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Regd. Office : IMEJournal, Laxmisagarpatna, Bhubaneswar 751 006
E-mail : indianminingjournal61@hotmail.com Mobile: +919861008387

Persons in the News

Dr. Manas Kumar Sharma took charge as Director (Exploration & Development) of Oil India Limited (OIL), India's second largest national exploration & production company on 20.04.2022. Dr. Sharma was serving Oil as Exeutive Director (Basin Manager-Shelf) prior to his appointment as Director (E&D), where he was involved in various E&P activities within the operational areas in Assam and Arunachal Pradesh of OIL. A skilled geoscientist and operational manager. Dr Sharma carries with him more than 30 years of experience in the oil and gas industry, he has first hand knowledge & experience in the subsurface & surface domain, both in the working as well as in the senior management level.

Dr. Sharma has conceptualized action plan for various exploration activities leading to identification of prospects for continued hydrocarbon exploration, appraisal of discoveries as well as formulation of revitalization plan for existing brown fields within Operational Areas in Assam and Arunachal Pradesh. He is also instrumental in establishing industry-Academia collaboration with Universities in the Northeast, which has helped in better understanding of the Assam & Assam-Arakan Basin for carring out extensive exploration activities by OIL in the Northeast.An alumnus of Dibrugarh University, Dr. Sharma is a Ph. D and M Tech in Applied Geology.

Shri G Srinivasan presently General Manager, Coal India Limited (CIL), has been selected for the post of Director (Finance), South Eastern Coalfields Ltd. A commerce graduate with first class from the Madras University, Srinivasan obtained a degree from the Institute of Cost and Works Accountants of India. He started his career in 1987 from Western Coalfields Limited (WCL), another entity of the CIL headquartered at Nagpur.

Srinivasan carries a vast experience spanning over three and a half decades in the field of taxation, budget, treasury management and corporate accounts. He has been instrumental and played crucial role in the successful implementation of Finance and Control (FICO) module of Enterprise Resource Planning (ERP) in the state-run CIL.

He has also discharged his duties effectively in the corporate accounts of SECL and other vital positions. He has been the key figure in the CIL affairs related to budget, MoUs and ERP implementation.

Shri Krishna Kumar Singh presently Executive Director (P&A), Steel Authority of India Ltd (SAIL), has been selected for the post of Director (Personnel), Steel Authority of India Ltd (SAIL). Shri Singh is an Engineering Graduate (B Tech in Electrical Engineering) from Banaras Hindu University. He also has a Post Graduate Diploma in Human Resource Management from Indira Gandhi Open University (IGNOU). Shri Singh started his career in SAIL as Junior Manager on July 8, 1988, at Bhilai Steel Plant. He was promoted as Manager on June 30, 1996, He worked in Blooming and Billet Mill. Thereafter, on June 30, 2001, he was promoted as Senior Manager and posted in Human Resource Development Department where he was made Assistant General Manager on June 30, 2005.

Shri Singh was promoted as Executive Director (Personnel and Administration) of Bhilai Steel Plant on November 16, 2018. Subsequently, on 26 October 2019, he was transferred to SAIL Corporate Office where he served as Executive Director (Personnel and Administration). On December 31, 2021, he was transferred to Bhilai Steel Plant as Executive Director (Personnel and Administration).

Shri Jaikumar Shrinivasan presently, Director-Finance, NLC India Limited, has been selected for the post of Director (Finance), NTPC Limited recommended by Public Enterprises Selection Board (PESB). Shri Jaikumar Srinivasan is a Commerce Graduate and a Member of Cost & Management Accountants of India. He is heading the Finance and commercial portfolio in the Company. Prior to his joining NLC, he was Director (Finance) of M/s Maharashtra State Electricity and Distribution Company Limited (MSEDCL) and prior to which he has Director (Finance) in MAHAGENCO both state PSU of Government of Maharashtra. He also served as part time Director in Mahuguj Colliery Company Limited, UCM Coal Company Ltd and other subsidiary companies of MAHAGENCO. He has undergone a study on Best Practices in Power Sector at Milan and ESCP Business School & Torino and Paris.

Shri Debasish Nanda presently Executive Director, Indian Oil Corporation Ltd. has been selected for the post of Director(Business Development), Coal India Limited (CIL) recommended by PESB. Shri Debasish Nanda is a graduate in Mechanical Engineering from Sambalpur University with a Post-Graduation in Production Engineering from REC, Rourkela. He has also done Masters in International Business from IIFT, New Delhi. Shri Nanda joined IndianOil in 1988 as a Management Trainee in Marketing Division and spent 11 years in marketing of Servo lubricants. Thereafter, he moved to Business Development Group in 1999. He had a stint in Business Development activities viz. expansion of lube business overseas exports of POL, setting-up of IndianOil's subsidiaries etc before moving to IndianOil's Gas Business in 2009.

Shri Shankar Nagachari presently General Manager, South Eastern Coalfields Limited has been selected to the post of Director (Technical), Central Mine Planning & Design Instutute Ltd (CMPDIL) recommended by PESB.

COAL NEWS

SAFETY MEASURE IN COAL MINES

Inquiries into all fatal accidents, major serious accidents and dangerous occurrences are conducted by Directorate General of Mines Safety (DGMS) officers to find out the causes and circumstances leading to the accidents/ incidents in coal mines. As per the findings of the enquiries, suitable actions or measures are taken as per the provisions of the Mines Act, 1952 to prevent recurrence of such accidents or dangerous occurrences. The following measures taken:

i. Based on the analysis, technical circulars are issued from time to time to the industry.
ii. National Conference on Safety in Mines (NSC), a national level tripartite forum is organized periodically in which detailed deliberations on prevention of mine accidents and improving safety are made and the recommendations of NSC, are disseminated in the form of circulars and are reviewed periodically by different coal producing companies.
iii. Scientific studies are carried out with the help of reputed institutes/scientific bodies to find out safe working culture.
iv. Follow-up inspections are made periodically based on risk analysis.
v. Improvement notices under section 22A of the Mines Act, 1952 are issued.
vi. Penal actions/prosecution against the persons/ officials found responsible for the accidents based on the enquiry findings of the report.
vii. Coal Mines Regulations, 2017 has been enforced, which provides for risk based safety Management Plan (SMP) and preparation of safe Operating Procedure (SOPS).

The Coal Mines Regulations, 1957 was suitably amended incorporating provisions for conduct of scientific study for method of work, ultimate pit slope, dump slope & monitoring of slope stability, at opencast coalmines under Regulation 106 of the Coal Mines Regulations, 2017. All mines conduct Scientific Study, under these provisions of Coal Mines Regulations, 2017 before starting mechanized opencast working and work shall be carried out as per the recommendations of the Scientific Study reports. In case of landslides/slope failure, investigations are carried out and management are directed to conduct fresh Scientific Study & review the working parameters to prevent such slope failures.

Guidelines for systematic monitoring of slopes in coal and metalliferous Mines was circulated vide DGMS (Tech) Circular No. 02 of 2020 dated 09.01.2020 regarding real-time monitoring of slope stability.

Certain mines are provided with automatic alarm systems such as Slope Stability RADAR (SSR) for the early warning of slide at opencast mines. In other mines, regular monitoring of slope stability is carried out by using prisms and total stations.

This information was given by the Union Minister of Coal, Mines and Parliamentary Affairs Shri Pralhad Joshi in a written reply in LokSabha today.
(Source : Posted On: 01 DEC 2021 by PIB Delhi)

COAL INDIA LTD CAPEX UP 12% TO RECORD RS 14,834 CRORE IN FY22

Coal India Ltd (CIL) scaled up its capex to Rs 14,834 crore ending FY22, 101% of the set target and the highest spend so far. The MoU target for the fiscal was Rs 14,685 crore. The capex increase was up by 12% (Rs 1,550 crore) in FY22 compared to Rs 13,284 crore in FY21, a senior official said. CIL's FY21 capex doubled in a year from that of Rs 6,270 crore of FY20. The entire capex was met through internal accruals.

"CIL's capex boost was to catalyse the output growth and align it with evacuation outlets. Most of the capex was spread on land, procurement of heavy earth moving machinery, setting up CHP/silos and creation of rail infrastructure for coal transportation" the CIL official said.

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Land and HEMM combined accounted for 40% of the total capex at Rs 5,867 crore. Capex under land was Rs 3,262 crore during 2021-22 posting a jump of 17% over previous fiscal's Rs 2,786 crore. Acquisition of land is vital for CIL to enhance its production from OC mines. Land procured for two projects of MCL -Searmal and Talacher would help the company further widen its mining operations, the official said.

The centralised procurement of HEMM for ECL, NCL, SECL amounted to the bulk of Rs 2,605 crore under this head. Replacing the old fleet with the modernised equipment to be deployed in OC mines especially in SECL and NCL is essential for output ramp up.

The other important head of capex spend, at Rs 2,322 crore, was for setting up coal handling plants/silos with a major share taken up by NCL, SECL and MCL. Strengthening of evacuation infrastructure through rail sidings and corridors accounted for Rs 2,307 crore of total capex.

MINING NEWS

FOUNDATIONS OF AI: A FRAMEWORK FOR AI IN MINING PUBLISHED

GMG has published Foundations of AI: A Framework for AI in Mining – a white paper that offers an overview of the process of planning for and implementing artificial intelligence (AI) solutions for mining companies.

AI-based innovation is being used increasingly in the mining industry as a means to improve processes and decision-making, derive value from data and increase safety, but the levels of operational maturity are variable across the industry. Though many mining stakeholders are adopting AI, there is still uncertainty about the technology and how it can be harnessed in the mining industry.

This white paper – developed collaboratively through workshops, conference calls and online collaboration tools – addresses a variety of concerns, such as the challenge of establishing data infrastructure, apprehensions about the effect on the workforce and worries about failure after investing substantial time and funds into an AI project. It offers a realistic strategy for building a foundation for planning, implementing and moving forward with AI.

The primary audience is those in charge of introducing or expanding the use of AI in mining companies. Rob Johnston, Project Manager at CITIC Pacific Mining and GMG AI Project Leader, says, “There has been a recent explosion in the application of AI in industry, and this document aims to assist mining companies to fully embrace this exciting technology and drive business value.”

Having this information available will also help cut through the hype that surrounds AI. “Although mining stakeholders generally recognize the value of understanding the technology, many are intimidated by the concept and see expertise in AI as a very specialized knowledge set, so this will help them start off on the right foot,” says Andrew Scott, GMG Vice-Chair Working Groups and Principal Innovator at Symbiotic Innovations.

This document will also be useful for those who are part of the ecosystem that surrounds mining companies, which comprises those who will assist in applying the technology, culture and safety considerations and regulatory frameworks that are necessary for a successful AI strategy. Speaking from his perspective as a solution provider, Kevin Urbanski, CTO at Rithmik Solutions, says the white paper will provide “current and future customers with a macro view of artificial intelligence and related solutions,” while helping mining operations to “identify opportunities to apply these powerful algorithms within their organizations.”

“Mining companies know best what their needs are, and this document will help them match those needs with what’s possible.” Urbanski adds that the document will also help to standardize communications around the technology, saying it will “provide great level-setting, ensuring that we and our customers are speaking the same language when talking about AI.”

Johnston says that while this publication is an important step, the document will be reviewed and updated as needed: “The field of AI moves so fast that this will be a document that will be updated regularly in order to remain relevant to the industry.”

MAHARASHTRA GOVT DECLARES JSW STEEL AS PREFERRED BIDDER FOR AJGAON IRON ORE BLOCK

Ajgaon iron ore block in Sindhudurg district is at a distance of about 400 km from Dolvi where JSW Steel runs an integrated steel plant.

JSW Steel has been declared as preferred bidder for Ajgaon iron ore block in Maharashtra.

Ajgaon iron ore block in Sindhudurg district is at a distance of about 400 km from Dolvi where JSW Steel runs an integrated steel plant having capacity of 10 million tonne per annum (MTPA).

"The company has been declared as a preferred bidder vide communication received from the Directorate of Geology and Mining, Maharashtra, for Composite Licence of Ajgaon iron ore block in the auctions held by government of Maharashtra on March 30, 2022," JSW Steel said in a regulatory filing.

The highest final offer price by the company to become a preferred bidder is 25 per cent of the average monthly prices of iron ore of different grades and quality, it said without divulging any further information related to the mine.

JSW Steel further said it will take requisite steps to obtain Letter of Intent (LoI), statutory clearances to execute the lease deed with mine development and production agreement (MDPA) to start operation.

RED MUD OR BAUXITE RESIDUE UTILISATION

Millions of tonnes of Red Mud is now stored in specially designed ponds near Alumina plants of Nalco, Utkal Alumina, Hindalco(Muri) and have remained a threat to environment. Most companies send huge amount to keep them safer and also ensure their storage leak proof. Despite that there were instances of breach in dams causing immense loss to the land and agri fields etc. In India several attempts were made to use them as back fill material in abandoned bauxite mines/pits. Hindalco had collaborated with many research organisations to develop a system to backfill by ,making them environmentally safe to the ground water and land mass.

Montreal-based Geomega Resources has received funding to build its C$4 million alumina waste processing plant in Quebec.

Sustainable Development Technology Canada (SDTC), a government body providing funding to small- and medium-sized businesses, will provide C$1.5 million in funding.

Geomega partner Rio Tinto will provide C$1.2 million in financing. Half of Rio Tinto's global aluminium production comes from Quebec.

Rio Tinto operates an alumina refinery, four smelters, six hydropower plants, its Arvida Research and Development Centre, the Aluminium Operational Centre, a rail network, and one port in the Saguenay-Lac-Saint-Jean region.

The Quebec Ministry of Economy and Innovation, via Investissement Quebec, has provided C$300,000.

The remaining C$450,000 will be funded by a third-party organisation in the later stages of the project, Geomega said.

The plant, developed by Geomega subsidiary Innord Inc, will take bauxite residue generated from aluminium production, and reduce the volume of red mud by 70% to 90%, STDC chief executive Leah Lawrence said.

The plant will also recover minerals from this waste, she added.

The technology is "aimed at finding new uses for bauxite residue," Rio Tinto's Director of By-Product Valorisation Stephane Poirier said.

"This has the potential to not only reduce the environmental footprint at aluminium production, but to also deliver new sources of materials such as critical minerals needed to support a low-carbon future."

The funds will be put towards the completion of a feasibility study and construction of a pilot plant in Boucherville, Quebec.

Collaborate research work between Innord and Rio Tinto will be led by Dr Pouya Hajjani, Geomega's Chief Technology Officer.

The Innord research team has been working with technical experts from Rio Tinto over the past year to finalise a bench-scale study project, and will now work together on scaling up the project, Hajjani said.

The two-year project "will ultimately form the basis for a techno-economic feasibility study of the process," she said. The study will assess the environmental performance of Innord's technology and assess the marketability of the products, Hajjani said.

The technology is based on Geomega's hydrometallurgical process to recover rare earths. In February, Geomega received provincial funding to test its process on its Montviel rare earths project, also in Quebec.

USE OF PLASTIC WASTE IN IRON & STEEL INDUSTRIES WILL GENERATE WEALTH FROM THE WASTE

Union Minister of Stee, Shri Ram Chandra Prasad Singh has said that Iron and Steel Industry will play a vital role towards making this planet pollution free. He was addressing the inaugural session of the plastic Recycling Conference, Asia 2.0 at Gurugram. The Minister added that together we must ensure the healthy quality of air, water and food. He said that working on developing clean and green steel, decarbonisation and carbon neutral with a planned manner will be beneficial for our future. Shri Singh further said that the use of plastic waste in place of coking and non-coking coal will be helpful to reduce pollution and convert the waste in to wealth. It will be in the interest of all the peoplw associated with it and everyone will win. Recycling plastic will reduce pollution, help steel industry reduce coking coal imports and create new employment opportunities."

STEEL MINISTER REVIEWS CAPES WITH CMDs OF SAIL, NMDC RINL, KIOCL MOIL & MECON

The Union Steel Minister, Shri Ram Chandra Prasad Singh chaired a meeting to review the capital expenditure (CAPEX) incurred by Steel CPSE during the FY 2021-22 and to assess the plans of the CPSEs for achieving the CAPEX targets for the current year 2022-23. The CMDs of Steel CPSEs viz. SAIL, NMDC, RINL, KIOCL MOIL and MECON and senior officers of the Ministry of Steel attended the meeting.

The Steel Minister emphasized the imprtance of timely capital expenditure for enhancing steel production capacity, modernizing old plant equipment, and taking up environmentally efficient technologies for the future. Such expenditure also provides a fillip to the Indian economy. It was noted that in FY 2021-22 the CAPEX spending by Steel CPSEs was Rs. 10,038 crores, this is an increase of 38% over the CAPEX of Rs. 7266.70 crores for FY 2020-21.

The CAPEX target for FY 2022-23 in respect of Steel CPSEs is Rs. 1,3156.46 crores. The Union Minister of Steel advised the CPSEs to adhere to their monthly CAPEX plans and closely monitor projects for ensuring time bound implementation and achievement of annual target successfully on time. The CMDs of Steel CPSEs assured that CAPEX targets for FY 2022-23 would be achieved.

During the review, deliberations where also held on the CPSEs' plans under the National Steel Policy (NSP) 2017, as the envisions creating a globally competitivew steel industry in India. The NSP 2017 envisages 300 million tonnes (MT) steel-making capacity and a per capita consumption of 158 kgs. Notwithstanding, the pandemic the Indian steel sector has added capacity of 16.29 MTPA in the last five years to reach the capacity of 154.27 MTPA. Based on the present assessment Government is confident to reach the capacity of 300 MTPA by 2030-31. Most of the capacity expansion comes through brown field and some greenfield expansion which may come from 2025-30.

The Minister gave directions to Steel CPSEs to plan their capital projects prudently in line with the NSP-2017. In order to ensure their capacity goes up by about 80% from present level to reach 45 MTPA by 2030-31 from the present level of around 25 MTPA. The Minister further stressed that CPSEs should take adequate measures to incorporate the learning's from the past and current expansion projects in their future plans to ensure adherence to the envisaged capacity expansion.

The Union Minister for Steel Shri Ram Chandra Prasad Singh also directed the CMDs of the Steel CPSEs to develop their exploration expertise, work for capacity enhancement while keeping climate concerns in mind and work towards production of Green Steel, plan and prepare the roadmap for 'Amrit Kal', reinvent and develop expertise for future needs and prepare their skilling road maps accordingly and to also diversity their portfolios with a view to remaining competitive in the market.

GOVT TO MERGE MECL IN CMPDIL; CO TO REMAIN CIL UNIT

The government will merge non-coal mineral exploration and consultancy Mineral Exploration Corporation Limited (MECL) into Coal India's consultancy arm Central Mine Planning and Design Institute Limited (CMPDIL) to create an integrated exploration organisation.

In this regard, the Ministry of Coal has clarified that CMPDIL is a subsidiary of Coal India Limited (CIL) that provides exploration and consultancy services primarily to the coal sector. Keeping in view the scope for its business expansion in other minerals, the Government has plans for its strengthening, for which it is being considered to merge MECL into CMPDIL, an official statement said.

"Such merger and creation of one integrated exploration and consultancy organization with requisite expertise for coal and non-coal sector would result in growth and value addition. At the same time, CMPDIL will continue to be a subsidiary of Coal India Limited," it statement said.

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Optimum Blasting Techniques of Charty Limonite in Kamarda Chromite Mines for Chrome Ore Production

Er. Nikhlesh Patel* Er. Dibyendu Behera**

ABSTRACT

Drilling and Blasting is being practiced in Sukinda valley where-in nearly 20% of Cherty limonite deposit in Sukinda valley is being reported before ore production overburden and waste extraction than ore production is possible.

20 percentage of waste rock Cherty limonite extraction by drilling and blasting method final application in extraction of chromite ore. Drilling and Blasting method is also amenable to another Minerals Extraction. Kamarda Chromite Mines is Percentage of Cherty Limonite is About approx. 60 to 70 percentage in current senecio so Drilling and blasting adopted for over burden and ore extraction Drilling and Blasting Method aim to maximise Mineral and waste burden extraction percentage with minimum Cost.

OBJECTIVE

Kamarda Chromite Mines completed ore production as per company and market requirement in economically with follow of Tata steel Mining Limited Value of Zero Harms of environment, Local eco system, Local Peoples, Employees and without violation of any DGMS and PESO guidelines.

Kamarda Chromite Mines Mining lease comprising of 107.24 Hectare is Located Village Kamarda, Balipada, Talangi Tehsil/Taluka Sukinda District Jajpur Sate Odisha Indian the details of the lease area as per the Geological Study Report provided by the State Government and the mining lease deed are as below:

GEOLOGY

Kamarda Chromite Mines a part of famous chromite bearing Sukinda ultramafic complex. Kamarda Chromite Mines is located in south-eastern part of Sukinda ultramafic complex.

The area forms a part of the chromite rich Sukinda Ultramafic Complex which covers an area of about 50 Square Kilometres extending from the South- West corner of the Survey of India Toposheet No. 73G/16 to South-East corner of 73G/12 bounded by the latitudes N 21001' and 210 05' and longitudes 850 40' and 850 43'. The centre of this laccolith is occupied by an amygdaloidal basaltic lava low with plagioclase or olivine as phenocrysts, overlapping the ultramafics and occasionally containing inclusions of ultramafic rocks. The lithological constituents are ultramafic intrusives or dunite-pyroxenite-peridotite and acid differentiates of granite and granophyre. All these rocks are traversed by a swarm of dolerite dykes which have not only cut across the rocks but also have displaced the ore bands at many places.

The area exposes different litho-units. The local Stratigraphic sequence is established as follows:

Soil & Alluvium
Laterite
Pyroxenite
Chromiferrous ultramafics
Yellow limonite with Goethite
Limonite with chromite disseminations
Cherty limonite
Quartzite

Soil & alluvium: Plain land in the M.L area is mostly covered by the recent sediments known as soil & alluvium which is lateritic / limonitic in nature. It is around 10cm thick and ranges from yellowish brown to reddish brown in colour.

Laterite: Two types of laterites are commonly observed. The older laterite is pisolitic while the younger laterite is canga type consisting of transported boulders of older laterite. These laterites might have been derived from the basic & ultrabasic rocks and are often in nature. Average thickness of laterite encountered in boreholes is around 8m.

Silicified cherty rocks: These are milky white to dirty brown in colour, hard and compact. These are massive and structure less and appeared to be traversed by lode

**Deputy Manager (Mines) **ADM (Mines)*
Tata Steel Mining Limited, Kamarda Chromite Mines

lets of amorphous silica or quartz. These are uniform except where these engulf with serpentinites and limonitized rocks. These rocks are exposed in quarries within the limonitized rocks in the form of thin lenticular lenses (~50cm) and termed as silicified cherty rocks.

Weathered Serpentinite: These rocks are exposed in the south-western and south-eastern part of the M.L area. It is pale apple green to milky white colour, schistose and soft.

Quartzite: Quartzite is exposed in the lower flanks of Mahagiri hill range and falls in southern part of the M.L area. It is fine to medium grained and highly jointed crushed ferruginous in nature belonging to the iron ore group.

Chromite ore: - Chromite ore occurs in form of thick linear stratiform zones in form of bands in association with limonite and serpentinite. Chromite is brown in colour and mostly friable in nature**.**

Blasting: Blasting is one of the most important operation in the production cycle of a mine. A strong link exists between blasting and other operations like fragmentation, crushing and loading. The efficiency of different operations vis-à- vis the economics mainly depend upon optimum fragmentation. However, optimization is a dynamic process and requires updating based on many input parameters. Every effort will be made to keep the impacts like ground vibration, Air over pressure, Fly rock, Noise, Dust & fumes well within the permissible limits. The following blasting practices are being adopted depending on the situation for achieving the above result

Deep hole blasting will be practiced with drill hole of diameter 115 mm. The holes will be drilled using down the hole drills with staggered drilling pattern. The blasting will be conducted three to four times a week. To achieve the target of 700 Cubic Meter of Cherty Limonite per day, either about 11-12 holes will be blasted on an average in single day for pattern 1 or about 23 holes will be blasted on an average in single day for pattern 2. Blasting will be conducted in between the A and B shifts.

SECONDARY BLASTING

No secondary blasting is proposed. Secondary blasting will be replaced by secondary breaking by hydraulic rock breaker. Boulders generated out of prime blasting will broke by rock breaker.

FIELD BLASTING DATA

<table>
<tr><td colspan="3">Blast id: - KCM/22/001</td><td colspan="2">Location: - North pit RL132</td><td colspan="2">Date – 21.01.2022</td></tr>
<tr><td>Spacing</td><td colspan="2">Burden</td><td>Depth</td><td>Hole blasted</td><td>Hole Dia</td><td>Stemming</td></tr>
<tr><td>3.5 m</td><td colspan="2">3 m</td><td>6.0 m</td><td>18</td><td>115 mm</td><td>3.8 m</td></tr>
<tr><td colspan="2">Explosive</td><td colspan="2">TLD</td><td colspan="2">Combi-DET (Nonel)</td><td>IED</td></tr>
<tr><td>Soler Prime</td><td>Soler gel</td><td colspan="2">25MS (4Meter)</td><td colspan="2">17ms/250ms (11 Meter)</td><td rowspan="2">01 No.</td></tr>
<tr><td>75 kg</td><td>205.5 kg</td><td colspan="2">04 Nos</td><td colspan="2">18 Nos</td></tr>
</table>

Average Explosive Charge per holes – 15.58 kg/hole
Powder factor – 4.04 Cubic Meters/Kg (8.08 Tonne/Kg)
Fragmentation – Heaved (Good)

CONCLUSION

Kamarda Chromite Mines all other rocks like-Soil & Alluvium, Laterite, Pyroxenite, Chromiferrous ultramafic, Yellow limonite with Goethite, Limonite with chromite disseminations extracted without blasting but Cherty limonite excavation is not possible without drilling and blasting method. 60 to 70 Percentage of waste rock Cherty limonite deposit in Kamarda Chromite Mines is being reported before ore production overburden and waste extraction than ore production is possible finally Kamarda mines Started Optimum Blasting Techniques with Maximum Powder Factor, Minimum Vibration, Minimum Fly rock, Good Fragmentation and all the Blasting Parameter in Control with Zero Harms Of environment, Local eco system, Local Peoples, Employees and without violation of any DGMS and PESO guidelines.

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4. Prof. Gayanindra Kumar Pradhan, 3rd edition Explosive and Blasting Techniques , Mintech Pulication Bhubneshwar.

FORM IV

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I, Pradhan Anita, hereby declare that the particulars given above are true to the best of my knowledge and belief, March, 2022

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Analysis of Continuous Miner Technology with Specific Focus for Improving Production, Productivity and Techno Economic Parameters in Indian Underground Coal Mines

Mithilesh Kumar Mishra* S.Dasgupta**

ABSTRACT

In spite of hue and cry by environmentalists and global concern regarding fossil fuel India's energy requirement is met mainly by coal. Coal is likely to remain the main source of energy in near future. To meet the energy need of country the production has grown many folds since nationalisation. Production at the time of nationalisation was 68 million te out of which only 16 million tonne was from opencast mining and 52 million te was from underground mining, The production has grown manifold and has become 750 million te in 2021-22. But the entire increase in production has come from surface mining [4].Due to factors like fast depletion of low lying coal and environmental concern the focus has now shifted towards improving production from underground. The main method of mining in India was Bord and pillar. This method was having the following three major concerns: i) Poor Productivity, ii) % recovery is poor and ii) Safety record is not good [1]. Continuous Miner addresses all the above concerns .Continuous Miner is a mass production technology which gives a boost to productivity and safety of underground mines. Indian underground mines are now adopting this cutting edge technology. However their adoption largely depends on availability of sufficient reserve. Further their performance is largely dependent on the geotechnical parameters and performance of ancillary subsystems. Marked improvement in productivity has been noticed after introduction of continuous miner technology. This paper analyses continuous miner technology with specific focus for improving production, Productivity and techno economic parameters in an Indian UG coal mine.

Key word: Fossil fuel, Productivity, Continuous Miner, Techno Economic Parameters.

INTRODUCTION

Mechanisation is the key to increase production, Productivity and safety with due regard to conservation. Continuous miner has been proved to be successful globally as a mass production technology. 80% of total coal reserve in India is extractable by underground mining technology but only 7% coal production comes from underground [2]. From the current level of UG production Indian underground industry plans to increase its share to 30% by 2030 [4]. India has started to deploy continuous miner since last decade, but its performance has not been able to satisfy the aspiration of companies. At the same time manufactureres also have failed to prove their claims. As such this is a grey area for research.

In India Bord and pillar was the dominant mining method and huge amount of coal to the tune of 3000 million te is standing on pillar [5]. So the continuous miner technology was introduced not only in virgin seams but was also implemented in already developed seams. Continuous miner has adopted many welcome changes like remote operations and ranging drum so that full recovery of coal is possible.

Continuous miner is a large steel drum equipped with tungsten carbide teeth that on rotation gives abrassive force causing chipping out and crushing coal from the seam. The fallen coal is scraped by apron and pushed on to the chain conveyor with the help of rotating gathering arms. The chain conveyor transfers the coal on to the shuttle car or battery hauler which carries the coal to feeder breaker. Feeder breaker crushes the coal to desired size and then transported to surface through belt conveyor.

Case Study

The mine which was selected for study is an old mine of a mini ratna company where a huge quantity of coal is standing on pillar. The mine was being worked by Bord and pillar method with LHD and belt conveyor. Due to its extensive development and associated problems the production was languishing at 200 te per day with a loss of Rs 11202 per te.(As per cost sheet of 2016-17). The recovery % was only 30%. After introduction of continuous miner in Churi mine in 2019 the loss has reduced from

**Pursuing M.Tech(Mining) at AKS University*
***Associate Professor(Mining) & Expert UG Coal Mining & Sustainable Development*

Rs 11200/Te to Rs 1320/Te only. (As per provisional cost sheet of 2021-22.)

The details of the mine is as follows: Churi underground (Re-organization) is an on-going project with rated capacity of 0.81 MTPA. It has been approached through a pair of inclines (Inc.No-6 & Inc. No-7). No.6 Incline is being used for man and material transportation having an average gradient of 1 in 4 for a length of 400 m. No.7 Incline is being used as conveyor belt line for evacuation of produced coal having an average gradient of 1 in 4.5 for a length of 450m. The depth of mine varies from 80-90 m. The mine is divided in three blocks namely Churi old, CRO and Benti block. There are two rivers passing along the east and west side of the property namely Saphi and Damodar respectively.

Location

Churi-Benti U/G project is located in the South-central part of North Karanpura Coalfield between the latitudes 23° 41' 05" and 23° 42' 04" and the longitudes 85° 03' 00" and 85° 04' 20" covering an area of about 7.68 sq.kms. in Ranchi district of Jharkhand state.

Churi-Benti UG project is situated at a distance of 8 km on fair weather road connecting Khalari and Ray railway stations on the Gomoh-Dehri-on-Sone loop line of the East Central Railway. An all weathered 25 km long road links Khalari with Bijupara village on the National highway connecting Ranchi and Daltonganj. The P.W.D. road connecting Khalari and Barkagaon in Hazaribagh district also passes through the Churi block. CCL Hq. at Ranchi is situated at a distance of 73 km from Churi project.

Project Boundary & Reserve

The mine boundaries of Churi UG mine covers area laying in Churi block and part of Benti block. The boundary of the Churi UG is as under (Figure 1 & 2) :

North/North- East	Adjusted boundary between Ashok OCP (Piparwar Area) & Churi UG in Benti block and Common boundary with Ray Bachra UG along fault F17-F17
West	Arbitrary line beyond Fault F11A along the fault F11A plane and Damodar River
South -East	Saphi River
South/South-West	Common Boundary between Churi and Manki Colliery (now exhausted).

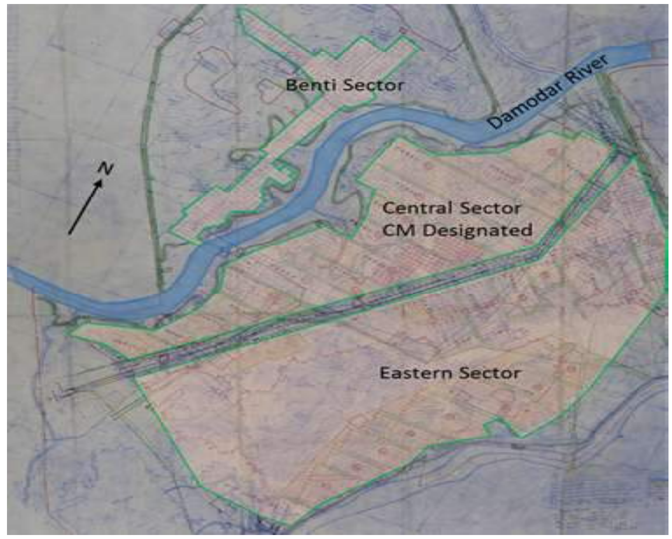


Figure 1 : Showing Designated mining sectors in Churi

The proposed mine boundaries for Churi-Benti UGP is same as existing mine boundaries of Churi UGP

Regional Structural Geology

Churi Block lies between faults F17 & F10. Fault F17 exists in the north-eastern part of the block where fault F10 exists in the southern and south-western part of the block. The throw of fault F17 is about 50 m towards north-west in the northern part which gradually decreases to around 5 m near borehole No. CHPR-57 located on the left bank of Saphi River. The throw of fault F10 varies from 15-25 m and the throw is towards north-east. The area between these two faults is characterised by simple geological structure. There are three more faults (F11A, F12, & F13) in addition to above two faults which trend almost NW-SE with north-easterly throw of 5 to 13 m. There are four minor slips also F11B, F11, F15 and F18) whose throw varies from 2 to 5 m (Ref. Stratum contour plans).

Of the above faults, F11, F11A, F11B, F12 and F15 have been encountered in the mine workings while F18 was responsible for omission of Upper Bachra Seam in NNKC-24. Fault F15 encountered in the mine workings was also responsible for omission of Upper Bachra seam in NNKC-19.(Table 1).

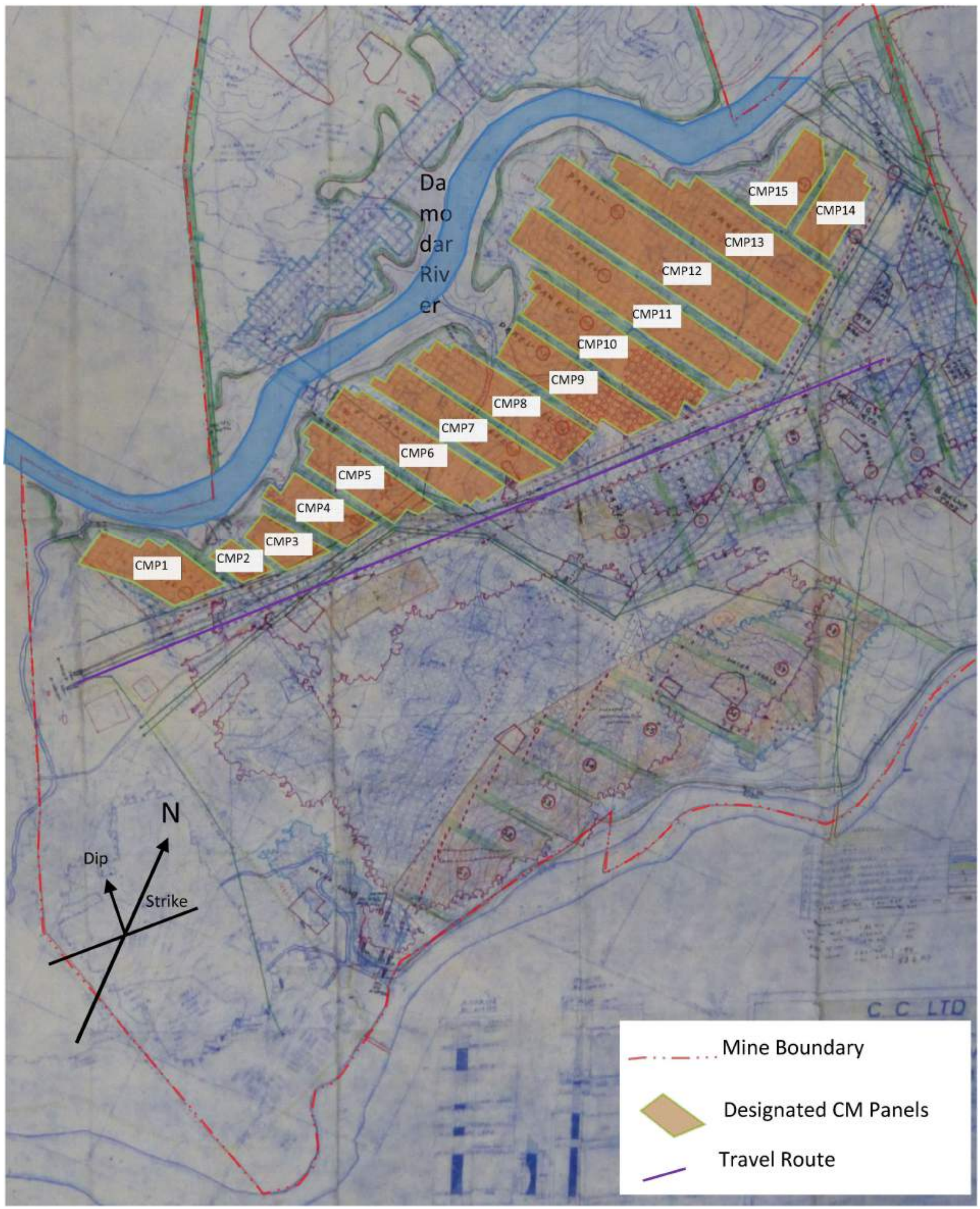


Figure 2 : Location of CM Designated Area - Churi

Table 1: Details of Faults Located Around Churi Block

Sl. No.	Fault No.	Trend	Direction of throw	Amount of throw (m)	Remarks/Evidence
1	**F10**	**NW-SE**	**NE**	**7-15m throw diminishing in SE direction**	**Omission of Lower Bachra seam in CBM-6; also encountered in workings of south central part.**
2	F_{11}	NW-SE	SW	0-10m dies out in the west	Encountered in the workings of Lower & Upper Bachra seam in the south Central part and seen in the Saphi river.
3	F11a	NW-SE	N-E	5m	Based on stratum contours.
4	F11b	E-W	South	2m	Based on stratum contours
5	F_{12}	NW-SE	NE	5m	Encountered in UG workings.
6	F_{12A}	NE-SW	SE	0 to 3m, dies out in the north	Omission of Upper Bachra seam in CCPS-3.
7	F_{13}	NW-SE	NE	8 to 10m	Based on aerial photographs & stratum contours.
8	F_{15}	East-West	South	3m	Upper Bachra seam omitted in borehole NNKC-19. Minor slips in the workings of Churi Colliery.
9	F_{17}	NW-SE	NE	5-50m Reduces eastward	Based on aerial photographs and floor contours
10	F_{18}	E-W	S	0-4m	Omission of Upper Bachra Seam in NNKC-28.

The seam strike within the block is roughly NE-SW in the major part of the area which gradually swings to almost north-south in the eastern part. The strike between fault F13 and F17 in the north-eastern part has further taken swing to almost NNW-SSE. The local swings in strike is mainly due to rolls. The dip of the strata generally varies between 2^o& 3^o (1 in 20 to 1 in 40) in the major part of the property. However, in the southern part of the area, gradient gradually increases locally as could be seen from the stratum contour plans.

Coal Seams

In the Central Sector, two seams, Upper Bachra (UBS) and Lower Bachra (LBS) are present. Seam thickness contours are shown in Figure 5.

Upper Bachra Seam (UBS- Figure 3)

The UBS varies in thickness from 0.13 m (NNKC-35) to 4.84 m (CCPS-10) and is generally 2.0 to 3.0 m in thickness (Figure 5). The seam thickness decreases to less than 1.2 m in the south-western part (NNKC- 26, 28, 33, 35, 40, 48) and in the northern part of the property (NNKC- 43, 44, 49). The immediate roof of UBS is generally grey shale, sandy shale, conglomerate, medium to coarse grained sandstone, carbonaceous shale etc. The immediate floor is predominantly carbonaceous shale and grey shale.

Lower Bachra Seam (LBS)

The LBS ranges in thickness from 1.71m to 11.24m (NNKC-48) and occurs 0.68m to 20.27m (CCPS-4) below the UBS. The Iso-parting indicates that the parting gradually increases from 3m in the middle of the property to about 18m in the south-eastern region. In the north-western part, parting varies from 1 to 3 m. The thickness normally varies from 3-5 m, which gradually increases to 9m in the western part near the Damodar River.

It has been observed from the seam structure plans that there is generally a persistent dirt band of carbonaceous shale/grey shale occurring about 2 to 2.5 m below the roof. The bottom section of the seam is generally clean and better in quality than the upper section which is commonly inter banded and often contains thick shaly coal horizons.

Figure 3 : Seam Contours for Upper Bachra Seam

Seam Dip and Depth

The seam dips gently at 1:20 (2°) to 1:40 (3°) and strikes NE - SW. All the mechanised equipment deployed by JMS will be working within their design parameters, as stipulated by the manufactures specifications. The depth of cover over designated panels CMP-W/14 and W/15 ranges between 85 m and 95 m.

CHURI BLOCK

The seams belong to Karharbari formation, which is known to contain seams with erratic behaviours; therefore, the confidence level of geological interpretation is comparatively low. Two workable seams namely Upper Bachra and Lower Bachra exist in the Block. The details of their thickness is as under

A. Upper Bachra Seam: Varies from 0.13 m to 4.84 m. Generally 2 to 3 m in thickness in major part of area

B. Lower Bachra Seam: Varies from thickness from 1.71m to 11.24m. Normally varies from 3-5m

Benti block

A. Upper Bachra Seam**:** It occurs in a small patch in sector-A along the bank of Damodar River. Thickness (<1m).

B. Lower Bachra Seam**:** The seam is splitted into 3 horizons in the block

i. Bottom Lower Bachra : Thickness of seam varies from 0.24 to 4.25m

ii. Lower Section of Top Lower Bachra : Thickness 1.2 to 2m

iii. Upper Section of Top Lower Bachra : Thickness 0.45 to 4.15m

iv. Combined Top Lower Bachra : Thickness 1.10m to 5.10m

Available coal reserves for Continuous Miner - Lower Bachra Seam: 4.214 Mt

Rock Mass Classification

Rock mass classification for the design of tunnel support was first reported in 1946 by Terzaghi (1946). He estimated rock loads, carried by steel sets, on the basis of a descriptive classification. Since Terzaghi (1946), many rock mass classification systems have been proposed, the most important of which are stated below-

- Lauffer (1958)
- Deere (1970): Rock Quality Designation, RQD
- Wickham et al. (1972): Rock Structure Rating (RSR – Concept)
- Bieniawski (1973): Geomechanics Classification, Rock Mass Rating
- Barton et al. (1974): Q- System
- Buddery and Oldroyd (1992): Impact splitting Test
- Molinda and Mark (1994): Coal Mine Roof Rating

Most of the multi-parameter classification schemes by Wickham et al. (1972), Bieniawski (1973,1989) and Barton et al. (1974) were developed from civil engineering case histories in which most of the components of the engineering geological character of the rock mass were included.

These have main application for both hard and soft jointed rock masses. Several classification systems have been developed and modified for underground coal mining in line with coal measure strata geology. Site specific classification systems were also developed to determine the roof qualities and support systems. Impact Splitting Test developed by Oldroyd and Buddery (1992) for South African coal mines is one such popularly adopted Test.

The production of coal has started from 24.03.2019 with the help of Continuous Miner in conjunction with Battery Hauler. The existing belt conveyors systems are already replaced with higher capacity belt conveyors to cater the need of more transportation of coal. CMP-W/15, CMP-W/14, CMP-W/13 & CMP-W/12 are already depillared and currently depillaring is going on in CMP-W/11 by Modified Nevid Method.

* Mine was sealed on 08-08-20 due to fire & restarted production on 10-04-21.
At present, daily production is being achieved at a rate of 2000 TPD on average to achieve the production target of 0.5 MT.

Classification of Coal measure Strata for Bord and Pillar Operations [6]

Classification coal measure strata for bord and pillar operations was done by Impact Splitting Test (IST) Method. This is a quick and simple test. In this test, the classification of roof and other strata are classified broadly under five different classes.

The impact splitting test involves imparting the same impact to the core at 20 mm intervals. The resulting fracture frequency is then used to determine a roof rating. The instrument shown in Figure 4, consists of an angle iron base which holds the core. Mounted on this is a tube containing a chisel with a mass of 1.5 kg and a blade width of 25 mm. The chisel is dropped onto the core from a constant height according to core size, 100 mm for a 60 mm diameter core and 64 mm for 48 mm diameter core. The impact splitter caused weak or poorly cemented bedding planes and laminations to open, thus giving an indication of the likely *in situ* behavior when subjected to bending stresses.

It is suggested that, when designing coal mine roof support, 2.0 m of strata above the immediate roof should be tested. If the roof horizon is in doubt, then all strata from the lowest likely roof horizon to 2.0 m above the highest likely roof horizon are tested so that all the potential horizons may be compared. In this classification system, the strata are divided into geotechnical units. The units are then tested and the mean fracture spacing for each unit is obtained. An individual rating for each unit is determined by using one of the following equations:

$$\text{For } fs < 5 \text{ rating} = 4fs$$
$$\text{For } fs > 5 \text{ rating} = 2fs+10$$

Where fs = fracture spacing is in *cm*

Figure 4 : The Impact Splitting Test setup

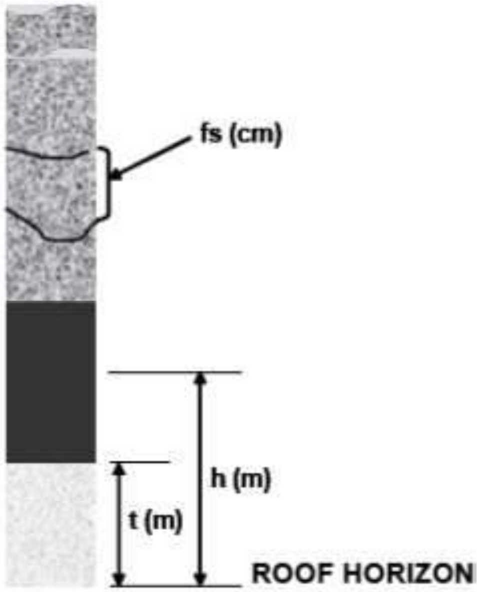


Figure 5 : Impact Splitting unit rating Calculation

This value is then used to classify the individual strata units into rock quality categories as shown in Table for coal mine roofs, the individual ratings are adjusted to obtain a roof rating for the first 2.0 m of roof. It was stated that the immediate roof unit will have a much greater influence on the roof stability and consequently the unit ratings are weighted according to their position in the roof by using the following equation:

Weighted rating = rating x 2(2-*h*) *t*

Where *h* is mean unit height above the roof in meters and *t* is thickness of unit in meters (Figure 5).

The weighted ratings for all units are then totaled to give a final roof rating. Buddery and Oldroyd [7] who have developed this test, is based on the assumption that coal mine roof stability may be governed by the width of the opening created and the frequency of lamination or bedding planes and their potential to separate above this opening.

Latilla et al. (2002) revised the unit and coal roof classification system, and recommended the following Table 2, for classification of coal mine roofs:

Table 2 : Unit and coal roof classification system (after Latilla et el, 2002)

Unit Rating	Rock Class	Roof Rating
< 9	Very poor	< 34
10 – 13	Poor	35 – 51
14 – 19	Moderate	52 – 75
20 – 28	Good	76 – 113
29 – 42	Very good	114 – 167
> 42	Excellent	> 167

Table 3, represents the rock classes proposed in this paper is shown below together with one added to cater for Indian conditions

Table 3: Unit Ratings, Rock Classes and the Weighted Roof Rating

Unit rating	Rock class	Caving Class
<11	Very poor	Easy
11 to <18	Poor	
=18 to <27	Moderate	
=28 to <32	Good	Moderate
=32 to 40	Very good	
=40	Extremely good*	Difficult

**Added for Indian Conditions*

Impact Splitting Results for Caveability

As part of this study, all the available core (up to 50 m above The Seam), from Borehole A, located 77-78L/6D and Borehole B, located 59L/6-7D have been impact split tested according to a method of categorising coal measure roof strata, initially developed for South African conditions. In order not to over complicate the results of this analysis three caving groups are proposed based on the unit rock class ratings obtained from impact splitting:

- **Easy –** Comprising the rock classes VERY POOR, POOR and MODERATE.
- **Moderate –** Comprising the rock classes GOOD and VERY GOOD.
- **Difficult –** Comprising the new rock class, DIFFICULT.

Easy (Very Poor, Poor and Moderate)

Rock types in these classes typically require some form of roof support to enable mining to safely progress in normal bord and pillar operations. Thus a 4 to 6m wide road would require support to maintain stability. When much larger spans than this are created in typical de-pillaring operations caving is expected to readily occur and may cause some difficulty by failing too readily within the extraction zone.

Moderate (Good and Very Good)

Rock in these classes generally form good roof types requiring little or even no roof support at normal bord widths. For example a very good roof at a 6.5 m road width would typically be self-supporting, geological weaknesses excluded. However, as spans increase to those levels found during pillar extraction, caving of good rock and eventually very good rock types will occur reasonably well. This will especially be the case where geological weaknesses such as bedding planes, slips and joints are present that will further weaken the rock mass.

Difficult (Difficult)

In this class the rock is very tough and generally does not fracture at all during the impact splitting test. The word tough is deliberately used here as the Unconfined Compressive Strength (UCS) data tends to suggest fairly low values of strength when compared to South African rock types.

The results of the impact splitting test depends to a large extent on the frequency of and the propensity of bedding planes to open and fracture under stress. It has been noted, generally in India, that the frequency of bedding planes is less in many of the Indian sandstones examined than found in most South African sandstones. Also it is fairly typical for Indian sandstones to be much coarser grained. When fractures have been induced during impact splitting in the Indian sandstones the surfaces are often found to be extremely rough. Rough joint surfaces produce much stronger surfaces more resistant to lateral movement than smooth ones.

However, at Churi Benti, close to moderately spaced, continuous bedding planes are present within some sections of sandstone strata, which will to readily part, thus rocks classed as difficult to cave will generally propagate. Also ‘difficult to cave’ sections observed in the boreholes to date are relatively thin in section and are bound by thick sections of ‘moderate’ rock, which will cave reasonably well.

Method of mining
Ventilation

There are two nos. of Main Mechanical Ventilators (MMVs) installed at Churi Colliery. One MMV (fan) is used to ventilate the mine and another one is a stand-by MMV (fan).

A PV200 main mechanical fan is situated at fan house of fan drift of Churi. To ensure the proper and effective ventilation of the mine a new mechanical fan (Axial flow fan) of equivalent PV200 is installed and the existing fan is kept in standby mode.

Mining Equipments at Churi
This mine has one set of continuous miner, two set of Twin bolter – 2 set, two sets of Battery hauler, one Feeder breaker and one Load center. In addition to this a set of conveyor belt system is in place to evacuate the coal. Table 4, presents the transport system of the mine to handle the CM produced coal.

Modified Navid Angle Method for depillaring - First of all the original gallery of 4.2m*3m is widened and heightened up to 6m and 4.6m respectively. After heightening and widening the pillar is reduced to 19m*19m size. Then the Continuous miner takes I, II and III. After that IV, V and VI cut is completed. Then VIIA, VIIIA cut is completed in 2nd no pillar then VII, VIII cut in pillar no 1 is completed. This way the entire panel is depillared. We follow straight line of extraction and the depillaring sequence is shown by the arrow.

Strata Control &Equipment:

i) Dual Height Tel Tale

ii) Auto Warning Tel Tale

iii) Strain Gauge Bolt

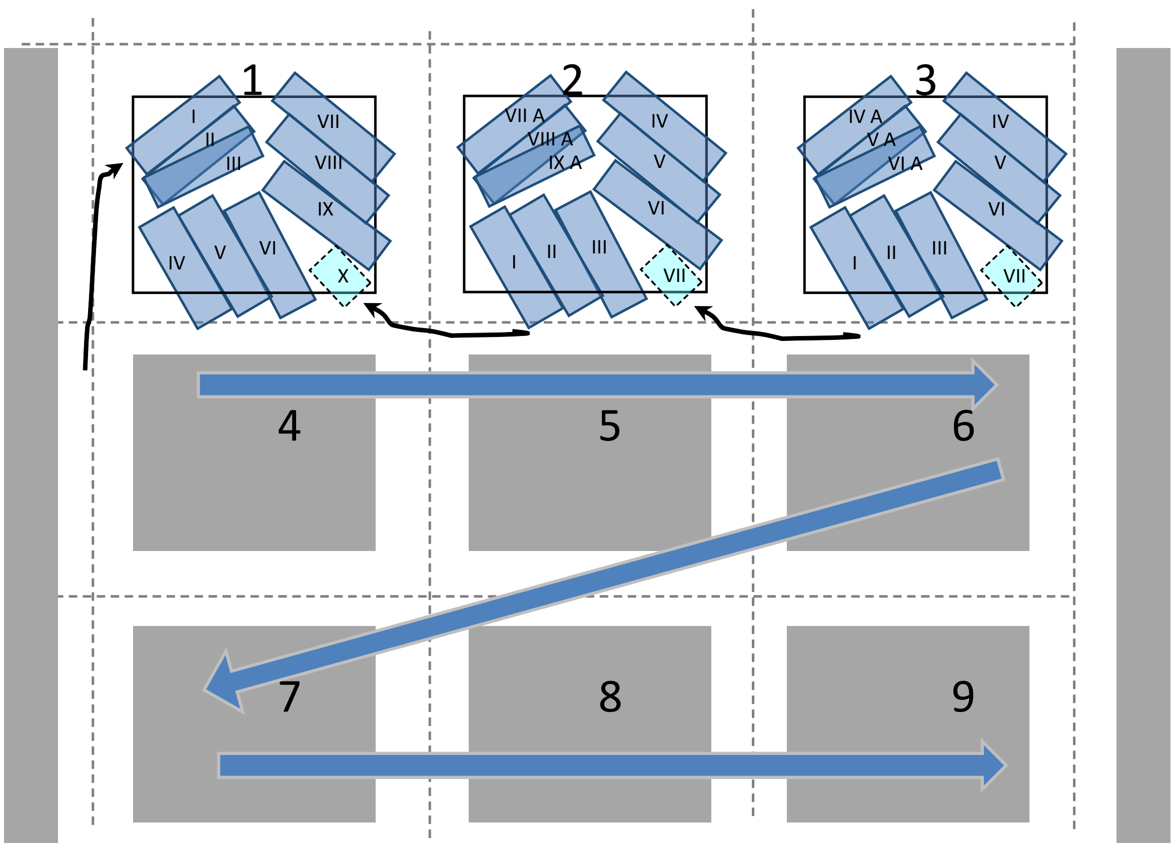
iv) Stress Cell

v) Remote Reading tel Tale

Table 4 : Transport System / Belt Conveyor System

	Conveyor No.	Location	width	Length	Lift in mtr.	Capacity (TPH)	Motor power rating & supply voltage
01	TB1	Main Incline(No.07)	1000	500	111	600	2*150kw.3.3kv,3phase AC NFLP
02	TB2	05Lto 34L	1000	1000	10	600	2*75kw.550kv,3phase AC FLP
03	TB3	34L to 65L	1000	1000	0	600	2*75kw.550kv,3phase AC FLP
04	TB4	65L to 70L	1000	180	13	600	1*90kw.550kv,3phase AC FLP

CUTTING SEQUENCE



Techno economic Study

Study of CMTechnology Vs Conventional mining with LHD/ SDL

For CM Technology following may be the rough calculation

Production: 2000 TPD

List of Equipment

Continuous Miner – 1No

Shuttle Car/Battery Hauler- 2No

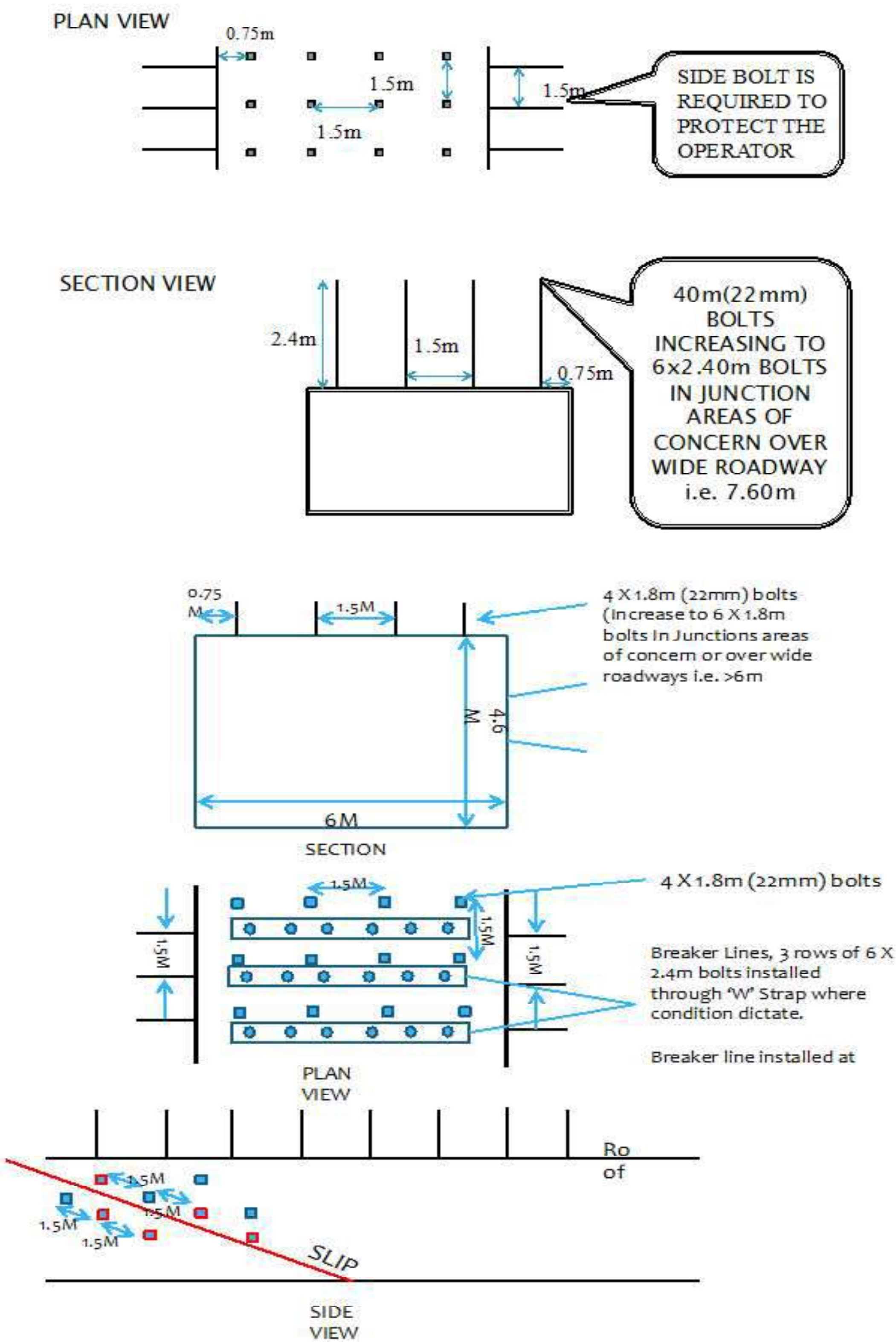
Feeder Breaker- 1no

Electricals for CM package- 1 set

LHD For Service- 1

Cost of full package of above materials: 150000 lakhs

A. REDEVELOPMENT GALLERY SUPPORT



Assumptions:
If we consider life of 9 years then Annual cost of machines = 150000/9=1667 lakhs /year
Manpower Required for CM District- 110 no
EMS- Rs 4500/te
Store Cost-Rs 310/Te
Power Cost- Rs 300/te
OMS- 18.18
Hence CM district cost Rs /te Assuming 6,00,000 te Production per annum
Equipment Cost Rs 1667Lakh or Rs 278/Te
Salary and wages Rs 4500*110/2000 = Rs 248/te
Store Cost Rs 310/te
Power Cost Rs 300/Te
Total 1136/te
For a LHD district:
Production – 150 te/LHD or 600 TPD or .18 MTY
No of LHD /district-4 @75 lakh =300 lakhs
Life 9 years
Pony belt 100 lakhs Life 3years
Roof Bolter 2 no @75 lakh= 150 lakh 9years
Store cost- Rs 300/te
Power Cost- Rs 300/te
Manpower 220
OMS- 2.73
EMS- Rs 4500/Person- Rs 1650/Te
So Cost of LHD District for 600 TPD or 0.18MTY
Cost of LHD- 300/9= 33.33 Lakh/Year= Rs 19.00/te
Belt- Rs 18.00/Te
Roof Bolt- Rs 9.00/Te
Salary and Wages- Rs 1650/Te
Store Cost - Rs300/Te
Power Cost- Rs 300/Te

Total- Rs2296/Te

On comparison we can see that the cost of CM District is almost half of that of LHD District.

Problems identified

* Long travelling distance.
* Geological disturbances in the panel required to install more support i.e. w-straps & wire nets.
* Weak & watery floor conditions due to that BH stucking frequently.
* Continuous flow of Water from strata after drilling holes for strata monitoring instruments.
* Presence of syncline area in the panel
* Inrush of more than 800 GPM water from goaf of present & previous panel which is creating problem to extract of trough zone area.
* Voltage fluctuation due to that LC tripping frequently.
* Undersize incline belt due to that jamming problem occurs frequently.
* Poor ventilation in the panel
* Long & semi mechanised transportation system due to this delay in reaching of spare parts during emergency.
* Unnecessary instrumentation which is increasing the idle time of CM.

Mitigating Measures Suggested

* Arrangement of man rider or FSV
* Floor trimming & route preparation by coal dumping or some other material
* Proper maintenance of trunk belts
* Installation of Automatic capactiorbank
* Introduction of Multi utility vehicle for transportation of material
* Increasing of ventilation capacity.
* Only necessary work like important & reliable instruments needs to be installed.
* Positive approach toward the increasing capacity of men &machinery(i.e Motivation for manpower & Maintenance of equipment's.

Production

Table 5, presents the level of production since 2018-19 from this mine. Except for the period of closure during8th August 2020 to 10th April 2021, the production remained stable in all the months.

Table 5 : Presents production trend (Figures in Tonnes)

Year	Target	Achievement	Remarks
2018-19	0	1950	Commissioning of CM
2019-20	3,00,000	4,76,164	
2020-21	4,00,000	2,10,629	Mine was closed due to fire from 08.08.2020 to 10.04.2021.
2021-22	5,00,000	5,83,814	

CONCLUSION

It has been found during the study that Continuous miner is a mass production technology and can substantially improve production of a mine. In the mine under study it was found that the loss has been drastically reduced and thereby mine has earned a notional profit.This technology can be used for redevelopment and depillaring very successfully with a % of extraction to the tune of 75%.The production can be further improved if the sub system of CM works with full efficiency and almost zero down time by introducing preventive maintenance. By comparing the cost per te for a CM district VS LHD district it is found that techno economic feasibility of CM is much better than Conventional LHD District.

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Diamond Bearing Conglomerate Occurrence in Panna, M. P.

R. K. Dixit[1] S. Tignath[2] D.K. Deolia[2] V. K. Mishra[3] R. N. Tiwari[4]

ABSTRACT

Panna Diamond belt of Madhya Pradesh state is one of the initial productive belts of India. Diamondiferous conglomerate beds associated with Jhiri shale of the Vindhyan Supergroup and their weathered products have been exploited since ancient times in the area between Darera and Hardua with Panna town being located more or less in the central parts of this area. Exploitation of diamondiferous conglomerate beds and their weathered products is still continuing in some parts of the belt. This research work is very helpful to finding the exploring new primary and secondary source of diamond and its locations.

INTRODUCTION

The Panna Diamond Belt (PDB) occupying the northern margin of the Vindhyan Basin in Panna district, Madhya Pradesh hosts the primary, secondary and tertiary sources of diamond. It comprises the basement of Bundelkhand granitoids to the north overlain by Vindhyan Supergroup of rocks to the south. The diamond mining activity is confined mainly to the Baghain plateau and to a lesser extent to the Gahadra plateau. The two kimberlite pipes known in Panna Diamond Belt are Majhgawan and Hinota pipes emplaced in Baghain Sandstone lying to the west of PDB. The basal conglomerate interbeds Upper Rewa and Lower Rewa have been extensively mined for diamond in the past. The alluvial and colluvial placer diamond workings are ancient and present, spread over the Baghain plateau mainly between Panna town in the west and Paharikhera in the east. The enigma of the absence of kimberlite/lamproite diatreme other than ones near Majhgawan and Hinauta in Panna Diamond belt, has been a point of great concern to the Geological community since long. Though diamond occurrences are known to be present all over the Panna Diamond Belt (PDB), which is more than 2500 sq.km. in area, no additional pipes have been located up to now. As a sequel to the realisation that economic potential of a diamondiferous is more in the crater part rather than the root zone, which is normally present in the basement, significance has been given to the study of Vindhyan sediment. The purpose of research work is locate new probable primary source of diamond in Panna diamond belt, determined diamond constituency and developed new diamond bearing area, measuring Diamond incident and its tendency with calculating economic importance of study area with this study.

Panna Diamond Belt (PDB) is over the last two centuries and presently hosts the only primary diamond-producing mine in India. The Vindhyan Basin is well known for its primary, secondary and tertiary sources of diamonds (Rau 2007). Mathur et al. (1973) worked on Angor ultramafic body and described it as Harzburgite-Pyroxenite-Gabbro complex. They worked on its diamond incidence. Mapping the surrounding area, they came across another small outcrop of an ultramafic rock adjoining the main body. Jhingran et al. (1958) summarized the work of his colleagues including S.M. Mathur, S.N. Puri, R.S. Sharma and P.C. Mathur and carried out mapping of Bundelkhand granitoids in Chhatarpur District (MP). He distinguished ten types of granites on the basis of grain size, colour of feldspar and presence or absence of ferromagnesians. The other rock types mentioned by them are gneisses, quartz reefs, basic dykes and some enclaves within the granites. Bundelkhand granitoids are dominantly granodioritic, locally varying to adamelite. He has also mentioned that the Bundelkhand granites are products of intrusion of two magmas formed by anatexis and palingenesis followed by metasomatism. Misra (1948) concluded that the metasediments occurring in the terrain of Bundelkhand granite are older than granites. This was later corroborated by Mathur, S.M. (1954) and Saxena (1980) on the basis of presence of pegmatites, heavy mineral percentages in the country rock and granites, granitization of quartzites and their relicts in granites. Saxena (1980) dealt on Petrography, Petrochemistry and structures of the Mau-Ranipur and Kabrai areas. He also proposed correlation of the Meta sediments with the Middle Dharwarian rocks and the granites as the equivalent to clospet granite. He was of the opinion that alkali metasomatism led to the formation of the Bundelkhand granites. Mishra (2011) proposed a plate

[1]*Directorate of Geology and Mining, Bhopal, M. P.*
[2]*Department of Geology, Government Model Science College, Jabalpur, M. P.*
[3]*NMDC Limited, Panna, M. P.*
[4]*Department of Geology, Govt. Model Science College, Rewa, M.P.*
Corresponding Author: rkdixit85@gmail.com

tectonic model in which he suggested hiatus of 500-600 Ma between the Lower Vindhyan and Upper Vindhyan sequences. Mishra and Tripathi (1972) have worked out the stratigraphy and structure of the Bundelkhand complex. They divided Bundelkhand Group into tour Formations, namely (i) Kuraicha (ii) Palar (iii)Bundelkhand granites and (iv) Bundelkhand basic intrusives. They correlated the Kuraicha Formation (high grade metamorphics) with the upper Dharwarian rocks and Palar Formations (low grade metamorphics) with the Bijawar Group. They also suggested that the rocks of Bundelkhand region have undergone five episodes of deformation. Ghosh (1982) recognised four phases of granites and dioritic variant in Bundelkhand terrain adjoining the Vindhyan basin. The diorite is thought to have been formed from the assimilation of basic rocks by granite magma. Dolerite, basalt, lamprophyre, gabbroic, pyroxenite kimberlite dykes traverse the above rocks. An ENE-WSW trending ultrabasic dyke located around Biharpur shows similarity in composition with that of Basaltic kimberlitic variants of Majhgawan Kimberlite diatreme. Singh et al. (1992) have carried out regional geochemical stream sediment and soil sampling in Bundelkhand granite terrain with an aim to search for primary source rock for diamond. Geochemical stream and soil sampling has clearly indicated direct correlation between the rock types and the concentration of characteristic trace elements (Niobium, Chromium, Cobalt and Nickel).

Stream draining known Majhgawan and Hinauta kimberlite pipes has indicated anomalous concentration of the above referred elements (Ghosh, 1981). Basu (1980) is of the opinion that quartz reefs are intrusive within Bundelkhand granites rather than of sedimentary origin. The present geochronology and chemostratigraphy give substantial isotopic data from the silisiclastic-carbonate sequences, covering the most important part of the Vindhyan succession (Banerjee & Frank 1999; A. Kumar et al. 2001; B. Kumar et al. 2002; Rasmussen et al. 2002; Ray et al. 2002, 2003; Singh et al. 2002; Sarangi et al. 2004; S. Kumar et al., 2005; Ray 2006). Vredenburg in 1906 study the under report a few sections of the Semri series have been observed, and they show differing successions, each containing only a few members. It is, therefore, not possible in all cases to give the actual position of a formation in the stratigraphic succession shown in figure 2. Auden (1933) reclassified Semri series in the Son Valley and Bundelkhand area no such attempt has been made so far, but it is hoped that after completion of the mapping of the Panna diamond field. Mathur, 1958-1959 find the sequence of formations that constitute the Vindhyan System is fairly well established. But, the succession in the Panna diamond field needs revision on several points, which though minor, are of considerable importance in correlation, and, therefore, in locating diamond deposits that are associated with them.

Major contributions were made by different researchers on the geology of the Vindhyans Super Group by Mathur (1965, 1972,1973), Banerjee (1999), Misra (1969), Kumar (1976, 1978,), Singh (1973, 1980, 1980a, 1985), Bhattacharya et al. (1996), Prasad (2007), Sastry and Moitra (1984), Mishra et al. (1962), Kumar et al. (1976), Sarkar and Bose (1974), Chakrabarti (2007), Valdiya (1969), Sarkar et al. (1983, 1974), Bose et al. (2001) and many more.

Apart of all these above studies many more researcher do in recent years and significantly contributed to the field of Geology, Geotechnology, Environmental Geology, Palaeogeography, Tectonic history and Lithostratigraphy of the Vindhyans Super Group. Geological Survey of India published the proceedings of the symposium on the Vindhyans of Central India in 1981.

STUDY AREA

The study area is bounded by Latitude 24°30’00"N – 24°45’00"N and Longitude 81°15’00"E – 81°30’00"E, falls under Panna and Satna districts in Madhya Pradesh state. The study area falls in the survey of India Toposheet no. 63D/06 (700 sq km area). The location of area is shown in figure 1. The camp was settled at Panna town which lies 10 km west of the toposheet 63D/06 and is well connected with National Highway 75 which connects Panna and Satna via Devendra nagar town for carrying out fieldwork for completion of the assigned NQT during the FS 2018-19. The National highway 75 is connecting district headquarters Panna and Satna passes through the centre of the Toposheet no. 63D/06 in the NE-SW direction.

The major localities present in the T.S. no. 63D06 are Devendra nagar, Kakrehati, Lakshmipur, Bikrampur, etc. of Panna district and Shivrajpur, etc. of Satna district which are accessible by metalled road. The study area is well connected with road and rail routes. The Rail journey (the distance between Jabalpur railway station to Satna railway station or vice versa is approx. 189 km which can be travel in 2.50 hrs) can be performed on Allahabad-Jabalpur section of West Central railways from Jabalpur railway station (a broad gauge station) to Satna railway station (It is the nearest railway station for reaching the study area) via Katni railway station with regular train services followed by taxi to Panna town. The road journey (the distance between Jabalpur to Panna or vice versa is approx. 213 km which can be travel in approx. 6-7 hrs) can be performed from Jabalpur bus stand (Deendayal bus stand) to Panna bus stand with regular buses running between Jabalpur and Panna via Sihora, Katni, Pawai and Amanganj towns. Also, road network (metalled and unmetalled) present within the study area is adequate for the collection of the approx. 75% samples by Outsource vehicle; rest approx. 25% samples falling in inaccessible areas of Protected forest and open mixed jungle have been collected via tracking. The nearest airport is Khajuraho airport which is approx. 40 km NW of Panna town.

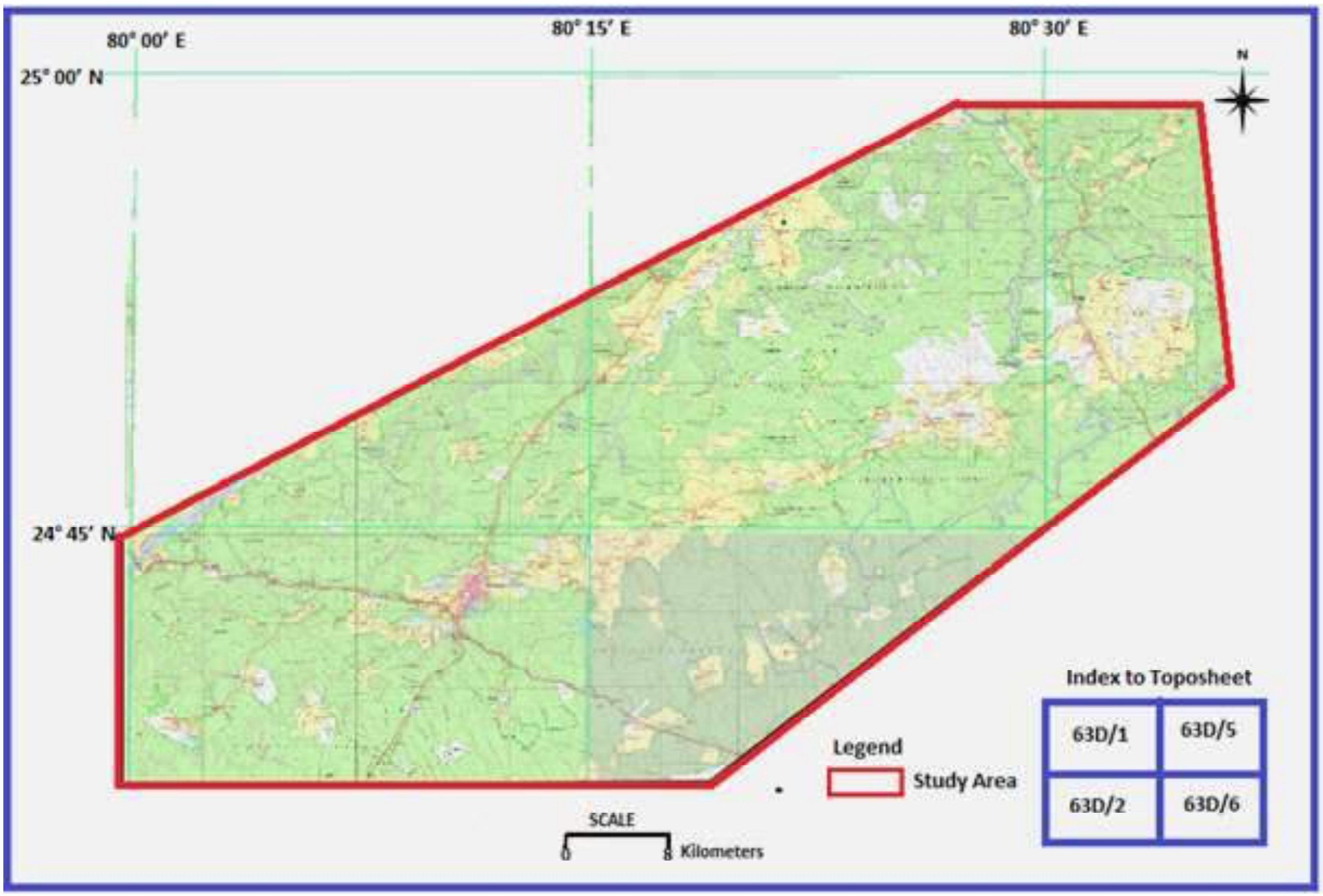
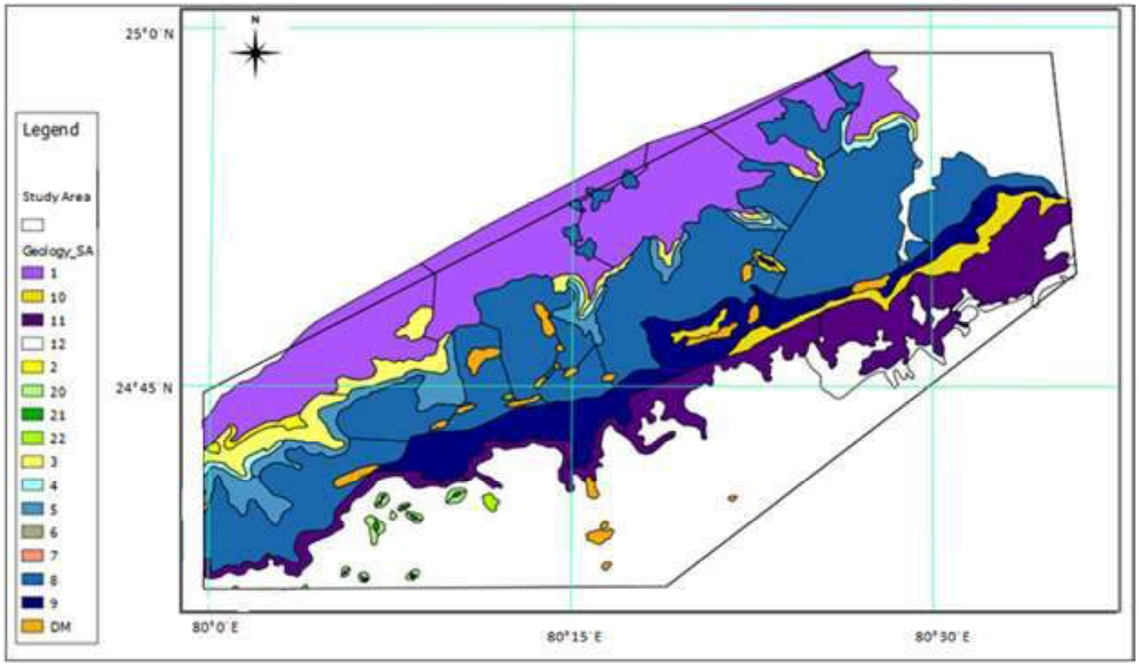


Figure 1: Location Map of study area on Toposheet no. 63D/1, 63D/2, 63D/5 and 63D/6.

METHODOLOGY

The most common methods of mineral exploration across the world are shown in Figure 3. All are aware that Mineral exploration is the process of searching for evidence of any mineralization hosted in the surrounding rocks. In this process, general principle works by extracting pieces of geological information from several places, and extrapolating this information over the larger area to develop a geological picture. Exploration works in stages of increasing sophistication, with cheap, cruder methods implemented at the start, and if the resultant information is economically interesting, this warrants the next, more advanced (and expensive) techniques. However, it is very rare to find sufficiently enriched ore bodies, and so most exploration campaigns stop after the first/couple of stages.



1-Granite, gneiss & migmatite (BGC); 10-Sandstone (Rewa Group); 11-Shale (Rewa Group); 12-Sandstone (Rewa Group); 2-Quartzite & Chert Breccia (Bijawar Group); 20- Shilty Shale with pocket of clay (Lameta Group); 21-Basalt (Deccan Trap); 22-Laterite; 3- Quartzite/sandstone (Semri Group); 4-Limestone (Semri Group); 5-Shale with porcellanite (Semri Group); 6-Dolomitic sandstone interbed within Shale (Semri Group); 7- Conglomerete (Kaimur Group); 8- Fine grained sandstone (Kaimur Group); 9-Shale (Rewa Group); DM- Diamond mine

Figure 2: Geological map of the study area

Figure 3: Exploration pyramid

The Mapping is the foundation of all geological-related studies, whether it be geotechnical, groundwater, geohazards or mineral exploration etc. It is vital for developing the base-level picture of an area's geology, with each subsequent step of work in an area building off and correlating back to this initial stage. When mapping with a mineral exploration focus, quite often prospecting will be conducted alongside.

Soil Sampling: Soil is composed of several layers, and one in particular 'catches' the metal ions leaking from the underlying rocks, accumulating a mineral-rich horizon. This is the desired layer in soil sampling, from which a 1kg specimen is collected to test the chemistry of the geology beneath. This technique is extremely important for collecting data in the countryside where the rocks are blanketed by soil and vegetation.

Stream Sediments: This method works on the principle that sediment material in stream beds is derived from the erosion of the rocks further upstream. Therefore sampling this material in various locations can give clues as to the geology of the upland area, as well as being tested for their chemistry to provide hints as to whether any metals of interest may be hosted within.

Drilling: Drilling is the peak of a mineral exploration campaign. It is an extremely expensive process and so will only be used in the rare locations which have proven considerably interesting for their mineral potential. However, in these few places, drilling provides physical evidence of the rock below, and is used to confirm the theories of the underlying geology which were developed during earlier techniques such as soil sampling etc. Drilling is an essential component of late-stage exploration projects.

Whereas the above methods analyse the chemistry (directly or indirectly) of the geology below surface, geophysics is used to test for the physical properties of the rock. These techniques can offer another side of the story to any geological theories, and so an exploration campaign can quite often compare and collaborate both geochemical and geophysical studies. The processes are magnetic, electromagnetic, electrical resistivity, induced polarisation, seismic and radiometric surveys.

RESULT AND DISCUSSION

The ancient time of immemorial Diamond has been adorned as the king of gemstone. The Panna Diamond Belt (PDB) covers an area of about 4000 sq. km. along the northern margin of the Vindhyan basin in Panna District, Madhya Pradesh, India. Shallow pit holes depth of diamond mines has been operated by unorganized sector under the permission from the Department of Mining and Geology, Government of Madhya Pradesh, India. The Vindhyan Super Group (VSG) is represented mostly by arenaceous and argillaceous litho stratigraphic units with minor amounts of calcareous component belonging to the Kaimur, Rewa and Bhander group. The PDB occurs as a part of Vindhyan super group in the northern edge of Vindhyan basin (Soni et. al., 1987; Chalapathi Rao, 2005 and 2006).

The diamondiferous conglomerate beds are located in the Baghain sandstone, Panna shale, Rewa sandstone and Jhiri shale formations of Vindhyan super groups. Vindhyan Super Group rock formation shows a general strike direction of ENE-WSW and dipping 2º to 5º towards SSE direction. Approximately 25 km from Panna in SW direction, the pear shaped and nearly circular kimberlite, lamproite and diatremes are located near Majhgawan and Hinota villages respectively (Hamilton, 1819; Merh, 1952; Babu, 1998).

Conglomerate bed are well represented practically thick with gradual tapering and strikes in ENE and WSW directions. The thicker part of the conglomerate beds consist of larger pebble too. Hence, it is inferred that they represent N-S or NNW-SSE trending paleochannels. The normal thickness of the conglomerate bed which containing diamond is 0.60m and yield 27.91 carats /100 tons. The conglomerate bed also contains high percentage of gem quality diamonds (55 %) when compared to Majhgawan kimberlite (38%) (Rau and Soni, 2003).

VARIOGRAM SLOPES AND FRACTAL DIMENSIONS

This is the Geostatistical analysis from each direction of DEM of the area. The following data and graph recorded.

N-S:-999.0000 -496.500, **NE-SW: -**999.0000 -496.500,

E-W:-999.0000-496.500, **SE-NW: -**999.0000 -496.500

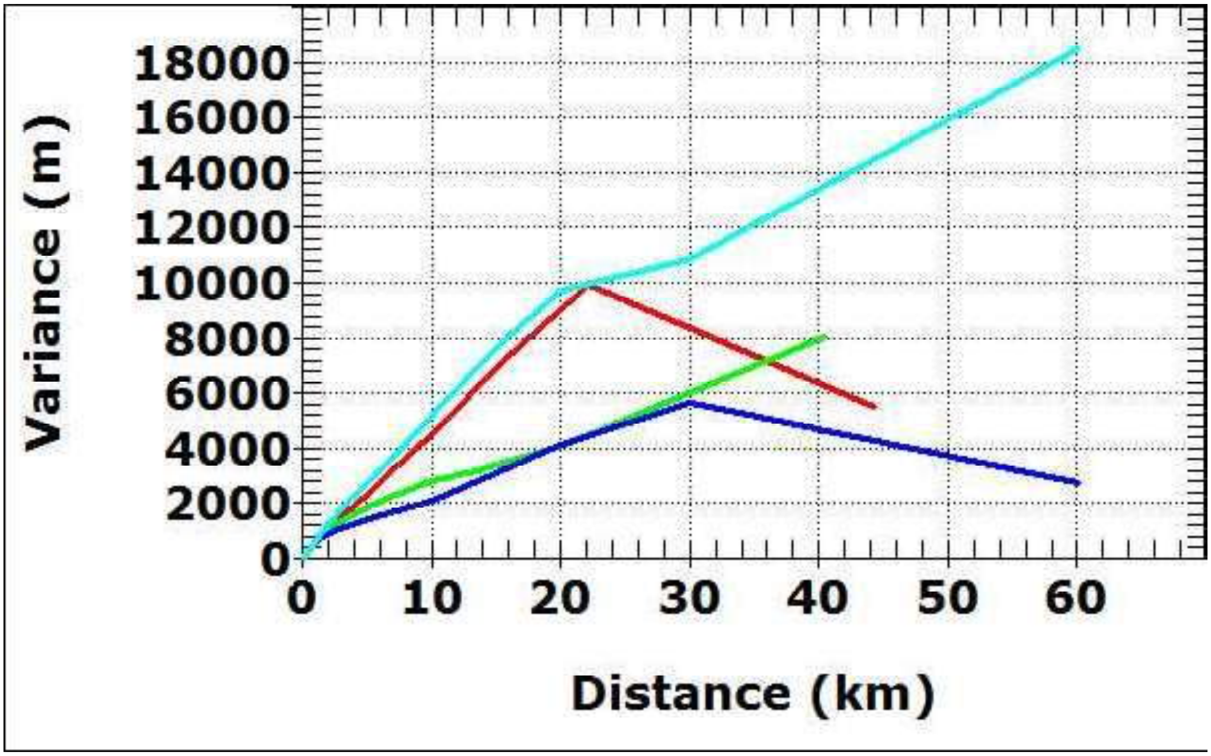


Figure 4: Variogram Slopes and fractal Dimensions of the area

SHALLOW PIT LOG DATA INTERPRETATION

On the basis of origin and mode of occurrence diamondiferous source rocks have been classified into mainly three types in Panna. These three belt are manly associated with

a) Primary-Kimberlite/Lamproite and other ultramafic rocks.
b) Secondary-Diamondiferous conglomerate inter beds of Rewa Group and
c) Tertiary belt are further divide into two belt i.e.
i) Superficial lateritic gravel on the tap of Baghain and Gahadra Sandstone surfaces.
ii) Quaternary alluvial gravel deposits along the streams draining of Panna diamond belt.

The pit holes lithology of the area indicate that the regional geology is mainly the Itwa conglomerates, Jhiri conglomerate, Banghen sandstone majorly occurred with diamond bearing zones. This was logged as dolomite, but it is more widely known to include interbedded shale, dolomite, sandstone and mudstone. Groundwater is ows mainly in weathered and fractured zones within this variably competent formation.

Based on this research work done earlier on the nature of occurrence of diamond from secondary source like conglomerates and sandstones. The conglomerate beds associated with Jhiri Shale formation and its weathered products have been very important source for diamonds in the Panna area.

This present study is based on the nature of the conglomerates beds and traces the provenance of the constituent pebbles, besides their dipward side extensions. The examination of conglomerate beds observed in the excavations recently undertaken by private miners, washed material heaped close to old diamond pits in the study area. The term conglomerate has been used to denote for the rock transportation of sub angular to rounded fragments larger than +2 mm. and constitute more than 20% of the rock. Constituent fragments of these conglomerate beds usually vary in size from 2 mm. to 10 cm. in hole area but occasionally boulders up to about 40 cm. found. The categorization in the rock is usually quite poor.

The study area conglomerate are mainly formed with granules, pebbles, cobbles and occasionally even boulders of greenish grey quartzitic sandstone, grayish white quartzitic sandstone, glauconite bearing quartzitic sandstone, jasper, vein quartz, siltstone, chert, lenticles and pellets of poroellanic shale, set in a compact arenaceous matrix which at places tend to be rather silty and occasionally even shaly. The proportions of conglomerate are varying with different constituent fragments from place to place. The rock colour is usually varies from greysih white to greenish grey but often due to the reddish brown and sometimes even very dark brown.

Rarely the conglomerate is formed mainly of granules and small pebbles of the above noted rock types but at places the proportion of the larger constituent fragments has been occur to be fairly high. On the basis of the size of the constituent fragments two types of conglomerate were recognized (Mathur, 1974) in the area viz. granular (buck shot) and pebbly the former usually overlying the latter. Quite often, however, only one of the above two varieties is found to be developed in any given area.

Sometime the conglomerate beds are meet with at more than a few horizons, those occurring in the basal parts of Jhiri shale formation are originate to be rather more persistent and good developed. Repeatedly the conglomerate beds are occur overlying the undven surface of the Baghain sandstone but sometimes the latter is separated from the conglomerate beds by slim inter bed of silty shale and shale. It may be mentioned here that sometimes the impersistent conglomerate beds occurring in the higher horizons of Jhiri Shale Formation, are originate overlying the sandstone and siltstone inter beds in the shale formation. A detail description of the nature of different constituent pebbles present in the conglomerate beds, is given below and an attempt has been made to trace their origin which may ultimately recommend the provincial target area for the search of ultramafic rock bodies which had contributed to diamonds in these rock lithological beds.

The rock formations in the study area occur a variety of sedimentary structures like cross bedding, current lineation, ripple marks, pebble orientation, flute cast, mud cracks, halite casts. The cross bedding sedimentary structure occur in the top parts of Baghain sandstone and also in some sandstone inter beds in the lower parts of Jhiri Shale formation indicate to bimodal current directions varying from southwest to southeast and locally from west to northwest direction.

Greenish grey quartzitic sandstone is the most common constituent of the conglomerate beds and ranges varies in size from tiny granules to boulders measuring up to 40 cm. across area.

The quartzitic sandstone is usually fine grained, greenish grey, quite often tending to be greyish white in colour, with vitreous to subvitreous lustre and sub-conchoidal facture. The cobbles are subangular to subrounded often bearing irregular cavities and depressions in the study area.

Pinkish grey quartzitic sandstone is associated with medium to fine grained texture and compact usually with a pinkish and at times rather violetish, tone. This rock is occurring with vitreous luster and fracture is sub-conchoidal. The fragments range in size varies from tiny granules to large pebbles measuring up to approximately 12 cm. and cobbles being only occasionally found. The pebbles of this rock are usually ellipsoidal and illustrate with indistinct laminations which become conspicuous on faintly weathered surface.

Quartz Vein is shown as rounded to subrounded granules and pebbles and as rarely cobbles present in the conglomerate. The vein of quartz is milky white to greyish white in colour with occasional shades with pink colour. In some of veins are the loose cobbles meet with in the area about 200m.

Jasper is a noticeable constituent of these conglomerate beds found commonly as granules but large pebbles measuring up to about 10 cm. diagonally are not unusual. It is associated with the brick red to reddish brown colour and locally yellow and yellowish green colors. It may be banded and even very thinly laminated.

Por-cellanic shale of yellowish and greyish white colour is mainly observed as a main constituent of the conglomerate. The quantity of these shale fragments in the conglomerate varies from place to place. In the presence of the fragments of these shales in the conglomerate is measured by the local miners to be a good quality indication of the diamondiferous nature of the conglomerate. These rocks fragments have great lithological resemblance with the porcellanite beds occurring in the Palkawan Shale formation of Semiri Group so well exposed in the ghat section of Marla-Panna road along the northern flanks of Vindhyan Plateau.

Shale is associated with small pebbles and granules of dark brown ferruginous siltstone at place tending to be rather silty shale are also observed locally in the conglomerate. They are slightly insufficient in the conglomerate beds occurring in the basal part of Jhiri Shale formation but are moderately often meet with in the conglomerates found in the higher horizons viz. area about 2.25 km. NW of Narangi bagh and within 1.0 km. NE of Ranibagh.

The size, shape and roundness of the fragments in the diamondiferous conglomerate from the different parts of the area were studied to suppose the possible mode of their transport and origin. Samples of washed material dumped near the old workings were collected from selected places especially where the diamond mining activity has been intensive. The sphericity which mostly depends upon the early lithology, jointing, bedding and transportation, though not a very helpful indicator of the provenance, it is observed to be more in the greenish quartzites as compared to the fragments of Bijawar violetish grey quartzite, jasper and vein quartz, wherein the spericity is quite low and occasionally moderate.

Figure 5: Field photograph showing rounded boulder with conglomerate deposits

Section-1

In this section, 4 shallow pits are inclined in straight line. The pit 65, 75, 88 share the common litho type beneath the subsurface and their rock type depth vary. The top layer consist of shale and exposed on surface as well. The Jhiri conglomerate follows shale. The thickness of the jhiri conglomerate is very less and vary between 0.02 m to 0.05 m. The next layer of Sandstone (SST) exist and again followed by Itwa conglomerate. The depth of the Itwa conglomerate is more than Jhiri conglomerate. Further Baghin sandstone is observed in the end of pits depth. The pit 186 follows the lithology in sequence of Sandstone (SST), Jhiri conglomerate, Sandstone (SST), Itwa conglomerate and Baghin sandstone. In this pit also, the depth of itwa conglomerate is more than jhiri conglomerate. The difference in these section is that on

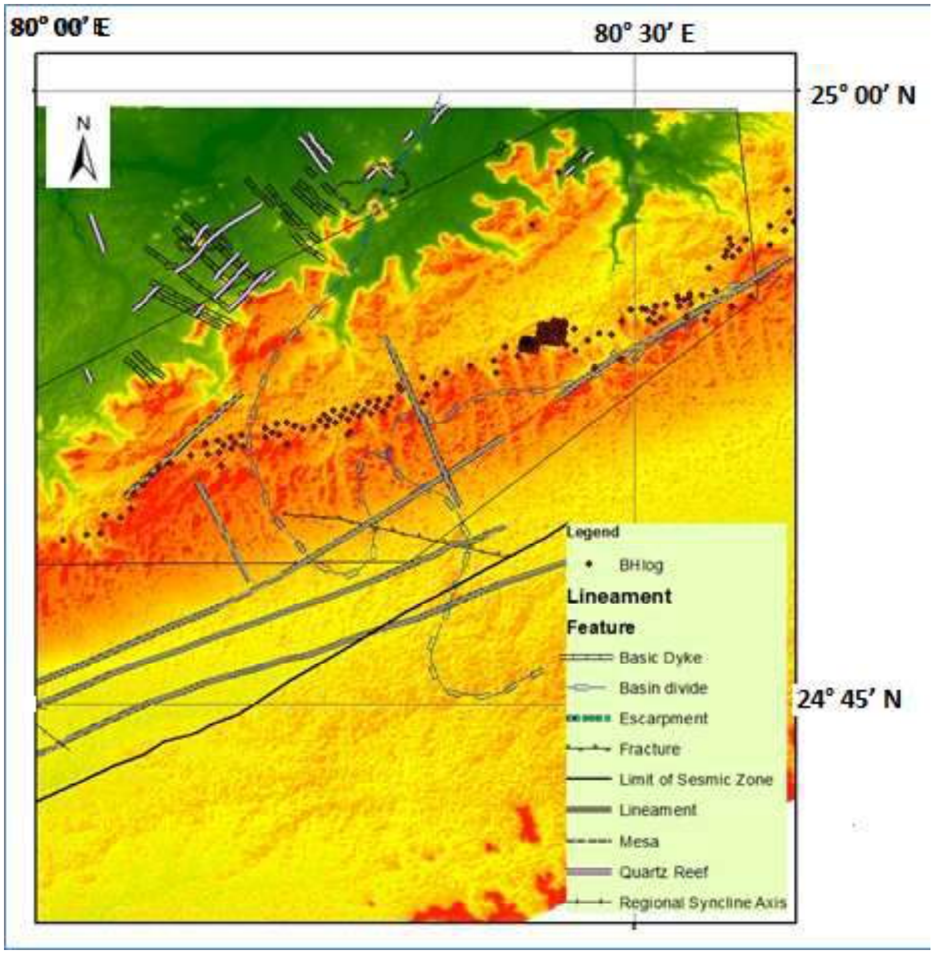


Figure 6: Pit hole locations on DEM and Lineaments map

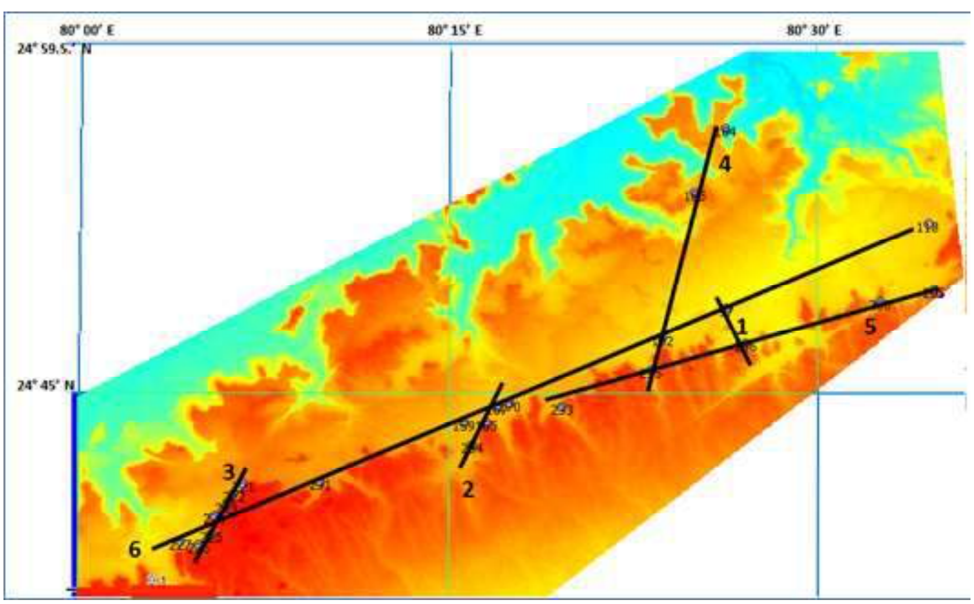


Figure 7: Indicating profile section for lithologs

the near to surface layer the SST is exposed around pit 186 and then it is replaced by Shale in rest of the profile line. Such change may indicate the movement of landmass.

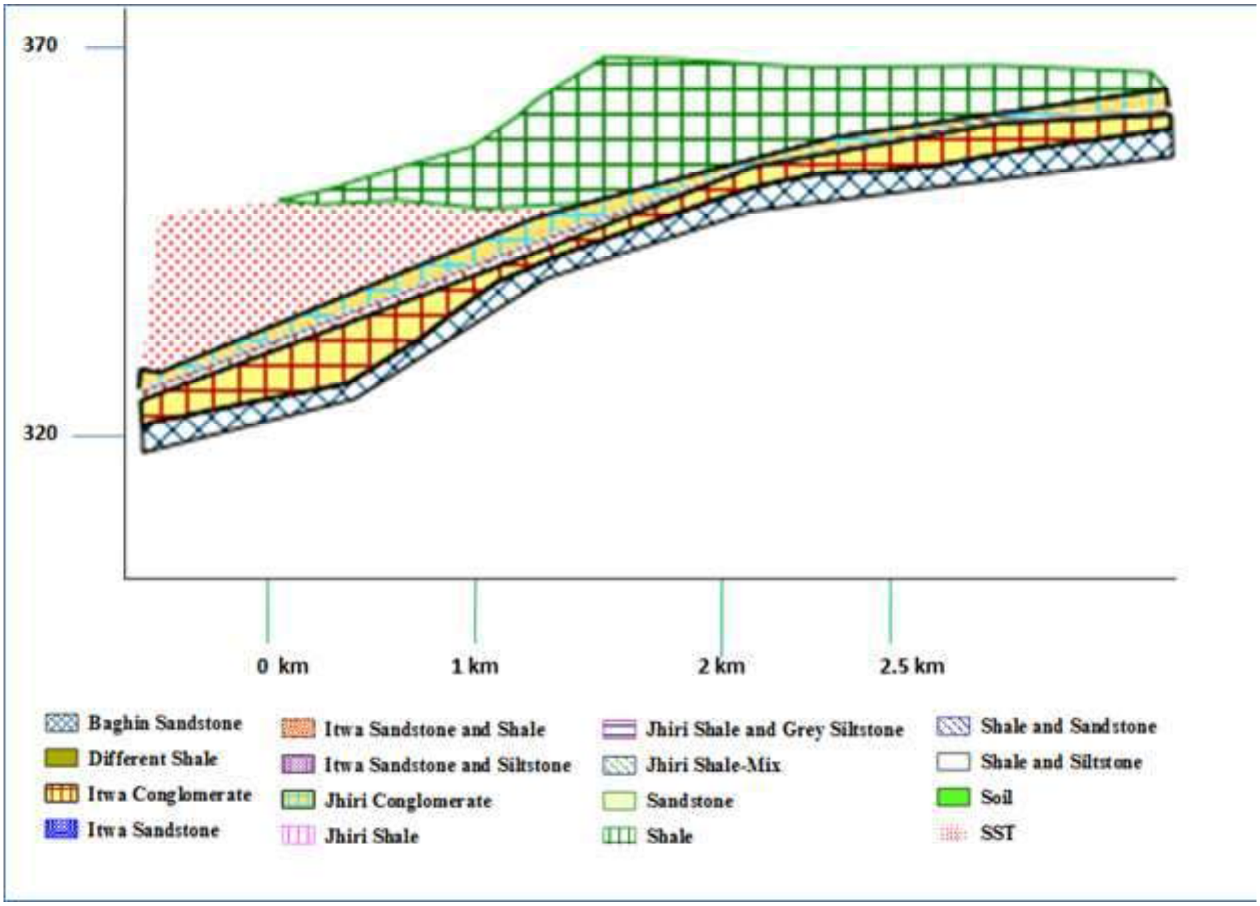


Figure 8: Cross section of section 1.

Section-2

In this section, 3 shallow pits are inclined in straight line. The pit 234, 165, 167 shares the complex and very intermixed litho type beneath the subsurface and their rocktype depth vary. The area under 165 and 167 pit, the top layer consist of SST and exposed on surface as well. The Jhiri conglomerate follows SST. The thickness of the jhiri conglomerate is high and vary between 0.04 m to 20 m. The next layer of Sandstone (SST) exist and again followed by Jhiri conglomerate. The depth of the jhiri conglomerate is less than previous conglomerate layer. Again SST and Jhiri Conglomerate is found in the downward sequence respectively. Further Baghin sandstone is observed in the end of pits depth. The pit 234 follows the complex lithology. The shale and sandstone are interbedded in the area upto some depth which is followed by Jhiri shale and this bed is thicker than 10 m. Again Jhiri shale is followed but interbedded with green fragements in it and followed by Jhiri conglomerate. This conglomerate bed has approx 0.05 m thickness. Further down, shale interbedded with grey siltstone is found and followed by Jhiri conglomerate and sandstone. Further shale and sandstone are interbedded and Baghin sandstone are found. In this pit, the depth jhiri conglomerate is very less.

Section-3

In this section, 6 shallow pits are inclined in straight line. The pit 226, 225, 224, 223, 222,221 are used in this section profile and streaches approx 5.5 Km. This profile share the common rock type except some variation in central part. The top surface includes SST and vary from 6 to 46 m beneath the ground level. Pit 221, 224 have similar profiles and the occurance take place as SST, Jhiri

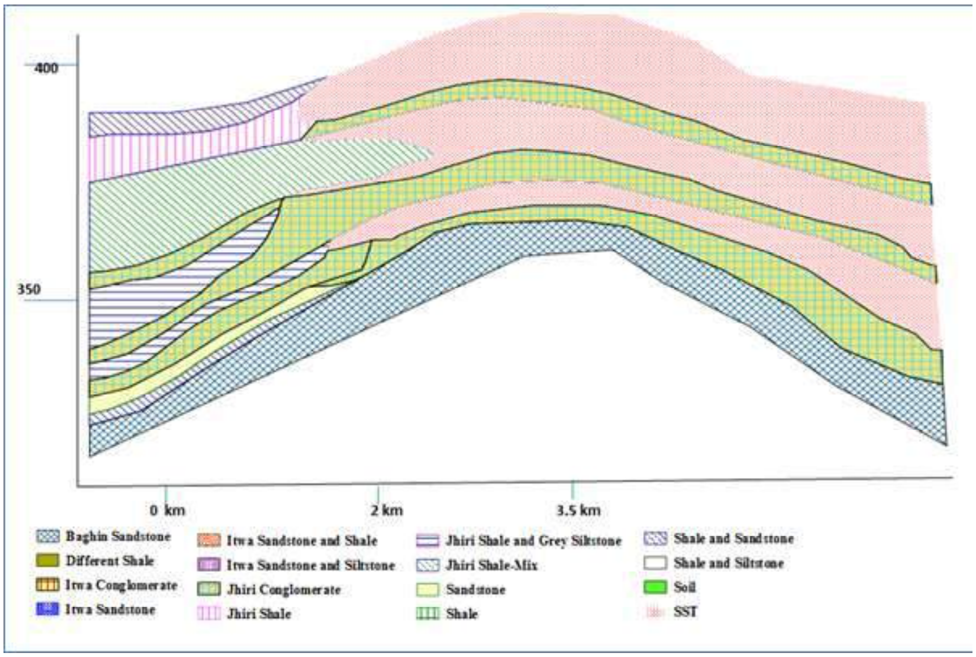


Figure 9: Cross section of section 2

conglomerate, SST, Jhiri conglomerate and Baghin sandstone. The pit 222, 223, 225, 226 have following sequence of rocks occurance as SST, Jhiri conglomerates and Baghin sandstone. The thickness of Jhiri conglomerates is very less and don't excedd 0.05 m in this profile. The possibility of interbedding of SST and Jhiri conglomerate in continuity of rest of lithology exist due to some faults present in the area.

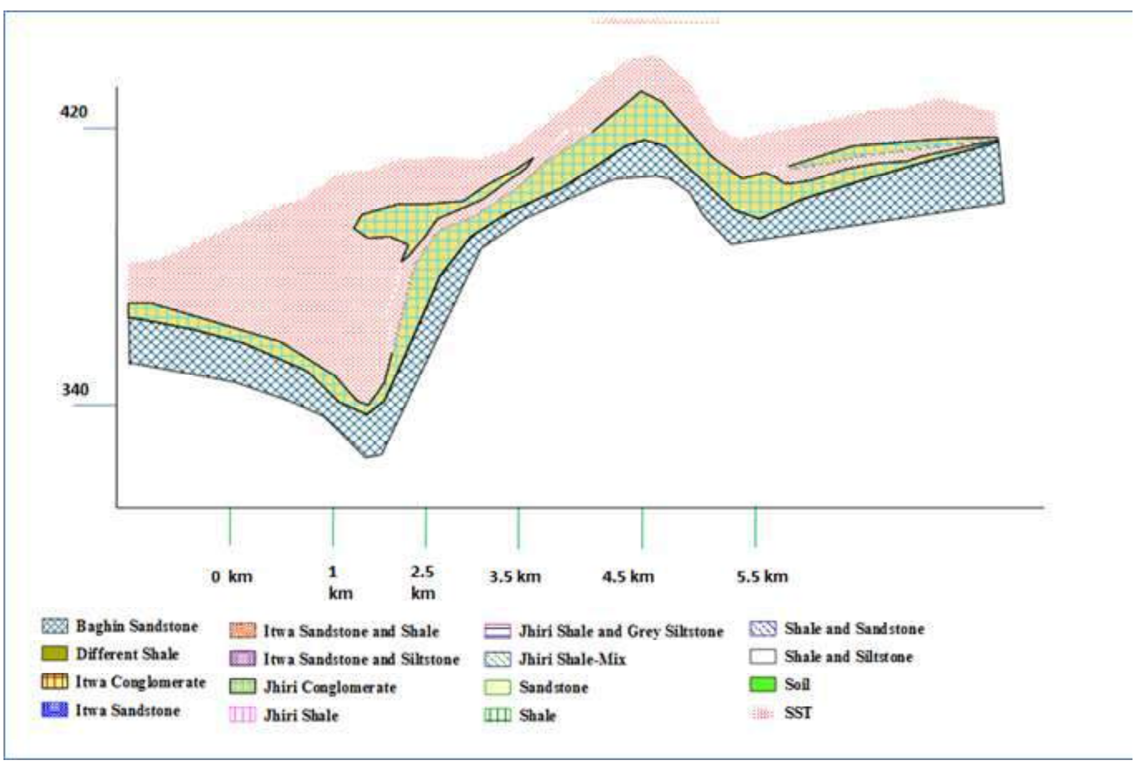


Figure 10: Cross section of section 3

Section 4

In this section, 4 shallow pits are inclined in straight line. The pit 235, 182, 185, 184 are used to prelare the profile of this section. The profile under the proximity of pits 182, 185 and 184 share uniform lithology including the SST and depth varies from 10 to 20 m below the surface. The complexity in profile starts when the trace has been developed from 182 to 235. 14 different type of lithology is reported in this part of section and may multiple fold system exist in this part. The lithology have the sequence in manner as Soil, Jhiri Shale, Shale, Jhiri shale interbedded and mixed with siltstone, sandstone, jhiri shale intermixed with grey coloured silt stone. Further Jhiri conglomerate, Itwa sandstone mixed with siltstone is present and followed by Itwa conglomerate and Itwa sandstone. Further Shale is found in association with siltstone and followed with mixed presence of siltstone and Itwa sandstone. Further Itwa sandstone is followed by Baghin sandstone. The conglomerate bed have less than 0.02 m thickness in this part and may be small portion.

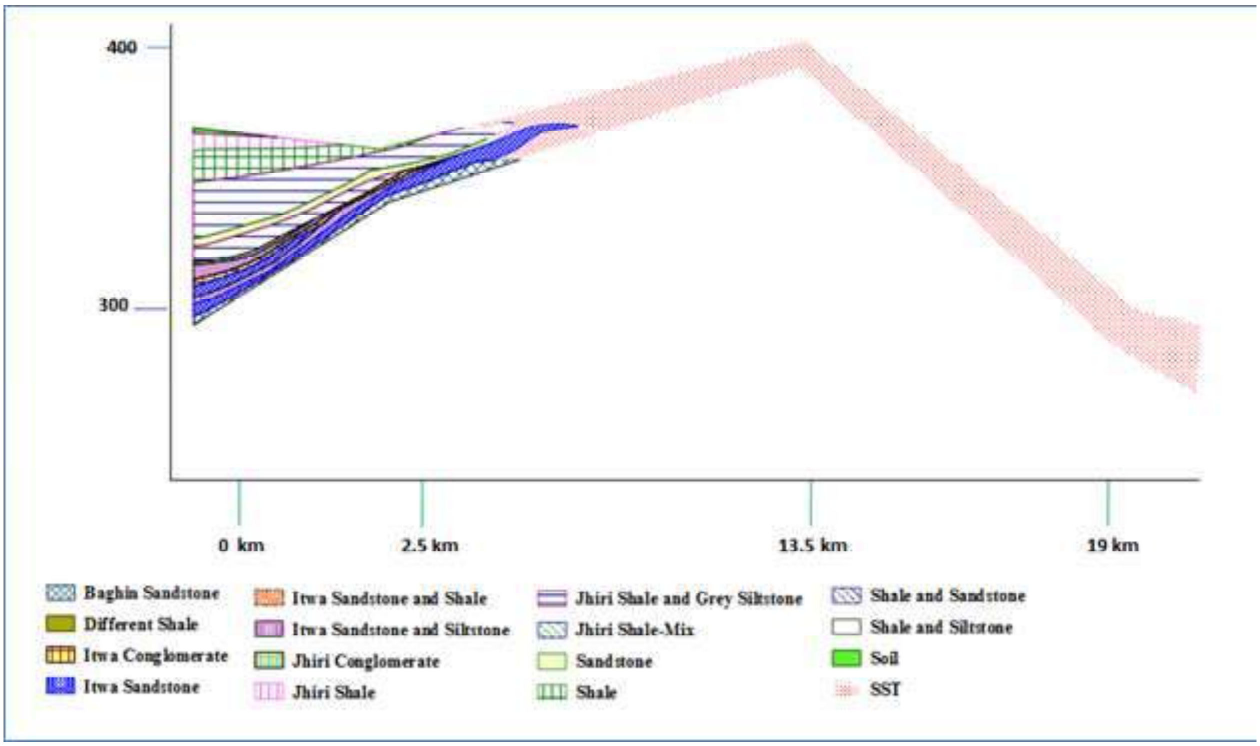


Figure 11: Cross section of section 4

Section 5

In this section, 4 shallow pits are inclined in straight line. The pit 233, 236, 200, 205 share the complex litho type beneath the subsurface and their rocktype depth vary. The top layer consist of soil and exposed on earth surface. The occurrence of soil, Jhiri shale, Jhiri shale (mixed with different colour), Jhiri shale interbedded and mixed with grey siltstone and Jhiri conglomerates is common in the proximity of 233 and 236 respectively. Upto this sequence the depth also reduced to half from 233 to 236 and further down the variation in lithology also exist. After Jhiri conglomerate, in proximity area of 233 the lithology sequence is in order of jhiri shale mixed with siltstone, Jhiri conglomerate and this sequence is repeated 3 more times then followed by Jhiri shale, Jhiri conglomerate, Itwa sandstone and Baghin sandstone. While in proximity area of 236, the sequence after Jhiri conglomerate is as sandstone, Jhiri conglomerate, Jhiri shale and further follow same repeated sequence 2 more times and followed with Itwa sandstone of 3 different type and further down Baghin sandstone is found.

When we trace toward pit 200 and 205 from 236, the reduction in lithology sequence is observed in the profile. The continuation of soil is changed into SST at surface and followed by Jhiri conglomerate in area under proximity of pit 200 and 205. The sequence of SST and Jhiri

Conglomerate is repeated 1 more time in proximity of pit 200 and followed by SST and Itwa conglomerate with Baghin sandstone. In proximity area of pit 205, SST is followed by Jhiri conglomerate and Baghin sandstone only. The top layer consist of soil and exposed on earth surface. The occurrence of soil, Jhiri shale, Jhiri shale (mixed with different colour), Jhiri shale interbedded and mixed with grey siltstone and Jhiri conglomerates is common in the proximity of 236 respectively. the sequence after Jhiri conglomerate is as sandstone, Jhiri conglomerate, Jhiri shale and further follow same repeated sequence 2 more times and followed with Itwa sandstone of 3 different type and further down Baghin sandstone is found. In the proximity of 159 and 170, SST, Jhiri Conglomerates is repeated 2 and 3 times and then followed by Beghin sandstone. The thickness of conglomerate bed is approx 0.05 m in different layers. Further the lithology change is not visible if moved towards pit 182 and in this area only SST is exposed beneath the surface. If the traverse is taken towards pit 97, 118 and 210 then different lithology is visible. In their proximity area Shale, Soil and SST is exposed on surface respectively. Around 97, shale is followed by Jhiri conglomerate and Baghin sandstone. Around pit 118, Soil is followed by Jhiri shale, Conglomerate of Itwa resemblance and Baghin sandstone beneath the ground. The further trace toward pit 210, SST is found on top layer but Jhiri shale and Jhiri conglomerate is replaced with Itwa conglomerate. SST and Itwa conglomerate sequence is repeated 2 times in the area and followed by Baghin sandstone.

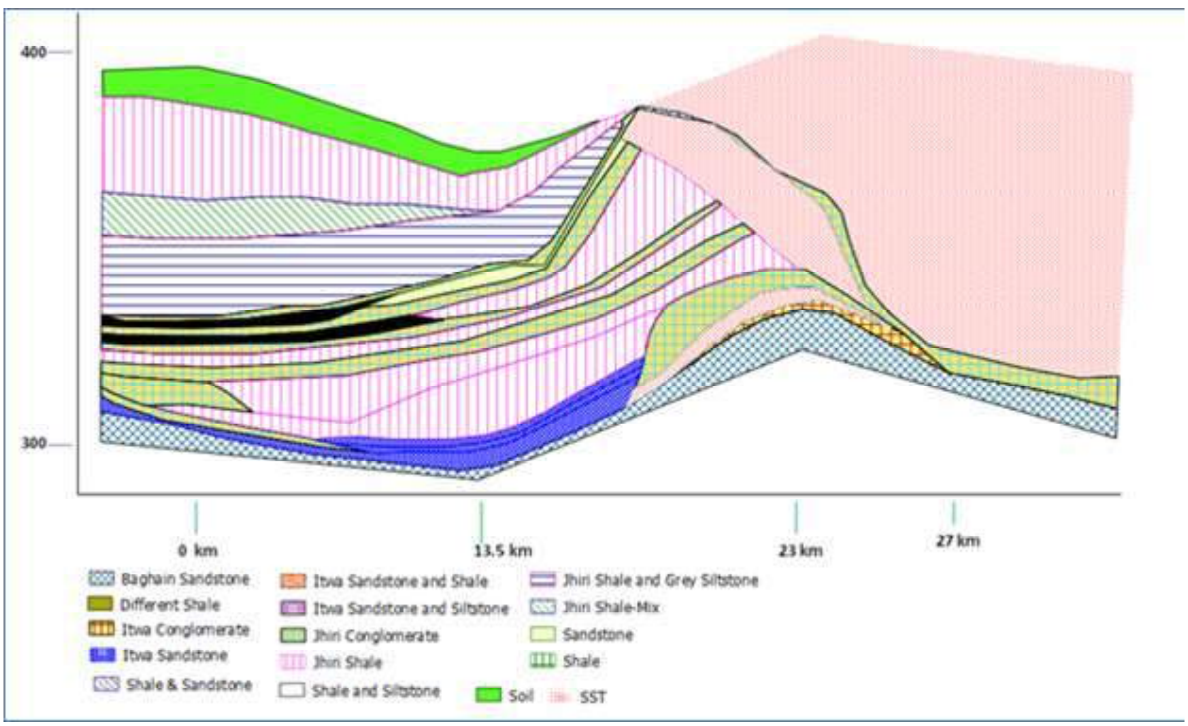


Figure 12: Cross section of section 5

OCCURENCE OF DIAMOND

Mineral resources of the area are diamond, dimension stone, molybdenite, building stone, base metal, laterite/ bauxite, etc. There are two sources for diamonds- Primary source and Secondary source.

Primary Source

There are two primary sources i.e. Majhgawan and Hinauta diatremes. Since Hinauta diatreme falls under National Park area and also that it s incidence of diamonds is poor, it is not being exploited presently.

Majhgawan mine the only diamond producing mine in the country. NMDC is the exploiting agency. A reserve of 18.19 million tonnes of diamondiferous rock down to a depth of 150m and 21.80 million tonne down to 200m has been estimated by NMDC. Since 1968 diamonds weighing 3.9 lakhs carats have been recovered so far. At present 24000 carats of diamonds are being recovered per year. About 14 carates of diamonds per hundred tonne are being recovered from the mine. Relative proportion of different type/ quality of diamonds are-

Average size of the diamond is 0.45 carats. The diamonds recovered from Majhgawan mine is periodically sold in rough form, through public auction at various centres in India. Tailings (after the recovery of diamonds) of pipe rock of Majhgawan can be used to improve crop yield in acidic soil, sandy loam soil and heavy black soil. This can also be used as glaze material for tiles and also as body for ceramic and mosaic tiles. Efforts are also being made to recover magnesium and magnesium salt from the tailings.

Secondary Source

a) **Conglomerate**

Itwa conglomerate is the second most important source of diamond in the belt. The quarry for diamondiferous conglomerate is now restricted to the area south of Baghain river around Hatupur village. Here the conglomerate is encountered at the depth of 4-8m below the surface. Diamonds are fairly good gem quality. Sometimes, off coloured and industrial variety of diamonds are also recovered; diamonds are mostly, of one carat or less in weight, occasionally upto 6 carats of diamonds have also been recovered. Recently, in the area north of Kitha, diamonds are being recovered from Itwa conglomerate. Though, Jhiri conglomerate is also diamondiferous and in the past, diamonds have been recovered from the quarries in the area presently these conglomerates are not Being quarried owing to poor recovery:

b) Quaternary gravels

They have also yielded significant amounts of diamonds. There are two types of gravels, river gravel and laterite gravel. River gravels occurring along the Baghain River are being treated for diamonds. Gravel workings are confined to north of Itwa (upto Kauhari) Village. Old workings are also present along Chahla nala and Sonhara area. Lateritic gravel workings are extensively developed in Sakaria area over Gahadra Sandstone surface. Baghain and Gahadra surfaces have developed laterite gravels around Dahlan, Majha, Hurra chauwki, Jhalha-Nippania, Motwa Halka, and Tindini etc. and were worked extensively for diamond.

Private parties are engaged for the recovery of diamonds from the secondary source under the supervision of the Diamond office of the State Govt. All the diamonds are deposited with the Diamond office attached to the collectorate of Panna. These diamonds are auctioned and the proportionate amount after deducting the state revenue is given to the private party concerned.

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Panna Diamond Belt Lineament Identification Using SRTM and Secondary Data

R. K. Dixit[1] S. Tignath[2] D.K. Deolia[3]

ABSTRACT

The remote sensing is in use for various purposes and in Mining programs, it is been used for primary exploration stages and shortening of the area. The 30 min arc data is used for lineament identification at regional scale. The SRTM data is used for relief or morphology, flow patterns, and lineament extraction. An attempt is made to understand the structural evolution of the tectonically active Vindhyans by means of lineaments extracted from remotely sensed data of SRTM.

Key Word: SRTM, Lineament, Panna Diamond Belt.

INTRODUCTION

Remote sensing technology has grown faster, for spatial, temporal, and spectral resolution, so the applications have become wider. Remote sensing data for geology could be used for identification of mine area, lithology identification, or geomorphological mapping, and identification of other geological parameter. The remote sensing utilization on geology was based on some identification of main parameters, such as relief or morphology, drainage patterns, and lineament

The lineament was the linear feature that could be mapped from the surfaces, and was morphological expression of geologic structure. The straight river valley and parallel segment of the valley was the typical geomorphologic expression of the lineament (O' Leary, 1976 on Hung et al., 2005). The lineament density information to understand the lineament accumulation on an area. One of the benefits from the lineament density information was by helping decided the mineralization prospects faster based on parameter of weak zone density, that could be seen as consideration factor of a potential area (Verdiansyah, 2015).

The lineament density data was proved effective to be done on various locations, such as mineralization analysis in Afganistan (Hubart et al., 2012), lineament analysis in Maran – Malaysia (Abdullah et al, 2010), tectonic evaluation in north Iraq (Thannoun, 2013).

[1]Directorate of Geology and Mining, Bhopal, M. P.
[2]Department of Geology, Government Model Science College, Jabalpur, M. P.

Corresponding Author: rkdixit85@gmail.com

MATERIAL & METHODOLOGY

Panna area, situated in Vindhyans (Bundelkhand craton) , was become a research location because of Diamond occurance in the region along with traces of radioactive minerals. The diamonds are mined by local syndicate without Permission prior to existence of NMDC. After NMDC is formed by govt and the diamond exploration task is authorized to the organization with scientific development. The used data was SoI toposheets of year 1962 and imagery of SRTM (Shuttle Radar Topography Mission) with resolution of 30m.

The SRTM data is used to identify certain lineaments in panna area. The identification was manually based on interpretation keys. To do the identification manually, SRTM imagery (Fig.1) needed to be created the Releif map, DEM, Drainage to ease identification of various lineaments in area.

It compass direction that is a topographic slope faces, usually measured in degrees from north. Aspect can be generated from continuous elevation surfaces. The aspect of a slope can make very significant influences on its local climate (microclimate). For example, because the sun's rays are in the west at the hottest time of day in the afternoon, in most cases a west-facing slope will be warmer than a sheltered east-facing slope (unless large-scale rainfall influences dictate otherwise). This can have major effects on altitudinal and polar limits of tree growth and also on the distribution of vegetation that requires large quantities of moisture. It also provides the information on Weathering in the area.

Aspect is also important in many other fields such as the broader study of terrain analysis. Aspect combined with precipitation, temp, growing periods, and slope can

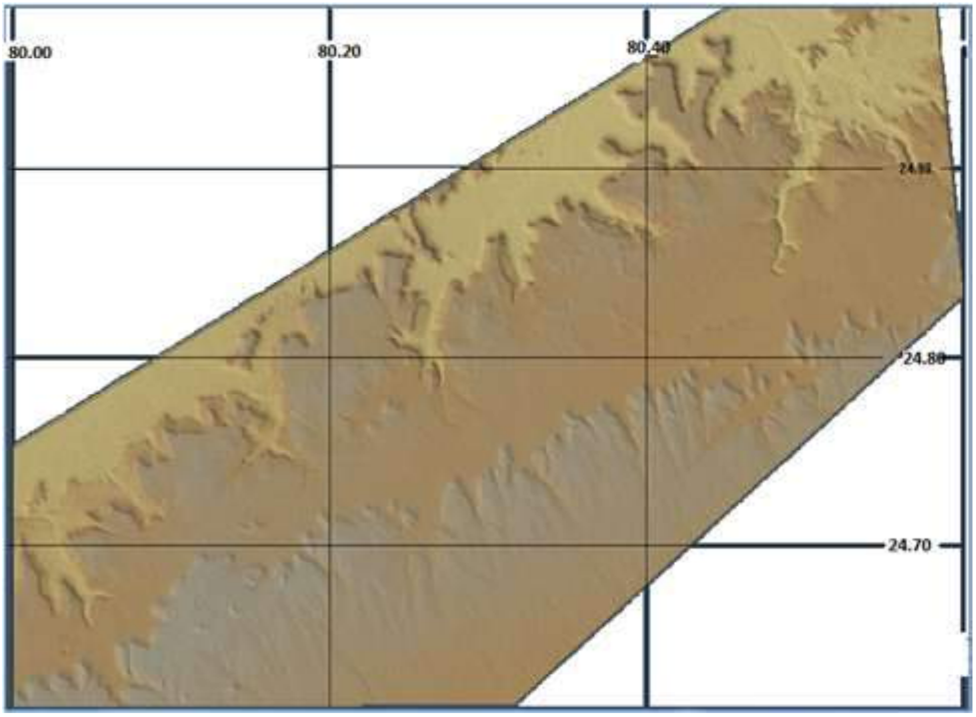

Fig.1: SRTM image of study area

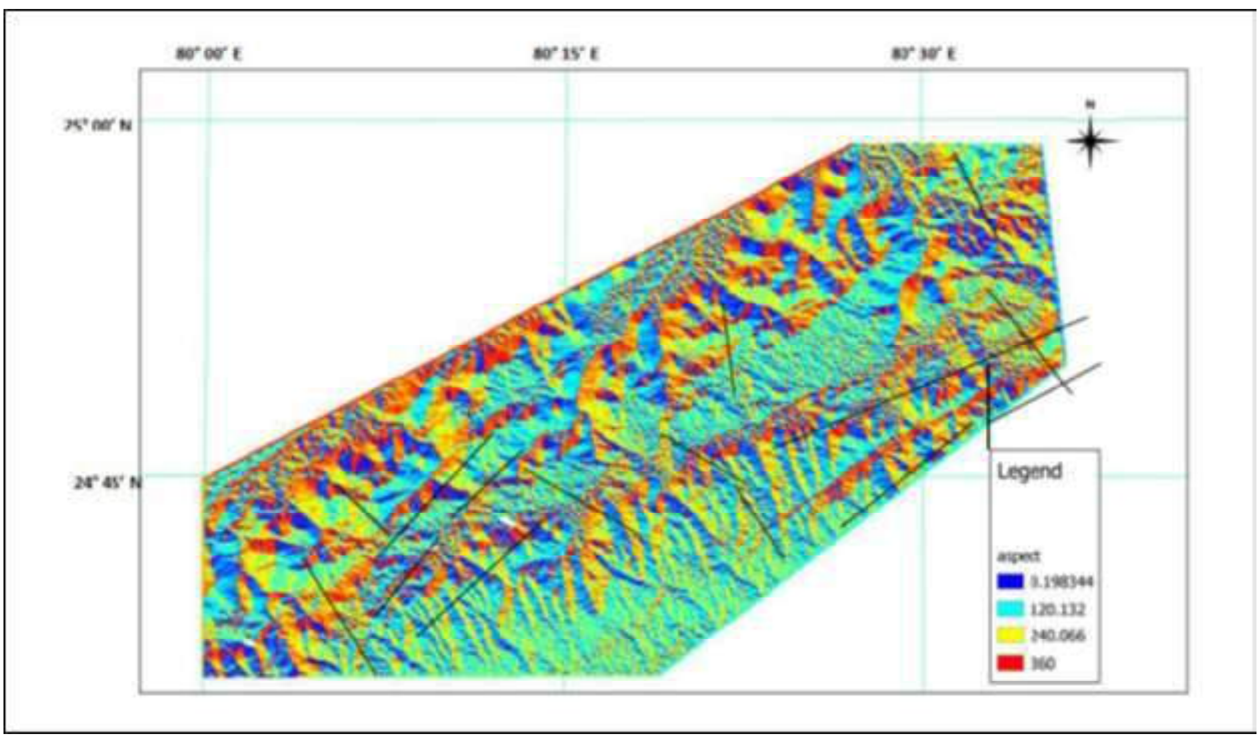

Fig.2: Aspect Map of study area

enhance erosion modeling. The aspect maps (Fig. 2) suggests that the majority of the area is south facing.

The scarpment in vindhyans are parallel to eachother. The drainage map (Fig.3) shows that the area is under the constant force and drainage patterns show very unique form of rectangular patterns. Fig. 4 show the lineaments derived from aspect map and secondary data sources. It suggests that the left portion of the map have higher density of lineaments.

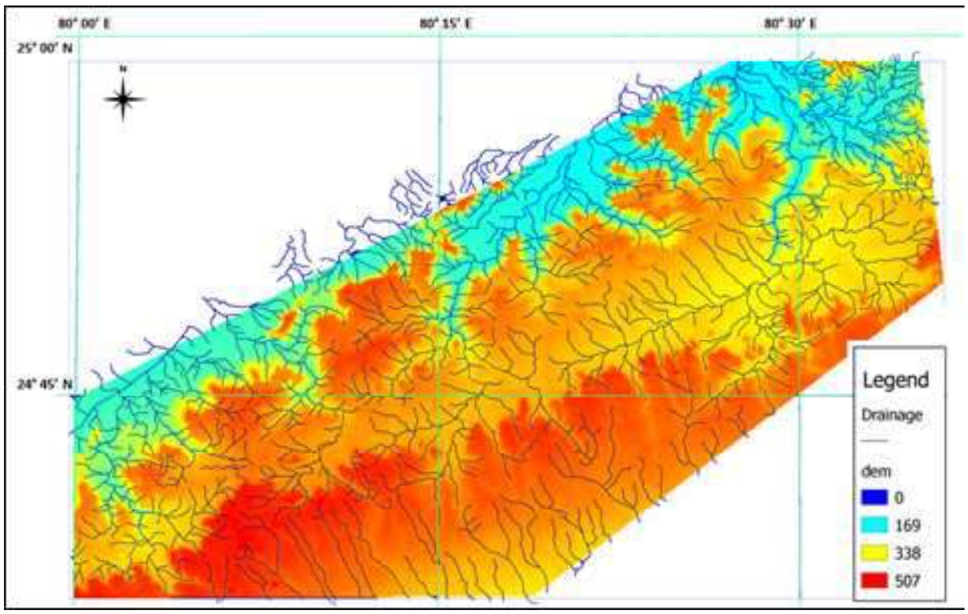

Fig. 3: Drainage map derived from SRTM and Contour Map

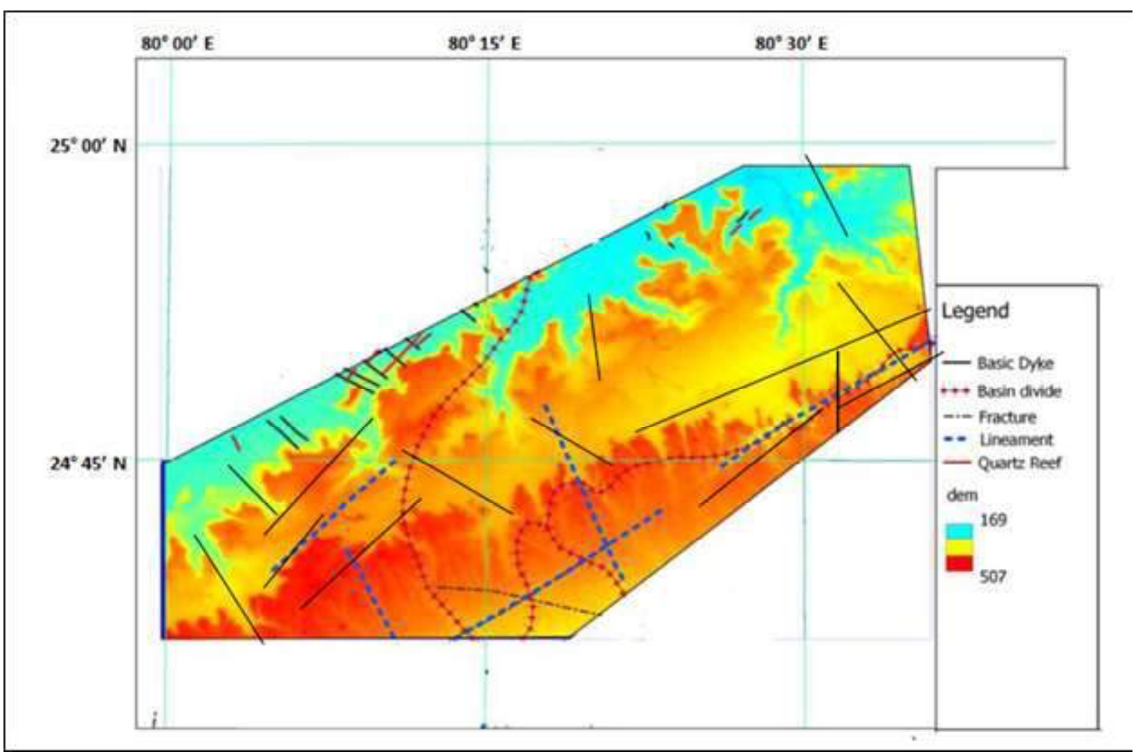

Fig. 4: Lineaments map derived from SRTM and secondary data

CONCLUSION

The image result of hillshade process (Figure 2b) showed linear features, such as valley lineament or the mountain peak on SRTM image which looked more prominent. It was caused by combination of dark – bright or shadow effect, where the different input of variable value would produce the difference of shadow form, and influenced the lineament pattern – the existence lineament. The lineament information that was produced on this research (Figure 4) showed that mostly lineament had the northwest – southeast direction.

DEM SRTM data could be used to create lineament density information. In some areas that had high lineament density were weak zones that were caused by tectonic process on those areas. The lineament density information could be used to get presumed mineral potency zone to support exploration activities.

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