY DIFFRACTION

Mrs. Debajanee Sahoo

INTRODUCTION:

X-rays are electromagnetic radiation with very short wavelength. The unit measurement is A^o; 10^{-8} cm. X-rays discovered by the German physicist William Conrad Roentgen in 1895 and were so named because their nature was unknown at that time. In 1912, the phenomenon of x-ray diffraction by crystals was discovered'. This discovery proved the wave nature of x-rays and provided a new method for investigating the fine structure of matter.

THEORY OF XRD:

X-Ray Diffraction (XRD) Analysis is an analytical technique designed to provide more in-depth information about crystalline compounds, including identification and quantification of crystalline phases. The result from an XRD analysis is a diffractogram showing the intensity as a function of the diffraction angles. Positive ID of a material using XRD analysis is based on accordance between the diffraction angles of a reference material and the sample in question.

Generation of X-rays:

- X-rays are produced when charged particles such as electrons are rapidly decelerated due to interaction with matter.
- The radiation being produced in an x-ray tube which contains a source of electrons and two metal electrodes; cathode and anode.
- The high voltage maintained across these electrodes, rapidly draws the electrons to the anode or target, where they strike with very high velocity.
- X-rays are produced at the point of impact and radiate in all directions. The cathode is maintained at a ground potential.
- Most of the kinetic energy of the electrons striking the target, is converted into heat, less than 1% being transformed into x-rays.

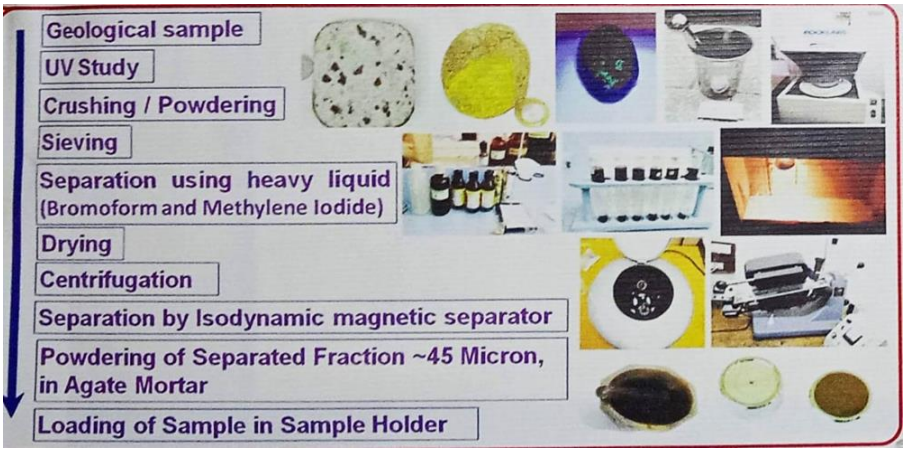
X-Ray Diffraction:

It is the constructive reinforcement of scattered beam in a crystal and occurs when phase between different scatter beams is satisfied. The X-Rays deflect or "diffract" in various ways depending on the crystal structure (inter-atomic distances) of the sample. The locations (angles) and intensities of the diffracted X-Rays are measured. It is a valuable tool in the elucidation of the lattice parameter, crystal structure, stress analysis, crystallite size and study of phase equilibria.

X-Ray Scattering:

A primary use of the technique is the identification and characterization of compounds based on their diffraction pattern. The dominant effect that occurs when an incident beam of monochromatic X-rays interacts with a target material is scattering of those X-rays from atoms within the target material.

FLOW SHEET FOR SAMPLE PREPARATION AND XRD ANALYSIS:

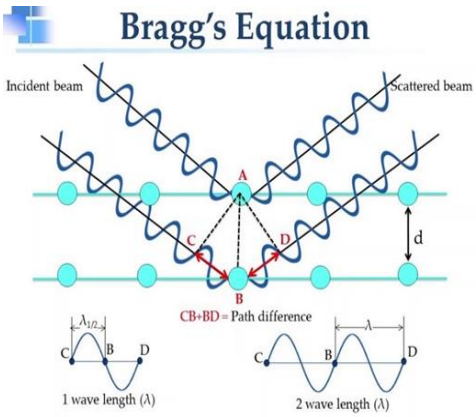


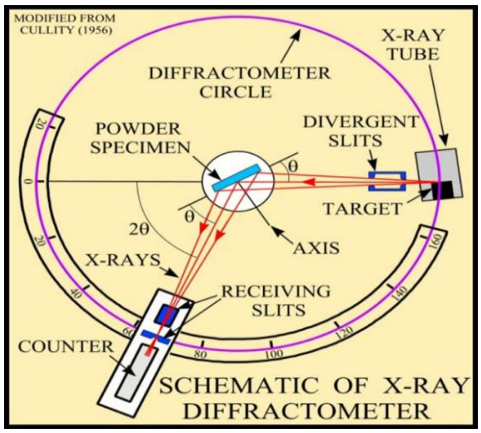
How does X-ray diffraction work?

When monochromatic X-rays are projected onto a crystalline material at an angle (θ), diffraction occurs when the distance travelled by the rays reflected from successive planes differs by an integer (n) of wavelengths (λ). All X-Ray interpretations are based on Bragg's law (nλ=2d sin θ).

W.H. Bragg (father) and William Lawrence. Bragg (son) developed a simple relation for scattering angles, now call **Bragg's law**. The interaction of the incident rays with the sample produces constructive interference (and a diffracted ray) when conditions satisfy Bragg's Law (nλ=2d sin θ). This law relates the wavelength of electromagnetic radiation to the diffraction angle and the lattice spacing in a crystalline sample. By varying the angle θ, the Bragg's Law conditions **[n λ = 2d sin θ**] are satisfied by different d-spacing.

- Plotting the angular positions and intensities of the resultant diffracted peaks produces a characteristic pattern where different phases are present, the diffraction trace represents the sum of the individual patterns. The XRD technique takes a sample of the material and places a powdered sample in a holder, then the sample is illuminated with x-rays of a fixed wave-length and the intensity of the reflected radiation is recorded using a goniometer.
- This data is then analysed for the reflection angle to calculate the inter-atomic spacing (D value in Angstrom units - 10-8 cm).The intensity(I) is measured to discriminate (using I ratios) the various D spacing and the results are to identify possible matches.
- When the rays, coming from the target, are analysed, they are found to consist of a mixture of different wavelengths and the variation of intensity with wavelength is found to depend on the tube voltage.
- Planes going through areas with high electron density will reflect strongly, planes with low electron density will give weak intensities.
- The intensity is zero up to a certain wavelength, called the short wavelength limit (), increases rapidly to a maximum and then decreases with no sharp limit on the long wavelength side.





APLLICATIONS:

- Identification of Primary and secondary uranium minerals, Rare metal and Rare earth minerals; Iso-structural , Metamict and Clay minerals; Mineral phases associated with beach sand and off-shore mineral deposits.
- Determination of unit cell parameters of atomic minerals.
- X-ray crystallographic and substantial solid solution studies, mainly on U, Th, Nb, Ta, Sn ore minerals.
- Determination of trinicity of feldspar in pegmatites/ granites to elucidate the evolutionary history of parent rocks and hosted mineralisation.
- Characterisation of metamict minerals & influence of the degree of metamictisation on uranium beneficiation.

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Platinum Group Elements associated with Sukinda Ultramafic Complex and Baula-Nuasahi complex of Singhbhum craton, Odisha

Surya Narayan Das

Platinum, a metal almost white with silky sheen was used by Egyptians around 800 BC. It derived from Spanish term *platina* (Little silver) and is a dense, malleable, ductile, precious, transition metal. Six elements of Group 8, 9 and 10 in the periodic table (Fig.1) constituent the platinum group metal (PGMs): Platinum (Pt), palladium (Pd), rhodium (Rh), ruthenium (Ru), iridium (Ir) and osmimum (Os). These are further subdivided into iridium-group (IPGEs: Os, Ir, Ru) and the palladium group (PPGEs: Rh, Pt, Pd) based on their behavior in geological systems. These are the rarest of precious metals in the Earth's crust. The crustal abundant is very low and PGE deposit are too few in number compared to other metals.

Manganese 25 Mn	Iron 26 Fe	Cobalt 27 Co	Nickel 28 Ni	Copper 29 Cu
Technetium 43 Tc	Ruthenium 44 Ru	Rhodium 45 Rh	Palladium 46 Pd	SIlver 47 Ag
Rhenium 75 Re	Osmimum 76 Os	Iridium 77 Ir	Platinum 78 Pt	Gold 79 Au
Bohrium 107 Bh	Hassium 108 Hs	Meitnerium 109 Mt	Drmstadium 110 Ds	Roentgenium 111 Rg

Fig. 1 Platinum group of metal in the periodic table

Sukinda Ultramafic Complex, Jajpur District

The Meshoarchiean Sukinda Massif in the Singhbhum craton is the largest chromite ore deposit in India that contains 95% of Indian Cr resources. The Sukinda Massif consists of an elongated layered ultramafic unit that occurs within the 3.5 Ga suprcrustal sequences the Tomka-Daitari-Mahagiri greenstone belt in eastern India. This ultramafic complex is exposed as an ENE-WSW trending wedge shaped body bounded by metasedimentaries to the Nortn as well as South. The ultramafic unit compriecomprises serpemtinized,dunite, orthopyroxenite and chromite. Hydrothermally altered dunite, peridotite, and chromite constituent the first cycle of intrusion. Coarse-grained enstatitite make up the second cycle. Mafic variants are absent.

There are six different levels of parallel chromite bodies; five are exposed intermittently over more than seven kilometers. Low grade olivine chromitite and chromite indicated occasional anomalous PGE value. The Pt value ranges between 2 and 400 ppb and that of Pd range between 1 and 500 ppb. Limonitic capping on ultramafic rocks showed PGE (Pt & Rd) from 40 to n290 ppb. No ore grade PGE has yet been located. Sulphide content veries from 0.5 to 0.82%. Specks of chalcopyrite and pyrite are ubiquitous in all rock type. Sarkar *et al*. (2001, 2003) have reported presence of magmatic breccia containing minor gold and PGE minerals in Kathpal mines of OMC Ltd. PGM in the form of native alloys of Os-Ir-Ru, metallic solid solutions of Ir-Pt, sulfides of Os-Ir-Ru and as laurite-erlichmante are also reported form Kathpal (Mohanty and Sen, 2007; Raju *et al*., 2007). Mukherjee (1998) has reported 2-400 ppb Pt and 1-500 ppb Pd in olivine chromite and chromitites of this complex. The Mahagiri lode zone section with three ore seams appears interesting; the hanging wall contact area seems to be of geological potential for PGE which might have been concentrated by gravity settling in zones of magma mixing. Modern concept of oriented lithogeochemical survey that identifies the critical breaks for PGE should be attempted.

Baula-Nuasahi complex, Keonjhar District

The mesoarchean Boula-Nuasahi ultramafic complex is situated in the south eastern flank of the Singhbhum craton. The potential of this complex for Platinum-group elements (PGE) rich facies in addition to high grade chromite deposit in mafic-ultramafic layered complex was tested in the late 1980s and 1990s by the Geological Survey of India (GSI). Boula-Nuasahi is a small ultramafic intrusion, some 3 km long by 0.5 km wide trending NW-SE in its northern part and N-S in southern part. It hosted by gabbro-anorthsite suite which shows a subtle eastward differentiation. The ultramafic complex contains a lower orthopyroxinite (basal) unit with 3 cheomite seams froms the core of the ultramafic complex. Massive to dissminited chromites occur as bands within serpentinised dunite, layered harzburgite and pyroxinite.

Two types of PGE mineralization have been observed. In the southern side of the Baula-Nuasahi complex (Banguru area), the breccias zone is represented by relics of dunite and chromite extracted mechanically from the ultramafic sequence by an intrusive gabbro. This breccias zone platinum group of minerals (PGM) like malanite [Cu (Pt, Ir)$_2$ S$_4$], braggite [(Pt, Pd, Ni) S], laurite (Ru S$_2$), isoferroplatinum [(Pt Pd)$_3$ (Fe Cu)] and sperrylite (Pt As$_2$). Type-1 PGM, these PGMs occurs as inclusions in magmatic cumulus silicates. This mineralization occurs in a sulphide-free magmatic environment with high Pt/Pd= 8-9. Type-2 PGM, in the northern and central portion of the complex PGE mineralization in breccia zone. This can be further subdivided into a footwall impersistent Type-2A, comprising geversite [Pt (Sb, Bi)$_2$], sperrylite (Pt As$_2$), braggite [(Pt, Pd, Ni) S] with ferritchromite and without sulphide phase dominated by Pt (Pt/Pd=2-3). The more ubiquitous hangingwall mineralization in breccias zone is Type-2B, comprising sudburyite [(Pd, Ni) Sb], merenskyite (Pt, Pd) (Te, Bi)$_2$, sperrylite (Pt As$_2$) and many unknown Pd-antimonide-telluride phases. Sulphides are most prominente in Type-2B. It is dominated by Pd (Pt/Pd=0.5).

Conclusion

The Sukinda Ultramafic Complex and Baula-Nuasahi complex is lies in the Singhbhum ceaton are enriched in PGE. Platinum Group Elements of Sukinda Ultramafic Complex there is no ore grade PGE has yet been located in this area the Pt value range between 2 to 400 ppb and Pd value ranges between 1 to 500 ppb. In this area the PGE like Pt and Rd value ranges from 40 to 400 ppb in the limonite coating ultramafic rock. Baula-Nuasahi complex two types of PGE mineralization have been observed Type-1 PGM, these PGMs occurs as inclusions in magmatic cumulus silicates with high Pt/Pd= 8-9. Type-2 PGM is divided Type-2A, comprising geversite, sperrylite, braggite and Type-2B, comprising sudburyite, merenskyite, sperrylite. Type-2A is dominated by Pt (Pt/Pd=2-3). And Type-2B dominated by Pd (Pt/Pd=0.5).

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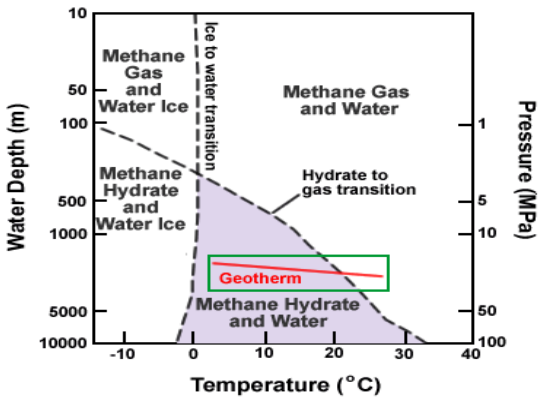
Methane Hydrate

The Next Energy "Game Changer"?

Subrat Kumar Sinha

As **natural gas** from **shale** becomes a global energy "game changer," oil and gas researchers are working to develop new technologies to produce natural gas from methane hydrate deposits. This research is important because methane hydrate deposits are believed to be a larger hydrocarbon resource than all of the world's oil, natural gas and coal resources combined. If these deposits can be efficiently and economically developed, methane hydrate could become the next energy game changer.

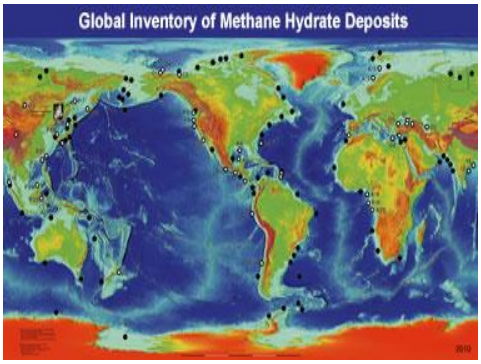
Enormous amounts of methane hydrate have been found beneath Arctic permafrost, beneath Antarctic ice, and in sedimentary deposits along continental margins worldwide. In some parts of the world they are much closer to high-population areas than any natural gas field. These nearby deposits might allow countries that currently import natural gas to become self-sufficient. The current challenge is to inventory this resource and find safe, economical ways to develop it.

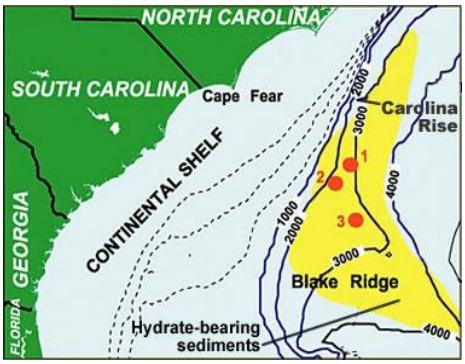


Methane hydrate stability chart: This phase diagram shows water depth (pressure) on the vertical axis and temperature on the horizontal axis. The dashed lines separate stability fields of water, water ice, gas and gas hydrate. The line labeled "hydrate to gas transition" is significant. Conditions for the formation of methane hydrate occur below this line. Above this line methane hydrate will not form. The red line traces a geotherm (the change of temperature with depth at a specific location). Note how, as depth increases, the geotherm crosses the hydrate to gas transition line. This means that gas hydrate in sediments usually overlies free gas. Graph modified after NOAA.

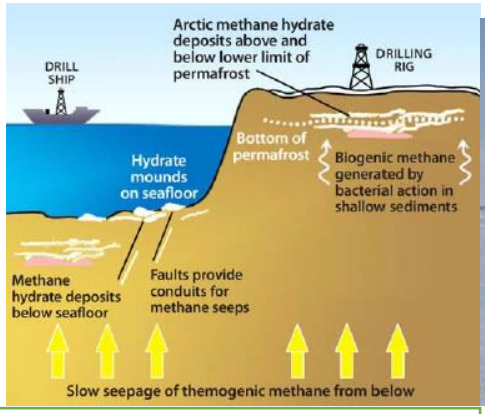
What is Methane Hydrate?

Methane hydrate is a crystalline solid that consists of a methane molecule surrounded by a cage of interlocking water molecules. Methane hydrate is an "ice" that only occurs naturally in subsurface deposits where temperature and pressure conditions are favourable for its formation. These conditions are illustrated in the phase diagram on this page. If the ice is removed from this T/P environment, it becomes unstable. For this reason, methane hydrate deposits are difficult to study. They cannot be drilled and cored for study like other subsurface materials because as they are brought to the surface, the pressure is reduced and the temperature rises. This causes the ice to melt and the methane to escape. Several other names are commonly used for methane hydrate. These include: methane clathrate, hydro methane, methane ice, fire ice, natural gas hydrate, and gas hydrate. Most methane hydrate deposits also contain small amounts of other hydrocarbon hydrates. These include propane hydrate and ethane hydrate.



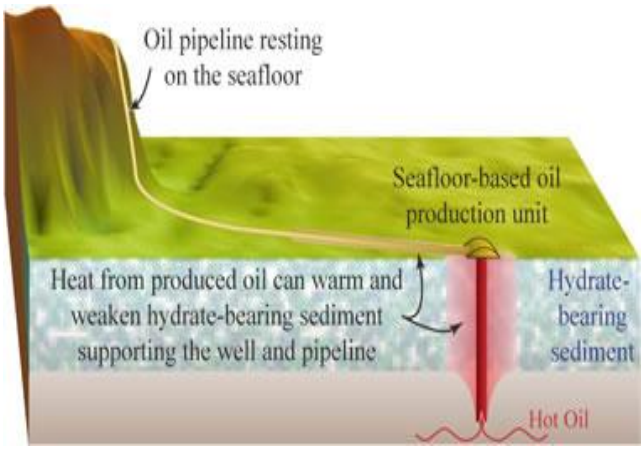


Gas hydrate map: One of the most extensively studied gas hydrate deposits is Blake Ridge, offshore North Carolina and South Carolina. Challenges of producing methane from this deposit are the high clay content and the low methane concentration.



Methane hydrate deposit models: Deposit models for methane hydrate deposits at continental margins and under permafrost.

Gas hydrate well: Ignik Sikumi #1 gas hydrate well on the Alaska North Slope. A USGS gas hydrate resource assessment determined that the North Slope has an extensive gas hydrate resource trapped below permafrost. Department of Energy photo.



Gas hydrate melting: When oil wells are drilled through hydrate-bearing sediments, the warm temperature of the oil moving up through the frozen hydrate zone can cause melting. This can result in well failure. Warm pipelines running over frozen hydrate outcrops is also a hazard.USGS image.

Where Are the Methane Hydrate Deposits?

Four Earth environments have the temperature and pressure conditions suitable for the formation and stability of methane hydrate. These are: 1) sediment and **sedimentary rock** units below **Arctic** permafrost; 2) sedimentary deposits along continental margins; 3) deep-water sediments of inland lakes and seas; and, 4) under **Antarctic ice**. With the exception of the Antarctic deposits, methane hydrate accumulations are not very deep below Earth's surface. In most situations the methane hydrate is within a few hundred meters of the sediment surface.

In these environments methane hydrate occurs in the sediment as layers, nodules, and intergranular cements. The deposits are often so dense and laterally persistent that they create an impermeable layer that traps natural gas moving upwards from below.In 2008, the United States Geological Survey estimated the total undiscovered gas hydrate resource for the Alaska North Slope area. They estimate that the total undiscovered natural gas resource in the form of gas hydrate ranges between 25.2 and 157.8 trillion cubic feet. Because very few wells have been drilled through the gas hydrate accumulations, the estimates have a very high level of uncertainty.

Where is Methane Hydrate Produced Today?

To date there has been no large-scale commercial methane production from gas hydrate deposits. All of the production has either been small scale or experimental.

In early 2012, a joint project between the United States and Japan produced a steady flow of methane by injecting carbon dioxide into the methane hydrate accumulation. The carbon dioxide replaced the methane in the hydrate structure and liberated the methane to flow to the surface. This test was significant because it allowed the production of methane without the instabilities associated with a melting gas hydrate.

The most likely methane hydrate deposits to be selected for first development will have the following characteristics: 1) high concentrations of hydrate; 2) reservoir rocks with high permeability; and, 3) locations where there is an existing infrastructure. Deposits meeting these characteristics will likely be located on the Alaska North Slope or in northern Russia.

Did You Know? Methane hydrate has a very high concentration of methane. If you melt a one-cubic-meter block of methane hydrate, about 160 cubic meters of gaseous methane will be released.

Methane Hydrate Hazards

Methane hydrates are sensitive sediments. They can rapidly dissociate with an increase in temperature or a decrease in pressure. This dissociation produces free methane and water. The conversion of a solid sediment into liquids and gases will create a loss of support and shear strength. These can cause submarine slumping, landslides, or subsidence that can damage production equipment and pipelines.

Methane is a powerful greenhouse gas. Warmer Arctic temperatures could result in gradual melting of gas hydrates below permafrost. Warming oceans could cause gradual melting of gas hydrates near the sediment-water interface. Although many news reports have presented this as a potential catastrophe, USGS research has determined that gas hydrates are currently contributing to total atmospheric methane and that a catastrophic melting of unstable hydrate deposits is unlikely to send large amounts of methane into the atmosphere.

Enormous Potential

Although methane hydrate accumulations are located in difficult environments and present numerous technical challenges, they are widely distributed and the largest source of hydrocarbons on Earth. A variety of technologies could be developed to produce them using pressure reduction, ion exchange, and other processes that take advantage of their unique chemical and physical properties. The United States, Canada, Japan, and India all have vigorous research programs working to discover viable technologies for producing gas hydrates. Methane hydrate will likely play an important role in our future energy mix.

GEOLOGY AND HYDROGEOLOGY OF BALASORE DISTRICT

Dr. Rosalin Das

INTRODUCTION

Balasore is a unique district in northeast coast of Odisha with rich and varied geology. This paper comprises of the complete geological and hydrogeological survey of the district with an aim to highlight the varied topography, lithology, geomorphology and vast mineral deposit of the area. The district spreads over an area of 3634 sq.km lies between 20° 48’ and 21° 59’ North latitudes and 86°16’ and 87°29’ East longitudes. The mountain ranges comprise mainly of highland plateau and valleys with intrusive running through them. The second physiographic unit is Tertiary Plain occurring in the eastern part of the district. The third physiographic unit is Alluvial Plain. Nilgiri mountain is the chief central part of the district. The geology of the district is constituted by the Nilgiri granite complex at its central part belonging the Archaean age, unconformably lying over Singhbhum Granite and Banded Iron Formation (BIF). It consists of three alternate bands of volcano sedimentary units uniquely disposed in a ring like circular pattern formed under sub- marine conditions. Important mineral resources include iron, copper, titanium, vanadium, china clay, nickel, kyanite, quartz, talc, steatite, soapstone and bauxite. The huge deposits of granite stones at Nilgiri, Khaira, Oupada regions provides tremendous scope for development of few more industries based on these resources.

The drainage density is observed to be fairly moderate and drainage pattern is dendritic in nature. It is in the coastal section of Odisha blessed with hot and humid climate, with alluvium soil and intersected by the perennial rivers, which collectively provides conducive infrastructure for the growth of agriculture in the region. Rice, Pulses, oil seeds like Groundnut, Mustard, Castor and linseed are grown in the District of Balasore.

Four main types of soil groups (USDA Soil Classification System) can be observed in the Balasore District. These are Alfisols, Aridisols, Entisols and Ultisols. Alfisols are the dominant soil groups in the district, occupying approximately 55% of the geographical area. They have a clay-enriched subsoil and relatively high native fertility. "Alf" refers to aluminium (Al) and iron (Fe). They can be further sub-divided into Older Alluvial Soils, Red Gravelly Soils and Red Sandy Soils. They are widely used both in agriculture and forestry, and are generally easier to keep fertile than other humid-climate soils. Alfisols have undergone only moderate leaching and have at least 35% base saturation, meaning calcium, magnesium, and potassium are relatively abundant.

Physiography:

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

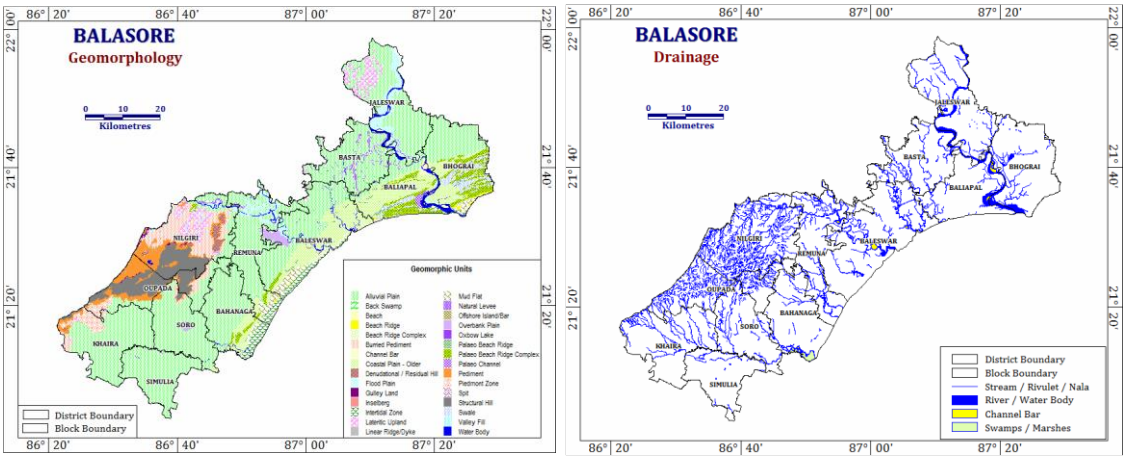


Figure 1: Geomorphology and Drainage map of Balasore District.

HYDROGEOLOGY

Bhograi is the block with highest ground water utilization of 68.77% in the district. Nilgiri is the block with lowest ground water utilization of 32.42% in the district. Net ground water availability of the district is assessed to be 1, 10,063 HM and the gross annual draft for domestic, industrial, and irrigation uses is 58,651.12 HM. The average stage of Ground water development in the district is 53.29%.

Hydrogeomorphology:

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

i. Coastal Plain: Coastal plain predominantly consist of sand silt and clay is developed all along the coast of Balasore district. It is gently sloping plain occurring parallel to the coast. The saline marshy tract with shrubby vegetation comes under this coastal plain. Tidal streams are very active during high tide time. Ground water prospect is good but salinity is a major problem in this tract. **ii. Beach:** Beach is mainly formed by marine action. Beach ridges are very common and these are formed due to sea waves. They are mainly consisting of sand mixed with silt etc. Ground water prospect is good within a depth of 30-40 m, where fresh ground water pockets are available. Deep tube wells in these areas may lead to sea water ingress. **iii**. **Mud flat:** This is a relatively marshy area covered with fine silt and mud along the shore. Mangrove's vegetation is very common along the coastal tract. **iv. Paleo mud flat:** These are the ancient mud flat consisting of fine sand and mud. These are mostly converted to agricultural land in due course of time. Due to marine regression ground water quality is saline. **v. Off shore Bar:** Off shore bar is an elongated bar of sand occurring in the sea more or less parallel with the coast line. These comprises of sand. **vi. Channel Bar:** It is a depositional fluvial land form developed inside the channel due to the recession of the velocity of water. It is mainly consisted of alluvial deposits. **vii. Meander Alluvial Deposits:** This is an abandoned river course mostly filled with alluvial deposits. Ground water prospects are good to excellent. **viii. Oxbow Lake:** This is a cut off meander filled with alluvial material. The shape of the land form looks like an oxbow. The rivers often meander giving rise to the occasional formation of oxbow lakes along their courses. Ground water prospect is excellent in these areas. **ix. Paleo Channel:** This includes buried as well as abandoned channels. These are mostly comprised of fluvial deposits of varying grain size. Ground water prospect is good to excellent. **x. Flood Plain:** This is an area adjacent to the river and mostly built up by river

This is an area adjacent to the river and mostly built up by river borne deposits during high floods. Flood plains primarily consist of unconsolidated materials like sand, gravel and silt. Groundwater prospect is good to very good. **xi. Younger Alluvial Plain:** This is a flat to gently undulating plain of large extent formed by river action. The area encompasses various fluvial landforms in the latter stage of deposition in the fluvial cycle. This constitutes unconsolidated materials like gravel, sand and clay of varying size and forms prolific aquifers.

Drainage:

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

GEOLOGY:

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

STRATIGRAPHY:

Holocene: Sand dune, newer alluvium

Older alluvium

Laterite

Quaternary: Recent to sub-Recent Laterites and lateritic gravels

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

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

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

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

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

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

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

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

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

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

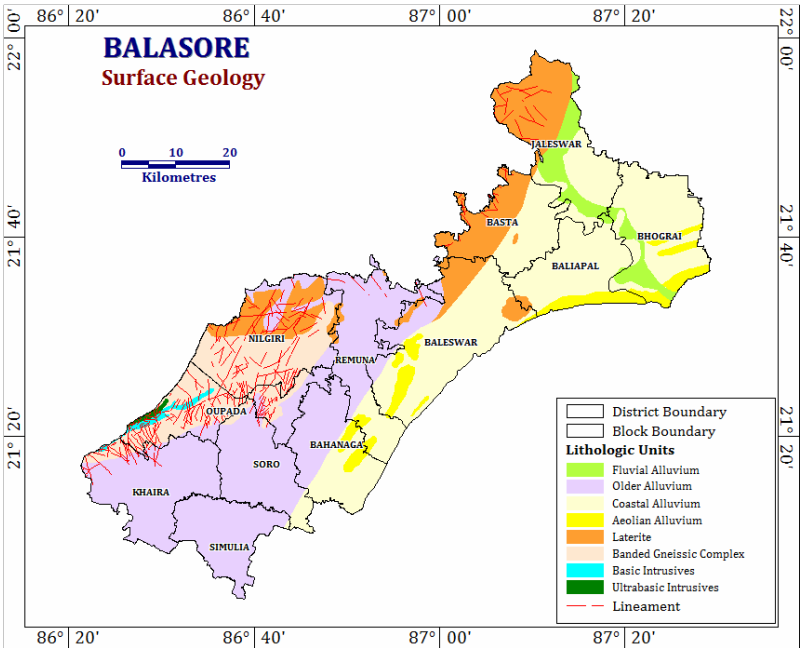


Figure 2: Surface Geological Map of Balasore District

MINERAL RESOURCES :

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

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

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

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

Laterite: Laterites are found around Bhalukasuni, Rangamatia, Kusundaspur, Khaira and Kupari areas. Thickness of laterite in these areas vary from 10m to 12m and used for laterite brick purpose.

Dolerite: Dolerites found in the district are important for dimension stone. These occur as intrusive dykes within Nilgiri granite around Barakhada, Tiakata, Khandihuda, Betei, Morichua, Basanga, Padmapokhari, Barikdhara and Raipal village. These are used as polished blocks and tiles for flooring, kitchen platforms and wall panels etc. China Clay: White plastic gritty china clay deposit occur to the north of Arbanda hosted in highly decomposed gneiss. Though the deposit is extensive, the clay content is only about 10%. About 23m thick white clay deposit occurs to the north of Garidihi concealed underaterite capping. The clay is banded in appearance and is slightly gritty

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

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Fig.3: Nilagiri hill

COVID-19 Surges: A Geo-Spatial Approach

Dr Smruti Rekha Sahoo, Assistant Professor

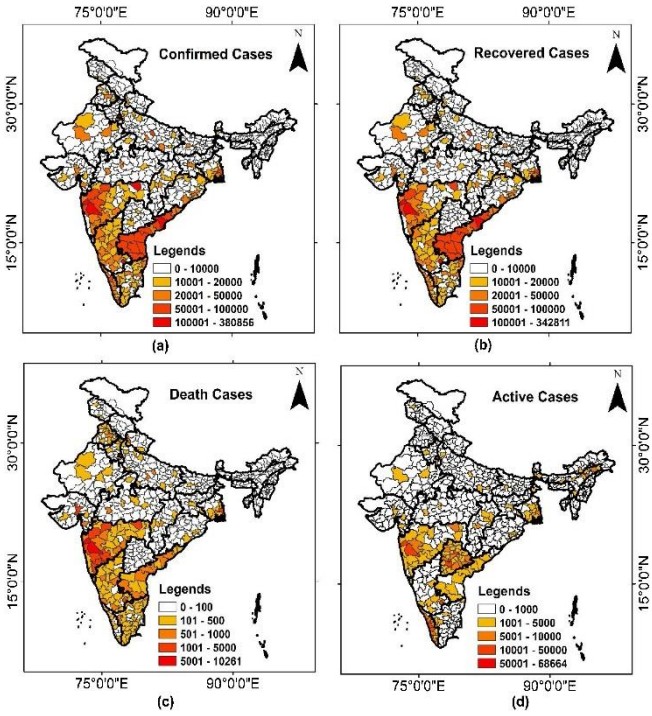
At the onset of the COVID-19 outbreak, spatial statistics software development team worked to incorporate several open-source models into the geospatial toolbox, starting with the model based study. Bringing a model into a geographic information system (GIS) aligns it directly to the data source that drives the model. This integration provides the means to visualize a problem geographically and ties model outputs to solutions designed for immediate action.

The GIS users can drill more deeply into specific geographies to see model outputs alongside other spatially varying data—such as senior populations or communal living places which are more vulnerable—to explore what the model results mean for people and places. This approach also fuels the next question, which is, "where and when should resources be moved to meet the demand?" Tools such as location-allocation can guide these decisions and make sure demand is met as effectively and equitably as possible.

The use of GIS to determine geographical distribution patterns of diseases in medical and health sciences has increased significantly. Defining the geographical distribution of diseases, the spatial study of care facilities and health services, determining the geographical boundaries of communities that are essential components of epidemiological and health studies are some of the applications of GIS in the field of health. Spatial modelling in GIS is directly used to understand the differences in the spatial distribution of diseases and their relationship with environmental factors and health care system; as a result, GIS technology is currently a major tool in health research in the field of infectious diseases.

The GIS directly supports discussions within Emergency Operations Centers where model outputs can be shared on large screens to guide collaborative planning discussions. Then, when decisions about what actions to take are made, GIS provides the means to push data and directives into map-driven apps and solutions first responders use in field work as shown in figure.

Details such as average hospital length of stay, the percentage of people who will be ventilated or need intensive care, are also key inputs to the model. The model can then be compared to current hospital capacity, such as available beds and ventilators. Comparing the peak of disease spread to hospital capacity helps local authorities determine when more hospital beds may be needed and plan ahead to meet spikes in demand. While users of a model can input generalized (averaged) parameters, they will achieve greater accuracy and thus higher value by using more precise values that better represent each area's underlying population characteristics and response to social distancing efforts. However, as time goes on and more data became available, more complex GIS tools come into play.



ଭୂତତ୍ତ୍ୱବିତ୍ ଓ ପଥରର ଭିନ୍ନ ଏକ କାହାଣୀ

ଅରୁଣ କୁମାର ନାଏକ ଓ କବିତା ନାଏକ

ପୁରାତନ ପ୍ରସ୍ତର ଯୁଗରୁ ମନୁଷ୍ୟ ନିଜର ଖାଦ୍ୟ ସଂଗ୍ରହ ଓ ନିରାପତ୍ତା ପାଇଁ ପଥରର ବ୍ୟବହାର କରିଆସୁଛି। ପଥରରେ ବିଭିନ୍ନ ହାତହତିଆର ତିଆରି କରି ବିଭିନ୍ନ କାର୍ଯ୍ୟରେ ବ୍ୟବହାର କରୁଥିବାର ପ୍ରମାଣ ମଧ୍ୟ ମିଳିଛି। ସମୟକ୍ରମେ ମନୁଷ୍ୟର ବୌଦ୍ଧିକ ବିକାଶ ଘଟିଲା ଏବଂ ପଥରକୁ ପଥର ସହିତ ଘଷି ନିଆଁର ବ୍ୟବହାର ମଧ୍ୟ ଜାଣିଲା। ତା ସହିତ ବସ୍ତ୍ର ଓ ବାସଗୃହର ମଧ୍ୟ ବ୍ୟବହାର କଲା। କ୍ରମଶଃ ସେ ଲେଖା ପଢା ଜାଣିଲା ଏବଂ ନିଜର ଭାବକୁ ବିଭିନ୍ନ ଲିପି ମାଧ୍ୟମରେ ତଥା ଚିତ୍ରକଳା ମାଧ୍ୟମରେ ପ୍ରକାଶ କଲା ଯାହାସବୁ ବର୍ତ୍ତମାନ ଯୁଗରେ ବହୁ ପୁରାତନ ଗୁମ୍ଫା ମଧ୍ୟରେ ସଂରକ୍ଷିତ ହୋଇ ରହିଛି। ସମୟ ସ୍ରୋତରେ ମନୁଷ୍ୟ ଅଗ୍ରସର ହେବା ସହିତ ତା'ର ଆଧ୍ୟାତ୍ମିକ ଚେତନା ମଧ୍ୟ ଜାଗ୍ରତ ହୋଇଥିଲା ଏବଂ ସେ ପ୍ରକୃତିର ଉପାସନା ଆରମ୍ଭ କଲା। ସେ ନଦୀ, ପର୍ବତ, ସୂର୍ଯ୍ୟ, ବୃକ୍ଷ ଆଦିକୁ ପୂଜା କରିଥିଲା ତଥା ପଥର ମୂର୍ତ୍ତିକୁ ପୂଜା କରିବା ଆରମ୍ଭ କରିଥିଲା।

ଏକ ସାଧାରଣ ମଣିଷ ଏକ ପଥରକୁ ଦେଖି ଉପରୋକ୍ତ କଥା ଗୁଡ଼ିକ ବିଷୟରେ ଚିନ୍ତା କରେ। କିନ୍ତୁ ପୃଥିବୀ ସୃଷ୍ଟି ହେବାଠାରୁ ଆଜି ପର୍ଯ୍ୟନ୍ତ ଯାହା ସବୁ ଘଟଣାବଳୀ ଘଟିଆସିଛି ସେ ସବୁର ମୁକ ସାକ୍ଷୀ ହେଉଛି ପଥର। ଆଉ ଯିଏ ସେ ପଥରର ଅନ୍ତରର କଥାକୁ ବୁଝିପାରିଥାଏ ସେ ହଉଛି ଭୂତତ୍ତ୍ୱବିତ୍ । ଏକ ଭୂତତ୍ତ୍ୱବିତ୍ ପୃଥିବୀ ଗର୍ଭରେ ଲୁଚି ରହିଥିବା ରହସ୍ୟମୟ ଖଣିଜ ପଦାର୍ଥକୁ ବାହାର କରି ଏ ସମାଜକୁ ପ୍ରଦାନ କରିଛି ଯାହା ଆଧୁନିକ ଯୁଗରେ ଦୈନନ୍ଦିନ ଜୀବନକୁ ବଞ୍ଚିବାର ଶୈଳୀକୁ ଉନ୍ନତ ମାନର କରୁଅଛି। ପଥରକୁ ଅଧ୍ୟୟନ କରି ଆମେ 4.2ଅରବ ବର୍ଷ ପୂର୍ବରୁ ପୃଥିବୀ ସୃଷ୍ଟି ହେବା ପ୍ରକ୍ରିୟାଠାରୁ ଆରମ୍ଭ କରି ବହୁମୂଲ୍ୟ ଖଣିଜ ପଦାର୍ଥ ତଥା ଜୈବଇନ୍ଧନର ସୃଷ୍ଟି ହେବା ପ୍ରକ୍ରିୟା ଏବଂ ସେମାନଙ୍କର ପୃଥିବୀ ପୃଷ୍ଠରେ ବିତରଣ ପ୍ରଣାଳୀକୁ ସହଜରେ ବୁଝି ପାରିଥାନ୍ତି। ପଥରରେ ଥିବା minerals ଏବଂ ଜୀବାଶ୍ମରେ ଥିବା isotopesକୁ ଅଧ୍ୟୟନ କରି ସେହି ପରିବେଶର ବୟସ ନିର୍ଧାରିତ କରିଥାଉ।

ଜଣେ ଭୂବିଜ୍ଞାନି ପଥର ସହିତ କଥାବାର୍ତ୍ତା କରେ ଏବଂ ତା'ର ସବୁ ଦୁଃଖ କଷ୍ଟକୁ ବୁଝି ପାରିଥାଏ। ସେ ପଥର କିପରି ସେହି ସ୍ଥାନରେ ସୃଷ୍ଟି ହେଲା କିମ୍ବା କୌଣସି ସ୍ଥାନରୁ ସେହି ସ୍ଥାନକୁ ପରିବହନ ଦ୍ୱାରା ପହଞ୍ଚିଲା ପଥରର ଏପରି କାହାଣୀକୁ ବୁଝିଥାଏ। ଓଡ଼ିଶାର ବାଲେଶ୍ୱର ସ୍ଥିତ ଆମ ଫକୀରମୋହନ ବିଶ୍ୱବିଦ୍ୟାଳୟରେ ଥିବା ଭୂତତ୍ତ୍ୱବିଜ୍ଞାନ ବିଭାଗରେ ଉଦ୍ଦୀୟମାନ ଯୁବ ଭୂବିଜ୍ଞାନିମାନେ ଭବିଷ୍ୟତ ନିମନ୍ତେ ପ୍ରସ୍ତୁତ ହେଉଛନ୍ତି। ସେମାନେ ମଧ୍ୟ ଭାରତରେ ବିଭିନ୍ନ ସ୍ଥାନକୁ ଯାଇ ପ୍ରସ୍ତର ସହିତ ଲୁଚି ରହିଥିବା କାହାଣୀକୁ ବୁଝିବାକୁ ନିଜର ପ୍ରଚେଷ୍ଟା ଜାରି ରଖିଛନ୍ତି।




ବିଗତ ବର୍ଷ ୨୦୨୧ରେ ଆମେ ଏକ ଭୂତତ୍ତ୍ୱବିତ୍ ଗୋଷ୍ଠୀ ଝାଡ଼ଖଣ୍ଡ ରାଜ୍ୟର ରାମଗଡ଼ ଜିଲ୍ଲା ଅନ୍ତର୍ଗତ କୁଜୁ ଅଞ୍ଚଳକୁ ଯାଇଥିଲୁ ଏବଂ ସେଠାରେ ଆମେ ଭାରତର ଜାତୀୟ ଭୂବିଜ୍ଞାନି ସଂସ୍ଥା ସହିତ ଏକ ସ୍ଥାନକୁ ପରିଦର୍ଶନ କରିଥିଲୁ। ସେଠାରେ ଏକ ବିଶାଳ ପଥର ଫାଂକ ମଧ୍ୟରେ ଏକ ସୂକ୍ଷ୍ମ ପଟୁସମ ଶିଳାର ଅବସ୍ଥିତି ଏକ ବିଶାଳ ବରଫଖଣ୍ଡ ଦ୍ୱାରା ଯେ ଜମା ହୋଇଥିବ ଏକ ସାଧାରଣ ମଣିଷ ଚିନ୍ତା ମଧ୍ୟ କରି ନ ଥିବ। କିଛି ଦୂର ଆଗକୁ ଚାଲିବା ପରେ ବିଭିନ୍ନ breccia ଏକ ପ୍ରକାର ସ୍ତରିଭୂତ ଶିଳା ଦୃଶ୍ୟମାନ ହୋଇଥିଲା ଯାହା ସବୁ ବରଫଖଣ୍ଡ ବା glacier ଦ୍ୱାରା ଉତ୍ପାଦିତ। ଆଉ କିଛି ବାଟ ଆଗେଇଲା ପରେ Tillite ଦେଖିବାକୁ ମିଳିଥିଲା ଯାହା ବଡ଼ ବଡ଼ ପଥର ଖଣ୍ଡର ସମନ୍ୱୟରେ ଗଠିତ ହୋଇଥିଲା, ତାହା ମଧ୍ୟ glacier ଉତ୍ପାଦିତ। ଯେତେ ଆଗକୁ ଆଗକୁ ପାଦ ବଢୁଥାଏ ସେତିକି ସେହି ପଥରଖଣ୍ଡମାନଙ୍କର ଆକାର କମ୍ ହେବାକୁ ଲାଗିଲା ଏବଂ ତାହା ସଂକେତ ପ୍ରଦାନ କରୁଥିଲା ଅନ୍ୟ ଏକ ପରିବେଶର। ଏହା ନଦୀ ସ୍ରୋତରେ ପ୍ରବାହିତ ହୋଇ ଜମା ହେଉଥିବାର ପ୍ରମାଣ ଦିଏ। କିଛି ଦୂର ଆଗକୁ ଗଲା ପରେ ସାମୁଦ୍ରିକ ପରିବେଶର ଅବସ୍ଥିତିର ସୁଚନା ମିଳିଥିଲା ସେ ଶିଳାର sediments ର ଆକାର ଓ sedimentary structure କୁ ଲକ୍ଷ୍ୟ କରି। Sediments ର ଆକାରରେ ପରିବର୍ତ୍ତନ ଏବଂ sedimentary structure ରେ ପରିବର୍ତ୍ତନ, sediments ଜମା ହେଉଥିବା ପରିବେଶର ପରିବର୍ତ୍ତନ glacial ଠାରୁ fluvio-glacial ତାପରେ fluvial ଠାରୁ marine ଅତି ସୁନ୍ଦର ବର୍ଣ୍ଣନା କରୁଅଛି। କିନ୍ତୁ ଏସବୁକୁ ବୁଝିବା ନିମନ୍ତେ ଭୂତତ୍ତ୍ୱବିତ୍ ହେବାକୁ ପଡ଼ିବ।

ଅରୁଣ କୁମାର ନାଏକ ଓ କବିତା ନାଏକ
ଫକୀରମୋହନ ବିଶ୍ୱବିଦ୍ୟାଳୟ

॥ ବାପାଙ୍କ ସାଇକେଲ ॥

ସର୍ବେଶ୍ୱର ରାଉତ

ସାଇକେଲର ପ୍ରଚଳନ କେବଳ ଆଜିକାଲି ନୁହେଁ । ଯାହା ଅନୁମାନ କରାଯାଏ , ପ୍ରାୟ ଦୀର୍ଘ ଦୁଇ ଶହ ବର୍ଷ ତଳୁ ସାଇକେଲ ଜନ୍ମ ଲାଭ କରିଛି । ଆଧୁନିକ ଯୁଗ ଅର୍ଥାତ୍ ଆଜି ପର୍ଯ୍ୟନ୍ତ ସାଇକେଲର ବ୍ୟବହାର ବଳବତ୍ତର ରହିଆସିଛି ।

ଏ କଥା ମୋ ଜେଜେବାପାଙ୍କଠାରୁ ଗପ ଶୁଣିବା ବେଳେ ଜାଣିଥିଲି । ତାଙ୍କ ସମୟରେ ଦଶ ଖଣ୍ଡ ଗାଁରେ କାଁ ଭାଁ ଜଣେ କିଏ ସାଇକେଲ କିଣିଥିବାର ଜଣାପଡୁଥିଲା । ସେ ସାଇକେଲ ବା ଶୂନଗାଡ଼ିକୁ ଦେଖିବା ପାଇଁ ଲୋକମାନଙ୍କର ଲମ୍ବା ଭିଡ଼ ମଧ୍ୟ ଲାଗି ରହୁଥିଲା । ଯେଉଁ ଲୋକଟି ସାଇକେଲ କିଣିଥିଲା , ସେହି ଲୋକଟି ସେତେବେଳେ ଜମିଦାରଙ୍କ ନିକଟରେ ଗୁମାସ୍ତା କାମ କରୁଥିଲା । ଜମିଦାର ଘୋଡ଼ାଗାଡ଼ି ଚଢୁଥିବା ବେଳେ ନିଜ ଗୁମାସ୍ତାକୁ ଖୁସିରେ ସାଇକେଲଟିଏ ଉପହାର ଦେଇଥିଲେ । ଗୁମାସ୍ତା ଜଣକ ଜମିଦାରଙ୍କ ଠାରୁ ସାଇକେଲଟିଏ ଉପହାର ପାଇବା ପରଠୁ ଜମିଦାରଙ୍କ କାମରେ ଗୁମାସ୍ତାର ସୁବିଧା ହେଉଥିଲା, ନହେଲେ ଆଗରୁ ଚାଲିଚାଲି ଯିବାକୁ ପଡୁଥିଲା ।

ଜମିଦାର ନିଜ ଗୁମାସ୍ତାକୁ ସାଇକେଲଟିଏ ଉପହାର ସ୍ୱରୂପ ଦେବାର ଦେଖି ଜେଜେବାପାଙ୍କର ମନ ବିକଳ ହେଲା । ତାଙ୍କ ପୁଅ ଅର୍ଥାତ୍ ମୋ ବାପାଙ୍କ ପାଇଁ ସାଇକେଲଟିଏ କିଣିବା ପାଇଁ କଳେବଳେ କୌଶଳେ ପ୍ରତ୍ୟେକ ଦିନ କିଛି କିଛି ଟଙ୍କା ସଞ୍ଚୟ କଲେ । ଟଙ୍କା ସଞ୍ଚୟ କରିବା ପାଇଁ ଜେଜେଙ୍କର ବର୍ଷେ ଦୁଇ ବର୍ଷ ବିତିଗଲା । ତା' ପରେ କଟକ ଯାଇ ନୂଆ ସାଇକେଲଟିଏ କିଣିଆଣିଲେ ନିଜ ପୁଅ ପାଇଁ । ସାଇକେଲ ଚଳାଇବା ଶିଖିନଥିବାରୁ ଘରକୁ ଗଡ଼େଇ ଗଡ଼େଇ ଆଣିଥିଲେ ।

ବାପା ସେତେବେଳେକୁ ସପ୍ତମ ଶ୍ରେଣୀ ପାସ୍ କରିସାରିଥିଲେ । ଅଷ୍ଟମ ଶ୍ରେଣୀରେ ପଢ଼ିବା ପାଇଁ ଗାଁ ଠାରୁ ସାତ ଆଠ କିଲୋମିଟର ଚାଲି ଚାଲି ଯିବାକୁ ପଡୁଥିଲା । ବାପା ସାଇକେଲ ଚଳାଇବା ଶିଖିନଥିଲେ , ସେଥିପାଇଁ ଗାଁରେ ପ୍ରଥମେ ସେ ଗଡ଼େଇବା ଶିଖିଲେ । ତା' ପରେ ଗୋଡ଼ ଗଳା ଚଢ଼ିଲେ । ବହୁ କଷ୍ଟରେ ପଡ଼ିଉଠି ସାଇକେଲ ଚଢ଼ା ଶିଖିଲେ । କିଛିଦିନ ପରେ ଭଲରେ ସିଟ୍ ଉପରେ ବସି ସାଇକେଲ ଚଳାଇବାର ଦେଖାଗଲା ।

ବାପା ମାଟ୍ରିକ ପାସ କଲାପରେ ପୋଷ୍ଟ ଅଫିସରେ ଚାକିରି କଲେ । ସେହିବର୍ଷ ବାପା ବିବାହ କରିଥିଲେ ବୋଲି ଜେଜେବାପା ଗପ କହୁଥିବାବେଳେ ମୋତେ ମନେ ପକାଇ ଦେଇଥିଲେ । ସେତେବେଳେ ବିବାହ ପାଇଁ ଯୌତୁକ ବାବଦରେ ସାଇକେଲ , ରେଡ଼ିଓ , ଘଣ୍ଟା ଇତ୍ୟାଦି ମୁଖ୍ୟ ଦାଉରୀ ଥିଲା । ବାପା ସେ ସବୁ ଯୌତୁକରେ ପାଇଥିଲେ । ସେ ସମୟରେ ଗାଁ ଗାଁରେ ମଟରସାଇକେଲ ଭର୍ତ୍ତି । କିନ୍ତୁ ବାପାଙ୍କର ସାଇକେଲ ଭଲ ତ ସବୁ ଭଲ । ସବୁଦିନ ସାଇକେଲ ଚଳାଇ ଅଫିସ ଯିବାଆସିବା କରନ୍ତି । ଦେହ ଫୁର୍ତ୍ତି ରୁହେ । ଏକ ପ୍ରକାର ବ୍ୟାୟାମ ବା ଯୋଗ ମଧ୍ୟ ହୋଇଯାଏ । ରୋଗ ବୈରାଗ୍ୟ କିଛି ହୁଏନାହିଁ ।

ଆମ ସମୟ ଆସିଗଲା । ବାପାଙ୍କ ସାଇକେଲ ଆଉ କାମ ଦେଲାନାହିଁ । କାଁ ଭାଁ ଚଳାଉ । ମଟର ସାଇକେଲ ଅଛି ତ ଯୁଆଡ଼େ ଇଚ୍ଛା ସିଆଡ଼େ ଖୁବ୍ ଶୀଘ୍ର ଚାଲିଯାଉ । କିନ୍ତୁ ପେଟ୍ରୋଲ ବାବଦକୁ ବହୁ ଟଙ୍କା ଖର୍ଚ୍ଚ ହୋଇଯାଏ । ସେ ସବୁ ବାପାଙ୍କ ପକେଟରୁ ଯାଏ । ଆଜି ବି ବାପା ସାଇକେଲ ଚଳାଉଛନ୍ତି । ସେ ସବୁବେଳେ ସୁସ୍ଥ ରହିବା ପାଇଁ ସାଇକେଲ ବ୍ୟବହାରକୁ ଗୁରୁତ୍ୱ ଦେଉଅଛନ୍ତି। ଅତି ଆବଶ୍ୟକ ବେଳେ ମଟର ସାଇକେଲ ଲୋଡୁଛନ୍ତି । କିନ୍ତୁ ଆମେ ତ କିଛି ଶିଖିଲୁ ନାହିଁ କି ବୁଝିଲୁ ନାହିଁ , ଯେଉଁଠି ଚାଲି ଚାଲି ଗଲେ ଚଳିବ ସେଠି ଆମେ ପେଟ୍ରୋଲ ଚଳିତ ମଟର ସାଇକେଲ ବ୍ୟବହାର କରୁଛୁ । ଏହା ଦ୍ୱାରା ଆମେ କର୍ମଠ ହୋଇପଡୁଛୁ । ଆମ ଶରୀରରେ କିଛି କସରତ ହେଉନାହିଁ , ଯାହାଫଳରେ ଅନେକ ସମୟରେ ବହୁ ପ୍ରକାର ରୋଗ ଆମକୁ ମାଡ଼ି ବସୁଛି ।

ବାପାଙ୍କ ସାଇକେଲ ଆମ ଗାଁରେ ଆଦର୍ଶର ନମୁନା ପାଲଟିଯାଇଛି । ଇତିହାସ ପାଇଁ ମୁଖ୍ୟସାକ୍ଷୀ । ବର୍ତମାନ ପରିସ୍ଥିତିରେ ଅହେତୁକ ପେଟ୍ରୋଲର ମୂଲ୍ୟବୃଦ୍ଧି ଚିନ୍ତାର କାରଣ ପାଲଟିଛି । ସମସ୍ତେ ଏଥିପାଇଁ ସଚେତନ ହେବା ଆବଶ୍ୟକ । କେବଳ ଅତି ଆବଶ୍ୟକ ସମୟରେ ପେଟ୍ରୋଲ ଚାଳିତ ମଟର ସାଇକେଲ ବ୍ୟବହାର କରିବା । ନଚେତ୍ ଯେଉଁ ସ୍ଥାନକୁ ଚାଲି ଚାଲି ଗଲେ ଚଳିବ , ସେହି ସ୍ଥାନକୁ ଚାଲି ଚାଲି ଯିବା ପାଇଁ ଚେଷ୍ଟା କରିବା । ଏବେ ମୋ ବାପାଙ୍କ ସାଇକେଲ ମନେ ପକାଇ ଦେଉଛି ଯେ ସାଇକେଲ ଗୋଟିଏ ଅତି ଉପକାରୀ ସାଧାରଣ ଗାଡ଼ିଟିଏ ।

ସର୍ବେଶ୍ୱର ରାଉତ
ଦ୍ୱିତୀୟ ବର୍ଷ ସ୍ନାତକୋତ୍ତର ଭୂତତ୍ତ୍ୱ ବିଭାଗ ଛାତ୍ର
ଫକୀରମୋହନ ବିଶ୍ୱବିଦ୍ୟାଳୟ , ନୂଆପାଡ଼ୀ , ବାଲେଶ୍ୱର
ଦୂରଭାଷ-୯୧୭୮୭୭୧୪୫୨

ପଥରରେ ବି ଜୀବନ

ରିଜୟସ ନାୟକ
ଭୂତତ୍ତ୍ୱ ବିଜ୍ଞାନ ବିଭାଗ, ଦ୍ୱିତୀୟ ବର୍ଷ

ଶକତ କଠିନ ଲାଗୁଚି ଉପରେ
ଜୀବନ ଧରିଛି ଦେହେ
ପାଷାଣ ହୋଇ ବି ସହୁଛି କଷଣ
ନୀରବେ ସେ କଥା କହେ ।

ଗଡି ଗଡି ଯାଏ ଦିଗହରା ପରି
ପାହାଡରୁ ପାଦଦେଶେ
ଦେହରେ ଧରିଛି ଅନେକ ଖଣିଜ
ରଙ୍ଗ ବେରଙ୍ଗ ର ବେଶେ ।

ସ୍ୱଂୟ ଜୀବନ ବହିଅଛି ଦେହେ
ସଭିଙ୍କର ଅଗୋଚର
କଠିନ ହୋଇବି ଫୁଟାଏ ସେ ଗଛ
ଜଳ ପ୍ରବାହି ଶରୀରେ ।

ପ୍ରତୀକ ସେ ଅଟେ ଅନେକ ସ୍ମୃତି ର
ସମୟ ଚକ୍ର ର ସାକ୍ଷୀ
କହେ ନାନା ପ୍ରଜାତି ସୃଷ୍ଟି ର
ରହସ୍ୟମନରେ ସାଇତି ରଖି ।

କେବେ ସେ ଖାଇଛି ହାତୁଡ଼ି ପ୍ରହାର
ମଣିଷ ର ସ୍ୱାର୍ଥ ପାଇଁ
କେବେ ପୁଣି ସେ ତୁଠ ର ପଥର
ଶିଉଳି କୁ ଦେହେ ବହି ।

ଅଂଶାବଶେଷ ରୁ ମୃତ୍ତିକା ର ଜନ୍ମ
କରୁଚି ମହତ କାମ
ଲାଭା ରୁ ବାହାରି ନିଆଁ କୁ ତିଆରି
କାର୍ଯ୍ୟ ତା ଜୀବନ୍ତ ସମ ।

ନିର୍ଜୀବ ନୁହେଁ ସେ ସଜୀବ ଅଟଇ
ସମର୍ପିତ ପରହିତେ
ପାଷାଣ ଦେହରେ ଜୀବନ ରହିଛି
ବୁଝାଇ ଦେଲି ମୁଁ ଗିତେ ।

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ବାଲି ର ସହର ବାଲେଶ୍ୱର

ରିଜୟସ ନାୟକ
ଭୂତତ୍ତ୍ୱ ବିଜ୍ଞାନ ବିଭାଗ, ଦ୍ୱିତୀୟ ବର୍ଷ

ବାଲି ର ସହର ବାଲେଶ୍ୱର ସେତ
କ୍ଷେପଣାସ୍ତ୍ର ତାର ଗର୍ଭେ
ଚାନ୍ଦିପୁର ର ବେଳାଭୂମି ରେ
ପର୍ଯ୍ୟଟକ ଙ୍କ ମନ ମୋହେ ।

ପୂର୍ବ ଓଡ଼ିଶା ର ଜଗୁଆଳ ପୁଣି
ସାଜିଛି ବୀର ଙ୍କ ଭୂମି
ଇରମରେ ଯେବେ ଲକ୍ଷ୍ୟଲକ୍ଷ୍ୟ ପ୍ରାଣ
ଗଲା ମାତୃକା ରେ ସମି ।

ଫକୀର ମୋହନ ଙ୍କ ନିପୁଣତା ର
ଏହି ଜିଲ୍ଲା ମୁକ ସାକ୍ଷୀ
କ୍ଷୀରଚୋରା ଆଉ ପଞ୍ଚୁଲିଙ୍ଗେଶ୍ୱର
ଯାହାର କଳା କିରତୀ ।

ବୁଢ଼ାବଳଙ୍ଗ ଓ ସୁବର୍ଣ୍ଣରେଖା ରେ
ଆବଦ୍ଧ ହୋଇଛି ସିଏ
ଏହି ଦୁଇ ନଦୀ ମୁହାଣ ତିଆରି
ଲୋକଙ୍କ ଜୀବିକା ବହେ ।

ଇମାମି ରେ ଜଗନ୍ନାଥ ଙ୍କ ମନ୍ଦିର
ଚନ୍ଦନେଶ୍ୱର ରେ ଶିବ
ଦଣ୍ଡକାଳୀ ଖଣ୍ଡପଡା ରେ ଅଛନ୍ତି
ଅଯୋଧ୍ୟା ରେ ସୂର୍ଯ୍ୟ ଦେବ ।

ବିଶ୍ୱବିଦ୍ୟାଳୟ ଆମ ର ଏଇଠି
ନୀଳଗିରି ର ପାଦ ଦେଶେ
ସବୁଜ ସୁନ୍ଦର ଏହି ପରିବେଶ
ବନବନାନି ର ବେଶେ ।

ଗର୍ବିତ ଆମେ ଏହି ସହର ରେ ପଢ଼ି
କରିବୁ ଅନେକ କାମ
ଫକୀର ମୋହନଙ୍କ ଭଳି ବିଶ୍ୱ ବିଦିତ ହୋଇ
ରଖିବୁ ଜିଲ୍ଲା ର ନାମ ।

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ପରୀକ୍ଷା ଋତୁ ରେ ମୁଁ.....

ରିଜୟସ ନାୟକ
ଭୂତତ୍ତ୍ୱ ବିଜ୍ଞାନ ବିଭାଗ, ଦ୍ୱିତୀୟ ବର୍ଷ

ପରୀକ୍ଷା ଆସିକି ମୁଣ୍ଡ ଉପରେ
କାନ ମୁଣ୍ଡ ମାରେ ଝାଇଁ
ଆଖି ଟଳମଳ ନିଦ ରାଇଜ ରେ
କିଛି ମନେ ରହେ ନାହିଁ ।

ସାରିବାକୁ ହେବ ଅସରନ୍ତି ନୋଟ
ଘୋଷିବି ଅନେକ କିଛି
ଆରମ୍ଭ ରୁ ଶେଷ ଆମୂଳଚୁଳ
ଲେଖେ ଧାଡ଼ି ବାଛି ବାଛି ।

କ'ଣ କରିବି କେମିତି ପଢିବି
ଭାବି ଚିନ୍ତା ରେ ବସେ
ସାଙ୍ଗ କୁ ଦେଖି କଳା ବାଦଲ
ମୁଣ୍ଡ ଉପରେ ଭାସେ ।

ଯେତେବେଳ ପଡେ ଘଣ୍ଟା କୁ ଦୃଷ୍ଟି
ଥଙ୍ଗେଇ ଯାଏ ମନ
ଟ୍ରେନ ବେଗ ରେ ଦୌଡୁଥାଏ ସେ
ଗାଇ ମୋ କଷ୍ଟ ର ଗାନ ।

ଏତେ ବାଟ ଯାଏଁ ନ ହାରି ଆସିଛି
ମନ ଘଣ୍ଟା କୁ କୁହେ
ତୁ ଦେଖିବୁ ମୁଁ ନିଶ୍ଚୟ ଲେଖିବି
ରଖିବି ଶହେ ରୁ ଶହେ ।

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॥ ମୋ ପ୍ରିୟା ॥

ଦେବାଶିଷ ମହାନ୍ତି
ଭୂତତ୍ତ୍ୱ ବିଜ୍ଞାନ ବିଭାଗ, ଦ୍ୱିତୀୟ ବର୍ଷ

ପ୍ରେମରେ ତୁମରି ସାଜିଛି ପ୍ରେମିକ
ଆଗୋ ମୋର ପ୍ରିୟତମା
ସ୍ୱପ୍ନ ମୁଁ ଦେଖୁଛି ଦିନରାତି ଖାଲି
ଡେଇଁ ସବୁ ପରିସୀମା ।

ମୋ ହୃଦୟ ସ୍ପନ୍ଦନ ତୁମ ନାଁ ଧରି
ଗାଏ ପ୍ରୀତିଭରା ଗୀତ
ପ୍ରତି ମୁହୂର୍ତ୍ତରେ ଖୋଜେ ସେ ତୁମକୁ
କରିବାକୁ ମନ ମିତ ।

ତୁମ ହାତ ଧରି ବାଟ ଚାଲିବାକୁ
ଦେଖିଛି ମୁଁ ସ୍ୱପ୍ନ କେତେ
ରହିଥିବା ପ୍ରିୟା ସାଥି ହୋଇ ଆମେ
ଆସୁ ପଛେ ଦୁଃଖ ଯେତେ ।

ଖୋଜି ଖୋଜି ପ୍ରିୟା ତୁମକୁ ପାଇଛି
ଏତେ ବଡ଼ ଦୁନିଆରେ
ହାତ ଛାଡ଼ି ପ୍ରିୟା ଯିବ ନାହିଁ କେବେ
ମରିଯିବି ବିରହରେ ।

ତୁମେ ମୋ ଜୀବନ ତୁମେ ମୋର ଧନ
ତୁମେ ମୋର ସବୁକିଛି
ତୁମ ପାଇଁ ପ୍ରିୟା ଲେଖକ ମୁଁ ସାଜି
ପ୍ରେମ କବି ପାଲଟିଛି ।

ସୁଖେ ଦୁଃଖେ ମୋର ପ୍ରତିଛବି ପରି
ମୋ ସାଙ୍ଗେ ଚାଲୁଥିବ ବାଟ
ମୁକ୍ତ ହୃଦୟରେ ଭଲ ପାଉଥିବି ତୁମକୁ
ଭୁଲି ଯାଇ ସବୁ ଦୁଃଖ କଷ୍ଟ ।

କୋମଳ ହୃଦୟରେ ଛୁଇଁ ଚାଲିଗଲ
ଦେବୀ ରୂପୀ ବନ୍ଦନୀୟା
କେତେ ଯେ ମୁଁ ତୁମକୁ ପାଉଅଛି ଭଲ
ତୁମେ ପରା ମୋର ପ୍ରିୟା ।
ମୋ ପ୍ରିୟା.....ମୋ ପ୍ରିୟା.....ମୋ ପ୍ରିୟା

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।। ମା ।।

ଦେବାଶିଷ ମହାନ୍ତି
ଭୂତତ୍ତ୍ୱ ବିଜ୍ଞାନ ବିଭାଗ, ଦ୍ୱିତୀୟ ବର୍ଷ

ସତ ମିଛର ଏ ଦୁନିଆ ଦେଖିଲି
ତୋ କୋଳ ଛାଡିବା ପରେ,
ଚଳନ୍ତି ଠାକୁର ତୁ ମୋର ଜାଣିଲି
ତୋ ପାଦ ଛୁଇଁଲା ପରେ ।

ମମତାମୟୀ ତୁ ସ୍ନେହର ସାଗର
ତୋ କୋଳେ ସରଗ ସୁଖ,
ତୋ କାନିକୁ ଧରି ବାଟ ଚାଲୁଥିଲେ
ଦୁଃଖ ମାଡେନାହିଁ ପାଖ ।

ତୋର ସେ ପଣତ ଶ୍ରୀମନ୍ଦିରର ନେତ
ସ୍ନେହ ମମତାର ଘର,
ଯେତେ ଝଡ଼ଝଞ୍ଝା ଆସିଲେ ପଛେ ତୁ
କରିବୁନି କେବେ ପର ।

ତୋ ହାତ ପରଶେ ଦୁଃଖ କଷ୍ଟ ମୋର
ଯାଏ ତ ସବୁ ଉଭେଇ,
ତୋ ବିନା ମରିବା ଜିଇଁବା
ସମାନମୂଲ୍ୟହୀନ ଯେ ମୋ ପାଇଁ ।

କେଉଁ ଦରବ ବା ଉପହାର ଦେବି
ଯୋଗ୍ୟ କିଏ ହେବ ତୋର,
ହୃଦୟର ସହ ଗ୍ରହଣ କରିବୁ
ମୋର ଛୋଟ ଉପହାର ।

ତୋ ଡାକ ଶୁଣିବା ପରେ ହିଁ ବୁଝିଛି
ତା ଠାରୁ ମଧୁର ନାହିଁ କିଛି,
ତୋ ଛୁଆଁ ପାଇବା ପରେ ହିଁ ଭାବୁଛି
ସେଇ ଅନୁଭବ ସବୁକିଛି ।

ତୋ ବିନା ମରିବା ଜିଇଁବା ସମାନ
ମାନେ ନାହିଁ କିଛି ଜୀବନର,
ତୋ କଥା ଲେଖିବା ପରେ ହିଁ ଭାବୁଛି
ଶବ୍ଦ ସରିଗଲା ଦୁନିଆର ।

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॥ ଗନ୍ଧମାର୍ଦ୍ଦନ ॥

ଶ୍ରୀଲିମା ଶୁଭଦର୍ଶନୀ ସାହୁ
ଭୂତତ୍ତ୍ୱ ବିଜ୍ଞାନ ବିଭାଗ, ପ୍ରଥମ ବର୍ଷ

ଗନ୍ଧମାର୍ଦ୍ଦନ ଉତୁଙ୍ଗ ଚୂଡ଼ାରେ
ଦେଖିଛି ଲାଜେଇ ଅଳସୀ ଜହ୍ନ
ଶୁଣିଛି ଗହନ ବନର ଗହଳେ
ଉଲ୍ଲସିତ ବିହଙ୍ଗମର ମୂନ ।
ପୂତ ରୂପାନର ଧାର ମୁଁ ଦେଖିଛି
ଦେଖିଛି କୁଶାଙ୍ଗୀ ବନ ଝରଣା
ଆକାଶ ଛାତିର ଝୁଲା ମେଘ ଦେଖି
ଚାତକୀ ହୃଦର ମଧୁ ଯନ୍ତ୍ରଣା ।
ହୋଇଛି ମୁଁ ପୁଲକିତ ଅବିରତ
ମହୁଲିଆ କାଞ୍ଜିପାଣି ପବନେ
କାଶ ଫୁଲ ନାଚ ବହଳ ପଠାର
ପ୍ରୀତି ଭରିଦିଏ ପ୍ରୀତି କାନନେ ।

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॥ ତୃଷାର୍ତ୍ତ ପଥିକ ॥

ତାରିଣୀ ପ୍ରଭା ରାଉତରାୟ
ଭୂତତ୍ତ୍ୱ ବିଜ୍ଞାନ ବିଭାଗ, ପ୍ରଥମ ବର୍ଷ

ତପ୍ତ ମରୁର ଆକାଶ ରେ
ଚେନାଏ କଳା ମେଘ
ତୁହା କୁ ତୁହା ବର୍ଷିବାର
ଜୀବନ୍ତ ଅଭିନୟ କରେ ॥
ଭିଜିବାର ଅଦମ୍ୟ ସୁଖ ରେ
ମୁଁ ତୃଷାର୍ତ୍ତ ପଥିକ
ଆଉଁଷି ଚାଲୁଥାଏ ମୋର ତୃଷା କୁ ॥
ନାଁ ସେ ବର୍ଷିଛି, ନାଁ ମୁଁ ଭିଜି ପାରିଛି
ଦଲକାଏ ପବନ ଦୀର୍ଘଶ୍ୱାସ ହୋଇ
ଏଇ ମରୁ ସାଥେ ମିଶି ଯାଇଛି ॥

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॥ ଭୂତତ୍ତ୍ୱ ପରିବାର ॥

ସୁଶାନ୍ତ କୁମାର ଦାସ
ଭୂତତ୍ତ୍ୱ ବିଭାଗ
ଦୂରଭାଷ - ୮୨୪୪୫୯୧୫୧୯

ଛୋଟ ଆମ ପରିବାର
ସବୁଠୁ ସୁନ୍ଦର
ସେନେହ ଡୋରିରେ ବନ୍ଧା
ଆମ ଭୂତତ୍ତ୍ୱ ପରିବାର
ଟିକି ଟିକି ପିଲା ଆମେ
ଏହି ବିଭାଗ ଦୁଆରେ
ଗୁଣ୍ଡି ହୋଇ ରହିଅଛୁ
ଗୋଟିଏ ପଥର ଖଣିରେ
ଅରୁଣ ସାରଙ୍କର କ୍ୟାରିୟର କଥା
ମନେ ଆଣେ ସରାଗ
ନେଟ, ଗେଟ ପଢିବା ପାଇଁ
କରାନ୍ତି ଆମକୁ ସଜାଗ
ଆଜି ସିନା ପିଲା ଆମେ
ଭୂତତ୍ତ୍ୱବିତ୍ ହୋଇ ଫୁଟିବୁ
ସୁବାସିତ ହୋଇ ଆମେ
ହାଇଡ୍ରୋଲୋଜିଷ୍ଟ ର ନାଁ ରଖିବୁ
ମୁରୁକି ମୁରୁକି ହସନ୍ତି
ଗବେଷଣା ତାଙ୍କ ପାଣି
ନାଁ ଟି ତାଙ୍କର ରୋଜାଲିନ
କୁହନ୍ତି ସେ ଅକୁହା ବାଣୀ

କଠୋର ତାଙ୍କର ରୀତିନୀତି
ନାଁ ତାଙ୍କର ସ୍ମୃତି
ଅଜ୍ଞାନ ରୂପକ ଅନ୍ଧକାରରେ
ଢାଳନ୍ତି ସେ ଜ୍ଞାନ ଜ୍ୟୋତି
ଟପ ଟପ ଟ୍ରିକ ବତାନ୍ତି
ଟ୍ରିକ ଯୋଗୁଁ ସେ ଖ୍ୟାତି
ପିଲାମାନଙ୍କର ବନ୍ଧୁ ସେ
ଅସୀମ ସାର ପ୍ରିୟ ଅତି
ରମିୟ ସାରଙ୍କର ସାହାଯ୍ୟ ପାଇଁ
ଆମେ ହେଉ ସବୁ ଖୁସି
ସହଜ ସରଳ ଭାଷାରେ ବୁଝାନ୍ତି
ଯାଏ ସମୟ ବିତି

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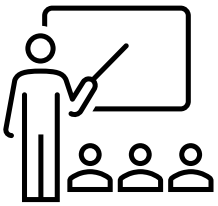
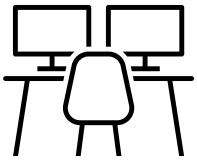


Teaching Staff

Dr. Rosalin Das	**Associate Professor**
Prof. Rabindra Nath Hota	**Adjunct Professor**
Dr. Satyabrata Nayak	**Visiting Professor**
Dr. Smruti Rekha Sahoo	**Assistant Professor**
Dr. Asim Amitabh Pradhan	**Assistant Professor**
Mr. Arun Kumar Naik	**Assistant Professor**
Dr. Pankajini Mahanta	**Guest Faculty**



Non-Teaching Staff

Mr. Raumya Ranjan Swain	**Lab Assistant**
Mr. Pradeep Kumar Nayak	**Lab Attendant**
Ms. Dhaneedipti Murmu	**Clerk**
Mr. Prasant Kuma Das	**Peon**

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