

**GEOLOGICAL REPORT ON RECONNAISSANCE SURVEY (G-4)
FOR QPC HOSTED GOLD AND COPPER MINERALIZATION
IN KALASAPURA BLOCK (129.00 sq.km Area)
DISTRICT- CHIKKAMAGALURU, KARNATAKA
(Under NMET Programme)
(TEXT, ANNEXURE 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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**कलसापुरा ब्लॉक में क्यूपीसी द्वारा होस्टेड स्वर्ण एवं तांबा खनिजीकरण हेतु
सर्वेक्षण (जी-4) पर भूवैज्ञानिक रिपोर्ट
(129 वर्ग किमी क्षेत्र)
जिला: चिक्कमगलुरु, कर्नाटक**

**अध्याय 1
कार्यकारी सारांश**

- 1.1.0 कलसापुरा ब्लॉक क्षेत्र दक्षिणी भारत के पश्चिमी धारवाड़ क्रेटन के बाबाबुदन शिस्ट बेल्ट का सबसे दक्षिणी भाग है। यह क्षेत्र ओलिगोमिक्टिक कांग्लोमेरेट्स (क्यूपीसी) में सोने के खनिजकरण और धारवाड़ सुपर ग्रुप के बाबाबुदन समूह से जुड़े ग्रे मैसिव कार्टजाइट्स में तांबे के खनिजकरण की उपस्थिति के लिए जाना जाता है, जैसा कि पूर्व में पिछले भू-विदों द्वारा रिपोर्ट किया गया था।
- 1.2.0 कलसापुरा ब्लॉक (129 वर्ग किमी) में सोने और तांबे के लिए आवीक्षण सर्वेक्षण (जी4) का प्रस्ताव एनएमईटी फंडिंग के तहत क्षेत्र में संभावित स्वर्णयुक्त क्यूपीसी क्षेत्रों और तांबे के खनिजकरण का पता लगाने के लिए तैयार किया गया था। एनएमईटी की 60^{वीं} टीसीसी की सिफारिशों पर, एनएमईटी की 33^{वीं} कार्यकारी समिति (ईसी) ने कार्यालय ज्ञापन एफ.सं. 23/421/2024-एनएमईटी/526, नई दिल्ली, दिनांक 27 फरवरी 2024 के तहत प्रस्ताव को मंजूरी दी।
- 1.3.0 एमईसीएल ने 16 अप्रैल, 2024 के दौरान कर्नाटक के चिक्कमगलुरु जिले के कलसापुरा ब्लॉक में सोने और तांबे के लिए सर्वेक्षण (जी4) कार्य शुरू किया और 15 सितंबर, 2024 को पूरा किया। वर्तमान कार्य में 129 वर्ग किलोमीटर क्षेत्र में बड़े पैमाने पर भूवैज्ञानिक मानचित्रण (1:12500 स्केल) शामिल है, कुल 115 नग बेडरॉक, 15 नग चैनल और 20 नग स्ट्रीम सेडिमेंट के नमूने एकत्र किए गए और पेट्रोग्राफिक और माइनरग्राफिक अध्ययनों के साथ-साथ Au, Cu, Pb, Zn, Ni, Co, Mo, Se और Te का विश्लेषण किया गया।
- 1.4.0 इस क्षेत्र की चट्टान संरचनाएं प्री- कैम्ब्रियन मेटा-सेडिमेंटरी और मेटा- ज्वालामुखी चट्टानों (धारवाड़ सुपर ग्रुप) से संबंधित हैं, जो सुपरिभाषित कोणीय असंगति के साथ ग्रे पोर्फिरीटिक ग्रेनाइट पर अप्रतिम रूप से टिकी हुई हैं। इस क्षेत्र में पाए जाने वाले प्रमुख चट्टान प्रकार हैं ग्रेनाइट, कार्टज पेबल कांग्लोमेरेट (क्यूपीसी),

कार्टजाइट/फ्यूचसाइट कार्टजाइट, एम्फीबोलाइट/क्लोरीटिक शिस्ट, मेटा गैब्रो, गैब्रो डाइक और कार्टज वेन्स/रीप्स।

- 1.5.0 क्यूपीसी में कार्टजाइट के गोल कंकड़ होते हैं जो कार्टजोज मैट्रिक्स में सेट होते हैं। मैट्रिक्स में काफी मात्रा में फ्यूचसाइट और फैले हुए पाइराइट के बारीक दाने होते हैं। मुख्य रूप से क्यूपीसी में पाए जाने वाले सल्फाइड खनिज (पाइराइट, चाल्कोपीराइट), कार्टजाइट/फ्यूचसाइट कार्टजाइट और कार्टज वेन्सों से जुड़े एम्फीबोलाइट/क्लोराइट शिस्ट।
- 1.6.0 बड़े पैमाने पर मानचित्रण के दौरान, कार्टज पेबल कांग्लोमेरेट (क्यूपीसी) क्षेत्र के भीतर E-W दिशा में रेखिक बैंडों को मैप किया गया। एकल क्यूपीसी बैंड की नतिलंब लंबाई 430 मीटर से 6330 मीटर तक भिन्न होती है। क्षेत्र से एक्सपोजर/आउटक्रॉप के दौरान नियमित अंतराल पर क्यूपीसी क्षितिज (मैट्रिक्स/पेबली/मिश्रित क्षितिज) से कुल 72 बेडरॉक चिप नमूने एकत्र किए गए। कुल 72 बेडरॉक नमूनों में से, 6 क्यूपीसी नमूनों में कार्तिकिरे के पूर्व, देवगोंडानहल्ली के दक्षिण-पश्चिम और कलसापुरा के दक्षिण-पश्चिम में 0.10 पीपीएम से 0.45 पीपीएम एयू तक सोने का मान दिखाया गया। क्यूपीसी में सोने के मान उत्साहजनक नहीं हैं।
- 1.7.0 कार्टज पेबल कांग्लोमेरेट (क्यूपीसी) में सोने की कम सांद्रता कई भूवैज्ञानिक और भू-रासायनिक कारकों के कारण हो सकती है जैसे कि सोने से भरपूर स्रोत चट्टानों की कमी, तलछटी परिस्थितियाँ, सोने के जाल की कमी और क्यूपीसी जमाव का समय। इस क्षेत्र में उपयुक्त सोने के हरे पथरों की अनुपलब्धता जो इन प्राचीन समूहों की तुलना में बहुत बाद में विकसित हुई, इसलिए शायद क्यूपीसी में महत्वपूर्ण सोने की मात्रा नहीं है।
- 1.8.0 कनिवेहल्लि क्षेत्र के पश्चिम में, रेलवे कटिंग सेक्शन में उजागर हुई पतली कार्टज वेन्सों से जुड़े एम्फीबोलाइट/क्लोराइटिक शिस्टोज चट्टान में छिटपुट कॉपर सल्फाइड खनिजकरण देखा गया। सामान्य तौर पर, सल्फाइड क्षेत्र पूर्व-पश्चिम से उत्तरउत्तरपश्चिम-दक्षिणदक्षिणपूर्व दिशा की ओर है और रेलवे ट्रैक के साथ लगभग 900 मीटर की संचयी लंबाई में दक्षिण से दक्षिणपूर्व की ओर 20° से 70° तक नति है। क्षेत्र से एकत्र किए गए कुल 12 बीआरएस नमूनों में Cu मान 138.20 पीपीएम से 5900 पीपीएम Cu तक दिखाया गया है। 3 बीआरएस नमूनों में उच्च Cu मान 561 पीपीएम से 5900 पीपीएम Cu तक दिखाया गया है। रेलवे कटिंग सेक्शन में उजागर एम्फीबोलाइट/क्लोराइटिक शिस्ट चट्टान से एकत्र किए गए कुल 6 चैनल/ग्रोव नमूनों में उच्च Cu मान 634.36 से 1800 पीपीएम तक दिखाया गया है। रेलवे ट्रैक सेक्शन के

साथ-साथ बेडरॉक/चैनल नमूनों में तांबे के लिए उच्च असामान्य मान रिपोर्ट किए गए हैं। तांबे के लिए भू-रासायनिक स्ट्रीम सेडिमेंट विसंगतियाँ भी कनिवेहल्ली क्षेत्र के आसपास एकत्र सतह के नमूनों के साथ मेल खाती हैं।

- 1.9.0 बेडरॉक और चैनल नमूनों के विश्लेषण के आधार पर, तांबे के खनिजकरण के लिए 2.3 वर्ग किलोमीटर से अधिक का एक संभावित क्षेत्र (क्षेत्र-1) कनिवेहल्ली के पश्चिम में चिह्नित किया गया है। स्काउट ड्रिलिंग और संबंधित ट्रेडिंग कार्य खनिजकरण की उप-सतह गहराई निरंतरता की पुष्टि करने में सहायक होंगे। हालांकि, संभावित क्षेत्र से गुजरने वाली रेलवे लाइन आगे के गवेषण करने में मुख्य बाधा है।
- 1.10.0 25 और 26 नवंबर, 2024 को आयोजित 71^{वीं} टीसीसी बैठक में वीडियो कॉन्फ्रेंसिंग के माध्यम से प्रस्तुत किए गए कार्य (चरण-I) के परिणाम। यह माना गया कि संभावित क्षेत्र रेलवे ट्रैक के बहुत करीब है और इस क्षेत्र में आगे के गवेषण के लिए बाद में व्यवहार्यता संबंधी समस्याएं उत्पन्न हो सकती हैं। उपरोक्त को देखते हुए, टीसीसी समिति ने परियोजना को बंद करने और रिपोर्ट प्रस्तुत करने की सलाह दी।
- 1.11.0 अभी तक इस क्षेत्र में आगे कोई कार्य करने की अनुशंसा नहीं की गई है। हालांकि, कॉपर खनिजीकरण के लिए सीमांकित कनिवेहल्ली क्षेत्र (2.3 वर्ग किमी) में भविष्य में व्यवहार्यता मुद्दों की पूर्ति के अधीन आगे गवेषण की संभावना है।

**GEOLOGICAL REPORT ON RECONNAISSANCE SURVEY (G-4) FOR QPC HOSTED
GOLD & COPPER MINERALIZATION IN KALASAPURA BLOCK (129 sq.km. Area)
DISTRICT: CHIKKAMAGALURU, KARNATAKA**

**CHAPTER-I
EXECUTIVE SUMMARY**

- 1.1.0 Kalasapura block area forms the extreme southern part of the Bababudan Schist Belt of Western Dharwar craton of southern India. The area is known for incidence of gold mineralisation in oligomictic conglomerates (QPC) and copper mineralisation in grey massive quartzites associated with of Bababudan group of Dharwar super group as reported by the previous workers in the past.
- 1.2.0 The proposal for Reconnaissance Survey (G4) for Gold and Copper in Kalasapura Block (129 sq.km.) was formulated to locate the potential auriferous QPC zones and copper mineralisation in the area under NMET funding. On the recommendations of 60th TCC of NMET, 33rd Executive Committee (E.C.) of NMET approved the proposal vide Office Memorandum F.No. 23/421/2024-NMET/526, New Delhi, dated, 27th February 2024.
- 1.3.0 MECL commenced Reconnaissance survey (G4) work for Gold and Copper in Kalasapura block, District Chikkamagaluru, Karnataka during 16th April, 2024 and completed on 15th September, 2024. The present work included large scale geological mapping (1:12,500 scale) over 129 sq.km. area; total 115 nos. Bedrock, 15 nos. channel and 20 nos. stream sediment samples were collected and analysed each for Au and Cu, Pb, Zn, Ni, Co, Mo, Se & Te respectively along with petrographic and minegraphic studies.
- 1.4.0 The rock formations of the area belong to the Pre-Cambrian meta-sedimentary and meta-volcanic suits of rocks (Dharwar Super Group) resting uncomfortably over grey porphyritic granite with well-defined angular unconformity. The major rock types exposed in the area are granite, Quartz Pebble Conglomerate (QPC), Quartzite/fuchsite quartzite, Amphibolite/Chloritic schist, Meta Gabbro, Gabbro dyke and Quartz veins/reefs.

- 1.5.0 The QPC consist of well rounded pebbles of quartzite set in a quartzose matrix. The matrix consists of considerable amount of fuchsite and fine grains of disseminated pyrite. The sulphide minerals (pyrite, chalcopryite) mainly observed in QPC, Quartzite/fuchsite quartzite and amphibolite/chlorite schist associated with quartz veins.
- 1.6.0 During the course of large-scale mapping, Quartz Pebble Conglomerate (QPC) bearing linear bands trending in E-W direction mapped within the area. Strike length of individual QPC bands varies from 430m to 6330m. Total 72 nos. bedrock chip samples collected from QPC horizon (matrix/pebbly/mixed horizon) at regular intervals throughout the exposures/outcrops from the area. Out of total 72 nos. bedrock samples, 6 nos. QPC samples have shown gold values ranging from 0.10ppm to 0.45 ppm Au in East of Kartikere, SW of Devagondanahalli and SW of Kalasapura. Gold values in QPC are not encouraging.
- 1.7.0 Low concentration of gold in Quartz pebble conglomerate (QPC) may be attributed to several geological and geochemical factors such as lack of gold rich source rocks, sedimentary conditions, lack of gold traps and timing of QPC deposition. Non availability of suitable auriferous greenstones in the region which developed much later than these ancient conglomerates hence perhaps QPC not inherit significant gold content.
- 1.8.0 In west of Kanivehalli area, sporadic copper sulphide mineralisation noticed in Amphibolite/chloritic schistose rock associated with thin quartz veins exposed in Railway cutting section. In general, the sulphide zone trending E-W to NNW-SSE direction and dipping 20° to 70° towards S to SSE over a cumulative strike length of about 900m along the railway track. Total 12 nos BRS samples collected from the area show Cu value range from 138.20 ppm to 5900 ppm Cu. 3 nos BRS samples shown high Cu value range from 561 ppm to 5900ppm Cu. Total 6 nos. Channel/grove samples collected from the exposed Amphibolite/Chloritic schist rock in Railway cutting section shown high Cu values range from 634.36 to 1800 ppm. High anomalous values for copper reported in bedrock/channel samples all along the Railway track section. Geochemical stream sediments anomalies for copper also coincide with surface samples collected around Kanivehalli area.
- 1.9.0 Based on the analysis of the Bedrock and Channel samples, one potential area (Area-1) over 2.3 sq.km. for copper mineralisation has been demarcated west of Kanivehalli. Scout drilling and associated trenching work would be helpful to confirm the sub-surface depth

continuity of mineralisation. However, Railway line passing through the potential area is the main constraint to carry out further exploration.

1.10.0 The outcome of work (Phase-I) presented in 71st TCC meeting held on 25th & 26th Nov, 2024 through V.C. It was opined that the potential area is in close proximity with Railway track and may likely to pose feasibility issues later for further exploration in the area. In view of the above, the TCC committee advised to close the project and submit the report.

1.11.0 As of now no further work recommended in the area. However, demarcated Kanivehalli area (2.3 sq.km.) for Copper mineralisation hold potential for further exploration subject to fulfilment of feasibility issues in future.

CHAPTER-2

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

(To be provided separately for all the qualified persons signing of the report)

Table No 2.1
Details of exploration agency involved during exploration work

TITLE	DETAILS
(a) Name:	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)
(b) Communication Address:	Dr. Babasaheb Ambedkar Bhawan, Highland Drive Road, Seminary Hills, Nagpur-440006.
(c) Contact Mobile No:	0712-2510289, 0712-2511829
(d) E-Mail id:	cmd@mecl.gov.in gm-exploration@mecl.gov.in
(e) Qualification of Technical Personnel	M.Sc. Geology/ Applied Geology
(f) Experience:	Professionals have more than 30+ years of experience
(g) Affiliation to any organization/company, if yes, specify the name of the organization or company.	A Govt. of India Enterprise; A Miniratna-I PSE Ministry of Mines, Govt. of India

2.2.0 DETAILS OF PERSONS ASSOCIATED WITH VARIOUS ASPECTS OF EXPLORATION ASSESSMENT OF RESOURCES AND RESERVES

2.2.1 The list of personnel associated with the execution of different exploration activities carried out in Kalasapura Exploration Block (G-4), District: Chikkamagaluru, Karnataka given in the following **Table No-2.2**.

Table-2.2
List of Person(s) associated with the Exploration Work

S No.	Title	Name of the Personnel
1	Overall Guidance	Shri P. Ravindran Nair, G.M (Exploration)
2	Overall planning, Coordination & Supervision	Shri P. Ravindran Nair, G.M (Exploration) Shri Pradeep Kulkarni, Retd. D.G.M. (Exploration) Shri Mohamad Dasthageer, Manager (Geology)
3	Project Management & Field operation	Shri Anil Tiwari, Project Manager Shri Kashung Chinaoshang, Assistant Manager (Geology)
4	Physical Execution of Work	
	Geology	Shri Kashung Chinaoshang, Assistant Manager (Geology)
5	Chemical Laboratory	Shri P. Ravindran Nair GM (Exploration) Shri Rohit Sharma, Senior Manager (Chemical) Dr. Deepti Rahangdale, Manager (Chemical) Fawaz SVP, Asst. Manager (Chemical)
6	Petrographic Studies	Shri Sayantan Pal, Manager (Geology)
7	Data Processing & Documentation	Shri Mohammad Dasthageer, Manager (Geology) Shri Kashung Chinaoshang Assistant Manager (Geology) Shri Uday A. Patil, Sr. Operator (Computer) Shri N. C. Reddy, Sr. Operator (Computer)
8	Hindi Translation	Shri C.S. Tiwari, Senior Hindi Officer
9	Reprography and Printing	Shri Jagdish Thakral, Survey & Map OIC Shri. Kaushik Bhattacharya, Survey & Map Officer Shri Durgesh Devarshi, Senior Technical Assistant (S & M)

CHAPTER-3

TITLE AND OWNERSHIP

3.1.0 TITLE OF THE REPORT

GEOLOGICAL REPORT ON RECONNAISSANCE SURVEY (G-4) FOR QPC HOSTED GOLD & COPPER MINERALIZATION IN KALASAPURA BLOCK (129 sq.km. Area), DISTRICT: CHIKKAMAGALURU, KARNATAKA

Ownership: Government of Karnataka

Name of Prospector: MINERAL EXPLORATION AND CONSULTANCY LIMITED
(Formerly Mineral Exploration Corporation Limited)

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

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

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

3.2.0 DETAILS OF PERIOD OF PROSPECTING

- 3.2.1 Kalasapura block area lies in the extreme southern part Bababudan schist belt of Western Dharwar craton of southern India. The area is known for incidence of gold in the basal oligomictic conglomerates (Quartz Pebble Conglomerate) of Bababudan group. QPC hosted gold mineralisation is reported in Kartikere, Devagondanahalli and Kalasapura areas. Disseminated copper mineralisation in grey massive quartzites representing Bababudan group are also reported from Kalasapura area by previous workers in the past.
- 3.2.2 The exploration proposal for Reconnaissance Survey at G4 stage for Gold and Copper in Kalasapura Block has been formulated to locate potential auriferous zones hosted by QPC and also for copper mineralisation in the Kalasapura Block area.
- 3.2.3 DMG, Karnataka given consent to MECL for carrying out Reconnaissance survey (G-4) in Kalasapura Block vide their letter No. DMG-17013/6/2018/2021-22 dated 19.06.2021.

- 3.2.4 The proposal for Reconnaissance Survey (G4) for Gold and Copper in Kalasapura Block (129 sq.km.) was put up in the 60th meeting of Technical-cum-Cost Committee (TCC), National Mineral Exploration Trust (NMET) held on 27th & 28th December-2023, through video-conferencing at Geological Survey of India, DGCO, A-II Pushpa Bhawan, New Delhi. The proposal was technically evaluated by the TCC and recommended the proposal for approval of EC (Executive committee) of NMET.
- 3.2.5 Subsequently, the 33rd Executive Committee (E.C.) held on 19th February 2024 approved the Reconnaissance Survey (G-4) stage proposal for Kalasapura Block at an estimated exploration cost of Rs. 1,52,40,702 i.e. approximately 152.40 Lakhs, vide Office Memorandum F.No. 23/421/2024-NMET/526, New Delhi, dated, 27th February 2024 (**Annexure No. VIII**).
- 3.2.6 Accordingly, MECL initiated Reconnaissance survey (G4) work in Kalasapura block and field work commenced on 16th April, 2024 and completed on 15th September, 2024. Phase-I work including large scale geological mapping on 1:12,500 over 129 sq.km. and collection and analysis of surface samples for gold, copper and associated minerals.
- 3.2.7 Based on Bedrock and channel sample results, one potential area (2.3 sq.km.) west of Kanivehalli demarcated for copper. The findings of Geological mapping and sampling were presented in 71st TCC meeting held on 25th and 26th Nov, 2024 through V.C. However, the area is falling in close proximity with the railway line and may likely pose feasibility issue later for further exploration. In view of the above, the TCC committee advised to close the project and submit the report. No further work recommended in the area.

CHAPTER-4

DETAILS OF THE AREA UNDER STUDY

4.1.0 LOCATION OF THE BLOCK

4.1.1 The Kalasapura Block area lies in part of Survey of India Toposheet No. 48O/15, which covers an extent of 129.00 sq.km. The block lies in the jurisdiction of Chikkamagaluru District of Karnataka. Kalasapura, Neetikerahalli, Marle, Sindigeri, Hoskote, Ramanahalli, Mugulavalli, Amble, Gowdanahalli, Laximpura, Kanivehalli, Kabbigeri, etc. are the villages located in the block area. The block is bounded by latitudes 13°16'03.97" N to 13°21'37.37" N and longitudes 75°46'59.11" E to 75°59'48.48" E. The Co-ordinates of the corner points of the block area both geodetic and UTM are given in below **Table 4.1**. The location map of the block is furnished as **Text Fig No-1** as well as **Plate No-I**.

Table-4.1
Co-ordinates of Corner Points of the block boundary of Kalasapura (G-4) Block.
Chikkamagaluru District, Karnataka

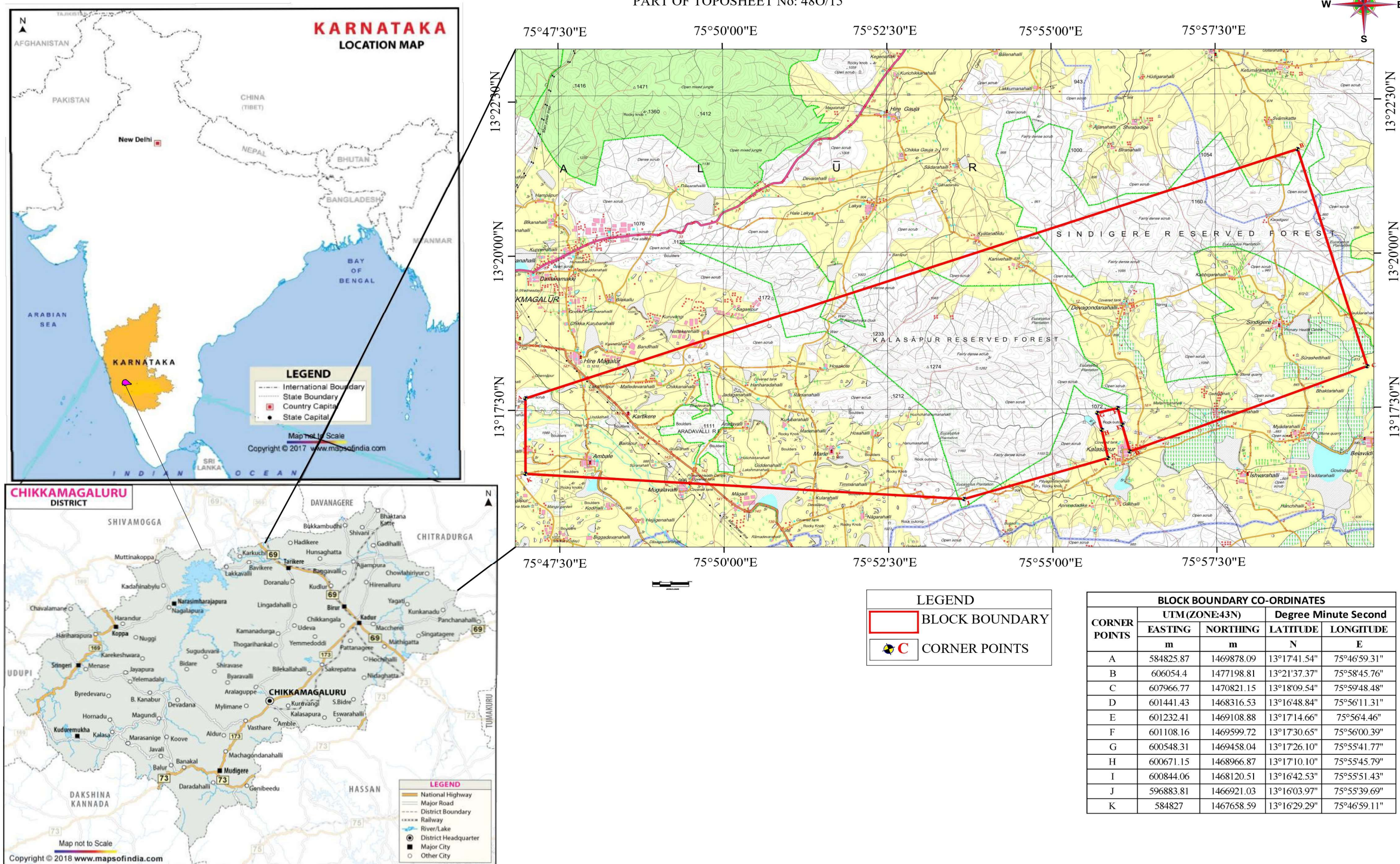
Sl. No.	Block Cardinal Points	Datum: WGS-84			
		Geographic (DD°MM'SS.SS")		UTM (Zone- 43P)	
		Latitude	Longitude	Easting(m)	Northing(m)
1	A	13°17'41.54"	75°46'59.31"	584825.870	1469878.090
2	B	13°21'37.37"	75°58'45.76"	606054.400	1477198.810
3	C	13°18'09.54"	75°59'48.48"	607966.770	1470821.150
4	D	13°16'48.84"	75°56'11.31"	601441.430	1468316.530
5	E	13°17'14.66"	75°56'4.46"	601232.410	1469108.880
6	F	13°17'30.65"	75°56'00.39"	601108.160	1469599.720
7	G	13°17'26.10"	75°55'41.77"	600548.310	1469458.040
8	H	13°17'10.10"	75°55'45.79"	600671.150	1468966.870
9	I	13°16'42.53"	75°55'51.43"	600844.060	1468120.510
10	J	13°16'03.97"	75°55'39.69"	596883.810	1466921.030
11	K	13°16'29.29"	75°46'59.11"	584827.000	1467658.590

4.2.0 ACCESSIBILITY TO THE BLOCK

4.2.1 The block is located about 5km east from Chikkamagaluru Town, which is the district headquarter. The nearest railway station is Chikkamagaluru Railway Station located 5 km west from the Block area. The State Highway SH-57 passes through the western part of the block. Motorable/ metaled roads are available in the area to approach the villages and interior parts within block. A few forest roads branch out from the above roads. The interior villages of the area are connected by tar, semi-metalled roads. On the whole, the area is easily accessible by vehicle except northern part of the area which are occupied by high hills and dense forest. The nearest domestic airport is Mysore Airport located about 170km from the Block area and Kempegowda International Airport, Bengaluru located around 275km away from the block area.

LOCATION MAP OF KALASAPURA BLOCK (G4) EXTENT-129.00Sq.Km, CHIKKAMANGALURU DISTRICT KARNATAKA

PART OF TOPOSHEET No: 480/15



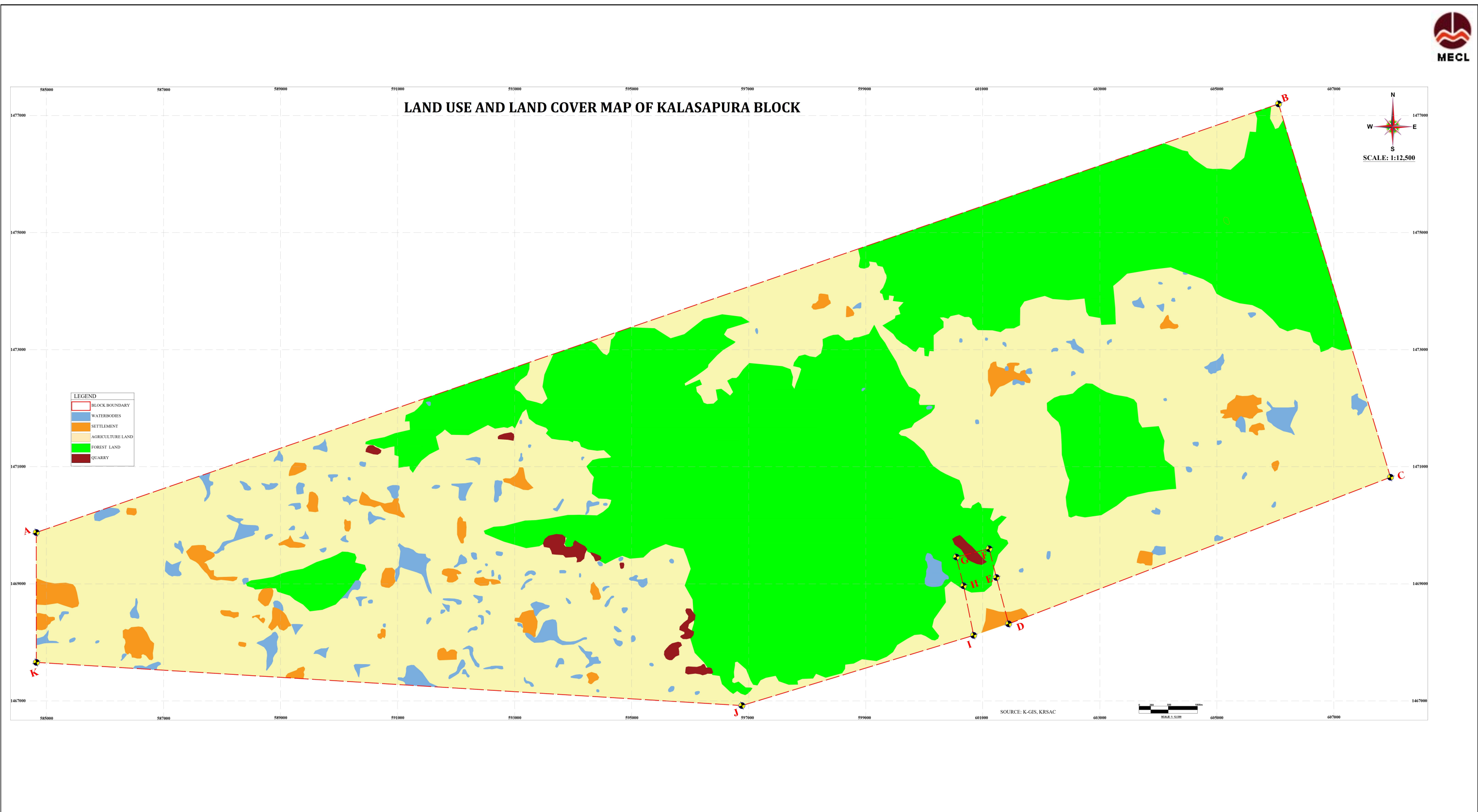
Text Figure-1: Location Map of Kalasapura G-4 Block, District- Chikkamagaluru, Karnataka

4.3.0 DETAILS OF THE AREA WITH LAND USE

4.2.1 The majority parts of the study area in Toposheet No:48O/15 is covered by fairly-dense forest, open mixed jungle which falls under the Reserved Forest namely, Aradavalli Reserved Forest, Kalasapura Reserved Forest & Sindigere Reserved Forest. Forest occupies major part of the central and eastern part of the block area. Cadastral details and land details (government, private and forest) of the area are not available. As per available land use and land cover map of the block area sourced from Karnataka State Remote Sensing Application Centre (KSRSAC), the major portion of western & south eastern parts of the study area is covered by agricultural land. Settlement is scattered throughout the study area. Majority of the habitat are on the western parts of the study area. Few building stone quarries are present at the centre of the study area near Kalasapura and Hanumanahalli Village. The land use and land cover map of the block of the study area (Source-KSRSAC) is furnished as **Text Figure No-2**.

4.4.0 MINERAL(S) UNDER INVESTIGATION

4.4.1 The Kalasapura block was explored for the occurrences of QPC hosted gold and copper mineralisation.



Text Figure-2: Land use and Land cover Map of Kalasapura G-4 Block, District- Chikkamagaluru, Karnataka

CHAPTER-5

PHYSIOGRAPHY AND ENVIRONMENT

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

5.1.1 Chikkamagaluru, a district in the state of Karnataka, India located in the foothills of the Western Ghats and has a geography characterized by hills, forests, and rivers. Chikkamagaluru is located at an elevation of 1,090 meters (3,580 ft) above sea level, making it the third highest city in Karnataka. The highest point in the district is Mullayanagiri, which is 1,926 meters above sea level.

5.1.2 In general, the study area forms the south-eastern part of the lofty Bababudan hills characterised by the parallel hill ranges trending in an almost east-west direction. Physio-graphically the area is hilly and elevation range from 1060m to 1274m above mean sea level (AMSL) in hilly area and 860m AMSL in plain lands. In general, topography sloping towards south. The hills near Kalasapura rise more than 213 m above the ground level.

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

5.2.1 The Kalasapura Block area lies in Chikkamagaluru District (Toposheet No 48O/15) of Karnataka State which is well connected by roads & railways. The State Highway (SH-57) which connects Chikkamagaluru to Bangalore passing through the block on the western side and the whole block is well connected by the village tar roads. The railway track which connects Chikkamagaluru to Kadur passing from west to the north of the block.

5.2.2 The high-tension power transmission line is passing at the centre of the block. The high transmission line is connecting Chikkamagaluru to Kalasapura and surrounding villages.

5.2.3 Telephone and Internet line networks are well connected in the area.

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

- 5.3.1 As per census India 2011, Chikkamagaluru had population of 1,137,961 of which male and female were 566,622 and 571,339 respectively.
- 5.3.2 Average literacy rate of Chikkamagaluru in 2011 were 79.25%. Gender wise, male and female literacy were 85.41% and 73.16% respectively. For 2001 census, same figures stood at 80.29% and 64.01% in Chikkamagaluru District. Total literate in the District were 818,345 of which male and female were 438,257 and 380,088 respectively.
- 5.3.3 With regards to Sex Ratio in Chikkamagaluru, it stood at 1008 per 1000 male compared to 2001 census figure of 984. The average national sex ratio in India is 940 as per latest reports of Census 2011 Directorate. In 2011 census, child sex ratio is 969 girls per 1000 boys compared to figure of 959 girls per 1000 boys of 2001 census data.
- 5.3.4 In 2011, total 521 families live on footpath or without any roof cover in Chikkamagaluru district of Karnataka. Total Population of all who lived without roof at the time of Census 2011 numbers to 2,023. This approx. 0.17777410649398% of total population of Chikkamagaluru district. The initial provisional data released by census India 2011, shows that density of Chikkamagaluru district for 2011 is 158 people per sq. km. In 2001, Chikkamagaluru district density was at 158 people per sq. km. Chikkmangalur district administers 7,202 square kilometres of areas.

The details of the Population Census 2011, of Chikkamagaluru District are given in **Table-5.1.**

Table-5.1
Census Data of Chikkamagalur district, Karnataka

Description	Urban	Rural
Number of households	4840	25703
Total Population	21,199	1,25,651
Population (%)	14.44%	85.56%
Male Population	10,822	65,848
Female Population	10,377	59,803

(Source: www.census2011.co.in)

5.4.0 SOCIO DEMOGRAPHIC PROFILE OF THE AREA AND NEARBY

5.4.1 Out of the total Chikkamagaluru population for 2011 census, 21.05 percent lives in urban regions of district. In total 239,508 people lives in urban areas of which males are 119,077 and females are 120,431. Sex Ratio in urban region of Chikkamagaluru district is 1011 as per 2011 census data. Similarly child sex ratio in Chikkamagaluru district was 963 in 2011 census. Child population (0-6) in urban region was 23,123 of which males and females were 11,779 and 11,344. This child population figure of Chikkamagaluru district is 9.89 % of total urban population. Average literacy rate in Chikkamagaluru district as per census 2011 is 87.93 % of which males and females are 91.40 % and 84.51 % literates respectively. In actual number 190,262 people are literate in urban region of which males and females are 98,071 and 92,191 respectively.

5.4.2 As per 2011 census, 78.95 % population of Chikkamagaluru district live in rural areas. The total population living in rural areas is 898,453 of which males and females are 447,545 and 450,908, respectively. In rural areas of the district, sex ratio is 1008 females per 1000 males. Child sex ratio data of Chikkamagaluru district is 971 girls per 1000 boys. Child population in the age 0-6 is 82,205 in rural areas of which males were 41,714 and females were 40,491. The child population

comprises 9.32 % of total rural population of Chikkamagaluru district. Literacy rate in rural areas of Chikkamagaluru district is 76.95 % as per census data 2011. Gender wise, male and female literacy stood at 83.82 and 70.15 percent respectively. In total, 628,083 people were literate of which males and females were 340,186 and 287,897 respectively.

- 5.4.3 Scheduled Caste (SC) constitutes 22.29% of the population while Scheduled Tribes (ST) are 3.95% of the population. Approximately 21.05% of the districts population resides in urban areas. Chikkamagaluru's economy is predominantly agrarian, with about 80% of the population engaged in agriculture and allied activities. The district is renowned for its coffee plantations, contributing significantly to both the local and national economy. The socio-demographic insights into Chikkamagaluru districts highlight its rich cultural diversity, economic reliance on agriculture, particularly coffee cultivation,, and a balanced gender ratio with commendable literacy rates.

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

- 5.5.1 Chikkamagaluru district is located at the western ghat section. There are various religious holy/sacred places such as Mullayana Giri, Nandi Mantapa, Hazrat Dada Hayath Dargah, etc.
- 5.5.2 Public utilities like school, colleges, primary health center, Banks, Post office etc are available at Kalasapura. Primary school are also available at every villages.
- 5.5.3 The district is an abode of numerous reputed educational institutions. It also provides platform for higher education. Several recognized educational institutions like Govt. College, Medical College, etc are situated in Chikkamagaluru district.
- 5.5.4 The main government hospital is available at Chikkamagaluru town. Besides, there are many private health care facilities and dispensaries available in the Chikkamagaluru. The banking and hotels facilities are available in Chikkamagaluru city. Other infrastructure facilities like, market, workshops etc. are also available in the close vicinity of the block.

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

- 5.6.1 The district has a variety of forest types, including evergreen, semi-evergreen, moist deciduous, dry deciduous, and thorn forests. The forests include the Balur State Forest in Mudigere range, which is a wet evergreen forest, and the Kadur range, which is a thorny scrub forest. In total, the district has a forest cover of about 2,000 sq. km.
- 5.6.2 Bhadra & Kudremukh Landscape has over 2,000 square kilometres of forest area typically of sensitive shola forests and grasslands. It also has about 5,000 square kilometres of adjoining coffee plantations, farms and villages, which act as a buffer and connect the forest area in a meaningful swath of land.
- 5.6.3 Bhadra Wildlife Sanctuary is a protected area and tiger reserve as part of the Project Tiger, situated in Chikkamagaluru district, 23 km south of Bhadravathi city, 38 km from Tarikere town, northwest of Chikkamagaluru and 283 km from Bengaluru city in Karnataka state, India.^[2] Bhadra sanctuary has a wide range of flora and fauna and is a popular place for day outings. The 1,875 m (6,152 ft) above MSL Hebbe Giri is the highest peak in the sanctuary.
- 5.6.4 The Kudremukh National Park in the Western Ghats is a part of the world's 38 'hottest hotspots' of biological diversity, a UNESCO World Heritage Site

5.7.0 FLORA AND FAUNA

- 5.7.1 The common species of flora in and around the area include crepe myrtle (lanceolata), kadam, thaasal (tiliaefolia), simpoh (pentagyna), teak, kindal, Indian-laurel, rosewood, Indian kino tree, fig tree, mangosteen, Kydia calycina, indigo, toddy palm, Ceylon oak, jalari, jamba tree, slow match tree, thorny bamboo and clumping bamboo, Mathi, Honne, Nandi and Tadasalu.
- 5.7.2 Fauna found in and around the area include jungle cat, jackal, wild dog, mouse deer, common langur, bonnet macaque, slender loris, small Indian civet, common palm civet, pangolin, porcupine and squirrel.

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

- 5.8.1 There is dendritic pattern of drainage forming few seasonal nalas in the flat areas within the block having a general slope towards south and east. While in the hills, combination of radial and dendritic drainage pattern can be observed. No major Rivers, reservoirs exist in the area.

5.9.0 CLIMATIC CONDITIONS

- 5.9.1 Kalasapura falls in the rain shadow zone of Bababudan hills and receives an average rainfall of 600 mm. per annum compared to average rainfall of 2,600 mm. in the Bababudan hills. Daily temperature ranges between 18-32° celsius on any given day across the district. Minimum temperature 20°C (Dec-June), and maximum temperature up to 39°C (March-June). The area receives heavy rainfall as well during the monsoon from June to September which is more than 2,600mm rainfall every year.
- 5.9.2 Chikkamagaluru is a large district with its East-West dimension larger than its North-South. This vast area covers higher western ghats in the west to lower semi-arid plains in the east. Thus, evergreen forest, wet deciduous, dry deciduous and dry forests are all found in the district. Rainfall pattern follows West-East direction, with western portion receiving a whopping 5000mm rainfall annually and eastern portion receiving less than 1000mm. Kigga village in Sringeri taluk is the wettest place in the Chikkamagaluru district, as per Karnataka State Natural Disaster Monitoring Centre(KSNDMC).Daily temperature ranges between 18-32°celsius on any given day across the district. During summers the temperature reaches as high as 38-40°C and during winters there is high diurnal temperature variation as the night temperature dips below 10°C.

5.10.0 OTHER PHYSIOGRAPHIC, SOCIAL AND ENVIRONMENTAL FACTOR

- 5.10.1 Geomorphologically the block area falls in highly dissected hills. The general elevation in the area varies from 835m to 1295m (MSL). The highest elevation in the area is situated in the Kalasapura Reserved Forest, south of Kanivehalli Village, while the lowest elevation area is situated in the east of Kalasapura Village. The drainage of the area is mainly originated from the Kalasapura Reserved Forest and Sindigere Reserved Forest forming dendritic to sub-dendritic drainage patterns. The general slope of the area varies between 25° to 45°.
- 5.10.2 Most of the population of the area are dependent for their livelihood on agriculture and poultry farming. Agriculture and tourism are the backbone of the economy of the district. Some of its chief agricultural crops are cotton, cabbage, maize, chilly, ginger, pulses, etc. with unique and countryside landscape of endless waves of agricultural field.
- 5.10.3 Chikkamagaluru nestled in the foothills of Karnataka's western Ghats, is a heaven for nature enthusiasts and adventure seekers. Renowned for its lush coffee plantations and serene landscapes, the region offers a plethora of attractions like Mullaynagiri, Baba Budangiri, Hebba Falls, Kudremukh National Park and Badhra Wildlife sanctuary. Chikkamagaluru often hailed as the 'Coffee Land of Karnataka', holds a significant place in India's coffee industry. The district's association with coffee dates back to the 17th century.

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 investigation area located in the villages of Kalasapura, Neetikerahalli, Marle, Sindigeri, Hoskote, Ramanahalli, Mugulavalli, Amble, Gowdanahalli, Laximpura, Kanivehalli, Kabbigeri, etc. The houses were made up of stone, clay and cement. Government schools are there in all the villages whereas Primary health Centre and Police Station are located at Kalasapura. The block can be approached from major cities such as Chikkamagaluru and Belur through state highway (SH-57) which passes through the block. The SH-57 connect Chikkamagaluru and Belur which passes through the block towards western side of the block. The interior parts of the block are well connected by the inter village link road through fair weather jeepable tracks. Bengaluru is the capital city of Karnataka and the distance from the block is 250km and the nearest railways connecting to this block is from Chikkamagaluru Junction with a distance of 5 km. The nearest domestic airport is the Mysore Airport, which is about 170km away from the block and the International Airport is at Kempegowda International Airport, Bengaluru which is about 275km away from the block.

6.1.2 In terms of local infrastructure, the block has adequate electricity and good water supply. The industrial area of Chikkamagaluru District is located on the western side of the block. The block has a small coffee industry located at the heart of the block. These industries mainly use the raw materials which is available within the periphery of the block.

CHAPTER-7

7.0.0 GEOLOGY OF THE AREA

7.1.0 REGIONAL GEOLOGY

7.1.1 Kalasapura block area forms the extreme southern part of the Bababudan Schist Belt of western Dharwar Craton of southern India. The rock formations belong to the Pre-cambrian meta-sedimentary and meta-volcanic assemblage of rocks representing Bababudan group of Dharwar Super Group, The generalized succession of these formations was first suggested by Viswanathan (1973) is given in the **Table 7.1**.

Table 7.1

Regional Stratigraphic sequence of Litho units (after Viswanathan, 1973)

PROTEROZOIC	DHARWAR SUPER GROUP		10. Dolerite
			9. Vein quartz carrying specks of pyrite and chalcopyrite.
			8. Pink porphyritic diorite
		BABABUDAN GROUP	7. Banded iron formations
			6. Chloritic and graphitic phyllite
			5. Quartz-chlorite-schist interbedded with chlorite phyllite and tuff
			4. Meta-basalt (amygdaloidal amphibolites) interbedded with garnetiferous chlorite phyllite and current bedded quartzite meta-pyroxenite and sills of gabbro
			3. Current bedded quartzite and quartz sericite-schist carrying sulphide mineralization of interest.
			2. Conglomerate (oligomictic) with sulphide dissemination and with possible concentrations of gold and Uranium
-----Unconformity-----			
ARCHEAN		1. Grey porphyritic granite (part of Peninsular Gneissic complex)	

7.1.2 Pre-Cambrian meta-sedimentary and meta-volcanic suite of rocks (Dharwar Super group), unconformably resting over the grey porphyritic granite and the associated migmatite with a well-defined angular unconformity.

7.1.3 The conglomerates are characterised by the presence of well-rounded quartzite and bluish vein quartz pebble, set in a quartzite matrix. The matrix of the QPC consists

of quartz (sand-size), muscovite, sericite, fuchsite, biotite, microcline, pyrite, chalcopyrite, rutile, zircon and ilmenite. This type of basal conglomerate is termed "Oligomictic". The conglomerates exhibit grading and sorting, with alternate pebbly zones and quartzite bands. These are overlain by a thick bed of current bedded quartzite, and quartz-sericite schist which forms the host rock for sulphide mineralisation. The conglomerate quartzite horizon is overlain by a thick sequence of meta-volcanic suite of rocks represented by amygdular amphibolite and greenstone, acid lava flows and tuff. These volcanics are also interbanded with current-bedded quartzite and garnetiferous chlorite phyllite and are in turn overlain by chloritic and graphitic phyllites and banded iron formations.

- 7.1.4 The meta-basalts in the lower parts of the sequence comprise amygdular amphibolite with interbeds of garnetiferous phyllite while the upper parts of the sequence comprise green stones with chlorite phyllite (in places graphitic). These formations are intruded by dolerite/gabbro, veins of quartz, dykes of pink porphyritic diorite and ultramafic rocks. Regional geological map with location of Kalasapura Block is shown as **Text figure -3** and given as **Plate No.II**.

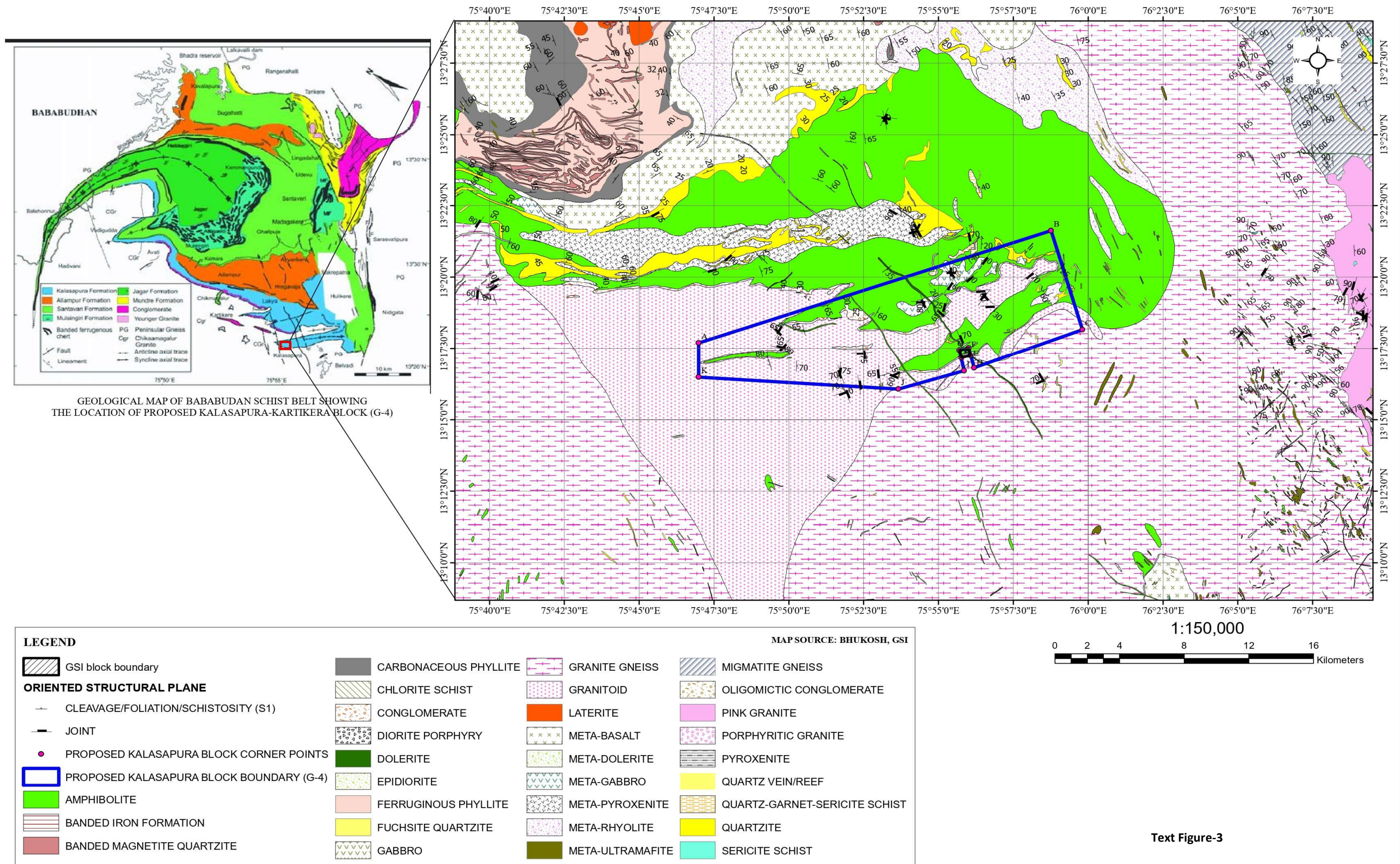
7.2.0 REGIONAL STRUCTURE

- 7.2.1 The formations in the arcuate Bababudan schist belt show gentle dips at the outer edges of the basin but show steeper dips with penecontemporaneous folds in the central part occupied by banded iron formations. The general strike of the rocks in the southern parts is almost east-west with northerly dips, which gradually veers to north-south with westerly dips and further retains its east-west strike with southerly dips thus forming almost a circular basin with converging dips. The rocks show faulting often with the dykes emplaced along the faults. There are no inversions of the beds.

7.3.0 REGIONAL MINERALIZATION

- 7.3.1 Bababudan schist belt is Archaean greenstone belt comprises of a basal uraniferous, pyritiferous and gold bearing QPC, which has been derived from a source area exposed to anoxic atmosphere and deposited in a reducing environment. The area is known for incidence of gold mineralisation in oligomictic conglomerates (QPC) and copper mineralisation in grey massive quartzite of Bababudan group of Dharwar Super group.

Regional Geological Map with location of Kalasapura Block, District Chikkamagaluru, Karnataka



7.4.0 GEOLOGY AND STRUCTURE OF THE BLOCK

7.4.1 **GEOLOGY:** The study area comprises Pre-Cambrian meta-sedimentary and meta-volcanic suite of rocks representing Bababudan Group of Dharwar Super Group, unconformably resting over the grey porphyritic granite with a well-defined angular unconformity. The Oligomictic conglomerate is characterised by the presence of well-rounded quartzite and bluish vein quartz pebble, set in a quartzite matrix. The matrix of the QPC consists of quartz (sand-size), muscovite, sericite, fuchsite, biotite, chlorite, microcline and pyrite. The conglomerate exhibits grading and sorting, with alternate pebbly zones and quartzite bands. These are overlain by a thick bed of current bedded quartzite with quartz-sericite schist carrying sulphide mineralisation in north of Kalasapura. The conglomerate quartzite horizon is overlain by a thick sequence of meta-volcanic suite of rocks represented by amygdular amphibolite and greenstone. These formations are intruded by gabbro dykes and quartz veins.

7.4.2 The major rock types exposed in the area are granite, Quartz Pebble Conglomerate (QPC), Quartzite/fuchsite quartzite, Amphibolite/Chloritic schist, Gabbro/Meta Gabbro and Quartz veins/reefs. The sulphide minerals mainly associated with the QPC, Quartzite and amphibolite/schist. The local stratigraphic succession of the Kalasapura block is given below.

Table 7.2 Block Stratigraphic Succession of the area (After, GSI)

Group	Lithology
Bababudan Group	Quartz Veins
	Meta-basalt (amygdaloidal amphibolite) with interbedded Quartzite, Chlorite schist, Gabbro/Meta Gabbro
	Current bedded Quartzite/fuchsite quartzite and quartz sericite-schist
	Quartz Pebble Conglomerate (oligomictic)
-----Unconformity-----	
Archean	Grey porphyritic granite

7.5.0 DESCRIPTION OF ROCK TYPES

Detailed description of rock types is given below.

Granite:

The grey porphyritic granite forms the basement rock over which meta sedimentary and meta volcanic rocks lie unconformably. It occupies the valley portion of the block area. The granite terrain is characterised by the presence of small dome shaped hillocks and knolls. Granite is leucocratic, medium to coarse grain and characterized by the presence of large plates of feldspar often traversed by quartz and pegmatites. It is poorly jointed. At places it shows intense shearing. Granite is being quarried for construction buildings & roads purposes near Marle Hanumanhalli & Payagondanahalli village.

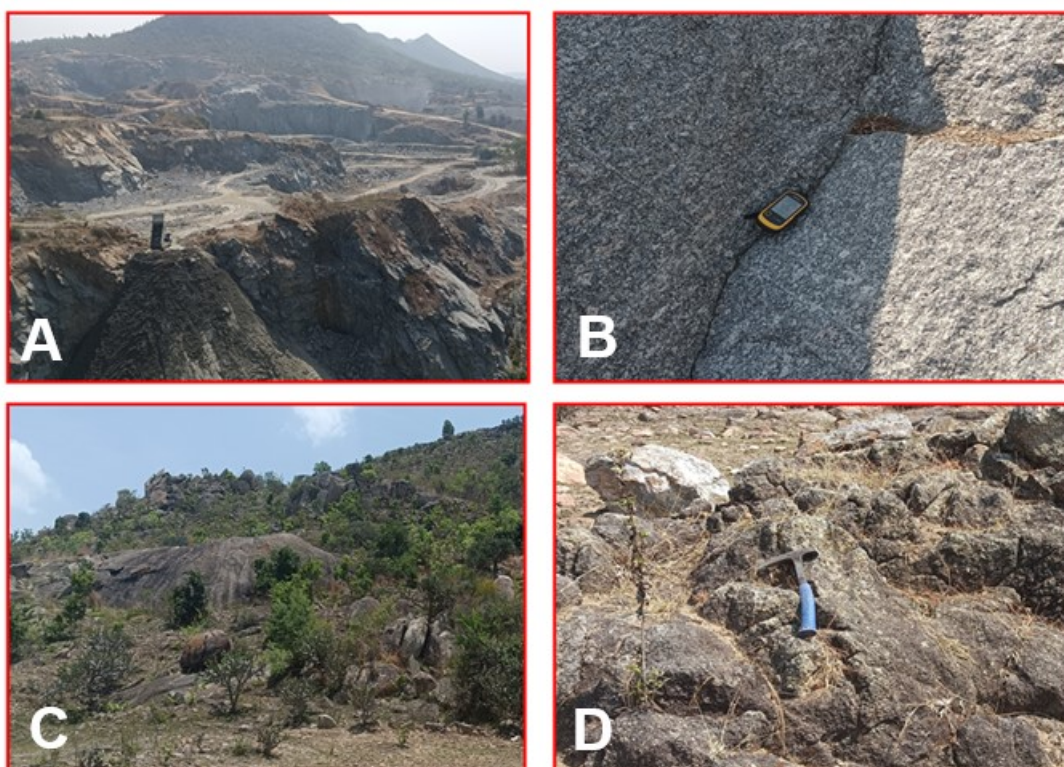


Photo-7.1: Field Photograph showing Grey Granite exposures/outcrop.

(A) Grey granite quarry, S of Hoskete. (B) Grey granite exposure, Kartinere. (C) Grey granite outcrop, Sof Hoskete. (D) Granite outcrops, Devagondanahalli

Under thin section study (MSBPS03), microcline occurs as coarse to medium subhedral prismatic grains showing perthitic exsolutions. Plagioclase is present as medium subhedral prismatic grains showing saussuritization. Quartz occurs as medium to fine anhedral grains, often clustering in pockets. Biotite is seen present as fine flakes and flaky aggregates. Sericite/ muscovite are present as very fine to fine flaky aggregates, mostly developing after plagioclase alterations. Epidote occurs as very fine to fine subhedral prismatic to anhedral patchy grains developing after plagioclase alterations. Sphene is present as anhedral patches showing relicts of opaques within it. Opaques occur as fine subhedral grains and anhedral patches, often showing association with biotite. Calcite fillings have seen intruded in areas. Chlorite occurs as fine to very fine flakes and flaky aggregates in association with epidote and biotite. Apatite occurs as fine subrounded grains in accessories. Zircon is noted as very fine inclusions within biotite, around which pleochroic haloes are observed (Pmg-2).

2. QPC (Quartz Pebble Conglomerate):

Quartz Pebble Conglomerate (QPC) outcrops/exposures seen in an around Kartikere, Kalasapura, Devagondanahalli and Sindigere. QPC generally trending E-W strike and dip varies from 12° - 55° due northerly. The QPC consist of well rounded pebbles of quartzite set in a quartzose matrix. The matrix consists of considerable amount of fuchsite and fine grains of disseminated pyrite. The contact between conglomerate and quartzite is gradational and at places the quartzite band consists of thin pebbly horizons indicating variation in sedimentation. The size of the pebbles in the conglomerate varies from a few mm to as much as 8cm and individual beds of the conglomerate thickness varies from 0.20m to 1.5m. The conglomerate is dark brown to reddish brown in appearance, massive, compact and consists of deep yellow sulphurous spots, at places on the weathered surface indicating sulphide mineralisation. The QPC with a fuchsite intercalations also carry rich disseminations of pyrite in the matrix.

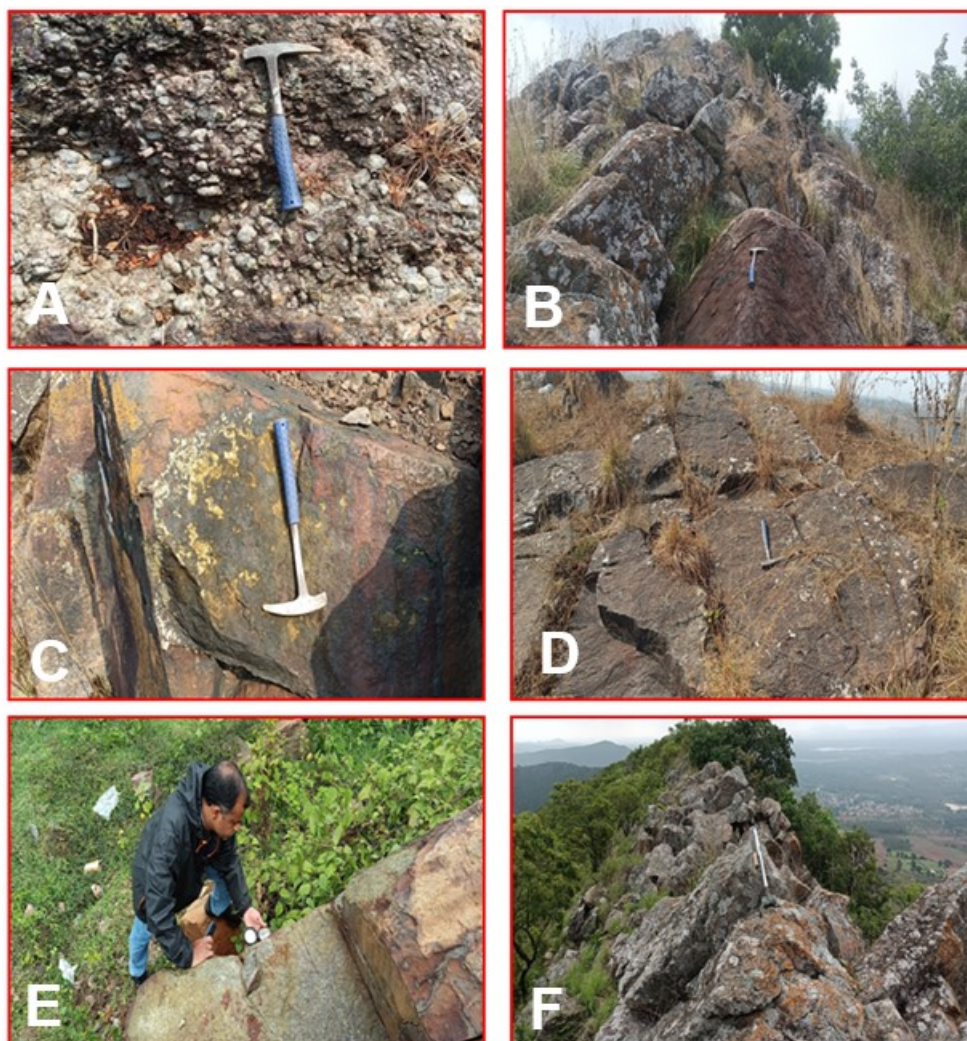


Photo-7.2: Photograph showing QPC (Quartz Pebble Conglomerate) exposure

(A): QPC outcrop, W of Kartikere (B): QPC outcrop, E of Kartikere (C): QPC with sulphides, NW of Kartikere. (D): QPC outcrop, W of Kartikere (E) Measuring attitude of QPC (F). QPC outcrop, Kartikere

3. Quartzite/Fuchsite Quartzite:

Thick bed of brown coloured quartzite, which rests on the undulatory surface of grey porphyritic granite with an angular unconformity. The base of the quartzite unit is marked by a thin zone of oligomictic quartz-conglomerate at places. Some members show current bedding and good sorting. There are pebbly beds separated by quartzite in the lower parts. The pebble zones carry pyrite concentrations in the matrix. The

quartzite unit also carries intercalations of quartz-sericite-schist and bands of amygdular amphibolite and tuff. North of Kalasapura quartzite with quartz-sericite schist forms the host rock for sulphide mineralisation. The quartzite unit is overlain by a thick sequence of amygdular amphibolite (metabasalt) which is exposed in the central and northern part of the block.

The quartzite is light grey/grey, brownish to buff white and few are brownish red in colour, medium grain, massive occur within the metabasalt and are exposed along the ridges of the hillocks. The general trends of the quartzite are east-west and are faulted at some places with a normal traverse fault. The fault zone is occupied by intrusive rock of gabbro. It is well jointed and exhibits drag folding north of Kalasapura. Sulphide disseminations (Pyrite and chalcopyrite) together with malachite and azurite encrustations are noted in the quartzite band north of Kalasapura. At some places good specs of pyrite disseminations are noted in the grey quartzite band whereas the sheared buff quartzite band is mostly barren with weak pyrite disseminations at some places. The quartzite band shows ripples mark at some places with a band width varies from 1.00m to 30.00m. A numerous band of QPC/quartzite band is exposed along the ridges of the hills.

The fuchsite quartzite is greenish in colour, fine to medium grain. The fuchsite quartzite is exposed in the east of Kalasapura, south east of Devagondanahalli and north of Karadigavi. The general trend of the fuchsite quartzite is E-W.

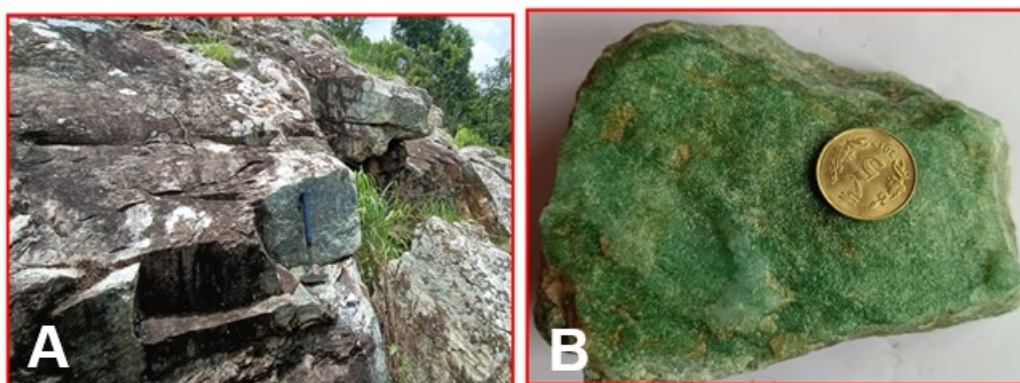


Photo-7.3: Field photograph showing fuchsite quartzite.

(A): Fuchsite outcrop & (B) Fuchsite quartzite hand specimen, NE of Kalasapura:

Under thin section studies (MKBPS05), it is fine to medium grain rock showing granular texture. It is a monomineralic rock, composed of fine to medium anhedral to subhedral quartz grains showing tight quartzitic contacts. Grains are poorly sorted and tightly packed. Quartz recrystallization is noted in areas. Sericite/ fuchsite are seen present as very fine flakes and flaky aggregates along quartz grain contacts, at places. Opaques and rutile are noted as very fine grains and blades in accessories.

Mineralised fuchsite quartzite (MKBPS04) is fine to medium grained rock showing granular texture and mineralisation. Quartz occurs as fine to medium anhedral grains and moderately coarse porphyro-clasts showing tight quartzitic texture and recrystallization in areas. Opaques occur as fine anhedral to subhedral grains in dissemination. Fuchsite is present as very fine flaky aggregates in zones. Reddish ferruginous patches are seen associated with opaque dissemination. Sphene is noted as fine to medium anhedral patches. Rutile is seen present as very fine blades in accessories. (Pmg-3)

4. Amphibolite/Meta Basalt:

The amphibolite which is found in the north of Kalasapura is massive and amygdaloidal in nature associated with traces of specks of Pyrite, whereas the amphibolite schist with actinolite, quartz veins and a thin band of chlorite schist with a disseminated of pyrite and chalcopyrite and traces of garnet is clearly exposed along the railway track south west of Kanivehalli. The amphibolite schist with actinolite and thin band of chlorite schist with a numerous of quartz veins and devoid of sulphide mineralization is mainly encountered towards Sindigere area.

The amphibolite/Meta basalt is greenish grey, medium grain, massive rock with numerous quartz veins which vary in width from a few mm. to as much as 2m. and are traceable over strike lengths varying from 1m. to 50m in Kanivehalli. Quartz veins occurring as thin veins are white in colour and contain specks of pyrite and malachite encrustation. At few places, megascopic examination of these rocks reveals the presence of needles of actinolite, garnet and altered feldspar. The band of sheared amphibolite schist was clearly exposed on the railway track cutting south

west of Kanivehalli village associated quartz veins and trace of pyrite and chalcopryrite. The general strike of the rock formations is east-west corresponding to the linear trends of the hills. The general dip is southerly. They are often associated with chloritic or sericitic tuffs which weather into characteristic needle shaped pieces.

The vesicular and amygdular amphibolite and garnetiferous amphibolite, still preserve the relict volcanic structures. Development of acicular needles of hornblende and the well developed crystals of garnet are noted in the metamorphosed types. These rocks occur unconformably over the grey porphyritic granite and are separated by conglomerate/quartzite exhibiting typical sedimentary structure.

Under thin section studies (MKBPS02), it is a greenish grey coloured very fine to fine grained massive rock. Actinolite occurs as very fine to fine acicular grains. Plagioclase is present as very fine to fine subhedral to anhedral grains and as medium blasto-porphyritic grains in areas. Hornblende occurs as fine rhombic grains and anhedral patches in association with actinolite. Quartz occurs as fine anhedral grains, often clustering in pockets and also seen present as fine fillings/ veinlets. Opaques are present as fine anhedral to subhedral disseminated grains. Chlorite is noted as fine to very fine flakes replacing amphiboles.

In another thin section (MKBPS07), Tremolite-actinolite occurs as very fine to fine flaky/ acicular grains and its aggregates. Plagioclase occurs as turbid patches altering to zoisite/ epidote. Zoisite/ epidote are present as very fine granular aggregates developing after plagioclase alterations. Opaques occur as fine anhedral to subhedral and skeletal grains in dissemination and as very fine segregations in pockets. Chlorite and biotite are seen present as flakes and patches replacing amphiboles. Quartz is noted as fine anhedral grains clustering in pockets.

Under thin section studies (MKBPS06) Actinolite-plagioclase-quartz-schist rock is greenish grey coloured fine grained rock showing schistosity. Actinolite occurs as fine acicular aggregates showing parallel alignment. Plagioclase occurs as fine subhedral to anhedral and subrounded patchy grains showing parallel alignment. Calcite is present as streaky aggregates and patches aligned along the foliation and comprising fine to medium anhedral to subhedral aggregates. Quartz occurs as

clustered pockets, often showing association with calcite streaks and aligned along the foliation. Epidote occurs as fine subhedral to anhedral grains, possibly developing after plagioclase alterations. Opaques are seen present as fine anhedral to subhedral and skeletal grains in dissemination. Chlorite occurs as fine flakes and flaky aggregates, seen replacing amphiboles (Pmg-4)

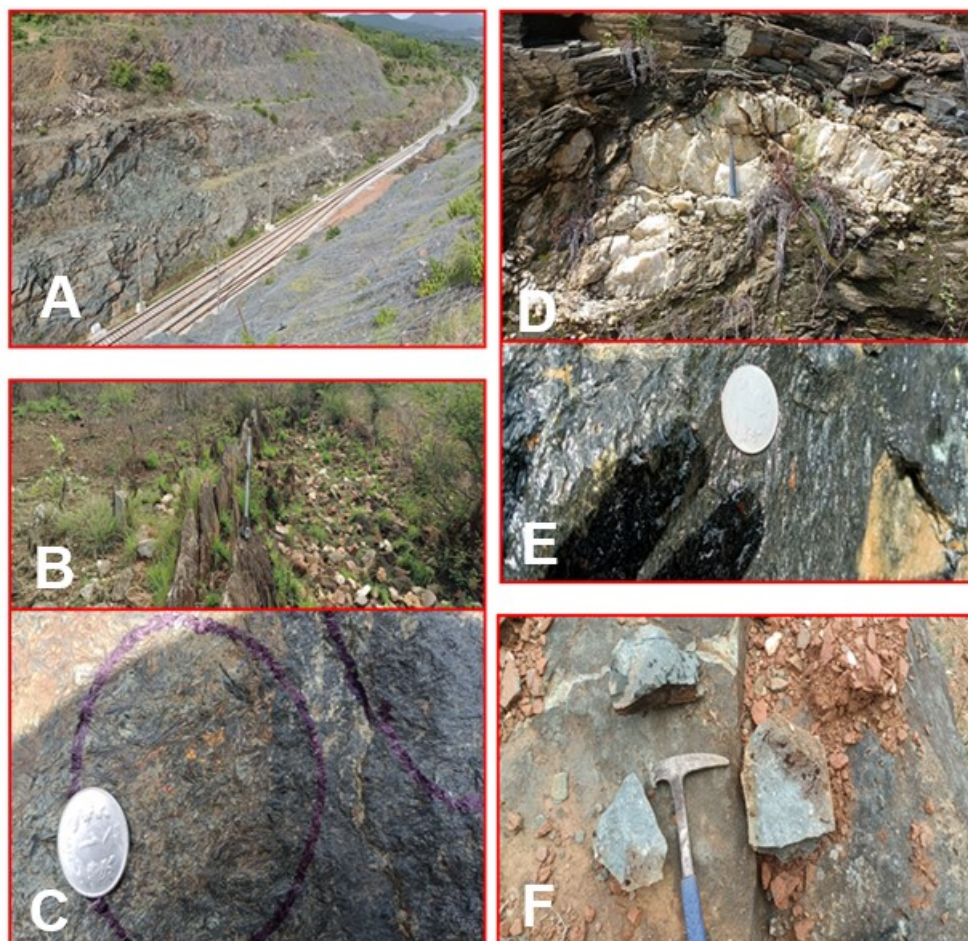


Photo-7.4: Field photograph showing Amphibolite schist/Amphibolite outcrops

(A): Amphibolite exposure, Railway track section, Kanivehalli (B) Amphibolite/Actinolite schist outcrop, Kalasapura (C) Amphibolite schist with chalcopryrite, Railway track, W of Kanivehalli (D) Amphibolite schist with quartz veins with malachite stains, Kanivehalli Railway track (E) Amphibolite schist with chalcopryrite, Railway track, W of Kanivehalli (F) Amygdoidal Amphibolite, NW of Kalasapura:

5. Gabbro/Meta Gabbro:

The gabbro is coarse grained dark green in colour and associated with specks of pyrite and chalcopryrite showing spheroidal weathering on the surface. The gabbro is exposed in the block as a dyke with a general trend of north-south and east-west

direction, with a width varies from 30.0m to 130.0m. Three major gabbro dyke is exposed in the block, the gabbro which is exposed north of Hariharadahalli village is trending east-west with a strike length of 3.3 km, and devoid of sulphide minerals. Gabbro dyke which is cutting perpendicular to the QPC and amphibolite schist which is running parallel to the Hosakote & Hosahalli village on the eastern side with a strike length of 7080m with a width range from 30.0m to 90.0m and the other dyke which runs from Kalasapura to Kanivehalli village trending of north-south with a strike length of 7.6 km and the width range from 20.0m to 130.0m. This dyke is associated with specks of pyrite & chalcopyrite. This greenish grey gabbro dyke is quarried in the north of Kalasapura Village.

Meta gabbro is medium to coarse grained and are dark greenish grey in colour, bouldary, massive, which is mainly found on the northern part of the block. The cumulative strike length of the outcrop is about 900m trending NW to SE direction with a width of 250m.



Photo-7.5: Field photograph showing gabbro dyke exposure.

(A): Spheroidal weathering in Gabbro outcrop, N of Kalasapura (B): Hand specimen of Gabbro with trace of Chalcopyrite (C) Gabro dyke quarry, N of Kalasapura (D) Bouldery Gabbro dyke exposure W of Devagondanahalli

Under thin section studies (MKBPS01), Altered gabbro is medium to coarse grained rock showing granular texture. Plagioclase occurs as medium to coarse subhedral prismatic grains showing intense sericitization. Augite occurs as medium to coarse subhedral prismatic grains being replaced by uraltite and chlorite from periphery in areas. Opaques are present as fine to medium subhedral and anhedral patchy grains in dissemination. Sericite occurs as cloudy patches comprising very fine flaky aggregates, seen developing after plagioclase alterations. Uralite is present as fine to very fine aggregates and anhedral patches replacing augite from periphery. Chlorite is noted as patchy pockets comprising very fine flaky aggregates and seen replacing plagioclase and pyroxenes. Epidote is seen present as very fine granular aggregates and anhedral patches developing after plagioclase alterations. Quartz occurs as fine granular aggregates in pockets, indicating minor silicification (Pmg-1).

6. Quartz Veins:

Numerous quartz veins were associated with the amphibolite schist and at some places carry few specks of pyrite. The quartz veins are milky white in colour, width varies from 0.25m to 1.5m and a length of 0.5m to 3.0m. Quartz veins in the area are mostly devoid of sulphide mineralisation. Majority of the quartz veins and reef is encounter towards north eastern of Sindigere village within amphibolite schist.

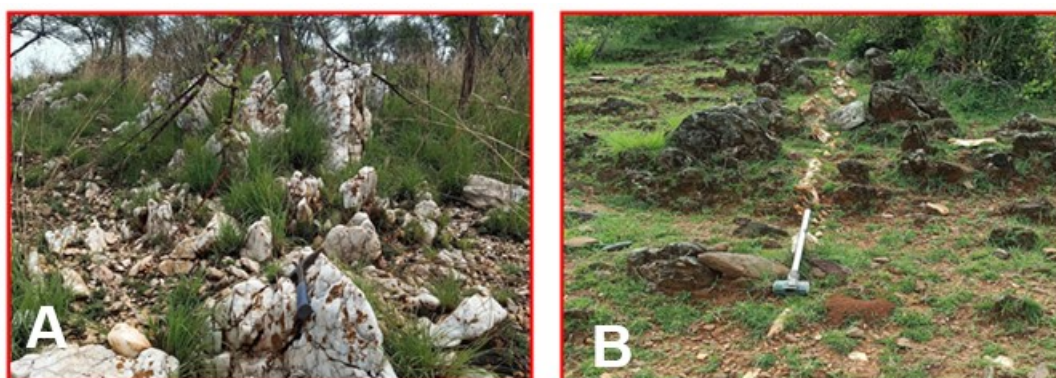
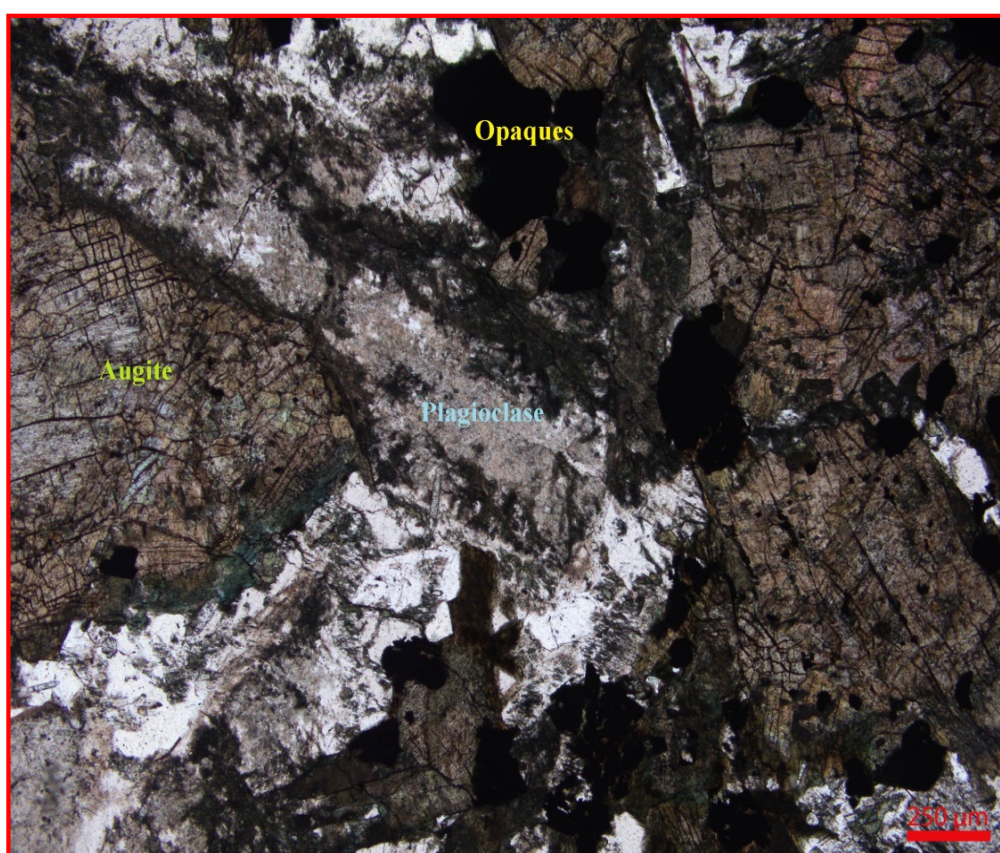


Photo-7.6: Field photograph showing Quartz veins outcrops

(A): Quartz Reef outcrop, (B) Quartz vein outcrop Hand

7.6.0 PETROGRAPHIC STUDY:

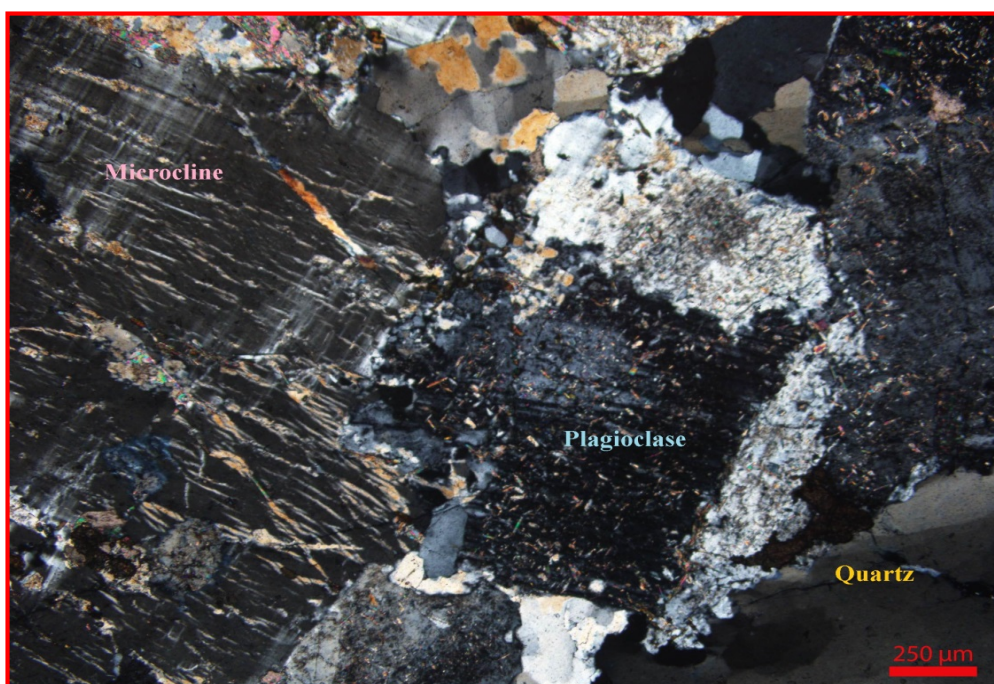
7.6.1 A total of 7 Nos. of rock samples collected from different litho-unit have been subjected for petrographic studies. The findings of petrographic study have been discussed along with the description of rock types in the area. However, the petrographic study report has been attached as Annexure No-V. The photomicrographs of the thin sections are given as **Pmg-1 to Pmg-4**



Pmg – 1: Photomicrograph showing association of plagioclase, augite and opaques where plagioclase is altering to sericite and augite is being replaced by uraltite from periphery as seen under plane polarized light.

Specimen No. : MKBPS01

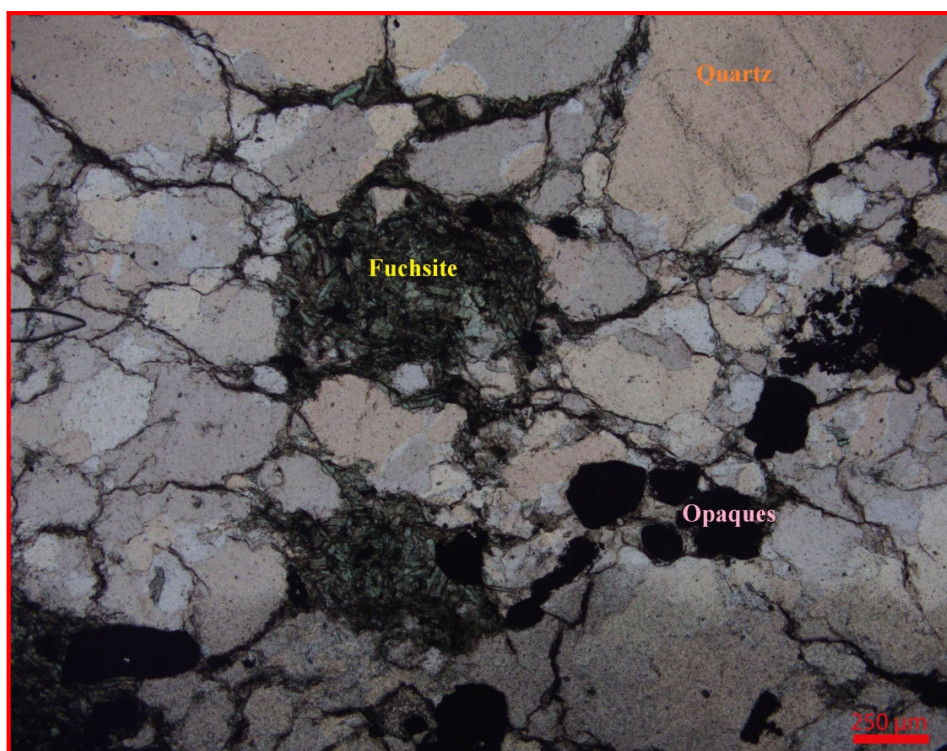
Magnification : 40X



Pmg – 2: Photomicrograph showing association of microcline, plagioclase and quartz, where microcline is showing perthitic exsolutions and plagioclase is showing saussuritization as seen under crossed nicol.

Specimen No. : MKBPS03

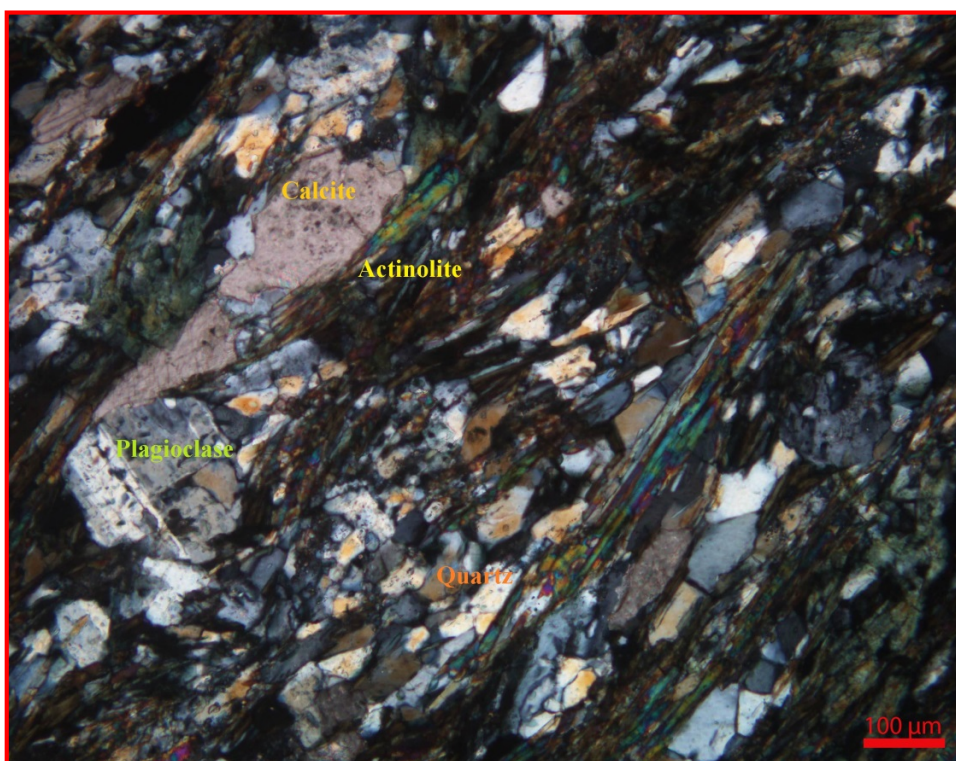
Magnification : 40X



Pmg – 3: Photomicrograph showing association of quartz, fuchsite and opaques in mineralized fuchsite quartzite as seen under plane polarized light.

Specimen No. : MKBPS04

Magnification : 40X



Pmg – 4: Photomicrograph showing association and parallel alignment of actinolite, plagioclase, calcite and quartz as seen under crossed nicol.

Specimen No. : MKBPS06

Magnification : 100X

7.7.0 STRUCTURE:

7.7.1 The general strike of the rock formation in the area is east-west corresponding to the linear trends of the hills. The general dip is northerly. The Quartz Pebble conglomerate and quartzites show 10°- 25° dip to north, but varying upto 55°, as seen north of Kalasapura and Hosakote. Further the quartzite bands show intense shearing, drag folding, slicken sliding and grooving with the grooves pitching at angles from 25° to 40° to the east. Due to the rolling dips, the quartzite bed at places becomes horizontal and becomes very steep (50°-65°) at places. Correspondingly, the strike also locally swerves from east-west to almost north-south. Quartzite beds dip northerly in the western side of gabbro dyke whereas bed dips south-easterly or southerly in the eastern part of the gabbro dyke might be due to anticlinal plunging fold. Weak disseminations of pyrite are noted throughout the quartzite band, concentrations of pyrite and chalcopyrite is restricted to the over-folded portion in north of Kalasapura. The formations north of Kalasapura represent a syncline. In the

valley north of Kalasapura hill the amygdular amphibolites are seen occurring juxtaposed with granite.

7.8.0 MINERALISATION IN THE BLOCK

- 7.8.1 The conglomerate bands and pebbly quartzite with chloritic biotitic and fuchsitic intercalations carry rich dissemination of pyrite in the matrix. During the course of geological mapping several linear QPC bands mapped in Kartikere, north of Kalasapura and South West of Devagondanahalli. Individual band strike length varies from 430m to 6330m.
- 7.8.2 Sporadic specks to stringer/disseminated sulphide mineralization in the area occurs mainly in QPC, quartzite and amphibolite. Stringers and dissemination of sulphide are also observed in gabbro dyke and show feeble dissemination of pyrite in quartz veins. The other litho-units grey granite found to be devoid of sulphide minerals. The stringers and veinlet of pyrite in most of the places are aligned along the foliation planes. The sulphides occur as stringers, veinlets and fracture filling types. The gabbro dyke association of the mineralization indicates that sulphide minerals were remobilized during later intrusion within the amphibolite schist and were emplaced in suitable weak planes like foliations, fractures and joints.
- 7.8.3 The sporadic occurrence of sulphide mineralization is observed in the west of Kanivehalli village. Considerable stains of malachite/azurite with sulphide minerals (pyrite, chalcopyrite) associated with quartz veins in Amphibolite/Schist rocks exposed along the railway track section (West of Kanivehalli) over a stretch of about 950m strike length trending in general E-W to NNW-SSE direction and dipping 20° to 70° towards S to SSE.
- 7.8.4 Surface indications of the mineralisation is noted as malachite, azurite encrustations/stains, along with disseminations of pyrite and chalcopyrite in amphibolite/schist associated quartz veins and quartzites. features like iron stains leached aureoles, ferruginisation, goethitisation are noted in Amphibolites and quartzite.

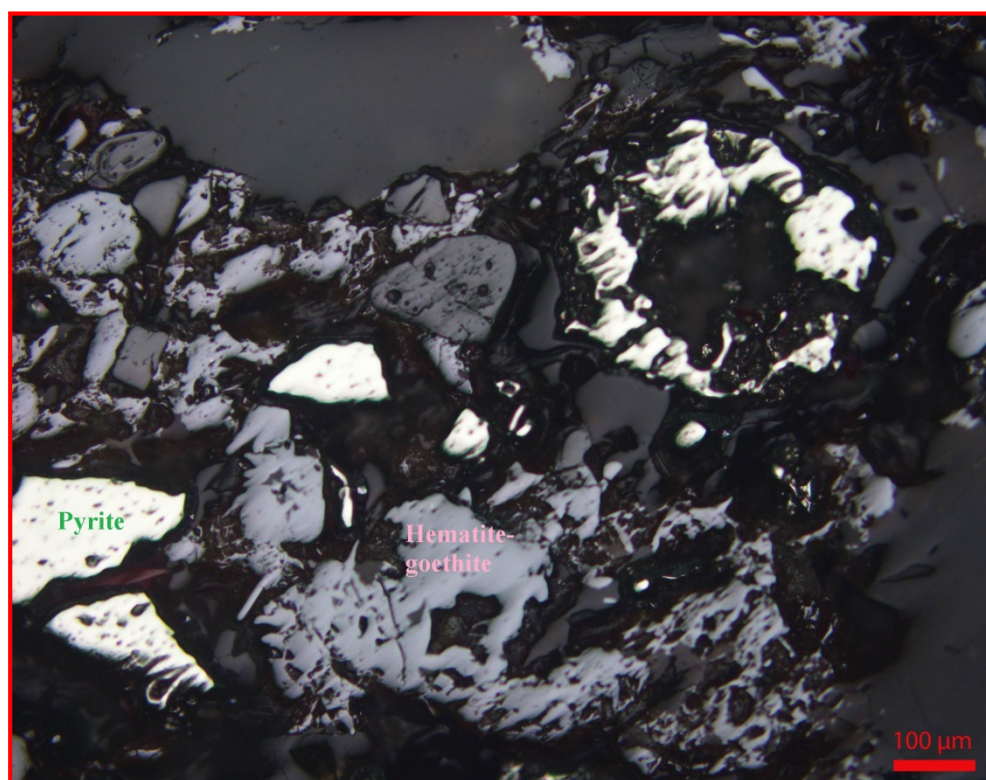
- 7.8.5 The mineralization occurs mainly as sulphide. Pyrite and chalcopyrite are the ore minerals while the gangue includes hematite, goethite, magnetite, ilmenite. Malachite and azurite are secondary minerals derived from the primary sulphides
- 7.8.6 During Geological mapping bedrock chip, channel and stream sediment sampling have been carried out and analysed for Au, Cu, Pb, Zn, Ni, Co, Mo Se & Te elements and findings discussed under Chapter-10.

7.9.0 MINERAGRAPHIC STUDY:

- 7.9.1 A Total 6 Nos. of samples collected from Quartz Polymictic Conglomerate, Fuchsite quartzite/quartzite and Amphibolite with sulphides have studied for mineragraphic study by preparing polished section. The study of polished section reveals that major (>5%) and minor (<5% to >1%) ore minerals are Hematite, Goethite, Pyrite, Ilmenite, Chalcopyrite, Magnetite, Digenite, Pyrrhotite, Limonite, Sphene, Chalcocite and Bornite. Zircon, Hematite, Covellite, Anatase, occurs as accessory minerals.
- 7.9.2 QPC (MKBMS01) under polished section, Hematite-goethite occurs as intermixed granular aggregates, patches and as moderately thick reticulate fillings along intergranular places of lensoidal quartz. Hematite is also present as very fine specks as fracture fillings. Pyrite occurs as fine to medium anhedral to subhedral grains and patches. Limonite is seen present as reddish fillings and stains in association with hematite-goethite fillings. Zircon occurs as very fine slender prismatic and elliptical shaped grains in dissemination. Chalcopyrite and pyrrhotite are noted as very fine inclusions within pyrite (Pmg-5)
- 7.9.3 Fuchsite QPC (MKBS06) under polished section, Hematite occurs as fine to medium anhedral to subhedral grains, blades, patches and as fine fillings. Pyrite occurs as fine anhedral grains in dissemination. Zircon is noted as fine prismatic and subrounded zoned grains in accessories (Pmg-8).
- 7.9.4 Quartzite (MKBMS02) under polished section, Goethite is present as fine to very fine patchy fillings. Pyrite occurs as very fine to fine disseminated specks/ grains,

often seen being replaced by goethite fillings from periphery. Hematite is noted as very fine specks in accessories (Pmg-5). Magnetite occurs as very fine disseminated specks and as inclusions within mica minerals (Pmg-6). In Fuchsite quartzite (MKBMS04), Digenite is noted as fine anhedral patches. Chalcopyrite and pyrrhotite are seen present as very fine specks in traces.

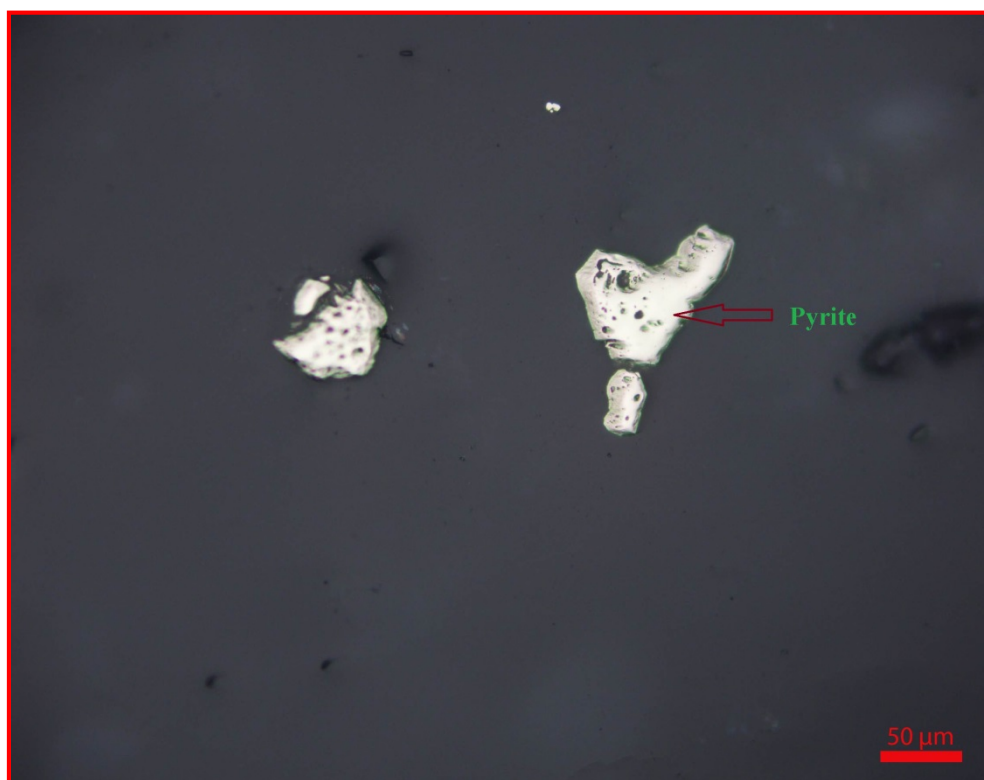
- 7.9.5 Amphibolite (MKBMS03) under polished section, Ilmenite occurs as fine subhedral to anhedral, skeletal and bladed grains in dissemination and is being replaced by very thin corona of sphene in areas. Sphene is also present as fine to very fine wedges and anhedral patches. Chalcopyrite occurs as medium to fine anhedral patches being replaced by digenite-chalcocite and covelite from periphery. Digenite-chalcocite also occurs as fine anhedral patches. Bornite is noted as fine to very fine relicts within chalcopyrite (Pmg-7). In another polished section of Amphibolite (MKBMS05), Ilmenite occurs as fine to medium subhedral to anhedral, bladed and streaky grains showing parallel alignment along the foliation. Hematite and anatase are noted as very fine specks along fractures as fillings.
- 7.9.6 The sample wise details of the mineragraphic studies are presented as Annexure-VII and the photomicrographs of the polished sections are given as **pmg-5 to pmg-8**.



Pmg – 5: Photomicrograph showing hematite-goethite intermixed patches and fillings associating anhedral grains of pyrite as seen under reflected light.

Specimen No. : MKBMS01

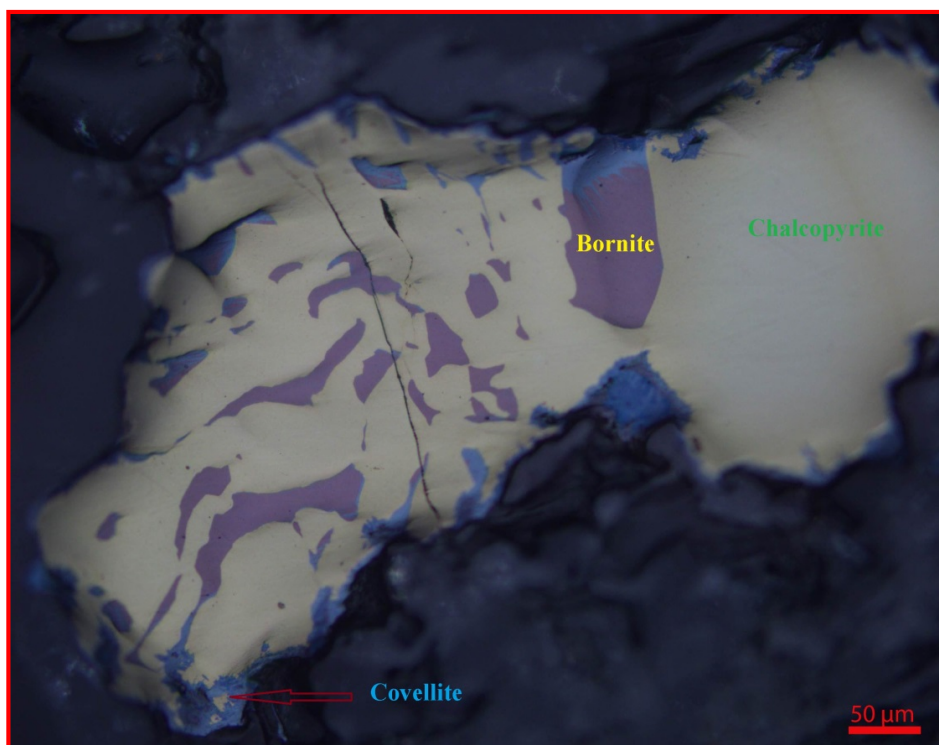
Magnification : 100X



Pmg – 6: Photomicrograph showing very fine grains of pyrite as seen under reflected light.

Specimen No. : MKBMS02

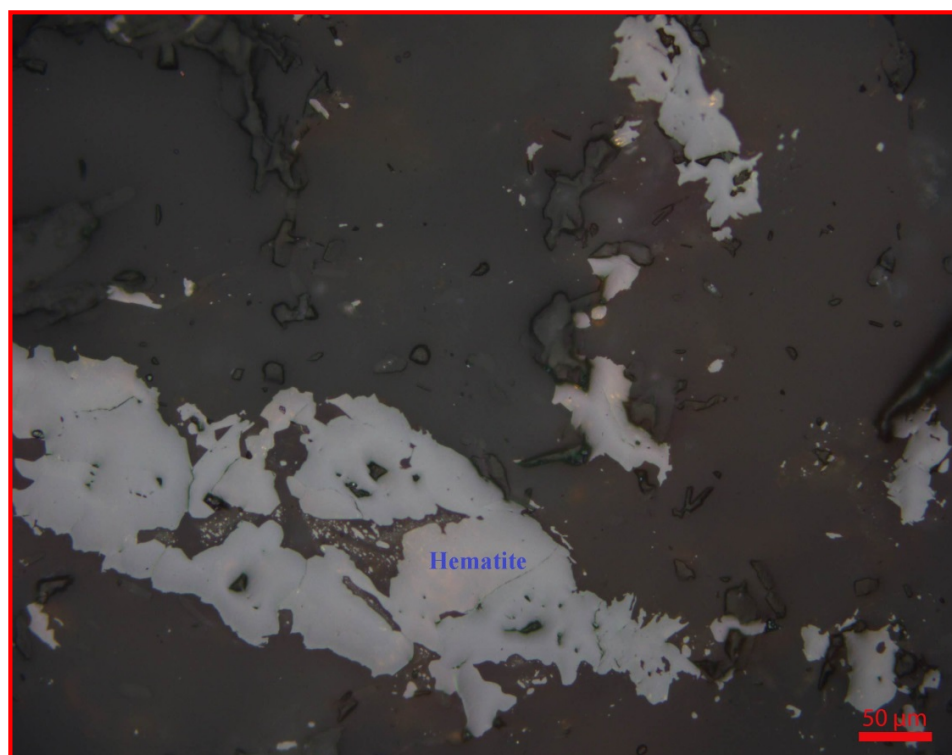
Magnification:200X



Pmg – 7: Photomicrograph showing relicts of bornite within chalcopyrite and chalcopyrite is further replaced by covellite from periphery as seen under reflected light.

Specimen No. : MKBMS03

Magnification : 200X



Pmg – 8: Photomicrograph showing anhedral patches of hematite as seen under reflected light.

Specimen No. : MKBMS06

Magnification : 200X

CHAPTER-8

PREVIOUS WORK

8.1.0 DETAILS OF PREVIOUS EXPLORATION CARRIED OUT BY OTHER AGENCIES

- 8.1.1 Bruce Foote (1900) recorded the presence of copper carbonates in the basement conglomerate for the first time. Ancient attempts at mining and smelting have been recorded by him near Devagondanahalli village. Later Smeeth (1913) of the Mysore Geological Department carried out prospecting work on these conglomerates and recorded the presence of copper and gold. Large number of samples collected by Balaji Rao (1913) of the same Department, indicated traces of gold and minor values for Cu. However, two samples from Kalasapura band collected by him gave a value of 0.42% Cu and traces of gold.
- 8.1.2 Smeeth (1913) carried out prospecting on the basal conglomerate of Bababudan schist belt and recorded the presence of copper and gold. Rama Rao (1963) reported the presence of gold in the basal conglomerate horizon to the north of Chikkmangalur in the Bababudan belt. According to him, panning of these pebbly conglomerates indicated traces of gold and only one stray sample indicated 2 dwt of gold. Following this result, 66 samples were collected by the Mysore Geological Department and all those samples assayed less than 1 dwt. of gold. (Rama Rao, 1963).
- 8.1.3 Narasimhan and Viswanatha of GSI (1970) carried out investigations involving regional mapping (150 sq.km on 1:63,360 scale), plane table mapping (0.33 sq.km on 1:1000 scale), trenching (232 cu.m.) and surface groove sampling (231 nos.) and indicated that the copper mineralisation revealed in grey massive quartzites over a strike length of 800 m over an exposed width of 80 m and an estimated thickness of 15 m. An exploratory drilling programme was recommended to ascertain the width and grade of the deposit.
- 8.1.4 Later during 1973, Viswanatha had carried out exploratory drilling of 9 boreholes (885.25m) in Kalasapura area revealed copper mineralisation occurs in the grey massive quartzite/quartz as fine disseminations over a continuous strike length of 240 metres in the Western Block and as sporadic weak disseminations to over a

strike length of 420 metres in the East Block. Copper mineralisation in individual borehole in the West Block varies from 1.10 to 8.01 m with an average thickness of 3.27 m, over a strike length of 240 metres. The grade varies from 0.13 to 0.29 % Cu with some sections containing up to 0.43% Cu. Mineralized quartzite/quartz reef proved over a strike length of 240 m, with an exposed outcrop width of 60 m and an average thickness of 3.7m. The grade of copper varies from 0.13 % to 0.43%. A possible resource of 0.16 m.t. with an average grade of 0.25% Cu was estimated.

- 8.1.5 Atomic Minerals Directorate for Exploration and Research (AMD) has carried out investigations in various phases during 1973-74, 1974-75, 1975-76, 1976-77 and 2004-05 to locate uranium mineralisation associated with QPC in and around the area. QPC exposed from Hukkund in the west to Gaddalahalli in the east and occurs as detached beds due to folding, faulting and erosion over a stretch of 34 km. Five bands of QPC have been identified with strike lengths. Reconnoitary drilling (2,829m) was carried out by AMD in three areas Viz., Kalasapura (3 boreholes), Devagondanahalli (9 boreholes) and Hosakote (2 boreholes) to explore QPC type of uranium mineralisation. No significant radioactivity has been recorded by AMD in the overlapping part of the block (near Kalasapura), which is mostly soil covered. However, during the course of investigations, as many as 30 uranium bearing QPC occurrences were located by AMD near Kalasapura, Devagondanahalli and Kartikere areas. Radioactivity was recorded intermittently in the QPC and the pebbly quartzite along the Hanumahalli-Kalasapura tract. Grab samples of pebbly quartzite from Hanumahalli-Kalasapura band assayed up to 41 ppm eU_3O_8 (Ra) and 129 ppm ThO_2 whereas samples of QPC assayed 58ppm eU_3O_8 (Ra) and 82 ppm ThO_2 . Further the QPC samples from Hosakote-Devagondanahalli band assayed up to 134 ppm eU_3O_8 (Ra) 296 ppm ThO_2 . A cumulative length of 353.50m SP logging was carried out in the QPC HukundaIndevara-Kartikere-Hosakote-Devagondanahalli-Kalasapura tract which indicated radioactivity up to 0.029% eU_3O_8 . Three boreholes (KPR-1 to KPR-3) with a cumulative meterage of 1,124.50m were drilled in Kalasapura area recorded radioactivity in QPC up to 0.041% eU_3O_8 and thickness up to 2.10m. In view of the radioactivity recorded in QPC in Kalasapura area, AMD recommended that

Gamma-ray logging of boreholes will be helpful in understanding the uranium potential of the block as well as giving clearance for auction in future.

- 8.1.6 GSI (F.S.1986-87) carried out preliminary examination of oligomict conglomerate for gold in parts of the Bababudan group of Dharwar super group in southern Karnataka. The work consisted of large scale mapping, sampling for gold assay, panning and testing for radio activity by G. M. counter in the field at some selected sections in Bababudan, Siggegudda and Chitradurga schist belts. In the type area of Bababudan belt for quartz pebble conglomerate horizon, poor gold mineralisation was met within Kartikere outlier and in the area to the west of Devagondanahalli. Here the QPC horizon is interbanded with orthoquartzite showing current bedding and asymmetric ripple marks. In general, an upward fining of pebble size from 10 cm at the base to 2 cm at the top of the bed is noticeable in this area. Within the section, the QPC horizon containing pyrite and fuchsite mica is invariably auriferous, the gold value ranges from 0.1 g/t to 0.84 g/t. This sulphidic QPC is 1 to 2m wide and the overall thickness of QPC ranges from 10 to 20m. The poor gold value in the basal QPC of Bababudan Group is attributed to a predominantly granitic source area, antiquity of these volcano sedimentary successions and consequent non-availability of suitable auriferous greenstones which developed much later than these ancient conglomerates (3000 m. y. to 3200 m. y.) (Mukherjee, 1990)
- 8.1.7 Under the project National Geophysical Mapping, Regional Gravity and Magnetic (TF) surveys carried out by GSI in Survey of India TS Nos; 48O/1, 48O/2, 48O/11, 48O/13 and 48O/15 in parts of Chikkamagaluru and Shimoga Districts of Karnataka covering an area of 3,600 sq.km during F.S. 2020-21. The Bouguer gravity anomaly map of 48O/11, 48O/13 and 48O/15 demarcates a clear boundary between the PGC-I and Bababudhan group of rocks. Over the Bababudhan Group of rocks, high gravity anomaly and over the granite and gneisses low anomalies are observed. In the central part of the toposheet no 48O/11 and 48O/15, the gradient of gravity contour is very high and shows the tight folding structure which could be the important zone for mineralization point of view. In the magnetic anomaly map a strong bi-polar anomaly is observed in the northern part of the toposheet 48O/11 which could be due to the BMQ bands within the ferruginous phyllite.

CHAPTER-9

AERIAL OR GROUND GEOPHYSICAL OR GEOCHEMICAL DATA

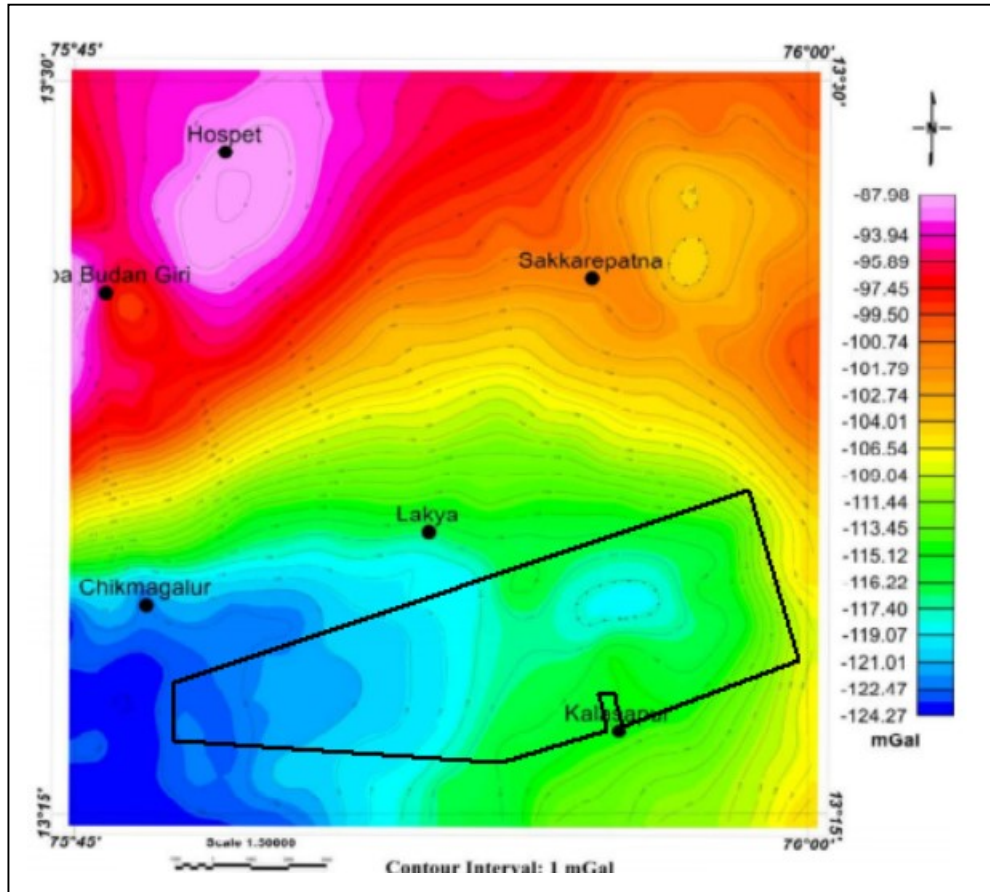
9.1.0 Aerial Or Ground Geophysical Survey

- 9.1.1 Air borne geophysical data is not available for the study area. However, aerial/ground geophysical survey not carried out during present investigation as there is no scope of work.
- 9.1.2 Under the project National Geophysical Mapping (NGPM), Regional Gravity and Magnetic (TF) surveys carried out by GSI in Survey of India TS Nos; 48O/1, 48O/2, 48O/11, 48O/13 and 48O/15 in parts of Chikkamagaluru and Shimoga Districts of Karnataka covering an area of 3,600 sq.km during F.S. 2020-21. The Bouguer gravity anomaly map of 48O/11, 48O/13 and 48O/15 demarcates a clear boundary between the PGC-I and Bababudhan group of rocks. Over the Bababudhan Group of rocks, high gravity anomaly and over the granite and gneisses low anomalies are observed. In the central part of the toposheet no 48O/11 and 48O/15, the gradient of gravity contour is very high and shows the tight folding structure which could be the important zone for mineralization point of view.
- 9.1.3 The Bouguer gravity anomaly map with 1 mGal contour interval is prepared for Toposheet No. 48O/15 with geophysical data of toposheet 48O/15 and presented in **Text Figure- 4**. The gravity anomaly varies from -87.98 mGal to -124.27 mGal. In the southern part of the toposheet gravity low anomaly is observed. In the north-western part high gravity anomaly is observed. In the central part intermediate anomaly is observed.
- 9.1.4 The magnetic anomaly map is prepared using the magnetic data of toposheet 48O/15 with contour interval 100 nT and presented in **Text Figure-5**. The magnetic anomaly varies from 562 nT to -489 nT. The map shows bi-polar anomaly in the north-western part. Intermediate anomalies observed in the eastern part of the study area.
- 9.1.6 The Kalasapura block area is characterised by low (western part) to moderate (eastern part) gravity anomalies and high (western part) to moderate (eastern part)

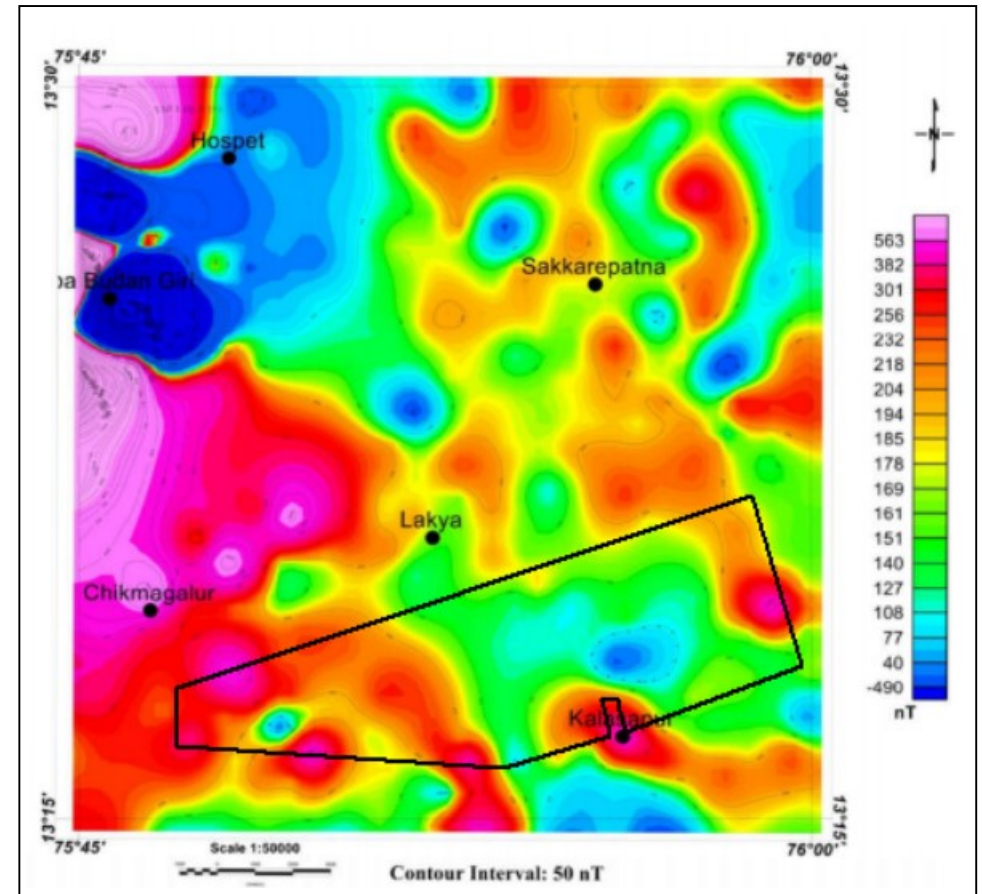
magnetic anomalies. Low gravity anomalies coinciding with high magnetic anomalies in the western part while moderate bouger anomalies coincide with moderate magnetic anomalies in the eastern part of the block area (**Text Figure-4 & 5**).

9.2.0 Geochemical Survey

- 9.2.1 National Geochemical Sampling (NGCM) data of GSI is available for toposheet no. 48O/15 in parts of Chikkamagaluru District of Karnataka. Geochemical data downloaded from NGDR portal and utilised for interpretation for Copper and Gold values in Kalasapura Block. An isolated concentric Copper anomaly (139 ppm and 104.6ppm Cu) observed north of Kalasapura and near Kavinahalli villages respectively. No significant values/geochemical anomalies for gold observed in the area. Geochemical anomaly map for Copper and Gold for Toposheet No. 48O/15 is given as **Text Figure-6 & 7**.
- 9.2.2 During present investigation, stream sediments samples collected and analysed for Au, Cu, Pb, Zn, Ni, Co, Te, Mo and Se and geochemical results discussed in para 10.3.7 of Chapter-10.

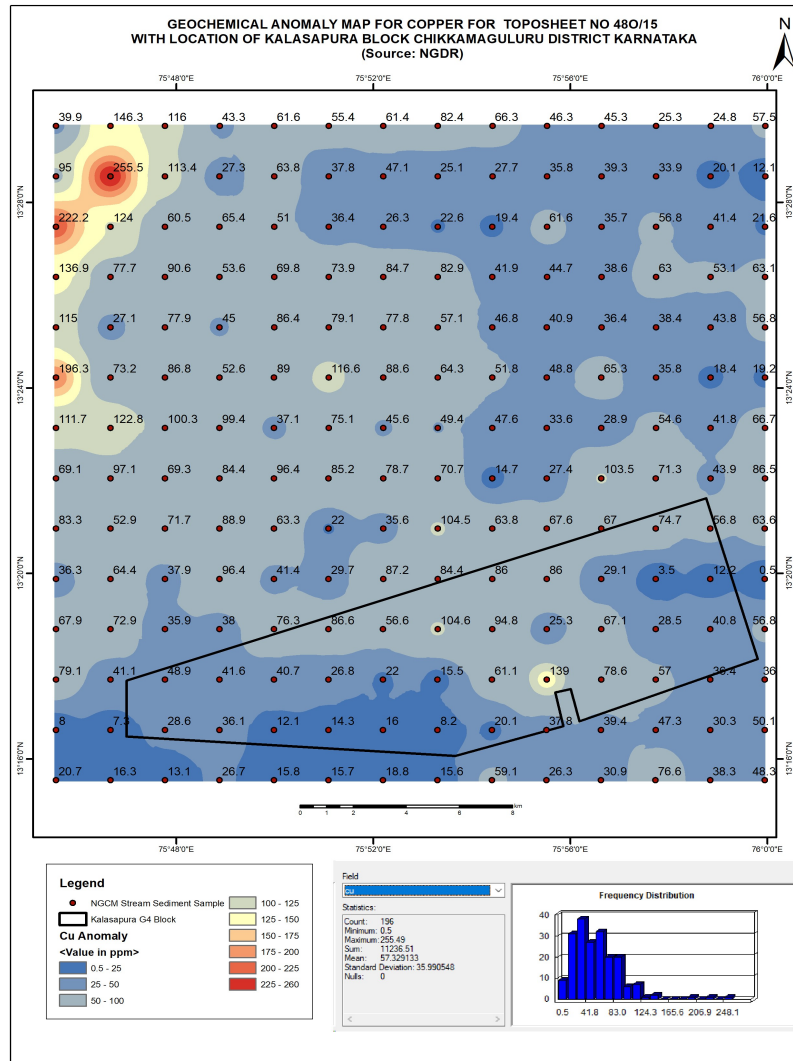


Text Figure-4: Bouguer gravity anomaly map for TS No. 48015



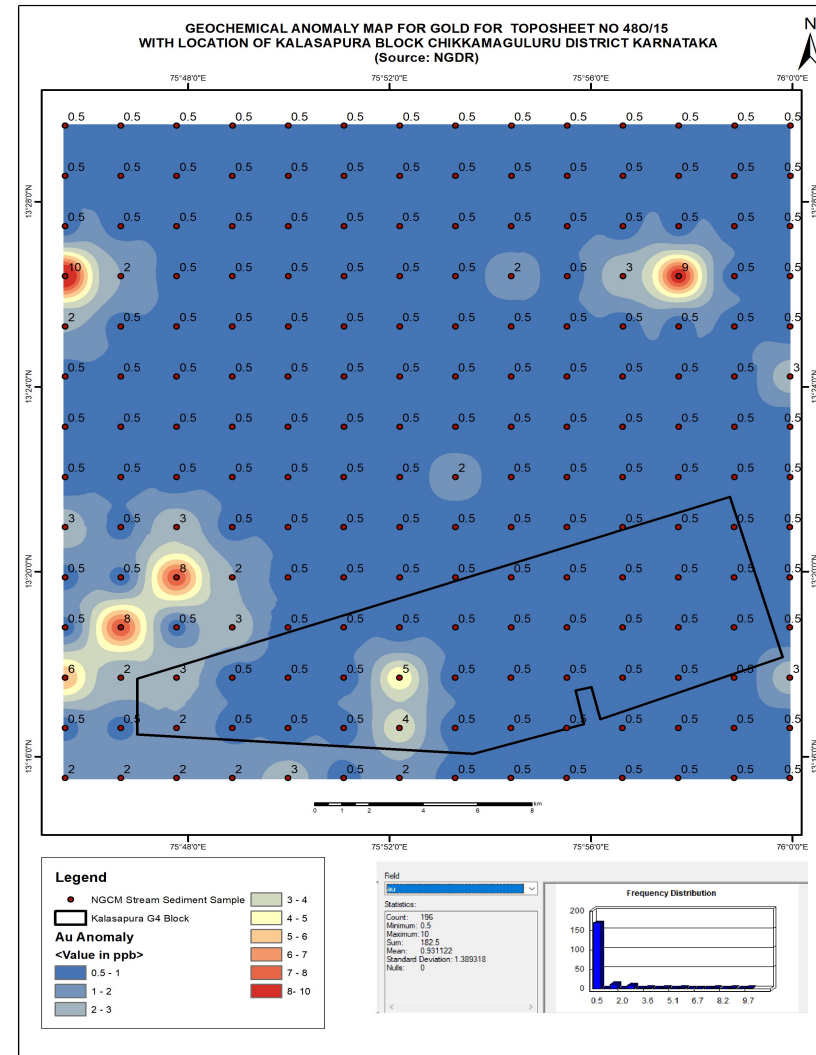
Text Figure.5: Magnetic anomaly map for TS No. 48015

Source: GSI Report on Geophysical Mapping in Toposheet Nos. 480/1,480/2, 480/11, 480/13 and 480/15 in Chikmagalur & Shimoga districts of Karnataka (2021)



Text Figure- 6: Geochemical Anomaly map for copper

Source: NGDR



Text Figure-7: Geochemical Anomaly map for Gold

CHAPTER-10

EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

10.1.0 Background Information

- 10.1.1 Kalasapura (G4) block area lies in the extreme southern part of Bababudan schist belt of Western Dharwar craton of southern India. The area is known for incidence of gold in the basal conglomerates (QPC) from Kartikere, Devagondanahalli and Kalasapura. Disseminated copper mineralisation in grey massive quartzite representing Bababudan group are also reported from Kalasapura area by previous workers in the past.
- 10.1.2 Ancient mining activity, and evidence of smelting for copper ore in the form of slag dumps and clay crucibles seen in the vicinity of Devagondanahalli and Kabbigaragalli of Chikkamagaluru District of Karnataka.
- 10.1.3 In Kartikere and west of Devagondanahalli, the QPC horizon containing pyrite and fuchsite mica is invariably auriferous, the gold value ranges from 0.1 g/t to 0.84 g/t. (Mukherjee, 1990). Sulphide bearing QPC is 1 to 2m wide and the overall thickness of QPC ranges from 10 to 20m. Panning of some samples showed rare fine gold specks. (Mukherjee, 1990).
- 10.1.4 Bhushan, et.al (2010) reported that Bababudan group of QPC contains detrital pyrite and uraninite, and resembles the well-known uranium and gold bearing conglomerates of the Witwatersrand Basin of South Africa.
- 10.1.5 Visawanatha of GSI (F.S.1972-73) carried out exploratory drilling in 9 boreholes (885.25m) in the Kalasapura area (0.33 sq.km) and revealed copper mineralisation in grey massive quartzites associated with quartz-chlorite-schist over a continuous strike length of 240m and 420m in the western and the eastern block respectively. Mineralized quartzite/quartz reef proved over a strike length of 240 m, with an exposed outcrop width of 60 m and an average thickness of 3.7m. The grade of copper varies from 0.13 % to 0.43%. A possible resource of 0.16 m.t. with an

average grade of 0.25% Cu was estimated. Viswanatha (1973) recommended that “The attractive feature of the occurrence is the absence of overburden and favourable topography with the mineralised beds dipping parallel to the slope. If the occurrence proved promising, the prospect appears attractive for cheap cost of exploitation”.

10.1.6 The exploration proposal for Reconnaissance Survey at G4 stage for Gold and Copper in Kalasapura Block has been formulated over larger area of 129 sq.km. excluding the previously GSI (F.S.1972-73) explored block (0.33 sq.km.) to locate potential auriferous zones hosted by QPC and copper mineralisation in the Kalasapura Block area.

10.2.0 OBJECTIVES OF INVESTIGATION

10.2.1. The objectives of present Reconnaissance Survey (G-4 Stage) programme as following.

- a) To carry out large scale Geological mapping on 1:12,500 scale associated with surface geochemical sampling (bedrock/channel/stream sediment) and analysis to identify the surface manifestations and lateral disposition of the QPC hosted Gold mineralisation and copper mineralized zones in the block.
- b) To carryout trenching/pitting work in the identified anomalous areas.
- c) Based on the positive outcome of geological mapping, surface geochemical sample results, and trenching/pitting work, scout drilling (500m in 5 Bhs) shall be carried out in the potential mineral bearing area to confirm the subsurface continuity of mineralisation.
- d) To estimate Reconnaissance resource (334) for Gold, Copper along with accessory elements if any as per UNFC norms and Minerals (Evidence of Mineral Content) Rules-2015 at G-4 level.

10.3.0 PRESENT EXPLORATION

10.3.1 The components of G-4 level of exploration for Gold and Copper mineralisation in Kalasapura block to full fill the above-mentioned objective in accordance with MEMC rule 2015 (amended till 2021) as approved by NMET is furnished in the

Table no 10.1 and the details of the nature and quantum of work proposed vs achieved during present investigation are given.

Table – 10.1
Summarised Table showing Component wise proposed quantum of Work vs. Actual achievement by MECL in Kalasapura Block

Sl. No.	Item of Work	Unit	Target	Achieved
1	Geological Mapping			
	Large scale Geological Mapping (1:12,500 Scale)	Sq.km	129	129
2	Geochemical Sampling			
	a) Bed rock/soil/ stream/channel sampling			
	i. For Gold	Nos.	150	150
	ii. For Cu, Pb, Zn, Ni, Co, Te, Mo and Se	Nos.	150	150
3	Pitting/Trenching			
	i. Excavation of Trenches	cu.m.	200	-
4	Scout Drilling			
	Drilling (6 Scout boreholes)	m.	300	-
5	Borehole Geophysical logging	m.	300	-
6	Laboratory Studies			
	i) Surface Sampling (Bed Rock/Channel/Stream sediment) (Primary samples)			
	a) For Au by Fire Assay	Nos	150	150
	b) For Cu, Pb, Zn, Ni, Co, Te, Mo and Se by AAS	Nos	150	150
	ii) Check Samples (10% External)			
	a) For Au by Fire Assay	Nos	15	15
	b) For Cu, Pb, Zn, Ni, Co, Te, Mo and Se by AAS	Nos	15	15
	i) Trench Samples (Primary & Check samples)			
	a) For Au (Gold) by Fire Assay	Nos	165	-
	b) for Cu, Pb, Zn, Ni, Co, Te, Mo and Se (AAS Method)	Nos	165	-
	i) Borehole Core Samples (Primary & Check samples)			
	a) For Au (Gold) by Fire Assay	Nos	165	-
	b). for Cu, Pb, Zn, Ni, Co, Te, Mo and Se (AAS Method)	Nos	165	-
	c) 34 Elements by ICPMS	Nos	15	-
	Petrological Samples (Surface & Bh Core Samples)			
	a) Preparation of Thin Section		10	7
	b) Study of Thin Section	Nos	10	7
	Mineragraphic Studies (Surface& Bh Core Samples)			
	a) Preparation of Polished Section		10	6
	b) Study of Polished Section	Nos.	10	6
	c) Digital Photograph		10	8
	Whole Rock Analysis	Nos.	10	10
	Specific Gravity	Nos.	5	-
7	Geological Report	Nos.	1	1

10.3.2 The Reconnaissance Survey (G4) work for Gold and Copper mineralisation in Kalasapura Block included large scale geological mapping on 1:12,500 scale over 129 sq.km. area, collection and analysis of surface samples (Bedrock/Channel/stream sediment) and associated laboratory studies. The component wise description has been given in subsequent paragraphs.

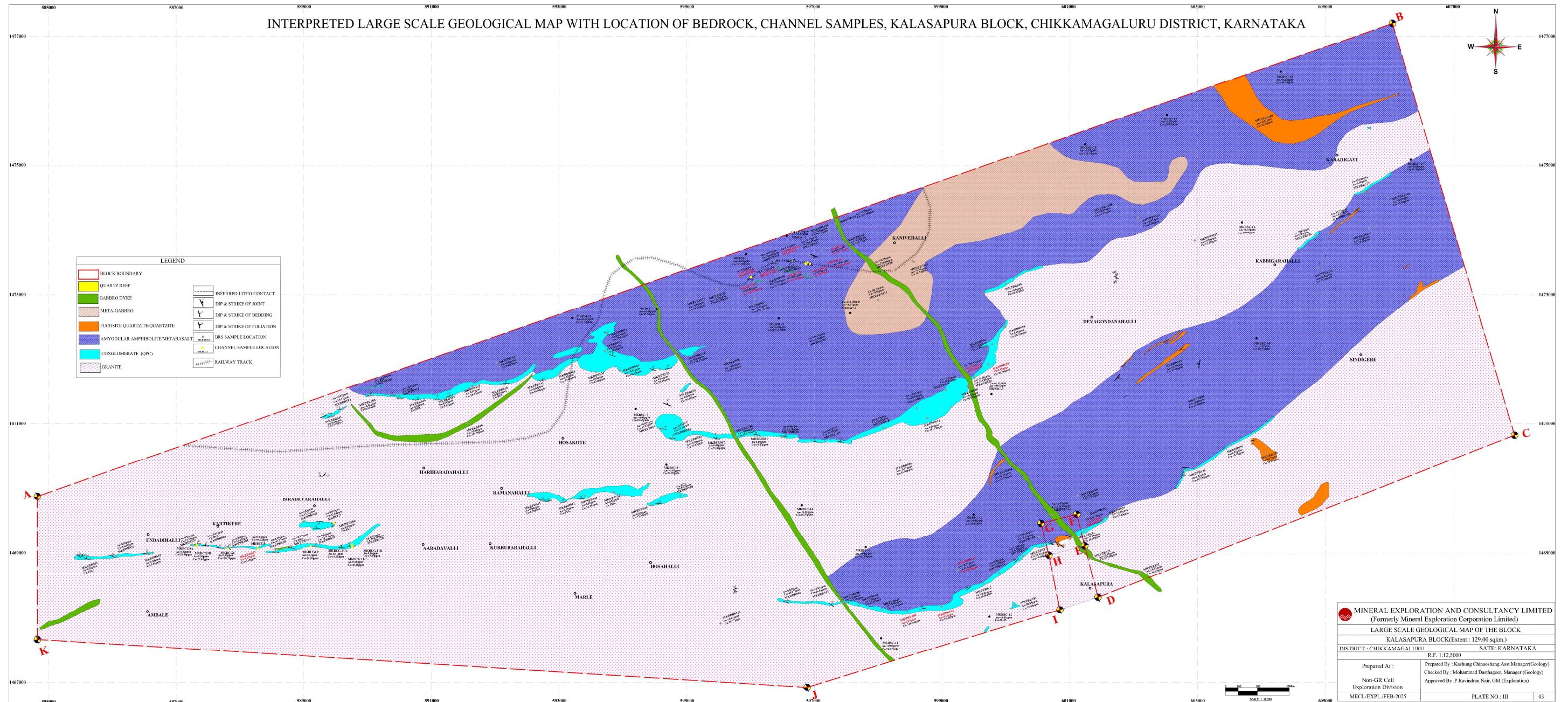
10.3.3 Geological mapping

Large scale Geological Mapping (LSM) was carried out over 129.0 sq. km area on 1:12,500 scale in the Kalasapura Block located in part of Survey of India toposheet no 48O/15. Survey of India toposheet was used to understand the topography, roads, and drainage of the mapped area and was also used as a base map for the LSM.

For recording precise sample location and to carry out a geological survey, handheld GPS of Garmin 10X has been used. The coordinates had been recorded in UTM coordinate system with WGS 1984 datum. Variation of lithologies along with the structural elements were systematically recorded and prepared the final geological map as presented in **Plate No-III** as well as **Text Fig No 8**.

During mapping, various lithounits encountered in Kalasapura block are Quartz Pebble Conglomerate, Quartzite, Fuchsite quartzite, Amphibolite Schist, Granite, Gabbro Dyke and Meta Gabbro. The description of lithology has been furnished in paragraph no 7.5.0 of Chapter No -7.

Text Figure-8: Interpreted Large Scale Geological Map of Kalasapura Block, Dist.-Chikkamagaluru, Karnataka



10.3.4 Sampling

Sampling is a systematic process for collection of material from any media which can provide the best representation. In the present study, sampling includes bed rock sampling (BRS), channel sampling and Stream Sediment Sampling (SS). Total of 230 nos. of BRS, 30 nos channel samples from exposed outcrops and 40 nos. stream sediment samples (SS) have been collected mainly from the 2nd order and 3rd order of the streams. Total 10 nos of BRS sample have been collected for whole rock analysis. Moreover, total 7 nos. BRS samples for petrographic and mineragraphic studies from different lithologies exposed in the block.

10.3.5 Sampling techniques:

A. Bedrock Samples: A total of 115 nos. of bed rock samples (BRS) were collected systematically from different litho units exposed in the study area. The targeted QPC occurring throughout the area was sampled for gold mineralisation and Amphibolite/Amphibolite schist, quartzite sampled for copper contents. Out of total 115 nos. BRS samples, total 72 nos. samples collected from QPC Total 12 nos of BRS samples collected in an around Undadihalli, Kartikere & Birradevarahalli out of this 7 nos of BRS of QPC collected from pebbly horizon of QPC and 5 nos samples from mixed horizon of QPC respectively. Total 6 nos of QPC BRS samples collected in an around Ramanahalli & Hosahalli out of this 3 nos of QPC pebbly horizon and 3 nos of QPC mixed horizon were collected respectively. Total 35 nos of QPC BRS samples collected in an around Hariharadahalli, Hosakote & Devagondanahalli, out of this 19 nos of QPC pebbly and 16 Nos of QPC mixed were collected respectively. Total 16 nos of QPC BRS samples collected in an around Kalasapura, out of this 7 nos of QPC pebbly and 9 nos of QPC mixed horizon were collected respectively., 20 nos. from Amphibolite, 9 nos. from Gabbro, 5 nos. each from fuchsite quartzite and quartz veins, 3 Nos. from Granite and one sample from meta gabbro rock. The Bedrock chip samples were collected by chipping exposed rock units in 1 m radius by sledge hammer (5kg) and chisel. During the sampling, surface was properly cleaned and each sample was collected in separate plastic bags. After collecting each sample, all the instruments were properly cleaned before proceeding for next sample collection to maintain quality and to avoid contamination. The sample locations are

plotted on geological map (**Plate No-III**). First, each Bedrock sample of 2-3 kgs collected from the field was crushed. After crushing, the crushed samples were mixed thoroughly and reduced the sample size to 500 gm by coning and quartering. This representative samples were powdered and completely passed through (-) 200 mesh size sieves from which 100 gm sample packed in polythene sample pouch and submitted for chemical analysis for Au by fire assay method and for Cu, Pb, Zn, Ni, Co, Te, Mo and Se by AAS method from MECL Laboratory, Nagpur. Total 10 selected samples of varied rock types were also analysed for major oxides by XRF. The remaining 400 gm sample has been preserved for future reference.

B. Channel Samples: Channel samples were collected from the suitable exposed outcrops/ sections where alteration features and sulphide incidence are noted. The channelling was done cutting across the strike direction of the zone by using proper hammer and chisel. The zone was marked properly on the surface using colour paint. Channel sample were collected with an interval of 1m based on the type of mineralization/lithology Chipped samples were collected along the channel cut and packed in polythene sample bags with proper labelling. While sampling, due care was taken to avoid contamination of samples. The sample locations are plotted on geological map (**Plate No-III**). A total of 15 Nos. channel samples were collected from west of Kanivehalli area and sent for analysis for Au by fire assay method and for Cu, Pb, Zn, Ni, Co, Te, Mo and Se by AAS method from MECL Laboratory, Nagpur.

C. Stream Sediment sampling: The drainage map has been prepared by digitizing the Survey of India toposheet no 48O/16 by using AutoCAD/ArcGIS software to plan and collect stream sediment samples. Then the probable location for collection of stream sediment samples were carefully marked on 2nd or 3rd order streams within the block. Probable locations marked on the prepared drainage map were visited and identified suitable trap sites around that point for collection of samples. Each stream sediment sample comprises of material collected from five points around the suitable trap sites. Due care was taken during collection of samples from narrow channels and avoided material that has fallen from the banks. About 5 Kg samples was collected with the help of scoop and shovel and the sample was dried in natural sunlight. Samples collected from central and eastern part of the block area. Thus, a total 20

Nos of Stream sediment samples were collected from the Kalasapura block and the samples were marked systematically with suffix “MKBSG”. The sample locations are plotted on geological map (**Plate No-IV**). These samples were preserved in plastic bags and samples were transported to MECL Laboratory, Nagpur for further processing. The 5 kg samples were passed through available (-)72 mesh sieve to get uniform natural fraction of the samples. Then these portions were pounded and passed through (-) 200 mesh sized sieve from which 500 gm sample has been collected by coning and quartering. From the 500 gm sample, 100 gm sample packed in polythene sample pouch and submitted for chemical analysis for Gold by fire assay method and for Cu, Pb, Zn, Ni, Co, Te, Mo and Se by AAS method from MECL Laboratory, Nagpur. The remaining 400 gm sample has been preserved in another polythene pouch for future reference.

10.3.6 Geochemical Analysis

Geochemical analysis of 115 nos. bedrock samples, 15 nos. Channel samples and 20 nos of stream sediments were subjected to gold analysis and for copper and associated elements (Cu, Pb, Zn, Ni, Co, Te, Mo and Se). Further, 10 nos of selected varied litho unit samples were subjected to analyses of major oxides, i.e., SiO₂, Al₂O₃, Fe₂O₃, TiO₂, MnO, CaO, MgO, Na₂O, K₂O, H₂O, P₂O₅, CO₂, S by XRF instrument. All these analyses have been carried out in MECL’s Chemical Laboratory in Nagpur. The details of chemical analyses are given in **Annexure-IA, IB, IIA, IIB, IIIA, IIIB & IV**.

10.3.7 Discussion on Geochemical Analyses

A. Bedrock Samples:

Lithounits showing signatures of sulphides presence or suspected for sulphide potential with alternation features were sampled to confirm the existence of mineralization through geochemical abundance. Total 115 nos Bedrock samples collected from the block area for analysis of Au, Cu, Pb, Zn, Ni, Co, Mo, Se & Te. The details of collected bed rock samples are provided for Au in **Annexure-I-A** and for 8 radicals (Cu, Pb, Zn, Ni, Co, Mo, Se & Te) in **Annexure-I-B**. The location of samples along with Au & Cu value on **Plate-III**. The collected samples are categorized in 7 groups namely Quartz pebble conglomerate, Amphibolite, Gabbro

dyke, Quartz vein/reef, Quartzite/Fuchsite quartzite, Granite and Metagabbro. The samples were analysed for Au by fire assay method and for base metals ((Cu, Pb, Zn, Ni, Co, Te, Mo and Se) by AAS method and their summarized details are provided for Au and Cu in **Table 10.2**.

Table 10.2: Bedrock sample details for Gold & Copper in Kalasapura Block

S.No.	Lithology	Au			Cu		
		Total Samples (Nos.)	Min (ppm)	Max (ppm)	Total Samples (Nos.)	Min (ppm)	Max (ppm)
1	Quartz Pebble Conglomerate	72	0.01	0.45	72	2.01	281.18
2	Amphibolite	20	0.01	0.1	20	138.2	5900
3	Gabbro dyke	9	<0.01	<0.01	9	187	566
4	Quartz Vein/Reef	5	<0.01	<0.01	5	11.01	17.74
5	Quartzite/Fuchsite quartzite	5	<0.01	<0.01	5	15.66	33.25
6	Granite	3	<0.01	<0.01	3	12.21	16.9
7	Meta Gabbro	1	<0.01	<0.01	1	80.59	80.59
	Total	115			115		

Out of 115 nos bedrock samples, total 72 nos samples collected from QPC outcrops/exposures from pebbly and mixed (matrix/pebbly) horizon throughout the area and analysed for Au. Total 12 nos of BRS samples collected in an around Undadihalli, Kartikere & Birradevarahalli out of this 7 nos of BRS of QPC collected from pebbly horizon of QPC and 5 nos samples from mixed horizon of QPC respectively. Total 6 nNos of QPC BRS samples collected in an around Ramanahalli & Hosahalli out of this 3 nos of QPC pebbly horizon and 3 nos of QPC mixed horizon were collected respectively. Total 35 nos of QPC BRS samples collected in an around Hariharadahalli, Hosakote & Devagondanahalli, out of this 19 nos of QPC pebbly and 16 nos of QPC mixed were collected respectively. Total 16 nos of QPC BRS samples collected in an around Kalasapura, out of this 7 nos of QPC pebbly and 9 nos of QPC mixed horizon were collected respectively.

Out of total 72 nos BRS samples collected, total 6 nos. QPC samples shown 0.11ppm to 0.45 ppm Au, 46 nos samples shown 0.01ppm to 0.09ppm Au and 20 nos samples analysed <0.01 ppm Au.

Samples collected from Pebbly horizon of QPC indicated Au values range from 0.01 to 0.17 ppm Au, while Mixed horizon (matrix/pebbly) of QPC shown Au value range from 0.01 ppm to 0.45 ppm Au.

Out of total 20 nos samples collected from Amphibolite, one sample (MKBBRS27) collected from Railway track section near Kanivehalli shown 0.10ppm Au value, two samples shown 0.01 ppm to 0.03 ppm Au and 17 nos samples analysed <0.01 ppm Au. Other litho units not shown any values (<0.01 ppm Au) for Gold.

Copper sulphide mineralisation noticed in Amphibolite/chloritic schistose rock associated with thin quartz veins exposed in Railway cutting section west of Kavinahalli. Total 12 nos BRS samples collected from the area shown Cu value range from 138.20 ppm to 5900 ppm Cu. 3 nos BRS samples shown high Cu value range from 561 ppm to 5900ppm Cu.

B. Channel Samples: Total 15 nos channel samples collected from outcrops/sections of QPC and Amphibolite to check for gold, copper and associated mineralisation. The details of collected channel samples are provided for Au in **Annexure-II-A** and for 8 radicals (Cu, Pb, Zn, Ni, Co, Mo, Se & Te) in **Annexure-II-B**. Total 9 nos channel samples collected from QPC outcrops near Kartikere area indicated 0.01 ppm Au to 0.06 ppm over 1.0m length. Out of 9 nos Channel samples, total 8 nos samples collected from mixed horizon (matrix/Pebble) of QPC indicated 0.01 ppm to 0.06 ppm Au while one sample collected from Pebbly horizon of QPC (MKBCHG10) shown 0.03 ppm Au value. Cu values range from 19.65 ppm to 120.76 ppm Cu, Pb value from 12.82ppm to 24.57 ppm Zn value from 11.63 ppm to 33.27 ppm Zn, Ni value from 3.28 ppm to 12.91ppm, Co value from 4.67ppm to 45.24ppm, Mo value from 1.07 ppm to 3.10ppm, Se value from BDL to 0.33ppm and Te value from 0.13ppm to 0.53 ppm. Sample analysis of QPC for Au, Cu, Pb, Zn, Ni, Co, Mo, Se & Te are not encouraging. Summarized details of channel samples are provided for Au and Cu in **Table 10.3**.

Table 10.3: Channel sample details for Gold & Copper in Kalasapura Block

S.No.	Lithology	Au			Cu	
		Total Samples (Nos.)	Min (ppm)	Max (ppm)	Min (ppm)	Max (ppm)
1	Quartz Pebble Conglomerate	9	0.01	0.06	19.65	120.76
2	Amphibolite	6	<0.01	0.03	634.36	1800

Amphibolite samples (6 nos.) collected from Railway track section in west of Kanivehalli shown Au value range from <0.01ppm to 0.03 ppm Au. Channel samples (6 nos.) shown encouraging high values for Cu range from 634.36ppm 1800ppm over 0.5m length. Pb value range from 8.23 ppm to 61.64 ppm, Zn value from 73.30ppm 201.72 ppm, Ni value 27.24ppm to 70.03ppm, Co value 29.59ppm to 84.20ppm, Mo value from 0.37ppm to 1.41 ppm, Se value from BDL to 0.59ppm and Te value from BDL to 0.31ppm. Sample analysis of Amphibolites for Au, Pb, Zn, Ni, Co, Mo, Se & Te are not encouraging.

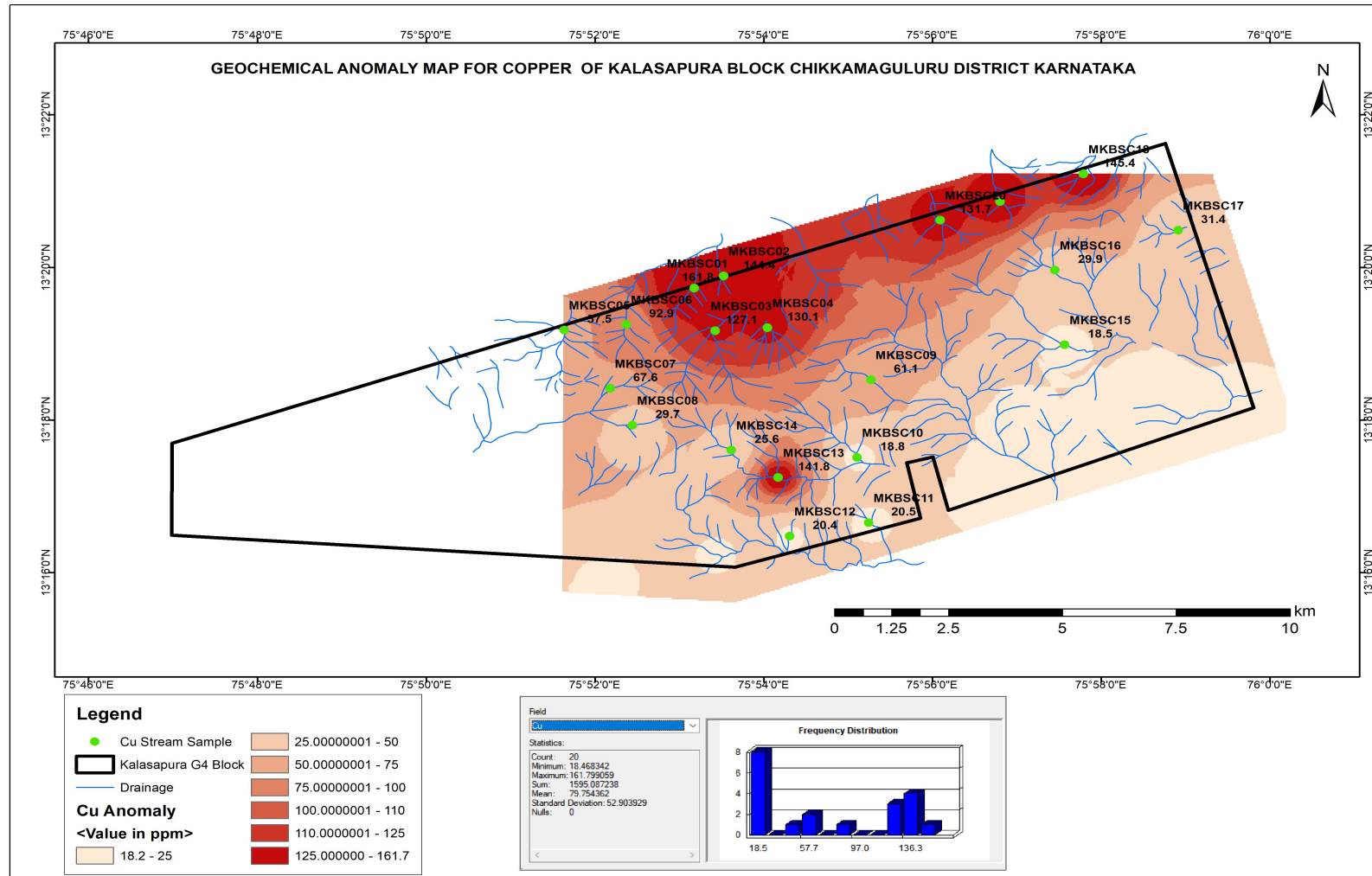
C. Stream Sediment Samples: Total 20 nos stream sediment samples collected from 2nd and 3rd order streams from the central and eastern part of the block area for analysis of Au, Cu, Pb, Zn, Ni, Co, Mo, Se & Te. The details of collected stream sediments samples are provided for Au in **Annexure-III-A** and for 8 radicals (Cu, Pb, Zn, Ni, Co, Mo, Se & Te) in **Annexure-III-B**. All samples analysed poor Au values (<0.01 ppm Au). Cu values varying from 18.47 ppm to 161.80 ppm with an average 79.75ppm. Total 8 nos samples indicated Cu value 127.13ppm to 161.80ppm. The geochemical map for copper has been prepared based on stream sediment sample data and given as **Text Fig No-9** and **Plate No. IV**. Geochemical map for Copper shows relatively higher concentration of Cu anomalies around Kavinahalli area and northeastern part of the Kalasapura block.

Stream sediment samples for Pb value varying from 6.71ppm to 16.16ppm with an average 11.12ppm, Zn value from 24.27ppm to 118.48ppm with an average 70.45ppm, Ni value from 9.10ppm to 272.26ppm with an average 78.17ppm, Co value from 3.61ppm to 93.99ppm with an average 39.17ppm, Mo value from 0.28ppm to 1.70ppm with an average 0.80ppm, Se value from 0.19ppm to 1.06ppm

with an average 0.53ppm and Te value from <0.01 to 0.28ppm with an average 0.05 ppm. Stream sediment sample analysis for Au, Pb, Zn, Ni, Co, Mo, Se & Te are not encouraging.

10.3.8 Whole Rock analysis

Total 10 nos. samples representing Quartz Pebble Conglomerate, Amphibolite, quartzite, Gabbro, Quartz, Granite were subjected to whole rock analysis. Study of the samples revealed that Amphibolite and Gabbro contain high iron oxides while Quartz pebble conglomerate contains relatively high titanium dioxide. Whole rock analysis of samples is given in **Annexure No-IV**.



Text Figure-9

10.3.9 Petrographic Study

Petrographic study was carried out 7 nos of samples collected from different litho units i.e., QPC with pyrite/fuchsite, Amphibolite/metabasalt, quartzite, meta gabbro, dolerite and granite. The findings of petrographic study have been discussed along with the description of rock types in the area. However, the petrographic study report has been attached as **Annexure No-VI**.

10.3.10 Mineragraphic Study

Total 6 nos of samples collected from QPC with pyrite/fuchsite, fuchsite quartzite, Amphibolite/metabasalt with sulphides have been subjected to mineragraphic study by preparing polished section. The mineragraphic study report has been attached as **Annexure No-VII**.

10.3.11 Outcome of Present work:

During the course of large-scale mapping, Quartz Pebble Conglomerate (QPC) bearing linear bands trending in E-W direction mapped within the area. Strike length of individual QPC bands varies from 430m to 6330m. Out of total 72 nos. bedrock samples collected from QPC, 6 nos samples shown gold values range from 0.10ppm to 0.45 ppm Au in East of Kartikere, SW of Devagondanahalli and SW of Kalasapura. Gold values in QPC are not encouraging.

Low concentration of gold in Quartz pebble conglomerate (QPC) may be attributed to several geological and geochemical factors such as lack of gold rich source rocks, sedimentary conditions, lack of gold traps and timing of QPC deposition. Non availability of suitable auriferous greenstones in the region which developed much later than these ancient conglomerates hence perhaps QPC not inherit significant gold content.

In North of Kalasapura village, sulphide hosted grey quartzites associated with quartz-chlorite schist occurring in the previously explored GSI block (0.33 sq.km.) is mostly restricted within the GSI block only and no further strike extensions are seen in the block area. Bedrock samples collected from quartzite in strike extension shown poor copper values as the quartzite contain poor/no copper sulphides.

In West of Kanivehalli area, Copper sulphide mineralisation noticed in Amphibolite/chloritic schistose rock associated with thin quartz veins exposed in Railway cutting section. In general, the sulphide zone trending E-W to NNW-SSE direction and dipping 20° to 70° towards S to SSE over a strike length of about 900m along the railway track. Total 12 BRS samples collected from the area shown Cu value range from 138.20 ppm to 5900 ppm Cu. 3 BRS samples shown high Cu value range from 561 ppm to 5900ppm Cu. Total 6 nos. Channel/grove samples collected from the exposed Amphibolite/Chloritic schist rock in Railway cutting section shown high Cu values range from 634.36 to 1800 ppm. High anomalous values for copper reported in bedrock/channel samples all along the Railway track section. Geochemical stream sediments anomalies for copper also coincide with surface samples results around Kanivehalli area.

Based on the analysis of the Bedrock and Channel samples, one potential area (Area-1) over 2.3 sq.km. for copper has been demarcated west of Kanivehalli (**Plate No. V**). Scout drilling and associated trenching work would be helpful to confirm the sub-surface depth continuity of mineralisation. However, Railway line passing through the potential area is the main constraint to carry out further exploration.

The outcome of work (Phase-I) presented in 71st TCC meeting held on 25th & 26th Nov, 2024 through V.C. It was opined that the potential area is in close proximity with Railway track and may likely to pose feasibility issues for further exploration in the area. Hence, the TCC committee advised to close the project, submit the report and no further work recommended in the area.

10.3.12 Preparation of Geological Report:

Geological Report has been prepared in Corporate Office, MECL, Nagpur by integration of geological and geochemical data. AutoCAD and ArcGIS software has been used for preparation of various maps. The report has been written using Microsoft word and excel 2021 version.

CHAPTER-11

SUB-SAMPLING TECHNIQUES AND SAMPLE PREPARATION

11.1.0 Sampling

11.1.1 Sampling has been carried out in the Kalasapura Block includes Bedrock, Channel samples and stream sediments. A total of 115 nos. of BRS collected from varied litho units, 15 nos channel samples collected from outcrops, cutting, sections and 20 nos. stream sediment samples have been collected each for analysis of Au and Cu, Pb, Zn, Co, Mo, Se & Te respectively. Total 10 nos. Bedrock samples collected for whole rock analysis.

11.2.0 Nature, quality and appropriateness of sample preparation technique

11.2.1 Sampling methodology adopted for bedrock, channel and stream sediment is different from each other. The detailed description of sampling methods for each type of sample has already been discussed in Chapter-10.

11.3.0 Quality control procedures adopted during sampling

11.3.1 The samples have been prepared under the supervision of geologist and qualified sampling technician. During the sampling, surface was properly cleaned and each sample was collected in separate plastic bags for bedrock/channel samples. After collecting each sample, all the instruments were properly cleaned before proceeding for next sample collection to maintain quality and to avoid contamination. All the stream-sediment samples collected from the field were dried under natural sunlight packed properly in the polythene sample bag with proper tag. Then the entire samples were transported to central sample processing unit located in Nagpur. It has been thoroughly checked that none of the sample bags were damaged during transportation.

11.3.2 Further measures have been taken during sieving and pounding/grinding of samples. The sieve and containers have been cleaned after processing of each sample to avoid contamination and measures have also been taken to avoid loss of powder in air.

11.4.0 Measures taken to ensure that the sampling is representative of the in-situ material collected.

11.4.1 It is very important to submit the representative sample of collected material for geochemical analyses. As discussed in the previous chapter, initial sieving in (-) 72 mesh size have been carried out on the soil and stream sediment samples to collect the natural fraction. Further after pounding and passing samples of soil and stream sediment through (-)120 mesh sieve and crushing, grinding and passing through (-) 200 mesh sieves for Bed rock samples, quantity of the samples has been reduced to 500 gm by coning and quartering method after thoroughly mixing to maintain the homogeneity of the samples. Hence it can be assumed that the samples remain representative in nature of in situ material collected.

11.5.0 Appropriateness of grain size

11.5.1 In accordance with the standard sampling procedures, it has also been observed that smaller the particle size, higher the homogeneity of the sample as well as higher the dissolvability during the chemical analysis. As per the standard practice, Bedrock, Channel and stream sediment samples are generally pounded to (-) 200 mesh size for analysis of Au, Cu, Pb, Zn, Ni, Co, Mo, Se & Te.

CHAPTER-12

QUALITY OF ASSAY DATA AND LABORATORY TESTS

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

The primary samples from gold and copper mineralization have been analyzed for Au, Cu, Pb, Zn, Co, Ni, Se, Mo & Te in Chemical Laboratory of MECL. The methodology of chemical analysis is described in the following paragraphs.

12.1.1 Analysis of Copper and associated minerals by AAS Method

The analysis for copper and associated elements has been carried out by Atomic Absorption Spectroscopy (AAS) method by Analytical Jena ZEE nit model instrument. The Standard Operating Procedure (SOP) for the Determination of Copper (Cu) and associated elements using AAS is given below.

Reagents and Standards

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

Procedure

1. Weigh 0.3 – 1.0 gm of the sample in a 250 ml beaker and add 50-60 ml aqua regia.
2. Cover the beaker with watch glass, and digest on hot plate for 5-6 hrs till syrup like solution is formed.
3. After digestion, add 10-20 ml water and heat for 5-10 minutes and filter by Whatman grade – 40 filter paper, in 250 ml volumetric flask.
4. Wash the residue with hot distilled water for four to five times.
5. Add the washings to the filtrate and makeup the volume up to 250ml.
6. Aspirate the sample solution in AAS using Air-Acetylene flame mode with following settings-
(AAS to be calibrated before testing samples with at least 10 calibration points)
 - Wavelength - 324.7 nm,
 - Slit width - 0.5 nm,

- Lamp current - 4.0 mA
- Instrument mode - Absorbance

7. Read the absorbance and concentration on atomic absorption spectrophotometer (Analytical Jena ZEE nit model).

(Run CRM and repeat samples after every 20 samples)

Calculation

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

12.1.2 Analysis of Gold (Au) by fire assay method.

Samples are prepared as weighted 50 fusion pots in a batch. Prior to using fusion pots for weighing a visual inspection inside the fusion pot is performed. The sample is weighed 50g in a fusion crucible containing flux of Lead monoxide, sodium carbonate, borax, silica, silver nitrate fused in a preheated fusion furnace 1050⁰C for 45 minutes and the molten melt is poured into a cast iron mold. The lead bottom is separated from the slag and oxidized in a cupellation furnace keeping in a cupel for one hour. The obtained Prill is cooled and digested in aqua regia and aspirated in Atomic Absorption Spectrometer for ppm levels.

12.1.3 Methodology of Chemical Analyses by XRF

Chemical Laboratory, MECL, Nagpur have RIGAKU make ZSX PRIMUS IV XRF instrument for analyses of major oxides. First pellets of the powdered samples are made using hydraulic press. Then the XRF instrument is calibrated using suitable matrix matching CRMs. After calibration of the instrument the samples are analyzed and the values of the SiO₂, Al₂O₃, Fe₂O₃, MnO, MgO, CaO, Na₂O, K₂O, TiO₂, P₂O₅, CO₂, H₂O, S are obtained from the software.

12.2.0 NATURE OF QUALITY CONTROL PROCEDURES ADOPTED

12.2.1 The standard procedure of quality control has been adopted during the chemical analysis in Chemical laboratory, MECL, Nagpur which includes

- (i) Analysis of Certified reference materials/measurement standards
- (ii) Analysis of blind samples
- (iii) Use of QC samples and control charts
- (iv) Analysis of blank samples
- (v) Analysis of spiked samples
- (vi) Analysis in duplicate samples

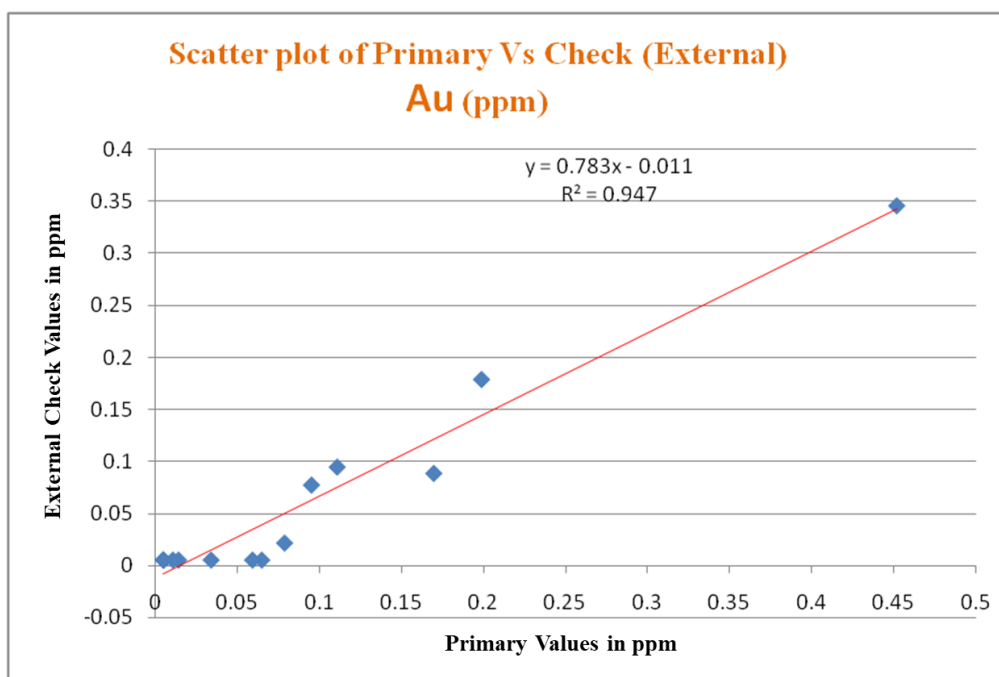
12.3.0 CHECK ANALYSIS FROM THIRD PARTY NABL ACCREDITED LABORETORY

12.3.1 In accordance to the standard practice of quality assurance and quality control, 15 numbers of primary samples (10% of primary samples) have been analysed as external check samples for Au and Cu, Pb, Zn, Ni, Co, Mo, Se & Te in NABL accredited laboratory i.e. M/s Shiva Analyticals Laboratory, Bengaluru. In order to assess the reliability of homogeneity of primary samples and repeatability of their chemical analysis with primary samples results of MECL laboratory and external check sample results of M/s Shiva Analyticals Laboratory has been compared with primary sample results for all elements and found no major or significant difference between the results. The details of Primary and External Check samples are given in the **Annexure-V-A & V-B respectively**.

12.3.2 The comparative studies of primary Vs External check analysis for Gold (Au) is given in Table-12.1 and scatter plots is represented as Text Figure- 10.

Table-12.1: Comparison of Primary vs Internal Check Samples for Gold

SL. NO.	COMPARISION INDEX	Primary Analysis for Cu (ppm)	External Check Analysis for Cu (ppm)
1	No. of Sample pairs	15	
2	Arithmetic Mean	0.087	0.057
3	Standard Deviation	0.114	0.092
4	Standard Error of Mean	0.029	0.024
5	Variance	0.013	0.008
6	Mean of Deviation	0.031	
7	Correlation coefficient	0.973	
8	Paired T value	3.654	
9	F Test value	1.544	



Text Figure 10: Scatter Plot of primary V/s Check (External) Analysis Au (ppm)

12.3.3 The data set for primary Vs external check analysis comprises 15 pairs of samples. Table-12.1 shows that the difference in arithmetic mean, standard deviation, standard error of mean and variance of primary and external check samples are not high. The value of R^2 given in scatter plot (Text Figure – 10) is 0.947, which is close to 1.00 and indicates a good correlation in primary and external check analysis.

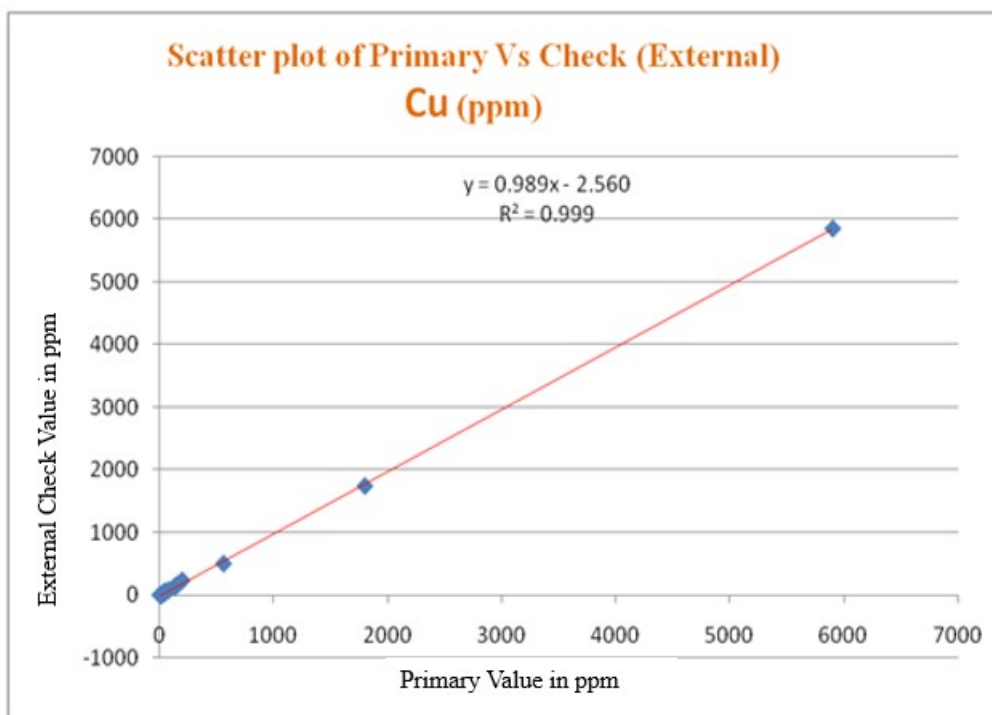
12.3.4 The statistical and comparative studies for primary Vs external check samples shows the repeatability of the analysis for Au i.e. insignificant differences between

primary and external check analysis, which support the reliability of sampling procedure.

12.3.5 The comparative studies of primary Vs External check analysis for Copper (Cu) is given in Table-12.2 and scatter plots is represented as Text Figure- 11.

Table-12.2: Comparison of Primary vs Internal Check Samples for Copper

SL. NO.	COMPARISION INDEX	Primary Analysis for Cu (ppm)	External Check Analysis for Cu (ppm)
1	No. of Sample pairs	15	
2	Arithmetic Mean	609.353	600.249
3	Standard Deviation	1481.21	1465.463
4	Standard Error of Mean	382.447	378.381
5	Variance	2193983.401	2147582.525
6	Mean of Deviation	9.105	
7	Correlation coefficient	0.999	
8	Paired T value	1.31	
9	F-Test value	1.022	



Text Figure 11: Scatter Plot of primary V/s Check (External) Analysis Cu (ppm)

12.3.3 The data set for primary Vs external check analysis comprises 15 pairs of samples. Table-12.1 shows that the difference in arithmetic mean, standard deviation,

standard error of mean and variance of primary and external check samples are not high. The value of R^2 given in scatter plot (Text Figure – 10) is 0.999, which is close to 1.00 and indicates a good correlation in primary and external check analysis.

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

12.4.0 SECURITY AND CHAIN OF CONTROL OF SAMPLES

- 12.4.1 The samples have been prepared at centralized mechanized sampling unit with proper labeling and tag and sent to chemical laboratory in supervision of qualified sampling technician. The samples has been transported from field to sample processing unit with proper sealing of sampling bags and the same has been verified in the sampling unit before opening the bags. At the sampling unit, standard procedure has been followed and all the precautionary measures have been taken to avoid the contamination. Further the remaining samples are propoerly preserved with sample tags for any future reference under the custody of the company.

CHAPTER-13

SUMMARY AND RECOMMENDATIONS

13.0.0 SUMMARY

- 13.1.0 Kalasapura block area forms the extreme southern part of the Bababudan Schist Belt of Western Dharwar craton of southern India. The area is known for incidence of gold mineralisation in oligomictic conglomerate (QPC) and copper mineralisation in grey massive quartzite associated with of Bababudan group of Dharwar super group.
- 13.1.1 The Reconnaissance Survey (G4) work for Gold and Copper mineralisation in Kalasapura Block, Chikkamagaluru District of Karnataka has been carried out to locate potential auriferous QPC zones & copper mineralisation in the area.
- 13.1.2 Kalasapura Block lies in the southern part of Survey of India Toposheet No. 48O/15, which covers an extent of 129.00 sq.km. Block is located 5km east of Chikkamagaluru which is the district headquarter.
- 13.1.3 The present Reconnaissance Survey (G-4 stage) work included large scale geological mapping (1:12,500 scale) over 129 sq.km. area total 115 Nos. Bedrock, 15 Nos. channel and 20 Nos. stream sediment samples collected and analysed each for Au and Cu, Pb, Zn, Ni, Co, Mo, Se & Te respectively and petrographic and minergraphic studies.
- 13.1.4 The rock formations of the area belong to the Pre-cambrian meta-sedimentary and meta-volconic suite of rocks (Dharwar Super Group) resting uncomfortably over grey porphyritic granite with veins of pegmatite with well-defined angular unconformity. The major rock types exposed in the area are granite, Quartz Pebble Conglomerate (QPC), Quartzite/fuchsite quartzite, Amphibolite/Chloritic schist, Meta Gabbro, Gabbro dyke and Quartz veins/reefs.
- 13.1.5 The QPC consist of well rounded pebbles of quartzite set in a quartzose matrix. The matrix consists of considerable amount of fuchsite and fine grains of disseminated

pyrite. The sulphide minerals (pyrite, chalcopyrite) mainly observed in QPC, Quartzite/fuchsite quartzite and amphibolite/chlorite schist associated with quartz veins.

- 13.1.6 During the course of large-scale mapping, Quartz Pebble Conglomerate (QPC) bearing linear bands trending in E-W direction mapped within the area. Strike length of individual QPC bands varies from 430m to 6330m. Out of total 72 Nos. bedrock samples collected from QPC horizon (matrix/pebbly/mixed), 6 Nos samples shown gold values range from 0.10ppm to 0.45 ppm Au in East of Kartikere, SW of Devagondanahalli and SW of Kalasapura. Gold values in QPC are not encouraging.
- 13.1.7 Low concentration of gold in Quartz pebble conglomerate (QPC) may be attributed to several geological and geochemical factors such as lack of gold rich source rocks, sedimentary conditions, lack of gold traps and timing QPC deposition. Non availability of suitable auriferous greenstones in the region which developed much later than these ancient conglomerates hence perhaps QPC not inherit significant gold content.
- 13.1.8 In west of Kanivehalli, sporadic copper sulphide mineralisation noticed in Amphibolite/chloritic schistose rock associated with thin quartz veins exposed in Railway cutting section. In general, the sulphide zone trending E-W to NNW-SSE direction and dipping 20° to 70° towards S to SSE over a cumulative strike length of about 900m along the railway track. Total 12 Nos of BRS samples collected from the area shown Cu value range from 138.20 ppm to 5900 ppm Cu. 3 Nos of BRS samples shown high Cu value range from 561 ppm to 5900ppm Cu. Total 6 Nos. Channel/grove samples collected from the exposed Amphibolite/Chloritic schist rock in Railway cutting section shown high Cu values range from 634.36 to 1800 ppm. High anomalous values for copper reported in bedrock/channel samples collected all along the Railway track section. Geochemical stream sediments anomalies for copper also coincide with surface sample results around Kanivehalli area.
- 13.1.9 Based on the analysis of the Bedrock and Channel samples, one potential area (Area-1) over 2.3 sq.km. for copper has been demarcated west of Kanivehalli. Scout drilling and associated trenching work would be helpful to confirm the sub-surface depth

continuity of mineralisation. However, Railway line passing through the potential area is the main constraint to carry out further exploration.

13.1.10 The outcome of work (Phase-I) presented in 71st TCC meeting held on 25th & 26th Nov, 2024 through V.C. It was opined that the potential area is in close proximity with Railway track and may likely to pose feasibility issues later for further exploration in the area. In view of the above, the TCC committee advised to close the project and submit the report.

13.2.0 RECOMMENDATIONS

1.11.0 As of now no further work recommended in the area. However, demarcated Kanivehalli area (2.3 sq.km.) for Copper mineralisation hold potential for further exploration subject to fulfilment of feasibility issues in future.

CHAPTER-14

PLATES AND MAPS

14.1.0 List of Plates

Sl. No.	Plate No	Title	R.F
1.	I	Location map of Kalasapura Block Chikkamagaluru District, Karnataka	1:50,000
2.	II	Regional Geological Map Showing Kalasapura Block, Chikkamagaluru District, Karnataka	1:1,00,000
3.	III	Interpreted Large Scale Geological Map along with bedrock & channel sample locations, Kalasapura Block, Chikkamagaluru District, Karnataka	1:12,500
4	IV	Geochemical Anomaly map for Copper showing stream sediment sample locations, Kalasapura Block, Chikkamagaluru District, Karnataka	1:25,000
5	V	Map showing potential Area-1 (West of Kanivehalli) of 2.34 Sq.Km for Copper mineralization, Kalasapura Block, Chikkamagaluru District, Karnataka	1:5000

CHAPTER-15

ANNEXURE / ENCLOSURES TO THE REPORT

The report includes all the relevant annexure and maps, plans, sections, photographs etc. List of annexures, tables, maps, plans sections, photographs, Text figures & etc are provided in the Geological Report.

CHAPTER-16

ANY OTHER INFORMATION

16.1.0. Any other information as may be available or required by any authority as prescribed.

16.1.0 REFERENCES

1. Bruce Foote, R. (1900), Geological Notes on Traverses through the Mysore State, Mem. M.G.D. Vol.I.
2. Balaji Rao (1913), Report on prospecting work to the east and south of Chickmagalur. Rec. M.G.D. Vol XII. Pt I. pp.139-150.
3. Smeeth, W.F. (1913), General Report of the work of the Geological Department Rec.Mys.Geol.Dept.Vol.XIII. Pp20-21.
4. Rama Rao. S., (1963), Gold occurrences in Mysore and their prospects for large scale exploration Gold Mining Industry in India, Geological society of India. Mem-1.
5. Narasimhan, M. and Viswantha, M.N. (1970), Report On Kalasapura Copper Investigation Chikkamagaluru District. Mysore State, Geological Survey of India Field season 1968-69.
6. Details of Exploration carried out by AMD around Kalasapura by Atomic Minerals Directorate for Exploration and Research (AMD), Dept. of Atomic Energy, Govt. of India, Letter No. AMD/MECL/2021/1, dated 3rd Feb, 2022.
7. Report On The Geology Of Bababudan Hills, Chikkamagaluru Tahsil, Chikkamagaluru District, Mysore State (Parts of Topo-sheets 48 0/11 &15) By J. Narayana Murthy Geologist (Sr) & A. Umapathi Rao, Geologist, Geological Survey of India September, 1965.
8. Exploratory Drilling for Copper Ore In Kalasapura, Chikkamagaluru District, Karnataka By M N. Viswanatha Geologist (Jr) Geological Survey of India- (Progress report for the Field Season 1970-71, 71-72, 72-73)
9. Preliminary Examination of Oligomict Conglomerate For Gold In Parts Of Southern Karnataka by M.M. Mukherjee, Geologist (Sr.), Geological Survey of India (Progress

Report for the Field Season 1986-87) 1990.

10. Report on Geophysical Mapping in Toposheet Nos. 48O/1, 48O/2, 48O/11, 48O/13 and 48O/15 in Chikkmagaluru & Shimoga districts of Karnataka by Faizan Ahmad et al. (Final report for field season 2020-21). Sep, 2021

16.2.0 PEER REVIEW OF GEOLOGICAL REPORT

Geological report has been peer reviewed by Shri G.N. Dwivedi, Add. D.G. (Retd.), GSI and his review comments received on 21/03/2025. Suggested peer review comments have been attended (Annexure No. IX) and incorporated in the Final Geological Report. Final review of the project was presented in 75th TCC meeting held on 27th March, 2025 and committee advised to submit the Final Geological Report by 31st March, 2025.

CHAPTER-17

CERTIFICATE FROM THE QUALIFIED PERSON WITH NAME,

DATE AND SIGNATURE

17.1.0 CERTIFICATION

This is to certify that geological report has been prepared in respect of Reconnaissance Survey (G-4) for Gold and Copper Mineralisation in Kalasapura Block (129 sq.km. area), District: Chikkamagaluru, State: Karnataka by Mineral Exploration and Consultancy Limited (MECL) on behalf of National Mineral Exploration Trust (NMET). The report has been prepared in accordance with the Minerals (Evidence of Mineral Contents) Rule 2015 specified under Mineral Auction Rule, 2015 and amended up to 2021.

NAME: **P. RAVINDRAN**

DESIGNATION: **GENERAL MANAGER (EXPLORATION)**

DATE:

LOCALITY INDEX

Locality	Latitude (N)	Longitude (E)
Amble	13° 16' 43.2946" N	75° 47' 56.4499" E
Undadihalli	13° 17' 22.1729" N	75° 47' 56.8968" E
Kartikere	13° 17' 26.1353" N	75° 48' 33.2209" E
Biradevarahalli	13° 17' 36.2757" N	75° 49' 23.5490" E
Hiraharadahalli	13° 17' 55.0211" N	75° 50' 20.5335" E
Aaradavahalli	13° 17' 16.5423" N	75° 50' 20.0488" E
Kurrubarahalli	13° 17' 16.8097" N	75° 50' 54.9348" E
Ramanahalli	13° 17' 44.8314" N	75° 51' 01.0028" E
Hosakote	13° 18' 09.8470" N	75° 51' 33.0206" E
Marle	13° 16' 51.7631" N	75° 51' 39.0126" E
Hosahalli	13° 17' 07.1936" N	75° 52' 18.4063" E
Kanivehalli	13° 19' 47.7458" N	75° 54' 26.0401" E
Devagondanahalli	13° 19' 09.9430" N	75° 56' 08.6436" E
Kalasapura	13° 16' 53.3965" N	75° 56' 07.1497" E
Sindigere	13° 18' 50.3309" N	75° 58' 28.6509" E
Kabbigarahalli	13° 19' 35.9751" N	75° 57' 43.9892" E
Karadigavi	13° 20' 31.2095" N	75° 58' 16.5809" E

ABBREVIATIONS USED

SL. No.	Abbreviation	Full form
1	GSI	Geological Survey of India
2	MECL	Mineral Exploration and Consultancy Limited
3	CPSE	Central Public Sector Enterprises
4	NMET	National Mineral Exploration Trust
5	TCC	Technical cum Cost Committee
6	EC	Executive Committee
7	DMG	Directorate of Mines & Geology
8	NABL	National Accreditation Board for Testing and Calibration Laboratories
9	F.S.P.	Field Season Programme
10	MEMC	Minerals (Evidence of Mineral Contents)
11	MMDR	Mines & Minerals (Development and Regulation)
12	NH	National Highway
13	WGS-84	World Geodetic System-84
14	UTM	Universal Transverse Mercator
15	RL	Reduced Level
16	Cu m	Cubic Meter
17	GPS	Global Positioning System
18	DMS	Degree Minute Second
19	M / m	Meter
20	Sq. km	Square Kilometre
21	M. Sc.	Master of Science
22	M. Sc. Tech	Master of Science Technology
23	AMSL	Above mean sea level in meters
24	R.F.	Representative Factor
25	QA/QC	Quality Assessment/ Quality Checks
26	BDL	Below detection limit
27	AAS	Atomic Absorption Spectrometry
28	NGCM	National Geochemical Mapping
29	NGPM	National Geophysical Mapping
30	Au	Gold
31	Co	Cobalt
32	Ni	Nickel
33	Cu	Copper
34	Zn	Zinc
35	Se	Selenium
36	Mo	Molybdenum
37	Te	Tellurium
38	Pb	Lead