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SYSTEMATIC AND SCIENTIFIC MINE PLANNING OF OPENCAST MINE OF RED OCHRE MINERAL

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Abstract - *This research study focuses on the Red Ochre mining lease area located 25 km from Nimbahera railway station, District Chittorgarh, in the southern part of Chittorgarh district, India. The study area is characterized by a semi-arid climate with wide variations in temperature and rainfall. The region's topography is gently sloping towards the western side with no natural water bodies or drainage.*

The geological investigation reveals that the area belongs to the Vindhya Super Group of Satola Group of Bhagwanpura limestone, and it is covered with a thin layer of soil with Red Ochre scree. Red Ochre is found in the area, but it is of inferior quality and suitable for use only in cement industries.

The research includes a reserve estimation based on UNFC parameters, and the calculated reserves are categorized as proved reserve, probable reserve, and possible reserves. The mining operation is proposed to be an open-cast method due to the soft nature of the Red Ochre deposit, and excavation will be done using excavators without the need for drilling and blasting. The study also outlines the year-wise development plan for the next five years, detailing the excavation quantities and the proposed mining layout.

Key Words: **Red-ochre open pit planning, Closure planning, Scientific planning.**

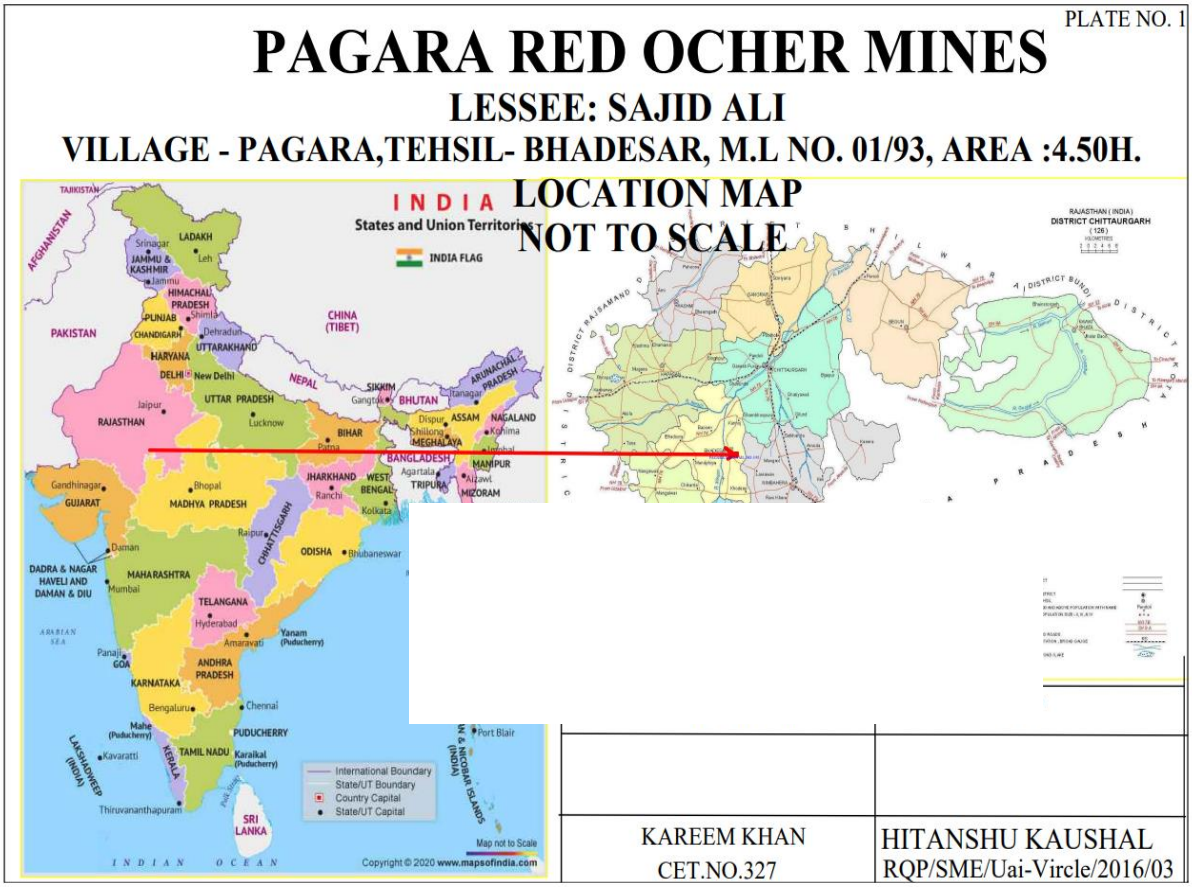
1. INTRODUCTION

Mine planning may be described as the process of maximizing the usage of mineral deposits for maximum added value while remaining aligned with the commercial enterprise's strategic goals and objectives. This process involves a complicated collection of actions aimed at determining the best feasible mine design and production schedule, taking into account factors such as capital investments, operating costs, revenue projections, and cash flow management. It is a crucial component of mining enterprises' financial characteristics.

The design of an open pit is divided into various stages, the first of which is the creation (planning) of a scheme or group of alternative plans, followed by an evaluation and selection of the best scheme. The most cost-effective final pit design is determined by elements beyond the control of the mining engineer, such as the ore body's geometric form, ore distribution within the ore body, terrain, maximum permitted slope angles, and so on. The mining program's economics, on the other hand, are dependent on criteria defined by the mining engineer, such as the mining ratio, output rates, and equipment.

1.1 Red Ochre

Red ochre deposits can be found primarily in Rajasthan's Bharatpur, Bhilwara, Bikaner, Chittorgarh, and Udaipur districts; Madhya Pradesh's Gwalior, Katni, and Rewa districts; Andhra Pradesh's Anantapur, Kadapa, and Visakhapatnam districts; Gujarat's Bhavnagar, Kachchh, and Patan districts; and Maharashtra's Yellow ochre deposits can be found in Andhra Pradesh's Guntur and Kurnool districts, Madhya Pradesh's Jabalpur, Mandla, Satna & Shahdol districts, and Maharashtra's Nagpur district. About 87 percent of the overall resources are red ochre, 11 percent are yellow ochre, and the remaining 2% are grade "Unknown." Rajasthan has roughly 78 percent of the resources, followed by Madhya Pradesh with 11 percent, Andhra Pradesh with 7 percent, and Gujarat with 2 percent. Karnataka, Maharashtra, Jharkhand, and Uttar Pradesh have the remaining 2% of resources. And the figure1 shows the location of the mine.



1.2 Mine Planning using CAD software

Mining software is now a necessity in both underground and open-pit mining operations. In recent years, the mining industry has faced considerable problems, with the critical need to accomplish automated processes that reduce the chance of losses and dangers in mining operations. Geoscience data analysis, geological resource estimation, geological modelling, mine planning, ventilation design, supply chain control, mine production management, and dilution control are just a few of the procedures. Mining must either be abandoned or transformed from surface to underground activities in such a situation. Furthermore, surface mining requires a more complex selection of excavation methods and equipment than subterranean mining. Surface mining blasting patterns must be carefully developed in order to provide enough overburden fragmentation.

2 FIELD INVESTIGATION AND LABORATORY WORK

The study area is situated in the southern part of Chittorgarh district having almost plain terrain, Annexure 4.1, 4.2 shows the location and key plan map of study area respectively. The region is generally gentle sloping towards western side. The small part of the area is covered with layer of thin soil with Red Ochre scree. Shape of the lease area is an irregular polygon type with highest elevation is of 450mRL and lowest elevation is 448mRL. There is no natural vegetation with in the mining lease area. There is no forest land in or around the mining lease area. Due to poor quality of soil crops in the area are scare. It is covered by a thin layer of soil with 0.10m of red ochre scree. Average thickness that can be seen on a surface geological plan and that may be sold combined with red ochre material. Within the excavated well it is exposed. There are two dug wells in the lease area, and mineral has been proven up to 136 metres. The colour of red ochre is reddish. It's a reddish leftover from tropical weathering that's high in iron and aluminium oxides. It is of inferior quality. The lustre is often low and earthy, and the meat is light to dark red in colour. Chemical properties of red ochre is given in Table 1.

Table 1 Chemical properties of Red-ochre

LoI	10.60%
Fe_2O_3	32.87%
Al_2O_3	26.55%
SiO_2	22.48%
CaO	1.67%
MgO	0.20%
TiO_2	5.23%

2.1 Reserve Estimation

Reserves of the area are estimated as per UNFC parameters. Three limits are demarked depending on the exploration carried out. The three limits are UNFC-111 reserve (Proved reserves), UNFC-121 + 122 reserve (Probable reserve) and UNFC-211 reserve (Possible reserve). As per field geological mapping, the Red Ochre is exposed in entire area. In the past recovery varied and in near future it might change at varying depth depending upon the nature of subsurface strata. So that recovery factor is variable & not fixed and it will depends upon the nature of rocks i.e. joints, weathered, fractured or massive, inter bedding, traversing by other rocks units and also depend on market demands. The table no.2 shows the reserve estimation.

Table 2 Reserve estimation

Category	UNFC	Total minable Reserves MT	Achieved production of last five years MT (2017-2022)	Net balance of Minable reserves MT
1	2	3	4	5 =3-4
Proved	111	3828787	1011875	2816912
Probable	122	715197	0	715197
Total		4533984		3532109

2.2 Scientific Opencast Mine Planning of Red-ochre

The red Ochre is overlying by thin soil about 0.1m average in the lease area. The OB as well as Red Ochre is not very hard and compact, so no drilling and blasting is required. The opencast method of mining for winning the mineral is the natural choice. The benches with a height of 10 m & width of 10 m with slope angle of 75^0 have been planned.

The OB as well as mineral will be handled by excavator as the mineral occurring in the lease area in the form of massive pockets.

The year wise excavation of mineral & overburden is given in Table 3

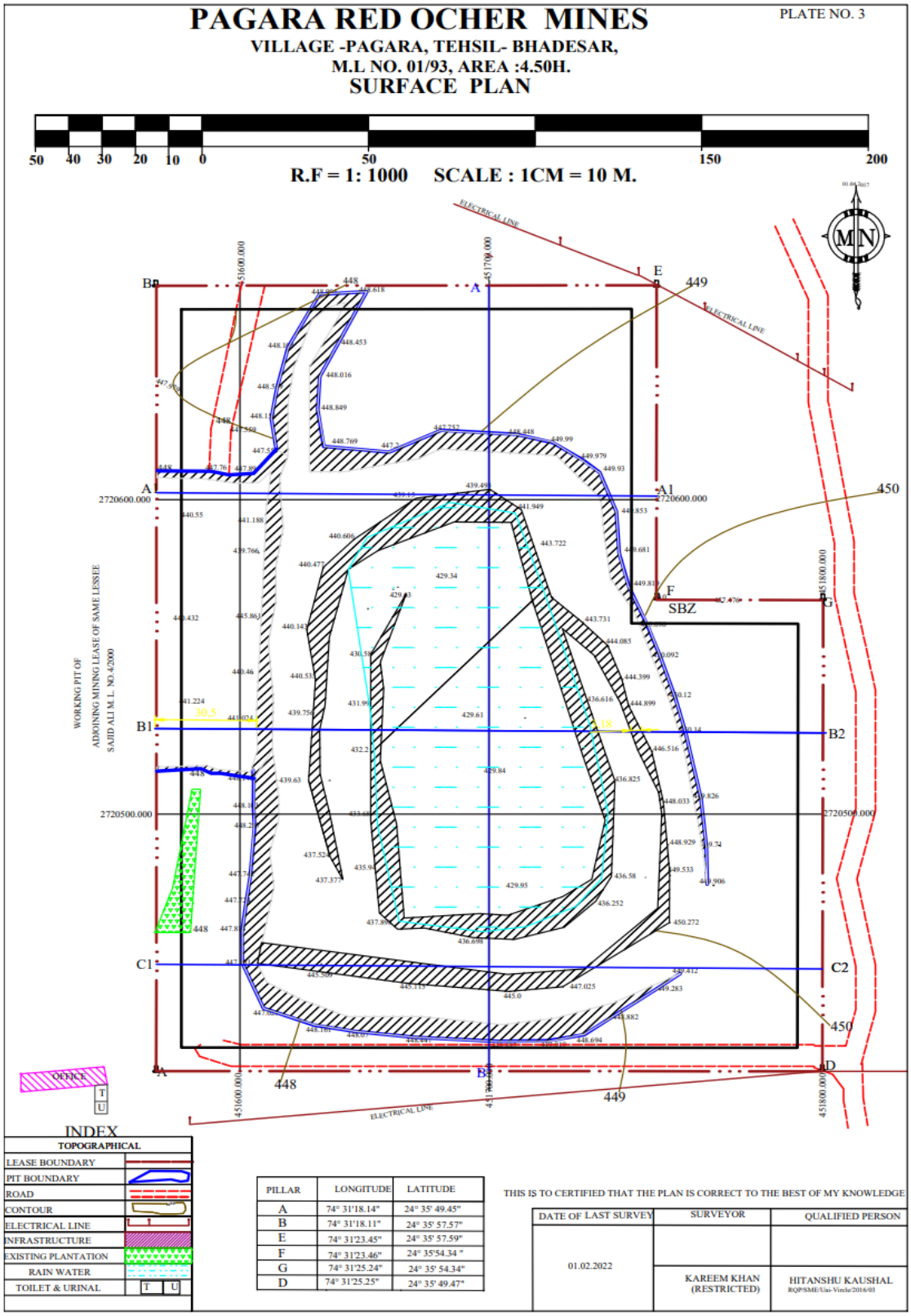
Table 3 Year wise excavation of mineral

Year	Total Excavation (MT)	Res Ochre (MT)
1st Year 2023-24	512002	512002
2nd Year 2024-25	569264	569264
3rd Year 2025-26	589604	589604
4th Year 2026-27	595386	595386
5th year 2027-28	634743	634743
Total	2900999	2900999

The work will be done towards North, South, East and West side in the lease area. A Development Plan and Sections have been prepared on the basis of survey conducted as scale 1:1000 for year wise projection. In each year development, the total quantity of mineral and overburden have to be mined out from concerning year. And the surface plan is shown in figure2 and table no.4 shows the life of the mine including present proposal at the excavation rate.

Table 4 Life of the mine including present proposal at the excavation rate

Minable reserves	3532109MT
Proposed five year production	2900999MT
Balance of reserves	3532109-2900999 = 631110MT
Production capacity as per EC obtain	125771 MTA
Production capacity as per proposal	634743mt


PAGARA RED OCHER MINES
PLATE NO. 3
VILLAGE -PAGARA, TEHSIL- BHADESAR,
M.L NO. 01/93, AREA :4.50H.
SURFACE PLAN
50 40 30 20 10 0 50 150 200
R.F = 1: 1000 SCALE : 1CM = 10 M.
ELECTRICAL LINE
SBZ
WORKING PIT OF ADJOINING MINING LEASE OF SAME LESSEE SAJID ALI M. L. NO.4/2000
OFFICE
INDEX
TOPOGRAPHICAL
LEASE BOUNDARY
PIT BOUNDARY
ROAD
CONTOUR
ELECTRICAL LINE
INFRASTRUCTURE
EXISTING PLANTATION
RAIN WATER
TOILET & URINAL
PILLAR LONGITUDE LATITUDE
A 74° 31'18.14" 24° 35' 49.45"
B 74° 31'18.11" 24° 35' 57.57"
E 74° 31'23.45" 24° 35' 57.59"
F 74° 31'23.46" 24° 35'54.34 "
G 74° 31'25.24" 24° 35' 54.34"
D 74° 31'25.25" 24° 35' 49.47"
THIS IS TO CERTIFIED THAT THE PLAN IS CORRECT TO THE BEST OF MY KNOWLEDGE
DATE OF LAST SURVEY 01.02.2022
SURVEYOR KAREEM KHAN (RESTRICTED)
QUALIFIED PERSON HITANSHU KAUSHAL

3. RESULTS AND DISCUSSION

- **Geology of Red ochre mineral based on exploration and prospecting data**

  Geologically the area belongs to Vindhya Super Group of Satola group of Bhagwanpura limestone. Area is having Red Ochre overlain by thin layer of soil red-ochre is exposed the sand, the Lasrawan, the Khorip and the Kaimur Groups (Lower Vindhyans of Middle Proterozoic age) and the Rewa and Bhander Groups (of Upper Proterozoic age). The limestone of these assemblages, at places, show algal structures, known as stromatolites. A total of nine flows have been recognised in Chittaurgarh Pratapgarh sector between 308-350 m. It is exposed within the dug well. 2 dug well exist near the lease area & mineral is proved up to 136m. Red Ochre is reddish in color. It is reddish residual product of tropical weathering, rich in oxides of iron and aluminum mineral. It is low grade. Luster is usually dull earthy and steak is light to dark red. The occurrence of red Ochre is in residual from.

- **Reserve and Resource estimation of Red ochre based in UNFC**

  Reserves of the area are estimated as per UNFC parameters. Three limits are demarked depending on the exploration carried out. The three limits are UNFC-111 reserve (Proved reserves), UNFC-121 + 122 reserve (Probable reserve) and UNFC-211 reserve (Possible reserve). As per field geological mapping the Red Ochre is exposed in entire area.

  The reserve is economic, because of there is demand of Red ochre is good in the industries near by the cement plants. The area is consented by the govt., and the deposit is economically viable. The total mineral resource using UNFC code is 4994752MT, while Proved mineral reserve is 2816912MT and the Probable reserve is 705197MT. There is no marignal grade applicable in Red ochre. Even the lowest quality of mineral is salable.

- **Optimization of mining operation, systematic and scientific mine planning**

  The benches will maintain a height of 10 m & width of 10 m with slope angle of 75^0 is taking place. The OB as well as mineral will be excavated by excavator as the mineral occurring in the lease area in the form of massive deposit. Mineral loaded into dumper and dispatch to the cement plants. Two excavator having capacity of 0.9 cubic meter with 8 dumper of 10 tonne capacity will be used for transportation for optimum use of mine machinery.

  The life of the mine including present proposal at the excavation rate, the minable reserves is 3532109MT and the Proposed five year production is 2900999MT, Production capacity as per proposal is 634743MT. During I year development pit will be extended towards North, East and West sides with total 512002MT of mineral will be mined out from two benches. The pit will be extended towards South, East and West sides in II year and the total 569264MT mineral will be mined out from two I^{st} & II^{nd} benches. While during III year development the pit will be extended towards South, East and West sides and the total 589604MT of mineral will be mined out from I^{st} & II^{nd} benches. During IV & V year development, the pit will be extended towards South, East and West sides and the total 595386MT, 634743MT mineral will be mined out from I^{st} ,II^{nd} % III^{rd} benches of the pit respectively.

- **Progressive mine closure planning**

  There are no OB dumps and no extra construction after closure of mine. The pit may be used as water pond or rainy water. And plantation on fresh ground area in 0.5812ha will be done. In ultimate life of the mine, a green patch of 0.5812ha wil be developed by growing trees & bushes as shown in conceptual plan. The existing plantation in present propsal is Neem, Babol, Khair, Emli etc.

4. CONCLUSIONS

The study was conducted with the aim of achieving and exploring systematic and scientific mine planning of Red Ochre mineral mining leases. From the study, the following conclusions were drawn:

1. Geologically, the study area falls within the Vindhya Super Group of the Satola group, specifically the Bhagwanpura limestone formation. This region predominantly features the presence of Red Ochre, which is readily exposed within

the confines of dug wells. It is classified as a low-grade mineral, displaying a typically dull earthy luster and hues ranging from light to dark red.

2. Field geological mapping confirms the extensive exposure of Red Ochre across the entire area. Total minable reserves before commencing mining operations were estimated at 4,533,984 tonnes, with remaining minable reserves standing at 3,532,109 tonnes based on UNFC (United Nations Framework Classification) parameters.

3. The mining operation is optimized through systematic and scientific mine planning. The mining benches are designed with a height and width of 8 meters and a slope angle of 75 degrees. Given the massive deposit nature of the mineral within the lease area, both overburden (OB) and mineral will be excavated using excavators & damper combination with (0.9 cubic meters & 10-tone) respectively.

4. A crucial aspect of the mining operation is progressive mine closure planning. Currently, the total area under consideration is 4.5 hectares, with 2.36 hectares allocated for in-pit and quarry activities, 0.26 hectares for mineral storage, 0.1 hectares for roads, and 0.026 hectares designated for plantation. The remaining area is left unused. Post-mining, 3.9188 hectares will be designated for pit and quarry activities, while 0.5812 hectares will be allocated for plantation. The pit area may be repurposed as a rainwater collection pond for agricultural use, benefiting the local community.

5. In conclusion, this study highlights the imperative need for evolving current mining practices to align with principles of community development, equity, and environmental stewardship. Emphasizing responsible resource management and sustainable development. Improved planning can lead to optimized production and productivity while minimizing environmental impact.

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