GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION (G3) FOR COPPER ORE IN

THAKURDIH-CHARAKMARA BLOCK

SINGHBHUM COPPER BELT,

EAST SINGHBHUM DISTRICT, STATE – JHARKHAND

(Under NMET Programme)

(TEXT, ANNEXURES AND PLATES)

Core Photograph of MTCB-11 showing Copper mineralisation in Qtz-Bio Rock (Depth: 54.20-54.25m)

Core Photograph of MTCB-06 showing sulfide mineralisation in Chl-Bio-schist (Depth: 35.40-35.50m)

MINERAL EXPLORATION AND CONSULTANCY LTD.

(Formerly Mineral Exploration Corporation Ltd.)

मिनरल एक्सप्लोरेशन एंड कंसल्टेंसी लिमिटेड

(पूर्व में मिनरल एक्सप्लोरेशन कार्पोरेशन लिमिटेड)

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Ministry of Mines, Govt of India Enterprise, MINIRATNA-I CPSE

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

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ठाकुरडीह-चरकमारा ब्लॉक में तांबा अयस्क के लिए प्रारंभिक गवेषण पर भूवैज्ञानिक रिपोर्ट (जी3) सिंहभूम तांबा बेल्ट, पूर्वी सिंहभूम जिला, राज्य - झारखंड

अध्याय-1बी

कार्यकारी सारांश

1.0.0 परिचय

1.1.1 तांबे ने अपने अद्वितीय भौतिक, यांत्रिक और विद्युत गुणों के साथ, किसी देश के औद्योगिक विकास में महत्वपूर्ण भूमिका निभाई है। भारत में, लगभग 75% मांग आयात के माध्यम से पूरी की जाती है। आर्थिक महत्व के नए तांबे के भंडार के गवेषण से देश में तांबा धातु की बढ़ती मांग को कम किया जा सकता है। उपरोक्त को ध्यान में रखते हुए, बारहवीं योजना के दस्तावेज़ में तांबे के अयस्क की गवेषण को उच्च प्राथमिकता दी गई है।

1.1.2 पिछले तीन दशकों के दौरान, भारत में किसी भी बड़े आधार धातु भंडार की खोज नहीं की गई है। हालाँकि, तकनीकी प्रगति और बढ़ी हुई परिचालन दक्षता के माध्यम से छोटे खनिज पिंडों के एक-दूसरे के निकट काम करने की संभावना से इंकार नहीं किया जा सकता है। इसलिए, समूहों में ऐसे छोटे आकार के निक्षेपों का पता लगाना और उनको गवेषित करना अत्यंत आवश्यक है।

1.1.3 ठाकुरडीह-चरकमारा ब्लॉक क्षेत्र सिंहभूम शीयर जोन के दक्षिण-पूर्वी छोर के पास स्थित है और बहरागोड़ा तांबा प्रॉस्पेक्ट का हिस्सा है । क्षेत्र में तांबे के लिए पुराने कामकाज (उथले गड्ढे) के अस्तित्व की सूचना पिछले भुवैज्ञानिकों (स्टोहर 1870 और डन 1937) द्वारा दी गई थी। इस क्षेत्र को 1963 में एयरबोर्न मल्टी-इंस्ट्रूमेंट भूभौतिकीय सर्वेक्षणों द्वारा कवर किया गया था। उपलब्ध भूवैज्ञानिक ज्ञान के साथ विद्युत चुम्बकीय और चुंबकीय हस्ताक्षरों के जमीनी मूल्यांकन ने बहरागोड़ा क्षेत्र में संभावित खनिज क्षेत्रों की उपस्थिति का संकेत दिया। जीएसआई (एफएस 1975-76 और 1977-78) द्वारा क्षेत्र में एकीकृत भूवैज्ञानिक, भू-रासायनिक और जमीनी भूभौतिकीय सर्वेक्षण और गवेषणात्मक वेधन ने कई छोटे ब्लॉकों यानी मुंडादेवता-दरखुली और दक्षिण झरिया और चरकमारा क्षेत्र का संकेत दिया। मुंडादेवता-दरखुली और दक्षिण झरिया ब्लॉक को हाल ही में तांबे के लिए जी2 चरण में एमईसीएल (2021-22) द्वारा गवेषित किया गया था और 0.50% Cu कट-ऑफ पर 0.96% Cu के 1.75 मिलियन टन और 1.46% के 0.64 मिलियन टन का शुद्ध भूवैज्ञानिक संस्थान संसाधन था। 1.00 Cu कट-ऑफ पर Cu का अनुमान 245 मीटर ऊर्ध्वाधर गहराई तक लगाया गया था। वर्तमान ठाकुरडीह-चरकमारा गवेषण ब्लॉक मुंडादेवता-दरखुली और दक्षिण झरिया ब्लॉक से सटा हुआ और विस्तारित है।

1.1.4 चरकमारा के पूर्व में, ग्रेनाइटिक स्थानीय चट्टानों के भीतर मेटाबैसाइट्स , बेसिक शिस्ट और बायोटाइट क्वार्ट्ज शिस्ट में NE-SE दिशा में लगभग 500 मीटर की दूरी तक असंतुलित गड्ढों की एक पंक्ति है। जीएसआई (1974) के पिछले कार्य ने चरकमारा क्षेत्र में मजबूत भू-रासायनिक विसंगतियों और कमजोर भूभौतिकीय आईपी विसंगतियों का संकेत दिया था । चरकमारा क्षेत्र में वेधन किए गए जीएसआई के दो परीक्षण पुराने बोरहोल (बीसी-1 और बीसी-2) ने लगभग 60 मीटर ऊर्ध्वाधर

गहराई पर 0.85 मीटर से 2.05 मीटर की चौड़ाई और 2.05% Cu से 0.92% Cu और 0.17% Ni ग्रेड के खनिज क्षेत्र को प्रतिच्छेदित कर दिया। यह क्षेत्र नतिलंब और नति के साथ बने रहने की संभावना है। ठाकुरडीह गांव के पास एरिया-1 में स्थित NW-SE दिशा में कुछ पुराने कामकाज चलन में हैं। जीएसआई के पिछले काम ने ब्लॉक क्षेत्र के क्षेत्र -1, 2 और 3 में तांबा और मजबूत आईपी भूभौतिकीय विसंगतियों के लिए मजबूत भू-रासायनिक विसंगतियों का संकेत दिया और पुराने कामकाज और भू-रासायनिक विसंगतियों के साथ अच्छी तरह से पुष्टि की।

1.1.5 खनिज क्षमता की संभावना और क्षेत्र में जीएसआई द्वारा किए गए पिछले कार्यों के आधार पर, एमईसीएल ने ठाकुरडीह चरकमारा क्षेत्र में गवेषण करने के लिए गवेषण प्रस्ताव तैयार किया और खान और भूविज्ञान विभाग (डीएमजी), झारखण्ड सरकार के पत्रांक संख्याभू0नि0अन्वे0- 42/2018/ 1820 एम0/राँची , दिनांक:-30 .09.2021(अनुलग्नकXI)से सहमति प्राप्त की।

1.1.6 एनएमईटी की 36वीं टीसीसी बैठक 23 और 24 दिसंबर, 2021 को भारतीय भूवैज्ञानिक सर्वेक्षण, डीजीसीओ, ए-द्वितीय पुष्पा भवन , नई दिल्ली में वीडियो कॉन्फ्रेंसिंग के माध्यम से आयोजित की गई जिसमें प्रस्तावित कार्य को पूरा करने के लिए 12 महीने की समय सीमा में जीएसटी सहित 388.59 लाख रुपये की अनुमानित लागत के साथ ठाकुरडीह चरकमारा ब्लॉक में तांबे के लिए प्रारंभिक गवेषण(जी 3) के लिए ईसी द्वारा अनुमोदन के लिए परियोजना की सिफारिश की। इसके बाद, परियोजना को 11 मार्च, 2022 को आयोजित एनएमईटी की 23वीं ईसी द्वारा अनुमोदित किया गया था और खान मंत्रालय द्वारा पत्र संख्या एफ.सं.23/236/2022-एनएमईटी/301, नई दिल्ली दिनांक 25 मार्च , 2022 (अनुलग्नक XI)के माध्यम से एमईसीएल को सूचित किया गया था।

1.1.7 ठाकुरडीह-चरकमारा (जी3) ब्लॉक 10.0 वर्ग किमी के क्षेत्र को कवर करता है और इसमें चरकमारा, क्षेत्र-1, 2 और 3 जैसे चार उप-ब्लॉक शामिल हैं जो एक-दूसरे के करीब हैं। गवेषण की योजना में सर्वेक्षण, बोरहोल निर्धारण और डीजीपीएस द्वारा बोरहोल के समन्वय और कम स्तर का निर्धारण, ग्राउंड जियोफिजिकल सर्वेक्षण, वेधन, कोर लॉगिंग, कोर सैंपलिंग और संबंधित प्रयोगशाला अध्ययन शामिल हैं।

1.1.8 ठाकुरडीह चरकमारा ब्लॉक में प्रारंभिक गवेषण (जी-3) चरण में वर्तमान गवेषण कार्यक्रम एमईसीएल द्वारा कार्य की अनुमोदित मात्रा के अनुसार निष्पादित किया गया था। 60 मीटर और 120 मीटर ऊर्ध्वाधर गहराई पर खनिज क्षेत्रों को काटने के लिए चरकमारा क्षेत्र में 100 मीटर के अंतराल पर गवेषणात्मकवेधन की गई। क्षेत्र-1, 2 और 3 में एकीकृत भूभौतिकीय सर्वेक्षण किया गया और ठाकुरडीह-चरकमारा ब्लॉक के क्षेत्र-1 और 3 में भूभौतिकीय विसंगति परीक्षण वेधन के आधार पर किया गया। गवेषणात्मकवेधन डेटा के आधार पर, कट-ऑफ ग्रेड मापदंडों के अनुसार क्षेत्र में अनुमानित ग्रेड के साथ तांबा अयस्क संसाधनों और यूएनएफसी की 333/334 श्रेणी के तहत रखे गए तांबा अयस्क संसाधनों।

1.2.0 ब्लॉक का स्थान और पहुंचने की सुविधा

1.2.1 अध्ययन क्षेत्र झारखंड के पूर्वी सिंहभूम जिले में बहरागोड़ा शहरऔर तहसील मुख्यालय से लगभग 4 किमी उत्तर पश्चिम में ठाकुरडीह, चरकमारा, दरखुली, मधुपुर और झरिया गांवों में और उसके आसपास स्थित है। ब्लॉक क्षेत्र तक बहरागोड़ा से पक्की सड़क द्वारा पहुंचा जा सकता है। बहरागोड़ा

पूर्वी सिंहभूम जिले में NH-49 (खड़गपुर से बिलासपुर) और NH-18 (धनबाद-बालासोर) के जंक्शन के पास एक छोटा सा शहर है और भारत के झारखंड के दक्षिण-पूर्व कोने पर स्थित है।

1.2.2 भारतीय सर्वेक्षण टोपोशीट संख्या 73जे/11 के अंतर्गत आने वाला ब्लॉक क्षेत्र, 10.0 वर्ग क्षेत्र को कवर करता है और 22° 16' 52.7078" उत्तर से 22° 19' 23.4125" उत्तर अक्षांश और 86° 40' 34.8022" पूर्व से 86° 42' 17.8870" पूर्व देशांतर के बीच स्थित है। ब्लॉक का स्थान **प्लेट-I** और **टेक्स्ट चित्र-1** में दिखाया गया है। ठाकुरडीह-चरकमारा ब्लॉक, सिंहभूम तांबा बेल्ट, पूर्वी सिंहभूम जिला, झारखंड के कार्डिनल बिंदुओं के स्थानिक निर्देशांक (भौगोलिक और यूटीएम) **तालिका 1.1** में दिए गए हैं ।

टेबल 1.1
ब्लॉक, सिंहभूम तांबा बेल्ट, पूर्वी सिंहभूम जिला , झारखंड की ब्लॉक सीमा के कोने बिंदुओं का समन्वय

कार्नर कार्डिनल बिंदु	डब्ल्यूजीएस-84 (डीएमएस)		यूटीएम (जोन 45एन)	
	अक्षांश	देशान्तर	पूर्वांक	उतरांक
1	22° 19' 23.1904" उत्तर	86° 40' 34.8022" पूर्व	466667.00	2468627.00
2	22° 19' 23.4125" उत्तर	86° 41' 56.3542" पूर्व	469000.00	2468629.00
3	22° 18' 10.7567" उत्तर	86° 41' 56.5099" पूर्व	469000.00	2466395.00
4	22° 18' 10.6238" उत्तर	86° 41' 20.5106" पूर्व	467970.00	2466393.00
5	22° 17' 26.1977" उत्तर	86° 41' 20.6089" पूर्व	467970.00	2465027.00
6	22° 17' 26.2469" उत्तर	86° 42' 17.1600" पूर्व	469588.15	2465025.27
7	22° 16' 52.8471" उत्तर	86° 42' 17.8870" पूर्व	469606.95	2463998.27
8	22° 16' 52.7078" उत्तर	86° 40' 35.1488" पूर्व	466667.00	2464000.00

1.2.3 अध्ययन क्षेत्र घाटशिला (50 कि.मी.) से सभी मौसमों वाली सड़कों से अच्छी तरह जुड़ा हुआ है। बारीपांडा (50 किमी), खड़गपुर (60 किमी), जमशेदपुर (90) और कोलकाता (200 किमी)। चाकुलिया और धालभूमगढ़ निकटतम रेलवे स्टेशन हैं। निकटतम हवाईअड्डा नेताजी है सुभाष चंद्र बोस अंतर्राष्ट्रीय हवाई अड्डा, कोलकाता जो क्षेत्र से पूर्व की ओर 200 किमी दूर है।

1.3.0 ब्लॉक का भूविज्ञान और संरचना

1.3.1 ठाकुरडीह-चरकमारा ब्लॉक क्षेत्र प्रमुख सिंहभूम तांबा बेल्ट के दक्षिणपूर्वी छोर पर स्थित है। ब्लॉक क्षेत्र में मुख्य रूप से आर्कियन (सिंहभूम ग्रेनाइट कॉम्प्लेक्स) के ग्रेनाइट/ग्रेनाइट नीस, आर्कियन-प्रोटेरोज़ोइक के नए डोलेराइट, पैलियोप्रोटेरोज़ोइक के क़ार्टजाइट, पैलियोप्रोटेरोज़ोइक के शिस्टोज़ चट्टानें, ग्रावेल्स ऑफ टरटीयरी और सैंड सील्ट क्ले प्लीस्टोसीन-होलोसीन के कैलकेरियस कंक्रीट को उजागर करती है। अधिकांश क्षेत्र मिट्टी के आवरण के नीचे ढका हुआ है। क्षेत्र में रॉक एक्सपोज़र कम है और खनिज क्षेत्र की सतह की अभिव्यक्ति सीमित है और शीयर जोन अच्छी स्थिति में नही है। हालाँकि, पिछला जियोकेमिकल नमूनाकरण और आईपी प्रतिरोधकता सर्वेक्षण कुछ विसंगतियाँ

प्रदान करता है, लेकिन भूविज्ञान और सल्फाइड खनिजीकरण पर अधिकांश जानकारी वेधछिद्र से प्राप्त की गई है। सल्फाइड खनिज स्थानिक रूप से मेटाबैसाइट्स या उनके व्युत्पन्न (शिस्टोज़ चट्टानों) जैसे क्लोराइट- बायोटाइट शिस्ट, क्वार्ट्ज -बायोटाइट शिस्ट और बायोटाइट-क्वार्ट्ज़ाइट्स से जुड़ा हुआ है। सामान्य तौर पर, लिथो इकाइयां चरकमारा क्षेत्र में एसई के तरफ नतिलंब एन20^{0}ई-एस20^{0}डब्ल्यू पर 60^0 से 70^0 की नति और ब्लॉक क्षेत्र के क्षेत्र-1 में एन60^{0}डब्ल्यू-एस60^{0}ई पर 70^0 से 80^0 उत्तर पूर्व दिशा में नति हैं।

1.3.2 एमईसीएल द्वारा वेधन किए गए बोरहोल में प्रतिच्छेदित मुख्य लिथो इकाई हैं एम्फीबोलाइट, शिस्ट (बायोटाइट क्लोराइट शिस्ट / बायोटाइट शिस्ट / बायोटाइट क्वार्ट्ज शिस्ट / क्लोराइट बायोटाइट शिस्ट / क्लोराइट शिस्ट / गार्नेटिफेरस क्लोराइट शिस्ट, क्वार्ट्ज बायोटाइट क्लोराइट शिस्ट), डोलराइट, ग्रेनाइट, ग्रेनाइट नीस और क्वार्टजाइट चट्टान।

1.4.0 खनिजीकरण

1.4.1 चरकमारा क्षेत्र में, ग्रेनाइटिक स्थानीय चट्टानों के भीतर मेटाबैसाइट्स , बेसिक शिस्ट्स और बायोटाइट क्वार्ट्ज शिस्ट में एनई-एसडब्ल्यू दिशा में लगभग 500 मीटर की दूरी तक असंतुलित गड्ढों की एक पंक्ति है । उसी प्रकार ठाकुरडीह क्षेत्र (क्षेत्र-1) में स्थित कुछ पुराने कामकाजी एनडब्ल्यू-एसई दिशा मे है।

1.4.2 सल्फाइड खनिजकरण निकट दूरी वाली कैंची से जुड़े विदर विएन प्रकार के रूप में होता है , जो ज्यादातर विभिन्न लिथोलॉजी में पत्तियों के उप-समानांतर के समानांतर होता है । इस क्षेत्र में खनिजीकरण किसी विशेष स्ट्रैटिग्राफिक क्षितिज या किसी विशेष लिथो-इकाई तक ही सीमित नहीं है। हालाँकि, कुछ लिथो-इकाइयाँ अन्य की तुलना में पसंद की जाती हैं। खनिज स्थानिक रूप से मेटाबैसाइट्स या उनके व्युत्पन्न शिस्टोज़ चट्टानों यानी क्लोराइट- बायोटाइट शिस्ट, क्वार्ट्ज - बायोटाइट शिस्ट और बायोटाइट-क्वार्ट्ज़ाइट्स से जुड़ा हुआ है ।

1.4.3 खनिजीकरण मुख्य रूप से फैलाव, स्ट्रिंगर्स और पैच/धारियों के रूप में होता है जो पत्तियों के उप-समानांतर के समानांतर निकट दूरी वाले शीयर जोन से जुड़े होते हैं। चाल्कोपाइराइट मुख्य अयस्क खनिज है जिसके बाद पाइराइट (+मार्कासाइट) और मैग्नेटाइट आते हैं। निकेल सल्फाइड कम मात्रा में पाए जाते हैं।

1.4.6 खनिजयुक्त क्षेत्र 0.2% Cu कट-ऑफ मान पर चित्रित बोरहोल में प्रतिच्छेदित होते हैं। चरकमारा क्षेत्र में वेधन डेटा से पता चलता है कि चार खनिजयुक्त जोन लोड-1, 1ए, 1बी और 2 के रूप में गिने जाते हैं, जो फुटवॉल की तरफ से शुरू होते हैं और जीएसआई और एमईसीएल बोरहोल द्वारा वेधन किए गए बोरहोल में एक दूसरे को काटते हैं। क्षेत्र-1 में, खनिजकरण के तीन क्षेत्र क्रमांक 1ए, 1बी, 1एए और फुटवॉल की ओर से शुरू होने वाले स्थानीय को एमईसीएल द्वारा वेधन किए गए बोरहोल में काट दिया गया है। तांबे का खनिजकरण प्रकृति में अनियमित है और व्यक्तिगत लोड/जोन सीमित प्रभाव और गहराई निरंतरता के साथ ग्रेड में पतले दुबले क्षेत्र हैं। लोड की चौड़ाई और ग्रेड कट-ऑफ ग्रेड, मोटाई और विभाजन की ताकत पर निर्भर करते हैं।

1.5.0 वर्तमान जांच के दौरान किया गया गवेषण

1.5.1 वर्तमान जी3 चरण के गवेषण के दौरान, एमईसीएल ने पूर्वेक्षण की अनुमोदित योजना के अनुसार गवेषण कार्य किया।ब्लॉक क्षेत्र में 1497.50 मीटर की कुल 12 बोरहोल वेधन की गईं। उत्खनन वेधन कार्य 23.04.2022 (MTCB-01) को शुरू हुआ और 09.06.2023 (MTCB-12) को समाप्त हुआ। सर्वेक्षण कार्य यानी बोरहोल निर्धारण और डीजीपीएस द्वारा बोरहोल के समन्वय और कम स्तर का निर्धारण, ग्राउंड जियोफिजिकल सर्वेक्षण और संबंधित सर्वेक्षण कार्य, वेधन, कोर लॉगिंग, कोर सैंपलिंग आदि सहित संबद्ध क्षेत्र-कार्य एक साथ पूरे किए गए । ब्लॉक में सर्वेक्षण कार्य डब्ल्यूजीएस-84 डाटम में डीजीपीएस की मदद से किया गया। रासायनिक विश्लेषण और भौतिक विश्लेषण यानी पेट्रोग्राफिक, खनिज विज्ञान और विशिष्ट गुरुत्व अध्ययन सहित प्रयोगशाला अध्ययन एमईसीएल और अन्य सरकारी प्रयोगशालाओं /एनएबीएल मान्यता प्राप्त प्रयोगशालाएँ में एक साथ किए गए थे।

1.5.2 प्रस्तावित कार्य की प्रकृति और मात्रा बनाम उपलब्धि का विवरण तालिका-1.2 में दिया गया है।

तालिका 1.2

ठाकुरडीह-चरकमारा ब्लॉक में एमईसीएल द्वारा कार्य की मात्रा बनाम उपलब्धि ,
सिंहभूम तांबा बेल्ट, जिला: पूर्वी सिंहभूम, झारखंड

क्र.सं.	कार्य की वस्तु	इकाई	अनुमोदित	प्राप्ति	टिप्पणी
1	सर्वेक्षण (1:5000 पैमाने पर): बोर होल निर्धारण और डीजीपीएस द्वारा बोरहोल के निर्देशांक और कम स्तर का निर्धारण	प्रति अवलोकन बिंदु	12	12	-
2	बीएच कंक्रीट स्तंभों का निर्माण	प्रति बोरहोल	12	12	-
3	ग्राउंड जियोफिजिकल सर्वे: -प्रेरित ध्रुवीकरण (आईपी), प्रतिरोधकता और चुंबकीय	प्रति लाइन किमी	60	60	-
4	300 मीटर तक वेधन (हार्ड रॉक) और बीएच जियोलॉजिकल लॉगिंग	एम	1500	1497.5	-
5	मल्टीशॉट कैमरा द्वारा बोरहोल विचलन सर्वेक्षण	एम	1500	1497.5	-
6	वेधन कोर संरक्षण	प्रति मी	300	300	-
7	**प्रयोगशाला अध्ययन: रासायनिक विश्लेषण**				
i)	**प्राथमिक नमूने**				
	क. Cu, Ni, Mo, Co, W के लिए	नग	150	142	-
	ख. अग्नि परख द्वारा Au (सोना) के लिए	नग	20	20	-
ii)	**आंतरिक नमूना जाँच (5%)**				
	क. Cu, Ni, Mo, Co और W के लिए	नग	5	5	-
	ख.अग्नि परख द्वारा Au (सोना) के लिए	नग	1	1	
iii)	**बाहरी नमूना जाँच (10%)**				
	क. Cu, Ni, Mo, Co और W के लिए	नग	10	10	
	ख. अग्नि परख द्वारा Au (सोना) के लिए	नग	2	0	
iii)	**समग्र नमूने**				

क्र.सं.	कार्य की वस्तु	इकाई	अनुमोदित	प्राप्ति	टिप्पणी
	क.5 रेडिकल्स (Cu, Ni, Co, W Mo)के लिए	नग	10	3	-
	ख. अग्नि परख द्वारा Au (सोना) के लिए	नग	10	0	-
8	पेट्रोलॉजिकल नमूने (पतले खंड की तैयारी और अध्ययन)	नग	10	10	
9	खनिज विज्ञान अध्ययन (पॉलिश अनुभाग की तैयारी और अध्ययन)	नग	10	10	
10	डिजिटल तस्वीरें	नग	10	10	
11	भूवैज्ञानिक रिपोर्ट	नग	1	1	

1.6.0 भूभौतिकीय सर्वेक्षण

1.6.1 क्षेत्र में 100 मीटर/50 मीटर प्रोफ़ाइल अंतराल और 20 मीटर स्टेशन अंतराल (60 लाख किमी) पर किए गए एकीकृत भूभौतिकीय सर्वेक्षण (आईपी प्रतिरोधकता और चुंबकीय) ने क्षेत्र-1, 2 और 3 में कुछ प्रमुख विसंगतियों को सामने लाया है। उच्च प्रभार्यता और कम प्रतिरोधकता वाले क्षेत्रों को क्षेत्र-1 और 3 में चित्रित किया गया था और जीएसआई के पुराने कामकाज, पिछले भूभौतिकीय और भू-रासायनिक विसंगतियों के साथ अच्छी तरह से पुष्टि की गई है। (अनुलग्नक-XII)

1.6.2 भूभौतिकीय सर्वेक्षण के परिणाम के आधार पर कुल 3नग 60 मीटर ऊर्ध्वाधर गहराई पर भूभौतिकीय विसंगति का परीक्षण करने के लिए क्षेत्र-1 में परीक्षण बोरहोल (एमटीसीबी-9, 10 और 11) और क्षेत्र-3 में एक परीक्षण बोरहोल (एमटीसीबी-12) वेधन किया गया। बोरहोल संख्या एमटीसीबी-09 और 10 ठाकुरडीह-चरकमारा ब्लॉक के क्षेत्र-1 में तांबे के लिए सकारात्मक खनिज क्षेत्र को प्रतिच्छेदित करते हैं।

1.7.0 गवेषणात्मक वेधन

1.7.1 वर्तमान गवेषण कार्यक्रम के दौरान, चरकमारा क्षेत्र में तांबा युक्त अयस्क क्षेत्रों की नतिलंब और गहराई की निरंतरता की जांच करने और क्षेत्र -1 एवं ब्लॉक क्षेत्र का एरिया-3में भूभौतिकीय विसंगति का परीक्षण करने के लिए कुल 1497.50 मीटर गवेषणात्मकवेधन (जी 3 चरण) वाले कुल 12 बोरहोल किए गए। (अनुलग्नक IA)

1.7.2 चरकमारा क्षेत्र में, जमीन की सतह से 60 मीटर ऊर्ध्वाधर गहराई (20 एमआरएल) तक खनिजीकरण की जांच करने के लिए शुरुआत में कुल 5 बोरहोल (600.00 मीटर) यानी एमटीसीबी-01 से एमटीसीबी-05 वेधन किए गए। सकारात्मक खनिजयुक्त क्षेत्र चौराहों के आधार पर और टीसीसी समिति की सलाह के अनुसार तीन सशर्त बोरहोल यानी एमटीसीबी -06, एमटीसीबी -07 और एमटीसीबी -08 को जमीन की सतह से 120 मीटर ऊर्ध्वाधर गहराई (-40 एमआरएल) तक दूसरे स्तर के प्रतिच्छेदनों के लिए वेधन किया गया था। बोरहोल 100 मीटर के अंतराल पर लगाए जाते हैं और चरकमारा क्षेत्र में बोरहोल की गहराई 120.00 मीटर से 160 मीटर तक होती है।

1.7.3 भूभौतिकीय सर्वेक्षण के परिणाम के आधार पर कुल 3 नग. लगभग 60 मीटर ऊर्ध्वाधर गहराई पर भूभौतिकीय विसंगति का परीक्षण करने के लिए क्षेत्र-1 में परीक्षण बोरहोल (एमटीसीबी-9, 10 और 11) और क्षेत्र-3 में एक परीक्षण बोरहोल (एमटीसीबी-12) वेधन किया गया। परीक्षण बोरहोल प्रकृति में स्काउट बोरहोल हैं और गहराई में भूभौतिकीय विसंगति का परीक्षण करने के लिए निर्दिष्ट स्थानों पर वेधन किए जाते हैं। क्षेत्र-1 और 3 में बोरहोल की गहराई न्यूनतम 85 मीटर (एमटीसीबी -10) से अधिकतम 97.50 मीटर (एमटीसीबी -11) तक होती है ।

1.7.4 सभी बोरहोल कोर को लॉग किया गया और खनिज क्षेत्रों की पहचान की गई और एमईसीएल रासायनिक प्रयोगशाला, नागपुर और अन्य सरकारी/एनएबीएल मान्यता प्राप्त प्रयोगशालाएँ में तांबे और संबंधित तत्वों के नमूने तैयार किए गए और उनका विश्लेषण किया गया । ।

1.7.5 चरकमारा क्षेत्र में, कुल 94 नमूनों के बोरहोल कोर प्राथमिक नमूना विश्लेषण से संकेत मिलता है कि Cu मान न्यूनतम <0.01% Cu से अधिकतम 20.06% Cu तक होता है। कुल 94 नमूनों में से , कुल 75 नमूनों में <0.20% Cu और 17 नमूनों में Cu का मान >0.20% Cu से 0.81% Cu तक दर्शाया गया है। दो नमूनों में क्षेत्र में उच्च Cu मान 6.41% Cu (नमूना # MTCB-06/08) और 20.06% Cu (नमूना # MTCB-6/07) दिखाया गया है। (अनुलग्नक III-ए)

1.7.6 कुल 94 बोरहोल कोर नमूनों से पता चलता है कि चरकमारा क्षेत्र में Ni मान न्यूनतम <0.01% Ni से अधिकतम 0.25% Ni तक होता है। केवल दो नमूनों में >0.10% Ni यानी 0.13% Ni (नमूना # MTCB07/07) और 0.25% Ni (नमूना # MTCB04/02) दर्शाया गया है। Mo का मान न्यूनतम <0.01% Mo से अधिकतम 0.04% Mo तक होता है, Co का मान <0.01% Co से 0.03% Co तक होता है और W का मान 0.01% से कम होता है। Ni, Mo, Co और W के लिए बोरहोल कोर नमूना विश्लेषण उत्साहवर्धक नहीं है। (अनुलग्नक III-ए)

1.7.7 क्षेत्र-1 में, कुल 42 नमूनों के बोरहोल कोर नमूना विश्लेषण से संकेत मिलता है कि Cu मान न्यूनतम <0.01% Cu से अधिकतम 2.44% Cu तक होता है। कुल 30 नमूनों में <0.2% Cu मान दर्शाया गया है और 12 नमूनों में Cu मान >0.20% Cu से 2.44% Cu तक दर्शाया गया है। एक नमूने में उच्च Cu मान 2.44% Cu दिखाया गया (नमूना # MTCB-10/10)। Ni का मान न्यूनतम <0.01% Ni से लेकर अधिकतम 0.10% Ni, Co का मान <0.01% Co से 0.05% Co, Mo और W का मान एरिया-1 में 0.01% से कम है। **Ni, Mo, Co**और **W** के लिए बोरहोल कोर नमूना विश्लेषण मूल्य उत्साहजनक नहीं हैं।

1.7.8 क्षेत्र-3 में, कुल 6 संख्या (MTCB-12) नमूनों में Cu मान <0.01% Cu से 0.08% Cu तक दर्शाया गया है, Ni मान 0.01% Ni से 0.04% Ni, Mo, Co और Wo मान इससे कम हैं क्षेत्र-3 में 0.01%है। तांबे और उससे जुड़े तत्वों के मूल्य उत्साहवर्धक नहीं हैं।

1.7.9 कुल20 नग. एमईसीएल प्रयोगशाला, नागपुर में अग्नि परख विधि द्वारा सोने (Au) के लिए प्राथमिक नमूनों का विश्लेषण किया गया । Au का मान <0.1 पीपीएम से 0.24 पीपीएम तक

होता है । कुल 20 में से 12 नमूने <0.1ppm Au और 2 नग नमूने दर्शाए गए >0.2 पीपीएम Au। सोने के मान उत्साहवर्धक नहीं हैं।

1.7.10 व्यक्तिगत प्राथमिक नमूनों के विश्लेषणात्मक परिणामों के आधार पर, बोरहोल्स में प्रतिच्छेदित खनिज क्षेत्रों की पहचान लोड सहसंबंध के लिए 0.2% Cu कट-ऑफ पर की गई है। कुल 14 बोरहोलों में से (12 नग एमईसीएल + 02 नग जीएसआई), 11 नग बोरहोल के कट-ऑफ मान 0.2% Cu पर खनिज क्षेत्र को प्रतिच्छेदितकिया गया है। एमईसीएल के कुल 9 बोरहोल्स ने 0.2% घन कट-ऑफ मूल्य पर खनिज क्षेत्रों को प्रतिच्छेदित किया। प्रतिच्छेदनकी गहराई चरकमारा क्षेत्र में जमीन की सतह से ऊर्ध्वाधर गहराई 38.45 मीटर (52.60 mRL) से 164 मीटर (-39.68 mRL) और क्षेत्र -1 में 75.0 मीटर 927.30 mRL) से 84.90 (20.60 mRL) तक भिन्न होती है। 0.20% Cu पर बोरहोल के अनुसार खनिजयुक्त विवरण (केवल सहसंबंध उद्देश्य के लिए) अनुबंध V-A में दिया गया है।

1.7.11 चरकमारा क्षेत्र में, तांबाधारित जोन/लोड 60° से 70^0 SE दिशा में नति के साथ $N20^0$ E-$S20^0$ W नतिलंब हैं । 0.2% Cu कट-ऑफ/थ्रेसहोल्ड पर चार खनिज क्षेत्र, जिन्हें Lode-1, 1A, 1B और 2 के रूप में क्रमांकित किया गया है, चरकमारा क्षेत्र में पिछले जीएसआई और वर्तमान एमईसीएल बोरहोल द्वारा वेधन किए गए बोरहोल में प्रतिच्छेदित हैं। लोड-1 (MTCB-07 3.22 मीटर मोटाई पर 0.27% Cu का विश्लेषण करता है) क्षेत्र में सबसे स्थायी लोड है। चरकमारा क्षेत्र में जीएसआई (1984) के पिछले 2 बोरहोलों ने 0.59% Cu, 1.35m मोटाई से अधिक 0.11% Ni और 2.05m मोटाई से अधिक 2.74% Cu के दो खनिज क्षेत्रों का संकेत दिया।वेधन डेटा से संकेत मिलता है कि चरकमारा क्षेत्र में खनिज निर्माण की प्रकृति अनियमित है। अलग-अलग लोड मोटाई में कम और ग्रेड में कम होते हैं, जिनमें सीमित नतिलंब और गहराई की दृढ़ता होती है।

1.7.12 क्षेत्र-1 में, एकीकृत भूभौतिकीय विसंगति ने वेधन किए गए बोरहोल में 1ए, 1बी, 1एए और एक स्थानीय लघु क्षेत्र की गहराई पर खनिजीकरण के तीन क्षेत्रों को प्रतिच्छेदितकिया। लोड 1बी (एमटीसीबी-09 3.22 मीटर से अधिक मोटाई में 0.26% Cu का विश्लेषण करता है) और लोड-1एए (5.20 मीटर से अधिक मोटाई में 0.46% Cu के साथ एमटीसीबी-10) क्षेत्र-1 में प्रतिच्छेदित हैं, उनकी काफी मोटाई के लिहाज से महत्वपूर्ण हैं और जोन मेंनतिलंब और गहराई केसाथ-साथ बने रहने की संभावना है। क्षेत्र-3 में वेधन किया गया एक परीक्षण बोरहोल किसी भी खनिज क्षेत्र को नहीं प्रतिच्छेदित करता है।

1.7.13 कुल 1797.95 मीटर वेधन डेटा में एमईसीएल के 12 बोरहोल (1497.50 मीटर) और जीएसआई के 2 पुराने बोरहोल (300.45 मीटर) शामिल हैं, जिन्हें कट-ऑफ ग्रेड मानदंड मापदंडों के अनुसार भूवैज्ञानिक व्याख्या, सहसंबंध और संसाधन के मूल्यांकन के लिए ध्यान में रखा गया है।

1.8.0 संसाधन आकलन तकनीक

1.8.1 तांबे के लिए खनिज क्षेत्रों को 0.20% Cu कट-ऑफ ग्रेड पर बोरहोल नमूनों के प्राथमिक रासायनिक विश्लेषण के परख के आधार पर संसाधन अनुमान के लिए चित्रित किया गया है,

जिसमें 2.00 मीटर की न्यूनतम स्टॉपिंग चौड़ाई को वास्तविक मोटाई और अधिकतम 3.00 मीटर के पार्टिंग पर विचार किया गया है। . (अनुलग्नक V-B)।

1.8.2 ब्लॉक क्षेत्र केतांबे के अयस्क संसाधन का अनुमान "भूवैज्ञानिक क्रॉस-सेक्शन विधि" (प्रधान विधि) के साथ-साथ "अनुदैर्ध्य ऊर्ध्वाधर खंड विधि" (चेक विधि) द्वारा चरकमारा क्षेत्र और ब्लॉक क्षेत्र के क्षेत्र-1 में अलग-अलग किया गया है।

1.8.3 ब्लॉक में तांबा अयस्क संसाधन अनुमान के लिए औसत विशिष्ट गुरुत्व 3.00 लिया गया है।

1.9.0 संसाधनों की रिपोर्टिंग

1.9.1 ठाकुरडीह-चरकमारा ब्लॉक के चरकमारा और क्षेत्र-1 में भूवैज्ञानिक क्रॉस सेक्शन विधि द्वारा **0.20% Cu कट-ऑफ ग्रेड मानदंड** पर अनुमानित कुल तांबा अयस्क संसाधन । **45017** का कुल सकल संसाधन **चरकमारा क्षेत्र में टन (0.045 मिलियन टन) अनुमानित है । सकल संसाधनों से 10% कटौती के बाद कुल शुद्ध भूगर्भिक संसाधन 40516 टन (0.040 मिलियन टन) हैं** , जिनका औसत ग्रेड 2.96 मीटर की औसत मोटाई पर **0.27% Cu है।** संसाधन का अनुमान 100 मीटर की स्ट्राइक लंबाई और 135 मीटर (-50 एमआरएल) की ऊर्ध्वाधर गहराई तक है । चरकमारा क्षेत्र में अनुमानित संसाधन को यूएनएफसी की अनुमानित खनिज संसाधन श्रेणी (333) के अंतर्गत रखा गया है। (अनुलग्नक-IX)

1.9.2 क्षेत्र-1 में, कुल **सकल** और **शुद्ध भूवैज्ञानिक यथास्थान** संसाधन क्रमशः **142987 टन (0.14 मिलियन टन)** और **128689** टन (**0.13 मिलियन टन) हैं** , ब्लॉक में 3.23 मीटर की औसत मोटाई पर **0.39% Cu के औसत ग्रेड** के साथ क्षेत्र। संसाधन 200 मीटर की संचयी स्ट्राइक लंबाई और 90 मीटर (-5.00 mRL) की ऊर्ध्वाधर गहराई तक अनुमानित है। अनुमानित संसाधनों को यूएनएफसी की रिकॉन्सैसेंस मिनरल रिसोर्स (334) श्रेणी के अंतर्गत रखा गया है। (अनुलग्नक-IX).

1.9.3 चरकमारा क्षेत्र और क्षेत्र-1 के लिए क्रॉस सेक्शन विधि द्वारा अनुमानित 0.20% बोरहोल-वार संसाधन का विवरण **अनुबंध-IX** में प्रस्तुत किया गया है। ठाकुरडीह-चरकमारा ब्लॉक क्षेत्र में 0.2% Cu कट-ऑफ पर क्रॉस सेक्शन विधि द्वारा चरकमारा क्षेत्र और क्षेत्र-1 के सारांशित संसाधन तालिका संख्या 1.3 के नीचे दिए गए हैं।

तालिका संख्या 1.3:
क्रॉस सेक्शन विधि द्वारा अनुमानित संसाधनों (333 और 334) का सारांश
0.2 Cu कट-ऑफ ग्रेड पर।

क्षेत्र का नाम	यूएनएफसी संसाधन श्रेणी	सकल कुल संसाधन (टन)	शुद्ध संसाधन (टन)	औसत ग्रेड (Cu%)	औसत मोटाई (एम)	लोड नं.	कुल धातु सामग्री (टन)
चरकमारा	(333)	45017	40516	0.27	2.96	1	109
क्षेत्र-1	(334)	142987	128689	0.39	3.23	1बी, 1एए	502
कुल	**(333+334)**	**188004**	**169205**	**0.36**	**3.10**	**-**	**611**

1.9.4 भूवैज्ञानिक क्रॉस सेक्शन विधि द्वारा अनुमानित संसाधन की विश्वसनीयता का पता लगाने के लिए, चरकमारा और ठाकुरडीह-चरकमारा के क्षेत्र-1 में अनुदैर्ध्य ऊर्ध्वाधर (एलवी) अनुभाग पैनल विधि द्वारा 0.20% घन कट ऑफ ग्रेड का अनुमान लगाया गया है । अवरोध पैदा करना। चरकमारा क्षेत्र में एलवी सेक्शन पैनेल विधि द्वारा यूएनएफसी की 333 श्रेणी के तहत 0.20% **Cu** कट-ऑफ पर अनुमानित कुल सकल भूवैज्ञानिक यथास्थान और शुद्ध संसाधन **45278 टन (0.045 मिलियन टन) और** औसत के साथ **40750 टन (0.040 मिलियन टन) 0.27% Cu** का ग्रेड है। **इसी तरह यूएनएफसी की 334 श्रेणी के अंतर्गत क्षेत्र-1 में 0.20% Cu कट-ऑफ पर अनुमानित कुल सकल भूवैज्ञानिक इन-सिटू और शुद्ध संसाधन 0.39 के औसत ग्रेड के साथ 142918 टन (0.14 मिलियन टन) और 128626 टन (0.13 मिलियन टन) हैं । % Cu.** चरकमारा क्षेत्र और क्षेत्र-1 के लिए एलवी सेक्शन पैनल पद्धति द्वारा अनुमानित 0.20% बोरहोल-वार संसाधन का विवरण **अनुबंध- X** में प्रस्तुत किया गया है। चरकमारा क्षेत्र (यूएनएफसी कोड :333) और क्षेत्र-1 (यूएनएफसी कोड:334) में एलवी अनुभाग पैनल विधि द्वारा 0.20% घन कट ऑफ पर अनुमानित संसाधनों का सारांश तालिका **-1.4 में दिया गया है।**

तालिका 1.4
एलवी अनुभाग विधि द्वारा 0.2% Cuकट ऑफ ग्रेड पर तांबाअयस्क संसाधन
(333+334) का सारांश

क्षेत्र का नाम	यूएनएफसी संसाधन श्रेणी	सकल कुल संसाधन (टन)	शुद्ध संसाधन (टन)	औसत ग्रेड (Cu%)	लोड नं.	कुल धातु सामग्री (टन)
चरकमारा	(333)	45278	40750	0.27	1	110
क्षेत्र-1	(334)	142918	128626	0.39	1बी, 1एए	502
कुल	**(333+334)**	**188196**	**169376**	**0.36**	**-**	**605**

1.9.5 चरकमारा क्षेत्र में 0.20% Cu कट-ऑफ ग्रेड पर भूवैज्ञानिक क्रॉस सेक्शन और एलवी सेक्शन पैनल विधि द्वारा अनुमानित संसाधन के बीच का अंतर 0.58% है यानी भूवैज्ञानिक क्रॉस सेक्शन द्वारा अनुमानित संसाधन एलवी अनुभाग पैनल विधि की तुलना में 0.58% कम है। . हालाँकि, एलवी सेक्शन और जियोलॉजिकल क्रॉस सेक्शन विधि द्वारा अनुमानित ग्रेड समान यानी 0.27% है । क्षेत्र-1 में दोनों संसाधनों की तुलना करने पर, भूवैज्ञानिक क्रॉस सेक्शन विधि द्वारा अनुमानित संसाधन एलवी अनुभाग पैनल विधि की तुलना में थोड़ा 0.04% अधिक है और एलवी अनुभाग और भूवैज्ञानिक क्रॉस सेक्शन विधि द्वारा अनुमानित ग्रेड समान हैं। दोनों विधियों के संसाधनों में भिन्नता मामूली (नगण्य) है और सीमा के भीतर है (अर्थात <5%)। इसलिए, संसाधन अनुमान की विश्वसनीयता स्थापित की गई है और सभी व्यावहारिक उद्देश्यों के लिए भूवैज्ञानिक क्रॉस सेक्शन विधि द्वारा अनुमानित संसाधन पर विचार किया गया है।

1.9.6 चरकमारा क्षेत्र मेंवर्तमान गवेषण के दौरान, पहलेस्तर (60 मीटर ऊर्ध्वाधर गहराई) और कुछ दूसरेस्तर (120 मीटर ऊर्ध्वाधरगहराई) पर खनिज क्षेत्रों की नतिलंब और गहराई की निरंतरता की जांच करने के लिए पहले से वेधन किए गए जीएसआई बोरहोल के अनुरूप लगभग 100 मीटर के अंतराल पर बोरहोल लगाए गए थे। क्षेत्र में पाए जाने वाले तांबे के अयस्क क्षेत्र/लोड दुबले, अनियमित, लेंसोइडल, पृथक अयस्क शूट हैं। खनिजकरण की प्रकृति और शैली, बोरहोल घनत्व और भूवैज्ञानिक अनुभाग अंतराल 100 मीटर को ध्यान में रखते हुए एमईएमसी नियम 2015 के अनुसार तांबे के लिए जी-3 चरण की खोज के मानदंडों को लगभग पूरा करते हुए। चरकमारा क्षेत्र के कुल अनुमानित तांबा अयस्क संसाधन को "अनुमानित खनिज संसाधन" के रूप मेंयूएनएफसी प्रणाली के अनुसार कोड 333 के साथ श्रेणी और खनिज (खनिज सामग्री के साक्ष्य) नियम -2015 में दिए गए विनिर्देशों के अनुसार वर्गीकृत किया जा सकता है।

1.9.7 क्षेत्र-1 में वेधन किए गए तीन परीक्षण बोरहोल प्रकृति में स्काउट बोरहोल हैं जो 60 मीटर ऊर्ध्वाधर गहराई तक एकीकृत सतह भूभौतिकीय विसंगति का परीक्षण करने के लिए निर्दिष्ट स्थानों में वेधन किए गए हैं। इसलिए, क्षेत्र-1 में अनुमानित संसाधन को यूएनएफसी प्रणाली और एमईएमसी नियम 2015 के अनुसार कोड 334 के साथ "आवीक्ष खनिज संसाधन" श्रेणी के रूप में वर्गीकृत किया जा सकता है।

1.9.8 ब्लॉक क्षेत्र के कुल अनुमानित संसाधनों को चरकमारा क्षेत्र में "अनुमानित खनिज संसाधन" (333) के अंतर्गत और ठाकुरडीह-चरकमारा ब्लॉक क्षेत्र के क्षेत्र -1 में "आवीक्ष खनिज संसाधन" (334) श्रेणी के अंतर्गत रखा गया है।

1.10.0 सिफ़ारिशें

1.10.1 एकीकृत भूभौतिकीय विसंगतियों ने क्षेत्र-1 में वेधन किए गए परीक्षण बोरहोल में काफी मोटाई और ग्रेड के महत्वपूर्ण खनिज क्षेत्रों को गहराई पर प्रतिच्छेदित किया है। इसलिए, पूर्वेक्षण की संभाव्यता का पता लगाने के लिए, ठाकुरडीह-चरकमारा ब्लॉक के क्षेत्र -1 में अयस्क क्षेत्र की नतिलंब और गहराई की दृढ़ता की पुष्टि करने के लिए सिमरहित जी 3/ जी 2 चरण के गवेषण की सिफारिश की गई है।

1.10.2 चरकमारा क्षेत्र में तांबे के खनिजकरण में सीमित नति और नतिलंब निरंतरता के पतले लेंस/ अयस्क शामिल हैं जो संभवतः छोटे अयस्क शूट के कारण होते हैं। हालाँकि, बोरहोल MTCB-04 ने सतह से 120 मीटर ऊर्ध्वाधर गहराई पर लोड-1 (3.15 मीटर मोटाई पर 0.27% Cu का विश्लेषण) को प्रतिच्छेदित किया है। खनिज पदार्थ की अनियमित प्रकृति को ध्यान में रखते हुए , इस स्तर पर सीमित वेधन डेटा से अयस्क शूट की उपसतह प्रकृति और नियंत्रण का पता नहीं लगाया जा सकता है। इसके अलावा, निकटवर्ती मुंडादेवता-दरखुली और दक्षिण झरिया जी2 ब्लॉक संसाधन का सतह से 245 मीटर ऊर्ध्वाधर गहराई तक परीक्षण किया गया। इसलिए, क्षेत्र की समान भूवैज्ञानिक संरचना को ध्यान में रखते हुए, ठाकुरडीह-चरकमारा प्रखंड के चरकमारा ब्लॉक में अयस्क क्षेत्रों की नतिलंब और गहराई की दृढ़ता का परीक्षण करने के लिए अनुभाग संख्या 1-1' से 5-5' के बीच 300 मीटर ऊर्ध्वाधर गहराई तक कुछ गहरे स्तर के बोरहोल प्रतिच्छेदनों को वेधन किया जा सकता है।

GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION (G3) FOR COPPER ORE IN THAKURDIH-CHARAKMARA BLOCK SINGHBHUM COPPER BELT, EAST SINGHBHUM DISTRICT, STATE – JHARKHAND

CHAPTER-1B

EXECUTIVE SUMMARY

1.0.0 INTRODUCTION

1.1.1 Copper with its unique physical, mechanical and electrical properties, has played a vital role in the industrial growth of a nation. In India, around 75% of demand is met through imports. The increasing demand of Copper metal in the country can be eased with the exploration of new copper deposits of economic importance. In view of the above, exploration for copper ore has been accorded high priority in the XIIth Plan document.

1.1.2 During the last three decades, no large base metal deposit has been discovered in India. However, the possibility of working of small mineral bodies in proximity to each other, through technological advances and increased operational efficiency, cannot be ruled out. Therefore, it is utmost imperative to locate and explore such small sized deposits in clusters.

1.1.3 Thakurdih-Charakmara Block area is located near the southeastern extremity of the Singhbhum Shear Zone and forms the part of Baharagora Copper prospect. The existence of old workings (shallow pits) for copper in the area was reported by previous workers (Stoehr 1870 & Dunn 1937). The area was covered by airborne multi-instrument geophysical surveys in 1963. Ground evaluation of the electromagnetic and magnetic signatures coupled with the available geological knowledge indicated the presence of potential mineralized zones in the Baharagora area. Integrated geological, geochemical and ground geophysical surveys and exploratory drilling in the area by GSI (FS 1975-76 & 1977-78) indicated a number of small blocks i.e. Mundadevta-Darkhuli & South Jharia and Charakmara area. Mundadevta-Darkhuli & South Jharia block was recently explored by MECL (2021-22) at G2 stage for Copper and a net geological instu resource of 1.75 million tonnes of 0.96% Cu at 0.50% Cu cut-off and 0.64 million tonnes of 1.46% Cu at 1.00 Cu cut-off was estimated up to 245m vertical depth. The present Thakurdih-Charakmara exploration block is just adjoining and extention to the Mundadevta-Darkhuli & South Jharia Block.

1.1.4 To the east of Charakmara, there is a line of discontinuous pits for a distance of about 500m in a NE-SE direction in metabasites, basic schists and biotite quartz schist within the granitic country rocks. Previous work of GSI (1974) indicated

Strong Geochemical anomalies and weak Geophysical IP anomalies in Charakmara area. Two test old boreholes (BC-1 &2) of GSI drilled in Charakmara area intersected a zone of mineralisation varying in width from 0.85m to 2.05m and in grade from 2.05% Cu to 0.92% Cu and 0.17% Ni at about 60m vertical depth. This zone is likely to persist along strike and dip. Similary few old workings trending in NW-SE direction located in Area-1 near Thakurdih village. Previous work of GSI indicated strong Geochemical anomalies for Copper and strong I.P. geophysical anaomalies in Area-1, 2 and 3 of the block area and corroborated well with old workings and geochemical anomalies.

1.1.5 Based on the mineral potentiality of the prospect and previous work carried out by GSI in the area, MECL formulated Exploration proposal to carry out exploration in the Thakurdih Charakmara Area and obtained consent from Department of Mines and Geology (DMG), Govt. of Jharkhand vide letter no. भू0नि0अन्वे0—42/2018/ 1820 एम0/राँची, दिनाँक:- 30.09.2021.(Annexure XI)

1.1.6 The 36th TCC meeting of NMET held on 23rd and 24th December, 2021 through vedio conferencing at Geological Survey of India, DGCO, A-II Pushpa Bhawan, New Delhi recommended the project for approval by EC for Preliminary Exploration (G3) for copper in Thakurdih Charakmara Block with an estimated cost of Rs 388.59 Lakhs including GST in time schedule of 12 months for carrying out the proposed work. Subsequently, the project was approved by 23th EC of NMET held on 11th March 2022 and same was intimated to MECL by Ministry of Mines vide letter number F.No. 23/236/2022-NMET/301, New Delhi dated 25th March, 2022. (Annexure XI).

1.1.7 The Thakurdih-Charakmara (G3) block covers an area of 10.0 sq.km and comprises four sub-blocks namely Charakmara, Area-1, 2 & 3 in close proximity to each other. The scheme of exploration includes surveying, borehole fixation and determination of co-ordinates & reduced level of boreholes by DGPS, ground geophysical survey, drilling, core logging, core sampling and associated laboratory studies.

1.1.8 The present exploration program at Preliminary Exploration (G-3) stage in Thakurdih Charakmara Block was executed by MECL as per the approved quantum of work. Exploratory drilling at 100m spacing interval carried out in Charakmara area to intersect the mineralized zones at 60m and 120m vertical depth. Integrated geophysical survey carried out in Area-1, 2 and 3 and based on geophysical anaomaly test drilling carried out in Area-1 and 3 of Thakurdih-Charakmara block. Based on exploratory drilling data, Copper ore resources with grade estimated in the area as per cut-off grade parameters and Copper ore resources placed under 333/334 category of UNFC.

1.2.0 LOCATION AND ACCESSIBILITY OF THE BLOCK

1.2.1 The study area is situated in and around Thakurdih, Charkamara, Darkhuli, Madhupur and Jharia Villages about 4km Northwest of Baharagora town and tehsil headquarter in East Singhbhum District, Jharkhand. The block area can be approached by metal road from Baharagora. Baharagora is a small town near the junction of NH-49 (Kharagpur to Bilaspur) and NH-18 (Dhanbad-Balasore), in East Singhbhum district and situated on the south-east corner of Jharkhand, India.

1.2.2 The block area covered under Survey of India Toposheet No. 73J/11, covering an area of 10.0 sq and lies between 22° 16' 52.7078" N to 22° 19' 23.4125"N latitudes and 86° 40' 34.8022"E to 86° 42' 17.8870"E longitudes. The block location is shown in **Plate-I** and **Text Figure-1**. The locational co-ordinates (Geographic & UTM) of the cardinal points of the Thakurdih-Charakmara Block, Singhbhum Copper Belt, East Singhbhum District, Jharkhand are in given in **Table 1.1**.

Table-1.1
Co-ordinates of the corner points of the block boundary of Thakurdih-Charakmara Block, Singhbhum Copper Belt, East Singhbhum District, Jharkhand

Corner Cardinal points	WGS -84 (DMS)		UTM (Zone 45N)	
	LATITUDE	LONGITUDE	Easting	Northing
1	22° 19' 23.1904" N	86° 40' 34.8022" E	466667.00	2468627.00
2	22° 19' 23.4125" N	86° 41' 56.3542" E	469000.00	2468629.00
3	22° 18' 10.7567" N	86° 41' 56.5099" E	469000.00	2466395.00
4	22° 18' 10.6238" N	86° 41' 20.5106" E	467970.00	2466393.00
5	22° 17' 26.1977" N	86° 41' 20.6089" E	467970.00	2465027.00
6	22° 17' 26.2469" N	86° 42' 17.1600" E	469588.15	2465025.27
7	22° 16' 52.8471" N	86° 42' 17.8870" E	469606.95	2463998.27
8	22° 16' 52.7078" N	86° 40' 35.1488" E	466667.00	2464000.00

1.2.3 The study area is well connected by all weathered roads to Ghatshila (50km) , Baripanda (50km), Kharagpur (60km), Jamshedpur (90) and Kolkata (200km). Chakulia and Dhalbhumgarh are the nearest railway stations. The nearest airport is Netaji Subhas Chandra Bose International Airport, Kolkata which is 200 km towards East from the area.

1.3.0 GEOLOGY AND STRUCTURE OF THE BLOCK

1.3.1 Thakurdih-Charakmara block area is located in the southeastern extremity of prominent Singhbhum Copper Belt. The block area exposes mainly Granite/ Granite Gneiss of Archaean (Singhbhum Granite Complex), Newer Dolerite of Archaean-

Proterozoic, Quartzite of Palaeoproterozoic, Schistose rocks of Palaeoproterozoic, Gravels of Tertiary and Sand Silt Clay Calcareous concretions of Pleistocene – Holocene. Most of the area is concealed under soil cover. Rock exposures are scanty in the area and the surface expression of the mineralized zone is limited and shear zone is ill defined. The previous Geochemical sampling and I.P. Resistivity survey, however, provide some anomalies but most of the information on the geology and the sulphide mineralization has been obtained from the drill holes. Sulphide mineralistion is spatially associated with metabasites or their derivates (schistose rocks) such as Chlorite-biotite schist, quartz-biotite schist and biotite-quarztites. In general, litho units strike $N20^0E$-$S20^0W$ diping 60^0 to 70^0 due SE in Charakmara area and $N60^0W$-$S60^0E$ dipping 70^0 to 80^0 due NE in Area-1 of of the Block area.

1.3.2 The main lithounits intersected in the boreholes drilled by MECL are Amphibolite, schists (biotite chlorite schist / biotite schist / Biotite Quartz Schist / Chlorite Biotite Schist / Chlorite Schist / Garnetiferous Chlorite Schist, Quartz Biotite Chlorite Schist), Dolerite, Granite, Granite Gneiss and Quartzite rock.

1.4.0 MINERALISATION

1.4.1 In Charakmara area, there is a line of discontinuous pits for a distance of about 500m in a NE-SW direction in metabasites, basic schists and biotite quartz schist within the granitic country rocks. Similary few old working trending NW-SE direction located in Thakurdih area (Area-1).

1.4.2 Sulphide mineralisation is in the form of fissure vien type associated with closely spaced shears, mostly parallel to sub-parallel to the foliation in varied lithologies. Mineralisation in this area is not confined to any particular stratigraphic horizon nor to any particular litho-unit. However, some litho-units are preferred relative to other. Mineralistion is spatially associated with metabasites or their derivative schistose rocks i.e. Chlorite-biotite schist, quartz-biotite schist and biotite-quarztites.

1.4.3 Mineralisation occur chiefly as disseminations, stringers and patches/streaks associated with with closely spaced shear zones parallel to sub-parallel to the foliation. Chalcopyrite is the main ore mineral followed by pyrite (+ marcasite) and magnetite. Nickel sulphides occur in small proportions.

1.4.6 Mineralized zones intersected in the boreholes delineated at 0.2% Cu cut-off value. Drilling data in Charakmara area indicate that four mineralized zones numbered as Lode-1, 1A, 1B and 2 starting from footwall side intersected in the boreholes drilled by GSI & MECL boreholes. In Area-1, three zones of mineralisation numbered 1A, 1B, 1AA and local starting from footwall side have been intersected in the boreholes drilled by MECL. The copper mineralisation is erratic in nature and individual lodes/zones are thin lean zones in grade with limited strike and depth continuity. The widths and grades of the lodes depend on the cut-off grade, thickness and strength of the partings.

1.5.0 EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

1.5.1 During the present G3 stage exploration, MECL carried out exploration work as per the approved scheme of prospecting. Total 12 nos of boreholes involving 1497.50m drilled in the block area. Explotory drilling work commenced on 23.04.2022 (MTCB-01) and concluded on 09.06.2023 (MTCB-12). The allied field-works including survey work i.e. borehole fixation and determination of co-ordinates & reduced level of boreholes by DGPS, ground geophysical survey and associated survey work, drilling, core logging, core sampling etc. were completed simultaneously. The survey work in the block was carried out with the help of DGPS in WGS-84 Datum. The laboratory studies including chemical analysis and physical analysis i.e. petrographic, mineragraphic and specific gravity studies were carried out simultaneously in laboratories of MECL and other Govt. /NABL accredited laboratories.

1.5.2 The details of the nature and quantum of work proposed Vs achievement is given inTable-1.2.

Table 1.2

Quantum of Work vs. Achievement by MECL in Thakurdih-Charakmara Block, Singhbhum Copper Belt, District: East Singhbhum, Jharkhand

SN	Item of Work	Unit	Approved	Achieved	Remarks
1	Survey (on 1:5000 Scale): Bore Hole Fixation and determination of co-ordinates & Reduced Level of the boreholes by DGPS	Per Point of observation	12	12	-
2	Construction of BH concrete pillars	Per Borehole	12	12	-
3	Ground Geophysical Survey : - Induced Polarization (I.P), Resistivity and Magnetic	Per Line KM	60	60	-
4	Drilling up to 300m (Hard Rock) and BH Geological Logging	m	1500	1497.5	-
5	Borehole deviation Survey by Multishot Camera	m	1500	1497.5	-
6	Drill Core Preservation	per m	300	300	-
7	**LABORATORY STUDIES : Chemical Analysis**				

SN	Item of Work	Unit	Approved	Achieved	Remarks
i)	**Primary samples**				
	a. for Cu, Ni, Mo, Co, W	Nos	150	142	-
	b. Au by Fire Assay	Nos	20	20	-
ii)	**Check samples Internal (5%)**				
	a. for Cu, Ni, Mo, Co & W	Nos	5	5	-
	b) For Au (Gold) by Fire Assay	Nos	1	1	
iii)	**Check samples External (10%)**				
	a. for Cu, Ni, Mo, Co & W	Nos	10	10	
	b) For Au (Gold) by Fire Assay	Nos	2	0	
iii)	**Composite Samples**				
	a) For 5 Radicals (Cu, Ni, Co , W Mo)	Nos	10	3	-
	b) For Au (Gold) by Fire Assay	Nos	10	0	-
8	Petrological samples (Preparation and study of thin section)	Nos	10	10	
9	Mineragraphic Studies (Preparation and study of polished section)	Nos	10	10	
10	Digital Photographs	Nos	10	10	
11	Geological Report	Nos.	1	1	

1.6.0 GEOPHYSICAL SURVEY

1.6.1 Integrated geophysical survey (I.P. Resistivity and Magnetic) carried out in the area at 100m/50m profile interval and 20m station interval (60 Lkm) in has brought out some prominent anomalies in Area-1, 2 & 3. High chargeability and low resistivity zones were delineated in Area-1 & 3 and are well corroborated with old workngs, previous geophysical and geochemical anomalies of GSI. (Annexure-XII).

1.6.2 Based on the outcome of Geophysical survey, total 3 nos. test boreholes (MTCB-9, 10 &11) drilled in Area-1 and one test borehole (MTCB-12) drilled in Area-3 to test the geophysical anomaly at about 60m vertical depth. Borehole No. MTCB-09 & 10 intersected positive mineralized zones for copper in Area-1 of Thakurdih-Charakmara block.

1.7.0 EXPLORATORY DRILLING

1.7.1 During the present exploration program, total 12 boreholes involving total 1497.50m exploratory drilling (G3 stage) carried out to check the strike and depth continuity of

copper bearing ore zones in the Charakmara area and to test the geophysical anomaly in Area-1 & Area-3 of the block area. (Annexure I-A).

1.7.2 In Charakmara area, initially total 5 boreholes (600.00m) i.e. MTCB-01 to MTCB-05 drilled to check the mineralisation up to 60m vertical depth (20 mRL) from ground surface. Based on the positive mineralized zone intersections and as per the TCC committee advice three conditional boreholes i.e. MTCB -06, MTCB -07 & MTCB -08 were drilled for 2nd level intersections up to 120m vertical depth (-40mRL) from ground surface. Boreholes are spaced at 100m interval and Borehole depth varies from 120.00m to 160m in Charakmara area.

1.7.3 Based on the outcome of Geophysical survey, total 3 nos. test boreholes (MTCB-9, 10 &11) drilled in Area-1 and one test borehole (MTCB-12) drilled in Area-3 to test the geophysical anomaly at about 60m vertical depth. Test Boreholes are scout boreholes in nature and drilled at specified locations to test the geophysical anlomaly at depth. Borehole Depth varies from minimum 85m (MTCB -10) to maximum 97.50 m (MTCB -11) in Area-1 & 3.

1.7.4 All borehole cores were logged and mineralized zones have been identified and samples were prepared and analysed for copper and associated elements in MECL Chemical Laboratory, Nagpur and other Govt. /NABL accredited laboratories.

1.7.5 In Charakmara area, Borehole core primary sample analysis of total 94 samples indicate that Cu values range from minimum <0.01% Cu to maximum 20.06% Cu. Out of total 94 samples, total 75 nos samples indicated <0.20% Cu and 17 nos samples shown Cu values range from >0.20% Cu to 0.81% Cu. Two samples shown high Cu values 6.41% Cu (Sample # MTCB-06/08) and 20.06% Cu (Sample # MTCB-6/07) in the area. (Annexure III-A)

1.7.6 Borehole core samples of total 94 nos. samples indicate that Ni values range from minimum <0.01% Ni to maximum 0.25% Ni in Charakmara area. Only two samples indicated >0.10% Ni i.e. 0.13% Ni (Sample # MTCB07/07) and 0.25% Ni (Sample # MTCB04/02). Mo values range from minimum <0.01% Mo to maximum 0.04% Mo, Co values from <0.01% Co to 0.03% Co and W values are less than 0.01%. Borehole core sample analysis for Ni, Mo, Co and W are not encouraging. (Annexure III-A)

1.7.7 In Area-1, Borehole core sample analysis of total 42 samples indicate that Cu values range from minimum <0.01% Cu to maximum 2.44% Cu. Total 30 nos samples indicated <0.2 % Cu value and 12 samples shown Cu values range from >0.20% Cu to 2.44% Cu. One sample shown high Cu value 2.44% Cu (Sample # MTCB-10/10). Ni values range from minimum <0.01% Ni to maximum 0.10% Ni, Co values range from <0.01% Co to 0.05% Co, Mo & W values are less than 0.01% in

Area-1. Borehole core sample analysis values for Ni, Mo, Co and W are not encouraging.

1.7.8 In Area-3, total 6 nos (MTCB-12) samples indicated Cu values range from <0.01% Cu to 0.08% Cu, Ni values 0.01% Ni to 0.04% Ni, Mo, Co and Wo values are less than 0.01% in Area-3. Copper and associated element values are not encouraging.

1.7.9 Total 20 nos. Primary samples were analysed for Gold (Au) by fire assay method at MECL laboratory, Nagpur. Au values range from <0.1 ppm to 0.24 ppm. Out of total 20 nos, 12 nos samples indicated <0.1ppm Au and 2 nos. indicated >0.2 ppm Au. Gold values are not encouraging.

1.7.10 Based on the analytical results of individual primary samples, Mineralised zones intersected in the boreholes have been identified at 0.2% Cu cut-off for lode correlation. Out of total 14 numbers of boreholes (12 no MECL + 02 no GSI), 11 nos. of boreholes have intersected mineralized zone at cut-off value 0.2% Cu. Total 9 Boreholes of MECL intersected mineralized zones at 0.2% Cu cut-off value. The depth of intersection varies vertical depth of 38.45m (52.60 mRL) to 164m (-39.68 mRL) from ground surface in Charakmara area and 75.0m 927.30mRL) to 84.90 (20.60mRL) in Area-1. Borehole wise Mineralized details at 0.20% Cu (for correlation purpose only) are given in Annexure V-A.

1.7.11 In Charakmara area, Copper bearing zones/lodes strike $N20^0E$-$S20^0W$ with dip of 60° to 70^0 SE direction. At 0.2% Cu cut-off/threshold four mineralized zones numbered as Lode-1, 1A, 1B and 2 intersected in the boreholes drilled by previous GSI & present MECL boreholes in Charakmara area. Lode-1 (MTCB-07 analysing 0.27% Cu over 3.22m thickness) is the most persistant lode in the area. The previous 2 boreholes of GSI (1984) in Charakmara area indicated two mineralized zones of 0.59% Cu, 0.11% Ni over 1.35m thickness and 2.74% Cu over 2.05m thickness. Drilling data indicate that mineralisastion is erratic in nature in Charakmara area. Individual lodes are lean in thickness and low in grade with limited strike and depth persistence.

1.7.12 In Area-1, integrated geophysical anomaly intersected three zones of mineralisation at depth numbered 1A, 1B, 1AA and one Local minor zone in the drilled boreholes. Lode 1B (MTCB-09 analysing 0.26% Cu over 3.22m thickness) and Lode-1AA (MTCB-10 with 0.46% Cu over 5.20 thickness) intersected in Area-1 are significant interms of their considerable thickness and zones are likely to persist along strike and depth. One test borehole drilled in Area-3 not intersected any mineralized zone.

1.7.13 Total 1797.95 m drilling data includes 12 Boreholes (1497.50m) of MECL and 2 old boreholes (300.45m) of GSI has been taken into consideration for geological interpretation, correlation and evaluation of resource as per the cut-off grade criteria parameters.

1.8.0 RESOURCE ESTIMATION TECHNIQUE

1.8.1 Mineralized zones for copper have been delineated for resource estimation on the basis of assay of primary chemical analysis of borehole samples at 0.20% Cu cut-off grade considering the minimum stoping width of 2.00m as true thickness and maximum parting of 3.00m. (Annexure V-B).

1.8.2 The copper ore resource of the block area has been estimated by "Geological cross-section Method" (principal method) as well as "Longitudinal Vertical Section Method" (check method) separately in Charakmara area and in Area-1 of the block area.

1.8.3 The average specific gravity for the copper ore resource estimation in the block is taken as 3.00.

1.9.0 REPORTING OF RESOURCES

1.9.1 The total copper ore resources estimated by Geological Cross Section Method at **0.20% Cu cut-off grade** criteria in Charakmara and Area-1 of Thakurdih-Charakmara block. Total Gross resource of 4**5017 tonnes (0.045 million tonnes)** estimated in Charakmara area**.** After 10% deduction from gross resources total **Net geological in situ resource are 40516 tonnes (0.040 million tonnes)** with an **average grade of 0.27% Cu** over average thickness of 2.96m. The resource estimated over a strike length of 100 m and upto vertical depth of 135m (-50 mRL). Resource estimated in Charakmara area placed under Inferred Mineral Resource category (333) of UNFC. (Annexure-IX)

1.9.2 In Area-1, total **Gross** and **Net geological in situ** resources are **142987 tonnes (0.14 million tonnes)** and **128689** tonnes (**0.13 million tonnes)** respectively with **average grade of 0.39% Cu** over an average thickness of 3.23m in the block area. The resource estimated over a cumulative strike length of 200m and up to a vertical depth of 90m (-5.00 mRL). Estimated resources placed under Reconnsaissance Mineral Resource (334) category of UNFC. (Annexure-IX).

1.9.3 The details of borehole wise resource at 0.20% estimated by Cross Section Method estimated for Charakmara area and Area-1 are presented in the **Annexure-IX**. The summarized resources of Charakmara area and Area-1 by cross section method at

0.2% Cu cut-off in the Thakurdih-Charakmara block area are given below **Table No.1.3**.

Table No. 1.3:
Summary of Estimated Resources (333 & 334) by cross section method At 0.2 Cu cut-off grade.

Area Name	UNFC Resource category	Gross Total Resource (Tonnes)	Net Resource (Tonnes)	Average Grade (Cu %)	Average Thickness (m)	Lode No.	Total Metal content (Tonnes)
Charakmara	(333)	45017	40516	0.27	2.96	1	109
Area-1	(334)	142987	128689	0.39	3.23	1B, 1AA	502
Total	**(333+334)**	**188004**	**169205**	**0.36**	**3.10**	**-**	**611**

1.9.4 In order to ascertain the reliability of resource estimated by Geological Cross Section Method, the same has been estimated at 0.20% Cu cut off grade by the Longitudinal Vertical (LV) Section Pannel method in Charakmara and Area-1 of Thakurdih-Charakmara block. The total gross geological in-situ and net resource estimated at 0.20% Cu cut-off under 333 category of UNFC by LV Section Pannel method in Charakmara area are 45278 tonnes (0.045 million tonnes) and 40750 tonnes (0.040 million tonnes) with an average grade of 0.27% Cu. Similary the total gross geological in-situ and net resource estimated in Area-1 under 334 category of UNFC at 0.20% Cu cut-off are 142918 tonnes (0.14 million tonnes) and 128626 tonnes (0.13 million tonnes) with an average grade of 0.39% Cu. The details of borehole wise resource at 0.20% estimated by LV Section Panel Method estimated for Charakmara area and Area-1 are presented in the **Annexure-X**. The summary of resources estimated in Charakmara area (UNFC Code:333) and in Area-1 (UNFC Code: 334) by LV Section Panel Method at 0.20% Cu cut off are given in Table**-1.4.**

Table-1.4
Summary of Copper Ore Resource (333+334) at 0.2% Cu cut off grade By LV Section Method

Area Name	UNFC Resource category	Gross Total Resource (Tonnes)	Net Resource (Tonnes)	Average Grade (Cu %)	Lode No.	Total Metal content (Tonnes)
Charakmara	(333)	45278	40750	0.27	1	110
Area-1	(334)	142918	128626	0.39	1B, 1AA	502
Total	**(333+334)**	**188196**	**169376**	**0.36**	**-**	**605**

1.9.5 The difference between resource estimated by Geological Cross Section and LV Section Panel Method in Charakmara area at 0.20% Cu cut-off grade is 0.58% i.e.

the resource estimated by Geological Cross Section is 0.58% lower than that of LV Section Panel Method. However, the grade estimated by LV Section and Geological Cross Section Method are same i.e 0.27%. On comparing both the resource in Area-1, the resources estimated by Geological Cross Section Method is slightly 0.04% higher than that of LV Section Panel Method and the grade estimated by LV section and Geological Cross section method are same. The variations in the resources of both the methods is minor (negligible) and are within the limit (i.e. <5%). Hence, the reliability of resource estimation has been established and resource estimated by Geological Cross Section Method has been considered for all practical purposes.

1.9.6 During the present exploration, boreholes were spaced at 100m interval approximately in line with previously drilled GSI boreholes to check the strike and depth continuity of mineralized zones at 1st level (60m vertical depth) and few 2nd level (120 m vertical depth) in Charakmara area. The copper ore zones/ lodes occurring in the area are lean, irregular, lensoildal, isolated ore shoots. considering the nature and style of mineralisation, borehole density and geological section interval 100m approximately fulfilling the criteria of G-3 stage exploration for copper as per MEMC Rules 2015. The total estimated copper ore resource of Charakmara area may be categorized as "Inferred Mineral Resource" category with Code 333 as per UNFC system and as per the specifications given in the Mineral (Evidence of Mineral Contents) Rule-2015.

1.9.7 Three test boreholes drilled in Area-1 are scout boreholes in nature drilled in specified locations to test the integrated surface geophysical anomaly in depth up to 60m vertical depth. Hence, estimated resource in Area-1 may be categorized as "Reconnaissance Mineral Resource" category with Code 334 as per UNFC system and MEMC Rules 2015.

1.9.8 Total estimated resources of the block area are placed under "Inferred Mineral Resource" (333) in Charakmara area and under "Reconnaissance Mineral Resource" (334) category in Area-1 of Thakurdih-Charakmara block area.

1.10.0 RECOMMENDATIONS

1.10.1 Integrated geophysical anomalies intersected significant mineralized zones of considerable thickness and grade at depth in the test boreholes drilled in Area-1. Hence, in order to ascertain the potentiality of the prospect, Seamless G3/G2 stage exploration is recommended to confirm the strike and depth persistence of ore zone in Area-1 of Thakurdih-Charakmara block.

1.10.2 Copper mineralisation in Charakmara area comprising thin lenses/orebodies of limited dip and strike continuity probably due to small ore shoots. However, Borehole MTCB-04 intersected Lode-1 (analysing 0.27% Cu over 3.15m thickness)

at 120m vertical depth from surface. Keeping in view of erratic nature of mineralisaiton, the sub surface nature and control of the ore shoots cannot be made out from limited drilling data at this stage. Moreover, the adjoining Mundadevta-Darkhuli & South Jharia G2 block resource estimated up to 245m Vertical depth from surface. Hence, in view of similar geological set up of the area few deeper level boreholes intersections up to 300m vertical depth between Section No. 1-1' to 5-5' may be drilled to test the strike and depth persistence of ore zones if any in Charakmara area of Thakurdih-Charakmara block.

CHAPTER-2

DETAILS OF THE QUALIFIED PERSON(S) / EXPLORATION AGENCY

MINERAL EXPLORATION AND CONSULTANCY LIMITED

(Formerly Mineral Exploration Corporation Limited)

(A Govt. of India Enterprise; A Miniratna-I PSE)

(Ministry of Mines, Govt. of India)

Dr. BabasahebAmbedkar Bhawan, High Land Drive Road,

Seminary Hills, Nagpur-440006.

CHAPTER-3

TITLE AND OWNERSHIP

3.1.0 TITLE OF THE REPORT

GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION (G3) FOR COPPER ORE IN THAKURDIH-CHARAKMARA BLOCK, SINGHBHUM COPPER BELT, EAST SINGHBHUM DISTRICT, JHARKHAND

Ownership: Government of Jharkhand

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

Address of Prospector: Dr. Babasaheb Ambedkar Bhavan,
High Land Drive Road, Seminary Hills, Nagpur, Pin- 440006
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 G3 stage exploratory work (Phase-I & II) in the Thakurdih-Charakmara block commenced with the surveying and exploratory drilling work with drilling of Borehole No. MTCB-01 on date 23.04.2022 and completed with the closure of Borehole No. MTCB-12 on date 09.06.2023. As per approved quantum of work, initially total 5 boreholes i.e. MTCB-01 to MTCB-05 were drilled to target ore zones at 1st level i.e 60m vertical depth (20mRL) from the surface in Charakmara area. Integrated geophysical survey (I.P. Resistivity, Magnetic) carried out to delineate potential mineralized zones in Area-1, 2 & 3. The project was reviewed in 46th TCC and 52nd meeting and as per committee advice three conditional boreholes i.e. MTCB-06 & MTCB-08 were drilled during for deeper intersections at 2nd level i.e. 120m vertical depth (140mRL) in Charakmara area. Based on the positive outcome of surface geophysical survey in Area-1 & 3, total three scout boreholes i.e. MTCB-09 to MTCB-11 drilled in Area-1 and one borehole i.e. MTCB-12 drilled in Area-3 to test the geophysical anomaly up to the vertical depth of 60m from ground surface. Altogether total 1497.50m of diamond core drilling in twelve (12nos.) boreholes achieved in the block area. Borehole fixation and determination of co-ordinates & reduced level of boreholes by DGPS, ground geophysical survey and associated

survey, diamond core drilling, core logging, core sampling etc. were completed simultaneously. The survey work in the block was carried out with the help of DGPS in WGS-84 Datum. The laboratory studies including chemical analysis and physical analysis i.e. petrographic, mineragraphic and specific gravity studies were carried out simultaneously in laboratories of MECL and other Govt. /NABL accredited laboratories.

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

3.3.1 Exploration agency: Mineral Exploration and Consultancy Limited (Formerly Mineral Exploration Corporation Limited) (A Govt. of India Enterprise-A Miniratna PSE)

3.3.2 Experience: Since 1972

Exploration agency: Mineral Exploration and Consultancy Limited

(Formerly Mineral Exploration Corporation Limited)

(A Govt. of India Enterprise-A Miniratna PSE)

Experience: Since 1972

M.Sc./M.Sc. Tech (Geology/Geophysics)

CHAPTER-4

DETAILS OF THE AREA

4.1.0 LOCATION AND ACCESSIBILITY OF THE BLOCK

4.1.1 The study area is situated in and around Thakurdih, Charkamara, Darkhuli, Madhupur and Jharia Villages about 4km Northwest of Baharagora town and tehsil headquarter in East Singhbhum District, Jharkhand. The block area can be approached by metal road from Baharagora. Baharagora is a small town near the junction of NH-49 (Kharagpur to Bilaspur) and NH-18 (Dhanbad-Balasore), in East Singhbhum district and situated on the south-east corner of Jharkhand, India. The block area covered under Survey of India Toposheet No. 73J/11, covering an area of 10.0 sq and lies between 22° 16' 52.7078" N to 22° 19' 23.4125"N latitudes and 86° 40' 34.8022"E to 86° 42' 17.8870"E longitudes.

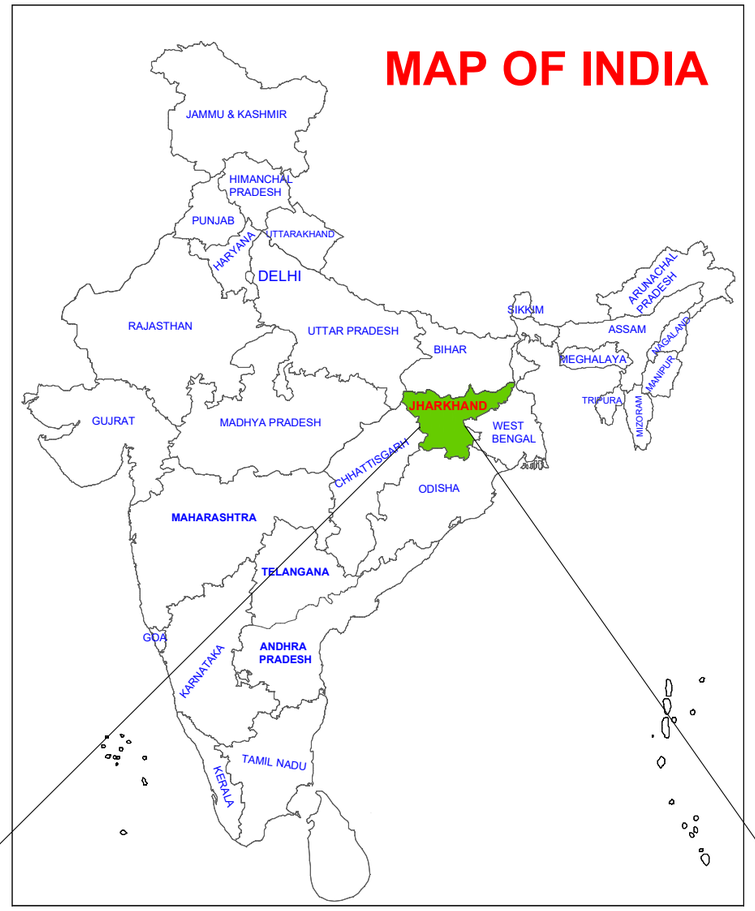
4.1.2 The block location is shown in **Plate-I** and **Text Figure-1**. The locational co-ordinates (Geographic & UTM) of the cardinal points of the Thakurdih-Charakmara Block, Singhbhum Copper Belt, East Singhbhum District, Jharkhand are in given in Table 4.1.

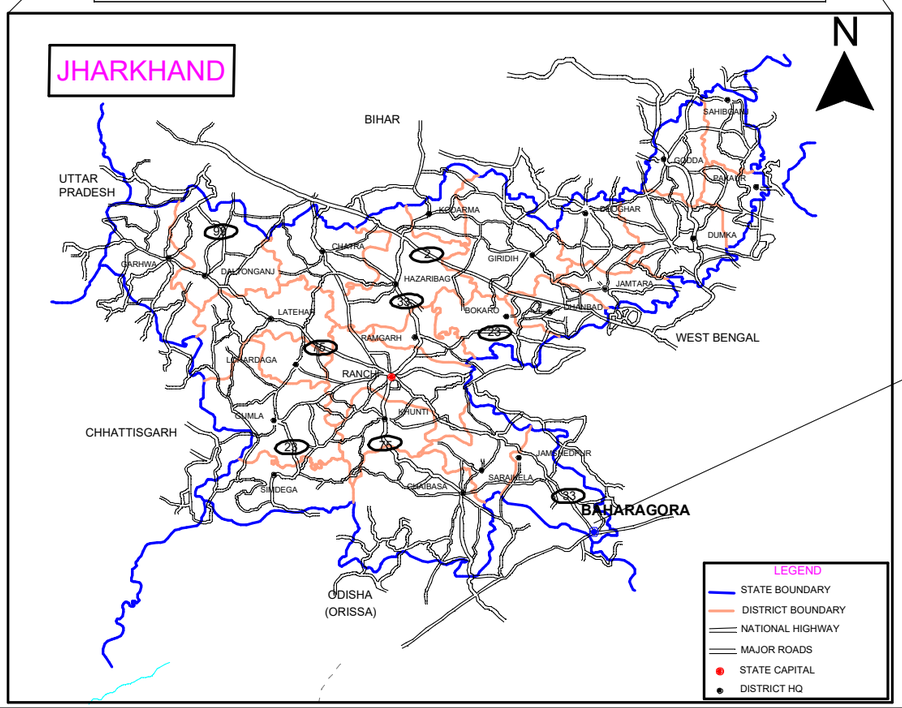
Table-4.1
Co-ordinates of the corner points of the block boundary of Thakurdih-Charakmara Block, Singhbhum Copper Belt, East Singhbhum District, Jharkhand

Corner Cardinal points	WGS -84 (DMS)		UTM (Zone 45N)	
	LATITUDE	LONGITUDE	Easting	Northing
1	22° 19' 23.1904" N	86° 40' 34.8022" E	466667.00	2468627.00
2	22° 19' 23.4125" N	86° 41' 56.3542" E	469000.00	2468629.00
3	22° 18' 10.7567" N	86° 41' 56.5099" E	469000.00	2466395.00
4	22° 18' 10.6238" N	86° 41' 20.5106" E	467970.00	2466393.00
5	22° 17' 26.1977" N	86° 41' 20.6089" E	467970.00	2465027.00
6	22° 17' 26.2469" N	86° 42' 17.1600" E	469588.15	2465025.27
7	22° 16' 52.8471" N	86° 42' 17.8870" E	469606.95	2463998.27
8	22° 16' 52.7078" N	86° 40' 35.1488" E	466667.00	2464000.00

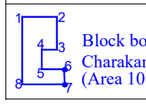
4.1.3 The study area is well connected by all weathered roads to Ghatshila (50km) , Baripanda (50km), Kharagpur (60km), Jamshedpur (90) and Kolkata (200km). Chakulia and Dhalbhumgarh are the nearest railway stations. The nearest airport is Netaji Subhas Chandra Bose International Airport, Kolkata which is 200 km towards East from the area.

LOCATION MAP OF THAKURDIH CHARAKMARA BLOCK



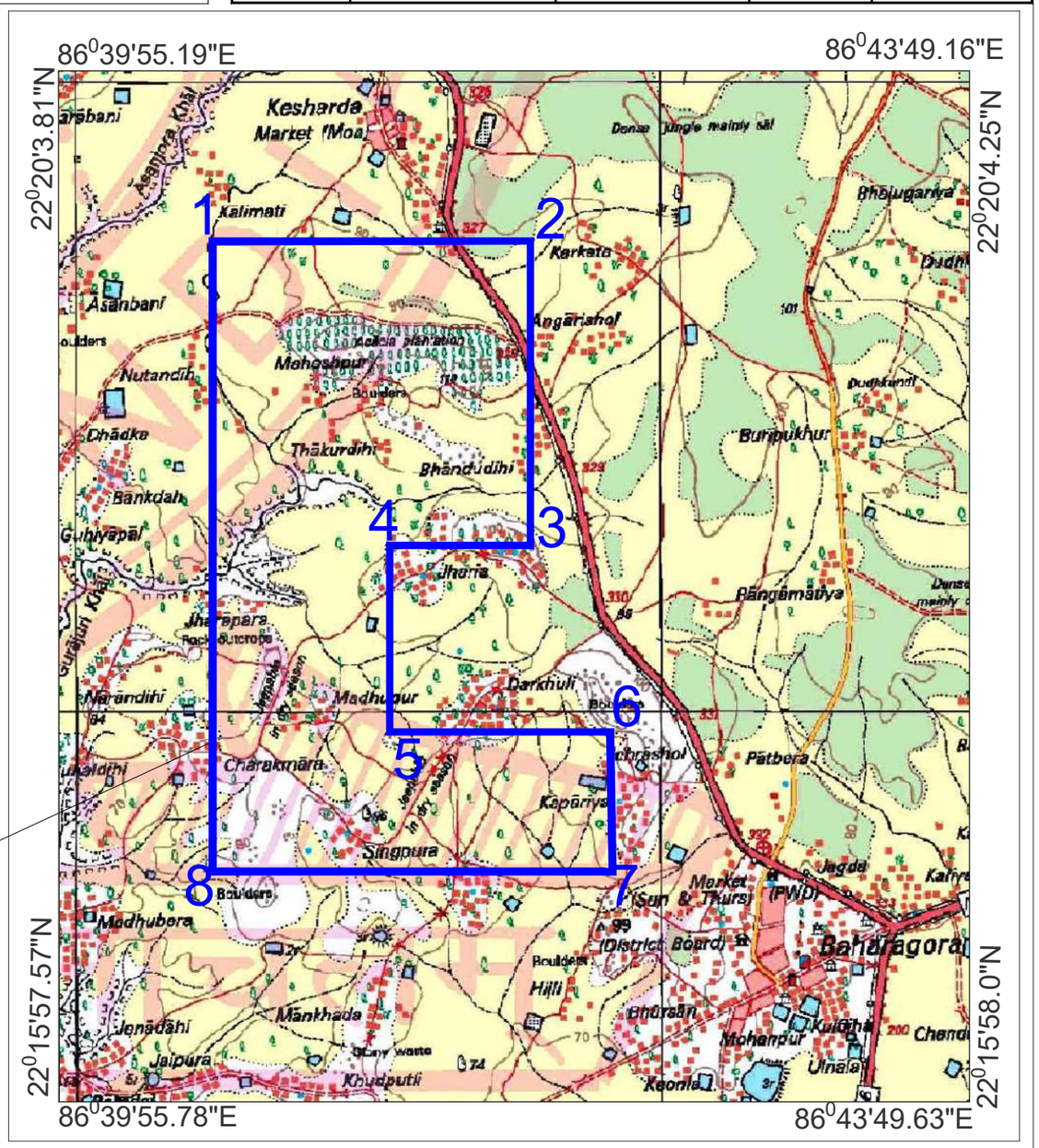


LEGEND



Block boundary of Thakurdih - Charakamara Block (Area 10 sq.km)

Corner Cardinal points	WGS -84 (DMS)		UTM (Zone 45N)	
	LATITUDE	LONGITUDE	Easting	Northing
1	22° 19' 23.1904" N	86° 40' 34.8022" E	466667.00	2468627.00
2	22° 19' 23.4125" N	86° 41' 56.3542" E	469000.00	2468629.00
3	22° 18' 10.7567" N	86° 41' 56.5099" E	469000.00	2466395.00
4	22° 18' 10.6238" N	86° 41' 20.5106" E	467970.00	2466393.00
5	22° 17' 26.1977" N	86° 41' 20.6089" E	467970.00	2465027.00
6	22° 17' 26.2469" N	86° 42' 17.1600" E	469588.15	2465025.27
7	22° 16' 52.8471" N	86° 42' 17.8870" E	469606.95	2463998.27
8	22° 16' 52.7078" N	86° 40' 35.1488" E	466667.00	2464000.00



TEXT FIGURE-1

4.2.0 DETAILS OF THE AREA WITH LAND USE

4.2.1 Area of the block is devoid of forest and majorly falls under private cultivated land.

4.3.0 MINERAL(S) UNDER INVESTIGATION

4.3.1 The block has been explored for Copper at G-3 Stage exploration.

CHAPTER-5

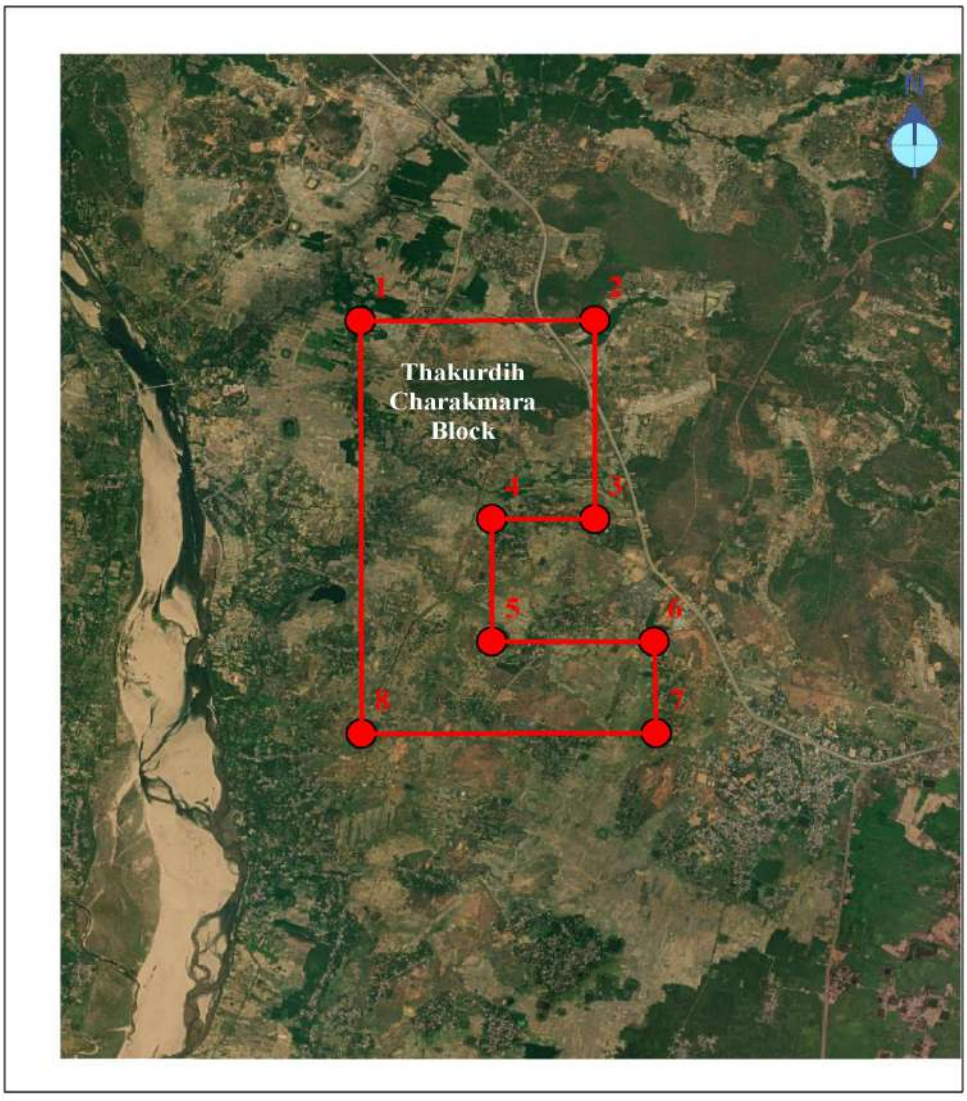
PHYSIOGRAPHY AND ENVIRONMENT

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

5.1.1 The topography in the block is generally flat except for small isolated hillocks trending NE-SW near Thakurdih Charakmara village. The elevation of the area varies from maximum 115m above MSL in northcentral part of the area (Area-1) to minimum 67.70m above MSL in Charakmara area. The major part of the area is covered by soil and alluvium and most of the area is under cultivation.

5.1.2 The Subarnarekha River flowing in north to south direction is located about 2km from the western boundary of the block area. There are no major river and nalas/streamlets exist in the area except small seasonal nalas. The general slope of ground is south, southwesterly. The block area shows the dendritic drainage pattern. The block location depicted on google satellite imagery is shown as **Text Figure No.2.**

LOCATION MAP OF THAKURDIH-CHARAKMARA BLOCK DEPICTED ON GOOGLE SATELLITE IMEGERY, EAST SINBHUM DISTRICT, JHARKHAND (Extent: 10 sq.km)



Co-ordinates of the corner points of the block boundary of Thakurdih-Charakmara Block, Singbhum Copper Belt, Giridh District, Jharkhand

Corner Cardinal points	WGS -84 (DMS)		UTM (Zone 45N)	
	LATITUDE	LONGITUDE	Easting	Northing
1	22° 19' 23.1904" N	86° 40' 34.8022" E	466667.00	2468627.00
2	22° 19' 23.4125" N	86° 41' 56.3542" E	469000.00	2468629.00
3	22° 18' 10.7567" N	86° 41' 56.5099" E	469000.00	2466395.00
4	22° 18' 10.6238" N	86° 41' 20.5106" E	467970.00	2466393.00
5	22° 17' 26.1977" N	86° 41' 20.6089" E	467970.00	2465027.00
6	22° 17' 26.2469" N	86° 42' 17.1600" E	469588.15	2465025.27
7	22° 16' 52.8471" N	86° 42' 17.8870" E	469606.95	2463998.27
8	22° 16' 52.7078" N	86° 40' 35.1488" E	466667.00	2464000.00

TEXT FIGURE-2

0.0 km 1.5 km 3.0 km

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

5.2.1 The area under study is about 4 km NW of Baharagora town. Baharagora is a small town near the junction of NH-49 (Kharagpur to Bilaspur) and NH-18 (Dhanbad - Balasore), in East Singhbhum district and situated on the south-east corner of Jharkhand, India. It is 60 km from Kharagpur, 90 km from Jamshedpur, 50 km from Ghatshila, 50 km from Baripada and 200 km from Kolkata. Chakulia and Dhalbhumgarh are the nearest railway stations. The nearest airport is Netaji Subhas Chandra Bose International Airport, Kolkata which is 200 km towards East from the area.

5.2.2 There are two high tension (HT) power line trending NW-SE and NNE-SSE passes through the present exploration block. No major telephone line passes through the block.

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

5.3.1 As per census of 2011, the total population of the district was 2293919 persons. The total urban population is 1274591 persons whereas the total rural population is 1019328 persons. The administrative division and population of the district is given in **Table – 5.1.**

Table 5.1: Administrative Division and population (Census 2011) of East Singhbhum District, Jharkhand.

Sr. No	Sub division	Block	Rural population			Urban population		
			Male	Female	Total	Male	Female	Total
1	Dalbhum	Patamda	41751	41125	82876	--	--	--
2		Boram	35142	33871	69013	--	--	--
3		Golmuri-Cum-Jugsalai	52218	50405	102623	602229	555349	1157578
4		Potka	94601	94526	189127	5317	5168	10485
5	Ghatshila	Ghatshila	45006	44275	89281	20912	19712	40624
6		Musabani	28662	28824	57486	25594	24004	49598
7		Dumaria	31043	31085	62128	--	--	--
8		Dhalbhumgarh	31309	30623	61932	--	--	--
9		Gurbandha	21703	21298	43001	--	--	--
10		Chakulia	54960	53850	108810	8352	7954	16306
11		Baharagora	78103	74948	153051	--	--	--
Total			514498	504830	1019328	662404	612187	1274591

5.4.0 SOCIO DEMOGRAPHIC PROFILE OF THE AREA AND NEARBY

5.4.1 The Thakurdih Charakmara Block lies in the Baharagora Block, East Singhbhum District Jharkhand. Baharagora block forms an administrative division in Ghatshila sub division of East Singhbhum. As per the Census India 2011, Baharagora block has a total population of 153,051, all of which are rural. There are 78,103 (51%) males and 74,988 (49%) females. Population in the age range 0-6 years are 19,937.

5.4.2 The details of the Population Census 2011, of Baharagora block are given in **Table-5.2**

Table-5.2: Census Data of Baharagora block, East Singhbhum district, Jharkhand.

Description	Rural	Urban
Number of households	35194	-
Total Population	153051	-
Population (%)	6.67%	-
Male Population	78,103	-
Female Population	74,988	-
Sex Ratio	960	-
Literacy (%)	64.45%	-

5.4.3 In Baharagora, whole population lives in rural area. There are 6.84% Scheduled Caste (SC) and 35.91% Scheduled Tribe (ST) of total population in Baharagora area.

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

5.5.1 One tourist attraction is Chitreshwar temple situated in Chitreshwar village in Baharagora Block 12 km from Baharagora. The temple is said to be one of the largest natural Shiva linga. Many devotees of Shiva come daily. Chitreshwar temple is believed to have the largest Shiva linga after Lingaraja Shiva linga in Bhubneshwar. It has another temple called Bhuteshwar, which is in Baharagora Block. Ghatsila a famous tourist spot and is also situated in the district which was once inhabited by renowned Bengali poet Bibhutibhushan Bandyopadhyay. Rankini Temple located near the mining town of Jadugora and Ghatshila are also worth mentioning. Goddess Rankini is held in high esteem and worshiped by the tribal and non-tribal people inhabiting the district.

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

5.6.1 Block area is devoid of any forest and majorly falls under private cultivated land. There are no National parks and wild life sanctuaries etc. in the vicinity of the block area.

5.7.0 FLORA AND FAUNA WITHIN AND NEARBY

5.7.1 The area is characterized by tropical flora. The rocky uplands and gravely mounds are generally occupied by thorny bushes and isolated deciduous trees. Plains are generally covered by green grass shrubs and trees. The important among them are Sal (Shorearobusta), Tamarind (Tamarindus indica), Shisham (Dalbergia latifolia), Mahua (Bassia latifolia), Bair (Zozyplus jujuba), Mango (Mangnifera indica), Jackfruit (Artocarpus integrifolia), and Bamboo (Dandrocalamusstrictus). Recently cashew nut and acacia plantation is being done in the soil covered area.

5.7.2 The wild animals present in the East Singhbhum District include Elephant, deer, bears, Pigs and Wild dogs. Tigers and panthers are present but make very rare appearance. At times they do attack village cattle and in stray cases human beings. Bears are present in large number and attack at times human being and do heavy damage to crops and fruits. Pigs are present in fairly large number and cause damage to cultivation. Wild dogs are seen frequently. (Source: https://jamshedpur.nic.in/florafauna). However, wild animals are not present/ not seen in the block area except commonely seen animals like dogs, birds and rabbits, snakes etc.

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

5.8.1 The major part of the area is covered by alluvium / soil and gravel cover. There is no major river/stream and reservoir exist in the area. However, few considerable water bodies exist on southern and north western part of the block area. The North to south flowing Subarnarekha River is draining about 2 km from the western boundary of the block area.

5.9.0 CLIMATIC CONDITIONS

5.9.1 The area experiences tropical climate. The winter season ranges from November to middle of March. The summer season commences by the end of March and continues up to early June. The summer months are scorchy and very hot. The temperature variation ranges from 9°C to 42°C in the area.

5.9.2 The rainy season starts in early June and prolong up to October. Pre-monsoon rains are also very common in the area. Being nearer to the coast, cyclonic rain is also very common. The The average annual rainfall in the East Singhbhum District is reported about 1200-1300 mm, mainly during June to August.

5.10.0 OTHER PHYSIOGRAPHIC, SOCIAL AND ENVIRONMENTAL FACTOR

5.10.1 East Singhbhum district has a leading position in respect of mining and other industrial activities in Jharkhand state. Jamshedpur is the districts headquarter of East Singhbhum. An almost five-decade old copper refinery of Hindustan Copper Limited is in operation in Moubhandar, Ghatsila, and another town of the district. The Singhbhum Shear Zone, a geological feature lying between Subarnarekha River on the northeast and Dhanjori ranges on the southwest houses the mines of Copper and Uranium. Most notable copper mines are Banalopa, Badia, Pathargora, Dhobni, Kendadih, Rakha and Surda in Musabani. Of these, only Surda remains operational. Uranium Corporation of India explores uranium in Jadugora, Narwapahar, Bhatin, Turamdih and Baghjanta. Chakulia, an important town in the southeastern part of the district, is famous for its rice mills, oil mills, washing soap factories, and bamboo production.

CHAPTER-6

INFRASTRUCTURE

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

6.1.1 The area lies in the heart of mining activity centre with producing copper mines like Surda, with one concentrator located at Mosabani and a copper smelter at Moubhandar which are in operation and close to the area (58 km). Banking and postal facilities are available at Baharagora area. Jamshedpur, the steel city has all workshop and marketing facilities. Small workshop and market is also available at Baharagora.

6.1.2 The host population, historical sites, forests, sanctuaries, national park and environmental setting of the area have been described in para 5.0.0 (Physiography and Environment).

CHAPTER-7

GEOLOGY

7.1.0 REGIONAL GEOLOGY AND STRUCTURE

7.1.1 The Precambrian Geology of the Singhbhum Craton was first built up by Dunn (1929,1937), Dunn and Dey (1942) and they divided the craton into four major structural units, which are I) Singhbhum geo-anticline comprising highly metamorphosed rocks of Iron Ore Series, II) Dalma lava geo-syncline in the north, running parallel to the geo-anticline, III) a shear-zone, known as Singhbhum Shear Zone, and IV) a second geo-anticline to the north of the Dalma Lava Geo-syncline with an intervening thrust zone. According to them Singhbhum shear zone extends from Duarpuram, North-East of Chakradharpur, in an approximately East-West direction, turns South-East near Jamshedpur and continues through Jaduguda-Rakhamines, Surda-Mosaboni-Badia mines and eventually ends up at Granites near Baharagora. However later studies revealed that the shear zone extends upto Mayurbhanj districts of Odissa where its trace can be found through some N-S trending shears.

7.1.2 Recent studies by Sarkar and Saha (1959, 1962, 1966) and subsequently Sarkar, Saha ana Miller (1969) revised the stratigraphic sequence in Singhbhum and adjoining areas (Table-I). According to these authors, the Singhbhum cratonic area had undergone three orogenic cycles- The Older Metamorphic Orogeny (3035m.y.), the Iron Ore Orogeny (2000 m.y.) and the Singhbhum Orogeny (905-934 m.y).

7.1.3 The Stratigraphic succession of the Singhbhum and adjoining areas, After Sarkar, Saha& Miller (1969) are given in following Table-7.1 and the regional geological map is given as **Plate-II** and **Text Figure-3.**

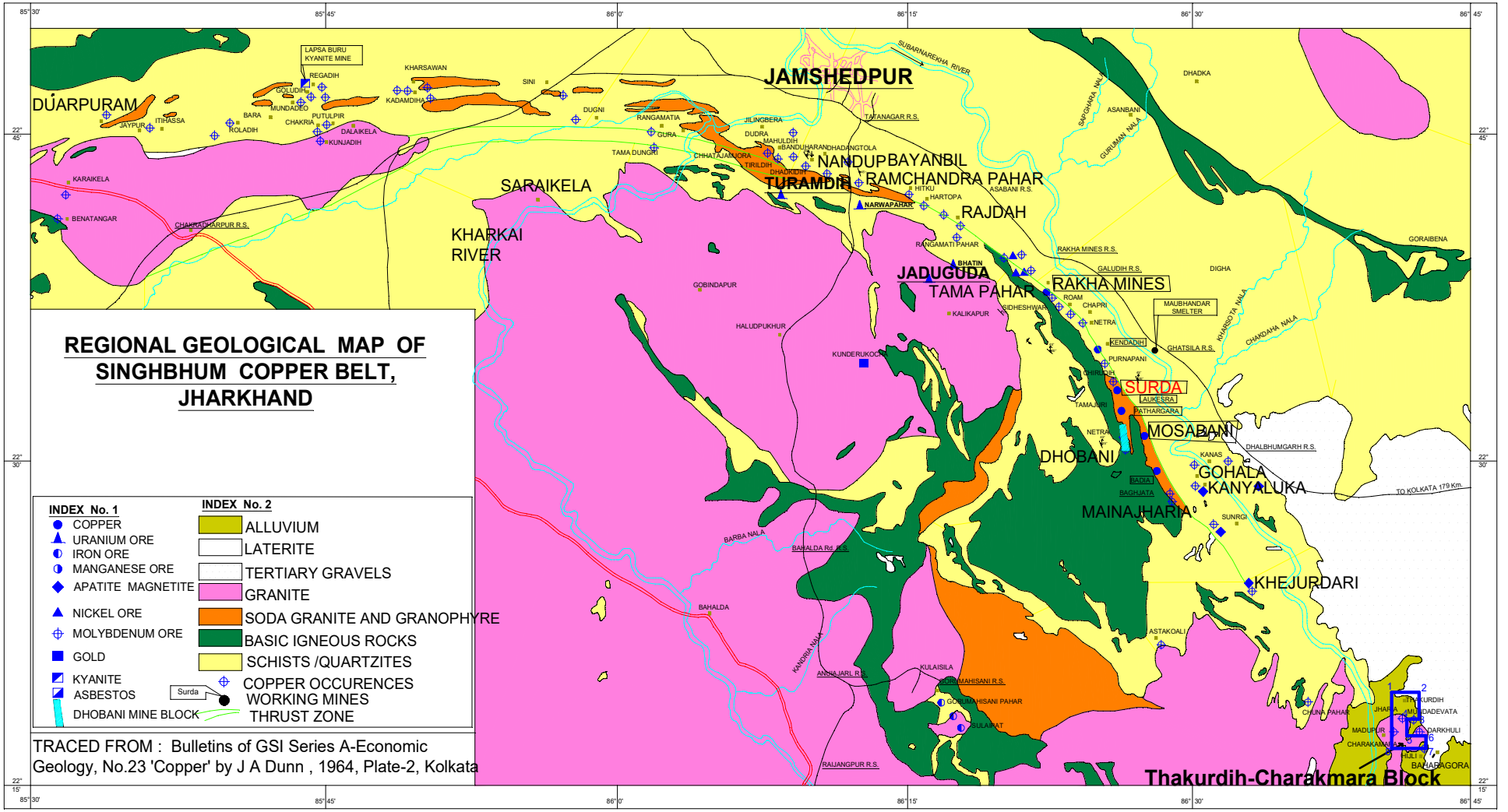
Table-7.1:

Geological Succession of the Precambrian rocks of Singhbhum and adjoining areas. After Sarkar, Saha & Miller (1969)

South of copper Belt-Thrust Zone in Singhbhum, N. Mayurbhanj and N. Keonjhar			North of Copper Belt Thrust Zone in Sungbhum		Sundargarh District
----------End of Singhbhum orogenic cycle (C. 850 m.y.)----------					
NEWER DOLERITES	Biotite Granite-gneiss of SE Singhbhum and N Mayurbhanj		Soda-granite, granophyre? Chakradharpur granite-gneiss		
	Graniphyres Gabbro-anorthosite (1470m.y.), Ultramafic intrusions (within and outside Singhbhum granite)		Kuilapal granite		
	Kolhan Group (C. 1500-1600 m.y.)		Dalma Lavas		
	Jagannathpur Lavas (1600-1700 m.y.)	Dhanjori formations	Dhalbhum formation, Chaibasa formation	Singhbhum Group? (2000-1700 m.y.)	Dhalbhum formation (I.O.S. of Krishnan Gr. Gangpur)
----------Unconformity---------- *-----End of Iron Ore Orogenic cycle (c. 2700 m.y.)---*					
	Singhbhum Granite				
	Upper shales with sandstone and volcanics Banded hematite Jasper				
Iron Ore Group	Lower shales Basic lavas Sandstone and conglomerate				
----------Unconformity---------- -- End of Older Metamorphic Orogenic Cycle (C 3200 m.y.)- -----					
	Granitic activity				
	Basic intrusives				
	Older Metamorphic Group, Calc-Gneiss, Calc-Schist, Hornblende Schist, Quartzite and Quartz Schist.				

7.1.4 Thakurdih Charakmara block is located in the southeastern extremity of Singhbhum Shear Zone and forms the Baharagora Copper prospect. The Baharagora area is the SE extension of the main Singhbhum Shear Zone. The portion in between is covered with thick alluvium for about 13km. Baharagora copper prospect consititues several sub blocks namely, Mudadevta-Darkhuli & South Jharia, Thakurdih-Charakmara. The present exploration block forms part of Baharagora copper prospect and is just adjoining and extension block to the previously explored Mundadevta-Darkhuli & South Jharia G2 block (2021-22) by MECL. The main rock types are quartzites, quartz schist, mica schist and phyllites which are intruded by basic rocks and granites. The strike varies from N-S, NE-SW to NW–SE and dip 70°-80° due E, SE and NE. Copper mineralisation associated with Ni and Mo occurs in chlorite-biotite-quartz schist associated with shears.

TEXT FIGURE-3: REGIONAL GEOLOGICAL MAP OF SINBHUM COPPER BELT, JHARKHAND SHOWING LOCATION OF THAKURDIH-CHARAKMARA BLOCK, DISTRICT EAST SINGHBHUM, STATE- JHARKHAND



HCL / ICC,Geol. Dept. (Msb) Drg. No. 348 / 88

7.2.0 REGIONAL STRUCTURE

7.2.1 The Singhbhum Shear Zone is the most important single structural element and has been traced for more than 200km, from West to the southeast, with widths varying from a few hundred meters to several kilometers, dipping about 40° northward. Mineralisation localized along the shear zone.

7.2.2 According to previous workers, the Singhbhum Shear Zone or the Copper Belt Thrust extending east from N. Singhbhum through Seraikela, turns south-east near Jamshedpur and continues through Baharagora towards Mayurbhanj in Orissa. Baharagora is thus located almost at south-eastern end of the Copper Belt Thrust. Evidences of shearing and breciation are common and preserved in the mica schists, quartzite, quart schist and quartz granulite.

7.2.3 In the Baharagora area, the shear zone is rather ill-defined, narrow and limited in extent and becomes almost obscure in the granite country. The foliation planes in schists away from the granite have been found to be shear-plates formed by transposition of earlier S-planes in the zone of shearing. The dominant linear structures are parallel to the direction of tectonic transport with the sense of movement broadly up-dip in all places.

7.3.0 MINERALISATION IN THE REGION

7.3.1 Mainly three types of mineralisation has been localised along this shear zone: Apatite-Magntite, Sulphide and Uranium mineralisation irrespective of any good relationship of time and space in between. The main sulphide minerals are Chalcopyrite, Pyrite and Pyrrhotite. Other minerals occur in minor to very minor proportions. Sulphide mineralisation is not restricted to any particular lithology. Copper is the metal mainly found with the traces of other metals such as Mo, Ni, Co, Au also reported. A number of workable deposits are there situated in the South-Eastern section of this structural unit, numerous other sulphide occurrences also found in the rest of the belt.

7.3.2 The nature and geological setting of the ore bodies, their close association in space with the metavolcanics or their derivatives, the stratabound nature of the ore bodies, absence of a well-defined pattern of wall rock alteration, metamorphosed nature of the ores, co-folding of the ore bodies with the enclosing rocks and parallelism of the ore shoots to the dominant down-dip lineations in the area indicate that the ores were emplaced at an early stage of the geologic evolution of the belt from the ore solutions derived through the leaching of ore elements of the volcanic rocks by the convective circulation of surface water (Majumdar 1984).

7.4.0 GEOLOGY OF THE BLOCK

7.4.1 Thakurdih Charakmara block is situated near the extreme southeastern tip of Singhbhum Copper Belt. The block area exposes mainly Granite/ Granite Gneiss of Archaean (Singhbhum Granite Complex), Newer Dolerite of Archaean-Proterozoic, Quartzite of Palaeoproterozoic, Schistose rocks of Palaeoproterozoic, Gravels of Tertiary and Sand Silt Clay Calcareous concretions of Pleistocene –Holocene. Exposure of rocks e.g. Granite intruded by newer dolerite dykes outcrops near Charakmara village. Quartzite/Quartz schist varying to quartz granulite forms low ridges above schistose rocks in Area-1 of the Block area. In general, most of the block area is concealed under soil cover and is under cultivation except few scanty isolated outcrops in the block area. The local geological succession of the Block area is given in **Table No. 7.2**.

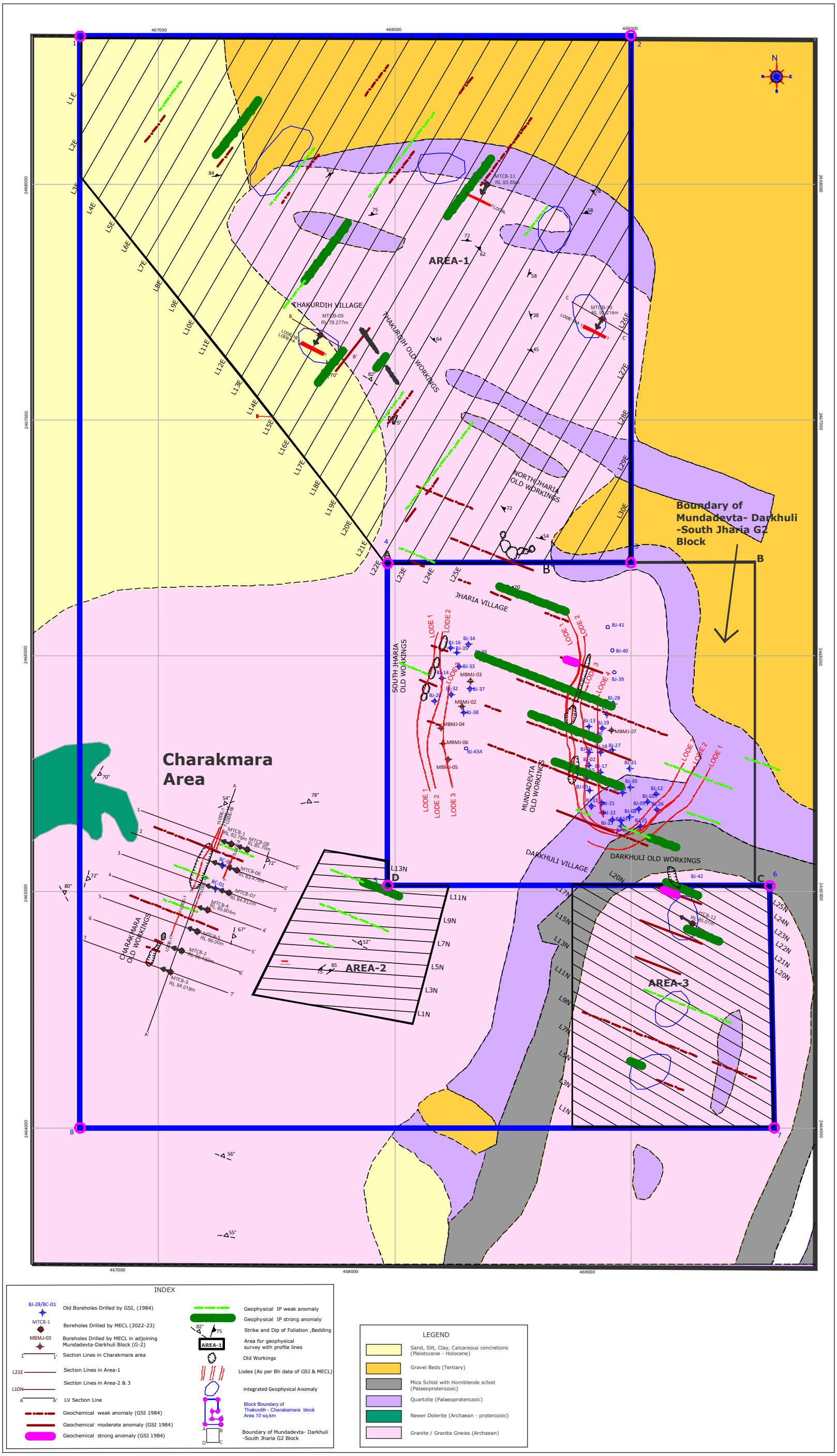
Table No. 7.2: The Local Stratigraphic Succession of the Block area

Age	Litho-units
Pleistocene - Holocene	Soil, Sand – Silt- Clay – Calcareous Concretions
Tertiary	Gravel Beds
Palaeoproterozoic	Schistose rocks,Mica Schist with Hornblende schist
	Quartzite
Archaean -Proterozoic	Newer Dolerite
Archaean	Granite / Granite gneiss

7.4.2 The main lithounits intersected in the boreholes drilled by MECL are Amphibolite, schists (biotite chlorite schist / biotite schist / Biotite Quartz Schist / Chlorite Biotite Schist / Chlorite Schist / Garnetiferous Chlorite Schist, Quartz Biotite Chlorite Schist), Dolerite, Granite, Granite Gneiss and Quartzite rock.

7.4.3 Geological mapping is not part of the present scope of work. However, available geological map (GSI) of the area sourced from Bhukosh web portal has been utilized for exploration work. The available map is verified in the field and updated map reproduced on 1:5000 scale. The Geological map of the block is presented as **Plate No.-III** and **Text Figure-4.**

TEXT FIGURE- 4 GEOLOGICAL MAP OF THAKURDIH- CHARAKMARA BLOCK



7.5.0 DESCRIPTION OF DIFFERENT LITHO UNITS

The detailed megascopic charactersitics and petrography description of rocks exposed/ intersected in the boreholes in the area are given below.

1. **Granite gneiss:** Granite gneiss present in the block area is pink, pinkish grey, grayish white to pinkish white in colour. Rock is medium grained, very hard and compact, gneissic texture, sheared and brecciated at places. Gneissosity 50° to 60° with respect to core axis, sheared fracture 20° with respect to core axis.

2. **Granite:** Granite is occupied by the major part of the block area. Granite present in the block area is pink, pinkish, pinkish white, greyish to pinkish grey, yellowish to grey in colour. Rock is medium grained, hard and compact, weathered along fractures low angle (~35° core axis) potassic alteration along few fractures at places.

   Under microscope, MTCB06/ P6 (94.54-94.62m) Microcline/ orthoclase are present as medium to moderately coarse subhedral to anhedral grains showing perthitic exsolutions. Quartz occurs as medium to fine anhedral to subhedral grains, often clustering in pockets and showing recrystallization. Plagioclase is present as fine to medium subhedral prismatic grains. Biotite is present as fine to very fine disseminated flakes. Opaques occur as fine anhedral to subhedral disseminated grains. Chlorite is seen present as fine flakes and patches showing relicts of actinolite in areas. Sericite occurs as very fine flakes developing after plagioclase alteration. Kaolinite is seen preset as dirty cloudy patches developing after microcline/ orthoclase alterations. The specimen is showing minor granulation, as very fine mottled quartzo-feldspathic aggregates are noted in areas.

3. **Dolerite:** Dolerite present is grey, greenish grey, greenish, dark greenish grey to dark grey in colour. Rock is hard compact, fine-medium grained at places few fractures are filled with secondary minerals.

   Under microscope, MTCB06/ P4 (16.96-17.04m) The specimen is made up of augite and plagioclase, where augite occurs as fine to medium subhedral prismatic to anhedral patchy grains and plagioclase occurs as fine to medium prismatic laths

showing intergranular and sub-ophitic texture. Opaques occur as fine anhedral to subhedral disseminated grains and patches showing thin corona of sphene around it, at places. Uralite/ tremolite-actinolite and chlorite together occur as greenish patches around augite grains and seen replacing it. Calcite has intruded as thin fillings and seen replacing plagioclase in areas.

4. **Quartzite:** Quartzite is well exposed in northern part of the block area i.e. Thakurdih area (Area-1). Quartzite is generally massive, hard compact light grey in colour, fine grained with hairline fractures, carbonate filling along few fractures.

Under microscope, MTCB01/ P1 (70.00 - 70.10 m) Quartz occurs as fine to medium anhedral to subhedral grains and as clustered pockets showing tight quartzitic texture. Albite is present as fine to medium subhedral prismatic grains and as turbid patches. Biotite is present as very fine flaky aggregates, mostly seen segregating in pockets. Tourmaline occurs as fine to very fine prismatic grains, patches and as fillings. Epidote occurs as fine subhedral grains. Opaques are noted as very fine specks in accessories.

5. **Schistose rocks:** These are the most abundant litho units intersected in the boreholes. These are fine to medium grained, dark grey, greyish black, greenish black and reddish brown coloured showing schistose texture. The wide range of schistose rocks occurs in the blocks and varies with varying composition, degree of metamorphism and degree of alteration. The predominant schistose rocks are biotite chlorite schist / biotite schist / Biotite Quartz Schist / Chlorite Biotite Schist / Chlorite Schist / Garnetiferous Chlorite Schist and Quartz Biotite Chlorite Schist.

The major mineral assemblage of schistose rocks are Phlogopite, quartz, chlorite, muscovite, albite, biotite, garnet, actinolite with feldspar, opaques, biotite, chlorite, albite, carbonates as minor minerals and epidote, opaques, zircon, tourmaline and sericite are present as accessory minerals.

Under microscope, ref. MTCB09/ P7 (69.90m - 70.00m) Quartz occurs as fine anhedral and elongated grains showing parallel alignment. Muscovite and biotite are present as fine to very fine disseminated flakes showing parallel alignment. Albite

occurs as fine subhedral to anhedral grains showing parallel alignment and also occurs as medium to moderately coarse porphyroblasts showing rotation. Opaques are present as fine to very fine subhedral to anhedral grains and blades aligned along the schistosity. Epidote is noted as fine to very fine anhedral to subhedral grains in accessories. The specimen is a quartz-muscovite-albite schist.

7. **Amphibolite**: The amphibolite present in the block area is greenish, greenish grey to greenish black, fine-medium grained, massive. At places, few fractures are filled with quartz carbonate and with some potassic alteration along fractures.

Under microscope, ref. MTCB06/ P5 (53.36-53.46m) Actinolite occurs as fine to medium subhedral grains and as medium to moderately coarse anhedral patchy poikiloblastic grains where very fine plagioclase and quartz grains are hosted within. Plagioclase also occurs as fine to medium subhedral to anhedral grains. Biotite is present as fine flaky aggregates in pockets. Chlorite is present as pseudomorphic patches developing after actinolite replacement.Opaques occur as fine anhedral to subhedral and skeletal grains in disseminations. Hornblende occurs as fine to medium subhedral to anhedral grains being replaced by chlorite. Sericite is noted as very fine flakes developing after plagioclase alterations.

8. **Soil:** A major portion of the block area is covered by soil with varying depth from 3.00m to 31.00m as intersected in Borehole No. MTCB-05 (Charakmara area) and MTCB-09 (Area-1) respectively. As the area is conceled under soil cover, few scanty isolated outcrops are rarely seen in the block area except in few places. Soil is yellowish to yellowish brown in Charakmara area and reddish brown, yellowish grey to brownish grey in Area 1. Soft Loose, fine, cohesive, sandy, poorly sorted, micaceous soil occurring in the area is product of weathering of parent rock underneath. Tertiary Gravel Beds mapped on the northern and northeastern part of the block area while sand, silt, clay and calcareous concretions of Pleistocene -Holocene on northwestern part of the block area. Most of the block area is under cultivated land.

7.5.1 **Field Photographs** :

Photograph No. 1: General topography of the area, Charakmara

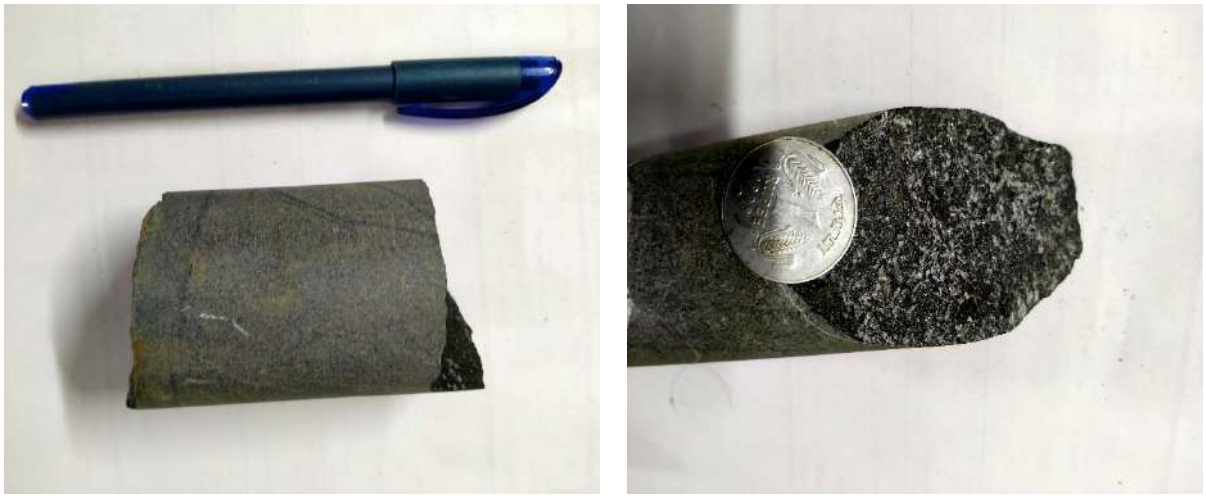
Photograph No. 2 :Dump material with malachite encrustations at Old working, Charakmara

Photograph No. 3: Granite outcrop, Charakmara

Photograph No.4: Core Photograph of MTCB-01 showing sheared Quartz biotite rock (Depth: 70.00 - 70.10 m)

Photograph No.5: Core Photograph of MTCB-01 showing Chlorite biotie schist (Depth: 82.10 - 82.17m)

Photograph No.6: Core Photograph of MTCB-02 showing Granite (Depth: 39.90 - 39.99m)

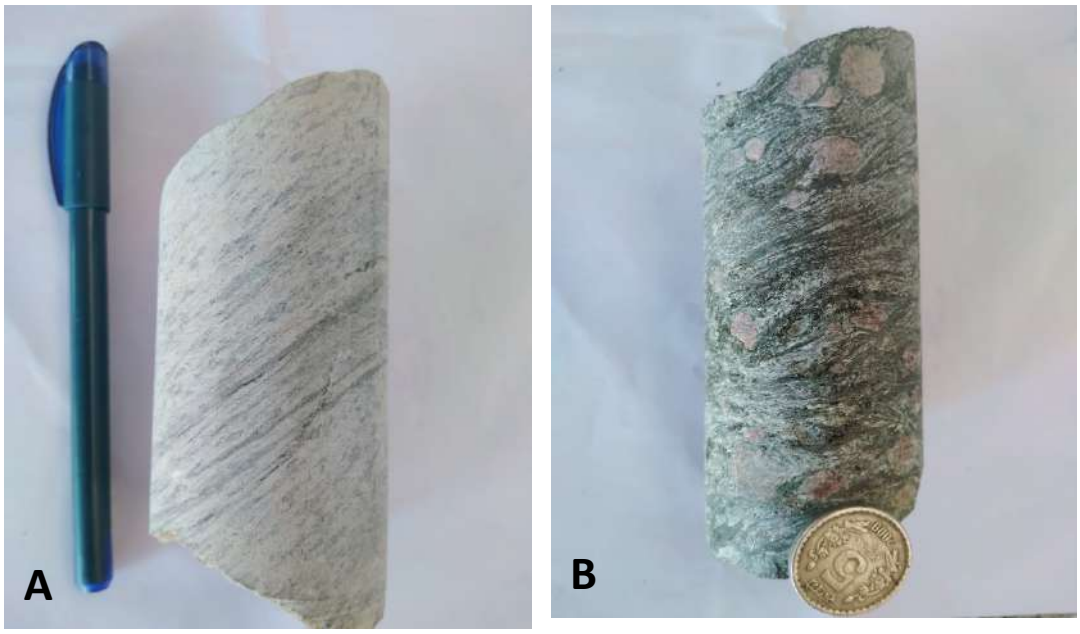


Photograph No.7: Core photograph of MTCB-06 showing Dolerite (Depth: 16.96m - 17.04m)

Photograph No.8: Core Photograph of MTCB-06 showing Amphibolite (Depth: 53.36m – 53.46m)

Photograph No.9: Core Photograph of MTCB-06 showing Granite geniss

(Depth: 94.54m – 94.62m)



Photograph No.10: Core Photograph of MTCB-9 showing Biotite Quartz schist (Depth: 69.90m-70.0m) B: Core Photograph of MTCB-10 showing Garnetiferous Chlorite schist (Depth: 52.0m – 52.11m)

Photograph No.11: Core Photograph of MTCB-11 showing Qtz-Bio-Chl schist (Depth: 69.42m-69.50m) B: Core Photograph of MTCB-12 showing Biotite schist (Depth: 28.40m – 28.48m)

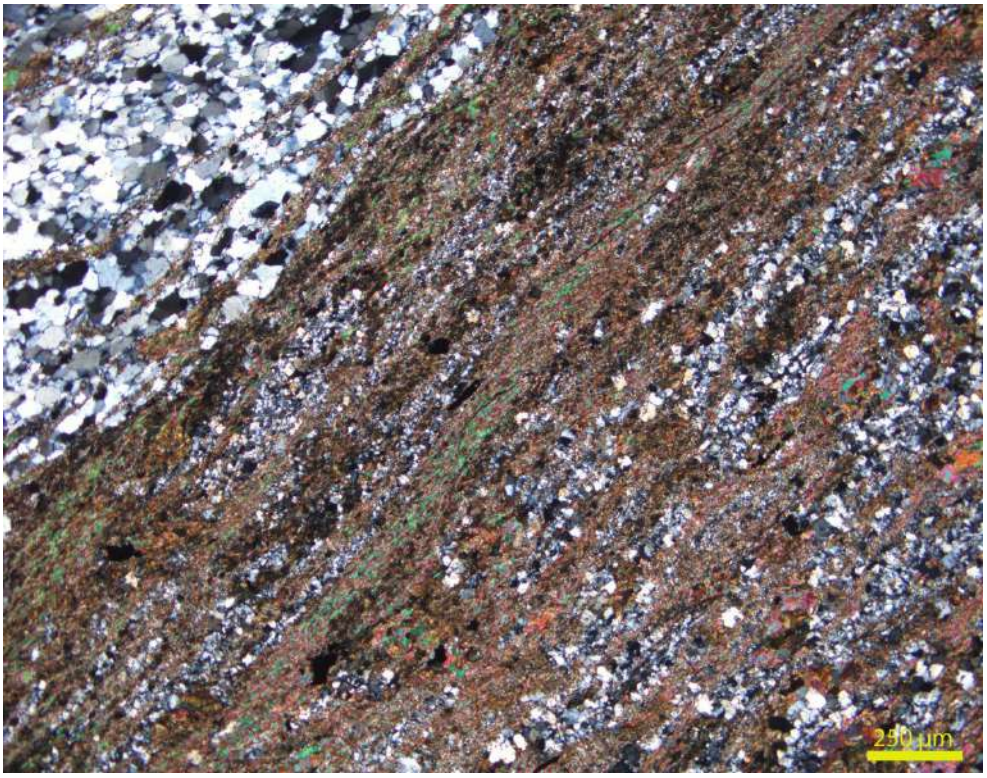
Photograph No.12: Core Photograph of MTCB-11 showing Copper mineralisation in Qtz-Biotite Rock (Depth: 54.20-54.25m)

Photograph No.13: Core Photograph of MTCB-04 showing Granite gneiss (Depth: 82.0m-82.07m)

Photograph No.14: Core Photograph of MTCB-06 showing sulfide mineralisation in Chlorite-Biotite-schist (Depth: 35.40-35.50m)

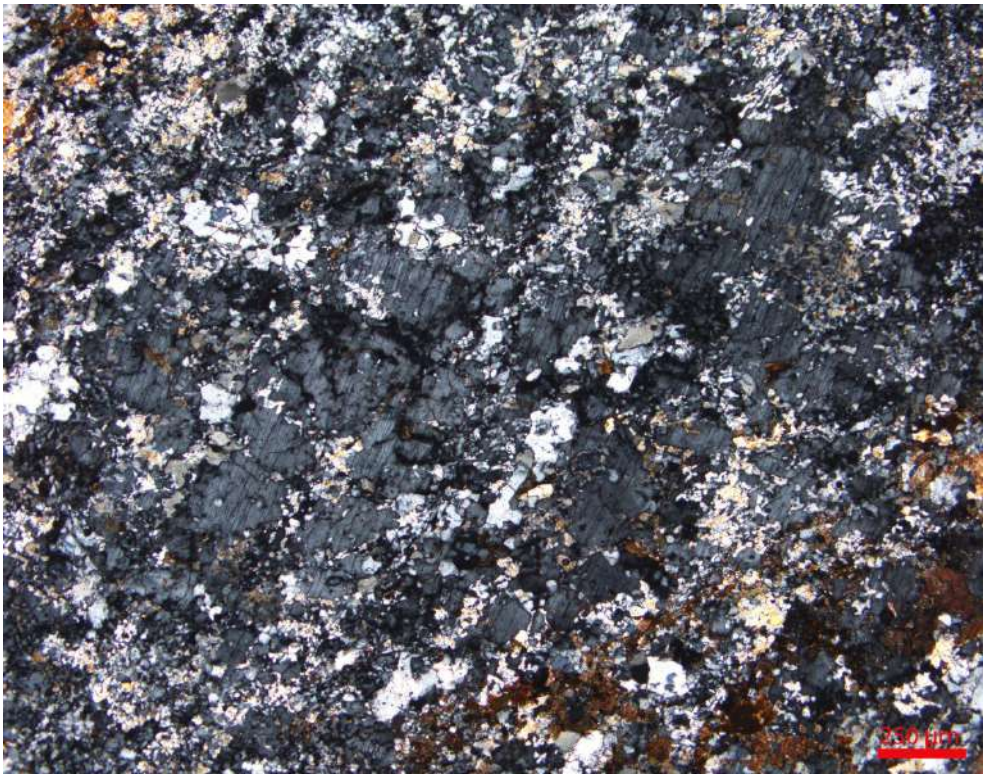
Photograph No.15: Core Photograph of MTCB-09 showing sulphide mineralisasiton in Biotite-schist (Depth: 76.10m -76.19m)

7.5.2 A total of 10 number of rock samples from borehole have been subjected for petrographic studies and the sample wise details are given as Annexure-VII. The photomicrographs of the thin section are given as pmg-1 to pmg-4.



Pmg – 1: Photomicrograph showing association and parallel alignment of phlogopite and quartz, where phlogopite is seen segregating into moderately thick zones as seen under crossed nicols.

Specimen No. : MTCB01/ P2 **Magnification :40X**

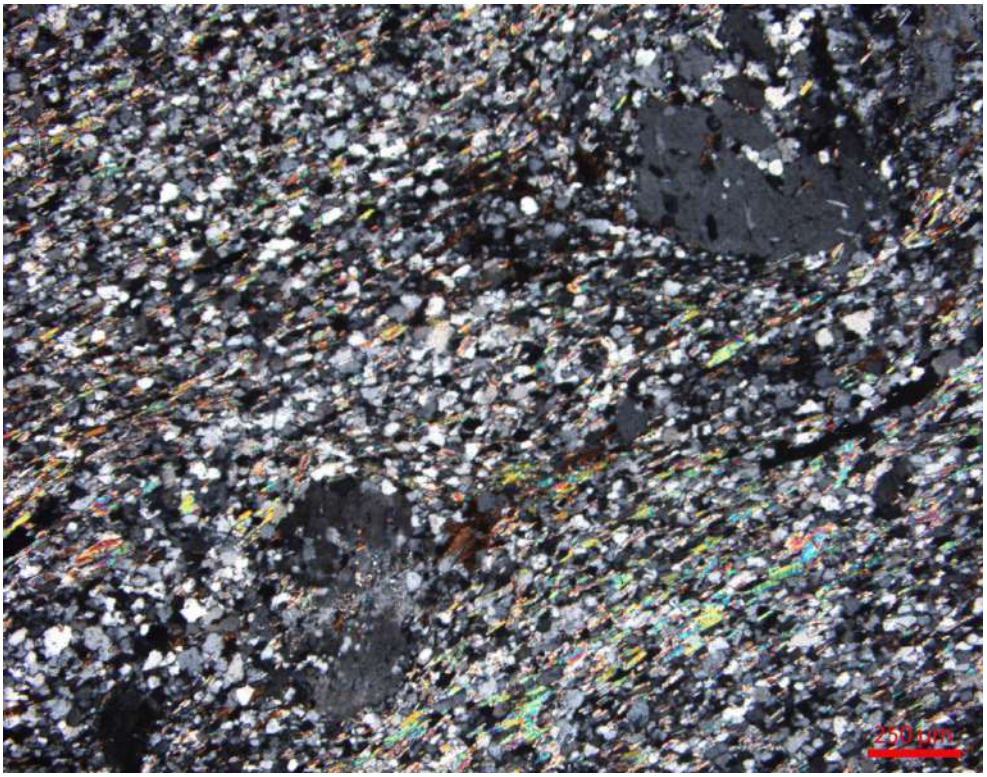


Pmg – 2: Photomicrograph showing albitization in biotite rich feldspathic (albitised) quartzite as seen under crossed nicols.

Specimen No. : MTCB02/ P3 **Magnification :40X**

Pmg – 3: Photomicrograph showing sub-ophitic and inter-granular texture in dolerite as seen under crossed nicols.

Specimen No. : MTCB06/ P4 **Magnification :100X**



Pmg – 4: Photomicrograph showing association and parallel alignment of quartz, muscovite and albite, where albite is also seen present as medium to moderately coarse porphyroblasts with rotation as seen under crossed nicols.

Specimen No. : MTCB09/ P7 **Magnification :40X**

7.6.0 STRUCTURE OF THE BLOCK

7.6.1 Thakurdih-Charakmara block is located almost at the south-eastern end of the copper belt thrust/ Singhbhum shear Zone and forms the part of baharaghora Copper prospect. In Baharagora area shear zone is ill defined, narrow and gradually disguised into the granite. The dominant linear structures are parallel to the direction of tectonic transport. As per the previous workers the following structural elements have been observed and are briefly discussed below.

7.6.2 The planer structure present in this area are stratification plane (S1), axial plan foliation (S2), crenulation cleavage (S3). Slickenside and Joints. S1 preserved in very few places and are marked by compositional variations. S2 appears as fine foliation in mica schist and shows brilliant preferred orientation of mica and chlorite in metabasic rocks. These planar structures are interpreted as axial planner schistosity is parallel to the axial planes of the folds on S1. Slickensides are prevalent in quartz schist and quartzite. Joints are very profound in competent rock like quartzite and quartz schist. 3 sets of joints namely i) Strike Joints, ii) Dip joints, iii) Diagonal joints are well developed.

7.6.3 The main linear structures found are puckers, mineral lineation, Bedding-Cleavage intersection, streaking and grooving.

7.6.4 No major faults except small drag faults due to stretching in quartzite/ quartz schist are noticed at places.

7.6.5 Quartzite & Quartz schist in the Baharagora area are thrown into S-shaped, plunging synforms and antiforms, with plunge varying from 35°to 50° towards northeast. In the Mundadevta-Darkhuli block, the synformal flexure is asymmetric with eastern limb dipping more steeply (80-85°) than the western limb (60-65°). The plunge of the fold axis is about 40° towards N40°E. No major folds mapped in the Thakurdih-Charakmara block area except small scale folds including chevrons and mullions at places. In general litho units strike $N20^0E$-$S20^0W$ diping 60^0 to 70^0 due SE in Charakmara area and $N60^0W$-$S60^0E$ dipping 70^0 to 80^0 NE in Area-1 of of the Thakurdih-Charakmara block.

7.7.0 METAMORPHISM

7.7.1 Metamorphism in this area indicated by minerals as Biotite, Garnet, Staurolite and kyanite points towards middle amphibolite facies of metamorphism (Fyfe & Turner 1966). Occurrence of these index minerals during regional metamorphism constitutes a progressive series which is followed by retrogressive metamorphism

during later shearing movements resulting developments of Biotite, muscovite and chlorite indicating Middle Greenschist facies.

7.8.0 MINERALISATION

7.8.1 In Charakmara area, there is a line of discontinuous pits for a distance of about 500m in a NE-SW direction in metabasites, basic schists and biotite quartz schist within the granitic country rocks. Similary few old working trending NW-SE direction located in Thakurdih area (Area-1). Rock exposures are scanty in the area and the surface expression of the mineralized zone is limited and ill defined. Geochemical sampling and I.P. Resistivity survey, however, provide some anomalies but most of the information on the geology and the sulphide mineralization has been obtained from the drill holes

7.8.2 Sulphide mineralisation is in the form of fissure vien type associated with closely spaced shear zones, mostly parallel to sub-parallel to the foliation. Four main modes of occurrence of copper-nickel ore in and around the area is dessiminations confined to Biotite quartz rock, stringers and veinlets along the foliation and fractures of schist, massive sulphide veins in brecciated vein quartz and minor streaks and replacement patches. In general, sulphide mineralisation occurs in the area as dissemination, stringers, veins, minor streaks and replacement patches associated with closely spaced shears.

7.8.3 Mineralisation in this area is not confined to any particular stratigraphic horizon nor to any particular litho-unit. However, some litho-units are preferred relative to other. Mineralistion is spatially associated with metabasites or their derivates such as Chlorite-biotite schist, quartz-biotite schist and biotite-quarztites.

7.8.4 Mineralisation in this area is broadly controlled by litho-structure i.e. various openings as a result of multi stage deformation. Ore bodies are located along the shear tension surfaces and are more or less parallel to the foliations of the host rock. Different openings thus gave rise to in-filling types of mineralisation such as stringers, veins and veinlets, Breccia filling etc.

7.8.5 Chalcopyrite is the main ore mineral followed by pyrite (+ marcasite) and magnetite. Nickel sulphides occur in small proportions.

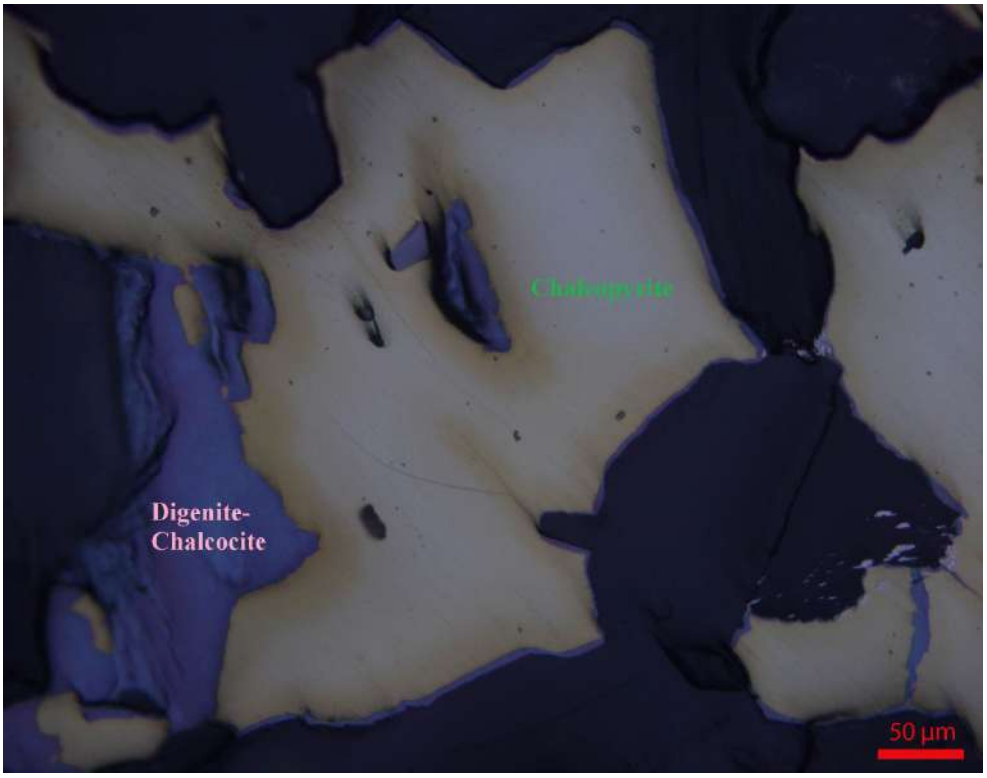
7.8.6 Drilling in Charakmara area indicate that four mineralized zones numbered as Lode-1, 1A, 1B and 2 starting from footwall side intersected in the boreholes drilled by GSI & MECL boreholes. In Area-1, three zones of mineralisation numbered 1A, 1B, 1AA and local starting from footwall side and a Local minor zone have been intersected in the boreholes drilled by MECL. The copper mineralisation is erratic in

nature and individual lodes are low grade thin/lean bands in nature with limited strike and depth continuity. The widths and grades of the lodes depends on the cut-off grade, thickness and strength of the partings.

7.9.0 MINERAGRAPHIC STUDIES OF MINERALISED CORE SAMPLES

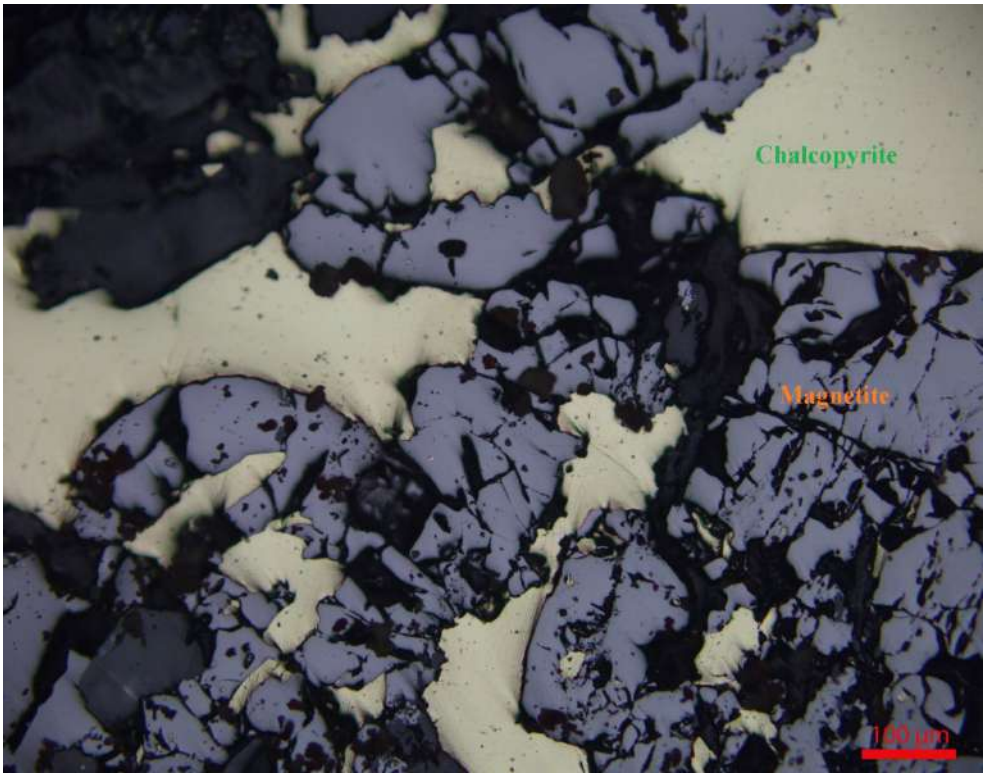
7.9.1 A total of 10 number of polished sections of mineralized core samples subjected to mineragraphic studies reveals that the major and minor ore minerals (>1%) are pyrite, chalcopyrite, magnetite, pyrrhotite, cubanite, digenite-chalcocite, pentlandite, covellite. Besides, hematite, tennantite, sphalerite, pentlandite are present as accessory mineral. The sample wise details of the mineragraphic studies are presented as Annexure-VIII and the photomicrographs of the polished sections are given as pmg-5 to pmg-10.

1) Pyrite occurs as fine to medium subhedral to anhedral grains and patches, often seen being entrapped within chalcopyrite patches. (pmg-9)
2) Chalcopyrite occurs as fine to medium disseminated grains, patches, streaks and veinlets/ fillings. (pmg-5, 6, 7, 8, 9 & 10).
3) Magnetite is present as fine to medium disseminated grains, patches, streaks and fillings. (pmg-6 & 9)
4) Pyrrhotite and chalcopyrite together occur as intermixed patches, veinlets and fillings, often being cut across by pyrrhotite-chalcopyrite fillings. (pmg-8 & 9)
5) Pentlandite is present as patchy intergrowths within chalcopyrite. (pmg-8).
6) Cubanite is present as fine lamellar exsolutions within chalcopyrite and pentlandite is noted as very fine lamellar exsolutions within pyrrhotite. (pmg-10).
7) Digenite-Chalcocite are noted as intermixed thin corona around chalcopyrite and seen replacing it. (pmg-5)
8) Covellite is present as very thin rim around chalcopyrite and seen replacing it.
9) Hematite is seen developing after magnetite replacement in areas.
10) Tennantite is noted as fine to very fine inclusions within chalcopyrite.
11) Sphalerite is noted as fine to very fine intergrowths within chalcopyrite and pyrrhotite. (pmg-7)



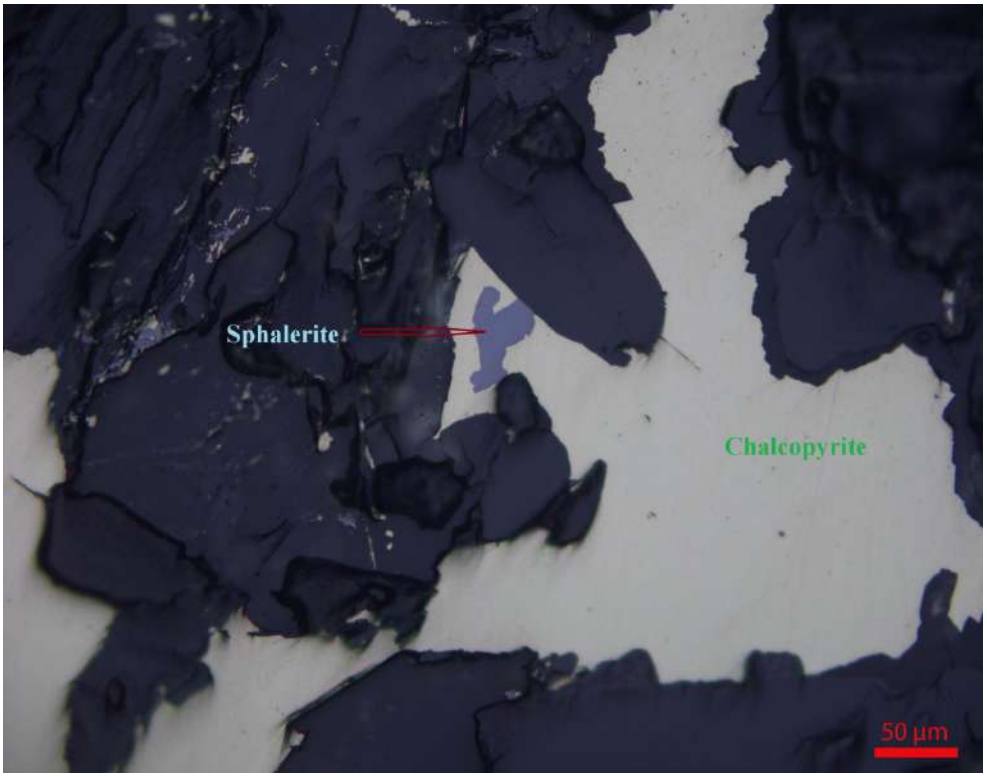
Pmg – 5: Photomicrograph showing chalcopyrite is being replaced by digenite-chalcocite along periphery as seen under reflected light.

Specimen No. : MTCB01/ M1 **Magnification :200X**



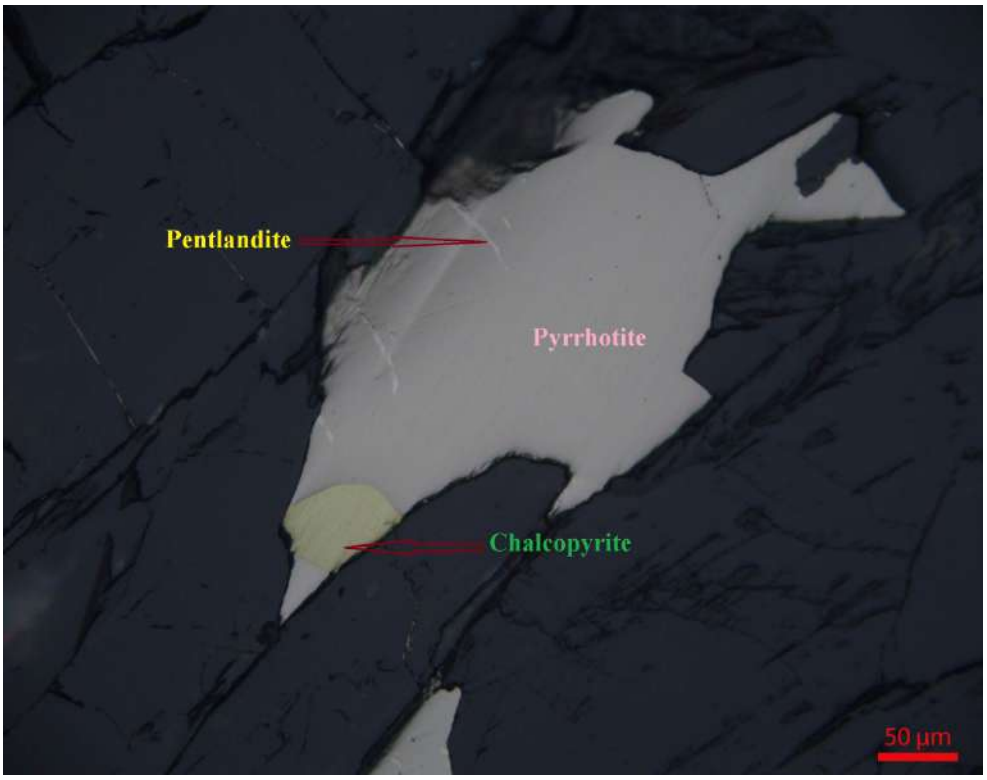
Pmg – 6: Photomicrograph showing magnetite patches being cut across by chalcopyrite veinlets/ fillings as seen under reflected light.

Specimen No. : MTCB04/ M2 **Magnification :100X**



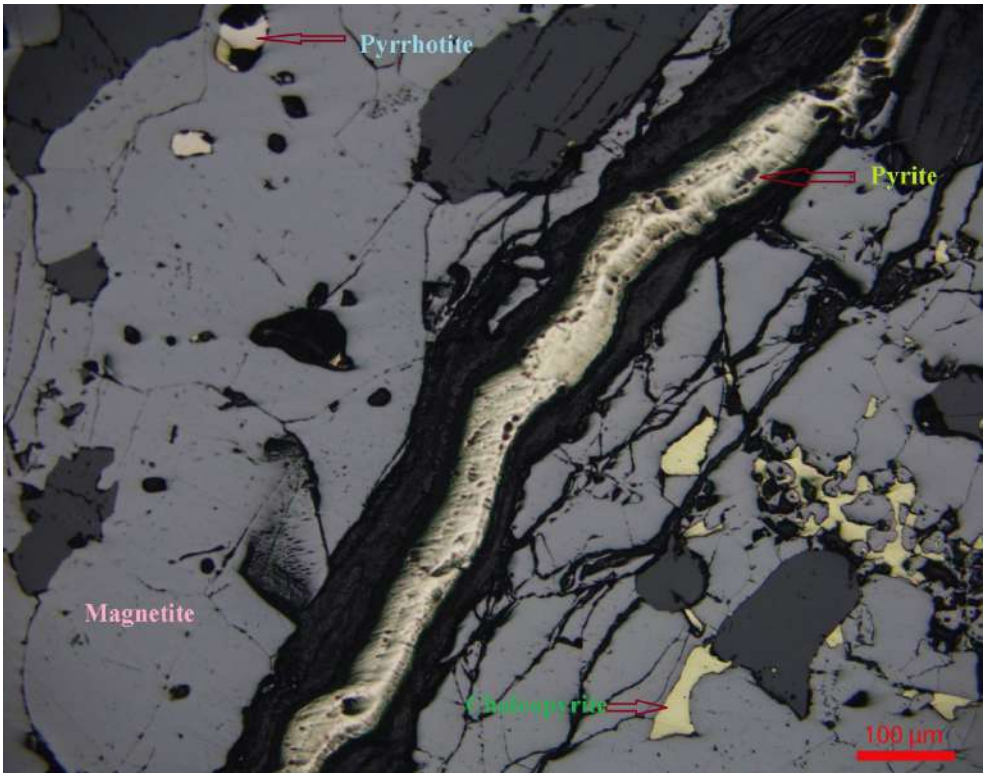
Pmg – 7: Photomicrograph showing fine inclusions of sphalerite within chalcopyrite patches as seen under reflected light.

Specimen No. : MTCB09/ M6 **Magnification :200X**



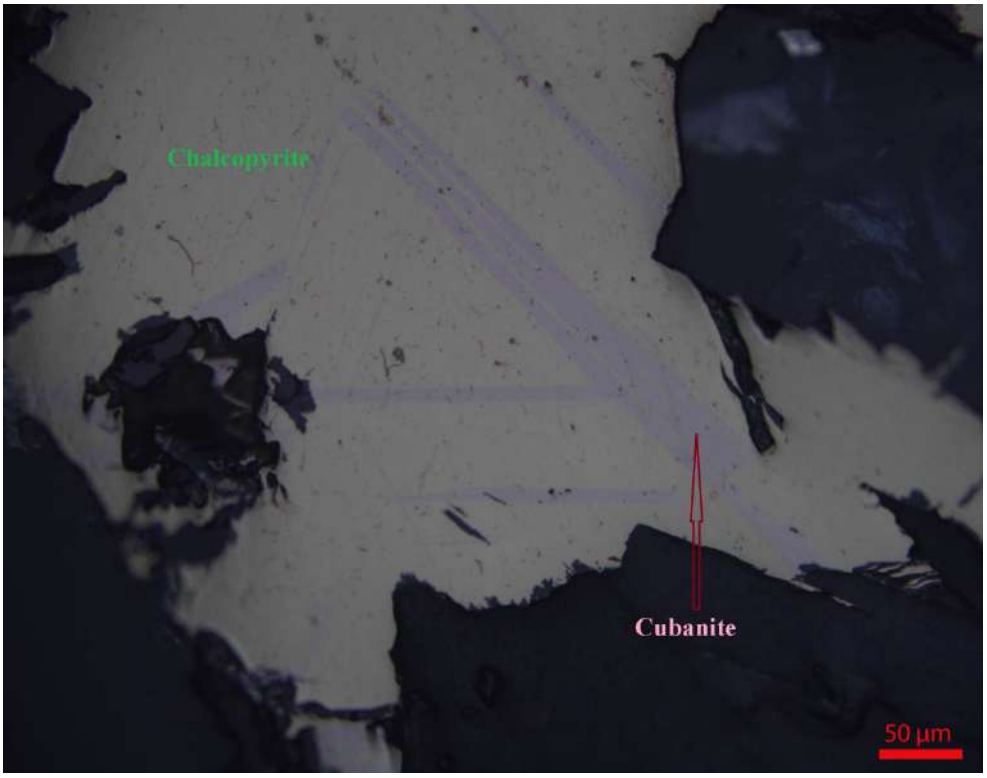
Pmg – 8: Photomicrograph showing very fine lamellar exsolutions of pentlandite within pyrrhotiteas seen under reflected light.

Specimen No. : MTCB10/ M7 **Magnification :200X**



Pmg – 9: Photomicrograph showing pyrite stringers and chalcopyrite-pyrrhotite fillings are cutting across magnetite patches as seen under reflected light.

Specimen No. : MTCB10/ M8 **Magnification :100X**



Pmg – 10: Photomicrograph showing fine lamellar exsolutions of cubanite within chalcopyrite as seen under reflected light.

Specimen No. : MTCB11/ M9 **Magnification : 200X**

CHAPTER-8

PREVIOUS WORK

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

8.1.1. The Baharagora Copper Prospect is located near the southeastern extremity of the Singhbhum Shear Zone. The present exploration block forms the part of Baharagora Copper prospect. The existence of old workings (shallow pits) for copper in the Baharagora area area was reported as early as 1870 by Stoehr. A description of these workings was given by Dunn (1937). The area was covered by airborne multi instrument geophysical surveys in 1963.

8.1.2 The Airborne Mineral Surveys and Exploration wing of GSI carried airborne Geophysical survey under "Operation Hardrock" in 1967-68. Airborne Geophysical data supplemented with Ground Geophysical Reconnaissance indicated a probable zone of Mineralisation in the Baharagora Area. Ground evaluation of the electromagnetic and magnetic signatures coupled with the available geological knowledge indicated the presence of potential mineralised zones. This led to the intensification of efforts in the form of integrated geological, geochemical and ground geophysical surveys and exploratory diamond drilling to locate ore bodies and to assess the potentiality of the deposit. Results of all these efforts have indicated that the Baharagora copper deposit consists of a number of small blocks/mineralised grounds Mundadevta Darkhuli, South Jharia and Charakmara Blocks are apparently more promising. Detailed drilling operations were carried out by GSI in the Mundadevta-Darkhuli Block. A geological reserve/resource of 1.22m tonnes of 1 .23% Cu and 0.70m tonnes of 0.87% Cu and 0.21% Ni was estimated in the area. (Majumder, 1971).

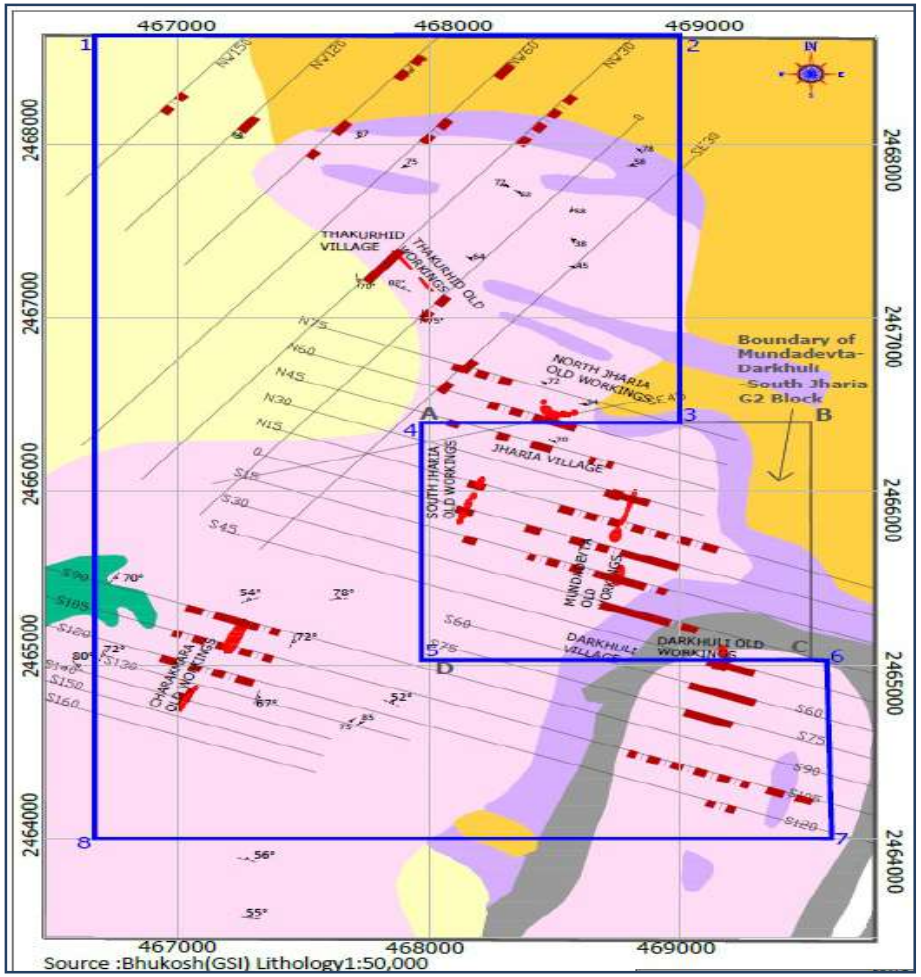
8.1.4.1 Based on the outcome of previous work of GSI, MECL explored Mudadevta-Darkhuli & South Jharia Block for Copper and associated minerals overn an area of 2.13 sq.km. at G2 stage in 2021-22. Total 5112m in 23 nos Boreholes were drilled in the area. Copper ore resources estimated at 0.50% Cu and 1.0% Cu cut-off separately with 2.0m minimum stoping width (M.S.W.) as true width and 3.0m maximum parting. Total 1.74 milllion tonnes of net geological in-situ resources with an average grade of 0.96% Cu over 3.58m thickness at 0.50% Cu cut-off and 0.64 milllion tonnes of net geological in-situ resource with an average grade of 1.46% Cu over 3.53m thickness at 1.00% Cu cut-off up to a vertical depth of 245m from ground surface estimated in Mundadevta-Darkhuli & South Jharia block.

8.1.5 The Thakurdih-Charakmara block is just adjoining and extension to the Mundadevta-Darkhuli & South Jharaia G2 Block. In Charakmara village there is a line of discontinuous pits for a distance of about 500m in a NE-SW direction in metabasites, basic schists and biotite quartz schist within the granitic country rocks. Similarly, NW-SE trending old workings located in Thakurdih (Area-1) area.

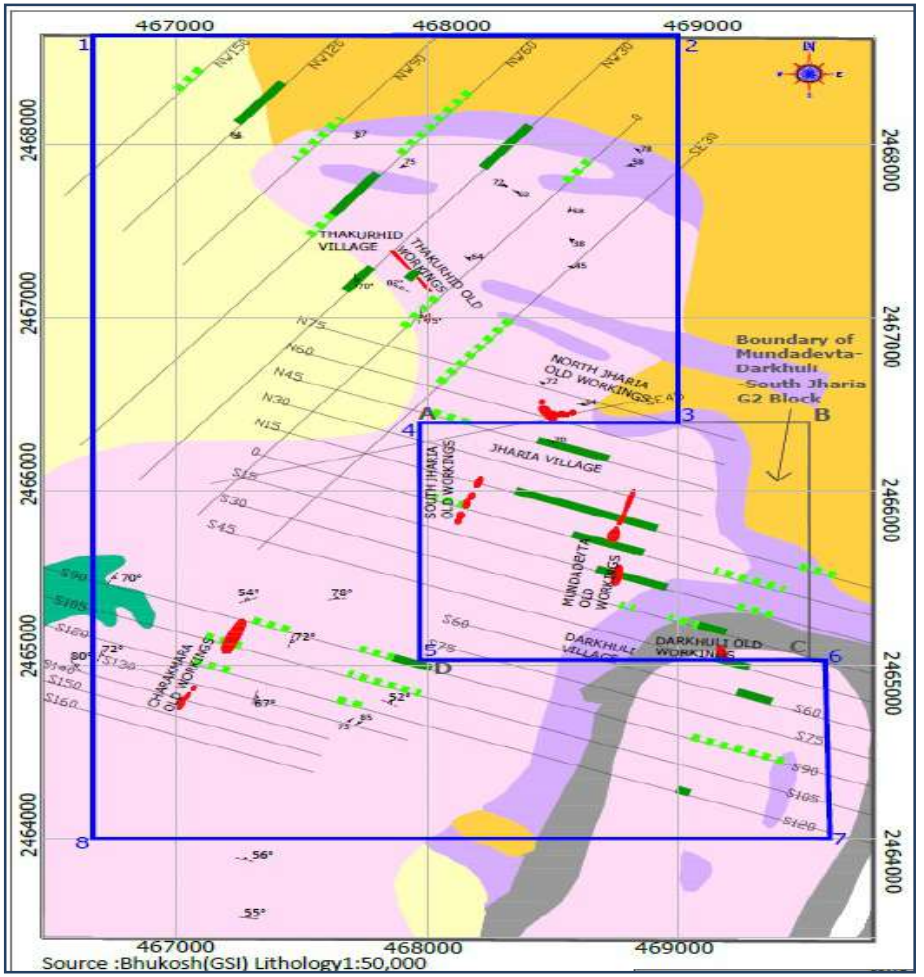
8.1.6 During the F.S. 1975-76 & 1977-78 , GSI carried out Geochemical survey followed by geophysical survey carried in the Block area. Soil samples at closer intervals (10-15m) were collected from the anomalous zones and analyzed for copper, nickel, cobalt and molybdenum which resulted with 46 anomalies with weak, moderate, and strong categories.In general, geochemical anomalies coincide with the old workings, values are upto 10000ppm for Cu. Subsequently, the area was covered by IP-Resistivity traverses at interval of 150/300 m with dipole length of 150m. In some sections, detailing with shorter dipole separation (30m) had been done which resulted with 15 no of high chargeable IP and Magnetic anomaly zones with values 200nT to maximum value 1200 nT.Geophysical anomalies indicated weak IP anomalies in Charakmara area and strong IP anomalies in Area-1, Area-2 and Area-3 of the block area. Geophysical anomalies (IP) corroborated well with geochemical anomalies and old workings in the area. (Text Figure 4-A & 4-B)

8.1.7 GSI drilled 2 test boreholes namely BC-1 and BC-2 in Charakmara area involved 300.45m drilling spaced 100m apart. A zone of mineralisation in BC-1 intersected over a width of 1.35m with 0.59% Cu & 0.11% Ni and in BC-02 over a width of 2.05m with 2.74% Cu. Since only two test boreholes were drilled in the Charackmara Block, no reserve has been estimated for this block. To ascertain the ore potential of the Charackmara Block further drilling was recommended by the previous workers and further it was opiened that there is a reasonable chance of finding some tonnage from this block.

8.1.8 Based on the potentiality of the prospect and recommendations of the previous workers, MECL formulated exploration proposal at G3 stage to explore the block area in detail. Exploratory drilling at 100m spacing interval in line with previously drilled GSI boreholes (BC-01 & 02) planned in Charakmara area to confirm the strike and depth persistence of ore zones at 60m and 120m vertical depth at G3 stage. Simultaneously, Integrated Ground geophysical survey (I.P., Resistivity, Magnetic) at 100/50 m profile at 20m interval planned to delineate potential mineralized zones in Area-1, 2 and 3 in Thakurdih Charakmara block area.



TEXT FIGURE: 4-A. Geochemical anomaly map (after GSI 1974)



TEXT FIGURE: 4-B. Geophysical anomaly map (after GSI 1974)

8.1.9 Present exploration program at G3 stage was carried out to confirm the strike and depth continuity of ore zones at approximately 100m interval at two levels i.e. 60 m and 120 m vertical depth from surface in Charakmara area. Integrated Geophysical surveys (I.P, Resistivity and Magnetic) carried out in Area-1, 2 & 3 to delineate the potential ore zones in extention of previously explored "Mundadevta-Darkhuli and south Jharia G2 block" for copper. Based on the positive outcome of geophysical survey test drilling was carried out in Area-1 and Area-3 of the block area. The previously drilled borehole data of GSI in Charakmara area have been integrated with present borehole data of MECL for geological correlation and evaluation of copper ore resources and grade as per the cut-off grade criteria parameters in the Block area. The details of previously drilled GSI boreholes (FS. 1975-76 & 1977-78) are given in **Annexure-I B** and lode intersection details are given in **Annexure-III-B**.

CHAPTER-09

EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

9.1.0 INTRODUCTION

9.1.1 Copper with its unique physical, mechanical and electrical properties, has played a vital role in the industrial growth of a nation. In India, around 75% of demand is met through imports. The increasing demand of Copper metal in the country can be eased with the exploration of new copper deposits of economic importance. In view of the above, exploration for copper ore has been accorded high priority in the XIIth Plan document.

9.1.2 During the last three decades, no large base metal deposit has been discovered in India. However, the possibility of working of small mineral bodies in proximity to each other, through technological advances and increased operational efficiency, cannot be ruled out. Therefore, it is utmost imperative to locate and explore such small sized deposits like in clusters.

9.1.3 In view of the enactment of the MMDR Amendment Act-2015 and Mineral Auction Rule- 2015 by the Govt. of India, it has become mandatory for all state governments to undertake G-3 stage exploration for copper to make the block ready for auction.

9.1.4 Based on the mineral potentiality of the prospect and previous work carried out by GSI in the area, MECL formulated Exploration proposal to carry out exploration in the Thakurdih Charakmara Area and obtained consent from Department of Mines and Geology (DMG), Govt. of Jharkhand vide letter no. भू0नि0अन्वे0—42/2018/ 1820 एम0/राँची, दिनाँक:- 30.09.2021 **(Annexure-XI).**

9.1.5 In 36th TCC meeting of NMET held on 23rd and 24th December, 2021 through video conferencing at Geological Survey of India, DGCO, A-II Pushpa Bhawan, New Delhi, the committee recommended the proposal for approval by EC for Preliminary Exploration (G3) for copper in Thakurdih Charakmara Block with estimated cost of Rs 388.59 Lakhs including GST in time schedule of 12 months for carrying out the proposed work. Subsequently, the project was approved by 23th EC of NMET held on 11th March 2022 and same was intimated to MECL by Ministry of Mines vide letter number F.No. 23/236/2022-NMET/301, New Delhi dated 25th March, 2022. **(Annexure XI).**

9.1.6 The exploratory drilling work in Thakurdih Charakmara block commenced with the surveying and exploratory drilling work with drilling of Borehole No. MTCB-01 on

date 23.04.2022 and completed with the closure of Borehole No. MTCB-12 on date 09.06.2023. Total 1497.50m of diamond core drilling in twelve (12) boreholes achieved in the block area. The allied field-works including borehole fixation and determination of co-ordinates & reduced level of boreholes by DGPS, ground geophysical survey, drilling, core logging, core sampling etc. were completed simultaneously. The survey work in the block area was carried out with the help of DGPS in WGS-84 Datum. The laboratory studies including chemical analysis and physical analysis i.e. petrographic, mineragraphic and specific gravity studies were carried out simultaneously in laboratories of MECL and other Govt. /NABL accredited laboratories.

9.1.7 The details of the nature and quantum of work proposed Vs an actual achievement is given in **Table-9.1.**

Table – 9.1
Quantum of Work vs. Achievement by MECL in Thakurdih-Charakmara Block, Singhbhum Copper Belt, District: East Singhbhum, Jharkhand

SN	Item of Work	Unit	Approved	Achieved	Remarks
1	Survey (on 1:5000 Scale): Bore Hole Fixation and determination of co-ordinates & Reduced Level of the boreholes by DGPS	Per Point of observation	12	12	-
2	Construction of BH concrete pillars	Per Borehole	12	12	-
3	Ground Geophysical Survey : - Induced Polarization (I.P), Resistivity and Magnetic	Per Line KM	60	60	-
4	Drilling up to 300m (Hard Rock) and BH Geological Logging	m	1500	1497.5	-
5	Borehole deviation Survey by Multishot Camera	m	1500	1497.5	-
6	Drill Core Preservation	per m	300	300	-
7	**LABORATORY STUDIES : Chemical Analysis**				
i)	**Primary samples**				
	a. for Cu, Ni, Mo, Co, W	Nos	150	142	-
	b. Au by Fire Assay	Nos	20	20	-
ii)	**Check samples Internal (5%)**				
	a. for Cu, Ni, Mo, Co & W	Nos	5	5	-
	b) For Au (Gold) by Fire	Nos	1	1	

SN	Item of Work	Unit	Approved	Achieved	Remarks
	Assay				
iii)	**Check samples External (10%)**				
	a. for Cu, Ni, Mo, Co & W	Nos	10	10	
	b) For Au (Gold) by Fire Assay	Nos	2	0	
iii)	**Composite Samples**				
	a) For 5 Radicals (Cu, Ni, Co , W Mo)	Nos	10	3	-
	b) For Au (Gold) by Fire Assay	Nos	10	0	-
8	Petrological samples (Preparation and study of thin section)	Nos	10	10	
9	Mineragraphic Studies (Preparation and study of polished section)	Nos	10	10	
10	Digital Photographs	Nos	10	10	
11	Geological Report	Nos.	1	1	

9.2.0 OBJECTIVES OF INVESTIGATION

9.2.1. The objectives of present exploration programme at G-3 stage are as follows.

1. To confirm the strike and depth persistence of copper mineralisation at 100m spacing interval over 700m strike length and to intersect ore zone at 1st level i.e. 60m vertical depth (20mRL) and few boreholes at 2nd level i.e. 120m vertical depth (-40mRL) from surface in Charakmara area.

2. To carry out integrated Geophysical Surveys Induced polarization (I.P), Resistivity and Magnetic at 100m, 50m profile interval and 20m station interval to delineate potential ore zone in Area-1, Area-2 and Area-3.

3. To carry out test drilling in Area-1 & 3 based on the integrated geophysical anomaly.

4. To estimate copper ore resources at G3/G4 level as per UNFC norms and Minerals (Evidence of Mineral Contents) Rules 2015.

9.3.0 DETAILS OF PITTING, TRENCHING, DRILLING, ETC.

9.3.1 Pitting and trenching activities not carried out in the Block area in the present exploration as they are not part of the scope of work.

9.3.2 The approved scheme of Preliminary Exploration (G-3) work in Thakurdih-Charakmara Block includes Borehole surveying, drilling, core logging, core sampling and associated laboratory studies.

9.3.3 **Exploratory Drilling:** During the present exploration program, total 12 boreholes involving total 1497.50m exploratory drilling (G3 stage) carried out to check the strike and depth continuity of copper bearing ore zones in the Charakmara area and to test the geophysical anomaly in Area-1 & Area-3. Initially total 5 boreholes (600.00m) i.e. MTCB-01 to MTCB-05 drilled to check the mineralisation up to 60m vertical depth (20 mRL) from ground surface. The project was reviewed in 47th & 52nd TCC meeting and based on the mineralized interesections and as per committee advice total three conditional boreholes i.e. MTCB -06, MTCB -07 & MTCB -08 were drilled for deeper level (2nd level) intersections up to 120m vertical depth (-40mRL) from ground surface. Borehole depth varies from 120.00m to 160m in Charakmara area and 85m (MTCB -10) to 97.50 m (MTCB -11) in Area-1 & 3. All borehole cores were logged and mineralized zones have been identified and samples were prepared and analysed for copper and associated elements in MECL Chemical Laboratory, Nagpur.

9.3.5 Details of presently drilled boreholes of MECL and previously drilled boreholes by GSI (FS 1975-76 & 1977-78) with depth of intersection details are summarised in below given Table No. 9.2. The details of MECL and GSI boreholes are given in **Annexure No. IA** and **IB** respectively.

Table-9.2
Details of Boreholes drilled by MECL and GSI in Thakurdih-Charakmara Block, Singhbhum Copper Belt, District East Singhbhum, Jharkhand

Sr. No.	Agency	Section No.	Borehole No.	Angle from horizontal (°)	Azimuth (°)	Total Depth (m)	Depth & RL of Intersection (m)	Area Name
1	MECL (2022-23)	1	MTCB-01	50	290	120.00	53.75m (40.91mRL)	Charakmara
							66.20m (31.06mRL)	
							77.11m (22.60mRL)	
2		6	MTCB-02	50	290	120.00	-	

Sr. No.	Agency	Section No.	Borehole No.	Angle from horizontal (°)	Azimuth (°)	Total Depth (m)	Depth & RL of Intersection (m)	Area Name
3		7	MTCB-03	50	290	120.00	-	
4		4	MTCB-04	50	290	120.00	51.00 m (46.30mRL)	
5		5	MTCB-05	50	290	120.00	108.20m (4.30mRL)	
6		2	MTCB-06	50	290	180.00	38.45m (52.60mRL)	
							40.00m (51.40mRl)	
							159.72m (-42.64mRL)	
7		3	MTCB-07	50	290	180.00	151.80m (-28.10mRL)	
8		1	MTCB-08	50	290	180.00	164.00m (39.68 mRL)	
9		L15E	MTCB-09	60	210	91.00	75.78m (13.30mRL) 82.50m (7.63mRL)	
							82.50	Area-1
10		L25E	MTCB-10	60	210	85.00	75.00m (27.30mRL)	
11		L18E	MTCB-11	60	210	91.50	84.90m (20.60mRL)	
12		L20N	MTCB-12	60	300	90.00	-	Area-3
13	GSI (FS. 1975-76 & 1977-78))	3	BC-01	50	290	145.45	92.32m (14.18mRL)	Charkamara
14		2	BC-02	50	290	155.00	87.25m (16.89mRL)	
Total MECL (12 Bhs)						**1497.50**		
Total GSI (2 Bhs)						**300.45**		

9.3.6 Based on the analytical results of individual primary samples, Mineralised zones intersected in the boreholes have been identified at 0.2% Cu cut-off for lode correlation. Out of total 14 numbers of boreholes (12 no MECL + 02 no GSI), 11 nos. of boreholes have intersected mineralized zone at cut-off value 0.2% Cu. Total 9 Boreholes of MECL intersected mineralized zones at 0.2% Cu cut-off value. The depth of intersection varies vertical depth of 38.45m (52.60 mRL) to 164m (-39.68 mRL) from ground surface in Charakmara area and 75.0m 927.30mRL) to 84.90 (20.60mRL) in Area-1. The previous 2 boreholes of GSI (1984) in Charakmara area indicated two mineralized zones of 0.59% Cu, 0.11% Ni over 1.35m thickness and 2.74% Cu over 2.05m thickness. Borehole wise Mineralized details at 0.20% Cu (for correlation purpose only) are given in **Annexure V-A.**

9.4.0 DATA SPACING FOR REPORTING OF EXPLORATION RESULTS

9.4.1 The boreholes (GSI & MECL) were spaced at 100m interval approximately in Charakmara area to confirm the strike and depth persistence of copper bearing ore zones at two levels (60m & 120 m vertical depth) and is sufficient to establish copper ore resources at G-3 stage (preliminary exploration) as per the exploration norms of Minerals (Evidence of Mineral Content) Rule-2015. However, three test boreholes drilled in Area-1 are scout boreholes in nature at specified locations to test the integrated surface geophysical anomaly in depth up to 60m vertical depth. Hence, as per the MEMC Rule-2015 and UNFC system the estimated resources in the Charakmara area and Area-1 may be categorized under "Inferred Mineral Resource" category with 333 code of UNFC and "Reconnaissance Mineral Resource" category with 334 code of UNFC (334) respectively in Thakurdih-Charakmara Block area.

CHAPTER-10

LOCATION OF DATA POINTS

10.1.0 ACCURACY AND QUALITY OF SURVEY USED TO LOCATE DRILL HOLES

10.1.1 The Block area is located near Madhupur village in East Singhbhum District of Jharkhand. Thakurdi-Charakmara Block covers an area of 10.0 sq.km falling Survey of India Toposheet No.73J/11. Survey site is located about 4km NNW direction from Baharagora town and approximately 90 km from Tatanagar, District headquarters of Jharkhand.

Block Location

SL	LAT/LONG	WGS-84 DATUM (DMS)
1	LATITUDE	*22° 16' 52.7078" N to 22° 19' 23.1904" N*
2	LONGITUDE	*86° 40' 34.8022"E to 86°42'17.1600"E*

10.1.2 Total 12 nos. Boreholes drilled in Thakurdih-Charakmara Block were surveyed with respect of their location with the help of DGPS Instrument for surveying.

TECHNICAL SPECIFICATION OF DGPS

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

a*) MEASUREMENT ACCURACY*:

- *PPK Mode (Static)*
- *Horizontal – 3 mm +0.1 ppm or better.*
- *Vertical – 3.5 mm +0.4 ppm or better.*

10.1.2 The survey work has been carried out with the help of DGPS (Make-Trimble GNSS System, Model-R8s). The DGPS Base Station B-1 was established on road side ground centre pillar near Mundadevta (Muradevta) village. Particulars of base station are given below **Table No.10.1**

Table-10.1
The R.L & Coordinate of Base station determined by DGPS instrument in WGS-84 Datum. (UTM Zone 45 North)

Station ID	WGS-84 (DMS)		UTM ZONE - 45		R.L (Meter)	Feature Code
	Latitude	Longitude	Northing (Meter)	Easting (Meter)		
B-1	N22°17'52.17818"	E86°41'57.72927"	2465823.686	469033.750	99.419	DGPS BASE STATION

10.1.3 Topographical contour survey not carried out in the area as it is not part of the scope of the work. However, for drawing section profiles etc. contours have been generated at 2m interval by Aster Data using GIS software. Surface features like road, water bodies, villages etc. taken have been taken from available topographic map of the area and the same has been depicted in topographical map and is given as **Plate-III.**

10.1.4 Total 12 boreholes drilled by MECL in the present exploration i.e. MTCB-01 to MTCB-12 have been fixed by DGPS survey instrument. Borehole locational co-ordinates & Reduced level (RL) of the borehole are given in **Annexure-I-A** and also shown in **Plate-III-A.**

10.2.0 QUALITY AND ADEQUACY OF TOPOGRAPHIC CONTROL

10.2.1 The survey work has been carried out with the help of DGPS (Make-Trimble GNSS System, Model-R8s) for higher level measurement accuracy. In order to have control on survey work, one base station B-1 has been fixed. After competition of field survey work, raw data was downloaded from DGPS Instrument and data has been through Trimble Business Centre software ***(TBC)*** for generating point list summary amd Base line processing report. Survey work carried out by the experienced qualified surveyor as per the prevailing standard procedures.

CHAPTER-11

GROUND GEOPHYSICAL SURVEY

11.1.0 INTRODUCTION

11.1.1 The contrast in the physical properties of the mineralised zones and the host rocks forms the basis of Geophysical Survey. Based on the physical properties of the Basemetals (Cu, Pb, Zn) in typical geological settings the variation in Resistivity, Conductivity and Self potential are very high. So Integrated Geophysical surveys Induced Polarization (I.P), Resistivity, and Magnetic were planned to carry out in Thakurdih-Charakmara block.

11.1.2 In the demarcated areas, the Geophysical Survey was carried out for delineating mineralised zone along with depth, strike and extent of occurrences and depositions of Cu ore & its host rocks with other associated mineralized zone.

11.2.0 BACKGROUND INFORMATION

11.2.1 GSI (1971) had carried out Geological mapping, Geo-physical survey and Geochemical sampling in the study area. A total of 7 no. of Geo-physical Aero-EM anomalous intercept recorded and subsequently ground Geophysical IP survey conducted in 26 grid lines covering entire proposed area with 150-300m line interval and dipole length 30m to 150m.

11.2.2 Entire proposed area was covered with Geo-chemical soil sampling for Cu, Ni, Co and Mo. The soil grid planned with 30m sampling interval, 150-300m line spacing, and closer spacing 10- 15m adopted at anomalous zones. A total 48 no. of anomalies identified and categorized week, moderate, strong. In general, geochemical anomaly maxima coincide with the old workings and dump debris. Most of the Geo-chemical anomalies supported surface persistence of Geophysical anomaly. A total 15 no. of IP strong anomalies and 23 no. of IP week anomalies have identified which need to be tested through drilling.

11.2.3 In view of the above, an integrated Geophysical surveys program comprising of Induced polarisation (I.P), Resistivity and Magnetic at 100m, 50m profile interval and 20m station interval to delineate potential zone areas for basemetal mineralisation has been taken up in Airea-1 , 2 & 3 of Thakurdih-Charakmara block area .

11.3.0 OBJECTIVE AND SCOPE OF THE WORK

11.3.1 The main objective of Ground geophysical survey is to carry out integrated Geophysical Surveys Induced polarisation (I.P), Resistivity and Magnetic at 100m, 50m profile interval and 20m station interval to delineate potential zone areas.

11.3.2 The scope of work was Acquisition, Processing and Interpretation of Ground Induced Polarization (IP), Resistivity & Magnetic data in Area-1, 2 & 3 sub-blocks of Thakurdih-Charakmara Block, East Singhbhum, Jharkhand.

11.4.0 SURVEY LAY OUT

11.4.1 The present study area has been concentrated in three areas namely Area-1, Area-2 and Area-3. The Geophysical Survey has been carried out with 100m as profile and 20m as station interval i.e.100m x 20m grid, covering an area of 4.10 Sq.km in Area-1 and 50m as profile and 20m as station interval i.e.50m x 20m grid, covering an area of 0.38 Sq.km in Area-2 and 0.86 Sq.km in Area-3 respectively.

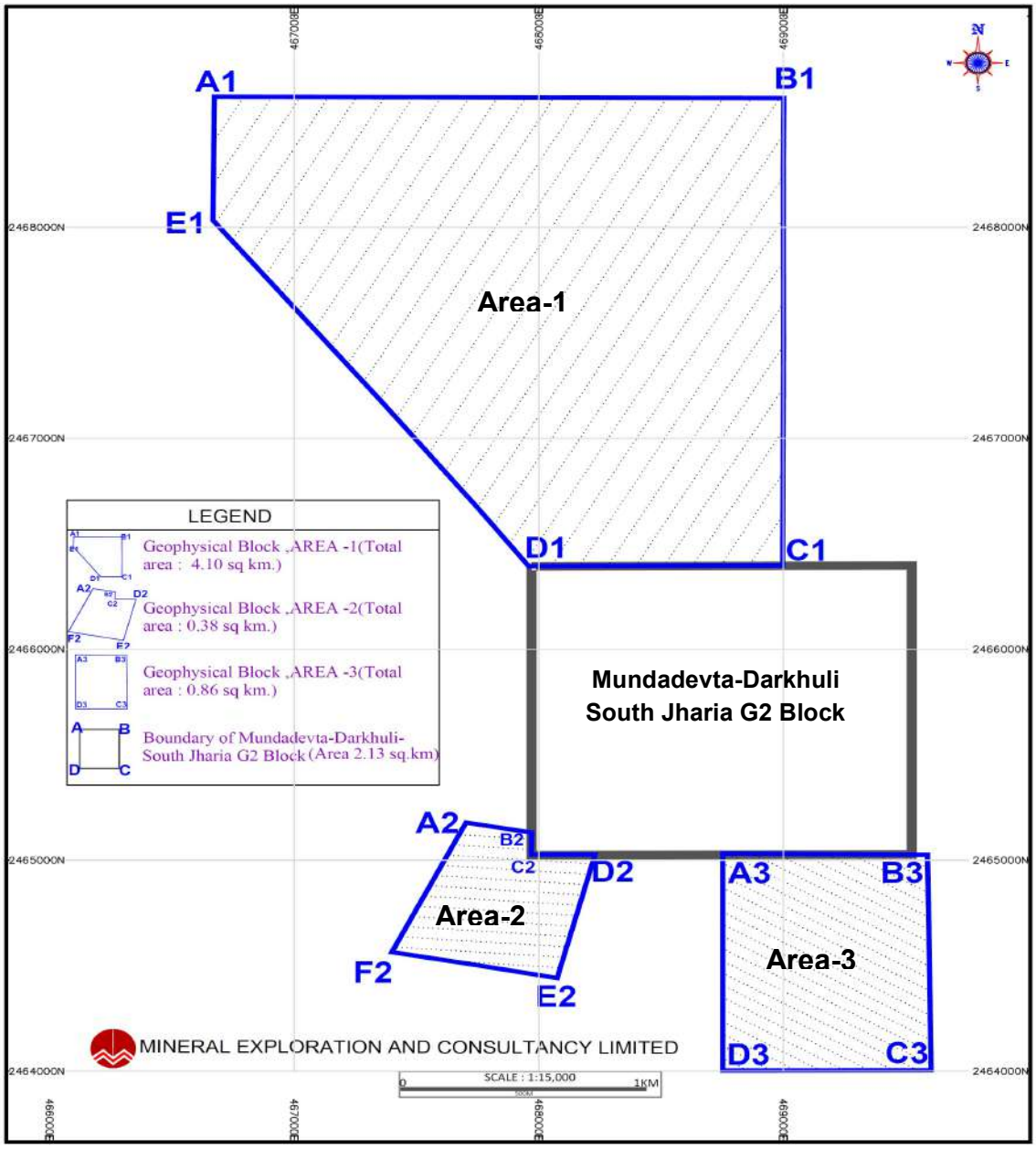
11.4.2 The above survey pattern comprises of total 60 Line Km of IP, Resistivity and Magnetic Profile as approved by NMET. The main objective of the Geophysical survey was to delineate Cu ore and its host rock with other associated mineralized zone.

11.4.3 Total area surveyed and line kilometre recorded in the block is given below in **Table 11.1.**

Table No. 11.1
Details of Surface Geophysical Survey by MECL
in Thakurdih-Charakmara Block

Block	Parameter	Area (Sq. Km.)	Grid (m x m)	Line Km	Profile Direction
Area 1	Induced Polarization (IP) Resistivity & Magnetic	4.10	100 X 20	40.56	N30°E
Area 2		0.38	50 X 20	7.34	N94°E
Area 3		0.86	50 X 20	16.7	N120°E

TEXT FIGURE- 5: LAYOUT MAP OF GEOPHYSICAL STATIONS IN THAKURDIH- CHARKAMARA BLOCK



11.5.0 DATA REDUCTION AND PROCESSING

11.5.1 Instrument Details:

MAGNETOMETER	
Type	Proton Precision magnetometer (PPM)
Make	Scintrex (ENVI PRO)
Sensitivity	0.10 nT
Accuracy	+/- 1.0 nT
Range	23000 to 100,000 nT

IP & RESISTIVITY EQUIPMENTS	
Type	Multi-Electrode
Make	IRIS (SysCal Pro)
Maximum No of Channel	72
Minimum Channel Interval	10
Sensitivity	1µV/0.2%

SURVEY EQUIPMENTS	
Type	DGPS (PPK)
Make	Trimble (R8s)
Sensitivity	10 cm
Accuracy	+/- 1 cm
Range	Upto 30 Km

11.5.2 Field Data Acquisition:

11.5.2.1 The Block boundary was demarcated by DGPS system. The survey stations were fixed in the grid pattern with 100m as profile interval station for Area 1, 50 as profile interval for Area 2 &3 and 20 m as station interval in all the blocks by using DGPS. The Profile direction was planned in N30°E, N94°E & N120°E direction for Area 1, 2 & 3 respectively. Pegs with marked station number were placed at every point. The Reduced level (RL) of every station was determined with DGPS with an accuracy of ±1 cm.

11.5.2.2 The Block boundary was demarcated by DGPS system. The survey stations were fixed in the grid pattern with 100m as profile interval station for Area 1, 50 as profile interval for Area 2 &3 and 20 m as station interval in all the blocks by using DGPS. The Profile direction was planned in N30°E, N94°E & N120°E direction for Area 1, 2 & 3 respectively. Pegs with marked station number were placed at every point. The Reduced level (RL) of every station was determined with DGPS with an accuracy of ±1 cm.

11.5.2.3 The Magnetic data was recorded at every station with respect to a fixed base station on routine basis with Proton Precision Magnetometer (PPM). The coordinates of the base station for Magnetic survey are given below in **Table 11.2.**

Table No. 11.2
The coordinates of the base station for Magnetic survey in Thakurdih-Charakmara Block

Base Station	Easting	Northing	Reduced Level (RL)
Magnetic	469656	2465566	101.134 m

11.5.2.4 IP & Resistivity profile data was recorded by 20 m dipole-dipole array configuration with max 36 channels and min 4 channels of 20 m dipole interval. A sum of 60 L Km profile data was recorded in Area 1, 2 & 3.

11.5.2.5 The digital elevation map (RL) of study area derived from data acquired by DGPS system. The Block areas are mostly covered with low lying thick soil of cultivation land and barren ground with the presents of small irregular hilly terrain.

11.6.0 DISCUSSION OF RESULTS

11.6.1 MAGNETIC SURVEY RESULTS

Magnetic Anomaly: -

11.6.1.1 The aim of a magnetic survey is to investigate subsurface geology on the basis of the anomalies in the earth's magnetic field resulting from the magnetic properties of the underlying rocks. In general, the magnetic content (susceptibility) of rocks is variable depending on the rock type. Commonly causes of magnetic anomalies include dykes, faults and lava flows. In case of geothermal environment, due to high temperatures, the susceptibility decreases. It is not usually possible to identify with certainty the causative bodies of any anomaly from magnetic information alone. The magnetic method involves the measurement of the earth's magnetic field intensity. The total magnetic field has been measured. Measurements of the horizontal or vertical component or horizontal gradient of the magnetic field may also be made. Magnetism is, just like gravity, a potential field. So it is also possible to transform one potential field to others. Anomalies in the earth's magnetic field are caused by induced or remnant magnetism. Induced magnetic anomalies are the result of secondary magnetization induced in a ferruginous body by the earth’s magnetic field. The shape dimensions, and amplitude of an induced magnetic anomaly is a function of the orientation, geometry, size, depth, and magnetic susceptibility of the body as well as the intensity and inclination of the earth's magnetic field in the survey area.

11.6.1.2 The total variation in TMI of 4088 nT was observed with the highest value of 48607 and 44519 nT as lowest. The variation of 4088 nT with -1659 nT as lowest and 2423 nT as highest was observed in Magnetic anomaly.

11.6.1.3 The total magnetic intensity (TMI) as well as magnetic anomaly (MA) has indicated characteristic variations of magnetic response over different litho units with significant E-W direction with some local variations in Area 1, and in N-S direction with some local variations in Area 2 & 3. These are reflecting significant quartz veins with highly structural disturbance which may caused by folding and faulting in geological strata. It can be observed that there is a major folding pattern of quartz veins has been developed in Area 1 with multiple parallel loads in E-W direction. There is also possibility of a major fault in western part of the Block as derived by TMI.

11.6.2.0 Reduced to Pole (RTP):

11.5.2.1 Because of the dipolar nature of geomagnetic field, the magnetic sources observed anywhere except magnetic poles are asymmetric; this feature makes the interpretation of magnetic data difficult. The reduced to pole (RTP) technique is implemented over the Magnetic anomaly grid in order to convert magnetic anomaly to symmetrical shape so that the angle of inclination is 90 degree and declination is zero and hence, the effect of dipoles were eliminated. In the present study reduced to pole is applied on the diurnally corrected Magnetic Anomaly data. From the RTP image of the Magnetic anomaly, it can be observed that the anomalous zone has been slightly shifted towards NE direction, by which it overcomes the asymmetric effect of magnetic sources in Area 1, confined within central portion of Area 2 which was scattered in TMI map and there is no major changed in Area 3. It is concluded that the igneous basement along with quartz veins in aligned in EW direction in Area 1, NS direction in Area 2 and lensoidal bodies with slight NS trend in Area 3.

11.6.2.2 The general pattern of magnetic intensity which is the NW-SE direction is interrupted due to some near surface magnetic effects which is being eliminated in RTP anomaly map which indicates that the local interrupting bodies are shallow or scattered on the surface in Area 1. The general pattern of magnetic intensity which is the N-S direction in scattered manner which is interrupted due to some near surface magnetic effects which is being eliminated in RTP anomaly map which indicates that the local interrupting bodies are shallow or scattered on the surface in Area 2. There is no major variation in RTP map in comparison with magnetic intensity map in Area 3.

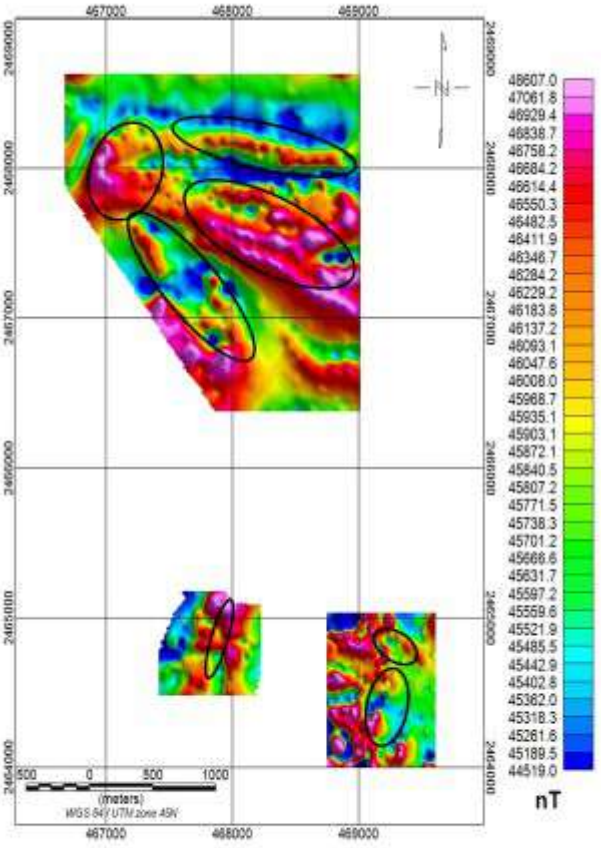


Figure: 2.3.1.1 Total Magnetic Intensity (TMI) Map.

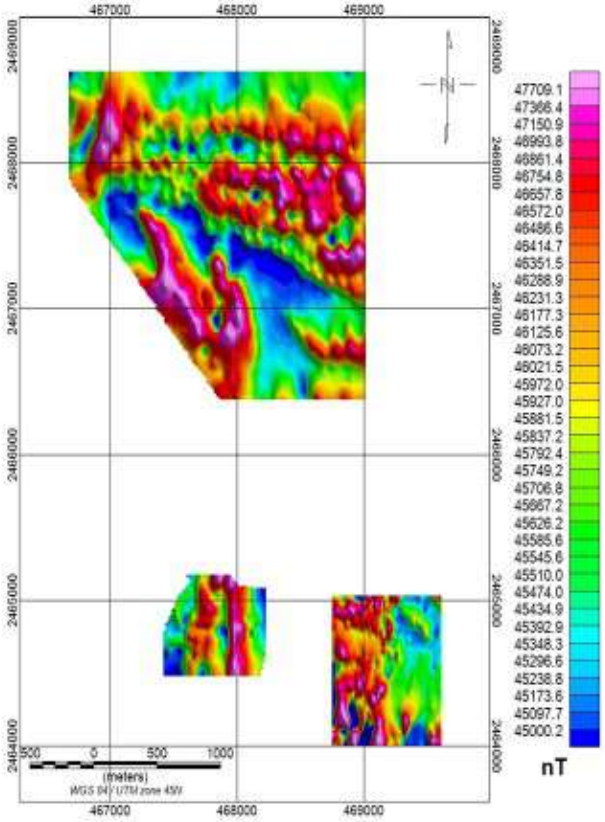


Figure: 2.3.1.3 Reduced to Pole (RTP) Map of (TMI).

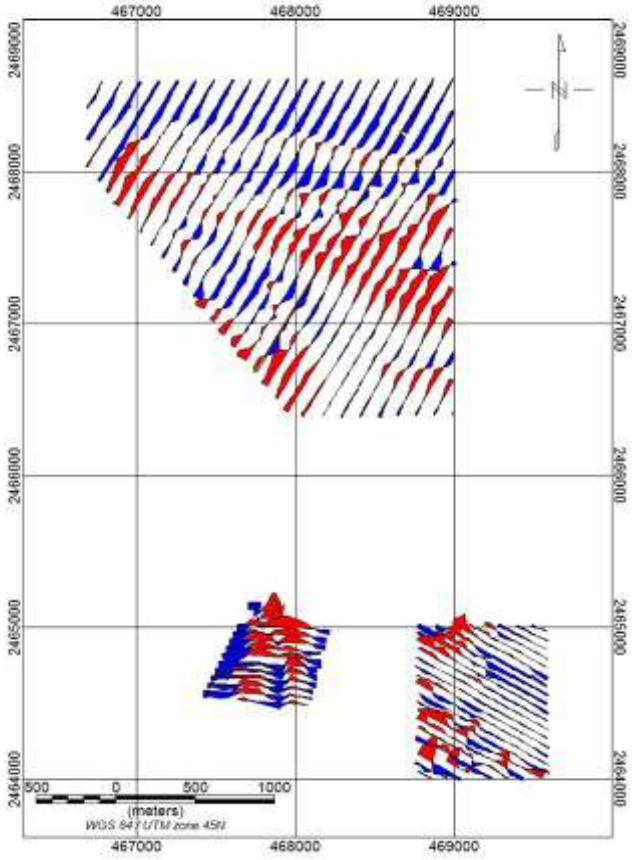


Figure: 2.3.1.16 Profile Plots of TMI.

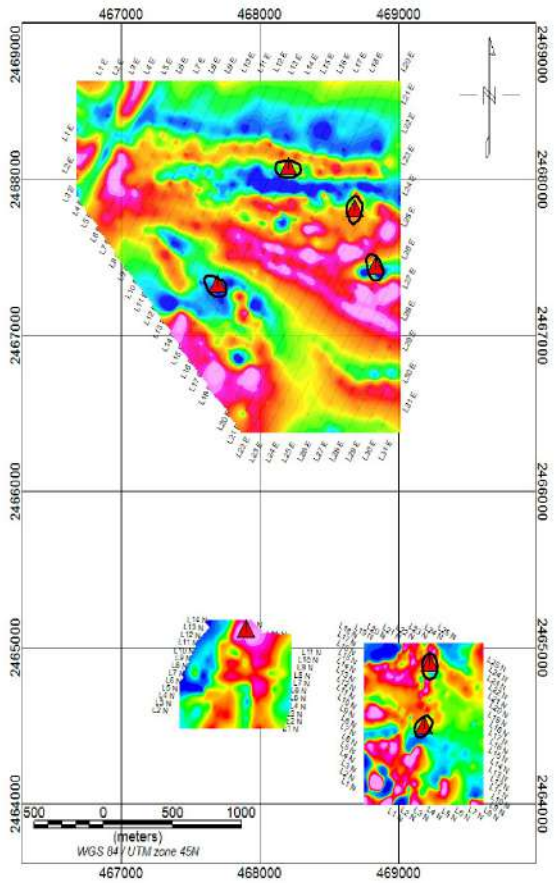


Figure: 2.3.2.20 Borehole locations over Total Magnetic Intensity (TMI) Map.

Residual Magnetic Anomaly: -

11.6.2.3 The detected anomalies on the residual magnetic anomaly map of 50m, 100m, and 200m upward continuation strongly reflects the geological features / structures. The horizontal derivative, the first vertical derivative maps of TMI has been generated for enhancing local anomalies. Derivative tends to sharpen the edges of anomalies and to enhance shallow features. Thus, the smaller anomalies in the Magnetic anomaly map in areas of strong regional disturbances are more readily apparent on the residual Magnetic anomaly map. The vertical derivative map is much more responsive to local influences than to broad or regional effects and therefore tends to give sharper picture than the map of the total magnetic field intensity. The first vertical derivative of TMI has clearly demarcated the anomalous zone in Area 1, 2 & 3.

Analytical Signal Analysis: -

11.6.2.4 The Analytical signal analysis known as total gradient method is useful in demarcating the edges/lithological boundaries of source of magnetic bodies. The shape of the analytical signal of the magnetic field is nearly independent of field orientation and remanence. The analytical signal analysis map of the study area helped in inferring lithological boundaries in the form of high intensity analytical signal amplitude along the contacts and shallow anomalous bodies.

Source Parameter Imaging:-

11.6.2.5 An attempt also has been made to determine the depth of anomalous zones / bodies in the area by Source parameter imaging. In addition to the depth estimation of the bodies by Source parameter imaging, it also locates the edges of the bodies. The source parameter imaging works well on 3D bodies and the map of the tilt angle was obtained from potential data, the minimum of which is placed on the boundaries of the causative bodies. From Source parameter imaging of RTP of Magnetic intensity, the depth of mineralized zones at proposed boreholes are found well corroborated with the estimation derived from IP and Apparent Resistivity map ranging and is from 50 m to 80 m. From the profile plots the general trend of litho units appears to be in E-W direction in Area 1 and N-S direction in area 2 &3.

Radially averaged power spectrum: -

11.6.2.6 The radially averaged power spectrum is a function of wave number and is obtained by averaging energy in all directions for the same wave number. The magnetic data is transferred to frequency domain for calculating the radially averaged power spectrum. The spectral analysis is used to resolve depth to the causative sources of different magnetic interface due to magnetic susceptibility contrast. The maximum depth of mineralization zone from radially averaged power spectrum of TMI was found upto a maximum depth of 100 m and minimum depth of 50m.

3.1.1 Resistivity/IP Imaging Survey

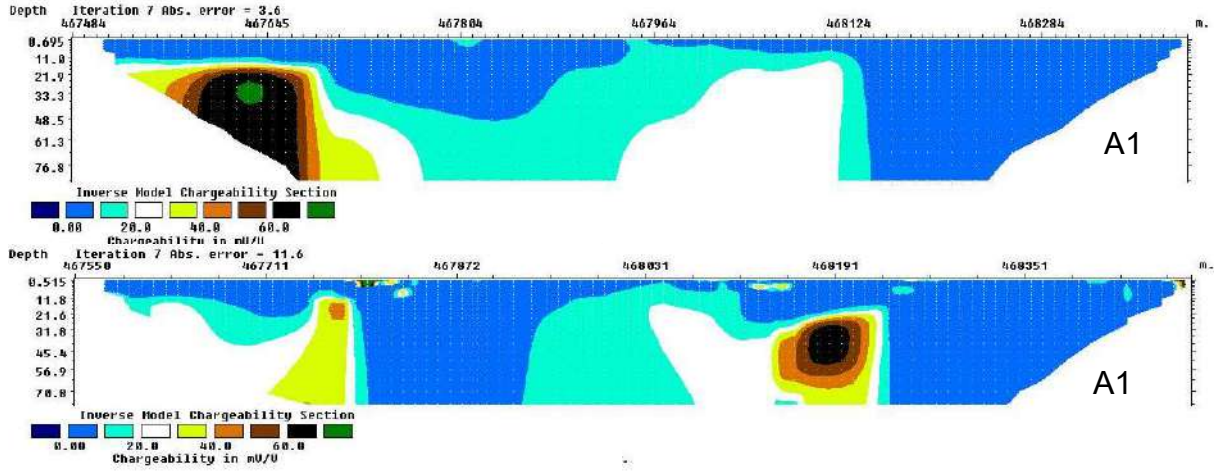
11.6.2.7 Geo-electrical resistivity survey is a widely used geophysical method for subsurface studies for including Coal exploration, mineral exploration, groundwater exploration, environmental application and other engineering applications. The main benefit of this method is that it allows for performing the survey quite fast and in a cost effective manner. Detection of different types of subsurface geology, variation of resistivity with depths (distinguishing layered earth), contaminants plume detection, detection of bedrocks depth, overburden thickness, etc. are the objectives of ERT survey. The interpretation of electrical resistivity data is the process of deriving the values of true resistivity's (ρ) and thicknesses (t) of various subsurface strata from the values of recorded resistance (R) or apparent resistivity (ρa). There are a number of interpretation techniques for evaluating ρ and t of each of the stratum as proposed by many investigators. These can be grouped as analytical, numerical, empirical, and graphical; with several procedures within each category.

11.6.2.8 Similarly, IP method is one of the most widely used techniques in mineral exploration and mining industry and it has other applications in hydrogeophysical surveys, environmental investigations and geotechnical engineering projects. The interpretation of electrical resistivity data is the process of deriving the values of true chargeability (M) and thicknesses (t) of various subsurface strata from the values of recorded Chargeability (M).

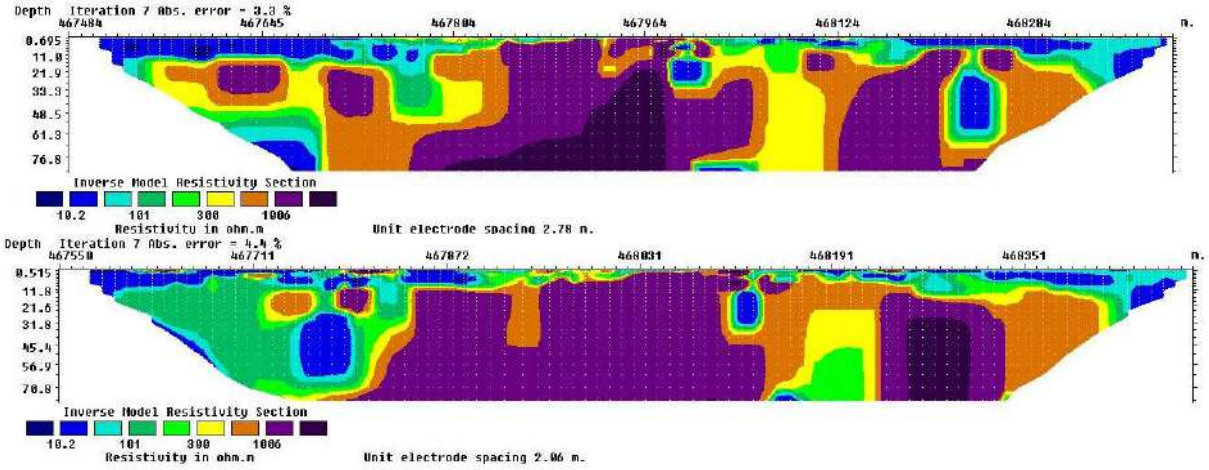
11.6.2.9 The computer software, RES2DINV, was used to analyze the filtered and processed field data. The software inverts the field data, calculates the appropriate model in term of resistivity/Chargeability, and provides output in the form of resistivity and chargeability contours. This inversion data is used to draw up the lithological and geological information.

11.6.2.10The resistivity/chargeability of any given layer depends upon rock type, grain size, degree of void spaces and amount of water present, degree of weathering, mineral constituents etc.

The data is processed and models of all the lines were generated as shown in figures 2.3.2.17, 18 in the enclosed Report**. (Annexure-XII)**



2D models generated from IP data.



2D models generated from Resistivity data.

11.7.0 CONCLUSIONS AND RECOMMENDATIONS

11.7.1 The integrated geophysical survey as approved by NMET has been conducted in the Thakurdih-Charakmara Block by adopting IP, Resistivity and Magnetic methods. The objective of the survey was to find out the potential zones for base metals comprising copper and other associated mineralisation. The effectiveness of these methods along with its limitation depends upon the physical properties contrast of the target and surroundings. The adopted methodology has successfully demarcated (fig 2.3.1.1) the possible mineralized zones along with structural features like faults/shear zone and lithological contacts. To demarcating the zones of interest and their contacts spatial filtering technique like first vertical derivative, Horizontal derivatives and analytical signal analysis etc. were applied on magnetic data to enhance the outcomes. The area of Mineralization has also been marked in IP and apparent Resistivity sections and has plotted over profile (fig 2.3.2.21). In order to obtain source depth information, source parameter imaging, radially averaged power spectrum and analytical signal analysis maps of Magnetic anomaly etc. has been generated and depth of the anomalous zones were found ranging from 50m to 100m in different segments of all the three blocks. These features are well corroborated with the Geological & geochemical maps.

11.7.2 The results from both Resistivity and IP method surveys have a lot of similarities. The extents of potential mineralisation zone have been plotted over the profiles in location map. These results are in well agreement with Magnetic as well as prior studies. The potential zones with high probability of mineralisation are also identified and purposed for further exploration in which purposed boreholes are given. Total 4 boreholes proposed in Area-1, one borehole in Area-2 and two boreholes in Area-3.

11.7.3 Report of Induced Polarization (IP), Resistivity and Magnetic in Thakurdih-Charakmara Block, East Singhbhum District, Jharkhand is enclosed as **Annexure-XII.**

CHAPTER-12

SAMPLING TECHNIQUE

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

12.1.1 The sampling and analysis have been carried out for entire mineralized zones/length intersected in the boreholes drilled on visual basis. The primary samples have been marked in the mineralized zones intersected in the borehole based on type and concentration of mineralization /lithology and in general the sample length has been kept as 1.0 m which varied in some instances because of variation in lithology and type and concentration of mineralisation. The mineralized core has been split into two equal halves in such a way that the concentrations of ore minerals are uniform in both the equal halves. One half of the core sample has been crushed to (–) 200 mesh size. By progressive coning and quartering and repeatedly mixing the sample has been reduced to 600 grams. The representative sample of 100 grams has been collected and analysed for copper (Cu) and associated elements at Chemical Laboratory of MECL, Nagpur.

12.1.2 During the present exploration, a total of 142 nos. of primary core samples have been generated and subjected for Cu, Ni, Mo, Co and W analysis. Total 20nos of selected primary core samples analysed for Au by fire assay method. The details of analysis of primary core samples for Cu, Ni, Mo, Co, W and for Gold (Au) are given in **Annexure –IIIA** and **IIIC** respectively. The details of analysis of samples of previously drilled GSI boreholes in Charakmara area (F.S. 1975-76 & 1977-78) are given in **Annexure –IIIB.**

12.1.3 In order to check analytical bias if any, internal (5%) and external (10 %.) check samples as per approved quantum for analysis of Cu, Ni, Mo, Co & W and Au by fire assay method have been carried out in MECL laboratory and in External NABL accredited laboratories. The details of internal check analysis of samples for Cu, Ni, Mo, Co and W are given in **Annexure –IVA** and for Gold (Au) are given in **Annexure No. IVB.**

12.1.4 External check samples for Cu, Ni, Mo, Co & W analysed at JNARDDC, Nagpur. The details of External check analysis of total 10 samples for Cu, Ni, Mo, Co & W are given in **Annexure –IVC**. External check for Gold not analysed.

CHAPTER-13

DRILLING TECHNIQUES AND DRILL SAMPLING EMPLOYED

13.1.0 DRILLING TYPES AND DETAILS

13.1.1 During the present investigation, MECL drilled total 12 no of boreholes involving total 1497.50m diamond core drilling along with associated borehole deviation survey and borehole logging, sampling and laboratory studies in the block area. The details of boreholes drilled by MECL are given in **Annexure-IA** and summary of borehole is given in **Table-10.2**.

13.1.2 Drilling operation was carried out by two hydrostatic drill rigs KDR-600 (MEC-394) and KDR-1000 (MEC-377) and two conventional wireline drill rigs RD-60 (MEC-348) and RD-100 (MEC-345). Rotary wash type of wireline drilling method was undertaken. Diamond impregnated NQ bit (outer diameter 75.7 mm and inner diameter 47.6 mm) had been used during drilling operation. At the starting few meters, all the boreholes have been used with HX and NX casing to cover soil cover and loose friable weathered formation. All the precautions had been taken to maintain quality of drilling and achieve maximum core recovery. The core recovery varies from minimum 77% (MTCB-08) and maximum 100% (MTCB-01, 02, 03, 04, 05, 06, 07 09 & 11) with an average core recovery is about 96%.

13.1.3 The average core recovery in the mineralized zones is about 95% which is satisfactory. The quality of drilling was ensured during the operation. After closure, all the boreholes have been properly plugged and sealed with cement pillars.

13.1.4 All the inclined exploratory boreholes drilled by MECL in the block area 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 in **Table-13.1.**

Table-13.1
The specifications of the Deviation Survey Instrument

1	Name of instrument	Borehole deviation survey instrument
2	Name of manufacturer (model and make)	Eastman Company Private Limited (Germany)
3	Parameters	Inclination and azimuth angle
4	Inclination range	0 to 90 degrees
5	Azimuth range	0 to 360 degrees from north
6	Inclination resolution	NA
7	Azimuth resolution	NA

13.1.5 The boreholes have been washed properly after closing and before pull down the deviation camera and after that drill strings have been pulled out from the borehole.

13.1.6 Deviation survey instrument is based on the concept of continuous recording of azimuth and inclination when it is lowered into the borehole. After assembling the deviation survey instrument, it is lowered into the borehole so that its top coincides with the ground level. The instrument is lowered to desired depth i.e., 6.00m interval and keep it stationary for half a minute in order to record stabilized readings required. Several readings have been obtained in this way at regular depth interval i.e., 6.00m till the closure depth of the bore hole. Once the survey instrument reaches the closure depth, it is pulled out of borehole and transfer the recording in a system.

13.1.7 The initial readings are generally erratic due to magnetism on account of casing lowered in the borehole and hence not considered for deviation data plotting. The borehole deviation data is plotted on the geological cross section with the help of GDM software. The borehole wise deviation data obtained/determined is presented as **Annexure-I C.**

Figure-5-A: Borehole deviation survey instrument

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

13.2.1 The core samples have been recorded properly and the details run wise litholog and summarized litholog for boreholes drilled by MECL are given in **Annexure- II A** and **Annexure- II B** 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 ofmineralisation as well as texture, structural features such as joints, fractures, foliations etc. and their attitude with respect to core axis and identification of different litho units.

13.2.2 The mineralised zones/length recorded during the geological core logging has been subjected for sampling and analyses for copper (Cu) and associated elements. The primary sample had been marked in the mineralized zones intersected in the borehole based on ore type and concentration of mineralisation/lithology. In general, the sample length has been kept at 1.00 m interval which varied in some instances because of variation in lithology and type and concentration of mineralisation. The details of analysis of primary core samples for Cu, Ni, Mo, Co & W and for Au are given in **Annexure-III A & III C**.

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

13.3.1 The short runs were drilled as per necessity so that optimum core recovery is maintained. The core recovery in the mineralized zones is about 95% which is satisfactory. Whenever core recovery is less, the grade of the recovered portion has been extrapolated over the non-recovered section. The quality of drilling was ensured during the operation.

13.4.0 WHETHER THE RELATIONSHIP EXISTS BETWEEN SAMPLE RECOVERY AND GRADE

13.4.1 The core recovery in the mineralized zones is about 95% approximately which is satisfactory. The entire mineralized zones / length recorded during the geological logging on visual basis have been analysed for copper (Cu) and associated elements and the copper ore zones identified at 0.20% Cu cut-off grade. Since, the recovery percentage in the mineralized zones is high there is no any negative effect from the core recovery.

13.5.0 CORE LOGGING

13.5.1 The drilled core recovered from the boreholes has been logged systematically to demarcate various litho-units. The core recovery varies from 77% (MTCB-08) and

maximum 100% (MTCB-01, 02, 03, 04, 05, 06, 07 09 & 11) with an average core recovery percentage of all the boreholes is about 96%. 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 copper mineralisation as well as texture, structural features such as joints, fractures, foliations etc. and 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.

13.5.2 The logging was carried out run-wise for boreholes drilled by MECL. Since the variation of litho units were less except in schistose rock in down-hole direction and run lengths were short, thus consolidated / summarized litholog for all the boreholes were prepared with all details to show the litho units as graphic representation. The grouping of litho units intersected in the boreholes was done as Top Soil, Amphibolite, Biotite Chlorite schist/Biotite schist/Altered schistose rock, Biotite Quartz schist/Biotite chlorite schist, Chlorite Biotite schist/Chlorite schist/Gr. Chlorite schist, Dolerite, Granite, Granite gneiss/Metabasic rock, Quartz biotite Chlorite schist/ Quartz biotite schist/Quartz schist & Quartzite.

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 The details of sampling procedure are described in Para 12.1.0. During the sample preparation the core sample has been split longitudinally into two equal halves with the help of hydraulic core splitter. One half has been preserved and the other has been crushed for the preparation of primary samples at -200 mesh size. Sample has been homogenized by proper mixing and coning quartering as per the standard sampling procedure.

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 12.1.0. The composite samples have been prepared after delineation of mineralised zones at required thickness and cut-off grade. The powdered primary samples from delineation of mineralised zones at required thickness and cut-off grade, have been mixed in proportion of their extrapolated length to prepare the composite samples. The samples have been mixed thoroughly and required quantity of samples had been drawn by through mixing and coning and quartering. The composite samples prepared have been analysed for Cu, Ni, Co, W & Mo elements.

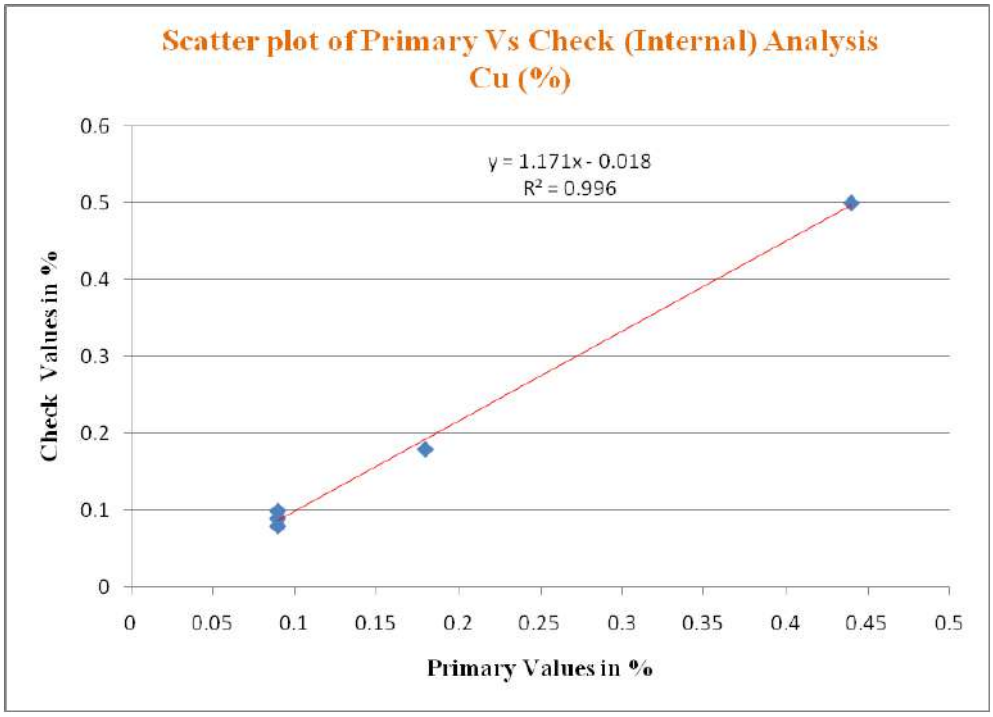
14.3.0 QUALITY CONTROL PROCEDURES ADOPTED

14.3.1 Standard sampling procedure in supervision of qualified sampling technician has been adopted and the samples have been prepared at project sampling unit. Total 142 nos. of primary samples have been prepared and analysed for Cu, Ni, Mo, Co, W total 20 nos for Au by fire assay method in MECL laboratory, Nagpur. In order to check the sampling and analytical bias if any, a total of 5 numbers of internal checks analysed in MECL laboratory and total 10 nos. external check samples analysed in JNARDDC Laboratory, Nagpur for analysis of Cu, Ni, Mo, Co W. The details of Internal check and external check samples are given in the **Annexure-IV A and IV C**.

14.3.2 The comparative studies of primary Vs internal check analysis for copper (Cu) is given in Table-14.1 and scatter plots is represented as Text Figure- 6.

Table-14.1: Comparison of Primary vs Internal Check Samples for Copper

SL. NO.	COMPARISION INDEX	PRIMARY	INTERNAL CHECK
1	No. of Samples	5	
2	Arithmetic Mean	0.178	0.190
3	Standard Deviation	0.136	0.159
4	Standard Error of Mean	0.061	0.071
5	Variance	0.018	0.025



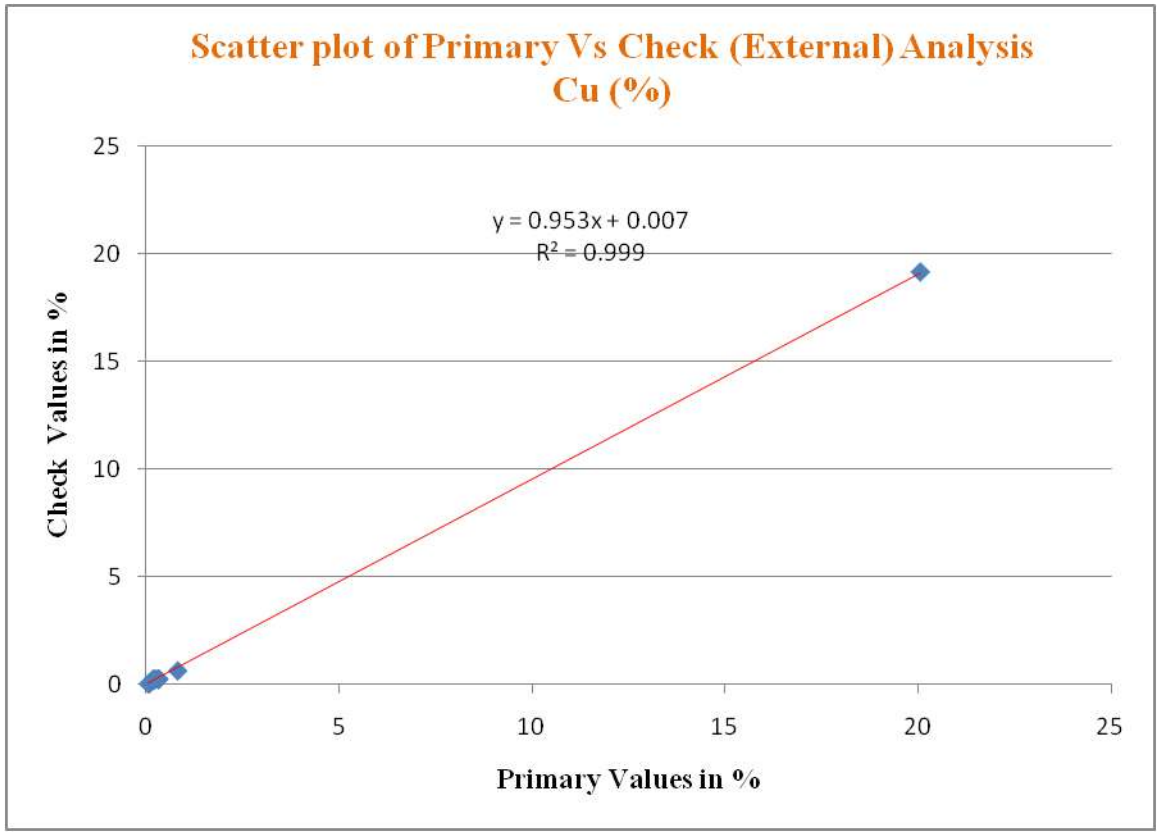
Text Figure-6: Scatter Plot of Primary Vs Check (Internal) Analysis of Cu

14.3.3 The data set for primary Vs internal check analysis comprises 05 pairs of samples. Table-14.1 shows that the difference in arithmetic mean, standard deviation, standard error of mean and variance of primary and exterrnal check samples are not high. The value of R^2 given in scatter plot (Text Figure – 6) is 0.996, which is close to 1.00 and indicates a good correlation in primary and internal check analysis.

14.3.4 The comparative studies of primary Vs external check analysis for copper (Cu) is given in Table-14.2 and scatter plots is represented as Text Figure- 7.

Table-14.2: Comparison of Primary vs External Check Samples for Copper

SL. NO.	COMPARISION INDEX	PRIMARY	EXTERNAL CHECK
1	No. of Samples	10	
2	Arithmetic Mean	2.253	2.156
3	Standard Deviation	5.939	5.663
4	Standard Error of Mean	1.878	1.791
5	Variance	35.268	32.073



Text Figure 7: Scatter Plot of primary V/s Check (External) Analysis Cu (%)

14.3.5 The data set for primary Vs external check analysis comprises 10 pairs of samples. Table-14.2 shows that the difference in arithmetic mean, standard deviation, standard error of mean and variance of primary and exterrnal check samples are not high. The value of R^2 given in scatter plot (Text Figure – 7) is 0.999, which is close to 1.00 and indicates a good correlation in primary and external check analysis.

14.3.6 The statistical and comparative studies for primary Vs internal check & primary Vs external check samples shows the repeatability of the analysis for Cu i.e. insignificant differences between primary and exterrnal check analysis, which support the reliability of sampling procedure.

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

14.4.1 All the primary samples have been marked and prepared from copper mineralised cores. During the preparation of primary samples, the mineralised cores have been studied meticulously and samples have been marked properly. These mineralised cores are subjected for preparation of primary samples as per the sampling procedure for primary samples are described in Para 12.1.0. The composite samples have been prepared from the powdered primary samples after delineation of mineralised zones at required thickness and cut-off grade. The proper marking of primary samples from drilled cores and following standard procedure for primary and composite 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

14.5.1 The primary samples have been prepared (–) 200 mesh size and all the other samples have been prepared from primary samples. As per the previous studies in and surroung the area, the (–) 200 mesh size is appropriate for the liberation of mineral grains and analysis for copper (Cu) and associated elements 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 chemical analysis of primary samples for copper (Cu) and associated elements has been carried out in Chemical Laboratory of MECL. The analysis has been carried out by Atomic Absorption Spectroscopy (AAS) method by Analytical Jena ZEEnit model instrument. The Standard Operating Procedure (SOP) for the Determination of Copper (Cu) and associated elements using AAS is given below.

Reagents and Standards

- Aqua Regia – 50-60 ml (Prepared using AR Grade Acids)
- Stock standards for copper – 1 ml of solution = 1 mg of copper (1000 ppm).

Procedure

1. Weigh 0.3 – 1.0 gm of the sample in a 250 ml beaker and add 50-60 ml aqua regia.
2. Cover the beaker with watch glass, and digest on hot plate for 5-6 hrs till syrup like solution is formed.
3. After digestion, add 10-20 ml water and heat for 5-10 minutes and filter by Whatman grade – 40 filter paper, in 250 ml volumetric flask.
4. Wash the residue with hot distilled water for four to five times.
5. Add the washings to the filtrate and makeup the volume up to 250ml.
6. Aspirate the sample solution in AAS using Air-Acetylene flame mode with following settings-

   (AAS to be calibrated before testing samples with at least 10 calibration points)

   - Wavelength - 324.7 nm,
   - Slit width - 0.5 nm,
   - Lamp current - 4.0 mA
   - Instrument mode - Absorbance

7. Read the absorbance and concentration on atomic absorption spectrophotometer (Analytical Jena ZEEnit model).
   (Run CRM and repeat samples after every 20 samples)

Calculation

$$\text{copper in \%} = \frac{\text{Cu ppm reading x volume (ml) x 100 x Dilution factor}}{\text{1000000 x weight of sample (gm)}}$$

15.2.0 NATURE OF QUALITY CONTROL PROCEDURES ADOPTED

15.2.1 The standard procedure for chemical analysis as per provision made in the proposal for QA/QC has been followed. All the primary samples have been analyzed in the Chemical Laboratory of MECL, Nagpur. In order to assess the bias and inaccuracies in analytical determination, one standard, one blank and one repeat samples has been analysed for each 20 numbers of primary samples.

15.3.0 CHECK ANALYSIS FROM THIRD PARTY NABL ACCREDITED LABORATORY

15.3.1 The third party external check samples analyses being carried out at JNARDDC Laboratory, Nagpur. Total of 10 numbers of external check samples for Cu, Ni, Mo, Co & W have been sent to JNARDDC Laboratory, Nagpur. Total 10 nos sample analytical results of external check for Cu, Ni, Mo, Co & W are given in **Annexure-IV-C.**

15.3.2 Total 10 numbers of external check samples for analysed for Cu, Ni, Mo, Co & W at JNARDDC laboratory, Nagpur, showed no major difference between primary and check analysis **(Annexure No.IVC).** The analytical results of third party analysis by NABL laboratory for external check samples are in conformity with the analysis of primary samples support the insignificant differences between both the laboratories.

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

15.4.1 The samples have been prepared at project sampling unit with proper lebeling and tag packed in sealed polythene bag 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 possibility of contamination.

CHAPTER-16

MOISTURE

16.1.0 All the analysis for copper and associated elements has been carried out with natural moisture.

CHAPTER-17

BULK DENSITY

17.1.0 Bulk density/ specific gravity studies not carried out as there is no scope of work in the present exploration program.

17.1.1 The Thakurdi-Charakmara block area is just adjoining to the Mudadevta-Darkhuli & South Jharia block which was previously explored by GSI and recently by MECL (2021-22) for Copper and associated minerals at G2 stage. The average specific gravity for copper bearing mineralized zones was determined as 3.00 based on total 25 nos. borehole core samples. Hence, the average specific gravity for copper ore zones for 0.2% Cu cut-off grade has been taken as 3.00 for the resource estimation in Thakurdi-Charakmara block area.

CHAPTER-18

BENEFICIATION STUDIES

18.1.0 Beneficiation studies not carried out as there is no scope of work in the present stage exploration.

CHAPTER-19

RESOURCE ESTIMATION TECHNIQUE

19.1.0 DISCUSSION ON DATA DENSITY TO ASSURE CONTINUITY OF MINERALISATION

19.1.1 Thakurdih-Charakmara block is located in the southeastern tip of the Singhbhum Shear Zone and forms the part of Baharagora copper prospect. The Baharagora area comprises a number of blocks and the area was previously explored by GSI. The present Thakurdi-Charakmara G3 stage exploration block is located just adjoining and extension to the Mudadevta-Darkhuli South Jharia G2 block which was previously explored by GSI and recently by MECL (2021-22) at G2 stage.

19.1.2 To the east of Charakmara, there is a line of discontinuous pits for a distance of about 500m in a NE-SE direction in metabasites, basic schists and biotite quartz schist within the granitic country rocks. Previous work of GSI (1974) indicated Strong Geochemical anomalies and weak Geophysical IP anomalies in Charakmara area. Two test old boreholes (BC-1 &2) of GSI drilled in Charakmara area intersected a zone of mineralisation varying in width from 0.85m to 2.05m and in grade from 2.05% Cu to 0.92% Cu and 0.17% Ni at about 60m vertical depth. This zone is likely to persist along strike and dip. Similary few old workings trending in NW-SE direction located in Area-1 near Thakurdih village. Previous work of GSI indicated strong Geochemical anomalies for Copper and strong I.P. geophysical anaomalies in Area-1, 2 and 3 of the block area and corroborated well with old workings and geochemical anomalies.

19.1.3 Based on the previous work carried out in the area the present G3 stage exploration program has been executed as per the approved quantum of work by MECL. Exploratory drilling in Charakmara area and Integrated geophysical survey (I.P. Resistivity and Magnetic) carried out in Area-1, 2 and 3 of the block area. During the present G3 stage exploration, total 1497.50m drilling in 12 boreholes carried out in the block area in the block area. To confirm the strike and depth persistence of copper bearing mineralized zones in line with previously drilled GSI boreholes total 8 boreholes drilled in Charakmara area at 100m spacing interval to intersect the ore zones up to 1st and 2nd level i.e.60m and 120m vertical depth respectively. In Charkamara area, total 600m in 5 Boreholes drilled at 1st level and 540m in 3 boreholes drilled in 2nd level for deeper level intersections. Based on the ground geophysical survey anomaly total 3 test boreholes involving 267.50m drilled in Area-1 and one test borehole of 90m depth drilled in Area-3 at 60m vertical depth.

19.1.4 Total 1797.95 m exploratory drilling data in 14 nos. of boreholes includes total 300.45 m (2 Boreholes) of previously drilled GSI boreholes in Charakmara area and 1497.50m (12 Boreholes) of present exploration of MECL in Charkamara area, Area-1 & 3 has been taken into consideration for geological interpretation, correlation and ore resource estimation for copper ore as per the cut-off grade criteria in Thakurdih-Charakmara block.

19.2.0 WHETHER PREVIOUS EXPLORATION DATA HAS BEEN USED

19.2.1 Previously drilled GSI (1984) borehole data of total 300.45m in 2 no of test boreholes in Charakmara area has been used for geological interpretation, correlation and evaluation of copper ore resource in line with presently drilled MECL borehole data. Details of GSI Boreholes and Chemical Analysis of samples is given as **Annexure No. I B and III-B** respectively. Core recovery details are not available with previously drilled two test boreholes (BC-1&2) of GSI. However, sufficient mineralized zone intersection details along with borehole collar details are available. Hence, the material information as to the lithology has been used to construct the geological controls in the section and correlation along with the most recent drilling of MECL. In view of limited borehole data in Charakmara area, old GSI Boreholes data of two test boreholes has been considered for the evaluation of copper ore resources subject to the fulfillment of cut-off grade criteria parameters set for resource estimation.

19.3.0 THE NATURE AND APPROPRIATENESS OF THE ESTIMATION TECHNIQUE(S) APPLIED AND KEY ASSUMPTIONS

19.3.1 The copper ore resource of the block area has been estimated by "**Geological cross-section Method**" (as principal method), as well as "**Longitudinal Vertical Section Method**" (as secondary method). Certain axiomatic assumptions are inherently involved in estimation of overall grade and resource of the deposit, which are given below.

1. The rule of gradual change or law of linear function has been applied (Constantine C. Popoff, 1966) along with the rule of nearest points for application of influence of half way between successive boreholes.

2. The boreholes which are not intersecting any mineralisation have been considered as negative boreholes and completely eliminated from resource estimation.

3. The thickness and grade of each mineralized zone intersected in the borehole have been considered as it is for the entire influence area of the borehole.

19.4.0 THE BASIS FOR CLASSIFICATION OF THE MINERAL RESOURCES

19.4.1 During the present exploration, boreholes were spaced at 100m interval approximately in Charakmara area and is sufficient to establish copper ore resources at G-3 stage (preliminary exploration) as per the exploration norms of Minerals (Evidence of Mineral Content) Rule-2015. Hence, estimated resources in Charakmara area may be placed under Inferred Mineral Resource (333) category of UNFC. However, in Area-1 the boreholes are scout boreholes in nature to test the surface geophysical anomaly at depth in the specified locations. Thus, the resource estimated in Area-1 may be categorized underr Reconnaissance Mineral Resource (334) category of UNFC in Thakurdih-Charakmara block.

19.5.0 THE ASSUMPTIONS MADE REGARDING RECOVERY OF BY PRODUCTS

19.5.1 The present exploration (G3) has been carried out for copper ore and associated minerals in Thakurdi-Charakmara block. The copper bearing ore zones have been delineated on the basis of the primary sample analysis. Total 3 nos of composite samples have been prepared from the delineated mineralized zones at 0.2% Cu cut-off and analysed in MECL Laboratory, Nagpur for analysis of five elements i.e. Cu, Ni, Co, W & Mo. Analytical results of composite samples for Cu range from 0.26% to 0.65% Cu, Ni values range from 0.02% to 0.04%, Co values range from 0.01% to 0.03% Co. W and Mo values are less than 0.01%. The analytical results of composite samples are given in **Annexure-VI A**. A comparision study between computed Vs analytical results of composite samples for Cu carried out and found no major difference between two results. The details of Computed Vs Analytical results of composite samples for Cu are given in **Annexure VI-B**. Borehole data indicate that Nickel, Cobalt, Molybdenum and Tungsten values are not encouring.

19.5.3 Total 20 nos. Primary samples were analysed for Gold (Au) by fire assay method at MECL laboratory, Nagpur. Au values range from <0.1 ppm to 0.24 ppm. Out of total 20 nos, 12 nos samples indicated <0.1ppm Au and 2 nos. indicated >0.2 ppm Au. Au values are not encouring.

19.6.0 DETAILED DESCRIPTION OF THE METHOD USED AND THE ASSUMPTIONS MADE TO ESTIMATE TONNAGE AND GRADES

19.6.1 The copper ore resource and grade has been estimated by "**Geological cross-section Method**" (as principal method), as well as "**Longitudinal Vertical Section Method**"

(as secondary method) and estimated resources in Charakmara area are placed under Inferred (333) and in Area-1 under Reconnaissance Resource (334) category of UNFC considering the following parameters and assumptions.

1. **Cut-off Grade**: For the purpose of estimation of grade vis-à-vis resource of the copper ore the overall average grade of the mineralized zones with 0.20% Cu cut-off grade has been considered for resource estimation.

2. **Minimum Stoping Width and Maximum Parting:** As per standard practice, the minimum stopping width of 2.00 m as true width and maximum parting upto 3.00 m is considered for delineation of copper ore lodes/zones for resource estimation.

3. In case of copper ore lodes/zones with true thickness less than 2.00m, the sample at hanging wall /footwall of below cut-off grade has been included to earmark the true thickness of 2.00m, considering the overall grade after dilution must be above the required cut-off grade.

4 **Section influence:** In Charakmara area, the sectional area influence of 25.00m from the borehole intersection or up to the mid of the two boreholes towards the down dip direction and towards updip direction as the case may be has been included under Inferred category (333) having the same thickness and the grade as of the intersection in the boreholes. The grade of the copper ore lodes intersected in the borehole has been assigned to its influence zones.

5 In Area-1. the sectional area influence of 25.00m from the borehole intersection towards down dip direction and up to 50.00m towards up dip direction or up to the soil/weathered zone which ever is less has been included under Reconnaissance category (334) having the same thickness and the grade as of the intersection in the boreholes. The grade of the copper ore lodes intersected in the borehole has been assigned to its influence zones.

6 **Strike influence:** In general, boreholes are spaced at 100 m strike interval in Charakmara area. Hence, the strike influence for all the sections has been considered up to the midpoint (half of the distance) of the next section on either side of section line. In Area-1, scout boreholes drilled to test the geophysical anomaly and boreholes are not spaced in a regular interval. However, geophysical profile lines spaced at 100m interval. Hence, the strike influence for all the sections has been cosndiered up to the midpoint (half of the distance) of the next section on either side of the section line. The grade of the copper ore lodes intersected in the borehole has been assigned throughout the section influence.

6 **Specific Gravity:** The average specific gravity for copper ore mineralized zones has been taken as 3.00 for 0.20% cut-off grade for estimation of resources in Thakurdih-Charakmara block area.

7. An overall deduction of 10% is applied to the total gross tonnage to arrive at the net in-situ geological resource of copper to account for geological reasons i.e., data gaps, geological uncertainities, irregular nature of deposit and abrupt change in zone thickness etc.

19.6.2 **Exploration Data for Resource Estimation:** During the present investigation, total 1497.50m in 12 Boreholes pertaining to MECL and 2 old boreholes of GSI has been taken into consideration for the evaluation of resources in the area as per the cut-off grade crieteria parameters. Also, the intersection positions have been used only as an approximation to guide the trend of mineralization in the cross section. During present investigation of MECL, out of total 12 nos boreholes, 8 nos. boreholes drilled in Charakmara area to confirm the strike and depth persistence of copper bearing ore zones in two levels. Initial 05 boreholes (MTCB-01 to MTCB-05) targeted to intersect the ore zones at 20mRL (60m vertical depth) and remaining 03 boreholes (MTCB-06, 07 & 08) targeted for deeper level intersections at -40 mRL (120m vertical depth) from the surface. Total 3 nos. test boreholes (MTCB-9, 10 &11) were drilled in Area-1 and one test borehole (MTCB-12) in Area-3 to test the geophysical anomaly at about 60m vertical depth.

19.6.3 In Charakmara area the borehole core sample analysis of total 94 samples indicated that Cu values range from minimum <0.01% Cu to maximum 0.81% Cu. Two samples indicated high Cu values 6.41% Cu (Sample # MTCB-06/08) and 20.06% Cu (Sample # MTCB-6/07) in the drilled boreholes. The previous boreholes (2 nos.) of GSI (1984) in Charakmara area indicated two mineralized zones of 0.59% Cu, 0.11% Ni over 1.35m thickness and 2.74% Cu over 2.05m thickness.

19.6.4 MECL Borehole core samples for Ni analysis of total 94 nos samples in Charakmara area indicated Ni values range from minimum <0.01% Ni to maximum 0.25% Ni. Only two samples indicated >0.10% Ni i.e. 0.13% Ni (Sample # MTCB07/07) and 0.25% Ni (Sample # MTCB04/02). Mo values range from minimum <0.01% Mo to maximum 0.04% Mo, Co values from <0.01% Co to 0.03% Co and W values are less than 0.01%. Borehole core sample analysis values for Ni, Mo, Co and W are not encouraging.

19.6.5 In Area-1, borehole core sample analysis of total 42 samples indicated that Cu values range from minimum <0.01% Cu to maximum 2.44% Cu. Only one samples indicated high Cu values 2.44% Cu (Sample # MTCB-10/10) and all the rest of the samples indicated less than 0.85% Cu. Total 42 nos of core samples indicated Ni values range minimum from <0.01% Ni to maximum 0.10% Ni, Co values range from <0.01% Co to 0.05% Co, Mo & W values are less than 0.01%.

19.6.6 In Area-3, total 6 nos samples indicated Cu values range from <0.01% Cu to 0.08% Cu, Ni values 0.01% Ni to 0.04% Ni, Mo, Co and Wo values are less than 0.01%. Values for Copper and associated elements are not encouraging in Area-3.

16.6.7 Borehole core sample analysis values for Ni, Mo, Co and W are not encouraging in Charakmara, Area-1 & 3 of Thakurdih-Charakmara block.

16.6.8 Moreover, total 20 nos. primary samples were analysed for Gold (Au) by fire assay method at MECL laboratory, Nagpur. Au values range from <0.1 ppm to 0.24 ppm. Out of total 20 nos, 12 nos samples indicated <0.1ppm Au and 2 nos. indicated >0.2 ppm Au. **(Annexure No.III-C)**. Au values are not encouraging.

16.6.9 Total 1797.95 m exploratory drilling data in 14 nos. of boreholes includes total 300.45 m (2 Boreholes) of previously drilled GSI boreholes in Charakmara area and 1497.50m (12 Boreholes) of present exploration of MECL in Charkamara area, Area-1 & 3 has been taken into consideration for geological interpretation, correlation and ore resource estimation for copper ore as per the cut-off grade criteria in Thakurdih-Charakmara block.

19.6.10 **Copper ore lodes:** The lodes/zones have been delineated on the basis of assay of chemical analysis i.e., Cu% at 0.2% Cu cut-off grade (for correlation). The lodes intersected in the boreholes have been plotted on the geological cross sections (Plate-IVA) and level plans (Plate-VA and VB). Further, the lodes are correlated and given nomenclature from footwall side. Four copper ore lodes (Lode-1, 1A, 1B and 2) in Charakmara area and four copper ore lodes (Lode-1A, 1B and 1AA, Local) have been delineated on the basis of 0.2% Cu cut-off grade (for correlation purpose only) details provided in **Table no. 19.1 (Annexure V-A).** For estimation of resource lodes have been identified on the baseis of assay chemical analysis i.e. Cu% at 0.2% Cu cut-off grade considering the minimum stoping width of 2.00m as true thickness and maximum parting of 3.00m details provided in **Table no. 19.2 (Annexure V-B)**.

Table-19.1: Borehole wise Ore Zone at 0.2% Cu cutoff (For correlation purpose only) Thakurdih-Charakmara Block, District-East Singhbhum, Jharkhand (By MECL & GSI)

Section No.	Borehole No.	Depth of Intersection(m)		Thickness (m)	True Thickness	Grade Cu (%)	Lode No.	Area Name	Agency
		From	To						
3	BC-01	92.32	93.67	1.35	1.27	0.59	1	Charakmara	GSI
2	BC-02	87.25	89.30	2.05	1.93	2.74	1	Charakmara	GSI
1	MTCB-01	53.75	54.75	1.00	0.94	0.28	1B	Charakmara	MECL
1	MTCB-01	66.20	67.10	0.90	0.85	0.39	1A	Charakmara	MECL
1	MTCB-01	77.11	78.11	1.00	0.94	0.81	1	Charakmara	MECL
4	MTCB-04	51.00	52.00	1.00	0.94	0.24	1B	Charakmara	MECL
5	MTCB-05	108.20	109.20	1.00	0.94	0.32	1	Charakmara	MECL
2	MTCB-06	38.45	39.13	0.68	0.64	0.23	2	Charakmara	MECL
2	MTCB-06	40.00	40.76	0.76	0.71	0.30	2	Charakmara	MECL
2	MTCB-06	159.72	161.42	1.70	1.60	1.00	1	Charakmara	MECL
3	MTCB-07	151.80	154.95	3.15	2.96	0.27	1	Charakmara	MECL
1	MTCB-08	164.00	165.00	1.00	0.94	0.21	1	Charakmara	MECL
L15E	MTCB-09	75.78	79.00	3.22	2.47	0.26	1B	Area-1	MECL
L15E	MTCB-09	82.50	83.00	0.50	0.38	0.27	1A	Area-1	MECL
L25E	MTCB-10	75.00	80.20	5.20	3.98	0.46	1AA	Area-1	MECL
L18E	MTCB-11	84.90	85.50	0.60	0.46	0.24	Local	Area-1	MECL

Table-19.2: Borehole wise Ore Zone at 0.2% Cu cutoff with 2.00m MSW and 3.00m Maximum parting Thakurdih-Charakmara Block, District-East Singhbhum, Jharkhand (By MECL)

Section No.	Borehole No.	Depth (m)		Thickness (m)	True Thickness (m)	Grade Cu (%)	Lode No.	Area Name
		From	To					
3-3'	MTCB-07	151.8	154.95	3.15	2.96	0.27	1	Charakmara
L15E	MTCB-09	75.78	79.00	3.22	2.47	0.26	1B	Area-1
L25E	MTCB-10	75.00	80.2	5.20	3.98	0.46	1AA	Area-1

19.6.11 In Charakmara area, Copper bearing zones/lodes strike N20^{0}E-S20^{0}W with dip of 60° to 70^0 NE direction. Total 4Nos of Lodes have been encountered in the area namely Lode-1, 1A, 1B and 2. Lode-1 is the most persistant lode in the area. Copper mineralisation in the area is hosted by Schistose rocks i.e. Chlorite-Biotite-Schist, Quartz-Biotite rock,

Quartz-Chlorite-Biotite schist, Biotite chlorite schist, Metabasites and its variants in association with shears. With the available limited borehole data mineralized zones are erratic in nature constituing lean zones with low grade having limited Strike and depth persistence.

19.6.12 In Charakmara area, out of the 8 boreholes drilled by MECL, 6 boreholes intersected copper mineralized zones at 0.20% Cu cut-off/threshold value analyzing minimum 0.21% Cu over 1.00m thickness to maximum 1.00% Cu over 1.70m thichness. Only one previously drilled GSI holes i.e. BC-02 has given significant copper values viz., 2.74 % Cu over 2.05m thickness. However as per the cut-off grade criteria parameters set for resource estimation there is only Lode-1 intersected in Borehole MTCB-07 with 0.27% Cu over 3.15m thickness. Drilling indicated that mineralized zones are thin/lean zones low in grade with limited strike and depth continuity. This may probably due to small ore shoots.

19.6.13 All 3 nos. scout boreholes (MTCB-09, 10 & 11) drilled in Area-1 intersected mineralized zones at 0.20% cut-off value. As per the cut-off grade criteria parameters for resource estimation two considerable mineralized zones intersected in two boreholes i.e. Lode-1B in MTCB-09 (0.26% Cu over 3.22m thickness) and Lode-1AA in MTCB-10 (0.46%Cu over 5.20m thickness). Area-1 hold potential for further exploration.

19.6.9 **METHODOLOGY ADOPTED IN CROSS-SECTION METHOD OF RESOURCE ESTIMATION**

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

1. In Charakmara area, a total of 7 Nos. Geological Cross Sections serially numbered as 1-1′ to 7-7′ were drawn in N70^{0}W-S70^{0}E direction perpendicular to general strike of the mineralised zones/old workings, based on the interpretation of surface and sub-surface geological data i.e., litho-units intersected in the borehole and its attitude i.e., foliation angle etc., copper ore lodes along with nomenclature, thickness and qualitative data.

2. Similary in Area-1, total 3 Nos. Geological cross sections numbered L15E-L15E', L18E-L18E' & L25E-l25E' were drawn in S30^{0}W-N30^{0}E direction perpendicular to the general strike of the litho units/mineralized zones. One Geological cross section L20N-N20N' drawn in N60^{0}W- S60^{0}E direction in Area-3 of Thakurdih-Charakmara block.

3. The cross-sections have been prepared by marking surface geology on the profile and the borehole data (lithology, nomenclature, thickness and analytical data of copper ore lodes) plotted on section along each inclined borehole. The path of the inclined boreholes has been plotted along the Geological Cross Sections by considering the deviation along depth and azimuth with the help of GDM software **(Plate-IVA, IVB, IVC and Text Figure - 8)**

4. The different copper ore lodes at required cut-off grade and MSW (minimum stopping width) plotted on the sections have been correlated based on the thickness, grade and their spatial disposition i.e., strike and depth persistence in Level Plans and Geological Cross Sections and designated with the different name for identification and correlation. Level plan prepared at 20mRL and -40mRL and given in **Plate-VA and VB** respectively**.** Level plan at 20mRL is given as Text **Figure - 9.**

5. Copper Ore resource has been estimated based on the copper ore lodes deciphered and demarcated on earlier mentioned parameters of resource estimation.

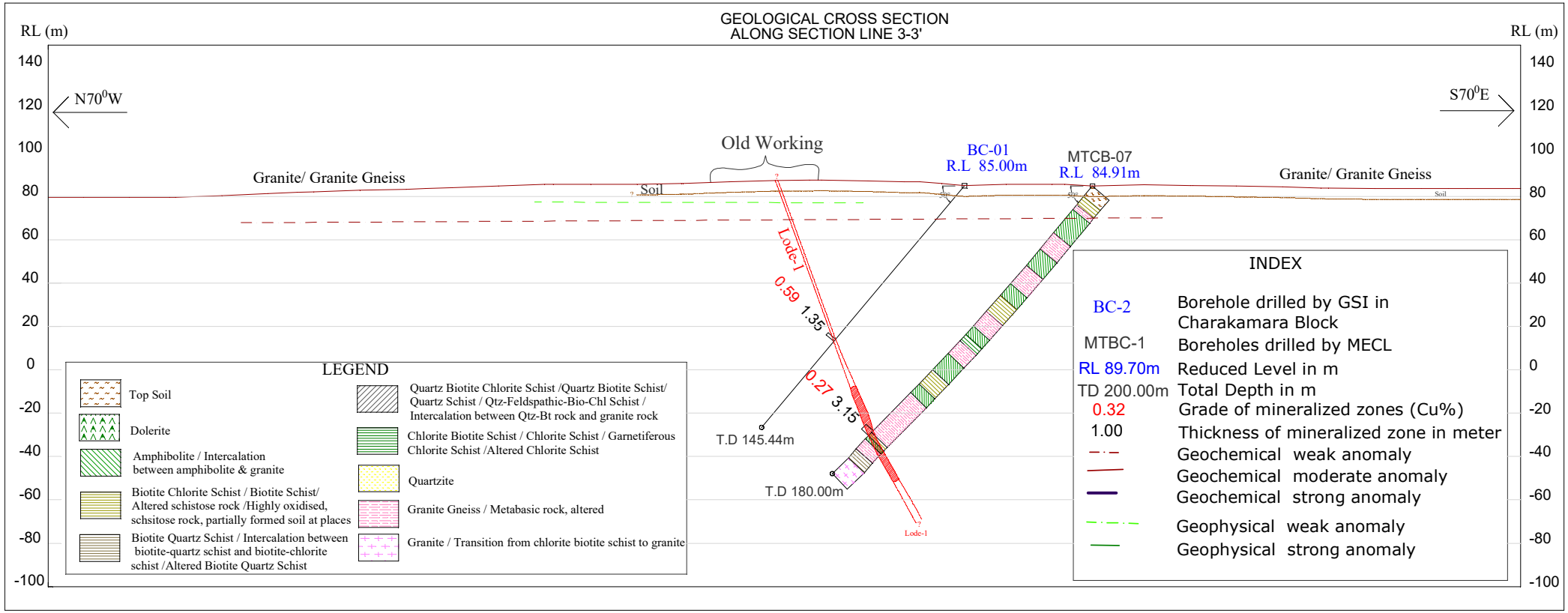
6. The area measurements have been made with the help of computer aided Auto-CAD Map 2020 software.

7. The area of influence have been summed up to arrive at the lode-wise total area for the cross-section.

8. Thus, the area obtained has been multiplied by cross sectional influence (strike influence) to obtain the sectional volume.

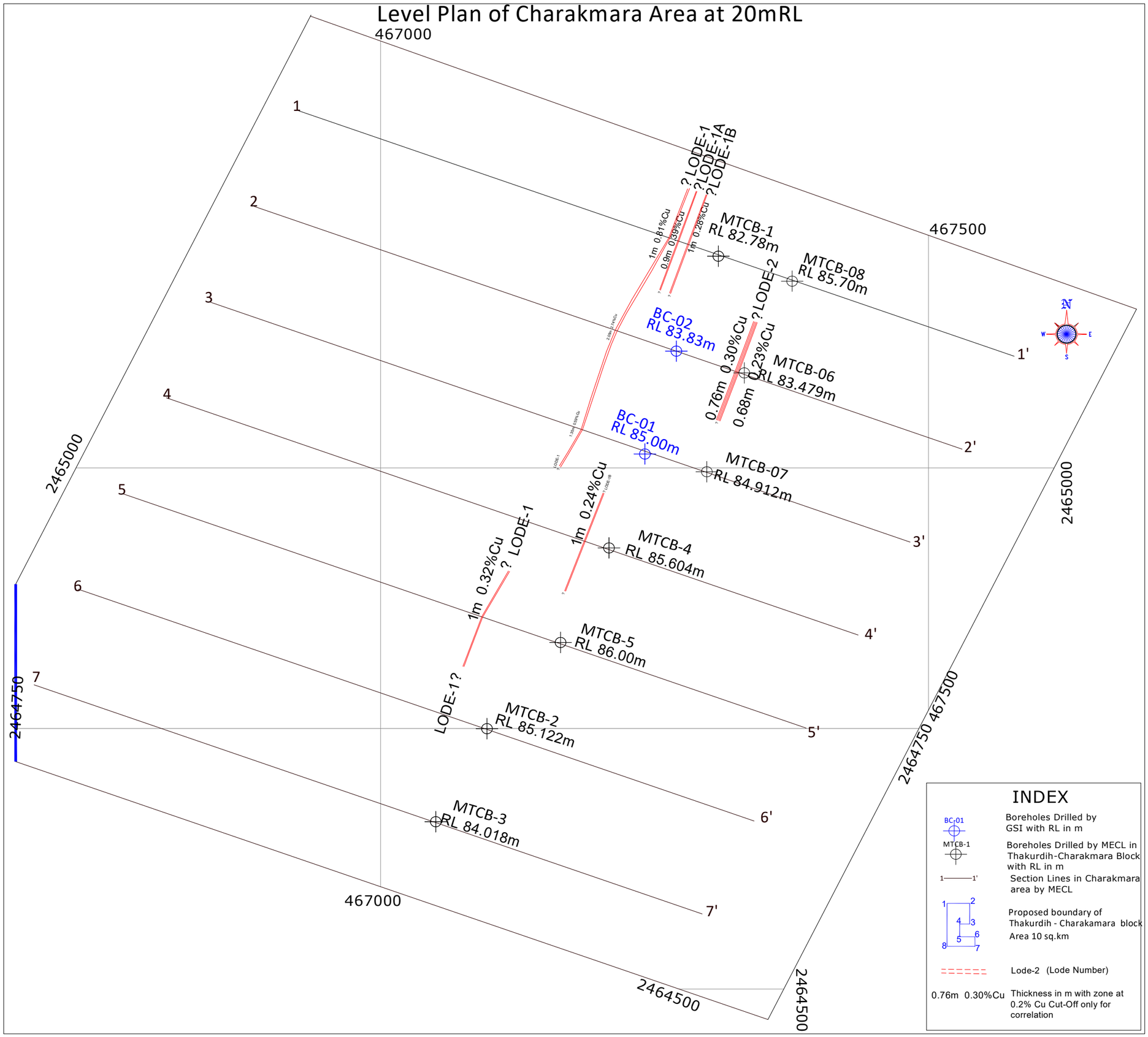
9. The obtained volume has been multiplied by the average specific gravity (3.00) to arrive at the resource in tonnes.

10. Thus, the sum of Section-wise cross-sectional resource is the total geological gross in-situ resource.



TEXT FIGURE - 8

Level Plan of Charakmara Area at 20mRL



INDEX

BC-01	Boreholes Drilled by GSI with RL in m
MTCB-1	Boreholes Drilled by MECL in Thakurdih-Charakmara Block with RL in m
1——1'	Section Lines in Charakmara area by MECL
1 2 4 3 6 5 8 7	Proposed boundary of Thakurdih - Charakamara block Area 10 sq.km
======	Lode-2 (Lode Number)
0.76m 0.30%Cu	Thickness in m with zone at 0.2% Cu Cut-Off only for correlation

TEXT FIGURE - 9

19.6.10 **METHODOLOGY ADOPTED IN LV SECTION PANEL METHOD OF RESOURCE ESTIMATION:**

In order to ascertain the reliability of resource estimated by Geological Cross Section Method, copper ore resources also estimated by LV Section Panel Method. Following methodology has been used for preparation of the LV Section Panel and resource calculation.

1. The grade wise LV section panel has been prepared separately for all the lodes at 0.2% Cu cut-off, 2.0m MSW and 3.00 maximum parting. The LV Sections have been prepared along the A-A' line in Charakmara area, B-B' & C-C' in Area-1 of Thakurdih-Charakmara block which also named as LV section lines **(Plate-VI and Text Figure - 10).**

2. The LV section Line A-A', B-B' & C-C' has been marked on Geological Map. LV section has been generated by using GDM software for all lode along the section lines at 0.2% Cu cut-off. The LV panel has been drawn by considering the minimum and maximum RL of lode intersected in a particular borehole and strike influence of the particular section.

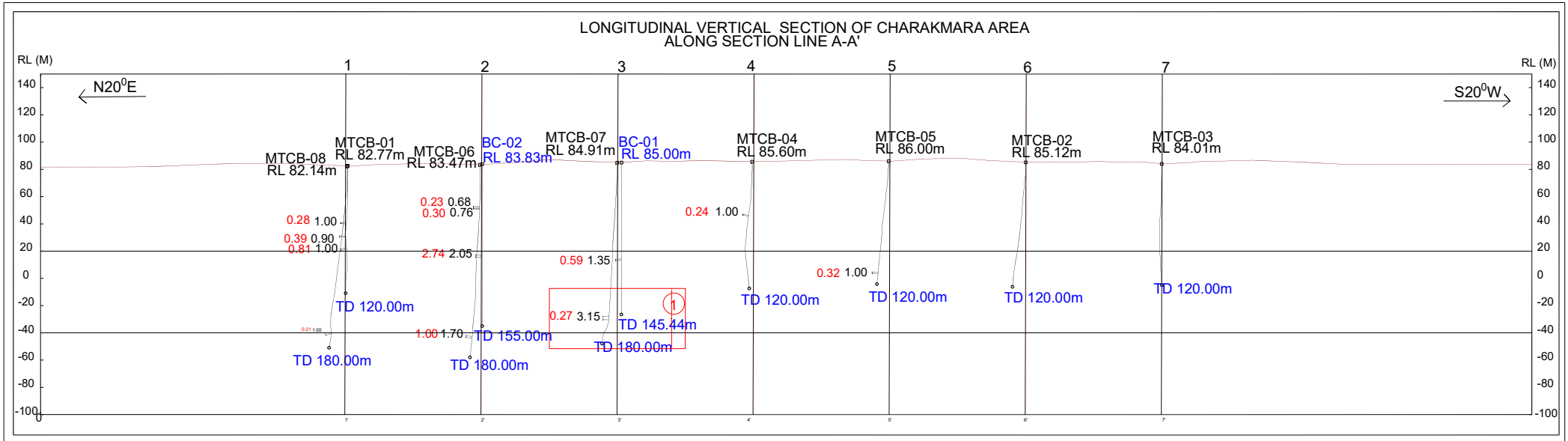
3. Nomenclature has been assigned for each panel for resource estimation purpose. The area of panel has been calculated with the help of computer aided AutoCAD Map 2023 software.

4. Thus, the area obtained has been multiplied with true width of the lode and dip factor and the volume of lode has been calculated.

5. The volume of the copper ore lodes was multiplied by the average specific gravity factor (3.00) and total geological gross in-situ resource has been estimated.

19.7.0 DESCRIPTION OF THE GEOLOGICAL INTERPRETATION USED TO CONTROL THE RESOURCE ESTIMATES

19.7.1 The resource has been estimated by two methods i.e. Geological Cross Section method and Longitudinal Vertical Section method and resource estimated by both the method has been compared. There is no significant difference between the resources estimated by both the method which support the reliability of both the resource estimation methods. An overall deduction of 10% is applied to the total gross tonnage to arrive at the geological net in-situ resource of copper to account for data gaps, geological uncertainities, irregular nature of deposit and abrupt change in zone thickness etc.



INDEX

MTCB-01 RL 82.77m	Boreholes drilled by MECL with Reduced Level in meter	0.27	Grade of Mineralized zones (Cu)
		3.15	Thickness in meter
TD 180.00m	Total Depth in m	(1)	Panel No.
BC-02 RL 83.83m	Boreholes drilled by GSI with Reduced Level in meter		

TEXT FIGURE - 10

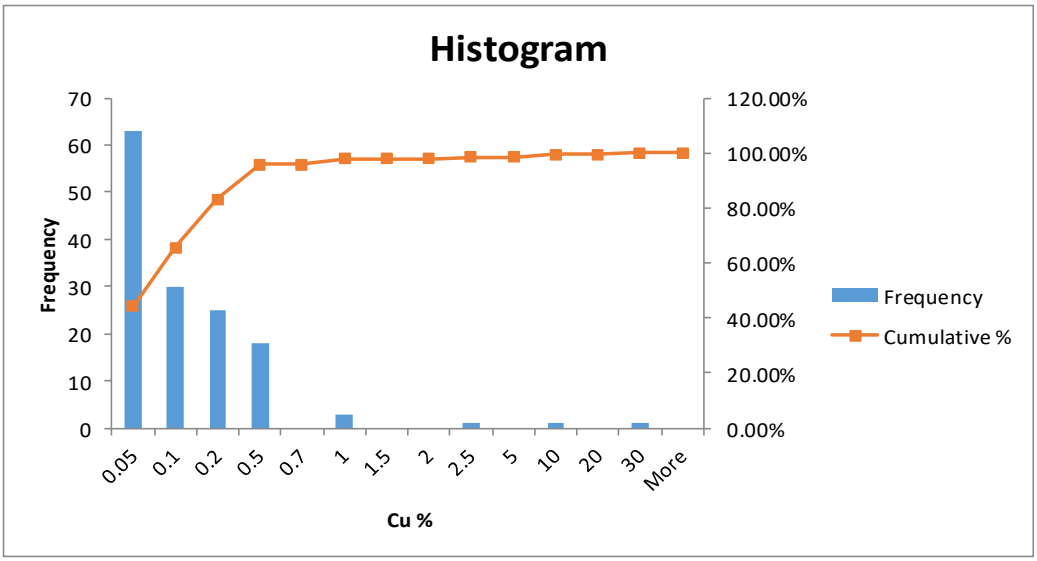
19.8.0 DESCRIPTION OF BASIS FOR USING OR NOT USING GRADE CUTTING OR CAPPING

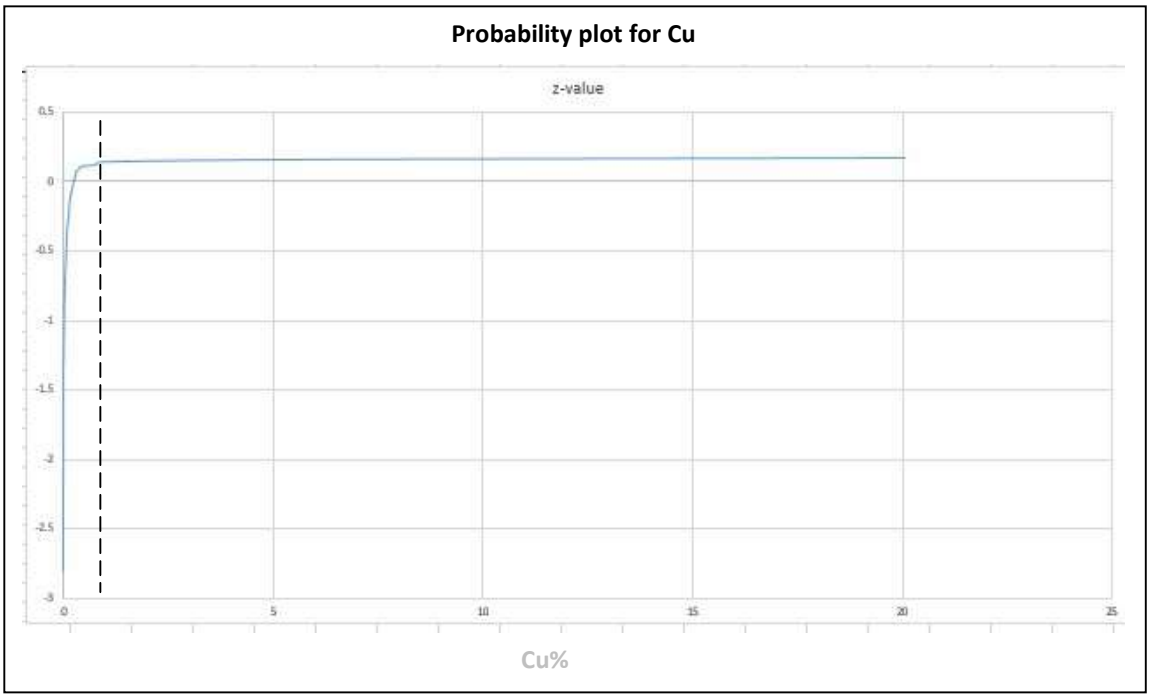
19.8.1 The present exploration has been carried out at G-3 stage for copper (Cu) mineralization in the Thakurdih-Charakmara block. Keeping in view the nature and style of mineralisation the entire borehole primary sample data of MECL (n=142) has been subjected to statistical evaluation and it is inferred that the frequency distribution is positively skewed as could be seen from the **Text Figure 11.** statistical parameters estimated for primary samples given in **Table 19.3.** From the frequency histograms and probability plots of raw samples grade capping is 0.85 % to 1.00 % Cu. At around 0.85% Cu, the first drop or else closed to the zero. The exercise assumes that the gap between 0.85% Cu and 1.0% Cu values is due to paucity in exploration and with additional drilling this gap would be abridged. Hence, grade capping is considered as 1.00% Cu. There are 03 no. of samples had fallen beyond 1.0% Cu. These values are erratic highs and need to be tonned down for processing the exploration data for evaluation purpose. Hence all values >1.0% Cu equated to 1.0% Cu in the borehole sample data. Statistical analysis not carried out for GSI boreholes as sample details and borehole logs are not available except mineralized zone intersection details.

Table-19.3: Statistical parameters estimated for primary sample (Entire data n=142)

Parameters (n=142)	
Minimum	0.00
Maximum	20.06
Mean	0.31
Standard deviation	1.77
Skewness	10.35
Variance	3.12

Text Figure-11
Frequency histogram & Probability plot of
Primary Analysis borehole entire data (n=142)





19.9.0 GEOSTATISTICAL METHODS DETAIL

19.9.1 The resource has been estimated by Geological Cross Section method as well as Longitudinal Vertical Section method. Geostatistical methods not used for resource estimation in the block area.

19.10.0 DATA VERIFICATION AND/OR VALIDATION PROCEDURES USED

19.10.1 The resource has been estimated by two methods i.e., Geological Cross Section method and Longitudinal Vertical Section method. The resource estimated by both the method has been compared and found there is no major significant difference in estimation of resources by these methods. The details are discussed in Para 20.3.0.

CHAPTER-20

REPORTING OF RESOURCES

20.1.0 RESOURCE AND GRADE

20.1.1 The copper ore resource and grade has been estimated by the Geological Cross Section Method and section wise, lode wise, grade wise and category wise resource at 0.2% Cu cut-off grade is given in **Annexure-IX**.

20.1.2 The total copper ore resources estimated by Geological Cross Section Method at **0.20% Cu cut-off grade** criteria in Charakmara and Area-1 of Thakurdih-Charakmara block. Total Gross resource of 4**5017 tonnes (0.045 million tonnes)** estimated in Charakmara area**.** After 10% deduction from gross resources total **Net geological in situ resource are 40516 tonnes (0.040 million tonnes)** with an **average grade of 0.27% Cu** over average thickness of 2.96m. The resource estimated over a strike length of 100 m and upto vertical depth of 135m (-50 mRL). Resource estimated in Charakmara area placed under Inferred category (333) of resource as per UNFC code.

20.1.3 In Area-1, total **Gross** and **Net geological in situ** resources are **142987 tonnes (0.14 million tonnes)** and **128689** tonnes (**0.13 million tonnes)** respectively with **average grade of 0.39% Cu** over an average thickness of 3.23m in the block area. The resource estimated over a cumulative strike length of 200m and up to a vertical depth of 90m (-5.00 mRL). Estimated resources placed under Reconnsaissance category (334) of resource as per UNFC code.

20.1.4 The summarized resources of Charakmara area and Area-1 by cross section method at 0.2% Cu cut-off in the Thakurdih-Charakmara block area are given below **Table No.20.1**.

Table No.20.1:

Summary of Estimated Resources (333 & 334) by cross section method At 0.2 Cu cut-off grade.

Area Name	UNFC Resource category	Gross Total Resource (Tonnes)	Net Resource (Tonnes)	Average Grade (Cu %)	Average Thickness (m)	Lode No.	Total Metal content (Tonnes)
Charakmara	(333)	45017	40516	0.27	2.96	1	109
Area-1	(334)	142987	128689	0.39	3.23	1B, 1AA	502
Total		**188004**	**169205**	**0.36**	**3.10**	**-**	**611**

20.1.5 In order to ascertain the reliability of resource estimated by Geological Cross Section Method, the same has been estimated at 0.20% Cu cut off grade by the Longitudinal Vertical (LV) Section Pannel method in Charakmara and Area-1 of Thakurdih-Charakmara block. The total gross geological in-situ and net resource estimated at 0.20% Cu cut-off under 333 category of UNFC by LV Section Pannel method in Charakmara area are 45278 tonnes (0.045 million tonnes) and 40750 tonnes (0.040 million tonnes) with an average grade of 0.27% Cu. Similary the total gross geological in-situ and net resource estimated in Area-1 under 334 category of UNFC at 0.20% Cu cut-off are 142918 tonnes (0.14 million tonnes) and 128626 tonnes (0.13 million tonnes) with an average grade of 0.39% Cu. The details of borehole wise resource at 0.20% estimated by LV Section Panel Method estimated for Charakmara area and Area-1 are presented in the **Annexure-X**. The summary of resources estimated in Charakmara area (UNFC Code:333) and in Area-1 (UNFC Code: 334) by LV Section Panel Method at 0.20% Cu cut off are given in Table-**20.2.**

Table-20.2
Summary of Copper Ore Resource (333+334) at 0.2% Cu cut off grade By LV Section Method

Area Name	UNFC Resource category	Gross Total Resource (Tonnes)	Net Resource (Tonnes)	Average Grade (Cu %)	Lode No.	Total Metal content (Tonnes)
Charakmara	(333)	45278	40750	0.27	1	110
Area-1	(334)	142918	128626	0.39	1B, 1AA	502
Total		188196	169376	0.36	-	**605**

20.2.0 COMPUTATION OF AVERAGE GRADE:

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

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

Here `V' = Volume of Copper ore in individual borehole
`G'= Grade of the respective Copper ore in the corresponding borehole

20.3.0 COMPARISON OF RESOURCE ESTIMATION BY CROSS-SECTION AND LV SECTION METHOD:

20.3.1 The total copper ore resource with average grade estimated separately at 0.2% Cu cut-off by the Geological Cross Section and LV Section Methods have been compared to ascertain the confidence level of resource estimation. The comparison of resource for Charakmara area and Area-1 are given in **Table-20.3 and Table-20.4** respectively.

Table- 20.3

Comparison of Geological Resource estimated at 0.2% cut-off by Cross Sectionand LV Section Methods (333) in Charakmara area

Methods of Resource Estimation	Gross Resource (Tonnes)	Net in situ Resource (Tonnes)	Average Grade (Cu%)	Metal Content (Tonnes)
Geological Cross Section	45017	40516	0.27	109
LV Section	45278	40750	0.27	110
Difference	-261	-234	Nil	-1
Difference (%)	0.58	0.58	Nil	0.9

Table- 20.4

Comparison of Geological Resource estimated by Cross Sectionand LV Section Methods (334) in Area-1

Methods of Resource Estimation	Gross Resource (Tonnes)	Net in situ Resource (Tonnes)	Grade (Cu%)	Metal Content (Tonnes)
Geological Cross Section	142978	128689	0.39	502
LV Section	142918	128626	0.39	502
Difference	60	63	Nil	Nil
Difference %	0.04	0.04	Nil	Nil

20.3.2 The difference between resource estimated by Geological Cross Section and LV Section Panel Method in Charakmara area at 0.20% Cu cut-off grade is 0.58% i.e. the resource estimated by Geological Cross Section is 0.58% lower than that of LV Section Panel Method. However, the grade estimated by LV Section and Geological Cross Section Method are same i.e 0.27%. On comparing both the resource in Area-1, the resources estimated by Geological Cross Section Method is slightly 0.04% higher than that of LV Section Panel Method and the grade estimated by LV section and Geological Cross section method are same. The variations in the resources of both the methods is minor (negligible) and are within the limit (i.e. <5%). Hence, the

reliability of resource estimation has been established and resource estimated by Geological Cross Section Method has been considered for all practical purposes.

20.4.0 CATEGORY OF RESOURCE:

20.4.1 During the present exploration, boreholes were spaced at 100m interval approximately in line with previously drilled GSI boreholes to check the strike and depth continuity of mineralized zones at 1st level (60m vertical depth) and few 2nd level (120 m vertical depth) in Charakmara area. The copper ore zones/ lodes occurring in the area are lean, irregular, lensoildal, isolated ore shoots. considering the nature and style of mineralisation, borehole density and geological section interval 100m approximately fulfilling the criteria of G-3 stage exploration for copper as per MEMC Rules 2015. The total estimated copper ore resource of Charakmara area may be categorized as "Inferred Mineral Resource" category with Code 333 as per UNFC system and as per the specifications given in the Mineral (Evidence of Mineral Contents) Rule-2015.

20.4.2 Three test boreholes drilled in Area-1 are scout boreholes in nature drilled in specified locations to test the integrated surface geophysical anomaly in depth up to 60m vertical depth. Hence, estimated resource in Area-1 may be categorized as "Reconnaissance Mineral Resource" category with Code 334 as per UNFC system and MEMC Rules 2015.

CHAPTER-21

SUMMARY AND RECOMMENDATIONS

21.1.0 DISCUSSION ON THE OUTCOME OF THE EXPLORATION WORK DETAILING THE NATURE OF THE DEPOSIT

21.1.1 Thakurdih-Charakmara Block area is located near the southeastern extremity of the Singhbhum Shear Zone and forms the part of Baharagora Copper prospect. The existence of old workings (shallow pits) for copper in the area was reported by previous workers (Stoehr 1870 & Dunn 1937). The area was covered by airborne multi-instrument geophysical surveys in 1963. Ground evaluation of the electromagnetic and magnetic signatures coupled with the available geological knowledge indicated the presence of potential mineralized zones in the Baharagora area. Integrated geological, geochemical and ground geophysical surveys and exploratory drilling in the area by GSI (FS 1975-76 & 1977-78) indicated a number of small blocks i.e. Mundadevta-Darkhuli & South Jharia and Charakmara area. Mundadevta-Darkhuli & South Jharia block was recently explored by MECL (2021-22) at G2 stage for Copper and a net geological instu resource of 1.75 million tonnes of 0.96% Cu at 0.50% Cu cut-off and 0.64 million tonnes of 1.46% Cu at 1.00 Cu cut-off was estimated up to 245m vertical depth. The present Thakurdih-Charakmara exploration block is just adjoining and extention to the Mundadevta-Darkhuli & South Jharia Block.

21.1.2 The Thakurdih-Charakmara block comprises four sub-blocks namely Charakmara, Area-1, 2 & 3 in close proximity to each other. The block area exposes mainly Granite/ Granite Gneiss of Archaean (Singhbhum Granite Complex), Newer Dolerite of Archaean-Proterozoic, Quartzite of Palaeoproterozoic, Schistose rocks of Palaeoproterozoic, Gravels of Tertiary and Sand Silt Clay Calcareous concretions of Pleistocene –Holocene. Most of the area is concealed under soil cover. Rock exposures are scanty in the area and the surface expression of the mineralized zone is limited and ill defined. Geochemical sampling and I.P. –Resistivity survey, however, provide some anomalies but most of the information on the geology and the sulphide mineralization has been obtained from the drill holes.

21.1.3 Sulphide mineralisation is in the form of fissure vien type associated with closely spaced shears, mostly parallel to sub-parallel to the foliation in varied lithologies. Mineralisation in this area is not confined to any particular stratigraphic horizon nor to any particular litho-unit. However, some litho-units are preferred relative to other. Mineralistion is spatially associated with metabasites or their derivative schistose rocks i.e. Chlorite-biotite schist, quartz-biotite schist and biotite-quarztites.

21.1.4 The sulphide mineralisation occur chiefly as disseminations, stringers and patches/streaks associated with Chlorite-Biotite-schist, Quartz-Biotite rock, Quartz-Chlorite-Biotite schist etc. Chalcopyrite is the main ore mineral followed by pyrite (+ marcasite) and magnetite. Nickel sulphides occur in small proportions.

21.1.5 During the present G3 stage exploration, MECL carried out exploratory drilling work in Charakmara area and integrated ground geophysical survey (I.P, Resistivty and Magntic) and test drilling in Area-1, 2 & 3 of Thakurdih-Charakmara block as per the approved scheme of prospecting. Explotory drilling work commenced on 23.04.2022 (MTCB-01) and concluded on 09.06.2023 (MTCB-12). The allied field-works including surveying, ground geophysical survey, drilling and sampling etc. were completed simultaneously.

21.1.6 During present investigation, total 12 nos of boreholes involving 1497.50m drilled in the block area by MECL. Out of total 12 nos boreholes, 8 nos. boreholes (1140m) drilled in Charakmara area to confirm the strike and depth persistence of copper bearing ore zones in two levels. During 1st phase, initially 05 boreholes (MTCB-01 to MTCB-05) targeted to intersect the ore zones at 60m vertical depth (20mRL) and remaining 03 boreholes targeted for deeper level intersections at 120m vertical depth (-40 mRL) from the surface.

21.1.7 Integrated geophysical survey (I.P. Resistivity and Magnetic) carried out in the area (60 Lkm) has brought out some prominent anomalies in Area-1 & 3. High chargeability and low resistivity zones were delineated and are well corroborated with old workngs, previous geophysical and geochemical anomalies of GSI. Based on the outcome of Geophysical survey, total 3 nos. test boreholes (MTCB-9, 10 &11) drilled in Area-1 and one test borehole (MTCB-12) drilled in Area-3 to test the geophysical anomaly at about 90m vertical depth.

21.1.8 In Charakmara area, Borehole core sample analysis of total 94 samples indicate that Cu values range from minimum <0.01% Cu to maximum 20.06% Cu. Out of total 94 samples, total 75 nos samples indicated <0.20% Cu and 17 nos samples shown Cu values range from >0.20% Cu to 0.81% Cu. Two samples shown high Cu values 6.41% Cu (Sample # MTCB-06/08) and 20.06% Cu (Sample # MTCB-6/07) in the area. The previous 2 boreholes of GSI (1984) in Charakmara area indicated two mineralized zones of 0.59% Cu, 0.11% Ni over 1.35m thickness and 2.74% Cu over 2.05m thickness.

21.1.9 Borehole core samples (94 nos.) of MECL indicated Ni values range from minimum <0.01% Ni to maximum 0.25% Ni in Charakmara area. Only two samples indicated >0.10% Ni i.e. 0.13% Ni (Sample # MTCB07/07) and 0.25% Ni (Sample # MTCB04/02). Mo values range from minimum <0.01% Mo to maximum 0.04% Mo, Co values from <0.01% Co to 0.03% Co and W values are less than 0.01%. Borehole core sample analysis for Ni, Mo, Co and W are not encouraging.

21.1.10 In Area-1, Borehole core sample analysis of total 42 samples indicate that Cu values range from minimum <0.01% Cu to maximum 2.44% Cu. Total 30 nos samples indicated <0.2 % Cu value and 12 samples shown Cu values range from >0.20% Cu to 0.85% Cu. One samples shown high Cu value 2.44% Cu (Sample # MTCB-10/10). Ni values range minimum from <0.01% Ni to maximum 0.10% Ni, Co values range from <0.01% Co to 0.05% Co, Mo & W values are less than 0.01% in Area-1. Total 6 nos samples indicated Cu values range from <0.01% Cu to 0.08% Cu, Ni values 0.01% Ni to 0.04% Ni, Mo, Co and Wo values are less than 0.01% in Area-3. Borehole core sample analysis values for Ni, Mo, Co and W are not encouraging.

21.1.11 Total 20 nos. Primary samples were analysed for Gold (Au) by fire assay method at MECL laboratory, Nagpur. Au values range from <0.1 ppm to 0.24 ppm. Out of total 20 nos, 12 nos samples indicated <0.1ppm Au and 2 nos. indicated >0.2 ppm Au. Gold values are not encouraging.

21.1.12 Total 1797.95 m drilling data includes 12 Boreholes (1497.50m) of MECL and 2 old boreholes (300.45m) of GSI has been taken into consideration for geological interpretation, correlation and evaluation of resource as per the cut-off grade criteria parameters. Mineralized zones for copper have been delineated at 0.20% Cu cut off on the basis of assay of primary chemical analysis of borehole samples for correlation and interpretation of zones.

21.1.13 In Charakmara area, Copper bearing zones/lodes strike N20E-S20W with dip of 60° to 70^0 NE direction. The present drilling data indicate that four mineralized zones numbered as Lode-1, 1A, 1B and 2 intersected in the boreholes drilled by previous GSI & present MECL boreholes in Charakmara area. Lode-1 (MTCB-07 analysing 0.27% Cu over 3.22m thickness) is the most persistant lode in the area. Drilling data indicate that mineralisastion is erratic in nature and lodes are lean/thin in thickness and low in grade with limited strike and depth persistence in Charakmara area.

21.1.14 In Area-1, integrated geophysical anomaly intersected three zones of mineralisation at depth numbered 1A, 1B, 1AA and one Local minor zone in the drilled boreholes. Lode 1B (MTCB-09 analysing 0.26% Cu over 3.22m thickness) and Lode-1AA (MTCB-10 with 0.46%Cu over 5.20m thickness) intersected in Area-1 are significant and likely to persist along strike and depth. Area-1 hold potential for further exploration. One test borehole drilled in Area-3 not intersected any mineralized zone.

21.1.15 The copper resource of the block has been estimated by “Geological cross-section Method” (principal method) as well as “Longitudinal Vertical Section Method”

(check method) cosnidering 0.20% Cu cut-off, 2.00m minimum stoping width (M.S.W) as true width and 3.00m maximum parting. The average specific gravity for the copper ore resource estimation in the block is taken as 3.00.

21.1.16 The copper ore resources estimated by Geological Cross Section Method at **0.20% Cu cut-off grade** at 2.0m minimum stoping width (M.S.W) and 3.00m maximum parting in Charakmara and Area-1 of Thakurdih-Charakmara block. Total Gross resource of 4**5017 tonnes (0.045 million tonnes)** estimated. After 10% deduction from gross resources total **Net geological in situ resource are 40516 tonnes (0.040 million tonnes)** with an **average grade of 0.27% Cu** over average thickness of 2.96m. The resource estimated over a strike length of 100 m and upto vertical depth of 135m (-50 mRL). Resource estimated in Charakmara area placed under Inferred category (UNFC:333) of resource in Charakmara area as per UNFC code.

21.1.17 In Area-1, total **Gross** and **Net geological in situ** resources are **142987 tonnes (0.14 million tonnes)** and **128689** tonnes (**0.13 million tonnes)** respectively with **average grade of 0.39% Cu** over an average thickness of 3.23m in the block area. The resource estimated over a cumulative strike length of 200m and up to a vertical depth of 90m (-5.00 mRL). Estimated resources placed under Reconnsaissance category (334) of resource as per UNFC code.

21.1.18 The summarized resources of Charakmara area and Area-1 by cross section method at 0.2% Cu cut-off in the Thakurdih-Charakmara block area are given below **Table No.21.1**.

Table No.21.1:

Summary of Estimated Resources (333 & 334) by cross section method At 0.2 Cu cut-off grade.

Area Name	UNFC Resource category	Gross Total Resource (Tonnes)	Net Resource (Tonnes)	Average Grade (Cu %)	Average Thickness (m)	Lode No.	Total Metal content (Tonnes)
Charakmara	(333)	45017	40516	0.27	2.96	1	109
Area-1	(334)	142987	128689	0.39	3.23	1B, 1AA	502
Total		**188004**	**169205**	**0.36**	**3.10**	**-**	**611**

21.1.19 In order to ascertain the reliability of resource estimated by Geological Cross Section Method, the same has been estimated at 0.20% Cu cut off grade by the Longitudinal Vertical (LV) Section Pannel method in Charakmara and Area-1 of Thakurdih-Charakmara block. The total gross geological in-situ and net resource estimated at 0.20% Cu cut-off under 333 category of UNFC by LV Section Pannel method in Charakmara area are 45278 tonnes (0.045 million tonnes) and 40750

tonnes (0.040 million tonnes) with an average grade of 0.27% Cu. Similary the total gross geological in-situ and net resource estimated in Area-1 under 334 category of UNFC at 0.20% Cu cut-off are 142918 tonnes (0.14 million tonnes) and 128626 tonnes (0.13 million tonnes) with an average grade of 0.39% Cu. The details of borehole wise resource at 0.20% estimated by LV Section Panel Method estimated for Charakmara area and Area-1 are presented in the **Annexure-X**.

21.1.20 The variations in the resources of Geological cross section method and LV section Panel method are minimum (neglibible) and are within the limit (i.e. <5%). Hence, the reliability of resource estimation has been established and resource estimated by Geological Cross Section Method has been considered for all practical purposes.

21.1.21 Total estimated resources in Charakmara area placed under "Inferred Mineral Resource" (333) and resource of Area-1 under "Reconnaissance Mineral Resource" (334) category as per UNFC system and the specifications given in the Mineral (Evidence of Mineral Contents) Rule-2015 in the Thakurdih-Charakmara block area.

21.2.0 RECOMMENDATIONS

21.2.1 Integrated geophysical anomalies intersected significant mineralized zones of considerable thickness and grade at depth in the test boreholes drilled in Area-1. Hence, in order to ascertain the potentiality of the prospect, seamless G3/G2 stage exploration is recommended to confirm the strike and depth persistence of ore zone in Area-1 of Thakurdih-Charakmara block.

21.2.2 Copper mineralisation in Charakmara area comprising thin lenses/orebodies of limited dip and strike continuity probably due to small ore shoots. However, Borehole MTCB-04 intersected Lode-1 (analysing 0.27% Cu over 3.15m thickness) at 120m vertical depth from surface. Keeping in view of erratic nature of mineralisaiton, the sub surface nature and control of the ore shoots cannot be made out from limited drilling data at this stage. Moreover, the adjoining Mundadevta-Darkhuli & South Jharia G2 block resource estimated up to 245m Vertical depth from surface. Hence, in view of similar geological set up of the area few deeper level boreholes intersections up to 300m vertical depth between Section No. 1-1' to 5-5' may be drilled to test the strike and depth persistence of ore zones if any in Charakmara area of Thakurdih-Charakmara block.

CHAPTER-22

PLATES AND MAPS

Sl. No.	Plate No.	Title	R.F.
1	I	Location Map of Thakurdih-Charakmara Block, District-East Singhbhum, Jharkhand	1:40000
2	II	Regional Geological Map of Singhbhum Copper Belt, Showing location of Thakurdih-Charakmara Block, District –East Singhbhum, Jharkhand	1:300000
3	III.A	Topographical Map, Thakurdih-Charakmara Block, District-East Singhbhum, Jharkhand.	1:5000
4	III.B	Geological Map, Thakurdih-Charakmara Block, District-East Singhbhum, Jharkhand	1:5000
5	IV.A	Geological cross section along section lines 1-1' to 7-7'in Charakmara area of Thakurdih-Charakmara Block, District-East Singhbhum, Jharkhand.	1:1000
6	IV.B	Geological cross section of Area-1 along section lines L15E-L15E', L18E-L18E' & L25E-L25E' of Thakurdih-Charakmara Block, District-East Singhbhum, Jharkhand	1:1000
7	IV.C	Geological cross section of Area-3 along section line L20N-L20N'of Thakurdih-Charakmara Block, District-East Singhbhum, Jharkhand	1:1000
8	V.A	Level Plan of Charakmara area at 20m RL, Thakurdih-Charakmara Block, District-East Singhbhum, Jharkhand.	1:1000
9	V.B	Level Plan of Charakmara area at -40m RL, Thakurdih-Charakmara Block, District-East Singhbhum, Jharkhand.	1:1000
10	VI	Longitudinal Vertical Section along Section Line A-A' of Charakmara area and along Section Line B-B' & C-C' in Area-1 at 0.20% Cu Cut-Off, Thakurdih-Charakmara Block, District-East Singhbhum, Jharkhand.	1:1000

CHAPTER-23

ANNEXURE / ENCLOSURES TO THE REPORT

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

CHAPTER-24

ANY OTHER INFORMATION

24.1.0 GEO-TECHNICAL STUDIES

24.1.1 No specific geotechnical studies have been undertaken. However, as part of geological logging, the following geo-tech parameters have been collected.

1. Core recovery
2. RQD%

24.2.0 PEER REVIEW OF GEOLOGICAL REPORT

24.2.1 Geological report has been peer reviewed by Shri R N Singh, Director (Retd.) GSI and his review comments recieved on 24th November, 2023. Suggested peer review comments have been attended (Annexure No. XIII) and incorporated in the present Final Geological Report. Final review of the project was presented in 59th TCC meeting held on 28th November 2023 & 29th November 2023 and committee advised to submit the Final Geological Report by 15th December, 2023.

CHAPTER-25

CERTIFICATE FROM THE QUALIFIED PERSON WITH NAME, DATE AND SIGNATURE

NAME: P. RAVINDRAN NAIR

DESIGNATION: GENERAL MANAGER (EXPLORATION)

DATE:

LIST OF PERSONNEL ASSOCIATED WITH EXPLORATION IN THAKURDIH CHARAKMARA BLOCK, SINGHBHUM COPPER BELT, DISTRICT: EAST SINGHBHUM, JHARKHAND

1	Overall guidance	*Shri P. Ravindran Nair, General Manager (Exploration)*
2	Overall Planning, Co-ordination and Supervision	*Shri P. P. Kulkarni, Dy. General Manager (Exploration)*
		Shri J. Narayana Moorthy, Ex-HoD (Expl. and GS.) *Shri IVVSV Prasad, Ex-Manager (Geology)*
3	Project Management	*Shri Ankit Gautam, Asst. Manager (Drilling)/ Project Manager*
4	Physical Execution of work	
	a) Geology	*Shri Ripun Kumar Gogoi, Assistant Manager (Geology)*
		Shri Dipankar Manna, Senior Geologist
	b) Survey	*Shri Jagdish Kumar Thakral, Survey and Map Officer*
		Shri Sk. Nazimuddin Ahmad, Sr. T.A. (S & D)
	c) Geophysics	*Shri G.S.Dhami, General Manager (Expl. and GS)*
		Shri Soumya Mukherjee, Assistant Manager (Geophysics)
		Shri Ramesh chauhan, Sr. Geophysicist
		Biswajit pal , Tech. Assist. (Survey & Draftsman)
	d) Drilling	*Shri Ankit Gautam, Asst. Manager (Drilling)*
		Shri Ankit Prabhakar, Asstt. Manager (Drilling)
		Shri Amit Kumar, Drilling Engineer
5	Chemical Laboratory	*Shri G.S.Dhami, General Manager (Expl. and GS)*
		Shri Rohit Kumar Sharma, Manager (Head, Labs)
		Dr. (Mrs.) Deepti . R. Rahangdale, Manager (Labs)
		Shri Fawaz SVP, Assistant Manager (Chemistry)
		Miss Shikha Priyadarshini, Sr. Chemist
6	Petrographic Studies	*Shri Sayantan Pal, Manager (Geology)*

7	Documentation	*Shri G.S.Dhami, General Manager (Expl. and GS)*
		Shri Mohammad Dasthageer, Manager (Geology)
		Bimalendu Roy, Manager (Geophysics)
		Ujjawal Kumar, Assistant Manager (Geophysics)
		Smt. Swati Vidyarthi, Assistant Manager (Geology)
8	Non-Coal Geological Report Cell	*Shri Jayanto Kumar Chowdhury, Sr. Manager (Systems)*
		Smt. Swati Vidyarthi, Asstt. Manager (Geology)
		Shri Uday Ashok Patil, Sr. Computer Operator
		Shri Shivananda, Sr. Computer Operator
9	Reprography and Printing	*Shri Jagdish Kumar Thakral, Survey and Map Officer*

LOCALITY INDEX

Locality	Latitude	Longitude
Jharia	22°18’ 7.4”	86° 41’29.48”
Darkhuli	22°17’34.31”	86° 41’48.43”
Baharagora	22°16’39.75”	86° 43’29.24”
Thakurdih	22°18’35.33”	86° 41’15.96”

REFERENCES

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GSI(F.S. 1991-1994)	A Report on synthesis of Geology of Malanjkhand Grainitoids in Balaghat and Rajnandgaon Districts of Madhya Pradesh
GSI(F.S. 1966-1967),	Report on the investigation for copper in the Malanjkhand Area, BaiharTahsil, Balaghat District, Madhya Pradesh
GSI	Bhukosh web portal of Geological Survey of India.

ABBREVIATIONS USED

SL. No.	Abbreviation	Full form
1	M / m	Meter
2	Cu m	Cubic Meter
4	RL	Reduced Level
5	mRL	Reduced Level in metre
6	M.S.L.	Mean sea level
7	IBM	Indian Bureau of Mines
8	GSI	Geological Survey of India
9	NMET	National Mineral Exploration Trust
10	TCC	Technical cum Cost Committee
11	EC	Executive Committee
12	MMDR	Mines and Minerals (Development and Regulation)
13	MEMC	Minerals (Evidence of Mineral Contents)
14	MECL	Mineral Exploration and Consultancy Limited
15	NABL	National Accreditation Board for Testing and Calibration Laboratories
16	JNARDDC	Jawaharlal Nehru Aluminium Research Development and Design Centre
17	QA/QC	Quality Assessment/ Quality Checks
18	WGS-84	World Geodetic System-84
19	DMS	Degree Minute Second
20	UTM	Universal Transverse Mercator
21	F.S.P.	Field Season Program
22	DGPS	Differential Global Positioning System
23	XRF	X-ray Fluorescence
24	ICP-MS	Inductively Coupled Plasma Mass Spectrometry
25	BDL	Below Detection Limit
26	MT	Million Tonnes