GEOLOGICAL REPORT ON RECONNAISSANCE SURVEY (G-4 STAGE) FOR GLAUCONITIC SANDSTONE IN

PARSADA-NAWAPARA-GURUR BLOCK

(Area-144 Sq Km)

DISTRICT- BALOD, STATE- CHHATTISGARH

(Under NMET Programme)

Parts of Toposheet no. 64H06

TEXT, ANNEXURE AND PLATES

MINERAL EXPLORATION AND CONSULTANCY LIMITED

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" परसदा–नवापारा–गुरुर ब्लॉक (144 वर्ग कि.मी.), जिला–बालोद, छत्तीसगढ़ में ग्लॉकोनाइटिक सैंडस्टोन के लिए आवीक्षण सर्वेक्षण (जी-4 चरण) पर भूवैज्ञानिक प्रतिवेदन"

अध्याय 1

कार्यकारी सारांश

1.1.0 प्रस्तावना

1.1.1 नाइट्रोजन और फॉस्फोरस के साथ-साथ पोटैशियम भी पौधों के स्वास्थ्य और कृषि उत्पादकता के लिए आवश्यक तीन प्रमुख स्थूल पोषक तत्वों (मैक्रोन्यूट्रिएंट्स) में से एक है। यह विभिन्न शारीरिक प्रक्रियाओं जैसे कि एंजाइम सक्रियण, जल विनियमन, प्रकाश संश्लेषण और प्रोटीन संश्लेषण में महत्वपूर्ण भूमिका निभाता है। फसल की उपज और गुणवत्ता में इसके महत्त्वपूर्ण योगदान के कारण, पोटैशियम सतत कृषि पद्धतियों के लिए बड़ी मात्रा में आवश्यक होता है।

1.1.2 पौध पोषण में पोटैशियम की महत्वपूर्ण भूमिका के प्रति बढ़ती जागरूकता ने वैश्विक पोटाश उद्योग को जन्म दिया और तेजी से विकसित किया, जो पोटैशियम-आधारित उर्वरकों का प्रमुख आपूर्तिकर्ता है। ऐतिहासिक अभिलेख बताते हैं कि 1921 तक वैश्विक पोटाश उत्पादन लगभग 10 लाख टन तक पहुँच गया था। तब से उत्पादन में निरंतर और सशक्त वृद्धि हुई है।

1.1.3 संयुक्त राज्य भूवैज्ञानिक सर्वेक्षण (USGS, 2013a; 2013b) के आँकड़ों के अनुसार, 2013 तक वैश्विक पोटैशियम उत्पादन लगभग 34.6 मिलियन टन तक पहुँच गया। यह वृद्धि प्रवृत्ति जारी रही, और अनुमान है कि 2022 तक उत्पादन लगभग 37.8 मिलियन टन तक पहुँच गया, जो लगभग 2.9% की चक्रवृद्धि वार्षिक वृद्धि दर (CAGR) को दर्शाता है (Rawashdeh et al., 2016)। यह बढ़ती मांग वैश्विक खाद्य सुरक्षा हेतु पोटैशियम के रणनीतिक महत्व को रेखांकित करती है और ग्लॉकोनाइटिक बलुआ पत्थर सहित वैकल्पिक पोटाश स्रोतों की खोज को और भी तीव्र करती है।

1.1.4वर्तमान में, वैश्विक पोटाश की मांग का अधिकांश हिस्सा समुद्री एवैपोरेट (evaporite) जमाओं और पोटाश-समृद्ध खारे जल स्रोतों से पूरा किया जाता है। ये प्राकृतिक जमाएँ जल में घुलनशील पोटैशियम-युक्त खनिजों जैसे कि सिल्वाइट (KCl), कार्नलाइट ($KMgCl_3 \cdot 6H_2O$), कायनाइट ($KMg(SO_4)Cl \cdot 3H_2O$), और पॉलीहेलाइट ($K_2Ca_2Mg(SO_4)_4 \cdot 2H_2O$) से बनी होती हैं। ये या तो परतदार खनिज बिस्तरों के रूप में मिलती हैं या सतही एवं उपसतही खारे जलाशयों के रूप में। इन्हें

मुख्यतः पोटैशियम क्लोराइड (म्यूरिएट ऑफ पोटाश – MOP) और पोटैशियम सल्फेट (SOP) तैयार करने के लिए प्रसंस्कृत किया जाता है—जो सबसे व्यापक रूप से उपयोग किए जाने वाले पोटाश उर्वरक हैं।

1.1.5 इन उच्च-गुणवत्ता वाले पारंपरिक पोटाश संसाधनों का वैश्विक वितरण अत्यंत सीमित है, और उत्पादन का 90% से अधिक हिस्सा 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 राष्ट्र न केवल बड़े भंडार नियंत्रित करते हैं, बल्कि वैश्विक निर्यात बाजार पर भी प्रभुत्व रखते हैं, जिससे अन्य देशों, विशेषकर भारत जैसे पोटाश आयातक देशों, में आपूर्ति-निर्भरता की स्थिति बनती है।

1.1.6 आपूर्ति का यह भू-राजनीतिक केंद्रीकरण, बढ़ती वैश्विक मांग, मूल्य अस्थिरता और आपूर्ति विविधीकरण की आवश्यकता ने कई देशों को गैर-पारंपरिक और स्वदेशी पोटैशियम स्रोतों, जैसे कि ग्लॉकोनाइटिक बलुआ पत्थर और फेल्डस्पैथिक चट्टानों की खोज हेतु प्रेरित किया है।

1.1.7दीर्घकालिक कृषि उत्पादकता बनाए रखने और आयात पर निर्भरता कम करने के लिए वैकल्पिक पोटैशियम संसाधनों की खोज आवश्यक है, विशेषकर उन देशों में जिनके पास पारंपरिक पोटाश भंडार नहीं हैं। एक आशाजनक विकल्प K-युक्त सिलिकेट और गैर-सिलिकेट खनिजों का अध्ययन है, जिन्हें उचित तकनीकों द्वारा प्रसंस्कृत करके पोटैशियम प्राप्त किया जा सकता है। हालिया शोध इंगित करता है कि फेल्डस्पार, ग्लॉकोनाइट और अभ्रक जैसे पोटैशियम-युक्त एल्युमिनोसिलिकेट उपयुक्त भू-रासायनिक और तकनीकी परिस्थितियों में पोटाश के व्यवहार्य स्रोत हो सकते हैं (Manning, 2010; 2012; Ciceri et al., 2015)।

1.1.8 भारत, जो विश्व का एक प्रमुख पोटाश उपभोक्ता है, के पास कोई भी आर्थिक रूप से खनन योग्य एवैपोरेट पोटाश भंडार नहीं है। इस कमी के कारण ग्लॉकोनाइटिक बलुआ पत्थर, पोटाश-समृद्ध शेल, फेल्डस्पैथोइड्स और ग्लॉकोनाइटिक बलुआ पत्थरों जैसे स्वदेशी, गैर-पारंपरिक पोटाश स्रोतों की खोज रणनीतिक रूप से आवश्यक हो गई है। विश्व में कई देशों ने पहले ही ऐसे विकल्पों की संभावना प्रदर्शित की है। उदाहरण के लिए, ऑस्ट्रेलिया के न्यू साउथ वेल्स के बुले डीलाह क्षेत्र में 5–10% K_2O वाले एलुनाइट भंडारों का व्यावसायिक शोषण किया गया। इसी तरह, Everest et al. (1964) ने शेल से

पोटैशियम निकालने के सफल प्रयासों का दस्तावेजीकरण किया, जबकि पूर्व USSR में ग्लॉकोनाइट का उपयोग प्राकृतिक पोटैशियम उर्वरक के रूप में सक्रिय रूप से किया गया (GSI, CGPB Report, 1978, p. 94)।

1.1.9 ये वैश्विक उदाहरण भारत में ग्लॉकोनाइटिक बलुआ पत्थर को पोटाश का पूरक या विकल्प स्रोत के रूप में उपयोग करने की संभावना को और मजबूत करते हैं।

1.1.10 ग्लॉकोनाइटिक बलुआ पत्थर एक अवसादी चट्टान है, जिसमें ग्लॉकोनाइट खनिज समृद्ध मात्रा में पाया जाता है। यह खनिज हल्के हरे रंग का आयरन-पोटैशियम फायलोसिलिकेट है, जो प्रायः समुद्री शेल्फ पर्यावरणों में कम अवसादन और हल्के अपचयनकारी परिस्थितियों में बनता है। भूवैज्ञानिक रूप से, ग्लॉकोनाइटिक बलुआ पत्थर स्तरीय सहसंबंध, प्राचीन पर्यावरणीय पुनर्निर्माण और पेट्रोलियम भंडार अध्ययन में महत्वपूर्ण भूमिका निभाता है। हालाँकि, हाल के वर्षों में इसकी आर्थिक क्षमता, विशेषकर गैर-पारंपरिक पोटैशियम उर्वरक स्रोत के रूप में, नए सिरे से ध्यान आकर्षित कर रही है।

1.1.11 पारंपरिक एवैपोरेट पोटाश के विभिन्न स्वदेशी विकल्पों में, ग्लॉकोनाइटिक बलुआ पत्थर भारत में सबसे संभावनाशील और प्रचुर मात्रा में उपलब्ध संसाधनों में से एक के रूप में उभर रहा है। 3000 मिलियन टन से अधिक अनुमानित भंडार पहचाने गए हैं, जिनमें पोटैशियम ऑक्साइड (K_2O) की मात्रा 4% से 8% तक है, जो इसे आयातित पोटाश उर्वरकों के संभावित विकल्प के रूप में स्थापित करता है।

1.1.12 उत्तर प्रदेश, बिहार, छत्तीसगढ़, राजस्थान और गुजरात राज्यों में महत्वपूर्ण भंडारों की सूचना दी गई है, जहाँ ग्लॉकोनाइट विभिन्न अवसादी बेसिनों में क्रिटेशियस से पेलियोजीन संरचनाओं का हिस्सा है (Kumar और Bakliwal, 2005)।

1.1.13 खनिज और खनिज (विकास और विनियमन) अधिनियम, 1957 (MMDR Act) में वर्ष 2023 के संशोधन अधिनियम द्वारा एक नई धारा 1D जोड़ी गई, ताकि भारत के विकास ढाँचे में महत्त्वपूर्ण खनिजों के सामरिक और आर्थिक महत्व को संबोधित किया जा सके। यह धारा केंद्र सरकार को महत्त्वपूर्ण खनिजों की पहचान, अधिसूचना और नीलामी करने का अधिकार प्रदान करती है।

1.1.14 इसके सामरिक महत्व को ध्यान में रखते हुए, ग्लॉकोनाइट को भारत सरकार द्वारा राष्ट्रीय महत्त्वपूर्ण खनिज मिशन की सूची में सम्मिलित किया गया है। इस मिशन का उद्देश्य कृषि, स्वच्छ ऊर्जा, इलेक्ट्रॉनिक्स, अंतरिक्ष, रक्षा और औद्योगिक विकास के लिए आवश्यक खनिजों की सुरक्षित, सतत और आत्मनिर्भर आपूर्ति सुनिश्चित करना है।

1.1.15एक गैर-पारंपरिक, स्वदेशी पोटाश (K_2O) स्रोत के रूप में, ग्लॉकोनाइट भारत की पोटाश आयात पर निर्भरता को कम करने की अपार क्षमता रखता है, जिससे राष्ट्रीय पोषण सुरक्षा और आत्मनिर्भर भारत (आत्मनिर्भर भारत) के लक्ष्यों को सहयोग मिलेगा।

1.1.16राष्ट्रीय महत्त्वपूर्ण खनिज मिशन लक्षित अन्वेषण कार्यक्रमों, NMET के माध्यम से वित्तीय सहायता, और वाणिज्यिक उपयोग हेतु ग्लॉकोनाइट-युक्त संरचनाओं की नीलामी को प्रोत्साहन देता है।

1.1.17भारत सरकार ने महत्वपूर्ण और सामरिक खनिज ब्लॉकों की व्यवस्थित नीलामी ट्रेंच-आधारित दृष्टिकोण से शुरू की है, ताकि स्वच्छ ऊर्जा परिवर्तन, औद्योगिक विकास और राष्ट्रीय सुरक्षा हेतु खनिज आवश्यकताओं को सुनिश्चित किया जा सके।

1.1.18पारदर्शी आवंटन, निजी क्षेत्र की भागीदारी और संसाधनों के त्वरित विकास को सक्षम बनाकर, यह नीलामी प्रक्रिया भारत को ऊर्जा प्रणालियों के डिकार्बोनाइजेशन, खनिज आपूर्ति शृंखला में आत्मनिर्भरता और लचीले एवं सतत आर्थिक विकास की दिशा में सशक्त बनाती है।

1.1.19परसदा–नवापारा–गुरुर ब्लॉक क्षेत्र, चंद्रपुर समूह की कंसापथर और लोहारडीह संरचनाओं से संबंधित मेसो–नियो प्रोटेरोज़ोइक युग की शैल इकाइयों से बना है, जो ग्लॉकोनाइटिक बलुआ पत्थर और फॉस्फोराइट की संभाव्यता के लिए जाना जाता है। GSI द्वारा 1987-88 में 1:50,000 पैमाने पर किए गए प्रणालीगत भूवैज्ञानिक मानचित्रण के दौरान खर्रा, दर्रा, नरबदा, दिया बाती, थेकवाडी और उसरवाड़ा गाँवों में ग्लॉकोनाइटिक बलुआ पत्थर की उपस्थिति दर्ज की गई थी।

1.1.20MECL ने उपलब्ध भूविज्ञान आँकड़ों के आधार पर डेस्क स्टडी की और पाया कि बालोद जिले के आसपास का क्षेत्र ग्लॉकोनाइट और फॉस्फोराइट के लिए प्रसिद्ध है। इसके आधार पर परसदा–नवापारा–गुरुर ब्लॉक, जिला बालोद (छत्तीसगढ़) में ग्लॉकोनाइटिक बलुआ पत्थर के लिए पुनर्ज्ञान (G4) सर्वेक्षण का प्रस्ताव तैयार किया गया।

1.1.21परसदा–नवापारा–गुरुर ब्लॉक, बालोद, छत्तीसगढ़ में ग्लॉकोनाइटिक बलुआ पत्थर के लिए पुनर्ज्ञान सर्वेक्षण का प्रस्ताव 64वीं TCC बैठक (29–30 अप्रैल, 2024) में अनुशंसित किया गया और तत्पश्चात 35वीं कार्यकारी समिति (16.05.2024) में अनुमोदित हुआ। MECL को 35वीं कार्यकारी समिति, NMET से पत्र संख्या 23/457/2024-NMET/120, दिनांक 10 जून 2024 द्वारा 12 माह की समय-सीमा के साथ स्वीकृति प्राप्त हुई। इस अन्वेषण ब्लॉक का क्षेत्रफल 144 वर्ग कि.मी. है, हालाँकि प्राप्त OM में टंकण त्रुटि के कारण 146.27 वर्ग कि.मी. दर्शाया गया है। MECL द्वारा 16 जून 2024 को फील्ड कार्य प्रारंभ किया गया, जिसमें 1:12,500 पैमाने पर भूवैज्ञानिक मानचित्रण, शैल नमूना संग्रह, पिटिंग और ड्रिलिंग कार्य किया गया और भूवैज्ञानिक प्रतिवेदन सितम्बर 2025 में प्रस्तुत किया जा रहा है।

1.2.0 स्थान और सुगमता (LOCATION AND ACCESSIBILITY)

1.2.1 परसदा–नवापारा–गुरुर जी-4 अन्वेषण ब्लॉक भारत के सर्वेक्षण (Survey of India) के टोपोशीट संख्या 64H06 के भागों में स्थित है, जो 20°39'25.931" उत्तरी अक्षांश से 20°44'59.276" उत्तरी अक्षांश तथा 81°15'00.000" पूर्वी देशांतर से 81°30'00.000" पूर्वी देशांतर के बीच आता है। यह 144.0 वर्ग किलोमीटर क्षेत्रफल को आच्छादित करता है, जिसमें कई गाँव सम्मिलित हैं जैसे – परसदा, बेलमंड, करहीभदर, चिचबोर, चिरचोरी, करकाभाट, खैरवाही, नवापारा, मुजगहन, धोबनपुर, धनोरा, गुरुर, थेकवडीह तथा चितौड़। ये सभी गाँव जिला बालोद (छत्तीसगढ़) के गुरुर और बालोद तहसीलों में स्थित हैं।

1.2.2यह ब्लॉक बालोद जिले के पूर्वी भाग में स्थित बालोद ग्लॉकोनाइटिक बलुआ पत्थर पट्टी (Balod glauconitic sandstone belt) का हिस्सा है। यह दुर्ग से दुर्ग–बालोद सड़क (NH-7) के माध्यम से पहुँचा जा सकता है तथा पूर्व–पश्चिम दिशा में बालोद–धमतरी सड़क द्वारा पार किया जाता है, जो करहीभदर, गुरुर और आनंदपुर से होकर एनएच-930 पर धमतरी को जोड़ती है। धमतरी रेलवे स्टेशन, जो रायपुर–धमतरी शाखा रेलखंड (बिलासपुर–नागपुर सेक्शन) पर स्थित है, ब्लॉक से लगभग 16 कि.मी. उत्तर-पूर्व में स्थित निकटतम रेलवे स्टेशन है। वहीं, निकटतम हवाई अड्डा रायपुर में है, जो उत्तर–उत्तर-पूर्व दिशा में लगभग 80 कि.मी. की दूरी पर स्थित है।

1.2.3 ब्लॉक क्षेत्र के मुख्य बिंदुओं (cardinal points) के निर्देशांक, दोनों जियोडेटिक (Geodetic) तथा यूटीएम (UTM) में, तालिका संख्या 1.1 में दिए गए हैं।

तालिका संख्या – 1.1

परसदा–नवापारा–गुरुर जी-**4** ब्लॉक (ग्लॉकोनाइटिक बलुआ पत्थर हेतु)**,** जिला–बालोद**,** छत्तीसगढ़ की सीमा के मुख्य बिंदुओं (**Cardinal Points**) के निर्देशांक

मुख्य बिंदु (Cardinal Points)	UTM (ZONE- 44)		DDMMSS (WGS84)	
	ईस्टिंग (m)	नॉर्थिंग (m)	अक्षांश (Latitude)	देशांतर (Longitude)
A	526025.32	2294477.70	20° 44' 59.276" N	81° 15' 0.000" E
B	529697.91	2294129.72	20° 44' 47.758" N	81° 17' 6.982" E
C	535133.69	2293304.52	20° 44' 20.575" N	81° 20' 14.895" E
D	547734.89	2288583.86	20° 41' 46.011" N	81° 27' 30.163" E
E	552073.2	2287347.84	20° 41' 5.389" N	81° 30' 0.000" E
F	552082.63	2284290.31	20° 39' 25.931" N	81° 30' 0.000" E
G	526035.84	2287663.51	20° 41' 17.616" N	81° 15' 0.000" E

1.3.0 ब्लॉक की भूगर्भिकी और संरचना (GEOLOGY AND STRUCTURE OF THE BLOCK)

1.3.1 परसदा–नवापारा–गुरुर जी-4 अन्वेषण ब्लॉक छत्तीसगढ़ बेसिन के दक्षिणी भाग में स्थित है तथा यह छत्तीसगढ़ सुपरग्रुप के रायपुर और चंदरपुर समूहों (Raipur and Chandarpur Groups) का हिस्सा है, जिनकी आयु मेसो–नियोप्रोटेरोज़ोइक (Meso–Neoproterozoic) काल की है। यह बेसिन मध्य भारत का एक प्रमुख प्रोटेरोज़ोइक अवसादी बेसिन है, जिसमें दीर्घकालिक भूवैज्ञानिक इतिहास संरक्षित है और यह आर्थिक दृष्टि से महत्वपूर्ण खनिजों (जैसे ग्लॉकोनाइट, जिसे हाल ही में एक महत्वपूर्ण खनिज के रूप में मान्यता दी गई है) की मेज़बानी करता है। ब्लॉक के भीतर चट्टानी इकाइयाँ मुख्यतः चंदरपुर समूह (Chandarpur Group) की हैं, जो सिलिसिक्लास्टिक अवसादी चट्टानों से बनी हैं। इनका निक्षेपण (deposition) नदीय (fluvial) से लेकर समुद्री (marine) परिवेशों में हुआ है। क्षेत्र में दो मुख्य फार्मेशन (Formations) हैं –

- कंसापथर फार्मेशन (**Kansapathar Formation**) (नवीनतम/ऊपरी)
- लोहारडीह फार्मेशन (**Lohardih Formation**) (पुराना/निचला)
  ये बेसिन विकास (basin evolution) के भिन्न–भिन्न चरणों का प्रतिनिधित्व करते हैं।

1.3.2 कंसापथर फार्मेशन (**Kansapathar Formation**), चंदरपुरसमूह की सबसे ऊपरी इकाई है। यह एक अग्रगामी–प्रत्यागामी अनुक्रम (**transgressive–regressive sequence**) को दर्शाता है, जिसके निचले भाग में महीन–ऊपर की ओर क्रमित स्तर (fining-upward strata) पाए जाते हैं, जो समुद्री अग्रगमन (marine transgression) का संकेत देते हैं; और ऊपरी भाग में मोटे–ऊपर की ओर चक्रीय स्तर (coarsening-upward cycles) पाए जाते हैं, जो उथले समुद्री से लेकर तटीय निक्षेपण (prograding shallow marine to coastal deposition) को प्रतिबिंबित करते हैं। यह फार्मेशन मुख्यतः अच्छे से छनित (well-sorted), मध्यम से मोटे दानेदार क्वाट्र्ज एरेनाइट (quartz arenite) से बना है, जो उच्च-ऊर्जा वाले निक्षेपण परिवेश को दर्शाता है। आर्थिक दृष्टि से विशेष महत्त्वपूर्ण है – इस फार्मेशन में ग्लॉकोनाइट की उपस्थिति, जो पेलेट्स (pellets) और डिट्राइटल दानों की सतह पर परत (coating) दोनों रूपों में पाया जाता है। इनका फार्मेशन निम्न-ऊर्जा, अवायवीय (anoxic) समुद्री स्थितियों में अग्रगमन चरण के दौरान हुआ।

1.3.3कंसापथर फार्मेशन के नीचे लोहारडीह फार्मेशन (**Lohardih Formation**) स्थित है, जो चंदरपुर समूह की आधारभूत इकाई है। इसमें लौहधारी (ferruginous) फेल्डस्पैथिक बलुआ पत्थर (feldspathic sandstones), शेल स्तर (shale partings), तथा बहुविध शैल–कंकड़ शैलों वाले समुच्चय (polymictic conglomerates) शामिल हैं, जो आर्कियन (Archean) बेसमेंट पर असंगत रूप से (unconformably) स्थित हैं। कंकड़ शैलों की परतें उच्च-ऊर्जा निक्षेपण को दर्शाती हैं, जो ऑलुवियल फैन से फैन-डेल्टा (alluvial fan to fan-delta) परिवेश में बनीं, और बाद में अग्रगमन (transgression) के समय उथले समुद्री शोल-बार (shoal-bar) तंत्र में परिवर्तित हो गईं। शेल परतें सतह पर दिखाई नहीं देतीं, लेकिन ये बलुआ पत्थर इकाइयों के बीच बोरहोल कोर में अंतःस्थापित (intercalated) रूप में पाई गई हैं। स्थानीय स्तर पर लेटराइटिक आवरण (lateritic cappings) भी विकसित हैं।

1.3.4 ब्लॉक क्षेत्र में भू-आकृति (topography) मृदु और लगभग समतल है। शैल परतें ई.एन.ई–डब्ल्यू.एस.डब्ल्यू से ई–डब्ल्यू दिशा में फैली हुई हैं और उत्तर–उत्तर-पश्चिम की ओर 2–5° के हल्के झुकाव (gentle dip) पर हैं। ब्लॉक क्षेत्र में उजागर चट्टानी इकाइयों का प्रारंभिक स्तरीकरण अनुक्रम (tentative stratigraphic sequence) (GSI के अनुसार) तालिका 1.2 में दिया गया है।

तालिका 1.2

परसदा–नवापारा–गुरुर जी-**4** ब्लॉक का स्तरीकरण अनुक्रम (दास एवं अन्य, 1992, GSI के अनुसार)

आयु (Age)	**सुपरग्रुप (Super Group)**	**समूह (Group)**	**फार्मेशन (Formation)**	**शैलविज्ञान (Lithology)**
				लेटराइट (Laterite)
मेसो–प्रोटेरोज़ोइक – नियो–प्रोटेरोज़ोइक	छत्तीसगढ़ (Chhattisgarh)	चंदरपुर(Chandarpur)	कंसापथर (Kansapathar)	ग्लॉकोनाइटिक बलुआ पत्थर (Glauconitic Sandstone)
			चपोरडीह(Chaporadih)	शेल / क्वार्ट्ज एरेनाइट (Shale / Quartz arenite)
			लोहारडीह (Lohardih)	लौहधारी बलुआ पत्थर / सबआर्कोज (Subarkose) युक्त आधारभूत कंकड़ शैल (basal conglomerate)
				लेटराइट (Laterite)

1.4.0 खनिजीकरण (MINERALIZATION)

1.4.1परसदा–नवापारा–गुरुर जी-4 ब्लॉक में, ग्लॉकोनाइट मुख्यतः चंदरपुर समूह की कंसापाठर बलुआ पत्थर इकाई में विद्यमान है। यह विशिष्ट हरे से जैतून-भूरे रंग के स्तर (horizons) बनाता है, जिन्हें सतही उजागर चट्टानों (outcrops) और बोरहोल कोर दोनों में पहचाना जा सकता है। बलुआ पत्थर मध्यम से महीन-दानेदार, मध्यम से अच्छे से छनित (moderately to well-sorted) है और इसमें उप-वृत्ताकार क्वार्ट्ज दाने (sub-rounded quartz grains) पाए जाते हैं, जो ग्लॉकोनाइट-समृद्ध मैट्रिक्स में अंतःस्थापित हैं या स्वतंत्र ग्लॉकोनाइट पेलेट्स के रूप में मिलते हैं। ग्लॉकोनाइट की मात्रा समृद्ध परतों में लगभग 1% से लेकर 8% से अधिक तक होती है, जो इसे हरा रंग प्रदान करती है, जबकि अपक्षय (weathering) के बाद यह फीके जैतून-भूरे रंग में परिवर्तित हो जाती है।

1.4.2संरचना (texture) की दृष्टि से, ग्लॉकोनाइट अंडाकार से उप-अण्डाकार (ovoid to sub-elliptical) पेलेट्स (0.1–1 मि.मी.) और पतली लमिनाओं (thin laminae) के रूप में दिखाई देता है। ये कभी-कभी गुच्छों (clusters) में पाए जाते हैं और अपरिपक्व, मृदुल, अभ्रकी (micaceous) रूप से लेकर अच्छी तरह क्रिस्टलीकृत, चमकीले (lustrous) रूप तक विभिन्न परिपक्वता अवस्थाएँ दर्शाते हैं। यह क्वार्ट्ज दानों के बीच अंतःकणीय रिक्तियों (intergranular fillings) या सतही आवरण (coatings) के रूप में पाया जाता है। पतला खंड (thin-section) अध्ययन में यह दानेदार से कृमिल (vermicular) बनावट प्रदर्शित करता है, जिसमें विशिष्ट हरा द्विवर्तन (birefringence) दिखाई देता है। सहायक खनिजों में अल्प मात्रा में अभ्रक (mica), फेल्डस्पार और भारी खनिज सम्मिलित हैं।

1.4.3 अवसादन विज्ञान (Sedimentology) की दृष्टि से, ग्लॉकोनाइटिक परतें लौहधारी बलुआ पत्थर और शेल के साथ अंतर्व्यवस्थित (interbedded) हैं। इनमें निम्न-कोणीय क्रॉस-बेडिंग (low-angle cross-bedding), तरंग चिह्न (ripple marks) और समतल लमिनेशन (planar lamination) जैसी विशेषताएँ पाई जाती हैं। ये इंगित करती हैं कि निक्षेपण एक उथले समुद्री शेल्फ वातावरण (shallow marine shelf environment) में धीमी अवसादन दर (slow sedimentation) के साथ हुआ, जहाँ हल्की अवकरणीय से लेकर आंशिक ऑक्सीकरणीय स्थितियाँ थीं, जो ग्लॉकोनाइट की स्वजनन प्रक्रिया (authigenesis) के लिए अनुकूल रहीं। ब्लॉक क्षेत्र में ग्लॉकोनाइटिक परतों की निरंतरता यह संकेत करती है कि कंसापाठर निर्माण के दौरान व्यापक समुद्री अग्रगमन (marine transgressions) हुए। आर्थिक दृष्टि से, ये क्षेत्र पोटैशियम-समृद्ध उर्वरक की संभावना के लिए महत्त्वपूर्ण हैं, और प्रारंभिक लाभकारीकरण (beneficiation) अध्ययनों ने इनके कृषि और औद्योगिक उपयोगों की संभावना प्रदर्शित की है।

1.5.0 वर्तमान अन्वेषण में की गई गतिविधियाँ (EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION)

1.5.1 परसदा–नवापारा–गुरुर जी-4 ब्लॉक में अन्वेषण कार्य 16 जून 2024 से प्रारंभ हुआ। इसमें 1:12,500 पैमाने पर भू-मानचित्रण (geological mapping) किया गया, साथ ही सतही शैल नमूने (bedrock sampling) भी लिए गए ताकि शैलविज्ञान (lithology) और खनिजीकरण का आकलन किया जा सके। परिणामों में ग्लॉकोनाइट-समृद्ध क्षेत्र पहचाने गए, जिनके आधार पर आगे चयनित क्षेत्रों में पिटिंग और पाँच बोरहोल में कोर ड्रिलिंग की गई ताकि अधःसतही निरंतरता और ग्रेड वितरण का आकलन हो सके। फील्ड गतिविधियों में सतही नमूनाकरण, पिट नमूनाकरण, बोरहोल कोर नमूनाकरण और प्रयोगशाला विश्लेषण शामिल थे। इन-हाउस परीक्षण MECL ने किए जबकि बाहरी जाँच विश्लेषण (external check analyses) जेएनएआरडीडीसी (JNARDDC) द्वारा रासायनिक विश्लेषण के तुलनात्मक अध्ययन हेतु किए गए।

1.5.2 भू-मानचित्रण पूरे 144 वर्ग कि.मी. क्षेत्र में **1** किमी × **1** किमी ग्रिड प्रणाली के माध्यम से किया गया ताकि समान कवरेज सुनिश्चित हो और कोई डेटा अंतराल न रहे। फील्ड टीमों ने शैलविज्ञान, संरचना, खनिज उपस्थिति और अन्य विशेषताओं का अभिलेखन किया। शैल संपर्क (litho-contacts) और शैल प्रवृत्तियों (rock attitudes) को मानचित्रित करने हेतु जीपीएस और कम्पास मापन किए गए। क्षेत्र की भूगर्भिकी मुख्यतः ग्लॉकोनाइटिक बलुआ पत्थर, लौहधारी बलुआ पत्थर, धूसर बलुआ पत्थर, लेटराइट और कंकड़ शैल (conglomerate) से बनी है, जिनमें कंसापाठर निर्माण का ग्लॉकोनाइटिक बलुआ पत्थर प्रमुख होस्ट रॉक के रूप में विद्यमान है। प्रमुख प्रसार (exposures) पूरे ब्लॉक में देखे गए, विशेषकर कुलिया, केनेरी, नवागाँव, धोबनपुर, गुरुर, धनोरा, करकाभाट और करहीभदर के पास।

1.5.3 फील्ड जांच में पाया गया कि ग्लॉकोनाइटिक बलुआ पत्थर निकाय प्रमुख लेकिन असतत (discontinuous) हैं, जिनका अनुमानित उजागर घनत्व (outcrop density) लगभग 50% है। लौहधारी बलुआ पत्थर और धूसर बलुआ पत्थर, जो प्रायः लेटराइट आवरण (laterite-capped) से ढके होते हैं, भी व्यापक रूप से पाए जाते हैं। सभी टिप्पणियों को एकीकृत करके व्याख्यायुक्त भूगर्भीय मानचित्र (interpreted geological map) तैयार किया गया, जिसमें प्रत्यक्ष और अनुमानित ग्लॉकोनाइटिक स्तर दोनों दर्शाए गए। इसी आधार पर पिटिंग, ड्रिलिंग और विस्तृत नमूनाकरण की योजना बनाई गई। शैल

नमूनाकरण (bedrock sampling) में सतह से ताज़े, अपरदित टुकड़े (unweathered fragments) तोड़े गए ताकि पेट्रोग्राफिक अध्ययन और रासायनिक विश्लेषण हेतु प्रतिनिधि नमूने उपलब्ध हों।

1.5.4 कुल 121 शैल नमूने लिए गए और उनका विश्लेषण K_2O, SiO_2, Al_2O_3 और Fe_2O_3 के लिए किया गया। इनमें से 21 नमूनों में ≥1% K_2O पाया गया, अधिकतम मान 2.15% तक था। इसके आधार पर 22 पिट स्थान चुने गए। उत्खननों में ताज़ा ग्लॉकोनाइटिक बलुआ पत्थर क्षितिज (horizons) उजागर किए गए। पिट का आकार प्रायः 2.0 मी. × 2.0 मी. और गहराई 1.5–2.0 मी. रही। 22 पिट नमूनों में से 6 में >1% K_2O था, जो 1.06% से 6.44% तक पाया गया। सर्वाधिक मान 6.44% कुलिया के पास स्थित पिट-09 से मिला।

1.5.5ड्रिलिंग में कुल 228 मीटर की कोर ड्रिलिंग पाँच स्काउट बोरहोल (MPN-01 से MPN-05) में की गई, जिन्हें सतही और पिट नमूनों के सकारात्मक परिणामों के आधार पर चुना गया। बोरहोल लॉगिंग में शैलविज्ञान, संरचनात्मक और खनिज संबंधी विवरण दर्ज किए गए। लगभग सभी बोरहोल में ग्लॉकोनाइटिक बलुआ पत्थर और ग्लॉकोनाइटिक शेल पाए गए। नमूनाकरण पहले दो बोरहोल में प्रायः 1 मीटर अंतराल पर और शेष तीन में 2 मीटर अंतराल पर किया गया। विश्लेषण से कई K_2O समृद्ध क्षेत्रों का संकेत मिला। बोरहोल के निर्देशांक WGS-84 डैटम पर DGPS द्वारा निर्धारित किए गए।

1.5.6 बोरहोल MNP-01 में 39.90 मी. मोटाई का क्षेत्र पाया गया, जिसमें >4% K_2O (सीमा 4.36% – 7.20% K_2O) है।बोरहोल MNP-02 में 24.50 मी. मोटाई का क्षेत्र पाया गया, जिसमें >4% K_2O (6.21% K_2O) है।बोरहोल MNP-03 में 31.50 मी. मोटाई का क्षेत्र पाया गया, जिसमें >4% K_2O (सीमा 4.68% – 6.98% K_2O) है।बोरहोल MNP-04 में 44 मी. मोटाई का क्षेत्र पाया गया, जिसमें >4% K_2O (सीमा 5.32% – 6.11% K_2O) है।बोरहोल MNP-05 में 36 मी. मोटाई का क्षेत्र पाया गया, जिसमें >4% K_2O (सीमा 4.13% – 6.03% K_2O) है।ये परिणाम ब्लॉक की संसाधन अनुमान (resource estimation) और आर्थिक संभाव्यता मूल्यांकन (economic potential evaluation) के लिए मजबूत आधार प्रदान करते हैं।

1.5.7ग्लॉकोनाइटिक बलुआ पत्थर के सतही और कोर नमूनों के K_2O मानों में स्पष्ट असमानता पाई गई। 22 पिट नमूनों का औसत K_2O मान 1.08% है, जबकि पाँच बोरहोल के भारित औसत K_2O मान 5.36% से 6.21% तक हैं। यह अंतर संभवतः (i) सतही अपक्षय और लीचिंग, जिससे पिट नमूनों में K_2O घटता है; तथा (ii) गहराई पर K युक्त खनिजों का बेहतर संरक्षण और समृद्धि, के कारण है। इसके अतिरिक्त, ग्लॉकोनाइट के अलावा अन्य पोटैशियम युक्त अवस्थाएँ, जैसे फेल्डस्पार (ऑर्थोक्लेस/माइक्रोक्लाइन),

इलाइट/अभ्रक, तथा डायजेनेटिक रूप से परिवर्तित डिट्राइटल खनिज, भी कुल K_2O मात्रा में योगदान कर सकते हैं।

1.5.8फिर भी, बोरहोल नमूनों में पाए गए उच्च K_2O मान इस क्षेत्र में ग्लॉकोनाइटिक बलुआ पत्थर की उपस्थिति को नकारते नहीं हैं। छत्तीसगढ़ बेसिन की कंसापाठर निर्माण में ग्लॉकोनाइट की उपस्थिति क्षेत्रीय स्तर पर अच्छी तरह प्रलेखित है और ग्लॉकोनाइटिक बलुआ पत्थर का शैलविज्ञानिक संबद्ध (lithological association) इस इकाई का सुसंगत स्तरीकरणीय लक्षण है। इसलिए, भले ही देखे गए K_2O मानों में ग्लॉकोनाइट का सटीक योगदान अतिरिक्त पोटैशियम युक्त अवस्थाओं की उपस्थिति के कारण परिवर्तित हो सकता है, किंतु भूगर्भीय संदर्भ स्पष्ट रूप से इस व्याख्या का समर्थन करता है कि अन्वेषित अनुक्रम में ग्लॉकोनाइटिक बलुआ पत्थर वास्तव में विद्यमान है।

1.5.9पेट्रोग्राफिक अध्ययनों से संकेत मिलता है कि ग्लॉकोनाइट अधिकतर महीन-दानेदार बलुआ पत्थरों और शेलों में पाया जाता है, क्योंकि उनकी निम्न-ऊर्जा अवसादी परिस्थितियाँ इसके विकास और संरक्षण के लिए अनुकूल होती हैं। इस कारण, महीन फेसिज़ (finer facies) में इसका संकेंद्रण मोटे बलुआ पत्थरों की तुलना में अधिक होता है।

1.5.10स्वीकृत कार्य बनाम वास्तविक उपलब्धि का विवरण तालिका-1.3 में दिया गया है।

तालिका – 1.3

परसदा–नवापारा–गुरुर जी-**4** ब्लॉक (ग्लॉकोनाइटिक बलुआ पत्थर हेतु)**,** जिला – बालोद**,** छत्तीसगढ़ में **MECL** द्वारा स्वीकृत कार्य बनाम वास्तविक उपलब्धि

क्र.सं.	कार्य मद	इकाई	लक्ष्य	उपलब्धि
1	भू-मानचित्रण (1:12500 पैमाना)	वर्ग कि.मी.	144	144
2	सतही भू-रासायनिक नमूनाकरण (शैल/चैनल/चिप नमूना)	संख्या	200	121
3	अन्वेषण खनन (पिटिंग)	घन मी.	150	125.5
4	ड्रिलिंग (कोर)	मी.	250	228
5	नमूना तैयारी और रासायनिक विश्लेषण			
A.	सतही नमूने (शैल/चिप आदि)			
	संख्या	220 (200+20)	133 (121+12)	
B.	पिट नमूने			
	संख्या	165	24 (22+2)	

क्र.सं.	कार्य मद	इकाई	लक्ष्य	उपलब्धि
		(150+15)		
C.	बोरहोल नमूने			
	संख्या	110 (100+10)	154 (140+14)	
6	पेट्रोग्राफिक अध्ययन	संख्या	10	14
7	एक्स-रे विवर्तन अध्ययन (XRD Study)	संख्या	5	5
8	थोक घनत्व निर्धारण (Bulk Density)	संख्या	2	2
9	भूगर्भीय रिपोर्ट तैयारी	संख्या	1	1

1.6.0 संसाधन एवं ग्रेड का आकलन संसाधन का आकलन दो विधियों से किया गया है:

- क्रॉस-सेक्शनल पद्धति (मुख्य पद्धति), तथा
- पॉलीगोनल पद्धति (जांच हेतु पद्धति)।

1.6.1संसाधनों की गणना में, सकल *in-situ* आँकड़ों से **20%** की कटौती की गई है, ताकि अदृश्य भूवैज्ञानिक कारकों—जैसे कोर रिकवरी की सीमाएँ, गुहाएँ, गुफाएँ तथा अन्य संरचनात्मक अनियमितताएँ—को ध्यान में रखा जा सके।

1.6.2क्रॉस-सेक्शनल पद्धति द्वारा, कुल **104.53** मिलियन टन शुद्ध *in-situ* रिकॉन्नेसांस संसाधन (श्रेणी 334) औसत **6.11% K_2O** ग्रेड सहित, आंका गया है।

1.6.3पॉलीगोनल पद्धति द्वारा, कुल **105.28** मिलियन टन शुद्ध *in-situ* रिकॉन्नेसांस संसाधन (श्रेणी 334) औसत **6.05% K_2O** ग्रेड सहित, आंका गया है।

1.6.4दोनों आकलनों के बीच का अंतर—**104.53** मिलियन टन (क्रॉस-सेक्शनल) और **105.28** मिलियन टन (पॉलीगोनल)—कुल **0.75** मिलियन टन अथवा लगभग **0.71%** अधिक (पॉलीगोनल पद्धति में) है। यह अंतर अनुमेय सीमा के भीतर आता है, जो संसाधन आकलन की विश्वसनीयता एवं सटीकता की पुष्टि करता है।

1.7.0 सिफारिशें

1.7.1ब्लॉक में किए गए **G-4** स्तर के अन्वेषण कार्य से प्राप्त आँकड़ों के आधार पर, ग्लॉकोनाइट की पाँच महत्वपूर्ण संभावित पट्टियाँ चिन्हित की गई हैं।

1.7.2उपरोक्त संभावित क्षेत्रों की स्ट्राइक निरंतरता स्थापित करने तथा गहराई एवं ग्रेड की निरंतरता का आकलन करने के **लिए**, सुनियोजित ड्रिलिंग कार्यवाही की जानी चाहिए, ताकि ब्लॉक को **G-4** से **G-3** स्तर तक उन्नत किया जा सके।

1.7.3भविष्य के कार्यों में **SEM-EDS** अध्ययन की अनुशंसा की जाती है, ताकि क्षेत्र में ग्लॉकोनाइट बनाम फेल्डस्पार/माइका की उपस्थिति को सत्यापित किया जा सके।

GEOLOGICAL REPORT ON RECONNAISSANCE SURVEY (G-4 STAGE) FOR GLAUCONITIC SANDSTONE IN PARSADA-NAWAPARA-GURUR BLOCK (144 Sq Km) DISTRICT-BALOD, CHHATTISGARH

CHAPTER-1

EXECUTIVE SUMMARY

1.1.0 INTRODUCTION

1.1.1 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.

1.1.2 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.

1.1.3 According to data from the United States Geological Survey (USGS, 2013a; 2013b), global potassium production soared to nearly 34.6 million tonnes in 2013. This growth trend has continued, with estimates suggesting production levels were estimated to reach around 37.8 million tonnes by 2022, reflecting a compound annual growth rate (CAGR) of approximately 2.9% (Rawashdeh et al., 2016). 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.

1.1.4 At present, the overwhelming majority of global potash demand is fulfilled through the exploitation 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 ($KMgCl_3 \cdot 6H_2O$), kainite ($KMg(SO_4)Cl \cdot 3H_2O$), and polyhalite ($K_2Ca_2Mg(SO_4)_4 \cdot 2H_2O$). 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.

1.1.5 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.

(Source-https://natural-resources.canada.ca/minerals-mining/mining-data-statistics-analysis/minerals-metals-facts/potash-facts,
https://www.vantagemarketresearch.com/industry-report/potash-market-2565?,
www.nytimes.com/2013/07/12/editorial/global-outlook-on-fertilizer-markets.html)

1.1.6 This geopolitical concentration of supply, coupled with rising global demand, price volatility, and the need for supply diversification, has prompted several nations to explore non-traditional and indigenous potassium sources, including glauconitic sandstone, feldspathic rocks, and glauconitic sandstones, to ensure long-term nutrient security and fertilizer self-reliance.

1.1.7 To sustain long-term agricultural productivity and reduce dependence on imports, it is essential to explore alternative potassium resources, particularly in countries lacking conventional potash reserves. One such promising avenue is the investigation of 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 to potash independence for countries with limited access to high-grade evaporite deposits.

1.1.8 India, despite being one of the world's largest consumers of potash fertilizers, does not possess any economically viable, mineable evaporite potash deposits. This supply gap has necessitated the strategic exploration of non-conventional, indigenous potash sources, including glauconitic sandstone, potash-rich shales, feldspathoids, and glauconitic sandstones. Globally, several countries lacking conventional evaporite resources have already demonstrated the potential of such alternatives. For instance, in Bulla Dealah, New South Wales (Australia), alunite deposits containing 5–10% K_2O were commercially exploited as a potash source. Similarly, Everest et al. (1964) documented successful efforts to extract potassium from shales, while in the former USSR, glauconite was actively used as a natural potassium fertilizer (GSI, CGPB Report, 1978, p. 94).

1.1.9 These global precedents reinforce the feasibility of using glauconitic sandstone as a supplementary or substitute source of potash in India. Given its widespread occurrence in various sedimentary basins, glauconite-rich formations represent a strategically significant indigenous resource that could support national efforts toward nutrient security and import substitution.

1.1.10 Glauconitic sandstone is a type of sedimentary rock enriched in the mineral glauconite—a greenish iron potassium phyllosilicate typically formed in marine shelf environments under low sedimentation and mildly reducing conditions. Geologically, glauconitic sandstone plays a key role in stratigraphic correlation, paleoenvironmental reconstruction, and petroleum reservoir studies. However, its economic potential has gained renewed attention in recent years, particularly for its use as a non-conventional source of potassium fertilizer.

1.1.11 Among various indigenous alternatives to conventional evaporite potash, glauconitic sandstone is emerging as one of the most promising and abundantly available resources in India. Extensive reserves—estimated at over 3,000 million tonnes—have been identified, with potassium oxide (K_2O) content ranging from 4% to 8%, making it a potential substitute for imported potash fertilizers.

1.1.12 Significant deposits are reported from the states of Uttar Pradesh, Bihar, Chhattisgarh, Rajasthan, and Gujarat, where glauconite occurs in various sedimentary basins as part of Cretaceous to Paleogene formations (Kumar and Bakliwal, 2005). These reserves not only offer a sustainable solution for addressing India's potassium deficiency in agriculture but also support the vision of achieving nutrient self-reliance and import substitution through the utilization of strategically important indigenous mineral resources.

1.1.13 Under the Mines and Minerals (Development and Regulation) Act, 1957 (MMDR Act), a new Section 1D was introduced via the MMDR Amendment Act, 2023, to address the strategic and economic importance of critical minerals in India's development framework. Section 1D empowers the Central Government to Identify, notify auctioning the critical minerals, which are essential for the country's economic development and national security.

1.1.14 In recognition of its strategic importance, glauconite has been included in the list of critical minerals under the National Critical Mineral Mission, launched by the Government of India. This mission aims to ensure the secure, sustainable, and self-reliant supply of minerals that are essential for agriculture, clean energy, electronics, space, defense, and industrial growth.

1.1.15 As a non-conventional, indigenous source of potash (K_2O), glauconite holds immense potential to reduce India's dependence on potash imports, thereby supporting national goals of nutrient security and Atmanirbhar Bharat (self-reliant India). Its inclusion under the mission underscores the Government's focus on diversifying supply sources and accelerating domestic exploration, development, and beneficiation of such minerals.

1.1.16 The National Critical Mineral Mission promotes targeted exploration programs, funding support through NMET, and facilitation of block auctioning for commercial utilization of glauconite-bearing formations across states like Chhattisgarh, Rajasthan, Uttar Pradesh, Bihar, and Gujarat.

1.1.17 The Government of India has undertaken the systematic auctioning of critical and strategic mineral blocks through a tranche-based approach to secure the nation's mineral requirements for clean energy transition, industrial growth, and national security.As of date, auctions have been successfully conducted in five tranches, while the 6th tranche is currently underway. These auctions include mineral blocks containing lithium, REEs (Rare Earth Elements), glauconite, graphite, vanadium, nickel, cobalt, phosphorite, and others—critical for the development of battery storage, electric mobility, renewable energy technologies, and fertilizer security.This initiative is an integral part of India's broader commitment to achieving its Net-Zero Emission Target by 2070. The transition to a low-carbon economy hinges upon the availability of critical minerals, which are essential inputs for solar panels, wind turbines, electric vehicles (EVs), energy storage systems, and green hydrogen production.

1.1.18 By enabling transparent allocation, private sector participation, and accelerated resource development, the auctioning process strengthens India's pathway toward:

- Decarbonization of energy systems
- Self-reliance in mineral supply chains
- Resilient and sustainable economic development

The role of designated agencies such as MECL, along with support from NMET, is pivotal in preparing mineral blocks, conducting reconnaissance and exploration, and facilitating informed auction processes.

1.1.19 The Parsada-Nawapara-Gurur block area consist of Meso-Neo Proterozoic age lito-units of Kansapathar and Lohardih formations of Chandarpur Group of the Chhattisgarh Supergroup of rocks which is known for its mineral potentiality for glauconitic sandstone and phosphorites.GSI during systematic geological mapping on 1:50000 scale during 1987-88, observed the occurence of glauconitic sandstone in the Kharra, Darra, Narbada, Diyabati, Thekwadhi and Usarwara villages which are located in the central and eastern part of the present exploration block. Parsada-Nawapara-Gurur block is in the SE of GSI's Kotera-Reghai G-4 block (FSP 2023-24) for Glauconite, where the Glauconite bearing sandstone of Lohardih formation is found to be present.Apart from that several blocks of GSI for phosphorite are present in the north and NE of the proposed block including Sambalpur G-2 block (F.S 2022-23), Nawagaon G-4 block (F.S. 2023-24), Latabor G-4 block (F.S. 2023-24) and Nipani Kharra G-4 block (F.S. 2024-25). It suggests that the area is very much suitable for the exploration of fertilizer minerals.

1.1.20 In view of that, MECL had conducted desktop studies with the help of the available geoscience data and found the area in and around Balod district known for glauconites and phosphorites. This paved the way for the formulation of proposal for reconnaissance (G4) survey for glauconitic sandstone in the Parsada-Nawapara-Gurur Block, District Balod of Chhattisgarh This exploration proposal was submitted to 64th TCC of NMET for discussion, aims to assess the glauconitic mineralisation in the area.

1.1.21 The Reconnaissance Survey for Glauconitic sandstone in Parsada-Nawapara-Gurur block, Balod, Chhattisgarh was recommended in 64th TCC held on 29th-30th April, 2024 and was subsequently approved in 35th EC held on 16.05.2024. MECL has received approval from the 35th Executive Committee of NMET through letter no. 23/457/2024-NMET/120, dated 10th June 2024, with the designated time duration of 12 months. The area of the exploration block is 144sq. km, However the OM received has a typographic error and it is showing as 146.27 sq. km. Field operation was initiated by MECL on 16th

June 2024, carried out Geological Mapping on 1:12,500 scale, bedrock sampling, pitting and drilling and the Geological Report is being submitted in September 2025.

1.2.0 LOCATION AND ACCESSIBILITY

1.2.1 The Parsada–Nawapara–Gurur G4 exploration block lies in parts of Survey of India Toposheet No. 64H06, between latitudes 20°39'25.931" N to 20°44'59.276" N and longitudes 81°15'00.000" E to 81°30'00.000" E. It covers an area of 144.0 sq. km, encompassing several villages including Parsada, Belmand, Karahibhadar, Chichbor, Chirchori, Karkabhat, Khairwahi, Nawapara, Mujgahan, Dhobanpur, Dhanora, Gurur, Thekwadih, and Chitod, located in Gurur and Balod tehsils of Balod district, Chhattisgarh.

1.2.2 The block forms part of the Balod glauconitic sandstone belt in the eastern part of Balod district. It is accessible from Durg via the Durg–Balod Road (NH-7) and is traversed east–west by a road connecting Balod to Dhamtari, passing through Karahibhadar, Gurur, and Anandpur via NH-930. Dhamtari railway station, located 16 km to the northeast on the Raipur–Dhamtari branch line of the Bilaspur–Nagpur section, is the nearest railhead, while the nearest airport is at Raipur, about 80 km to the north-northeast.

1.2.3 The co-ordinates of the cardinal points of the block area both in geodetic and in UTM are given in Table No. 1.1.

Table No.-1.1

Co-ordinates of Cardinal Points of Block Boundary of Parsada-Nawapara-Gurur G-4 Block for Glauconitic Sandstone, District-Balod, Chhattisgarh

CARDINAL POINTS	UTM (ZONE- 44)		DDMMSS (WGS84)	
	EASTING (m)	NORTHING (m)	LATITUDE	LONGITUDE
A	526025.32	2294477.70	20° 44' 59.276" N	81° 15' 0.000" E
B	529697.91	2294129.72	20° 44' 47.758" N	81° 17' 6.982" E
C	535133.69	2293304.52	20° 44' 20.575" N	81° 20' 14.895" E
D	547734.89	2288583.86	20° 41' 46.011" N	81° 27' 30.163" E
E	552073.2	2287347.84	20° 41' 5.389" N	81° 30' 0.000" E
F	552082.63	2284290.31	20° 39' 25.931" N	81° 30' 0.000" E
G	526035.84	2287663.51	20° 41' 17.616" N	81° 15' 0.000" E

1.3.0 GEOLOGY AND STRUCTURE OF THE BLOCK

1.3.1 The Parsada–Nawapara–Gurur G4 exploration block lies in the southern part of the Chhattisgarh Basin and forms part of the Raipur and Chandarpur Groups of the Chhattisgarh Supergroup, belonging to the Meso–Neoproterozoic age. This basin is a major Proterozoic sedimentary basin in central India, preserving a long geological history and hosting economically important minerals, including glauconite, recently recognized as a critical mineral. Within the block, the litho-units belong mainly to the Chandarpur Group, which is composed of siliciclastic sedimentary rocks deposited in environments ranging from fluvial to marine. The two main formations in the area are the younger Kansapathar Formation and the older Lohardih Formation, representing distinct episodes of basin evolution.

1.3.2 The Kansapathar Formation, the uppermost unit of the Chandarpur Group, exhibits a transgressive–regressive sequence with fining-upward strata at the base (indicating marine transgression) and coarsening-upward cycles at the top (reflecting prograding shallow marine to coastal deposition). It is composed mainly of well-sorted, medium- to coarse-grained quartz arenite, indicative of high-energy settings. Of particular economic interest is the occurrence of glauconite in this formation, both as pellets and coatings on detrital grains, formed in low-energy, anoxic marine conditions during the transgressive phase.

1.3.3 Beneath the Kansapathar Formation lies the Lohardih Formation, the basal unit of the Chandarpur Group, comprising ferruginous feldspathic sandstones, shale partings, and polymictic conglomerates resting unconformably on the Archean basement. The conglomerates reflect high-energy deposition in alluvial fan to fan-delta environments, later transitioning to shallow marine shoal-bar systems during transgression. Shale layers, although not observed at the surface, occur as intercalations in borehole cores between sandstone units. Lateritic cappings are also locally developed. The block area has subdued, nearly flat topography with strata striking ENE–WSW to E–W and dipping gently (2–5°) towards NNW. The tentative srtratigraphic sequence of litho units exposed in the Block area (After GSI) is given in Table 1.2.

Table 1.2
Stratigraphic sequence of the Parsada-Nawapara-Gurur G4 Block
(After Das et.al,1992, GSI)

Age	Super Group	Group	Formation	Lithology
				Laterite
Meso Proterozoic – Neo Proterozoic	Chhattisgarh	Chandarpur	Kansapathar	Glauconitic Sandstone
			Chaporadih	Shale / Quartz arenite
			Lohardih	Ferruginous Sandstone /Sandstone
				Subarkose with basal conglomerate

1.4.0 MINERALIZATION

1.4.1 In Parsada–Nawapa–Gurur G-4 block, glauconite is primarily hosted within the Kansapathar Sandstone of the Chandarpur Group, forming distinctive greenish to olive-grey horizons that can be traced in both outcrops and borehole cores. The sandstone is medium- to fine-grained, moderately to well-sorted, and composed of sub-rounded quartz grains within a glauconite-rich matrix or interspersed with discrete glauconite pellets. Glauconite content ranges from about 1% to more than 8% in enriched layers, imparting the characteristic green colour that weathers to a dull olive-brown.

1.4.2 Texturally, glauconite appears as ovoid to sub-elliptical pellets (0.1–1 mm) and thin laminae, sometimes clustered, showing various maturity stages from friable, micaceous forms to well-crystallised, lustrous varieties. It occurs as intergranular fillings or coatings on quartz grains and, under thin-section analysis, displays granular to vermicular textures with typical green birefringence. Associated minerals include minor mica, feldspar, and heavy minerals.

1.4.3 Sedimentologically, glauconitic layers are interbedded with ferruginous sandstone and shale, displaying features such as low-angle cross-bedding, ripple marks, and planar lamination. These indicate formation in a shallow marine shelf environment with slow sedimentation, under mildly reducing to slightly oxidising conditions conducive to glauconite authigenesis. The persistence of glauconitic beds across the block points to laterally extensive marine transgressions during Kansapathar deposition. Economically, these zones are noteworthy for potassium-rich fertiliser potential, with preliminary beneficiation studies suggesting possible agricultural and industrial applications.

1.5.0 EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

1.5.1 Exploration in the Parsada–Nawapara–Gurur G-4 block began on 16 June 2024 with geological mapping at a 1:12,500 scale, accompanied by surface bedrock sampling to assess lithology and mineralisation. The results identified glauconite-enriched zones, which guided further work, including pitting in selected areas and core drilling in five boreholes to evaluate subsurface continuity and grade distribution. Field activities such as surface sampling, pit sampling, borehole core sampling, and laboratory analyses were carried out, with MECL handling in-house testing and JNARDDC conducting external check analyses for comparative study of the chemical analysis.

1.5.2 Geological mapping covered the entire 144 sq. km block using a systematic 1 km × 1 km grid approach to ensure uniform coverage and avoid data gaps. Field teams recorded lithology, structures, mineral occurrences, and other features, while GPS and compass measurements were used to map litho-contacts and rock attitudes. The area's geology is dominated by glauconitic sandstone, ferruginous sandstone, grey sandstone, laterite, and conglomerate, with glauconitic sandstone of the Kansapathar Formation serving as the main host rock. Major exposures occur across the block, notably near Kuliya, Kaneri, Nawagaon, Dhobanpur, Gurur, Dhanora, Karkabhat, and Karahibhadar.

1.5.3 Field investigations showed glauconitic sandstone bodies to be prominent but discontinuous, with an estimated outcrop density of around 50%. Ferruginous sandstone and grey sandstone, often laterite-capped, are also widespread. Observations were integrated to produce an interpreted geological map showing both observed and inferred glauconitic horizons, which served as the base for planning pitting, drilling, and detailed sampling. Bedrock sampling involved chipping fresh, unweathered fragments from exposed glauconitic sandstone, ensuring representative samples for petrographic studies and chemical analysis.

1.5.4 A total of 121 bedrock samples were collected and analysed for K_2O, SiO_2, Al_2O_3, and Fe_2O_3. Twenty-one samples contained ≥1% K_2O, with values up to 2.15%, leading to the selection of 22 pit locations. Excavations exposed fresh glauconitic sandstone horizons for sampling, with pit dimensions generally 2.0 m × 2.0 m and depths of 1.5–2.0 m. Of the 22 pit samples, six had >1% K_2O, ranging from 1.06% to 6.44%, the highest value being from Pit-09 near Kuliya.

1.5.5 Drilling comprised 228 m in 5 scout boreholes (MPN-01 to MPN-05), selected on the basis of positive surface and pit sample results. Borehole logging recorded lithological, structural, and mineralogical details, with glauconitic sandstone and glauconitic shale encountered in almost all the boreholes. Sampling was generally done at 1 m intervals in the first two boreholes and 2 m intervals in the remaining three. Analytical results indicated multiple K_2O enriched zones, and the borehole coordinates were determined using DGPS in WGS-84 Datum.

1.5.6 In borehole MNP-01, zone of 39.90m thickness with >4% K2O% (Range 4.36% - 7.20% K2O) has been found. In borehole MNP-02, a zone of 24.50m thickness with >4% K2O% (6.21% K2O) has been found. In borehole MNP-03, zone of 31.50m thickness with >4% K2O% (Range 4.68% - 6.98% K2O) has been found. In borehole MNP-04, zone of 44m thickness with >4% K2O% (Range 5.32% - 6.11% K2O) has been found. In borehole MNP-05, zone of 36m thickness with >4% K2O% (Range 4.13% - 6.03% K2O) has been found. These results provided a robust basis for subsequent resource estimation and evaluation of the block's economic potential.

1.5.7 A distinct disparity is observed in the K_2O content of surface and core samples of glauconitic sandstone. The average K_2O content of 22 pit samples is 1.08%, whereas the weighted average of K_2O content from five boreholes ranges between 5.36% and 6.21%. This difference may be attributed to (i) surface weathering and leaching, which reduce K_2O in pit samples, and (ii) better preservation and enrichment of K-bearing minerals at depth. Additionally, 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.

1.5.8 Nevertheless, the elevated K_2O values observed in the borehole samples do not negate the occurrence of glauconitic sandstone in the area. The Kansapathar Formation of the Chhattisgarh Basin is regionally well documented for its glauconite content, and the characteristic lithological association of glauconitic sandstone is a consistent stratigraphic feature of this unit. Therefore, while the precise contribution of glauconite to the observed K_2O values may vary due to the presence of additional potassium-bearing phases, the geological context strongly supports the interpretation that glauconitic sandstone is indeed present within the explored sequence.

1.5.9 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.

1.5.10 The details of the nature and quantum of work approved vs actual achievement is given in Table-1.3.

Table – 1.3
Approved Quantum of Work vs. Actual achievement by MECL in Parsada-Nawapara-Gurur G-4 Block for Glauconitic Sandstone, District: Balod, Chhattisgarh

Sl. No.	Item of Work	Unit	Target	Achievement
1	Geological Mapping (1:12500 scale)	Sq. Km	144	144
2	Surface Geochemical sampling (Bed Rock/Channel/Chip Sample)	Nos.	200	121
3	Exploratory Mining (Piting)	Cu M.	150	125.5
4	Drilling (Core)	m.	250	228
5	Sample Preparation & Chemical Analysis			
A.	Surface samples (Bedrock/ Chip etc)			
	i) Primary, & 10% External check for 4 radicals viz. K_2O, SiO_2, Al_2O_3 & Fe_2O_3	Nos.	220(200+20)	133(121+12)
B.	Pit Samples			
	i) Primary, & 10% External check for 4 radicals viz. K_2O, SiO_2, Al_2O_3 & Fe_2O_3	Nos.	165 (150+15)	24 (22+2)
C.	BH samples			
	i) Primary, & 10% External check for 4 radicals viz. K_2O, SiO_2, Al_2O_3 & Fe_2O_3	Nos.	110 (100+10)	154 (140+14)
6	Petrographic Studies	Nos	10	14
7	XRD Study	Nos.	5	5
8	Determination of Bulk Density	Nos.	2	2
9	Geological Report preparaton	Nos.	1	1

1.6.0 ESTIMATION OF RESOURCE AND GRADE

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.

1.6.1 In calculating resources, a deduction of 20% from the gross in-situ figures was applied to account for unseen geological factors such as core recovery limitations, cavities, caverns, and other structural irregularities.

1.6.2 A total of 104.53 million tonnes of Net in-situ Reconnaissance Resources (334 category) with average grade of 6.11% K_2O has been estimated by cross-sectional method.

1.6.3 However, total of 105.28 million tonnes of Net in-situ Reconnaissance Resources (334 category) with average grade of 6.05% K_2O has been estimated by polygonal method.

1.6.4 The difference between the two estimates—104.53 Mt (cross-sectional) and 105.28 Mt (polygonal)—represents a variation of 0.75 million tonnes, or roughly 0.71% higher in the polygonal method. This variance falls within the permissible limits, confirming the reliability and accuracy of the resource estimation.

1.7.0 RECOMMENDATION

1.7.1 Five substantial glauconite potential zones have been delineated based on the exploration data generated during the G4 stage exploration work carried out in the block.

1.7.2 To establish strike continuity and to assess the depth and grade continuity of the above-mentioned potential areas, systematic drilling operations may be undertaken to upgrade the block to the G-3 level.

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

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 QUALIFIED PERSONS

Exploration agency: Mineral Exploration and Consultancy Limited

Experience: 52 Years, Since 1972

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

Table 2.1
List of qualified persons involved in exploration of the block

Sl No.	Name
1	Shri P. Ravindran, Ex. GM (Exploration)
2	Shri Shrikant Sharma, HoD (Exploration)
3	Vikash Kumar, Sr. Manager (Geology)
4	Shri K.M Ram Pramod, Manager (Geology)
5	Sri Omkar Narayan Behera, Geologist
6	Shri Deepesh Rawat, Manager (Drilling)
7	Shri Mitesh Kumar, Manager (Drilling)
8	Shri Rohit Sharma, Manager (Chemical lab)
9	Shri Sayantan Pal, Manager (Geology)
10	Ms. Rajanya Roy, Assistant Manager (Geology)

CHAPTER-3

3.0.0 TITLE AND OWNERSHIP

3.1.0 TITLE OF THE REPORT

"GEOLOGICAL REPORT ON RECONNAISSANCE SURVEY (G-4 STAGE) FOR GLAUCONITIC SANDSTONE IN PARSADA-NAWAPARA-GURUR BLOCK (144 Sq Km) DISTRICT-BALOD, CHHATTISGARH"

Ownership: Government of Chhattisgarh

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 Reconnaissance Survey for glauconitic sandstone in Parsada-Nawapara-Gurur block, Balod, Chhattisgarh was recommended in 64th TCC held on 29th-30th April, 2024 and was subsequently approved in 35th EC held on 16.05.2024. MECL has received approval from the 35th Executive Committee of NMET through letter no. 23/457/2024-NMET/120, dated 10th June 2024, with the designated time duration of 12 months. The area of the exploration blockis 144sq. km, However the OM received has a typographic error and it is showing as 146.27 sq. km. Field operation was initiated by MECL on 16th June 2024, carried out Geological Mapping on 1:12,500 scale, bedrock sampling, pitting and drilling and the Geological Report is being submitted in September 2025.

MECL

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: 52 Years, Since 1972

Exploration agency: Mineral Exploration and Consultancy Limited

CHAPTER-4

DETAILS OF THE AREA

4.1.0 LOCATION AND ACCESSIBILITY OF THE BLOCK

4.1.1 The Parsada-Nawapara-Gurur G-4 exploration block falls in parts of the Survey of India Toposheet No. 64H06 and it lies between 20° 39' 25.931" N to 20° 44' 59.276" N latitudes and 81° 15' 0.000" E to 81° 30' 0.000" E longitudes.

4.1.2 The exploration block covers an area of 144.0 sq. km, situated in and around the villages of Parsada, Belmand, Karahibhadar, Chichbor, Chirchori, Karkabhat, Khairwahi, Nawapara, Mujgahan, Dhobanpur, Dhanora, Gurur, Thekwadih, Chitod, and adjoining settlements. These villages fall within Gurur and Balod tehsils of Balod district, in the state of Chhattisgarh. The location map of the exploration block is presented in PLATE–I for spatial reference. The coordinates of the cardinal points defining the block boundary, provided in both geodetic and UTM formats, are compiled in Table 4.1 and detailed further in Annexure–I.

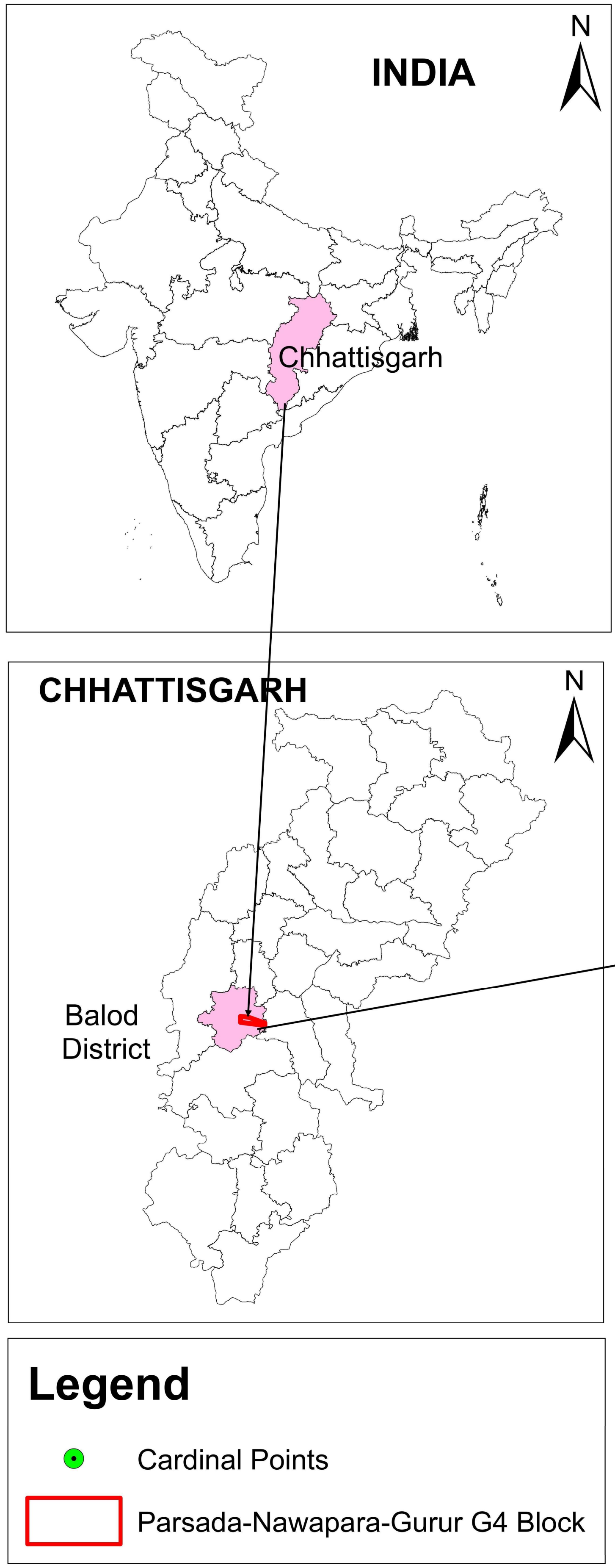
Table No.-4.1

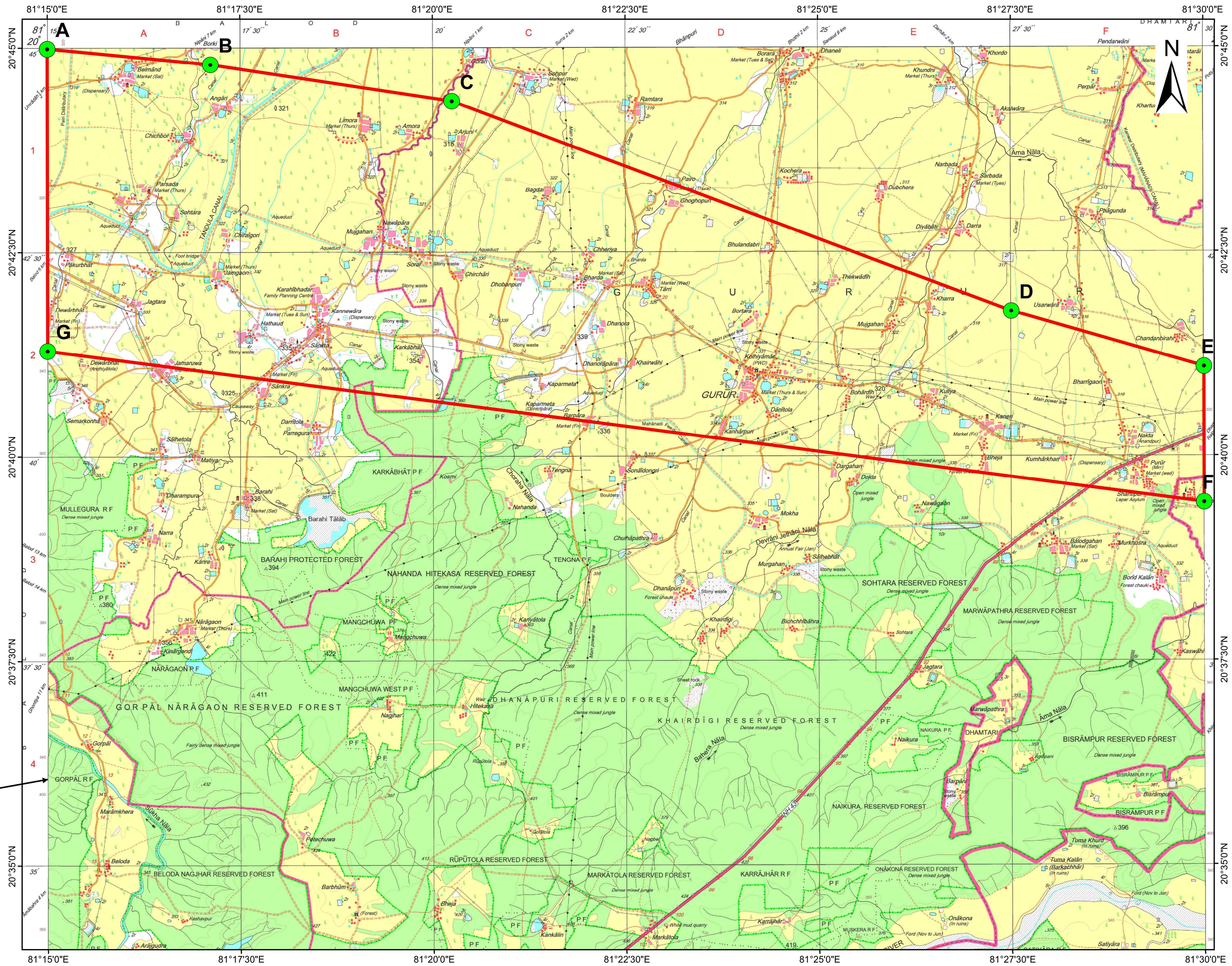
Co-ordinates of Cardinal Points of Block Boundary of Parsada-Nawapara-Gurur G-4 Block for Glauconitic Sandstone, District-Balod, Chhattisgarh

CARDINAL POINTS	UTM (ZONE- 44)		DDMMSS (WGS84)	
	EASTING (m)	NORTHING (m)	LATITUDE	LONGITUDE
A	526025.32	2294477.70	20° 44' 59.276" N	81° 15' 0.000" E
B	529697.91	2294129.72	20° 44' 47.758" N	81° 17' 6.982" E
C	535133.69	2293304.52	20° 44' 20.575" N	81° 20' 14.895" E
D	547734.89	2288583.86	20° 41' 46.011" N	81° 27' 30.163" E
E	552073.2	2287347.84	20° 41' 5.389" N	81° 30' 0.000" E
F	552082.63	2284290.31	20° 39' 25.931" N	81° 30' 0.000" E
G	526035.84	2287663.51	20° 41' 17.616" N	81° 15' 0.000" E

4.1.3 The Parsada-Nawapara-Gurur block is a part of Balod glauconitic sandstone belt and it is situated in the eastern part of the Balod Distt., Chhattisgarh. It falls in the Survey of India toposheet no. 64H06. The exploration block can be reached from Durg via Durg-Balod Road through NH-7. The road connects Balod to Dhamtari and passes throughout the block in east-west direction and passes through Karahibhadar, Gurur, and Anandpur via NH-930. Dhamtari railway station is the nearest railway station from the block located 16

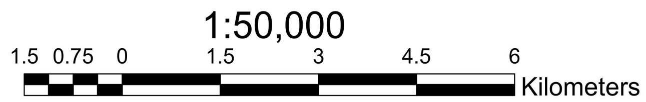
Km away in NE direction on Raipur–Dhamtari branch line of Bilaspur–Nagpur section. Raipur is the nearest airport from the block which is 80 km in NNE direction from the block. The location Map of the exploration block is also provided as Text Figure- 4.1.





Co-ordinate of Cardinal Point of Parsada-Nawapara-Gurur G-4 Block for Glauconite
District: Balod, Chhattisgarh

Cardinal Point	UTM Zone 44N (m)		DD° MM' SS"		Area (Sq. Km)
	Easting	Northing	Latitude	Longitude	
A	526025.3173	2294477.70	20° 44' 59.276" N	81° 15' 0.000" E	144
B	529697.9134	2294129.72	20° 44' 47.758" N	81° 17' 6.982" E	
C	535133.6888	2293304.52	20° 44' 20.575" N	81° 20' 14.895" E	
D	547734.8914	2288583.86	20° 41' 46.011" N	81° 27' 30.163" E	
E	552073.1969	2287347.84	20° 41' 5.389" N	81° 30' 0.000" E	
F	552082.6253	2284290.31	20° 39' 25.931" N	81° 30' 0.000" E	
G	526035.8366	2287663.51	20° 41' 17.616" N	81° 15' 0.000" E	



Text Figure-4.1: Location Map of Parsada-Nawapara-Gurur (G-4 stage) Block for Glauconitic Sandstone, District- Balod, Chhattisgarh

4.2.0 DETAILS OF THE AREA WITH LAND USE

4.2.1 Southern part of the block partially falls in Forest area (Protected Forest, Durg Circle, Balod Division Forest) and some parts falls under revenue land. Block is free from ESZ and Wildlife Sanctuary area. The exploration block is free from minor or major mineral leases.

4.2.2 The cadastral details of the area are not acquired.

4.3.0 MINERAL(S) UNDER INVESTIGATION

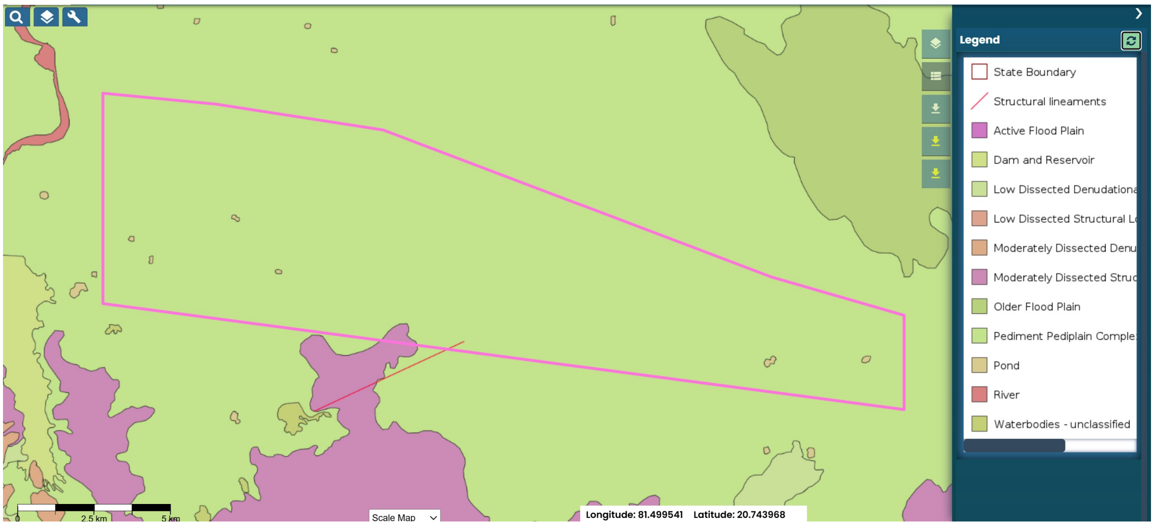
4.3.1 The block has been explored for glauconitic sandstone.

CHAPTER-5

PHYSIOGRAPHY AND ENVIRONMENT

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

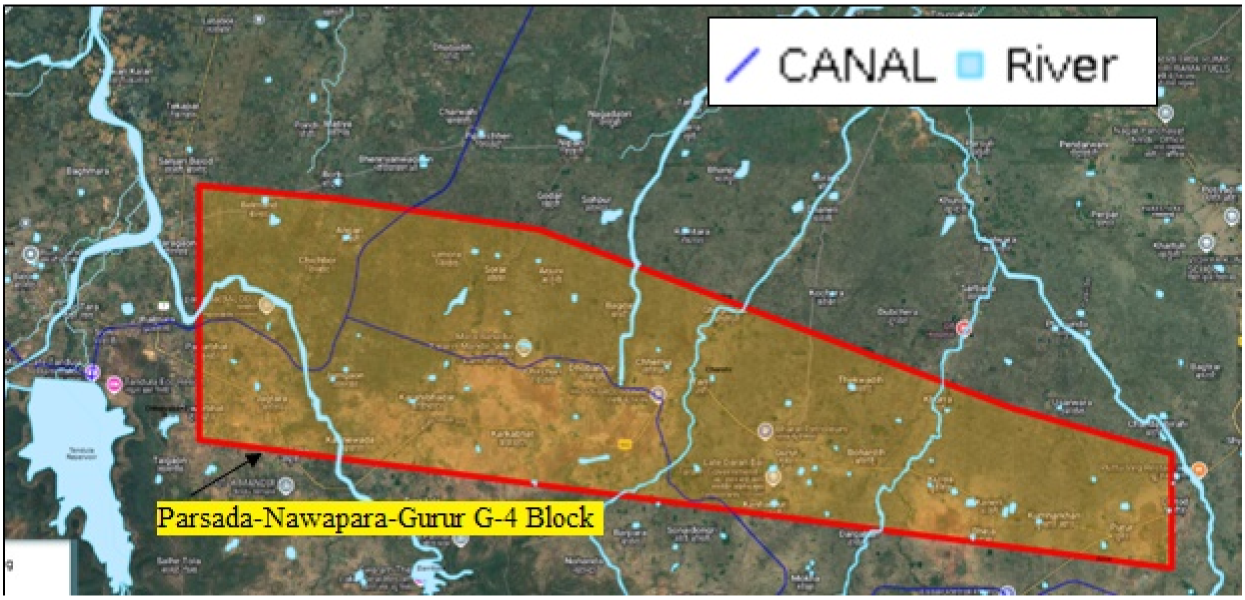
5.1.1 The topography of the area exhibits flat topography with slight variations. Exploration block falls in the southern part of Chhattisgarh basin and lithostratigraphically covers sandstone of two different formations. The regional slope of the area is towards north and northeast. The highest elevation of the area is 338m in the southern part of the block. The lowest elevation of the area is 319m in the western and eastern part of the block. Map showing Geomorphological features in and around the block is presented in Text figure 5.1. Major part of the block is Pediment Pediplain Complex reprented in green colour in the map while moderately dissected structural lower plateau is represented in pink colour is present near the southern margin of the block



Text Figure 5.1 Map showing Geomorphological features in and around the Parsada-Nawapara-Gurur G-4 block (Source : NGDR Portal)

5.1.2 The drainage pattern in the area is of dendritic type. No significant stream is present in the area. Mahanadi River passes about 8 km in the east from the eastern margin of the block. Map showing distribution river tributaries/canal in and around the Parsada-

Nawapara-Gurur G-4 block is presented as Text figure 5.2. River tributaries (skyblue colour), Canal (blue lines) passing through the block. Nearby reservoir is Tandula Reservoir.



Text Figure 5.2 Map showing distribution river tributaries/canal in and around the Parsada-Nawapara-Gurur G-4 block (Source : PM Gatishakti Portal)

5.1.3 The drainage pattern in the area is of dedritic type and it is mainly lithologically controlled. It varies from sub-parallel to dendritic and radial drainage. In the westernpart of the block, a significant nala flows in south to north direction and passes through Jamurawa in the south, Parsada (central part) and Chichbor(north) villages. In the central part of the block, Choraha Nala flows in south to north direction and and passes through Kaparmeta in the southern part and crosses near to Khairwahi, Tarri and Ghopuri in the north. Another significant Nala which is named as Devrani-Jethani Nala enters into the block near to Darghan in the south and flows in south to north direction and passes through Bohardih and Kharra villages. Banas river flows north to south in the west from of the block. All these three traverse the block from south to north and are more or less parallel to each other.

5.1.4 Block area is primarily characterized by its rural and forest landscape. Water resources play a crucial role in the lives of its residents for various purposes, including agriculture, drinking water supply and industrial use. Groundwater is an essential source of water for both agricultural and domestic purposes in the area. The area has few wells, hand pumps, and tube wells that tap into the groundwater reserves. The area has few water bodies, some of which are natural, while several canals have been created for water storage and irrigation purposes. Tandula canal is the major canal present in the western part of the block. These water bodies contribute to local water availability which is used for irrigation and livestock. Irrigation canals, often derived from the rivers/streamlets, are used to distribute water to agricultural fields across the area.

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

5.2.1 The exploration block can be approached from Durg via Durg-Balod Road through NH-7. From Balod to Dhamtari, the route travels east-west across the block, passing through Karahibhadar, Gurur, and Anandpur on NH-930.

5.2.2 The closest train station from the block is Dhamtari, which is 16 kilometers away in a northeastern direction on the Raipur–Dhamtari branch line of the Bilaspur–Nagpur section. The closest airport to the block is Raipur, which is located 80 kilometers to the northeast.

5.2.3 There are good networks of power transmission lines are available in the block. There is a major power line connecting Sohapur to Balod traverses the block in north-south direction via Bharda, Kaparmeta, Barpara etc. One of them connectes Barpara-Gurur-Kuliya-Purur, passes through the south central to eastern part of the block. Another one connects Balod to Kuliya passes through South of Gurur in SW-NE alignment, present in the south central part to eastern part of the block. Another significant power lines present in the block are Jamgaon-Sankra-Karkabhat-Dhanorapara-Kolhiyamata and Nawapara-Sorai-Chirchari-Bharda-Tarri having West-East alignment. Telephone and Internet line network is well developed in Balod district.

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

5.3.1 Balod district comprises of 7 tehsils - Balod, Dondi, Dondilohara, Marri Bangla-Devri, Arjunda, Gunderdehi and Gurur. The Parsada-Nawapara-Gurur (G-4 stage) block lies in the Balod and Gurur Tehsil, Balod district Chhattisgarh. There are 704 villages in Balod District. As per the Census India 2011, Balod district has 175469 households, population of 826,165, of which 105,498 (12.77%) live in urban areas. Balod has a sex ratio of 1022 females per 1000 males. Scheduled Castes and Scheduled Tribes make up 8.28% and 31.36% of the population respectively The total area of Balod district is 3527 sq.km with population density of 233 per sq.km.

5.3.2 Balod Tehsil of Durg district has a total population of 125,407 as per the Census 2011. Out of which 62,058 are males while 63,349 are females. In 2011 there were a total 27,370 families residing in Balod Tehsil. The Average Sex Ratio of Balod Tehsil is 1,021.

5.3.3 As per Census 2011 out of total population, 18.9% people live in Urban areas while 81.1% live in the Rural areas. The average literacy rate in urban areas is 88.1% while that in rural areas is 80.5%. Also the Sex Ratio of Urban areas in Balod Tehsil is 1,004 while that of Rural areas is 1,025.

5.3.4 The population of Children of age 0-6 years in Balod Tehsil is 14078 which is 11% of the total population. There are 7082 male children and 6996 female children between the age 0-6 years. Thus as per the Census 2011 the Child Sex Ratio of Balod Tehsil is 988 which is less than Average Sex Ratio (1,021) of Balod Tehsil.The details of the Population Census 2011, of Balod Tehsil are given in Table-5.1.

Table-5.1
Census Data of Balod Tehsil, Balod district, Chhattisgarh

Description	Total	Urban	Rural
Number of households			
Population	125407	23,648	101,759
Population (%)	100%	18.86%	81.14%
Children (0 - 6 years)	14,078	2,536	11,542
Schedule Caste	8,619	1,830	6,789
Schedule Tribe	32,740	2,733	30,007
Literacy	81.95%	88.06%	80.52%
Sex Ratio	1,021	1004	1025

Source: https://www.censusindia.co.in/subdistrict/balod-tehsil-balod-chhattisgarh-3321

5.3.3 Balod District in the state of Chhattisgarh has a significant tribal population. According to the 2011 Census of India (which is the most recent district-level detailed demographic source), here’s the status for Balod district, Chhattisgarh:

Total population: 826,165

Scheduled Tribe (ST) population: 259,043 □ 31.36% of the district population

For Balod Tehsil (a sub-division within Balod district):

Total population: 125,407

ST population: 32,740 □ 26.11% of the tehsil's total

5.4.0 SOCIO DEMOGRAPHIC PROFILE OF THE AREA AND NEARBY

5.4.1 Based on the 2011 Census data, Balod district in Chhattisgarh presents the following socio-demographic profile:

- Total Population: 826,165.
- Urban Population: 105,498 (12.77%).
- SC Population: 68,431 (8.28%).
- ST Population: 259,043 (31.35%).
- Literacy Rate: 80.28%.
- Sex Ratio: 1022 females per 1000 males.
- Child Sex Ratio: 983 females per 1000 males.
- Number of Households: 175,469.
- Work Participation Rate: 51.5%.
- Population Density: 233 people per square kilometer.
- Number of Villages: 704.
- Number of Village Panchayats: 437.
- Number of Subdivisions: 5.
- Number of Tehsils: 7.
- Number of Blocks: 5.

5.4.2 **Economic characteristics –**

- Agriculture: Balod is known for its production of paddy, grams, sugarcane, and wheat. The Tandula, Kharkhara, and Gondli dams are the main sources of irrigation in the district, according to the Balod District Administration. This suggests a strong agro-industrial potential in the area.

➢ Minerals: Balod has rich mineral resources, contributing approximately 78% of the district's revenue, according to the Balod District Administration.

5.4.2 In town, public facilities are easily available like auto rickshaw, bus, taxi. Dhamtari railway station is the nearest railway station from the block located 16 Km away in NE direction on Raipur–Dhamtari branch line of Bilaspur–Nagpur section. Balod district has witnessed significant improvements in road infrastructure, especially through the Pradhan Mantri Gram Sadak Yojana (PMGSY), under which over 270 km of rural roads and several key bridges have been constructed or upgraded. The district is also connected by National Highway NH-930, enhancing regional mobility toward Maharashtra and neighboring districts. State Public Works Department (PWD) initiatives have further improved intra-district link roads, including resurfacing and last-mile access to essential services. However, seasonal challenges like monsoon-related damage, including bridge collapses, continue to affect connectivity in certain areas, highlighting the need for more resilient and climate-proof infrastructure.

5.4.3 Balod district, located in the Durg division of Chhattisgarh, has a fairly well-distributed but basic educational infrastructure. According to government data, there are around 1,500–1,600 schools operating in the district across all levels, with a significant majority being government-run. These include primary, upper primary, secondary, and higher secondary schools. Most villages in the district have access to at least one primary school, while upper and higher secondary schools are more centralized in larger villages or block headquarters. The literacy rate stands at 80.28%, which is higher than the state average, though disparities remain—especially between urban and rural areas and between male and female literacy rates.

5.4.4 Several CBSE-affiliated institutions operate in Balod, including Jawahar Navodaya Vidyalaya, DAV Ispat Public School, and Eklavya Model Residential School (serving tribal populations). These schools cater to students from across the district and nearby areas, offering relatively better academic and extracurricular infrastructure. However, in most government schools, especially in remote areas, the availability of modern amenities like computer labs, science laboratories, and digital classrooms remains limited. Teacher absenteeism and infrastructure gaps in rural schools have been noted in anecdotal accounts, though exact district-level statistics on these issues are scarce.

5.4.5 At the higher education level, Balod district houses several government degree colleges offering undergraduate programs in arts, science, and commerce. These include Government College Balod, Government Eklavya College in Dondi Lohara, and others in Arjunda, Gurur, and Armarikala. However, the district lacks professional or technical institutions, such as engineering or medical colleges. Students aspiring for such careers typically move to Bhilai, Durg, or Raipur, where universities like Hemchand Yadav Vishwavidyalaya and CSVTU are located.

5.4.6 In summary, while the basic schooling network is relatively widespread in Balod, there is still a need for improved infrastructure, teacher availability, and access to quality education, especially in tribal and remote areas. For higher education and professional studies, students must rely on nearby urban centers. Continued efforts toward upgrading facilities, digital access, and skill-based education will be crucial for balanced educational development in the district.

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

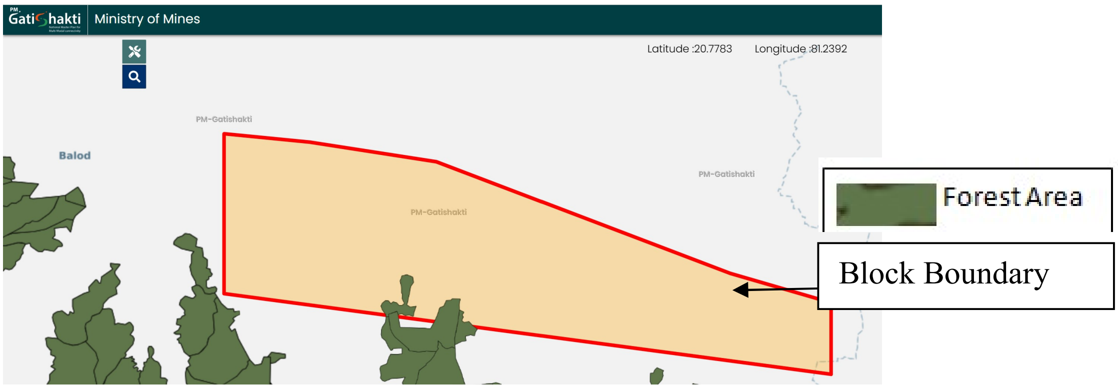
5.5.1 Balod district of Chhattisgarh is rich in cultural heritage and religious architecture, featuring several ancient temples and archaeological sites. Among the most notable are the Kapileshwar group of Shiva temples, known for their stone carvings and traditional temple design, and believed to date back centuries. Other significant heritage temples include those at Jagannathpur, Khapari (Kukur Dev Temple), and Dondi Lohara, reflecting the district's long-standing association with Shaivism and Hindu temple traditions.

5.5.2 The district also hosts several revered places of worship, attracting pilgrims and tourists alike. The Ganga Maiya Temple at Jhalmala is a prominent shrine dedicated to Goddess Durga and becomes a hub of activity during Navratri. Similarly, the Jaleshwar Mahadev Temple, located on the banks of Dasoundi Pond near Balod town, features a submerged Shiva Linga and is considered spiritually significant. The Siya Devi Temple, nestled in a forest near Naragaon, combines mythology with natural beauty, being linked to the Ramayana era and surrounded by scenic waterfalls.

5.5.3 In terms of public infrastructure and recreational utilities, the Tandula Dam stands out as both a vital water resource and a tourist attraction. Constructed in the early 20th century on the Tandula and Sukha rivers, it supplies drinking water to nearby cities like Bhilai and Durg while also serving as a popular picnic and nature spot for locals. Overall, Balod's mix of heritage temples, religious destinations, and natural sites offers both cultural depth and community utility.Block is free from any ASI monuments.

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

5.6.1 The **Parsada–Nawapara–Gurur G-4 exploration block** is free from any **Eco-Sensitive Zones (ESZ)** and **Wildlife Sanctuary** limits, making it environmentally permissible for mineral exploration without violating protected ecological regulations. However, a portion in the **southern part of the block** falls within **Protected Forest areas**, governed by the **Durg Forest Circle under the Balod Forest Division**.



Text Figure 5.3 Map showing Forest area in and around Parsada-Nawapara-Gurur G-4 block

5.7.0 FLORA AND FAUNA WITHIN AND NEARBY

5.7.1 Balod district lies at the confluence of tropical dry and moist deciduous forest ecoregions, creating a rich natural mosaic of flora and fauna. Forest surveys highlight dominant tree species—including Sal (Shorea robusta), Teak (Tectona grandis), Arjun (Terminalia arjuna), Saja (Terminalia tomentosa), Bija, Haldu, Mahua, Tendu and other hardwoods frequently found in traditional agroforestry systems across villages in Dondi and Dondi Lohara blocks (Source:Forest Clearancekrishikosh.egranth.ac.in). These are complemented by a host of medicinal and non-timber plants common to Chhattisgarh's woodlands, such as Neem, Imli, Mahua, Giloy, Aswagandha, and Aloe Vera (Source :enviscecb.org).



Photo 5.1 Mahua tree, Dauri Fruit and Tendu Tree (Local Names) near Dhanora Village

5.7.2 The district supports a range of wildlife typical of central Indian forests. Mammalian fauna reportedly include nilgai, sambar, chital, sloth bears, leopards, wild boar, monkeys, hyenas, jackals, jungle cats, and smaller mammals such as porcupines, civets, and hares (Source : enviscecb.org). More recently, a pangolin—a rare and threatened mammal—was rescued in a village in Balod, underscoring the district's wildlife significance beyond protected areas

5.7.3 Avian diversity in Balod is promising: eBird records from 2025 include sightings of Common Myna, Spilopelia doves, Large Grey Cuckoo (Centropus), Oriental Magpie-Robin (Copsychus), and Pagoda Starling (Sturnia), especially around water bodies like Tandula, Gondli, and Kharkhara dams (Source : ebird.org). Conservation initiatives are underway, such as a 2025 CAMPA-sponsored biodiversity restoration program planting over 1.16 lakh saplings across 171 hectares using scientific methods, as well as efforts to cover open wells in the Balod forest division to prevent wildlife accidents.Together, these diverse forest types, agroforestry landscapes, and growing conservation measures offer a robust basis for biodiversity in Balod.

5.8.0 WATER BODIES SUCH AS RIVER, STREAM, RESERVOIR, ETC

5.8.1 The Parsada–Nawapara–Gurur G-4 exploration block in Balod district exhibits a predominantly flat terrain, with a gentle regional slope towards the north and northeast. Elevations in the block range from 338 meters in the south to 319 meters in the western and eastern margins. The drainage pattern is dendritic, typical of uniform lithology and moderate slopes, though no prominent perennial streams exist within the block itself. Notably, the Mahanadi River—a major regional watercourse—flows approximately 8 kilometers east of the block and contributes to the broader hydrological framework of the area.

5.8.2 Hydrologically, the Kharun River is the primary surface water system in the region, flowing from south to north through the Gurur block before merging with the Shivnath River. It is sustained by tributaries like Ama Nala and Choraha Nala, which facilitate local watershed drainage, support agriculture, and contribute to groundwater recharge.

5.8.3 Under the Narwa Vikas Yojana, a major watershed rejuvenation initiative by the Chhattisgarh government, over 40 sq. km of catchment—including Kharun Nala—was treated using 406 micro-structures like check dams, contour trenches, and percolation pits. These interventions have significantly improved soil moisture, increased water availability, and enhanced agricultural productivity and livestock sustainability, particularly during dry periods.

5.8.4 Tandula Dam located about 2 km from Balod town, serves as a crucial reservoir. Tandula Dam is constructed on the Tandula River, which is a tributary of the Shivnath River (part of the Mahanadi basin) in Chhattisgarh with a catchment area of 827 sq. km and a storage capacity of 302 million cubic meters, it provides drinking water to Durg and Bhilai, and supports irrigation and industrial supply. Other small reservoirs such as Gondli and Kharkhara (in Dondi Lohara block) also contribute to seasonal irrigation and biodiversity conservation. The Kharkhara Dam, with its picturesque waterfall and reservoir setting, plays an additional role in promoting local ecotourism, especially during the monsoon.

5.8.5 Refer to Text Figure 5.2 showing distribution river tributaries/canal in and around the Parsada-Nawapara-Gurur G-4 block.

5.9.0 CLIMATIC CONDITIONS

5.9.1 The area has a moderate semi-arid / sub-tropical climate. It experiences a tropical climate, characterized by three distinct seasons: summer, monsoon, and winter.(Source:https://www.worldweatheronline.com/Balod-weather-averages/chhattisgarh/in.aspx).

5.9.2 The climate of Balod district is classified as tropical monsoon type, characterized by three distinct seasons—summer, monsoon, and winter. The cold season typically spans from mid-November to the first week of February, lasting about 2.7 months. During this period, average daytime temperatures remain below 29°C, with December being the coldest month, witnessing average lows of 15°C and highs around 26°C.

5.9.3 The hot season occurs between mid-April and mid-June, lasting approximately 2 months, and is marked by intense heat and dry conditions. May is the hottest month, with average day time highs reaching around 40°C and night time lows averaging 28°C, often accompanied by hot winds and dry spells.

5.9.4 The monsoon season arrives by late June, bringing the bulk of the district's average annual rainfall of about 1090 mm, primarily concentrated in July and August. This seasonal rainfall is crucial for recharging groundwater, sustaining agriculture, and supporting the natural vegetation in the region.

5.9.5 Overall, Balod's climatic conditions are typical of central India, with moderate winters, scorching summers, and a rain-fed agricultural dependency during the monsoon. The variability in rainfall and temperature also influences land use patterns, cropping cycles, and water resource management across the district.

5.10.0 OTHER PHYSIOGRAPHIC, SOCIAL AND ENVIRONMENTAL FACTOR

5.10.1 Various physiographic, social, and environmental factors play a significant role in shaping the region. Here are some of the key factors in each of these categories:

5.10.2 **Physiographic Factors:**

1. Topography: Balod district lies predominantly within the Central Chhattisgarh Plain, a gently undulating terrain formed over Proterozoic sedimentary rock, with an average elevation of 324 m above sea level. The land features structural plains and occasional floodplains along river courses.

2. Soil: Typical soils include Entisols, Alfisols, Inceptisols, and Vertisols, with Alluvium saturating about 3-5 % of the total area, particularly near major rivers. This geological and soil mosaic provides relatively fertile conditions and moderate agricultural productivity

3. Rivers and Water Bodies: From a physiographic and hydrological standpoint, the district is drained by tributaries of the Mahanadi River, particularly the Tandula River, which is impounded by the Tandula Dam near Balod town. Additional sources of irrigation include the Kharkhara and Gondli dams, while smaller water retention structures under the Narwa Vikas Yojana have significantly enhanced water availability for agriculture in blocks like Gurur and Gunderdehi.

4. Forests and Natural Resources: Environmentally, Balod supports mixed dry deciduous forests, albeit with relatively modest forest cover compared to districts in Bastar. Dominant species include Sal (Shorea robusta) as part of the state's emblem, along with Teak, Mahua, and Terminalia species. These forests are important habitats for wildlife, but density is lower than in core forest districts of Chhattisgarh

5.11.0 Social Factors:

1. Demographics: The district has a diverse population comprising various ethnic groups, including indigenous communities. The demographic composition affects cultural practices, languages spoken, and social dynamics. Socially, Balod is a predominantly rural district, with over 87% of its population residing in village areas. Scheduled Tribes (31%) and Scheduled Castes (8%) contribute significantly to the demographic mix, and tribal cultural practices, languages, and festivals strongly influence community life across both tribal and non-tribal populations.

2. Education: Access to quality education is a critical social factor. The literacy rate and educational infrastructure in Balod impact the overall development of the region.Balod district has a fairly robust educational infrastructure with over 1,650 schools serving nearly 1.86 lakh students, primarily through government institutions. Primary and secondary schooling is widespread, and literacy rates are relatively high—about 81.95% overall, with male literacy at 90.5% and female literacy at 73.6%. Initiatives like the Swami Atmanand English Medium Schools (SAGES) have expanded access to quality English-medium education, especially benefiting rural and tribal populations. However, some rural schools still face challenges such as limited digital infrastructure and uneven teacher distribution, which the Chhattisgarh government is addressing through a large-scale recruitment and rationalization drive. At the higher education level, the district hosts several general degree colleges affiliated with Hemchand Yadav Vishwavidyalaya, offering undergraduate courses in arts, science, and commerce. Vocational training institutes like the Bharat Institute of Nursing add to the district's educational options, though there remains a lack of in-district professional institutions for engineering, medicine, or management. Students often migrate to urban centers like Durg and Raipur for advanced studies. District Mineral Foundation (DMF) funds and state programs are also being leveraged to improve infrastructure and promote educational inclusion among Scheduled Tribes and Scheduled Castes, which form a significant portion of the local population.

3. Healthcare: Healthcare facilities and access to healthcare services play a crucial role in the well-being of the population. Availability of hospitals and healthcare professionals is an important social consideration. Balod district has a structured public healthcare system comprising a District Hospital, Community Health Centres (CHCs), Primary Health Centres (PHCs), and Sub Centres, many of which are empanelled under the Ayushman Bharat scheme offering cashless treatment. Despite this infrastructure, challenges such as shortages of medical specialists and uneven service delivery in rural areas persist. Mobile medical units under the Mukhyamantri Haat Bazaar Clinic Programme have improved outreach in remote and tribal regions. The district has demonstrated effective emergency responses, such as during bird flu and diarrheal outbreaks, but continues to face public health

issues related to water quality, sanitation, and equitable access for vulnerable populations.

4. Cultural Diversity: Balod is known for its rich cultural heritage, with various festivals, traditions, and art forms that reflects the diversity of its residents. Balod district showcases rich cultural diversity, deeply rooted in Chhattisgarh's tribal and folk traditions. The region is home to various tribal communities like Gond and Halba, who contribute to a vibrant cultural landscape through their distinct languages, customs, festivals, and crafts. Local celebrations such as Hareli, Pola, and Matar attract widespread participation and are marked by folk dances like Panthi and Raut Nacha. Traditional art forms, music, and cuisine reflect a harmonious blend of tribal heritage and rural agrarian life. Despite modern influences, Balod continues to preserve its indigenous identity, with cultural programs and state-sponsored initiatives promoting local traditions and inter-community cohesion.

5. Livelihood:

   a) Livelihood in Balod district is deeply rooted in agriculture-based subsistence farming, which continues to sustain the majority of rural families. Traditional agroforestry systems—such as agrisilviculture, homestead mixed cropping, agri-horti-silvipasture, and silvipasture—contribute additional income, though often less than 5% of annual earnings. In blocks like Dondi and Dondi Lohara, agriculture provides between 65–97% of household income, and average annual income ranges from ₹80,000 to ₹2.5 lakh per household. Cultivated crops typically include rice, wheat, chickpeas, sugarcane, and lentils, often grown under rainfed conditions on small landholdings (mostly under 2 hectares), which defines an agrarian livelihood closely tied to the monsoon cycle BalodKrishikoshJPDS.

   b) Complementary livelihoods are shaped by animal husbandry and cheaper to adopt forest-based resources. Livestock—such as poultry, goats, cattle, buffaloes, and pigs—serves as a buffer income source against crop failures, and acts as draught power or manure providers. Non-timber forest products (NTFPs) supplement household earnings, especially in tribal blocks, albeit modestly. Around 80% of rural households engage in some form of livestock rearing, as agriculture alone often yields low returns. State schemes and new interventions aim to strengthen livestock productivity through better veterinary support and breed improvement.

c) The district's prosperity is further shaped by mineral wealth, particularly iron ore deposits mined at Dalli Rajhara, which feed the Bhilai Steel Plant. Mining provides alternative livelihood opportunities to tribal and non-farming communities through wage labor, although most of the economic benefits flow outwards due to external company ownership and limited local value addition https://mpcg.ndtv.in/Reddit. Meanwhile, government initiatives like PM-Kisan Samman Nidhi and District Project Livelihood College training programs offer financial support and vocational training to enhance farm incomes, diversify skills, and build resilience among rural households Sakshi PostBalod.

d) Overall, the livelihood tapestry in Balod reflects a dual economy: rainfed agriculture backed by agroforestry and livestock, and mining-based wage employment, intertwined with modern social protection instruments and skill development schemes to stabilize incomes and reduce rural poverty.

5.12.0 Environmental Factors:

1. Biodiversity: The district's diverse ecosystem supports a variety of flora and fauna. Conservation efforts are essential to protect the region's biodiversity.

2. Agriculture: Agriculture is a major source of livelihood in Balod. Environmental factors such as rainfall, soil quality, and irrigation infrastructure influence the crop production.

3. Environmental Conservation: Issues like deforestation, soil erosion, and water pollution are environmental challenges that need attention to ensure sustainable development.

4. Climate: The district's climate, influenced by its geographical location, impacts agricultural practices, water resources, and the overall environment. Climate change concerns also need to be addressed.

5. Pollution: As industrialization and urbanization increase, issues related to air and water pollution may arise, affecting the health and well-being of the population.

6. Water Resources: Managing water resources is crucial for agriculture, drinking water supply, and overall sustainability. Reservoirs, Rivers and other Groundwater Resources in the region are essential for water management.

5.13.0 These factors interact in complex ways to shape the physiographic, social, and environmental landscape of region. Sustainable development and improving the quality of life in the district require a comprehensive understanding of these factors and their interplay.

CHAPTER-6

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 Parsada-Nawapara-Gurur G-4 stage block lies in the vicinity of Parsada, Belmand, Karahibhadar, Chichbor, Chirchori, Karkabhat, Khairwahi, Nawapara, Mujgahan, Dhobanpur, Dhanora, Gurur, Thekwadih, Chitod etc villages in Gurur and Balod tehsil of Balod district in State of Chhattisgarh. There are no any major or minor mining leases present inside and outside of the block. Block is free from ESZ and Wildlife Sanctuary area. Southern part of the block partially falls in Forest area (Protected Forest, Durg Circle, Balod Division Forest).Block is free from any ASI monuments.

Text Figure 6.1 Map showing villages in and around Parsada-Nawapara-Gurur G-4 block

6.1.2 In Balod, educational infrastructure includes one general college, a government training center, and a health-care-associated polytechnic. The district as a whole, encompassing Balod and Gurur Tehsil, hosts several institutions—including Government Shri Ghanshyam Singh Gupt College, Government Engineering and Polytechnic colleges, and the established Government Shaheed Kaushal Yadav College. Schools in Gurur and surrounding blocks offer considerable coverage with numerous government schools along with several private and English-medium schools, improving reach of secondary education in rural cluster.

6.1.3 Balod town maintains a strong network of nationalized and private banks (Axis Bank, Bank of Baroda, HDFC, among others), ensuring robust access to financial services in and around Balod town – encompassing both urban and peri-urban populations. Gurur Tehsil relies on these branches for banking needs, with scope remaining to bring in agent-based or micro-banking units to remote villages for inclusion.

6.1.4 Tandula Dam, completed in 1921/23, lies approximately 2–5 km from Balod. Beyond its vital role supplying drinking and industrial water (e.g., Bhilai Steel Plant), the dam's slowly rippling reservoir environs and nearby tourist resort (managed by state tourism) are favored by locals and visitors.Other scenic reservoirs—Gondli Dam and Matiyamoti Dam—within 5–10 km of Balod offer tranquil settings.

6.1.5 While the district does not yet have a formal museum or heritage interpretive centre, many historic and geological sites (temples, rock-art caves, megaliths, dams) are used informally as living museums. Local civic spaces such as parks are minimal; most recreational green zones occur organically around water bodies (Tandula, Siya Devi reservoir) rather than purpose-built urban parks.

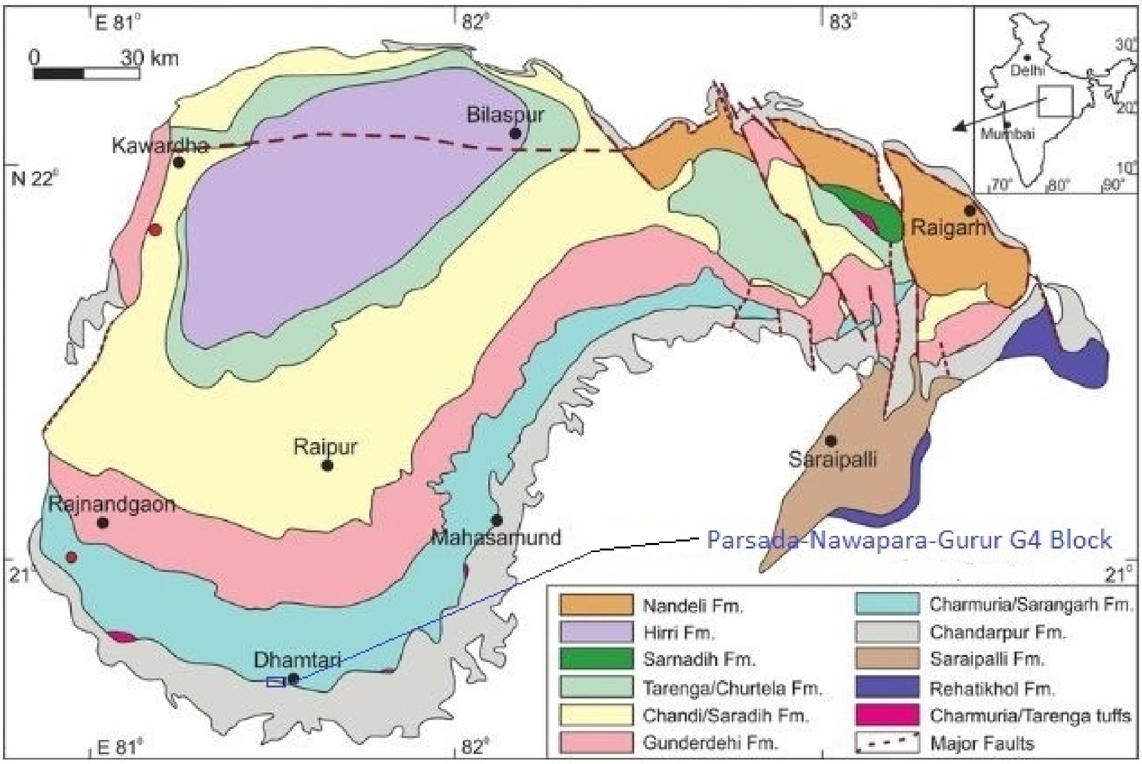
6.1.4 The details of host population, historical sites, forests and environmental setting of the area has been described in Chapter-5 (Physiography and Environment).

CHAPTER-7

GEOLOGY OF THE AREA

7.1.0 REGIONAL GEOLOGY

7.1.1 Regionally, the present exploration block falls in the southern part of Chhattisgarh basin and lithostratigraphically forms part of Raipur Group and Chandarpur Group of Chhattisgarh Supergroup belonging to Meso-Neo proterozoic age. The Chhattisgarh Basin is a major sedimentary basin located in central India. Geologically significant, it preserves an extensive record of Proterozoic sedimentation and is notable for hosting economically viable minerals, including glauconite, which has recently garnered attention due to its classification as a critical mineral.



A generalized geological map of the Chhattisgarh Basin showing various lithological units of the Chhattisgarh Supergroup, modified after Mukherjee et al. (2014) and Saha and Patranabis-Deb (2014).

Text Figure 7.1 A generalized Geological Map of the Chhattisgarh Basin showing various lithological units of the Chhattisgarh Supergroup, modified after Mukherjee et. al. (2014) and Saha and Patranabis Deb (2014)

7.1.2 The basin is crescent-shaped, covering approximately 33,000 square kilometers across several districts—namely Raipur, Durg, Balod, Rajnandgaon, Bilaspur, and Raigarh in Chhattisgarh, with extensions into parts of Odisha and Maharashtra. Its spatial extent and stratigraphic integrity make it a key target for both academic research and mineral exploration.

7.1.3 The Chhattisgarh Basin is categorized as an intracratonic basin, which means it developed within the stable interior of a continental crust. It exhibits minimal deformation and low-grade metamorphism, making it an ideal repository for preserved sedimentary sequences.

7.1.4 Tectonically, the basin lies over a Precambrian basement. The Bastar Craton forms its southern floor and is composed of Archaean to Lower Proterozoic granite-gneiss, greenstone belts, and supracrustal rocks. In contrast, the northern margin interfaces with the Satpura Mobile Belt, comprising high-grade metamorphics of the Bilaspur-Raigarh-Sarguja group.

7.1.5 The basin is bounded by significant geological formations and lineaments. On the western side, it is constrained by the Dongargarh Supergroup volcanics, exhibiting faulted margins. The Mahanadi Lineament defines the northeast boundary, while the Eastern Ghats Mobile Belt (EGMB) borders it to the southeast. These structural features played a crucial role in basin subsidence and sediment accumulation.

7.1.6 Stratigraphically, the Chhattisgarh Basin is divided into two primary groups: the Chandarpur Group (older) and the Raipur Group (younger). These groups encompass various formations that represent distinct depositional environments, ranging from fluvial to shallow marine.

7.1.7 The Chandarpur Group, found at the base of the basin's sedimentary sequence, consists primarily of sandstones, ferruginous beds, and glauconitic sandstones. It records the initial transgressive marine phase and includes formations like Lohardih, Kansapathar, and Chaporadih. These formations are significant for both their stratigraphic and mineral potential.

7.1.8 Overlying the Chandarpur Group is the Raipur Group, composed predominantly of stromatolitic limestones and dolostones. Formations such as Charmuria and Gunderdehi suggest a stable, shallow marine platform environment. These carbonates provide insights into Proterozoic biogenic activity and basin-wide transgression events.

7.1.9 In a typical exploration block within Balod or Gurur tehsils, distinct litho-units of the Chhattisgarh Supergroup can be traced spatially. These include Charmuria cherty limestone in the north, Kansapathar glauconitic sandstone in the east, Lohardih ferruginous sandstone in the center, and exposures of Dongargarh Granite in the south.

7.1.10 The Kansapathar Formation of the Chandarpur Group hosts glauconitic sandstone and is of immense geological and economic interest. Glauconite here appears as fine-grained, greenish, friable sandstone enriched with glauconite pellets, indicative of deposition in a marine shelf environment.

7.1.11 The glauconitic sandstones represent sedimentation under slow sedimentation rates, low oxygen conditions, and transgressive marine settings, where chemical conditions favored the authigenesis of glauconite minerals. These conditions prevailed during the Meso-Neoproterozoic and align with the glauconite-forming periods.

7.1.12 Glauconite is rich in potassium (K_2O), often ranging from 6% to 10% in Chhattisgarh samples. This makes it a potential alternative source of potash, which is crucial for fertilizers. India's current reliance on imports for potash makes glauconite a mineral of strategic importance.Due to its potassium content and applicability in green technologies (like CO_2 capture and slow-release fertilizers), glauconite has been designated as a critical and strategic mineral by the Government of India. Its extraction could help reduce dependence on imported resources and support sustainable agriculture.

7.1.13 Exploration studies by MECL and GSI have confirmed glauconite presence in Balod and Gurur tehsils, particularly in the eastern sectors where Kansapathar Formation is well exposed. These findings have encouraged state-level initiatives to auction glauconite blocks under critical mineral exploration. The Lohardih Formation, comprising ferruginous sandstone, lies centrally in the block and may host iron enrichment. To the north, the Charmuria Formation consists of cherty limestones and represents a more stable carbonate platform. These units provide stratigraphic markers and context for glauconite distribution.

7.1.14 The Dongargarh Granite, exposed in the southwestern and southeastern parts of the region, represents the basement complex. These coarse pink granites form the structural and chronological floor over which the Chhattisgarh sediments were deposited. Their uplift and erosion also influenced sediment supply.

7.1.15 Regional geology map (Plate-II and Text Figure 7.2) show distinct zoning of lithologies and structural patterns. The overall dip of formations is gentle, and the region is marked by lineaments, fracture zones, and minor faulting.

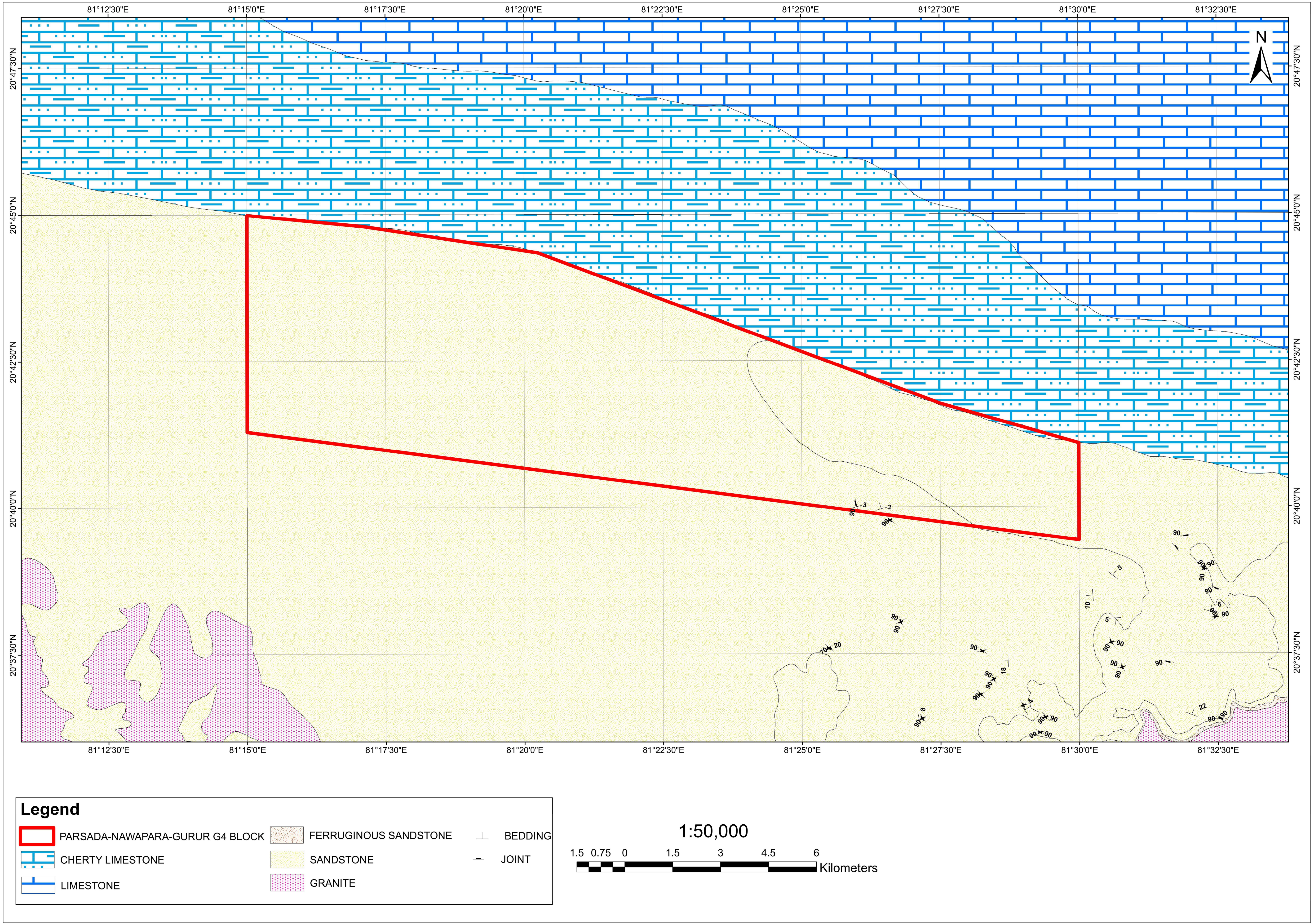
7.1.16 Regional stratigraphic succession of the litho-units after Das et. al (1992), GSI is illustrated in the Table 7.1

Table 7.1
Regional Stratigraphic sequence of Litho units (After Das et. al, 1992, GSI)

Age	Super Group	Group	Formation	Lithology
Late Proterozoic	Dongargarh			Dongargarh Granite
Meso Proterozoic – Neo Proterozoic	Chhattisgarh	Raipur	Charmuria	Purple limestone (phosphatic), Dark grey bedded limestone with shale intercalations, cherty limestone.
		-----------------Gradational contact------------------		
		Chandarpur	Kansapathar	Glauconitic Sandstone
			Chaporadih	Shale / Quartz arenite
			Lohardih	Ferruginous Sandstone

MECL

Text Figure 7.2: Regional Geology map showing the Parsada-Nawapara-Gurur (G-4 stage) block



7.2.0 REGIONAL STRUCTURE

7.2.1 The Chandarpur Group of the Chhattisgarh Basin exhibits a predominantly stable and gently deformed structural setting, which plays a crucial role in the deposition and preservation of glauconitic sandstone, particularly in the Kansapathar Formation. The Chhattisgarh Basin, being an intracratonic sag basin, experienced limited tectonism during sedimentation. This relative tectonic stability allowed for the accumulation of glauconite—a green, iron-rich, authigenic mineral—under marine conditions with slow sedimentation and low oxygen levels. The Kansapathar Formation lies conformably over the ferruginous sandstone of the Lohardih Formation and underlies finer siliciclastic sediments of the Gunderdehi Formation, forming a continuous stratigraphic sequence with little structural disruption.

7.2.2 Structurally, the Chandarpur Group is characterized by gentle dips (3°–10°), with broad open folds and shallow synclines and anticlines developed over the basement topography. The glauconitic sandstone horizons are largely undeformed and maintain good lateral continuity across the basin. However, local thickness variations within the Kansapathar Formation suggest minor structural influences such as differential subsidence, basement undulations, and syn-sedimentary faulting, which may have created localized accommodation space for glauconite-bearing sediments. The central and eastern parts of districts like Balod and Durg host better-developed glauconitic sequences, likely reflecting structural lows or depositional troughs.

7.2.3 The regional structure also includes a few normal faults and fractures, often aligned along NE-SW and NW-SE directions, which may represent minor tectonic reactivation post-deposition. These features generally do not disrupt the glauconitic unit but may have contributed to post-depositional fluid movement, influencing the diagenesis and iron content of the sandstone. In some zones, joints and fractures have facilitated lateritization and surface weathering, potentially altering the glauconite mineralogy.

7.2.4 In conclusion, the regional structure of the Chandarpur Group—marked by broad, gentle folds and minimal faulting—has preserved the glauconitic sandstone in relatively pristine condition. The basin's tectonic quiescence, combined with favorable depositional environments, made it ideal for glauconite formation. Understanding these structural features is essential not only for geological mapping but also for mineral exploration and resource assessment of this strategic mineral.

7.3.0 REGIONAL MINERALIZATION

7.3.1 The Chandarpur Group of the Chhattisgarh Basin hosts notable occurrences of glauconitic sandstone, particularly within the Kansapathar Formation, which is emerging as a key target for strategic mineral exploration in India. Regional mineralization within this unit is characterized primarily by the presence of glauconite, an iron-potassium silicate mineral of sedimentary origin. Glauconite forms under specific geochemical and sedimentary conditions, and its occurrence in the Chandarpur Group signifies significant paleoenvironmental and mineral potential.

7.3.2 Nature of Mineralization

The glauconitic mineralization in the Chandarpur Group is stratabound and conforms to the sedimentary bedding within the Kansapathar Formation. The glauconite occurs as:

- Greenish, friable to compact sandstone beds,
- Pellets and coatings over detrital grains,
- Dispersed fine particles and lenses within sandstone and siltstone layers.

The mineralization is typically confined to the lower to middle sections of the Kansapathar Formation, where the conditions were most favorable for glauconite formation: low sedimentation rate, shallow marine reducing environment, and slow burial. The concentration of glauconite varies across different parts of the basin, influenced by facies variation, sedimentary energy, and basement topography.

7.3.3 Regional Distribution

Significant glauconitic sandstone horizons have been identified in the Balod, Durg, and Rajnandgaon districts of Chhattisgarh. These areas correspond to structurally controlled basinal lows or synclinal zones, where relatively thick sediment packages were deposited during the Proterozoic. The Balod-Gunderdehi region, in particular, exhibits thick sequences of glauconitic-bearing sandstone, with concentrations often exceeding 10–20% glauconite in some zones, as per exploration reports.These occurrences are continuous over several kilometers, showing promising potential for bulk mining. Regional exploration efforts, including geological mapping, trenching, and drilling, have confirmed the lateral persistence and uniformity of glauconitic mineralization.

7.3.4 Mineralogical and Chemical Features

Glauconite in the Chandarpur Group is green to dark green in color and commonly shows:

- Botryoidal or pellet-shaped textures,
- Association with quartz, feldspar, and mica,
- Enrichment in Fe (iron), K (potassium), Al (aluminum) and trace elements like REEs (rare earth elements) in some zones.

The chemical composition of glauconite renders it valuable for multiple applications:

- As a potassium-bearing fertilizer,
- As a natural pigment and industrial filler,
- As a source of critical minerals such as potash and iron.

7.3.5 Genesis and Paleo-environmental Significance

The mineralization of glauconite within the Chandarpur Group points to deposition in a shallow marine, low-energy shelf environment, where reducing conditions, organic-rich sediments, and microbial activity promoted glauconite authigenesis. These factors are typically found in transgressive systems tracts, where marine transgression leads to condensation and reduced clastic influx—ideal for glauconite formation.The glauconite beds also serve as paleoenvironmental markers, indicating marine incursions, eustatic sea-level changes, and sediment starvation—all critical parameters for understanding basin evolution and guiding further mineral exploration.

7.3.6 Economic and Strategic Importance

Given India’s thrust on critical and strategic mineral development, glauconite-bearing rocks of the Chandarpur Group are receiving renewed attention. The mineral is being considered a domestic substitute for potash imports, which are otherwise heavily dependent on foreign sources. Moreover, with the growing global interest in green fertilizers and eco-friendly mineral products, glauconite holds significant promise.The regional mineralization in the Kansapathar Formation positions Chhattisgarh as a future hub for glauconite-based mineral industries, especially in the Balod-Gurur-Gunderdehi belt.

7.4.0 BLOCK GEOLOGY

7.4.1 Parsada-Nawapara-Gurur G-4 block lies within the southern sector of the Chhattisgarh Basin, hosting Meso- to Neoproterozoic litho-units belonging to the Chandarpur Group of the Chhattisgarh Supergroup. This sequence comprises predominantly siliciclastic sedimentary rocks and records significant transitions in depositional settings, from fluvial to marine environments. The two prominent formations occurring in the area are the Kansapathar Formation (younger) and the Lohardih Formation (older), representing distinct geological episodes and sedimentary processes within the basin.

7.4.2 The Kansapathar Formation, being the uppermost unit of the Chandarpur Group, displays classic features of a transgressive-regressive sequence. The lower part of this formation consists of fining-upward strata, suggesting a marine transgression over an older fluvial plain, while the upper part shows a coarsening-upward pattern, indicative of prograding shallow marine to coastal settings. Lithologically, the Kansapathar Formation is dominated by well-sorted, medium- to coarse-grained quartz arenite, signifying high-energy depositional conditions. One of the most economically significant aspects of this formation is the presence of glauconite, often occurring in variable concentrations throughout the sandstone beds.

7.4.3 The glauconitic sandstones of the Kansapathar Formation represent strategic mineralization within the explored block. Glauconite typically forms under marine, low-energy, anoxic conditions, which correspond to the transgressive phase observed in the Kansapathar sequence. The presence of glauconite is critical not just for its use as a potash alternative in fertilizers but also due to the complexity of extracting it.The glauconite occurs in pellet form and as coatings on detrital grains, with thickness and concentration varying across facies belts. These glauconitic horizons are being explored actively for their economic and strategic value.

7.4.4 The Lohardih Formation, underlying the Kansapathar Formation, marks the basal unit of the Chandarpur Group and represents the earliest stage of siliciclastic deposition in the Chhattisgarh Supergroup. This formation is predominantly composed of ferruginous sandstone, which is feldspathic and medium- to coarse-grained, and often includes shale partings and polymictic conglomerates at the base. The conglomerates signify high-energy depositional episodes—possibly from braided fluvial systems and alluvial fans—that reflect the tectonic rejuvenation and erosion of the surrounding Archaean-Proterozoic basement.

7.4.5 The depositional regime of the Lohardih Formation suggests a transition from continental to shallow marine conditions. The lower conglomeratic facies indicate proximal alluvial fan settings, possibly developed adjacent to active basement highs or uplifted blocks. This is followed by a more mature marine transgression, resulting in the development of wave- and tide-influenced shoal-bar systems. These bars likely reworked earlier fluvial sediments, forming hybrid arenites enriched in iron oxides, which give the rocks their characteristic ferruginous hue. This vertical facies transition captures a significant part of the early basin evolution.

7.4.6 Shale has not been observed on the surface within the block area, but inaviably found in the boreholes as intercalation with sandstone, sandwiched between the Kansapathar sandstone below and other overlying units

7.4.7 The conglomerate of the Lohardih Formation in the block, marks the basal unit of the Chandarpur Group, comprising poorly sorted, matrix-supported clasts deposited in a high-energy alluvial fan to fan-delta setting. It rests unconformably over the Archean basement and signifies the onset of sedimentation in the Chhattisgarh Basin.

7.4.8 Apart from these, laterites also observed in the area at places.

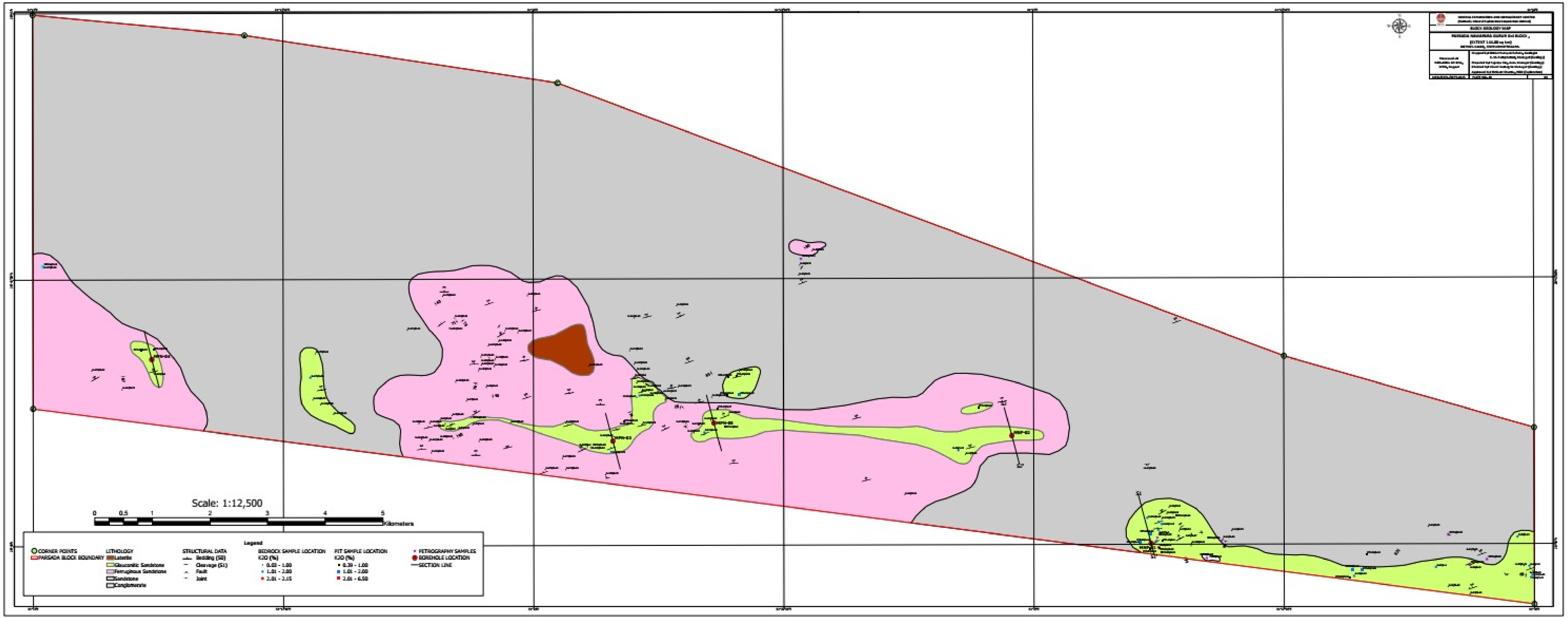
7.4.9 The topography of the area is subdued and bears almost flat topgrpahy and the general strike ENE-WSW to E-W with sub horizontal dipping (2-5°) towards NNW direction.The tentative srtratigraphic sequence of litho units exposed in the block area (After GSI) is given in Table 7.2.

Table 7.2
Stratigraphic sequence of the Parsada-Nawapara-Gurur G4 Block (After Das et. al, 1992, GSI)

Age	Super Group	Group	Formation	Lithology
				Laterite
Meso Proterozoic – Neo Proterozoic	Chhattisgarh	Chandarpur	Kansapathar	Glauconitic Sandstone
			Chaporadih	Shale / Quartz arenite
			Lohardih	Ferruginous Sandstone /Sandstone
				Subarkose with basal conglomerate

7.4.10 The block geology map is represented on 1:12,500 scale as Plate-III and as Text figure. - 7.3.

Text Figure 7.3: Block Geology Map of Parsada-Nawapara-Gurur (G-4) Block for Glauconitic Sandstone, Distt.- Balod, Chhattisgarh



7.5.0 DESCRIPTION OF ROCK TYPES

Various lithounits exposed in the Parsada-Nawapara-Gurur (G-4 stage) block are described as follows-

7.5.1 Laterite:

7.5.1.1 Laterite capping, ranging in thickness from approximately 1.2 m to 3 m, is extensively developed over the outcrop in the southern part of the block, around Karkabhat, village and ajoining area. The laterite comprises hematite, goethite, and clays of varying colors. In several locations, lateritic murrum soils exhibit concentric, celloform banding, indicative of advanced lateritization processes. Additionally, well-rounded iron-rich pebbles are exposed intermittently, further confirming the ferruginous nature of the capping.(Photo 7.1 and 7.2).

Photo 7.1 Photograph showing laterite capping over Sandstone near Karkabhat village

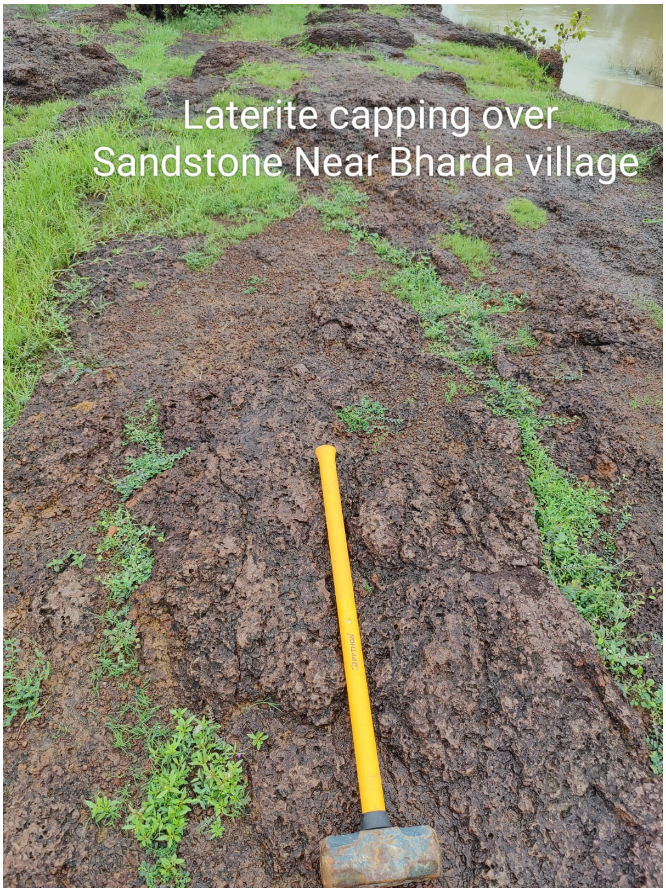


Photo 7.2 Photograph showing Laterite capping over Sandstone near Bharda village

7.5.2 Glauconitic Sandsone:

7.5.2.1 The glauconitic sandstone in Balod District is predominantly medium-to fine-grained, becoming coarser in places, and exhibits a greenish to olive-grey coloration due to the presence of glauconite, a potassium-iron silicate mineral indicative of a marine depositional environment. The unit occurs as massive to distinctly ub-horizontally bedded sandstone with moderate dip towards NNW, conformably and gradationally overlying the underlying white subarkosic sandstone.

7.5.2.2 The sandstone is moderately cemented and displays prominent sedimentary structures such as cross-bedding, ripple marks, and fine laminations of alternating ferruginous and non-ferruginous bands, typically 2–4 mm thick. These features collectively suggest deposition in a shallow marine to intertidal setting.

7.5.2.3 The glauconitic sandstone is well exposed from the eastern to western parts of the block, with notable occurrences near Kuliya, Kaneri, Nawagaon, Dhobanpur, Gurur, Dhanora, Karkabhat, and Karahibhadar villages.

Photo 7.3 Glauconitic sandstone near Nawagaon village

Photo 7.4 BH core (MPN-02) of glauconitic sandstone, Depth 10.0-10.10m, K_2O-5.86%

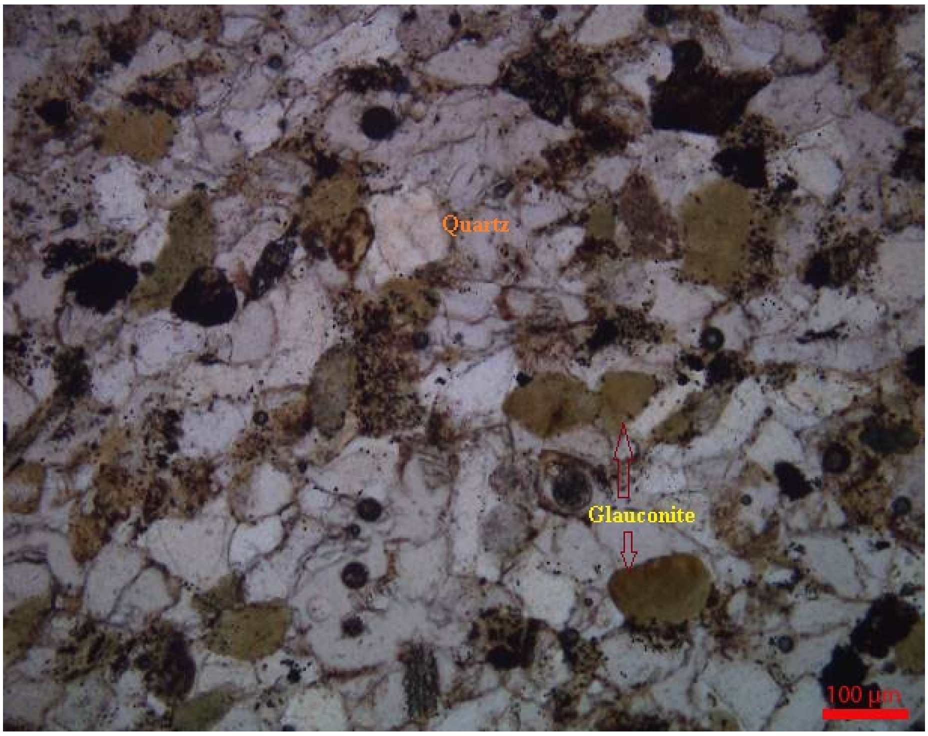
Photo 7.5 Glauconitic sandstone near Karkabhat village

Photo 7.6 Flow bending in Glauconitic sandstone near Kuliya village

Photo and labels: 

Photo 7.7 Glauconitic sandstone showing current ripples trending 105°/5° with wavelength 1m and amplitude 10cm@ Dhobanpuri Village(536627.66432N 2287995.6862E)

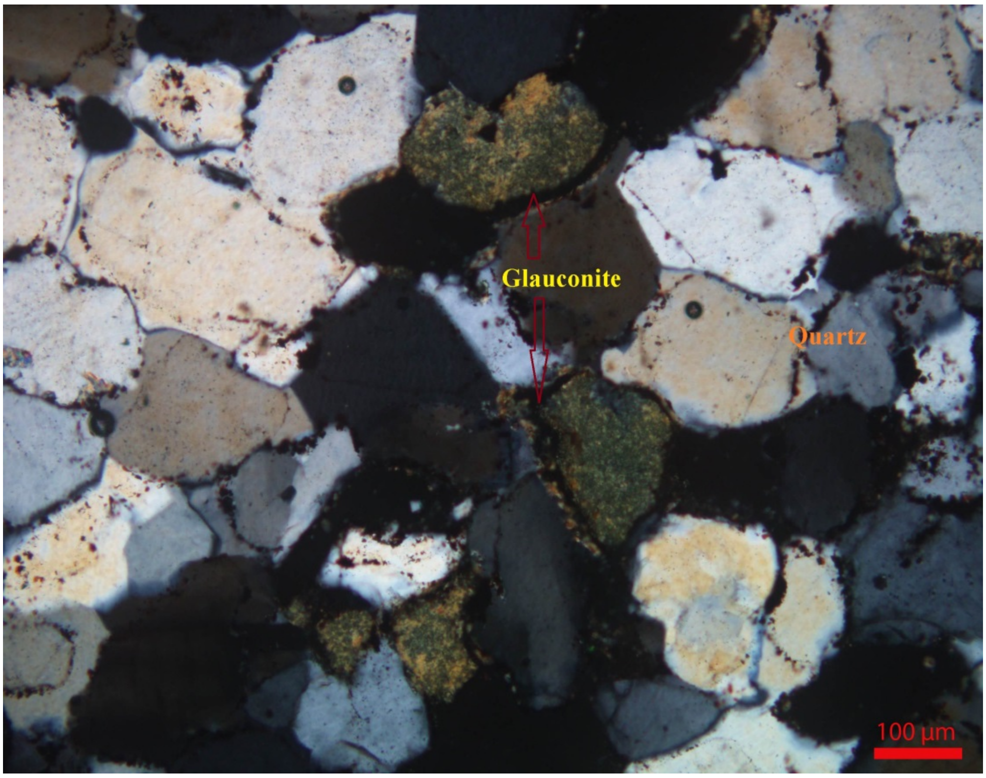
7.5.2.4 One of the specimen for petrography study is found to be thinly laminated fine grained rock showing granular texture. Quartz occurs as fine subrounded to subangular grains showing compact contacts. Grains are well sorted and tightly packed. Glauconite occurs as fine subrounded pellets/ patches in dissemination. Ferruginous matter/ opaques are present as very fine aggregates, anhedral patches and fillings. Feldspar occurs as fine subangular to subrounded grains, mostly microcline in nature. Lithic fragments are also noted in areas. Sericite/ muscovite occur as very fine disseminated flakes. Tourmaline is seen present as very fine prismatic grains in accessories.(Pmg 7.1)



Pmg 7.1 Photomicrograph showing presence of fine to medium subrounded pellets/ patches of glauconite in dissemination within quartz arenite as seen under plane polarized light.

Specimen No. : MPNG/P3 **Magnification :100X**

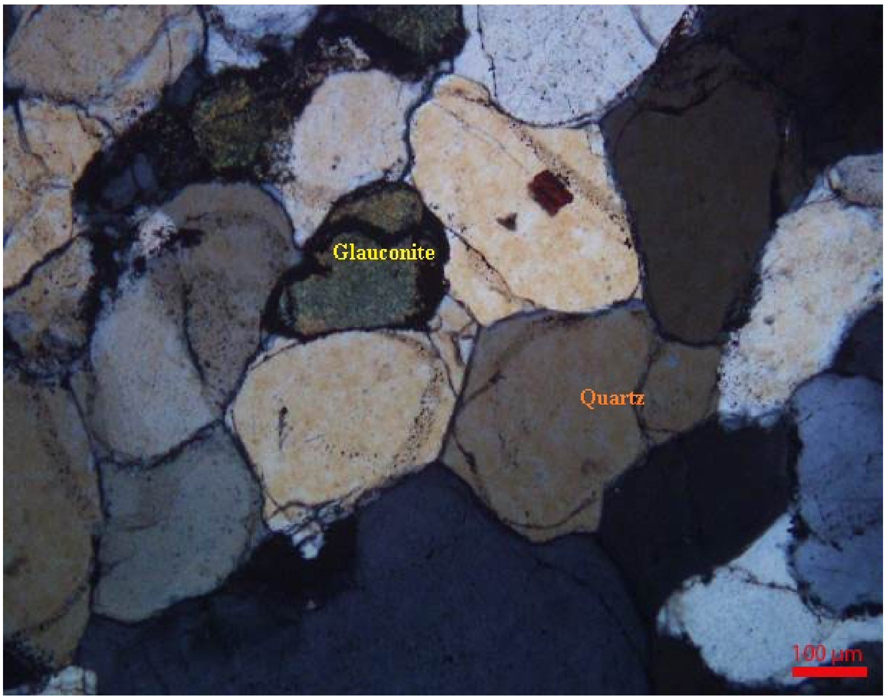
7.5.2.5 Another specimen for petrography study is found to be a fine to medium grained rock showing granular texture.Quartz occurs as fine to medium subrounded grains showing well sorting and tight packing. Glauconite occurs as fine to medium subrounded pellets/ patches in dissemination. Ferruginous matter/ opaques occur as very fine aggregates and fillings along intergranular spaces of quartz. Opaques are also seen present as medium to fine anhedral patches in pockets.Lithic fragments are present as fine to medium subrounded grains comprising very fine quartz aggregates. Tourmaline is noted as very fine prismatic grains in accessories.



Pmg 7.2 Photomicrograph showing presence of fine to medium subrounded pellets within quartz areniteas seen under crossed nicols.

Specimen No. : MPNG/P6 **Magnification :100X**

7.5.2.6 An Another specimen for petrography study is found to be a fine to medium grained rock showing granular texture.The specimen is mostly composed of quartz, occurring as fine to medium subrounded grains showing compact contacts. Glauconite is present as fine to medium subrounded grains. Ferruginous matter/ opaques occur as very fine aggregates and fillings along intergranular spaces of quartz. Opaques are also seen present as fine to very fine anhedral grains and specks. Lithic fragments are present as fine subrounded grains, mostly quartzitic in nature. Tourmaline is noted as fine subrounded grains in accessories. Calcite occurs as very fine fillings in accessories.



Pmg 7.3 Photomicrograph showing presence of fine subrounded glauconite grains within quartz arenite as seen under crossed nicols.

Specimen No. : MPNG/P9

7.5.3 Ferruginous Sandstone:

7.5.3.1 In the Parsada–Nawapa–Gurur area of Balod District, the ferruginous sandstone occurs as medium- to coarse-grained, moderately to well-sorted reddish-brown to purple-coloured beds, the hue imparted by pervasive iron-oxide (hematite/goethite) cement and grain coatings. It is dominantly composed of sub-rounded quartz with minor feldspar, rare glauconite, and locally abundant micaceous minerals concentrated along intrastratal surfaces. Bedding styles range from massive to well-developed planar stratification, with low-angle planar and trough cross-stratification, ripple marks, and occasional ferruginous pisolitic concentrations. Iron oxides occur as both pore-filling and lamina-bound cement, with weathering altering hematite to limonite, producing softer crumbly surfaces.

7.5.3.2 The facies comprises medium- to fine-grained, very well-sorted quartzose sandstone that occurs as laterally persistent tabular beds, 40–90 cm thick, with laminae 1–2 mm thick. Planar bedding is dominant, but cross-bedding is also present, particularly in the western and eastern parts of the block around Jagtara, Nawagaon, Parsada and Purur villages. In hand specimen, beds often display a thin, coarser-grained layer above the medium- to fine-grained strata, and occasional ripples.

7.5.3.3 Field evidence suggests deposition in a shallow marine to marginal-marine setting under oxidizing conditions, with episodic higher-energy events producing the coarse interbeds and ripple structures. The lateral persistence of tabular beds, high sorting, and well-developed planar stratification indicate sustained tractional currents, possibly in a shoreface or tidal flat environment. Early diagenetic precipitation of iron oxides imparted the ferruginous character, while later surficial weathering enhanced limonite staining.

Photo 7.8 Photograph showing ferruginous sandstone near Nawagaon village

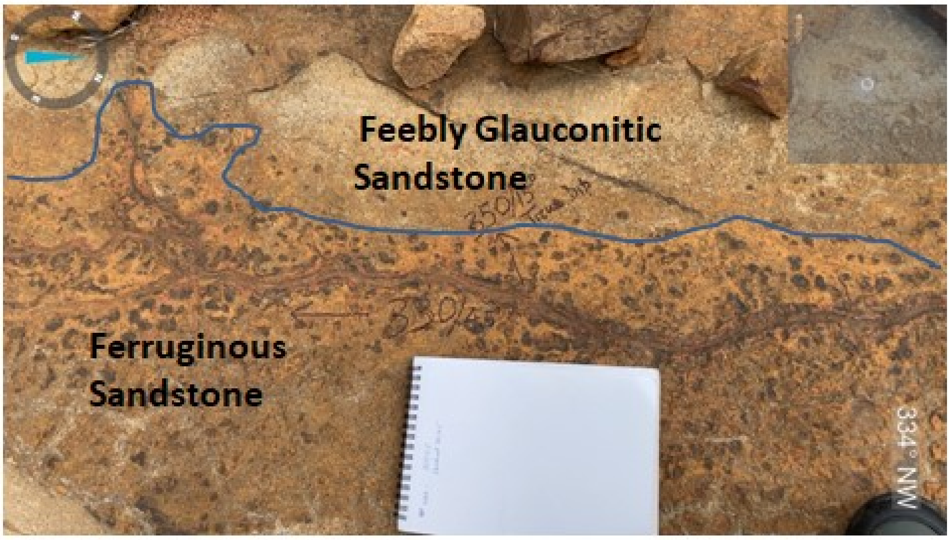


Photo 7.9. Photograph showing contact between feebly glauconitic sandstone and ferruginous sandstone near Kuliya village

Photo 7.10. Photograph showing iron nodules in the ferruginous sandstone near Karkabhat village

Photo 7.11. Photograph showing open folds(Hindge Line-190°/10°) of sandstone layer with lateritic capping near Dhanora Village (538091.5309N 2287705.64E) sandtone bottom-90cm , Middle Soil- 40cm and top lateritic cover(1-1.5m)

Photo 7.12. Photograph showing trough cross bedding structure in ferruginous sandstone at Karkabhat village (533018.0592N 2286935.7675E)

7.5.4 Shale:

7.5.4.1 In the Parsada–Nawapa–Gurur block, shale were not observed on surface but invariably recorded in boreholes. It occurs as thinly laminated to fissile, dark grey to black, locally greenish-grey intervals, oftenly interbedded with medium to fine grained sandstone. The lithology is dominated by compacted clay minerals with silt-sized quartz and scattered mica flakes, giving a slight micaceous lustre on fresh surfaces. Core samples show well-developed bedding planes with thin laminations. On weathered surfaces, the shale turns yellowish-brown to olive-grey, with iron staining along fractures. Most of the shales encountered in boreholes are showing good concentration of glauconites.(Photo 7.13)

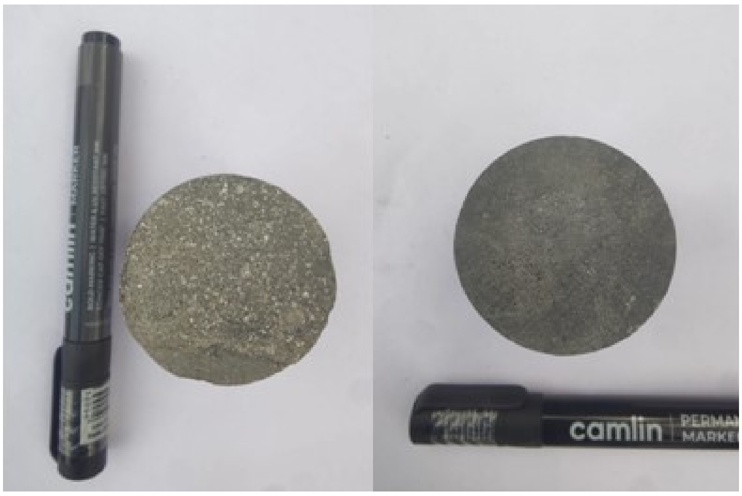


Photo 7.13 BH core of Glauconitic bearing shale in BH No.MPN-02, Depth 24.15-24.25m, K_2O-7.15%

7.5.4.2 The specimen for petrography study is found to be dark grey coloured very fine grained massive glauconite bearing shale. Under microscope,, Quartz and feldspar are present as very fine silt sized clasts, where feldspar is seen altering to sericite/ clay minerals. Sericite/ clay mineralsoccur as cloudy patches comprising very fine flaky aggregates and mostly seen developing after feldspar alterations. Biotite and muscovite are present as very fine disseminated flakes showing parallel alignment. Carbonates are present as fine subrounded, lensoidal and elongated clasts. Glauconite occurs as fine subrounded grains in pockets. Opaques are noted as very fine specks in dissemination and also occur as fine fillings and patches.

7.5.5 Sandstone/ Grey Sandstone

7.5.4.1 These are non-ferrous, non-glauconitic sandstones, the most dominant lithology in the present exploration block. The facies is represented by mature, medium to coarse-grained quartzose sandstone that occurs as extensive sheets in Lohardih Formation. The beds are about 10-20 cm thick, laterally persistent and tabular with planar bounding surfaces. They often amalgamate to form up to 2m-4m thick units. Successive beds, when not amalgamated, are separated by thin concentrates of micaceous minerals. The beds consist of ~ 5mm thick planar strata, characterized by high grain-size sorting. Most of the beds exhibit multiple lamina-sets, generally between 4 and 10 cm in thickness, with slightly discordant, very low angle planar erosional surfaces between them. The majority of the lamina-sets are gently inclined between 2mm and 4mm towards the basal contact, though a few sets are inclined in the opposite direction. Strong segregation of grains according to size, with a clear cut limit at coarse sand, within the lamina-sets is the hallmark of this facies. Oval shaped cavities are formed in the grey sandstones due to water action and eventually replaced by semi-consolidated quartz rocks.

Photo 7.14 Longitudinal bars in grey sandstone trending 235°N & regional dip is 5° towards 255°N near Dhobanpuri Village (534022.26982N 2288382.0102E)

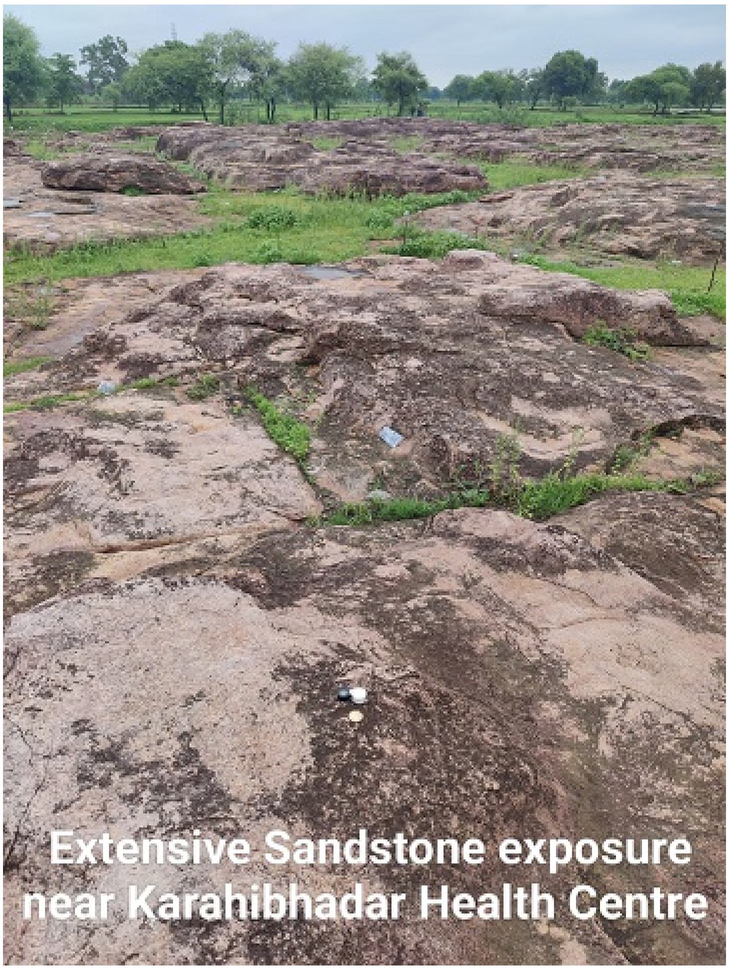


Photo 7.15 Massive sandstone exposure near Karahibhadar village

7.5.5 Conglomerate

7.5.5.1 Conglomerates occur as coarse-grained, clast-supported units within the Lohardih Formation, typically forming lenticular bodies have been observed at places Conglomerates has been reported in the west of Bheja village as confirmed by the petrography analysis of thesample number MPNG/P-07. It consist of sub-rounded pebbles and cobbles of quartz, chert, and occasional ferruginous clasts, set in a medium- to coarse-grained sandy matrix. Clasts are generally in the range from 2 to 3 cm in size.

7.5.5.2 Under microscope, Quartz occurs as granule to coarse sand sized well rounded grains. Grains are moderately sorted and tightly packed. Minor recrystallization in noted in areas. Lithic fragments are noted as well rounded grains, mostly cherty and quartzitic in nature. Ferruginous matter/ opaques occur as very fine aggregates, anhedral grains/ patches and as fillings. Tourmaline is seen present as fine subhedral prismatic grains in accessories.

7.6.0 PETROGRAPHIC STUDIES:

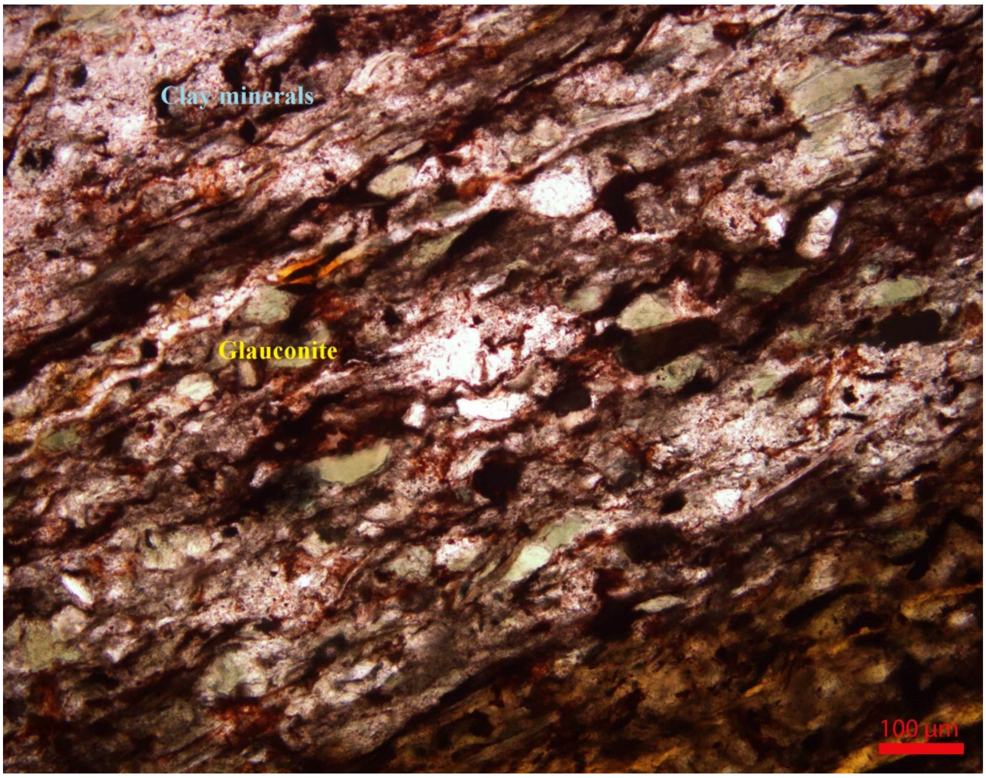
7.6.1 A total of 14 nos of surface and BH samples of various litho-units collected during geological mapping and field traverses in Parsada-Nawapara-Gurur G-4 block, were subjected to petrographic studies at Petrology Laboratory, MECL Nagpur. The results are furnished as Annexure-V.

7.6.2 The detailed petrographic studies indicate that glauconite occurance is more inclined in fine-grained sandstones and is even prominently developed within associated shale units. The finer grain size of these sediments might be providing favorable conditions for the authigenic growth and preservation of glauconite, as the relatively low-energy depositional environment promotes slow sedimentation rates and extended residence time of detrital material on the sea floor—factors considered essential for glauconitization. Consequently, glauconite tends to be better concentrated in finer clastic facies rather than in coarser sandstones.

7.6.3 Summary of the petrographic study done by Petrology Laboratory, MECL is displayed in Table 7.3.

Table No. 7.3
Summary of the petrographic study done by Petrology Laboratory, MECL for Parsada-Nawapara-Gurur G-4 block

SL. NO	SAMPLE NO.	UTM (Zone-44)		ROCK TYPE CONFIRMED BY PETRO LAB
		EASTING /BH Depth (m)	NORTHING/ BH Depth (m)	
1	MPNG/P-01	539354	2290269	Quartz Arenite
2	MPNG/P-02	550586	2285493	Glauconite rich ferruginous claystone, Pmg 7.4
3	MPNG/P-03	550956	2284984	Glauconite rich quartz arenite, Pmg 7.1
4	MPNG/P-04	551258	2285068	Quartz Arenite
5	MPNG/P-05	546655	2285390	Quartz Arenite
6	MPNG/P-06	533632	2287520	Glauconite rich quartz arenite, , Pmg 7.2
7	MPNG/P-07	546390	2285081	Conglomerate
8	MPNG/P-08	545540	2285441	altered Amphibolite
9	MPNG/P-09	535723	2286994	Glauconite rich quartz arenite, Pmg 7.3
10	MPNG/P-10	526206	2290127	Quartz Arenite
11	MPN-02/P1	24.10	24.20	Glauconite bearing shale
12	MPN-03/P1	04.70	04.80	Glauconite rich quartz arenite
13	MPN-04/P1	42.25	42.50	feldspathic wacke
14	MPN-05/P1	08.70	08.80	Glauconite bearing shale.



Pmg 7.4: Photomicrograph showing presence of fine to medium subrounded pellets/ patches of glauconite in dissemination within ferruginous claystone as seen under plane polarized light. **Specimen No. : MPNG/P2**

7.7.0 MINERALISATION IN THE BLOCK

7.7.1 In the Parsada–Nawapa–Gurur G-4 block, glauconite occurs chiefly within the Kansapathar Sandstone of the Chandarpur Group, forming distinct greenish to olive-grey horizons that are observed in outcrops and borehole cores. The glauconitic sandstone is generally medium- to fine-grained, moderately to well-sorted, with sub-rounded quartz grains set in a glauconite-rich matrix or with discrete glauconite pellets disseminated between framework grains. Glauconite content varies from 1% to over 8% in enriched layers, giving the rock its characteristic greenish tint, which weathers to dull olive-brown.

7.7.2 Texturally, glauconite occurs as well-formed, ovoid to sub-elliptical pellets (0.1–1 mm in size), and thin lamination occasionally aggregated into clusters. Pellets display varying degrees of maturity — from loosely compacted, micaceous, friable forms to well-crystallised, dark green, lustrous varieties — indicating different stages of in-situ marine authigenesis. The mineral commonly fills intergranular spaces or coats quartz grains, and in thin sections, exhibits a granular to vermicular habit with characteristic green birefringence under plane-polarised light. Associated minerals include subordinate mica, feldspar, and heavy minerals.

7.7.3 Sedimentologically, the glauconitic horizons are interbedded with ferruginous sandstone and shale, often associated with low-angle cross-bedding, ripple marks, and planar lamination. The mineralisation is interpreted to have developed under slow sedimentation rates in a shallow marine, shelf-like environment, under mildly reducing to slightly oxidising conditions that favoured the authigenic transformation of biotite/illite precursors into glauconite. The persistence of glauconite-bearing beds across the Parsada, Nawapa, and Gurur block suggests laterally extensive marine transgressive phases during Kansapathar deposition.

7.7.4 From an economic perspective, the glauconite-bearing zones in this area are significant for their potential as a source of potassium-bearing fertiliser, given their thickness, lateral continuity, and moderate to high glauconite content. Preliminary beneficiation studies suggest that physical separation can yield enriched glauconite concentrates suitable for agricultural and industrial applications, though further mineralogical characterisation and resource estimation are necessary for economic viability assessment.

7.8.0 X-RAY DIFFRACTION STUDIES

7.8.1 A total of 5 nos. of composite borehole samples from selected zones of boreholes were subjected to X-Ray diffraction studies at Physical Laboratory of MECL. Only crystalline phases of the samples have been recorded. Amorphous phases are out of the scope of XRD and hence excluded. XRD analysis results have confirmed the presence of glauconite but in traces.Major minerals were notedas Quartz, Muscovite, Illite, Microcline etc.The results are furnished as Annexure-VI.

CHAPTER-8

PREVIOUS WORK

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

8.1.1 Pioneering geological work in the Chhattisgarh basin was carried out by V. Ball (1877), W. King(1885-90) and Fermor (1919), followed by Narayana Murthy (1955, 1960), Narayana Murthy and Radhakrishna (1961), N.V.B.S. Dutt (1964), W.A. Schnitzer (1971), Murti (1996), Das et al. (1992). Chaudhari et al. (2002) and Deb (2004) provided recent geological summaries of the basin.

8.1.2 H.B. Medlicott (1866–67) and W.T. Blanford (1869–70) conducted traverses in the Chhattisgarh Basin, noting quartzites and limestones and correlating them with the Cuddapah Supergroup. P.N. Bose (1898–99) described the sequence as the “Chhattisgarh Plain Series,” comprising lower Chandarpur Sandstone and upper Raipur shales and limestones, correlating them with the Lower Vindhyans. D. Bhattacharjee (1936–38) mapped western Durg district and correlated the formations with the Cuddapahs, listing the sequence as: Raipur limestones, shales and phyllites, Chandarpur sandstone, and Khairagarh sandstone. Later, Sen (1963–64), Sen & Satyanarayanan (1964–65), Satyanarayanan (1965–67), and Murti (1967–72) undertook systematic mapping in Raipur, Durg, and Bilaspur districts, identifying rock phosphate-bearing clay pockets in the upper Chandarpur Sandstone and at the base of the Charmuria Limestone.

8.1.3 Dutt (1964) studied the southwestern Chhattisgarh Basin and classified the succession into five units: Chandarpur Sandstone, Charmuria Limestone, Gunderdehi Shale, Khairagarh Sandstone, and Raipur Shale–Limestone. Schnitzer (1969–71) identified five sedimentation cycles, separated by unconformities, in the east-central basin. Murti (1987) assigned “Supergroup” status to the succession, dividing it into two unconformity-bounded groups: the lower Chandarpur Group and the upper Raipur Group, each comprising multiple formations. Das et al. (1992) further recognized the Singhora Group as the lowermost unit of the Chhattisgarh Supergroup, lying between the basement granite gneissic complex and the Chandarpur Group.

8.1.4 N.V.B.S. Dutt, K.S. Murti, and several GSI geologists made significant contributions to understanding the stratigraphy and structure of the Chhattisgarh Basin. Dutt (1963), through traverse mapping in the southern basin, proposed the following succession:

Raipur Shale and Limestone – 450 m
Khairagarh Sandstone – variable thickness
Gunderdehi Shale – 180 m
Charmuria Limestone – 300 m
Chandarpur Sandstone – 300 m
— Unconformity —
Archean Granitoids

8.1.5 During phosphorite investigations U.S. Vatsa et al. in 1972–73, identified three lithological members within the Chandarpur Formation in the southern Chhattisgarh Basin: ferruginous sandstone, feldspathic sandstone, and orthoquartzite. They also reported phosphate occurrences with P_2O_5 content reaching up to 29% in certain clay samples within the cherty-limestone of the Charmuria Formation.

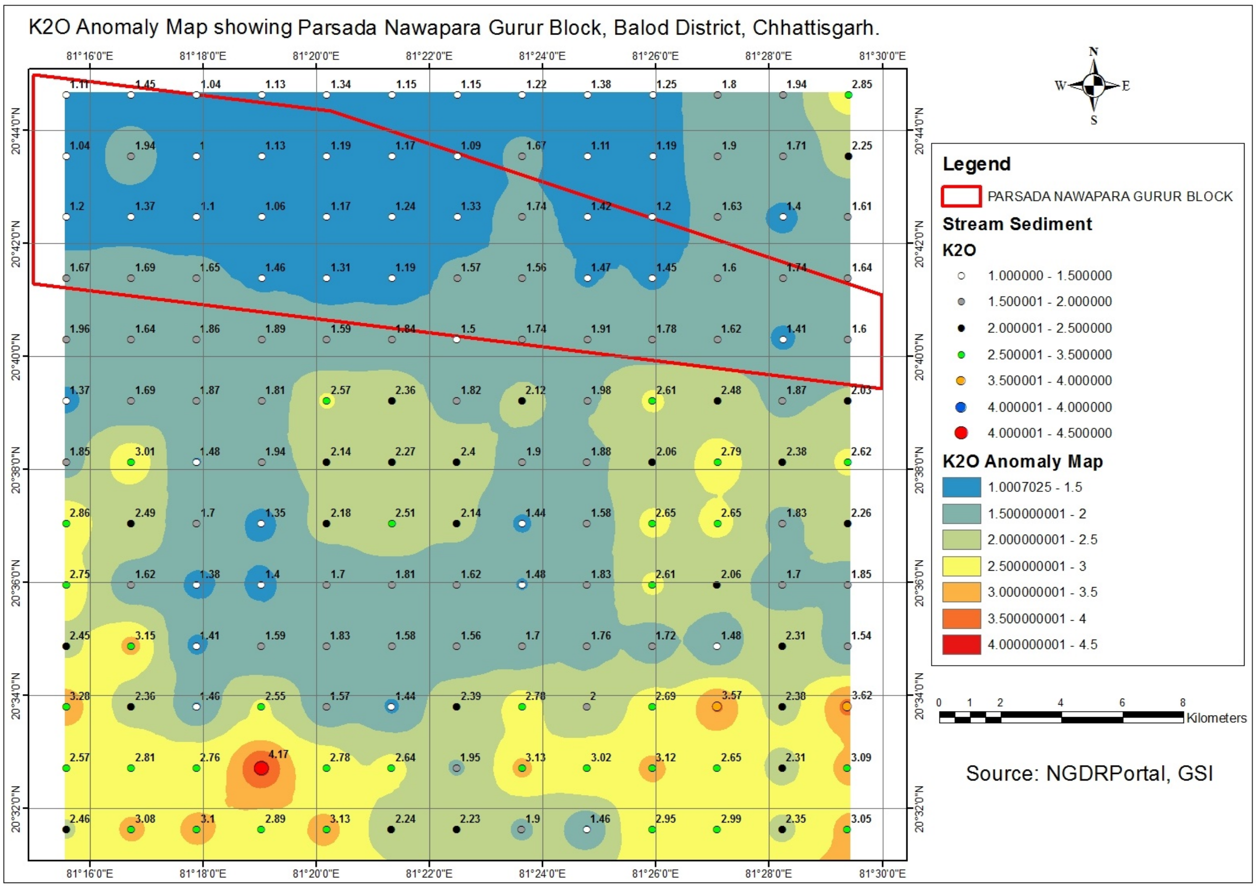
8.1.6 Bhattacharya et al. (1987–88), during 1:50,000 scale mapping of toposheets 64H10 and 64H06, documented glauconitic sandstone in the western part of the mapped area near Kharra, Darra, Narbada, and Diyabati villages (within the proposed block). This sandstone is deep green, medium- to coarse-grained, laminated, and often pyritiferous, with green and white laminae. At Thekwadhi, grey finely laminated micaceous shale overlies the glauconitic sandstone, while at Usarwara, a thin band of very coarse, granular subarkosic sandstone occurs below the shale horizon.

8.1.7 Studies at Bhalukona and Chhuipali (Das et al., 1992; 2003), along with work by Patranabis-Deb (2004) and Patranabis-Deb & Chaudhuri (2008), proposed a threefold classification for the succession in the eastern part of the basin: Chandarpur Group, Raipur Group, and Kharsiya Group. Later, Chakraborty et al. (2015) introduced a four-tier lithostratigraphy for the Chhattisgarh Supergroup, comprising the Singhora, Chandarpur, Raipur, and Kharsiya Groups.

8.1.8 Das et al. (1992) subdivided the Chhattisgarh Basin into the Hirri and Baradwar sub-basins, and the Singhora and Barapahar protobasins. They classified the Chhattisgarh Supergroup into three unconformity-bounded groups, in ascending order: Singhora Group, Chandarpur Group, and Raipur Group.

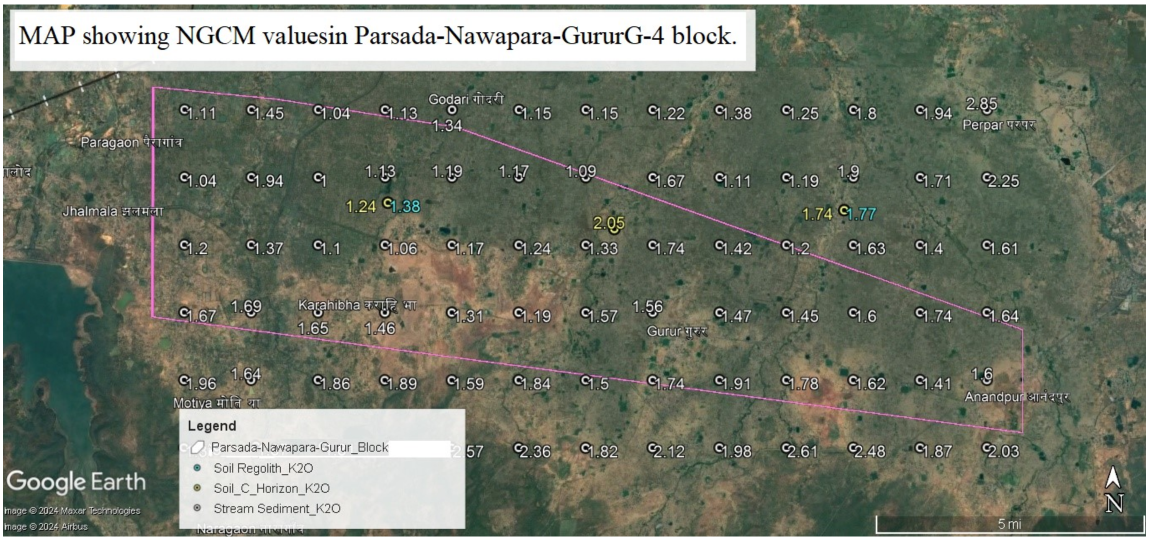
8.1.9 The present reconnaissance survey in the Parsada–Nawapara–Gurur block, located southeast of GSI's Kotera–Reghai G-4 block (FSP 2023–24), targets glauconite-bearing sandstone of the Lohardih Formation. Several phosphorite exploration blocks lie to the north and northeast, including Sambalpur G-2 (FSP 2022–23), Nawagaon G-4 (FSP 2023–24), Latabor G-4 (FSP 2023–24), and Nipani Kharra G-4 (FSP 2024–25), indicating high potential for fertilizer mineral exploration in the area.

8.1.10 **NGCM Investigation :** As part of the National Geochemical Mapping (NGCM) programme, the Geological Survey of India conducted systematic stream sediment sampling in the study area using a 1 × 1 km grid pattern. A total of 35 stream sediment samples were collected within the proposed block, showing K_2O values ranging from 1.00% to 1.92% (Text Figure 8.1). A similar range of K_2O values is recorded in the adjacent northern area, which contains a GSI block for glauconitic sandstone.



Text Figure 8.1- K_2O Anamoly Map for StreamSediment Samples as per NGCM data for Toposheet No. 64H06 alongwith Parsada-Nawapara-Gurur G-4 block

8.1.11 A total of 2 soil samples from C horizon and 2 soil regolith samples falls within the present ex-ploration block for which values of K_2O are 1.24% , 2.05% and 1.38% , 1.89% respectively.(Text Figure. 8.2).



Text Figure 8.2- K_2O Anamoly Map for Soil C-Horizon Samples and Soil Regolith Samples as per NGCM data in Parsada-Nawapara-Gurur G-4 block

CHAPTER-9

GEOPHYSICAL SURVEY

9.1.0 Ground geophysical surveys were not envisaged as an input in to the pesent G-4 investigations.

CHAPTER-10

EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

10.1.0 INTRODUCTION

10.1.1 The Parsada-Nawapara-Gurur (G-4 stage) block over an area of 144sq. km.lies in the Balod and Gurur tehsil of Balod district in Chhattisgarh. The exploration block is covered in Survey of India Toposheet no. 64H06. The current investigation was aimed to find out the potentiality for glauconitic sandstone in the block.

10.2.0 OBJECTIVES OF INVESTIGATION

10.2.1 The exploration programme in Parsada-Nawapara-Gurur G-4 block has been formulated to fulfil the following objectives:

1. To carry out Geological & structural mapping on 1:12,500 scale for demarcation of glauconitic sandstone with the structural features to identify the surface manifestations and lateral and vertical disposition of the mineralized zones.

2. To collect surface samples including bedrock, bedrock and pit samples & to analyze for glauconite to shape up for further course of exploration program.

3. To carry out pitting to expose the concealed host rock and mineralization.

4. If phase-I exploration data gives anamolous values, 05 Nos. of scout boreholes may be drilled.

5. To estimate resources as per UNFC norms Minerals (Evidence of Mineral Contents) Amendment Rules 2021.

6. To upgrade the block to the higher level of exploration.

10.3.0 DETAILS OF EXPLORATION ACTIVITIES TAKEN UP

10.3.1 The Exploratory operations in the block commenced on 16.06.2024 with geological mapping on 1:12,500 scale. Simultaneously, surface bedrock sampling was initiated at strategically selected locations to assess lithological and mineralogical characteristics. Based on the results of surface sampling, zones of glauconite enrichment were delineated, guiding the next phase of exploration.Subsequently, pitting was undertaken in target areas, followed by core drilling in five boreholes to evaluate subsurface continuity and grade distribution of glauconite-bearing horizons. Allied field activities—including surface sampling, pit sampling, borehole core sampling, and sample preparation—were carried out.Analytical and laboratory studies on the collected samples were performed at MECL laboratories, while external check analyses were conducted at the Jawaharlal Nehru Aluminium Research Development and Design Centre (JNARDDC), Nagpur, ensuring reliability and accuracy of the results.

10.3.2 **Geological Mapping:** Geological mapping has been carried out in the block for the entire area of 144 sq. km depicting the lithology, structure and mineralization signatures. Geological mapping is carried out in the area by dividing the area into 1 km × 1 km grids as a systematic approach to ensure uniform coverage and avoid both data gaps and excessive data clustering. In this method, the entire study area was overlaid with a grid network on a base map over GIS platform, with each grid treated as a separate mapping unit. Field geologists then traversed each grid systematically, recording lithology, structures, mineral occurrences, and other geological features, while ensuring representative sampling and observation points were evenly distributed. This grid-based approach improved spatial accuracy, maintained consistent observation density, facilitated data integration, and helped in identifying subtle geological variations that might otherwise have been overlooked. It also enabled efficient planning, monitoring, and progress tracking of mapping activities.

10.3.3 Identification and demarcation of mineralised zones, thus helped in marking the geochemical sampling locales for bedrock sampling and further pitting. Lithological units and litho-contacts have been mapped with the help of handheld GPS. Attitude and structural features of rocks like bedding, foliation and joints has been recorded by Brunton Compass. General Strike of the litho-units is ENE-WSW to E-W with sub horizontal dipping (2-5°) towards NNW direction.. The readings recorded in the field were plotted and produced in the form of geological map given as Plate III.

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

10.3.4 The Parsada–Nawapara–Gurur area is characterized by predominantly flat topography. The major lithological units identified during geological investigations include glauconitic sandstone, ferruginous sandstone, grey sandstone, laterite, and conglomerate. Glauconitic sandstone of the Kansapathar Formation serves as the primary host rock for glauconite mineralization in the area. These sandstones are extensively exposed from the eastern to western parts of the block, with prominent occurrences near Kuliya, Kaneri, Nawagaon, Dhobanpur, Gurur, Dhanora, Karkabhat, and Karahibhadar villages.

Photo 10.2 Photograph showing three distinct sandstone layers near Chitaud village

10.3.5 Geological investigations in the Parsada–Nawapara–Gurur area revealed the presence of prominent yet discontinuous bodies of glauconitic sandstone. Apart from that, the area is predominantly coverd by ferrugineous sanstone and grey sanstone with laterite capping at places. These occurrences are well distributed across the block, with an estimated outcrop density of approximately 50%. However, systematic field mapping and surface observations were integrated to prepare an interpreted geological map. This map incorporates both observed outcrops and inferred subsurface continuity, thereby providing a comprehensive representation of the glauconitic sandstone distribution. The interpreted geological map subsequently served as a fundamental base document for planning and executing further stages of exploration, including pitting, drilling, and detailed sampling in the area.

10.3.6 **Surface / Bedrock sampling** During geological traverses, exposures with glauconitic mineralisation were identified and bedrock sampling carried out by systematically chipping fresh, unweathered rock fragments from exposed glauconitic sandstone across a representative section of the outcrop to avoid localized bias. Using a geological hammer, the weathered surface was removed to reveal the greenish to olive-grey fresh glauconite horizons, from which chips are collected all along the exposure. This method ensures that the sample captures the average glauconite content, texture, and mineral distribution within the bedrock, providing a reliable basis for subsequent petrographic, mineralogical, and chemical analysis to assess glauconite grade and resource potential of the area.

Photo 10.3 Photograph showing team involved in bedrock sampling in the block

10.3.7 During, geological traverses, MECL has carried out surface sampling and collected a total of 121 bedrock samples for the analysis of K_2O, SiO_2, Al_2O_3 and Fe_2O_3 (Annexure-IIA). Out of 121 bedrock samples, 21 no. of samples are showing ≥ 1% K_2O content with K_2O values ranging between 1.00% - 2.15%. On the basis of the analytical results 5-6 target exposure were identified. Bedrock sample location are displayed on the geological map in Plate-III.

10.3.8 On, the basis of bedrock sample analysis, 22 locations were identified for pitting to locate lateral and subsurface continuity of the mineralsied bodies.

10.3.9 **Pitting** A total of 22 nos. of pits have been excavated (125.5 cu. m) at 22 locations demarcated on the basis of the results of bedrock samples. Pitting for glauconitic sandstone in the Parsada–Nawapara–Gurur block was undertaken to evaluate the distribution, thickness, and quality of near-surface glauconitic horizons. Pit locations were selected based on prior surface sampling, reconnaissance mapping, with infill pits in anomalous zones. Each site was recorded using GPS, and pits were excavated to expose fresh, unweathered bedrock, with dimensions typically around 2.0 m in length and width, and up to 1.5m to 2.0m deep. All the pit locations are marked on the geological Map (Plate-III).

10.3.10 A total of 22 nos. pit samples from 22 pits have been collected and analysed for K_2O, SiO_2, Al_2O_3 and Fe_2O_3 (Annexure-IIB). Pit sample analysis from the Parsada–Nawapara–Gurur block shows that a total of 6 out of 22 samples contain more than 1% K_2O, indicating moderate to high glauconite enrichment in several locations. K_2O values range from 1.06% to 6.44%. Pit no. 9 has resulted the grade of 6.44% K_2O. The enriched horizons likely representing primary glauconite concentrations in less-weathered sandstone making them prime exploration targets.

10.3.11 The details of pit samples sample values for K_2O% are tabulated below in Table 10.1.

Table 10.1.
Details of pit samples sample values for K_2O% in Parsada-Nawapara-Gurur (G-4 stage) block, Balod, Chhattisgarh.

Sr. No.	Pit No.	Primary Sample No.	Easting (m)	Northing (m)	RL (m)	K_2O(%)
1	PIT-01	MPNG/PIT-01	549169	2285152	334	0.69
2	PIT-02	MPNG/PIT-02	549091	2284875	336	1.06
3	PIT-03	MPNG/PIT-03	548876	2284744	325	0.56
4	PIT-04	MPNG/PIT-04	548925	2284891	328	1.12
5	PIT-05	MPNG/PIT-05	545608	2285184	326	0.92
6	PIT-06	MPNG/PIT-06	545578	2285258	327	0.88
7	PIT-07	MPNG/PIT-07	545410	2285234	322	0.82
8	PIT-08	MPNG/PIT-08	545245	2285365	325	1.10
9	PIT-09	MPNG/PIT-09	545430	2285365	326	6.44
10	PIT-10	MPNG/PIT-10	545419	2285509	326	1.54
11	PIT-11	MPNG/PIT-11	545628	2285382	329	0.50
12	PIT-12	MPNG/PIT-12	545869	2285830	333	0.48
13	PIT-13	MPNG/PIT-13	538098	2288214	333	0.81
14	PIT-14	MPNG/PIT-14	538238	2288237	325	0.58
15	PIT-15	MPNG/PIT-15	538291	2287912	332	1.74
16	PIT-16	MPNG/PIT-16	538073	2287911	337	0.64
17	PIT-17	MPNG/PIT-17	537909	2287675	333	0.47
18	PIT-18	MPNG/PIT-18	538048	2287359	330	0.80
19	PIT-19	MPNG/PIT-19	536288	2287441	340	0.39
20	PIT-20	MPNG/PIT-20	527902	2288665	334	0.73
21	PIT-21	MPNG/PIT-21	528127	2288686	330	0.56
22	PIT-22	MPNG/PIT-22	542431	2287689	325	0.99

	
Photo 10.4 Photograph showing Pitting and sampling in Pit-09 near South of village Kuliya (K_2O-6.44%)	Photo 10.5 Photograph showing Pitting at Pit-15 near village Dhanora (K_2O-1.74%)

10.3.12 **Drilling** MECL executed a total of 228.0 m of exploratory drilling in five boreholes (against the approved meterage of 250.0 m). As evident from Annexures IIA and IIB, several surface and pit samples from the block recorded positive K_2O values. Based on these results, five scout boreholes (designated MPN-01 to MPN-05) were planned and executed within the block. 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 (Annexure-IB) are presented in PLATE-III. Detailed borehole specifications and drilling particulars are provided in Table 10.2.

Table- 10.2

Details of Boreholes in Parsada-Nawapara-Gurur G-4 block for glauconitic sandstone, District-Balod, Chhattisgarh

Sl. No.	BH No.	UTM (Zone- 44)		RL (m)	Total Depth (m)	Angle
		Easting	Northing			
1	MPN-01	545431.93	2285340.58	328.114	50.00	90°
2	MPN-02	543013.28	2287203.39	327.551	28.00	90°

Sl. No.	BH No.	UTM (Zone- 44)		RL (m)	Total Depth (m)	Angle
		Easting	Northing			
3	MPN-03	536093.64	2287107.23	338.495	50.00	90°
4	MPN-04	528092.24	2288517.40	328.664	50.00	90°
5	MPN-05	537846.54	2287420.23	338.073	50.00	90°

10.3.13 Geological logging of borehole cores were properly done alongwith all the structural, lithological and mineralogical observations.(Annexure IIIA and IIIB). Sampling in boreholes has been carried for 1m length with slight variations at places in first two boreholes while sampling in boreholes has been carried for 2m length with slight variations at places in rest of the three boreholes. In almost all the boreholes, we have encountered glauconitic sandstone and glauconitic shale. The associated laboratory studies have been completed simultaneously. Results of the chemical analysis of borehole samples have been provided in Annexure IVA.

10.3.14 The following table 10.3 presents the delineated mineralisation zones identified within the Parsada–Nawapara–Gurur G-4 block, Balod District, Chhattisgarh, based on subsurface exploration through boreholes. It summarises the depth intervals where glauconitic sandstone with significant K_2O enrichment has been encountered, along with the calculated average K_2O grades for each mineralised zone. This data provides a concise overview of the spatial distribution, thickness, and quality of glauconite-bearing horizons within the explored block

Table- 10.3

Table showing mineralisation zone and average grade for K2O encountered in boreholes, Parsada-Nawapara-Gurur G-4 block, Balod, C.G..

BH No.	From (m)	To (m)	Thickness (m)	Average K_2O %
MPN-01	3.00	8.00	5.00	6.96
	9.00	12.00	3.00	5.82
	14.00	17.00	3.00	4.36
	21.10	50.00	28.90	7.20
MPN-02	3.50	28.00	24.50	6.21
MPN-03	3.00	7.00	4.00	5.15
	8.50	14.00	5.50	5.80
	16.00	18.00	2.00	4.68
	24.00	28.00	4.00	6.98
	34.00	50.00	16.00	4.94
MPN-04	4.00	38.00	34.00	6.11
	40.00	50.00	10.00	5.32

BH No.	From (m)	To (m)	Thickness (m)	Average K_2O %
MPN-05	6.00	28.00	22.00	6.03
	32.00	44.00	12.00	5.65
	48.00	50.00	2.00	4.13

10.3.15 The borehole data from Parsada–Nawapara–Gurur, G-4 Block, Balod, C.G., reveals multiple K_2O-bearing zones across five boreholes (MPN-01 to MPN-05). In borehole MNP-01, zone of 39.90m thickness with >4% K2O% (Range 4.36% - 7.20% K2O) has been found. In borehole MNP-02, a zone of 24.50m thickness with >4% K2O% (6.21% K2O) has been found. In borehole MNP-03, zone of 31.50m thickness with >4% K2O% (Range 4.68% - 6.98% K2O) has been found. In borehole MNP-04, zone of 44m thickness with >4% K2O% (Range 5.32% - 6.11% K2O) has been found. In borehole MNP-05, zone of 36m thickness with >4% K2O% (Range 4.13% - 6.03% K2O) has been found. These results provided a robust basis for subsequent resource estimation and evaluation of the block's economic potential.

10.3.16 Most boreholes display several mineralised intervals at varying depths, indicating a consistent presence of potash mineralisation across the area.

Photo 10.6 Photograph showing drilling at borehole no.MPN-03

10.3.17 A distinct disparity is observed in the K_2O content of surface and core samples of glauconitic sandstone. The average K_2O content of 22 pit samples is 1.08%, whereas the weighted average of K_2O content from five boreholes ranges between 5.36% and 6.21%. This difference may be attributed to (i) surface weathering and leaching, which reduce K_2O in pit samples, and (ii) better preservation and enrichment of K-bearing minerals at depth. Additionally, 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.

10.3.18 Nevertheless, the elevated K_2O values observed in the borehole samples do not negate the occurrence of glauconitic sandstone in the area. The Kansapathar Formation of the Chhattisgarh Basin is regionally well documented for its glauconite content, and the characteristic lithological association of glauconitic sandstone is a consistent stratigraphic feature of this unit. Therefore, while the precise contribution of glauconite to the observed K_2O values may vary due to the presence of additional potassium-bearing phases, the geological context strongly supports the interpretation that glauconitic sandstone is indeed present within the explored sequence.

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

10.3.20 The details of the nature and quantum of work approved vs actual achievement is given in Table-10.4.

Table – 10.4
Approved Quantum of Work vs. Actual achievement by MECL in Parsada-Nawapara-Gurur G-4 Block for Glauconitic Sandstone, District:Balod, Chhattisgarh

Sl. No.	Item of Work	Unit	Target	Achievement
1	Geological Mapping (1:12500 scale)	Sq. Km	144	144
2	Surface Geochemical sampling (Bed Rock/Channel/Chip Sample)	Nos.	200	121
3	Exploratory Mining (Piting)	Cu M.	150	125.5
4	Drilling (Core)	m.	250	228
5	Sample Preparation & Chemical Analysis			
A.	Surface samples (Bedrock/ Chip etc)			
	i) Primary, & 10% External check for 4 radicals viz. K_2O, SiO_2, Al_2O_3 & Fe_2O_3	Nos.	220(200+20)	133(121+12)
B.	Pit Samples			
	i) Primary, & 10% External check for 4 radicals viz. K_2O, SiO_2, Al_2O_3 & Fe_2O_3	Nos.	165 (150+15)	24 (22+2)
C.	BH samples			
	i) Primary, & 10% External check for 4 radicals viz. K_2O, SiO_2, Al_2O_3 & Fe_2O_3	Nos.	110 (100+10)	154 (140+14)

Sl. No.	Item of Work	Unit	Target	Achievement
6	Petrographic Studies	Nos	10	14
7	XRD Study	Nos.	5	5
8	Determination of Bulk Density	Nos.	2	2
9	Geological Report preparaton	Nos.	1	1

CHAPTER-11

LOCATION OF DATA POINTS

11.1.0 ACCURACY AND QUALITY OF SURVEY USED TO LOCATE DRILL HOLES

11.1.1 The survey of boreholes drilled in the block has been carried out by the DGPS (Make-Trimble GNSS System, Model-R8s) (Annexure-IB). The photograph of DGPS is given in Photo-11.1.

Photo-11.1: DGPS (Make-Trimble GNSS System, Model-R8s)

11.1.2 The base station has been utilised for fixing of the boreholes position on the ground as well as for reduced levels of the boreholes. The base station was set up away from any disturbances. The coordinates of base station is given in Table-11.1.

Table-11.1

Co-ordinates of the Base Point for DGPS survey of Parsada-Nawapara-Gurur G-4 Block for Glauconitic Sandstone, District:Balod, Chhattisgarh

Base Station	Latitude	Longitude	Easting (m)	Northing (m)	RL (m)
PGN-1	20°40'01.02989"	81°26'12.41055"	545494.366	2285350.306	333.232
NPG-2	20°41'17.93027"	81°19'19.71587"	533549.115	2287686.439	337.947

11.2.0 TECHNICAL SPECIFICATION OF DGPS

MAKE	**TRIMBLE DGPS**
MODEL	**R8-S**
YEAR	**2017**

a) MEASUREMENT ACCURACY:

- Static Mode
- Horizontal – 10 mm +0.1 ppm or better.
- Vertical – 20 mm +0.4 ppm or better.
- **b) BASE LINE ACCURACY**:
  a. Accuracy Horizontal shall not be more than 4 mm for 10 km baseline with occupation line of 10 minutes or less.
  b. Accuracy vertical shall not be more than 7.5 mm for 10 km baseline for with occupation of 10 minutes or less.
- c) **FAST STATIC:**
  a. Horizontal – 3mm +0.5 ppm
  b. Vertical – 5 mm +0.5 ppm
- **GNSS RECEIVER:**
- Trimble R8s Multiple frequency GNSS Receiver has internal on board memory via SD card or internal memory.
- Trimble R8s has 440 channels (GPS + GLONASS +GAGAN) and should be capable of tracking.
- GPS: LIC/A, L2C, LIC, L2E,L5
- GLONASS: LIC/A, L2C/A, LIP, L2P, & L3
- Beidou : B 1 complete with(phase 2) & B2
- SBAS: LIC/A,L5
- Galileo: E1, E5A, E5B
- Systems: EGNOS, QZSS, SBAS, WAAS, GAGAN, (MUST take correction from GAGAN) etc.
- R8s is water proof, shock proof, dust proof, humidity proof, and condensation proof.
- IP 67 with temporary submission in water up to 1 m.

- **SOFTWARE & COMMUNICATION**: Fully functional and Trimble business centre office post processing software.

- **CONTROLLER:**
- Trimble TSC 3 windows based controller for base and 02 nos. Rovers should be provided.
- Alpha numeric hard QWERTY keyboard for Base and 02 no's Rover should be provided.
- Internal Memory – 256 MB RAM & 8 GB Non Volatile memories should be provided.
- Integrated camera for Geo Tagging Must with inbuilt GPS, Compass and Accelerometer should be provided.

CO-ORDINATE SYSTEM MANAGER: Should have datum and projection support & should support Grid coordinates.

- **COGO:** support COGO functionality & able to Key in lines, Sub-divide lines and creating parallel lines for staking out purpose.
- **TRANSFER DATA BETWEEN FIELD AND OFFICE:** Should be capable of e-mail data collected in the field, should be able import and export DXF files in the field for effective GIS support.
- **BACKGROUND MAP**: Able to accept background maps in CAD format.
- **OPERATING SYSTEMS**: Windows 6.5 should be provided.
- **EXPORT**: Able to exporting the data in RINEX format as well in CAD format.
- **REPORTING**: Software should be capable of generating reports directly from the surveyed data.
- **POST PROCESSING SOFTWARE ADVANCE CAPABILITY**: Trimble Business Centre Post Processing software capable of processing Base line with IGS station and processing drawing including engineering application such as contouring, Cross section & L section etc. All software shall be same OEM make.

CHAPTER-12

SAMPLING TECHNIQUE

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

12.1.1 In the geochemical sampling programme, representative bedrock samples were systematically collected from glauconite-bearing formations, with particular emphasis on glauconitic sandstone units exposed in the field. To maintain the integrity of the samples, all visibly weathered and altered surfaces were removed prior to sampling, ensuring that only fresh, unaltered portions of the outcrop or bedrock were used. Sampling was carried out by chipping evenly across the exposure to obtain a representative composition, while taking care to avoid contamination and inadvertent mixing with adjoining lithologies. Each sample weighed approximately 2.0–2.5 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 rigorous 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

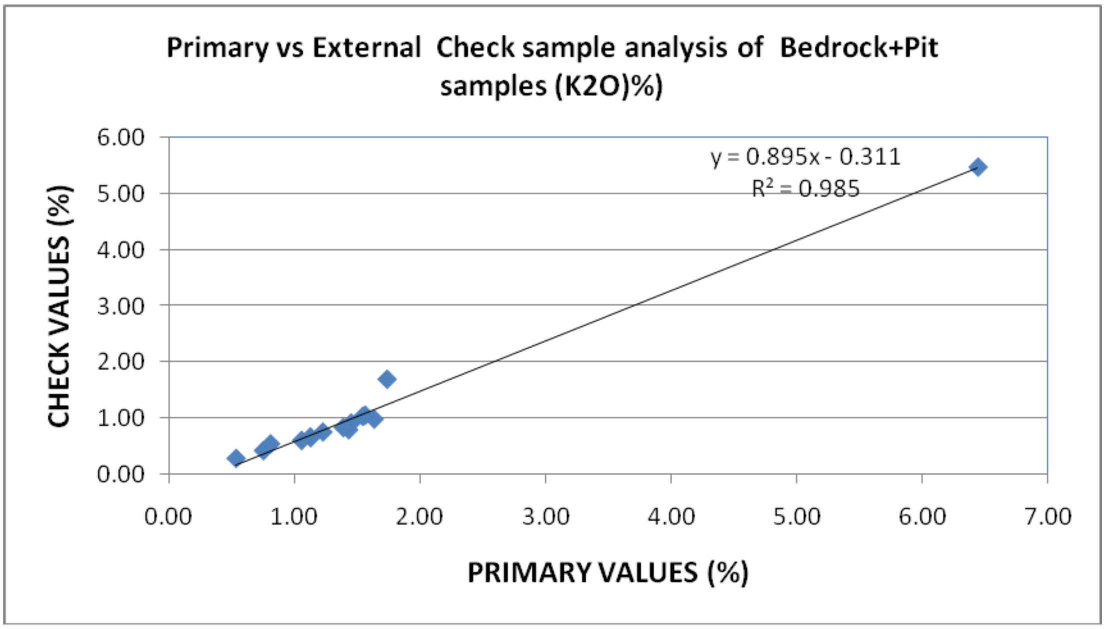
12.2.0 PRIMARY AND CHECK SAMPLE STUDIES OF BEDROCK AND PIT SAMPLING

12.2.1 The present work was undertaken to carry out a Reconnaissance Survey (G-4 stage) for glauconitic sandstone in the Parsada–Nawapara–Gurur block, based on the occurrence of mineralised bodies reported in earlier investigations by the Geological Survey of India (GSI) and supported by preliminary field and laboratory studies conducted by MECL. During the exploration programme, systematic sampling was carried out, comprising surface/bedrock sampling, pit sampling, and collection of samples for petrographic studies.

12.2.2 During geological traverses, specific locations were identified for surface/bedrock sampling. A total of 121 surface bedrock chip samples were collected and analysed for K_2O, SiO_2, Al_2O_3, and Fe_2O_3 (Annexure-IIA). The samples were obtained by chipping across the bedrock exposure using a hammer and chisel, ensuring that the surface was properly cleaned prior to collection. Each sample was placed in a separate labelled plastic bag. All tools were thoroughly cleaned after collecting each sample to maintain quality control and prevent cross-contamination

12.2.3 Further, at twenty two identified locations, pitting was carried out and sampling from pits was done. From pits, one repsentative samples from the pit were taken. pit sampling was carried out by excavating pits to expose fresh glauconitic sandstone beneath the weathered zone, typically upto the depths of 1.5–2.0 m. The pit walls were cleaned, and representative samples were collected. About 3–4 kg of fresh sample was taken from each pit, placed in clean, labelled bags, and recorded with pit coordinates, depth, and lithological details. All tools were thoroughly cleaned before each sample to prevent cross-contamination, ensuring the reliability of subsequent analyses.

12.2.4 During the present exploration, a total of 121 nos. of primary bedrock chip samples and 22 pit samples for the analysis of K_2O, SiO_2, Al_2O_3, and Fe_2O_3 were collected, accordingly, 15 nos. of external check samples were prepared and analysed for surface andpit 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 bedrock samples, primary pit samples and external check bedrock+pit samples are given in Annexure-IIA, and Annexure-IIB respectively. Comparison of primary and external check bedrock sample analysis has been given in Annexure-IIC.



Text Figure 12.1 Scatter Plot of Primary vs Check (External) sample analysis of Bedrock and Pit samples

12.2.5 Scatter plot of primary vs external check analysis for bedrock samples for K_2O% is provided in the Text figure-12.1. Correlation Coefficient is 0.993, which is near to 1, suggests repeatability and reliability of the analysis and homogeneity of the prepared samples.The detail of all the statistical parameters pertaining to radicals for K_2O values in bedrock+pit samples are provided in Table-12.1.

Table-12.1

Statistical comparison of Primary and External Check sample analysis for K_2O (Bedrock+Pit samples)

Comparision of Primary v/s External Check sample analysis (Bedrock+Pit Samples)		
Comparision Index	**Total Fixed K_2O%**	
	Primary	**Check**
No. of sample pairs	15	
Arithmetic mean	1.588	1.110
Standard Deviation	0.382	0.245
Standard error of mean	0.099	0.063
Variance	0.146	0.060
Mean of deviation	0.478	
Standard Deviation (Error)	0.202	
Correlation Co-efficient	0.993	
Mean absolute error	0.478	
Mean relative random error	35.788	
Paired T-value	9.159	
F- test value	2.433	

CHAPTER-13

DRILLING TECHNIQUES AND DRILL SAMPLING EMPLOYED

13.1.0 DRILLING TYPES AND DETAILS

13.1.1 MECL executed a total of five (05) scout boreholes, cumulatively involving 228.00 m of vertical core drilling, as part of the subsurface exploration programme in the block. These boreholes were strategically positioned based on surface geological mapping, sampling results, and interpreted glauconite mineralisation trends, with the objective of assessing subsurface lithology, thickness, grade continuity, and depth persistence of glauconitic sandstone horizons.

13.1.2 The drilling programme in the block was executed in two distinct phases. In the first phase, two scout boreholes—MPN-01 and MPN-02—were drilled in accordance with the recommendations of the NMET Technical Coordination Committee (TCC). The primary objective of this phase was to obtain preliminary subsurface geological data, confirm the occurrence of glauconitic sandstone horizons, and assess their thickness, grade, and continuity.

13.1.3 Following the completion of the first phase, the drilling results were reviewed in detail during the 77th TCC meeting. Based on the encouraging geological and analytical outcomes, and in line with the committee’s recommendations, the second phase of drilling was undertaken. In this phase, the remaining three scout boreholes—MPN-03, MPN-04, and MPN-05—were drilled to further delineate the glauconite-bearing zones.

13.1.4 The first-phase drilling operation in the block was carried out using a Hydrostatic Drill Rig MEC-371 (KDR-1000) Core Drilling Rig. All boreholes were drilled in *NQ* size with a single-barrel wire-line wet core drilling method. Initially, *HW* casing was set from 0.00 m to 6.00 m to cover the surface layer, followed by *NW* casing from 0.00 m to 18.00 m to stabilize loose strata. After casing, drilling progressed in *NQ* size. Borehole MPN-01 was drilled to a depth of 50.00 m and MPN-02 to 28.00 m, both completed with CMC-made NQ diamond bits.

13.1.5 Only one rig (MEC-371, KDR-1000), with an ideal capacity of 1,000 m in NQ size, was deployed. Polymer-based drilling fluid was used to flush cuttings, stabilize borehole walls, and cool drill bits. Core recovery exceeded 90% in glauconitic sandstone, though it was lower in weathered, loose, or fractured zones, and in solution cavities. In such cases, the grade of recovered portions was extrapolated over non-recovered sections. Drilling quality was ensured by regulating water pressure, using proper liners, applying optimum head pressure, and relying on skilled drilling technicians. Core recovery details for each borehole are detailed in the lithologs provided in Annexure-IIIA.

13.1.6 The second-phase drilling operation in the block was also executed using Hydrostatic Core Drilling Rig, KDR-1000. All 3 boreholes of 2^{nd} phase were drilled in NQ size employing a single-barrel wire-line wet core drilling method. To stabilise the upper loose strata, HW casing was set from 0.00 m to 6.00 m in each borehole. After casing installation, drilling progressed in NQ size to the target depths, with operations continuing until borehole closure. Drilling was conducted using CMC-manufactured NQ diamond bits to ensure efficient penetration in glauconitic sandstone formations.

13.1.7 Only one rig—MEC-396 (KDR-1000)—was deployed for the programme, having an ideal drilling capacity of 600.00 m in NQ size under favourable conditions. Polymer-based drilling fluid was used to facilitate cuttings removal, stabilise borehole walls, and act as a coolant to prevent drill bit overheating.

13.1.8 Overall, core recovery exceeded 90% in glauconitic sandstone horizons. Reduced recovery was encountered in weathered, loose, and fractured zones, as well as in solution cavities. In such cases, the grade of the recovered portion was extrapolated over the non-recovered intervals. To ensure drilling quality and maximise recovery, operational precautions included regulating water pressure, using proper liners, maintaining optimum head pressure, and employing experienced drilling technicians. Core recovery details for each borehole are detailed in the lithologs provided in Annexure-IIIA.

Photo-13.1 Photograph of KDR-1000 drill Rig under operation during day shift at MPN-01

Photo-13.2 Photograph of KDR-1000 drill Rig under operation in night shift at MPN-05

13.1.3 All the boreholes are vertical boreholes. The quality of drilling was ensured during the operation. After closure, all the boreholes have been properly plugged and sealed with cement pillars. The details of all 05 boreholes with number, DGPS coordinate details, RL, depth and section lines numbers etc are provided in Annexure-IB.

13.2.0 DRILLING TECHNIQUE

13.2.1 Drill Rod & Casing Setup – First Phase

- Drilling Method: Single-barrel wire-line wet core drilling
- Core Size: NQ
- Initial Casing:
  - HW Casing: 0.00 m to 6.00 m (surface layer support)
  - NW Casing: 0.00 m to 18.00 m (loose strata stabilisation)
- Drill Rods: NQ rods used from end of NW casing to target depth
- Bit Type: CMC-made NQ diamond bit
- Drilling Depths:
  - MPN-01: 50.00 m
  - MPN-02: 28.00 m

13.2.2 Drill Rod & Casing Setup – 2nd Phase

- Drilling Method: Single-barrel wire-line wet core drilling
- Core Size: NQ
- Initial Casing:
- HW Casing: 0.00 m to 6.00 m (installed in each borehole to stabilise upper loose strata)
- Drill Rods: NQ rods used for drilling from end of HW casing to target depth
- Bit Type: CMC-made NQ diamond bit
- Drilling Depth: Advanced in NQ size to planned depth until borehole closure

13.2.3 Core Recovery Optimization

- Average Core Recovery: Maintained above 90% in glauconitic sandstone horizons.
- Low Recovery Zones: Weathered, loose, and fractured strata, and solution cavities.
- Mitigation Measures:
- Modulated (regulated) water pressure
- Use of proper liners
- Application of optimum head pressure
- Deployment of skilled drilling technicians
- Drilling Fluid Role: Polymer-based drilling fluid used to flush cuttings, stabilise borehole walls, and act as a coolant to prevent drill bit overheating.
- Data Handling: Grades from recovered core were extrapolated over non-recovered intervals when necessary.

13.3.0 DRILLING TECHNIQUE

13.3.1 Here's the table for Borehole & Core Diameters – Phase I & Phase II:

Table 13.1
showing Borehole & Core Diameters – Phase I & Phase II, Parsada-Nawapara-Gurur G-4 block, Balod, C.G.

Phase	Drilling/Casing Size	Borehole Diameter (mm)	Core Diameter (mm)	Purpose/Remarks
Phase I	HW Casing	~114.3	~71.6	Surface layer support (0.00–6.00 m)
Phase I	NW Casing	~88.9	~54.7	Loose strata stabilisation (0.00–18.00 m)
Phase I & II	NQ Drilling	~75.7	~47.6	Main core drilling to target depth
Phase II	HW Casing	~114.3	~71.6	Surface layer support (0.00–6.00 m)

13.4.0 DEVIATION SURVEY IN DRILLING

13.4.1 All the exploratory boreholes drilled in the block are vertical with depth ranging from 28.00m to 50.00m. 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.

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

13.5.1 On completion of each drilling run, the recovered core was carefully laid out on corrugated GI sheets at the drill site and washed to remove drilling fluid and loose cuttings. Initial field logging was then carried out by site geologists, which included marking downhole indications, meterage intervals, fitting and aligning core pieces, inspecting for lost intervals, and recording basic geotechnical parameters. Core recovery was measured run-wise, with any zones of loss identified and documented in detail.

13.5.2 The cleaned cores were placed in Wooden/GI core boxes with a storage capacity of 5 m per box, arranged in a systematic "book pattern" for ease of handling and examination. Proper run-wise depth markings and directional arrows were provided throughout to ensure accurate orientation and correlation during subsequent detailed logging and analysis.

13.5.3 The core samples have been recorded properly and the detailed run wise litholog and summarized litholog for boreholes are given in Annexure-IIIA and Annexure-IIIB respectively. The logging of run wise borehole cores helped in deciphering the physical characters like colour, shape, size and nature of the mineralisation as well as texture, structural features etc. thereby identification of different litho units.

13.5.4 The mineralised zones / length recorded during the geological core logging have been sampled and analysed for 4 radicals i.e., K_2O, SiO_2, Al_2O_3, and Fe_2O_3. The primary samples have been marked in the mineralized zones intersected in the borehole based on ore type and concentration of mineralisation/lithology and in general the sample length has been kept as 1.0 m in first phase and 2.0m in 2nd phase asper the advice of NMET, TCC. However, length of the sample 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-IVA.

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

- **Optimized Drilling Parameters:**

- Modulated water pressure to avoid washing away fine material.
- Maintained optimum head pressure to ensure smooth penetration and minimal sample disturbance.

- **Use of Proper Equipment:**

- Appropriate liners used to retain core integrity.
- High-quality CMC-made diamond bits for efficient cutting.
- Deployment of polymer-based drilling fluid to flush cuttings, stabilise borehole walls, and cool the drill bits.

- **Skilled Workforce:**

- Experienced drilling technicians employed to adjust operational parameters in challenging strata.

- **Adaptation in Problematic Zones:**

- Special care taken in weathered, loose, and fractured formations, and in solution cavities.
- Where core recovery was low, the grade of recovered sections extrapolated to non-recovered intervals based on geological continuity.

- **Quality Control:**

- Continuous monitoring of recovery percentage for each borehole.
- Detailed lithological logging for correlation and verification

13.7.0 WHETHER THE RELATIONSHIP EXISTS BETWEEN SAMPLE RECOVERY AND GRADE

13.7.1 No such definite relation exists between sample recovery and grade.

13.8.0 CORE LOGGING

13.8.1 The borehole cores were geologically logged in detail, recording textural, lithological, mineralogical, and structural characteristics. Lithologies were identified using standard nomenclature, with careful documentation of colour, grain size, mineral variations, and lithological changes. Depth intervals of weathering, oxidation, and fracturing were noted, along with delineation of mineralisation zones and megascopic descriptions of identifiable ore minerals. Core recovery was measured for each run, with variations linked to lithology and weathering features. Mineralised zones were re-logged after core splitting to obtain additional geological and mineralogical information in support of accurate resource estimation.

Photo-13.3: Photograph showing borehole core logging

13.7.2 In short, all relevant data that complements the resource estimation was collected while logging. These data will also guide the future investigations that may follow-up.All the cores were kept and preserved properly in the Wooden/GI core boxes of specifications given by NMET following "book pattern". The detailed run wise litholog and summarized litholog for boreholes are given in Annexure- IIIA and Annexure- IIIB respectively.

Photo-13.4: Photograph showing preservation of borehole cores (MPN-04)

CHAPTER-14

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 (Photo 14.1). 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.

Photo-14.1: Photograph showing mineralized core sampling

14.1.2 The mineralised core was split into two equal halves using a core splitter (Photo 14.2, Photo 14.3), 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 14.4 and 14.5). 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.

Photo-14.2: Photograph showing core splitter used to split borehole cores

Photo-14.3: Photograph of half splitted borehole cores of MPN-02

14.1.2 During the present exploration, a total of 140 primary borehole (BH) core samples and 14 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.

14.1.3 To ensure analytical accuracy and reproducibility, a set of 14 external check samples — representing various lithologies and grade ranges — 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.

14.1.4 The detailed analytical results of the primary BH core samples and the external check samples are presented in Annexure-IVA and Annexure-IVB, 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

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 Reconnaissance Survey (G-4 stage) for glauconitic sandstone in the Parsada–Nawapara–Gurur Block, Balod District, Chhattisgarh, included comprehensive laboratory analyses covering surface, pit, and borehole (BH) 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). In addition, X-ray diffraction (XRD) studies were conducted on selected BH samples to determine mineralogical composition. 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 XRD STUDIES

15.3.1 X-ray Diffraction (XRD) is a non-destructive analytical technique that utilises X-rays to characterise the crystallographic properties of a material. In the present study, XRD was employed for the following purposes:

- **Crystal Structure:** Determination of the degree of order in the atomic arrangement.
- **Phase Composition:** Identification of mineral phases present in the sample (e.g., quartz, feldspar, hematite, etc.).
- **Crystallite Size:** Estimation of crystallite size, particularly for nanomaterials, using the Scherrer equation.
- **Lattice Parameters:** Measurement of unit cell dimensions, useful for distinguishing polymorphs or solid-solution series.

- **Strain and Defects:** Evaluation of micro-strain and detection of lattice defects through peak broadening and analysis of preferred orientation.

Photo 15.2 Photograph showing XRD instrument (PANalytical, Netherland) at Chemical Lab, MECL, Nagpur

15.3.2 PRICIPLES OF XRD STUDIES

It works on the principle of Bragg's Law:

$n\lambda = 2d\sin\theta$ (n = 1, 2, 3……n)

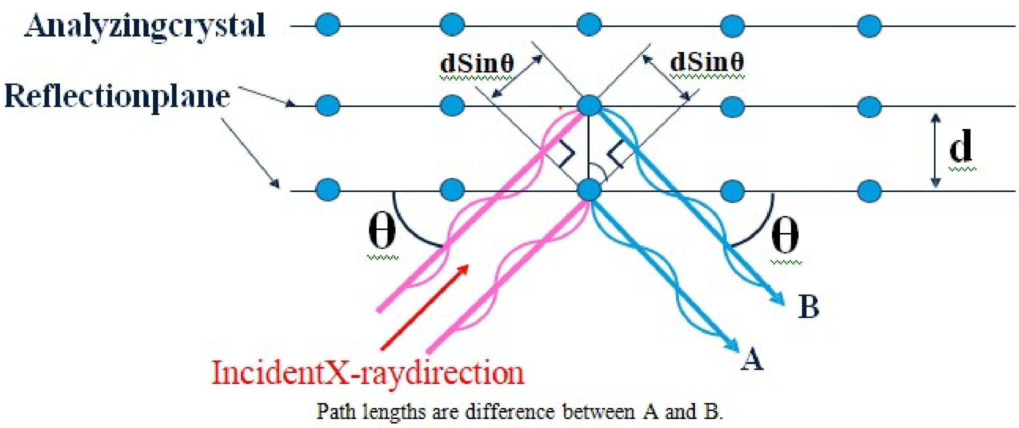
Where:

λ is the wavelength of the X-ray

d is the interplanar spacing

θ is the angle of incidence

n is an integer (order of reflection)



Text figure 15.1 Diagramatic representation of the principles of XRD Studies

15.3.3 PROCEDURE OF XRD STUDIES

Prior to commencing sample analysis, the XRD instrument was calibrated using silica Certified Reference Materials (CRMs) to ensure accuracy. The following procedure was adopted for the analysis:

1. **Sample Collection:** Obtain a few tenths of a gram (or more) of the prepared sample.
2. **Grinding:** Pulverise the sample to a fine powder of less than ~200 mesh size to minimise preferred orientation effects and achieve a random lattice orientation.
3. **Pellet Preparation:** Place the powdered sample into the sample holder to form a pellet, ensuring a smooth, flat upper surface and a random particle orientation. Care was taken to avoid introducing any texture unless an oriented mount was specifically required.
4. **Analysis:** Run the prepared pellet in the XRD instrument to obtain raw diffraction data.
5. **Interpretation:** Process and interpret the diffraction patterns using *HighScore Plus* software to identify mineral phases and determine crystallographic parameters.

15.4.0 CHECK ANALYSIS FROM THIRD PARTY NABL ACCREDITED LABORATORY

15.4.1 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 of 15 external check samples from surface and pit sampling, and 14 external check samples from borehole (BH) cores, were analysed for K_2O, SiO_2, Al_2O_3, and Fe_2O_3. A comparison of primary versus external check analyses for all four oxides, presented in Annexures IIC and IVB respectively, shows a high degree of similarity. This consistency demonstrates the repeatability and reliability of the analytical results, the homogeneity of the prepared samples, and confirms that the primary laboratory analyses are accurate and dependable.

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

15.5.1 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.

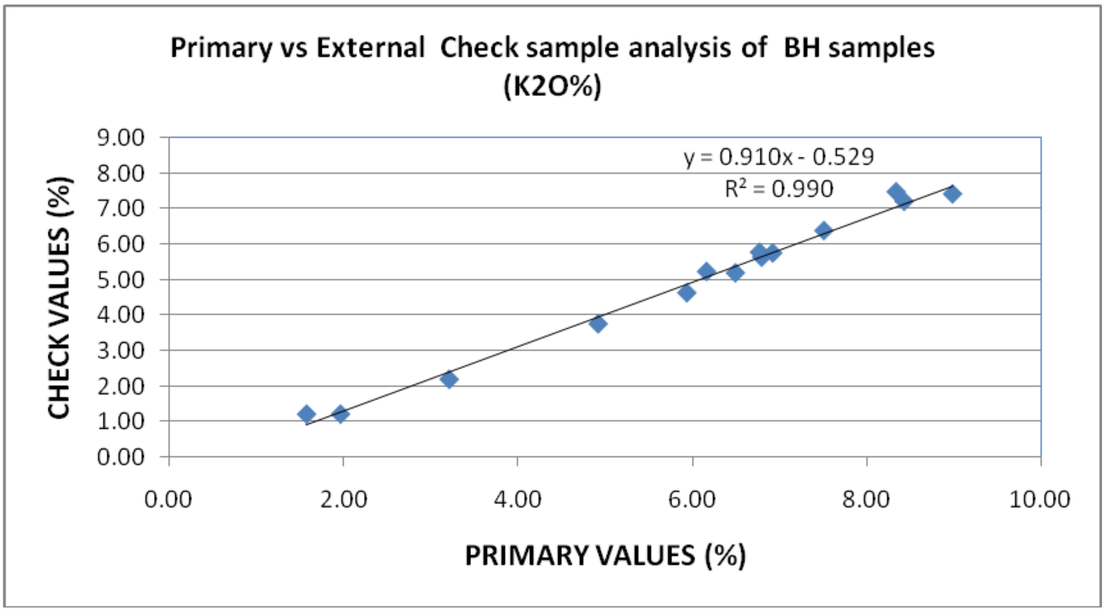
15.5.2 Standard operating procedures and robust precautionary measures were strictly followed to prevent any possibility of contamination, ensuring the reliability of analytical results. The sampling unit operates independently from the chemical laboratory, eliminating the risk of cross-contamination. 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.

15.6.0 NATURE OF QUALITY CONTROL PROCEDURES ADOPTED

15.6.1 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.

15.6.2. A total of 14 nos. of external check BH samples analyses has been carried out at chemical laboratory of JNARDDC, Nagpur. Details of external check borehole sample results are furnished as Annexure-IVB.

15.6.3 Scatter plot of primary vs external check analysis for BH samples for K_2O% is provided in the Text figure-15.2. Correlation Coefficient is 0.995, which is near to 1, suggests repeatability and reliability of the analysis and homogeneity of the prepared samples.The detail of all the statistical parameters pertaining to radicals for K_2O values in bedrock+pit samples are provided in Table-15.1.



Text Figure 15.2 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 of Primary v/s External Check sample analysis (BH Samples)		
Comparision Index	**Total Fixed K_2O%**	
	Primary	**Check**
No. of sample pairs	14	
Arithmetic mean	5.997	4.933
Standard Deviation	2.539	2.302
Standard error of mean	0.678	0.615
Variance	6.444	5.298
Mean of deviation	1.064	
Standard Deviation (Error)	0.280	
Correlation Co-efficient	0.995	
Mean absolute error	1.064	
Mean relative random error	19.887	
Paired T-value	14.205	
F- test value	1.216	

CHAPTER-16

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

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 two 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 are 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 Parsada-Nawapara-Gurur (G-4 stage) block,Balod, C.G.

Sl. No.	Pit no.	Borehole no.	From (m)	To (m)	Bulk Density (gm/cm^3)
1	MPN01/BD1	MPN-01	32.40	32.50	2.62
2	MPN02/BD2	MPN-02	24.10	24.20	2.67
				Average Bulk Density	**2.65**

CHAPTER-18

BENEFICIATION STUDIES

18.1.0 The present exploration is of Reconnaissance Survey (G-4 stage) category. Beneficiation study has not been carried out at this reconnaissance stage.

CHAPTER-19

RESOURCE ESTIMATION TECHNIQUE

19.1.0 GENERAL

19.1.1 MECL carried out a Reconnaissance Survey (G-4 stage) in the Parsada–Nawapara–Gurur block targeting glauconitic sandstone. The exploration programme comprised detailed geological mapping on a 1:12,500 scale, bedrock chip sampling, pitting, and drilling through vertical boreholes. Through this integrated approach, MECL thoroughly evaluated the exploration block, delineated zones of glauconite mineralisation, and subsequently estimated the Reconnaissance Resource under UNFC Category 334.

19.1.2 A total of five vertical scout boreholes (MPN-01 to MPN-05) were drilled along five section lines, designated S1–S1′ to S5–S5′. 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 4% K_2O, mineralised zones ranging in thickness from 2.00 m to 34.00 m were delineated and plotted on the geological cross-sections (Plate-IV).

Table 19.1.

Table showing mineralisation zone and average grade for K_2O encountered in boreholes, Parsada-Nawapara-Gurur G-4 block, Balod, C.G.

BH No.	From (m)	To (m)	Thickness (m)	Average K_2O %
MPN-01	3.00	8.00	5.00	6.96
	9.00	12.00	3.00	5.82
	14.00	17.00	3.00	4.36
	21.10	50.00	28.90	7.20
MPN-02	3.50	28.00	24.50	6.21
MPN-03	3.00	7.00	4.00	5.15
	8.50	14.00	5.50	5.80
	16.00	18.00	2.00	4.68
	24.00	28.00	4.00	6.98
	34.00	50.00	16.00	4.94
MPN-04	4.00	38.00	34.00	6.11
	40.00	50.00	10.00	5.32
MPN-05	6.00	28.00	22.00	6.03
	32.00	44.00	12.00	5.65
	48.00	50.00	2.00	4.13

19.2.0 ASSUMPTIONS FOR RESOURCE ESTIMATION

19.2.1 The resource is estimated using both the Cross-sectional method and the Polygonal 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 The zones of K_2O have been demarcated from the values of primary sample analysis as per the commonly prescribed threshold value. It is to be noted that cut-off grade of 4% K_2O for estimating the resources has been takeninto the consideration. The minimum thickness of 2.00m of K_2O zone has been considered for resource calculation in both methods.

19.2.3 A total of 2 nos.of BH core samples of glauconite horizon were analysed for bulk density determination.

19.2.4 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 core, recovery factor, cavities/caverns and other structural features.

19.3.0 PARAMETERS FOR RESOURCE ESTIMATION

19.3.1 **Sampling procedure**

The core sampling methodology ensured accurate representation of the in-situ formation, with borehole cores split into two equal halves—one powdered to (-)200 mesh size for chemical analysis and the other preserved for future studies. Sampling was conducted at 1m interval for 1st two boreholes and at 2m interval in the remaining boreholes as per the advice of the TCC committee of NMET. Standardized sample preparation techniques were followed, including contamination-free processing, rigorous cleaning of equipment, and adherence to the coning and quartering method for sample reduction. Each final 300-gram sample was divided into three equal portions for primary analysis, check analysis, and future reference. The -200 mesh size ensured optimal fineness for laboratory testing by XRF, while the sample size was appropriate for accurate chemical analysis. In total, 140 primary samples and 14 external check samples were generated.

19.3.2 Chemical analysis

A total of 140 nos. of primary core samples in Parsada-Nawapara-Gurur (G-4 stage) block were analyzed by in-house chemical lab of MECL, Nagpur. For reliability of the primary analysis, 10% of primary samples, i.e. 14 nos. of samples have been analyzed in an NABL approved external chemical lab of JNARDDC, Nagpur.

19.3.3 Cut-off grade

The resource estimation for glauconitic sandstone in the Parsada-Nawapara-Gurur block has been conducted based on the threshold values set by the IBM which is under the Ministry of Mines. The minimum threshold value takeninto consideration is 4% K_2O.

19.3.4 Bulk density

A total of two 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 2.65 g/cm³.

19.4.0 METHODOLOGY ADOPTED FOR CROSS SECTIONAL METHOD FOR RESOURCE ESTIMATION

19.4.1 In Parsada-Nawapara-Gurur G-4 blocks, drilling has been taken up in 05 prominent glauconitic bodies. Geological cross-sections were prepared by correlating lithology and K_2O zones to delineate the shape of the mineralisation zone, with profiles generated using GDM software.

19.4.2 For resource estimation, the sectional area of K_2O rich zone corresponding to a particular borehole was defined. Cross sectional area on each section has been measured with the help of Auto CAD map 2025 software and recorded systematically. The influence of each borehole is extended up to 400m on either side or up to the limit of the boundary of the K_2O rich mineralised body.

19.4.3 To calculate the volume of the deposit, the sectional area corresponding to each borehole was multiplied by the sectional influence. This method ensured an accurate representation of the volume of mineralised body associated with each borehole. Once the volume was determined, it was multiplied by the bulk density of the corresponding borehole to derive the resource estimate. Bulk density values were obtained through systematic measurements, ensuring reliable tonnage calculations.

19.4.4 Finally, the total in-situ geological resource was determined by summing the individual resource estimates from all boreholes. This methodology ensures a systematic and accurate assessment of the Glauconitic resource within the block, providing a solid foundation for further geological and economic evaluations.

19.5.0 METHODOLOGY ADOPTED FOR POLYGONAL METHOD FOR RESOURCE ESTIMATION

19.5.1 The resource estimation for K_2O rich mineralisation in the Parsada-Nawapara-Gurur block was also conducted using the Polygonal Method. These mineralised bodies represent the mineralized zones within which resource calculations were performed. The polygonal method involves defining individual borehole influence areas within these mineralized zones, ensuring that the estimated resources are systematically allocated based on spatial distribution and geological continuity.

19.5.2 The polygonal resource map, as depicted in Plate-V, provides a visual representation of these borehole influences in each polygon. Area each polygon has been calculated using Auto CAD.

19.5.3 Resource calculation polygons were generated using a 400 m influence radius from each borehole. The aggregate resource area was subsequently constrained to the mapped boundary of the mineralised body.The polygonal areas for each borehole were precisely measured using AutoCAD Map 2025 software, allowing for accurate delineation of mineralized zones. Once the polygonal area corresponding to each borehole was determined, it was multiplied by the measured thickness of the mineralised zone in that borehole to calculate the volume of the mineralisation. This approach ensures that the volumetric estimation reflects both the areal extent and stratigraphic thickness of the deposit.

19.5.4 Finally, the calculated volume for each borehole was multiplied by the respective bulk density values obtained through systematic in-field measurements. This step converted the volume into tonnage, yielding the estimated K_2O resource for each borehole. The sum of resources from all boreholes provided the total in-situ geological resource for the Parsada-Nawapara-Gurur block. This method ensures an accurate and systematic assessment of the glauconite resource, facilitating further economic evaluation and potential extraction planning.

Table- 19.2

Boreholes and corresponding Polygonal area in Parsada-Nawapara-Gurur G -4 block

Sl.No.	Borehole No.	Area of polygon (m^2)
1	MPN-01	379336.7831
2	MPN-02	189368.4193
3	MPN-03	299986.1924
4	MPN-04	211286.8765
5	MPN-05	309416.6005

CHAPTER-20

REPORTING OF RESOURCES

20.1.0 RESOURCE ESTIMATION

20.1.1 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. In the Cross-Sectional Method, resources were estimated on a borehole-wise and section-wise basis, following the specifications and basic assumptions established earlier. This method involved delineating geological cross-sections along designated section lines, correlating lithology and K_2O grade to define the mineralised body's shape and volume. In the Polygonal Method, resources were estimated on a borehole-wise and polygon-wise basis. Each borehole was assigned a specific polygonal area, determined by spatial distribution within the mineralized glauconitic bodies. The estimated resource for each borehole was calculated based on its corresponding polygonal area, zone thickness, and bulk density, ensuring systematic and reliable assessment. By comparing results from both methods, the accuracy and reliability of the resource estimation were validated.

20.1.2 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 core, recovery factor, cavities/caverns and other structural features.

20.1.3 A total of **104.53 million tonnes** of Net in-situ Reconnaissance Resources (334 category) with average grade of **6.11% K_2O** has been estimated by cross-sectional method**.**

20.1.4 However**,** total of **105.28 million tonnes** of Net in-situ Reconnaissance Resources (334 category) with average grade of **6.05% K_2O** has been estimated by polygonal method**.**

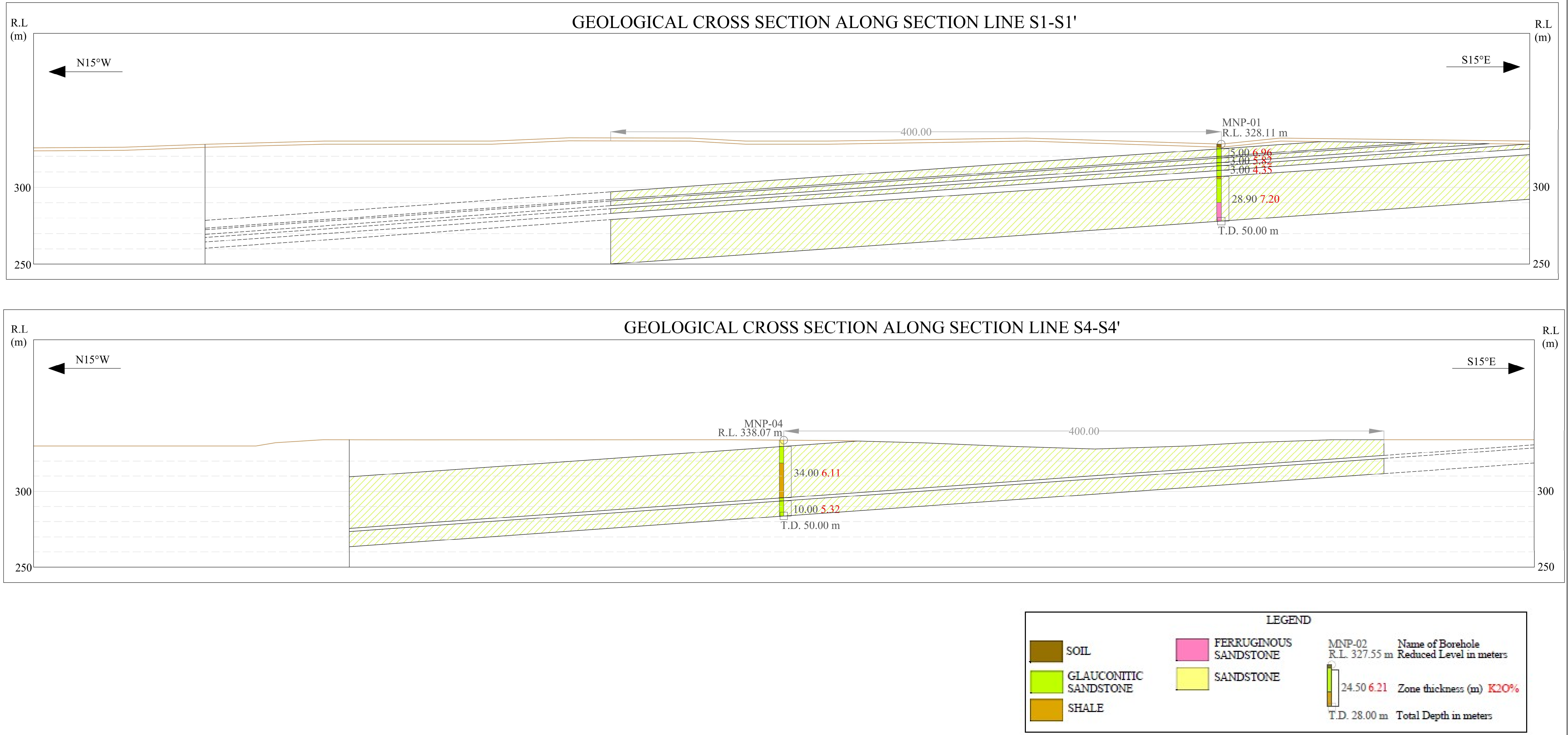
Table 20.1
Summary and comparison of Reconnaissance Resources (334), Estimated by Cross Sectional method and Polygonal method in Parsada-Nawapara-Gurur (G-4 stage) Block, Balod Distt., Chhattisgarh

Resource	Cross-Sectional Method		Polygonal Method		% Difference in Resources
	Net in-situ Resources (million tonnes)	Average Grade (K_2O%)	Net in-situ Resources (million tonnes)	Average Grade (K_2O%)	
	104.53	**6.11**	**105.28**	**6.05**	**0.71**

20.1.5 All estimated resources have been classified under the Reconnaissance Category (334) as per the United Nations Framework Classification (UNFC) guidelines. The details of estimation of resource by cross sectional method and polygonal method are furnished at Annexure- VIII & XI respectively.

20.1.6 All calculations for grade estimation are made by weighted average method. The sample interval was maintained at 1.00m and 2.00m with the exception of minor variations or structural implications.

20.1.7 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 0.71% 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.



Text Figure-20.1: Representative cross section along S1-S1' and S4-S4' for Parsada-Nawapara-Gurur (G-4 stage) Block for Glauconitic Sandstone, District- Balod, Chhattisgarh

CHAPTER-21

SUMMARY AND RECOMMENDATIONS

21.1.0 SUMMARY

21.1.1. The Parsada-Nawapara-Gurur exploration block (G-4 stage) for glauconitic sandstone covers an area of 144.0 sq. km, encompassing parts of the villages Parsada, Belmand, Karahibhadar, Chichbor, Chirchori, Karkabhat, Khairwahi, Nawapara, Mujgahan, Dhobanpur, Dhanora, Gurur, Thekwadih, Chitod, and surrounding areas in Gurur and Balod tehsils of Balod district. The exploration block falls in the Survey of India toposheet no. 64H06. The exploration block can be reached from Durg via Durg-Balod Road through NH-7.

21.1.2. The Parsada–Nawapara–Gurur G-4 block lies in the southern part of the Chhattisgarh Basin and hosts Meso– to Neoproterozoic litho-units of the Chandarpur Group, comprising the Kansapathar Formation (younger) and Lohardih Formation (older). The Kansapathar Formation represents a transgressive–regressive sequence with lower fining-upward marine-transgressive strata and upper coarsening-upward shallow marine to coastal deposits. It is dominated by well-sorted, medium- to coarse-grained quartz arenite and is economically significant for its glauconitic sandstone horizons, which formed under marine, low-energy, anoxic conditions during transgression. Glauconite occurs as pellets and coatings on detrital grains, with variable thickness and concentration, and holds potential for potash and critical element extraction.

21.1.3 The underlying Lohardih Formation marks the basal Chandarpur Group and records the earliest siliciclastic deposition in the basin. It consists mainly of ferruginous feldspathic sandstone with shale partings, polymictic conglomerates, and occasional laterite. The conglomerates rest unconformably over the Archean basement, reflecting high-energy alluvial fan to fan-delta settings during early sedimentation, followed by marine shoal-bar systems enriched in iron oxides. Shale occurs only in borehole intersections, intercalated with sandstone. The area exhibits subdued, nearly flat topography, with strata striking ENE–WSW to E–W and dipping gently (2–5°) towards the NNW.

21.1.4 Exploration in the Parsada–Nawapara–Gurur G-4 block began on 16 June 2024 with geological mapping at a 1:12,500 scale, followed by systematic surface bedrock sampling to assess lithology and mineralization. Zones of glauconite enrichment identified from these samples guided subsequent pitting and drilling activities. Mapping covered the full 144 sq. km area using a 1 km × 1 km grid system, ensuring uniform data coverage. Field observations recorded lithology, structures, and mineral occurrences, with structural measurements taken by Brunton compass and coordinates logged via GPS. Laboratory analyses were carried out at MECL facilities, with check analyses performed at JNARDDC, Nagpur.

21.1.5 Bedrock sampling during geological traverses involved collecting 121 samples, of which 21 samples showed ≥1% K_2O (1.00–2.15%), defining 5–6 target zones. Based on these results, 22 pits were excavated (125.5 cu. m) at selected locations to evaluate lateral and subsurface continuity of mineralized horizons. Pit samples revealed K_2O grades ranging from 0.39% to 6.44% (highest in Pit-09 near Kuliya village). Six pits returned values above 1% K_2O, indicating moderate to high glauconite enrichment, particularly in less-weathered sandstone.

21.1.6 Drilling comprised 228 m in 5 scout boreholes (MPN-01 to MPN-05), selected on the basis of positive surface and pit sample results. Borehole logging recorded lithological, structural, and mineralogical details, with glauconitic sandstone and glauconitic shale encountered in almost all the boreholes. Sampling was generally done at 1 m intervals in the first two boreholes and 2 m intervals in the remaining three. Analytical results indicated multiple K_2O enriched zones, and the borehole coordinates were determined using DGPS in WGS-84 Datum.

21.1.7 In borehole MNP-01, zone of 39.90m thickness with >4% K2O% (Range 4.36% - 7.20% K2O) has been found. In borehole MNP-02, a zone of 24.50m thickness with >4% K2O% (6.21% K2O) has been found. In borehole MNP-03, zone of 31.50m thickness with >4% K2O% (Range 4.68% - 6.98% K2O) has been found. In borehole MNP-04, zone of 44m thickness with >4% K2O% (Range 5.32% - 6.11% K2O) has been found. In borehole MNP-05, zone of 36m thickness with >4% K2O% (Range 4.13% - 6.03% K2O) has been found. These results provided a robust basis for subsequent resource estimation and evaluation of the block's economic potential.

21.1.8 A distinct disparity is observed in the K_2O content of surface and core samples of glauconitic sandstone. The average K_2O content of 22 pit samples is 1.08%, whereas the weighted average of K_2O content from five boreholes ranges between 5.36% and 6.21%. This difference may be attributed to (i) surface weathering and leaching, which reduce K_2O in pit samples, and (ii) better preservation and enrichment of K-bearing minerals at depth. Additionally, 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.

21.1.9 Nevertheless, the elevated K_2O values observed in the borehole samples do not negate the occurrence of glauconitic sandstone in the area. The Kansapathar Formation of the Chhattisgarh Basin is regionally well documented for its glauconite content, and the characteristic lithological association of glauconitic sandstone is a consistent stratigraphic feature of this unit. Therefore, while the precise contribution of glauconite to the observed K_2O values may vary due to the presence of additional potassium-bearing phases, the geological context strongly supports the interpretation that glauconitic sandstone is indeed present within the explored sequence.

21.1.10 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.

21.1.11 The resource estimation for glauconitic sandstone in the Parsada–Nawapara–Gurur block was carried out using the **Cross-sectional Method** as the principal approach and the **Polygonal Method** as a check. A standard 20% deduction was applied to gross in-situ resources to account for unseen geological factors such as core recovery, cavities, and structural variations, yielding Net in-situ Reconnaissance Resources (UNFC 334 category).

21.1.12 The resource estimation indicates **104.53 million tonnes** of net in-situ Reconnaissance Resources (UNFC 334) with an **average grade of 6.11% K_2O** by the cross-sectional method, while the polygonal method estimates **105.28 million tonnes** with an **average grade of 6.05% K_2O**.

21.1.13 The difference between the two estimates—**104.53 Mt** (cross-sectional) and **105.28 Mt** (polygonal)—represents a variation of **0.75 million tonnes**, or roughly **0.71% higher** in the polygonal method. Itis well within the permissible limit.

21.1.14 The Reconnaissance Survey for glauconitic sandstone in the Parsada–Nawapara–Gurur block, Balod, Chhattisgarh, was recommended in the 64th TCC meeting held on 29–30 April 2024, and subsequently approved in the 35th EC meeting held on 16th May 2024. MECL received formal approval from the 35th Executive Committee of NMET through letter no. 23/457/2024-NMET/120, dated 10 June 2024, with a designated completion period of 12 months. The exploration block covers an area of 144 sq. km; however, the OM issued contains a typographical error, recording the area as 146.27 sq. km. Field operations commenced on 16 June 2024, during which MECL carried out geological mapping on a 1:12,500 scale, bedrock sampling, pitting, and drilling. The Geological Report is now being submitted in September 2025.

21.1.15 The Geological Report has been prepared by MECL and peer-reviewed by Dr. P. R. Golani, Retd. DDG, GSI. All necessary inputs, corrections, and suggestions provided by the peer reviewer have been duly incorporated, and the final report is being submitted in September 2025

21.2.0 RECOMMENDATIONS

21.2.1 Five substantial K_2O rich potential zones have been delineated based on the exploration data generated during the G4 stage exploration work carried out in the block.

21.2.2 To establish strike continuity and to assess the depth and grade continuity of the above-mentioned potential areas, systematic drilling operations may be undertaken to upgrade the block to the G3 level.

21,2,3 SEM-EDS studies are recommended in future work to validate the presence of glauconite vs feldspar/mica in the area.

CHAPTER-22

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.

22.2.0 Regional Geology Map is given as Plate-II.

22.3.0 Block Geological Map on 1:12,500 with Bedrock and pit and BH Locations is given as Plate-III.

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

22.5.0 Map for the mineralised body used for determination of polygonal resources, on 1: 25,000 scale is given as Plate-V

CHAPTER-23

ANNEXURE / ENCLOSURES TO THE REPORT

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

CHAPTER-24

ANY OTHER INFORMATION

24.1.0 ANY OTHER INFORMATION

No Such information is required to be mentioned additionally.

CHAPTER-25

CERTIFICATE FROM THE QUALIFIED PERSON WITH NAME, DATE AND SIGNATURE

This is to certify that geological report in respect of Reconnaissance Survey for Glauconitic sandstone in Parsada-Nawapara-Gurur block, Balod, Chhattisgarh was recommended in 64th TCC held on 29th-30th April, 2024 and was subsequently approved in 35th EC held on 16.05.2024. MECL has received approval from the 35th Executive Committee of NMET through letter no. 23/457/2024-NMET/120, dated 10th June 2024, with the designated time duration of 12 months. Field operation was initiated by MECL on 16th June 2024, carried out Geological Mapping on 1:12,500 scale, bedrock sampling, pitting and drilling and the Geological Report is being submitted in September 2025.

NAME: **SHRIKANT SHARMA**

DESIGNATION: **HoD (EXPLORATION)**

DATE: **08.09.2025**

LIST OF PERSONNEL ASSOCIATED WITH RECONAISSANCE SURVEY (G-4) FOR GLAUCONITIC SANDSTONE IN PARSADA-NAWAPARA-GURUR BLOCK (144 SQKM) DISTRICT-BALOD, CHHATTISGARH

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)
		Vikash Kumar, Sr. Manager (Geology)
3	Operation	Shri S.N. Khadse, GM (Exploration) Shri Jayprakash Choudhury, Sr. Manager (Geology)/Head (Operation) Shri Alok Daharwal, Sr. Manager (Geology) Shri Sandeep Sarangi, Manager (Geology)
4	Project Management	Shri Deepesh Rawat, Manager (Drilling) Shri Mitesh Kumar, Manager (Drilling)
5	Physical Execution of work	
	a) Geology	Shri Ram Pramod, Manager (Geology) Shri Omkar Narayan Behera, Ex. Geologist
6	Sample Processing	Shri Ankush Wagh, Sr. Sampling Assistant Shri Ram Pramod, Manager (Geology)
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	Vikash Kumar, Sr. Manager (Geology)
		Shri Ram Pramod, Manager (Geology)
10	Non-Coal Geological Report Cell	Shri S. K. Satpathy, Sr. Manager (Geology)
		Ms. Rajanya Roy, Assistant Manager (Geology)
		Shri Uday Patil, Sr. Computer Operator
		Shri Shivanand, Sr. Computer Operator
11	Reprography and Printing	Shri P. S. Negi, Survey & Map Officer
		Shri Durgesh Devarshee, Assistant Survey & Map Officer
		Shri Deepanjan Halder, Assistant Survey & Map Officer
12	Proposal Formulation	Vikash Kumar, Sr. Manager (Geology)
13	Hindi Translation	Vikash Kumar, Sr. Manager (Geology)

LOCALITY INDEX

Locality	Latitude	Longitude
Belmand	20° 44' 38.94"N	81° 15' 55.33"E
Parsada	20° 43' 06.49"N	81° 16' 29.64"E
Jagtara	20° 41' 54.15"N	81° 16' 05.67"E
Jamgaon	20° 42' 07.67"N	81° 17' 12.66"E
Karahibhadar	20° 41' 52.81"N	81° 18' 36.99"E
Karkabhat	20° 41' 21.36"N	81° 19' 53.10"E
Chirchari	20° 42' 16.85"N	81° 20' 18.40"E
Sorar	20° 43' 46.52"N	81° 19' 33.58"E
Dhobanpur	20° 42' 18.24"N	81° 21' 01.72"E
Kaparmeta	20° 40' 51.55"N	81° 21' 29.81"E
Gurur	20° 41' 04.31"N	81° 24' 03.23"E
Kuliya	20° 40' 40.52"N	81° 26' 28.05"E
Purur	20° 39' 57.13"N	81° 29' 12.93"E
Chitod	20° 40' 22.68"N	81° 29' 55.38"E
Kumharkhan	20° 40' 08.35"N	81° 28' 11.72"E
Nawapara	20° 42' 27.90"N	81° 19' 50.75"E
Nawagaon	20° 39' 57.21"N	81° 26' 11.65"E

REFERENCES

1. Amarasinghe, U., Chaudhuri, A., Collins, A.S., Deb, G., and Patranabis-Deb, S. (2015).Evolving provenance in the Proterozoic Pranhita-Godavari Basin, India. Geosc. Front.,v.6, pp.453−463.

2. Ball, V. (1877) On the geology of the Mahanadi Basin and its vicinity. Rec. Geol. Surv. India, Vol. 10, Pt. 4, pp. 167-186.

3. Bathe, V.D. (1982) Photo-geological Investigation of karst areas in parts of Chhattisgarh Basin, MP Unpub. Report 1981-82.

4. Bhatia, M. R. (1983). Plate tectonics and geochemical composition of sandstones. Jour. Of Geol. v.91, pp.611−27.

5. Bhattacharya D.D., Rawat, P.V.S. and Mishra, V.P., Geology Of Banraud-Purur-Jamgaon Area, Durg And Raipur District, Madhya Pradesh, Parts Of Toposheet No. 64H/05, 64H06 & 64H/10, F.S. 1987-88.

6. Bickford, M.E., Basu, A., Patranabis-Deb, S., Dhang, P.C., and Schieber, J., (2011b).Depositional History of the Chhattisgarh Basin, Central India: Constraints from New SHRIMP Zircon Ages: The Jour. of Geol., v.119, pp.33−50.

7. Bose, P. N. (1898–1899). The iron ores of Raipur district, Central Provinces. Records of the Geological Survey of India, 31(4), 141–163.

8. Chakraborty, P.P., Das, K., Tsutsumi, Y., and Horie, K., (2011). Depositional history of the Chhattisgarh Basin, Central India: Constraints from new SHRIMP zircon ages: Adiscussion. The Jour. of Geol., v.119, pp.549−552.

9. Chakraborty, P.P., Saha, S., Das, P., (2015). Geology of Mesoproterozoic Chhattisgarh basin central India: current status and future goals.

10. Ciceri D., Manning D.A.C., Allanore A., Historical and technical developments of potassium resources, Journal: Science of the Total Environment, Volume 502, Pages 590–601, 2015

11. Das, D.P., Kundu, A., Das, N., Dutta, D.R., Kumaran, K., Ramamurthy, S., et al.1992. Lithostratigraphy and sedimentation of Chhattisgarh basin. Indian Minerals, 46: 271–288

12. Datta, B. (1998) Stratigraphic and sedimentologic evolution of the Proterozoic siliciclastics in the southern part of the Chhattisgarh and Khariar, central India. Jour. Geol. Soc. Ind.,v.51, pp.345-360.

13. Dhang, P. C., Patranabis-Deb, S. (2012). Lithostratigraphy of the basal part of the Chhattisgarh

14. Dutt, N. V. B. S. (1964). *A suggested succession of the Purana Formations of the southern part of Chhattisgarh, M. P.* In *Records of the Geological Survey of India*, Vol. 93(2), pp. 143–148

15. Dutta, N.V.B.S. (1963) A suggested succession of Purana Formation of southern part of Chhattisgarh basin, MP Rec. GSI Vol. 93, pp. 143-148.

16. Everest, D. A., Napier, E., & Wells, R. A. (1964). Extraction of potassium from adularia shale. *Chemical & Industry*, 40, 1684–1685

17. Fermor, L.L. (1919) The mineral resources of central Provinces, Rec. GSI

18. King, W. (1885) Sketch of the progress of geological work in the Chhattisgarh Division of Central Provinces, Rec. GSI, Vol. 18.

19. King, W. (1889) General report for the year 1896-99. Unpublished GSI Reports pp. 39-42.

20. Kruzer, H., Harse, W., Kursten, M., Schnitzer, W.A., Murthy, K.S., Srivastava, N.K. (1977). K/Ar dates of two glauconites from the Chandarpur series (Chhattisgarh/India): On the Stratigraphic status of the Late Precambrian basins in Central India. Geol Jb B v.28, pp.23−36

21. Kumar, S., & Bakliwal, P. C. (2005). *Occurrence of glauconite in Cretaceous–Paleogene sedimentary basins of India*.

22. Mazumdar, R., Eriksson, P.G.(Eds.),Precambrian Basins of India, Stratigraphic and Tectonic Context. Geol. Soc. Mem.Lond. v.43, pp.185−205.

23. Murti, K.S. (1968) Systematic geological mapping in parts of Raipur and Baloda Bazar Tehsils of Raipur District, MP Unpub. Pro. Rep. GSI 1968-69.

24. Murti, K.S. (1976) Sedimentary structures in the Central and south-eastern part of Chhattisgarh basin. Proc. Syn. Purana Formations of India Saugar, India.

25. Murti, K.S. (1987) Purana Basins of Peninsular India Memoir-6, 1987, GSI, Bangalore.

26. Murti, K.S. (1987). Stratigraphy and sedimentation in Chhattisgarh Basin. In Purana Basins of Peninsular India, Geol. Soc. Ind. Mem, v.6, pp.239-260.

27. Murti, K.S. (1996). Geology, sedimentation and economic mineral potential of the southcentral part of Chhattisgarh Basin. Geol. Surv. Ind. Mem., v.125, pp.139.

28. Murti, K.S. and (1967) Systematic geological mapping in parts of Mahasamund Tehsil, Raipur District, MP, Unpub. Prog. Rep. GSI, 1966-67.

29. Patranabis-Deb, S., and Chaudhuri, A.K. 2007. A retreating fan–delta system in the Neoproterozoic Chattisgarh rift basin, central India: major controls on its evolution. AAPG Bulletin, 91: 785–808. doi:10.1306/11270605182.

30. Patranabis-Deb, S., Bickford, M.E., Hill, B., Chaudhuri, A.K., and Basu, A. 2007. SHRIMP ages of zircon in the uppermost tuff in Chattisgarh Basin in central India require 500-Ma adjustment in Indian Proterozoic stratigraphy. Journal of Geology, 115: 407–415. doi:10.1086/518049.

31. Patranabis-Deb, S., Słowakiewicz, M., Tucker, M.E., Pancost, R.D., andBhattacharya, P. 2016. Carbonate rocks and related facies with vestiges of biomarkers: clues to redox conditions in the Mesoproterozoic ocean. Gondwana Research, 35: 411–424. doi:10.1016/j.gr.2015.06.007.

32. Pettijohn (1975) Sedimentary rocks III Edition, Harper Inc. New York.

33. Rajaya, V. (1992). Lithostratigraphy and sedimentation of Chhattisgarh Basin. Ind.Min. v.46 pp.271−288.

34. Ramakrishnan, M. & Vaidyanadhan, R. (2010). Geology of India, v.5. Geol. Surv. of Ind., Hyderabad.

35. Rawashdeh, R. A., Campbell, G. A., & Titi, A. (2016). The socio-economic impacts of mining on local communities: The case of Jordan. *The Extractive Industries and Society, 3*(2), 494–507. https://doi.org/10.1016/j.exis.2016.02.001

36. Rawashdeh, R., & Maxwell, P. (2014). *Analysing the world potash industry.* Resources Policy, 41, 143–151. https://doi.org/10.1016/j.resourpol.2014.05.004

37. Rawashdeh, R., Xavier-Oliveira, E., & Maxwell, P. (2016). The potash market and its future prospects. *Resources Policy, 47*, 154–163. https://doi.org/10.1016/j.resourpol.2016.01.011

38. Satyanarayan, J. (1965–67). Progress report on the geological mapping in parts of Raipur and Bilaspur districts, Madhya Pradesh. Geological Survey of India, unpublished Progress Report (Field Seasons 1965–67).

39. Schnitzer, W. A. (1971). *Das Jungpräkambrium Indiens ("Purana system").* Erlanger Geologische Abhandlungen, 85, 44.

40. Sen, S. N. (1963–64). Progress report on the geological mapping in parts of Raipur district, Madhya Pradesh. Geological Survey of India, unpublished Progress Report (Field Season 1963–64).

41. Sen, S. N., & Satyanarayan, J. (1964–65). Progress report on the geological mapping in parts of Raipur and Bilaspur districts, Madhya Pradesh. Geological Survey of India, unpublished Progress Report (Field Season 1964–65).

42. Singanenjam, S. and Suresh G. (1986) Geology of the area in and around Rajim Panduka-Magarlor, Raipur District, MP Unpub. Rep. GSI, 1985-86.

43. Vatsa, Sisodiya, and Prasad (1973) Report on reconnoitory traverses for locating phosphatic deposits in Chhattisgarh Basin in Durg, Rajnandgaon and Raipur Districts, MP Unpub. Prog. Rep. GSI 197 2-73.

44. Verma, R.K., Samadder, A.K., Murti, K.S. (1977). Palaeomagnetic study of Gunderdehi shale of Raipur Group from Chhattisgarh basin in India. Indian Jour. Earth Sci.,v.4, pp.183-191.

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, Chhattisgarh
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