GEOLOGICAL REPORT ON THE PRELIMINARY EXPLORATION (G-3) FOR MANGANESE IN NAGARDHAN BLOCK DISTRICT: NAGPUR, STATE: MAHARASHTRA

(Under NMET Programme)

(TEXT, ANNEXURES AND PLATES)

Photo - Manganese boulders alongside the manganese quarry

Photo – Northerly dipping manganese band along with gondite in abandoned pit

A MINIRATNA-I CPSE

MINERAL EXPLORATION AND CONSULTANCY LIMITED

(Formerly Mineral Exploration Corporation Limited)

Ministry of Mines, Government of India Enterprise

An ISO 9001:2015, 14001:2015 & 45001:2018 Certified Company

CORPORATE OFFICE, NAGPUR

MARCH 2025

CONTENTS

TEXT

LIST OF TABLES

LIST OF TEXT FIGURES

LIST OF ANNEXURES

S.No	ANNEXURE NO.	TITLE	PAGES
6	IV A	Analytical Details of Primary Samples for Manganese for Six (Mn, SiO2, P2O5, Fe2O3, MnO2 & Acid Insoluble) Radicals collected from channels & trenches excavated by MECL in Nagardhan (G3) Block, District: Nagpur, Maharashtra	1-2
7	IV B	Analytical Details of Primary Samples for Manganese for Six (Mn, SiO2, P2O5, Fe2O3, MnO2 & Acid Insoluble) Radicals collected from boreholes drilled by MECL in Nagardhan (G3) Block, District: Nagpur, Maharashtra	1
8	V	Details of Primary Sample Analysis Vs Check Sample Analysis (External Check) in Nagardhan (G3) Block, District: Nagpur, Maharashtra	1
9	VI	Section wise manganese ore resource estimated by cross section method, at 10%mn cut off, Nagardhan (G3) Block, District: Nagpur, Maharashtra	1
10	VII	Details of petrography study carried out in trench & borehole samples of Nagardhan Block (G-3), District – Nagpur, Maharashtra	1-3
11	VIII	Details of Minerography study carried out in trench & borehole samples of Nagardhan Block (G-3), District – Nagpur, Maharashtra	1
12	IX	Details of Specific Gravity study carried out in trench/borehole samples of Nagardhan Block (G-3), District – Nagpur, Maharashtra	1
13	X	NMET Approval of Nagardhan Block (G-3), District – Nagpur, Maharashtra	7
14	XI	Peer reviewer's comments and justifications on "geological report on the Preliminary Exploration (G-3) for Manganese in Nagardhan block District: Nagpur, State: Maharashtra"	1-3

LIST OF PLATES

Plate No.	Title	R.F.
I	Location Map of the Nagardhan (G3) Block for Managnese (2.00 SQ. KM) District- Nagpur, Maharashtra	N.S.
II	Regional Geological Map of Nagardhan (G3) Block for Managnese (2.00 SQ. KM) District- Nagpur, Maharashtra	N.S.
III	Topographic & Outcrop Map of Nagardhan (G3) Block for Managnese (2.00 SQ. KM) District- Nagpur, Maharashtra is given as Plate-III. (Scale 1:4000)	1:4000
IV	Interpreted Geological Map of Nagardhan (G3) Block for Managnese (2.00 SQ. KM) District- Nagpur, Maharashtra is given as Plate-IV. (Scale 1:4000)	1:4000
V	Geological Cross section along S1, S2 & S3 of Nagardhan (G3) Block for Managnese (2.00 SQ. KM) District - Nagpur, Maharashtra. (Scale 1:500)	1:500
VI	Trench Profile Along Trenches - Trench 1, Trench 2, Trench 3, Trench 4 and Trench 5 of Nagardhan (G3) Block for Managnese (2.00 SQ. KM) District - Nagpur, Maharashtra is given as Plate-V. (Scale 1:100)	1:100

अध्याय 1

कार्यकारी सारांश

1.1.0 **प्रस्तावना**

1.1.1 ब्लॉक नंदपुरी गांव के दक्षिण पश्चिमी भाग में स्थित है । यह क्षेत्र सौसर फोल्ड बेल्ट के पश्चिमी भाग का हिस्सा है जिसे महाराष्ट्र-मध्य प्रदेश मैंगनीज बेल्ट के नाम से जाना जाता है। इस क्षेत्र में खेती की गई भूमि है जिसमें बहुत कम दृश्यांश हैं। दृश्यांशों में नाले की कटाई, परित्यक्त खनन स्थल और क्षेत्र में खोदी गई खाइयाँ दिखाई देती हैं। ब्लॉक के मध्य भाग में गड्ढे हैं । परित्यक्त खनन गड्ढों की लंबाई 50 मीटर से 150 मीटर तक है और गहराई 1 मीटर से 3 मीटर तक है।

1.1.2 भूविज्ञान और खनन निदेशालय (डीजीएम), महाराष्ट्र सरकार, नागपुर ने पत्र संख्या तकनीकी/1848/2023/3938, दिनांक 22/12/2023 के माध्यम से एमईसीएल से 10(ए) 2(बी) खनन पट्टा क्षेत्रों में गवेषण करने का अनुरोध किया। नागरधन मैंगनीज ब्लॉक महाराष्ट्र राज्य सरकार द्वारा व्यपगत पट्टा क्षेत्र है, जिसे एमएमडीआर अधिनियम-15 की धारा 10(ए) 2(बी) के अनुसार प्रदान किया गया था। ब्लॉक मेसर्स एक्सेल माइनिंग इनकॉर्पोरेशन को 04/02/2011 से 03/02/2013 के दौरान 2 वर्षों के लिए प्रदान किया गया था।

1.1.3 एमईसीएल ने प्रस्तावित ब्लॉक में फील्ड विजिट किया है। भूवैज्ञानिक ट्रैवर्सेस के दौरान, अनुकूल मेजबान चट्टानें जैसे मस्कोवाइट शिस्ट और परित्यक्त खनन गड्ढे पाए गए। एमईसीएल ने मैंगनीज अयस्क के साथ गोंडाइट के 8 नमूने एकत्र किए और हाथ से पकड़े गए एक्सआरएफ द्वारा उनका विश्लेषण किया । नमूना विश्लेषण 14.55% से 23.78% Mn तक है।

1.1.4 भूविज्ञान और खनन निदेशालय (डीजीएम), महाराष्ट्र सरकार के निष्कर्षों और सहमति के आधार पर, एमईसीएल ने नागरधन ब्लॉक, नागपुर, महाराष्ट्र में भूवैज्ञानिक मानचित्रण (1: 4,000 स्केल), ट्रेंच सैंपलिंग और ड्रिलिंग सहित प्रारंभिक गवेषण (जी-3) का प्रस्ताव दिया है और 28 और 29 फरवरी, 2024 को आयोजित एनएमईटी की तकनीकी-सह-लागत समिति (टीसीसी) की 62 वीं बैठक में प्रस्तुत किया है।

1.1.5 13 मार्च, 2024 को आयोजित एनएमईटी की ईसी की 34वीं बैठक में 130.66 लाख रुपये की अनुमानित गवेषण लागत के साथ प्रस्ताव को मंजूरी दी गई और 12 मार्च, 2024 के कार्यालय

ज्ञापन एफ. संख्या 23/440/2024-एनएमईटी/595 के माध्यम से एमईसीएल को सूचित किया गया।

1.1.6 गवेषण कार्य 02 मई, 2024 को शुरू किया गया था और 21 जनवरी, 2025 को बेड रॉक और चैनल के नमूने एकत्र करने के साथ क्षेत्र कार्य पूरा हो गया है। नमूनाकरण सहित संबद्ध क्षेत्र-कार्य एक साथ पूरे किए गए। विश्लेषणात्मक/प्रयोगशाला अध्ययन एमईसीएल और अन्य सरकारी/एनएबीएल मान्यता प्राप्त प्रयोगशालाओं की प्रयोगशालाओं में एक साथ किए गए थे।

1.2.0 ब्लॉक का स्थान और पहुंचने की सुविधा

1.2.1 वर्तमान गवेषण ब्लॉक महाराष्ट्र के नागपुर जिले में रामटेक शहर से लगभग 7 किमी दक्षिण में स्थित है। नागरधन और नंदापुरी ब्लॉक में और उसके आसपास मौजूद कुछ प्रमुख गाँव हैं। ब्लॉक सर्वे ऑफ इंडिया टोपोशीट नंबर 55O/07 के हिस्से में स्थित है। अध्ययन क्षेत्र NH-44/SH-753 के माध्यम से नागपुर से आसानी से जुड़ा हुआ है, जहाँ कन्हान के माध्यम से या मानसर और रामटेक से यात्रा करके पहुँचा जा सकता है । यह क्षेत्र पूरे साल सभी मौसमों में पक्की सड़क के माध्यम से सुलभ है। ब्लॉक क्षेत्र के कॉर्नर बिंदुओं के निर्देशांक जियोडेटिक और यूटीएम दोनों नीचे दी गई तालिका में दिए गए हैं

तालिका- 1.1

नागरधन ब्लॉक के मुख्य बिंदुओं के निर्देशांक

क्रम सं.	कॉर्नर बिंदु	डीएमएस (WGS84)		यूटीएम 44एन	
		अक्षांश	देशान्तर	उत्तर(Y)	ईस्टिंग(X)
1	ए	21 ° 20' 03.45" उ	79 ° 18' 59.69" पूर्व	2360078.59	325418.14
2	बी	21 ° 20' 03.42" उ	79 ° 19' 41.43" पूर्व	2360064.86	326620.80
3	सी	21 ° 19' 09.40" उ	79 ° 19' 41.49" पूर्व	2358403.54	326604.89
4	डी	21 ° 19' 09.39" उ	79 ° 18' 59.65" पूर्व	2358416.08	325399.21

1.3.0 ब्लॉक का भूविज्ञान और संरचना

1.3.1 आउटक्रॉप एक्सपोजर सीमित हैं और मुख्य रूप से स्ट्रीम चैनल (नालों) और खनन स्थलों तक सीमित हैं, जिनमें पुराने, परित्यक्त और सक्रिय संचालन शामिल हैं। हालांकि, कुछ स्थानों पर लैटेराइट कैपिंग की बिखरी हुई उपस्थिति देखी गई हैं। यह ब्लॉक नंदपुरी गांव के दक्षिण

पश्चिमी भाग में स्थित है । यह क्षेत्र सौसर फोल्ड बेल्ट के पश्चिमी भाग का एक हिस्सा है जिसे महाराष्ट्र-मध्य प्रदेश मैंगनीज बेल्ट के रूप में जाना जाता है। इस क्षेत्र में खेती की गई भूमि है जिसमें बहुत कम आउटक्रॉप हैं। ब्लॉक के मध्य भाग में परित्यक्त खनन गड्ढे मौजूद हैं। परित्यक्त खनन गड्ढों की लंबाई 50 मीटर से 150 मीटर तक है और गहराई 1 मीटर से 3 मीटर तक है।

1.3.2 अध्ययन क्षेत्र में चट्टानों की मानसर संरचना आम तौर पर उत्तर या दक्षिण की ओर नति पश्चिम-उत्तर-दक्षिण-पूर्व दिशा में है और इसमें पेलिटिक , सैमैटिक और कैल्केरियस लिथोलॉजी शामिल हैं। मानसर संरचना, बारीक दाने वाली अभ्रक शिस्ट और क्वार्ट्ज-अभ्रक शिस्ट से बनी है जो फेल्डस्पैथिक से गार्नेटिफ़ेरस तक ग्रेडिंग कर रही है , जिसमें दो अलग-अलग मैंगनीज़ क्षितिज हैं जो दक्षिण-पूर्व दिशा में -पश्चिम-उत्तर-पश्चिम से पूर्व-पश्चिम दिशा में हैं और स्थानीय तह दिखा रहे हैं।

तालिका- 1.2

नागरधन ब्लॉक का स्ट्रेटीग्राफिक अनुक्रम

युग	***समूह***	***लिथोलॉजी***	***लिथोलॉजी विवरण***
हाल ही से उप हाल ही का			जलोढ़क/मृदा लेटराइट
मेसोप्रोटेरोज़ोइक	अंतर्वेधन	पोस्ट सॉसर	पेग्माटाइट और क्वार्ट्ज़ वेंस
	सौसोर ग्रुप	मानसर संरचना	मस्कोवाइट-बायोटाइट-शिस्ट, गार्नेटिफेरस क्वार्ट्ज बायोटाइट शिस्ट, स्थानों पर फेल्सपैथिक। पाइरोक्सेनाइट क्वार्ट्ज-अभ्रक-शिस्ट, एमएन अयस्क और गोंडाइट

1.4.0 **खनिजीकरण**

1.4.1 सौसर समूह में मुख्य रूप से मानसर संरचना के भीतर महत्वपूर्ण मैंगनीज अयस्क भंडार हैं, जहाँ दो अलग-अलग बैंड में सिनजेनेटिक स्ट्रेटा-बाउंड खनिजकरण होता है। ये बैंड, पश्चिमोत्तर-पूर्वोत्तर से पूर्वपश्चिम की ओर बढ़ते हैं, जो 12 - 15 मीटर मोटी क्वार्ट्ज-मस्कोवाइट शिस्ट परत द्वारा अलग किए गए हैं। मैंगनीज खनिजकरण बैंड, लेंस और प्रसार

में पाया जाता है, जो अक्सर गोंडाइट से जुड़ा होता है । पाइरोलुसाइट, साइलोमेलेन और क्रिप्टोमेलेन सहित अयस्क खनिज, बोट्रीओइडल, स्टैलेक्टाइटिक और बॉक्सवर्क जैसी संरचनाओं के साथ ग्रैनोब्लास्टिक से ग्रैनुलिटिक बनावट प्रदर्शित करते हैं । अयस्क आमतौर पर नरम, पाउडर जैसी बनावट के साथ स्टील ग्रे से फीके ग्रे रंग का दिखाई देता है।

1.4.2 उत्तरी बैंड (बैंड I) 264 मीटर लंबा और 1-2 मीटर चौड़ा है, जो उत्तर की ओर झुकता है, जबकि दक्षिणी बैंड (बैंड II) 4.75-5.20 मीटर की चौड़ाई के साथ 368 मीटर तक फैला है, जो दक्षिण की ओर झुकता है। यह अनुमान लगाया गया है कि ये बैंड मूल रूप से एक एकल मुड़े हुए मैंगनीज बैंड थे, जो बाद में शिखर पर अपरदन कर गए। अयस्क में ब्राउनाइट, पायरोलुसाइट और हौसमैनाइट के साथ मामूली मैग्नेटाइट/जेकबसाइट शामिल हैं। जबकि बैंड I सतह पर सिलिकायुक्त और गोंडाइटिक है , बैंड II अधिक नाजुक है और आंशिक रूप से मिट्टी के नीचे ढका हुआ है। बोरहोल डेटा से पता चलता है कि बैंड I गहराई पर असंतत है, संभवतः तीव्र तह के कारण है। मैंगनीज बैंड की सतही निरंतरता आउटक्रॉप और मैंगनीज फ्लोट्स द्वारा इंगित की जाती है ।

1.5.0 **वर्तमान जांच के दौरान किए गए गवेषण**

1.5.1 पैरा 10.4.0 में उल्लिखित उद्देश्यों को प्राप्त करने के लिए, एमईसीएल ने 2.00 वर्ग किलोमीटर के कुल नागरधन ब्लॉक क्षेत्र पर 1:4,000 पैमाने पर विस्तृत भूवैज्ञानिक मानचित्रण किया है और 1:4000 पैमाने पर 2 मीटर के अंतराल पर सतह समोच्च के माध्यम से क्षेत्र का स्थलाकृतिक सर्वेक्षण किया है, 3 बोरहोल में 180 मीटर की ड्रिलिंग भी की गई है। कुल 45 ट्रेंच /चैनल नमूने और 36 प्राथमिक बोरहोल नमूने एकत्र किए गए हैं और WD-XRF विधि और क्लासिकल विधि द्वारा Mn, SiO2, P2O5, Fe2O3, MnO2 और Acid Insolubles के लिए उनका विश्लेषण किया गया है । कुल 5 बोरहोल नमूनों को पेट्रोग्राफिक अध्ययन के अधीन किया गया है।

1.5.2 गवेषण कार्य 02 मई, 2024 को शुरू किया गया था और 21 जनवरी, 2025 को बेड रॉक और चैनल के नमूने एकत्र करने के साथ क्षेत्र कार्य पूरा हो गया है। नमूनाकरण सहित संबद्ध क्षेत्र-कार्य एक साथ पूरे किए गए। विश्लेषणात्मक/प्रयोगशाला अध्ययन एमईसीएल और अन्य सरकारी/एनएबीएल मान्यता प्राप्त प्रयोगशालाओं की प्रयोगशालाओं में एक साथ किए गए थे।

1.5.3 500 मीटर के लक्ष्य के मुकाबले केवल 180 मीटर की ड्रिलिंग ही हो पाई है। इस कमी का कारण आउटक्रॉप्स में मैंगनीज अयस्क क्षेत्रों का सीमित प्रदर्शन और ब्लॉक के भीतर केवल एक बोरहोल में गहराई पर खनिजीकरण पाया जाना है।

1.5.4 अनुमोदित कार्य की प्रकृति और मात्रा बनाम वास्तविक उपलब्धि का विवरण तालिका-1.3 में दिया गया है

तालिका – 1.3

एमईसीएल द्वारा स्वीकृत कार्य की मात्रा बनाम वास्तविक उपलब्धि

क्रम सं.	कार्य मद	इकाई	लक्ष्य	प्राप्त लक्ष्य
1	भूवैज्ञानिक मानचित्रण (1:4,000 पैमाने पर)	वर्ग किमी.	2.00	2.00
2	स्थलाकृतिक सर्वेक्षण (सतही विशेषताएँ/खाई/गड्ढे/बोरहोल* स्थान आदि)	वर्ग किमी.	2.00	2.00
3	गवेषणात्मक खनन (खाई/गड्ढा)			
	क) उत्खनन (खाई खोदना) (1मी*2मी*10मी)	घन मी.	140	127
4	खाई/गड्ढे का नमूना लेना			
	क) प्राथमिक नमूनाकरण	नग	50	45
	ख) नमूनों की जांच (10% बाहरी जांच)	नग	5	5
5	ड्रिलिंग (कोरिंग)*			
	क) ड्रिलिंग	मी.	500	180
6	ड्रिल कोर सैंपलिंग*			
	a) ड्रिल कोर (प्राथमिक) नमूने	नग	80	36
	बी) ड्रिल कोर (10% बाहरी जांच) नमूने	नग	8	0
7	पेट्रोलॉजिकल नमूने (सतह और बीएच कोर नमूने)			
	क) थीन सेक्शन की तैयारी	नग	10	5
	ख) थीन सेक्शन का अध्ययन	नग	10	5
8	माइनरोग्राफ़ी नमूने (सतह और बीएच कोर नमूने)	नग		
	क) थीन सेक्शन की तैयारी	नग	10	2
	ख) थीन सेक्शन का अध्ययन	नग	10	2
9	ड्रिल कोर संरक्षण	नग	150	60
10	विशिष्ट गुरुत्व अध्ययन	नग	5	2
11	रिपोर्ट तैयार करना (5 हार्ड कॉपी और एक सॉफ्ट कॉपी)	नग	1	1
12	गवेषण प्रस्ताव की तैयारी (5 हार्ड कॉपी एवं एक सॉफ्ट कॉपी)	नग	1	1

1.6.0 मानचित्रण एवं खाई/बोरहोल नमूनों के परिणामों पर चर्चा

1.6.1 मानचित्रण और ट्रेंचिंग अध्ययनों ने मैंगनीज खनिजकरण की पहचान की, जिसके परिणामस्वरूप पाँच खाइयों (127 घन मीटर) की खुदाई और कुल 180 मीटर की तीन

बोरहोल की ड्रिलिंग की गई। WD-XRF और शास्त्रीय तरीकों का उपयोग करके खाइयों और बोरहोल से कुल 81 नमूनों का विश्लेषण किया गया। 45 ट्रेंच नमूनों के विश्लेषण से 400 मीटर की नतिलंब लंबाई और 1 से 6 मीटर की चौड़ाई वाले खनिज क्षेत्र का संकेत मिला, जिसमें Mn सांद्रता 0.54% और 28.82% के बीच थी। उल्लेखनीय रूप से, 45 में से 19 नमूनों में Mn मान 10% से अधिक था।

1.6.2 पहचाने गए दो बैंड WNW-ESE से EW की ओर प्रवृत्त हैं, उत्तरी बैंड 42^{O} तक उत्तर की ओर नति है जिसकी अधिकतम चौड़ाई 2 मीटर है और दक्षिणी बैंड लगभग 30^{O} तक दक्षिण की ओर नति है, जिसमें खाइयों की अधिकतम चौड़ाई 5.20 मीटर है और स्थानीयकृत बैंड II के साथ सिनफॉर्म । खाई के निष्कर्षों के आधार पर, उत्तरी क्षेत्र को 500 मीटर की नतिलंब लंबाई पर तीन बोरहोल के साथ ड्रिलिंग के लिए लक्षित किया गया था। हालांकि, MNB-01 और MNB-03 से 36 बोरहोल नमूनों के विश्लेषण से केवल 10% Mn के साथ एक 1-मीटर खनिज क्षेत्र दिखाई दिया, जो सीमित गहराई निरंतरता को दर्शाता है।

1.7.0 संसाधन

1.7.1 मैंगनीज के संसाधन का अनुमान (+) 10% Mn कट-ऑफ (थ्रेशोल्ड वैल्यू, आईबीएम नंबर सी-284/3/सीएमजी/2017, दिनांक 25 अप्रैल 2018) पैरा संख्या 21.1.0 में उल्लिखित विनिर्देशों/मूलभूत मान्यताओं के अनुसार लगाया गया है। संसाधनों का अनुभागवार सारांश तालिका-20.1 में दिया गया है। मैंगनीज के लिए अनुभागवार अयस्क संसाधन अनुमान का विवरण अनुलग्नक VI में दिया गया है।

टेबल 1.4

नागार्धन ब्लॉक, नागपुर महाराष्ट्र में 10% Mn कट-ऑफ पर

आकलित भूवैज्ञानिक संसाधन वार सेक्शन सारांशित

सेक्शन सं.	बैंड सं.	वर्ग	ट्रेंच	नतिलंब प्रभाव (मी.)	विशिष्ट गुरुत्व	संसाधन (टन में)	Mn %	P_2O_5 %
एस 1	बैंड I	सरफेसियल (G4)	ट्रेंच -1	132	3.10	4861.30	26.16	0.30
एस 1	बैंड II	सरफेसियल (G4)	ट्रेंच -2	184	3.10	16815.39	15.08	0.21
एस 2	बैंड I	सरफेसियल (G4)	ट्रेंच-5	132	3.10	6183.01	18.43	0.29
एस 2	बैंड II	सरफेसियल (G4)	ट्रेंच -4	184	3.10	12457.54	20.88	0.17
कुल						**40317.24**	**18.72**	**0.22**

1.8.0 संसाधनों का वर्गीकरण

1.8.1 मैंगनीज अयस्क के संसाधनों को संयुक्त राष्ट्र फ्रेमवर्क वर्गीकरण (यूएनएफसी) के अनुसार आवीक्षण खनिज संसाधन (334) के अंतर्गत वर्गीकृत किया गया है।

1.9.0 सिफारिशें

1.9.1 भूवैज्ञानिक मानचित्रण और ट्रेंचों (खाईयों) की खुदाई से मैंगनीज खनिजीकरण का पता चला, जिसमें पाँच में से चार खाइयों में 10.88% और 28.74% के बीच 10% Mn कट-ऑफ पर Mn सामग्री पाई गई। बैंड I (उत्तरी बैंड) को लक्षित करने वाले तीन बोरहोल ने MNB-01 में केवल 1 मीटर चौड़ी पट्टी को काटा, जबकि अन्य दो बोरहोल में महत्वपूर्ण खनिजीकरण नहीं मिला। क्षेत्र में मैंगनीज अयस्क बैंड सतही, पतले और सीमांत ग्रेड के हैं, जिनमें सीमित नतिलंब और बहुत कम या कोई गहराई निरंतरता नहीं है। मानचित्रण के दौरान देखी गई संरचनात्मक जटिलता, साथ ही बोरहोल में पर्याप्त प्रतिच्छेदन की अनुपस्थिति, यह सुझाव देती है कि खनिजीकरण में गहराई की निरंतरता की कमी है। सीमित एक्सपोज़र के कारण, खनिजीकरण की नतिलंब और गहराई की सीमा अपुष्ट बनी हुई है। तथापि 0.04 मिलियन टन सतही मैंगनीज अयस्क के अनुमानित संसाधन को 334 संसाधन वर्गीकरण के तहत वर्गीकृत किया गया है।

1.9.2 ब्लॉक की स्थिति MMDR अधिनियम-2015 की धारा 10(A)2(B) के तहत समाप्त लीज के रूप में, इसकी एक कार्यरत भूमिगत मैंगनीज खदान के नजदीक स्थिति, इसके उल्लेखनीय उच्च-श्रेणी के सतही मैंगनीज भंडार, और इसकी जटिल संरचनात्मक भूविज्ञान को देखते हुए, संभावित गहरे अयस्क पिंडों का पता लगाने के लिए अतिरिक्त भूभौतिकीय सर्वेक्षण की सिफारिश की जाती है।

CHAPTER-1

EXECUTIVE SUMMARY

1.1.0 INTRODUCTION

1.1.1 The block is situated on the south western side of Nandapuri village. The area forms a part of the western portion of the Sausar Fold Belt which is popularly known as Maharashtra-Madhya Pradesh manganese belt. The area is represented by cultivated land with scanty outcrops. Outcrops are seen stream (nalla) cuttings, abandoned mining sites as well as trenches excavated in the area. Pits are present in the central part of the block. The length of the abandoned mining pits ranges from 50 m to 150 m with depth varying from 1 m to 3 m.

1.1.2 The Directorate of Geology and Mining (DGM), Government of Maharashtra, Nagpur requested to MECL to take up the exploration in lapsed 10(A) 2(B) mining lease areas vide letter no. Tech/1848/2023/3938, dated 22/12/2023. The Nagardhan Manganese block is lapsed lease area by State Government of Maharashtra, which was granted as per section 10(A) 2(B) of the MMDR Act-15. The block was granted to M/s. Excel Mining Incorporation during 04/02/2011 to 03/02/2013 for 2 years.

1.1.3 MECL has conducted field visit in the proposed block. During geological traverses, favourable host rocks viz. muscovite schist and abandoned mining pit were located. MECL collected 8 no. of samples of gondite with manganese ore and analysed by hand held XRF. The sample analysis ranges from 14.55% to 23.78% Mn.

1.1.4 Based on the findings and consent from Directorate of Geology and Mining (DGM), Government of Maharashtra. MECL has proposed preliminary exploration (G-3) exploration in Nagardhan Block, Nagpur, Maharashtra comprising geological mapping (1:4,000 scale), trench sampling and drilling and submitted in the 62nd meeting of Technical-Cum-Cost Committee (TCC) of NMET held on 28th & 29th Feburary 2024.

1.1.5 In the 34th Meeting of EC of NMET held on 13th March 2024, approved the proposal with an estimated exploration cost of Rs. 130.66 Lakh's and intimated MECL vide Office Memorandum F. No 23/440/2024-NMET/595 dated 12th March, 2024.

1.1.6 Exploration work had been commenced on 02nd May, 2024 and the field work has been completed with collection of bed rock and channel samples on 21st January, 2025. The allied field-works including sampling were completed simultaneously. The analytical/laboratory studies were carried out simultaneously in laboratories of MECL and other Government /NABL accredited laboratories.

1.2.0 LOCATION AND ACCESSIBILITY OF THE BLOCK

1.2.1 The present exploration block is located at about 7 km south of Ramtek town in the Nagpur district of Maharashtra. Nagardhan and Nandapuri are some of the major villages present in and around the block. Block lies in the parts of Survey of India Toposheet No. 55O/07. The study area is conveniently connected to Nagpur via NH-44/SH-753, which can be accessed through Kanhan or by traveling through Mansar and Ramtek.. The region is accessible year-round via an all weather metalled road. The Co-ordinates of the corner points of the block area both geodetic and UTM are given in table below

Table- 1.1

Coordinates of the cardinal points of the Nagardhan block

Sl. No.	Corner Points	DMS (WGS84)		UTM 44N	
		LATITUDE	LONGITUDE	NORTHING(Y)	EASTING(X)
1	A	21° 20' 03.45" N	79° 18' 59.69" E	2360078.59	325418.14
2	B	21° 20' 03.42" N	79° 19' 41.43" E	2360064.86	326620.80
3	C	21° 19' 09.40" N	79° 19' 41.49" E	2358403.54	326604.89
4	D	21° 19' 09.39" N	79° 18' 59.65" E	2358416.08	325399.21

1.3.0 GEOLOGY AND STRUCTURE OF THE BLOCK

1.3.1 Outcrop exposures are limited and are mainly restricted to stream channels (nallas) and mining sites, including old, abandoned, and active operations. However, scattered occurrences of lateritic cappings are observed in some locations. The block is situated on the south western side of Nandapuri village. The area forms a part of the western portion of the Sausar Fold Belt which is popularly known as Maharashtra-Madhya Pradesh manganese belt. The area is represented by cultivated land with scanty outcrops. Abandoned mining Pits are present in the central part of

the block. The length of the abandoned mining pits ranges from 50 m to 150 m with depth varying from 1 m to 3 m.

1.3.2 The Mansar formation of rocks in the study area generally trends WNW - ESE dipping towards North or south and consists of pelitic, psammatic, and calcareous lithologies. The Mansar Formation, composed of fine-grained mica schist and quartz-mica schist which is grading from feldspathic to garnetiferous, with two distinct manganese horizons trending ESE - WNW to E-W following southern and northern dip showing localized folding.

Table- 1.2

Stratigraphic Sequence of the Nagardhan block

Age	***Group***	***Lithology***	***Lithology Description***
Recent to Sub Recent			Alluvium/Soil Laterite
Mesoproterozoic	Intrusives	Post Sausor	Pegmatite and quartz veins
	Sausor Group	Mansar Formation	Muscovite-biotite-schist, Garnetiferous quartz biotite schist, felspathic at places. Pyroxenite Quartz-mica-schist, Mn ore and gondite

1.4.0 MINERALISATION

1.4.1 The Sausar Group hosts significant manganese ore deposits, primarily within the Mansar Formation, where syngenetic strata-bound mineralization occurs in two distinct bands. These bands, trending WNW-ESE to E-W, are separated by a 12 - 15 m thick quartz-muscovite schist layer. The manganese mineralization is found in bands, lenses, and disseminations, often associated with gondite. The ore minerals, including pyrolusite, psilomelane, and cryptomelane, exhibit granoblastic to granulitic textures with structures such as botryoidal, stalactitic, and boxwork. The ore typically appears steel grey to dull grey with a soft, powdery texture.

1.4.2 The northern band (Band I) is 264 meters long and 1-2 meters wide, dipping northward, while the southern band (Band II) extends 368 meters with a width of 4.75-5.20 meters, dipping southward. It is hypothesized that these bands were originally a single folded manganese band, later eroded at the crest. The ore contains braunite, pyrolusite, and hausmannite, with minor magnetite/jacobsite. While Band I is silicified and gonditic on the surface, Band II is more fragile and partly concealed beneath the soil. Borehole data suggests Band I is discontinuous at depth, likely due to intense folding. The surface continuity of manganese bands are indicated by outcrops and manganese floats.

1.5.0 EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

1.5.1 To achieve the objectives as enumerated in para 10.4.0, MECL has carried out Detailed geological mapping on 1:4,000 scale over total Nagardhan block area of 2.00 sq.km and conducted topographical survey of the area by means of surface contouring at 2m interval in 1:4000 scale, Drilling of 180 m in 3 Boreholes is also executed. A total of 45 nos of Trench/channel samples and 36 nos. of primary borehole samples have been collected and analysed for Mn, SiO2, P2O5, Fe2O3, MnO2 and Acid Insolubles by WD-XRF method and Classical method. Total of 5 nos of borehole samples have been subjected to petrographic studies, 2 nos for minerographic studies and 2 for Specific gravity studies.

1.5.2 Exploration work had been commenced on 02nd May, 2024 and the field work has been completed with collection of bed rock and channel samples on 21st January, 2025. The allied field-works including sampling were completed simultaneously. The analytical/laboratory studies were carried out simultaneously in laboratories of MECL and other Government /NABL accredited laboratories.

1.5.3 The drilling achieved is only 180 meters against the target of 500 meters. This shortfall was attributed to the limited exposure of manganese ore zones in the outcrops, and mineralization at depth was encountered in just one borehole within the block.

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

Table – 1.3

Approved Quantum of Work Vs Actual Achievement by MECL

Sl. No.	Item of Work	Unit	Target	Target Achieved
1	Geological Mapping (on 1:4,000 Scale)	Sq km	2.00	2.00
2	Topographical Survey (Surface features/Trench/Pit/Borehole* locations etc)	Sq km	2.00	2.00
3	Exploratory Mining (Trench/pit)			
	a) Excavation (Trenching) (1m*2m*10m)	Cu. m	140	127
4	Trench/pit Sampling			
	a) Primary Sampling	Nos	50	45
	b) Check Samples (10% External check)	Nos	5	5
5	Drilling (coring)*			
	a) Drilling	m	500	180
6	Drill Core Sampling*			
	a) Drill Core (Primary) Samples	Nos	80	36
	b) Drill Core (10% External check) Samples	Nos	8	0
7	Petrological Samples (Surface & BH Core Samples)			
	a) Preparation of Thin Section	Nos	10	5
	b) Study of Thin Section	Nos	10	5
8	Minerography Samples (Surface & BH Core Samples)	Nos		
	a) Preparation of Thin Section	Nos	10	2
	b) Study of Thin Section	Nos	10	2
9	Drill Core Preservation	Nos	150	60
10	Specific Gravity Studies	Nos	5	2
11	Report Preparation (5 Hard copies with a soft copy)	Nos.	1	1
12	Preparation of Exploration Proposal (5 Hard copies with a soft copy)	Nos.	1	1

1.6.0 DISCUSSION ON RESULTS OF MAPPING & TRENCH/BOREHOLE SAMPLES

1.6.1 Mapping and trenching studies identified manganese mineralization, leading to the excavation of five trenches (127 Cu. M) and the drilling of three boreholes totaling 180 meters. A total of 81 samples from trenches and boreholes were analyzed using WD-XRF and classical methods. Analysis of 45 trench samples indicated a mineralized zone with a 400-meter strike length and widths ranging from 1 to 6

meters, with Mn concentrations varying between 0.54% and 28.82%. Notably, 19 out of 45 samples had Mn values exceeding 10%.

1.6.2 The two bands identified are trending WNW-ESE to E-W, the Northern one is dipping towards north by an amount of 42^{O} having maximum width of 2m and southern one is dipping south by an amount of 30^{O} to 34^{O} as in trenches having maximum width of 5.20 m with a localised synform along Band II. Based on trench findings, the northern zone was targeted for drilling with three boreholes over a 500-meter strike length. However, analysis of 36 borehole samples from MNB-01 and MNB-03 showed only a single 1-meter mineralized zone with 10% Mn, indicating limited depth continuity.

1.7.0 RESOURCES

1.7.1 The resource of Manganese has been estimated at (+) 10% Mn cut-off (Threshold value, IBM No. C-284/3/CMG/2017, dated 25th April 2018) as per specifications/basic assumptions enumerated in Para No. 21.1.0. The section wise summary of resources is given in Table-20.1 Details of section wise ore resource estimation for manganese are given in Annexure VI.

Table-1.4

Summarised section wise geological resources estimated at 10 % Mn cut-off in Nagardhan Block, Nagpur Maharashtra

Section No	Band Number	Category	Trench	Strike Influence (m)	Specific Gravity	Resource (Tons)	Mn %	P_2O_5 %
S1	Band I	Surficial (G3)	Trench-1	132	3.10	4861.30	26.16	0.30
S1	Band II	Surficial (G3)	Trench-2	184	3.10	16815.39	15.08	0.21
S2	Band I	Surficial (G3)	Trench-5	132	3.10	6183.01	18.43	0.29
S2	Band II	Surficial (G3)	Trench-4	184	3.10	12457.54	20.88	0.17
Total						**40317.24**	**18.72**	**0.22**

1.8.0 CATEGORISATION OF RESOURCE

1.8.1 Resources of manganese ore have been categorized under Inferred Mineral Resources (333) as per the United Nations Framework Classification (UNFC).

1.9.0 RECOMMENDATIONS

1.9.1 Geological mapping and trenching revealed manganese mineralization, with four out of five trenches intersecting Mn content between 10.88% and 28.74% at a 10% Mn cut-off. Three boreholes targeting Band I (Northern band) intersected only a 1-meter-wide band in MNB-01, while the other two boreholes did not encounter significant mineralization. The manganese ore bands in the area are surficial, thin, and of marginal grade, with limited strike and little to no depth continuity. The structural complexity observed during mapping, along with the absence of substantial intersections in boreholes, suggests that the mineralization lacks depth persistence. Due to limited exposures, the strike and depth extent of the mineralization remain unconfirmed. However, an estimated resource of 0.04 million tonnes of surficial manganese ore has been estimated and categorized under the 333-resource classification.

1.9.2 Considering the block's status as a lapsed lease under Section 10(A)2(B) of the MMDR Act-2015, its proximity to an operational underground manganese mine, its considerable high-grade surface manganese deposits, and its complex structural geology, additional geophysical surveys are recommended to detect potential deep ore bodies.

CHAPTER-2

DETAILS OF THE QUALIFIED PERSON(S) / EXPLORATION AGENCY

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

TITLE	DETAILS
(a) Name:	MINERAL EXPLORATION AND CONSULTANCY LIMITED (Formerly Mineral Exploration Corporation Limited) (A Government of India Enterprise; A Miniratna-I PSE) (Ministry of Mines, Government of India)
(b)Communication Address:	Dr. Babasaheb Ambedkar Bhawan, Highland Drive Road, Seminary Hills, Nagpur-440006.
(c) Contact Mobile No:	0712-2510289, 0712-2511829
(d) E-Mail id:	gm-exploration@mecl.gov.in
(e) Qualification of Technical Personnel	M.Sc.(Tech)Geology/ M.Sc. Geology
(f) Experience:	Since October 1972
(g) Affiliation to any organization/company, if yes, specify the name of the organization or company.	-

2.2.0 PERSONNEL ASSOCIATED IN EXPLORATION WORK

2.2.1 The list of personnel associated with the execution of different exploration activities carried out in Preliminary Exploration (G-3) for Manganese in Nagardhan Block, District- Nagpur, Maharashtra are given in the Table-2.1.

Table-2.1
List of Personnel associated with Exploration Work

S No.	Title	Name of the Personnel
1	Overall Guidance	Shri P. Ravindran, G.M. (Expl.)
2	Overall planning, Coordination & Supervision	Shri P. Ravindran, G.M. (Expl.)
3	Project Management/OIC	Shri Mayank Dixit, Asst. Manager (Geology)
	Physical Execution of Work	
4	Geology & Survey	Shri Mayank Dixit, Asst. Manager (Geology) Miss Himanshi Bohra, Geologist
		Dulal Debnath, STA (Survey & Map)
		Shri Durgesh Devarshee, ASMO
5	Sample Preparation	Smt. Shikha Pandey, Sr. Tech. (Sampling)
		Shri Ankush Wagh, Sr. Tech. (Sampling)
6	Chemical Laboratory	Shri P. Ravindran, G.M. (Expl.)
		Shri Rohit Sharma, Manager (Labs)
		Shri Deepti Rahangdale, Manager (Labs)
		Shri Navin Kumar Singh, Asstt. Manager (Chemical)
7	Petrographic studies	Shri Sayantan Pal, Assistant Manager (Geology)
8	Documentation	Shri Mayank Dixit, Asst. Manager (Geology) Miss Himanshi Bohra, Geologist
9	Hindi Translation	Shri Shreekant rai, Sr. Hindi Transalator
10	GIS & I.T. Centre	Miss. Moumita Ghosh, Sr. Geologist
		Shri Shivananda, Sr. Computer Operator
11	Reprography and Printing	Shri Jagdish Thakral, Survey & Map Officer
		Shri Durgesh Devarshi, ASMO

CHAPTER-3

TITLE AND OWNERSHIP

3.1.0 TITLE OF THE REPORT

GEOLOGICAL REPORT ON THE PRELIMINARY SURVEY (G-3) FOR MANGANESE IN NAGARDHAN BLOCK DISTRICT: NAGPUR, STATE: MAHARASHTRA

Ownership: Government of Maharashtra

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 OF PERIOD OF PROSPECTING

3.2.1 The Exploration work had been commenced on 02nd May, 2024 and the field work involving geological mapping, collection of channel & trench samples and Drilling on 23rd Feburary, 2025. The allied field-works including sampling were completed simultaneously. The analytical/laboratory studies were carried out simultaneously in laboratories of MECL and other Government /NABL accredited laboratories.

CHAPTER-4

DETAILS OF THE AREA

4.1.0 LOCATION OF THE BLOCK

4.1.1 The present exploration block is located at about 7 km south of Ramtek town in the Nagpur district of Maharashtra. Nagardhan and Nandapuri are some of the major villages present in and around the block. Block lies in the parts of Survey of India Toposheet No. 55O/07 and and is bounded by latitude 21º 19' 09.39" N to 21º 20' 03.45" N and longitude 79° 18' 59.65" E to 79° 19' 41.49" E (Text Fig. No-1 & Plate No.-I). The Co-ordinates of the corner points of the block area both geodetic and UTM are given in table below

Table -4.1

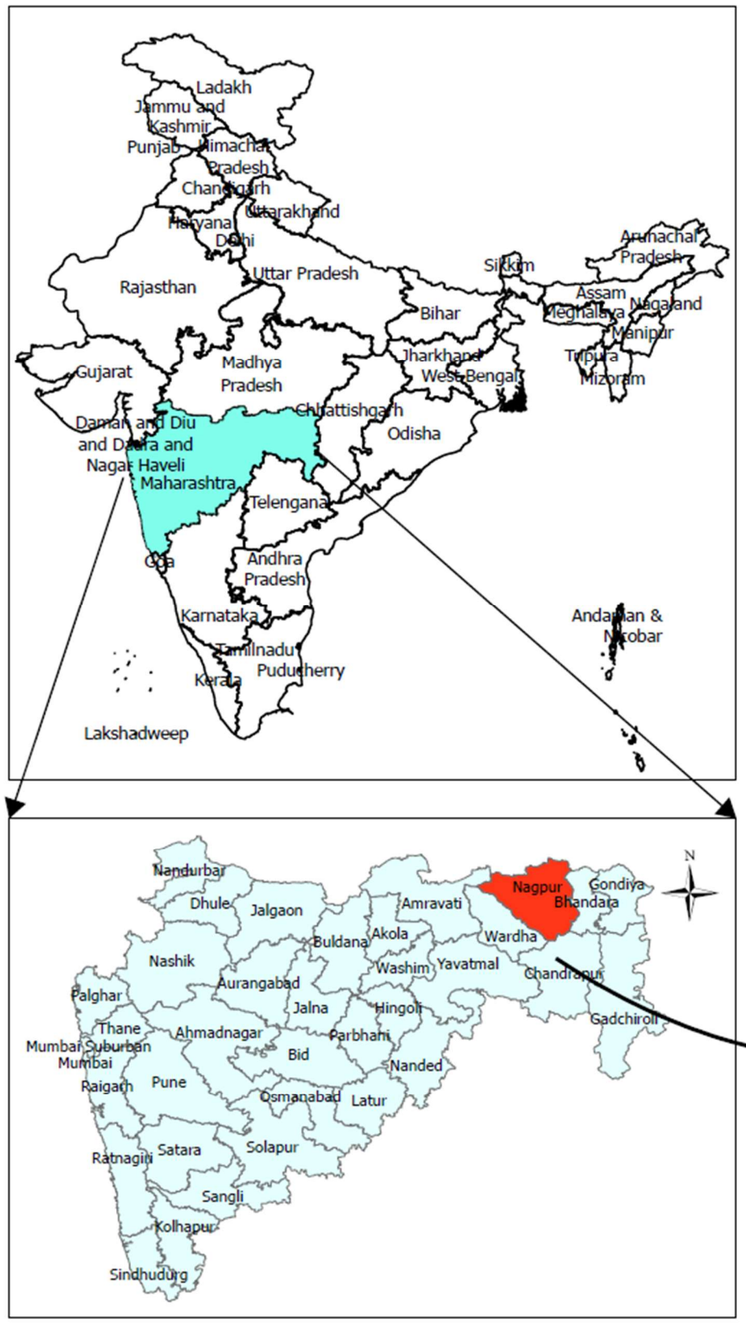
Co-ordinates of the cardinal points of Block Boundary of Nagardhan G3 Block, Dist: Nagpur, Maharashtra.

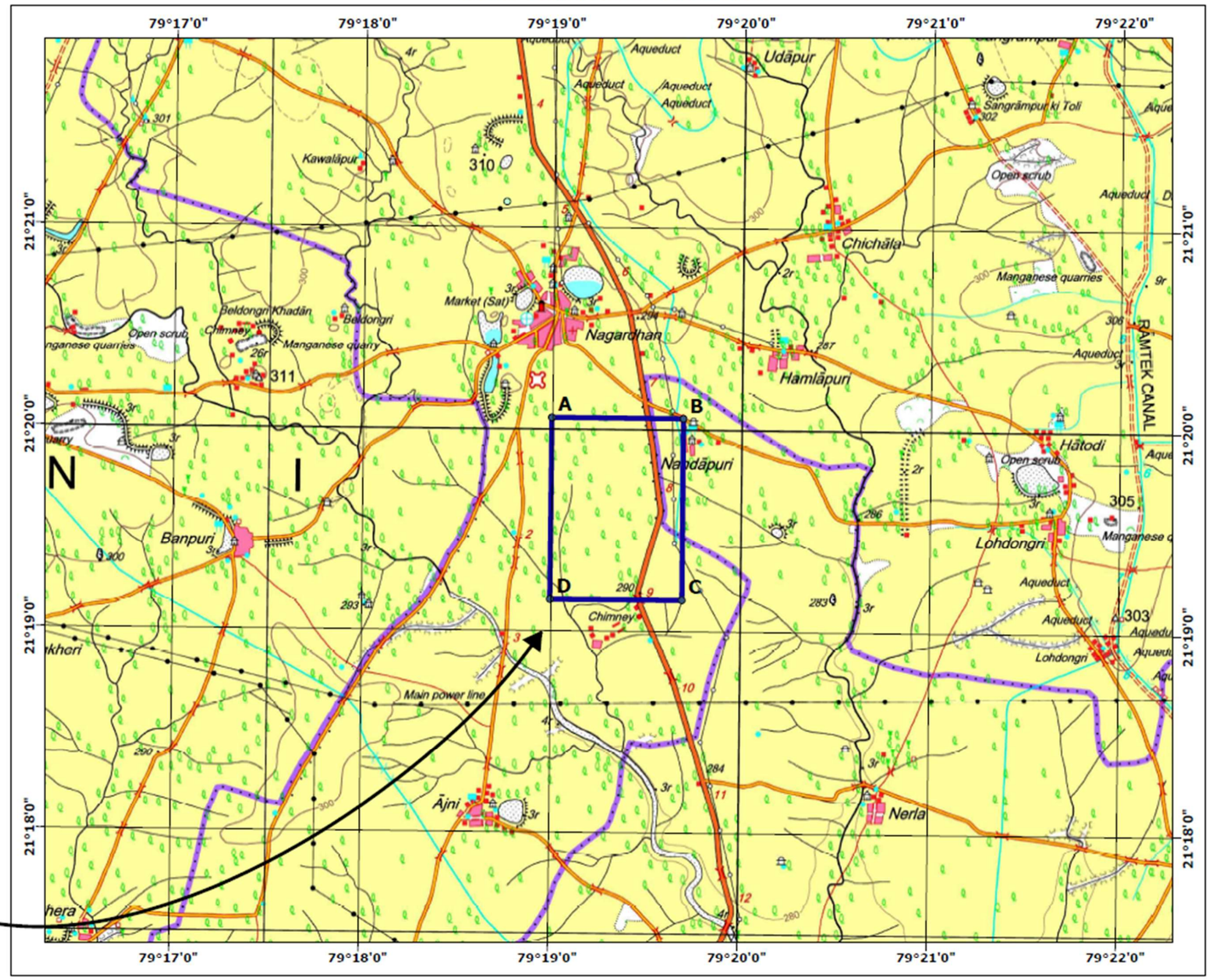
Sl. No.	Corner Points	DMS (WGS84)		UTM 44N	
		LATITUDE	LONGITUDE	NORTHING(Y)	EASTING(X)
1	A	21° 20' 03.45" N	79° 18' 59.69" E	2360078.59	325418.14
2	B	21° 20' 03.42" N	79° 19' 41.43" E	2360064.86	326620.80
3	C	21° 19' 09.40" N	79° 19' 41.49" E	2358403.54	326604.89
4	D	21° 19' 09.39" N	79° 18' 59.65" E	2358416.08	325399.21

4.2.0 ACCESSIBILITY

4.2.1 The study area is conveniently connected to Nagpur via NH-44/SH-753, which can be accessed through Kanhan or by traveling through Mansar and Ramtek. The region is accessible year-round via an all-weather metalled road. The closest railway station is Ramtek, situated on the Nagpur-Ramtek branch (8 km) of the South Eastern Railway, with Kanhan Junction (18 km) providing an additional rail option. The nearest major railway station is Nagpur (45 km), and air travel is facilitated by Dr. Babasaheb Ambedkar International Airport, Nagpur (50 km).

LOCATION MAP OF NAGARDHAN BLOCK (2.00 Sq. Km.) FOR MANGANESE (G3 STAGE), NAGPUR, MAHARASHTRA.





Legend

block_boundary

MECL	MINERAL EXPLORATION AND CONSULTANCY LIMITED
LOCATION MAP	
NAGARDHAN (G3) BLOCK (2.00 Sq. Km.)	
DISTRICT: NAGPUR	STATE: MAHARASHTRA
PARTS OF TOPOSHEET NO. – 55 O/07	
PREPARED BY- EXPLORATION DIVISION, MECL, NAGPUR	
M,E,C,L / EXPL,/Mar-2025	Text Fig. - 1

4.3.0 CADASTRAL DETAILS OF THE AREA WITH LAND USE, AREA UNDER FOREST WITH TYPE OF FOREST.

4.3.1 The area of the block is devoid of forest and falls under private land and the cadastral details of the area are not available

4.3.2 Most of the block area consists of agricultural land, where a single seasonal crop is cultivated, with no significant presence of other flora. However, the surrounding areas exhibit a diverse assemblage of flora and fauna, attributed to the variations in physical features.

4.4.0 MINERAL(S) UNDER INVESTIGATION:

4.4.1 The block has been explored for Manganese Mineral.

CHAPTER 5

PHYSIOGRAPHY AND ENVIRONMENT

5.1.0 PHYSIOGRAPHY

5.1.1 The block area features a gently rolling landscape with a general slope that inclines southward, with an average elevation of about 292 meters above sea level, gradually increasing to around 300 meters in the northern region. The land use pattern indicates a mix of irrigated and non-irrigated areas, the terrain is mainly covered by a 3–4 meter thick layer of soil and alluvium, which facilitates extensive agricultural activities.

5.1.2 Rock exposures are limited and are mainly restricted to stream channels (nallas) and mining sites, including old, abandoned, and active operations. However, scattered occurrences of lateritic cappings are observed in some locations.

Photo–1: Panoramic view of the block showing undulating plain topography having mainly cultivated fields

5.2.0 CLIMATIC CONDITIONS

5.2.1 The area has a moderately dry and wet climate, with temperature increases starting in March and reaching a high of around 45°C in April and May. May is the warmest month, with an average daily maximum of 42.7°C. The monsoon season usually starts in June and continues through September.

5.2.2 The arrival of the southwest monsoon in the second week of June brings relief from the scorching summer heat, with most of the rain is in July and August. The average rainfall per annum is between 1250 and 1500 mm.

5.2.3 The winter months, which are from November to February, are usually moderate with temperatures dipping below 10°C on colder days.

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

5.3.1 The region features mostly flat land with a gentle slope toward the south, with an average elevation of about 300 meters above sea level

5.3.2 The drainage system is mainly controlled by the Bhagi Nala, which directs surface runoff and eventually flows into the Kanhan River, situated about 18 km to the south of the block. The area displays a dendritic drainage pattern, which reflects its geological makeup and surface water processes. This well-established drainage network has a significant impact on water flow, soil erosion, the distribution of natural vegetation, and agricultural productivity.

5.3.3 Furthermore, the Ramteke Canal, which starts from Khindsi Lake, is an essential water source that plays a key role in maintaining the water supply for the southern part of the study area.

5.4.0 ROADS, RAILWAY TRACK, ELECTRIC TRANSMISSION LINE, TELEPHONE LINE, ETC., PASSING THROUGH THE AREA OR NEARBY

5.4.1 The area is a part of Ramtek Tahsil of Nagpur district, Maharashtra. The area is well connected by road lying in between Ramtek (in the North) and Kanhan (in the South), The area has very good connectivity of roadways. The NH-7 passes through TS no. 55O/7 and 6 km away from Ramtek which is 40 km NE of Nagpur.

5.4.2 All the villages of the block have electric supply line for domestic and agricultural/irrigational use. In the maximum part of the block mobile signals are available for telephonic communication.

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

5.5.1 Human settlements around the block area reflect a blend of traditional rural villages and emerging urban centers, all intricately connected. Nagardhan (large village) & Nandapuri (medium size village) are located around the block hosts a diverse population, including Schedule caste and schedule tribes.

5.5.2 The proximity to Nagpur city has led to gradual urbanization, bringing modern amenities and infrastructure improvements to the region. Despite these changes, the area retains its rustic charm, with traditional houses, local markets, and community gatherings being a common sight. The settlements nearby often reflect a blend of old and new, where age-old customs coexist with contemporary influences.

5.6.0 SOCIO DEMOGRAPHIC PROFILE OF THE AREA AND NEARBY

5.6.1 According to the 2011 Official Census Nagardhan contains a population of approximately 8,235 individuals, with a sex ratio of approximately 898 females per 1,000 males. Nandapuri is smaller but has an equal sex ratio. Both regions possess a large population of children, indicating vibrant communities.

5.6.2 Literacy Rate: Nagardhan has a literacy rate of 83.36%, which is above Nagpur district average, with male literacy being 87.82% and female literacy at 78.39%. Nandapuri focuses on education as well, which results in a fairly high literacy rate.

5.6.3 Caste and Tribe Population: Both regions have a mixed population with Scheduled Castes (SC) constituting 8.9% and Scheduled Tribes (ST) 9.2% of the population of Nagardhan. Major native communities are the Gond and Bhil tribes, which enhance the cultural landscape of the regions.

5.6.4 Occupation and Employment: The main occupation in both regions is agriculture, with most of the inhabitants involved in farming and agricultural work. Nagardhan has 94.2% of workers in main work and 5.8% in marginal work. Nandapuri also has small-scale industries and local enterprises offering other employment opportunities.

5.6.5 Neighboring Villages: The neighboring villages of Chichala, Ajani, Devhada, Hamlapuri, Minsi, Hatodi, Khandala, Lohadongari, and Kachurwahi are similar socio-demographically and have similar cultural and economic backgrounds, which constitute the overall region.

Table-5.1

2011 Census Data of Nagardhan & Nadapuri villages, Maharashtra

Sl. No.	Description	Total	Male	Female
1	Total No. of Houses	2211	-	-
2	Population	9668	5059	711
3	Child (0-6)	1193	611	104
4	Schedule Caste	808	437	37
5	Schedule Tribe	806	468	20
7	Literacy	83%	88%	78%
8	Total Workers	4449	2891	194
9	Main Worker	4061	-	-
10	Marginal Worker	388	105	158

5.7.0 FORESTS, SANCTUARIES, NATIONAL PARK AND WILD LIFE SANCTUARIES ETC:

5.7.1 The block area mostly falls under private land and devoid of any forest. No sanctuaries, national park and wild life sanctuaries are present within the 5 Km radius of the block.

5.8.0 FLORA AND FAUNA WITHIN AND NEARBY

5.8.1 The area in general is a cultivated private land with scanty vegetation of neem, tendu are seen. However, rice, wheat etc are grown extensively.

5.8.2 The area predominantly hosts domesticated animals, with limited fauna diversity. However, occasional sightings of wild animals such as foxes are reported from the reserve forest to the north, near Ramtek.

5.9.0 HISTORICAL SITES AND ARCHAEOLOGICAL MONUMENTS, PLACES OF WORSHIP, PUBLIC UTILITIES ETC. WITHIN OR NEARBY

5.9.1 About 250 m outside the North west corner of the block is Nagardhan fort of archeological importanc. Nagardhan, previously called Nandivardhan, was the first capital of the Vakataka dynasty. It's located 34 km northeast of Nagpur and about 5 km south of Ramtek, which is famous for its fortified hill temple.

5.9.2 The present Nagardhan fort, likely constructed by Raghuji Bhosale I around 1740 AD, was probably designed to protect the eastern approaches to Nagpur. This square-shaped fortification features an outer rampart with bastions and an inner wall surrounding the structures. The main gate, which remains in good condition, is situated on the northwest side. Within the fort, there is a subterranean temple, with the idol positioned on a ledge within a well-like structure.

5.9.3 Nearby the current fort site, large ancient bricks are frequently discovered, believed to be remnants of the ancient capital-cum-fort of the Vakatakas. Recent archaeological excavations at Nagardhan in Ramtek taluka, near Nagpur, have provided concrete evidence regarding the lifestyle, religious practices, and trade activities of the Vakataka dynasty, which ruled parts of Central and South India from the third to the fifth centuries. A 1,500-year-old sealing was excavated for the first time, and a new study in Numismatic Digest has attempted to understand the Vakataka rule under Queen Prabhavatigupta.

5.9.4 About 9 km north of the block is an important Ramtek temple. Ramtek Temple, is a significant religious and historical site. Perched atop a hill in the town of Ramtek, the temple is dedicated to Lord Rama and holds great spiritual importance for devotees. The temple complex is believed to date back to ancient times and is deeply associated with the epic Ramayana. It is said that Lord Rama, along with his wife Sita and brother Lakshmana, stayed at this location during their exile. The name "Ramtek" is derived from 'Ram' for Lord Rama and 'tek' meaning the resting place, indicating the significance of this place in the epic.

5.9.5 The architecture of Ramtek Temple is an exquisite blend of the medieval and Maratha styles, showcasing intricate carvings and detailed sculptures that add to the temple's grandeur. The temple complex consists of multiple shrines dedicated to various deities, with the main shrine devoted to Lord Rama. The serene surroundings and the panoramic view of the surrounding landscape from the temple hill make it a popular destination for pilgrims and tourists alike. The annual festivals and religious

ceremonies held here attract thousands of devotees, enhancing the temple's vibrancy and cultural significance.

5.10.0 WATER BODIES SUCH AS RIVER, NALA, STREAM, RESERVOIR, ETC., WITHIN OR NEARBY

5.10.1 The area comprises of wide spread plain land and almost flat terrain covered with agriculture land. The average height of the area is 310m above MSL. The general slope of the country is towards south and the drainage is collected by southerly flowing Bhagi nala ultimately draining into Kanhan River. The area has got dendritic pattern of drainage.Kanhan River about 18 km south of the block.

5.11.0 OTHER PHYSIOGRAPHIC, SOCIAL AND ENVIRONMENTAL FACTOR

5.11.1 Most of the population in the area are dependent for their livelihood on farming. Many manganese mines for manganese are also present in the surrounding area which also generate employment in the area. The future mining project in the block may generate employment for the local people and will increase socio-economic status of the people residing in the nearby areas.

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 The Block is located 1 km south of Nagardhan village and connected by fair weathered roads. Nearby villages are Nandapuri & Hamlapuri villages are approachable by fair weathered and metalled roads. No national park lies within the area. No arts, science, or engineering degree colleges, whether government funded or privately owned, exist in the village. There are, however, a private degree college and a private engineering college in Ramtek, which is about 5 - 10 kilometers from Nagardhan.

6.1.2 An underground Beldongri mine of MOIL is currently active in 3 km north west direction of the block. The modern facilities offered in Nagardhan encompass important public services and connectivity. A Junior college is located within the boundaries of the Nagardhan Gram Panchayat. Nagardhan has a Primary Health Centers (PHCs) provided by the government. This facilities offer basic medical care. The nearest police station and electrical substation are present in Ramtek town.

6.1.3 Nagardhan is a historic town, located 38 km northeast of Nagpur and about 9 km south of Ramtek. It was founded by a Suryavanshi King and is best known for the Nagardhan Fort, an important archaeological and architectural site. The fort, believed to have been built by Raja Raghuji Bhonsle of the Maratha Bhonsale dynasty, is its main attraction.

6.1.4 The fort features a square-shaped palace with an outer rampart, bastions, and an inner wall surrounding the structures. Its main gate, located on the northwest side, remains well-preserved. Inside the fort, near the palace, there is a unique two-level underground well designed with proper rooms for people to stay. The fort also houses an idol of Goddess Durga.

CHAPTER 7

GEOLOGY

7.1.0 REGIONAL GEOLOGY

7.1.0 The central part of the Indian Precambrian Shield exhibits the presence of two distinct crustal provinces: the Northern Crustal Province, encompassing the Bundelkhand region, and the Southern Crustal Province, known as Bastar. Within the Northern Crustal Province, there exists a subdivision comprising the Bundelkhand cratonic area and a broader zone of accretion to its south, following an ENE–WSW trend, identified as the Central Indian Tectonic Zone (CITZ).

7.1.1 The supracrustal rocks south of the SONA Zone (Son Narmada Lineament Zone) belong to the Sausar Group, which forms part of the Proterozoic Satpura Fold Belt (SFB). This fold belt trends east-west to east-northeast-west-southwest and marks the northern boundary of the Bastar Craton. It consists of metamorphosed Sausar Group metasediments, which were deposited in a stable shelf environment. The SFB is range considered to be from Meso to Neoproterozoic (Sarkar et al., 1986; Lippolt & Hautmann, 1994; Roy et al., 2006).

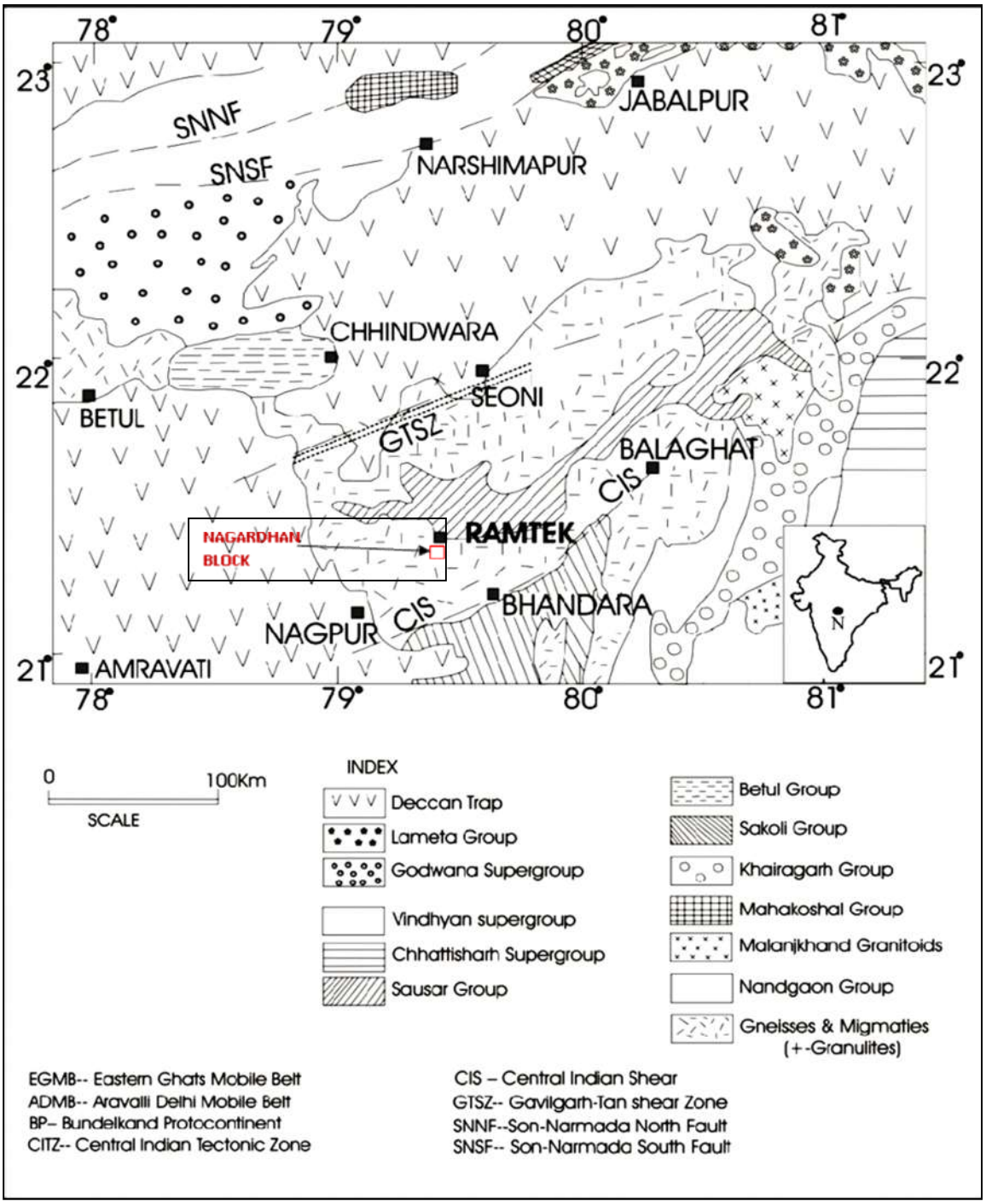
7.1.2 The SFB is dated to the Meso- to Neoproterozoic era (Sarkar et al., 1986; Lippolt & Hautmann, 1994; Roy et al., 2006) and is composed of two main geological units:

(1) Tirodi Biotite Gneiss (TBG) and Migmatite – Includes gneissic and plutonic igneous rocks such as granite gneiss, tonalite-trondhjemite gneiss, and granodiorite gneiss. It also contains older, high-grade metamorphic rock enclaves (Bhowmik et al., 1999; Chattopadhyay et al., 2001).

(2) Sausar Group (SG) – Represents a cratonic sequence of metamorphosed quartzite, pelites (fine-grained sedimentary rocks), and carbonate rocks, commonly referred to as the QPC assemblage (Condie, 1989).

7.1.3 The Sausar Fold Belt (SFB) extends over 200 km, from Ramakona (Chhindwara, Madhya Pradesh) in the west to Baihar (Balaghat, Madhya Pradesh) in the east. Recent studies suggest that Sausar metasediments may extend even further east to Ratanpur in Bilaspur District, Chhattisgarh (Jain et al., 1995).

7.1.4 India's richest manganese ore deposits are found primarily in the mica schist of the Mansar Formation, with smaller occurrences in the carbonate horizons of the Lohangi Formation within the Sausar Group.



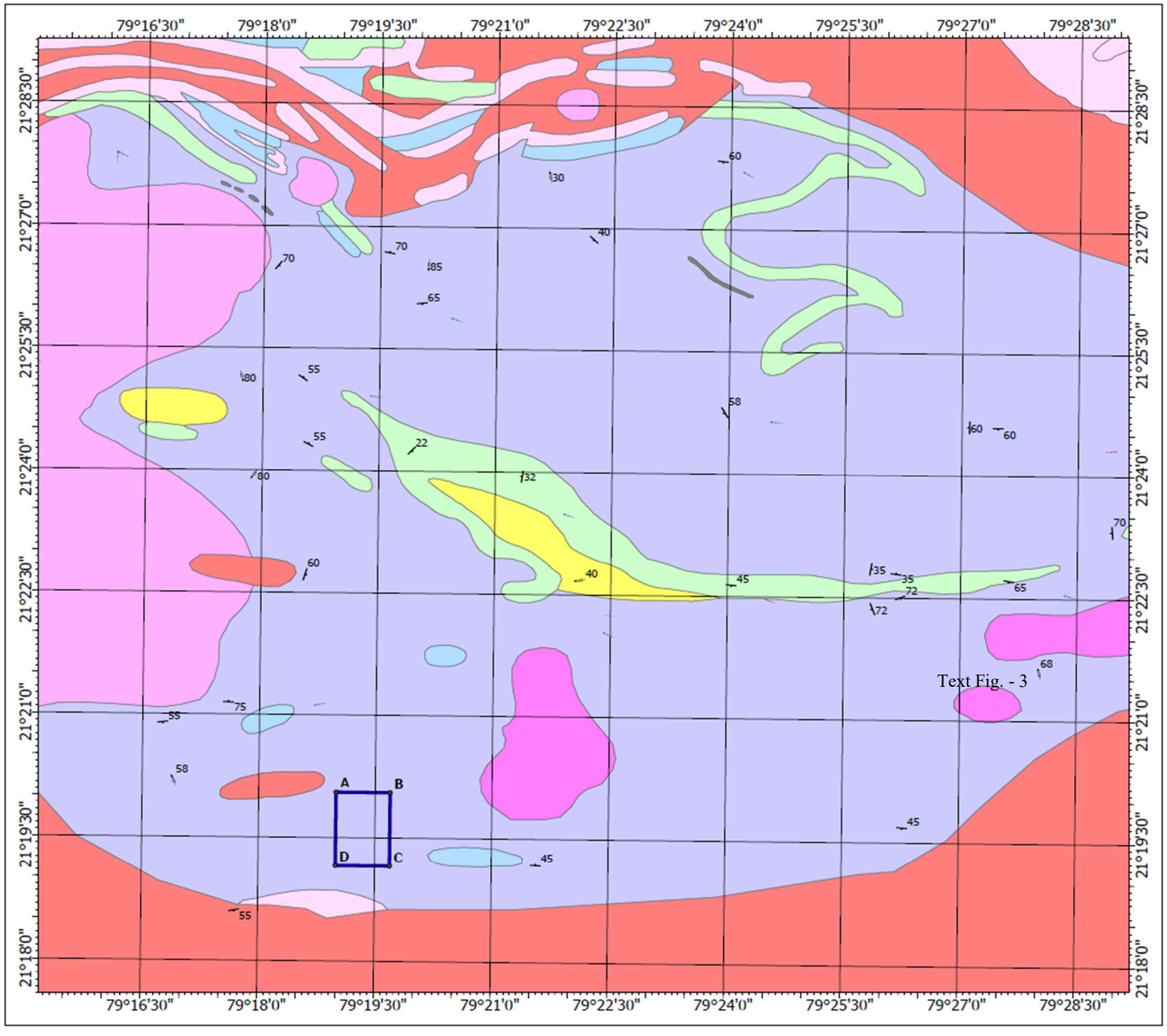
Text Fig:2 - Geological map of part of central Indian shield showing position of Sausar belt (after Roy and Prasad 2001)

7.1.5 The stratigraphic sequence of various formations of the region and as per Khan et al., 2002 generalised sequence of Sausar Group of rocks of this area is given below in Table 7.1:

Table -7.1
Generalized Stratigraphy of the area (Khan et al., 2002)

Group	**Formation**	**Lithology**
Quaternary	**Recent Deposits**	Alluvium & soils
		Laterite
	Intrusives	Massive potassic granite, pegmatite and quartz veins
		Foliated potassic granite
SAUSAR GROUP	Bichua Formation	White dolomitic marble ± red and yellow chert
	Chorbaoli Formation	Coarse grained, garnetiferous quartz-mica schist with local development of magnetite and garnet.
	Mansar Formation	Fine grained garnetiferous mica schist and quartz-mica schist with thin chert and quartzite and thick horizon of Mn ore and gondite
	Lohangi Formation	Calc silicate rocks, calc gneiss with subordinate pink calcite marble and minor Mn ore horizons.
	Sitasaongi Formation	Meta grit and micaceous quartzite.
Tectonised Contact		
Pre Sausar Basement (Archaean)	Amgaon Gneiss	Granite gneiss/migmatite
	Tirodi Biotite Gneiss	Multicomponent gneiss e.g. biotite gneiss, migmatitic gneiss, felsic gneiss with small metabasic & mafic granulite enclaves.

REGIONAL GEOLOGICAL MAP OF NAGARDHAN BLOCK (2.00 Sq. Km.) FOR MANGANESE (G3 STAGE), NAGPUR, MAHARASHTRA. (After GSI)



Text Fig. - 3

N

Legend

Lithology
- CALC GNEISS
- FOLIATED GRANITE
- GNEISS/MIGMATITE
- GONDITE/MANGANESE ORE
- GRANITE
- LATERITE
- MARBLE
- MUSCOVITE SCHIST
- QUARTZ MICA SCHIST
- QUARTZITE

Structure
- BEDDING
- CLEAVAGE/FOLIATION/SCHISTOSITY (S1)
- CRENULATION CLEAVAGE (S2)
- GNEISSIC FOLIATION
- FOLD AXIS (F1)
- FOLD AXIS (F2)
- FOLD AXIS (F3)
- BLOCK BOUNDARY

1 0.5 0 1 2 3 4 Kilometers

MINERAL EXPLORATION AND CONSULTANCY LIMITED	
REGIONAL GEOLOGICAL MAP (AFTER GSI)	
NAGARDHAN (G3) BLOCK (2.00 Sq. Km.)	
DISTRICT: NAGPUR	STATE: MAHARASHTRA
PARTS OF TOPOSHEET NO. – 55 O/07	
PREPARED BY- EXPLORATION DIVISION. MECL. NAGPUR	
M,E,C,L / EXPL./Mar-2025	Text Fig. - 3

7.2.0 REGIONAL STRUCTURE

7.2.1 The Sausar Group rocks have been deformed and metamorphosed through several stages. The folds in general are overturned to the north, and axial planes are steeply dipping (60°–80°) to the south in the southern region of the belt.

7.2.2 Regional structure of the Sausar Group is categorized into four distinct belts (Narayanswamy et al., 1962):

(1) Southern Belt – Isoclinal folding (tight, parallel folds).

(2) Northern Belt – Exhibits recumbent folds, thrust blocks, and nappe structures (large-scale thrust-displaced sheets of rocks).

(3) Central Belt – Consists of gneissic bodies interspersed by thin folded bands of schists.

(4) Cross-Folding and Refolding Regions – Regions in which previous fold structures have been overprinted by subsequent folding movements.

7.2.3 The east-west structural trend of the Sausar Fold Belt (SFB) is a product of three principal deformation phases (D1, D2, and D3). D1 was associated with low-angle thrusting that resulted in intermixing of basement and supracrustal rocks (Chattopadhyay et al., 2001, 2003). This phase was also responsible for the generation of small-scale, tightly folded folds (F1), isoclinal to recumbent and reclined, with an associated axial planar foliation (S1). The second folding (D2) created steeply to upright, non-cylindrical folds (F2), folding the previous thrust planes as well. The third deformation (D3) created gently east-plunging upright folds (F3), further folding the previously deformed L2 lineation. A small fourth deformation (D4) episode formed weak cross-folds (F4) on a north-south trending axial plane (Chattopadhyay et al., 2003).

7.3.0 METAMORPHISM IN THE REGION:

7.3.1 The Sausar supracrustal rocks show a metamorphic grade of greenschist-upper amphibolite facies with metamorphic intensity increasing from the east-southeast toward the northwest (Narayanswamy et al., 1963). Gneissic rocks bordering the Sausar Group from the north and south contain enclaves of pelitic and basic granulites through which is covered with low-grade amphibolite facies (Bhowmik et al., 1999).

7.3.2 Geochronological studies of the Sausar Fold Belt indicate that a tectonothermal event has taken place in the time range of 850-950 Ma, as indicated by Rb-Sr whole-rock and mineral isochron dating (Roy et al., 2006). This event imprinted an upper amphibolite facies fabric obliquely across older (~1100 MA) granulite-grade foliations in the high-grade quartzo-feldspathic gneisses of the Tirodi Biotite Gneiss (TBG) suite. Thus, the Sausar Belt is the last tectonothermal event broadly related to Grenvillian in the Central Indian Tectonic Zone (CITZ), vital in reconstructing Rodinia Supercontinent.

7.4.0 BLOCK GEOLOGY:

7.4.1 The block is situated on the south western side of Nandapuri village. The area forms a part of the western portion of the Sausar Fold Belt which is popularly known as Maharashtra-Madhya Pradesh manganese belt. The area is represented by cultivated land with scanty outcrops. Outcrops are seen stream (nalla) cuttings, abandoned mining sites as well as trenches excavated in the area. Abandoned pits are present in the central part of the block. The length of the abandoned mining pits ranges from 50 m to 150 m with depth varying from 1 m to 3 m.

7.4.2 The area is represented by Precambrian metasediments of sausar group which unconformmably overlie the Tirodi gneisses, quartz mica schist belonging to Mansar formation along with quartz reef and manganese float are present. Also thick soil and recent alluviums characterize the intervening areas

7.4.3 The Mansar formation of rocks in the study area generally trends WNW - ESE dipping towards North or south and consists of pelitic, psammatic, and calcareous lithologies. The Mansar Formation, composed of fine-grained mica schist and quartz-mica schist which is grading from feldspathic to garnetiferous, with two distinct manganese horizons trending ESE - WNW to E-W following southern and northern dip showing localized folding.

7.4.4 To establish the stratigraphy, a regional geological map at a scale of 1:50000, in conjunction with the Bhukosh/NGDR Map of Nagpur district by G.S.I., has been meticulously considered. The litho-stratigraphic sequence of the block under investigation is depicted in the table below, followed by a detailed description of the individual lithounits.

Table- 7.2
Stratigraphic Sequence of the Nagardhan block

Age	*Group*	*Lithology*	*Lithology Description*
Recent to Sub Recent			Alluvium/Soil Laterite
Mesoproterozoic	Intrusives	Post Sausor	Pegmatite and quartz veins
	Sausor Group	Mansar Formation	Muscovite-biotite-schist, Garnetiferous quartz biotite schist, felspathic at places. Altered Pyroxenite Quartz-mica-schist, Mn ore and gondite

7.5.0 LITHOUNITS EXPOSED IN THE BLOCK

Various lithounits exposed in the block area are described in the following paragraphs.

7.5.1 Quartz Mica Schist ± Garnet & Feldspar –

(1) The block is dominated by a single litho unit i.e. quartz muscovite biotite schist. The lithounit consists of garnet-bearing muscovite-biotite schist (pink and brown varieties), biotite-muscovite schist, muscovite-quartz schist, and muscovite-biotite-quartz schist. In some areas, these rocks have undergone feldspathization, giving them a gneissic appearance. This rock is light to dark grey, fine to medium grained schistose transitioning to gneiss, showing intense folding. This lithounit is composed of quartz, muscovite and biotite with plagioclase feldspar and garnet, at places.

(2) Under microscope, quartz occurs as medium to fine anhedral and lensoidal grains showing crude alignment. Muscovite and biotite/ phlogopite are present as fine disseminated flakes showing parallel alignment. Feldspar occurs as fine patchy relicts being replaced by clayey patches. Tourmaline is seen present as fine to very fine subhedral prismatic grains. Opaques are noted as very fine specks in accessories.

Photo–2: Quartz Mica Schist in MNB-03

7.5.2 Altered Pyroxenite

(1) Altered pyroxenite was intersected in borehole MNB-03, located in the central part of the study area. The rock features a coarse-grained, saccharoidal texture and displays colors ranging from pink to greenish.

(2) Under thin section analysis, the rock consists primarily of calcite, present as massive patches and fine filings throughout the specimen. Augite and pigeonite are found as medium to coarse lamellar relicts within the calcite patches. Tremolite occurs as fine to medium prismatic or bladed grains within the assemblage. Enstatite is also observed as patchy relicts within the calcite. Quartz appears as fine secondary fillings in various areas, and apatite is detected as fine subrounded grains among the accessories.

Photo–3 Pyroxenite with Calcitic veins

7.5.3 Gondite/Manganese mineralisation Band –

(1) Outcrops and manganese floats can be found in abandoned mines, pits, and cultivated fields. This rock unit is dark grey to black, with a fine to medium grain. It consists of a manganese silicate rock that is stratabound. The main form of manganese mineralization is found in primary bedded ore, which is interlayered with gondite in the northern band.

(2) Manganese mineralization and gondite appear as two discontinuous bands running from WNW - ESE, separated by quartz-muscovite-biotite schist. The presence of manganese minerals associated with gondite on the ground has led to their identification, referred to in the report as either the manganese mineralized zone or manganese band. When this mineralization exceeds the 10% manganese cut-off (as per IBM threshold values), it is referred to in the report as manganese ore bands or ore lenses.

(3) In polished section, Braunite and hausmannite are the main constituting minerals of the specimen, occurring as fine to medium subhedral aggregates, where hausmannite grains are relatively bigger in size and showing characteristic multiple set of scratches. Psilomelane is present as thin to very thin fillings and patches cutting across other constituting minerals. Magnetite/ jacobsite are noted as moderately coarse patches in pockets. Goethite is seen associated with psilomelane fillings in areas. The specimen is showing strong magnetism.

Photo 4. Manganese float intersected in Trench 3

Photo 5. Abandoned Manganese pit

7.5.4 LATERITES:

(1) There are limited exposures of laterites in the northern part of the block, suggesting the localized development of laterite over the quartz-muscovite schist. This rock unit typically shows a reddish-brown color and has a texture ranging from pisolitic to massive. The lithology consists of layers that are rich in iron and aluminum, with varying levels of kaolinization. The laterite is usually non-porous and hard.

7.5.5 QUARTZ VEINS/PEGMATITE:

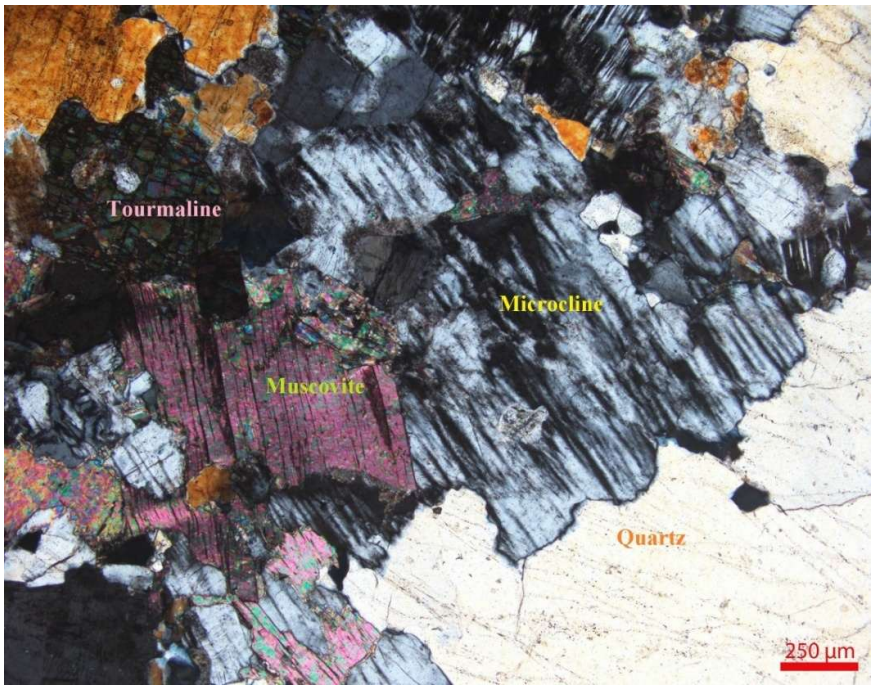
(1) Quartz veins are found both on the surface and in boreholes, while pegmatite, because of its fragile nature, is only intersected in boreholes. Detailed descriptions are provided in the following paragraphs.

(2) Numerous quartz veins have intruded into the host rocks, ranging in width from a few centimeters to 2.5 meters. Notably, a quartz vein approximately 100 meters in length and 2.5 meters in width is located due north of an abandoned mining pit, intruded into muscovite schist. These quartz veins primarily consist of smoky to pearl white quartz, with occasional iron coatings. Muscovite books, varying from thin to thick, are also observed within these quartz veins. The quartz vein may be associated with the regional lineament trending east-west.

(3) Pegmatites intersected in the boreholes intrude into the Mansar schist and are medium-grained, primarily composed of feldspars, quartz, muscovite, and tourmaline minerals. The width of the pegmatite bands varies from 1.5 to 3 meters. Under thin section, the pegmatites display plagioclase with sericitization and muscovite showing weak pleochroism from colorless to pale green. Multiple pegmatite veins have intruded into the basement rocks (TBG) and the Sausar Group rocks. These pegmatites exist in two phases: an early, finer-grained phase and a later phase with a range of grain sizes from fine to medium to very coarse. The pegmatites intrude both parallel to bedding/foliation and across the host rock, with structural elements such as fracture planes controlling their intrusion.

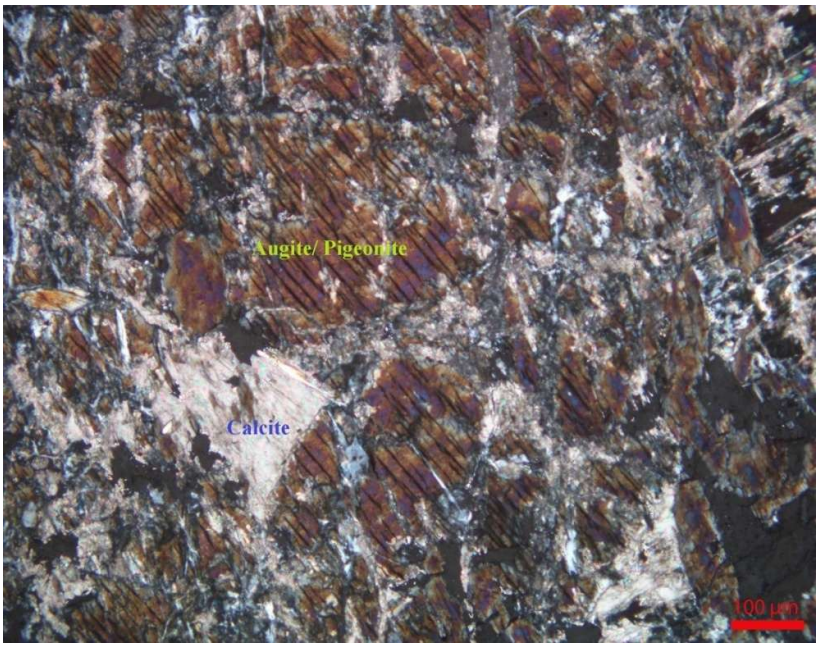
7.6.0 PETROGRAPHIC STUDIES:

7.6.1 A total of 5 number of Borehole samples from different lithologies have been subjected for petrographic studies. The photomicrographs of the thin section are given as Pmg-1 to Pmg-4. The major rock types identified by the petrographic studies are quartz-mica schist, pyroxenite and pegmatite. The description of all the rocks are given in above Para 7.4.3 and the sample wise details are given as Annexure-V A. The photomicrographs for petrographic studies are given from Pmg-1 to Pmg-4.



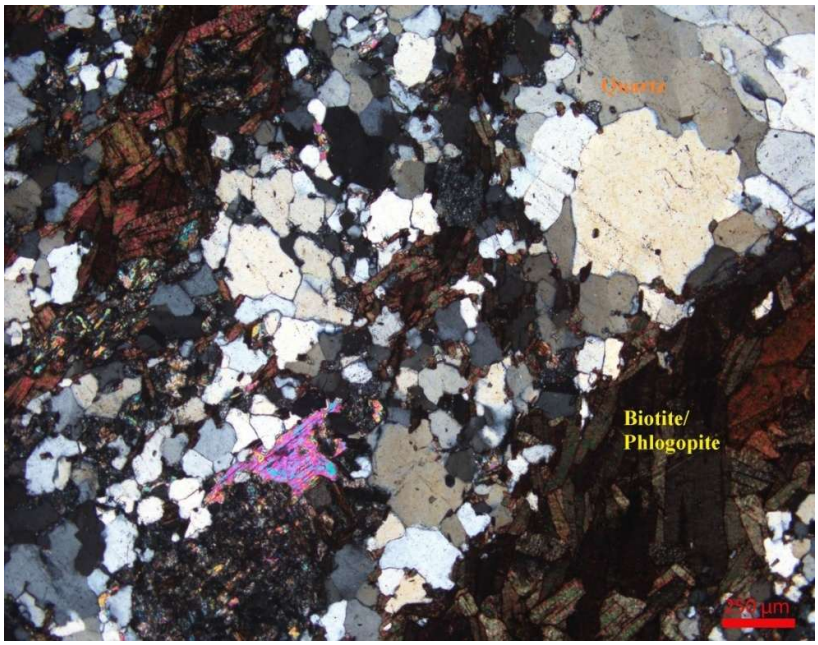
Pmg – 1: Photomicrograph showing association of quartz, microcline, muscovite and tourmaline in granite pegmatite as seen under crossed nicols.

Specimen No. : MNB-2/P-1 **Magnification : 40X**



Pmg – 2: Photomicrograph showing relicts of augite/ pigeonite being replaced by calcite as seen under crossed nicols.

Specimen No. : MNB-3/P-1 **Magnification : 100X**



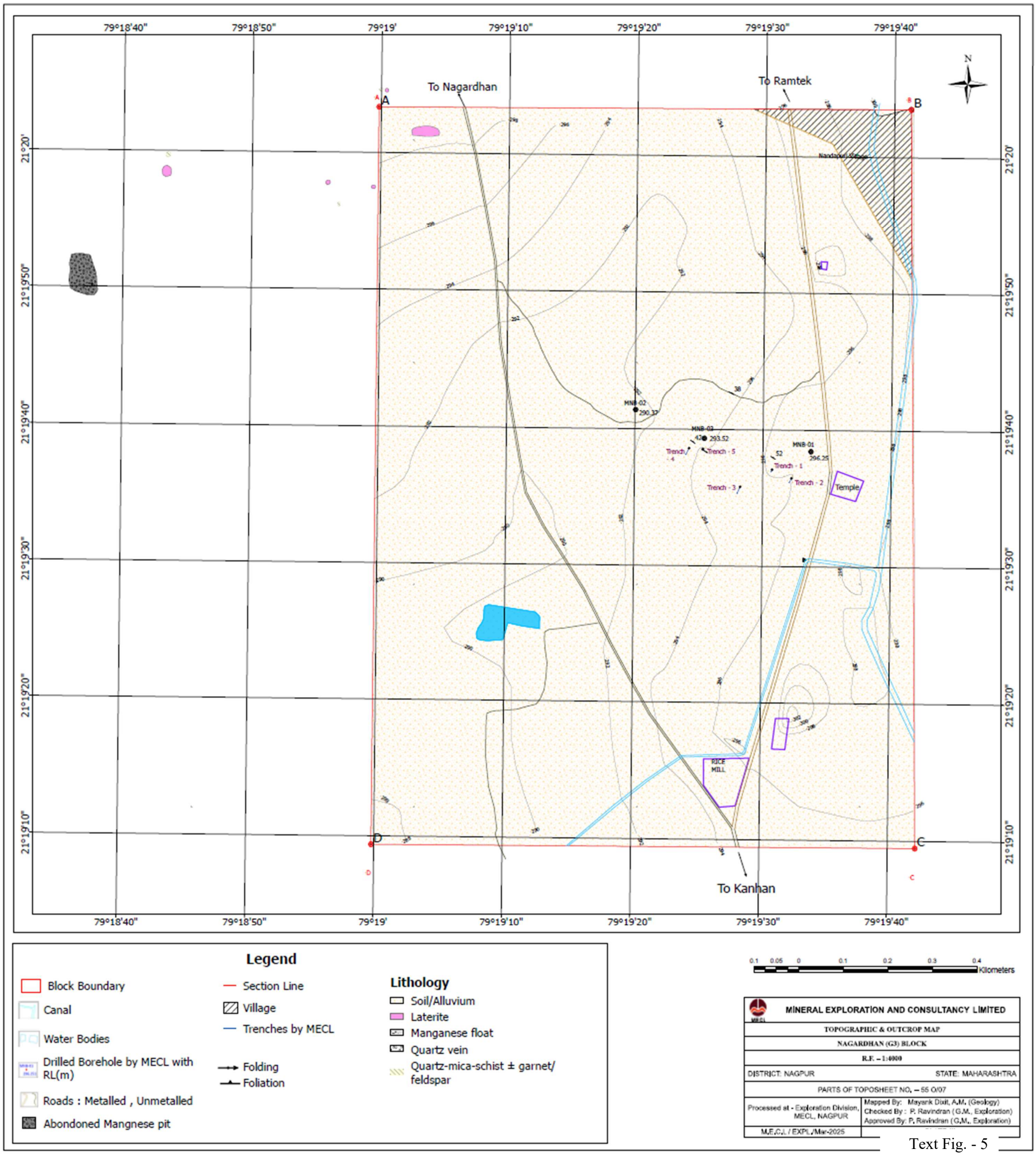
Pmg – 3: Photomicrograph showing association and parallel alignment of quartz and biotite/ phlogopite in quartz-mica gneiss as seen under crossed nicols.

Specimen No. : MNB-3/P-3 **Magnification : 40X**

Pmg – 4: Photomicrograph showing psilomelane-goethite intermixed patch as seen under reflected light.

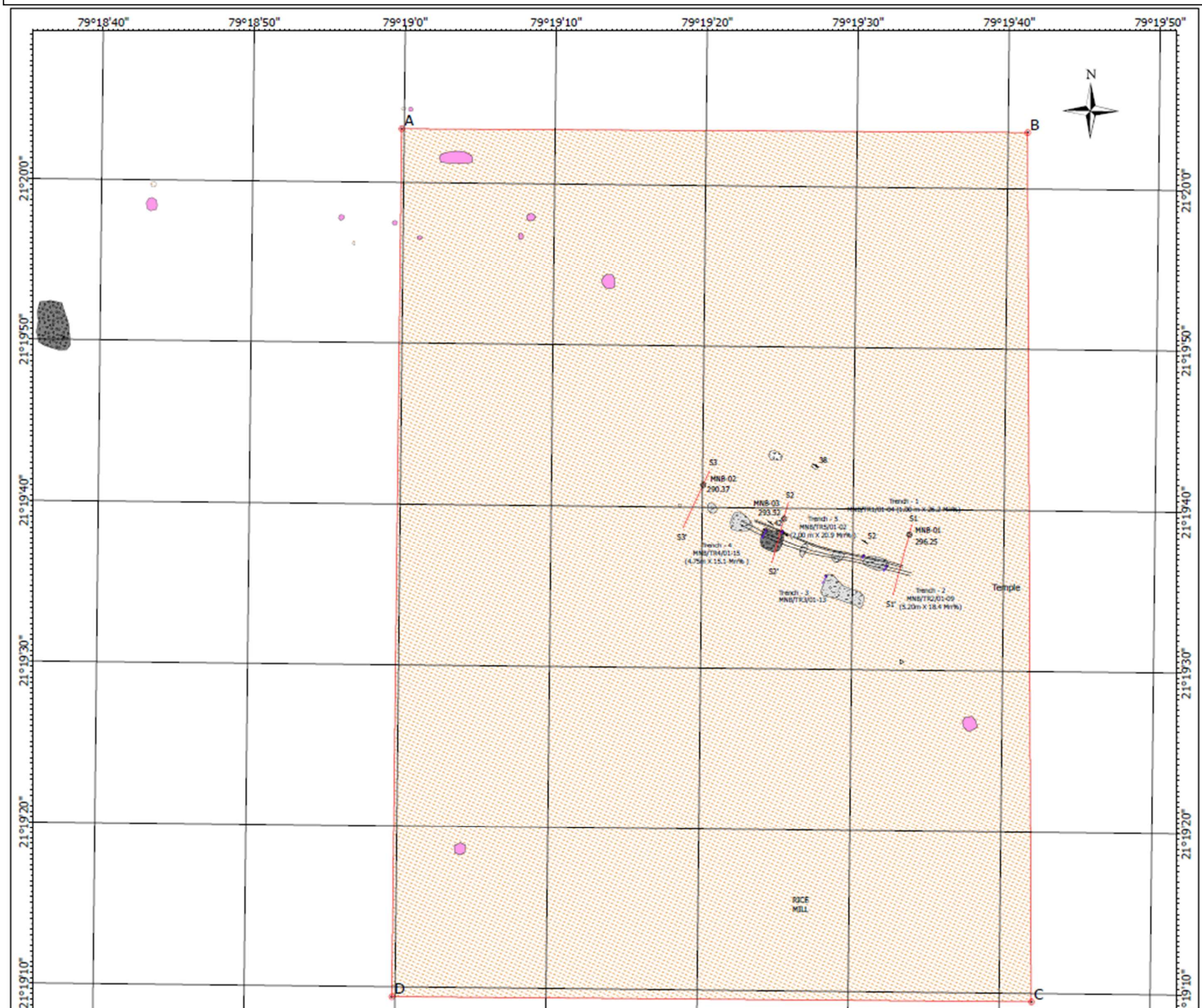
Specimen No. : MNB-3/M-1 **Magnification : 200X**

Topographic & Outcrop Map of Nagardhan Block (2.00 SQ. KM) District- Nagpur, Maharashtra



Text Fig. - 5

Interpreted Geological Map of Nagardhan Block (2.00 SQ. KM) District- Nagpur, Maharashtra



Legend

- Block Boundary
- Canal
- Water Bodies
- Drilled Borehole by MECL with RL(m)
- Roads : Metalled , Unmetalled
- Abondoned Mangnese pit
- Section Line
- Village
- Trenches by MECL
- Folding
- Foliation

Lithology

- Laterite
- Manganese float
- Quartz vein
- Quartz-mica-schist ± garnet/ feldspar

0.1 0.05 0 0.1 0.2 0.3 0.4 Kilometers

MINERAL EXPLORATION AND CONSULTANCY LIMITED	
INTERPRETED GEOLOGICAL MAP	
NAGARDHAN (G3) BLOCK	
R.F. – 1:4000	
DISTRICT: NAGPUR	STATE: MAHARASHTRA
PARTS OF TOPOSHEET NO. – 55 O/07	
Processed at - Exploration Division, MECL, NAGPUR	Mapped By: Mayank Dixit, A.M. (Geology) Checked By : P. Ravindran (G.M., Exploration) Approved By: P. Ravindran (G.M., Exploration)
M.E.C.L / EXPL./Mar-2025	

Text Fig. - 5

7.7.0 STRUCTURE OF THE BLOCK

7.7.1 **Geological Structure:** The area is largely covered with soil, with only limited exposures visible in quarries, nallahs, and well sections. Some structures are only seen in abandoned mine exposures. Based on the available data and drilling information, the geological structure trends from east-southeast (ENE) to west-northwest (WSW) to east – west with a dip ranging from 38° to 52° towards south or north. Variations in the trends are due to cross-folding.

7.7.2 **Manganese Ore Zone:** Analyzing surface outcrops and correlating subsurface data reveals that the manganese (Mn) ore zone is confined within the metapelitic rocks of the Mansar Formation. The ore bodies are intensely deformed, lens-shaped, and likely intricately folded along with the host rocks.

7.7.3 **Non-Diastrophic Structure:** Bedding (S0) is the primary sedimentary structure observed in manganese mineralization, marked by compositional variation, and trending WNW-ESE to E-W with a southerly dip.

7.7.4 **Diastrophic Structures:** Foliation and schistosity are observed within quartz-muscovite-biotite schist. Schistosity is defined by the parallel arrangement of quartz and muscovite with biotite. Foliation (S1) strikes WNW-ESE and dips towards the either north or south, ranging from 42° to 52°.

7.7.5 **Folding Phases:** The rocks in the area have undergone at least three phases of folding (S.S. Sahasrabuddhey et al., 1993-96). The first phase (F1) features tight isoclinal folds with axes plunging between 21° and 30° towards the west. These have been coaxially folded (F2) along an east-west (E-W) direction with fold axes plunging between 15° and 23°. The third phase of folding (F3) introduced cross-folds trending north-south (N-S) and plunging at approximately 50° towards the south. This has resulted in earlier folds plunging in two directions. In the Nagardhan area, a broad anticlinal fold with an easterly plunge has been inferred, characterized by the thickening and thinning of manganese horizons at the swelled-up crests and troughs, with pinched-out limbs of the plunging folds. The overturned nature of the folds is also indicated by the study of core angles in the drilling data.

7.8.0 MINERALISATION

7.8.1 The Sausar Group is well known for its manganese ore deposits, primarily within the Mansar Formation, which hosts syngenetic strata-bound mineralization. This mineralization is found in two separate bands, with the northern band separated by 12 meters of quartz-muscovite schist. These bands occur in the central area of the block and trend in a west-northwest to east-west direction..

7.8.2 **Ore Minerals and Textures**: In the manganese band, oxide ore minerals, notably pyrolusite and psilomelane, predominantly exhibit granoblastic to granulitic textures. The ore is commonly characterized by structures such as gravity filling, stalactitic, botryoidal, boxwork, and colloform. Manganese ore bodies occur as bands, lenses, pockets, and disseminations within the quartz-mica schist. The ore generally presents a steel grey to dull grey color and possesses a soft, powdery texture. Pyrolusite, psilomelane, and cryptomelane display mutual replacement textures.

7.8.3 **Manganese Mineralization:** Based on surface mapping, it is inferred that the manganese mineralization, along with the associated gondite, occurs as two discontinuous bands. These bands trend from WNW-ESE to E-W which is parallel to the host lithounit which consists of quartz-mica schist, the bands are separated by a layer of the host lithounit, approximately 12 to 15 meters thick. The presence of manganese minerals associated with gondite serves as a marker for manganese mineralization on the ground. In the report, this is referred to as manganese mineralization or manganese bands/lenses. When the mineralization is analyzed with a cut-off grade exceeding 10% Mn, it is designated as manganese ore bands or ore lenses.

7.8.4 **Band Characteristics:** The northern band (Band I) has a strike length of 264 meters and a width ranging from 1 to 2 meters, whereas the southern band (Band II) has a strike length of 368 meters and a width ranging from 4.75 to 5.20 meters. Both bands trend WNW-ESE. Band I dips towards the north, while Band II dips towards the south.

7.8.5 **Hypothesis on Manganese Bands:** It is hypothesized that the two manganese bands are limbs of the same folded manganese band, where the crest of the fold has been eroded. The manganese ore is composed of inter-banded manganese ore minerals or layers of gondite. The primary minerals include braunite, pyrolusite, and hausmannite, with minor amounts of magnetite/jacobsite.

7.8.6 **Continuity and Nature of Bands:** The northern band, Band I, is consistent along its strike length, while the southern band, Band II, is hidden beneath the soil. The southern ore band is visible in old, abandoned mining pits in the central part of the block. The northern ore band was intersected in just one of the three boreholes drilled, suggesting that the band is not continuous at depth, possibly due to intense folding in the area. Interestingly, the northern band is silicified and gonditic on the surface. On the other hand, the southern band is more fragile compared to Band I. Additionally, it has been observed that the bands are continuous along the strike on the surface, as indicated by the presence of outcrops and manganese floats.

CHAPTER 8

PREVIOUS WORK

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

8.1.1 The Sausar Group of rocks was first studied by Jenkins and Voysey in 1833. In 1909, Fermor was the first to use the term Sausar Series for the succession of rocks exposed in Sausar tahsil of Chhindwara district, Madhya Pradesh, after systematic mapping of the Central India province.

8.1.2 Fermor (1909) was the first to describe in detail the deposits in the entire manganese belt in his memoir, "The manganese ore deposits of India."

8.1.3 Subsequent studies by Fermor (1909), Dunn (1936), Basu (1964), Deshpande (1960), Roy (1961, 66, 68), Dasgupta et al. (1984), Pal and Bhowmik (1995), and others have discussed the mineralogical and paragenetic aspects of manganese ore and Gondite (a rock composed of quartz, spessartite garnet, and rhodonite with minor amounts of manganese amphibole).

8.1.4 MOIL carried out exploration for manganese ores, with notable work by Suryanarayana and Bhoskar in the 1970s. The most recent studies were done by Sahasrabuddhay and Nayak, and Reddy and Thorat in 1995.

8.1.5 GSI conducted investigations for the exploration and assessment of Mn ores, including those of ferromanganese grade, during F.S. 1993-94 in the Parsoda-Nagardhan-Chokhala area, Nagpur district, Maharashtra (F.S. 1994-95). The study covered 110 sq. km of geological mapping (1:12,500), 2.3 sq. km of detailed mapping (1:2000), 182 cu. m. of pitting/trenching, and sampling (including stream sediment samples, bedrock, core samples, and petrological samples), and 70.00 LKM of ground geophysical surveys (magnetic and gravity).

8.1.6 During F.S. 1996-98, the GSI conducted an investigation for manganese ores in the Parsoda area (Northern extension), Ramtek Tasil, Nagpur district, Maharashtra, drilling a total of 1453.35 meters in nine boreholes and reporting 0.183 million tonnes of reserves with an average grade of 38.39% to 45% Mn.

8.1.7 M/s Excel Mining Incorporation in 2011-13 was given PL by State Govt. of Maharashtra to conduct prospecting over an area of 8.14 Ha, involving 7 pits and 6 vertical boreholes. Manganese mineralization was found in 4 (BH-1, BH-2, BH-3, and BH-4) out of 7 vertical boreholes drilled in the block, reporting 50,800 tonnes of manganese ore with an average grade of 26.00% to 38.00% Mn

CHAPTER 9

GEOPHYSICAL SURVEY & GEOCHEMICAL SURVEY

9.1.0 GEOPHYSICAL SURVEY

9.1.1 Geophysical investigations to find manganese ore in the Bhandarbodi area of Ramtek Tehsil were conducted by Shri K. Sathyamurthy, Shri T. Mohana Rao, and Shri T. S. Ramachandran in 1972-73. The following year, 1973-74, Shri B. R. Dash, Shri Lakshmi Singh, and Shri S. K. Ghatak conducted similar investigations in the Mansar-Ramtek-Nagardhan-Satak area. A geophysical survey in the Bhandarbhori-Hiura block found no anomaly zones. However, another survey by Shri R. C. Pathak and K. J. Rao in 1994-95 in the Nagardhan-Lohadongri area of Ramtek Tehsil discovered two significant anomaly zones running almost parallel. Magnetic anomalies in these zones ranged up to 1500 gamma. Among these, the southern zone, which is 200 meters wide, is consistent and sharply defined, and it appears to coincide with the manganese-bearing Mansar Formations.

9.2.0 GEOCHEMICAL SURVEY

9.2.1 Geochemical survey has not been carried out in the block by MECL. However, Mrs. Rini Sasidharan et. al. in (2010-11) from GSI conducted Geochemical Mapping in Toposheet No. 55O/7 & 11 in parts of Nagpur & Bhandara Districts, Maharashtra.

CHAPTER 10

EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

10.1.0 GENERAL INFORMATION

10.1.1 The first utilization of manganese can be dated back to the Stone Age. Men were already using manganese dioxide as a pigment for their cave paintings during the upper paleolithic period 17,000 years ago. Later in Ancient Greece, the presence of manganese in the iron ore used by the Spartans is a likely explanation as to why their steel weapons were superior to those of their enemies. Manganese has also long been used in glass-making. Egyptian and Roman glassmakers used manganese compounds to either add color to glass or remove color from it. The use as "glassmakers' soap" continued through the Middle Ages until modern times and is evident in 14th-century glass from Venice.

10.1.2 In the middle of 17th century, the German chemist Glauber obtained permanganate, the first usable manganese salt. By the mid-18th century, the Swedish chemist Carl Wilhelm Scheele used manganese dioxide to produce chlorine. It was not until 1771 that manganese was recognized as an element by Scheele. Johan Gottlieb was the first to isolate an impure sample of manganese metal in 1774, by reducing the dioxide with carbon. At the beginning of the 19th century, both British and French scientists started to consider the use of manganese in steelmaking, a German researcher noticed that manganese increased the hardness of iron, without reducing its malleability or toughness. In 1826, Prieger in Germany produced a ferromanganese containing 80% manganese in a crucible. J.M. Heath produced metallic manganese in England in 1840. The major breakthrough in the use of manganese occurred in 1860. At that time, Sir Henry Bessemer was trying to develop the steelmaking process 1 this procedure made the Bessemer process possible, and thus paved the way for the modern steel industry.

10.1.3 The demand for manganese dioxide increased because of the invention of the Leclanché cell in 1866 and the subsequent improvement of batteries containing manganese dioxide as a cathodic depolarizer. Manganese metal was first produced by an aluminothermic process in 1898. The development of electrolytic manganese began on a pilot scale in 1940 and the first commercial sized plant was built fourteen years later in the USA.At present, nearly 90% of all of the manganese produced each

year is used in the production of steel, and the rest is mainly used in the production of batteries and chemicals.

10.2.0 INDIA'S DEMAND

10.2.1 The total world reserve of manganese ore is approximately 570 million tonnes which is unevenly distributed. Reserves are located in South Africa (26%), Ukraine (25%), Australia (17%), Brazil and India(9%). The deep-sea manganese nodules, which constitute an enormous untapped resource, are found in areas of deep-sea floor at water depths of 5 to 7 km. The Pacific Ocean alone is estimated to contain about 2.5 billion tonnes nodules containing about 25% Mn (IBM 2015)

10.2.2 In India the Manganese Ore deposits mainly occur as metamorphosed bedded sedimentary deposits associated with Gondite Series of Madhya Pradesh(Balaghat, Chhindwara&Jhabua districts), Maharashtra (Bhandara&Nagpur districts), Gujarat (Panchmahal district), Odisha (Sundargarh district) and Kodurite Series (Archaeans) of Odisha (Ganjam&Koraput districts) and Andhra Pradesh (Srikakulam& Vishakhapatnam districts).

10.2.3 The total reserves/resources of manganese ore in the country as on 1.04.2020 has been placed at 503.62 million tonnes as per NMI database, based on UNFC system (Mineral Year Book-2021). Out of these, 75.04 million tonnes are categorised as Reserves and the balance 428.58 million tonnes are in the Remaining Resources category. Gradewise, Ferromanganese grade accounts for 8%, Medium grade 6%, BF grade 29% and the remaining 57% are of Mixed, Low, Others, Unclassified, and Not-known grades including 0.16 million tonnes of Battery/Chemical grade (Mineral Year Book-2021).

10.2.4 Statewise, Odisha tops the total reserves/ resources with 34% share followed by Karnataka (24%), Madhya Pradesh (12%), Maharashtra (12%) & Goa (7%) , Andhra Pradesh (6%) and Jharkhand (3%). Rajasthan, Gujarat, Telangana and West Bengal together shared the remaining 2% resources.

10.2.5 The Govt. of India enacted the MMDR Amendment Act, 2015 duly introducing the system of auction for allocation of Mineral Concessions. Manganese has been categorized in the Fourth Schedule which needs prospecting and exploration by the State Govt. before auctioning of blocks. Thus in order to sustain the current level of production of Manganese ores and to meet the future demands, the exploration of manganese ore is the need of the hour.

10.3.0 BACKGROUND

10.3.1 The Directorate of Geology and Mining (DGM), Government of Maharashtra, Nagpur requested to MECL to take up the exploration in lapsed 10(A) 2(B) mining lease areas vide letter no. Tech/1848/2023/3938, dated 22/12/2023. The Nagardhan Manganese block is lapsed lease area by State Government of Maharashtra, which was granted as per section 10(A) 2(B) of the MMDR Act-15. The block was granted to M/s. Excel Mining Incorporation during 04/02/2011 to 03/02/2013 for 2 years.

10.3.2 MECL has conducted field visit in the proposed block. During geological traverses, favourable host rocks viz. muscovite schist and abandoned mining pit were located. MECL collected 8 nos of grab samples of gondite with manganese ore, which were analyzed in MECL's chemical laboratory.The sample analysis ranges from 14.55% to 23.78% Mn.

10.3.3 Based on the findings and consent from Directorate of Geology and Mining (DGM), Government of Maharashtra. MECL has proposed preliminary exploration (G-3) exploration in Nagardhan Block, Nagpur, Maharashtra comprising geological mapping (1:4,000 scale), trench sampling and drilling and submitted in the 62nd meeting of Technical-Cum-Cost Committee (TCC) of NMET held on 28th & 29th Feburary 2024.

10.3.4 In the 34th Meeting of EC of NMET held on 13th March 2024, approved the proposal with an estimated exploration cost of Rs. 130.66 Lakh's and intimated MECL vide Office Memorandum F. No 23/440/2024-NMET/595 dated 12th March, 2024 (Annexure-X).

10.4.0 OBJECTIVES OF PROPOSED EXPLORATION

10.4.1 Based on the evaluation of available geological data, the present exploration program has been formulated to fulfil the following objectives:

(1) To carry out Geological & Structural mapping on 1:4000 scale for identification of manganese bearing formation (host rock) with the structural features to identify the surface manifestation and lateral disposition of the mineralized zones.

(2) To prepare the detailed surface map of the area by means of surface contouring at 2m interval in 1:4000 scale.

(3) To establish three dimensional dispositions of the earlier reported mineralised zones of Manganese by means of trenching and drilling.

(4) To assess the quality and quantity of the resources (333) as per UNFC norms & Minerals (Evidence of Mineral Contents) Rules- 2021.

10.5.0 BASIS FOR TAKING UP INVESTIGATION

10.5.1 The Nagardhan Manganese block is lapsed lease area by State Government of Maharashtra, which was granted as per section 10(A) 2(B) of the MMDR Act-15. The block was granted to M/s. Excel Mining Incorporation during 04/02/2011to 03/02/2013 for 2 years.

10.5.2 The Directorate of Geology and Mining (DGM), Government of Maharashtra, Nagpur requested MECL to take up the exploration in lapsed 10(A) 2(B) mining lease areas vide letter no. Tech/1848/2023/3938, dated 22/12/2023.

10.5.3 M/s. Excel Mining Incorporation has carried out the prospecting in the area involving 7 pits and 6 vertical boreholes. Three (3) out of 7 no. of pits intersected manganese boulders and remaining 4 were barren in respect of manganese. The manganese mineralisation intersected in 4 (BH-1, BH-2, BH-3 & BH-4) out of 6 vertical boreholes drilled in the block. However the analytical data for pits as well as boreholes are not available.

10.5.4 MECL studied the data provided by the DGM, Maharashtra and carried out the field visit in and around the Nagardhan area. The geologist team studied the area and observed the surface indication of the manganese mineralisation in the paddy field and a shallow pit within the block area.

10.5.5 MECL collected 8 nos of grab samples of gondite with manganese ore, which were analyzed in MECL's chemical laboratory.

10.6.0 PRESENT EXPLORATION WORK

10.6.1 To achieve the objectives as enumerated in para 10.4.0, MECL has carried out Detailed geological mapping on 1:4,000 scale over total Nagardhan block area of 2.00 sq.km and conducted topographical survey of the area by means of surface contouring at 2m interval in 1:4000 scale, drilling of 180 m in 3 Boreholes is also executed. A total of 45 nos of Trench/channel samples and 36 nos. of primary borehole samples have been collected and analysed for Mn, SiO_2, P_2O_5, Fe_2O_3, MnO_2 and Acid Insolubles by WD-XRF method and Classical method. Total of 5 nos of borehole samples have been subjected to petrographic studies, 2 nos for minerographic studies and 2 for Specific gravity studies.

10.6.2 Exploration work had been commenced on 02nd May, 2024 and the field work has been completed with collection of bed rock and channel samples on 21st January, 2025. The allied field-works including sampling were completed simultaneously. The analytical/laboratory studies were carried out simultaneously in laboratories of MECL and other Government /NABL accredited laboratories.

10.6.3 The details of the nature and quantum of work approved vs. actual achievement are given in the Table-10.2

Table – 10.1
Approved Quantum of Work Vs Actual Achievement by MECL

Sl. No.	Item of Work	Unit	Target	Target Achieved
1	Geological Mapping (on 1:4,000 Scale)	Sq km	2.00	2.00
2	Topographical Survey (Surface features/Trench/Pit/Borehole* locations etc)	Sq km	2.00	2.00
3	Exploratory Mining (Trench/pit)			
	a) Excavation (Trenching) (1m*2m*10m)	Cu. m	140	127
4	Trench/pit Sampling			
	a) Primary Sampling	Nos	50	45
	b) Check Samples (10% External check)	Nos	5	5
5	Drilling (coring)*			
	a) Drilling	m	500	180
6	Drill Core Sampling*			
	a) Drill Core (Primary) Samples	Nos	80	36
	b) Drill Core (10% External check) Samples	Nos	8	0
7	Petrological Samples (Surface & BH Core Samples)			
	a) Preparation of Thin Section	Nos	10	5
	b) Study of Thin Section	Nos	10	5
8	Minerography Samples (Surface & BH Core Samples)	Nos		
	a) Preparation of Thin Section	Nos	10	2
	b) Study of Thin Section	Nos	10	2
9	Drill Core Preservation	Nos	150	60
10	Specific Gravity Studies	Nos	5	2
11	Report Preparation (5 Hard copies with a soft copy)	Nos.	1	1
12	Preparation of Exploration Proposal (5 Hard copies with a soft copy)	Nos.	1	1

10.6.4 The drilling achieved is only 180 meters against the target of 500 meters. This shortfall was attributed to the limited exposure of manganese ore zones in the outcrops, and mineralization at depth was encountered in just one borehole within the block.

10.7.0 TOPOGRAPHIC SURVEY

10.7.1 Topographical survey was conducted in the entire Nagardhan block area of 2.00 Sq. Km. Survey activities were carried out for block boundary co-ordinates, the surface features, contour points were surveyed by DGPS. Boreholes were fixed on the ground with the help of base and triangulation stations and the same had been surveyed again after drilling for the final location by DGPS instrument. Co-ordinate and RL details of the drilled boreholes have been provided in the Annexure-IB.

10.8.0 DETAILED GEOLOGICAL MAPPING:

10.8.1 Geological mapping was carried out at a 1:4,000 scale over an area of 2.00 square kilometers, depicting lithology, structure, and surface mineralization signatures. Broad lithological units and litho-contacts were mapped using handheld GPS devices. The attitude and structural features of rocks, such as bedding, folds, and joints, were recorded with a Brunton Compass. The general strike of the lithological units is ENE-WSW with a dip of 32-52° towards the north & south.

10.8.2 The Nagardhan block has moderate topography, The geological map was created by plotting different lithological units (soil, Quartz muscovite schist, manganese float ore, and manganese ore body) and structural features (strike and dip of foliations). Available regional map of the area by GSI have been updated and incorporated.An interpreted geological map was then prepared by integrating surface and subsurface data, including various lithologies found at the surface and intersected in trenches & boreholes is presented as Plate IV. A combined topographical and outcrop map, along with the interpreted geological map of the block, was produced at a 1:4,000 scale and presented as Plate III.

10.9.0 GEOCHEMICAL TRENCHING/CHANNEL SAMPLING

10.9.1 In the course of exploration for manganese mineralized zones, manganese mineralisation is observed in abandoned manganese pits and float of manganese ore minerals at centre part of the block, as the topography is gentle and thick layer of soil/alluvium is present in the area five trenches were excavated to exposed fresh rock and remove the weathered surface layer.

10.9.2 Provision for 140 cubic meters of trenching was approved, MECL excavated only 127 cubic meters to achieve a logical conclusion of the exploration. The trench has a total length of 55 meters, with a width of 1 meter and a depth of 2 meter to 2.5 meter.. Detailed geological mapping has been conducted along both walls of the trenches. The precise locations of the trenches are delineated in Plate – III of the Block Outcrop Map and the trench map is given as text fig-6

10.9.3 From these trenches, a total of 43 samples were collected from the manganese mineralised zone, footwall and hanging wall. These samples were collected from channels along the wall systematically carved within the lithological exposures. Sampling intervals ranged from 0.75 to 1 meter depending on the changes in the geological formation and manganese mineralization. 2 samples were collected from abandoned mining pit outside the block in the western extension to know the manganese mineraliation continuity

10.9.4 To ensure representative sampling, the collected chips from the channels underwent a staged grinding process, resulting in powdered samples of (-) 200 mesh size. This meticulous grinding process, coupled with repeated coning and quartering techniques, enabled the reduction of sample weight while preserving the integrity of the composition. Subsequently, a final finished sample weighing 500 grams was meticulously prepared. One portion of each sample was despatched to the chemical laboratory for comprehensive analysis, while the duplicate portion was securely preserved for quality control purposes.

10.9.5 The 45 collected samples were analysed utilizing the WD-XRF method and classic method to determine the concentrations of Mn, SiO_2, P_2O_5, Fe_2O_3, MnO_2 and Acid Insolubles. Detailed information regarding the location of each sample and their respective analytical results can be found in Annexure-III A for reference.

Table-10.2
Details of Trench excavated by MECL in Nagardhan Block, District: Nagpur, Maharashtra

Sl. No.	Trench No.	Location (UTM)		Azimuth of Trench towards	Dimension (L X B X H)	Remarks
		Northing	Easting			
1	Trench 1	2359252.80	326301.33	N22°E	19m X 1m X 2.5m	SSW side of Nandapuri village
2	Trench 2	2359228.54	326342.16	N22°E	7m X 1m X 1m	
3	Trench 3	2359205.01	326225.02	N21°E	15m X 1m X 2.5m	
4	Trench 4	2359293.38	326110.17	N20°E	11m X 1m X 2.5m	
5	Trench 5	2359302.69	326147.13	N22°E	7m X 1m X 1m	Deepening/re-excavated the abandoned pit of private company explorer.

Photo 6. Southwardly dipping managanese band in Trench 4

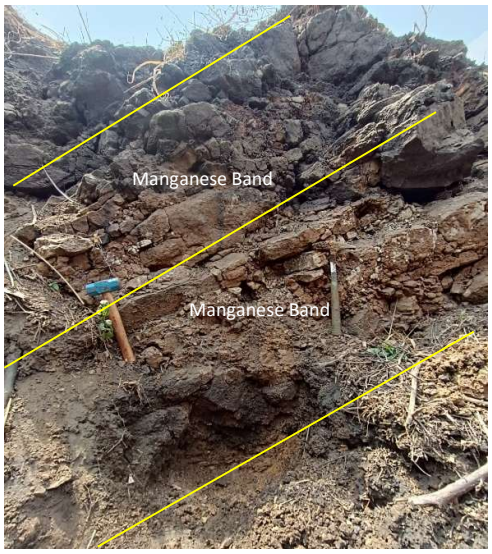
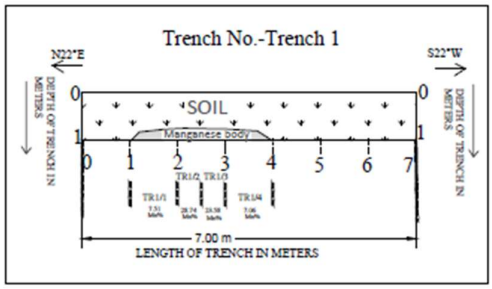
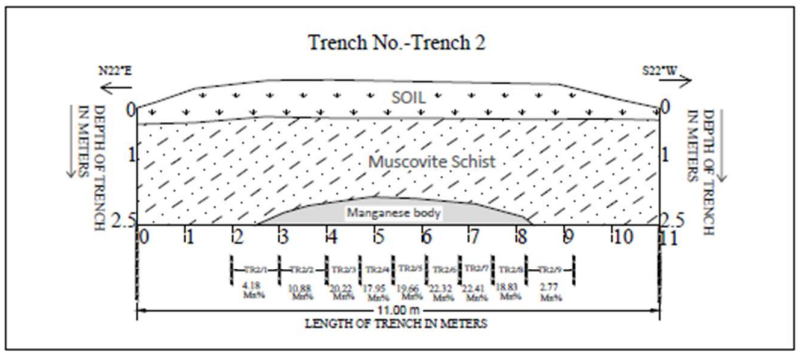
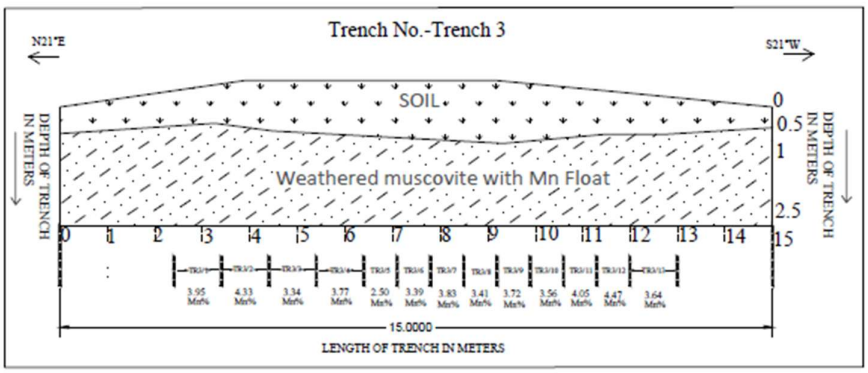
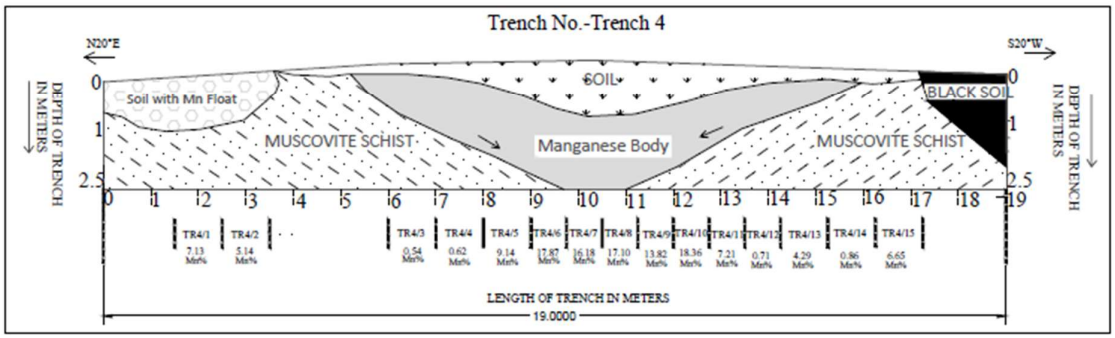


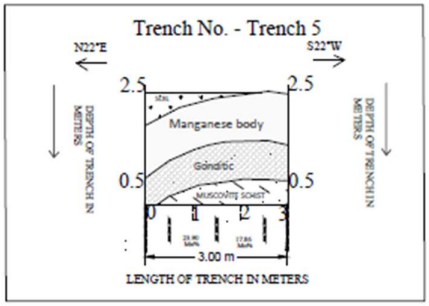
Photo 7. Northerly dipping managanese band in Trench 5


Trench No.-Trench 1
N22°E
S22°W
SOIL
Manganese body
DEPTH OF TRENCH IN METERS
7.00 m
LENGTH OF TRENCH IN METERS


Trench No.-Trench 2
N22°E
S22°W
SOIL
Muscovite Schist
Manganese body
DEPTH OF TRENCH IN METERS
11.00 m
LENGTH OF TRENCH IN METERS


Trench No.-Trench 3
N21°E
S21°W
SOIL
Weathered muscovite with Mn Float
DEPTH OF TRENCH IN METERS
15.0000
LENGTH OF TRENCH IN METERS


Trench No.-Trench 4
N20°E
S20°W
SOIL
Soil with Mn Float
MUSCOVITE SCHIST
Manganese Body
BLACK SOIL
MUSCOVITE SCHIST
DEPTH OF TRENCH IN METERS
LENGTH OF TRENCH IN METERS
19.0000


Trench No. - Trench 5
N22°E
S22°W
Manganese body
Gondrite
DEPTH OF TRENCH IN METERS
3.00 m
LENGTH OF TRENCH IN METERS

Text Fig. - 6

10.10.0 EXPLORATORY DRILLING –

10.10.1 To verify the strike and depth continuity of manganese mineralization, 3 inclined core boreholes have been drilled with a total of 180 m of meterage targeting the mineralized zones delineated by geological mapping & trench sampling. The boreholes reach depths of 60 meters with tentative intersection of manganese mineralisation at 35m vertical depth. Azimuth of the boreholes are different based on the disposition of the mineralized zones. Inclination of the boreholes were kept varying from 45^{O} to 60^{O}. Detailed information about the drilled boreholes is provided in Annexure-IA

10.11.0 CORE LOGGING & PRIMARY BOREHOLE SAMPLING

10.11.1 The core/ powdery materials recovered from the boreholes by dry as well as wet drilling were logged systematically to demarcate various litho-units. The logging of run wise cores and the powdery materials as well as the cuttings from boreholes have helped in discerning the physical characters like colour, shape, size and nature of Mn mineralisation as well as texture, structural features such as joints, fractures, foliations etc. & their attitude with respect to core axis and identification of different litho units. Besides, the qualitative analytical data have helped in delineating the ore and non-ore litho units. Detailed litho logs of the boreholes has been provided as Annexure-IIIA.

10.11.2 The manganese mineralised zones intersected in the boreholes drilled by MECL were identified based on the various physical properties of different manganese ore minerals. Samples from these visually delineated mineralised zones in the drill cores were then subjected to chemical analysis. A total of 36 no of primary samples have been analysed in Chemical Laboratory of MECL for determining six radicals i.e., Mn, SiO2, P2O5, Fe2O3, MnO2 and Acid Insolubles.

10.12.0 PETROGRAPHIC STUDIES

10.12.1 A total 5 nos. of Borehole samples were collected from various litho-units representing the study area, were sent to MECL Petrological laboratory for petrological studies. The details of the petrographic study are given as Annexure - VII.

10.13.0 MINEROGRAPHIC STUDIES

10.13.1 The 2 number of trench & borehole samples collected have been subjected to the minerographic analysis to check the rock types, their variation in chemical composition. The details of the minerographic studies are given as Annexure – VIII.

10.14.0 SPECIFIC GRAVITY STUDIES

10.14.1 The 2 numbers of trench samples collected have been subjected to specific gravity analysis. The average specific gravity of 3.10 is considered for resource calculation. The details of the Specific Gravity studies are given as Annexure - IX.

10.15.0 Discussion On Results of Mapping & Trench/Borehole Samples

10.15.1 Based on the mapping and presence of manganese mineralisation outcrops and floats five trenches were made amounting to 127 Cu. M of excavation and on the basis manganese mineralisation intersection in the trenches 3 boreholes have been drilled with total of 180 m of drilling.

10.15.2 A total of 81 trench & borehole samples have been collected from mineralized zones to establish Mn occurences and are analysed by WD-XRF and Classical method for the Six radicals in the block. Details are given in Annexure – IV & Annexure – V respectively

10.15.3 The analysis of 45 samples collected from the 5 trenches, the manganese mineralised zone having approx. 350 m strike and width of around 1 m to 5.2 m wide zone within the blocks central sector shows, the assay values for Manganese (Mn) exhibiting a notable range, with the maximum recorded value of 28.82% and the minimum value reported at 0.54%. with 19 out of the 45 samples of outcrop/trench having Mn concentrations more than 10% Mn. The analytical ranges (Max-Min) of five radicals (Mn, MnO_2, P_2O_5, Fe_2O_3, SiO_2) have been given in Table-10.4

Table-10.3

Ranges (Max-Min) of 45 nos. trench samples values, Nagardhan Block, District-Nagpur, Maharashtra

Sr.No.	Elements	Units	Maximum Value	Minimum Value
1	**Mn**	%	28.82	0.54
2	**MnO_2**		14.83	0.02
3	**P_2O_5**		0.71	0.03
4	**Fe_2O_3**		24.93	9.39
5	**SiO_2**		58.65	24.20

10.15.4 Based on the trench sample analysis and the trench mapping two manganese mineralised zones are identified. The two bands identified are trending WNW-ESE to E-W, the Northern one is dipping towards north by an amount of 42^O having maximum width of 2m and southern one is dipping south by an amount of approx. 30^O as in trenches having maximum width of 5.20 m with a localised synform along Band II.

10.15.5 Based on the findings, the northern one was targeted and 3 boreholes were drillied amounting a total of 180 m on three section lines over a strike length of 500 m. Analysis of 36 samples collected from the two boreholes MNB-01 & MNB-03 from the section line S1 & S2 had only one 1m zone for manganese mineralisation having Mn analysis of 10% Mn.

Table-10.4: Details of Manganiferous mineralization Bands

Mn Band	Dimension (length x width)	Location	Analytical Results	Remarks
Band I	264 m x 1 to 2 m	600 m SSW of Nandapuri village	MNB/TR1/01-04 – 1.00m X 26.57% Mn	
			MNB/TR5/01-02 – 2.00m X 20.88% Mn	
Band II	368 m x 4.75 to 5.20 m	600 m SSW of Nandapuri village	MNB/TR2/01-09 – 5.20m X 18.43% Mn	
			MNB/TR5/01-02 – 4.75m X 15.08% Mn	

CHAPTER 11

LOCATION OF DATA POINTS

11.1.0 ACCURACY AND QUALITY OF SURVEY

11.1.1 The entire survey work has been carried out with the help of DGPS (Make-Trimble GNSS System, Model-R8s). With the help of DGPS, cor-ordinates of surface features i.e., roads, village boundaries, water bodies, base station and co-ordinates of 28 nos. of block boundary cardinal points with R.L. has been determined (Annexure IA and IB) and accordingly the topographical map is presented (Plate-III). Contour interval in topographical map is taken as 2 m. The topographic survey was done in PPK (Post Precision Kinematics) mode. Positional (horizontal) accuracy of the survey is 3 mm while the elevation accuracy is 3.5 mm in PPK mode.

TECHNICAL SPECIFICATION OF DGPS	
MAKE	TRIMBLE
DGPS MODEL	R8-S
YEAR	2018

11.1.2 The survey of boreholes drilled in the block has also been carried out by the DGPS (Make-Trimble GNSS System, Model-R8s) (Annexure IC). The base station has been utilised for the fixing of the boreholes position on the ground as well as for reduced levels of the boreholes. The coordinate of base station is given in Table-11.1.

Table No. 11.1

Co-ordinates of the base station for DGPS survey of Nagardhan (G3) block Nagpur District, Maharashtra.

Sl. No.	Point Name	UTM (m)		RL (m)
		Northing	Easting	
1	BASE - ND	2359055.088	326375.735	297.030

11.2.0 QUALITY AND ADEQUACY OF TOPOGRAPHIC CONTROL

11.2.1 Block boundary co-ordinates, the surface features, contour points were surveyed by DGPS). The topographic survey was done in PPK (Post Precision Kinematics) mode. Positional (horizontal) accuracy of the survey is 10mm while the elevation accuracy is 20mm in PPK mode. The detailed topographical map of Nagardhan Block has been prepared on 1:4,000 scale

CHAPTER 12
SAMPLING TECHNIQUE

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

12.1.1 The manganese mineralization has been intersected in 4 trenches excavated and MNB-01 borehole drilled in the block. However, sampling have been carried out for entire mineralized zones/length intersected in the trenches and boreholes. The primary sample had been marked in the mineralized zones intersected in the trench and borehole based on type and concentration of mineralization/lithology and in general the sample length has been kept as 0.70 m to 1.00 m because of variation in mineralized zone. Trench samples were collected from potential zone where it is observed

12.1.2 The borehole core has been split into two equal halves in such a way that the concentration of ore minerals is uniform in both the equal halves. One half of the core sample has been powdered with the help with the help of crusher and pulverizer (Photograph-14 and 15) in the camp sieved with -200 mesh for manganese analysis through brass wire sieve and 600 gm sample was collected by progressive coning and quartering and repeated mixing. A representative 100 gm sample has been collected and analyzed for 6 radicals (Mn, SiO_2, P_2O_5, Fe_2O_3, MnO_2 and Acid Insolubles) at Chemical Laboratory, Nagpur and remaining sample has been preserved for preparation of check (internal and external) samples, composite samples etc. Other half of the core arranged in the G.I. core boxes with all relevant details and preserved for future reference.

CHAPTER 13

DRILLING TECHNIQUES AND DRILL SAMPLING EMPLOYED

13.1.0 DRILLING TYPES AND DETAILS

13.1.1 MECL planned to drill three boreholes targeting Level 1 manganese mineralization in depth. These boreholes aim to intersect the surface manganese mineralization outcrop at a vertical depth of 30 meters. MECL executed the drilling of three boreholes, accumulating a total meterage of 180.00 meters, along with other related geological analytical activities in the Nagardhan block. Detailed information about the boreholes can be found in Annexure-IB. The drilling operations were conducted using a skid-mounted RD 60 (MEC 352) rig. All boreholes were drilled in NQ size utilizing a single barrel wireline wet core drilling method. Initially, HW casing was set from 0.00m to 6.00m even upto 10 m in each borehole using HW casing short pieces. Post setting the HW casing, the drilling progressed in NQ size up to 60m, employing NQ Diamond bits (Hyden, Sandvik) until the borehole was closed. The drilling quality was meticulously ensured throughout the operation. Upon completion, all boreholes were properly plugged and sealed with cement pillars.

13.2.0 DEVIATION SURVEY IN DRILLING

13.2.1 All the inclined boreholes drilled by MECL in the block have been surveyed to ascertain deviation in azimuth and in the borehole path, if any, with the help of multi shot deviation camera. The specifications of the deviation survey instrument are given as under:

Table 13.1: The specifications of the Deviation Survey Instrument

Manufacturing Company		devico
Model Name		PeeWee
Technical Specification		
1	Weight	5.2 kg/11.5 lbs
2	Diameter	30 mm/1.18”
3	Length	1400 mm/55.12”
4	Magnetic	Yes
5	Running gear	Integrated
6	Inclination accuracy	±0.1º
7	Azimuth accuracy	±0.5º
8	Tool face accuracy	±0.2º

13.2.2 After assembling the deviation survey instrument, it is securely tied with a steel rope at the top of the instrument and lowered into the borehole. This is done so that the top of the instrument coincides precisely with the ground level. To obtain accurate readings, the instrument is further lowered by an additional 3.00 meters and kept stationary while recording the reading. This systematic recording procedure is repeated at regular depth intervals throughout the entire depth of the borehole until the closure depth point is reached. Following the final reading taken at the bottom of the borehole, the instrument is carefully retrieved to the top. It is then connected to a mobile monitor for the purpose of downloading the deviation data. Due to the influence of magnetism from the casing lowered in the borehole, the initial readings are generally erratic and, therefore, not considered for deviation data plotting. The obtained borehole deviation data is subsequently plotted on the cross-section using GDM software. The comprehensive deviation data for each borehole is presented in Annexure II.

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

13.3.1 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 core as well as the cuttings from boreholes have helped in discerning the physical characters like colour, shape, size and nature of the mineralisation as well as texture, structural features and identification of different litho units.

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

13.4.1 The entire core drilling operation was conducted using an NQ size diamond drill bit with a single barrel wireline, utilizing the wet core drilling method. Initially, from 0.00m to 6.00m upto 10.00 m, HW casing was set in each borehole using HW casing shortpieces. After setting the HW casing, drilling proceeded in NQ size. NW casing was then set at depths ranging from 10m to 20m, depending on the borehole formation. A polymer was used as the drilling fluid to flush out cuttings and stabilize the borehole wall, as well as to act as a coolant to prevent the drill bits from burning.

Proper core recovery was generally maintained; however, in weathered, loose, and fractured zones and solution cavities, core recovery was low. In instances of low core recovery, the grade of the recovered portion was extrapolated over the non-recovered section. To maintain drilling quality, precautions such as modulated water pressure, appropriate liner, optimal head pressure, and the expertise of a skilled drilling technician were employed.

13.5.0 CORE LOGGING

13.5.1 The entire core recovered through drilling was meticulously logged, detailing the lithological units along with observable mineralization details via visual inspection. Key aspects such as lithology, grain size, color, texture, structural features, the presence of intercalations, and cavities were thoroughly recorded. In instances where recovery was less than 100%, extrapolations of drilled depth were conducted proportionately, based on the physical characteristics of the individual recovered units. All cores were properly preserved in GI core boxes, adhering to the specifications provided by NMET, following a 60-degree "Book pattern." Detailed run-wise lithologs and summarized lithologs for boreholes are presented in Annexure IIA and Annexure IIB, respectively.

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 During large scale mapping for bedrock, channel and trenching were carried out and the Sample preparation technique is mentioned below.

14.1.2 Primary Borehole samples:

(1) Samples weighing about 1.0 kg were collected, crushed and powdered by help of crusher and pulverizer and finally sieved with -200 mesh for manganese analysis and through brass wire sieve. By progressive coning and quartering and repeatedly mixing the sample has been reduced to 600 gm. The representative sample of 100g has been collected and analysed Mn, SiO2, P2O5, Fe2O3, MnO2 and Acid Insolubles at Chemical Laboratory of MECL, Nagpur.

14.1.3 Trench samples

(1) Samples weighing about 1.5 to 2 kg were collected, crushed and powdered with the help of crusher and pulverizer and finally sieved to -200 mesh fractions. The representative sample collected of 100g has been analysed Mn, SiO2, P2O5, Fe2O3, MnO2 and Acid Insolubles for manganese mineralization

Photo 8: Crusher

Photo 9 : Pulveriser

14.2.0 NATURE, QUALITY AND APPROPRIATENESS OF THE SAMPLE PREPARATION TECHNIQUE

14.2.1 The details of sampling procedure for primary samples are described in Para 14.1.0.

14.2.2 During the present exploration, a total of 81 nos. of primary trench/borehole samples, 45 nos of Trench samples and 36 nos. of primary borehole samples for manganese mineralisation were prepared. The primary samples have been analysed for Mn, SiO2, P2O5, Fe2O3, MnO2 and Acid at Chemical Laboratory of MECL, Nagpur. The details of analysis of primary bedrock/channel samples, Primary Trench samples and primary borehole samples are given in Annexure-IV and Annexure-V respectively.

14.3.0 QUALITY CONTROL PROCEDURES ADOPTED

14.3.1 The samples have been collected on the basis of visual identification & mineralized zones and are prepared at Project sampling unit. The standard sampling procedure in supervision of qualified sampling technician has been adopted to control the quality of samples. Similarly, internal check and external check samples have also been prepared under the supervision of qualified sampling technician following the standard sampling procedure.

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

14.4.1 The trenches are excavated based on geological mapping and assumptions for the possibility of finding potential manganese mineralization zone. The trench samples were collected from walls of the trench excavated over the potential manganiferous phyllite. The proper sample collection and following standard procedure for sample preparation shows the representative samples have been collected from the in-situ materials.

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

14.5.1 The primary samples have been prepared (–) 200 & (-) 100 mesh size and all the other samples have been prepared from primary samples. As per the previous studies in the area, (–) 200 mesh size is appropriate for the liberation of Manganese mineralisation size is appropriate for the liberation and their analysis in the block area.

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 primary trench & borehole samples for manganese mineralization has been analysed for Mn, SiO2, P2O5, Fe2O3, MnO2 and Acid Insolubles in Chemical Laboratory of MECL (a NABL accredited laboratory). The analysis for MnO_2, Acid Insolubles is carried out by Classical method and for radicals Mn, SiO2, P2O5, Fe2O3 analysis has been carried out by WD XRF method. The Standard Operating Procedure (SOP) using is given below.

(i) Sample Particle Size:

The Sample is ground to a particle size <75µm, but <50µm is ideal.

(ii) Sample preparation: Pellets preparation

The process of making pressed pellets for XRF analysis includes grinding the sample to fine particle size and pressing the sample at pressure of between 15 to 35 ton.

(iii)Instrumentation:

(1) X-ray irradiates the sample.

(2) Sample emits secondary X-ray characteristic of a particular element.

(3) Analyzing sample rotates to accurately diffract each wavelength and satisfy Bragg's Law.

(4) Detector measures position and intensity of XRF peaks.

The LOI has been analysed by classical method. The Standard Operating Procedure (SOP) for the Determination of Loss on Ignition (L.O.I.) is given below.

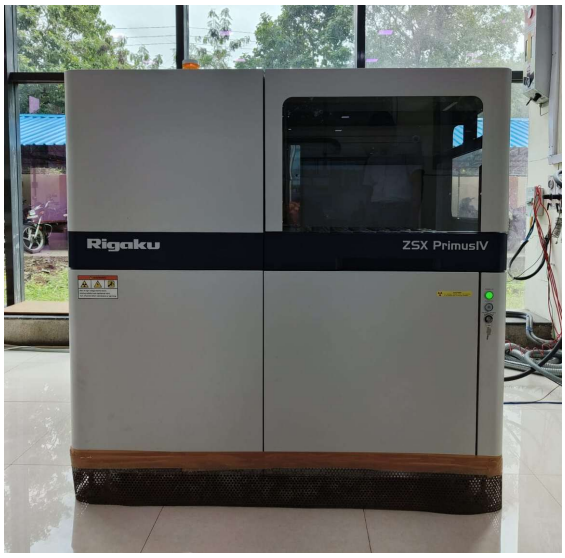


Photo 8 - Photograph showing WD-XRF instrument (Rigaku, Japan) at Chemical Lab, MECL, Nagpur

15.2.0 PROCEDURE OF ANALYSIS of 4 RADICALS

(1) Sample Preparation: Powdered samples were pelletized using a hydraulic press. The XRF instrument was calibrated using matrix-matching Certified Reference Materials (CRMs). After calibration, the samples were analyzed, and software provided the values for major oxides.

(2) Acid Insoluble's: Acid insoluble is determined by wet classical method.

(3) Remaining oxides and elements (Mn%, SiO2%, P2O5%, Fe2O3% and MnO2%) were determined by XRF.

(a) From the data obtained of few selected samples Calibrate the XRF equipment.

(b) Ensure the instrument is set up correctly according to standard guidelines

(c) Place the prepared pellet into the sample holder

(d) Ensure the sample cup is positioned correctly in the instrument for carrying out analysis

(e) Start the XRF analysis using software and initiate the analysis process automatically

(f) Allow the XRF instrument to scan the sample. It will emit X-rays onto the sample, causing the atoms to emit fluorescence

(g) Record the results in a report, including elemental concentrations and any relevant information about the analysis conditions

15.3.0 NATURE OF QUALITY CONTROL PROCEDURES ADOPTED

15.3.1 Typical Quality Control procedures adopted during the chemical analysis of major oxides included:

(1) Analysis of Certified reference materials/measurement standards

(2) Analysis of blind samples

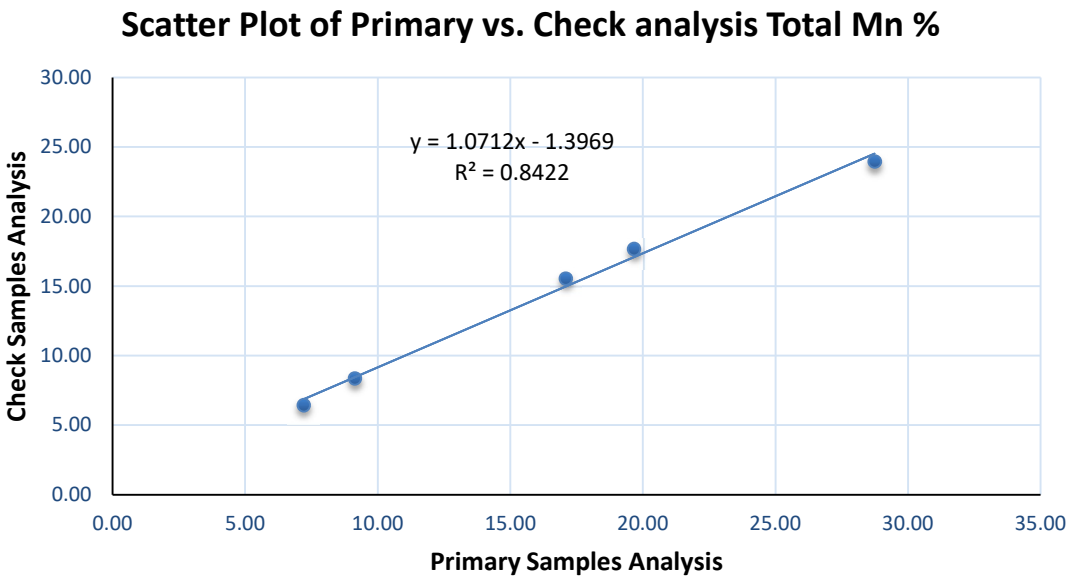
(3) Use of QC samples and control charts

(4) Analysis in duplicates & Internal Check standards.

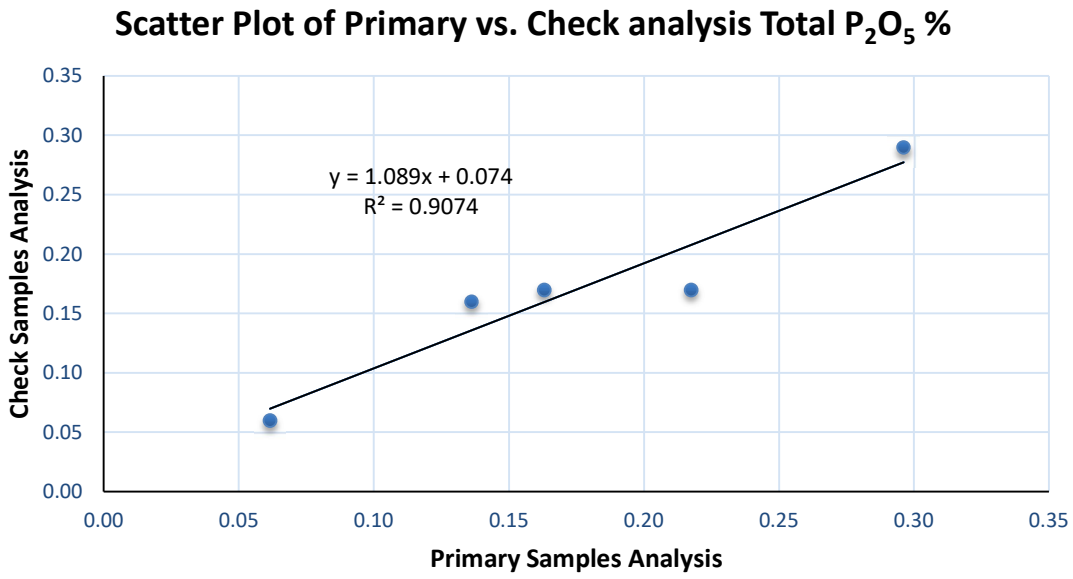
15.4.0 CHECK ANALYSIS

15.4.1 A total of 5 numbers of external check samples each for Mn, SiO2, P2O5, Fe2O3, MnO2 and Acid Insolubles have been analyzed. The results of External check samples for manganese mineralization are pending.

15.4.2 The third-party samples analyses were carried out at Jawaharlal Nehru Aluminium Research Development and Design Centre, (JNARDDC) Nagpur (A Government Laboratory) and a total of 5 numbers of external check samples each for Mn, SiO2, P2O5, Fe2O3, MnO2 and Acid Insolubles have been analyzed. The details of External check samples for iron and manganese mineralization is given in Annexure-V. Due to the insufficient number of samples, detailed geostatistics have not been conducted. However, scatter plots have been generated for Mn% and P2O5%, presented as Text Figures 7 and 8 respectively. The correlation coefficients between primary and check sample analysis obtained from the scatter plots are 0.84 for Mn analysis and 0.91 for P2O5 analysis which are near to 1. This statistical analysis verifies the good quality of sample preparation and the reproducibility of chemical analysis.



Text Fig. – 7. Scatter plot of Primary Vs. Check sample (Mn%)



Text Fig. – 8. Scatter plot of Primary Vs. Check sample (P_2O_5%)

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

15.5.1 The samples have been prepared at centralized mechanized sampling unit with proper lebeling and tag and sent to chemical laboratory in supervision of qualified sampling technician. At the sampling unit, standard procedure has been followed and all the precautionary measures have been taken to avoid the contamination. The sampling unit is separate from the chemical laboratory, so there is no chance of contamination.

CHAPTER 16

MOISTURE

16.1.0 All the analysis for manganese mineralisation has been carried out with natural moisture.

CHAPTER 17

BULK DENSITY

17.1.0 Bulk density tests was not carried out.

CHAPTER 18

BENEFICIATION STUDIES

18.1.0 The present Preliminary Exploration (G-3) has been carried out for manganese mineralisation in Nagardhan Block for which there is no provision for benificiation studies.

CHAPTER 19

RESOURCE ESTIMATION TECHNIQUE

19.1.0 GENERAL

19.1.1 The Preliminary exploration (G-3 stage) has been carried out for Manganese, in Nagardhan Block. The exploration has been concluded by excavating trenches amounting 127 Cu.m and drilling of 3 nos. of boreholes in so as to cover the entire mineralised area with the objective to make systematic assessment of Manganese ore and to estimate inferred category (333) resources and associated laboratory studies. There are 81 nos. of primary trench and borehole core samples for manganese mineralization which has been analysed and the results of the same is furnished in Annexure-IV and Annexure-V.

19.1.2 Within the block linear Mn ore bodies aligned parallel to strike of the enclosing formations are mapped in the block. Their exposures are in rugged boulder form. In general, oxide minerals i.e, pyrolusite and psilomelane associated with quartz veins. Manganese oxides show granoblastic to granulitic fabric. The ore, in general, is steel grey to dull grey, grayish to dark grey to black colour and is bouldery and soft and is invariably in powdery form. Pyrolusite, psilomelane and manganite are seen replacing each other. Manganese ore bodies occur as bands & lenses, within the Mansar group of rocks.

19.1.3 The Grades and Resource have been assessed on the basis of the end use grade classification as recommended by the Expert Group constituted by Indian Bureau of Mines in September 2000 in its reports on Classification of Minerals with Regard to its Possible Optimum Industrial Use is given in table below.

Sl No.	Grade of Ore	Chemical Composition	Specifications
1	Battery/Chemical	MnO2 by mass (dry basis)	72% (Min)
		Cu, Pb, Cr and Ni	Trace
2	Ferromanganese Grade	Mn	38% (Min)
		Mn: Fe Ratio	2.5:1 (Min)
		P	7:1(Max)
3	Blast Furnace Grade	Mn	25 to (-)35%
		P	0.2% (Max)
		Al2O3	7.5% (Max)
		SiO2	13% (Max)
4	Medium Grade	Mn	35 to 37%
5	Low Grade	Mn	18-25%

19.1.4 The manganese ore zones in the trenches were identified visually based on the physical properties of various manganese ore minerals and chemical assay results, specifically for manganese content (Mn%) at or Mn% at ≥10% (IBM Threshold value). Two manganese mineralized bands, Band I and Band II, were identified. These bands are surface-level and do not extend deeper. Only one borehole intersected manganese mineralization with a width of 1 meter above the 10% Mn threshold. Hence, borehole mineralization is not considered for resource estimation.

19.1.5 Samples from the visually identified ore zones in the trenches were subjected to chemical analysis. The ore zones were defined based on assay results with a cut-off grade of Mn% at or above 10%. Non-ore portions below this cut-off were excluded. The details of the mineralized zones intersected in the trenches are provided in the following tables.

Table 19.1

Details of Trench wise Manganese Zones at >10% Mn Cut-off in Nagardhan (G3) Block for Manganese, Dist.-Nagpur, Maharashtra

Trench No.	Band No.	Width (m)	Mn%	SiO_2%	P_2O_5%	Fe_2O_3%	MnO_2%	Acid Insoluble%
Trench - 1	Band - I	1.00	26.16	39.10	0.30	9.64	9.66	72.92
Trench - 2	Band - II	5.20	18.43	31.54	0.29	15.08	10.79	58.89
Trench - 4	Band - II	4.75	15.08	39.72	0.21	14.29	10.51	65.04
Trench - 5	Band - I	2.00	20.88	39.82	0.17	13.80	11.61	67.01

Table 19.2

Details of Manganese Zones intersected in borehole at >10% Mn Cut-off in Nagardhan (G3) Block for Manganese, Dist.-Nagpur, Maharashtra

BH No.	Depth (m)		Thick	Grade					
	From	To	(m)	Mn%	SiO_2 %	P_2O_5 %	Fe_2O_3 %	MnO_2 %	Acid Insoluble %
MNB-01	18	19	1	10.08	57.12	0.15	5.11	7.03	68.00

19.2.0 ESTIMATION OF RESOURCES

19.2.1 The geological resources have been estimated by cross section method considering borehole data coupled with outcrop mapping.

19.2.2 The formula for resource estimation is as follows:

R = A x T x Sp. gr.

Where R = Resources

A = Area of the manganese ore body/lens/band

T = True width.

Sp. gr. = Specific gravity

CHAPTER 20

REPORTING OF RESOURCES

20.1.0 RESOURCE ESTIMATION BY GEOLOGICAL CROSS-SECTION

Following parameters has been adopted while computation of ore resource estimation by cross section method:

20.1.1 Identification of Ore Bodies

(1) The ore bodies were delineated based on geological mapping, outcrop sampling, and drilling. These formations exhibit a lensoidal shape, with the northern band referred to as Band I and the southern band as Band II.

(2) Exploration findings indicate that these bands are primarily surficial, lacking depth continuity. As a result, resource estimation has been confined to near-surface ore mineralization.

20.1.2 Section Preparation and Data integration

(1) Cross-sections were developed by compiling data from geological mapping, drilling records, and chemical analyses.

(2) Trenches were projected onto the nearest adjacent geological sections, enabling the preparation of geological cross-sections with interpreted ore bodies. Subsequently, the area of the Mn ore band was calculated based on these sections.

(3) The geological resources were then estimated using the cross-sectional method.

20.1.3 Cut-off for Manganese Mineralization

(1) A manganese content of 10% Mn has been adopted as threshold value, in accordance with IBM guidelines, to define ore-grade mineralization.

20.1.4 Resource Estimation Parameters

(1) The geological resources for Band I (Northern) and Band II (Southern) have been estimated at a 10% Mn cutoff, based on positive intersections observed in trench sampling.

(2) The manganese-bearing bands showing positive trench intersections have been considered continuous for a strike length of 50 meters on either side of the trench in the strike of manganese band or up to the midpoint between adjacent trenches. These lengths have been used for resource estimation under the inferred category (333).

20.1.5 Grade and Depth Considerations

(1) The ore grade for each band or lens has been determined based on trench sample analyses at the points of intersection.

(2) The northern surficial band (Band I) depth continuity has been estimated as half the influence line along the inclined depth of the trench intersection with boreholes, excluding the soil/weathered zone due to the surficial and lensoidal nature of the bands.

(3) The southern band exhibits a synformal structure with no significant depth continuity. Therefore, a conservative estimate has been applied, considering only the band width of 2.00 meters for resource calculation.

20.1.6 Specific Gravity Assumption

(1) A specific gravity value of 3.10 has been used for resource estimation, based on laboratory analysis of two representative samples from mineralized zones.

20.1.7 Mining Considerations

(1) Given the open-cast mining potential of the deposit, a minimum workable ore thickness of 1.00 meter and a minimum non-ore parting of 1.00 meter have been considered in the resource estimation.

20.2.0 RESOURCES

20.2.1 The resource of Manganese has been estimated at (+) 10% Mn cut-off (Threshold value, IBM No. C-284/3/CMG/2017, dated 25th April 2018) as per specifications/basic assumptions enumerated in Para No. 21.1.0. The section wise summary of resources is given in Table-20.1 Details of section wise ore resource estimation for manganese are given in Annexure VI.

Table-20.1

Summarised section wise geological resources estimated at 10 % Mn cut-off in Nagardhan Block, Nagpur Maharashtra

Section No	Band Number	Category	Trench	Strike Influence (m)	Specific Gravity	Resource (Tons)	Mn %	P_2O_5 %
S1	Band I	Surfacial (G3)	Trench-1	132	3.10	4861.30	26.16	0.30
S1	Band II	Surfacial (G3)	Trench-2	184	3.10	16815.39	15.08	0.21
S2	Band I	Surfacial (G3)	Trench-5	132	3.10	6183.01	18.43	0.29
S2	Band II	Surfacial (G3)	Trench-4	184	3.10	12457.54	20.88	0.17
Total						**40317.24**	**18.72**	**0.22**

20.3.0 CATEGORISATION OF RESOURCE

20.3.1 Resources of manganese ore have been categorized under Inferred Mineral Resources (333) as per the United Nations Framework Classification (UNFC).

CHAPTER 21

SUMMARY AND RECOMMENDATIONS

21.1.0 SUMMARY

21.1.1 The Nagardhan (G3) block is situated approximately 7 km south of Ramtek town in Nagpur district, Maharashtra. It covers areas around major villages like Nagardhan and Nandapuri and falls within Survey of India Toposheet No. 55O/07. The block is largely covered by soil, with over 90% of the area lacking rock exposure. However, outcrops can be observed in stream (nalla) cuttings, old mining pits, and newly excavated trenches.

21.1.2 The block is composed of Precambrian metasediments of the Sausar Group, which unconformably overlie the Tirodi gneisses. Main lithounits include quartz-mica schist of the Mansar Formation, along with quartz reefs and manganese float.

21.1.3 The Lithologies along with manganese bands exhibits a WNW-ESE trend, with variable dips towards either the north or south inferred to be cross folding. The rock types found in this formation include pelitic, psammatic, and calcareous lithologies. Structural complexities in the area, including cross-folding, have resulted in variations in geological trends ranging from ENE-WSW to E-W, with dip angles between 38° and 52°.

21.1.4 The exploration proposal for the Nagardhan block was approved during the 34th NMET EC meeting held on 13th March 2024, with a sanctioned budget of ₹130.66 lakh. This approval was communicated through Office Memorandum F. No. 23/440/2024-NMET/595 dated 12th March 2024. Fieldwork commenced on 2nd May 2024 and was completed on 21st January 2025, culminating in the collection of bedrock and channel samples.

21.1.5 As part of the exploration activities, detailed geological mapping was carried out over an area of 2.00 sq. km. at a 1:4,000 scale. Trenching was undertaken, with a total excavation volume of 127 cubic meters, leading to the collection of 45 trench samples. Based on the trenching results, three boreholes were drilled, amounting to a total drilling depth of 180 meters. Additionally, five samples were analyzed for petrography, two for minerography, and two for specific gravity determination.

21.1.6 Manganese mineralization was observed over a strike length of approximately 400 meters, with the mineralized zone varying in width from 1 to 6 meters in the central part of the block. The analysis of 45 trench samples revealed manganese (Mn) concentrations ranging from 0.54% to 28.82%, with 19 samples exhibiting Mn content above 10%.

21.1.7 Drill core samples collected from boreholes MNB-01 and MNB-03 along section lines S1 and S2 were also analyzed. Among the 36 samples examined, only a single 1-meter interval showed manganese mineralization above 10% Mn, indicating limited subsurface continuity.

21.1.8 The exploration findings suggest the presence of two lensoidal manganese ore bands namely Band I (Northern Band) and Band II (Southern Band), which are inferred as to be part of the same manganese ore band/lens.

21.1.9 These ore bodies are primarily surficial and lack depth continuity. Therefore, the resource estimation has been confined to near-surface mineralization.

21.1.10 The specific gravity of the ore was determined to be 3.10, based on two analyzed samples, and this value was applied in the resource estimation process.

21.1.11 Based on the exploration data, the total manganese resource in the Nagardhan block is estimated at 40,317.24 tonnes (0.04 million tonnes), with an average grade of 18.72% Mn at a 10% Mn cutoff. These resources have been classified under UNFC Category 333 (Inferred Geological Resources**).**

21.2.0 RECOMMENDATIONS

1.9.3 Geological mapping and trenching revealed manganese mineralization, with four out of five trenches intersecting Mn content between 10.88% and 28.74% at a 10% Mn cut-off. Three boreholes targeting Band I (Northern band) intersected only a 1-meter-wide band in MNB-01, while the other two boreholes did not encounter significant mineralization. The manganese ore bands in the area are surficial, thin, and of marginal grade, with limited strike and little to no depth continuity. The structural complexity observed during mapping, along with the absence of substantial intersections in boreholes, suggests that the mineralization lacks depth persistence. Due to limited exposures, the strike and depth extent of the mineralization remain unconfirmed. However, an estimated resource of 0.04 million tonnes of surficial manganese ore has been estimated and categorized under the 333-resource classification.

1.9.4 Considering the block's status as a lapsed lease under Section 10(A)2(B) of the MMDR Act-2015, its proximity to an operational underground manganese mine, its considerable high-grade surface manganese deposits, and its complex structural geology, additional geophysical surveys are recommended to detect potential deep ore bodies.

CHAPTER 22

PLATES AND MAPS

22.1.0 Location Map of the Nagardhan (G3) Block for Managnese (2.00 SQ. KM) District- Nagpur, Maharashtra is given as Plate-I.

22.2.0 Regional Geological Map of Nagardhan (G3) Block for Managnese (2.00 SQ. KM) District- Nagpur, Maharashtra is given as Plate-II

22.3.0 Topographic & Outcrop Map of Nagardhan (G3) Block for Managnese (2.00 SQ. KM) District- Nagpur, Maharashtra is given as Plate-III. (Scale 1:4000)

22.4.0 Interpreted Geological Map of Nagardhan (G3) Block for Managnese (2.00 SQ. KM) District- Nagpur, Maharashtra is given as Plate-IV. (Scale 1:4000)

22.5.0 Geological Cross section along S1, S2 & S3 of Nagardhan (G3) Block for Managnese (2.00 SQ. KM) District - Nagpur, Maharashtra is given as Plate-V. (Scale 1:500)

22.6.0 Trench Profile Along Trenches - Trench 1, Trench 2, Trench 3, Trench 4 and Trench 5 of Nagardhan (G3) Block for Managnese (2.00 SQ. KM) District - Nagpur, Maharashtra is given as Plate-V. (Scale 1:100)

CHAPTER 23

ANNEXURE / ENCLOSURES TO THE REPORT

23.1.0 The report includes all the relevant annexure and maps/plans, sections photographs & photomicrograph etc.

CHAPTER 24

ANY OTHER INFORMATION

24.1.0 There is no additional information available in the block.

CHAPTER 25

CERTIFICATE FROM THE QUALIFIED PERSON WITH NAME, DATE AND SIGNATURE

NAME: **P. RAVINDRAN**

DESIGNATION: **GENERAL MANAGER (EXPLORATION)**

DATE: 29-03-2025

LOCALITY INDEX

Locality	Latitude	Longitude
Nandapuri	21° 20' 1.52"N	79° 19' 42.65"E
Nagardhan	21° 20' 31.91"N	79° 19' 0.33"E
Hamlapuri	21° 20' 21.43"N	79° 20' 9.44"E
Beldongri	21° 20' 13.45"N	79° 17' 27.89"E

REFERENCES

Fermor, L. L (1909)	The manganese ore deposit of India. Mem. Geol. Sur. India. Vol. 37.
Chakravorty, S. C. (1973)	The geology and manganese ore deposit of Kandri - Mansar area, north - eastern part of Nagpur district, Maharashtra. Bull. Geol. Sur. India. Ser. A. Eco. Geol. No. 22, pt. III.
Mulay, V. V. and Bhoskar, K. G (1976)	Report on the manganese ore investigation in parts of Nagpur and Bhandara districts, Maharashtra. Unpub. Progress Report, GSI.
Narayanswamy, S. et. al (1971)	The geology and manganese ore deposit of northern Bhandara district, Maharashtra. Bull. Geol Sur. India Ser. A. Eco. Geol. Ind. No. 22, pt. IV.
V.N Agarwal (1974)	Tectonics of the Manganese ore bodies associated with the Sausar Group, Nagpur District, Maharashtra.
S.S. Sahasrabuddhey et.al (1997)	Report on Preliminary Investigation of Manganese Ore in Satak Beldongri-Nagardhan-Chokhala and Parsoda Areas, Nagpur District of Maharashtra
Rini Sasidharan et. al. (2012)	Geochemical Mapping In Toposheet No. 55O/07 & 11 In Parts of Nagpur & Bhandara Districts, Maharashtra

ABBREVIATIONS USED

SL. No.	Abbreviation	Full form
1	Cu m	Cubic Meter
2	DGPS	Differential Global Positioning System
3	DMS	Degree Minute Second
4	EC	Executive Committee
5	F.S.P.	Field Season Programme
6	GSI	Geological Survey of India
7	IBM	Indian Bureau of Mines
8	ICP-MS	Inductively Coupled Plasma Mass Spectrometry
9	JNARDDC	Jawaharlal Nehru Aluminium Research Development and Design Centre
10	M / m	Meter
11	MECL	Mineral Exploration and Consultancy Limited
12	MEMC	Minerals (Evidence of Mineral Contents)
13	MMDR	Mines & Minerals (Development and Regulation)
14	mRL	Reduced Level in metre
15	NABL	National Accreditation Board for Testing and Calibration Laboratories
16	CITZ	Central Indian Tectonic Zone
17	SNNF	Son–Narmada North Fault
18	BIF	Banded Iron Formation
19	BHC	Banded Haematite Chert
20	BHJ	Banded Hanatite Jasper
21	NMET	National Mineral Exploration Trust
22	QA/QC	Quality Assessment/ Quality Checks
23	TCC	Technical cum Cost Committee
24	UTM	Universal Transverse Mercator
25	WGS-84	World Geodetic System-84
26	XRF	X-ray Fluorescence