

**GEOLOGICAL REPORT ON PRELIMINARY (G-3) EXPLORATION
FOR TUNGSTEN AND TIN ORE IN**

MURARA-DEVENDRAPURA BLOCK

DISTRICT- NIWARI, MADHYA PRADESH

(UNDER NMET PROGRAMME)

(TEXT, ANNEXURES AND PLATES)



A MINIRATNA-I CPSE

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

Ministry of Mines, Government of India Enterprise
An ISO 9001:2015, 14001:2015 & 45001:2018 Certified Company

CORPORATE OFFICE, NAGPUR

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Cover Photo Details

1. (a) & (b): Blue fluorescence of Scheelite in the drilled core of borehole no MMDB-09 under short wave (254nm wavelength) ultraviolet light.
2. Scheelite in the drilled core of borehole no MMDB-09 under short wave (254nm wavelength) ultraviolet light in presence of normal light.

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टंगस्टन और टिन अयस्क के लिए प्रारंभिक (जी-3) गवेषण

मुरारा-देवेंद्रपुरा ब्लॉक, जिला- निवाड़ी, मध्य प्रदेश

अध्याय - 1

कार्यकारी सारांश

1.1.0 प्रस्तावना

1.1.1 मुरारा-देवेंद्रपुरा ब्लॉक मध्य प्रदेश के निवाड़ी जिले में स्थित है और आर्कियन बुंदेलखंड क्रेटान का हिस्सा है। यह ब्लॉक सर्वे ऑफ़ इंडिया की टोपोशीट नंबर 54K/15 के अंतर्गत आता है और लगभग 4.16 वर्ग किमी. के क्षेत्र में फैला है। यह क्षेत्र झांसी से लगभग 30 किमी. पूरब में है और नेशनल हाईवे-39 और गांव के रोड नेटवर्क से अच्छी तरह जुड़ा हुआ है। यह जांच मिनरल एक्सप्लोरेशन एंड कंसल्टेंसी लिमिटेड ने नेशनल मिनरल गवेषण ट्रस्ट (NMET) प्रोग्राम के तहत टंगस्टन और उससे जुड़े खनिजीकरण के शुरुआती गवेषण (G-3 स्टेज) के लिए निष्पादित की थी।

1.1.2 यह जांच तारिखर खुर्द क्षेत्र में पहले किए गए G-4 स्टेज गवेषण के अनुवर्ती अध्ययन के तौर पर की गई थी, जहाँ मुरारा और देवेंद्रपुरा गाँवों के आसपास क्वार्ट्ज रीफ़ सिस्टम से जुड़े टंगस्टन की अच्छी वैल्यू और शीलाइट की उपस्थिति को रिपोर्ट की गई थीं। इन अच्छे संकेतों के आधार पर, मौजूदा G-3 स्टेज गवेषण प्रोग्राम को टंगस्टन मिनरलाइज़ेशन की कंटीन्यूटी, ज्योमेट्री, स्ट्रक्चरल कंट्रोल और सबसरफ़ेस परसिस्टेंस को स्थापित करने और यूएनएफसीदिशा-निर्देशों के अनुसार खनिज संसाधनों का आकलन करने के लिए बनाया गया था।

1.2.0 गवेषण के उद्देश्य

1.2.1 मौजूदा गवेषण प्रोग्राम के मुख्य उद्देश्य थे:

1. टंगस्टन मिनरलाइज़ेशन से जुड़े क्वार्ट्ज रीफ़ के साधनतिलंब और नति निरंतरता को बताने के लिए।
2. मिनरलाइज़ेशन के लिथोलॉजिकल और स्ट्रक्चरल कंट्रोल स्थापित करना।
3. कोर ड्रिलिंग के ज़रिए मिनरल वाले ज़ोन के सबसरफ़ेस परसिस्टेंस का पता लगाना।
4. संसाधन आकलन के लिए जियोलाॉजिकल, जियोकेमिकल और एनालिटिकल डेटाबेस बनाना
5. UNFC और MEMC नियम, 2015 के अनुसार इंफ़र्ड मिनरल रिसोर्स (333 श्रेणी) को स्थापित करना।

1.3.0 ब्लॉक का भूविज्ञान

1.3.1 भूवैज्ञानिक दृष्टिकोण से, यह ब्लॉक आर्कियन बुंदेलखंड ग्रेनाइट-नीसिक कॉम्प्लेक्स का हिस्सा है। यह क्षेत्र ज्यादातर प्रभावी ग्रेनाइटॉइड्स से अच्छादित हैं, जिनमें मोटे से मीडियम दाने वाले गुलाबी ग्रेनाइट, पोर्फिरिटिक ग्रेनाइट और ग्रेनोडायोरिटिक फेज़ शामिल हैं। इन ग्रेनाइटॉइड्स में खास क्वार्ट्ज रीफ़्स हैं जो ज्यादातर NNE-SSW से NE-SW दिशा में हैं।

1.3.2 गवेषण के दौरान मैप की गई और एक-दूसरे से मिली दूसरी लिथोलॉजिकल यूनिट्स में फेरुजिनस क्वार्ट्ज रीफ़, हाइड्रोथर्मली बदले हुए क्वार्ट्ज-ग्रेनाइट मिक्स्ड ज़ोन, एम्फीबोलिटिक एन्क्लेव, पोर्फिरिटिक एंडेसाइट

और पतले पायरोफिलिटिक ऑल्टरेशन ज़ोन शामिल हैं। कार्बो रीफ़ खास सीधी लकीरें बनाती हैं और तेज़ ब्रेसिएशन, शियरिंग, सिलिकिफिकेशन, फेरुजिनाइज़ेशन और हाइड्रोथर्मल ऑल्टरेशन दिखाती हैं।

1.3.3 कार्बो रीफ़ के स्ट्रक्चरल कंट्रोल वाले फ़ैक्चर्ड और टूटे हुए हिस्से टंगस्टन मिनरलाइज़ेशन के लिए अच्छी जगहें बनाते हैं। यह मिनरलाइज़ेशन मुख्य रूप से हाइड्रोथर्मल तरीके से बदले हुए कार्बो रीफ़ और कार्बो-ग्रेनाइट मिक्स्ड ज़ोन से जुड़ा है, जो शियरिंग और बार-बार फ़ैक्चरिंग से प्रभावित होते हैं।

1.4.0 खनिजीकरण

1.4.1 ब्लॉक में टंगस्टन मिनरलाइज़ेशन मुख्य रूप से स्ट्रक्चरल रूप से कंट्रोल किए गए हाइड्रोथर्मल कार्बो रीफ़ सिस्टम से जुड़ा है। मिनरलाइज़ेशन मुख्य रूप से बदले हुए कार्बो रीफ़ और आस-पास के बदले हुए ग्रेनाइट ज़ोन में बारीक फैले हुए और फ़ैक्चर-कंट्रोल्ड शीलाइट के रूप में है।

1.4.2 गवेषण के दौरान, शॉर्ट-वेव अल्ट्रावॉयलेट लाइट (254 nm वेवलेंथ) में कई जगहों पर, खासकर बोरहोल MMDB-09 में और लोकल तौर पर MMDB-06 में शीलाइटफ्लोरेसेंस देखा गया। मिनेरोग्राफिक स्टडीज़ से पता चलता है कि मिनरलाइज़्ड ज़ोन में पाइराइट, चाल्कोपाइराइट, कोवेलाइट और डाइजेनाइट जैसे जुड़े हुए सल्फाइड मिनरल मौजूद हैं।

1.4.3 मिनरलाइज़्ड ज़ोन आम तौर पर कार्बो रीफ़ के फ़ैक्चर्ड, टूटे हुए और सिलिसिफ़ाइड हिस्सों और उनसे जुड़े बदलाव वाले ज़ोन तक ही सीमित हैं। 150 ppm W थ्रेशोल्ड पर, मिनरलाइज़्ड ज़ोन की मोटाई 1 m से कम से लेकर 34 m से ज़्यादा तक है, जबकि 400 ppm W कट-ऑफ़ पर ज़ोन आम तौर पर लगभग 16 m तक मोटे हैं।

1.5.0 गवेषण कार्यक्रम

1.5.1 गवेषण प्रोग्राम में विस्तृत भूवैज्ञानिक मानचित्रण, ट्रेचिंग, शॉर्ट वेव (254nm वेवलेंथ) UV लाइट सर्वे, कोर ड्रिलिंग, जियोलॉजिकल लॉगिंग, कोर सैंपलिंग और लैबोरेटरी एनालिटिकल स्टडीज़ शामिल थीं।

1.5.2 अभी के G-3 स्टेज के गवेषण के दौरान, 1250 m के प्रस्तावित टारगेट के मुकाबले कुल 1220.50 m ड्रिलिंग के साथ कुल 11 झुके हुए बोरहोल पूरे किए गए। इनमें से, मुरारा सब ब्लॉक में सात (07) बोरहोल और देवेंद्रपुरा सब ब्लॉक में चार (04) बोरहोल ड्रिल किए गए। बोरहोल मिनरलाइज़्ड कार्बो रीफ़ की नतिलंब निरंतरता के साथ लगभग 200 m की दूरी पर ड्रिल किए गए थे।

1.5.3 कुल 535 कोर और 21 ट्रेच सैंपल इकट्ठा किए गए और टंगस्टन (W), टिन (Sn), कॉपर (Cu), लेड (Pb) और जिंक (Zn) के लिए उनका एनालिसिस किया गया। शीलाइट मिनरलाइज़ेशन की पहचान के लिए पूरे ड्रिल कोर को शॉर्ट-वेव अल्ट्रावॉयलेट लाइट में स्कैन किया गया।

1.5.4 ड्रिलिंग प्रोग्राम ने सतह के पास के लेवल से लेकर गवेषित गहराई तक टंगस्टन मिनरलाइज़ेशन की कंटीन्यूटी बनाई। गवेषण आम तौर पर मिनरलाइज़्ड ज़ोन में लगभग 50 m वर्टिकल गहराई के बराबर किया गया है। कई सेक्टर में नतिलंब के साथ और गहराई पर मिनरलाइज़ेशन खुला रहता है, जो सीधे गवेषण सबूत की मौजूदा गहराई से आगे भी मिनरलाइज़ेशन के जारी रहने की संभावना दिखाता है।

1.6.0 गवेषण का परिणाम

1.6.1 भूवैज्ञानिक, भू-रासायनिक, खनिज-विज्ञान और विश्लेषणात्मक आंकड़ों की एकीकृत व्याख्या ने मुरारा-देवेंद्रपुरा ब्लॉक में उत्तर-पूर्व-दक्षिण-पश्चिम प्रवृत्ति वाले कार्बोनेट रीफ प्रणालियों से जुड़े संरचनात्मक रूप से नियंत्रित हाइड्रोथर्मल टंगस्टन खनिजकरण की उपस्थिति को स्थापित किया है।

1.6.2 ज़ोन का सीमांकन और रिसोर्स का अनुमान जियोलॉजिकल क्रॉस-सेक्शन मेथड से किया गया है, जिसमें 400 ppm W कट-ऑफ ग्रेड और कम से कम 2.0 m काम करने लायक मोटाई का इस्तेमाल किया गया है। रिसोर्स कैल्कुलेशन के लिए 2.67 की स्पेसिफिक ग्रेविटी वैल्यू पर विचार किया गया है।

1.6.3 अभी के G-3 स्टेज गवेषण के आधार पर, कुल अनुमानित जियोलॉजिकल रिसोर्स (333 कैटेगरी) लगभग 1.138 मिलियन टन का अनुमान लगाया गया है, जिसका एवरेज ग्रेड लगभग 430.16 ppm W है।

1.6.4 सब-ब्लॉक के हिसाब से रिसोर्स का अनुमान इस तरह है:

उप ब्लॉक	संसाधन श्रेणी	अयस्क मात्रा (मिलियन टन)	औसत क्षेणी (पीपीएम W)
मुरारा उपखंड	अनुमानित (333)	1.031	427.75
देवेंद्रपुरा सब ब्लॉक	अनुमानित (333)	0.107	453.23
कुल	अनुमानित (333)	1.138	430.16

1.6.5 गवेषण के नतीजों से पता चलता है कि ब्लॉक में और डिटेल्ड गवेषण की अच्छी संभावना है। मिनरल वाले लोड कई सेक्टर में गहराई और नतिलंब पर खुले हैं और रिसोर्स कॉन्फिडेंस को इनफर्ड (333) से इंडिकेटेड कैटेगरी में अपग्रेड करने के लिए ज़्यादा पास ड्रिलिंग और सेकंड-लेवल गवेषण की ज़रूरत है।

1.7.0 निष्कर्ष और सिफारिशें

1.7.1 इस जांच से पता चला है कि मुरारा – देवेंद्रपुरा ब्लॉक में कार्बोनेट रीफ सिस्टम से जुड़े स्ट्रक्चरल कंट्रोल वाले हाइड्रोथर्मल टंगस्टन मिनरलाइज़ेशन की उपस्थिति है। गवेषणपरिणाम विस्तृत गवेषण हेतु उत्साहजनक संभावनाएँ प्रदर्शित करते हैं।

1.7.2 कई सेक्टर में नतिलंब के साथ और गहराई पर मिनरलाइज़्ड ज़ोन खुले हैं। इसलिए, ज़्यादा पास ड्रिलिंग, स्ट्रक्चरल स्टडी और गहरी ड्रिलिंग वाली डिटेल्ड फ़ॉलो-अप गवेषण की सलाह निम्न के लिए दी जाती है:

- खनिजयुक्त लोड्स की निरंतरता स्थापित करना,
- भूवैज्ञानिक विश्वास में सुधार,
- संसाधनों को इन्फर्ड (333) से इंडिकेटिव (332) श्रेणी में उन्नत करना, तथा
- ब्लॉक में टंगस्टन मिनरलाइज़ेशन की आर्थिक क्षमता का मूल्यांकन करना।

PRELIMINARY (G-3) EXPLORATION FOR TUNGSTEN AND TIN ORE IN MURARA-DEVENDRAPURA BLOCK, DISTRICT- NIWARI, MADHYA PRADESH

CHAPTER - 1

EXECUTIVE SUMMARY

1.1.3 INTRODUCTION

1.1.4 The Murara–Devendrapura Block is located in Niwari District of Madhya Pradesh and forms part of the Archean Bundelkhand Craton. The block falls in Survey of India Toposheet No. 54K/15 and covers an area of approximately 4.16 sq. km. The area is situated about 30 km east of Jhansi and is well connected through National Highway-39 and village road network. The investigation was undertaken by Mineral Exploration and Consultancy Limited under the National Mineral Exploration Trust (NMET) programme for Preliminary Exploration (G-3 stage) of Tungsten and associated mineralisation.

1.1.5 The present investigation was taken up as a follow-up study to the earlier G-4 stage exploration carried out in the Tarichar Khurd area, where encouraging tungsten values and scheelite occurrences associated with quartz reef systems were reported around Murara and Devendrapura villages. Based on these encouraging indications, the present G-3 stage exploration programme was formulated to establish the continuity, geometry, structural control and subsurface persistence of tungsten mineralisation and to estimate mineral resources as per UNFC guidelines.

1.8.0 OBJECTIVES OF EXPLORATION

1.8.1 The principal objectives of the present exploration programme were:

6. To delineate the strike and depth continuity of tungsten mineralisation associated with quartz reef.
7. To establish lithological and structural controls of mineralisation.
8. To assess subsurface persistence of mineralized zones through core drilling.
9. To generate geological, geochemical and analytical database for resource estimation.
10. To establish Inferred Mineral Resources (333 category) as per UNFC and MEMC Rules, 2015.

1.9.0 GEOLOGY OF THE BLOCK

1.9.1 Geologically, the block forms part of the Archean Bundelkhand Granite-Gneissic Complex. The area is predominantly occupied by granitoids comprising coarse- to

medium-grained pink granite, porphyritic granite and granodioritic phases. These granitoids are traversed by prominent quartz reefs trending mainly in NNE–SSW to NE–SW direction.

- 1.9.2 Other lithological units mapped and intersected during exploration include ferruginous quartz reef, hydrothermally altered quartz–granite mixed zones, amphibolitic enclaves, porphyritic andesite and thin pyrophyllitic alteration zones. The quartz reefs form prominent linear ridges and exhibit intense brecciation, shearing, silicification, ferruginisation and hydrothermal alteration.
- 1.9.3 Structurally controlled fractured and brecciated portions of quartz reefs constitute favourable locales for tungsten mineralisation. The mineralisation is mainly associated with hydrothermally altered quartz reefs and quartz–granite mixed zones affected by shearing and repeated fracturing.

1.10.0 MINERALISATION

- 1.10.1 Tungsten mineralisation in the block is mainly associated with structurally controlled hydrothermal quartz reef systems. Mineralisation occurs predominantly in the form of fine disseminated and fracture-controlled scheelite within altered quartz reefs and adjoining altered granitic zones.
- 1.10.2 During exploration, scheelite fluorescence under short-wave ultraviolet light (254 nm wavelength) was observed at several locations, particularly in borehole MMDB-09 and locally in MMDB-06. Mineragraphic studies indicate the presence of associated sulphide minerals such as pyrite, chalcopyrite, covellite and digenite within mineralized zones.
- 1.10.3 The mineralized zones are generally confined to fractured, brecciated and silicified portions of quartz reefs and associated alteration zones. At 150 ppm W threshold, mineralized zones vary from less than 1 m to more than 34 m apparent thickness, whereas at 400 ppm W cut-off the zones generally range up to about 16 m thickness.

1.11.0 EXPLORATION PROGRAMME

- 1.11.1 The exploration programme included detailed geological mapping, trenching, short wave (254nm wavelength) UV light survey, core drilling, geological logging, core sampling and laboratory analytical studies.
- 1.11.2 During the present G-3 stage exploration, a total of 11 inclined boreholes aggregating 1220.50 m drilling were completed against the proposed target of 1250 m. Out of these, seven (07 nos) boreholes were drilled in Murara Sub Block and Four (04 nos) boreholes were drilled in Devendrapura Sub Block. The boreholes were drilled at an

approximate spacing of about 200 m along the strike continuity of the mineralized quartz reefs.

- 1.11.3 A total of 535 core and 21 trench samples were collected and analysed for tungsten (W), tin (Sn), copper (Cu), lead (Pb) and zinc (Zn). Complete drill cores were scanned under short-wave ultraviolet light for identification of scheelite mineralisation.
- 1.11.4 The drilling programme established continuity of tungsten mineralisation from near-surface levels to the explored depth levels. Exploration has generally been carried out up to about 50 m vertical depth equivalent in the mineralized zones. The mineralisation remains open both along strike and at depth in several sectors, indicating possibility of continuation of mineralisation beyond the present depth of direct exploration evidence.

1.12.0 OUTCOME OF EXPLORATION

- 1.12.1 Integrated interpretation of geological, geochemical, mineragraphic and analytical data has established the occurrence of structurally controlled hydrothermal tungsten mineralisation associated with NE–SW trending quartz reef systems in the Murara–Devendrapura Block.
- 1.12.2 Zone demarcation and resource estimation has been carried out by Geological Cross-Section Method using 400 ppm W cut-off grade and minimum workable thickness of 2.0 m. A specific gravity value of 2.67 has been considered for resource computation.
- 1.12.3 Based on the present G-3 stage exploration, a total Inferred Geological Resource (333 category) of about 1.138 million tonnes has been estimated with average grade of about 430.16 ppm W.
- 1.12.4 Sub-block wise resource estimation is as follows:

Sub Block	Resource Category	Ore Quantity (Million Tonnes)	Average Grade (ppm W)
Murara Sub Block	Inferred (333)	1.031	427.75
Devendrapura Sub Block	Inferred (333)	0.107	453.23
Total	Inferred (333)	1.138	430.16

- 1.12.5 The exploration results indicate encouraging potential for further detailed exploration in the block. The mineralized lodes remain open at depth and along strike in several sectors and warrant closer spaced drilling and second-level exploration for upgrading the resource confidence from Inferred (333) to Indicated category.

1.13.0 CONCLUSION AND RECOMMENDATIONS

1.13.1 The present investigation has established the occurrence of structurally controlled hydrothermal tungsten mineralisation associated with quartz reef systems in the Murara–Devendrapura Block. The exploration results indicate encouraging potential for further detailed exploration.

1.13.2 The mineralized zones remain open along strike and at depth in several sectors. Therefore, detailed follow-up exploration involving closer spaced drilling, structural studies and deeper drilling is recommended to:

- establish continuity of mineralized lodes,
- improve geological confidence,
- upgrade resources from Inferred (333) to Indicated (332) category, and
- evaluate the economic potential of tungsten mineralisation in the block.

CHAPTER - 2

DETAILS OF THE QUALIFIED PERSON(S) / EXPLORATION AGENCY

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

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

2.2.0 PERSONNEL ASSOCIATED IN EXPLORATION WORK

2.2.1 The list of personnel associated with the execution of different exploration activities carried out in Preliminary (G-3) Exploration for Tungsten and Tin Ore in Murara-Devendrapura Block, District- Niwari, State-Madhya Pradesh is given in the Table-2.1.

Table-2.1

List of Personnel associated with Exploration Work

S No.	Title	Name of the Personnel
1	Overall Guidance	Shri P. Ravindran, Retd. GM (Exploration) Shri Shrikant Sharma, HoD (Exploration/NEM)
2	Overall planning, Coordination & Supervision	Shri Shrikant Sharma, HoD (Exploration/NEM) Shri Naveen Kumar Pala, Sr. Manager (Geology) Shri S.K. Satapathy, Sr. Manager (Geology)
3	Project Management / OIC	Shri Rajesh Patel, Manager (Geology)/OIC Shri Rajnikant Singh, Project Manager
Physical Execution of Work		
4	Geology	Shri Rajesh Patel, Manager (Geology)
5	Survey	Shri Dev Singh Sr. Tech (Survey) Shri Durgesh Devarshi, ASMO
6	Sample Preparation	Narendra Kumar Raikwar, Sr. Tech. (Sampling)
7	Chemical Laboratory	Shri Shrikant Sharma, HOD (Exploration/NEM) Shri Rohit Sharma, Head (LABS) Shri Deepti Rahangdale, Manager (LABS) Shri Fawaz SVP Manager (LABS)
8	Petrographic studies	Shri Sayantan Pal, Manager (Geology)
9	Documentation	Shri Rajesh Patel, Manager (Geology) Mohammad Kaif, Assistant Manager (Geology)
10	Hindi Translation	Shri Shreekant Rai, Sr. Hindi Translator
11	GIS & I.T. Centre	Shri Rajesh Patel, Manager (Geology) Mrs. Rajanya Roy, Assistant Manager (Geology) Mrs. Moumita Ghosh, Assistant Manager (Geology)
12	Reprography and Printing	Shri Pratap Singh Negi, ASMO Shri Durgesh Devarshi, ASMO

CHAPTER - 3

TITLE AND OWNERSHIP

3.1.0 TITLE AND OWNERSHIP

TITLE: GEOLOGICAL REPORT ON PRELIMINARY (G-3) EXPLORATION OF TUNGSTEN AND TIN ORE IN MURARA- DEVENDRAPURA BLOCK, DISTRICT: NIWARI, STATE: MADHYAPRADESH

Ownership: Government of Madhya Pradesh

Table – 3.1

Exploration agency details for Murara-Devendrapura Block, District- Niwari, State-Madhya Pradesh

(i) Name of the explorer/Mining or prospecting rights holder.	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:	Dr. Babasaheb Ambedkar Bhavan, High Land Drive Road, Seminary Hills, Nagpur, Pin- 440006
Telephone No.	0712-2510289; 0712-2511829
E-Mail id:	cmd@mecl.gov.in ; gm-exploration@mecl.gov.in
(ii) Details of period of prospecting/mineral right if any:	August 2024 to April 2026
In case of a license or lease:	
(a) Date of grant:	NA
(b) Date of execution:	NA
(c) Period of license or lease:	NA
(d) Date of completion	NA

3.2.0 DETAILS OF PERIOD OF PROSPECTING

3.2.1 The Mineral Exploration and Consultancy Limited (MECL) undertook exploration in the Murara–Devendrapura Block (G-3), which was upgraded/carved out from the Tarichar Khurd Block (G-4). The project proposal was reviewed during the 66th Technical-cum-Cost Committee (TCC) meeting held in June 2024 and subsequently approved by the 36th Executive Committee (EC) of National Mineral Exploration and Development Trust with an estimated cost of ₹308.81 lakh (including GST). MECL received the formal sanction order vide letter dated 29th August 2024, following which exploration activities commenced on 20th September 2024 with geological mapping and short-wave UV survey.

- 3.2.2 Exploration Progress and Outsourced Drilling: To expedite exploration activities and adhere to the stipulated timeline, MECL proposed outsourcing of the approved drilling programme of 1,250 m in 11 boreholes during the TCC-II meetings held between February and July 2025. The committee recommended outsourcing in place of in-house drilling with a revised project cost of ₹305.61 lakh (including GST), which was later approved by the 1st Project Sanctioning Committee (PSC) of NMEDT in October 2025. Accordingly, outsourced drilling commenced on 14th October 2025 and was completed by the end of December 2025, achieving a total drilling of 1,220.50 m in 11 boreholes.
- 3.2.3 Timeline Extension and Completion of Field Activities: Subsequently, MECL sought additional timeline extensions during the 21st TCC-II meeting in January 2026 for completion of chemical analysis, Geological Report (GR) preparation, peer review, and final submission. The 5th PSC meeting held on 9th February 2026 approved extension of the project timeline up to 31st March 2026. All allied field activities, including sampling, were completed simultaneously, while analytical and laboratory investigations were carried out at MECL laboratories and other Government/NABL-accredited laboratories.
- 3.2.4 Geological Report is completed and ready for submission to peer review in the month of May 2026.

CHAPTER - 4

DETAILS OF THE AREA UNDER STUDY

4.1.0 VILLAGE, DISTRICT, STATE

4.1.1 The block is about 30 km east of Jhansi city and connected by metalled road, which passes through the block. The villages fall near the block are- Niwari Tigela, Murara, Devendrapura, and Asati in Niwari Tehsil of Niwari district situated within and beside the block.

4.2.0 Survey of India Toposheet No., Differential Global Positioning System (DGPS) coordinates of all corner points of the area and in latitude and longitude (Degree Minutes Seconds) format WGS-84 Datum.

4.2.1 The Murara-Devendrapura Block (G-3) falls in the Survey of India Toposheet No.54K/15 and covers total area of 4.16km² (Murara sub block-1.83 km² and Devendrapura sub block- 2.33 km²). The block location is shown in Plate-I and Text Figure-1. The co-ordinates of the cardinal points of the Murara-Devendrapura Block (G-3), District: Niwari, Madhya Pradesh are given in Annexure-1-A and Table 4.1.

Table-4.1
Co-ordinates of the cardinal points of Block Boundary of Murara-Devendrapura Block (G-3), Dist: Niwari, Madhya Pradesh

Murara Sub Block (Area 1.83 sq. Km)						
Sl. No.	Cardinal Points	GCS(DMS)		UTM Zone-44 (m)		RL/Elevation (m)
		Latitude	Longitude	Easting (m)	Northing (m)	
1	A	25°22'32.27487"N	78°50'24.99232"E	282697.317	2808297.688	227.501
2	B	25°22'16.87448"N	78°50'47.35360"E	283314.840	2807813.677	225.970
3	C	25°21'17.35289"N	78°49'42.37071"E	281468.276	2806011.384	238.238
4	D	25°21'31.29011"N	78°49'24.76010"E	280982.823	2806448.287	230.115
Devendrapura Sub Block (Area 2.33 sq. Km)						
1	A	25°24'05.48470"N	78°50'01.95413"E	282099.748	2811176.510	218.378
2	B	25°23'50.37042"N	78°50'35.63845"E	283033.757	2810696.148	218.939
3	C	25°22'46.78233"N	78°49'48.12570"E	281673.873	2808760.831	224.043
4	D	25°23'04.19562"N	78°49'18.64896"E	280858.542	2809310.111	218.788

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

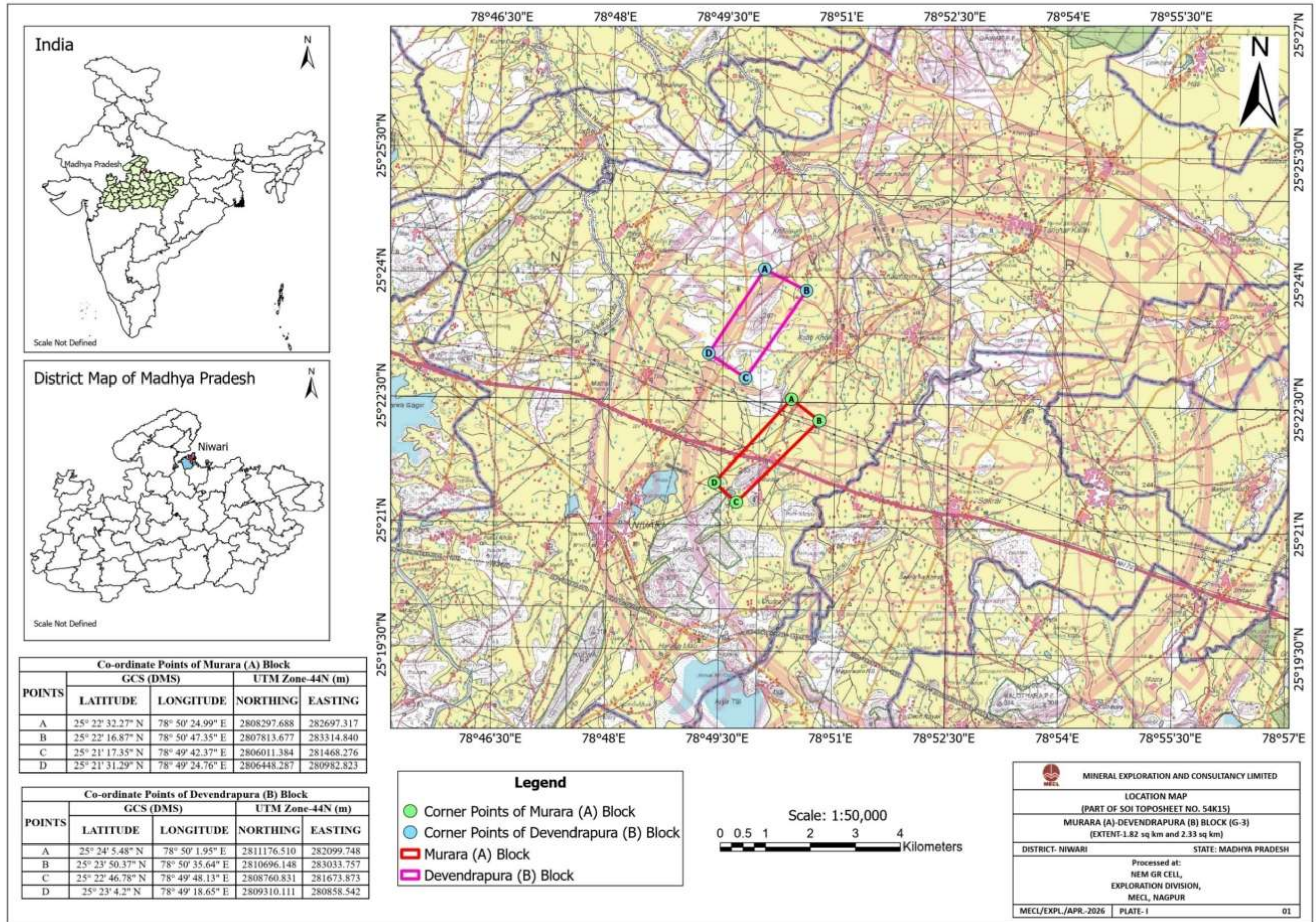
- 4.3.1 Cadastral details of the area are not available and in Murara-Devendrapura block there is no forest area present as per toposheet details and PM Gati Shakti portal of Ministry of Mines. The most of the area of the block falls under private and Government land. Majority of the plane areas are of agricultural land.



Photo –1: Image showing Murara-Devendrapura block area under non forest zone
(Source : PM GatiShakti portal)

4.4.0 MINERAL(S) UNDER INVESTIGATION

Tungsten, Tin, Copper, Lead and Zinc Minerals.



Text Fig. - 1

CHAPTER - 5

PHYSIOGRAPHY AND ENVIRONMENT

5.1.0 PHYSIOGRAPHY

- 5.1.1 Explored block is part of Bundelkhand Region which is situated between the Indo-Gangetic Plain towards the north and the Vindhyan Range in the south, representing the eastern extension of the Central India Plateau. It is bounded by the Rewa–Panna Plateau in the northeast and the Aravalli Range to the west. The physiography of the region is strongly controlled by its ancient crystalline geology, which imparts a rugged and highly eroded landscape.
- 5.1.2 The terrain is predominantly undulating, with isolated hills rising abruptly above the surrounding plains, forming steep and often inaccessible escarpments. Denudational processes have shaped much of the landscape, resulting in characteristic landforms such as inselbergs, which appear as scattered hillocks, and elongated, serrated ridges composed mainly of resistant quartz reefs.
- 5.1.3 The region largely consists of pediplains, which are gently sloping erosional surfaces developed under semi-arid conditions. These pediplains are intermittently interrupted by cultivated fields and dissected by valleys and seasonal drainage channels. The overall geomorphology reflects prolonged weathering and erosion, combined with climatic influences such as moderate to low and variable rainfall, which continue to shape the landforms and surface features of the Bundelkhand Region.



Photo –2: Topographic view of the block from the top of quartz reef outcrop near Murara village.



Photo –3: Drilling in Murara Sub block near Murara village.



Photo –4: Scarp face of quartz reef near Murara village.

5.2.0 ENVIRONMENT AND CLIMATIC CONDITIONS

5.2.1 The study area is characterized by a hot climate that ranges from semi-humid to semi-arid, particularly during the summer months. Owing to its location on a rocky plateau, it is subjected to significant temperature variations. During winter, minimum temperatures typically ranges between about 6°C and 12°C, while in summer, maximum temperature often rise between 42°C and 48°C. May is usually the hottest month, whereas December and January are the coldest. Spring sets in towards the end of February but lasts only briefly as a transitional period with summer commencing by April.

5.2.2 The monsoon season generally begins around the third week of June, although its onset may vary annually. Rainfall intensity gradually decreases through September, with the monsoon usually with drawing before the end of the month. The winter season extends from October to January. The area receives an average annual rainfall of approximately 910 mm. During summer, short but intense local storms may occur, often accompanied by dense dust clouds that can significantly reduce visibility even during daytime.

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

5.3.1 The Topographical analysis indicates that the elevation of the Murara sub-block of the Murara –Devendrapura block varies from 282 m to 226 m above mean sea level (MSL). The highest elevation, 282 m above MSL, occurs at the crest of a quartz reef

located near Murara village, approximately at the central part of the Murara sub-block. The lowest elevation, about 226 m above MSL, is recorded towards the north eastern corner of this sub-block.

- 5.3.2 In the Devendrapura sub-block, the ground elevation ranges between 264 m and 218 m above mean sea level. The maximum elevation of 264 m above MSL is observed at the top of a quartz reef situated in the central part of the sub-block, on the north western side of the Devendrapura sub-power station. The minimum elevation, approximately 218 m above MSL, occurs towards the north western extremity of this sector.
- 5.3.3 The study area is traversed by numerous streams and minor streamlets, which ultimately join higher-order drainage channels. These streams are predominantly seasonal, carrying flow mainly during the monsoon period. The drainage pattern developed in the area is chiefly sub-dendritic to dendritic, reflecting the influence of relatively homogeneous hard rock terrain with minor structural controls. The region is primarily drained by the Dungari Nadi and its tributaries, namely Kaina Nadi / Pankhi Nala, which are themselves tributaries of the major perennial river Betwa River.
- 5.3.4 Small- to medium-sized dams have been constructed at suitable locations, particularly where stream courses intersect quartz reefs. These reefs act as natural barriers, facilitating the impoundment of water and formation of localized reservoirs that cater to the needs of nearby settlements. A significant water reservoir, in the form of a sluice structure, is located to the south of the Murara–Devendrapura block near Niwari. Additionally, a minor water body is present south of the Murara sub-block. The Murara distributary canal runs along the northern margin of the Murara sub-block.
- 5.3.5 Water supply in the area is primarily derived from locally constructed dams situated in the southern part of the block, as well as from dug wells and overhead storage tanks. Stored water in dams and wells is mainly utilized for irrigation, while overhead tanks cater to domestic water requirements. The constructed canal system, namely the Murara distributary, also plays a significant role in supporting irrigation activities within the area.

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

- 5.4.1 The study block is located approximately 360 km from Bhopal, the state capital of Madhya Pradesh. National Highway 39 traverses the central part of the Murara sub-block, connecting Jhansi to Chhatarpur. The district headquarters, Niwari, lies to the

southwest of the Murara –Devendrapura block. The area is accessible from Jhansi via a metalled road of approximately 30 km length. Overall, the block is well connected by a network of fair-weather metalled roads, facilitating ease of transportation.

- 5.4.2 The nearest railway station is located at Niwari, approximately 3 km from the block. The major railhead is Virangana Lakshmibai Railway Station at Jhansi, situated about 30 km away. The nearest airport is at Gwalior, which lies at a distance of around 147 km from the study area.
- 5.4.3 All villages within the block are well connected to electrical supply lines catering to both domestic and agricultural/irrigational needs. High-tension transmission lines pass through the northeastern part of the Murara sub-block. Additionally, a power substation is located in the south-eastern portion of the Devendrapura sub-block. Telecommunication facilities are reasonably developed, with mobile network coverage available across most parts of the block, enabling effective communication.



Photo –5:Power substation situated near Devendrapura Village, District- Niwari, M.P.

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

- 5.5.1 In the Murara sub-block, the majority of human settlements are concentrated towards the eastern part of the area, whereas the Devendrapura sub-block has relatively sparse habitation. The population comprises mixed communities predominantly residing in small villages and in the nearby town of Niwari. A limited presence of local tribal groups is also observed in a few villages. The primary occupations of the inhabitants

include agriculture, small-scale trade, and activities related to granite quarrying and stone crushing in the adjoining districts of Niwari and Jhansi.

5.5.2 The majority of the plain areas within the block are utilized for agricultural purposes. Primary crops grown in the region include wheat, jowar, maize, chana (gram), peas, mustard, and various pulses. Agricultural practices in the block are largely dependent on surface and groundwater resources such as the Dungari Nadi and its tributaries, including Kaina Nadi / Pankhi Nala, in addition to local dams, dug wells, bore wells, and seasonal rainfall.

5.5.3 Most residential structures in the block are of pucca construction, though a few kaccha houses are present in certain areas. Basic educational infrastructure is available, including a government primary school located within the Murara sub-block.

5.6.0 SOCIO DEMOGRAPHIC PROFILE OF THE AREA AND NEARBY

5.6.1 Niwari district was formerly a part of Tikamgarh district and was carved out as a separate administrative unit on 1st October 2018. It is recognized as the smallest district in Madhya Pradesh in terms of both geographical area and population, and constitutes one of the 52 districts of the state.

5.6.2 As per the 2011 Census, Niwari district had a total population of 404,807, of which 79,218 individuals (19.57%) resided in urban areas. The district recorded a sex ratio of 897 females per 1000 males. The proportion of Scheduled Castes and Scheduled Tribes in the population was 24.57% (99,441 persons) and 4.51% (18,244 persons), respectively.

5.6.3 Linguistically, Bundeli is the predominant language spoken by 60.23% of the population, followed by Hindi, spoken by 39.51%. The district is largely inhabited by Hindus, accounting for 97.93% (396,427 persons) of the population, while Muslims constitute about 1.55% (6,279 persons). Major festivals celebrated in the region include Sankranti, Holi, Ramzan, Moharram, Vijayadashami, Ram Navami, Navaratri, Deepawali, Guru Poornima, and Raksha Bandhan, reflecting the cultural diversity of the area.

5.6.4 The population is predominantly distributed across small rural settlements. The social composition mainly includes Other Backward Classes, Scheduled Castes, Scheduled Tribes, and Muslim communities, with a minor presence of the Jain community in Niwari town. The primary sources of livelihood are agriculture, poultry farming, small-scale businesses, and employment in granite quarrying and stone crushing units in the adjoining districts of Niwari and Jhansi.

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

- 5.7.1 The Niwari district is endowed with several sites of historical, archaeological, and religious significance. Among these, Garh Kunder Fort is an important place, located on a hill in the Tarichar Khurd area and surrounded by scenic hills and forests, exhibiting remnants of ancient structures and associated temples. Another important heritage centre is Orchha, situated about 25 km from the district headquarters, established in the 16th century by Rudra Pratap Singh along the Betwa River, and well known for its preserved palaces, temples, and the Satdhara stream system. The Ram Raja Temple at Orchha is an important pilgrimage centre, distinguished by the unique tradition of worshipping Lord Ram in royal form with ceremonial honours.
- 5.7.2 Within the block, no sites of historical or archaeological significance have been identified. The Murara sub-block is characterized primarily by scattered residential dwellings, whereas the Devendrapura sub-block has sparse habitation along with the presence of a power substation.
- 5.7.3 In terms of infrastructure, basic public utilities are available within Niwari town; however, more comprehensive facilities and services are accessible at Jhansi, located approximately 30 km from the study area.

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

- 5.8.1 No forests, sanctuaries, national park and wild life sanctuaries are present within the 5 Km radius of the block. At the slope of the quartz reefs of the block scanty vegetation comprises bushes and shrubs present while most of the area of the block falls under private and Government land. Majority of the plane areas are of agricultural land.

5.9.0 FLORA AND FAUNA

- 5.9.1 Vegetation within the explored block area is generally sparse and is predominantly represented by bushes and shrubs. The study area is devoid of forest. The natural flora is mainly composed of species such as babul (*Acacia nilotica*), khair (*Acacia catechu*), palas (*Butea monosperma*), ber (*Zizyphus* spp.), tendu (*Diospyros melanoxylon*), mahua (*Madhuca indica*), semal (*Salmaliamalabarica*), and kardhai (*Anogeissus pendula*), in addition to a variety of herbs, shrubs, grasses, and other indigenous species. Agricultural vegetation is most prominent in the plains, with common crops including wheat, maize, gram, peas, pulses, oilseeds (mustard), and seasonal vegetables.

5.9.2 Common wild animals observed in the region include wild pig, nilgai (blue bull), fox, wolf, rabbit, sambar, and monkeys. Domesticated animals such as cows, oxen, buffaloes, goats, and dogs are also widely present. Avifauna in the area is diverse, with species such as peacock, eagle, owl, bat, crow, pigeon, and domestic poultry commonly recorded.

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

5.10.1 The region is characterized by the presence of numerous small streams and rivulets that eventually merge into higher-order drainage channels. These water courses are predominantly seasonal in nature, carrying flow mainly during the monsoon period. The drainage of the area is chiefly controlled by the Dungari Nadi and its tributaries, namely Kaina Nadi / Pankhi Nala, which ultimately drain into the major perennial river Betwa River.

5.10.2 Furthermore, several small- to medium-sized dams have been constructed at suitable locations, particularly at the junctions of stream courses and quartz reefs. These quartz reefs act as natural barriers, facilitating the formation of localized reservoirs that serve the water requirements of the surrounding population. Notable water bodies in the area include a sluice reservoir in south-western side (nearest to the block area), Sindur Sagar in the South-western side and Arjar Tal situated in the southern side of the block.

CHAPTER - 6

INFRASTRUCTURE AND ENVIRONMENT

6.1.0 LOCAL INFRASTRUCTURE, WITH ROADS, RAILWAYS, PORT FACILITIES, ELECTRICITY, WATER ETC. WITH DISTANCE FROM THE AREA. DETAILS OF NEARBY INDUSTRIES IN THE AREA WHICH MAY USE THE MINERAL COMMODITY LIKELY TO BE MINED.

- 6.1.1 The Murara–Devendrapura block is predominantly situated in and around the villages of Murara, Devendrapura, Niwari Tigela, and Asati in Niwari district. The district headquarters, Niwari, is the nearest and most developed small urban centre, providing essential facilities such as Government hospitals, medical stores, banks, educational institutions, petrol pumps, police stations, local markets, and postal services. Basic water supply for domestic use in the villages is ensured through piped distribution systems from constructed storage tanks. The nearest major urban centre is Jhansi, located approximately 30 km to the west of the block.
- 6.1.2 The block is well connected by road infrastructure, with National Highway 39 passing through the central part of the Murara sub-block, linking Jhansi in Uttar Pradesh to Chhatarpur, M.P. The area is accessible from Jhansi via a metalled road of about 30 km, and most villages within the block are connected by fair-weather roads. The nearest railway station is located at Niwari, approximately 3 km from the southern boundary of the block, while the railhead is Virangana Lakshmibai Railway (VGLJ) Station at Jhansi, about 30 km away. Jhansi lies on the major Delhi–Chennai and Delhi–Mumbai railway corridors under the North Central Railway zone of Indian Railways. The nearest airport is situated at Gwalior, approximately 147 km from the block.
- 6.1.3 Advanced infrastructure facilities, including major Government and private hospitals, medical colleges, university, banks, educational institutes, and transport services etc. are available at Jhansi city (one of the district of Uttar Pradesh). With respect to mineral-based industries, the surrounding regions of Niwari and Jhansi districts host several stone quarries and crusher units engaged in the production of building materials and refractory-grade stone, indicating potential utilization of mineral resources from the study area.
- 6.1.4 All villages within the block are electrified, with power supply available for both domestic and agricultural/irrigational purposes. High-tension transmission lines

traverse the northeastern part of the Murara sub-block. Additionally, a power substation is located near Devendrapura village within the block. Telecommunication facilities are reasonably developed, with mobile network connectivity available across most parts of the area.

7.1.2 The Bundelkhand Massif comprises the Bundelkhand gneissic complex (BGC) of Meso-Neoarchean age, the Bundelkhand metasedimentary and metavolcanics (BMM); the Madawara igneous complex (MIC) and Neoarchean-Paleoproterozoic Bundelkhand granitoids (BG) (Ram Mohan et al., op cit 2012). Mesoproterozoic quartz reefs and mafic dyke swarms are also integral part of the Bundelkhand Massif (Pradhan et al., 2012). TTG (Tonalite Tronjhemite Gneiss) rocks of BGC form the basement along with meta sedimentaries and volcanics, exposed as linear E-W trending belts. Bundelkhand Massif predominately consists of pink to grey granitoids (ca. 90%), which are intrusive into a relict gneiss-greenstone basement (Basu, 1986). The relict greenstone-gneiss basement consists of TTG gneisses, grey gneisses, metabasic rocks, ultramafic rocks, BIFs, quartzite, schist and calc-silicate rocks, which commonly occur as enclaves within younger and more abundant granitoids (Singh et al., opcit 2018). Two greenstone complexes are recognized in the relict basement; the central Bundelkhand complex comprising the Babina–Mauranipur greenstone belt, and the southern Bundelkhand complex consisting of the Rungaon–Girar greenstone belt (Singh and Slabunov, 2015). The central greenstone complex constitutes high-Mg metabasic rocks, serpentinised ultramafic rocks, BIFs and felsic to intermediate volcanic (Malviya et al., 2006). The southern greenstone complex largely consists of quartzite, ultramafic rocks and BIFs. The basement rocks are multi-deformed and metamorphosed, recording at least two phases of metamorphism (Singh et al., 2007). The stratigraphic succession of Bundelkhand Massif is presented by many authors and is compiled in the Table-7.1.

Table-7.1: Stratigraphic successions of the Bundelkhand Massif (After GSI)

Pascoe, 1950	Jhingran, 1958	Saxena, 1961	Prakash et al. 1976	Basu, 1986	Singh, 2015
Peridotites, pyroxenites (partially altered to serpentinites and talc actinolite dolerite-trap dykes)	Basic dykes Quartz reefs Granites (of ten megascopic types)	Dolerite and other basic dykes Quartz reefs Pink granites, migmatites	Madura Formation: (Pre-to-post- Bijawar age) a: dolerite dykes, granite member, Quartz vein pegmatite, graphic granite b: Gabbro member: coarse to medium grained gabbro, pillow lava, ultrabasic member; milky dense sheared veins quartz.	Dolerites Quartz reef (with pyrite, chalcopyrite, pyrophyllite and diaspore) Aplite, Esmeraldite Porphyries, Pegmatite Leucocratic Granites Migmatites Syenites	Madauara Ultrabasics Mafic Dykes and Swarm Quartz Reef Bundelkhand Granite Complex: Fine grain leucogranite Coarse grain leucogranite Foliated biotite granite Biotite granite Hornblende granite
Bundelkhand Granite Complex with quartz reef and with inclusions of Mahroni Schist	Relict meta sediments equivalent to Dharwars (?)	---unconformity--- Metasedimentary rocks	Bundelkhand, granite Formation: Dull pink, dense fine grained to Porphyritic, granite: coarsely crystalline pink un- Foliated granites and migmatities. ----Unconformity----- Berwar Formation: Iron-formation, carbonate rock, grey Green slates, Fuschsite quartzite and conglomerate. ----Unconformity----- Rajaula Formation: Sedimentation- volcanism (amphibolites,biotite-feldspar Foliated gneisses.)	Medium grained porphyritic granites, Coarse grained, Porphyritic granite, Coarse Biotite granite Gneisses. ----Unconformity----- Pre Bundelkhand Rocks: Banded iron-formation Meta basites, gneisses, marble, schists, Metamorphosed Mafics and amphibolite.	(Pre-Bundelkhand Granitoids) Newer Metamorphic Group: Metavolcanics Banded Magnetite Quartzite, micaceous quartzites, commingtonite-grunerite-garnet magnetite schist. Talc chlorite schist, actinolite-tremolite-talc schist, hornblende-chlorite-epidote schist, garnet chlorite actinolite schist Older Metamorphic Group: Biotite-gneiss, hornblende-biotite gneisses, sillimanite gneisses, amphibolite, garnet sillimanite gneisses. Tonalite-trondhjemite gneisses, granite-gneisses, migmatites.

7.2.0 REGIONAL STRUCTURE

- 7.2.1 The regional structure of the Bundelkhand Massif is manifested by emplacement of various rock types like quartz reefs and mafic dykes. Also structures like fold, fault, shearing are present in Older Metamorphics as well as Bundelkhand Granite. Polyphase banded gneisses of Bundelkhand Gneissic Complex (BGC) show early tight to isoclinal and reclined folds (F1) which are refolded by reclined folds (F2) that are coaxial and coplanar with F1 folds. The third set of folds is open to close, disharmonic folds. Superposed fold patterns including hook shapes are common. Subsequent to folding the gneisses have undergone two phases of shearing (Ramakrishna and Vaidyanathan, 2010).
- 7.2.2 The rocks of Bundelkhand metasedimentary and metavolcanics (BMM) are present along Babina-Mauranipur-Mohar Shear zone and generally trending in E-W direction with a dip to the north but at many locations, the rocks strike in NW-SE and NE-SW due to complex schistosity and deformation.
- 7.2.3 The regional trend of foliation in younger granitoids is WNW-ESE (Singh, et al., 2007). Two major shear zones in granitoids have been described by many workers (Basu; 1986, 2001, Sharma; 1998 and Roday et al; 1995). Both the sets of shear zones are generally steeply dipping or vertical. They interpreted that the shear zones are axial planar to F1 folds in the volcano sedimentary rocks, which indicates lack of time gap between the folding of volcano-sedimentary rocks and shearing of granites (c.2.5 Ga.). On the other hand, (Sharma, *Op. cit.*) conjectured that the F1 folds in the volcano-sedimentary rocks and gneisses (> 3.3 Ga.) were coeval, which implies that they are much older than (c.2.5 Ga) shearing event.
- 7.2.4 The Bundelkhand massif is traversed by two prominent sets of lineaments one having the general NE-SW trend and another trending NW-SE. The NE-SW one is observed as quartz veins and reefs, the NW-SE one as mafic dykes. Joints are developed to various extents in all rock types. In the granites, three set of joints are commonly developed NE-SW, NW-SE and E-W.
- 7.2.5 Structurally, the Bundelkhand Craton is considered highly favourable for tungsten mineralisation because of the widespread development of deep-seated fractures, shear zones, quartz reefs and hydrothermal alteration systems. Tungsten mineralisation in the craton is generally associated with structurally controlled quartz veins/reefs emplaced along major lineaments and zones of brittle deformation. Repeated tectonic reactivation, shearing and fracturing have provided favourable conduits for circulation

of mineralising hydrothermal fluids and subsequent deposition of tungsten-bearing minerals within quartz reef systems.

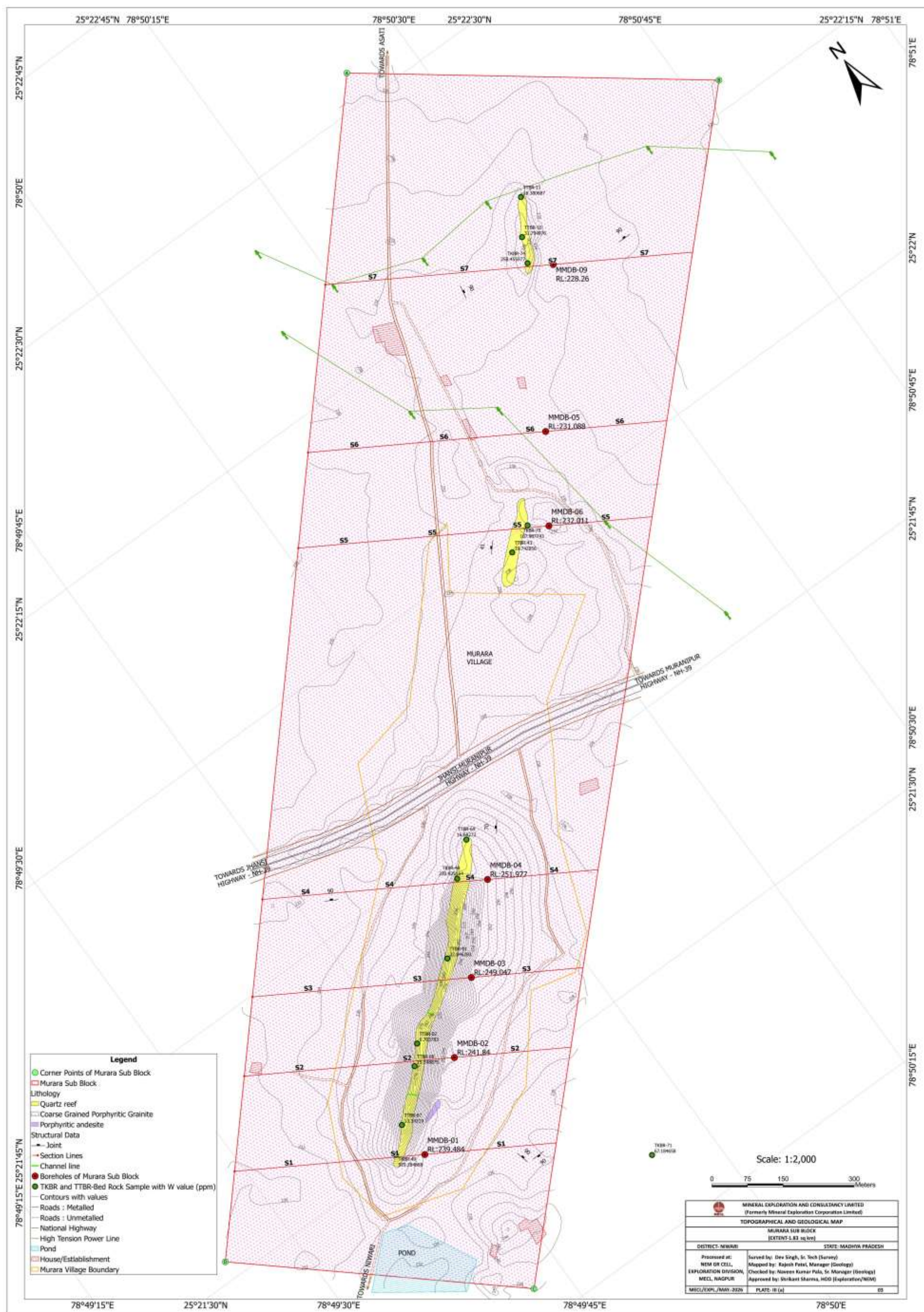
7.3.0 BLOCK GEOLOGY

- 7.3.1 The block's area is predominantly covered by soil, accounting approx. 60-70% of the area with sporadic exposures in scattered locations. The entire soil covered area is under extensive cultivation.
- 7.3.2 The study area at central part of the Archaean Bundelkhand granite-gneissic complex (~ 3.59 Ga; Saha et al., 2015) comprises granitoid varieties in different shades of colour such as porphyritic and non-porphyritic coarse grained pink granite, medium to fine grained granite with small to large enclaves of older metamorphics / supracrustals. Other important lithounits of study area are linear bodies of quartz reef which form prominent geomorphic features with positive relief in the study area.
- 7.3.3 The late phase of igneous activity is manifested by the intrusion of very large bodies of quartz reef. The quartz reefs are prominent in the area and form long ridges. Their outcrop pattern varies from lenticular to elongated ridges with multiple branching at the places. The quartz reefs in the mapped area show NNE-SSW to NE-SW general trend. In this quartz reef we also found the patches of highly crushed and brecciated silicified masses of dark chocolate coloured. In these crushed masses the network of milky quartz veins is absent instead we found clast and fragment of milky quartz which indicate later phase brecciation by which network of milky quartz veins get crushed and fragmented. In this quartz reef we observed very good cross-cut relationship between at least two generation of quartz veins in the older veins. Conspicuous solution structure such as comb structure is also well developed. At many places, iron encrustations have also been found.
- 7.3.4 To establish the stratigraphy, a regional geological map at a scale of 1:50000, in conjunction with the Bhukosh / NGDR Map of Niwari and Jhansi district by G.S.I., Geological map of Tarichar khurd block, lithologies intersected in the drilled borehole of the Murara-Devendrapura block have been meticulously considered. The litho-stratigraphic sequence of the block under investigation is depicted in the table below, followed by a detailed description of the individual lithounits. The readings recorded in the field were plotted and produced in the form of a geological map and given as Plate No-III-A and III-B.

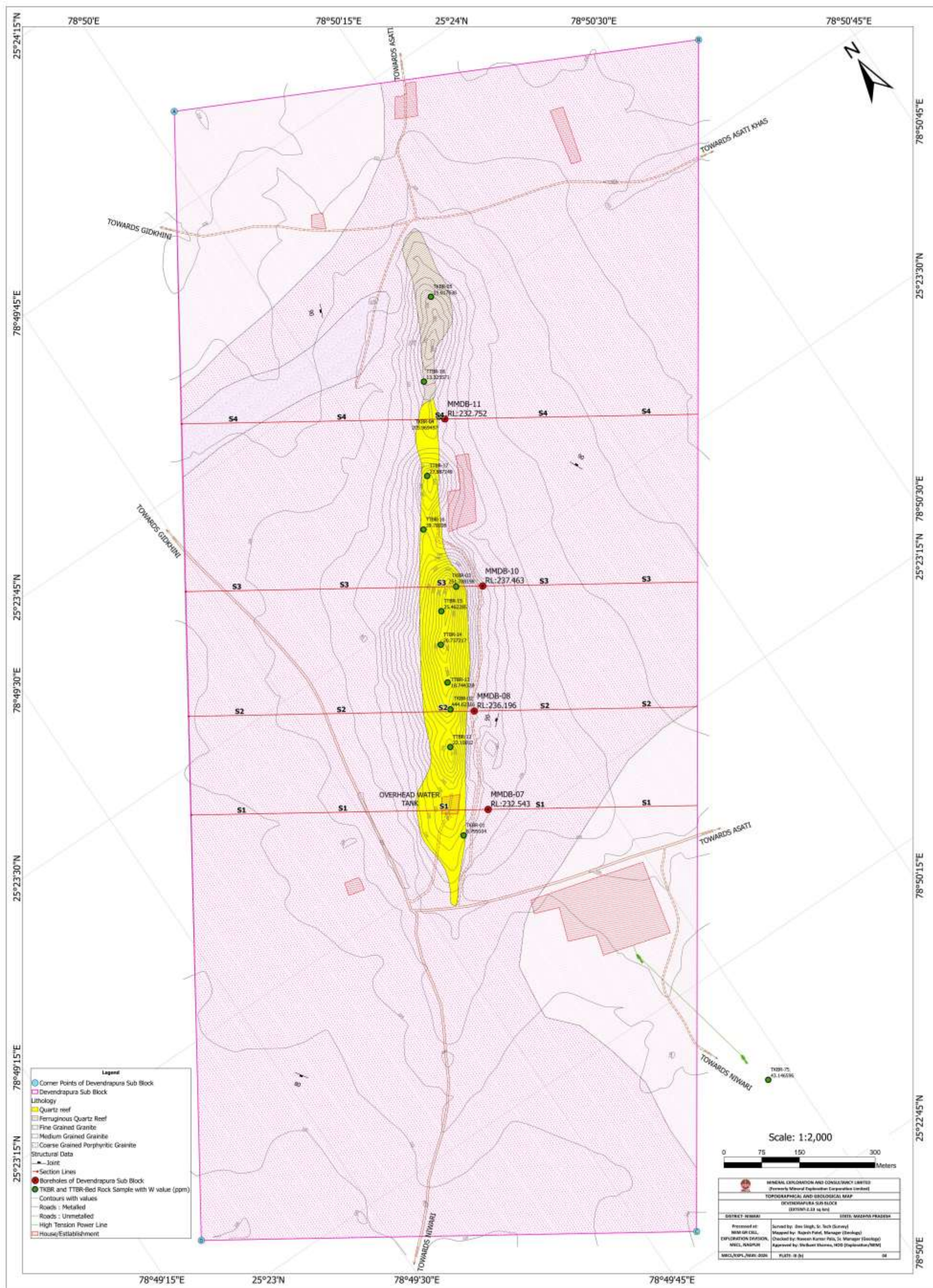
Table- 7.2
Stratigraphic Sequence of the Murara-Devendrapura block

Formation / Unit	Lithology
Recent	Soil / Alluvium
Intrusive / Extrusive / Hydrothermal Veins	Quartz veins, quartz reefs, pyrophyllitic altered zones / pyrophyllite-bearing quartz veins, porphyritic andesite, carbonatite veinlets.
Bundelkhand Granite	Fine-grained pink granite, medium-grained granite, coarse-grained pink granite, coarse-grained pink porphyritic granite, coarse-grained grey granite.
Newer Metamorphic Group	Banded Iron Formation (BIF)
Older Metamorphics	Granodiorite.

Note: Pyrophyllite has been incorporated under the intrusive/extrusive-hydrothermal vein category, as it appears to be related to alteration associated with quartz veins/reefs rather than forming a separate mappable stratigraphic unit and intersected in only one borehole (MMDB-10) of 1 m thickness.



Text Figure. - 3



Text Figure. - 4

7.4.0 DESCRIPTION OF LITHOUNITS MAPPED AND INTERSECTED IN THE BOREHOLES OF THE BLOCK

Various lithounits exposed, mapped and intersected in various boreholes of the block area and described in the following paragraphs.

7.5.0 ALLUVIUM/SOIL

- 7.5.1 Alluvium and soil constitute the youngest lithological cover in the study area of the Bundelkhand and occur as thin to moderately thick unconsolidated deposits overlying the granitic basement rocks. These deposits are developed mainly along drainage channels, valley portions, low-lying plains and weathered pediment surfaces.
- 7.5.2 The alluvium is generally composed of loose to semi-consolidated clay, silt, sand, gravel and pebble admixtures derived from prolonged weathering and erosion of the surrounding granitoids, quartz reefs and associated lithologies. The deposits are variable in thickness and lateral extent depending upon topography, drainage pattern and degree of weathering. In stream courses and nala sections, coarse sandy and gravelly materials with quartz pebbles are commonly observed, whereas finer clayey and silty materials dominate the low-lying areas.
- 7.5.3 The soil cover in the area is generally reddish brown, brown to yellowish brown in colour and varies from sandy soil to gritty in composition. The reddish to ferruginous nature of the soil is mainly due to weathering of feldspathic granites and oxidation of iron-bearing minerals. Residual soil developed over granitic terrain commonly contains quartz fragments and feldspar grains, ferruginous concretions and lateritic patches and clay-rich weathered material derived from feldspar alteration.
- 7.5.4 The weathered mantle/zone developed over the granitoids ranges from a few centimetres to several metres in thickness and grades downward into partially weathered and fractured basement rock. In boreholes drilled within the Murara–Devendrapura Block, the upper weathered zone commonly comprises loose soil, soil with rock fragments of granite and quartz reef material and highly decomposed granite before transitioning into moderately weathered hard rock.



Photo –6: Ferruginous /Lateritic soil cover near the slope of Quartz reef near Devendrapura Village.



Photo –7: Drilled soil in borehole no. MMDB-06 in Murara Sub block.

7.6.0 PORPHYRITIC ANDESITE

- 7.6.1 Porphyritic andesite has been mapped in the Murara sub block of the Bundelkhand Craton as one isolated patch occurring within the granitic terrain. The rock is generally observed as greenish grey, moderately weathered and fine- to medium-grained in appearance, showing characteristic porphyritic texture. The occurrence is interpreted as part of older metavolcanic or subvolcanic intrusive phases emplaced prior to or contemporaneous with granitic activity in the region.
- 7.6.2 Field characteristics indicate that the rock has undergone varying degrees of hydrothermal alteration and low-grade metamorphic overprinting. The rock commonly occurs along structurally weak zones and fracture-controlled domains, showing effects of chloritisation, sericitisation and ferruginisation. Such alteration features indicate post-emplacement fluid activity within the Murara Sub Block.
- 7.6.3 Petrological study of the representative specimen reveals the following characteristics: “It is a greenish grey coloured weathered rock showing porphyritic texture. Plagioclase occurs as medium to moderately coarse subhedral phenocrysts as well as very fine lath-shaped grains in the groundmass showing intense sericitisation. Actinolite-tremolite occurs as medium subhedral prismatic pseudomorphic patches comprising very fine acicular aggregates and often associating chloritic patches. Opaques are present as very fine disseminated grains. Biotite and chlorite are present as very fine flakes in groundmass. Reddish ferruginous patches and fillings are common in the specimen. Apatite is noted as very fine subhedral prismatic grains in accessories.”
- 7.6.4 The petrographic characteristics suggest that the original andesitic rock has undergone significant alteration under low-grade metamorphic to hydrothermal conditions. Intense sericitisation of plagioclase and development of actinolite–tremolite assemblages indicate alteration under greenschist facies conditions. Presence of chlorite, ferruginous fillings and disseminated opaques further support secondary hydrothermal modification of the rock.
- 7.6.5 The occurrence of porphyritic andesite in the Murara sub block is significant as it indicates the presence of older volcanic or subvolcanic phases within the Bundelkhand granitoid terrain and reflects a complex magmatic and hydrothermal evolutionary history of the area



Photo –8: Outcrop of Porphyritic andesite in Murara Sub block.

Photo –9: Porphyritic andesite

7.7.0 GRANODIORITE

- 7.7.1 Granodiorite occurrences have been intersected in minor proportions in a few boreholes drilled in the Murara–Devendrapura Block of the Bundelkhand Craton. The granodioritic phases occur as small intrusive bodies or transitional granitoid variants within the dominant granitic terrain of the area. These rocks are generally medium- to coarse-grained and are encountered over limited intervals in boreholes, indicating localized emplacement of comparatively intermediate felsic intrusive phases within the granitoid complex.
- 7.7.2 Granodiorite is a medium- to coarse-grained intrusive igneous rock closely related to granite, but containing comparatively higher proportion of plagioclase feldspar than orthoclase feldspar. As per the QAPF classification, granodiorite contains more than 20% quartz by volume, while 65–90% of the total feldspar content is represented by plagioclase. Compositionally, it ranges from felsic to intermediate in nature and represents the intrusive equivalent of dacite.
- 7.7.3 Megascopically, the rock is light grey to grey coloured, hard and medium- to coarse-grained in nature. The granodiorite shows evidence of hydrothermal alteration and secondary mineral development along fractures and grain boundaries. Quartz vein intrusions, epidotisation and chloritisation are commonly observed, indicating post-magmatic hydrothermal activity within the granitoid assemblage.
- 7.7.4 Petrological study of the representative specimen (petrographic sample no. MDP-02 & 04, Annexure-VI-A) reveals the following characteristics:
 “It is a medium to coarse grained rock showing hypidiomorphic granular texture. Plagioclase occurs as medium to coarse subhedral prismatic grains altering to epidote.

Microcline/orthoclase are present as medium to moderately coarse subhedral grains showing perthitic exsolutions in areas. Quartz occurs as medium to fine anhedral grains, often clustering in pockets. Very fine to fine quartz veins have intruded, at places. Epidote occurs as very fine to fine granular aggregates, developing after plagioclase alterations. Chlorite is present as patches and patchy fillings, often associating epidote and sphene with it. Calcite has intruded as very fine fillings. Dirty kaolinite particles are seen developing after microcline alterations in areas.”

- 7.7.5 The petrographic characteristics indicate that the granodiorite has undergone moderate hydrothermal alteration marked by epidotisation, chloritisation and kaolinisation. Development of epidote after plagioclase and chlorite associated with sphene suggests low-grade hydrothermal alteration. Presence of quartz veinlets and calcite fillings indicates circulation of late-stage fluids through fractures and microstructures within the rock.
- 7.7.6 The occurrence of granodiorite within the Murara–Devendrapura Block signifies compositional variation within the Bundelkhand granitoid suite and reflects multiphase intrusive activity in the region. These granodioritic bodies may represent early to intermediate intrusive phases subsequently affected by hydrothermal processes associated with regional tectono-magmatic evolution.

7.8.0 FERRUGINOUS QUARTZ REEF

- 7.8.1 In the Devendrapura sub block about 1.75 km WNW of Asati Khurd and NW of Devandrapura village, a highly ferruginous quartz reef hillock is located and mapped. The ferruginous quartzite having high specific gravity was folded with bands parallel to S0 or S1 (with dip 80° due to SE). The associated quartz reef has been emplaced in two generations. The chemical analysis of it shows higher iron content along with calcium and magnesium. Bed rock sample (TKBR-05, UTM Coordinate (Zone 44) - 2810583m N -282306m E) analysed from this outcrop during the previous G-4 exploration had given value of 35.53% Fe, 189.64 PPM Zn and 108.03PPM of Ni.



Photo-10: Ferruginous quartz reef Near Devendrapura village.

7.9.0 BUNDELKHAND GRANITE/ PORPHYRITIC GRANITE

- 7.9.1 The Bundelkhand massif is majorly occupied by a large plutonic complex of a batholithic dimension known as Bundelkhand granite. The emplacement of younger Bundelkhand granitoids is suggested to be resultant of collision related tectonics during the Neoarchean period (Mondal et al., 2002). In the Murara sub block, mainly coarse-grained porphyritic granite has maximum aerial extent, but in Devendrapura sub block small portion of medium grained granite and fine-grained granite are also exposed, while coarse-grained porphyritic granite has the maximum aerial extent.
- 7.9.2 Coarse-grained pink coloured porphyritic granite and granite of various shades constitute the dominant lithological units in the study area of the Bundelkhand Craton. These granitoid rocks have been intersected extensively in drilled boreholes within the Murara–Devendrapura Block and are also exposed as small discontinuous surface outcrops in the area.
- 7.9.3 The porphyritic granite is typically coarse-grained, pink to reddish pink in colour and characterized by prominent feldspar phenocrysts embedded within a medium- to coarse-grained crystalline groundmass. Granites of varying shades including pink, grey, light grey and reddish grey are also encountered in boreholes and surface

exposures, indicating compositional variation and multiphase intrusive activity within the Bundelkhand granitoid suite.

- 7.9.4 Megascopically, the rocks are hard, massive and crystalline in nature, composed predominantly of quartz, feldspar and mica. Quartz veins and veinlets are commonly observed intruding the granitic rocks along fractures and joints. In several boreholes, the granites are observed to be moderately to highly weathered and altered, particularly along structurally weak zones, fractures, shear planes and quartz reef contacts.
- 7.9.5 The granitic rocks intersected in the boreholes exhibit various hydrothermal alteration features such as:
- Epidotization, developed mainly after plagioclase feldspars;
 - Chloritization, occurring along fractures, mafic mineral sites and altered pockets;
 - Ferruginous alteration, manifested as reddish-brown staining, patches and fillings due to iron oxide development;
 - Pyrophyllitic alteration, observed as soft, pale coloured altered zones associated with silicification and sericitic alteration;
 - Minor kaolinisation and sericitisation of feldspars at places.
- 7.9.6 In some boreholes (majorly boreholes of Devendrapura sub block) intense alteration and weathering have rendered the granite soft, friable and discoloured. Pyrophyllitic and chloritic alterations are particularly prominent near quartz reef zones and hydrothermally altered sections, indicating circulation of late-stage mineralising fluids through fracture-controlled pathways.
- 7.9.7 The porphyritic texture of the pink granite indicates slow crystallisation under plutonic conditions followed by development of large feldspar phenocrysts during magmatic evolution. Variation in colour, grain size and mineral assemblage suggests emplacement of multiple granitoid phases during the tectono-magmatic evolution of the Bundelkhand Craton.
- 7.9.8 The widespread hydrothermal alterations including epidotization, chloritization, ferruginisation and pyrophyllitic alteration indicate extensive post-magmatic fluid activity in the area. These alterations are closely associated with silicification, quartz reef development and tungsten mineralisation, thereby signifying the role of hydrothermal processes in the metallogenic evolution of the Murara–Devendrapura block.



Photo-11: Weathered granite in the borehole MMDB-10.

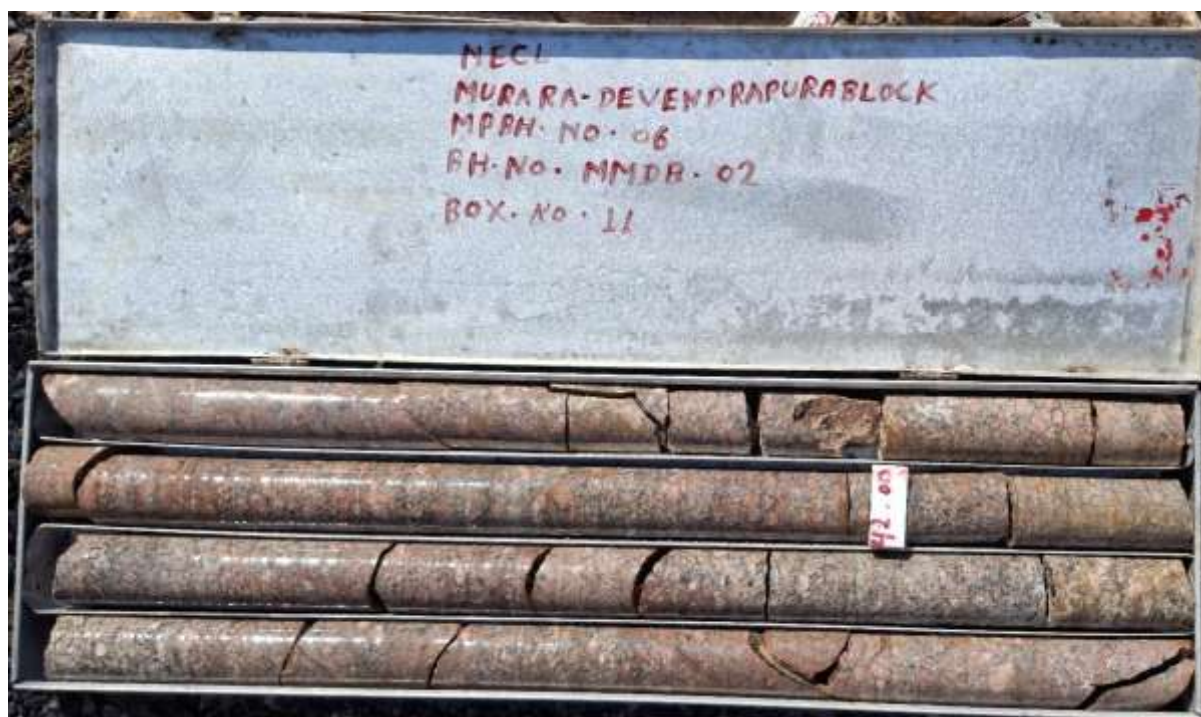


Photo-12: Pink coloured Porphyritic Granite in the borehole MMDB-02.



Photo-13: Granite with alteration and quartz veins in borehole no. MMDB-08.



Photo-14: Altered granite with epidotization in borehole no MMDB-07.

7.10.0 QUARTZ REEFS

7.10.1 Quartz reefs constitute one of the most prominent lithological and structural features within the Bundelkhand Craton and occur extensively in the Murara–Devendrapura block as linear to discontinuous ridge-forming bodies traversing the granitic terrain. These reefs are generally emplaced along fractures, joints, shear zones and other structurally weak planes developed within the granitoid rocks and represent hydrothermal silica-rich vein systems formed during late-stage tectono-magmatic activity.

- 7.10.1 In the block major quartz reefs are trending in NE–SW direction. The quartz reefs are of various colours viz. milky to dull white, buff, greenish, greyish and pinkish white or reddish white are common. No pattern is discernible in the disposition of different colours of quartz. Clusters of secondary quartz veins in the quartz reefs are frequently seen. At places, quartz reefs exhibit deep red ferruginous coating on the quartz crystals, which suggests that ferruginous solution activity has taken place in the quartz reef. These quartz reefs vary from hard, compact and massive to fractured and brecciated in nature. They occur as narrow veins, lensoidal bodies and prominent linear reefs extending over considerable strike lengths. The reefs generally trend along major structural directions and exhibit variable width ranging from a few centimetres to several metres. In Murara sub block the most prominent quartz reef is approx. 700m in length and 25 m in width and located in Murara village. Similarly, in Devendrapura sub block the most prominent quartz reef is approx. 800m in length and 50 m in width and located near electric power substation of Devendrapura village. The width of these reefs are variable in its strike direction.
- 7.10.2 In the study area, quartz reefs are observed and mapped as present on surface exposures and in drilled boreholes. Borehole intersections reveal that the reefs continue at depth with variable thickness and frequently occur associated with altered granite and quartz–granite mixed zones. In several boreholes, the quartz reefs are highly fractured and occasionally brecciated, with evidence of multiple phases of silica injection and hydrothermal activity.
- 7.10.3 Megascopically, the reefs are composed predominantly of quartz with occasional ferruginous staining, chloritic patches and various altered portions. At places and in the boreholes intersections the quartz reefs show:
- Silicification and recrystallisation, Epidotization
 - Ferruginous alteration along fractures and cavities
 - Chloritization and sericitic alteration near wall rock contacts
 - Pyrophyllitic alteration in highly altered hydrothermal zones etc.
- 7.10.4 The contact zones between quartz reefs and host granite are commonly marked by intense alteration, shearing and fracturing, indicating structural control over fluid movement and mineral deposition.
- 7.10.5 The quartz reefs are of significant metallogenic importance in the area as they host tungsten mineralisation. Geochemical analysis indicates anomalous tungsten values within several reef zones, although visible ore minerals such as wolframite are

generally absent and scheelite occurs only sporadically under short wave UV fluorescence. The tungsten is interpreted to occur in finely disseminated form within the quartz and associated alteration zones



Photo-15: Quartz reef near Murara village.

7.10.6 Genetically, the quartz reefs are interpreted as products of late-stage hydrothermal fluids derived from highly fractionated granitic magmatism. Silica-rich fluids migrated through fractures and structural discontinuities, leading to repeated quartz vein emplacement and associated hydrothermal alteration. These structurally controlled quartz reef systems therefore represent the principal loci for hydrothermal activity and tungsten mineralisation in the Murara–Devendrapura block of the Bundelkhand region.



Photo-16: Clusters of Secondary quartz veins in the quartz reefs near Murara village.



Photo-17: Quartz reef having brecciation and shattering in Borehole no. MMDB-10.



Photo-18: Quartz reefs exhibit quartz veins in borehole no MMDB-03.

7.11.0 PYROPHYLLITE

7.11.1 Pyrophyllite occurrence has been observed within the granitic terrain of the Bundelkhand Craton, particularly in association with hydrothermally altered zones developed along structurally weak planes and quartz reef systems. In the present investigation, pyrophyllite-bearing zone (1m thickness) were intersected in Borehole

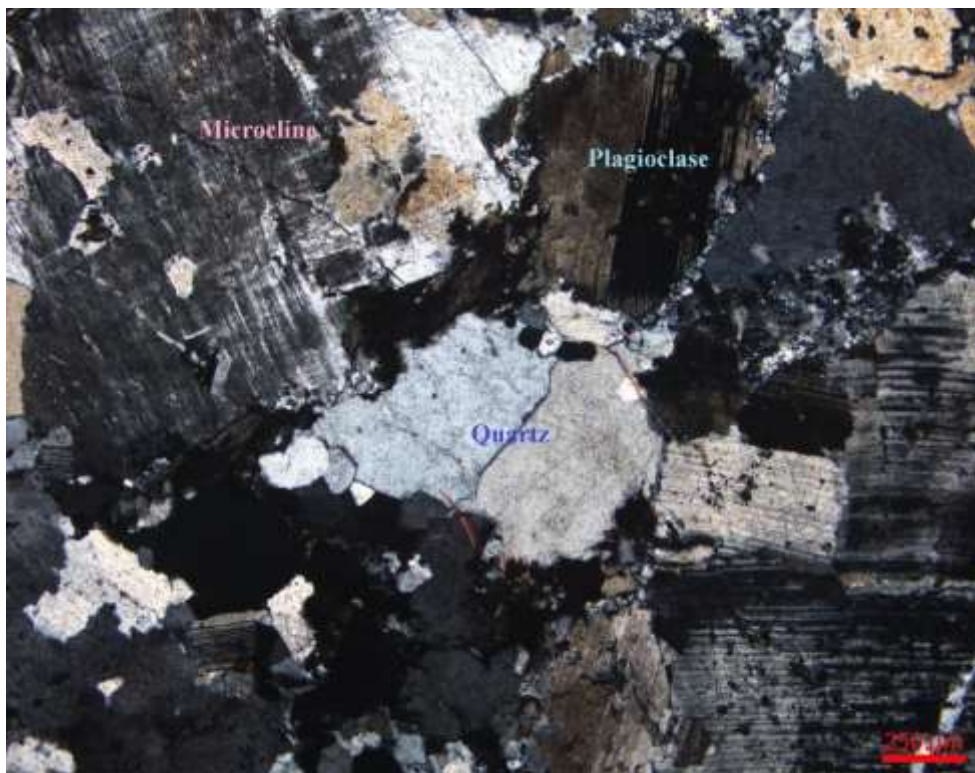
No. MMDB-10 of the Devendrapura Sub Block, indicating localized hydrothermal alteration within the granitoid host rocks.

- 7.11.2 The pyrophyllite occurrence is characterized by soft, compact to flaky pale coloured alteration zones developed within silicified and sericitized host rock. The mineralization appears to be structurally controlled and associated with late-stage hydrothermal activity related to felsic intrusive phases. The development of pyrophyllite along with sericitic alteration suggests alteration under low-temperature acidic hydrothermal conditions.
- 7.11.4 Petrological study of the representative sample indicates that: “It is a light yellowish green coloured very fine-grained massive rock. The specimen is entirely made up of very fine flaky to micro-crystalline aggregates of sericite/pyrophyllite showing radiating fan-like texture in areas. Quartz is noted as very fine anhedral grains in the assemblage. Opaques occur as very fine specks, anhedral grains and patches. Chlorite is seen present as very fine to fine patches in pockets.”
- 7.11.5 The radiating and microcrystalline texture of pyrophyllite/sericite aggregates indicates secondary hydrothermal origin. The presence of fine quartz, chlorite and opaque phases suggests alteration and recrystallization under hydrothermal conditions. Such assemblage reflects pervasive alteration of feldspathic granitic host rocks, possibly associated with fluid movement along fractures and shear zones.
- 7.11.6 The occurrence of pyrophyllite in Borehole No. MMDB-10 signifies hydrothermal alteration activity within the Devendrapura sub block and may serve as an important indicator of fluid pathways and associated mineralising processes in the area.



Photo-19: Pyrophyllite (green coloured) within the alteration zone in borehole no. MMDB-10.

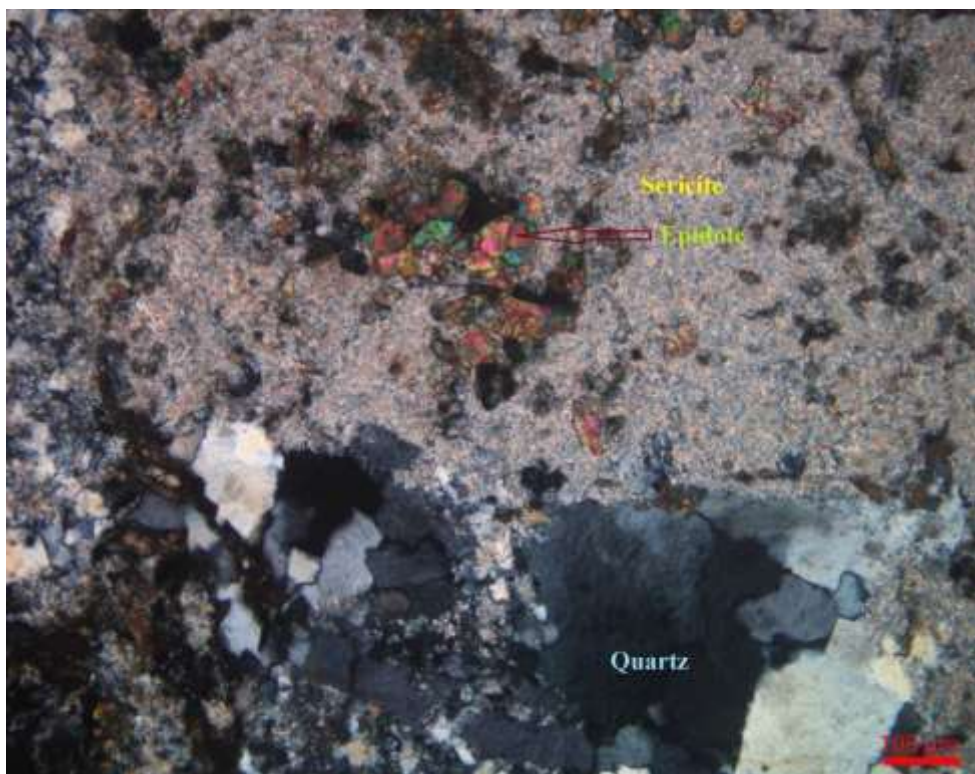
7.11.7 The description of detailed geological logging/lithologs of the core drilled in the block is given in the Annexure-II-A and summarized log in the Annexure-II-B. The photomicrographs for petrographic studies (Petrography details in Annexure-VI-A) are given from Pmg-1 to Pmg-5.



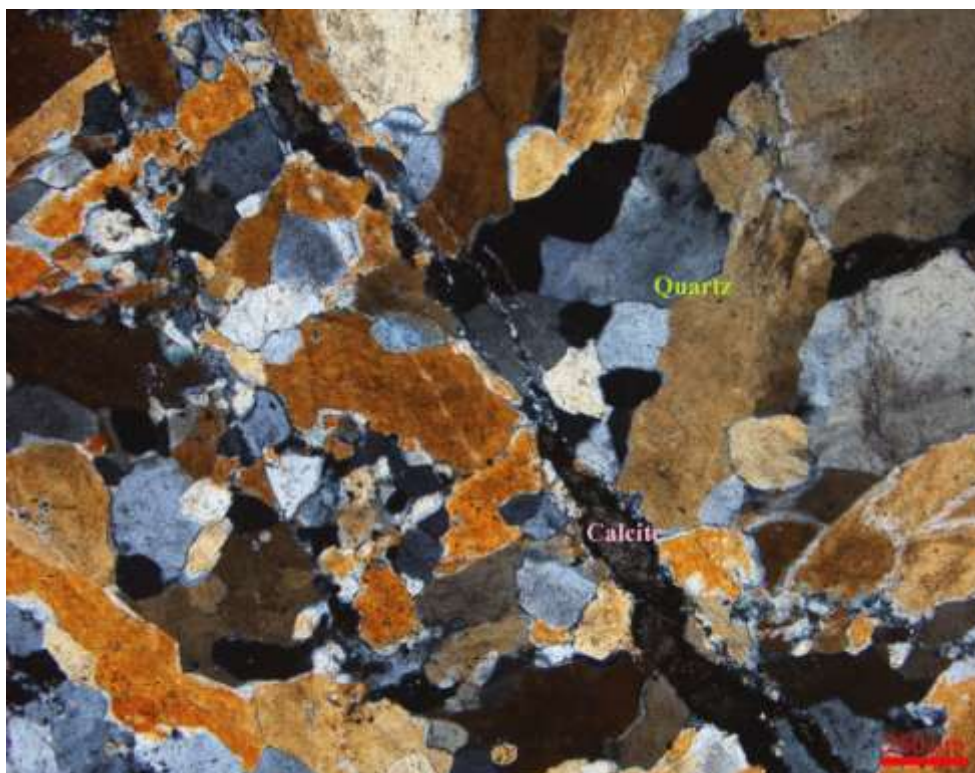
Pmg – 1: Photomicrograph showing association of plagioclase, microcline and quartz in granodiorite as seen under crossed nicols.

Specimen No. : MDP-02

Magnification : 40X



Pmg – 2: Photomicrograph showing association of sericite, epidote and quartz in altered rock (granodiorite?) as seen under crossed nicols.
Specimen No. : MDP-04 **Magnification : 100X**



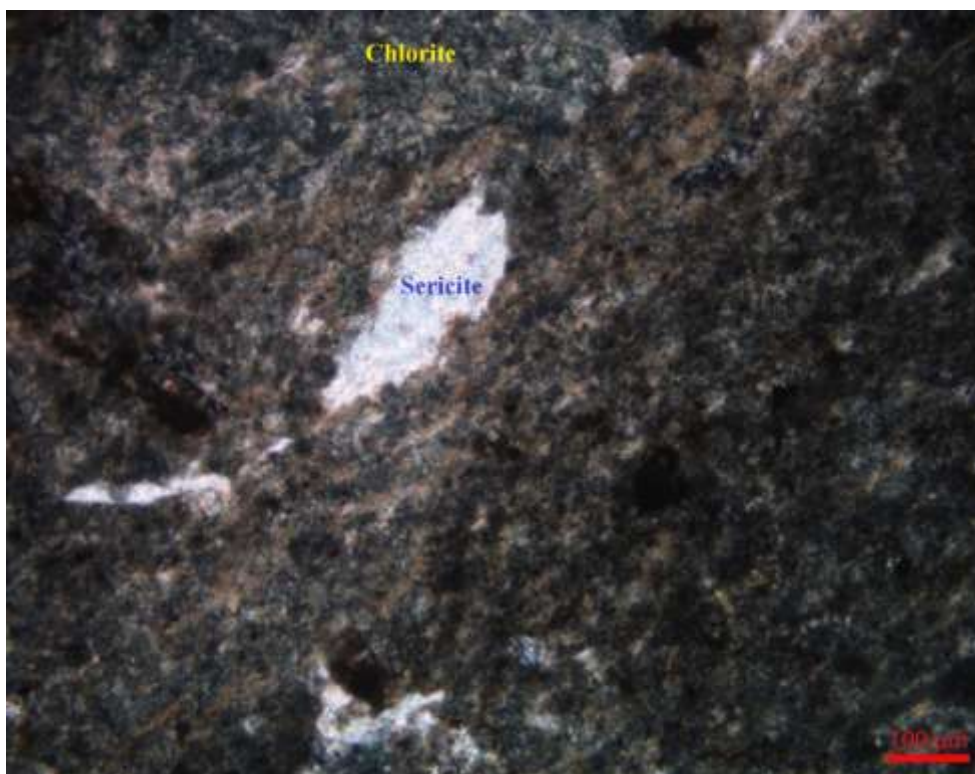
Pmg –3:Photomicrograph showing micro-fractures within vein quartz along minor granulation and calcite filling intrusion take place as seen under crossed nicols.
Specimen No. : MDP-06 **Magnification : 40X**



Pmg –4:Photomicrograph showing very fine aggregates of sericite/ pyrophyllite as seen under crossed nicols.

Specimen No. : MDP-09

Magnification : 100X



Pmg – 5:Photomicrograph showing sericite patches within chloritic aggregates as seen under crossed nicols.

Specimen No. : MDP-10

Magnification : 100X

7.12.0 STRUCTURE

- 7.12.1 The structural framework of the Bundelkhand Craton in the Jhansi–Niwari–Mauranipur sector is manifested by the emplacement of quartz reefs, mafic dykes and development of structural features such as folds, faults, fractures, joints and shear zones within the Older Metamorphic rocks as well as the Bundelkhand Granitoid Complex. The region has undergone multiple phases of tectonic activity, which is reflected in the complex structural disposition of lithological units and hydrothermal features.
- 7.12.2 One of the most prominent structural features in the area is the occurrence of giant NE–SW trending quartz reefs, which occupy a major portion of the Murara–Devendrapura block. These reefs occur as persistent linear ridges and are structurally controlled along major fracture and shear systems developed within the granitic terrain. The quartz reefs show sharp contacts with the granitoids and exhibit evidence of repeated tectonic reactivation.
- 7.12.3 Secondary quartz veins are frequently observed within the quartz reefs and generally trend in N50°W–S50°E and N80°W–S80°E directions also the veins trends in multiple directions and form clusters of veins. These veins are composed predominantly of comparatively milky white quartz and represent later phases of silica emplacement associated with hydrothermal activity. Multiple generations of quartz veins indicate polyphase fracturing and repeated circulation of silica-rich fluids.
- 7.12.4 Jointing is one of the most common structural features observed within the quartz reefs. The major joint sets recorded in the area include - NW–SE / vertical, NNW–SSE / vertical to sub-vertical, NS / vertical and NNE–SSW/vertical to sub-vertical
- 7.12.5 The reefs commonly exhibit intense fracturing, brecciation and shattering, indicating repeated deformation and tectonic reactivation. Polyphase deformation in the area is manifested by:
- Presence of major lineaments and faults
 - Multiple sets of quartz reefs and secondary quartz veins
 - Fracture-controlled silicification and hydrothermal alteration
 - Shearing and brecciation within quartz reef zones
- 7.12.6 These structural discontinuities have acted as important conduits for hydrothermal fluid migration and associated mineralisation.

- 7.12.7 In the Devendrapura area, ferruginous quartz reef having comparatively high specific gravity are observed to be folded with bands parallel to S₀/S₁ planes and dipping about 80° towards southeast. The folding pattern indicates compressional deformation affecting the older supracrustal sequences prior to or during emplacement of granitoid bodies.
- 7.12.8 Overall, the structural architecture of the block area indicates a prolonged tectono-magmatic history involving extensional fracturing, shearing and repeated hydrothermal activity. The NE–SW trending quartz reef systems, associated fractures and shear zones constitute the principal structural controls for hydrothermal alteration and tungsten mineralisation in the Murara–Devendrapura block of the Bundelkhand region.



Photo-20: Fractured, broken and altered quartz reef in borehole no. MMDB-07.



Photo-21: Drilled core in borehole no. MMDB-10 exhibits intense deformation, hydrothermal alteration and repeated fracturing within the quartz reef zone.

7.13.0 MINERALIZATION

A discussion on the type of the deposit based on the style of mineralisation and minerals under investigation. Suggested exploration plan with spacing of the sampling points and depth of exploration commensurate with the stage of exploration

7.13.1 The G-3 exploration in the block has been carried out for investigation of tungsten mineralisation. Total 11 boreholes were drilled aggregating 1220.50m in the block with average depth of 111 m. The samples generated from the drilled core were analysed for 5 elements i.e W, Sn, Cu, Pb and Zn by AAS method. Complete drilled core were scanned under short wave (254nm wavelength) ultraviolet light for identification of scheelite ore of tungsten. UV scanning of borehole MMDB-09 in the Murara sub-block exhibited blue fluorescence indicative of scheelite mineralisation between depths of 14 m to 42 m, occurring as scattered specks/disseminations (photo-22 to 24). In the borehole no MMDB-6 scheelite mineralisation also occurs as scattered specks/disseminations, The remaining nine boreholes did not exhibit scheelite fluorescence under UV examination. There is no visible wolframite observed in the block. Samples from complete zone of visually delineated quartz reef, quartz

reef with granite and different quartz veins in the drill core were collected and subjected to chemical analysis. After analysis of primary samples, 20nos samples with positive tungsten value zones selected and analysed for mineralogical phase analysis. Detailed analytical results of XRD samples are given in Annexure-IV.

- 7.13.2 During the previous G-4 Exploration of Tarichar Khurd block in the area, chemical analysis of bedrock and channel samples established that tungsten (W) mineralisation is primarily lithologically controlled and associated with quartz reef systems within the block. However, the present G-3 stage exploration indicates that tungsten mineralisation is mainly hosted within quartz reefs/quartz veins and associated quartz–granite mixed zones exhibiting varying degrees of hydrothermal alteration. Surface indications of scheelite under short-wave ultraviolet light are highly localised and sparse throughout the block area.
- 7.13.3 Integrated analysis of borehole-wise geochemical data, mineralogical study and XRD studies of selected high value tungsten samples and zones from the drilled boreholes of Murara-Devendrapura block provide significant insights into the nature of tungsten mineralisation.
- 7.13.4 The borehole-wise geochemical data establishes that tungsten is widely distributed within quartz reef and quartz–granite mixed zones, occurring as low- to moderate-grade mineralisation with variable thickness and good lateral persistence. However, mineralogical validation through XRD analysis of high value W samples and zones indicate that dominant crystalline tungsten minerals such as scheelite or wolframite are either absent or below the detection limit of routine XRD analysis.
- 7.13.5 The XRD analysis (Annexure-IV) indicate predominance of quartz as the major phase along with feldspars, mica and minor accessory/alteration minerals. The absence of distinct tungsten-bearing mineral peaks in the XRD patterns, despite elevated tungsten values obtained through chemical analysis, strongly suggests that tungsten is present in amorphous or finely disseminated tungstate phases within the quartz matrix and may also occur in lattice-bound or adsorbed form within silica and associated alteration minerals. This confirms that the tungsten mineralisation is largely “invisible” in nature and does not occur as coarse, discrete ore minerals.
- 7.13.6 **Metallogenic interpretation** of tungsten Mineralisation in the Murara–Devendrapura block of the Bundelkhand Craton is interpreted to correspond to a **granite-related hydrothermal tungsten system**. The mineralisation is predominantly hosted within quartz veins and quartz reef systems developed along structurally weak zones such as

fractures, faults and shear planes within the granitoid terrain. **Structural control** is one of the principal features governing emplacements of quartz reefs, hydrothermal alteration and tungsten concentration in the area. The mineralisation is characterised by low- to moderate-grade tungsten enrichment distributed over comparatively broader zones, indicating potential for a low-grade, large-tonnage hydrothermal system. Visible tungsten ore minerals are poorly developed, with only sporadic scheelite fluorescence and absence of megascopically identifiable wolframite, suggesting that tungsten occurs mainly in finely disseminated or invisible form within quartz reefs and associated altered zones.

- 7.13.7 The **genetic model of tungsten mineralisation** in the area suggests that the mineralisation is closely related to **highly fractionated granitic magmatism**. During magmatic differentiation, tungsten became enriched within the residual melt of evolved granitic phases. Subsequently, during the **hydrothermal stage**, tungsten was mobilised and transported mainly as tungstate (WO_4^{2-}) complexes within oxidising and slightly alkaline hydrothermal fluids migrating through fractures, joints and shear zones. These structurally controlled hydrothermal fluids led to the formation of quartz reefs and associated alteration zones, wherein tungsten was precipitated predominantly as finely disseminated, adsorbed or non-crystalline phases within silica-rich and hydrothermally altered zones during fluid–rock interaction. Limited availability of calcium restricted the formation of scheelite, while unfavourable iron and manganese conditions inhibited development of wolframite within the mineralized zones. Consequently, the tungsten mineralisation is not commonly represented by abundant visible ore minerals, and therefore geochemical continuity, hydrothermal alteration characteristics and systematic analytical evaluation constitute the principal criteria for assessment of mineralisation in the area.
- 7.13.8 The tungsten mineralisation in the study area of the Bundelkhand Craton is considered to be hydrothermal and granite-related in origin and is predominantly hosted within quartz reef and quartz–granite systems. The mineralisation is characterised by low- to moderate-grade tungsten values ranging from about 150 ppm to more than 500 ppm W and exhibits laterally persistent but diffuse distribution within structurally controlled quartz reef zones. Mineralogical and geochemical studies indicate that tungsten is predominantly present in amorphous, finely disseminated or “invisible” form rather than as coarse visible ore minerals.

7.13.9 The absence of distinct tungsten-bearing minerals in XRD studies, despite elevated tungsten values in chemical analysis, confirms that tungsten mainly occurs as finely disseminated, amorphous or lattice-bound phases within quartz and associated alteration minerals. The tungsten in the Bundelkhand quartz reefs is therefore interpreted to represent a cryptic in nature, making its identification through routine mineralogical techniques such as XRD and short-wave UV fluorescence comparatively very difficult. similar mode of occurrence is increasingly being recognised in granite-related tungsten systems worldwide.



Photo-22: (a & b) Blue fluorescence of Scheelite in the drilled core of borehole no MMDB-09 under short wave (254nm wavelength) ultraviolet light.

7.13.10 The present investigation has been carried out for tungsten mineralisation associated with quartz reefs. The exploration programme comprised detailed geological mapping, geochemical sampling and exploratory core drilling to establish the continuity, thickness and grade characteristics of tungsten-bearing quartz reef systems.

- 7.13.11 Drilling performed in the block for primarily targeting first-level (about 50 m vertical depth) intersections of quartz reefs and associated altered zones at depth. Boreholes were planned at an approximate spacing of about 200 m along continuous quartz reefs in order to assess lateral continuity of mineralisation. In areas where the reefs were discontinuous, structurally disturbed or obscured by soil cover, the borehole spacing exceeded 200 m depending upon surface continuity and structural disposition of the reefs.
- 7.13.12 Core sampling was carried out systematically across all quartz reef intersections encountered in the boreholes. In general, sampling was undertaken at approximately 1 m intervals within continuous quartz reef zones. However, wherever scheelite fluorescence were observed under short-wave ultraviolet light, closer sampling intervals of less than 1 m were adopted to delineate localised tungsten enrichment more precisely
- 7.13.13 The present G-3 stage exploration indicates that tungsten mineralisation is structurally controlled and associated with quartz reef and quartz–granite mixed zones. The mineralisation exhibits low- to moderate-grade tungsten enrichment with moderate lateral continuity and predominantly occurs in finely disseminated and cryptic form.

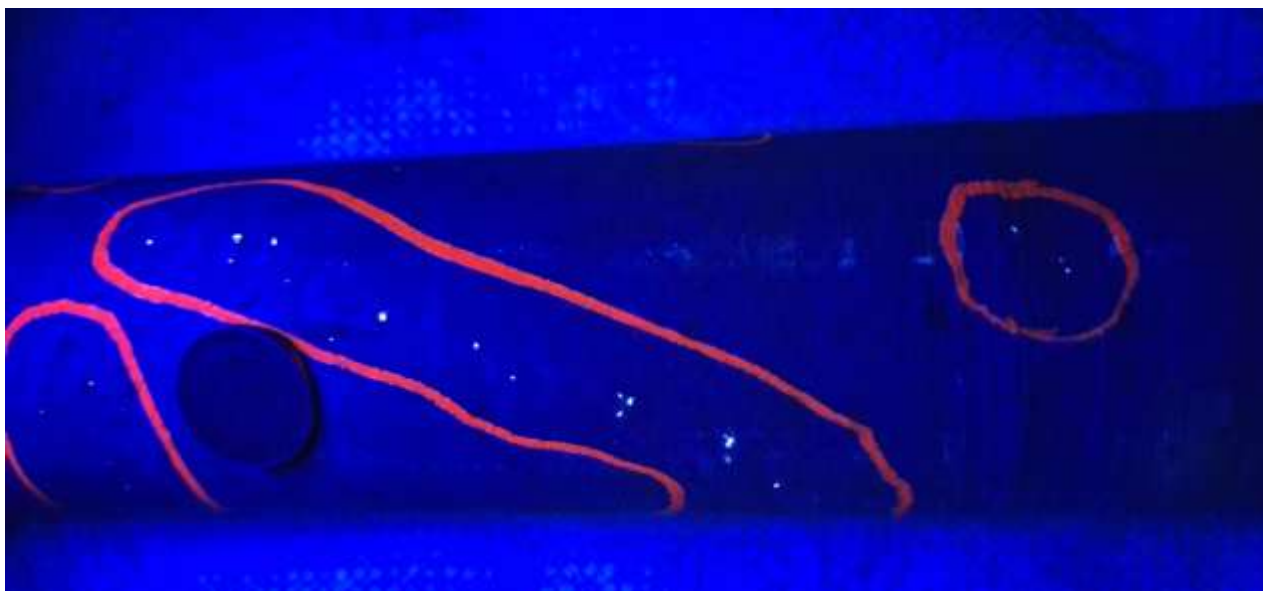


Photo-23: Blue fluorescence of Scheelite in the drilled core of borehole no MMDB-09 under short wave (254nm wavelength) ultraviolet light.



Photo-24: Scheelite in the drilled core of borehole no MMDB-09 under short wave (254nm wavelength) ultraviolet light in presence of normal light.

7.14.0 EXTENT OF MINERALIZATION

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

- 7.14.1 The tungsten mineralisation in the Murara–Devendrapura block of the Bundelkhand Craton is associated predominantly with NE–SW trending quartz reef systems and adjoining quartz–granite mixed zones. Based on geological mapping, borehole intersections and geochemical analytical results, the mineralisation exhibits variable but persistent continuity along strike within the major quartz reef zones.
- 7.14.2 Evaluation of borehole-wise mineralized intersections considering a threshold value of 150 ppm W indicates thick zones of low- to moderate-grade tungsten mineralisation distributed within continuous quartz reef segments. The mineralized zones intersected in boreholes show apparent thickness ranging from less than 1 m to more than 30 m, with several boreholes recording mineralized intervals exceeding 15–20 m thickness. This indicates widespread geochemical enrichment within the reef systems (Annexure-VII-A & B).
- 7.14.3 Higher-grade mineralized zones delineated at a threshold value of 400 ppm W occur as comparatively narrow but significant enriched pockets within the quartz reefs. These zones are observed intermittently within boreholes and generally exhibit

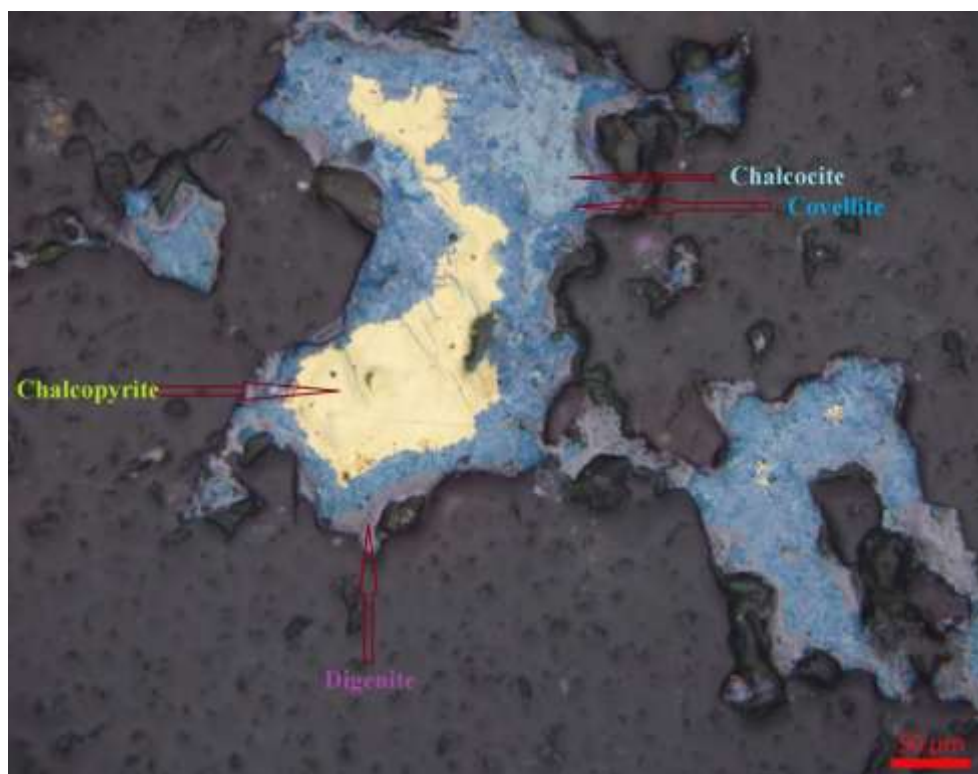
thickness varying from less than 1 m to about 16 m or more, with weighted average grades commonly ranging between nearly about 400 ppm and 500 ppm W. The higher-grade intervals appear to be structurally controlled and associated with intensely fractured, silicified and hydrothermally altered sections of the quartz reefs.

- 7.14.4 The borehole data further indicate that tungsten mineralisation is persistent in favourable structural zones but locally discontinuous due to pinching and swelling nature of the quartz reefs, structural disturbances, faulting, brecciation and intervening soil cover. Overall, the mineralisation represents a structurally controlled, quartz reef-hosted hydrothermal tungsten system exhibiting diffuse low-grade mineralisation with localised higher-grade shoots within the thicker mineralized zones (Plate-IVa, IVb & IVc).

7.14.5 Mineragraphic Studies:

- 7.16.6 Mineragraphic studies were carried out on eight polished core samples collected from selected boreholes of the Murara–Devendrapura block. The studies reveal sparse occurrence of sulphide and accessory minerals within the mineralized zones, represented chiefly by pyrite, chalcopyrite, sphene and trace tungsten-bearing phases. Pyrite commonly occurs in association with chalcopyrite, whereas chalcopyrite is present as very fine specks and inclusions within pyrite patches and, in places, exhibits secondary alteration to covellite, digenite and chalcocite. Sphene occurs as an associated accessory phase and locally contains very fine relict ilmenite inclusions. One polished section shows a probable minute speck resembling electrum; however, its occurrence is extremely sparse and requires further confirmation through advanced analytical studies. Trace xenomorphic scheelite grains observed in polished sections support the presence of tungsten-bearing phases within the mineralized zones. Overall, the mineragraphic characteristics indicate weak, very fine-grained and predominantly disseminated mineralisation, with tungsten-bearing phases occurring only sporadically and in non-prominent form

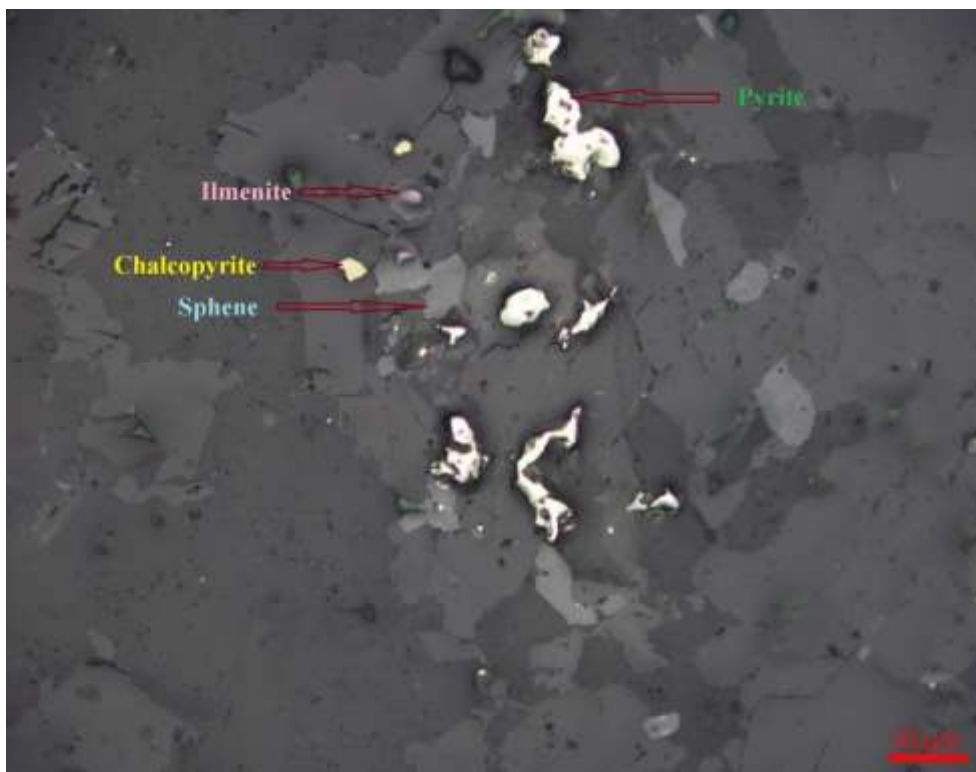
7.14.7 The details of mineragraphic study are mentioned in Annexure –VI-B and below are the 5 nos Photomicrograph (Pmg-6 to Pmg-10) of the polish section.



Pmg – 6: Photomicrograph showing chalcopyrite being replaced by covellite, digenite and chalcocite as seen under reflected light.

Specimen No. : MDM-02

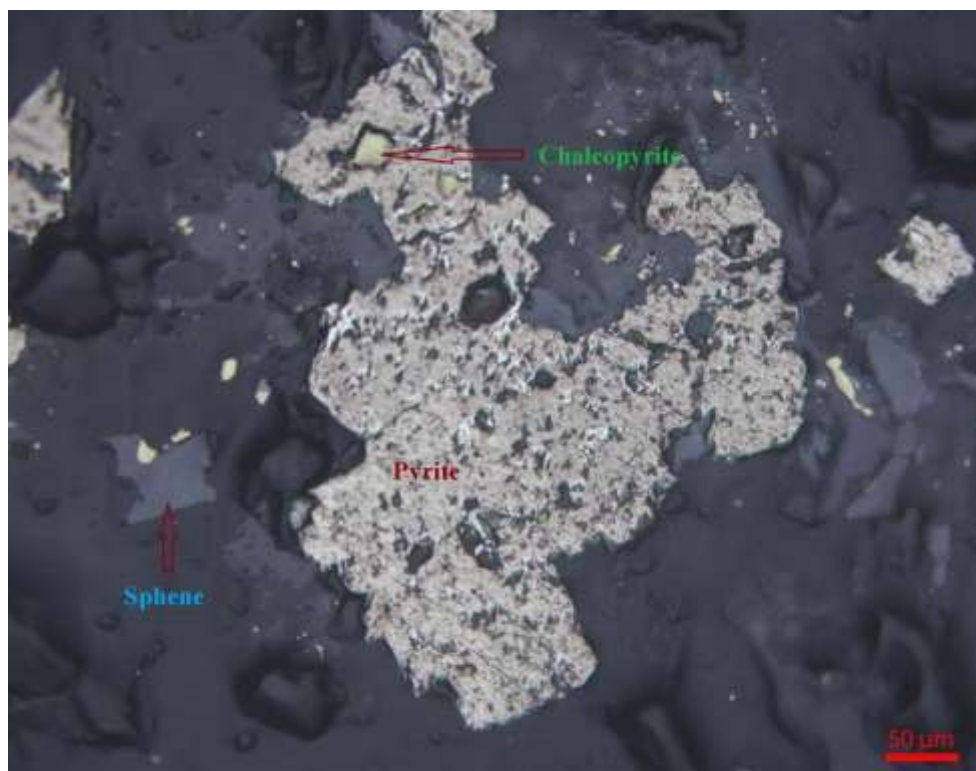
Magnification : 200X



Pmg – 7: Photomicrograph showing presence of pyrite, chalcopyrite and sphene, where sphene is showing very fine relicts of ilmenite within it as seen under reflected light.

Specimen No. : MDM-03

Magnification : 200X



Pmg – 8: Photomicrograph showing very fine chalcopyrite specks and as inclusions within pyrite patches and associated sphene as seen under reflected light.

Specimen No. : MDM-05

Magnification : 200X



Pmg – 9: Photomicrograph showing probable tiny speck of electrum as seen under reflected light.
Specimen No. : MDM-06 **Magnification : 200X**



Pmg – 10: Photomicrograph showing presence of xenomorphic scheelite as seen under reflected light.
Specimen No. : MDM-08 **Magnification : 200X**

CHAPTER - 8

PREVIOUS EXPLORATION

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

- 8.1.1 The Bundelkhand area is referred by Medlicott (1859) who mapped in various parts of the present Madhya Pradesh between 1860 and 1869. Oldham (1859), Hacket (1870) and Mallet (1868) mapped the granite and gneissic rocks of Bundelkhand province as Bundelkhand Granite. The word “Bundelkhand Gneiss” was coined by Dr. A. M. Heron (1935), who considered it as the oldest rock of Archaean age and correlated it with Banded Gneissic Complex and Berach Granite of Rajasthan.
- 8.1.2 The term “Bundelkhand Gneiss” was later modified by Mishra (1949) and Saxena (1955) as Bundelkhand Granite and associated rocks. These workers are of the opinion that the Bundelkhand Granite is a hybrid rock formed due to intermixing of the pre-existing formation with later granites. Later, Mishra and Saxena (1955), Mathur and Iqbal (1975) in course of mapping in Pungwan-Salaiya-Bhusor-Jamtoli area identified the rocks belonging to granite-granodiorite family older than the Bundelkhand Granite.
- 8.1.3 Jhingran and Puri (1956) studied the Bundelkhand Granite in detail. They described that Bundelkhand Granite is dominantly granodiorite in composition, grading locally into adamellite. They favoured that granite has evolved from anatexis, palingenesis and metasomatism process. Mathur (1954), Saxena (1957), Mishra and Saxena (1955) concluded that the Bundelkhand granite is of metasomatic origin. Mishra and Sharma (1974-1979) suggested an anatectic model of evaluation of granite and also worked on the origin of quartz reefs, pyrophyllite and diaspore. Sisodiya (1979-80) also worked on these pyrophyllite and diaspore deposits.
- 8.1.4 Work has also been carried out to locate ultramafic bodies by Mathur et al. (1972). Thambi and Jain (1982), Ghosh and Banerjee (1982), Banerjee and Singhai (1983), Ghosh and Singhai (1983) have carried out systematic geological mapping in the adjoining area. These workers have differentiated between different phases of granites and injections of alkaline, carbonatite, ultramafic and basic dykes.
- 8.1.5 Other geological investigations relating to minerals etc., in the Bundelkhand area were also carried out by GSI workers viz. Chatterjee (1941-42), Mehta (1944-45), Krishnaswamy (1945-46) and Roy Chowdhury (1947-48). The geochemical

investigations of two elements viz. Ni and Co, however, were first commenced in this region, during the field season 1968-69 by T.K. Bhattacharjee and H.L. Saha in the Madaura area and S.M.H. Zaidi and A.K. Trichal in the Bangawan area. Although no appreciable anomaly could be found in the latter area, encouraging results were obtained from the former area. This necessitated subsequent appraisal which was conducted by K.K. Srivastava, A.K. Basu, and Amitava Mukherjee during the field season 1969-70.

- 8.1.6 Gurusiddappa et al. (1984-85), reported specks, stringers and thin veinlets of pyrite, chalcopyrite, covellite along the joints and minor fracture planes within the grey-gneisses. Indications of specks and stringers of pyrite and chalcopyrite with stains have been reported within the medium-grained pink rock. The authors also reported diaspore and pyrophyllites occurring in the form of pocket deposits along quartz reefs trending northeast with fracture plane within metasedimentary rocks along these reefs cutting across. Few pockets of kaolin occur within the area due to alteration of feldspars.
- 8.1.7 During the F.S. 2016-2018, GSI carried out Application of Hyperspectral / Multispectral Remote Sensing techniques to prepare Alteration / Mineralized Zone in Tikamgarh and Jhansi Districts of Madhya Pradesh and Uttar Pradesh respectively. Sulphide and carbonate minerals, such as pyrite, chalcopyrite, azurite and malachite respectively, have been identified during the field work near Laron, Murara, Parara, Kumarpura, Sakera and Baron.
- 8.1.8 S.P. Nim of Geological Survey of India, during Annual Programme 2000-2001, worked in the region and in his report (February 2004) titled “Report on Reconnoitry Survey of Quartz Reefs in Bundelkhand Granitoid Complex for use as Abrasive/Refractory Minerals in parts of Southern Uttar Pradesh (Item No. MIP/NR/UP/2000/003)” he mentioned that the samples of quartz reef resulted anomalous value of tungsten (W) and it ranged between 337 and 1082 g/t and about >90% samples indicate range of tungsten content between 501 and 900 g/t. A total of 5 samples of reefs quartz were also re-analysed by VISUAL COLORIMETRY (VCM) method and all the samples showed anomalous value of tungsten from 100 to 150 ppm. X-Ray analysis of 5 samples of quartz reef of Banda district of U.P. was carried out and scheelite has been identified in one sample.
- 8.1.9 Mineral Exploration and Consultancy Limited (MECL) in the year 2022 had carried out Reconnaissance survey (G-4) Exploration for copper, lead, zinc and gold in

Laron block, District: Jhansi, State: Uttar Pradesh, which is situated about 30 km distance from the Murara-Devendrapura block and observed / reported that the integrated studies of Previous works, Gravity and Magnetic Survey, Geological Mapping, Geochemical sampling and analytical results of surface samples in Laron block were not encouraging for Copper, Lead, Zinc and Gold mineralisation.

- 8.1.10 Mineral Exploration and Consultancy Limited (MECL) in the year 2024 had carried out another Reconnaissance survey(G-4) and submitted the exploration report in April 2024 under the title “Geological report on Reconnaissance Survey (G-4) for copper, lead, zinc and gold in Tarichar Khurd Block, District: Niwari, State: Madhya Pradesh.”
- 8.1.11 In Tarichar Khurd Block MECL carried out Large scale Geological mapping on 1:12500 scale over block area of 101 sq.km and samples were collected and analysed for 34 elemental package analysis by ICP-MS method. Geological mapping and analytical data of surface samples were technically reviewed in 58th TCC of NMET held on 30th October, 31st October and 01st November, 2023 and the committee suggested MECL to carry out short wave ultra violet (UV) lamp survey and collection of bedrock/channel samples in the areas wherever W values are found. Accordingly, MECL did short wave UV survey in the tungsten potential areas and collected bedrock/channel samples in the block.
- 8.1.12 In Tarichar Khurd block exploration, it was observed that the integrated studies of Previous works, Geological Mapping, Geochemical sampling and analytical results of surface samples in the block were not encouraging for Copper, Lead, Zinc and Gold mineralisation. Hence further exploration in the block may not be recommended for Cu, Pb, Zn and Gold (Au) commodities. But the possibility of deep-seated mineralization cannot be ruled out.
- 8.1.13 It was also observed that majority of the quartz reefs of the Tarichar Khurd block had shown tungsten (W) value greater than 100 ppm in bed rock samples collected from these reefs. In the block area, a total of 153 nos. of bed rock, 16 nos. of stream sediment and 25 no. of channel samples were analysed for tungsten, in which W concentration ranges from 1.34 to 529.28 ppm. But two quartz reefs had given high value in the bed rock samples, one is situated near Devendrapura village which had given tungsten(W) value up to 444.62 ppm and also scheelite were identified under short-wave UV rays near 444.62 ppm value sample’s location, another was situated near the Murara village which had given tungsten(W) value up to 529.28ppm. It was,

therefore, recommended that detailed investigation for tungsten(W) may be undertaken in these two-quartz reef with large scale (1:4000) geological mapping, scout drilling and detailed sampling to increase the understanding of the disposition of tungsten mineralisation both in strike and depth wise.

8.1.14 Murara-Devendrapura Block (G-3) is the upgraded/ carved out block from the Tarichar khurd block (G4) which was proposed and reviewed in 66th Technical-cum-Cost Committee (TCC) meeting held on 24th, 25th & 26th June, 2024.

8.1.15 The details of chemical analysis of Bed rock samples along with Co-ordinates and Channel samples of five elements (out of 34 elements by ICP-MS) collected by MECL in Tarichar Khurd block fallen in Murara-Devendrapura block are as below:

Table No-8.1 a

Analytical values of bed rock samples (Located in Murara sub block) collected during G-4 exploration of Tarichar Khurd block

Sl. No.	Sample No.	UTM (m) Easting(X)	UTM (m) Northing(Y)	W	Sn	Cu	Pb	Zn
1	TKBR-48	281860	2806800	230.93	3.66	60.88	5.75	14.68
2	TKBR-49	281406	2806412	529.28	1.98	8.99	34.47	23.91
3	TKBR-73	282427	2807306	187.99	4.43	2.99	4.47	25.24
4	TKBR-74	282760	2807748	258.46	2.19	2.11	1.84	26.98
5	TTBR-01	281742	2806678	22.85	0.90	8.23	2.90	9.02
6	TTBR-02	281583	2806573	6.70	0.88	11.30	5.48	7.59
7	TTBR-10	282784	2807799	31.79	0.84	9.03	3.45	7.66
8	TTBR-11	282833	2807868	16.38	0.79	10.92	6.82	10.18
9	TTBR-43	282367	2807280	19.74	3.53	12.20	9.48	17.70
10	TTBR-67	281454	2806455	13.34	0.62	9.95	6.02	8.22
11	TTBR-68	281550	2806538	15.35	0.63	8.20	3.78	10.40
12	TTBR-69	281925	2806854	16.68	0.60	38.33	14.63	5.39

Table No-8.1b

Analytical values of bed rock samples (Located in Devendrapura sub block) collected during G-4 exploration of Tarichar Khurd block.

Sl. No.	Sample. No	UTM (m) Easting(X)	UTM (m) Northing(Y)	W	Sn	Cu	Pb	Zn
1	TKBR-01	281746	2809670	8.80	5.14	32.77	53.72	80.05
2	TKBR-02	281868	2809890	444.62	2.13	21.33	5.46	28.64
3	TKBR-03	282017	2810083	251.79	3.04	31.50	35.68	31.16
4	TKBR-04	282183	2810379	205.97	2.96	28.52	11.78	81.27
5	TKBR-05	282306	2810583	11.02	5.46	12.13	6.79	189.64
6	TTBR-12	281825	2809829	22.11	0.94	12.13	4.26	13.59

Sl. No.	Sample. No	UTM (m) Easting(X)	UTM (m) Northing(Y)	W	Sn	Cu	Pb	Zn
7	TTBR-13	281894	2809937	18.74	0.85	9.16	4.47	11.78
8	TTBR-14	281926	2810006	20.74	0.96	13.95	5.06	14.63
9	TTBR-15	281965	2810060	25.46	0.78	9.22	3.76	10.43
10	TTBR-16	282029	2810213	39.70	1.05	7.82	4.26	6.13
11	TTBR-17	282096	2810296	27.89	1.93	11.58	5.54	16.84
12	TTBR-18	282198	2810453	13.33	2.04	7.77	5.94	45.66

Table No-8.1c

Analytical results of channel samples collected in Tarichar Khurd (G-4) Block, Dist. Niwari, Madhya Pradesh, fallen in Murara Sub Block

Sl. No.	Sample No.	UTM (m) Easting(X)	UTM (m) Northing(Y)	W	Sn	Cu	Pb	Zn
1	CH-1/T-1	281514	2806485	20.05	0.48	9.02	4.72	4.77
2	CH-1/T-2			20.43	0.50	7.20	6.39	4.56
3	CH-1/T-3			18.59	0.52	7.08	2.51	5.08
4	CH-1/T-4			125.18	0.48	6.19	2.61	3.70
5	CH-1/T-5			25.64	0.58	6.56	2.90	6.84
6	CH-1/T-6			11.23	0.51	9.43	2.67	17.64
7	CH-1/T-7			15.11	0.58	7.17	4.94	5.52
8	CH-1/T-8			107.39	0.65	9.75	4.84	4.77
9	CH-1/T-9			15.47	0.48	5.51	2.05	4.77
10	CH-1/T-10			15.96	0.70	7.22	2.72	2.45
11	CH-1/T-11			13.27	0.76	7.40	2.71	4.09
12	CH-1/T-12			11.04	0.58	7.64	2.40	4.28
13	CH-1/T-13			11.05	0.56	7.58	1.95	3.86
14	CH-1/T-14			6.68	0.49	6.78	2.28	2.87
15	CH-1/T-15			9.66	0.54	6.26	2.26	3.35
16	CH-2/T-1	281646	2806601	174.45	0.53	8.11	2.06	3.88
17	CH-2/T-2			19.06	0.66	5.38	2.68	6.09
18	CH-2/T-3			19.56	0.56	5.34	2.61	4.26
19	CH-2/T-4			17.36	0.49	5.46	2.74	3.94
20	CH-2/T-5			18.52	0.54	6.65	3.52	4.94
21	CH-2/T-6			17.51	0.57	8.36	6.93	4.04
22	CH-2/T-7			9.23	0.58	6.24	2.54	3.88
23	CH-2/T-8			15.87	0.58	7.31	2.76	6.08
24	CH-2/T-9			11.01	0.57	5.31	2.17	3.63
25	CH-2/T-10			7.28	0.67	6.86	2.08	3.76

CHAPTER - 9

GEOPHYSICAL SURVEY & GEOCHEMICAL SURVEY

9.1.0 GEOPHYSICAL SURVEY

- 9.1.1 Geophysical survey has not been carried out in the block by MECL. However, Multisensor Aero geophysical surveys by Twin Otter were carried out by Airborne Mineral Surveys & Exploration (AMSE) wing, GSI (Geological Survey of India) in areas located in Jhansi district of U.P. and Tikamgarh district of M.P., during 2000-01. Ground evaluation of multi sensor aero geophysical anomalies resulting from these surveys falling in Survey of India toposheet 54K/6, 7, 9, 10, 13, 14 and 15 were carried out during F.S. 2002-03 and 2003-04 under the item code ASGE / AMS / ZS/2002/012 and compiled under “Report on Ground Evaluation of Radiometric and Magnetic Aero geophysical data Interpreted and Integrated with Geological and Remote Sensing data for Evaluation of Tectonic Features and Mineral Potential of Northern Part of Jhansi in Parts of Madhya Pradesh.”
- 9.1.2 The investigation of the above report identified major lineament systems, deep-seated fractures, shear zones and structurally controlled quartz reef systems trending mainly in NE–SW and NW–SE directions within the Bundelkhand Craton. The study highlighted the significance of these structural corridors as favourable zones for hydrothermal activity and associated mineralisation. Based on integrated geophysical anomalies and structural interpretation, several prospective zones for hydrothermal alterations and economic minerals, including base metals, pyrophyllite, diaspore, and possible polymetallic or tin-bearing mineralization within the granite complex may be delineated in the region. The exploration of Murara–Devendrapura block for tungsten and associated mineralisation resulted the mineralisation in quartz reef systems trending mainly in NE–SW supports the outcome of the report.
- 9.1.3 Further Geological Survey of India, Northern Region vide Item No.GPM/NR/HQ/2015/007 in its Field Season Programme 2015-16 did Geophysical survey in the area under project entitled “Ground Geophysical Mapping, in parts of Degree Sheet No. 54K and 54L (Toposheet Nos. 54K/ 15, 16 and 54L/10, 13 & 14) in Uttar Pradesh and Madhya Pradesh”. with the objective to delineate the subsurface geological structures with their lateral and vertical extensions and to provide data input for National Geophysical Mapping programme. This item identified critical subsurface structural contacts using gravity and magnetic mapping across parts of the

Bundelkhand Craton in Uttar Pradesh and Madhya Pradesh. The survey successfully delineated major NW-SE trending fractures.

9.1.4 Gravity and Magnetic Map of the area available on Bhukosh/NGDR portal.

9.2.0 GEOCHEMICAL SURVEY

9.2.1 MECL had collected bed rock and channel samples in Tarichar Khurd (G-4) block, the details of which is given in para no. 8.1.15. The Murara-Devendrapura block (G-3) is the upgradation of the previous G-4 work of the MECL based on the analytical values of the bed rock samples.

CHAPTER - 10

EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

10.1.0 GENERAL INFORMATION

- 10.1.1 Tungsten, also known as wolfram, is a rare dense lustrous greyish-white to steel grey metal with unique physical and metallurgical properties. Among all metals, tungsten has the highest melting point, very high tensile strength at elevated temperatures ($>1650^{\circ}\text{C}$), and one of the lowest coefficients of thermal expansion. Tungsten does not occur naturally in metallic form. The principal tungsten-bearing minerals are scheelite (CaWO_4), stolzite (PbWO_4) and wolframite, which represents a solid solution series between ferrous tungstate (FeWO_4) and manganous tungstate (MnWO_4). Most primary tungsten deposits are genetically associated with granitic intrusions and medium- to high-grade metamorphic terrains. Globally, tungsten deposits commonly occur within orogenic belts related to subduction and continental collision tectonic settings.
- 10.1.2 The total reserves/resources of tungsten ore in the country, as per updated NMI/IBM data based on the UNFC system, as on 1.04.2020, have been estimated at about 89.43 million tonnes containing approximately 144,650 tonnes of WO_3 . The entire resources are categorised under ‘remaining resources. IBM’s tungsten chapter says the resources are mainly in Karnataka (41%), Rajasthan (27%), Andhra Pradesh (17%), and Maharashtra (11%), with the balance in Haryana, Tamil Nadu, Uttarakhand, and West Bengal. In absolute ore terms, the table lists Karnataka at 36.68 million tonnes, Rajasthan at 23.93 million tonnes, Andhra Pradesh at 14.80 million tonnes, and Maharashtra at 10.12 million tonnes.
- 10.1.3 Tin (Sn) is the scarce element having an incidence of 2ppm in the earth’s crust. Pure tin is a silvery-white metal which is soft and malleable. It does not occur naturally as metal. By far, the most important tin mineral is cassiterite (SnO_2), which, in its purest form contains 78.6% tin. The less common tin ore is stannite ($\text{Cu}_2\text{SnFeS}_4$). Tin is now used mostly for tin plating, soldering special alloys and in making bronze.
- 10.1.4 The total reserves/resources of tin ore in India, as per NMI data based on the UNFC system and as on 1.4.2020, are placed at 83.72 million tonnes containing about 103,757 tonnes of tin metal. Of the total, 2,101 tonnes ore containing 973.99 tonnes metal fall under reserves, while the balance 83.72 million tonnes ore containing 102,782.91 tonnes metal are placed under remaining resources. The entire resources of tin ore are located in Haryana, Chhattisgarh and Odisha. Haryana accounts for about

64% of the total resources, followed by Chhattisgarh with about 36%, whereas Odisha has only marginal resources.

- 10.1.5 It can only be alleviated by finding new Tungsten and Tin deposits which can be mined to meet the country's increasing demand. Technological advancements and greater operational efficiency, however, may allow for working small mineral deposits adjacent to one another. Therefore, it is necessary to locate and explore such small sized deposits in clusters. In view of the above and to reduce the import bills and increase indigenous production, exploration for Tungsten and Tin ore has been accorded high priority in the country.
- 10.1.6 The geological milieu of Bundelkhand Gneissic Complex constitutes an interesting area for the mineral search especially for Tungsten, Tin, Copper, Lead and Zinc mineralization.
- 10.1.7 Based on available geosciences data and recommendations of previous works of GSI and MECL, MECL formulated and submitted G-3 stage of exploration proposal for tungsten, tin, copper, Lead and Zinc in Murara-Devendrapura block, District- Niwari, Madhya Pradesh and presented in TCC of NMET.
- 10.1.8 On the recommendation of Technical-cum-Cost Committee (TCC) of NMET, Executive Committee (EC) in its 36th EC meeting held on 29th July 2024 has approved the project with an estimated cost of Rs. 308.81 lakh (including GST) and MECL received the Sanction Order for execution and intimated vide F. No. 23/483/2024-NMET/303 dated 29th August, 2024 (Annexure-X).

10.2.0 OBJECTIVES OF PROPOSED EXPLORATION

- 10.2.1 Based on the evaluation of previous work, the present exploration program has been formulated to fulfil the following objectives:
1. To delineate the strike and depth continuity of tungsten mineralisation associated with quartz reef.
 2. To establish lithological and structural controls of mineralisation.
 3. To assess subsurface persistence of mineralized zones through core drilling.
 4. To generate geological, geochemical and analytical database for resource estimation.
 5. To establish Inferred Mineral Resources (333 category) as per UNFC and MEMC Rules, 2015.

10.3.0 BASIS FOR TAKING UP INVESTIGATION

- 10.3.1 Exploration for strategic, critical, precious, rare earths and PGE are given top priority by Govt. of India, after amendment of MMDR act 2015. Keeping in view, the Murara-Devendrapura block proposal was put up for Preliminary Exploration(G-3).
- 10.3.2 S.P. Nim of GSI in the “Report on Reconnoitry survey of quartz reefs in Bundelkhand granitoid complex for use as abrasive/refractory minerals in parts of southern Uttar Pradesh (Item No. MIP/NR/UP/2000/003)” has recommended that Quartz reefs of BGC, have quite promising concentration of tungsten and can be searched for tungsten deposits. Feasibility of exploitation for tungsten can be determined by detailed investigation.
- 10.3.3 In Tarichar Khurd block (G-4) two quartz reefs have given high value in the bed rock samples, one is situated near Devendrapura village which has given tungsten (W) value up to 444.62 ppm and also scheelite was identified under short-wave UV rays near the high value sample’s location, another is situated near the Murara village which has given tungsten (W) value up to 529.28 ppm. Block was recommended for detailed investigation for tungsten (W) in these two-quartz reef with detailed (1:4000 scale).
- 10.3.4 The Geological mapping and analytical data of surface samples of Tarichar khurd block (G-4) were technically reviewed in 58th TCC of NMET held on 30th October, 31st October and 01st November, 2023. The committee found that encouraging values of tungsten (W) were reported from the area. The committee recommended to prepare a G-3 stage item for Tungsten (W) in the area by carrying out UV lamp survey. MECL worked accordingly.
- 10.3.5 Further in the 64th Technical-cum-Cost Committee (TCC) meeting held on 25th, 29th & 30th April, 2024, the committee reviewed the work done after 58th TCC and peer reviewed Geological report of the Tarichar Khurd (G-4) block. In this meeting the committee again recommended MECL to take up G-3 stage proposal for tungsten (W) in the block.

10.4.0 PRESENT EXPLORATION WORK

- 10.4.1 To achieve the objectives as enumerated in para 10.2.0, MECL has carried out Detailed geological mapping on 1:2,000 scale over total Murara-Devendrapura Block area of 4.16 sq.km and conducted topographical survey of the area by means of surface contouring at 2m interval in 1:2000 scale and drilling of 1220.50 m in 11 Boreholes has also been executed. A total of 21 nos of Trench samples and 535 nos.

primary borehole samples have been collected and analysed for Sn, W, Cu, Pb & Zn by AAS method. Total of 10nos of samples have been subjected to petrographic studies, 8nos for mineragraphy studies and 5 nos for Specific gravity studies

10.4.2 Exploration work was commenced on 20th Sep 2024, with geological mapping and short-wave UV survey in the block. The outsourced drilling work had been commenced on 14th October 2025 and completed in the end of December 2025.

10.4.3 The allied field-works including, Geological mapping, Topographical Survey, Trenching, Core Logging, short wave UV scanning of the core and sampling etc. were completed simultaneously. The samples preparations and analytical/laboratory studies were carried out in laboratories of MECL and external samples in other Government / NABL accredited laboratories (JNRDDC).



Photo-25 (a & b): Short wave ultra violet (UV) scanning of drilled core in night
(Dotted Blue fluorescence is of Scheelite).

10.4.4 The details of the nature and quantum of work approved vs. actual achievement are given in the Table-10.1.

Table – 10.1

Approved Quantum of Work Vs Actual Achievement by MECL

SL	Item of Work	Unit	Approved	Achieved
1	Geological Mapping (on 1:2,000 Scale)	Sq km	4.16	4.16
2	Topographical Survey (Surface features/Trench/Pit/Borehole's locations etc.)	Sq km	4.16	4.16
3	Excavation			
	a) Pitting/Trenching (upto 2m)	Cu. m	180	42
4	Trench/pit Sampling			
	a) Primary Sampling	Nos.	90	21*
	b) Check Samples (10% External check)	Nos.	9	-
5	Drilling (coring)*			
	a) Drilling	m	1250	1220.50
6	Drill Core Sampling*			
	a) Drill Core (Primary) Samples	Nos.	500	535
	b) Drill Core (10% External check) Samples	Nos.	50	54
7	Petrological Samples			
	a) Preparation of Thin Section	Nos.	10	10
	b) Study of Thin Section	Nos.	10	10
8	Mineragraphy Samples (BH Core Samples)			
	a) Preparation of polish section	Nos.	10	8
	b) Study of polish section	Nos.	10	8
9	XRD	Nos.	20	20
10	Drill Core Preservation	m	650	650
11	Specific Gravity Studies	Nos.	5	5
12	Preparation of Exploration Proposal	Nos.	1	1
13	Report Preparation (5 Hard copies with a soft copy)	Nos.	1	1
Note: *Out of 90 nos approved quantum of trench samples 35 nos converted in core samples.				

10.5.0 TOPOGRAPHIC SURVEY

10.5.1 Topographical survey was conducted in the entire Murara–Devendrapura block area of 4.16 Sq. Km., Survey activities were carried out for block boundary co-ordinates, the surface features and contour points were surveyed by DGPS. Boreholes were fixed on the ground with the help of base and triangulation stations and the same had been surveyed again after drilling for the final location by DGPS instrument. Co-ordinate and RL details of the drilled boreholes have been provided in the Annexure-I-B. The topographical and geological maps are given in Plate-III(a) & III(b).



Photo-26: DGPS survey of drilled Borehole.



Photo-27: Topographical survey in the block.

10.6.0 DETAILED GEOLOGICAL MAPPING:

- 10.6.1 The block area depicting the lithology, structure, and identification of the location and attitude of the mineralized bodies has been undertaken. Broad lithological units have been mapped and litho contacts were marked with the help of a hand-held GPS device. Major litho units viz. Coarse-grained Porphyritic Granite, Medium grained Granite, Fine grained Granite, Quartz reef, Ferruginous Quartz reef and Porphyritic Andesite have been mapped ignoring minor variations. Attitude of structural features of rocks, lineation, and joints were recorded by Brunton compass. The readings recorded in the field were plotted and produced in the form of a Topographical and Geological Map of Murara sub-block (Plate No-III(a)) and Topographical and Geological Map of Devendrapura sub-block (Plate No-III(b)), District- Niwari, Madhya Pradesh.
- 10.6.2 The Murara-Devendrapura block has overall moderate topography and some quartz reefs have steep slopes particularly in Murara sub block. The geological map was created by plotting different lithological units and structural features. Available regional map of the area by GSI have been updated and incorporated. An interpreted geological map was then prepared by integrating surface and subsurface data, including various lithologies found at the surface, wells and intersected in trench and boreholes. A combined topographical map, along with the interpreted geological map of the block, was produced at a 1:2,000 scale and are presented as Plate III(a) and III(b). The dominant lithology of the area is coarse-grained porphyritic granite of Bundelkhand Gneissic Complex has the largest areal extent. The main targeted lithology of the block is quartz reefs intruding the granitoids. NE-SW trending quartz reefs are quite prominent in the block.



Photo-28: Geological mapping and data collection in the block.



Photo-29: Series of secondary quartz veins in the quartz reef near Murara village. .

10.7.0 GEOCHEMICAL TRENCHING/CHANNEL SAMPLING

- 10.7.1 In the course of exploration to expose the soil-covered quartz reef at section no S6-S6', one trench was excavated to expose fresh rock and remove the weathered surface layer. In this block provision for 180 cubic meters of trenching was approved, MECL excavated 42 cubic meters. The trench measures of 21 m in length, 1m in width and 2m in depth. The trench map is given as text fig-5 and Plate No-V.
- 10.7.2 From this trench, a total of 21 samples were collected from the walls and floor of the trench. Fresh bedrock could not be exposed up to the maximum trench depth of 2 m due to thick soil cover. However, quartz reef fragments and boulders were encountered within the trench material along the walls and floor. Representative chip

samples were collected from these quartz fragments and boulders at approximately 1 m intervals throughout the trench length.

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

10.7.4 The 21 collected samples were scanned under short wave UV rays for scheelite identification, but under the UV rays there was no fluorescence of scheelite observed in any of the samples. Further the samples analysed for five elements i.e W, Sn, Cu, Pb and Zn by AAS method. Details of chemical analysis of Trench Samples for five elements collected by MECL in Murara-Devendrapura Block (G-3), District- Niwari, Madhya Pradesh is given in Annexure-IIIC for reference.

Table-10.2
Details of Trench excavated by MECL in Murara-Devendrapura Block,
District: Niwari, Madhya Pradesh

Sl. No.	Trench No.	Location (UTM)		Azimuth of Trench towards	Dimension (L X B X H)	Remarks
		Northing (m)	Easting (m)			
1	Trench 1	2807469.03	282532.53	N59°W	21.0m X 1.0 m X 2.0m	Located at North side of Murara village



Photo-30: Site marking for trench (N59°W).



Photo-31: Trench (S59°E) in Murara sub block.



Photo-32: Trench (N59°W) in Murara sub block.



Photo-33: Mapping of trench in Murara sub block.

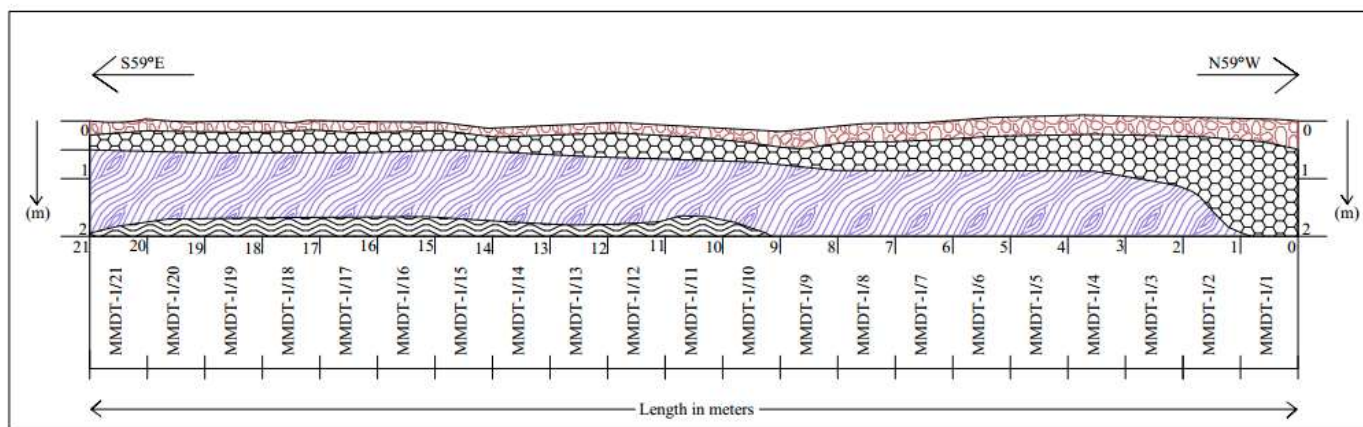


Photo-34: Wall marking for one metre length of each.



Photo-35: Representation of width of trench.

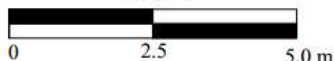
Murura Sub-Block Trench -1



INDEX

-  Fine to medium grained soil
-  Gritty soil
-  Variegated soil with fragments of Granite and Quartz
-  Weathered Granite with fragments of Quartz

SCALE



MINERAL EXPLORATION AND CONSULTANCY LIMITED	
Trench Profile Along Trench -1 of Murara Sub-Block	
MURURA -DEVENDRAPURA BLOCK	
DISTRICT : NIWARI	STATE : MADHYA PRADESH
AREA : 1.82 Sq.Km	PART OF TOPOSHEET NO : 54K/15
R.F. - 1 : 60	
Data Processed at: Non-Coal GR Cell, Nagpur	Prepared by : Rajesh Patel, Manager (Geology)
	Checked by : Navreen Pal, Sr Manager (Geology)
	Approved by : Shrikant Sharma, HOD (Exploration)
MECL/EXPLO/ APRIL-2026	PLATE NO. V

Text Fig-5: Trench Profile along trench-1

10.8.0 EXPLORATORY DRILLING

10.8.1 To establish the strike and depth continuity of the tungsten-bearing quartz reef, 11 inclined core boreholes were drilled, comprising a total drilling meterage of 1220.50 m. The average borehole depth was approximately 111 m, designed to intersect the target quartz reef at an approximate vertical depth of 50 m. Seven boreholes in the Murara sub-block were drilled along azimuth N59°W, while four boreholes in the Devendrapura sub-block were drilled along azimuth N57°W, based on the strike orientation of the quartz reef. All boreholes were drilled at an inclination of 50°. Detailed borehole information is provided in Annexure-I-B.



Photo-36: Exploratory drilling in Murara sub block.

10.9.0 CORE LOGGING & PRIMARY BOREHOLE SAMPLING

10.9.1 Drill cores recovered through wet drilling were systematically logged on a run-wise basis to delineate lithological units, structures, alteration features, and mineralized zones. Core logging included recording of lithology, colour, texture, grain size, joints, fractures, foliations, and their orientation with respect to the core axis. The analytical

data further aided in differentiating ore and non-ore zones. Detailed lithologs are provided in Annexure-IIA.



Photo-37: Geological logging of drilled core in the block.



Photo-38: Measurement of fracture in the

10.9.2 The quartz reef zones (Host for the tungsten mineralization) intersected in the boreholes drilled by MECL were identified based on the various physical properties of the quartz reef, various types of alteration feature present and identification of Scheelite under the short-wave UV light. Samples from these visually delineated quartz reef, quartz reef with granite and different quartz veins in the drill cores (half splitted) were collected and then subjected to chemical analysis. A total of 535 no of primary samples have been analyzed in Chemical Laboratory of MECL for determining five elements i.e., W, Sn, Cu, Pb and Zn by AAS method.

10.10.0 PETROGRAPHIC STUDIES

10.10.1 A total 10 nos. (9 nos. Borehole's and 1 surface) samples were collected from various litho-units representing the study area, were sent to MECL Petrological laboratory for petrological studies. The details of the petrographic study are given as Annexure – VI-A.

10.11.0 MINEROGRAPHIC STUDIES

10.11.1 The 8 number of borehole samples collected and subjected to the mineragraphic analysis to check the rock types, their variation in chemical composition. The details of the mineragraphic studies are given as Annexure –VII-B.

10.12.0 SPECIFIC GRAVITY STUDIES

10.12.1 The 5 numbers of borehole samples collected for specific gravity analysis. The average specific gravity of 2.67 is considered for resource calculation. The details of the Specific Gravity studies are given as Annexure -V.

10.13.0 DISCUSSION ON RESULTS OF MAPPING, TRENCH AND BOREHOLE SAMPLES

10.13.1 MECL carried out G-3 stage exploration comprising geological mapping, trenching, UV scanning, geochemical sampling, exploratory drilling, core logging, core sampling, and laboratory investigations to assess the tungsten mineralization potential and facilitate preliminary resource estimation under UNFC 333 category.

10.13.2 The block area is geologically mapped on 1: 2000 scale and its outcomes have been formulated in a geological map of the block. The geological maps along with the topographical data have been presented as Plate III (a) and III (b).

10.13.3 Based on the mapping and presence of quartz reef outcrops and floats, one trench was made on section line S6-S6' in soil covered area amounting to 42 Cu. M of excavation. A total of 21 trench samples were collected and scanned under short wave UV rays for scheelite identification, but under the UV there was no fluorescence of scheelite observed in any of the samples. Further the samples were analysed for five elements i.e W, Sn, Cu, Pb and Zn by AAS method. Details of chemical analysis of trench samples for five elements collected by MECL in Murara-Devendrapura Block (G-3), District- Niwari, Madhya Pradesh is given in Annexure-III-A for reference.

10.13.4 Analytical values of 21 trench samples resulted tungsten range (minimum and maximum value) 5.51 to 436.77ppm and average of 128.55 ppm. Out of 21 samples 8 samples have given tungsten values greater than 150ppm of which average is 262.30 ppm. Along the trench section line there also drilled one borehole (MMDB-05) to know the presence and depth continuity of quartz reef. The analytical ranges (Max-Min) of 21 nos. trench samples values given in Table-10.3.

Table-10.3

**Ranges (Max-Min) of 21 nos. trench samples values, Murara-Devendrapura Block,
District- Niwari, Madhya Pradesh.**

Sr.No.	Elements	Units	Maximum Value	Minimum Value (DL<1.00)
1	W	PPM	436.77	5.51
2	Sn		BDL	<1.00
3	Cu		40.06	2.44
4	Pb		20.73	4.75
5	Zn		32.75	<1.00

10.13.5 In present exploration, MECL has carried out exploratory drilling and simultaneously completed the core sampling and other associated geological and analytical works. Total 535 nos core samples were generated from 11 nos drilled boreholes and analysed for 5 elements i.e W, Sn, Cu, Pb and Zn by AAS method. All the drilled core scanned under short wave UV (254nm) rays for identification of tungsten ore (Scheelite). In the borehole no MMDB-09, fluorescence of scheelite observed under UV. The details of drilled boreholes are given in Annexure- I-B.

10.13.6 On the basis of analytical/assay values of the core samples, the tungsten mineralized zones have been delineated considering 150ppm and 400ppm elemental tungsten values. The zones have been calculated by taking weighted average grade. The details of analytical results are given in Annexure-III-A and the summary of borehole wise mineralized zones (at 150ppm and 400ppm) are given in Annexure-VII A and VII-B.

10.14.0 DATA SPACING FOR REPORTING OF EXPLORATION RESULTS

10.14.1 The G-3 stage exploration for tungsten, tin, copper, lead, and zinc in the Murara–Devendrapura Block, District Niwari, Madhya Pradesh, has been carried out through detailed geological mapping on 1:2000 scale, topographical survey with contouring at 2 m interval, and systematic core drilling. The exploration program also included short-wave UV scanning of the entire drill core, systematic collection of core samples, and associated laboratory analytical work.

10.14.2 During detailed geological mapping, various lithological units were delineated along with their contacts and structural features. Surface manifestations of mineralization and their disposition were recorded and integrated with subsurface data for interpretation.

- 10.14.3 Exploration in the block has been carried out primarily through core drilling with an approximate spacing of 200 m interval along the strike of the quartz reef hosting tungsten mineralization. The data set includes drill core logging, sampling, and analytical results, supplemented by limited surface geological observations. The adopted drill spacing is considered appropriate for G-3 stage exploration, providing a preliminary understanding of the geometry and distribution of tungsten mineralization within the quartz reef. The current spacing allows for inference of geological continuity along strike.
- 10.14.4 Due to the inherent variability of mineralization within quartz reef systems, the existing data spacing is not sufficient for higher confidence resource estimation (G2/G1 level). Further infill drilling at closer spacing (e.g., 100 m or less) is recommended to better delineate the ore body and upgrade the resource category.

CHAPTER - 11

LOCATION OF DATA POINTS

11.1.0 ACCURACY AND QUALITY OF SURVEY

11.1.1 The entire survey work has been carried out with the help of DGPS (Make-Trimble GNSS System, Model- Catalyst DA2). With the help of DGPS, co-ordinates of surface features i.e., roads, village boundaries, water bodies, base station and co-ordinates of 08 nos. of block boundary (4nos Murara and 4nos Devendrapura sub-blocks) cardinal points with R.L. have determined (Annexure-IA and I-B) and accordingly the Topographical and Geological Map of Murara and Devendrapura sub blocks have presented in Plate III(a) and III(b). Contour interval in topographical map is taken as 2 m. All survey work was done through Survey of India CORS System. Positional (horizontal) accuracy of the survey and while the elevation accuracy is as per the SOI. CORS System.

TECHNICAL SPECIFICATION OF DGPS	
MAKE	TRIMBLE
DGPS MODEL	Catalyst DA2
YEAR	2025

11.1.2 The survey of 11 nos boreholes drilled in the block has also been carried out by the DGPS (Make-Trimble GNSS System, Model- Catalyst DA2) (Annexure-IX). The SOI base station has utilized for the fixing of the boreholes position on the ground as well as for reduced levels of the boreholes. The coordinates of base station are given in Table-11.1.

Table No. 11.1
Co-ordinates of the base station for DGPS survey of Murara-Devendrapura block (G3), Niwari District, Madhya Pradesh.

Sl. NO.	BASE NAME	WGS-84		RL(m)
		LATITUDE	LONGITUDE	
1	BASE-SOI(MHGR)	N24°59'05.63006"	E78°40'39.42790"	313.321

11.2.0 QUALITY AND ADEQUACY OF TOPOGRAPHIC CONTROL

11.2.1 The topographic survey including surface features, contour points were surveyed by Trimble Catalyst DA2. Positional (horizontal) accuracy of the survey is 10mm while the elevation accuracy is 20mm. The detailed topographical map of Murara-Devendrapura Block has been prepared on 1:2,000 scale, which are provided in Plate-III-A and III-B.



Photo-39:DGPS (Trimble GNSS System, Model- Catalyst DA2).

CHAPTER - 12

SAMPLING TECHNIQUE

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

- 12.1.1 Sampling is a systematic process for collection of material from any media which can provide the best representation. During the G-3 stage exploration work in the block, there was a provision for 590 nos (500 Core and 90 trench) of geochemical samples collection and analysis for W, Sn, Cu, Pb and Zn by AAS method. There are 535 nos of core and 21 nos of trench samples have been collected from boreholes and trench in the block for analysis of the 5 elements. The details of analysis of primary core samples and trench samples have been given in Annexure-III-A and Annexure-III-C respectively.
- 12.1.2 Core sampling was carried out systematically on drill cores obtained from all boreholes intersecting the entire quartz reef /mineralized zones intersected in the boreholes. The sampling strategy was designed to ensure adequate representation of the quartz reef as well as the adjoining host rock. Samples were collected at approximately 1 m interval throughout the entire thickness of the quartz reef intercepted in the boreholes. In zones where the quartz reef occurred in association with granite (mixed lithology), sampling was continued across the contact without bias, maintaining the appropriate interval to capture the complete geochemical variation across mineralized and host rock portions. In core where scheelite fluorescence (in granitic zone) were observed under short wave (254nm) UV light, the samples length was taken about 50 cm/0.50m each for better results and less dilution of the mineralisation.
- 12.1.3 Care was taken to honour lithological boundaries wherever clearly defined, and sample lengths were adjusted slightly, if required, to avoid mixing distinctly different litho-units unless they occurred as intimate intergrowths.
- 12.1.4 For preparation of samples, the borehole cores splitted into two equal halves in such a way that the concentration of ore minerals is uniform in both the equal halves by using hydraulic core splitter. The samples were crushed, powdered and finally sieved to -200 mesh fractions for tungsten and associated elements analysis with the help of crusher and pulveriser (Photo-40 and 41). Powdered samples were then subjected to progressive coning, quartering and repeatedly mixing to homogenize. Thus, the

samples were reduced to 500 gm. A representative sample of 100 gm was drawn, the same was sent to MECL Chemical laboratory for analysis and remaining samples were preserved as duplicate samples for external check, composite and XRD samples etc. Other half of the core arranged in the G.I. core boxes with all relevant details and preserved for future reference. The samples were carefully packed with appropriate label.

12.1.5 Each core sample was obtained by splitting the drill core longitudinally, ensuring that one half was preserved for future reference while the other half was used for analysis. The splitting was carried out using appropriate core cutting equipment to maintain uniformity and minimize contamination or loss of material.

12.1.6 To ensure representativeness and reliability of analytical results, the following measures were adopted:

- Continuity in sampling was maintained across the quartz reef/mineralized zones to avoid selective bias.
- Uniform sample size and interval were followed to maintain consistency.
- Proper cleaning of core cutting equipment between samples was ensured to prevent cross-contamination.
- Systematic sample numbering and documentation were maintained for traceability.
- Duplicate and check samples were introduced at regular intervals to assess analytical precision.
- Samples were securely packed, sealed, and dispatched to the laboratory following standard protocols.

12.1.7 The adopted methodology ensured that the collected samples are representative of the quartz reef/ mineralisation and associated lithological variations, thereby providing reliable data for geochemical evaluation and resource estimation.



Photo-40:Crusher



Photo-41:Pulveriser

CHAPTER - 13

DRILLING TECHNIQUES AND DRILL SAMPLING EMPLOYED

13.1.0 DRILLING TYPES AND DETAILS

- 13.1.1 MECL drilled 11nos of inclined (50° inclination) boreholes aggregating 1220.50m drilling by deploying 3 nos of hydrostatic rigs and other associated geological and analytical works. The details of boreholes are given in Annexure-I-B.
- 13.1.2 All the boreholes in the block were drilled by wireline triple tube core barrels and double barrel diamond wet core drilling method. Initially drilling has been performed in HQ size and later HQ has been set as casing in boreholes and further boreholes lowered in NQ size drilling. In some boreholes HX casing used up to the weathered and loose formation. Triple tube diamond bit core drilling system used in the soil and weathered zone to obtained maximum recovery. Wet wire line diamond core drilling was continued with HQ and NQ IMP DIAMOND BIT (Ezy drill) till closure of the borehole. Drilling was done with crawler-mounted hydrostatic drill rig of KRATOS (Photograph-43) make.
- 13.1.3 The core recovery in the mineralized zones is about 90% which is quite satisfactory. The quality of drilling was ensured during the operation. After closure, all the boreholes have been properly plugged and sealed with cement pillars.



Photo-42: Pillars of completed boreholes.



Photo-43: Hydrostatic drill Rig deployed in the block (Kratos make)



Photo-44: HQ and NQ Diamond bits used in the block.

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 detailed run wise litholog and summarized litholog for boreholes 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 of mineralization 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 quartz reef / mineralized zones length recorded during the geological core logging have been subjected to sampling and analyses for W, Sn, Cu, Pb and Zn by AAS method in respective zone. The primary sample had been marked in the quartz reef/mineralized zone intersected in the boreholes based on quartz reefs/veins, alteration features and results of short-wave UV scanning. In general, the samples length was kept as 1.00 m which varied in some instances because of variation in lithology, type and concentration of mineralization. The details of analysis of primary core samples are given in Annexure-III-A.



Photo-45: Samples and mineralization marking on the core during logging and UV Scanning.

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

13.3.1 The drilling has been carried out with triple tube and double barrel to reduce the core loss and get the optimum core recovery. The short runs were also drilled as per necessity so that optimum core recovery was maintained. The core recovery in the mineralized zones is more than 90% which is quite 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 more than 90% which is quite satisfactory. The entire mineralized zones / length recorded during the geological logging on visual basis have been analyzed for respective elements/group of elements. Since, the recovery percentage in the mineralized zones is good; there is no negative effect in the core recovery.

13.5.0 CORE LOGGING

13.5.1 The drilled core recovered from the boreholes have been logged systematically to demarcate various litho-units. 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 mineralization 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. The detailed run wise litholog and summarized litholog for boreholes are given in Annexure- II-A and Annexure- II-B respectively.

13.5.2 The logging was carried out run-wise for boreholes. Since the variation of litho units were less in down-hole direction and run lengths were short, thus consolidated / summarized litholog for all the boreholes were prepared with all details ignoring minor variations to show the litho units as graphic representation.

13.6.0 ROCK QUALITY DESIGNATION (RQD %)

13.6.1 All the boreholes drilled by MECL have been logged for rock quality designation (RQD %) and the data for run-wise RQD% have been incorporated in the detailed logs of the boreholes given as Annexure-II-A.

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 core sampling and analyses have been carried out for entire mineralized zones/quartz reef length intersected in the boreholes drilled on visual basis. The primary samples were marked in the mineralized zones intersected in the borehole based on type and concentration of mineralisation/lithology and in general the samples length have been kept as 1.0 m which varied in some instances because of variation in lithology and result of short-wave UV scanning. The mineralized cores were splitted into two equal halves by core splitter in such a way that the concentrations of ore minerals were uniform in both the equal halves. One half of the core sample were crushed to (–) 200 mesh size for W, Sn, Cu, Pb and Zn mineralisation with the help of crusher and pulveriser. By progressive coning and quartering and repeatedly mixing the samples were reduced to 500 gm. The representative sample of 100gm were collected and analyzed for respective mineralization, at Chemical Laboratory of MECL, Nagpur.
- 14.1.2 During the present exploration, a total of 535nos of primary boreholes core samples for W, Sn, Cu, Pb and Zn mineralisation were prepared and analysed at Chemical Laboratory of MECL, Nagpur. The details of analysis of primary core samples and trench samples have been given in Annexure-III-A and Annexure-III-C respectively.



Photo-46: Hydraulic Core Splitter



Photo-47: Splitted mineralized core of borehole no. MMDB-04

14.2.0 NATURE, QUALITY AND APPROPRIATENESS OF THE SAMPLE PREPARATION TECHNIQUE

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

14.3.0 QUALITY CONTROL PROCEDURES ADOPTED

14.3.1 The primary core samples have been collected from entire mineralized zones/length intersected in the boreholes on visual basis and the samples have been prepared at centralized mechanized sampling unit. The standard sampling procedure in supervision of qualified sampling technician has been adopted to control the quality of samples. Similarly, 10% external check samples have also been prepared under the supervision of qualified sampling technician following the standard sampling procedure.

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

14.4.1 All the primary samples were marked and prepared from mineralized cores. During the preparation of primary samples, the mineralized cores were studied meticulously and samples were marked properly. These mineralized cores were subjected for preparation of primary samples as per the sampling procedure for primary samples as described in Para 14.1.0. The proper marking of primary samples from drilled cores

and following standard procedure for sample preparation shows the representative samples have collected from the in-situ materials.

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

- 14.5.1 The primary samples were prepared (–) 200 mesh size for W, Sn, Cu, Pb and Zn mineralization and all the other samples were prepared from primary samples. (–) 200 mesh size for W, Sn, Cu, Pb and Zn mineralisation is appropriate for the liberation of grains for analysis in respect of respective mineralisation.

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 535 nos of primary core samples and 21 nos trench samples were analysed for 5 elements i.e. W, Sn, Cu, Pb and Zn by AAS method at Chemical Laboratory of MECL (a NABL accredited laboratory). The descriptions and Standard Operating Procedure (SOP) used are given below.

15.2.0 STANDARD OPERATING PROCEDURE (SOP)

Determination of Cu, Pb, Zn, W and Sn by Flame AAS after Aqua Regia + HF + Perchloric Acid Digestion.

1. Objective

The objective of the analysis was to determine the concentration of tungsten (W), tin (Sn), copper (Cu), lead (Pb), and zinc (Zn) in samples collected from the Murara–Devendrapura Block. A total of 535 primary core samples and 21 trench samples were analysed at the Chemical Laboratory of MECL, which is a NABL-accredited laboratory.

2. Principle

The analytical method is based on the determination of Cu, Pb, Zn, W, and Sn by Flame Atomic Absorption Spectroscopy (FAAS) after near-total decomposition of the geological sample by mixed-acid digestion. The sample matrix was digested using Aqua Regia, hydrofluoric acid (HF), and perchloric acid (HClO₄), and the dissolved elements were measured by atomic absorption under calibrated instrumental conditions.

3. Sample Digestion

For **chemical** analysis, 0.5000 g of pulverized sample of - 200 mesh size was accurately weighed into a 100 mL PTFE beaker. To this, 15 mL Aqua Regia, 5 mL HF, and 5 mL HClO₄ were added, and the mixture was heated on a hot plate at 90–120°C till complete digestion and attainment of syrupy consistency. After cooling, the digested mass was dissolved in dilute nitric acid, filtered, and the filtrate was made up to 100 mL with 2% HNO₃ prepared in deionized water.

4. Calibration Standard

working standards for Cu, Pb, Zn, W, and Sn were prepared from certified 1000 mg/L stock solutions using the same acid matrix as that of the samples. A reagent blank was also prepared and analysed for baseline correction during instrumental measurement.

5. Instrumental Conditions (FAAS)

The elemental determinations were carried out by Flame Atomic Absorption Spectroscopy after adequate instrument warm-up and lamp stabilization. Copper, lead, and zinc were analysed using air–acetylene flame, whereas tungsten and tin were analysed using nitrous oxide–acetylene flame. The analytical wavelengths adopted were 324.8 nm for Cu, 217.0 nm for Pb, 213.9 nm for Zn, 255.1 nm for W, and 235.5 nm for Sn.

6. Analysis

The reagent blank and calibration standards were aspirated first in order to establish the calibration curve. Thereafter, the sample solutions were analysed under identical instrumental conditions, and wherever the concentration exceeded the calibration range, the samples were diluted with the same acid matrix and re-analysed.

7. Quality Control

Quality control during analysis was maintained by including one reagent blank, certified reference materials such as **GBW-07239** and **BCS-362**, and one repeat sample with every batch of 25 samples. The results of the certified reference materials were required to fall within the certified limits, and repeat analyses were monitored as per laboratory precision criteria to ensure analytical reliability.

8. Calculation

The concentration of each element in the sample was calculated from the relation v/w . In this relation, v represents the concentration obtained from calibration in mg/L, w is the final volume of solution in mL, and m is the sample weight in g. For a 0.5 g sample made up to 100 mL, the concentration in ppm is equivalent to 200

9. Safety and Precautions

All digestion steps were carried out in a fume hood using appropriate personal protective equipment, including gloves, goggles, and lab coat. Particular care is required in handling HF and HClO₄ because of their highly hazardous nature, and Aqua Regia should always be freshly prepared and should not be stored in closed containers.

15.3.0 NATURE OF QUALITY CONTROL PROCEDURES ADOPTED

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

Analysis of Certified reference materials/measurement standards

Analysis of blank samples

Use of QC samples and control charts

Analysis in duplicates & Internal Check standards.

15.4.0 CHECK ANALYSIS FROM THIRD PARTY NABL ACCREDITED LABORATORY

15.4.1 For assessing the acceptable levels of accuracy, third-party samples analysis was carried out at Jawaharlal Nehru Aluminium Research Development and Design Centre, (JNARDDC) Nagpur (A Government Laboratory) and a total of 54 numbers of external check samples each for 5 elements i.e. W, Sn, Cu, Pb and Zn by AAS method have been analysed. A summary of comparative statement of Primary Vs External Check Analysis (5elements) value has been given in Annexure –III-B.

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

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

CHAPTER 16

MOISTURE

16.1.0 All the analysis for Tungsten, Tin, Copper, Lead and Zinc mineralisation were carried out with natural moisture in Murara-Devendrapura block, Niwari, Madhya-Pradesh.

CHAPTER 17

BULK DENSITY

17.1.0 During the present exploration programme of Preliminary (G-3) Exploration in Murara- Devendrapura block there was no provision for the bulk density hence it has not been carried out in the block.

17.2.0 In the block there was a provision for specific gravity analysis of 5 nos samples which was carried out in the block. Result of specific gravity of core samples are as below in table no. 17.1.

Table-17.1

Murara-Devendrapura Block Specific Gravity Determination Results

Sl.No.	Sample No.	Specific Gravity
1	MDSG-01	2.71
2	MDSG-02	2.62
3	MDSG-03	2.67
4	MDSG-04	2.70
5	MDSG-05	2.67
Average Specific Gravity		2.67

CHAPTER 18

BENEFICIATION STUDIES

18.1.0 The beneficiation studies have not been carried out in the block as there was no provision for beneficiation study in the Murara- Devendrapura block, Niwari, Madhya Pradesh. It is recommended for next level of exploration.

CHAPTER 19

RESOURCE ESTIMATION TECHNIQUE

19.1.0 DISCUSSION ON DATA DENSITY TO ASSURE CONTINUITY OF MINERALISATION

- 19.1.1 The Preliminary Exploration (G-3 stage) for tungsten mineralisation was carried out in the Murara–Devendrapura Block of the Bundelkhand Craton. The exploration programme comprised detailed geological mapping, geochemical sampling and core drilling, short wave UV scanning with the objective of evaluating the continuity, thickness and grade characteristics of tungsten-bearing quartz reefs and associated altered granitoid zones and to estimate Inferred Mineral Resources (333 category).
- 19.1.2 A total of 11nos boreholes were drilled in the block with an average depth of about 111 m for first level (about 50 m vertical depth) intersection of quartz reefs and associated mineralized zones. Boreholes were generally planned at about 200 m spacing along continuous quartz reefs, while wider spacing were adopted in sectors where reefs were discontinuous or obscured due to soil cover and structural disturbances.
- 19.1.3 Systematic core sampling was carried out across the entire quartz reef intersections encountered in boreholes. In general, sampling was undertaken at approximately 1 m interval within continuous quartz reef zones, whereas closer sampling intervals of less than 1 m were adopted in zones exhibiting scheelite fluorescence under short-wave UV light.
- 19.1.4 The present resource estimation is based on borehole intersections, geological cross-sections, continuity of mineralized quartz reefs, structural disposition and weighted average tungsten grades obtained from chemical analytical data. The available drilling data indicate preliminary continuity of tungsten mineralisation along strike and dip directions within the interpreted influence zones. The broader tungsten mineralized zones were evaluated considering a threshold value of 150 ppm W, whereas comparatively enriched zones were assessed and resources have been calculated at higher 400 ppm threshold values.
- 19.1.5 Considering 400ppm W cut off, the mineralization were intersected in boreholes MMDB-02, MMDB-03, MMDB-04, MMDB-08 and MMDB-10. The mineralized zones were delineated (at 400ppm W) through sectional interpretation and correlated across sections S2-S2', S3-S3', S4-S4', S9-S9' and S10-S10'. Different lodes such as Lode-1, Lode-2, Lode-2A, Lode-2B, Lode-2C, Lode-3A and Lode-3C have been

identified and correlated based on continuity of lithology, mineralisation pattern and analytical values plotted in the geological cross sections (Plate- IV-a, b, & c) and level plan (only for the nomenclature and correlation purpose of the lodes).

- 19.1.6 Level plans are important for correlation and nomenclature of lodes because they provide a horizontal representation of the mineralised zones at a particular Reduced Level (RL), enabling better understanding of the spatial continuity, disposition and relationship of different lodes within the block. By projecting all borehole intersections and mineralised zones onto a common elevation plane, level plans help in tracing the lateral continuity of mineralisation between adjacent boreholes and in identifying whether different intersections belong to the same lode or represent separate parallel lodes.
- 19.1.7 In the Murara–Devendrapura Block, the level plans prepared at 150 mRL for Murara Sub Block (Plate-VI-a) and 200 mRL for Devendrapura Sub Block (Plate-VI-b) facilitated systematic correlation of mineralized quartz reef zones across the drilled area. The plans helped in establishing the continuity, splitting, merging and pinching–swelling nature of lodes and assisted in assigning consistent nomenclature to individual lodes. Since the tungsten mineralisation is structurally controlled and associated with discontinuous quartz reef systems, preparation of level plans was essential for understanding the geometry and continuity of mineralised zones in three dimensions.
- 19.1.8 Further, level plans also provide a basis for preparation of geological cross-sections, interpretation of ore body geometry and resource estimation by sectional methods. They are particularly useful in structurally complex terrains where mineralised lodes exhibit varying strike, dip and thickness along different parts of the block.

19.2.0 WHETHER PREVIOUS EXPLORATION DATA HAS BEEN USED

- 19.2.1 The present exploration programme has been formulated based on available regional geological information, previous exploratory findings of Tarichar Khurd block (G-4) from which this block was carved out and surface indications of mineralization in the Murara–Devendrapura block area. Geological and geochemical evidences generated during earlier stages of investigation were utilised for planning boreholes and delineation of mineralized lodes. The previous data helped in identifying favourable lithological units and structural controls responsible for tungsten mineralisation in the area. The present exploration programme further substantiated the continuity and tenor of mineralisation through subsurface investigations.

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

19.3.1 The tungsten (W) resource of the block has been estimated by “**Geological cross-section 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 have not intersect mineralisation (at 400ppm weighted average grade of W zone) have been considered as negative boreholes (borehole number MMDB-1, 5, 6, 7 and 9)) for resource estimation.
3. The thickness and grade of each mineralized zone intersected in the boreholes 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 The mineral resource estimation for the Murara–Devendrapura block has been carried out based on the available exploratory data generated through exploratory drilling, geological mapping and analytical studies. The level of exploration corresponds to G3 stage exploration under the UNFC system and specifications given in the Minerals (evidence of Mineral content) Rule-2015.

19.4.2 The resource estimated in the block is categorised under Inferred (333) Mineral Resource category due to limited borehole spacing and preliminary level of geological confidence. Further detailed exploration may enhance the confidence level and upgrade the resource category.

19.5.0 THE ASSUMPTIONS MADE REGARDING RECOVERY OF BY PRODUCTS

19.5.1 The present exploration programme was primarily aimed at delineation of tungsten mineralisation and analysis has been done for Tungsten (W), Tin (Sn), Copper (Cu), Lead (Pb) and Zinc (Zn). The Analytical results indicate encouraging tungsten values represented in ppm grades. No significant economically viable by-product mineralisation has been identified during the present investigation.

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

19.6.1 The tungsten (W) resource of the block has been estimated by “**Geological cross-section Method**” considering the following parameters and assumptions-

1. **Cut-off Grade:** For the purpose of estimation of grade vis-à-vis resource of the tungsten (W), it is necessary to arrive at a 'planning' cut-off grade. The broader tungsten mineralized zones were evaluated considering a threshold value of 150 ppm W, whereas comparatively enriched zones were assessed and resources have been calculated at higher 400ppm threshold values. Thus, the grade cut-off 400ppm W has been considered for resource estimation of tungsten in Murara-Devendrapura block.
 2. Considering the underground potentiality of the block, the minimum workable thickness / minimum stoping width of 2.00 m has been considered for resource calculation.
 3. The strike influence/length influence for the resource estimation has been considered/calculated up to the mid-point on either side of the section line along which mineralisation intersected in the borehole of interest. In case of end section, it is considered up to the mid-point of adjacent section and 25m from the end section as no control is available after the end section, therefore to minimise the overestimation of resource it has been considered only 25m.
 4. For the vertical persistence of lode, the up-dip influence is considered 25 metre above the intersections in the boreholes similarly the dip influence in down dip has been considered up to 25 m below the intersection in the boreholes.
- 19.6.2 **Specific Gravity:** The average specific gravity of the 5 samples analysed from W mineralisation in the block is determined as 2.67, which has been utilized for the resource estimation for tungsten (Annexure-V).
- 19.6.3 The tungsten resource has been estimated at various parameters based on the zones deciphered and delineated from qualitative data of W of primary samples. The zones have been delineated on the basis of weighted average tungsten values from primary assay of chemical analysis i.e. 400 ppm W cut-off grade. The zones intersected in boreholes have been plotted on the geological cross sections and the nomenclature of zones has been given from down dip side. There are 3 main tungsten (W) lodes (L-1 to L-3) with their split and merge have been delineated on the basis of 400 ppm W cut-off grade.
- 19.6.4 The zones below 2 m thickness have also been plotted for correlation purpose only, but they are not considered for resource calculation. The area of mineralized zones have been calculated section-wise from interpreted geological sections and multiplied by influence length and specific gravity to estimate geological resources.

The formula adopted for resource estimation is as follows:

$R = A \times L \times \text{Sp.gr.}$ Where,

R = Geological Resource A = Area of mineralized body (sq.m), L = Length of influence (m) and Sp.gr. = Specific gravity of mineralized material

A specific gravity value of 2.67 has been considered for estimation of resources of mineralized quartz reef material.

19.6.5 The borehole wise zones demarcated at 400ppm cut-off by calculating weighted average grade is mentioned in Annexure-VII-B and table 19.1.

Table-19.1

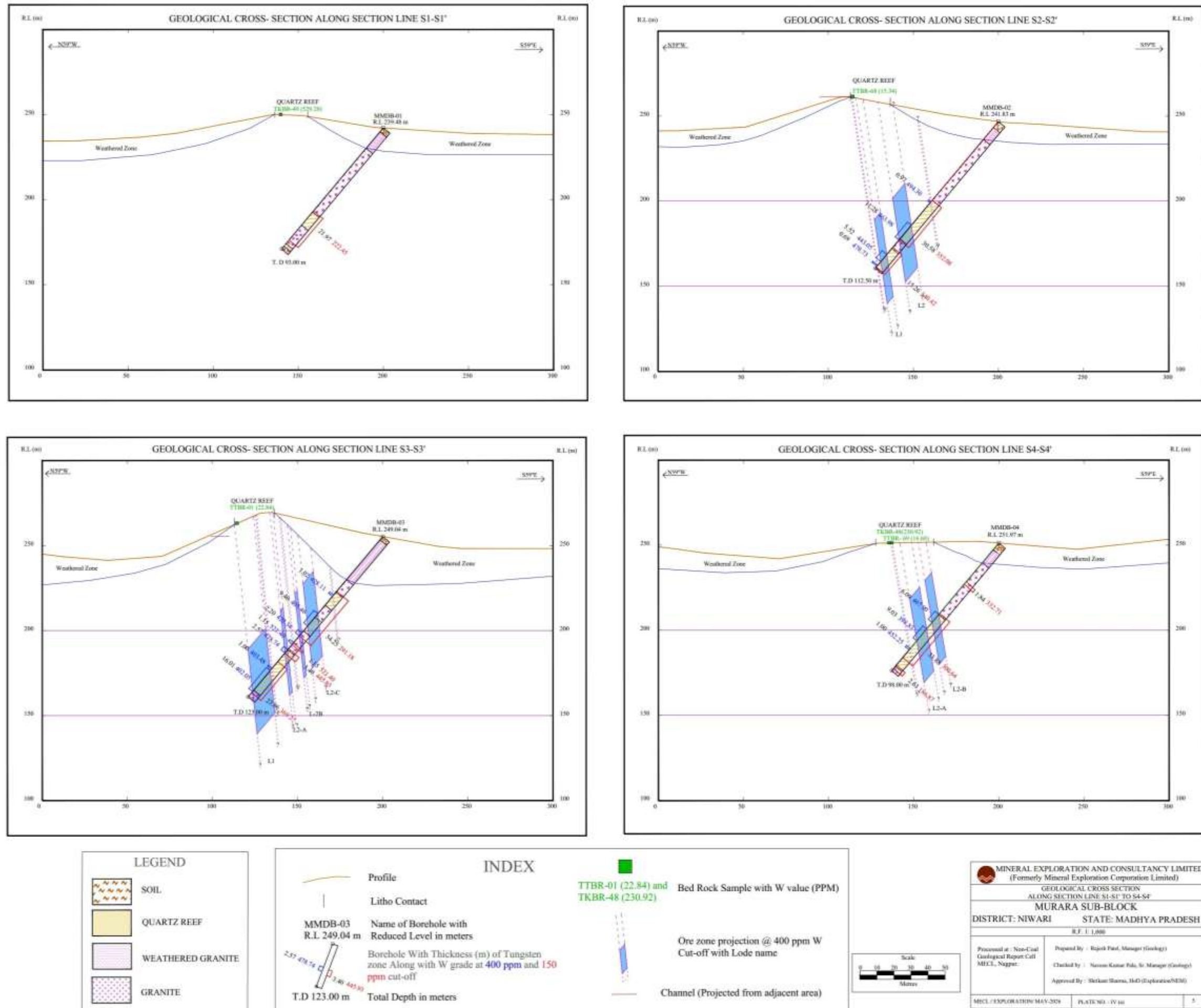
Details of Borehole wise tungsten (W) Zones demarcated at 400 PPM W cut-off in Murara-Devendrapura Block (G-3), District-Niwari, Madhya Pradesh

Borehole. No.	Intersection Depth (M)		Thickness (m)	W	Sn	Cu	Pb	Zn	Lode No.
	From	To		Calculated weighted average grade in PPM(DL=1PPM)					
MURARA SUB BLOCK									
MMDB-02	61.42	62.39	0.97	494.30	4.63	23.52	2.91	9.23	
	79.62	90.90	11.28	463.98	45.92	17.19	3.23	5.66	L-2
	102.00	107.52	5.52	443.05	<1	7.62	11.97	1.15	L-1
	111.00	111.69	0.69	478.73	<1	10.87	6.94	5.08	
MMDB-03	45.00	46.02	1.02	428.11	<1	11.83	<1	1.73	
	59.27	68.67	9.40	405.46	<1	11.78	27.92	2.59	L-2C
	74.05	76.25	2.20	429.34	<1	8.20	8.07	10.93	L-2B
	81.55	82.70	1.15	521.40	<1	12.12	5.52	4.41	
	86.83	89.40	2.57	478.74	<1	15.26	6.01	<1	L-2A
	101.00	102.00	1.00	403.48	<1	12.61	1.74	<1	
	102.99	119.00	16.01	402.05	<1	14.54	8.35	6.84	L-1
MMDB-04	54.92	61.01	6.09	467.90	<1	4.27	2.04	1.50	L-2B
	65.99	75.02	9.03	398.83	<1	13.61	17.53	4.25	L-2A
	80.98	81.98	1.00	452.25	<1	3.61	3.18	5.03	
MMDB-09	57.56	58.46	0.90	409.63	1.04	13.53	16.13	24.55	
	80.00	80.75	0.75	504.54	<1	180.93	282.51	1.09	
	82.28	82.75	0.47	471.38	<1	15.52	43.24	10.66	
	117.32	119.33	2.01	509.43	<1	25.83	50.44	11.75	L-3A
DEVENDRAPURA SUB BLOCK									
MMDB-08	81.91	84.73	2.82	397.84	<1	2.59	20.86	5.58	L-3C
	137.40	138.33	0.93	411.60	2.97	20.60	10.40	73.76	
	142.15	143.10	0.95	440.66	4.82	1.72	2.76	0.90	
MMDB-11	39.75	40.72	0.97	438.39	<1	18.98	3.37	<1	
	71.00	72.00	1.00	416.40	<1	8.61	<1	<1	
	78.00	79.00	1.00	425.73	<1	2.93	1.37	<1	
	82.05	83.03	0.98	422.14	<1	10.03	3.99	<1	

19.7.0 METHODOLOGY ADOPTED IN CROSS-SECTION METHOD OF RESOURCE ESTIMATION

19.7.1 Following methodologies have been adopted while computation of tungsten (W) resource by Geological Cross-Section Method.

1. Based on the interpretation of surface and sub-surface geological data i.e., litho-units on surface and intersected in the boreholes, 11nos of Geological Cross Sections serially numbered from south to north as S1-S1' to S11-11' (7 nos in Murara and 4 nos in Devendrapura sub block), perpendicular to general strike of the mineralized zones/quartz reefs have been drawn.
2. The cross-sections have been prepared by marking topography profile along the section line and plotting of surface geology as well as subsurface geology from boreholes along with the borehole data (lithology, nomenclature, thickness and analytical data of tungsten mineralisation). The zones delineated at required cut-off have plotted along the section lines with appropriate position, dip angle and thickness intersected in the boreholes and the nomenclature, thickness and qualitative data of zones have been assigned along the same. The geological cross section is mentioned in Plate-IV a, b & c and text fig-5 shows representative sections of Murara-sub block.
3. The area measurements were made with the help of computer aided Autodesk Auto CAD Map 3D 2026 software.
4. The area of influence was summed up to arrive at the total area for the cross-section.
5. Thus, the area obtained was multiplied by cross sectional influence (strike influence) to obtain the sectional volume.
6. After obtaining section wise volume, each was multiplied by the specific gravity (2.67) to arrive at the resource in tonnes.
7. Thus, the sum of cross-sectional resource is the total geological gross in-situ resource.



Text Figure. - 6

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

- 19.8.1 The resource estimation has been controlled through geological interpretation based on lithological continuity, structural disposition, borehole intersections and sectional correlation of mineralized zones. The lodes have been delineated through geological cross-sections prepared perpendicular to the strike direction of mineralisation.
- 19.8.2 The interpreted mineralized lodes demonstrate continuity within the influence areas considered for estimation. However, the present level of exploration corresponds to inferred category and additional drilling may further refine the geological model.

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

- 19.9.1 The analytical data generated from the borehole samples do not exhibit erratic or extreme outlier values. The grade distribution pattern of tungsten mineralisation appears reasonably consistent within the mineralized lodes. Therefore, no grade cutting or capping has been applied during resource estimation.

19.10.0 GEOSTATISTICAL METHODS DETAIL

- 19.10.1 No geostatistical method has been applied for resource estimation in the Murara–Devendrapura Block due to limited exploratory data and wide borehole spacing. The resource estimation has therefore been carried out using Geological Cross-Section Method suitable for the present stage of exploration.

19.11.0 DATA VERIFICATION AND/OR VALIDATION PROCEDURES USED

- 19.11.1 Site visits have been undertaken by the authorised persons during survey, core drilling, logging and core sampling. The survey reference/ benchmark points, accuracy levels, softwares used in data analysis and contour extrapolations etc. have been verified during the exploration as well as report preparation. The established facilities present at core drilling, sample collection and preparation, sample logging and sample storage centre were examined and satisfied. The core drilling, logging, sampling and analytical data obtained was verified and corrections were applied wherever necessary. Core recovery percentages reported in fragmentary and powdery type ores were again verified and proper corrections applied. The raw data from laboratory tests were verified for completeness and was then compiled, processed and assessed for use in mineral resource estimation. The sectional interpretations and resource calculations were verified through computer-aided methods and cross-checked for consistency. The analytical data is saved in digital format as a geological database.

CHAPTER 20

REPORTING OF RESOURCES

20.1.0 RESOURCE ESTIMATION BY GEOLOGICAL CROSS-SECTION METHOD

20.1.1 Following parameters have been adopted while computation of tungsten resource estimation by Geological Cross-Section Method:

20.2.0 IDENTIFICATION OF MINERALIZED LODES

20.2.1 The tungsten mineralized zones were delineated based on detailed geological mapping, surface evidences, borehole intersections, geochemical analytical data and sectional correlation of quartz reef hosted mineralisation.

20.2.2 The mineralisation is mainly associated with NE–SW trending quartz reefs, quartz veins and hydrothermally altered granite/quartz–granite contact zones occurring within the Murara–Devendrapura Block of Bundelkhand Craton.

20.2.3 On the basis of continuity of lithology, analytical values and sectional interpretation, the mineralized zones have been grouped into different lodes namely Lode-1, Lode-2, Lode-2A, Lode-2B, Lode-2C, Lode-3A and Lode-3C.

20.2.4 The mineralisation exhibits discontinuous to moderately persistent nature and is structurally controlled within fractured, altered and brecciated quartz reef systems.

20.3.0 PREPARATION OF GEOLOGICAL CROSS-SECTIONS AND DATA INTEGRATION

20.3.1 Geological cross-sections were prepared by integrating data generated from geological mapping, core drilling, lithological logging and chemical analytical results.

20.3.2 A total of 11 geological cross-sections serially numbered from S1-S1' to S11-S11' were prepared approximately perpendicular to the general strike of the mineralized quartz reefs.

20.3.3 The lithological contacts, quartz reef intersections, mineralized zones and analytical values obtained from borehole samples were plotted on the geological sections for interpretation of mineralized lodes.

20.3.4 The area of mineralized zones was calculated section-wise from interpreted geological cross-sections and the geological resources were estimated by Geological Cross-Section Method.

20.4.0 CUT-OFF FOR TUNGSTEN MINERALISATION

20.4.1 The tungsten mineralized zones were evaluated considering a threshold value of 150 ppm W.

20.4.2 Resource estimation has been carried out considering 400 ppm tungsten (W) as cut-off grade for delineation of economically significant tungsten mineralisation.

20.5.0 RESOURCE ESTIMATION PARAMETERS

20.5.1 The tungsten-bearing lodes intersected in boreholes MMDB-02, MMDB-03, MMDB-04, MMDB-08 and MMDB-10 have been considered for resource estimation.

20.5.2 The strike influence for resource estimation has been considered up to the mid-point on either side of the section line between successive boreholes.

20.5.3 In case of terminal sections, strike influence has been considered up to the midpoint of adjacent section and 25 m beyond the end section in order to minimise overestimation.

20.5.4 For vertical continuity of mineralized lodes, the up-dip influence has been considered 25 m above the borehole intersection and the down-dip influence has been considered 25 m below the borehole intersection.

20.5.5 The mineralized zones below minimum workable thickness (2m) have been utilised only for correlation purpose and have not been considered for resource estimation.

20.6.0 GRADE AND THICKNESS CONSIDERATIONS

20.6.1 The weighted average tungsten grade of each mineralized zone has been determined from chemical analytical data of borehole core samples.

20.6.2 Systematic core sampling was carried out generally at 1 m interval within continuous quartz reef intersections, whereas closer sampling intervals of less than 1 m were adopted in zones showing scheelite fluorescence under short-wave UV light.

20.6.3 Considering the underground mining potential of the block, a minimum workable thickness/minimum stoping width of 2.00 m has been adopted for resource estimation.

20.7.0 SPECIFIC GRAVITY ASSUMPTION

20.7.1 A specific gravity value of 2.67 has been adopted for resource estimation based on laboratory analysis of representative samples collected from tungsten-bearing mineralized quartz reef zones.

20.8.0 MINING CONSIDERATIONS

20.8.1 The present resource estimation has been carried out considering the subsurface persistence of tungsten-bearing quartz reef systems and their potential for future underground mining operations.

20.8.2 The mineralization is interpreted as low- to moderate-grade hydrothermal tungsten mineralization associated with quartz reef systems and hydrothermally altered granitoids.

20.9.0 RESOURCES

20.9.1 The tungsten resource of Murara–Devendrapura Block has been estimated at 400 ppm W cut-off based on the specifications and assumptions enumerated in Para 20.1.0. The resource has been estimated under G-3 stage of exploration.

20.9.2 The summary of the resources showing section wise, borehole wise and lode wise estimated by geological cross section method at 400ppm W cut-off and minimum stoping width of 2m in Murara-Devendrapura Block (G-3), District-Niwari, Madhya Pradesh is given in Annexure-VIII-A and table 20.1.

Table-20.1

Summary of resources estimated by geological cross section method at 400ppm W cut-off in Murara-Devendrapura Block (G-3), District-Niwari, Madhya Pradesh

RESOURCE CALCULATION OF MURARA SUB BLOCK							
Section No.	Borehole No.	Lode Name	Area (Sq.m)	Length of Influence (m)	Specific Gravity	Total Resource (Tons)	Weighted average grade of W in PPM
S2-S2'	MMDB-02	Lode-1	205.8481	182.06	2.67	100062.803	443.05
S2-S2'	MMDB-02	Lode-2	420.2307	182.06	2.67	204274.227	463.98
S3-S3'	MMDB-03	Lode-1	581.5795	183.61	2.67	285112.778	402.05
S3-S3'	MMDB-03	Lode-2A	90.7781	183.61	2.67	44502.938	478.74
S3-S3'	MMDB-03	Lode-2B	82.6695	183.61	2.67	40527.788	429.34
S3-S3'	MMDB-03	Lode-2C	336.8789	183.61	2.67	165151.074	405.46
S4-S4'	MMDB-04	Lode-2A	344.1933	125.00	2.67	114874.514	398.83
S4-S4'	MMDB-04	Lode-2B	228.8035	125.00	2.67	76363.168	467.90
TOTAL						1030869.290	427.75
Resource in Million tonnes (Murara-Sub Block)						1.031	427.75
RESOURCE CALCULATION OF DEVENDRAPURA SUB BLOCK							
S9-S9'	MMDB-08	Lode-3C	91.3833	221.76	2.67	54106.759	397.84
S10-S10'	MMDB-10	Lode-3A	68.8126	290.29	2.67	53334.051	509.43
TOTAL						107440.810	453.23
Resource in Million tonnes (Devendrapura-Sub Block)						0.107	453.23
Total Combined Resources (G3) of Murara and Devendrapura Sub Blocks (i.e Murara-Devendrapura Block) in million tonnes (MT)						1.138	430.16

20.9.3 The section-wise resource estimation of Murara sub block indicates that Section S3-S3' contributes the highest share of the mineral resource constituting about 51.93% of the total estimated resource of the Murara sub block. Details are mentioned in table no. 20.2. The section-wise resource estimation of Devendrapura sub block is given in table no. 20.3.

Table – 20.2

Section -wise Resource of Murara Sub block			
Section No.	Total Resource (Tons)	Grade (W in PPM)	Resource (%)
S2-S2'	304337.030	457.10	29.52
S3-S3'	535294.578	411.54	51.93
S4-S4'	191237.682	426.41	18.55
Total:	1030869.290	427.75	100
Resource in Million tonnes (Murara-Sub Block)	1.03086929	427.75	

Table – 20.3

Section -wise Resource of Devendrapura Sub block			
Section No.	Total Resource (Tons)	Grade (W in PPM)	Resource (%)
S9-S9'	54106.75886	397.84	50.36
S10-S10'	53334.05099	509.43	49.64
Total	107440.810	453.23	100.00
Resource in Million tonnes (Devendrapura-Sub Block)	0.10744081	453.23	

20.9.4 The combined resource estimation of Murara and Devendrapura sub blocks indicates continuity of tungsten-bearing hydrothermal quartz reef systems within the Murara–Devendrapura Block. Statement showing section wise resource estimated by geological cross section method at 400ppm W cut-off and minimum stoping width of 2m in Murara-Devendrapura Block (G-3), District-Niwari, Madhya Pradesh is given in Annexure-VIII-B.

20.9.5 **Borehole-wise resource statement of Murara sub block** indicates that significant tungsten mineralisation is associated with multiple lodes within the quartz reef systems of the Murara sub block. The maximum contribution to resource comes from boreholes MMDB-03 and MMDB-02. The estimated weighted average grade of the total mineral resource in the **Murara sub block** is about 427.75 ppm W. Details are mentioned in table no. 20.4.

Table – 20.4

Borehole-wise Resource Estimation of Murara Sub Block

Borehole No.	Section No.	Total Resource (Tons)	Grade (W in PPM)	Resource (%)
MMDB-02	S2-S2'	304337.03	457.10	29.52
MMDB-03	S3-S3'	535294.58	411.54	51.93
MMDB-04	S4-S4'	191237.68	426.41	18.55
TOTAL		1030869.29	427.75	100
Resource in Million tonnes		1.031	427.751	

20.9.6 **Borehole-wise resource statement of Devendrapura sub block** indicates that significant tungsten mineralisation is associated with only two boreholes MMDB-08 and MMDB-10 within the quartz reef systems of Devendrapura sub block. The estimated weighted average grade of the total mineral resource in the **Devendrapura sub block** is about 453.23ppm W. Details are mentioned in table no. 20.5

Table – 20.5

Borehole-wise Resource Estimation of Devendrapura Sub Block

Borehole No.	Section No.	Total Resource (Tons)	Grade (W in PPM)	Resource (%)
MMDB-08	S9-S9'	54106.76	397.84	50.3596
MMDB-10	S10-S10'	53334.05	509.43	49.6404
TOTAL		107440.8	453.23	100
Resource in Million tonnes		0.107	453.23	

20.9.7 **The lode-wise resource estimation of Murara Sub Block** indicates that Lode-1 contributes the maximum share of the total inferred resource accounting for about 37.36% of the total resource, followed by Lode-2 and associated subsidiary lodes. Lode-2 records comparatively higher weighted average tungsten grade of about 463.98

ppm W, whereas Lode-2B also exhibits encouraging grade values of about 454.53 ppm W. The Statement showing lode wise resource estimated by geological cross section method at 400ppm W cut-off and minimum stoping width of 2m in Murara-Devendrapura Block (G-3), District-Niwari, Madhya Pradesh is given in Annexure-VIII-C. Details of lode wise resources of Murara sub block is mentioned in table no. 20.6

Table – 20.6
Lode-wise Resource Estimation of Murara Sub Block

Lode Name	Total Resource (Tons)	Grade (W in PPM)	Resource (%)
Lode-1	385175.58	412.70	37.364
Lode-2	204274.23	463.98	19.816
Lode-2A	159377.45	421.14	15.460
Lode-2B	116890.96	454.53	11.339
Lode-2C	165151.07	405.46	16.021
Total:	1030869.29	427.75	100
Resource in Million tonnes (Murara-Sub Block)	1.031		

20.9.8 The lode-wise resource estimation of Devendrapura sub block indicates that Lode-3A contributes the maximum share of the total inferred resource accounting for about 50.36% of the total resource, followed by Lode-3C. Details are mentioned in table no. 20.7.

Table – 20.7
Lode-wise Resource Estimation of Devendrapura Sub Block

Lode Name	Total Resource (Tons)	Grade (W in PPM)	Resource (%)
Lode-3A	53334.05099	509.43	50.360
Lode-3C	54106.75886	397.84	49.640
Total:	107440.8098	453.2337257	100
Resource in Million tonnes (Devendrapura-Sub Block)	0.107		

20.9.9 In summary, the resource estimation based on geological mapping, drilling, sectional interpretation and analytical results, the total inferred geological resource (333

category) estimated for the Murara–Devendrapura Block at G-3 stage of exploration is as follows in table 20.8

Table – 20.8
Summary of Inferred Geological Resources (333 Category) of
Murara–Devendrapura Block

Sub Block	Resource (Million Tonnes)	Average Grade (W in ppm)
Murara Sub Block	1.031	427.75
Devendrapura Sub Block	0.107	453.23
Total Combined Resource	1.138	430.16

- 20.9.10 The resource estimation indicates encouraging potential for further detailed exploration. The mineralisation remains open along strike and at depth in several sectors and warrants closer spaced drilling and detailed exploration at G-2 stage for improved delineation of grade continuity and resource confidence.
- 20.9.11 The absence of visible tungsten ore minerals and sparse scheelite fluorescence, coupled with encouraging geochemical analytical results, suggests that tungsten occurs mainly in finely disseminated, amorphous or lattice-bound form within hydrothermally altered quartz reef systems.

20.10.0 CATEGORIZATION OF RESOURCE

- 20.10.1 The tungsten resources of Murara–Devendrapura Block have been categorised under Inferred Mineral Resource (333) category as per the United Nations Framework Classification (UNFC) and Minerals (Evidence of Mineral Contents) Rules, 2015.
- 20.10.2 The present categorisation is based on G-3 stage exploration involving geological mapping, borehole drilling, core sampling, analytical studies and sectional interpretation. Further close-spaced drilling and detailed exploration may upgrade the resource to higher confidence categories.

CHAPTER - 21

SUMMARY AND RECOMMENDATIONS

21.1.0 SUMMARY

A DISCUSSION ON THE OUTCOME OF THE EXPLORATION WORK DETAILING THE NATURE OF THE DEPOSIT, THE DIMENSION OF THE DEPOSIT, GENERAL STRUCTURAL TREND, DEPTH OF OCCURRENCE AND DEPTH UP TO WHICH EXPLORATION HAS BEEN DONE, POSSIBILITY OF CONTINUITY OF MINERALISATION BEYOND THE DEPTH OF EXPLORATION AND FUTURE EXPLORATION REQUIREMENTS, IF ANY

- 21.1.1 The Murara–Devendrapura Block (G-3), District–Niwari, Madhya Pradesh, covering an area of about 4.16 km², was taken up for Preliminary Exploration (G-3) for tungsten and associated minerals under the NMET programme. The block represents an upgraded/carved-out portion of the earlier Tarichar Khurd (G-4) exploration block, where encouraging tungsten values and scheelite occurrences under short-wave (254nm wavelength) UV light were reported from quartz reef systems near Murara and Devendrapura villages.
- 21.1.2 The present exploration programme was undertaken with the principal objectives of establishing the strike and depth continuity of tungsten mineralisation associated with quartz reefs, delineating mineralized lodes through systematic drilling, and estimating Inferred Mineral Resources (333 category) as per UNFC and MEMC Rules, 2015.
- 21.1.3 Geologically, the block forms part of the Bundelkhand Granite-Gneissic Complex of Archean age and is predominantly occupied by granitoids intruded by prominent NE–SW trending quartz reefs. Other lithological units mapped/intersected include granodiorite, pink coloured porphyritic granite, porphyritic andesite, ferruginous quartz reef and hydrothermally altered quartz–granite mixed zones. The quartz reefs occur as elongated ridges and exhibit structural features such as brecciation, shearing, silicification, repeated fracturing and hydrothermal alteration.
- 21.1.4 Structurally, the block is characterised by prominent NE–SW to NNE–SSW trending quartz reef systems, which constitute the principal loci of hydrothermal activity and tungsten mineralisation. The reefs exhibit pinching and swelling nature, repeated brecciation, shearing and local faulting. Tungsten mineralisation is interpreted to be

structurally controlled and associated mainly with hydrothermally altered quartz reef and quartz–granite mixed zones.

- 21.1.5 During the present G-3 exploration, detailed geological mapping, trenching, short-wave ultraviolet survey, systematic core drilling, geological logging, core sampling and laboratory analytical studies were carried out. A total of 11 inclined boreholes (07 in Murara sub block and 04 in Devendrapura sub block) were drilled involving 1220.50 m of drilling against the approved target of 1250 m. The boreholes were drilled at an approximate spacing of about 200 m along the strike of the mineralized quartz reefs with an average borehole depth of about 111 m.
- 21.1.6 A total of 535 core samples and 21 trench samples were generated and analysed for W, Sn, Cu, Pb and Zn. Complete drill cores were scanned under short-wave UV light (254 nm wavelength) for identification of scheelite mineralisation. Scheelite fluorescence were observed mainly in borehole MMDB-09 in scattered and dotted form between 14 m and 42 m depth, whereas only sparse fluorescence were recorded in borehole MMDB-06. No visible wolframite mineralisation was observed in the block.
- 21.1.7 Integrated evaluation of geological, geochemical, mineragraphic and XRD studies indicates that tungsten mineralisation in the block is predominantly present in finely disseminated, amorphous or lattice-bound form within hydrothermally altered quartz reef systems. The mineralisation is generally low- to moderate-grade in nature with localised higher-grade enriched zones. Sparse sulphide mineralisation represented by pyrite, chalcopyrite, covellite, digenite and trace scheelite has also been recorded within altered reef zones.
- 21.1.8 The tungsten mineralisation is predominantly associated with NE–SW trending quartz reef systems and adjoining quartz–granite mixed zones. Broad mineralized zones delineated at 150 ppm W threshold show apparent thickness ranging from less than 1 m to more than 34 m, whereas higher-grade zones delineated at 400 ppm W cut-off generally vary from less than 1 m to about 16 m thickness. The mineralisation occurs mainly within fractured, silicified and hydrothermally altered portions of quartz reefs.
- 21.1.9 Resource estimation has been carried out by Geological Cross-Section Method considering 400 ppm W cut-off grade and minimum workable thickness of 2.0 m. A specific gravity value of 2.67 has been adopted based on laboratory determination of

representative mineralized samples. Resource estimation was based on geological mapping, borehole intersections, sectional interpretation and analytical data generated during the present investigation.

- 21.1.10 The mineralized body has been delineated as multiple quartz reef or lode zones interpreted on 11 geological cross-sections, numbered S1-S1 to S11-S11, of which 7 sections lie in Murara Sub-block and 4 sections in Devendrapura Sub-block. For resource estimation, strike continuity was considered up to the midpoint between successive sections, with terminal influence extended by 25 m beyond end sections, while vertical continuity was considered 25 m above and 25 m below the borehole intersections. Mineralized zones below the minimum workable thickness of 2.00 m were used only for correlation and were not considered for resource estimation.
- 21.1.11 Based on the present G-3 stage exploration, the total Inferred Geological Resource (333 category) estimated in Murara–Devendrapura Block at 400 ppm W cut-off is about 1.138 million tonnes with an average grade of about 430.16 ppm W. Out of this, Murara sub block accounts for about 1.031 million tonnes with average grade of 427.75 ppm W, whereas Devendrapura sub block accounts for about 0.107 million tonnes with average grade of 453.23 ppm W.
- 21.1.12 Resource estimation indicates that significant tungsten mineralisation is associated with multiple lodes within the Murara sub block and with two principal lodes in the Devendrapura sub block. Lode-1 and Lode-2 systems of Murara sub block contribute the major share of the estimated resource, whereas Lode-3A and Lode-3C constitute the principal mineralized lodes in Devendrapura sub block.
- 21.1.13 The sparse occurrence of visible tungsten ore minerals and limited scheelite fluorescence, together with encouraging analytical results, suggest that tungsten is present largely in finely disseminated, amorphous or lattice-bound form within the altered quartz reef system.
- 21.1.14 The present drilling programme has established continuity of tungsten mineralisation up to the first-level intersections of the quartz reef systems. The upper limit of mineralisation generally commences below thin soil/weathered cover, whereas the lower limit of mineralisation has not been conclusively established because of limited depth persistence drilling at G-3 stage. The mineralisation remains open both along

strike and at depth in several sectors of the block, indicating encouraging potential to justify further detailed exploration for better delineation of grade continuity, ore geometry and depth persistence.

21.2.0 RECOMMENDATIONS

- 21.2.1 The present G-3 stage exploration has established the occurrence of structurally controlled hydrothermal tungsten mineralisation associated with quartz reef systems in the Murara–Devendrapura Block. The encouraging analytical results, continuity of mineralized lodes and estimated inferred resources indicate good potential for further detailed exploration in the block.
- 21.2.2 It is recommended that the block may be taken up for General Exploration (G-2 stage) with closer spaced drilling on approximately 100 m × 100 m or closer grid pattern in the mineralized sectors of Murara and Devendrapura Sub Blocks for upgrading the resource confidence from Inferred (333) to Indicated category (332).
- 21.2.3 Additional boreholes should be planned along strike and dip continuity of the mineralized quartz reefs to establish depth persistence, continuity of higher-grade shoots and structural controls of tungsten mineralisation. Particular emphasis should be given to the Lode-1 and Lode-2 systems in Murara Sub Block and Lode-3A and Lode-3C in Devendrapura Sub Block.
- 21.2.4 Second-level drilling is recommended below the present borehole intersections to establish the down-dip and depth continuity of tungsten mineralisation beyond the presently explored levels. Deeper boreholes should be planned in promising mineralized lodes, particularly in sectors where mineralisation remains open at depth, for assessing persistence of ore shoots and for delineation of additional resources at deeper levels.
- 21.2.5 Mechanised extensive close-spaced channel sampling should be carried out systematically over all exposed quartz reef zones and associated hydrothermally altered portions for proper delineation of mineralized zones and continuity of tungsten values on surface and along strike.
- 21.2.6 Since the tungsten mineralisation appears to be structurally controlled and associated with fractured, sheared and hydrothermally altered zones, the complete core of all drilled boreholes should be sampled and analysed irrespective of lithology intersected, so as to properly evaluate concealed and disseminated mineralisation occurring beyond visually identifiable quartz reef zones.

- 21.2.7 SEM–EDX (Scanning Electron Microscope–Energy Dispersive X-ray) studies should be carried out on representative mineralized samples for detailed identification of elemental composition and characterisation of tungsten-bearing phases while visualising their microstructural features. Such studies may help in understanding the mode of occurrence of tungsten mineralisation, association with gangue/sulphide minerals and its beneficiation characteristics.
- 21.2.8 Further detailed mineralogical, beneficiation and metallurgical studies are also recommended to evaluate the mode of occurrence, recoverability and economic feasibility of tungsten mineralisation, particularly because tungsten appears to occur mainly in finely disseminated or amorphous form within altered quartz reef systems.

CHAPTER - 22

PLATES AND MAPS

- 22.1.0** Location Map of Murara-Devendrapura Block (G-3), District- Niwari, Madhya Pradesh is given as Plate-I.
- 22.2.0** Regional Geological Map with location of Murara-Devendrapura Block (G-3), District- Niwari, Madhya Pradesh is given as Plate-II.
- 22.3.0** Topographical and Geological Map of Murara Sub-Block, District- Niwari, Madhya Pradesh is given as Plate-III (a).
- 22.4.0** Topographical and Geological Map of Devendrapura Sub-Block Block, District- Niwari, Madhya Pradesh is given as Plate- III (b).
- 22.5.0** Geological Cross section along section line S1, S2, S3 & S4 of Murara Sub Block, District- Niwari, Madhya Pradesh is given as Plate- IV (a).
- 22.6.0** Geological Cross section along section line S5, S6 & S7 of Murara Sub Block, District- Niwari, Madhya Pradesh is given as Plate- IV (b).
- 22.7.0** Geological Cross section along section line S8, S9, S10 & S11 of Devendrapura Sub Block, District- Niwari, Madhya Pradesh is given as Plate- IV (c).
- 22.8.0** Geological Cross section along section line S8, S9, S10& S11 of Devendrapura Sub Block, District- Niwari, Madhya Pradesh is given as Plate- IV (c).
- 22.9.0** Level Plan at 150 mRL of Murara Sub Block, District-Niwari, Madhya Pradesh is given as Plate- VI (a).
- 22.10.0** Level Plan at 200 mRL of Devendrapura Sub Block, District-Niwari, Madhya Pradesh is given as Plate- VI (b).

CHAPTER - 23

ANNEXURES / ENCLOSURES TO THE REPORT

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

CHAPTER - 24

ANY OTHER INFORMATION

24.1.0 There is no additional information available in the block.

CHAPTER - 25

CERTIFICATE FROM THE QUALIFIED PERSON WITH NAME, DATE AND SIGNATURE

25.1.0 CERTIFICATION

This is to certify that the Geological Report on Preliminary Exploration (G-3 Stage) for Tungsten and Tin Ore in Murara–Devendrapura Block, District: Niwari, State: Madhya Pradesh has been prepared by Mineral Exploration and Consultancy Limited (MECL) on behalf of National Mineral Exploration Trust (NMET), Ministry of Mines, Government of India.

The report presents the results of geological mapping, drilling, sampling, laboratory analysis and resource estimation carried out during the G-3 stage exploration programme. The report has been prepared in accordance with the provisions of the Minerals (Evidence of Mineral Contents) Rules, 2015 under the Mineral (Auction) Rules, 2015 and amendments made thereto from time to time.

The geological, geochemical, drilling and analytical data incorporated in this report truly represent the findings of the exploration work carried out in the block and the mineral resources have been estimated following the UNFC guidelines prescribed by the Ministry of Mines, Government of India.

NAME: **SHRIKANT SHARMA**

DESIGNATION: **HoD (EXPLORATION/NEM)**

DATE:

LOCALITY INDEX

Locality/Village	Latitude(Y)	Longitude(X)
	UTM (m)/Zone 44	
Asati Khas	2809643	283778
Devendrapura	2809374	281934
Murara	2806720	282038
Niwari	2805234	278894
Niwari Tigela	2807578	279893

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ABBREVIATIONS USED

SL. No.	Abbreviation	Full form
1	AAS	Atomic Absorption Spectroscopy
2	BIFs	Banded Iron Formations
3	BGC	Bundelkhand gneissic complex
4	BDL	Below Detection Limit
5	BMM	Bundelkhand metasedimentary and metavolcanics
6	CORS	Continuous operating reference system
7	Cu m	Cubic Metre
8	DL	Detection Limit
9	DGPS	Differential Global Positioning System
10	DMS	Degree Minute Second
11	EC	Executive Committee
12	Ext. thickness	Extrapolated Thickness
13	F.S.P.	Field Season Programme
14	GSI	Geological Survey of India
15	IBM	Indian Bureau of Mines
16	ICP-MS	Inductively Coupled Plasma Mass Spectrometry
17	JNARDDC	Jawaharlal Nehru Aluminium Research Development and Design Centre
18	Km	Kilometre
19	m	Metre
20	mRL	Reduced Level in metre
21	MIC	Madawara igneous complex
22	MSL	Mean Sea Level
23	MMDR	Mines & Minerals (Development and Regulation)
24	MEMC	Minerals (Evidence of Mineral Contents)
25	MECL	Mineral Exploration and Consultancy Limited
26	NABL	National Accreditation Board for Testing and Calibration Laboratories
27	Nos	Numbers
28	NMET	National Mineral Exploration Trust
29	PPM	Parts Per Million
30	QA/QC	Quality Assessment/ Quality Checks
31	RL	Reduced Level
32	R.F.	Reserve Forest
33	Rec. thickness	Recovered thickness
34	Sq. Km.	Square Kilometre
35	SOI	Survey of India
36	TCC	Technical cum Cost Committee
37	TTG	Tonalite Tronjhemite Gneiss
38	UTM	Universal Transverse Mercator
39	WGS-84	World Geodetic System-84
40	Rec. thickness	Recovered thickness
41	Ext. thickness	Extrapolated Thickness