GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION (G-3 STAGE) FOR GLAUCONITIC SANDSTONE IN

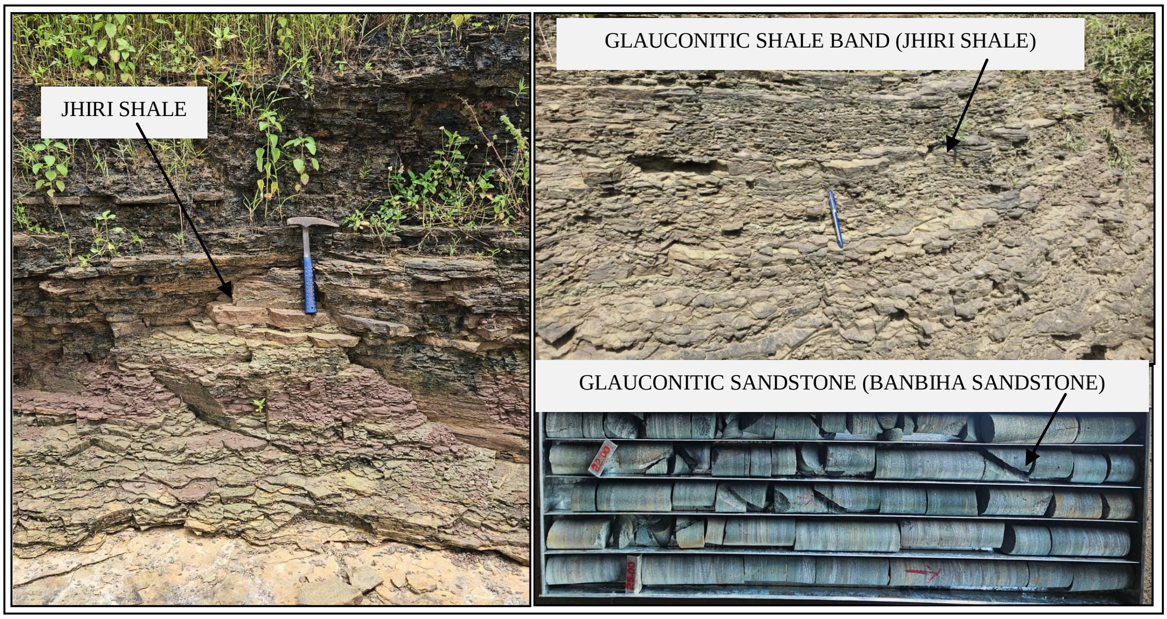
DEULHA BLOCK

(Area-8.5 Sq Km)

TEHSIL-MAJHGAWAN, DISTRICT- SATNA, MADHYA PRADESH
(Under NMET Programme)

Parts of Toposheet no. 63D13

TEXT, ANNEXURE AND PLATES



MINERAL EXPLORATION AND CONSULTANCY LIMITED
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देउलहा ब्लॉक (8.5 वर्ग किमी) में ग्लॉकोनाइटिक बलुआ पत्थर के लिए प्रारंभिक गवेषण (जी-3 चरण) पर भूवैज्ञानिक रिपोर्ट तहसील- मझगांव, जिला- सतना, मध्य प्रदेश

अध्याय 1

कार्यकारी सारांश

1.1.0 परिचय

1.1.1 ग्लॉकॉनाइट, एक पोटैशियम-समृद्ध हरा सिलिकेट खनिज है, जिसका प्राकृतिक उर्वरक, मृदा सुधारक तथा पोटाश के संभावित स्रोत के रूप में विशेष महत्व है, इस क्षेत्र में विंध्यन सुपरग्रुप की बलुआ-पत्थर की परतों में पाया जाता है।

1.1.2 पोटैशियम, नाइट्रोजन और फॉस्फोरस के साथ मिलकर पौधों के स्वास्थ्य और कृषि उत्पादकता के लिए आवश्यक तीन प्राथमिक प्रमुख पोषक तत्वों का समूह बनाता है। यह एंजाइम सक्रियण, जल विनियमन, प्रकाश संश्लेषण और प्रोटीन संश्लेषण सहित विभिन्न शारीरिक प्रक्रियाओं में महत्वपूर्ण भूमिका निभाता है। फसल उत्पादन और गुणवत्ता में इसके महत्वपूर्ण योगदान के कारण, टिकाऊ कृषि पद्धतियों के लिए पोटैशियम की पर्याप्त मात्रा में आवश्यकता होती है।

1.1.3 पौध पोषण में पोटैशियम की महत्वपूर्ण भूमिका के प्रति बढ़ती जागरूकता ने वैश्विक पोटाश उद्योग के उद्भव और तेज विकास को प्रेरित किया—जो पोटैशियम-आधारित उर्वरकों का एक प्रमुख उत्पादक है। ऐतिहासिक अभिलेख दर्शाते हैं कि वर्ष 1921 तक वैश्विक पोटाश उत्पादन लगभग 1 मिलियन टन तक पहुँच गया था। तब से उत्पादन में सतत और मजबूत वृद्धि देखी गई है।

1.1.4 संयुक्त राज्य भूवैज्ञानिक सर्वेक्षण (U.S. Geological Survey, Mineral Commodity Summaries, January 2025) के अनुसार, वर्ष 2024 में विश्व वार्षिक पोटाश उत्पादन क्षमता 65.2 मिलियन टन थी, जो 2028 तक लगभग 76.0 मिलियन टन K_2O तक बढ़ने का अनुमान है। बढ़ती मांग वैश्विक खाद्य सुरक्षा के लिए पोटैशियम के रणनीतिक महत्व को रेखांकित करती है और ग्लॉकॉनाइटिक बलुआ-पत्थर सहित वैकल्पिक पोटाश स्रोतों के अन्वेषण प्रयासों को और तेज कर रही है।

1.1.5 वर्तमान वैश्विक पोटाश मांग मुख्यतः समुद्री वाष्पीभवन से बने बिछे हुए परतदार जमाओं और पोटाश-समृद्ध खारे जल स्रोतों से पूरी होती है। ये प्राकृतिक जमाएं जल में घुलनशील पोटैशियम-युक्त खनिजों—जैसे सिल्वाइट (KCl), कार्नालाइट ($KMgCl_3 \cdot 6H_2O$), काइनाइट ($KMg(SO_4)Cl \cdot 3H_2O$), और पॉलीहेलाइट ($K_2Ca_2Mg(SO_4)_4 \cdot 2H_2O$)—से बनी होती हैं। ये परतदार खनिज स्तरों या सतही तथा अधस्तलीय खारे जल भंडारों के रूप में पाई जाती हैं और मुख्यतः पोटैशियम क्लोराइड (म्यूरेट ऑफ पोटाश अर्थात MOP) तथा पोटैशियम सल्फेट (SOP) के उत्पादन हेतु प्रसंस्कृत की जाती हैं—जो पोटाश उर्वरकों के दो सबसे व्यापक रूप से उपयोग किए जाने वाले प्रकार हैं।

1.1.6 वैश्विक स्तर पर इन उच्च-ग्रेड पारंपरिक पोटाश संसाधनों का वितरण अत्यंत सीमित है, और कुल उत्पादन का 90% से अधिक केवल कुछ ही देशों—विशेष रूप से कनाडा, रूस, बेलारूस, ब्राज़ील,

चीन, चिली, जर्मनी और संयुक्त राज्य अमेरिका—में केंद्रित है (Anderson, 1985; The New York Times Editorial Board, 2013; Rawashdeh & Maxwell, 2014)। ये देश न केवल बड़े भंडार नियंत्रित करते हैं, बल्कि वैश्विक निर्यात बाजार पर भी प्रभुत्व रखते हैं, जिसके कारण कृषि-आधारित देशों, विशेषकर भारत, को आयात पर निर्भर रहना पड़ता है।

1.1.7 दीर्घकालीन कृषि उत्पादकता बनाए रखने और आयात निर्भरता कम करने के लिए वैकल्पिक पोटैशियम संसाधनों का अन्वेषण आवश्यक है। वैकल्पिक पोटैशियम स्रोतों में K-युक्त सिलिकेट और गैर-सिलिकेट खनिज शामिल हैं, जो वाष्पीभवन खनिजों की तरह आसानी से घुलनशील नहीं होते, परंतु उपयुक्त निष्कर्षण तकनीकों द्वारा इनसे पोटैशियम प्राप्त किया जा सकता है। हालिया शोध इंगित करता है कि पोटैशियम-युक्त एल्युमिनोसिलिकेट—जैसे फेल्डस्पार, ग्लॉकॉनाइट और अभ्रक—उचित भू-रासायनिक और तकनीकी परिस्थितियों में पोटाश के संभावित स्रोत हो सकते हैं (Manning, 2010; 2012; Ciceri et al., 2015)। ये वैकल्पिक स्रोत उच्च-ग्रेड वाष्पीभवन जमाओं की कमी वाले देशों के लिए आत्मनिर्भरता का मार्ग प्रदान कर सकते हैं।

1.1.8 भारत विश्व के सबसे बड़े पोटाश उपभोक्ताओं में से एक है, किन्तु यहाँ आर्थिक दृष्टि से खनन योग्य वाष्पीभवन पोटाश जमाएं नहीं हैं। इस कमी के चलते ग्लॉकॉनाइटिक बलुआ-पत्थर, पोटाश-समृद्ध शेल तथा फेल्डस्पथॉयड जैसे गैर-पारंपरिक, स्वदेशी स्रोतों का अन्वेषण किया जा रहा है। विश्व के उदाहरण दर्शाते हैं कि ऐसे विकल्प व्यवहार्य हैं—जैसे ऑस्ट्रेलिया में एल्यूनाइट जमाएं, शेल से पोटैशियम निष्कर्षण (Everest et al., 1964), और पूर्व USSR में ग्लॉकॉनाइट का व्यापक उपयोग। भारत के अवसादी बेसिनों में ग्लॉकॉनाइटिक बलुआ-पत्थर की व्यापक उपस्थिति इसे पोषक सुरक्षा एवं आयात निर्भरता कम करने हेतु एक रणनीतिक संसाधन बनाती है।

1.1.9 ग्लॉकॉनाइटिक बलुआ-पत्थर एक अवसादी शैल है, जिसमें हरे रंग का ग्लॉकॉनाइट खनिज समृद्ध मात्रा में पाया जाता है, जो समुद्री शेल्फ परिस्थितियों में बनता है। पारंपरिक रूप से यह स्तरिकीय अध्ययन, प्राचीन पर्यावरण पुनर्निर्माण तथा पेट्रोलियम अन्वेषण में उपयोगी रहा है, किंतु अब इसे पोटैशियम उर्वरक के आर्थिक स्रोत के रूप में तेजी से पहचाना जा रहा है। भारत में 3,000 मिलियन टन से अधिक के भंडार रिपोर्ट किए गए हैं, जिनमें K_2O की मात्रा 4% से 8% तक है, और ये उत्तर प्रदेश, बिहार, मध्य प्रदेश, राजस्थान तथा गुजरात के क्रेटेशियस से पेलोजीन काल के निर्माणों में पाए जाते हैं। ये जमाएं आयातित पोटाश के लिए एक टिकाऊ विकल्प प्रस्तुत करती हैं और पोषक आत्मनिर्भरता के राष्ट्रीय लक्ष्य को सुदृढ़ करती हैं।

1.1.10 खनिजों के रणनीतिक महत्व को मान्यता देते हुए, खनिज एवं खनिज (विकास और विनियमन) संशोधन अधिनियम, 2023 के माध्यम से धारा 1D जोड़ी गई, जिसमें महत्वपूर्ण खनिजों पर विशेष ध्यान दिया गया है। ग्लॉकॉनाइट को 'राष्ट्रीय क्रिटिकल मिनरल मिशन' में शामिल किया गया है, जिसका उद्देश्य कृषि, स्वच्छ ऊर्जा, इलेक्ट्रॉनिक्स, अंतरिक्ष, रक्षा एवं उद्योग हेतु आवश्यक खनिजों की सुरक्षित और आत्मनिर्भर आपूर्ति सुनिश्चित करना है। यह मिशन लक्षित अन्वेषण, NMET फंडिंग सहायता तथा व्यावसायिक उपयोग के लिए ब्लॉक नीलामी को प्रोत्साहित करता है, जिससे ग्लॉकॉनाइट को देश के खनिज विकास ढांचे में प्राथमिकता प्राप्त हुई है।

1.1.11 महत्वपूर्ण खनिजों की आवश्यकता को पूरा करने हेतु भारत सरकार द्वारा ट्रेंच-आधारित रणनीतिक खनिज ब्लॉकों की नीलामी की जा रही है, जिनमें पाँच ट्रेंच पूर्ण हो चुकी हैं और छठी जारी है। इन नीलामियों में लिथियम, REEs, ग्लॉकॉनाइट, ग्रेफाइट, वैनाडियम, निकल, कोबाल्ट और फॉस्फोराइट शामिल हैं—जो स्वच्छ ऊर्जा तकनीकों और उर्वरक सुरक्षा के लिए आवश्यक संसाधन हैं। पारदर्शी आवंटन, निजी क्षेत्र की भागीदारी और MECL जैसी एजेंसियों की सक्रिय भूमिका

कार्बन-न्यूनीकरण, आपूर्ति शृंखला मजबूती और टिकाऊ आर्थिक विकास को बढ़ावा देती है। ग्लॉकॉनाइट जैसे खनिजों की उपलब्धता भारत के 2070 नेट-जीरो उत्सर्जन लक्ष्य के लिए अत्यंत महत्वपूर्ण है, जो सौर, पवन, ईवी, बैटरी भंडारण और हरित हाइड्रोजन उत्पादन में प्रगति सुनिश्चित करती है।

1.1.12 देउलहा G-3 ब्लॉक को पिंदरा साउथ-वेस्ट एक्सटेंशन ब्लॉक (39.23 वर्ग किमी) से निर्मित किया गया है, जिसमें विंध्यन सुपरग्रुप के रेवां समूह की प्रोटेरोज़ोइक आयु की शैल इकाइयाँ शामिल हैं, जो ग्लॉकॉनाइटिक बलुआ-पत्थर की खनिज संभाव्यता के लिए प्रसिद्ध हैं। MECL ने पिंदरा साउथ-वेस्ट एक्सटेंशन ब्लॉक (39.23 वर्ग किमी) में पुनर्सर्वेक्षण किया था, जिसमें उसी भू-आयु की रेवां ग्रुप की इकाइयाँ पाई गई थीं। इस ब्लॉक में MECL ने 1,918 मिलियन टन (mT) ग्लॉकॉनाइटिक बलुआ-पत्थर का संसाधन 6.96% औसत K_2O ग्रेड (UNFC कोड 334 के अनुसार) तथा लगभग 25 मीटर औसत मोटाई के साथ अनुमानित किया है।

1.1.13 GSI द्वारा पिंदरा उत्तर तथा MECL द्वारा पिंदरा साउथ-वेस्ट एक्सटेंशन ब्लॉकों में स्थापित ग्लॉकॉनाइटिक बलुआ-पत्थर की पार्श्विक निरंतरता को ध्यान में रखते हुए देउलहा ब्लॉक को G-3 स्तर पर अपग्रेडेशन हेतु निर्धारित किया गया है, जिसका उद्देश्य उच्च विश्वसनीयता के साथ संसाधन स्थापित करना तथा ब्लॉक को नीलामी के लिए उपयुक्त बनाना है।

1.1.14 देउलहा ब्लॉक, सतना, मध्य प्रदेश में ग्लॉकॉनाइटिक बलुआ-पत्थर के प्रारंभिक अन्वेषण प्रस्ताव को मार्च 2024 में आयोजित 63वीं TCC बैठक में प्रस्तुत किया गया, और विमर्श के बाद समिति ने इसे NMET की कार्यकारी समिति द्वारा अनुमोदन हेतु अनुशंसित किया।

1.1.15 35वीं कार्यकारी समिति (EC) ने परियोजना को पत्र संख्या 23/452/2024-NMET/81, दिनांक 20 मई 2024 द्वारा 09 माह की अवधि के साथ अनुमोदित किया।

1.1.16 8.5 वर्ग किमी क्षेत्रफल वाले इस अन्वेषण ब्लॉक में MECL द्वारा फील्ड संचालन 01 सितंबर 2024 से प्रारंभ किया गया, जिसमें 1:4,000 स्केल पर भूवैज्ञानिक मानचित्रण एवं स्थलाकृतिक सर्वेक्षण किया गया और तत्पश्चात ड्रिलिंग कार्य संपादित किया गया। भूवैज्ञानिक रिपोर्ट अक्टूबर 2025 में प्रस्तुत की जा रही है।

1.2.0 स्थान एवं अभिगम्यता

1.2.1 ग्लॉकोनिटिक सैंडस्टोन हेतु देउलहा G-3 ब्लॉक सर्वे ऑफ इंडिया के टोपोशीट संख्या 63D13 के एक भाग में स्थित है, जो 24°53'41.03" उत्तरी अक्षांश से 24°55'33.33" उत्तरी अक्षांश तथा 80°45'13.19" पूर्वी देशांतर से 80°48'04.70" पूर्वी देशांतर के मध्य है। यह 8.5 वर्ग किमी क्षेत्र को आच्छादित करता है, जिसमें उमरीहा, देउलहा, मझगाँव, कानपुर आदि कई गांव शामिल हैं।

1.2.2 अन्वेषण ब्लॉक मझगाँव तहसील, जिला सतना, मध्य प्रदेश में स्थित है और सतना से सतना–चित्रकूट (राज्य राजमार्ग 11) मार्ग पर लगभग 44 किमी की दूरी पर है। क्षेत्र की अभिगम्यता राज्य राजमार्ग 11 तथा NH–135BG द्वारा अच्छी है, जो इसे सतना, मैहर, उमरिया तथा उत्तर प्रदेश से जोड़ती है।

1.2.3 ब्लॉक क्षेत्र के कार्डिनल बिन्दुओं के भू-आकृतिक (Geodetic) एवं UTM को-ऑर्डिनेट नीचे तालिका में दिए गए हैं:

तालिका **1.1**

देउलहा G-3 **ब्लॉक (ग्लॉकोनिटिक सैंडस्टोन) जिले–सतना, मध्य प्रदेश** – **ब्लॉक सीमा के कार्डिनल बिंदुओं के निर्देशांक**

कार्डिनल पॉइंट	UTM (ZONE-44) EASTING (m)	UTM NORTHING (m)	LATITUDE	LONGITUDE
A	475878.650	2753321.112	24°53'41.30488"	80°45'40.19205"
B	475127.108	2754549.361	24°54'21.19425"	80°45'13.32421"
C	479936.655	2756760.375	24°55'33.33467"	80°48'4.66021"
D	479933.149	2754417.158	24°54'17.15159"	80°48'4.65727"

1.3.0 ब्लॉक की भूविज्ञान एवं संरचना

1.3.1 देउलहाG-3 ब्लॉक, सतना जिले के उत्तरी भाग में स्थित मझगाँव–पहाड़ियों पोटाश बेल्ट का एक हिस्सा है। भूवैज्ञानिक रूप से यह ब्लॉक विन्ध्यान सुपरग्रुप के रीवा समूह की शैलों से आच्छादित है, जो इस क्षेत्र में सुविकसित हैं। शैल-संरचनाओं का स्तरीकरण मझगाँव, पहाड़ीखेड़ा तथा सोहावल क्षेत्रों में स्थापित क्षेत्रीय स्तरीकरण के अनुरूप समानांतरता (Correlation) के आधार पर निर्धारित किया गया है।

तालिका 1.2

देउलहा G-3 **ब्लॉक का स्तरीय क्रम** (GSI **के अनुसार)**

<table>
<tr><th>आयु (AGE)</th><th>सुपरग्रुप / ग्रुप / कॉम्प्लेक्स</th><th>श्रृंखला (SERIES)</th><th>निर्माण (FORMATION)</th><th>शैलविज्ञान (LITHOLOGY)</th><th></th></tr>
<tr><td>नवीन से उप-नवीन (Recent to Sub-recent)</td><td></td><td></td><td colspan="3">एल्यूवियम / मिट्टी / लेटराइट</td></tr>
<tr><td rowspan="4">प्रोटेरोज़ोइक (Proterozoic)</td><td rowspan="4">विंध्यन सुपरग्रुप (Vindhyan Super Group)</td><td rowspan="4">रेवा (Rewa)</td><td>गहदारा सैंडस्टोन (Gahadara Sandstone)</td><td colspan="2">क्वार्ट्ज एरेनाइट (Quartz arenite)</td></tr>
<tr><td rowspan="3">झीरी शेल (Jhiri Shale)</td><td>ऊपरी शेल (Upper shale)</td><td>हरा और लाल शेल (Green & Red shale)</td></tr>
<tr><td>अपर व्हाइट सैंडस्टोन (Upper White Sandstone)</td><td>मध्यम दानेदार क्वार्ट्ज एरेनाइट</td></tr>
<tr><td>मध्य</td><td></td></tr>
</table>

आयु (AGE)	सुपरग्रुप / ग्रुप / कॉम्प्लेक्स	श्रृंखला (SERIES)	निर्माण (FORMATION)	शैलविज्ञान (LITHOLOGY)	
				ग्लॉकोनाइटिक सैंडस्टोन (Middle Glauconitic Sandstone)	
				निचला व्हाइट सैंडस्टोन (Lower White Sandstone)	मध्यम दानेदार क्वाट्र्ज एरेनाइट
				निचला शेल (Lower shale)	हरा एवं लाल शेल, कंकड़युक्त (conglomerate)
				रोहनिया सैंडस्टोन (Rohania Sandstone)	क्वाट्र्ज एरेनाइट, दानेदार कंकड़युक्त (conglomerate)
			इतवा सैंडस्टोन फॉर्मेशन (Itwa Sandstone Formation)	पिंड्रा शेल (Pindra Shale)	चूना पत्थर की अंतर-स्तरीय पट्टियों सहित हरा एवं लाल शेल
				भुलवा लिमेस्टोन (Bhulwa Limestone)	क्रीम रंग का चूना पत्थर, भूरे चर्ट सहित
				बनबीहा सैंडस्टोन (Banbiha Sandstone)	ग्लॉकोनाइटिक सैंडस्टोन
			पन्ना शेल (Panna Shale)	चूना पत्थर की अंतर-स्तरीय पट्टी सहित शेल	
		कैमूर (Kaimur)	बाघैन सैंडस्टोन (Baghain Sandstone)	मध्यम से मोटा सैंडस्टोन, महीन सैंडस्टोन, सिल्टस्टोन और शेल की अंतर-स्तरीय पट्टियों सहित मध्यम से मोटा सैंडस्टोन, कोणीय कंकड़युक्त सैंडी कांग्लोमरेट	
		अनकंफॉर्मिटी (Unconformity)			
	विंध्यन सुपरग्रुप	सेमरी (Semri)		पल्कवां शेल (Palkwan Shale) डोलोमाइटिक लाइमस्टोन (Dolomitic limestone) पांडवफॉल सैंडस्टोन (Pandwafall Sandstone)	
			पांडवा फॉल	बाँसागर सैंडस्टोन (Upper	

आयु (AGE)	सुपरग्रुप / ग्रुप / कॉम्प्लेक्स	श्रृंखला (SERIES)	निर्माण (FORMATION)	शैलविज्ञान (LITHOLOGY)	
			फॉर्मेशन (Pandwa Fall Formation)	Glauconitic Sandstone) कोहरी चर्ट (Kohari Chert) डोलोमाइटिक चर्ट और चर्ट ब्रेशिया कुदवारी सैंडस्टोन (Lower Glauconitic Sandstone)	
		अनकंफॉर्मिटी (Unconformity)			
प्रोटेरोज़ोइक (Proterozoic)	बुंधेलखंड ग्राइसिक कॉम्प्लेक्स (Bundelkhand Gneissic Complex)			ग्रेनाइट ग्राइस (Granite gneiss)ग्रेनाइट (Granite)	

1.3.2 ब्लॉक में सतह पर उजागर होने वाली सबसे पुरानी शैल रोहानिया सैंडस्टोन है, जो इतवा सैंडस्टोन गठन का ऊपरी सदस्य है। ड्रिलिंग डेटा दर्शाता है कि पन्ना शेल सबसे पुरानी अवस्थित शैल है, जिसके ऊपर इतवा सैंडस्टोन, झीरी शेल, गहदारा सैंडस्टोन तथा शीर्ष पर मृदा आवरण है।

1.3.3 ब्लॉक में लिथोस्ट्रैटिग्राफिक अनुक्रम कायमूर से लेकर रीवा समूह तक पूर्ण है, जो निक्षेपण वातावरण में कम-ऊर्जा (argillaceous) से उच्च-ऊर्जा (arenaceous) परिस्थितियों का संक्रमण दर्शाता है, जो ग्लॉकोनाइट/पोटाश खनिजीकरण के अनुकूल अवसादन परिस्थितियों का संकेत है।

1.3.4 ब्लॉक का स्थलाकृतिक ढाल 2°–5° है। संरचना NE–SW स्ट्राइक एवं दक्षिण-पूर्व डिप दिखाती है। कोई प्रमुख तंत्रिक (tectonic) व्यवधान नहीं है, जो स्थिर क्रेटोनिक सेटिंग को इंगित करता है।

1.4.0 खनिजीकरण

1.4.1 ग्लॉकोनाइट खनिजीकरण मुख्यतः रीवा समूह की इतवा सैंडस्टोन तथा स्थानीय रूप से झीरी शेल में पाया जाता है। प्राथमिक अवसादी संरचनाएँ—बेडिंग, क्रॉस-बेडिंग, रिपल मार्क, लेमिनेशन आदि—उथले सागरीय वातावरण को दर्शाती हैं।

1.4.2 झीरी शेल के मध्यम ग्लॉकोनिटिक सैंडस्टोन सदस्य में हरा, माइकायुक्त शेल, सैंडी शेल तथा सिल्टस्टोन पाए जाते हैं। इतवा गठन का बानबीहा सैंडस्टोन मुख्य ग्लॉकोनिटिक क्षितिज है, जिसे सभी बोरहोल में इंटरसेप्ट किया गया है।

1.4.3 ग्लॉकोनिटिक सैंडस्टोन में पायराइट का प्रसारण अवकरणीय (reducing) एवं क्षारीय परिस्थितियों में अवसादन का सूचक है। क्वार्ट्ज, फेल्डस्पार, मस्कोवाइट एवं क्लोराइट की उपस्थिति अम्लीय आग्नेय मूल स्रोत को दर्शाती है। पुरा-प्रवाह संकेत NW–N दिशा दिखाते हैं। ये परिस्थितियाँ स्थिर, उथले सागरीय वातावरण में ग्लॉकोनाइट के स्वजनित (authigenic) खनिजीकरण के लिए उपयुक्त हैं।

1.5.0 वर्तमान अन्वेषण कार्य

1.5.1 ब्लॉक का क्षेत्रफल 8.5 वर्ग किमी है। भू-मानचित्रण (1:4000) 1 सितंबर 2024 से प्रारंभ होकर 31 दिसंबर 2025 तक पूरा किया गया। प्रमुख लिथो यूनिट: गहदारा सैंडस्टोन, झीरी शेल, रोहानिया सैंडस्टोन एवं मध्य ग्लॉकोनिटिक बैंड।

1.5.4 ड्रिलिंग 24 मई 2025 से शुरू हुई। कुल 08 बोरहोल (MDLH-01 से MDLH-08) में 197 प्राथमिक एवं 20 चेक नमूने उत्पन्न हुए। प्राथमिक नमूने MECL रासायनिक प्रयोगशाला नागपुर में परीक्षण किए गए।

1.5.5 बोरहोल 800×800 मीटर ग्रिड पर रखे गए, जो G-3 स्तर के लिए खनिज साक्ष्य नियम 2015 के अनुरूप है।

1.5.6 स्वीकृत एवं वास्तविक उपलब्धि का विवरण (तालिका 1.3)।

1.6.0 क्षेत्र निर्धारण (Delineation of Zones)

1.6.1 सभी 08 बोरहोल में ग्लॉकोनाइट ज़ोन (>5% K_2O) झीरी शेल में 4–7 मी. गहराई पर और बानबीहा सैंडस्टोन में 12–36 मी. पर पाया गया, जिसकी मोटाई 1–24 मीटर के बीच है।

1.7.0 संसाधन एवं ग्रेड का आकलन

1.7.1 **संसाधन का आकलन दो विधियों से किया गया:**

- क्रॉस-सेक्शनल विधि (मुख्य)
- पॉलिगोनल विधि (जांच हेतु)

1.7.2 सकल संसाधन में से **20%** कटौती अपरिभाषित भूवैज्ञानिक कारकों हेतु की गई।

1.7.3 **क्रॉस-सेक्शनल विधि से:**

- **317.04** मिलियन टन (333 श्रेणी), औसत **6.80% K_2O**
- **119.18** मिलियन टन (334 श्रेणी), औसत **7.03% K_2O**
- कुल: **436.22** मिलियन टन, औसत **6.86% K_2O**

1.7.4 **पॉलिगोनल विधि से:**

- **448.68** मिलियन टन (334 श्रेणी), औसत **6.78% K_2O**

1.7.5 दोनों विधियों में मात्र 2.82% का अंतर आया, जो अनुमन्य सीमा में है और आकलन की विश्वसनीयता सिद्ध करता है।

1.8.0 अनुशंसा

1.8.1 MECL **ने** 8.5 वर्ग किमी क्षेत्र में 436.22 मिलियन टन संसाधन (औसत **6.86% K_2O)** स्थापित किए हैं। वर्तमान अन्वेषण के आधार पर ब्लॉक को CL/ML हेतु नीलामी में लाया जा सकता है। विस्तृत अन्वेषण के दौरान ग्लॉकोनाइट**,** फेल्डस्पार एवं मिका के बीच अंतर स्पष्ट करने हेतु SEM–EDS और बायमॉडल अध्ययन करने की अनुशंसा की जाती है।

GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION (G-3 STAGE) FOR GLAUCONITIC SANDSTONE IN DEULHA BLOCK (8.5 sq km) TEHSIL-MAJHGAWAN, DISTRICT- SATNA, MADHYA PRADESH

CHAPTER-1

EXECUTIVE SUMMARY

1.1.1 INTRODUCTION

1.1.1 Glauconite, a potassium-rich green silicate mineral of significant importance for use as a natural fertilizer, soil conditioner, and potential source of potash, occurs within the sandstone horizons of the Vindhyan Supergroup in this region.

1.1.2 Potassium, alongside nitrogen and phosphorus, forms the trio of primary macronutrients essential for plant health and agricultural productivity. It plays a vital role in various physiological processes; including enzyme activation, water regulation, photosynthesis, and protein synthesis. Due to its significant contribution to crop yield and quality, potassium is required in substantial quantities for sustainable agricultural practices.

1.1.3 The growing awareness of potassium's critical role in plant nutrition spurred the emergence and rapid development of the global potash industry—a key supplier of potassium-based fertilizers. Historical records indicate that global potash production reached approximately 1 million tonnes by 1921. Since then, production has witnessed a steady and robust upward trajectory.

1.1.4 According to data from the United States Geological Survey (U.S. Geological Survey, Mineral Commodity Summaries, January 2025), world annual potash production capacity was 65.2 million tons in 2024 and projected to increase to about 76.0 million tons of K_2O by 2028. This rising demand underscores the strategic importance of potassium in meeting global food security challenges and has further intensified exploration efforts for alternative potash sources, including glauconitic sandstone.

1.1.5 Currently, the global demands of potash is predominantly is made through mining of bedded marine evaporite deposits and potash-rich brine sources. These natural deposits comprise a suite of water-soluble potassium-bearing minerals such as sylvite (KCl), carnallite ($KMgCl_3·6H_2O$), kainite ($KMg(SO_4)Cl·3H_2O$), and polyhalite ($K_2Ca_2Mg(SO_4)_4·2H_2O$). They occur either as stratified mineral beds or in the form of sub-surface and surface brine reservoirs and are predominantly processed to extract potassium chloride (Muriate of Potash i. e. MOP) and sulfate of potassium (SOP)—the two most widely used potash fertilizers.

1.1.6 Globally, the distribution of these high-grade conventional potash resources is highly localized, with over 90% of production concentrated in just a few countries—notably Canada, Russia, Belarus, Brazil, China, Chile, Germany, and the United States (Anderson, 1985; The New York Times Editorial Board, 2013; Rawashdeh & Maxwell, 2014). These nations not only control large reserves but also dominate the global export markets, creating supply dependence for the rest of the world, especially in potash-importing countries like India which relies on agriculture.

1.1.7 To sustain long-term agricultural productivity and reduce dependence on imports, it is essential to explore alternative potassium resources. Alternating potassium sources are K-bearing silicate and non-silicate minerals, which, though not readily soluble like evaporite minerals, can be processed to release potassium through suitable extraction technologies. Recent research suggests that potassium-bearing aluminosilicates—such as feldspar, glauconite, and mica—could serve as viable sources of potash under the right geochemical and technological conditions (Manning, 2010; 2012; Ciceri et al., 2015). These alternative sources offer a potential pathway for self sufficiency for countries lacking high grade evaporite deposits.

1.1.8 India is among the world's largest consumers of potash fertilizers, yet it lacks economically mineable evaporite potash deposits. This shortfall has driven the exploration of non-conventional, indigenous sources such as glauconitic sandstone, potash-rich shales, and feldspathoids. Global precedents demonstrate the viability of such alternatives: alunite deposits in Australia, potassium extraction from shales as documented by Everest et al. (1964), and extensive glauconite use in the former USSR. Given its widespread occurrence in India's sedimentary basins, glauconitic sandstone emerges as a strategically important resource capable of supporting nutrient security and reducing import dependence.

1.1.9 Glauconitic sandstone is a sedimentary rock enriched in the greenish mineral glauconite, formed under marine shelf conditions. While traditionally valued for stratigraphic studies, paleoenvironmental reconstruction, and petroleum exploration, it is increasingly recognized for its economic potential as a source of potassium fertilizer. India's reserves, exceeding 3,000 million tonns with K_2O content ranging from 4% to 8%, are reported across Uttar Pradesh, Bihar, Madhya Pradesh, Rajasthan, and Gujarat in Cretaceous to Paleogene formations. These deposits present a sustainable alternative to imported potash, aligning with the national vision of nutrient self-reliance.

1.1.10 Policy recognition has been reinforced through the Mines and Minerals (Development and Regulation) Amendment Act, 2023, which introduced Section 1D to address the strategic importance of critical minerals. Glauconite has been included under the National Critical Mineral Mission, which aims to ensure a secure and self-reliant supply of minerals vital to agriculture, clean energy, electronics, space, defense, and industry. This mission promotes targeted exploration, NMET funding support, and block auction facilitation for commercial utilization, marking glauconite as a priority in the country's mineral development framework.

1.1.11 To meet critical mineral needs, the Government of India conducts tranche-based auctions of strategic mineral blocks, having completed five tranches with a sixth underway. These auctions encompass lithium, REEs, glauconite, graphite, vanadium, nickel, cobalt, and phosphorite—resources essential for clean energy technologies and fertilizer security. Transparent allocation, private sector participation, and active involvement of agencies like MECL strengthen decarbonization efforts, build resilient supply chains, and advance sustainable economic growth. Securing minerals like glauconite is integral to India's Net-Zero Emission Target by 2070, enabling progress in solar, wind, EV, battery storage, and green hydrogen production.

1.1.12 The Deulha G-3 block has been carved out from Pindra South-West Extension Block (39.23 sq. km) and it consist of Proterozoic age litho-units of Rewa Group of the Vindhyan Supergroup of rocks, which is well-known for its mineral potentiality for glauconitic sandstone. MECL has conducted a Reconnaissance Survey in the Pindra South-West Extension Block (39.23 sq. km) which comprises of Proterozoic age lithounits of Rewa Group within Vindhyan Supergroup which is known for hosting glauconitic sandstone. MECL has estimated a resource of 1,918 million tonns (mT) of glauconitic sandstone in this block, with an average grade of 6.96% K_2O (as per UNFC code 334) and average thickness of about 25 meters.

1.1.13 Considering the lateral continuity of glauconitic sandstone, as established by GSI in Pindra North and MECL in Pindra South-West Extension blocks, Deulha block has been carved out for upgradation at G-3 level, which aims to establish resources with higher confidence and block suitability for auction.

1.1.14 The Preliminary exploration proposal for Glauconitic sandstone in Deulha block, Satna, Madhya Pradesh was submitted in 63rd TCC held on March, 2024 and after deliberation committee recommended for approval of Executive committee of NMEDT.

1.1.15 35th Executive Committee (EC) approved the project vide letter no. 23/452/2024-NMET/81, dated 20th May 2024, with time duration of 09 months.

1.1.16 The area of the exploration block is 8.5 sq. km, Field operation was initiated by MECL on 01st September 2024, carried out geological mapping and topographical survey on 1:4,000 scale subsequently carried out drilling. The Geological Report is being submitted in October 2025.

1.2.0 LOCATION AND ACCESSIBILITY

1.2.1 The Deulha G-3 for Glauconitic Sandstone lies in part of Survey of India Toposheet No. 63D13, between 24° 53' 41.03''N to 24° 55' 33.33''N latitudes and 80° 45' 13.19'' E to 80° 48' 04.70'' E longitudes. It covers an area of 8.5 sq. km, encompassing several villages including Umariha, Deulha and Majhgawan, Kanpur etc.

1.2.2 The exploration block is situated in Majhgawan Tehsil, Satna District, Madhya Pradesh, about 44 km from Satna along the Satna–Chitrakoot (State Highway 11). The area has good connectivity through State Highway 11 and NH-135BG, linking it with Satna, Maihar, Umaria, and the Uttar Pradesh.

1.2.3 The co-ordinates of the cardinal points of the block area both in geodetic and in UTM are given below:

Table No.-1.1

Co-ordinates of Cardinal Points of Block Boundary of Deulha G-3 Block for Glauconitic Sandstone, District-Satna, Madhya Pradesh

CARDINAL POINTS	UTM (ZONE- 44)		DD MM SS (WGS84)	
	EASTING (m)	NORTHING (m)	LATITUDE	LONGITUDE
A	475878.650	2753321.112	24°53'41.30488''	80°45'40.19205''
B	475127.108	2754549.361	24°54'21.19425''	80°45'13.32421''
C	479936.655	2756760.375	24°55'33.33467''	80°48'4.66021''
D	479933.149	2754417.158	24°54'17.15159''	80°48'4.65727''

1.3.0 GEOLOGY AND STRUCTURE OF THE BLOCK

1.3.1 The Deulha G-3 block forms part of the Majhgawan–Paharikhera Potash Belt, located in the northern part of Satna District, Madhya Pradesh. Geologically, the block is underlain by the rocks of the Rewa Group belonging to the Vindhyan Supergroup, which is well exposed in this sector of the Vindhyan Basin. The stratigraphic nomenclature for the block has been adopted based on the lateral correlation of lithological units with the established regional stratigraphic succession in adjoining areas such as Majhgawan, Paharikhera, and Sohawal.

The stratigraphic sequence of litho units in the Block area (After GSI) is given below:

Table 1.2
Stratigraphic sequence of the Deulha G-3 Block
(After GSI)

<table>
<tr><th>AGE</th><th>SUPERGROUP/ GROUP / COMPLEX</th><th>SERIES</th><th>FORMATION</th><th colspan="2">LITHOLOGY</th></tr>
<tr><td>Recent to sub-recent</td><td></td><td></td><td colspan="3">Alluvium/soil/laterite</td></tr>
<tr><td rowspan="12">Proterozoic</td><td rowspan="12">Vindhyan Super Group</td><td rowspan="11">Rewa</td><td>Gahadara sandstone</td><td colspan="2">Quartz arenite</td></tr>
<tr><td rowspan="5">Jhiri Shale</td><td>Upper shale</td><td>Green & Red shale</td></tr>
<tr><td>Upper White sandstone</td><td>medium grained quartz arenite</td></tr>
<tr><td>Middle Glauconitic sandstone</td><td></td></tr>
<tr><td>Lower White sandstone –</td><td>medium grained quartz arenite</td></tr>
<tr><td>Lower shale</td><td>green and red shale with conglomerate</td></tr>
<tr><td></td><td>Rohania sandstone</td><td>quartz arenite with granular conglomerate</td></tr>
<tr><td rowspan="3">Itwa sandstone formation</td><td>Pindra Shale</td><td>green and red shale with limestone interband</td></tr>
<tr><td>Bhulwa limestone</td><td>cream colour limestone with brown chert</td></tr>
<tr><td>Banbiha Sandstone</td><td>glauconitic limestone</td></tr>
<tr><td>Panna Shale</td><td colspan="2">Shale with limestone interband</td></tr>
<tr><td>Kaimur</td><td>Baghain</td><td colspan="2">Medium to Coarse Sandstone, fine sandtone with siltstone and shale interbands.</td></tr>
</table>

AGE	SUPERGROUP/ GROUP / COMPLEX	SERIES	FORMATION	LITHOLOGY
			Sandstone	Medium to coarse sandstone, angular gravel bearing sandy conglomerate
		Unconformity		
	Vindhyan Super Group	Semri		Palkwan Shale Dolomitic limestone Pandwafall sandstone
			Pandwa fall formation	Bansagar sandstone (Upper glauconitic sandstone) Kohari chert (dolomitic limitation chert and chert breccia) Kudwari sandstone (Lower glauconitic sandstone)
	Unconformity			
Proterozoic	Bundhelkhand Gneissic Complex			Granite gneiss Granite

1.3.2 Within the block, the oldest formation exposed on the surface is the Rohania Sandstone, representing the uppermost member of the Itwa Sandstone Formation. Subsurface drilling data reveal that the Panna Shale is the oldest formation intersected in boreholes overlain by Itwa sandstone formation, Jhiri Shale formation, Ghadara sandstone formation of Rewa Group and caped by soil cover.

1.3.3 The lithostratigraphic succession in the block displays a complete sequence from the Kaimur to Rewa Groups, indicating a transitional sedimentary environment from argillaceous to arenaceous facies which indicated deposition gradually changed from low energy to high energy condition such as shallow marine environment, which is a favorable condition for glauconite/ potash mineralization.

1.3.4 The block has gentle sloping topography of 2°–5°, with minor warping and jointing, characteristic of the Vindhyan sedimentary terrain. The formation strikes NE-SW with dip due southeast, with of no major tectonic disturbances or metamorphism are observed, indicating a stable cratonic setting since deposition.

1.4.0 MINERALIZATION

1.4.1 The glauconite mineralization in the Deulha G-3 block occurs within the Rewa Group of the Vindhyan Supergroup, particularly in the Itwa Sandstone (Lower Rewa Sandstone) Formation and locally within the Jhiri Shale Formation. The sedimentary sequence exhibits diverse primary structures such as bedding variations, cross-bedding, ripple marks, lamination, and mud cracks, reflecting a dynamic depositional environment that fluctuated between shallow marine to nearshore conditions suggest deposition under a low to moderate energy environment.

1.4.2 The middle glauconitic sandstone Member of the Jhiri Shale Formation comprises green, micaceous shale, sandy shale, and siltstone horizons, forming the basal exposures along ENE–WSW trending escarpments in the block with limited subsurface continuity in drilling. The Banbiha Sandstone Member, forming the basal part of the Itwa Sandstone Formation, represents the principal glauconitic horizon which is intercepted in all the drilled boreholes. It is characterized by flaser bedding, trough cross-bedding, and alternating shale–sandstone laminae, indicating periodic energy fluctuations and episodic sediment supply. The presence of chert interbeds (2 mm–1.5 cm thick) within glauconitic sandstone layers further reflects gradational transitions in depositional energy and chemical conditions within the basin.

1.4.3 Mineralogically, the glauconitic sandstone hosts pyrite disseminations and encrustations, confirming deposition under reducing, mildly alkaline conditions (pH ~7.5; Eh 0.1–0.3). Associated minerals such as quartz (vein, smoky, and normal varieties), feldspar, muscovite, and chlorite indicate derivation from an acid igneous provenance. Paleocurrent indicators from cross-beds show north-westerly to northerly sediment transport, suggesting a proximal source area supplying detrital material to a low-energy marine shelf setting. Overall, the glauconitic horizons of the Deulha G-3 block represent authigenic mineralization formed under stable, reducing, and shallow marine conditions, marking an environment highly conducive for glauconite and associated potash enrichment within the Vindhyan sedimentary basin.

1.5.0 EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

1.5.1 The Deulha G-3 block (8.5 sq. km.) has been carved out from Pindra South-West Extension block. Exploratory operations in the block commenced on 1st September 2024 with geological mapping on 1:4000 scale was completed by 31st December 2025. The key lithological units mapped include Gahadara Sandstone, Jhiri Shale, Rohania Sandstone, and the Middle Glauconitic Sandstone Band, along with the lower sandstone–shale members of the Jhiri Formation. Structural data recorded using a Brunton compass revealed a general strike of NE–SW to ENE–WSW, with beds gently dipping (5°–10°) towards the southeast.

1.5.4 Drilling was commenced on 24th May 2025 and 08 nos. of boreholes (MDLH-01 to MDLH-08) were drilled and in total 197 primary and 20 check samples were generated. All the primary samples were analysed for 4 radicals viz. K_2O, at MECL chemical laboratory, Nagpur Maharashtra and extertal check samples were sent to Jawaharlal Nehru Aluminium Research Development and Design Centre, (JNARDDC) Nagpur (A NABL accridited Laboratory). All the drilling activities were completed on 28th June 2025.

1.5.5 The borehole placed at 800×800m grid interval which conform to the Minerals Evidence of Mineral Content Rules, 2015, which prescribe the data density for G-3 level exploration. Three previously drilled boreholes of Pindra South West Block were taken into consideration for correlation and calculation of glauconitic sandstone resources.

1.5.6 The details of the nature and quantum of work approved vs actual achievement is given below:

Table – 1.3

Approved Quantum of Work vs. Actual achievement by MECL in Deulha G-3 Block for Glauconitic Sandstone, District: Satna, Madhya Pradesh

Sl. No	Description of Work	Unit	Approved quantum	Achieved quantum
I	**Geological mapping (updating of map at 1:4000 scale)**	Ha	850	850
2	Topographical Survey BH co-ordinates	Ha Nos	850 08	850 08
II	**Exploratory Drilling**	M	400	393
III	**Laboratory Studies**			
	Primary and Check samples			
1	Primary sample analysis for 4 radicals K_2O, SiO_2, Al_2O_3 & Fe_2O_3	Nos	200	197
2	External Check Samples (10% of Primary) analysis for 4 radicals K_2O, SiO_2, Al_2O_3 & Fe_2O_3	Nos	20	20
IV	**Physical studies**			
1	Bulk Density determination	Nos	04	04
V	**Geological Report preparation**	**Nos.**	**1**	**1**

1.6.0 DELINIATION OF ZONES

1.6.1 MECL carried out a total 393.00 meters of drilling in 08 nos. of borehole, vertically drilled, which are spaced in 800m interval. In these boreholes the glauconite zone (demarcated at >5% K_2O cutoff) is intersected in Jhiri shale at depth ranging from 4.00 m depth in MDLH-04 to 7.00 m depth in MDLH-05 and thickness varies between 1.00 m (MDLH-03, K_2O -5.57%) to 5.00 m (MDLH-05, K_2O -6.11%). However, in Banbiha sandstone the glauconite zone (demarcated at >5% K_2O cutoff) is intersected at depth ranging from 12.00 m depth in MDLH-08 to 36.00 m depth in MDLH-06 and thickness varies between 20.50 m (MDLH-04, K_2O -6.16%) to 24.00 m (MDLH-01, K_2O -7.13%).

1.7.0 ESTIMATION OF RESOURCE AND GRADE

1.7.1 The resource estimation has been calculated using two methods: the Cross-Sectional Method (principal method) and the Polygonal Method (check method).

1.7.2 The Net geological resources are arrived after a deduction of 20% from the gross in-situ resource figures, which were applied to account for unseen geological factors such as, cavities, caverns, and other structural irregularities.

1.7.3 A total of **317.04 million tonnes** of Net in-situ Inferred Resources (333 category) with average grade of **6.80% K_2O** and **119.18 million tonnes** of Net in-situ Reconnaissance Resources (334 category) with average grade of **7.03% K_2O** have been estimated by cross sectional method. The cumulative **Net in-situ Resources (333+334)** by cross-section method is **436.22 million tonnes** with average grade of **6.86% K_2O.**

1.7.4 However**,** total of **448.68 million tonnes** of Net in-situ Reconnaissance Resources (334 category) with average grade of **6.78% K_2O** has been estimated by polygonal method.

1.7.5 The resource estimated through the Cross-Sectional Method and Polygonal Method were compared to assess the confidence level of the estimation. The polygonal Method, used as the check approach, yielded a resource estimate 2.82% higher as compare to the Cross-Sectional Method which is principal method. This variance falls within the permissible limits, confirming the reliability and accuracy of the resource estimation.

1.8.0 RECOMMENDATION

1.8.1 MECL has established **436.22 million tons** with average grade of **6.86% K_2O** of resources over 8.5 sq. km. area based on the outcome of the current exploration work the block may be auctioned at CL/ML. It is also recommended to carry out SEM-EDS and bimodal study to validate and distinguish the presence of glauconite from feldspar and mica during detailed exploration.

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CHAPTER-2

2.0.0 DETAILS OF THE QUALIFIED PERSON(S) / EXPLORATION AGENCY

2.1.0 MINERAL EXPLORATION AND CONSULTANCY LIMITED

(Formerly Mineral Exploration Corporation Limited)

A Govt. of India Enterprise; A Miniratna-I CPSE

Ministry of Mines, Govt. of India

Dr. Babasaheb Ambedkar Bhawan, High Land Drive Road,

Seminary Hills, Nagpur-440006

Maharashtra, India

2.2.0 PERSONNEL ASSOCIATED WITH PRELIMINARY EXPLORATION

Exploration agency: Mineral Exploration and Consultancy Limited

Experience: 51 Years, Since 1972

Email: cmd@mecl.gov.in; gm-exploration@mecl.gov.in

Sl.No.	Name of the Person	Designation	Qualification	Experience
1	Shri Shrikant Sharma	HOD (Exploration)	M.Sc., Geology	23 Years
2	Shri P. Ravindran	GM (Exploration) Rtd.	M.Sc., Geology	35 Years
3	Shri Naveen Kumar Pala	Sr. Manager (Geology)	M.Sc. (Tech.), Applied Geology	20 Years
4	Shri Vikash Kumar	Sr. Manager (Geology)	M.Sc. (Tech.), Applied Geology	20 Years
5	Shri Peeyush Kumar	Assistant Manager (Geology)	M.Sc., Geology	08 Years
6	Shri Aditya Chodhury	Sr. Geologist (Ex)	M.Sc., Geology	05 Years
7	Shri Rajnikant	Manager (Drilling)	B. tech	10 Years
8	Shri Dushyant Singh	Sr. Drilling Engineer	B. tech	12 Years
9	Shri Rohit Kumar Sharma	Manager (Chemical Lab)	M.Sc., Chemistry	15 Years
10	Shri Sayantan Pal	Manager (Geology)	M.Sc., Applied Geology	12 Years
11	Mrs. Saumya Anand	Assistant Manager (Geology)	M.Sc., Geology	08 Years

CHAPTER-3

3.0.0 TITLE AND OWNERSHIP

3.1.0 TITLE OF THE REPORT

GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION (G-3 STAGE) FOR GLAUCONITIC SANDSTONE IN DEULHA BLOCK (8.5 sq km) TEHSIL-MAJHGAWAN, DISTRICT- SATNA, MADHYA PRADESH

Ownership: Government of Madhya Pradesh

Name of Prospector: MINERAL EXPLORATION AND CONSULTANCY LIMITED (Formerly Mineral Exploration Corporation Limited)
A Govt. of India Enterprise; A Miniratna-I CPSE
Ministry of Mines, Govt. of India

Address of Prospector: Dr. Babasaheb Ambedkar Bhavan, High Land Drive Road, Seminary Hills, Nagpur, Pin- 440006, Maharashtra, India

E-mail of Prospector: cmd@mecl.gov.in; gm-exploration@mecl.gov.in

Telephone numbers of Prospector: 0712-2510289; 0712-2511829

3.2.0 DETAILS ABOUT PERIOD OF PROSPECTING

The exploratory programme in the block commenced on 01.09.2024 with detailed surveying and geological mapping conducted on a 1:4,000 scale. Subsequently, exploratory drilling operations were undertaken. Associated field activities—such as surveying, geological mapping, drilling, and borehole core sampling—were executed in parallel to ensure efficiency. In addition, analytical and laboratory investigations were carried out concurrently in MECL laboratories as well as other NABL-accredited laboratories.

3.3.0 DETAILS OF EXPLORATION AGENCY, QUALIFICATION, AND EXPERIENCE OF ASSOCIATED TECHNICAL PERSONS ENGAGED IN EXPLORATION

3.3.1 Exploration Agency: Mineral Exploration and Consultancy Limited

(Formerly Mineral Exploration Corporation Limited)
A Govt. of India Enterprise-A Miniratna-ICPSE

3.3.2 Qualification : M. Sc. / M. Sc. Tech. (Geology)

3.3.3 Experience:

Experience: Since 1972

Exploration agency: Mineral Exploration and Consultancy Limited

CHAPTER-4

4.0.0 DETAILS OF THE AREA

4.1.0 LOCATION AND ACCESSIBILITY OF THE BLOCK

4.1.1 The Deulha G-3 block falls in parts of the Survey of India Toposheet No. 63D13 and it lies between 24° 53' 41.03"N to 24° 55' 33.33"N latitudes and 80° 45' 13.19" E to 80° 48' 04.70" E longitudes.

4.1.2 The block covers an area of 8.50 sq.km, in and around Umariha, Deulha and Majhgawan, Kanpur villages of Majhgawan Tehsil, Satna district, Madhya Pradesh. The Location Map is given in Plate-I and Text Fig. 4.1. The co-ordinates of the corner points of the block area both in geodetic and in UTM are given in table No.- 4.1 and in Annexure IA.

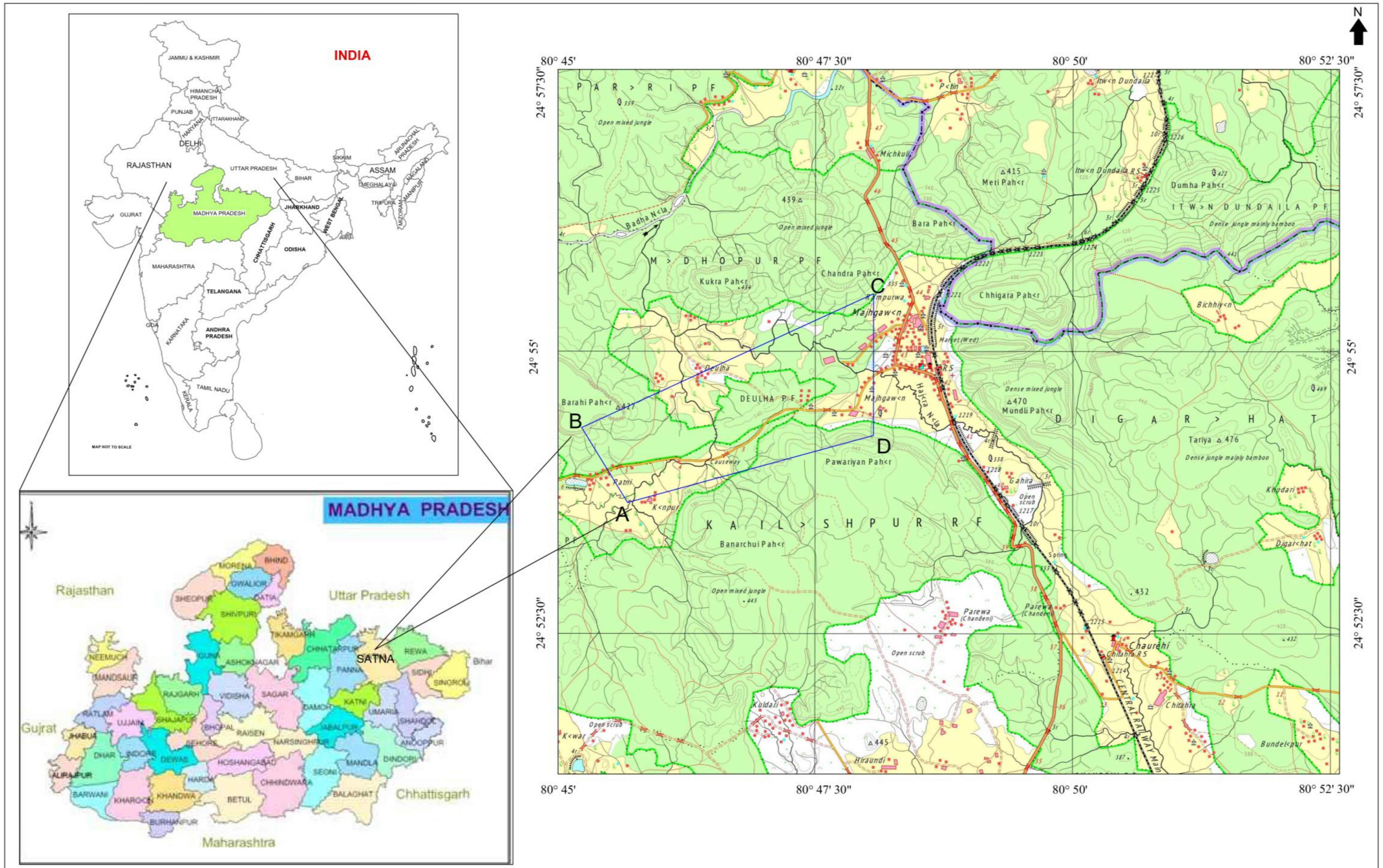
Table No.-4.1

Co-ordinates of cardinal points of block boundary of Deulha (G-3 stage) block for Glauconitic sandstone etc., Distt-Satna, Madhya Pradesh

CARDINAL PONTS	UTM Zone-44(m)		Geographic Co-ordinate WGS-84	
	Easting (m)	Northing (m)	LATITUDE (DMS)	LONGITUDE (DMS)
A	475878.650	2753321.112	24°53'41.30488"	80°45'40.19205"
B	475127.108	2754549.361	24°54'21.19425"	80°45'13.32421"
C	479936.655	2756760.375	24°55'33.33467"	80°48'4.66021"
D	479933.149	2754417.158	24°54'17.15159"	80°48'4.65727"

4.1.3 The exploration block is located in Majhgawan Tehsil of Satna District in Madhya Pradesh. It falls on State highway no. 11 and is about 44 km from Satna on Satna–Chitrakoot road. The road network around Dewlaha, Umariha, and Majhgawan consists of a mix of highways, district roads, and rural village roads. Majhgawan is well connected by State Highway 11 and NH-135BG, linking it to Satna, Maihar, Umaria, and the UP border. District-level roads like the Kotar–Mahuti–Majhgawan Road and a bypass further improve regional access. Dewlaha and Umariha, located about 5 km from Majhgawan, are linked through smaller gravel and murram village roads, which provide local connectivity but are less developed and often seasonal in quality. Overall, the area has excellent connectivities to town and highways while intra-village connections remain basic. Majhgawan railway station is 0.5 Km away in Eastern direction from the eastern boundary of the block and is located on Mumbai-

Jabalpur-Allahabad line, lies between Satna and Manikpur stations of Western Central Railway. Khajuraho, Madhya Pradesh (88 KM in WSW direction) and Prayagraj, Uttar Pradesh (123 KM in NE direction) are the nearby airport from the block.



LABEL	UTM (WGS84) - ZONE 44 R		GCS (DMS)	
	EASTING (m)	NORTHING (m)	LATITUDE (N)	LONGITUDE (E)
A	475878.650	2753321.112	24°53'41.30488"	80°45'40.19205"
B	475127.108	2754549.361	24°54'21.19425"	80°45'13.32421"
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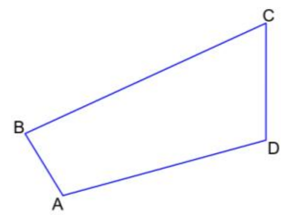


BLOCK BOUNDARY WITH CARDINAL POINTS OF DEULHA BLOCK

MINERAL EXPLORATION AND CONSULTANCY LIMITED
(Formerly Mineral Exploration Corporation Limited)

LOCATION MAP

DEULHA BLOCK, (EXTENT 8.5 sq km)
SATNA-DISTRICT, MADHYA PRADESH.

TOPOSHEET NO: 63D/13 — MAP NOT TO SCALE

PROCESSED AT :
NON COAL GR CELL,
MECL, NAGPUR.

MECL/EXPL./OCT-2025 — PLATE NO.- I — 01

Text Figure-4.1: Location Map of Deulha (G-3 stage) block explored for Glauconitic sandstone, District- Satna, Madhya Pradesh

4.2.0 DETAILS OF THE AREA WITH LAND USE

4.2.1 30% of the explored block falls under Madhopur and Deulha protected forest area, the remaining area is majorly covered by agricultural acvities.

4.2.2 The cadastral details of the area are not obtained.

4.3.0 MINERAL(S) UNDER INVESTIGATION

4.3.1 Block was explored for Glauconitic Sandstone.

CHAPTER-5

5.0.0 PHYSIOGRAPHY AND ENVIRONMENT

5.1.0 RELIEF OF THE AREA WITH MINIMUM AND MAXIMUM ELEVATION, DRAINAGE PATTERN, NATURAL WATER COURSES, RESERVOIRS, ETC.

5.1.1 The exploration block area lies on the undulating Vindhyan/central Indian plateau terrain: low hills, hill-slopes and inter-hill valleys with patches of reserve/forest cover in the entire block. This gives a landscape of gentle to moderate relief rather than steep mountains. Highest elevation in the area is around 436m in the Barahi Pahar hillock present in northwestern part of the exploration block. gradually elevation reduces in the central part and it goes down to 340m. General slope is towards NNW and towards North.

5.1.2 The drainage pattern of the area is dendritic to sub-dendritic in nature. There are no perineal rivers in the block area, however seasonal nala flows in the area. General flow direction is NNW. Satna River basin and its network are the main regional drainage feature; research and district profiles identify the Satna River as a key river flowing in this part of the district and as a tributary within the Tons system. Most natural channels around Deulha/Dewlaha are seasonal/intermittent carrying baseflow in the monsoon and drying or reduced to isolated pools in the dry season. During heavy monsoon events channels can swell rapidly

5.1.3 Occurrence and movement of ground water in hard rock is essentially controlled by development and nature of secondary joints and fractures. The Deulha (Dewlaha) area in Satna district falls in a shallow to moderate groundwater zone, where water occurs mainly in weathered and fractured Vindhyan sandstones and local alluvium. Depth to water table generally varies from about 6–22 m bgl in the pre-monsoon season, rising to 1–6 m bgl after the monsoon, though many dug wells turn dry during peak summer. Yields are moderate and highly seasonal, with borewells in fractured zones providing more reliable supply. Groundwater quality is mostly suitable for domestic and agricultural use, but pockets with fluoride above the permissible limit are reported, making site-specific testing essential. Since recharge depends almost entirely on rainfall and village tanks, levels decline sharply in dry months, highlighting the need for rainwater harvesting, check-dams, farm ponds, and revival of village tanks to sustain supply.

5.1.4 In and around Deulha (Majhgawan area) of Satna district, Bhaisawar Dam, located in south west direction, 5 km from the block is the nearby reservoir which serves arigation and village needs, the whole region sserved by Bansagar Dam on the Son River.

5.2.0 ROADS, RAILWAY TRACK, ELECTRIC TRANSMISSION LINE, TELEPHONE LINE, ETC.

5.2.1 The Deulha (Dewlaha) area in Majhgawan tehsil of Satna district is linked by a network of village and district roads that connect to the Satna–Chitrakoot corridor. These roads provide direct access to Satna town (the district headquarters) and nearby settlements, with smaller metalled village roads and feeder tracks ensuring connectivity to hamlets, agricultural fields, reservoirs, and local market centres. The area also benefits from the Satna–Majhgawan road, which serves as the main route for passenger and goods movement.

5.2.2 Majhgawan Railway Station (MJG), located 5km in east direction of the blockand lies on the Manikpur–Katni line is the nearest Railway Junction, which handles both passenger and goods movement and this station provides direct links to major towns like Satna, Katni and Manikpur.

5.2.3 Electricity reaches the area through the district's transmission network, with 33/11 kV sub-stations and distribution feeders supplying surrounding villages. While Satna hosts major grid infrastructure (400/220 kV and 220/132 kV lines), the local supply in Deulha is primarily through rural HT/LT distribution lines feeding households, farms, and small industries.

5.2.4 Telecommunication facilities include landline networks and mobile coverage from major operators, supported by rural towers and exchanges in Majhgawan and Satna. These ensure reliable voice and data services, though quality may vary with terrain and tower density.

5.3.0 HOST POPULATION (LOCAL TRIBES), HUMAN SETTLEMENTS WITHIN AND NEARBY THE AREA

5.3.1 The Deulha (G-3 stage) block lies in the Majhgawan Tehsil of Satna district in Madhya Pradesh. Majhgawan is one of the ten tehsils of Satna district. Majhgawan tehsil of Satna district in Madhya Pradesh comprises 193 villages and 2 towns—Chitrakoot (Nagar Panchayat) and Majhgawan—as per the 2011 Census, making it a predominantly rural tehsil with only a small urban presence. As per the 2011 Census, Majhgawan tehsil of Satna district had a total population of 150,362, comprising 79,158 males and 71,204 females, giving it a sex ratio of 900 females per 1,000 males, which is below the state average and reflects the demographic pattern of the region. (Source-https://www.censusindia.co.in)

Following two villages are falling under present block viz. Deulha and Umariha. Census details of viallage populaion is fiven below:

Village name	Male Population	Female Population	**Total population**
Deulha	679	630	**1309**
Umariha	37	37	**74**

5.3.2 Out of the total population, 60% belongs to Scheduled Tribes and litreracy rate is approximately 36%.

5.3.5 Human settlements within and near Deulha are mosaic type: small hamlets and clustered village habitations dominated by tribal households, interspersed with pockets of non-tribal farming families, and a few larger nucleated settlements (market villages, the Majhgawan railway/road node). Livelihoods are mainly rainfed and irrigated agriculture, livestock, daily wage labour, and forest/product collection; seasonal migration for work (to nearby towns or mines/industries in the district) is common where local agricultural incomes are marginal. (These livelihood patterns are typical for Satna tehsils and are consistent with low literacy and limited local industry reported for the district.

5.4.0 SOCIO DEMOGRAPHIC PROFILE OF THE AREA AND NEARBY

5.4.1 Majhgawan tehsil of Satna district has a population of about 1.5 lakh, mostly rural with only two small towns, and records a sex ratio of 900 and literacy rate of ~62%, with a wide gender gap. Livelihoods in both the tehsil and village are centred on rainfed farming, agricultural labour, livestock, and seasonal migration, with only limited access to higher education, healthcare, and organized employment. Basic infrastructure like roads, electricity, and hand-pump water exists, but gaps remain in sanitation, quality education, and health services, making the area socio-economically vulnerable and in need of targeted, community-sensitive development interventions.

5.4.2 Majority of the Population speaks Bagheli and Hindi.

5.4.3 The major occupation of the people of Satna district as well as Majhgawan tehsil people is agriculture, 50% of Majhgawan area is covered by forest and 50000 ha is under cultivation.

5.5.0 HISTORICAL SITES AND ARCHAEOLOGICAL MONUMENTS, PLACES OF WORSHIP, PUBLIC UTILITIES ETC.

5.5.1 Satna district has two major religious tourist places viz., Chitrakoot (~40km in northern direction from block) & Maihar (~74km in southern direction from block), along with an ancient city of Buddhist culture named 'Bharhut', whose archaeological remains have been gifted to the major museums in the country and the world. Tulsi museum at Ram Van has many unique artistic sculptures of ancient times found in this area. Lord Shiva Temple at Birsinghpur is also a famous and old temple in the region.

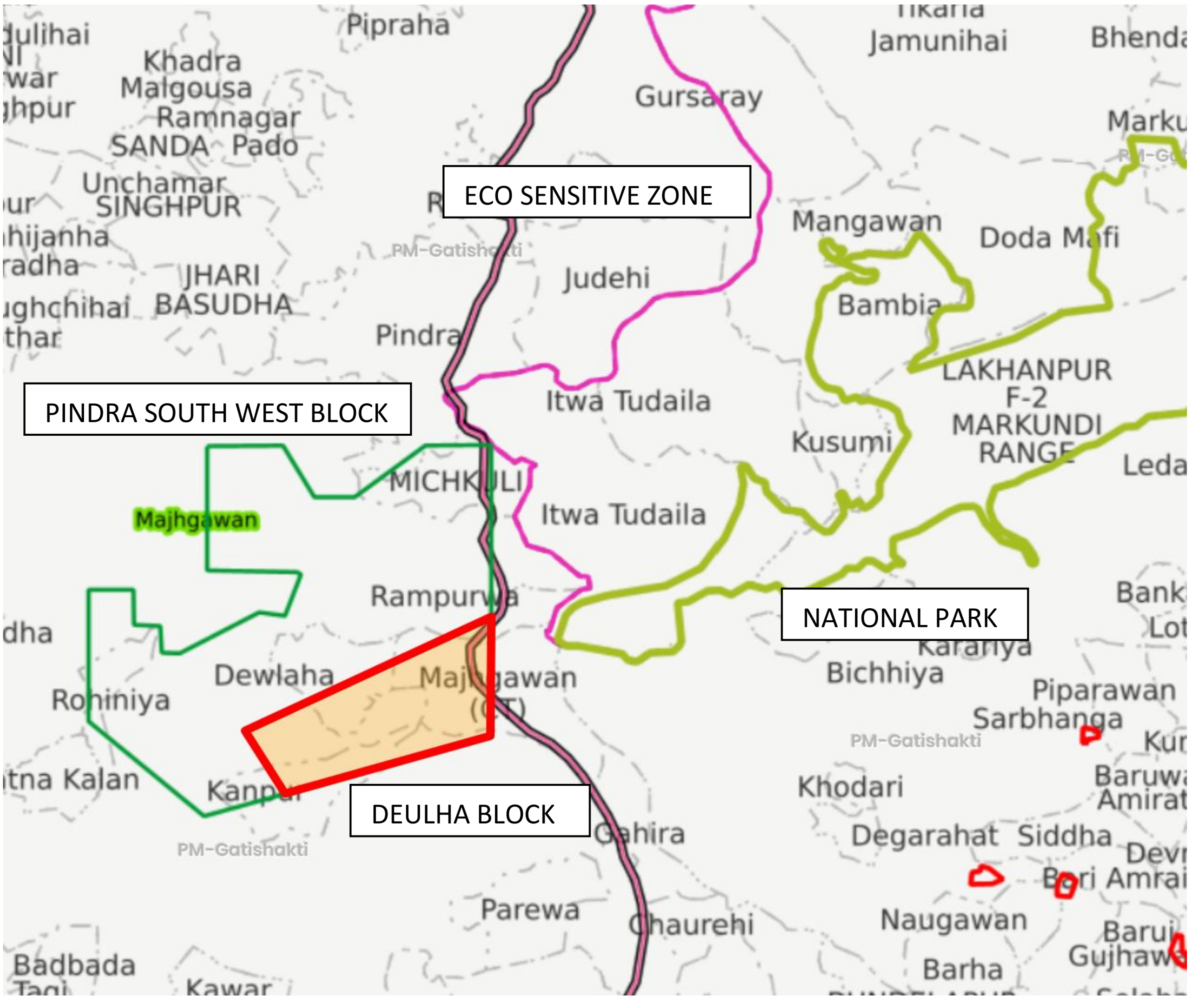
5.5.2 The Deulha (Dewlaha) area in Majhgawan tehsil, Satna district, does not have any documented archaeological monuments within the village itself, but the surrounding region is historically and culturally significant. Majhgawan is historically noted for the Majhgawan Copper Plates (510–511 CE), which highlight the area's ancient administrative and historical importance. Within the broader Satna district, sites like Bharhut, a major Buddhist archaeological site, and the Gupta-era Bhumara Temple reflect the rich cultural and historical heritage of the region, showcasing ancient temples, stupas, sculptures, and relics.

5.5.3 In terms of places of worship, the area around Deulha and Majhgawan hosts several Hindu temples and religious centers, including the Janki Kund Sita Mata Charan Temple, Shri Radha Krishna Pranami Temple, and Hanuman temples in nearby villages, which serve as focal points for local spiritual and social life. Additionally, spiritual ashrams such as Sarbhanga Ashram cater to religious activities and community gatherings, forming an important part of the socio-cultural landscape.

5.5.4 Public utilities in and around the area include basic civic infrastructure such as banks, hospitals, educational institutes, Aadhaar enrolment centers, local government offices, and water points often associated with temples or ashrams are available near Majhgawan town and at district head quarter i.e., Satna city. While major modern utilities like electricity and roads serve villages, smaller community-centric utilities—village ponds, tanks, and meeting spaces—also play an important role in daily life, often intertwined with the local religious and cultural institutions.

5.6.0 FORESTS, SANCTUARIES, NATIONAL PARK AND WILD LIFE SANCTUARIES ETC.

5.6.1 30% of the Deulha (G-3 stage) exploration block is situated in the parts of Deulha and Madhopur P.F. There is no Eco Sensitive Zone in the block. Ranipur (Kaimur) Wildlife Sanctuary Area is the nearest Eco Sensitive Zone and Wildlife Sanctuary Area. Text Figure-5.1.



Text Figure-5.1 Map showing the status of nearby ESZ and National park in the vicinity of the Deulha exploration block(Source – PM Gatishakti Portal)

5.7.0 FLORA AND FAUNA WITHIN AND NEARBY

5.7.1 The area surrounding Deulha (Dewlaha) in Majhgawan tehsil, Satna district, Madhya Pradesh, is rich in biodiversity, owing to its proximity to several protected forest areas and its location within the Satpura-Maikal bio-geographic region. The forests near Deulha are characterized by a mix of tropical dry deciduous and sal-dominated ecosystems. Common tree species include sal (Shorea robusta), teak (Tectona grandis), bamboo, tendu (Diospyros lotus), mahua (Madhuca longifolia), chironji (Buchanania lanzan), and kardhai (Anogeissus latifolia). These forests support a variety of medicinal plants, such as Aegle marmelos, Azadirachta indica, Withania somnifera, and Terminalia bellirica, which are utilized by local communities for traditional healing practices.

5.7.2 The district has rich forest resources. Fauna present in district are mainly herbivorous in dense forest with some carnivorous animals; some common fauna of this area are antelope, Nilgai, Gazelle, wild cats, fox, wolf, jackal, boar, stripped hyena, monkey, reptiles and birds like peacock, parrot, crows and doves.

5.8.0 CLIMATIC CONDITIONS

5.8.1 The climate of this district is tropical monsoon type. It is characterized by hot and dry summer from March to May, rainy season from July to October and winter from November to south.

5.8.2 The monsoon begins in first week of July and continues up to September-October and winter season starts from November and continues till middle to end of February in which December and January are the coolest months. The maximum and minimum temperature may go down to the coolest point on individual days in January and December. The maximum and minimum temperature for this district are 41.90°C (May) and 8.70°C (January), respectively. Mean annual temperature is 32.2°C and 19.00°C and annual rainfall received by satna district is 1046.00mm.

5.9.0 OTHER PHYSIOGRAPHIC, SOCIAL AND ENVIRONMENTAL FACTOR

5.9.1 Satna district, a part of Rewa division is a district of Madhya Pradesh with its administrative headquarters located at Satna town. The district got its name from the river Satna which is flowing through the region. Satna district is under the Baghelkhand region and earlier, a huge portion of the place was under the rule of the Rewa.

5.9.2 Almost entire Satna district lies on the Vindhyan plateau, which extends from the Kaimur hill range in the south to the edge of the Ganga valley in the north. It is traversed by three prominent hill ranges from south-south west to north-north east and is occupied by a higher plateau in the south-western part of the district known as “Parasmania Pahar” which is part of Bhander series. Maximum elevation of the district is 704 m above mean sea level, which is recorded near “Papra Reserve Forest” on Kaimur hill range on southern part of the district. The southern and northern fringes of the district lie low in the respective valleys of the Son and the Yamuna rivers.

5.9.3 The Kaimur hill range is passing through southern part of the district from Maihar and Amarpatan Tehsils in ENE-WSW direction forming water divide between Tons and Son Sub-basins.

5.9.4 Geographically, the district lies at 24°58'N latitude, 80°83'E longitude and 315m Altitude. In the year 2021, there was a total 23.35% forest area of total geographical area. The district encompasses a geographical area of 7,502 sq. km. and in terms of geographical area it occupies the ranks of 11th in the state and 124th in India. It is bounded by Uttar Pradesh on the North, Umaria district and Katni district on the South, Rewa district on the East and Panna district on the West. Administration wise, the district is divided into 10 tehsils namely Amarpatan, Birsinghpur, Kotar, Maihar, Majhgawan, Nagod, Raghurajnagar, Ramnagar, Rampur Baghelan and Unchahara. It also comprises 6 sub-divisions likewise Satna, Nagod, Rampur Baghelan, Amarpatan, Maihar, Majhgawan.

5.9.5 The economy of the district is mainly based on agriculture. The chief agricultural products in the district are paddy, maize, black gram, green gram, soyabean, pigeon pea, etc. The adoption of the new agricultural technologies amongst the farmers of the district helps to increase the production of various agricultural items. The district is scantily industrialized but some small industries of handloom weaving, flour, oilseed milling, fabric products, etc area available in the district. The district is well known for its dolomite and deposits. Several cement plants are there in Satna.

5.9.6 In 2006, the Ministry of Panchayati Raj declared Satna as one of the country's 250 most backward districts and currently receiving funds from the Backward Regions Grant Fund Programme (BRGF). In the year 2019-20 the gross domestic product in the district was Rs. 25, 07, 333 lakhs at current price and Rs. 15,45,796 lakhs at constant prices in the year 2011-2012. The net domestic product in the district during the period 2019-20 was Rs. 22,83,135 lakhs at current price and Rs. 13,72,002 lakhs at constant prices in the year 2011-2012. The Per Capita Income or NDDP, At Factor Cost during the period 2019-20 was Rs. 89,740 at current price and Rs. 53,928 at constant prices in the year 2011-2012. (Source: https://www.indiastatdistricts.com/madhyapradesh/satna-district).

5.10.7 The socio-economic situation supports the development of mines in the block. Mining activities will support the development of the area in all sense. There will be minimalistic affect on the natural resources that can easily managed with proper planning and execution accordingly.

CHAPTER-6

6.0.0 INFRASTRUCTURE AND ENVIRONMENT

6.1.0 LOCAL INFRASTRUCTURE, HOST POPULATION, HISTORICAL SITES, FORESTS, SANCTUARIES, NATIONAL PARK AND ENVIRONMENTAL SETTING OF THE AREA.

6.1.1 The district has several centers of attractions which allures people from different parts of the country as well as world. Bharhut Stupa, an ancient Buddhist cultured site located in the district was built in 3rd century BC. Moreover, the place was discovered by Sir Alexander Cunningham in 1873 Tulsi Archeological Museum situated at Ram Van has a Cunningham in 1873. Tulsi Archeological Museum, situated at Ram Van has a huge number of antique artistic sculptures. Chitrakoot Dham in the district is a pilgrimage centre with Puranic importance. Devotees from far distance place come to this Dham to offer their prayers.

6.1.2 The district is fortunate enough to have India's first rural university named Mahatma Gandhi Chitrakoot Gramoday Vishwavidyalaya, established in 1991.Some of the colleges in the district are also affiliated to Awdhesh Pratap Singh University, located in Rewa. Some other reputed educational institutions in the district are Indira Gandhi Govt. Girls Collage, Government Polytechnic College, Shri Rama Krishna College, Rajiv Gandhi Computer College, Mahatma Gandhi College, Vindhya Institute of Technology and Science, Sadguru Institute of Paramedical Sciences, etc. No any school or college is present within the exploration block.

6.1.3 The banking facilities are available in Majhgawan, Tehsil town. Other infrastructure facilities like, market, workshops etc. are also available in the close vicinity of the block. Hospitals and hotels are available at Majhgawan.

6.1.4 The host population, historical sites, forests, sanctuaries, national park and environmental setting of the area have been described in Chapter-5 (Physiography and Environment).

CHAPTER-7

7.0.0 GEOLOGY OF THE AREA

7.1.0 REGIONAL GEOLOGY

7.1.1 Regionally the rock types exposed in Satna district, range in age from Archaean to Cainozoic. The Archaean rocks comprise of granites & gneisses and are exposed only in northern western part of the Satna district. Vindhyan Super group formations comprised of Semri, Kaimur, Rewa & Bhander groups are exposed in most of the district. The Semri Group of rocks is represented by an alternating sequence of Sandstone and shale along with porcellanitic and limestone. The Semri Group of rocks mainly exposed in the southern and northern part of the district. The Rohtas Limestone of Semri Group is light to grey in colour, fine grained compact and well bedded. The Kaimur Group comprising mainly sandstone which is fine grained; massive and thickly bedded is exposed in the northern and southern part. The Rewa Group of rocks comprises mainly of sandstone, shale and conglomerate is exposed in northern part of the district.

7.2.0 Regional Stratigraphy of the Satna district is given in Table 7.1

Table 7.1 Regional Stratigraphic Sequence of lithology (After GSI, 1988)

AGE	SUPERGROUP/ GROUP / COMPLEX	FORMATION/ SERIES	LITHOLOGY
Recent to sub-recent			Alluvium
Proterozoic	Vindhyan Super Group	Rewa	Upper Rewa Sandstone Jhiri Shales Itwa Sandstone, Banbiha sandstone (Glauconitic sandstone) Panna Shales Diamondiferous Conglomerate beds
		Kaimur	Baghain Sandstone
	Unconformity		
	Vindhyan Super Group	Semri	Palkwan Shale Dolomitic limestone Pandwafall sandstone
		Semri Pandwa fall formation	Bansagar sandstone (Upper glauconitic sandstone) Kohari chert (dolomitic limitation chert and chert breccia) Kudwari sandstone (Lower

AGE	SUPERGROUP/ GROUP / COMPLEX	FORMATION/ SERIES	LITHOLOGY
			glauconitic sandstone)
Unconformity			
Proterozoic	Bundhelkhand Gneissic Complex		Granite gneiss Granite

7.2.1 **Bundelkhand Gneissic complex:**

7.2.1.1 Bundelkhand gneissic complex is represented by pink-coarse granite which are intruded with pegmatites and dolerites, these are exposed in north western part of the Satna dist. Coarse granite is rich in potash feldspar, often occurring as subhedral to euhedral phenocrysts; biotite as subordinate. Acid intrusions in some instances become aplitic. Basic and mafic dykes are common and younger than acidic veins.

7.2.2 **Vindhyan Super group**

7.2.2.1 The Vindhyan Basin is the largest Proterozoic intra-continental basin in central India that occupies an area of ca. 1,20,000 sq. km. and attains a huge thickness of ~ 4500-5000 m. In addition, about 80,000 sq km is overlain by the Deccan traps in the southern and south-western region and in the north about 10,000 sq.km is covered by the Gangetic alluvium (Mathur, 1986). The rocks are characteristically developed in the Son Valley and in parts of Rajasthan, Madhya Pradesh, Telangana and Andhra Pradesh.

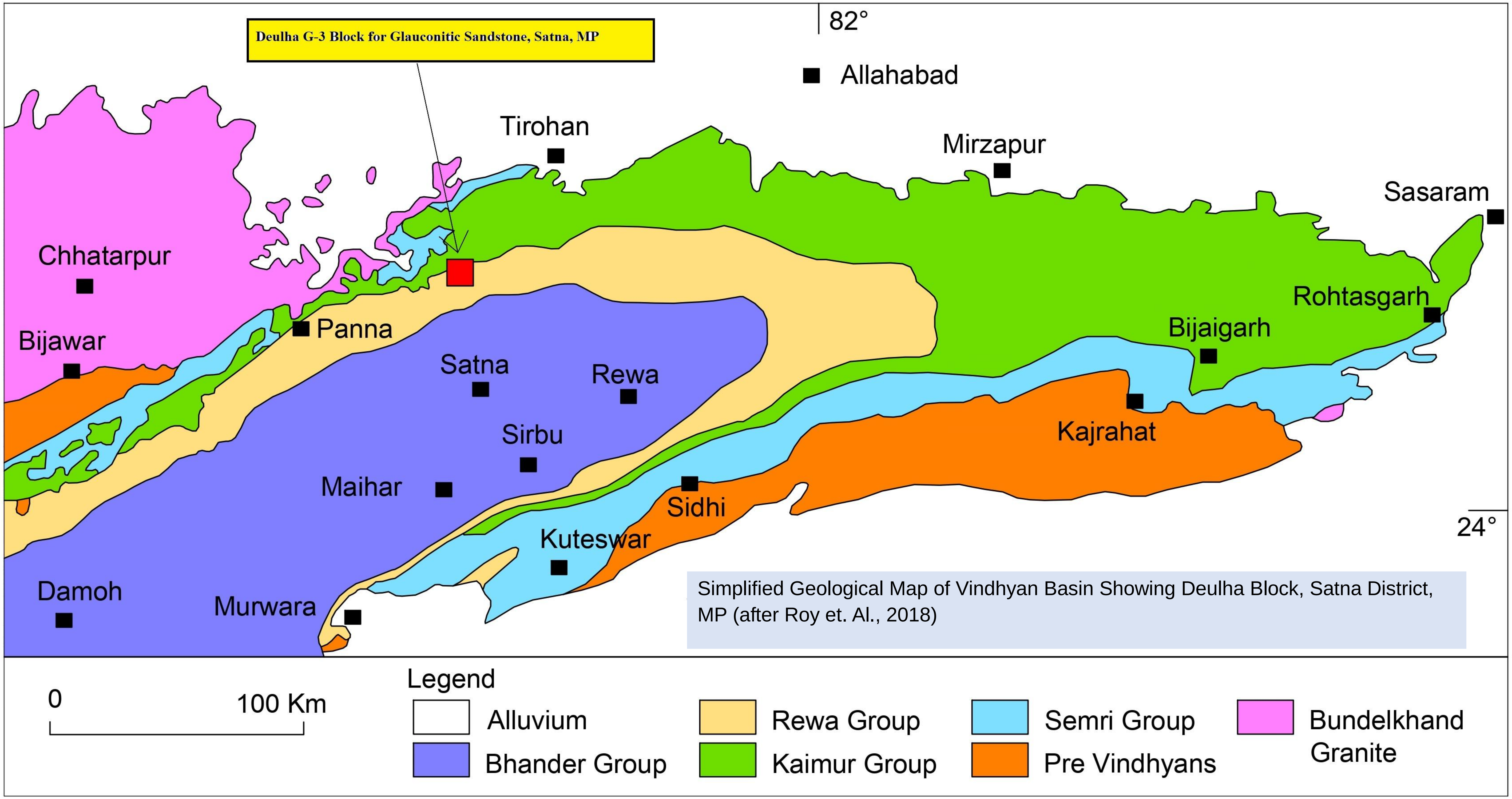
7.2.2.2 Vindhyan Super group is divided into upper and lower Vindhyan super group separated by unconformity Bhander, Rewa and Kaimur belong to upper Vindhyan and Semri series belongs to lower Vindhya group.

7.2.3 **Rewa Group:** The name Rewa is derived from a Rewa town in Madhya Pradesh in Central India. The Rewa Series occupies the middle position in the Upper Vindhyan. The rocks of the Rewa Series are exposed all along the synclinal exposure belt of the Vindhyan Supergroup in the Son Valley. This Series is composed of sandstones and shales. It contains kimberlite derived diamondiferous conglomerates (Bose et al., 2001). Sandstone and shale of this series have been subdivided into the Panna Shale, the Itwa Sandstone, the Jhiri Shale and the Gahadra Sandstone. The Panna Shale conformably overlies the Baghain Sandstone. It mainly comprises purple to olive green (khaki), thinly laminated flaggy shale with thin siltstone and fine sandstone. Itwa Sandstone conformably overlies the Panna Shale with a gradational contact. It forms a prominent stratigraphic division between the Panna Shale and the overlying Gahadra Sandstone. The Asan Sandstone comprises dirty green, greenish grey and variously coloured medium to fine grained sandstone with thin shale and siltstone partings. The Jhiri Shale is purple, greenish grey, khaki and chocolate coloured, thinly laminated with wavy to lenticular bedding. Sedimentary structures such as halite casts, load casts, flute casts, bounce marks, small scale cross bedding and ripple marks are commonly exhibited by silty and sandy units. The Gahadra Sandstone comprises a thickly bedded, current bedded and massive sandstone succession. It is compact and pink, light reddish brown and purple coloured, medium to fine grained, rarely gritty. A conglomerate (oligomictic type), comprising pebbles, cobbles and even boulder size fragments of vein quartz and sandstone, has yielded diamonds in the Sakaria area.

7.2.4 **Kaimur Group:** The is named after Kaimur hills in M.P. There is well marked unconformity between Kaimur and Semri Series. This group attains a thickness of 400 m and is characterized by argillo-arenaceous rocks. The sequence begins with conglomerate (containing pebbles of Jasper) and shale which is succeeded by the Susnai breccias, upper Kaimur sandstone and quartzites, the Bijaigarh Shale, Upper Kaimur Sandstone, scarps of sandstone and conglomerate and finally Dhandraul quartzites. This is the only horizon which can be traced from the eastern to the western part of the Vindhyan Basin. Thus, it can be considered as marker horizon.

7.2.5 **Semri Group:** The Semri series is the oldest of the Vindhyan System and is best exposed in the Son Valley area, Central India where it unconformably overlies the phyllites of the Bijawar Series. Auden (1933) divided it into four stages as the Basal Stage, the Porcellanite Stage, the Kheinjua Stage and the Rohtas Stage. The thickness of this group is about 3694 m. Semri series is further divided into Bansagar sandstone which is marked as upper glauconitic sandstone which is underlain by Kohari chert i.e. dolomitic chert breccia which is underlain by kudwari sandstone the lower glauconitic sandstone formation.

Text Figure 7.1: Regional Geological map showing the Deulha G-3 block



7.2.0 REGIONAL STRUCTURE

7.2.1 The Vindhyan sequence as a whole exhibit a mild southeasterly tilt, with a low dip of approximately 3°–5°, giving rise to the successive appearance of younger formations toward the southeast. Lithological contacts generally trend northeast–southeast, although the northeast–southwest trend may reflect either the original basin alignment or the orientation of the tilt axis. This gentle southeasterly dip is locally disturbed by minor deformations, resulting in variations in structure and thickness. Mild diastrophism has produced rare domes and low-plunging to non-plunging warps, which, due to their localized nature, do not significantly affect the overall map pattern. A consistent orientation of such warps—northwest–southeast and north-northeast–south-southwest—has been observed.

7.2.2 In several instances, bedding exhibits apparently moderate to steep dips due to the sliding of jointed blocks. Numerous sub-vertical joints, ranging from lengths observable in aerial photographs to as short as 20 meters, are present. Many nala and stream courses are controlled by these joints. These joint planes are non-penetrative and show variable trends, with northwest–southeast sets being the most prominent, followed by northeast-trending sets. Joint sets are particularly well-developed in the southwest and are less common in north–south and east–west directions. Notably, dykes and quartz veins in the Bundelkhand Granite generally trend northeast–southwest or northwest–southeast, mimicking the structural trends of the basement.

7.2.3 Localized sub-vertical faults have been observed at Guptagodavari (northeast–southwest trend, northwestern block down-thrown), Pathra (east–west trend, northern block down-thrown), and east of Hanuman Dhara (east–west trend, northern block down-thrown). Additionally, the nala courses south and west of Jateri Baba are aligned along linear zones of disturbance, likely associated with these faults.

7.3.0 REGIONAL MINERALIZATION

7.3.1 Vindhyans have rich in economic minerals like limestone, Glauconites, diamond, pyrite, dolomite and building stones etc. The Vindhyan basin, containing more than 5000 m thick sequence of sandstones, shales and limestones, occupies an area of about 1,62,000 sq.km of which about 80,000 Sq.km extends into the Ganga valley in the north and northeast beneath the Tertiary sediment of the Himalayan foredeep. The Vindhyan limestone is one of India's most important raw material sources for the lime and cement industries.

7.3.2 The Rohtas Limestone of the Lower Vindhyans, belonging to the Semri Group, is conformably overlain by the Lower Kaimur Group of the Vindhyan Supergroup in the Son Valley, Central India. These limestones are primarily micritic carbonates containing a notable proportion of detrital grains and rock fragments. The Lower Vindhyan sediments were deposited in a tidal-swept shallow marine environment, mainly within tidal flats under stable tectonic conditions. Such settings led to the development of condensation horizons characterized by exceptionally low rates of sediment accumulation.

7.3.3 The limestone horizon within the Lower Vindhyan sequence averages around 25 meters in thickness. Geochemically, the Lower Kaimur sandstones are dominated by silica, with SiO_2 averaging 92 wt%, whereas the Rohtas limestones contain about 9.52 wt% SiO_2 and 47 wt% CaO. Trace element data reveal that the limestones are relatively enriched in strontium (Sr = 352 ppm) and depleted in zirconium (Zr = 20 ppm), while the Lower Kaimur sandstones exhibit higher Zr content (400 ppm) due to the presence of heavy minerals such as zircon.

7.3.4 Rare Earth Element (REE) geochemistry shows that both limestone and sandstone display fractionated Light Rare Earth Element (LREE) patterns and nearly flat Heavy Rare Earth Element (HREE) distributions, along with a slight negative europium (Eu) anomaly. The REE patterns and concentrations of the Rohtas limestones are closely comparable to those of the Lower Kaimur sandstones rather than to pure micritic limestones.

7.3.5 This geochemical similarity indicates that the REE characteristics of the Rohtas limestones were largely influenced by the incorporation of detrital material. The detrital input likely originated from the same source area that supplied sediments to the Lower Kaimur sandstones, suggesting a genetic and sedimentary linkage between these two formations.

7.4.0 Block Geology

7.4.1 The Deulha G-3 block forms a part of the Majhgawan–Paharikhera Potash Belt, situated in the northern part of Satna District, Madhya Pradesh. This belt represents one of the most significant sedimentary basins within the Vindhyan Supergroup, known for its potential for glauconite and associated potash mineralization. The Deulha block occupies the central portion of this belt and exhibits a well-preserved stratigraphic succession of the Rewa Group, providing valuable insights into the depositional history and basin evolution of the region.

7.4.2 Geologically, the area is occupied by rocks of the Rewa Group belonging to the Upper Vindhyan Supergroup, which unconformably overlie the Kaimur Group of the Lower Vindhyans. The lithostratigraphic nomenclature has been established through lateral correlation of the lithounits with the standard stratigraphic sequences mapped in adjoining areas such as Majhgawan, Paharikhera, Sohawal, and Chitrakoot. The Vindhyan Supergroup in this part of Satna district displays an extensive spread of sandstone–shale alternations, reflecting shallow marine to nearshore depositional conditions during the Proterozoic period.

7.4.3 The oldest formation exposed within the Deulha block is the Rohania Sandstone, representing the uppermost member of the Itawa Sandstone Formation of the Rewa Group. It consists predominantly of fine- to medium-grained, buff to reddish-brown sandstone, occasionally glauconitic, with subordinate intercalations of shale. The Rohania Sandstone conformably overlies the Pindra Shale Member, which is mainly composed of greenish-grey to dark shale and siltstone, deposited under low-energy conditions, possibly in a restricted marine or lagoonal environment.

7.4.4 Subsurface drilling has revealed that the Panna Shale forms the oldest lithounit intersected in boreholes within the block. It consists of grey, fissile, and locally carbonaceous shale, occasionally containing thin interbeds of fine-grained sandstone. The Panaa Shale overlies the Baghain Sandstone of the Kaimur Group, marking the transitional boundary between the Kaimur and Rewa Groups. The presence of these lithounits indicates a gradual shift from fluvial to marginal marine sedimentation.

7.4.5 Towards the upper part of the succession, the Jhiri Shale Formation and the overlying Gahadara Formation (Quartz Arenite) are exposed in parts of the block. The Jhiri Shale comprises soft, dark grey to bluish-grey shale, locally silty, while the Gahadara Formation is dominated by quartz arenite, a hard, compact, and mature sandstone unit signifying high-energy shallow marine depositional conditions. The Gahadara Quartz Arenite represents the youngest exposed lithounit within the Deulha block.

7.4.6 Overall, the lithostratigraphic succession of the Deulha G-3 block displays a complete and conformable sequence from the Baghain Sandstone of the Kaimur Group through the Rewa Group, indicating a continuous phase of sedimentation under varying energy regimes. The glauconitic sandstone horizons, mainly within the Itawa and Pindra formations, form the principal mineralized zones of economic significance. These glauconitic units suggest slow sedimentation rates in a shallow marine shelf environment, conducive to the authigenic formation of glauconite.

7.4.7 Structurally, the area exhibits gentle dips (2°–5°) towards the southeast, with minor warping and jointing, typical of the Vindhyan sedimentary terrain. No major tectonic disturbances or metamorphism are observed, indicating a stable cratonic setting since deposition. The combination of favorable lithology, stratigraphic continuity, and minimal structural deformation renders the Deulha G-3 block highly prospective for systematic exploration and resource evaluation of glauconite and potash-bearing formations.

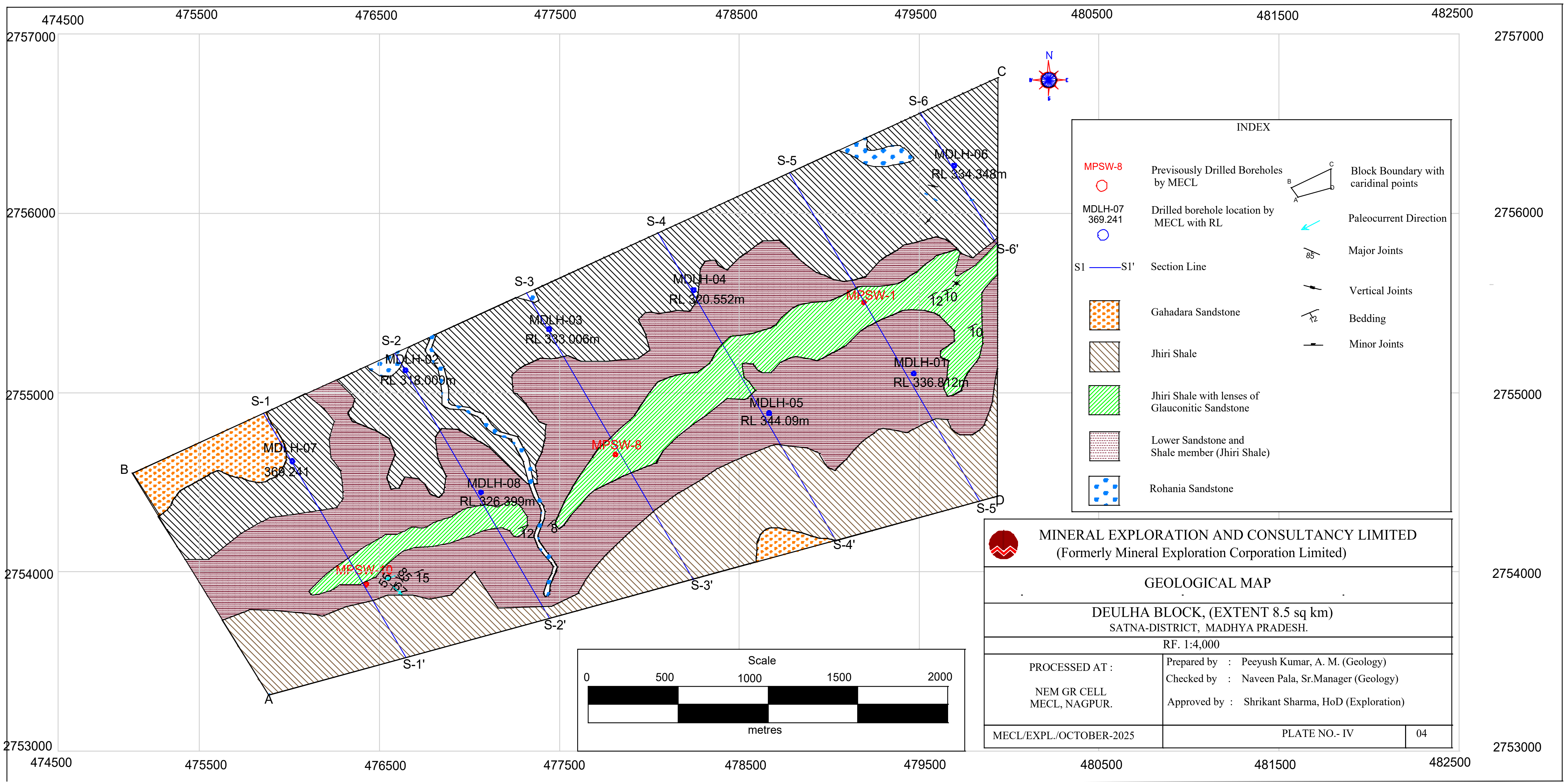
7.4.8 The local stratigraphic sequence of litho units exposed in the Deulha block area is given in Table 7.2.

Table 7.2
Stratigraphic Sequence of Deulha Block, Dist: Satna, Madhya Pradesh (After,GSI)

AGE	SUPERGROUP/ GROUP / COMPLEX	SERIES	FORMATION	LITHOLOGY	
Recent to sub-recent			Alluvium/soil/laterite		
Proterozoic	Vindhyan Super Group	Rewa	Gahadara sandstone	Quartz arenite	
			Jhiri Shale	Upper shale	Green & Red shale
				Upper White sandstone	medium grained quartz arenite
				Middle Glauconitic sandstone	
				Lower White sandstone –	medium grained quartz arenite
				Lower shale	green and red shale with conglomerate
				Rohania sandstone	quartz arenite with granular conglomerate
			Itwa	Pindra Shale	green and red shale with limestone interband

AGE	SUPERGROUP/ GROUP / COMPLEX	SERIES	FORMATION	LITHOLOGY	
			sandstone formation	Bhulwa limestone	cream colour limestone with brown chert
				Banbiha Sandstone	glauconitic limestone
			Panna Shale	Shale with limestone interband	
		Kaimur	Baghain Sandstone	Medium to Coarse Sandstone, fine sandtone with siltstone and shale interbands. Medium to coarse sandstone, angular gravel bearing sandy conglomerate	
		Unconformity			
	Vindhyan Super Group	Semri		Palkwan Shale Dolomitic limestone Pandwafall sandstone	
			Pandwa fall formation	Bansagar sandstone (Upper glauconitic sandstone) Kohari chert (dolomitic limitation chert and chert breccia) Kudwari sandstone (Lower glauconitic sandstone)	
	Unconformity				
Proterozoic	Bundhelkhand Gneissic Complex			Granite gneiss Granite	

7.4.9 The Geological plan is presented in Text fig. 7.2 and Plate –IV.



Text Figure.7.2 Surface Geological Plan of Deulha Block, Dist: Satna, Madhya Pradesh.

7.5.0 DESCRIPTION OF ROCK TYPES PRESENT IN DEULHA BLOCK:

7.5.1 SOIL: Most of the area within the block is covered by a layer of clayey to sandy soil, exhibiting brown to light brown coloration, which reflects varying degrees of oxidation and organic content. This soil cover forms a thin but widespread blanket over the underlying bedrock, indicating prolonged weathering and surface erosion processes under semi-arid to sub-humid climatic conditions. The average thickness of this soil horizon is about 2 meters, suggesting moderate soil development across the terrain.

7.5.1.1 However, subsurface data obtained from boreholes reveal noticeable local variations in the thickness of this soil layer, ranging between 0.50 meters and 3.00 meters. Such variation may be attributed to differences in topography, degree of weathering, and sediment accumulation in low-lying or depressional areas. In gently sloping or elevated zones, the soil tends to be thinner due to erosional removal, whereas in flat or valley portions, the thickness increases as a result of depositional processes and accumulation of fine-grained materials.

7.5.2 **LITHOLOGIES BELONGING TO REWA GROUP**

7.5.2.1 The Rewa Group stratigraphically consists of four distinct formations arranged in ascending order—Panna Shale, Itawa Sandstone, Jhiri Shale, and Gabadra Sandstone Formations. Within the present block, rock types belonging to the upper part of the Rewa Group are prominently exposed. These formations exhibit pronounced lateral and vertical facies variations, reflecting the dynamic nature of sedimentation during their deposition. The presence of facies multiplicity and variation in lithological characteristics indicates changes in depositional conditions, suggesting that this part of the basin evolved under environmental settings distinct from the rest of the Vindhyan Basin.

7.5.2.2 Although the Rewa Group as a whole comprises four formations, only three of these—Itawa Sandstone, Jhiri Shale, and Gabadra Sandstone—are exposed within the mapped block. The stratigraphic relationship among these units demonstrates a well-developed sequence of alternating arenaceous and argillaceous lithologies, indicative of repeated shifts between high-energy and low-energy depositional regimes, such as fluvial to shallow marine or deltaic environments.

7.5.2.3 Topographic and geological survey data further reveal that the Gabadra Sandstone Formation, being the youngest and uppermost member of the Rewa Group, occupies the highest elevations within the block, reaching a maximum reduced level (RL) of approximately 436.00 meters. In contrast, the Rohania Sandstone, representing the uppermost unit of the underlying Itawa Sandstone Formation and overlain by the Jhiri Shale Formation, is exposed at the lowest elevation, around 312.00 meters RL.

7.5.2.4 This variation in elevation among different formations reflects the regional structural disposition and differential erosion of the Rewa Group rocks. The higher topographic levels occupied by the Gabadra Sandstone suggest its relative resistance to weathering, whereas the lower levels of the Rohania Sandstone indicate areas of erosion or structural lowering. Collectively, these lithological and topographic relationships provide valuable insight into the stratigraphic succession, paleoenvironmental evolution, and geomorphological setting of the block.

7.5.2.5 **GAHADRA SANDSTONE FORMATION:** This formation represents the uppermost unit of the Rewa Group and conformably overlies the Jhiri Shale Formation. It is predominantly composed of light brownish to whitish, medium- to coarse-grained arenite, exhibiting well-developed bedding, cross-lamination, and occasional pebbly or gritty facies, indicative of deposition under high-energy shallow marine to near-shore fluvial conditions. The arenite is moderately to well sorted, compact, and shows ferruginous or siliceous cementation at places. It occurs mainly in the northwestern and southeastern parts of the area, forming prominent ridges and escarpments that stand out distinctly in the landscape. The formation attains a thickness of about 40–50 meters and covers an area of approximately 0.25 sq. km within the block. Its resistant nature and distinct topographic expression suggest considerable erosion of the surrounding softer lithounits, leaving behind isolated outcrops that mark the characteristic geomorphology of the region.

7.5.2.6 **JHIRI SHALE FORMATION:** All the members of the Jhiri Shale Formation are well exposed within the block. The upper member is characterized by alternating bands of red and green shale interbedded with fine- to medium-grained quartz arenite. This unit is separated from the lower shale and sandstone sequence by a distinct middle glauconitic sandstone band, which serves as an important marker horizon within the formation. The overall lithological succession reflects cyclic sedimentation under varying energy conditions, suggesting a transitional depositional environment influenced by periodic marine incursions and continental sediment supply. Photo. 7.1

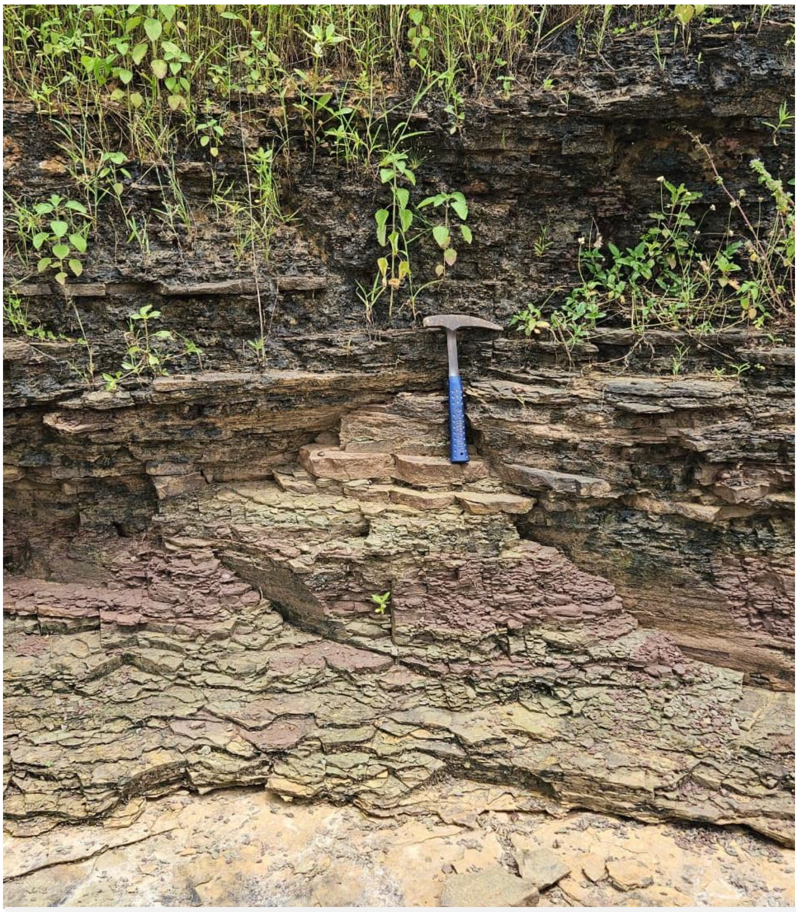


Photo.7.1: Red and green shale of Jhiri shale formation

7.5.2.7 **UPPER SHALE AND SANDSTONE MEMBER:**

The Upper Shale and Upper White Sandstone are reported as two distinct members within the Jhiri Shale Formation; however, their differentiation is not clearly discernible within the present block. The upper shale and siltstone lithounits of this member are distinctly overlain and separated by the Gahadra Sandstone. Lithologically, the unit comprises alternating beds of shale and siltstone, generally olive green and reddish in colour, with the lower part containing intercalated bands of quartz arenite within the shale horizons (Photo 7.2). The sequence exhibits fine rhythmic bedding, indicating alternating low- and moderate-energy depositional conditions. The maximum thickness of this unit, about 7.00 meters, has been recorded in borehole MDLH-06 within the block.

MDLH-07 From 0.00m to 9.30m

Photo.7.2: Core photograph showing Upper Shale and sandstone member and Glauconitic sandstone member in Borehole MDLH-07

7.5.2.8 **MIDDLE GLAUCONITIC SANDSTONE MEMBER:**

The Middle Glauconitic Sandstone Member comprises greenish, micaceous shale, sandy shale, and siltstone horizons, which occur prominently at the base of the ENE–WSW trending escarpment within the block. The shales are distinctly argillaceous, displaying well-developed parting planes containing thin flakes of muscovite. Within the Jhiri Shale Formation, more than one glauconitic shale horizon may be present, separated by non-glauconitic intervals, indicating multiple phases of glauconite deposition under fluctuating sedimentary conditions. The glauconitic horizons are fine- to medium-grained, compact, and moderately ferruginous in nature. The maximum thickness of 5.00 meters, with an average K_2O content of 6.11%, has been intersected in borehole MDLH-05, whereas a minimum thickness of 3.00 meters with 5.43% K_2O was recorded in borehole MDLH-03.

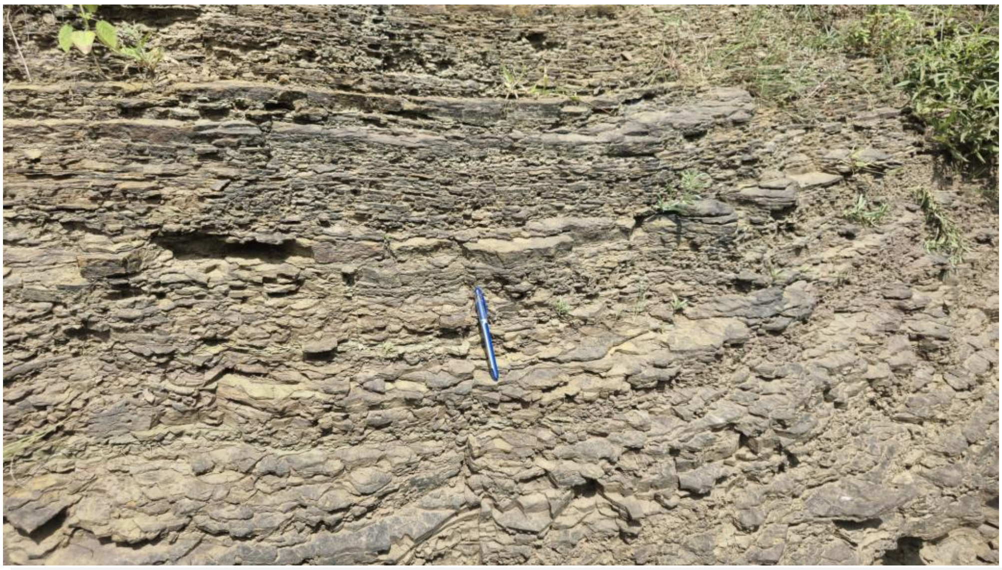


Photo.7.3: Glauconitic shale of Middle Glauconitic Sandstone Member

7.5.2.9 **LOWER SHALE AND SANDSTONE MEMBER:**

The upper unit of this member consists predominantly of white quartz arenite, lithologically comparable to the Upper White Sandstone band, whereas the lower unit comprises alternating red and green argillaceous shale and siltstone bands. However, the stratigraphic distinction between these two sub-units is not clearly established within the present block due to gradational lithological transitions. This member conformably overlies the Rohania Sandstone and is marked at the base by a granular conglomeratic bed, which is known to be diamondiferous in the western part of the region, particularly around Bhatawa and Majhgawan. In contrast, no evidence of diamond mineralization has been observed in the present explored area, indicating its probable non-diamondiferous nature. The thickness of this member varies from 3.00 meters, as recorded in borehole MDLH-02, to a maximum of 12.00 meters in borehole MDLH-06.

7.5.2.10 **ITWA FORMATION:** The Itwa Formation comprises a sequence of glauconitic sandstone, shale, limestone, chert, and quartz arenite horizons, displaying well-defined lithological variability and stratigraphic organization. Based on lithological characteristics and their order of superposition, the formation has been subdivided into four distinct members, each representing a specific phase of sedimentation and depositional environment within the stratigraphic succession.

7.5.2.11 **ROHANIA SANDSTONE MEMBER:** The Rohania Sandstone represents the uppermost member of the Itwa Sandstone Formation and is characterized by thin- to thick-bedded, white to dirty yellow, fine- to medium-grained sandstone, interbedded with thin shale layers in the lower part (Photo. 7.4 & 7.5). Lithologically, the unit is dominated by well-sorted quartz arenite, exhibiting moderate compactness and sub-angular to sub-rounded grains, with occasional ferruginous staining along bedding planes. The diamondiferous Itwa Conglomerate, which constitutes an important horizon within the Panna Diamond Belt, is regionally associated with this sandstone; however, in the present block, this conglomeratic bed is notably absent. The thickness of the sandstone as intersected in boreholes ranges from 2.0 to 5.0 meters. Surface exposure of the Rohania Sandstone is prominent in the northern part of the area, whereas within the present block, it is restricted to a narrow zone along the northern boundary.

MDLH-02 From 0.00m to 9.00m

Fig.7.4: Core photograph showing Rohania Sandstonein borehole MDLH-02

Photo.7.5: Surface exposure of Rohania sandstone

7.5.2.12 **PINDRA SHALE MEMBER:** The Pindra Shale Member represents a transitional facies between the underlying Bhulwa Limestone and the overlying Rohania Sandstone. In its basal part, the unit consists of greenish, calcareous shale interbedded with thin layers of limestone, reflecting a gradual shift from carbonate to clastic sedimentation. Upwards, the shale becomes non-calcareous and exhibits chocolate brown, pink, and grey hues, with well-developed lamination and intercalations of fine sandstone beds from the overlying sequence (Photo. 7.6). This vertical variation indicates progressive shallowing of the depositional environment. The member shows uniform lithological characteristics and consistent thickness across most of the block, except in a few boreholes where minor variations occur. Surface exposures of this unit are absent within the block; however, it has been intersected in boreholes, with a maximum thickness of 13.20 meters recorded in MDLH-01 and a minimum of 5.30 meters in MDLH-02.

MDLH-02 From 9.00m to 14.30m

Photo.7.6: Core photograph showing Pindra shale, Boreholeno.MDLH-02

7.5.2.13 **BHULWA LIMESTONE MEMBER:** The Bhulwa Limestone Member comprises two distinct lithounits— a lower chert breccia or brecciated chert horizon and an upper limestone horizon containing fine pyrite stringers. The lower chert breccia unit conformably overlies the Banbiha Sandstone, with a gradational contact characterized by the progressive upward appearance of thin, bedded chert bands within the upper glauconitic sandstone. These chert layers gradually transition into a brecciated chert zone composed of angular fragments of chert and glauconitic sandstone, eventually giving rise to a massive chert bed in the upper part (Photo. 7.7). The chert horizon varies in thickness from 10 cm to 50 cm, displaying local pinching and swelling but maintaining good lateral persistence across the area. The overlying limestone is fine-grained, compact, and often shows disseminated pyrite stringers, suggesting mildly reducing depositional conditions. The average thickness of the Bhulwa Limestone Member, as intercepted in boreholes, ranges from 1.00 to 5.00 meters.

MDLH-04 From 20.50m to 24.50m

Bhulwa Limestone

Chert band

Banbiha Sandstone (Glauconitic)

Photo.7.7: Core photograph showing Bhulwa Limestone and Banbiha Sandstone contact, Borehole-MDLH-04 (Depth -20.50m to 24.50m)

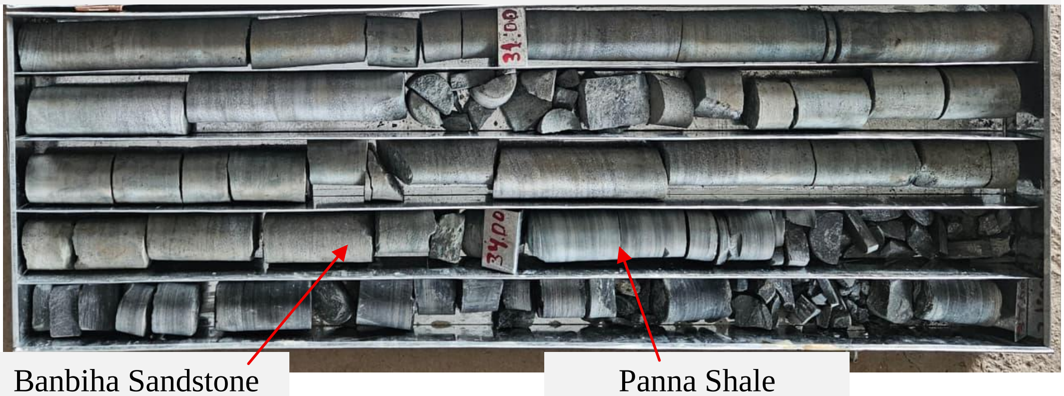
7.5.2.14 **BANBIHA SANDSTONE MEMBER:** Being the lowermost member of the Itwa Sandstone Formation, the Banbiha Sandstone conformably overlies the Panna Shale Formation, with a distinct lithological break marked by a sharp change in grain size and mineral composition. The sandstone is green to dark green in colour, fine- to medium-grained, and comprises thick cross-bedded units of glauconitic sandstone intercalated with quartz-rich sandstone and thin shale bands towards the upper part (Photo 7.8). The upper 5–6 meters of the sequence are reddish-green due to intense ferruginous staining resulting from oxidation, while the lower portion is dominantly bluish-green. Mineralogically, the unit consists mainly of glauconite, quartz, feldspar, mica, and subordinate ferro-magnesian minerals. The cementing material is primarily glauconitic mud, although local variations with siliceous and ferruginous cement are also observed. The Banbiha Sandstone is not exposed on the surface within the block but has been intersected in all eight boreholes drilled in the Deulha Block and in three previously drilled boreholes of the adjoining Pindra South-West Block. The maximum thickness of 33.00 meters, with 6.99% K_2O, was recorded in borehole MPSW-01, while the minimum thickness of 20.00 meters with 6.89% K_2O was noted in MPSW-08. The average thickness calculated from 11 boreholes (8 from Deulha Block and 3 from Pindra South-West Block) is 22.95 meters with an average K_2O content of 6.74%. The deepest intersection of this unit was observed in borehole MDLH-06, from 36.00 m to 57.50 m depth, whereas the shallowest intersection occurred in borehole MPSW-10, between 8.30 m and 34.00 m.

MDLH-08 From 21.00m to 25.80m

Photo7.8: Core photograph showing Glauconitic sandstone of Banbiha sandstone member in borehole -MDLH-08 (21.00m to 25.80m)

7.5.2.15 **PANNA SHALE FORMATION:** The Panna Shale Formation is represented by red, purple, green, yellow, grey, and greyish-black argillaceous shales (Photo 7.9). The shales are thinly bedded to finely laminated, displaying rhythmic alternations that reflect quiet-water depositional conditions. In the upper part of the sequence, the shales become distinctly calcareous, comprising alternating beds of greyish calcareous shale and thin bluish-grey argillaceous limestone, indicating intermittent carbonate sedimentation. The formation is not exposed within the present block; however, the best surface occurrences are observed along the Bandha Nala and in the scarp sections of the northern part of the explored area, where it forms a continuous band around the tablelands capped by the overlying Banbiha Sandstone. In these exposures, the thickness of the shale horizon varies between 15 and 25 meters. All exploratory boreholes were terminated after intersecting the Panna Shale Formation. Subsurface data indicate a maximum thickness of 10.00 meters, recorded up to a depth of 55.00 meters in borehole MDLH-01.

MDLH-08 From 30.50m to 35.50m



Banbiha Sandstone

Panna Shale

Photo.7.9: Core photograph showing of Banbiha sandstone member and Panna shale formation

7.6.0 STRUCTURAL DETAILS OF THE AREA SUCH AS DIP, STRIKE, FOLDS, FAULTS, ETC.

7.6.1 The rock units of the Majhgawan–Paharikheda Belt constitute a part of the northern limb of the Vindhyan Syncline. The regional strike trend is predominantly NNE–SSW with minor local variations, while the bedding generally dips gently—ranging from nearly horizontal to about 5° towards the SSE. To the north of the Deulha Block, a segment of the Bandha Nala follows the axial region of a mild antiformal warp trending ENE–WSW. The drainage pattern, controlled by structure, shows nalas aligned along synformal troughs, where they have deeply incised into the comparatively softer Banbiha Sandstone Member.

7.6.2 Structural interpretation based on borehole data indicates that bedding within the block is almost flat, with minor local dips ranging between 0.5° and 1°, either towards the NNW or SSE. Four prominent joint sets have been identified in and around the block, trending (i) ENE–WSW, (ii) NW–SE, (iii) NE–SW, and (iv) E–W. Among these, the ENE–WSW set is the most dominant, forming conspicuous lineaments observable on satellite imagery and in the field (Photo 7.10). One such major lineament traverses the southern part of the area and has been previously investigated in detail by Kalsotra and Sheo Prasad (1980). Within the present block, however, the joints are relatively minor, closely spaced, and show no significant structural displacement.

Photo.7.10: Photograph showing of two sets of joints; a) Cross section view. b) Top view

7.6.3 Various primary sedimentary structures such as parallel lamination, parallel bedding, ripple marks, cross-bedding, and clay galls have been observed within the block. The presence of ripple marks and cross-bedding suggests deposition under shallow-water conditions influenced by oscillatory and unidirectional currents. The occurrence of clay galls and mud pellets within the sandstone and shale horizons indicates intermittent subaerial exposure and reworking of semi-consolidated sediments, characteristic of a tidal mudflat or shallow marine depositional environment. These sedimentary features collectively suggest that the sediments were laid down in a near-shore to marginal marine setting with periodic fluctuations in energy and water depth.

7.7.0 MINERALIZATION

7.7.1 A discussion is presented on the classification of the deposit type, considering the style of mineralization and the specific minerals under study. An appropriate exploration plan is proposed, including recommended spacing of sampling points and exploration depths suited to the current stage of study.

7.7.2 The Vindhyan succession within the study area exhibits a diverse range of primary sedimentary structures such as bedding of varying thicknesses, multiple types of bedding planes, cross-bedding, cross-lamination, ripple marks, parting lineation, mud cracks, and syneresis cracks. These features collectively record a dynamic depositional environment influenced by periodic fluctuations in energy conditions, sediment supply, and water depth. Variations in formation thickness, colour, and mineral composition across different lithounits further support the interpretation of alternating shallow marine, tidal, and subaerial depositional settings. Based on these structural and lithological attributes, a synthesis of the depositional environment for the various rock units has been developed.

7.7.3 The Middle Glauconitic Sandstone Member of the Jhiri Shale Formation consists predominantly of green, micaceous shale, sandy shale, and siltstone horizons. These lithounits are exposed mainly at the base of the ENE–WSW trending escarpment within the area. Subsurface data indicate a limited areal extent for this horizon, as it has been intersected only along section lines S3–S3′ and S4–S4′ in a few boreholes. The restricted occurrence suggests localized development of glauconitic sedimentation, likely controlled by palaeotopography and depositional energy variations within a shallow marine setting.

7.7.4 The presence of disseminated pyrite within the Bhulwa Limestone Unit indicates deposition under reducing conditions, typical of a low-energy, restricted marine environment. The same limestone horizon also contains chert intraclasts and rare cross-bedding structures, implying episodic shoaling and deposition under shallow-water conditions. The observed southeasterly palaeocurrent direction probably reflects a regressive depositional phase (Photo 7.11). The culmination of this regressive phase was marked by minor oscillations within the basin, resulting in a gradational transition from the Itwa Sandstone Formation to the overlying Jhiri Shale Formation.

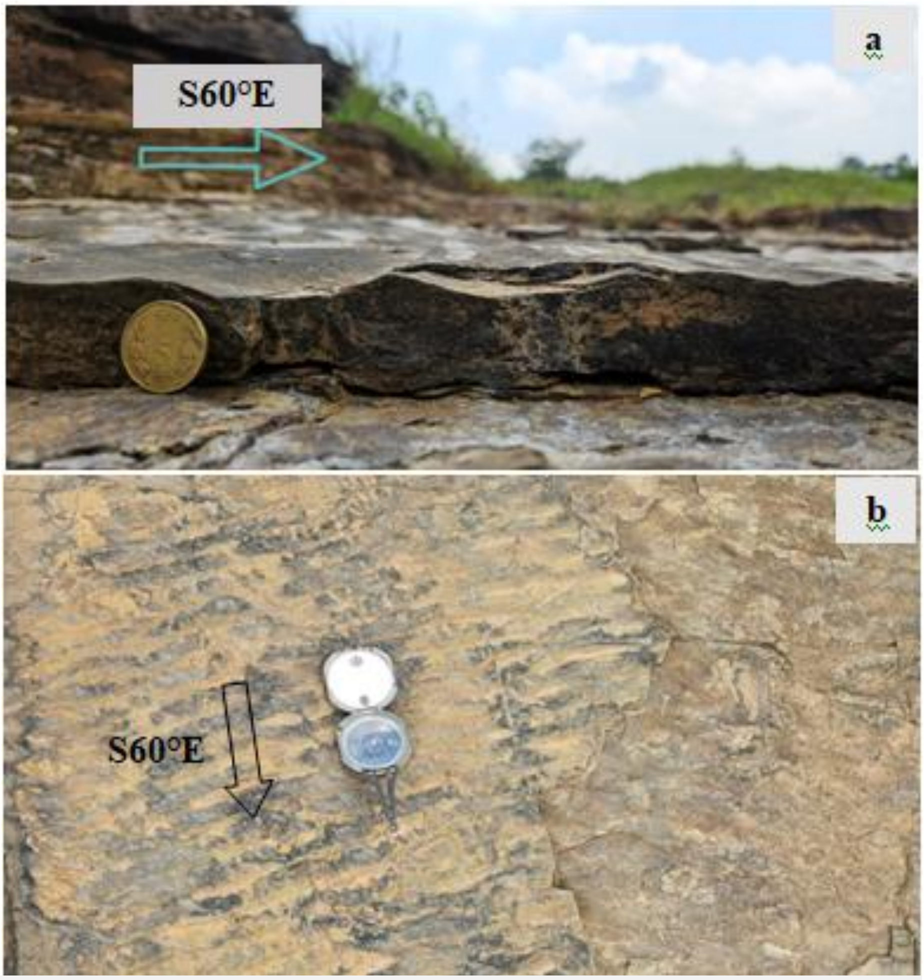


Photo.7.11: Ripple marks indicating the Paleocurrent direction; a) Cross section view b) Top view.

7.7.5 The Lower Rewa Sandstone, corresponding to the Itwa Sandstone Formation, comprises a well-defined lithological succession consisting of a basal glauconitic sandstone overlain by limestone, chert, red and green shale, and an upper quartz arenite unit. The basal Banbiha Sandstone Member forms the principal glauconitic horizon of the formation. This sandstone exhibits distinct sedimentary structures including normal bedding, flaser bedding, and cross-bedding throughout the sequence. Alternating units of parallel-bedded and cross-bedded sandstone are common, with trough-shaped, thin cross-beds (typically less than 15 cm thick) displaying foreset dips of 16° to 24°, as observed in drill cores. These structural attributes indicate sediment transport and deposition under low-intensity current regimes.

7.7.6 The lower part of the sandstone contains alternating thin shale interbeds, whereas the upper part includes thin chert laminae and intercalations. These vertical variations signify a gradual shift in depositional environment from moderately reducing, glauconite-bearing marine settings to more oxygenated shallow-water conditions. The chert bands are persistent and range from 2 mm to 1.5 cm in thickness. When associated with cross-bedded sandstone, the chert layers appear irregular, whereas in horizontally bedded glauconitic sandstone, they occur as parallel, flat bands, suggesting periodic silicification during diagenesis. Pyrite encrustations within the glauconitic sandstone further point to deposition under reducing conditions, with estimated pH values around 7.5 and Eh between 0.1 and 0.3 (Krumbein & Garrels, 1952).

7.7.7 Mineralogically, the presence of vein quartz, smoky quartz, normal quartz, feldspar, muscovite, and chlorite indicates derivation from an acid igneous provenance. The palaeocurrent directions, determined from cross-bedding orientations (SSE to SE), suggest sediment supply from the northwesterly to northerly source areas. While Rao (1980) proposed a high-energy reducing environment and proximity to the source for glauconitic sandstone deposition, the occurrence of trough-shaped cross-beds and thin, laminated bedding within the Banbiha Sandstone more convincingly supports deposition under relatively low-energy, shallow marine to near-shore conditions.

7.8.0 EXTENT OF MINERALIZATION

7.8.1 The extent and variability of the mineralization expressed as length (in meter) (along strike or otherwise), plan width, and depth below surface to the upper and lower limits of the Mineral Resource.

7.8.2 Middle Glauconitic sandstone member of Jhiri Shale formation exposure occupies nearly 0.98sq. km. area of the block and along strike ENE-WSW with average thickness of 1.00 m to 3.00 m and it has been intersected along section line S3-S3’ and S4-S4’ only in boreholes.

7.8.3 Glauconitic sandstone on Banbiha Sandstone member has extent over entire explores are i.e. 8.5 sq.km, deposit is simple planar deposit with pinching and swelling, which is along strike NW-SE with almost flat to gentle dip of 1-2 degrees towards south east and north west.

CHAPTER-8

8.1.0 PREVIOUS WORK

8.1.0 DETAILS OF PREVIOUS EXPLORATION CARRIED OUT BY OTHER AGENCIES/PARTIES

8.1.1 The regional geological mapping of the Majhgawan-Deulha area was initially carried out by Sanyal and Chakraborty (1982), with adjoining areas mapped earlier by Mehta (1942), Mathur (1954), Rao (1972), Soni (1981), Rao (1980), and Rao & Soni (1985). Stratigraphic aspects of the glauconite-bearing horizons and associated rocks were discussed in these studies. Adjoining regions to the east, falling within Uttar Pradesh, were examined by Kedar Karayan (1960), Safaya (1963–66), Hukku (1971), and Srivastava et al. (1977). Later, Kalsotra and Sheo Prasad (1980), while drilling along the ASMARA lineament in the neighboring UP area, intersected glauconitic horizons and analyzed samples of glauconitic sandstone. Subsequently, the Geological Survey of India (GSI), Uttar Pradesh Circle, conducted detailed exploration of glauconitic sandstone in the region during 1980–82.

8.1.2 In 1987, GSI drilled a total of 23 boreholes in the Pindra North Block to calculate glauconite reserves. Additionally, two boreholes (GMP-22 & GMP-23) were drilled to study the regional distribution of glauconitic sandstone and its potash (K_2O) content. The total drilling depth of the 23 boreholes was 456.90 m. The glauconitic sandstone thickness varied between 10 m and 19.40 m, with an average thickness of 15.89 m. In boreholes where the upper portion of the sandstone was eroded, thickness ranged from 10 to 15 m. The upper 5 m of the sandstone is ferruginous and brown due to iron oxidation, whereas the lower portion is bluish-green and non-ferruginous. The sandstone also contains thin bands, laminae, and chert fragments in the upper part, with thin grey shale bands in the lower part. Quartz-rich sandstone bands, ranging from 2 cm to 14 cm, occur within the horizon and dilute the K_2O content.

8.1.3 Detailed exploration of approximately 12 sq. km in Pindra North Block has indicated proved category reserves of around 266 million tonnes of glauconitic sandstone with an average grade of 4.90% K_2O. A substantial portion of this horizon carries more than 5% K_2O, making it a significant potash resource in the region.

8.1.4 M/s Nagur Minerals Pvt. Ltd. conducted exploration in the Chitrakoot-2 prospecting lease block, including geological mapping, surface sampling, pitting/trenching, and drilling of 16 boreholes. These investigations estimated a proved mineable resource of approximately 50.46 million tonnes of glauconitic sandstone, highlighting the commercial potential of the deposit.

8.1.5 Deulha G-3 block has been carved out from the Pindra South-West extension block of MECL. The MECL carried out a reconnaissance survey in the Pindra South-West extension block during 2023-24, covering an area of 39.23 sq. km. A total of 10 exploratory boreholes were drilled on a 1600 × 1600 m grid, totaling 472 m in depth. The survey established an extensive horizon of glauconitic sandstone across the block, with an average width of 2.5 km. The glauconitic sandstone is underlain by younger sediments, and its average thickness is 24.65 m. Based on its thickness and areal extent, reconnaissance resources of approximately 1918 million tonnes with an average grade of 6.96% K_2O have been estimated, confirming the area's potential as a major potash resource.

CHAPTER-9

9.1.0 AREAL OR GROUND GEOPHYSICAL OR GEO-CHEMICAL DATA

9.1.1 The present exploration has been carried out for Glauconitic sandstone etc. in Deulha G-3 stage block for which geophysical survey has not been carried out.

9.1.2 "Regional Geochemical Sampling of Stream sediment and soil in some selected blocks in Bundelkhand Granite Terrain, Panna Diamond Belt, Madhya Pradesh.", (Field season 1985-86, 1986-87, 1987-88 & 1988-89) was carried out by GSI which covers the present exploration block.

CHAPTER-10

10.0.0 EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

10.1.0 INTRODUCTION

10.1.1 The Preliminary exploration for Glauconitic sandstone in Deulha block, Satna, Madhya Pradesh was recommended in 63th TCC held on 22nd, 26th, 27th March, 2024 and was subsequently approved in 35th EC held on 16.05.2024.

10.1.2 The Deulha (G-3 stage) block, covering an area of about 8.5 sq. km, is situated in Majhgawan tehsil of Satna district, Madhya Pradesh, and is represented in Survey of India Toposheet No. 63D/13. The area lies within the Vindhyan Basin, which is regionally significant for its diverse lithological units and mineral occurrences. The block is well connected by approach roads and lies in proximity to Majhgawan railway station, ensuring accessibility for exploration activities and logistical support.

10.1.3 The present investigation was carried out to evaluate the potentiality of glauconitic sandstone within the block. Considering the strategic importance of glauconite in agriculture and industry, the exploration programme was designed to delineate glauconite-bearing horizons through geological mapping, exploratory drilling, core logging, sampling, and laboratory studies. This stage of investigation provides baseline data for resource estimation and helps establish the economic significance of glauconitic sandstone in the Deulha block, forming the basis for future exploration and development.

10.1.4 **OBJECTIVES OF INVESTIGATION** On approval of EC, NMEDT, the exploration programme in Deulha G-3 block has been formulated to fulfil the following objectives:

a. To carry out Geological & structural mapping on 1:4,000 scale for demarcation of glauconitic sandstone with the structural features to identify the surface manifestations and lateral and vertical disposition of the mineralized zones.
b. To conduct a topographical survey at 2 m contour interval on 1:4,000 scale.

c. To establish the depth continuity of glauconitic sandstone formations within the block.

d. To estimate the mineral resources (333 category) and determine the grade (K_2O content) of glauconite as per the guidelines of the UNFC and MEMC Rules, 2015 (amended up to 2021).

10.1.5 The quantum of work proposed vis-à-vis quantum of work carried out is furnished in Table no 10.1.

Table No 10.1

Details of Exploratory Work carried out by MECL in Deulha block area, Dist. Satna, Madhya Pradesh

Sl. No	Description of Work	Unit	Approved quantum	Achieved quantum
I	**Geological mapping (updating of map at 1:4000 scale)**	Ha	850	850
2	Topographical Survey BH co-ordinates	Ha Nos	850 08	850 08
II	**Exploratory Drilling**	M	400	393
III	**Laboratory Studies**			
	Primary and Check samples			
1	Primary sample analysis for 4 radicals K_2O, SiO_2, Al_2O_3 & Fe_2O_3	Nos	200	197
2	External Check Samples (10% of Primary) analysis for 4 radicals K_2O, SiO_2, Al_2O_3 & Fe_2O_3	Nos	20	20
IV	**Physical studies**			
1	Bulk Density determination	Nos	04	04
V	**Geological Report preparaton**	**Nos.**	**1**	**1**

10.2.0 DETAILS OF EXPLORATION ACTIVITIES TAKEN UP

10.2.1 LARGE SCALE GEOLOGICAL MAPPING:

10.2.1.1 Large-scale geological map of the parent Pindra South West Block was already available on 1:12,500 scale covering an area of 39.23 sq. km which serves as a comprehensive regional base map. Since the Deulha (G-3) block forms an integral part of this larger mapped area, the existing geological framework has been utilized and further refined for the present study. During detailed geological mapping of the

Deulha block, the lithological boundaries, structural elements, and stratigraphic contacts were critically examined in the field. Wherever discrepancies, lateral facies variations, or new geological features were identified, the map was updated on 1:4,000 scale to capture these local-scale variations with greater accuracy and precision. This updated mapping ensures that the geological representation of the Deulha block reflects the most recent field observations and structural interpretations, providing a reliable basis for subsequent exploration and resource evaluation.

Photo. 10.1 Photograph showing geologist involved in geological mapping in the block

10.2.1.2 The exploratory operations in the block commenced on 01.09.2024 and were successfully completed on 31.12.2024. Detailed geological mapping was carried out on a 1:4,000 scale, aimed at delineating lithological variations, structural features, and mineralization signatures across the block. The mapping involved systematic field observations and recording of litho-contacts, structural elements, and geomorphological expressions. Major lithological units such as Gahadara Sandstone, Jhiri Shale, Rohania Sandstone, the Middle Glauconitic Sandstone Band, and the Lower Sandstone–Shale Band within the Jhiri Shale Formation were carefully identified and mapped. Lithological boundaries and contacts were established with the aid of a handheld GPS, ensuring spatial precision in plotting. Structural data, including attitude of bedding planes and joint orientations, were recorded using a Brunton Compass to understand the overall structural disposition of the area. The general strike of the litho-units is observed to be NE–SW to ENE–WSW, with sub-horizontal dips (5°–10°) towards the southeast. All field data and observations were systematically compiled and represented in the geological map (Plate–IV), which forms the basis for subsequent subsurface correlation and interpretation.

10.2.1.3 Deulha G-3 block exhibits a predominantly flat to gently undulating topography, characteristic of the Vindhyan plateau region. The major lithological units delineated during geological investigations comprise red and green shale interbedded with siltstone and clay, quartz arenite, and glauconitic sandstone with shale belonging to the Jhiri Formation, which are well exposed along the ENE–WSW trending escarpment. In addition, limited exposures of quartz arenite of the Gahadara Sandstone Formation and creamish-white, fine- to medium-grained sandstone of the Rohania Sandstone Member occur in small isolated patches within the block. The spatial distribution of these litho-units reflects a stratigraphic continuity with local variations in grain size, color, and composition, indicating depositional and diagenetic heterogeneity within the sequence.

10.2.2 Surface / Bedrock sampling: No surface samples were taken owing to the previous exploration in the present area.

10.2.3 Exploratory Drilling:

10.2.3.1 During the present exploration program, drilling was planned by placing 08 nos. of boreholes in 800 x 800 m grid interval along 06 nos. of NW-SE trending section lines placed 800m apart, to chek the extent and depth of mineralization.

10.2.3.2 Exploratory core drilling for G-3 level of exploration commenced on 24th May 2025 and concluded on 28th June 2025, thus completing meterage of 393.00 mts in 08 number of boreholes (MDLH-01 to MDLH-08). The coordinates and reduced levels (RLs) of all boreholes were determined using DGPS in the WGS-84 Datum. The borehole locations along with section lines over the block’s geological map are presented in PLATE-IV.

10.2.3.3 A total 03 nos. of boreholes (MPSW-01, 08 & 10) drilled in previous phase (Pindra South-West G-4 Block) are considered for correlation and resource evaluation of Glauconite horizon of Deulha G-3 block.

10.2.3.4 Details of boreholes drilled in Deulha block (2024-25) and previously drilled boreholes in Pindra South West block (2023-24) with total depth are summarised in below given table 10.2 and 10.3 and submitted as Annexure No. IIA and IIB respectively.

Table- 10.2

Details of Boreholes in Deulha G-3 block for glauconitic sandstone, District-Satna, Madhya Pradesh

Sl.No.	BH.No.	RL (m)	Northing (m)	Easting (m)	Date of Commencement	Date of Closure	Total Depth(m)
1	MDLH-01	336.812	2755094.912	479477.891	24.05.2025	27.05.2025	55.00
2	MDLH-02	318.009	2755107.848	476651.492	25.05.2025	28.05.2025	45.00
3	MDLH-03	333.006	2755341.537	477455.965	28.05.2025	31.05.2025	57.00
4	MDLH-04	320.552	2755561.872	478250.552	29.05.2025	02.06.2025	45.00
5	MDLH-05	344.090	2754874.127	478673.464	01.06.2025	03.06.2025	56.00
6	MDLH-06	334.348	2756235.239	479694.906	03.06.2025	06.06.2025	58.00
7	MDLH-07	369.241	2754616.950	476008.537	22.06.2025	25.06.2025	40.00
8	MDLH-08	326.399	2754398.282	477079.035	25.06.2025	28.06.2025	37.00

Table- 10.3

Details of Boreholes in Pindra South West Block (G-4) for glauconitic sandstone, District-Satna, Madhya Pradesh

Sl.No.	BH.No.	RL (m)	Northing (m)	Easting (m)	Date of Commencement	Date of Closure	Total Depth(m)
1	MPSW-01	334.948	2755497.722	479202.97	15.07.2023	19.07.2023	49.00
2	MPSW-08	346.164	2754645.419	477816.727	30.09.2023	07.10.2023	38.00
3	MPSW-10	330.541	2753920.895	476427.233	14.10.2023	18.10.2023	37.00

10.3.0 Data spacing for reporting of exploration results:

10.3.1 The boreholes were spaced at 800m interval approximately which is sufficient to establish glauconitic sandstone resources at G-3 stage (preliminary exploration) as per the exploration norms of Minerals (Evidence of Mineral Content) Rule-2015, The estimated resources in the block area may be placed under Inferred Mineral Resource (333) category as per UNFC code.

CHAPTER-11

11.0.0 LOCATION OF DATA POINTS

11.1.0 ACCURACY AND QUALITY OF SURVEY

11.1.1 The survey of boreholes drilled in the block has been carried out by the DGPS DA 2 Catalyst (Annexure-IB). The photograph of instrument is given in Photo-11.1.

Photo-11.1: DGPS survey in the block using DGPS DA 2 Catalyst System)

11.1.2 The SOI base station was utilised for fixing the borehole positions on the ground as well as for obtaining the reduced levels of the boreholes. The base station used from the SOI India CORS network was **V149**.The coordinates of the SOI base station are provided in Table-11.1.

Table-11.1

Coordinates of the SOI CORS Base Point for DGPS Survey of Deulha G-3 Block (Glauconitic Sandstone), District Satna, Madhya Pradesh

Base Station	Latitude	Longitude	Easting (m)	Northing (m)	RL (m)
V149	N24°54'32.04700"	E80°47'19.72400"	478673.385	2754877.205	404.475

11.1.3 TECHNICAL SPECIFICATIONS OF DGPS

Make: Trimble GNSS

- **Model:** DA-2 Catalyst
- **Year:** 2025

a) Measurement Accuracy:

- Static Mode
    - Horizontal: 10 mm + 0.1 ppm or better
    - Vertical: 20 mm + 0.4 ppm or better

b) Baseline Processing Results

After completion of the field survey work, raw data was downloaded from the GNSS Rover. The data was subsequently processed using the CORS-based subscription service provided by SOI, which falls under Region 1.A point list was then generated in the form of a summary along with a report. The baseline processing results are also enclosed with this report.

CHAPTER-12

12.0.0 SAMPLING TECHNIQUE

12.1.0 NATURE AND QUALITY OF SAMPLING AND MEASURES TAKEN TO ENSURE SAMPLE REPRESENTATIVITY

12.1.1 In the drill coresampling programme, representative borehole samples were systematically collected from glauconite-bearing zones encountered in the boreholes. To maintain the integrity of the samples, all visibly weathered and altered surfaces were avoided in sampling, ensuring that only fresh, unaltered portions of the cores were considered. Sampling was carried out by cutting the core in two equal halves using core splitter, out of which one half was sampled and another half was stored. Each sample weighed approximately 1.0–1.5 kg and was immediately placed in clean, high-quality cotton bags, which were securely tied and appropriately labelled to maintain proper sample identification and traceability.

12.1.2 During sample preparation, strict adherence to standard operating procedures (SOPs) was maintained to ensure data reliability and analytical accuracy. Glauconite-bearing rock samples were initially reduced in size using a sample crusher, followed by fine grinding in a pulveriser and further homogenisation with a mortar and pestle until a uniform powder of -200 mesh size was obtained. After processing each sample, all equipment—including the crusher, pulveriser, mortar, pestle, sample trays, brushes, and associated tools—was thoroughly cleaned to prevent cross-contamination. This cleaning protocol was applied consistently, thereby ensuring the integrity of the geochemical data generated from the prepared samples.

12.1.3 Following the initial crushing and homogenisation, representative portions of approximately 100 g were obtained through successive reduction by the coning and quartering method. In this procedure, the bulk powdered sample was poured onto a clean, flat surface to form a conical heap, which was then flattened and divided into four equal quadrants. Two diagonally opposite quadrants were retained for further processing, while the others were discarded. This process was repeated until the desired sample weight was achieved, ensuring statistical representativity of the final sample. Approximately 300 g of prepared sample was then divided into three equal packets of 100 g each—one for primary analysis, one for check analysis, and one for laboratory reference. The surplus powdered sample was securely stored in sealed, labelled containers under controlled conditions to prevent mixing or degradation. All tools and accessories used during sampling, reduction, and packaging were thoroughly cleaned between samples to eliminate any risk of cross-contamination.

Photo-12.1 Photograph showing sample sample crusher used in sample processing

Photo-12.2: Photograph showing pulveriser used in sample processing

Photo-12.3: Photograph showing coning-qurtering equipment used in sample processing

12.2.0 PRIMARY AND CHECK SAMPLE STUDIES

12.2.1 During the exploration work, a total of 393 meters of core drilling was carried out targetting the glauconitic zones. A total of 197 nos. of borehole samples were collected and analysed for K_2O, SiO_2, Al_2O_3, and Fe_2O_3 (Annexure-IV). 20 nos. of external check samples were prepared and analysed for BH samples. The primary samples have been analysed at Chemical Laboratory of MECL, Nagpur. The, external check samples have been analysed at Jawaharlal Nehru Aluminium Research Development and Design Centre, (JNARDDC) Nagpur (A NABL accridited Laboratory). The details of analysis done for primary BH samples, and external check BH samples are given in Annexure-IV, and Annexure-VI respectively.

CHAPTER-13

13.0.0 DRILLING TECHNIQUES AND DRILL SAMPLING EMPLOYED

13.1.0 DRILLING TYPES AND DETAILS

13.1.1 During the present investigation, MECL drilled a total 08 no of boreholes with 393.00m and carried out other associated geological and analytical work. The details of boreholes drilled by MECL are given in Annexure-IA and summary of borehole is given in Table-10.2.

13.1.2 Core drilling was carried out by two conventional wire line drill rigs viz. RD-100 (MEC-354) & RD-100 (MEC-355). All the boreholes in the block were drilled in NQ size with single barrel /wire line, wet core drilling method. Diamond impregnated NQ bit (outer diameter 75.7 mm and inner diameter 47.6 mm) and TC bit had been used during drilling operation. At the initial depths, all the boreholes have been used with HW and NW casing to control falling of soil cover and loose friable weathered formation. The polymer was used as drilling fluid to flush out the cuttings and stabilize the borehole wall. The drilling fluid also works as a coolant to avoid burning of drill bits. All the precautions had been taken to maintain quality of drilling and to achieve maximum core recovery. The core recovery varies from minimum 81.86% (MDLH-05) and maximum 99.85% (MDLH-03) with an average core recovery is about 93.07%.

13.1.3 The recovery in the mineralized zone is about 99.18% which is satisfactory. The quality of drilling was ensured during the operation. After closure, all the boreholes have been properly sealed with cement pillars.

13.2.0 EXPLORATORY DRILLING

13.2.1 Owning to the bedded nature of the deposit, drilling was drilling was planned vertically by placing 08 nos. of boreholes in 800 x 800 m grid interval along 06 nos. of NW-SE trending section lines placed 800m apart, to chek the extent and depth of mineralization.

13.2.2 Details of boreholes drilled by MECL in Deulha block are given in table no 10.2 in chapter 10.

13.3.0 DEVIATION SURVEY IN DRILLING

13.3.1 All the exploratory boreholes drilled in the block are vertical with depth ranging from 37.00m to 58.00m. There is no issue of deviation for these vertical and shallow depth boreholes. Hence, no deviation survey has been done for the boreholes in the block.

13.4.0 WHETHER CORE AND CHIP SAMPLE RECOVERIES HAVE BEEN PROPERLY RECORDED AND RESULTS ASSAYED.

13.4.1 The drill cores have been logged in detail, viz., lithology, grain size, colour, nature and type of mineralisation along with structural details viz. foliation, fracture, fracture fillings and rock quality designation. Major lithology intersected in the boreholes is shale, sandy shale, sandstone, limestone and glauconitic sandstone.

13.4.2 The detailed run wise litholog and summarized litholog for 08 boreholes drilled by MECL in Deulha block and 03 boreholes in Pindra South West block are given in Annexure- II A and Annexure- II B respectively.

13.4.3 Core recovery in glauconitic sandstone zones is 99.18% which is satisfactory. Samples were marked based on glauconitic sandstone zone based on visual basis, in general, the sample length has been kept at 1.00 m interval which varied in some instances because of variation in lithology and type and concentration of mineralisation. The details of analysis of primary core samples are given in Annexure-III A.

13.5.0 MEASURES TAKEN TO MAXIMIZE SAMPLE RECOVERY AND ENSURE REPRESENTATIVE NATURE OF THE SAMPLES.

13.5.1 The short runs were drilled as per necessity so that optimum core recovery is maintained. The core recovery in the mineralized zones is about 99.18% which is satisfactory. Whenever core recovery is less, the grade of the recovered portion has been extrapolated over the non-recovered section. The quality of drilling was ensured during the operation.

13.6.0 ROCK QUALITY DESIGNATION (RQD)

13.6.1 Rock Quality Designation (RQD) is a modified measure of the degree of jointing and the fracture in a rock mass, measured as a percentage of drill core in lengths if 10cm or more. High quality rock has RQD more than 75%, Low quality rock has RQD of less than 50%. D.U. Deere in 1963 define the RQD as the ratio of the sum of the total length of the core pieces of length 10cm and length recovered from drilling of one run (3.0 m) drilling.

13.6.2 The Rock Quality Designation (RQD) has been calculated using the standard formula:

RQD (%) = (Total length of the core in pieces of 10cm or more) / Length of the run) X100

13.6.3 During detailed geological core logging, RQD values were measured for the entire length of the core column, including the mineralized zones. The run-wise RQD data have been systematically recorded and incorporated into the corresponding lithological logs, providing a comprehensive assessment of rock mass quality across different litho-units.

13.6.4 The average RQD of all boreholes is less than 50% owing to ficible nature of shaly horizon, however in the glauconitic sandstone zone the RQD is 55.80%, hence all the formation falls in Low quality rock category.

13.7.0 BOREHOLE CORE SAMPLING

13.7.1 A total 197 no of primary samples are generated from borehole core obtained after drilling by MECL. Samples were marked considering variation of glauconitic sandstone zone as well as lithology. In general, the sample length has been kept at 1.00 m interval which varied in some instances because of variation in lithology and type and concentration of mineralisation. Hence, the overall sample length is varying with minimum 0.50 m to maximum 1.00 m.

13.7.2 Sample as demarcated during core logging by geologist, based on visual basis. Once the samples are marked, sample has been prepared by splitting of core into two equal halves by using core splitter identical half is crushed to 100mesh and remaining half split core is stored in core box for future reference. The crushed 100mesh sample was further grounded to fine powder and was passed through -200 mesh size sieve. Powdered material was mixed thoroughly and about 100 grams of samples taken for chemical analysis by successive coning and quartering as primary samples and rest of the material (-200 mesh size) kept as duplicate half for future reference.

CHAPTER-14

14.0.0 SUB SAMPLING TECHNIQUES AND SAMPLE PREPARATION

14.1.0 WHETHER CUT OR DRAWN AND WHETHER QUARTER, HALF OR ALL CORE TAKEN

14.1.1 Core sampling and analytical work were carried out for the entire mineralised zones or lengths intersected in the drilled boreholes. Sampling was conducted systematically to ensure complete and representative coverage of glauconite-bearing horizons. Each sample was precisely marked on the core, with depth intervals clearly indicated before extraction. Special emphasis was given to glauconite-bearing sandstones and associated shale units, covering both high-grade and marginal zones to evaluate vertical and lateral grade variations. This ensured that all significant lithological variations within the mineralised sequence were represented in the analytical dataset.

14.1.2 The mineralised core was split into two equal halves using a core splitter (Photo 14.1), ensuring uniform ore mineral distribution in both portions. One half was crushed to (-) 200 mesh, and a ~500 g representative sample was obtained by the coning and quartering method using a crusher and pulveriser (Photos 12.2 and 12.3). From this, two 100 g samples were prepared — one sent to MECL Chemical Laboratory, Nagpur, for primary chemical analysis (K_2O, SiO_2, Al_2O_3, Fe_2O_3) and the other retained for check analysis. The remaining 300 g was preserved for future studies.

14.1.3 During the present exploration, a total of 197 primary borehole (BH) core samples and 20 external check samples were prepared for chemical analysis. The primary BH core samples were analysed for K_2O, SiO_2, Al_2O_3, and Fe_2O_3 at the Chemical Laboratory of MECL, Nagpur, following standard analytical procedures.

Photo-14.1: Photograph showing core splitter used to split borehole cores

14.1.4 To ensure analytical accuracy and reproducibility, a set of 20 external check samples was sent to the Jawaharlal Nehru Aluminium Research Development and Design Centre (JNARDDC), Nagpur, a NABL-accredited laboratory. The comparative analysis of these check samples provided an independent verification of the primary laboratory results, thereby strengthening the reliability of the dataset.

14.1.5 The detailed analytical results of the primary BH core samples and the external check samples are presented in Annexure-IV and Annexure-VI, respectively.

14.2.0 NATURE, QUALITY AND APPROPRIATENESS OF THE SAMPLE PREPARATION TECHNIQUE

14.2.1 The sampling procedure for primary samples is described in detail in Para 14.1.0. To maintain the quality and integrity of the samples, strict QA/QC protocols were followed during preparation. All equipment used for crushing, sieving, and splitting was thoroughly cleaned before and after processing each sample to prevent contamination. Regular maintenance of the equipment was carried out to ensure consistent performance.

14.2.2 Samples were reduced to the required size fraction using proper crushing and sieving techniques, followed by the coning-and-quartering method to obtain representative splits. These operations were performed by trained and experienced personnel, ensuring that the prepared samples were homogeneous and free from bias. The adherence to proper technique and procedural discipline throughout the preparation process ensured that the samples remained representative of the in-situ material, thereby enhancing the reliability of subsequent analytical results.

14.3.0 QUALITY CONTROL PROCEDURES ADOPTED

14.3.1 The primary core samples were collected from the entire mineralised zones or lengths intersected in the drilled boreholes and subsequently prepared at the centralised mechanised sampling unit. Standardised sampling procedures, in accordance with established protocols, were followed under the direct supervision of qualified sampling technicians to ensure the quality and representativeness of the samples. Similarly, the external check samples were prepared at the same facility, also under the supervision of qualified sampling technicians, adhering strictly to the standard sampling procedures to maintain consistency and reliability in the analytical dataset.

14.4.0 MEASURES TAKEN TO ENSURE THE SAMPLING IS REPRESENTATIVE OF THE IN SITU MATERIAL COLLECTED

14.4.1 All primary samples were marked and prepared from mineralised cores. During sample preparation, the cores were examined in detail, and sampling intervals were accurately marked to ensure proper representation of the mineralised zones. The preparation of primary samples followed the procedure outlined in Para 14.1.0, ensuring uniformity and quality control. The combination of precise core marking and adherence to standard preparation protocols ensured that the collected primary samples were truly representative of the in-situ material.

14.5.0 WHETHER SAMPLE SIZES ARE APPROPRIATE TO THE GRAINSIZE OF THE MATERIAL BEING SAMPLED

14.5.1 For the determination of K_2O, SiO_2, Al_2O_3, and Fe_2O_3 by X-ray fluorescence (XRF) analysis, the core samples were first reduced to a particle size of (–)200 mesh to ensure homogeneity and reproducibility of results. The fine pulverisation to this size facilitates uniform mixing of mineral constituents, minimises analytical errors caused by particle-size variation, and enhances the precision of XRF measurement. The prepared powder was thoroughly homogenised before being used for pellet or fused bead preparation, as per standard analytical protocols, to obtain accurate and representative elemental concentrations.

CHAPTER-15

15.0.0 QUALITY OF ASSAY DATA AND LABORATORY TESTS

15.1.0 THE NATURE, QUALITY AND APPROPRIATENESS OF THE ASSAYING AND LABORATORY PROCEDURES

15.1.1 The Preliminary exploration (G-3 stage) for glauconitic sandstone in the Deulha Block, Satna District, Madhya Pradesh, included comprehensive laboratory analyses covering borehole samples. These samples were analysed for K_2O, SiO_2, Al_2O_3, and Fe_2O_3 using wavelength dispersive X-ray fluorescence (WD-XRF). Detailed descriptions of the analytical methods adopted are provided in the subsequent paragraphs.

15.2.0 ANALYSIS OF GLAUCONITE BEARING SAMPLES BY XRF

15.2.1 **WD XRF (Wavelength Dispersive X-ray Fluorescence)**

Wavelength Dispersive X-ray Fluorescence (WD-XRF) is a non-destructive analytical technique employed for the determination of major oxides in glauconitic samples. In the present study, WD-XRF was used to analyse four key oxides — K_2O, SiO_2, Al_2O_3, and Fe_2O_3 — utilising a RIGAKU make ZSX Primus IV XRF instrument. This method offers high precision and accuracy for elemental quantification while preserving the integrity of the original sample.

Photo 15.1 Photograph showing WD-XRF instrument (Rigaku, Japan) at Chemical Lab, MECL, Nagpur

15.2.2 PROCEDURE OF ANALYSIS BY WD XRF

Powdered samples were pelletised using a hydraulic press prior to analysis. The WD-XRF instrument (RIGAKU ZSX Primus IV) was calibrated using matrix-matched Certified Reference Materials (CRMs) to ensure accuracy and precision. After calibration, samples were analysed for K_2O, SiO_2, Al_2O_3, and Fe_2O_3, with oxide concentrations computed using the ZSX software. Loss on Ignition (LOI) was determined separately by heating the samples at 1000 °C in a muffle furnace and recording the weight loss.

Analytical Procedure:

1. Calibrate the WD-XRF instrument using selected representative samples and CRMs.
2. Verify that the instrument is set up according to standard operating guidelines.
3. Place the prepared pellet securely in the sample holder.
4. Ensure correct positioning of the sample cup within the instrument.
5. Initiate the WD-XRF analysis through the ZSX software.
6. Allow the instrument to scan the sample, during which incident X-rays excite atoms in the sample, causing emission of characteristic fluorescence.
7. Record and tabulate results, including oxide concentrations and relevant analytical parameters.

15.3.0 CHECK ANALYSIS FROM THIRD PARTY NABL ACCREDITED LABORATORY

15.3.1 The third-party sample analyses were conducted at the Jawaharlal Nehru Aluminium Research Development and Design Centre (JNARDDC), Nagpur — a NABL-accredited laboratory. During the present exploration, a total 20 external check samples from borehole (BH) cores, were analysed for K_2O, SiO_2, Al_2O_3, and Fe_2O_3. The analysis for these external check samples is pending as on date 08.10.2025.

15.4.0 SECURITY AND CHAIN OF CONTROL OF SAMPLES SHOULD BE CLEARLY MENTIONED

15.4.1 The security and chain of custody for samples — from the field unit to the sampling unit and subsequently to the chemical laboratory — were maintained through a meticulous and well-organised process. All samples were prepared at the centralised mechanised sampling unit under the supervision of qualified sampling technicians. Each sample was carefully labelled and tagged prior to dispatch, and transported to the chemical laboratory in securely sealed bags. The integrity of the seals was verified at the sampling unit before opening.

15.4.2 Standard operating procedures and robust precautionary measures were strictly followed to prevent any possibility of contamination, ensuring the reliability of analytical results. The sampling unit operates independently from the chemical laboratory, eliminating the risk of cross-contamination. Remaining sample portions were properly preserved, labelled, and stored for future reference, ensuring a secure and traceable chain of custody under the company's control.

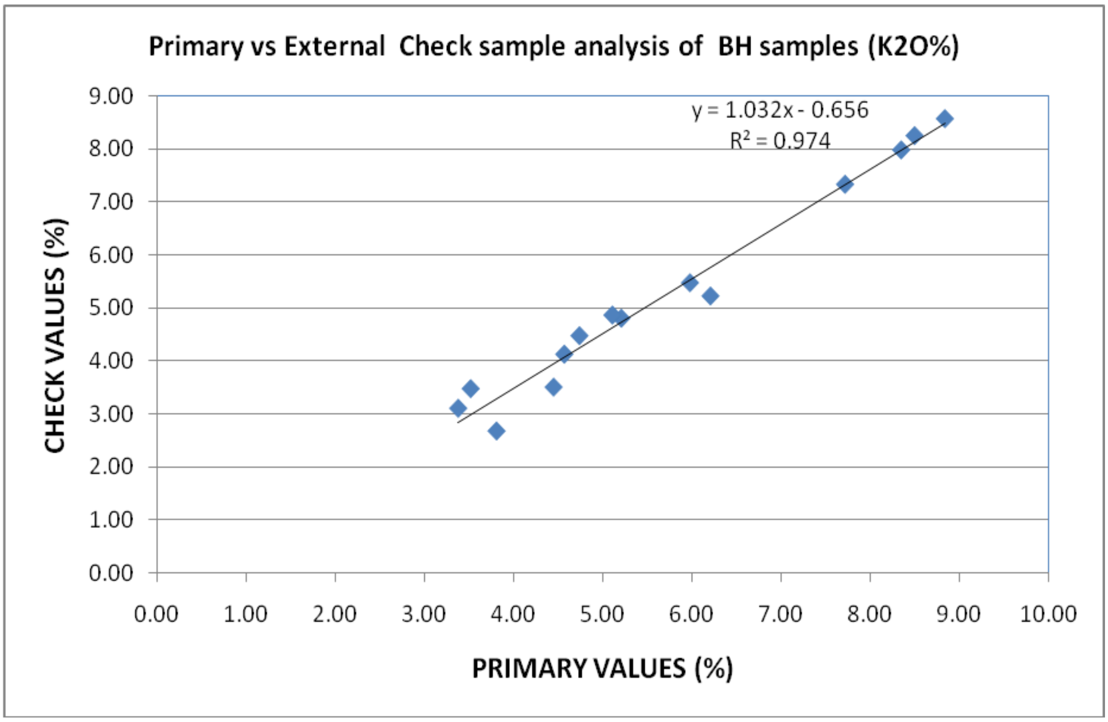
15.5.0 NATURE OF QUALITY CONTROL PROCEDURES ADOPTED

15.5.1 In order to ensure the accuracy of the analyzed samples, NCSDC-16006 has been used as certified reference material. The Certified Reference Material (CRM) was processed under similar conditions as samples and run after every 20 samples.

15.5.2 A total of 20 nos. of external check BH samples analyses has been carried out at chemical laboratory of JNARDDC, Nagpur. Comparison of primary and external check borehole sample results are furnished as Annexure-VI

15.5.3 The scatter plot illustrating the comparison between primary and external check analyses for K_2O% in borehole (BH) samples is presented in Text Figure-15.1. The calculated correlation coefficient of 0.753, being fairly close to 1, indicates a strong positive relationship between the two sets of analytical results. This, in turn, reflects good repeatability, reliability, and consistency of the analytical procedure, as well as the homogeneity of the prepared samples.

15.5.4 Furthermore, the detailed statistical parameters for K_2O values in borehole samples pertaining to primary and external check samples are comprehensively summarised in Table-15.1.



Text Figure 15.1 Scatter Plot of Primary vs Check (External) sample analysis of BH samples

Table-15.1

Statistical comparison of Primary and External Check sample analysis for K_2O **(BH samples)**

Comparision Index	Total Fixed K_2O%	
	Primary	Check
No. of sample pairs	20	
Arithmetic mean	5.645	5.143
Standard Deviation	1.817	2.081
Standard error of mean	0.406	0.465
Variance	3.302	4.331
Mean of deviation	0.502	
Standard Deviation (Error)	1.227	
Correlation Co-efficient	0.753	
Mean absolute error	0.821	
Mean relative random error	14.877	
Paired T-value	1.830	
F- test value	1.312	

CHAPTER-16

16.0.0 MOISTURE

16.1.0 All the analysis has been carried out with natural moisture. However, Moisture analysis has not been done at this stage. Hence, no information can be provided.

CHAPTER-17

17.0.0 BULK DENSITY

17.1.0 BULK DENSITY ANALYSIS DETAILS

17.1.1 Bulk density (BD) is a critical parameter, along with volume, for accurately estimating the tonnage of mineral resources and reserves. It depends on both the density of individual particles and their spatial arrangement within the ore body. Bulk density is defined as the ratio of the mass of a material to its volume, including the contribution of inter-particulate void spaces. It is commonly expressed in grams per cubic centimeter (g/cm^3) or tonnes per cubic meter (T/m^3).

17.2.0 BULK DENSITY DETERMINATION PROCEDURE

17.2.1 A total of four core samples were selected and subjected to bulk density determination to assess the physical characteristics of the glauconitic sandstone. The objective of this study was to obtain accurate bulk density values, which are essential for resource estimation The detailed procedure adopted for bulk density measurement is described below:

17.2.2 **Applicability**: This method shall be applicable in hard litho units, where regular solid cylindrical drill cores are obtained during the course of drilling. The drill core samples to be used for the study should be of NQ or larger diameter.

17.2.3 **Sample Preparation:** Take a full cylindrical drill core sample of minimum ten (10) centimeters - length with both ends trimmed smoothly at right angle to the core axis using a mechanical core cutter to form a regular cylinder.

17.2.4 **Measurement:** Measure the length of the sample, at-least at four locations along its axis by suitably rotating the sample. Measure the diameter of the sample using a calliper scale, at least at four locations, preferably at regular interval. Weigh the air-dried sample in a platform balance.

17.2.5 **Calculation:** Take mean average of all the readings for length and diameter. Divide the average mean value of diameter by two to arrive at the radius ofthe sample. The volume of a core sample is obtained by using formulae: $V = \pi r^2 h$ (where V = volume, r = radius and h = height or length of the cylindrical core). The bulk densityofthesample is determined byusingthe formula: B.D =M/V where B. D= bulk density, M= mass (weight) of the sample and V= volume of the sample.

17.2.6 **Number of Samples studied:** A total of five observations is carried out for each sample. The average of these observations results for each sample may be taken as the final bulk density for the purpose of estimation of resources. Bulk density determination results are mentioned below:

Table 17.1

Bulk density study results of glauconitic mineralisation for Deulha (G-3 stage) block, Satna, Madhya Pradesh

Sl. No.	Sample no.	Borehole no.	From (m)	To (m)	Bulk Density (gm/cm^3)
1	MDLH/BD01	MDLH-01	30.90	31.00	2.67
2	MDLH/BD02	MDLH-04	23.88	24.00	2.67
3	MDLH/BD03	MDLH-07	36.00	36.10	2.62
4	MDLH/BD04	MDLH-08	13.89	14.00	2.71
Average Bulk Density					2.67

CHAPTER-18

18.0.0 BENEFICIATION STUDIES

18.1.0 The present exploration is of Preliminary exploration (G-3 stage) category. Beneficiation study has not been carried out at this reconnaissance stage.

CHAPTER-19

19.0.0 RESOURCE ESTIMATION TECHNIQUE

19.1.0 GENERAL

19.1.1 MECL carried out a Preliminary Exploration (G-3 stage) in the Deulha block for glauconitic sandstone. The exploration programme comprised detailed geological mapping on a 1:4,000 scale, Topographical survey with contouring at 2m interval and drilling through 08 vertical boreholes at 800m x 800m spacing. Through this integrated approach, MECL thoroughly evaluated the exploration block, delineated zones of glauconite mineralisation, and subsequently estimated the Inferred Resources under UNFC Category 333.

19.1.2 In these boreholes the glauconite zone (demarcated at >5% K_2O cutoff) is intersected in Jhiri shale at depth ranging from 4.00 m depth in MDLH-04 to 7.00 m depth in MDLH-05 and thickness varies between 1.00 m (MDLH-03, K_2O -5.57%) to 5.00 m (MDLH-05, K_2O -6.11%). However, in Banbiha sandstone the glauconite zone (demarcated at >5% K_2O cutoff) is intersected at depth ranging from 12.00 m depth in MDLH-08 to 36.00 m depth in MDLH-06 and thickness varies between 20.50 m (MDLH-04, K_2O -6.16%) to 24.00 m (MDLH-01, K_2O -7.13%).

19.1.3 Apart from that, 3 boreholes (MPSW-01, MPSW-08 & MPSW-10) of Pindra SW Extension G-4 exploration work is also falling inside the Deulha G-3 block, outcome of these three boreholes was also taken into consideration while estimating the resource of Deulha G-3 Block. Details of these 03 boreholes and Chemical Analysis of samples is given as Annexure No. II-B and V-A respectively.

19.1.4 All these 11 boreholes are plotted on 6 Section lines (S1–S1′ to S6–S6′) which are aligned at N30°W-S30°E.

19.1.5 Geological cross-sections were prepared based on the interpretation of sub-surface borehole data, incorporating both the grade of mineralisation and integrated surface–subsurface geological information. Applying a cut-off grade of 5% K_2O, mineralised zones ranging in thickness from 1.00 m to 33.00 m were delineated and plotted on the geological cross-sections (Plate VIA & VIB).

19.1.6 Zone data of the mineralized zone from Deulha block and Pindra South West block taken into consideration for the resource estimation of Deulha G-3 block has been given below:

Table 19.1.
Table showing mineralisation zone and average grade for K_2O, SiO_2, Al_2O_3 and Fe_2O_3 encountered in boreholes taken into consideration for the resource estimation of Deulha G-3 block, Satna, Madhya Pradesh

Sl. No.	BH. No.	Section line	From (m)	To (m)	Thickness (m)	K_2O%	SiO_2%	Al_2O_3%	Fe_2O_3%
1	MDLH-01	S5–S5′	22.00	46.00	24.00	7.13	49.27	14.20	14.20
2	MDLH-02	S2–S2′	16.60	38.00	21.40	6.81	50.66	13.84	13.81
3	MDLH-03	S3–S3′	5.00	7.00	2.00	5.37	54.17	14.44	8.48
4	MDLH-03	S1–S1′	9.00	10.00	1.00	5.57	52.95	15.10	6.66
5	MDLH-03	S1–S1′	32.35	53.60	21.25	6.34	50.72	13.99	14.52
6	MDLH-04	S4–S4′	4.00	8.00	4.00	5.98	53.71	16.63	7.83
7	MDLH-04	S4–S4′	21.00	41.50	20.50	6.16	49.42	13.81	15.16
8	MDLH-05	S4–S4′	7.00	12.00	5.00	6.11	54.30	16.37	9.12
9	MDLH-05	S4–S4′	30.00	53.50	23.50	7.62	49.49	14.50	12.26
10	MDLH-06	S6–S6′	36.00	57.50	21.50	6.22	49.74	13.78	14.98
11	MDLH-07	S1–S1′	16.00	39.00	23.00	6.50	50.58	14.07	13.80
12	MDLH-08	S2–S2′	12.00	35.00	23.00	6.71	51.11	13.84	13.86

Table 19.2.
Table showing mineralisation zone and average grade for K_2O, SiO_2, Al_2O_3 and Fe_2O_3 encountered in boreholes of Pindra South West block, taken into consideration for the resource estimation of Deulha G-3 block, Satna, Madhya Pradesh

Sl. No.	BH. No.	Section line	From (m)	To (m)	Thickness (m)	K_2O%	SiO_2%	Al_2O_3%	Fe_2O_3%
1	MPSW-01	S5–S5′	13.00	46.00	33.00	6.99	15.38	48.15	13.00
2	MPSW-08	S3–S3′	15.50	35.50	20.00	6.89	14.89	47.71	16.22
3	MPSW-10	S1–S1′	8.30	34.00	25.70	7.38	14.76	49.09	13.22

19.2.0 PARAMETERD AND ASSUMPTIONS FOR RESOURCE ESTIMATION

19.2.1 The resource is estimated using both the Cross-sectional as principal method and the Polygonal as check method. While applying these techniques, certain axiomatic assumptions were inherently considered to determine the overall grade and resource potential of the deposit. These assumptions, which form the basis of the estimation process, are outlined below:

19.2.2 A total of 197 nos. of primary core samples in Deulha (G-3 stage) block were analyzed by in-house chemical lab of MECL, Nagpur. For reliability of the primary analysis, 10% of primary samples, i.e. 20 nos. of samples have been analyzed in the NABL approved external chemical lab of JNARDDC, Nagpur.

19.2.3 The zones of K_2O have been demarcated from the values of primary sample analysis, Cut-off grade of 5% K_2O for estimating the resources has been taken into the consideration as per IBM. The minimum thickness of 1.00m of K_2O zone has been considered for resource calculation in both methods.

19.2.4 All the boreholes were placed at 800m strike interval, Hence, strike influence for all the sections has been considered up to the midpoint (half of the distance) of the next section on correlation and along the down dip and up dip, 400m has been considered from the mineralization intersection.

19.2.5 A total of four borehole core samples from the K_2O rich horizon were analysed to determine bulk density. The measured values are considered representative of the K_2O rich mineralization in the area, thereby enhancing the accuracy of resource estimation and providing a reliable basis for tonnage calculations. The average bulk density has been computed as 2.67 g/cm^3.

19.2.6 A deduction of 20% from Gross in-situ resources has been made to arrive at Net-in-situ resources by geological cross-section and, polygon method for unseen geological factors i.e. nature of cavities/caverns and other structural features.

19.3.0 METHODOLOGY ADOPTED FOR CROSS SECTIONAL METHOD FOR RESOURCE ESTIMATION

19.3.1 Following methodology has been adopted while computation of glauconite resource by Geological Cross-Section Method.

19.3.2 A total of 06 Nos. Geological Cross Sections serially numbered as S1-S1′ to S6-S6′ and were drawn perpendicular to general strike of the mineralised zones spaced at 800m interval.

19.3.3 Geological Map along with topographical survey data and boreholes header data has been considered for preparation of profiles, the vertical boreholes has been plotted along the profile with the help of GDM software.

19.3.4 The cross-sections have been prepared and correlated on the profile by marking the surface and subsurface geological data i.e., litho-units intersected in the borehole and its attitude i.e., foliation angle etc., mineralization zone along with nomenclature, thickness and qualitative data and the borehole data (lithology, nomenclature, thickness and analytical data of gluconite).

19.3.5 The Glauconite zone has been projected to 400m from intersection towards down dip or up dip direction as the case may be where the adjacent borehole has no mineralization. For the borehole with continuous mineralization in adjacent boreholes, half way influence has been considered. Accordingly, the sectional area has been calculated.

19.3.6 In general, boreholes spaced at approximately 800 m strike interval. Hence, strike influence for all the sections has been considered up to the midpoint (half of the distance) of the next section.

19.3.7 The measurements have been made with the help of computer aided Auto- CAD Map 2025 software.

19.3.8 The sectional area obtained has been multiplied by cross sectional influence (strike influence) to obtain the sectional volume.

19.3.9 The sectional volume has been multiplied by the average bulk density (2.67) to arrive at the resource tonnage.

19.3.10 The sum of Section-wise cross-sectional resource is the total geological gross/net in-situ resource.

19.4.0 METHODOLOGY ADOPTED FOR POLYGONAL METHOD FOR RESOURCE ESTIMATION

19.4.1 The resource estimation for K_2O-rich mineralisation in the Deulha (G-3 stage) block was carried out using the Polygonal Method to validate the resource by cross sectional method.

19.4.2 In this approach, the mineralised bodies delineated through exploration are treated as distinct zones within which the resource calculations are performed. The method ensures that the estimated resources are systematically allocated on the basis of spatial distribution and geological continuity.

19.4.3 The polygonal resource map, as depicted in Plate-VII, provides a visual representation of these borehole influences in each polygon.

19.4.4 The entire glauconite body intersected in 11 boreholes (08 boreholes of Deulha block and 03 boreholes of Pindra South West block) has been subdivided into eleven polygons (P1 to P11) of varying thickness. (Plate-VII). The influence area has been determined by constructing polygons through perpendicular bisectors of triangles and rectangles formed by adjoining boreholes. Area of each polygon has been calculated using Auto CAD 2025.

19.4.5 The thickness of each polygon represented by the cumulative thickness of glauconite horizons/bands encountered in the corresponding borehole. Area of the polygons were multiplied by the thicknessof the zones encountered in each borehole.

Table- 19.3
Boreholes and corresponding Polygonal area and corresponding zone thickness in Deulha G -3 block

Polygon No.	BH No.	Polygon Area (m^2)	Thickness (m)
P1	MDLH-01	865475.3663	33.00
P2	MDLH-02	409514.4294	28.61
P3	MDLH-03	528047.0945	2.00
P3	MDLH-03	528047.0945	1.00
P3	MDLH-03	528047.0945	21.25
P4	MDLH-04	745234.3427	4.00
P4	MDLH-04	745234.3427	20.50
P5	MDLH-05	969722.2475	5.00
P5	MDLH-05	969722.2475	23.50
P6	MDLH-06	642796.0451	21.50
P7	MDLH-07	900319.4249	23.00
P8	MDLH-08	844917.6022	23.00

Table- 19.4
Boreholes and corresponding Polygonal area and corresponding zone thickness in Deulha G -3 block drilled during the exploration program of Pindra South West block

Polygon No.	BH No.	Polygon Area (m^2)	Thickness (m)
P9	MPSW-01	707033.1695	28.61
P10	MPSW-08	962204.6072	20.00
P11	MPSW-10	983895.2382	25.70

19.4.6 The calculated volume for each borehole was multiplied by the respective bulk density values to arrive at the resource tonnage. The sum of resources from all boreholes provided the total in-situ geological resource for the Deulha G-3 block. The formula of resource estimation is as follows:

$$R = P_A \times Th \times \text{Average bulk density}$$

Where, P_A = Area of Polygon

R= Resource/ Tonnage

Th= Thickness of Glauconite zone

19.5.0 DATA VERIFICATION AND/OR VALIDATION PROCEDURES USED

19.1.1 The resource has been estimated by two methods i.e., Geological Cross Section (principle) and Polygonal Method (check) method. The resource estimated by both the method has been compared and found there is 2.82% of difference in estimation of resources which is under acceptable limits. The details are discussed in Para 20.3.0.

CHAPTER-20

20.0.0 REPORTING OF RESOURCES

20.1.0 RESOURCE AND GRADE

20.1.1 Considering the bedded nature of deposite, the resource estimation has been conducted using two methods: the Cross-Sectional Method as the principal method and the Polygonal Method as a check method. All the primary samples generated during current exploration analysed for K_2O, SiO_2, Al_2O_3 and Fe_2O_3.

20.1.2 The Resources have been estimated Section wise and borehole wise in Cross-section method and Plygonal method for glauconite >5% K_2O cutoff.

20.1.3 As per the standard practice, the gross geological resource has been reduced to 80% which is an empirical figure to arrive for Net In-situ geological resource owing to nature of the body, recovery loss during the drilling operation and any unforeseen conditions.

20.1.4 A total of **317.04 million tonnes** of Net in-situ Inferred Resources (333 category) with average grade of **6.80% K_2O** and **119.18 million tonnes** of Net in-situ Reconnaissance Resources (334 category) with average grade of **7.03% K_2O** have been estimated by cross sectional method (Annexure-IX)**.** The cumulative **Net in-situ Resources (333+334)** by cross-section method is **436.22 millon tonnes** with average grade of **6.86% K_2O.**

20.1.5 The summarized, borehole wise, section wise Cross sectional Inferred Resources (333 category) and Reconnaissance Resources at >5% K_2O cut-off in Deulha block (8.5 sq. km.) are given in table 20.1 and 20.2.

20.1.6 Total of **448.68 million tonnes** of Net in-situ Reconnaissance Resources (334 category) with average grade of **6.78% K_2O** has been estimated by polygonal method**.** (Annexure-X)**.**

20.1.7 The summarized, borehole wise and polygonal area wise Poygonal Reconnaissance resources at >5% K_2O cut-off in Deulha block (8.5 sq. km.) are given in table 20.3.

MECL

Table 20.1

Statement showing section wise, borehole wise Inferred Resource (333) of Glauconitic Sandstone, Estimated by Cross Sectional method, Deulha Block, District-Satna, Madhya Pradesh (Area 8.5 Sq. Km)

BH No.	Section Line	From (m)	To (m)	Thick ness (m)	Sectional Area (m^2)	Section Influence (m)	Volume (m^3)	Specific Gravity	Gross Geological Resources (tonnes)	Net in-situ Resources (tonnes)	Average Quality			
											K_2O%	SiO_2%	Al_2O_3%	Fe_2O_3%
MDLH-07	S1-S1'	16.00	39.00	23.00	13707.24	799.84	10963663.25	2.67	29272980.88	23418384.70	6.50	50.58	14.07	13.80
MPSW-10		8.30	34.00	25.70	19734.20	794.26	15674019.60	2.67	41849632.32	33479705.86	7.38	49.09	14.76	13.22
MDLH-02	S2-S2'	16.60	38.00	21.40	11226.79	800.18	8983440.99	2.67	23985787.44	19188629.95	6.81	50.66	13.84	13.81
MDLH-08		12.00	35.00	23.00	18236.62	800.00	14589296.00	2.67	38953420.32	31162736.26	6.71	51.11	13.84	13.86
MDLH-03	S3-S3'	5.00	7.00	2.00	964.64	800.55	772246.11	2.67	2061897.13	1649517.70	5.37	54.17	14.44	8.48
MDLH-03		9.00	10.00	1.00	421.40	800.55	337353.33	2.67	900733.38	720586.70	5.57	52.95	15.10	6.66
MDLH-03		32.35	53.60	21.25	13284.19	800.55	10634707.36	2.67	28394668.66	22715734.93	6.34	50.72	13.99	14.52
MPSW-08		15.50	35.50	20.00	15756.83	799.99	12605241.32	2.67	33655994.32	26924795.46	6.89	47.71	14.89	16.22
MDLH-04	S4-S4'	4.00	8.00	4.00	3159.75	800.03	2527906.34	2.67	6749509.94	5399607.95	5.98	53.71	16.63	7.83
MDLH-04		21.00	41.50	20.50	15745.39	800.03	12596841.92	2.67	33633567.94	26906854.35	6.16	49.42	13.81	15.16
MDLH-05		7.00	12.00	5.00	3799.99	800.83	3043162.29	2.67	8125243.32	6500194.65	6.11	54.30	16.37	9.12
MDLH-05		30.00	53.50	23.50	18799.35	800.83	15055164.10	2.67	40197288.14	32157830.51	7.62	49.49	14.50	12.26
MDLH-01	S5-S5'	22.00	46.00	24.00	15304.66	794.84	12164765.13	2.67	32479922.89	25983938.31	7.13	49.27	14.20	14.20
MPSW-01		13.00	46.00	33.00	21668.68	799.99	17334674.58	2.67	46283581.12	37026864.90	6.99	15.38	48.15	13.00
MDLH-06	S6-S6'	36.00	57.50	21.50	16460.40	676.96	11143040.48	2.67	29751918.08	23801534.47	6.22	49.74	13.78	14.98
Resources in tonnes									**396296145.87**	**317036916.70**	**6.80**	**45.91**	**18.26**	**13.75**
Resources in Million Tonnes									**396.30**	**317.04**				

Table 20.2

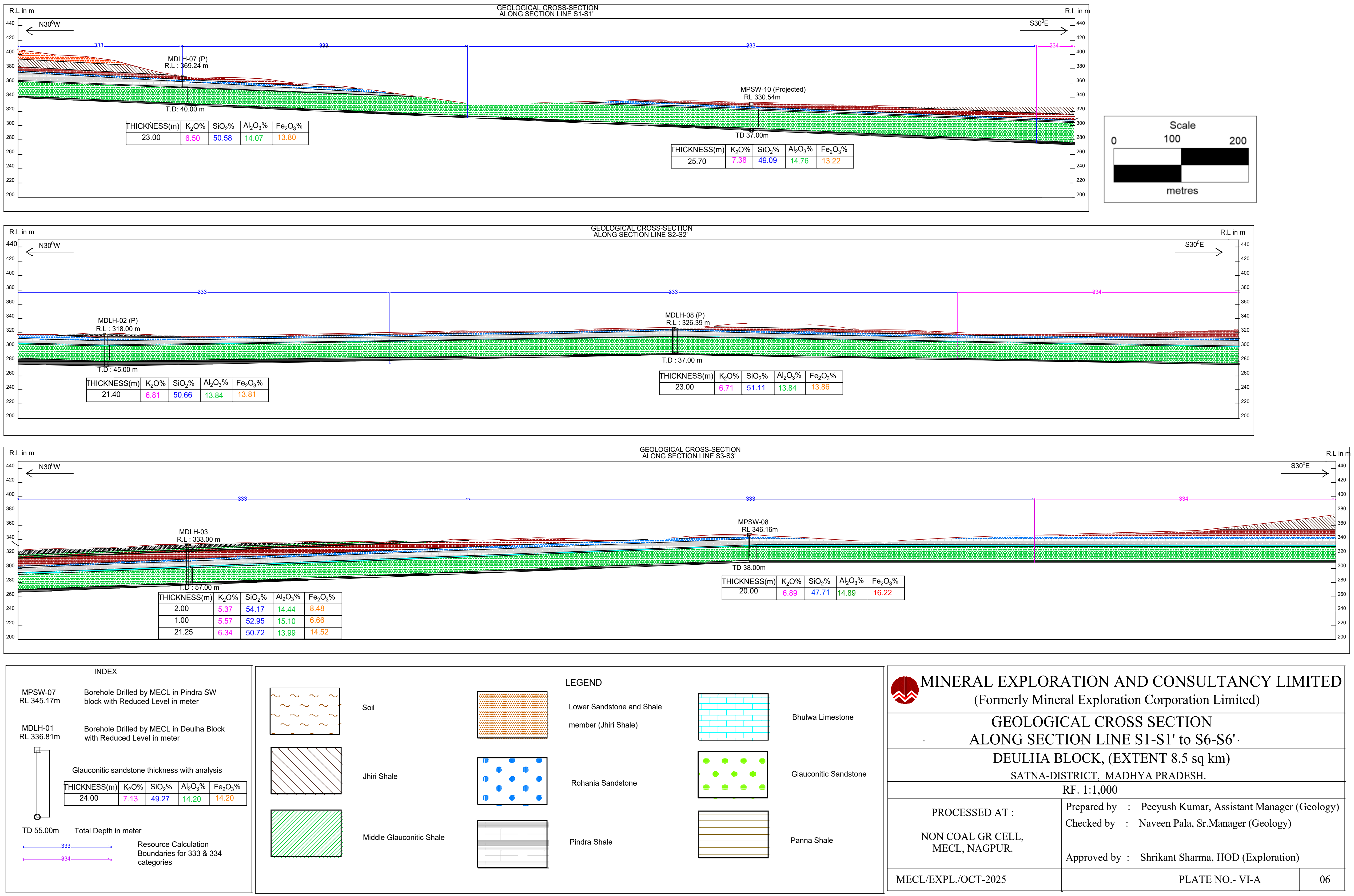
Statement showing section wise, borehole wise Reconnaissance Resource (334) of Glauconitic Sandstone, Estimated by Cross Sectional method, Deulha Block, District-Satna, Madhya Pradesh (Area 8.5 Sq. Km)

BH No.	Section Line	From (m)	To (m)	Thickness (m)	Sectional Area (m^2)	Section Influence (m)	Volume (m^3)	Specific Gravity	Gross Geological Resources (tonnes)	Net in-situ Resources (tonnes)	Average Quality			
											K_2O%	SiO_2%	Al_2O_3%	Fe_2O_3%
MDLH-07	S1-S1'	16.00	39.00	23.00	13707.24	416.15	5704288.59	2.67	15230450.52	12184360.42	6.50	50.58	14.07	13.80
MPSW-10	S1-S1'	8.30	34.00	25.70	19734.20	321.51	6344809.40	2.67	16940641.10	13552512.88	7.38	49.09	14.76	13.22
MPSW-10	S1-S1'	8.30	34.00	25.70	1446.84	895.67	1295896.22	2.67	3460042.91	2768034.32	7.38	49.09	14.76	13.22
MDLH-08	S2-S2'	12.00	35.00	23.00	9005.71	800.00	7204528.49	2.67	19236091.07	15388872.85	6.71	51.11	13.84	13.86
MPSW-08	S3-S3'	15.50	35.50	20.00	8258.28	799.03	6598612.02	2.67	17618294.09	14094635.28	6.89	47.71	14.89	16.22
MDLH-04	S4-S4'	4.00	8.00	4.00	16.72	713.68	11932.71	2.67	31860.34	25488.27	5.98	53.71	16.63	7.83
MDLH-04		21.00	41.50	20.50	81.76	713.68	58350.38	2.67	155795.53	124636.42	6.16	49.42	13.81	15.16
MDLH-05		7.00	12.00	5.00	16.73	785.58	13142.81	2.67	35091.29	28073.03	6.11	54.30	16.37	9.12
MDLH-05		30.00	53.50	23.50	81.81	785.58	64266.35	2.67	171591.16	137272.93	7.62	49.49	14.50	12.26
MDLH-05		7.00	12.00	5.00	1691.02	799.88	1352606.59	2.67	3611459.59	2889167.67	6.11	54.30	16.37	9.12
MDLH-05		30.00	53.50	23.50	10216.72	799.88	8172110.79	2.67	21819535.80	17455628.64	7.62	49.49	14.50	12.26
MDLH-01	S5-S5'	22.00	46.00	24.00	7487.10	574.19	4299023.42	2.67	11478392.53	9182714.02	7.13	49.27	14.20	14.20
MDLH-01		22.00	46.00	24.00	12753.14	156.26	1992838.18	2.67	5320877.93	4256702.35	7.13	49.27	14.20	14.20
MPSW-01		13.00	46.00	33.00	13744.96	801.19	11012321.84	2.67	29402899.31	23522319.45	6.99	15.38	48.15	13.00
MPSW-01		13.00	46.00	33.00	4157.61	360.09	1497106.24	2.67	3997273.67	3197818.93	6.99	15.38	48.15	13.00
MDLH-06	S6-S6'	36.00	57.50	21.50	404.20	427.20	172674.52	2.67	461040.96	368832.77	6.22	49.74	13.78	14.98
Resources in tonnes									**148971337.81**	**119177070.24**	**7.03**	**41.99**	**22.00**	**13.54**
Resources in Million Tonnes									**148.97**	**119.18**				

Table 20.3

Statement showing Polygon wise, borehole wise resources (333+334) of Glauconitic Sandstone by Polygonal Method, Deulha Block, District-Satna, Madhya Pradesh (Area 8.5 sq.km)

Polygon No.	BH No.	Polygon Area (m^2)	Thickness (m)	Volume (m^3)	Gross Geological Resources (tonnes)	Net In-situ Resources (tonnes)	Specific Gravity: 2.67			
							Average Quality			
							K_2O%	SiO_2%	Al_2O_3%	Fe_2O_3%
P1	MDLH-01	865475.3663	24.00	20771408.79	55459661.47	44367729.18	7.13	49.27	14.20	14.20
P2	MDLH-02	409514.4294	21.40	8763608.79	23398835.47	18719068.37	6.81	50.66	13.84	13.81
P3	MDLH-03	528047.0945	2.00	1056094.19	2819771.48	2255817.19	5.37	54.17	14.44	8.48
P3	MDLH-03	528047.0945	1.00	528047.09	1409885.74	1127908.59	5.57	52.95	15.10	6.66
P3	MDLH-03	528047.0945	21.25	11221000.76	29960072.02	23968057.62	6.34	50.72	13.99	14.52
P4	MDLH-04	745234.3427	4.00	2980937.37	7959102.78	6367282.22	5.98	53.71	16.63	7.83
P4	MDLH-04	745234.3427	20.50	15277304.03	40790401.75	32632321.40	6.16	49.42	13.81	15.16
P5	MDLH-05	969722.2475	5.00	4848611.24	12945792.00	10356633.60	6.11	54.30	16.37	9.12
P5	MDLH-05	969722.2475	23.50	22788472.82	60845222.42	48676177.94	7.62	49.49	14.50	12.26
P6	MDLH-06	642796.0451	21.50	13820114.97	36899706.97	29519765.58	6.22	49.74	13.78	14.98
P7	MDLH-07	900319.4249	23.00	20707346.77	55288615.88	44230892.71	6.50	50.58	14.07	13.80
P8	MDLH-08	844917.6022	23.00	19433104.85	51886389.95	41509111.96	6.71	51.11	13.84	13.86
P9	MPSW-01	707033.1695	33.00	23332094.59	62296692.56	49837354.05	6.99	15.38	48.15	13.00
P10	MPSW-08	962204.6072	20.00	19244092.14	51381726.02	41105380.82	6.89	47.71	14.89	16.22
P11	MPSW-10	983895.2382	25.70	25286107.62	67513907.35	54011125.88	7.38	49.09	14.76	13.22
Total Resources of Glauconitic Sandstone in tonnes					**560855783.88**	**448684627.11**	**6.78**	**45.75**	**18.43**	**13.74**
Total Resources for Glauconitic Sandstone in million tonnes					**560.86**	**448.68**				



Text Figure.20.1: Geological Cross section along section lines S1-S1', S2-S2' and S3-S3'of Deulha Block , Dist: Satna, Madhya Pradesh.

20.2.0 COMPUTATION OF AVERAGE GRADE

20.2.1 All calculations for grade estimation for glauconite are made by weighted average method. Since the sample interval was uniformly maintained along with different litho-units, the length of the sample was mostly maintained at 1.00m interval with the exception of litho-unit variations, and any structural implications. The, weighted average has been calculated by following formula:

$$\text{Weighted average grade} = \frac{V1 \times G1+V2 \times G2+V3 \times G3+\ldots\ldots\ldots\ldots+ Vn \times Gn}{V1+V2+V3+\ldots\ldots\ldots\ldots+Vn}$$

Here `V' = Volume of glauconitic body in individual borehole

`G'= Grade of the respective glauconitic body in the corresponding borehole

20.3.0 COMPARISON OF ORE RESOURCE BY GEOLOGICAL CROSS SECTION AND POLYGONAL METHOD

20.3.1 The total phosphorite resources estimated by Coss section and Polygonal method at >5% K_2O cutoff respectively have been compared for reliability of estimated resources. The comparison of resources is given below table.

Table no 20.4

Comparison of Cross Sectional and Polygonal resources, Deulha block, Tehsil-Majhgawan, District -Satna, Madhya Pradesh

Method of Resource Estimation	Gross Resource (million tonnes)	Net in situ Resource (million tonnes)	K_2O %	SiO_2 %	Al_2O_3 %	Fe_2O_3 %
Geological Cross Section	545.27	436.22	6.86	43.92	20.05	13.63
Polygonal Method	560.86	448.68	6.78	45.75	18.43	13.74
Difference	15.59	12.46	0.08	1.83	1.62	0.11
Difference (%)	**2.82**	**2.82**	**1.17**	**4.08**	**8.42**	**0.80**

20.3.2 The resource estimates obtained through the Cross-Sectional Method and Polygonal Method were compared to assess the confidence level of the estimation. The polygonal Method, used as the check approach, yielded a resource estimate 2.82% higher for K_2O as compare to the Cross-Sectional Method which is principal method. This variance falls within the permissible limits, confirming the reliability and accuracy of the resource estimation.

20.4.0 CATEGORY OF RESOURCES

20.4.1 The present exploration for glauconite in Deulha block is carried out at G-3 level of Exploration where the boreholes are placed at 800m strike interval. The glauconite zone is occurring as bedded homogenous deposit. Considering the nature and style of mineralization, borehole density and geological cross section interval which fulfil the criteria of G-3 stage exploration as per UNFC system and specifications given in Part: III-I of Minerals (evidence of Mineral content) Rule-2015, mineral resource in the **Deulha block** is categorised as **inferred category (333)**.

CHAPTER-21

SUMMARY AND RECOMMENDATIONS

21.1.0 SUMMARY

21.1.1. The Deulha exploration block (G-3 stage) for glauconitic sandstone covers an area of 8.5 sq. km, encompassing parts of the villages Umariha, Deulha and Majhgawan, Kanpur and surrounding areas in Majhgawan tehsils of Satna district. The exploration block falls in the Survey of India toposheet no. 63/D13. The block can be approached by State highway no. 11 and is about 44 km from Satna on Satna– Chitrakoot road. Majhgawan is well connected by State Highway 11 and NH-135BG, linking it to Satna, Maihar, Umaria, and the UP border.

21.1.2 The Deulha G-3 block forms a part of the Majhgawan–Paharikhera Potash Belt located in the northern part of Satna District, Madhya Pradesh. Geologically, the area is underlain by the Rewa Group of the Vindhyan Supergroup, which is extensively developed in this region of the Vindhyan Basin. The lithostratigraphic nomenclature adopted for the block has been correlated with the established regional succession in adjoining areas such as Majhgawan, Paharikhera, and Sohawal, ensuring consistency with the regional geological framework.

21.1.3 Within the Deulha block, the oldest exposed lithounit is the Rohania Sandstone, representing the uppermost member of the Itawa Sandstone Formation, which conformably overlies the Pindra Shale Member. Subsurface data indicate that the Panna Shale constitutes the oldest formation encountered in drilling, resting over the Baghain Sandstone of the Kaimur Group. The youngest exposed lithounits belong to the Gahadara Sandstone Formation, composed of quartz arenite that overlies the Jhiri Shale Formation. The overall lithological sequence thus records a transition from argillaceous to arenaceous facies within a stable sedimentary environment.

21.1.4 The stratigraphic succession of the block displays a near-complete section from the Kaimur to Rewa Groups, reflecting the gradual evolution of depositional conditions from marine to nearshore settings. The topography is subdued, with gentle slopes of 2°–5° towards the southeast, and the structural attitude of the beds is almost horizontal with minor warping and jointing typical of Vindhyan sedimentary terrain. The absence of significant tectonic disturbances and metamorphism indicates that the region has remained part of a stable cratonic platform since deposition. This combination of lithological suitability, stratigraphic continuity, and structural stability provides a highly favorable setting for glauconite and associated potash mineralization.

21.1.5 The glauconitic sandstoe mineralization in the block primarily occurs within the Itawa Sandstone (Lower Rewa Sandstone) Formation and locally within the Jhiri Shale Formation. The Middle Glauconitic Sandstone Member of Jhiri Shale comprises green, micaceous shale, sandy shale, and siltstone horizons forming basal exposures along ENE–WSW trending escarpments, while the Banbiha Sandstone Member of the Itawa Formation represents the main glauconitic horizon. These glauconitic sandstones exhibit features such as flaser and cross-bedding, ripple marks, and chert interbeds, indicating deposition under low to moderate energy, shallow marine conditions with reducing and mildly alkaline chemistry (pH ~7.5; Eh 0.1–0.3). The presence of pyrite, quartz, feldspar, muscovite, and chlorite suggests derivation from an acid igneous provenance and an environment favorable for authigenic glauconite formation and potash enrichment within the Vindhyan Basin.

21.1.6 The Deulha G-3 block, encompassing an area of about 8.5 sq. km, forms part of the Pindra South West G-4 Block. The area was earlier covered under a 1:12,500 scale geological map; however, due to observed lithological variations during the present investigation, the geological mapping was refined and updated on a larger scale of 1:4,000. This high-resolution mapping incorporated all visible changes in lithology, structure, and mineralization patterns, enabling more accurate delineation of stratigraphic contacts and glauconitic sandstone horizons significant for mineral resource evaluation.

21.1.7 Exploratory operations in the block commenced on 1st September 2024 and concluded on 31st December 2024. Geological mapping at 1:4,000 scale was carried out to identify major lithological and structural features, along with zones of glauconitic mineralization. The key formations mapped include Gahadara Sandstone, Jhiri Shale, Rohania Sandstone, and the Middle Glauconitic Sandstone Band, as well as the lower sandstone–shale members of the Jhiri Formation. Structural observations, made using Brunton compass readings, reveal a general strike of NE–SW to ENE–WSW with gentle dips (5°–10°) towards the southeast, suggesting a relatively undisturbed sedimentary regime.

21.1.8 Topographically, the block is characterized by a generally flat to gently undulating terrain, interspersed with minor escarpments exposing glauconitic horizons. The principal lithological assemblages comprise red and green shale, siltstone, quartz arenite, and glauconitic sandstone belonging to the Jhiri and Gahadara formations. The creamish-white, fine- to medium-grained Rohania Sandstone also occurs in small patches, while the glauconitic sandstone is prominently developed along the ENE–WSW escarpment in the central sector. Considering that sufficient sampling had already been undertaken during earlier phases of exploration, no additional surface or bedrock samples were collected in the current program.

21.1.9 Under the G-3 stage (preliminary) exploration, eight boreholes (MDLH-01 to MDLH-08) were drilled between 24th May and 28th June 2025 with a total 393.00 meters of drilling. Boreholes were placed on a systematic 800 m × 800 m grid pattern along 06 NW–SE trending section lines to establish the lateral and vertical continuity of glauconitic sandstone horizons. DGPS (WGS-84) was used for precise location and elevation control, and data were plotted on the updated geological map. Additionally, three boreholes (MPSW-01, MPSW-08, and MPSW-10) drilled earlier in the adjoining Pindra South West Block were integrated for correlation and resource evaluation. The adopted borehole spacing meets the requirements of the Minerals (Evidence of Mineral Content) Rules, 2015, ensuring adequate data density for G-3 level exploration and classification of the identified glauconitic sandstone as Inferred Mineral Resource (333) under the UNFC system—forming a robust foundation for future G-2 level detailed exploration/Auctioning and further resource upgradation.

21.1.10 Apart from glauconite, other potassium-bearing phases such as feldspar (orthoclase/microcline), illite/mica, and diagenetically altered detrital minerals may also contribute to the overall K_2O content. XRD studies and EPMA was not included in the NQT of the exploration programme. So, no such distict comment may be made on that. Nevertheless, the higher K_2O values observed in the borehole samples do not negate the occurrence of glauconite in the area.

21.1.11 Petrographic studies suggest glauconite is more common in fine-grained sandstones and shales, as their low-energy depositional conditions favor its growth and preservation, leading to higher concentrations in finer facies than in coarser sandstones.

21.1.12 A total of 317.04 million tonnes of Net in-situ Inferred Resources (333 category) with an average grade of 6.80% K_2O, and 119.18 million tonnes of Net in-situ Reconnaissance Resources (334 category) with an average grade of 7.03% K_2O, have been estimated using the cross-sectional method. The combined Net in-situ Resource (333 + 334) thus amounts to 436.21 million tonnes with an average grade of 6.86% K_2O.

21.1.13 Alternatively, resource estimation by the polygonal method indicates a total of 448.68 million tonnes of Net in-situ Reconnaissance Resources (334 category) with an average grade of 6.78% K_2O, suggesting good consistency between both estimation approaches and reaffirming the significant glauconitic potential of the block.

21.1.14 The preliminary exploration for glauconitic sandstone in the Deulha Block, Satna District, Madhya Pradesh, was recommended during the 63rd Technical Coordination Committee (TCC) meetings held on 22nd, 26th, and 27th March 2024, and subsequently approved in the 35th Executive Committee (EC) meeting on 16th May 2024. MECL received formal approval from the 35th Executive Committee of NMET through letter no. 23/452/2024-NMET/81 dated 20th May 2024, with a designated project duration of nine months. The exploration block covers an area of 8.5 sq. km, and field operations commenced on 1st September 2024, including geological mapping and topographical surveying on a 1:4,000 scale, followed by exploratory drilling.

21.2.0 RECOMMENDATIONS

21.2.1 Substantial glauconite potential have been established based on the exploration data generated during the G-3 stage exploration work carried out in the block.

21.2.2 SEM-EDS and Bimodal studies are recommended in future work to validate presence of glauconite vs feldspar/mica in the area.

21.2.3 Based on the outcome of the present exploration work, the block can be auctioned as CL block under the Auction programme of GOI for Critical and strategic minerals in future tranches of Auction.

CHAPTER-22

22.0.0 PLATES AND MAPS

22.1.0 Location Map of the block showing various topographic and physiographic features on SoI toposheet is given as Plate-I on 1:50,000 scale.

22.2.0 Regional Geology Map is given as Plate-II on 1:12,500 scale.

22.3.0 Topography Map is given as Plate-III on 1:4000 scale.

22.4.0 Block Geological Map on 1:4,000 with BH Locations is given as Plate-IV.

22.5.0 Geological Map of Pindra-SW G-4 block showing Deulha G-3 block, Dist.-Satna, Madhya Pradesh on 1:12,500 scale is given as Plate-V

22.6.0 Geological cross section along section lines S1-S1' S2-S2', S3-S3', S4-S4', S5-S5' and S6-S6' on 1:1000 scale is given as as Plate-VI.

22.7.0 Map for the mineralised body used for determination of polygonal resources, on 1: 4,000 scale is given as Plate-VII

CHAPTER-23

23.0.0 ANNEXURE / ENCLOSURES TO THE REPORT

23.1.0 The report includes all the relevant annexure and maps, plans, sections, photographs etc. List of annexures, tables, maps/plans/sections, photographs and Text figure etc are provided before the start of the text part of the Geological Report.

CHAPTER-24

24.0.0 ANY OTHER INFORMATION

24.1.0 ANY OTHER INFORMATION

N.A.

CERTIFICATE FROM THE QUALIFIED PERSON WITH NAME, DATE AND SIGNATURE

This is to certify that geological report in respect of Preliminary Exploration for Glauconitic sandstone in Deulha block, Satna, Madhya Pradesh was recommended in 63th TCC held on 22nd, 26th, 27th March, 2024 and was subsequently approved in 35th EC held on 16.05.2024. MECL has received approval from the 35th Executive Committee of NMEDT through letter no. 23/452/2024-NMET/81, dated 20th May 2024, with the designated time duration of 09 months. The area of the exploration block is 8.5 sq. km, Field operation was initiated by MECL on 01st September 2024, carried out geological mapping and topographical survey on 1:4,000 scale subsequently carried out drilling. The Geological Report is being submitted to NMEDT.

NAME: **SHRIKANT SHARMA**

DESIGNATION: **HoD (EXPLORATION)**

DATE: **November**

LIST OF PERSONNEL ASSOCIATED WITH PRELIMINARY EXPLORATION G-3) FOR GLAUCONITIC SANDSTONE IN DEULHA BLOCK (8.5 SQ KM) DISTRICT-SATNA, MADHYA PRADESH

1	Overall guidance	Shri P. Ravindran, Ex.GM (Exploration) Shri Shrikant Sharma, HoD (Exploration)
2	Overall Planning, Co-ordination & Supervision	Shri S.N. Khadse, GM (Exploration)
		Shri Naveen Kr. Pala, Sr. Manager (Geology)
3	Operation	Shri S.N. Khadse, GM (Exploration) Shri Jayprakash Choudhury, Sr. Manager (Geology Shri Alok Daharwal, Sr. Manager (Geology) Shri Sandeep Sarangi, Manager (Geology)
4	Project Management	Shri Rajnikant, Manager (Drilling)
5	Physical Execution of work	
	a) Geology	Shri Aditya Chodhury, Ex. Geologist Shri Peeyush Kumar, Assistant Manager (Geology)
6	Sample Processing	Shri Ankush Wagh, Sr. Sampling Assistant Shri Pushpraj, Sampling Assistant
7	Chemical Laboratory	Shri P. Ravindran, Ex.GM (Exploration)/ Lab. in-charge Shri Shrikant Sharma, HoD (Exploration)/Lab in-charge
		Shri Rohit Sharma, Manager (Chemical Lab)
		Dr. Deepti Rahangdale, Manager (Chemical Lab)
8	Petrographic Studies	Shri Sayantan Pal, Manager (Geology)
9	Documentation	Shri Vikash Kumar, Sr. Manager (Geology)
		Shri Piyush Kalwani, Assistant Manager (Geology)
10	Non-Coal Geological Report Cell	Shri S. K. Satpathy, Sr. Manager (Geology)
		Mrs. Saumya Anand, Assistant Manager (Geology)
		Shri Uday Patil, Sr. Computer Operator
		Shri Shivanand, Sr. Computer Operator
11	Reprography and Printing	Non-Coal Geological Report Cell
12	Proposal Formulation	Shri Naveen Kr. Pala, Sr. Manager (Geology)
13	Hindi Translation	Vikash Kumar, Sr. Manager (Geology)

LOCALITY INDEX

Locality	Latitude	Longitude
Umariha	24°54'21.29''N	80°46'6.53''E
Deulha (Dewlaha)	24°54'57.43''N	80°46'57.70''E
Majhgawan	24°54'50.79''N	80°47'57.60''E
Kanpur	24°53'53.99''N	80°46'13.20''E

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ABBREVIATION

SL. No.	Abbreviation	Full form
1	UNFC	United Nation Framework Classification
2	IBM	Indian Bureau of Mines
3	DGCO	Directorate General Camp Office
4	GSI	Geological Survey of India
5	MECL	Mineral Exploration and Consultancy Limited
6	CPSE	Central Public Sector Enterprises
7	NMET	National Mineral Exploration Trust
8	TCC	Technical cum Cost Committee
9	EC	Executive Committee
10	DMG, MP	Directorate of Geology & Mining, Madhya Pradesh
11	NABL	National Accreditation Board for Testing and Calibration Laboratories
12	JNARDDC	Jawaharlal Nehru Aluminium Research Development and Design Centre
13	F.S.P.	Field Season Programme
14	MEMC	Minerals (Evidence of Mineral Contents)
15	MMDR	Mines & Minerals (Development and Regulation)
16	NH	National Highway
17	WGS-84	World Geodetic System-84
18	UTM	Universal Transverse Mercator
19	RL	Reduced Level
20	cu m	Cubic Meter
21	ICP-MS	Inductively Coupled Plasma Mass Spectrometry
22	DGPS	Differential Global Positioning System
23	DMS	Degree Minute Second
24	M / m	Meter
25	Sq. km	Square Kilometer
26	M. Sc.	Master of Science
27	M. Sc. Tech	Master of Science Technology
28	mRL	Reduced Level in metre
29	R.F.	Reserve Forest
30	QA/QC	Quality Assessment/ Quality Checks
31	WD-XRF	Wavelength Dispersive X-ray Fluorescence
32	CRM	Certified Reference Material
33	SARM	South African Reference Material
34	SOI	Survey of India
35	GOI	Government of India
36	GNSS	Global Navigation Satellite System
37	CORS	Continuously Operating Reference Station