GEOLOGICAL REPORT

ON

RECONNAISSANCE SURVEY (G4) FOR IRON ORE IN MADHYAPUR AREA, KEONJHAR DISTRICT, ODISHA

6.5 sq. km

TOPOSHEET NO. 73G11 F45N11 & G15 F45N15

VOLUME-I

ODISHA MINING CORPORATION LIMITED

(A Gold Category State PSU)

Bhubaneswar-751001, Odisha

May 2025

Place: Bhubaneswar

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6.5 sq. km

TOPOSHEET NO. 73G11 F45N11 & G15 F45N15

AT A GLANCE:

Exploration Area Name:

Madhyapur Iron Ore area

(Over an area of 6.50 sq. km near Madhyapur village under Harichandanpur P.S of Keonjhar District, Odisha).

Allotment Order:

Allotment order No. GXVII(h)08/22-11519/DoMG, Dt. 13-09-2023 under rule 67 of MCR, 2016.

NMET:

58th TCC meeting held on 30th October 2023& approved in 32nd EC meeting held on 06th December 2023.

Sanction Order:

Sanction No. 23/409/2023-NMET/387, Dt: 15.12.2023

Period of Exploration:

15.12.2023 to 30.04.2025

Exploration Permission:

Area: 6.50 sq. km

Mineral: Iron Ore

Village: Madhyapur

District: Keonjhar

State: Odisha

ACKNOWLEDGEMENT

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Authors

CHAPTER 1. SUMMARY

Government of India has notified Odisha Mining Corporation Limited (OMC Ltd.)/erstwhile Odisha Mineral Exploration Corporation Limited (OMECL) for undertaking prospecting operation in pursuance of the second provision to sub-section (1) of Section 4 of the Mines and Minerals (Development and Regulation) Act, 1957 vide its notification No-GSR 389(E), dated 23.04.2018. Originally, Burhipada area in Keonjhar District was identified (by STC-OMC) based on positive analytical data of Fe (%) ranging from 45% to 65% of area covered by GSI during 2005-06 and (b) high magnetic anomaly shown in Reduce to pole magnetic map and VOXI Modelling of Aero-magnetic Data of the proposed Burhipada area. The area was proposed and subsequently area of 83.192 sq. km was allotted by Department of Steel and Mines, Govt. of Odisha for G4 stage of investigation (vide notification no. 8339/S&M, Bhubaneshwar dated 25.09.2024) falling in T.S. no. F45N11, 12, 15 & 16. The area was then presented in 58th TCC NMET meeting dated 30th October 2023, and the project proposal was sent to GSI for comments. GSI, informed that, parts of the proposed area are overlapping with the area earlier explored by GSI under G-4 stage during 2005-06 and that the composite license of 6.90 sq. km is also falling in the proposed area. Owing to these, the committee suggested to select area within the proposed area and upgrade the area to G3 stage of exploration by tracing the band of BIF. Accordingly, OMC has modified the proposal and identified 3 areas out of which Madhyapur area has been recommended to be executed presently. The TCC committee agreed to take up the project at G3 Stage of exploration in **Madhyapur area** (6.5 sq.km), which involves detailed mapping at 1:4000 scale and boreholes were suggested to be drilled at 800 m spacing with vertical depth of intersection of 30 m. The Madhyapur area was subsequently approved under G3 stage of investigation with a timeline of 12 months, by 32nd EC meeting, NMET held on 6th December 2023. Furthermore, the sanction order vide F. No. 23/409/2023-NMET/387 dated 15th December 2023 released first instalment of payment of project cost 78,83,056/- against approved project cost of 1,97,07,639/-. The work was presented and reviewed during the 71st TCC NMET meeting wherein OMC informed TCC-1 that all the assigned work, except drilling, in the project has been completed and sought approval for dropping of drilling component as the analytical data of Fe is non-encouraging. Upon review of the project, TCC-1, provided timeline extension up to 14th March 2025 so to prepare the GR and IPR and suggested to submit the report under G4 stage of investigation. During the 74th TCC, NMET, timeline extension was sought, and it was extended till 30th April 2025.

The Madhyapur area of Keonjhar District, Odisha is bounded by A) 85°45'44.148", 21°18'56.786", B) 85°45'48.079", 21°16'24.865", C) 85°45'49.019", 21°14'31.592", D) 85°45'52.911", 21°12'19.852", E) 85°41'53.293", 21°12'18.605" and F) 85°41'48.329", 21°18'51.383". The area covers an area of 6.5 sq. km and is featured in Survey of India (SOI) Toposheet No. 73G11 F45N11 & G15 F45N15. The objective of the said investigation is, a) to identify and demarcate the BIF bands, by geological mapping in 1:4000 scale, b) to establish the mineralized zones, c) upon proving of the mineralized zones, if any to assess subsurface continuity.

The Madhyapur area forms an isolated part of BIF-II (Tomka-Daitari belt). Geological mapping in the Madhyapur area was carried out at 1:4000 scale covering 6.5 sq. km of area. The litho-units demarcated during the mapping comprises of Granite, BHQ, Chlorite schist, Quartzite, Dolerite dykes and floats of BHQ. The BHQ shows weak magnetism as checked with the help of Tungsten carbide scriber pen having Neodymium magnet and displays reddish-brown streak colour. Two parallel BHQ bands trending in N-S to NNE-SSW direction with sub vertical dip were targeted for search of Iron ore mineralization. The strike length of the western BHQ is around 1900m with width varying from 30m to 70m. The western BHQ band dominantly shows the presence of Quartzite whereas Hematite bands are restricted to 5-10% of the total volume showing width of around 0.20 to 0.40 cm. The cumulative strike length of eastern BHQ is around 1000m strike length and 20m to 40m width. The eastern BHQ band has good thickness of Hematite bands which are more than 50% of the total volume as compared to quartzite. Also, HMO (hard massive ore, a variety of Hematite) is present discontinuously in the eastern BHQ bands.

Government of Odisha in the year 1993-98, conducted an Aero-Magnetic and Aero-Radiometric survey in the northern part of Odisha with a line spacing of 300m in N-S survey direction. The magnetic data was studied for litho-structural interpretation. The interpretation of legacy airborne magnetic data with reference to Madhyapur area reveals presence of two parallel bands of high susceptibility bodies in the east probably depicting limbs of the doubly plunging fold structure. This doubly plunging fold structure is disturbed by NE-SW trending regional fault (partly present in the study area) and NW-SE trending minor faults present in the study area.

A total of 44 nos. of BRS samples were collected in 100m*100m grid interval, from both the bands, however analytical data of only 3 nos. of samples in eastern BHQ band are above threshold value (Fe 45%) and of beneficiable grade. No mineralized zone is formed of the anomalous samples. Minor part of the eastern limb which has the highest concentration w.r.t. Fe% is present in the study area, whereas remaining part of this limb is traced to the south and was observed to be truncated at the southern NE-SW trending regional fault, as ascertained mapped from Aero-magnetic data.

Owing to Field observations and data integration studies involving Geology, Geophysics and Geochemistry, the study area was found to be of barren w.r.t. Iron Ore mineralization.

अध्याय 1: सारांश

भारत सरकार ने खान और खनिज (विकास और विनियमन) अधिनियम, 1957 की धारा 4 की उपधारा (1) के दूसरे प्रावधान के अनुसरण में पूर्वेक्षण कार्य करने के लिए ओडिशा माइनिंग कॉर्पोरेशन लिमिटेड (ओएमसी लिमिटेड)/पूर्ववर्ती ओडिशा मिनरल एक्सप्लोरेशन कॉर्पोरेशन लिमिटेड (ओएमईसीएल) को अपनी अधिसूचना संख्या जीएसआर 389 (ई), दिनांक 23.04.2018 के माध्यम से अधिसूचित किया है। मूल रूप से, क्योंझर जिले में बुरहीपाड़ा ब्लॉक की पहचान (एसटीसी-ओएमसी द्वारा) 2005-06 के दौरान जीएसआई द्वारा कवर किए गए क्षेत्र के 45% से 65% तक Fe (%) के सकारात्मक विश्लेषणात्मक आंकड़ों और (बी) प्रस्तावित बुरहीपाड़ा क्षेत्र के रिड्यूस टू पोल मैग्नेटिक मैप और एयरो-मैग्नेटिक डेटा के वीओएक्सआई मॉडलिंग में दिखाए गए उच्च चुंबकीय विसंगति के आधार पर की गई थी। ब्लॉक को 30 अक्टूबर 2023 की 58वीं टीसीसी एनएमईटी बैठक में प्रस्तुत किया गया और परियोजना प्रस्ताव टिप्पणियों के लिए जीएसआई को भेजा गया। जीएसआई ने सूचित किया कि प्रस्तावित क्षेत्र के कुछ हिस्से जी-4 चरण के तहत 2005-06 के दौरान जीएसआई द्वारा पहले खोजे गए क्षेत्र के साथ ओवरलैप कर रहे हैं और 6.90 वर्ग किमी का समग्र लाइसेंस भी प्रस्तावित क्षेत्र में आ रहा है। इनके कारण, समिति ने प्रस्तावित क्षेत्र के भीतर ब्लॉक का चयन करने और बीआईएफ के बैंड का पता लगाकर ब्लॉक को अन्वेषण के जी3 चरण में अपग्रेड करने का सुझाव दिया। टीसीसी समिति ने मध्यपुर ब्लॉक (6.5 वर्ग किमी) में अन्वेषण के जी3 चरण में परियोजना को शुरू करने पर सहमति व्यक्त की, जिसमें 1:4000 पैमाने पर विस्तृत मानचित्रण शामिल है और 30 मीटर की ऊर्ध्वाधर गहराई के साथ 800 मीटर की दूरी पर बोरहोल ड्रिल करने का सुझाव दिया गया था। मध्यपुर ब्लॉक को बाद में 6 दिसंबर 2023 को आयोजित एनएमईटी की 32वीं ईसी बैठक में 12 महीने की समयसीमा के साथ जी3 चरण की जांच के तहत मंजूरी दी गई। इसके अलावा, एफ. संख्या 23/409/2023-एनएमईटी/387 दिनांक 15 दिसंबर 2023 के तहत मंजूरी आदेश ने 1,97,07,639/- की स्वीकृत परियोजना लागत के मुकाबले 78,83,056/- की परियोजना लागत के भुगतान की पहली किस्त जारी की। 71वीं टीसीसी एनएमईटी बैठक के दौरान इस कार्य की प्रस्तुति और समीक्षा की गई, जिसमें ओएमसी ने टीसीसी-1 को सूचित किया कि परियोजना में ड्रिलिंग को छोड़कर सभी सौंपे गए कार्य पूरे हो चुके हैं और ड्रिलिंग घटक को छोड़ने की मंजूरी मांगी है क्योंकि Fe का विश्लेषणात्मक डेटा उत्साहजनक नहीं है। परियोजना की समीक्षा के बाद, टीसीसी-1 ने जीआर और आईपीआर तैयार करने के लिए 14 मार्च 2025 तक समय सीमा विस्तार प्रदान किया और जांच के जी4 चरण के तहत रिपोर्ट प्रस्तुत करने का सुझाव दिया। 74वीं टीसीसी, एनएमईटी के दौरान, समय सीमा विस्तार की मांग की गई, और इसे 30 अप्रैल 2025 तक बढ़ा दिया गया।

ओडिशा के क्योंझर जिले का मध्यपुर ब्लॉक A) 85°45'44.148", 21°18'56.786", B) 85°45'48.079", 21°16'24.865", C) 85°45'49.019", 21°14'31.592", D) 85°45'52.911", 21°12'19.852", E) 85°41'53.293", 21°12'18.605" और F) 85°41'48.329", 21°18'51.383" से घिरा है। ब्लॉक 6.5 वर्ग किलोमीटर क्षेत्र में फैला हुआ है और सर्वे ऑफ इंडिया (एसओआई) टोपोशीट संख्या 73G11 F45N11 & G15 F45N15 में दर्शाया गया है। उक्त जांच का उद्देश्य है, a) 1:4000 पैमाने पर भूवैज्ञानिक मानचित्रण द्वारा BIF बैंडों की पहचान करना और उनका सीमांकन करना, b) खनिजयुक्त क्षेत्रों की स्थापना करना, c) यदि कोई खनिजयुक्त क्षेत्र है तो उसके प्रमाण के आधार पर भूमिगत निरंतरता का आकलन करना। मध्यपुर ब्लॉक BIF-II (टोमका-दैतारी बेल्ट) का एक अलग हिस्सा है। मध्यपुर ब्लॉक में 6.5 वर्ग किलोमीटर क्षेत्र को कवर करते हुए 1:4000 पैमाने पर भूवैज्ञानिक मानचित्रण किया गया। मानचित्रण के दौरान सीमांकित लिथो-इकाइयों में ग्रेनाइट, BHQ, क्लोराइट स्किस्ट, क्वार्टजाइट, डोलराइट डाइक और BHQ के फ्लोट शामिल हैं। टंगस्टन कार्बाइड स्क्राइबर पेन की मदद से जांच करने पर बीएचक्यू कमजोर चुंबकत्व दिखाता है, जिसमें नियोडिमियम चुंबक होता है और यह लाल-भूरे रंग की धारियों को प्रदर्शित करता है। लौह अयस्क खनिजीकरण की खोज के लिए उप ऊर्ध्वाधर ढलान के साथ उत्तर-दक्षिण से उत्तर-पूर्व-दक्षिण-पश्चिम दिशा में चलने वाले दो समानांतर बीएचक्यू बैंड को लक्षित किया गया था। पश्चिमी बीएचक्यू की स्ट्राइक लंबाई लगभग 1900 मीटर है, जिसकी चौड़ाई 30 मीटर से 70 मीटर तक है। पश्चिमी बीएचक्यू बैंड में प्रमुख रूप से क्वार्टजाइट की उपस्थिति दिखती है, जबकि हेमेटाइट बैंड कुल आयतन के 5-10% तक सीमित हैं, जिनकी चौड़ाई लगभग 0.20 से 0.40 सेमी है। पूर्वी बीएचक्यू की संचयी स्ट्राइक लंबाई लगभग 1000 मीटर स्ट्राइक लंबाई और 20 मीटर से 40 मीटर चौड़ाई है इसके अलावा, एचएमओ (कठोर विशाल अयस्क, हेमेटाइट की एक किस्म) पूर्वी बीएचक्यू बैंड में असंतत रूप से मौजूद है।

वर्ष 1993-98 में ओडिशा सरकार ने उत्तर-दक्षिण सर्वेक्षण दिशा में 300 मीटर की लाइन स्पेसिंग के साथ ओडिशा के उत्तरी भाग में एयरो-मैग्नेटिक और एयरो-रेडियोमेट्रिक सर्वेक्षण किया था। चुंबकीय डेटा का अध्ययन लिथो-स्ट्रक्चरल व्याख्या के लिए किया गया था। मध्यपुर ब्लॉक के संदर्भ में विरासत हवाई चुंबकीय डेटा की व्याख्या से पूर्व में उच्च संवेदनशीलता निकायों के दो समानांतर बैंड की उपस्थिति का पता चलता है जो शायद दोहरी डुबकी वाली तह संरचना के अंगों को दर्शाते हैं। यह दोहरी डुबकी वाली तह संरचना NE-SW ट्रेंडिंग क्षेत्रीय फॉल्ट (अध्ययन क्षेत्र में आंशिक रूप से मौजूद) और अध्ययन क्षेत्र में मौजूद NW-SE ट्रेंडिंग मामूली फॉल्ट से परेशान है। दोनों बैंडों से 100 मीटर * 100 मीटर ग्रिड अंतराल में कुल 44 बीआरएस नमूने एकत्र किए गए थे असामान्य नमूनों से कोई खनिज क्षेत्र नहीं बना है। अध्ययन क्षेत्र में पूर्वी भाग का छोटा हिस्सा मौजूद है, जिसमें Fe% के संबंध में

सबसे अधिक सांद्रता है, जबकि इस भाग का शेष भाग दक्षिण की ओर पाया जाता है और एयरो-मैग्नेटिक डेटा से मैप किए गए दक्षिणी NE-SW ट्रेंडिंग क्षेत्रीय दोष पर कटा हुआ पाया गया। भूविज्ञान, भूभौतिकी और भू-रसायन विज्ञान से जुड़े क्षेत्र अवलोकन और डेटा एकीकरण अध्ययनों के कारण, अध्ययन क्षेत्र लौह अयस्क खनिजकरण के संबंध में बंजर पाया गया।

CHAPTER 2. INTRODUCTION

Iron ore is a crucial raw material for steel production, which serves as the foundation for industrial growth and infrastructure development worldwide. India, as the second largest producer of crude steel, relies heavily on its iron ore reserves to meet domestic and global demand. According to the Indian Minerals Yearbook 2022, Indian's total iron ore production was 253.97 million tonnes in 2021-22. The country possesses substantial reserves of hematite and magnetite, with Odisha being the largest contributor to production. Odisha accounted for 53.8% of India's total iron ore in 2021-22. The state's Iron ore deposits are predominantly located in the Keonjhar, Sundargarh, Mayurbhanj, and Jajpur Districts, with major mining activities in the Joda-Barbil and Koira regions. With its high-grade hematite reserves and well-developed transportation infrastructure, Odisha plays a critical role in sustaining India's steel industry and overall mineral economy.

Iron formations are economically important sedimentary rocks that are most common in Precambrian sedimentary successions. Iron formations host most the world's economic iron ore, which has fostered extensive research on their origin, depositional setting, and spatial and temporal distribution.

The supracrustal including banded iron formation and Iron ore of Precambrian age constitute three discrete geographic segments along the periphery of the North Odisha Iron Ore Craton (NOIOC). Among them, the western flank of the craton is occupied by the Bonai-Keonjhar (BK) belt forming the U-shaped synclinorium, which is known as the Horseshoe belt. In the northeastern boundary of the craton, there exists the arcuate shaped Badampahar-Gorumahisani-Suleipat (BGS) belt. Daitari-Tomka (DT) belt constitutes the southern periphery of NOIOC. These three prominent belts of Iron ore deposits along with the associated litho types have been designated as the Iron Ore Super Group (IOSG) of Odisha.

The rock assemblages of Badampahar-Gorumahisani-Suleipat belt, Daitari-Tomka belt and Bonai-Keonjhar belt have been assigned BIF-I, BIF-II and BIF-III respectively from old to young with respect to age.

Among these three prominent belts of IOSG Madhyapur area exists as a isolated patch of Daitari-Tomka belt. BIF-II is underlain and overlain by Badam quarzite and Dhanjori quartzite respectively. The litho-assemblages of this middle-aged belt among three BIFs consist of banded magnetite/hematite quartzite, banded magnetite/hematite jasper, quartz sericite schist, phyllites, slate and banded chert. A few ultrabasic intrusives are found in the area. The dominant minerals of the area are hematite, magnetite, martite and goethite. The rocks of BIF-II attain green schist facies of metamorphism.

2.1 Details of Project

Odisha Mining Corporation Limited (OMC) had proposed to undertake prospecting operation in Burhipada area over an area of 75.80 sq. km in around Burhipada, Madhyapur, Banabir, Pangaposhi, Sunapentha villages of Keonjhar District Odisha. Department of Steel and Mines, Government of Odisha vide notification no. 8339/S&M, Bhubaneswar dated 25.09.2024 have notified the said area under rule 67 of MCR, 2016 in favour of OMC for carrying out exploration upto G2 stage for a period of 2 years. Following this, the Burhipada area having 75.80 sq. km area under G4 stage of exploration was presented in 58th TCC, NMET meeting held on 30th October 2023 for approval and funding. However, owing to overlapping with the earlier explored area by GSI under G4 stage during FS 2005-06 and 2006-07, it was recommended in the 58th TCC NMET to upgrade the area to G3 stage of exploration with incorporation of systematic drilling. Subsequently, the exploration program was approved in the 32nd EC meeting held on 06th December 2023 for a period of 12 months. The sanction order no. 23/409/2023-NMET/387 was issued on 15th December 2023 wherein 1st advance instalment of 40% of estimated project cost i.e., 78,83,056/- was received against the approved amount of 1,97,07,639/-.

During the mapping activity, the study area was found to be of barren with respect to Iron ore mineralisation, upon discussion in the final review of TCC NMET, it was recommended to submit the report under G4 stage of exploration.

2.2 Investigating Agency

Odisha Mining Corporation (OMC) carried out Exploration work in the Madhyapur area from 15.12.2023 to 30.04.2025.

2.3 Objectives of Investigation

The primary objective of the Investigation is:

- To identify and demarcate the BIF bands, by geological mapping in 1:4000 scale.
- To establish the mineralized zones with the help of mapping & sampling activities.
- Upon proving of the mineralized zones, if any, to assess subsurface continuity.

2.4 Basis for taking up Investigation

Geological Survey of India (GSI) carried out work in this area from 2005-06 (Swain, B.B., Jena, P.K., 2006) and 2006-07 (Jena, S.K., Mishra, A.P., 2007) (Report reference number UE14037, UE14769). Large scale mapping on 1:12,500 scale was carried out over 50 sq. km area around Burhipada-Madhyapur in parts of Toposheet No. 73 G/11, 12, 15 & 16, Kendujhar district, Odisha. During F.S. 2006-07, iron ore exploration programme was formulated in the Pongaposhi- Madhyapur area, for quick assessment of resource by preliminary test drilling. Madhyapur area was further divided into Madhyapur North and South sub-areas because of the discontinuous lensoidal nature of iron ore which are of smaller dimension and of irregular pattern. Exploratory drilling was carried out at Madhyapur south sub-area. (2 BHs namely MBH-1 & MBH-2 were drilled having cumulative depth of 49m, MBH-1 and MBH-2 shows mineralized zone of 8.35m &3.1m respectively). The analytical data (Fe%) of 43 BRS & 6 core samples from Madhyapur South area varies from 45.89% to 65.83%. With this background Madhyapur Iron area having 6.5 sq. km was identified for carrying out G3 stage of exploration. The area co-ordinates are,

Table 1: Corner points Co-ordinates of Madhyapur Iron Area

CORNER POINTS	EASTING	NORTHING	LATITUDE (DD)	LONGITUDE (DD)
1	369173.85	2356870.73	21.3090	85.7388
2	370264.33	2356807.62	21.3085	85.7492
3	370262.24	2355600.05	21.2976	85.7492
4	370751.59	2355637.69	21.2980	85.7540
5	370708.81	2353213.02	21.2761	85.7537
6	368414.42	2353165.18	21.2755	85.7316

2.5 Details and Nature and Quantum of work Proposed vs Achievement

Table 2: Nature and Quantum of Work Proposed vs Achievement		
Activity	**Work proposed**	**Achievement**
1. Geological Survey		
i. Detailed Mapping (1:4000 scale)	6.5 sq. km	6.5 sq. km
2. Sampling		
i. BRS	44 nos.	44 nos.
ii. Core Sample	256 nos.	Nil
3. Laboratory analysis		
i. XRF analysis	300 nos.	44 nos.
ii. Thin section analysis	5 nos.	Nil
4. DGPS survey	11 nos.	7 nos.
5. Drilling (On the basis of the above results)	750m.	Nil
6. Geological report preparation	1 no	Completed

Justification for under achievement of NQT:

1. XRF study: As drilling was not carried out in the area, so core samples were not analysed and complete samples for XRF studies were not utilized and only BRS samples were analysed.

2. DGPS survey: As drilling was not carried out in the study area, so DGPS survey only for the area boundary was carried out and not for the BHs collar points.

3. Drilling: Based on the field observations & analytical data of BRS sample no mineralized zone was identified. Hence the assessment of subsurface continuity of mineralization was not required.

2.6 Personnel Involved

Table 3: Personnel involved in Geological exploration	
Different aspects of work	**Name**
Geological Mapping	Sh. Sunil Bhendarkar Sh. Saurabh Sen
Collection of BRS samples	Sh. Sunil Bhendarkar Sh. Saurabh Sen Dr. Vanit Patel
Geophysical Interpretation	Sh. Harsha Yalla
Supervision and guided by	Sh. Asim Chatterjee (ex-Program Manager)
Preparation of Geological report	Dr. Vanit Patel Sh. Pravasa Ranjan Chinara

2.7 Mode of operation of different work components and associated agency

Table 4: Work components vis-à-vis associated agency		
Sr. No	**Work Component**	**Associated Agency**
1.	Geological Mapping	STC-OMC
2.	Sampling	STC-OMC
3.	Geophysical Interpretation	STC-OMC
4.	XRF study	JNARDDC
5.	Submission of Geological report	STC-OMC

CHAPTER 3. PROPERTY DESCRIPTION

Details of the area

Village Name	Madhyapur
District	Keonjhar
Tehsil	Harichandanpur
State	Odisha
Toposheet number	73G11 F45N11 & G15 F45N15
Geo Coordinate with corner points of the investigated area	CORNER POINTS / EASTING / NORTHING A 369173.85 2356870.73 B 370264.33 2356807.62 C 370262.24 2355600.05 D 370751.59 2355637.69 E 370708.81 2353213.02 F 368414.42 2353165.18
Landuse/Land cover	Forest cover
Forest with type of forest	100%, Reserve forest
Free hold/Lease Hold	Free Hold
Location	The area is located approx 51 km. towards the south of District headquarters Keonjhar.
Accessibility	The Madhyapur area is approachable from Keonjhar via NH-20, followed by SH720 till Harichandanpur Tehsil followed by an interior road to the Madhyapur area. The road distance from the area to Keonjhar city and Barbil town is around 51 km and 127 km respectively. The nearest railway station is Harichandanpur railway station situated 10 km west of the area. The nearest airport is present at Bhubaneshwar city at around 180 km.
Physiography & Drainage	The area under exploration exhibits hilly and rugged topography characterized by high ridges with intermittent spur and plain lands. The ridges occupy the central part of the area and are N-S trending. The eastern part is mostly soil covered with a few low elevated mounds which are covered with dense vegetation. The highest elevation is 709m above MSL at Bramhanidei Peak, east of Banabir village. The nalas are perennial in nature and show sub dendritic drainage pattern, which ultimately join Mushala river in North and Bagira River in South.
Climate	Keonjhar has a Tropical wet and dry or savanna climate (Classification: Aw). The district's yearly temperature is 28.07ºC (82.53ºF) and it is 2.1% higher than India's averages. Keonjhar typically receives about 189.9 millimeters (7.48 inches) of precipitation and has 166.54 rainy days (45.63% of the time) annually. Annual high temperature: 31.86ºC (89.35ºF) Annual low temperature: 20.82ºC (69.48ºF)

	Average annual precipitation: 189.9mm (7.48in) Warmest month: May (39.38ºC / 102.88ºF) Coldest Month: January (13.62ºC / 56.52ºF) Wettest Month: July (481.9mm / 18.97in) Driest Month: January (11.69mm / 0.46in) Humidity: 63.0%
Flora/Fauna	Pongaposhi – Madhyapur area is partly covered by forest in the hilly parts. The ridges and slopes are mostly covered by dense mixed jungles, with plants like Sal, Asan, Teak etc. whereas dense undergrowths are found along nala courses. Valleys are made cultivable lands by local tribals. Wild animals like tigers, bears, hyena, elepahants, deers etc are found in the jungles with a variety of reptiles and birds.
Local infrastructure	Hospitals & Dispensaries:8 Sub-divisional/other hospitals, 17 Community Health Centers (CHCs), 66 Primary Health Centers (PHCs), 12 Mobile units, 48 Ayurvedic hospitals, 34 Homeopathic Hospitals/Dispensaries Electrification: 2069 out of 2123 villages in the district are electrified. Banking: 210 banks (Nationalized, Gramin, Private, and Cooperative) facilitate banking and financial activities. Roads and Rails: already discussed under sub section Accessibility.
Population	The total population of Madhyapur village is around 355 and the number of houses is 89.
Archaeological	Buddhist and Jain sites at Anandapur, Sitabinji Fresco Painting and Rock Inscription,
Historical Sites nearby	Murga Mahadev Temple, Gonasikha Temple, Brahmeshwar Mahadev temple, Baladevajew temple, Deogaon Kushaleswar, etc.

CHAPTER 4. PREVIOUS WORK

The area was mapped by M.N. Deekshitulu, 1950-51, G.H.S.V. Prasad Rao 1951-54 and R. N. Benarjii 1961-62, on 1:63000 scale. Prasad Rao (1953) described the lithounits under three categories in the chronological order, i.e. (i) younger one was late and post granites, which includes pegmatites and quartz veins, newer dolerite dykes. (ii) Granites includes porphyritic granite gneiss and hornblende & biotite granite gneiss (iii) older iron ore series, which encompasses epidiorites (meta gabbro & hornblende schist), banded hematite quartzite, banded jasper and ferruginous shale. Prasad Rao, Y.G.K. Murthy, M.N. Deekshitulu, 1964 grouped the Schists, quartzite, BMQ etc under first sequence and conglomerate, shale, banded jasper, phyllite under 2nd sequence. In their view, the shale and banded hematite jaspers, which are older to that of Bonai-Kendujhar belt have given rise to the iron ore deposits of Tomka-Daitari belt of Jajpur & Kendujhar districts.

Acharya (1984), Benarjii (1974), Iyenger and Alwar (1965) regarded the Daitari iron ore formation as well as the Gorumahisani-Badampahar iron ore formation to be older than the west Singhbhum-Kendujhar IOG sequence, based on presence of continental tholeiitic lava overlying the Daitari IOG basin in the south, which spreads to the north upto the southern margin of Bonai horseshoe synclinorium.

A.K. Saha, 1994 has described the Geology and structure of Daitari-Palaspal area and opined that there is no evidence to consider the IOG of Daitari basin is older to that of Bonai-Kendujhar belt.

Several narrow and discontinuous BMQ/BHQ bands associated with volcano sedimentary sequence have been recently reported by officers of GSI. OP. Odisha further northeast of Daitari deposit for a considerable strike length of iron ore bodies.

During FS 2005-06, the iron ore investigation work was carried out in Burhipada-Madhyapur bock covering about 50 sq. km. area. The work components included large scale mapping on 1:12,500 scale (Figure-1), detailed mapping on 1:2000 scale in Burhipada, Pongaposhi and Madhyapur area along with pitting and sampling. The iron ore is massive to hard laminated variety and occur as discontinuous bodies. The dimensions of iron bodies mapped around Burhipada and Pongaposhi 100m x 8m, and 230m x 40m, respectively having low to medium grade ore pockets. In this area some of the BRS on chemical analysis shows Fe content varies from 58.10 to 66.68%.

As per the LSM map, Granite, Actinolite chlorite schist, banded cherty quartzite, BHQ/BMQ and Iron ore are present in the approved Madhyapur Iron area.

During FS 2006-07 four boreholes were drilled at Pongaposhi and Madhyapur areas having a cumulative total meterage of 131.60m. Chemical analysis of twenty-seven core samples of Pongaposhi and Madhyapur South sub-areas were carried out to determine the grade of ore. 43000 tonnes of resource (Avg. grade of Fe - 57.10%) were estimated for Pongaposhi area. But the resource of Madhyapur area was not estimated as it were of less than 55% cut-off grade. No drilling was carried out in Madhyapur North sub-areas.

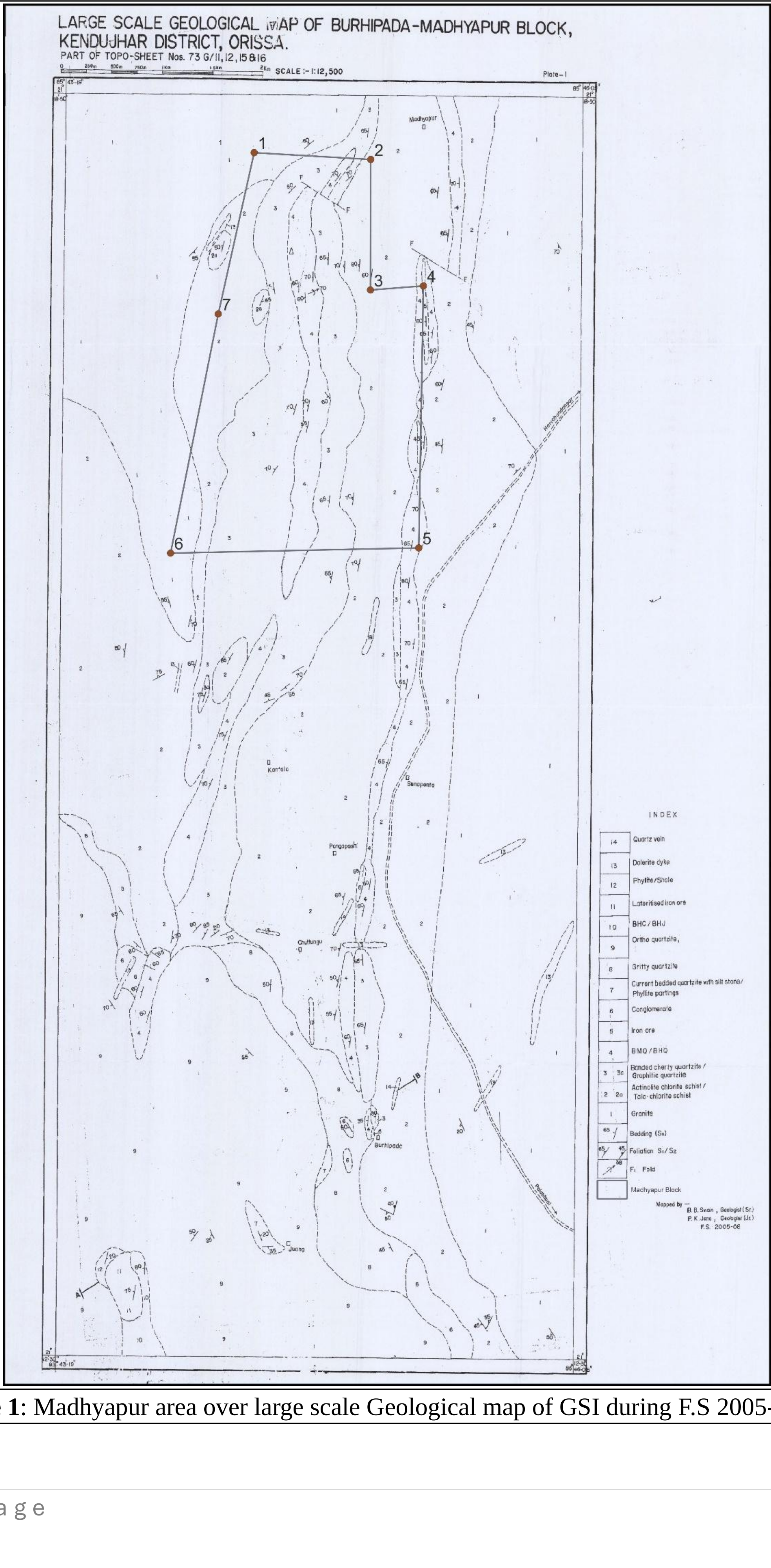


Figure 1: Madhyapur area over large scale Geological map of GSI during F.S 2005-06

CHAPTER 5. GEOLOGY OF THE AREA

5.1 Regional Geology

The Iron Ore Supergroup of rocks of Tomka-Daitari belt occur in the northeastern part of Singbhum Craton in north Odisha. The Singhbhum craton is a polycyclic Archaean crustal area. The supracrustals of the Older Metamorphic Group (OMG) are the oldest rocks (3.5 - 3.6 Ga) in the Singhbhum craton (Saha, 1994; Mukhopadhyay, 2001; Misra et al., 1999; Misra, 2006) and comprise mainly of para-and ortho-amphibolites, pelitic and psammopelitic schist and meta-arenite. The OMG rocks are intruded by the TTG gneisses (biotite-hornblende-tonalite gneiss) which are termed the Older Metamorphic Tonalite Gneiss (OMTG) and represent the vestigial first stable continental crust dated at 3.44 Ga (Goswami et al., 1995; Acharya et al., 2010). Both the OMG and OMTG are surrounded by the 3.2-3.3 Ga Singhbhum Granite Complex (SGC) expansive over nearly 10,000 km^2 covering major part of Archaean nucleus of this craton. Tait et al., (2011), Upadhyay et al., (2014) and Nelson et al., (2014) offer new age data on various litho-components of the Singhbhum craton. Supracrustals of the IOG comprising bimodal volcanic rocks, ultramafic rocks, banded iron formation (BIF), chert, shale and minor carbonates occur as three detached belts along the periphery of the nucleus viz. the NE-SW trending Noamundi-Jamda-Koira belt (NJK basin or the horse-shoe belt), the western IOG; the E-W trending Tomka-Daitari belt (TD basin), the southern IOG and the N-S trending curvilinear Badampahar-Gorumahisani belt (BG basin), the eastern IOG.

The volcano sedimentary rocks of the area are separated by granite from (i) 'Horseshoe' shaped basin of Bonai-Kendujhar belt and ii) Badampahar-Gorumahisani belt of Mayurbhanj District. The rocks exposed around Tomka-Daitari basin extend further towards Ghutang, Burhipada, Pangaposhi and Madhyapur area for about 50km length. The stratigraphic thickness of meta sedimentaries being conspicuously more around Daitari-Bali parbat sector gradually gets thinning down to the present working area. In the east, it gets terminated by folding back at east of Tomka, thereby shows maximum thickness of the BIF at Tomka and Daitari (Figure 2).

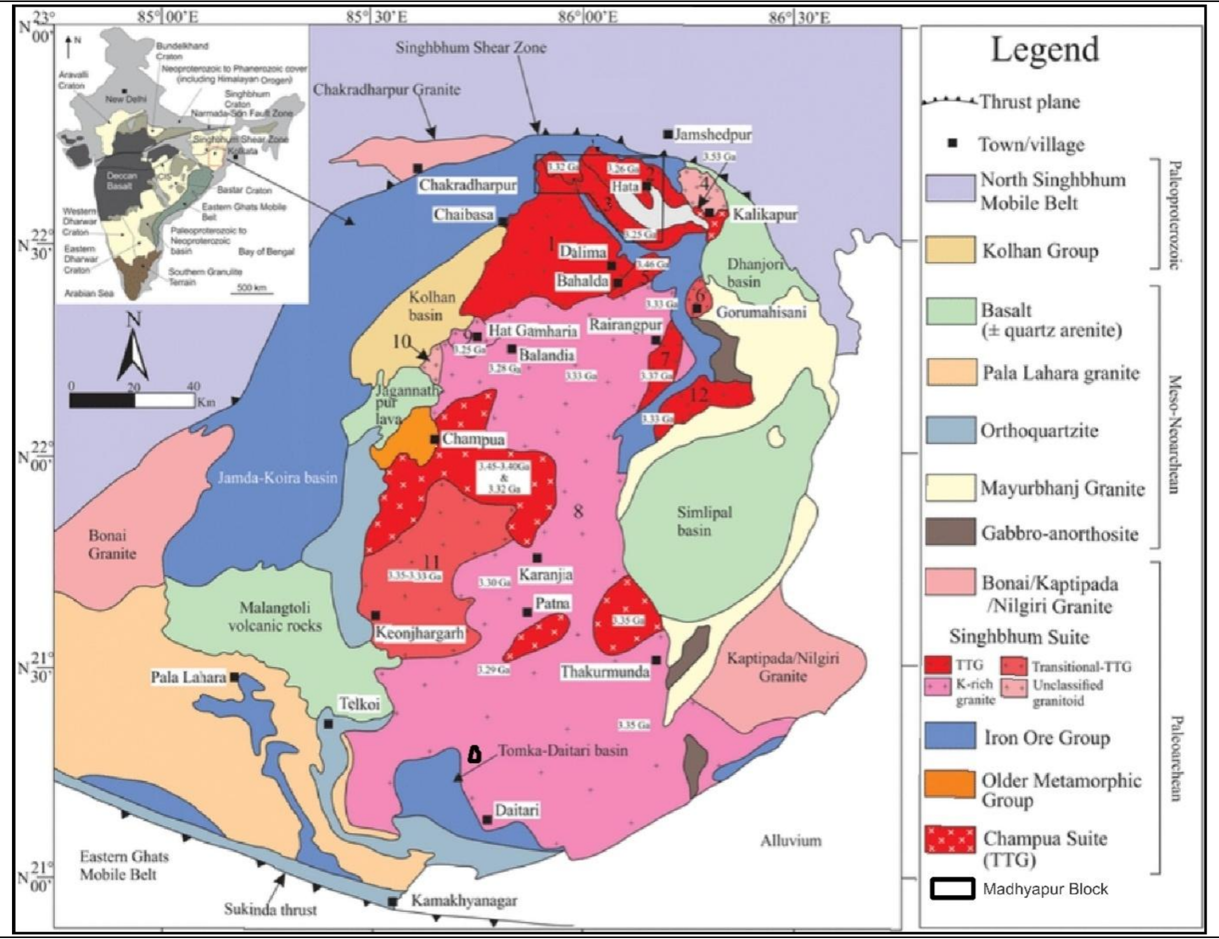


Figure 2: Madhyapur area superimposed over the Regional Geological map of the Singhbhum Craton.

The litho assemblages occupying in this entire belt comprises actinolite chlorite schist, talc tremolite schist, BHQ/ BMQ/ BHJ with pockets of iron ore, lenticular patches of conglomerate, gritty quartzite, carbonaceous phyllite, ferruginous shale and phyllite which are surrounded by granite towards both east, west and north. Dolerite dykes are found to occur as the intrusive rock to all these litho units. They are also traversed by late-stage quartz veins. The litho units extends along ENE-WSW strike in the eastern part of the basin from Tomka to Daitari for about 15 km and gradually towards west it takes turn to N S strike from Daitari to Talapada which again swerves to east-west trend near east of Kalisagar. Further north-west, the change of strike of these litho-units in N NW-SSE to NNE-SSW direction from Ghutang - Burhipada - Madhyapur sector indicate the influence of fold structure in the area. The general stratigraphic succession of rocks in this belt as worked out by Prasad Rao and Dekhitulu can be summarized as mentioned below:

Second sequence	Banded hematite jasper, banded jasper, black chert
	BHQ with alternate shales
	Grits and conglomerates, phylites, ferruginous shale, and carbonaceous shale.
First sequence	**…...............Unconformity…..................**
	Metavolcanics, chlorite schist, hornblende schist and amphibolites
	Quartzite, BHQ, etc
	Mica schist, fuchsite quartzite, micaceous quartzite etc

There are two distinct volcano-sedimentary sequence of rocks in the Rebana-Palaspal area, surrounding the Granite/Granite Gneiss, being separated by a polymictic conglomerate. In the eastern part of the area bordering the Granite gneiss, the lithounits of lower sequence is exposed. It comprises of talc-chlorite schist, meta lava, ferruginous shale/tuff, cherty quartzite, banded chert & meta chert, Banded Magnetite Quartzite (BMQ) and Banded Hematite Quartzite (BHQ), which is intruded by meta ultramafic, newer dolerite dyke and quartz veins. Magnetite is the main ore associated with BMQ/BHQ.

The upper sequence occurring further west is unconformably overlain by gritty quartzite, interbedded with phyllites/tuffs. The BHJ with hematite overlies the above units, further west of the mapped area.

Quartz vein and dolerite dykes	
…..........…......................	
Upper sequence	Phyllites
	Gritty and massive quartzite with siltstone and phyllite partings
	Conglomerate (polymictic)
	…..............................
Lower sequence	Meta basics and meta ultramafic
	Tourmaline bearing meta chert
	BMQ & BHQ with iron ore (mostly magnetite)
	Banded cherty quartzite (Black& green)
	Quartz-chlorite schist, talc-tremolite schist, Actinolite- chlorite schist etc.
	…...................................
	Granite & Granite gneiss
	Base not seen

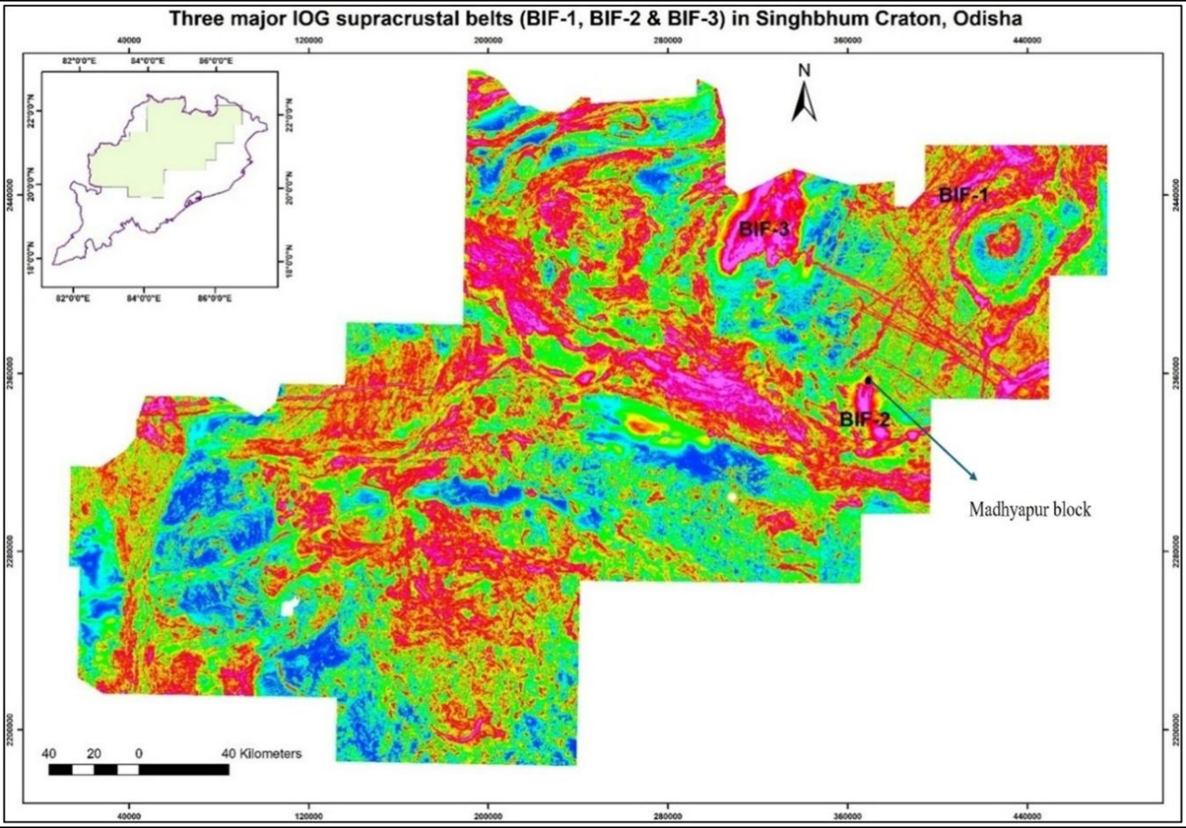


Figure 3: Aero-Magnetic RTP map showing IOG supracrustal belts in Singhbhum Craton. Madhyapur area part of BIF-II is plotted on the map.

5.2 Regional Structure

The bedding plane in form of colour banding cherty quartzite and compositional banding in BMQ, BHQ are well preserved in the area. The general strike of the bedding (S0) is N45°W-S45°E in the southern part of the area to N10°E-S10°W and N-S in the central and northern part of the area. Besides, primary sedimentary structure like current bedding, ripple marks and rhythmic banding and some pene-contemporaneous structures (PCD) like load cast, convolute and wavy laminations are occasionally preserved in the quartz-arenite rock exposed at the contact between gritty quartzite and orthoquartzite near Burhipada Juang.

Foliation is generally represented by the schistosity and gneissosity plane developed in phyllite, metabasic rocks and granite gneiss etc. The obscure mark of schistosity in the BMQ/BHJ as identified in the thin sections are defined by preferred orientation of flaky minerals. The axial plane schistosity (S1) and gneissosity being parallel to the bedding S0) plane in BMQ/BHJ as identified in the thin sections are defined by flattening of quartz grains, where as in metabasic and phyletic rocks it defined by preferred orientation of flaky minerals. The axial plane schistosity (S1) and gneissosity being parallel to the bedding (S0) plane in BMQ/BHQ rocks, extends in N 10°E-S10°W strike showing 45° to 75° dip towards west.

The rocktypes exposed in the area are affected by two generations of folding. The S0 (bedding) and S1 (axial plane foliation) planes being mutually parallel to each other in BHQ/BMQ and cherty quartzite and other schistose rocks are inherited by first phase of folding. The first fold (F1) is represented by tight asymmetrical folds with N10°E-S10°W to N-S striking axial plane best preserved in the BIF rocks near Pangaposi and quartzites near west of Burhipada Juang. The trend of fold axis of this F1 fold shows 55° plunge towards S80°W in the southern part of the mapped area near Burhipada and towards further north it veers to N80°W direction with 40°plunge near Nipania and Madhyapur.

A major set of cross fault trending in NW-SE direction occur in the Brahmnadihurhi and is marked by intense silicification and dislocation of the BMQ/BHC and quartzite bands (Plate III).

5.3 Regional Metamorphism

The presence of the Chlorite-epidote-zoisite-clinozoisite-muscovite mineral assemblages in the meta basic rocks suggest that the rocks exposed in the area have undergone low grade green schist facies of metamorphism.

CHAPTER 6. GEOSCIENCE INVESTIGATION

6.1 Geological mapping

6.1.1 Large scale mapping

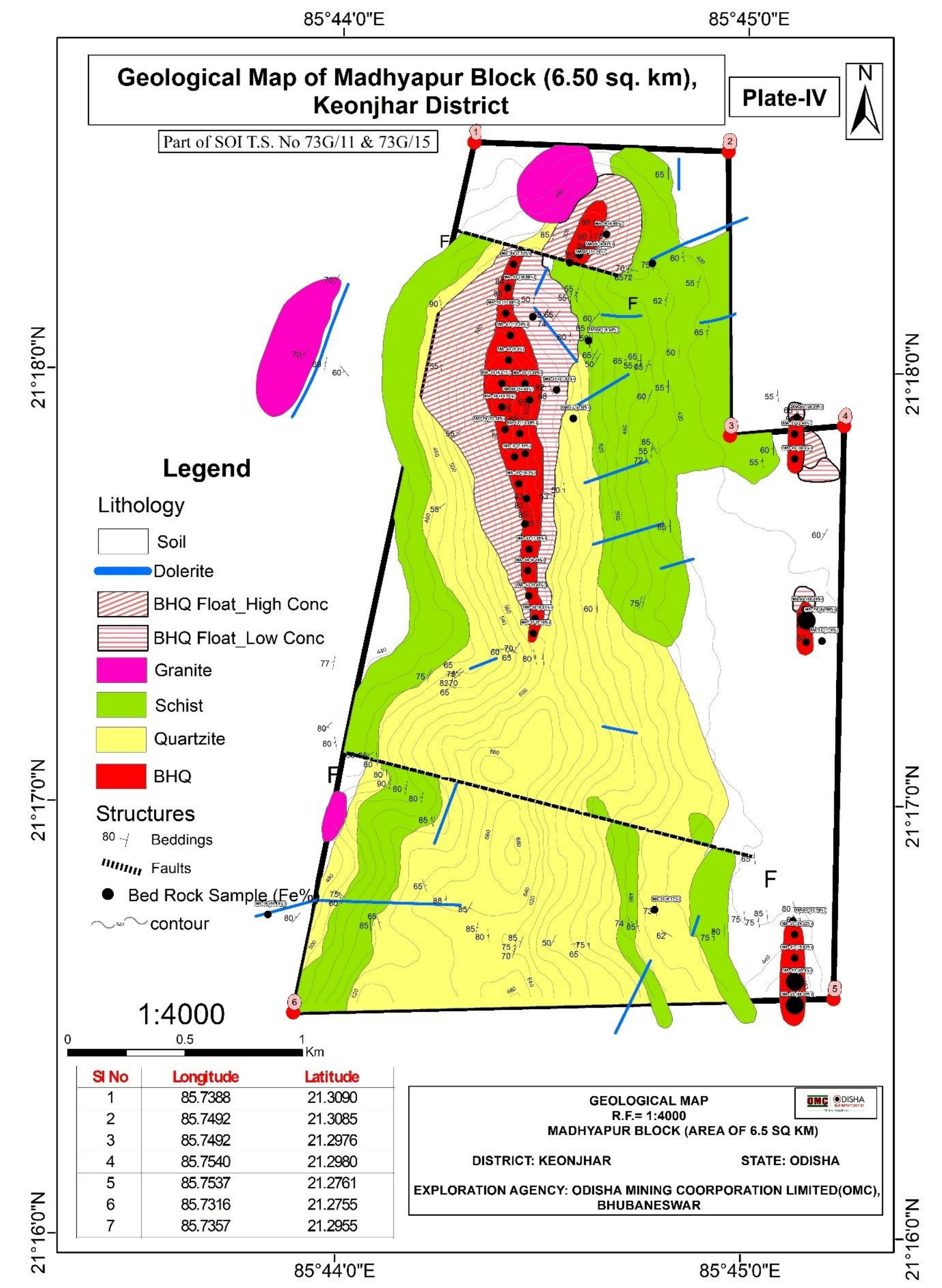
As per the approval accorded during the 58th TCC meeting held on 30th October 2023 and 32nd EC meeting held on 06th December 2023 and sanction order No. 23/409/2023-NMET/387, dated 15.12.2023; an area of 6.5 sq. km was mapped on 1:4000 scale in Madhyapur area of Keonjhar District, Odisha falling in parts of toposheet no. 73G11 F45N11 & G15 F45N15. The objective of this project is to identify and demarcate the BIF bands, by geological mapping in 1:4,000 scale, to understand the depth continuity of the limited Iron ore exposures and to prove the mineralized zones and check the subsurface continuity by Exploratory drilling.

Field mapping in Madhyapur area (G3-Stage) was carried out by using the Global Positioning System (GPS) for location, a Brunton compass, geological hammer, pocket lens, haversack, sample bags, measuring scale, hand magnet, field notebook, pencil-eraser, etc.

Initially, reconnaissance traverses were planned in the area to know the lithological variations & mutual relationships amongst different rock types and their contacts. Systematic geological mapping was carried out to gather detailed information on the geology of the area of interest. In this process, detailed mapping of the rock types and their structures, collection of bedrock samples and study of mineralization were carried out to understand the geology of the study area.

The procedure followed during the geological mapping starts with recording the latitude and longitude of the locations and plotting them on the toposheet in an interval of 40 to 50m for G3 stage with the help of GPS. The mapping was carried out demarcating the outcrops/exposures of the lithounits with observation of primary features like bedding, its strike-dip, and other structural information. Field maps were prepared by plotting the area boundary coordinates with the help of ArcGIS software, on the base map (Survey of India toposheet), and the toposheet of scale 1:50,000 is enlarged to 1:4000 scale. The observations of lithounits along with the structural data were recorded and the outcrops and litho-contacts were delineated on the base map (enlarged toposheet at 1:4000 scale) in the field itself. Field maps were then digitized with reference to Lamberts conformal conic projection system and WGS 84 datum in Arc GIS software with all structural, lithological, topographical and analytical data displayed on it.

The study area belongs to the Iron Ore Supergroup of rocks of Tomka-Daitari belt occurring in SW part of Singhbhum Craton. The rocks exposed around Tomka-Daitari basin extend further towards Ghutang, Burhipada, Pangaposhi and Madhyapur area for around 50 km. The large-scale mapping on 1:4000 scale has been carried out in the study area to delineate iron ore zones. During mapping, traverses were taken along and across the strike of different lithounits to establish the contact relations and to trace the mineralized zone. The mapping on the defined scale brought out all the lithological variations exposed in investigation along with their structural attributes. The major litho-units in the study area comprise of BHQ associated with the chloritic schist rocks and quartzite, those are present in the ridges and are surrounded by granite at low lying plains. The general trend of foliation varies from the N-S to N10ºE-S10ºW direction dipping at angles varying from 65º to 72º towards west, but mostly sub-vertical. In the western portion of the area and in its surrounding areas, the exposure of BHQ and Quartzites are encountered along with granitic gneiss. However, the contacts could not be marked due to the presence of thick soil cover and vegetation. The southern part of the area is covered by alternating sequence of thickly bedded quartzite and metabasics/chloritic schist. No textural or composition variation is observed within the quartzites encountered in the north and south. At places, banding was observed within the quartzite which was not mappable at 1:4000 scale. The entire metasedimentary sequence was intruded by dolerites and quartz veins along different fractures across all the older litho-units. Few traverses were also taken outside the area in the west where granitic gneiss was encountered along with BHQ, Quartzite and Metabasics. However, the contacts could not be marked due to thick soil cover and dense vegetation (Plate IV).



Sl No	Longitude	Latitude
1	85.7388	21.3090
2	85.7492	21.3085
3	85.7492	21.2976
4	85.7540	21.2980
5	85.7537	21.2761
6	85.7316	21.2755
7	85.7357	21.2955

Figure 4: Geological map of Madhyapur Iron area, Keonjhar District, Odisha.

a. BHQ

During mapping N-S trending, feebly magnetic BHQ was encountered in the high ridges in the western part of the area. The strike continuity of the BHQ band was terminated further north by NW-SE trending fault and towards south the body pinched out in the central part of the area. BIF, mostly represented by Banded Hematite Quartzite (BHQ) comprises of alternate Hematite and white or grey /dark brown quartzite. They are lensoidal in nature and trends in a N-S direction as two parallel to sub parallel bands in the study area.

It is a laminated to thinly bedded rock in which each lamination/band of quartzite is separated by dark coloured iron ore. Minor folds are seen to have developed in this rock. Quartzo-feldspathic veins are found as injections/intrusions along the bedding planes of BHQ.

The eastern BHQ band (at much lower elevation) is exposed as narrow and discontinuous mounds along with intercalations of quartzite and chloritic schist which extends from south of Madhyapur village to Burhipada village in south,while the western BHQ is exposed as a continuous band and forms a steeper hill (Brahmanidei hill).The continuity of eastern BHQ band could not be established due to thick soil cover.

Megascopically, the individual quartzite bands are much thicker as compared to that of the iron oxide rich bands. The western BHQ band dominantly shows the presence of Quartzite whereas Hematite bands are restricted to 5-10% of the total volume showing width of around 0.20 to 0.40 cm. The BHQ litho unit forms a steeper ridge. The cumulative strike length of the western BHQ is around 1900m with width varying from 30m to 70m. The eastern BHQ band has good thickness of Hematite bands which are more than 50% of the total volume as compared to quartzite. Also, HMO (hard massive ore, a variety of Hematite) is present discontinuously in all three nos. of eastern BHQ band. The eastern BHQ has around 1000m strike length and 20m to 40m width. The BHQ shows weak magnetism as checked with the help of Tungsten Carbide scriber pen having Neodymium magnet and reddish-brown streak colour.

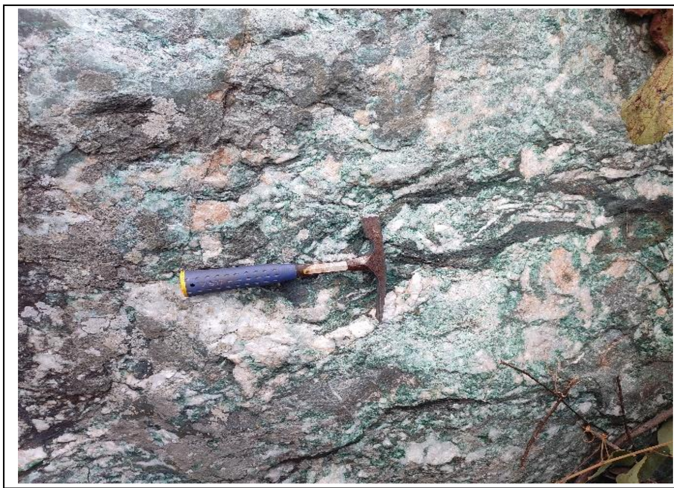
The contacts between BHQ and Quartzite is found to be gradational.The continuity of this eastern BHQ band is also obliterated due to thick soil cover. Contact of BHQ with Quartzite is rarely observed due to high concentration of floats. In the western portion of the area and in its surrounding areas, the exposure of BHQ and Quartzites are encountered along with granitic gneiss. However, the contacts could not be marked due to the presence of thick soil cover and vegetation.

	
Field Photograph 1: Eastern BHQ band showing intercalation of Hematite and Quartzite layers. (21.290005, 85.752534)	**Field Photograph 2:** Cherry red colour streak of BHQ band shown in left image. Also, it shows limonitization.
	
Field Photograph 3: Western BHQ band showing intercalation of Hematite and Quartzite layers. Quartzite is the dominant litho-unit. (21.301241, 85.740281)	**Field Photograph 4:** Western BHQ band showing intercalation of Hematite and Quartzite layers. Quartzite is the dominant litho-unit. (21.297925, 85.740461)
	

Field Photograph 5: HMO (hard massive ore, Hematite variety) present discontinuously in the Eastern BHQ band.	**Field Photograph 6:**HMO giving cherry red streak against the streak plate.
	
Field Photograph 7: Eastern BHQ band. Micro folding (ptygmatic folding) observed in BHQ (21.277104, 85.751943)	**Field Photograph 8:** Boudinage structure in BHQ.

b. Cherty Quartzite

Quartzite is exposed along the Bramhanidei hill ranges, enveloping the BHQ and trending in NNW-SSE direction. These are found as isolated patches, hard, compact, massive, high jointed in which bands or lenses of sericite schist is developed at places. Quartzite is fine grained, thickly bedded rock, at places sugary, off-white to grey in colour, though vitreous and greyish phases also occur frequently. Colour lamination/banding is well preserved at places. The rocks along the contact with dolerite intrusion appears to be of dark greyish black colour. Milky white quartz-veins are found to be intruding these rocks. It is characterized by very low dip (7° to 10°) and becomes horizontal at places.

	
Field Photograph 9: Actinolite bearing quartzite	**Field Photograph 10:** Massive Quartzite present in the western part of the area

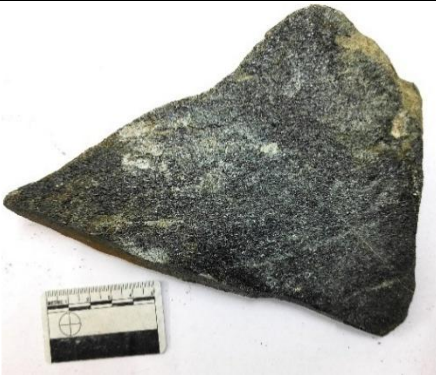
Field Photograph 11: Fuchsite Quartzite floats are present towards the southern part of the area.

c. Metabasics/Chloritic Schist

Sporadic exposures of schistose rocks were encountered mostly along the foothills and in the valleys. The schistose rocks mainly comprise of chlorite actinolite schist with minor assemblages of talc tremolite actinolite schist. It is medium to coarse grained rock with well-developed schistosity, most probably Gabbro as its precursor rock as per the field observations of remnant volcanic texture. It shows a greenish tinge may be due to chloritization. The rock is often altered over to chlorite and talc. Mineralogically it is composed of quartz, tremolite, actinolite and chlorite with minor opaques. The foliation is defined by flakes of Actinolite/ Tremolite and granulose quartz rich layers.

The rock shows inter-locating and inter granular texture and shows little effect of metamorphism by developing crude foliations in the rock.

Field Photograph 12: Chlorite schist in the central part of area.



Field Photograph 13: In hand specimen, Metagabbro appears as melanocratic, medium to coarse grained. The greenish tinge may be due to Chloritization.

d. Granite

Granitic occurs as small mounds, knolls or isolated sheets and detached outcrops within the pediplain. These are medium to coarse-grained, leucocratic rock exhibiting gneissose texture and is composed essentially of quartz, K-feldspars, biotite and opaque minerals and tourmaline and zircon present as accessory mineral. It is weathered and has undergone alteration to kaolinized feldspars. Pegmatite veins are found intruding the host rock.

	
Field Photograph 14: Granite showing ptygmatic folds of secondary quartz veins, exposed near the western area boundary.	**Field Photograph 15:** In hand specimen, Granite appears leucocratic, coarse to medium grained with quartz, feldspar, biotite, opaque minerals.

e. Dolerite

Dolerite dykes are medium grained and melanocratic. The dykes are mostly trending E-W to NE-SW and extends for about 5m to 10m length with up to 50cm width. They occur as intrusive into schist and granite gneiss at places. It is composed of mainly calcic-plagioclases, pyroxene and zoisite. The dykes mainly show NE-SW trend and extends for about 5m to 10m length with up to 1m width.

Field Photograph 16: Dolerite dyke trending NE-SW in the study area.

Field Photograph 17: In hand specimen, these are melanocratic, medium-grained, mafic igneous rock and magnetic in nature.

f. Quartz Veins

Small quartz–veins traverse through different lithounits of the area, intermittently both along and across the structural planes. These are milky white to off-white in colour. At places, quartz veins contain fuchsite mica. The veins mainly follow the foliation planes in quartzite and schist and at places crosscut the foliation in granitic gneiss.

Field Photograph 18: Field Photograph: Quartz veins in chloritic schist parallel to foliation

Field Photograph 19: Field Photograph: Quartz vein in granitic gneiss crosscutting the foliation

6.1.2 Structures

Regionally, the strike of axial planes of the dominant folds in different supracrustal belts changes from NNE-SSW in Gorumahisani-Badampahar to NE-SW near Nuasahi followed by ENE-WSW in Tomka-Daitari and NNE-SSW in Noamundi-Jamda-Koira (BK

Belt) (Sarkar and Saha, 1977). Tomka-Daitari lies in widely separated outcrops towards southeast, the intervening areas being occupied by metabasic lavas, granites, and clastic quartzites. Iron ore formations of Tomka-Daitari basin corresponds to BIF-II of the Iron Ore Supergroup (Acharya, 2000). The Iron ore Formation has been subjected to series of folding. It lies along the southern margin of the Singhbhum craton.

The study area is confined to Tomka-Daitari belt (BIF-II). The folds of different phases are co-axial and synchronously cross-folded having mutually perpendicular axial planes (Acharya, 2002). The regional trend of the dominant structure is in E-W direction and the plunge is towards west direction. Steeply dipping thick quartzite horizon is forming a prominent synform.

a. Primary structures

Bedding

Bedding planes are well developed in metasedimentary rocks. Bedding plane in form of colour banding in quartzite and compositional banding in BHQ are well preserved in the area. The laminations in BHQ shows conspicuous bedding plane. The general strike of the bedding (S_0) swerves from N-S to N10°E-S10°W with dip varying from 65° to 72° towards west but mainly having sub-vertical dip towards west. Besides, primary sedimentary structures like current bedding, ripple marks, rhythmic banding are occasionally preserved in the BHQ.

b. Secondary Structures

Schistosity

It is represented by the schistosity plane in metabasics rocks and cherty quartzite. It is generally parallel to the bedding plane of BHQ. It is defined by preferred orientations of long axis of actinolite, tremolite and chlorite. The general strike of bedding parallel foliation varies from N-S to N15°E-S15°W to N60°E-S60°W with dip varying from moderate to high dips (10° to 45°) towards both SE and NW. The major penetrative foliation in this study area can be interpreted as S_1 foliation.Structural data analysis in StereoNet 10 software showed a N-S trending open to closed fold with fold axis plunging 1° towards 189°. Broad warps in E-W direction led to scattering of data (poles) along N-S direction.

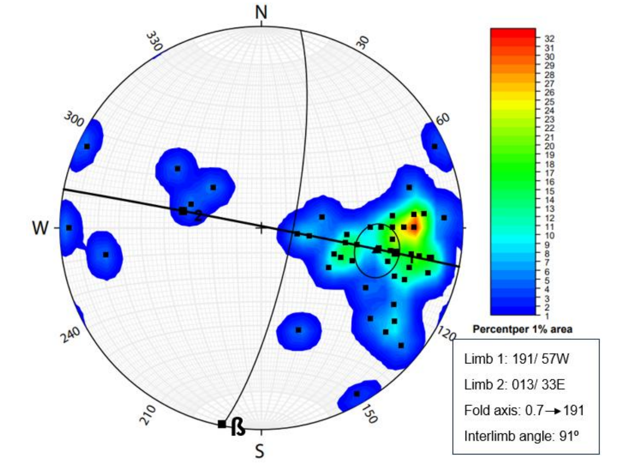


Figure 5: Plotting of foliation poles

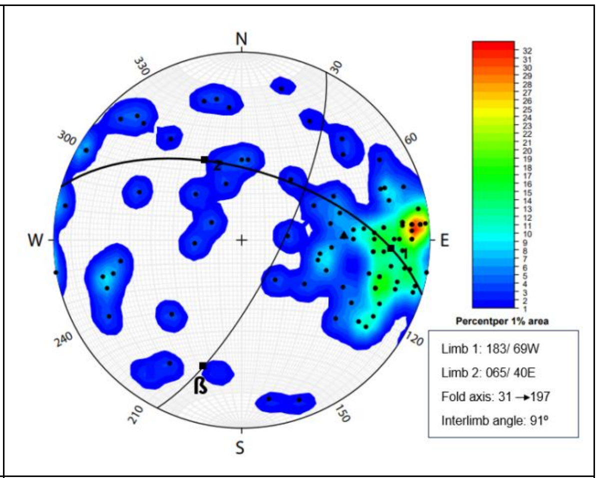


Figure 6: Plotting of bedding poles

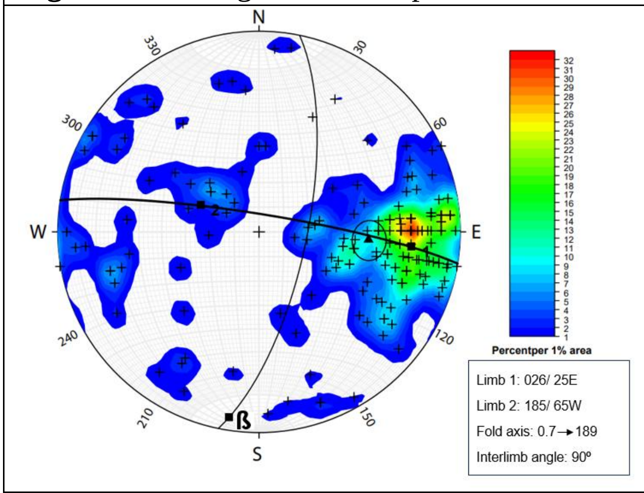


Figure 7: Plotting of bedding & foliation poles

Gneissosity

Gneissosity is found to develop in granites at a few places. It is defined by the preferred orientation of iron rich biotite and epidote.

Fault

Presence of NW-SE trending cross fault in the Bramhanidei mountain in the north and towards southern part of the explored area is marked by intense silicification and dislocation of BIF and quartzite bands. Micro-folding and Boudinage are also observed at places in the BHQ band.

Brecciation

Brecciation is occasionally observed in BHQ formation were angular fragments of brittle silica (quartzite) are embedded in iron oxide matrix. The zone of brecciation confines within undisturbed sequence of BHJ/BHQ.

Intraformational Folds

These folds are small scale and are confined within few successive layers of BHQ. These are localized in nature and the folded zones are confined within undisturbed sequence of BHQ on either side. It indicates that these were formed when interlayer gliding and slumping occur in the volcano sediments. Such types of folds vary in geometry from place to place and bear no relationship with the regional fold pattern. Minor folds are noticed mainly in the BHQ and banded quartzite. These are of the open type and often appear as warps (Plate IV & Figure 4).

Figure 8: A) Bedding parallel foliation in BHQ; B) Crenulations observed in schist; C) Minor folds in Banded quartzite, D) Microfolds in BHQ.

6.1.3 Metamorphism

The rocks of studied area have undergone very low to medium grade of metamorphism. The mineral assemblages viz. actinolite-chlorite-epidote and talc-tremolite-actinolite in metabasics rocks indicate green schist facies of metamorphism.

6.1.4 Sampling

The objective of sampling is that the surface/bedrock sample collected from the outcrop should display in a mini scale for all observed features of the object sampled and the sample quantity is sufficient for laboratory studies like mineralography, petrography, geochemistry. A fresh and unweathered sample is preferable to collect during field visit. The exact location of the sample is taken by GPS, the sample is numbered, and the field description of the samples is written on the field notebook. The megascopic description of samples has been carried out after the cleaning of samples. The representative surface samples collected during geological mapping from different parts of the area. The samples were labelled and packed weighing approximately 2 kg for further analysis.

Samples from different lithounits and float ores were collected. During the grab sampling, bed rock samples and float ore samples were collected from the outcrop. These samples were collected from shallow depths by slight manual pitting so that uncontaminated ones could be retrieved. The individual sample drawn locations were recorded by handheld GPS and their supporting photography was done by mobile phone camera. Bed rock samples (Grab samples) were planned and collected from the BHQ bands in a systematic manner of 100*100m grid interval. A total of 44 nos. of samples were collected. The sampling was carried out in a non-bias manner. Multiple chips were collected from a single 100*100m grid interval, and they were homogenized such that it to be representative of the 100*100m grid interval. The samples were analyzed with XRF, Muffle furnace from JNARDDC, Nagpur, India. The radicals analyzed were Fe, Al_2O_3, SiO_2, K_2O, Na_2O, Mn, P, S and LOI (Plate IV & Figure 6).

Table 5: Analytical Data of BHQ bands of Madhyapur Iron Area, Keonjhar District, Odisha												
Sr. No.	**Sample ID**	**Latitude**	**Longitude**	**Fe (%)**	**Al_2O_3 (%)**	**SiO_2 (%)**	**K_2O (%)**	**Na_2O (%)**	**Mn (%)**	**P (%)**	**S (%)**	**LOI (%)**
1	**MA-01**	21.2789	85.7521	23.79	0.16	65.12	0.01	0.1	0.04	0.02	0.02	0.35
2	**MA-02**	21.2909	85.7525	36.24	0.3	45.72	0.02	0.01	0.22	0.05	0.08	1.45
3	**MA-03**	21.2983	85.7521	38.99	0.5	41.49	0.01	0.02	0.02	0.02	0.02	1.79
4	**MA-16**	21.3053	85.7442	5.65	2.47	39.22	0.02	0.06	0.05	0.01	0.02	11.79
5	**MA-04**	21.3012	85.7435	18.48	0.12	72.33	0.01	0.03	0.11	0.02	0.03	0.77
6	**MA-05**	21.3045	85.7431	4.41	0.12	92.87	0.01	0.03	0.01	0.01	0.02	0.59
7	**MA-06**	21.2951	85.741	30.23	0.09	52.89	0.01	0.05	0.18	0.03	0.02	0.46
8	**MA-07**	21.3042	85.7427	14.16	0.08	78.32	0.01	0.04	0.06	0.01	0.02	0.71
9	**MA-08**	21.2989	85.7411	34.52	0.37	49.25	0.01	0.04	0.02	0.03	0.03	0.74
10	**MA-09**	21.2967	85.7405	15.25	0.11	75.11	0	0.03	0.01	0.02	0.02	2.81
11	**MA-10**	21.2967	85.7405	7.12	0.29	88.88	0.02	0.19	0.01	0.01	0.02	0.29
12	**MA-11**	21.3042	85.7461	30.03	1.52	43.39	0.12	0.01	0.89	0.12	0.03	6.67
13	**MA-12**	21.3021	85.7412	31.35	0.17	52.71	0.01	0.06	0.38	0.06	0.03	1.39
14	**MA-13**	21.2976	85.7407	14.69	0.17	78.26	0.01	0.01	0.01	0.01	0.15	0.22
15	**MA-14**	21.2993	85.7422	21.53	0.24	67.94	0.02	0.03	0.01	0.01	0.05	0.49
16	**MA-15**	21.2897	85.7532	1.16	0.12	97.2	0.01	0.03	0.01	0.01	0.04	0.15
17	**MA-17**	21.2982	85.7429	5.18	4.99	45.27	0.03	0.08	0.06	0.03	0.02	8.57
18	**MA-18**	21.2793	85.7464	9.17	13.56	49.26	0.63	2.4	0.11	0.04	0.02	1.21
19	**MA-19**	21.279	85.7305	10.19	11.75	49.73	1.13	0.74	0.15	0.03	0.03	1.92
20	**MA- 20**	21.27839	85.75217	29.22	0.4	56.15	0.075	0.016	0.01	0.006	0.026	1.08
21	**MA- 21**	21.27748	85.75218	15.83	0.34	76.05	0.02	0.015	0.01	0.005	0.007	0.34
22	**MA- 22**	21.27658	85.75219	45.4	0.17	32.94	0.027	0.004	0.23	0.019	0.013	1.33
23	**MA- 23**	21.27567	85.75219	58.29	0.28	9.5	0.034	0.008	0.24	0.026	0.064	5.95
24	**MA- 24**	21.29049	85.75255	44.99	0.22	32.74	0.011	0.004	0.55	0.027	0.021	1.57
25	**MA- 25**	21.28965	85.75255	1.55	0.72	96.24	0.174	0.003	0.02	0.009	0.019	0.4
26	**MA- 26**	21.29671	85.75202	39.6	0.18	42.79	0.007	0.011	0.04	0.016	0.007	0.16
27	**MA- 27**	21.29767	85.75201	2.48	0.19	95.82	0.019	0.006	0.01	0.006	0.020	0.25
28	**MA- 28**	21.29862	85.73996	14.76	0.08	77.86	0.006	0.005	0.01	0.016	0.008	0.86
29	**MA- 29**	21.29775	85.7401	20.09	0.09	69.89	0.005	0.009	0.06	0.023	0.002	1.05
30	**MA- 30**	21.29683	85.74093	15.59	0.1	76.15	0.008	0.005	0.01	0.014	0.005	1.33
31	**MA- 31**	21.29567	85.74068	16.2	0.13	75.07	0.008	0.006	0.09	0.017	0.005	0.39
32	**MA- 32**	21.29412	85.74095	3.94	0.07	93.83	0.008	0.005	0.01	0.006	0.008	0.39
33	**MA- 33**	21.29315	85.74112	1.38	0.05	97.78	0.006	0.005	0.05	0.004	0.008	ND
34	**MA- 34**	21.29232	85.74107	4.24	0.05	93.28	0.007	0.007	0.03	0.01	0.042	0.3
35	**MA- 35**	21.29135	85.74113	0.45	0.41	98.19	0.092	0.006	0.01	0.005	0.005	0.51
36	**MA- 36**	21.29049	85.74139	0.21	0.51	98.37	0.118	0.006	0.01	0.004	0.004	0.48
37	**MA- 37**	21.28991	85.74132	5.16	0.23	91.74	0.008	0.005	0.01	0.008	0.005	0.61
38	**MA- 38**	21.29953	85.73995	4.21	0.2	93.12	0.022	0.005	0.01	0.004	0.096	0.37
39	**MA- 39**	21.29953	85.7409	1.08	0.08	97.9	0.013	0.006	0.01	0.004	0.062	0.29
40	**MA- 40**	21.30043	85.74022	0.3	0.82	97.89	0.195	0.012	0.01	0.008	0.016	0.44
41	**MA- 41**	21.30138	85.74028	13.29	0.07	80.42	0.006	0.005	0.02	0.004	0.008	0.46
42	**MA- 42**	21.30223	85.74008	14.89	0.09	77.67	0.009	0.005	0.01	0.016	0.007	0.59
43	**MA- 43**	21.30321	85.74016	16.99	0.1	75.18	0.005	0.005	0.01	0.005	0.004	0.38

Sr. No.	Sample ID	Latitude	Longitude	Fe (%)	Al_2O_3 (%)	SiO_2 (%)	K_2O (%)	Na_2O (%)	Mn (%)	P (%)	S (%)	LOI (%)
44	**MA- 44**	21.30412	85.74039	7.52	0.24	88.21	0.019	0.005	0.01	0.007	0.125	0.35

Table5 represents the major oxides data for 44 nos. of BRS samples of BHQ bands. A total of 44 nos. of samples, were analysed from the study area. The samples were collected from continuous western and discontinuous eastern BHQ bands. As per IBM, threshold for Hematite is Fe @ 45% (min) for it to be Beneficiable grade. Only three sample shows above threshold values, and this grade indicates the area to be barren w.r.t. Iron mineralization.

6.2 Geophysical Exploration

Tomka-Daitari belt (BIF II) is one of the significant Iron ore belts in India producing large amount of Iron ores and many number of active mines are present in the area. Government of Odisha in the year 1993-97, conducted an Aero-Magnetic and Aero-Radiometric survey in the northern part of Odisha with a line spacing of 300m in NS survey direction. Magnetic data is useful in mapping regional structures, like fold & faults and magnetic minerals like magnetite/Hematite, pyrrhotite etc. Sediments deposited in iron-rich solutions associated with volcanogenic activity or Precambrian chemical precipitates, can contain appreciable magnetite or pyrrhotite. These sediments may be transitional to syngenetic massive mineralisation or BIFs. These rocks are highly magnetic, generally remanent magnetised and are characterised by strong anisotropy of susceptibility. The magnetic data of region around Madhyapur is magnetically active and was studied for understanding the structure and the disposition of BIF.

The Aero-magnetic data was studied for litho-structural interpretation. The regional magnetic grid was prepared in such a way that it covers the whole doubly plunging folded structure (Figure-12) The regional geological map (Figure 9) of the area was studied from GSI report having accession no. UE 13954 (Patra, R.N., Pasayat, R.N., 2002). The study area falls in the northeastern corner of the regional magnetic map, extensionas shown in Figure 10. Magnetic anomaly grid image overlaid on the regional geology map shown in figure. 10, 2500 nT bipolar anomaly is observed in the study area. This intensity of the anomaly indicates presence of high susceptibility minerals in the region. The first vertical derivative (1VD) of Reduced to Pole (RTP) of magnetic grid is presented in figure 11. RTP first vertical derivative image is used to interpret the edges of the high susceptibility body. As observed in figure 12, there is a correlation between the mapped BIF bodies from the geological map (Patra, R.N., Pasayat, R.N., 2002) with the RTP first vertical derivative image. The extension of this inferred sub-surface BIF can be interpreted from the RTP-1st VD image. The interpretation of legacy airborne magnetic data reveals presence of two parallel bands of high susceptibility bodies in the east probably depicting limbs of the doubly plunging fold structure. This doubly plunging fold structure is disturbed by NE-SW trending regional faults and NW-SE trending minor faults. The missing outer limb of the fold structure is shown for understanding shown by double dashed lines in figure 12 and 14. No BIF or iron rich body can be mapped to the north of the northern NE-SW trending regional fault. The geology map (Patra, R.N., Pasayat, R.N., 2002) indicates the presence of Singbhum granite in the mentioned region. In the southern part of the regional map, the gritty quartzite, exposes below which the extension of BIF can be mapped from magnetic data. The Madhyapur area, falls over the eastern limb as inferred from the magnetic data.

During the field visit, 44 bed rock samples were collected and analysed for Fe (%). The analysed results are plotted in figure 13. The analysis resulted in three samples averaging above 45% of Fe. These samples having higher concentration are restricted to the eastern limb (Figure 15&16). The eastern limb which had the highest concentration was traced to the south and was observed to be truncated at the southern NE-SW trending regional fault mapped from magnetic data. The inner limb of the doubly plunging fold is observed to be extending below the gritty quartzite in the south.

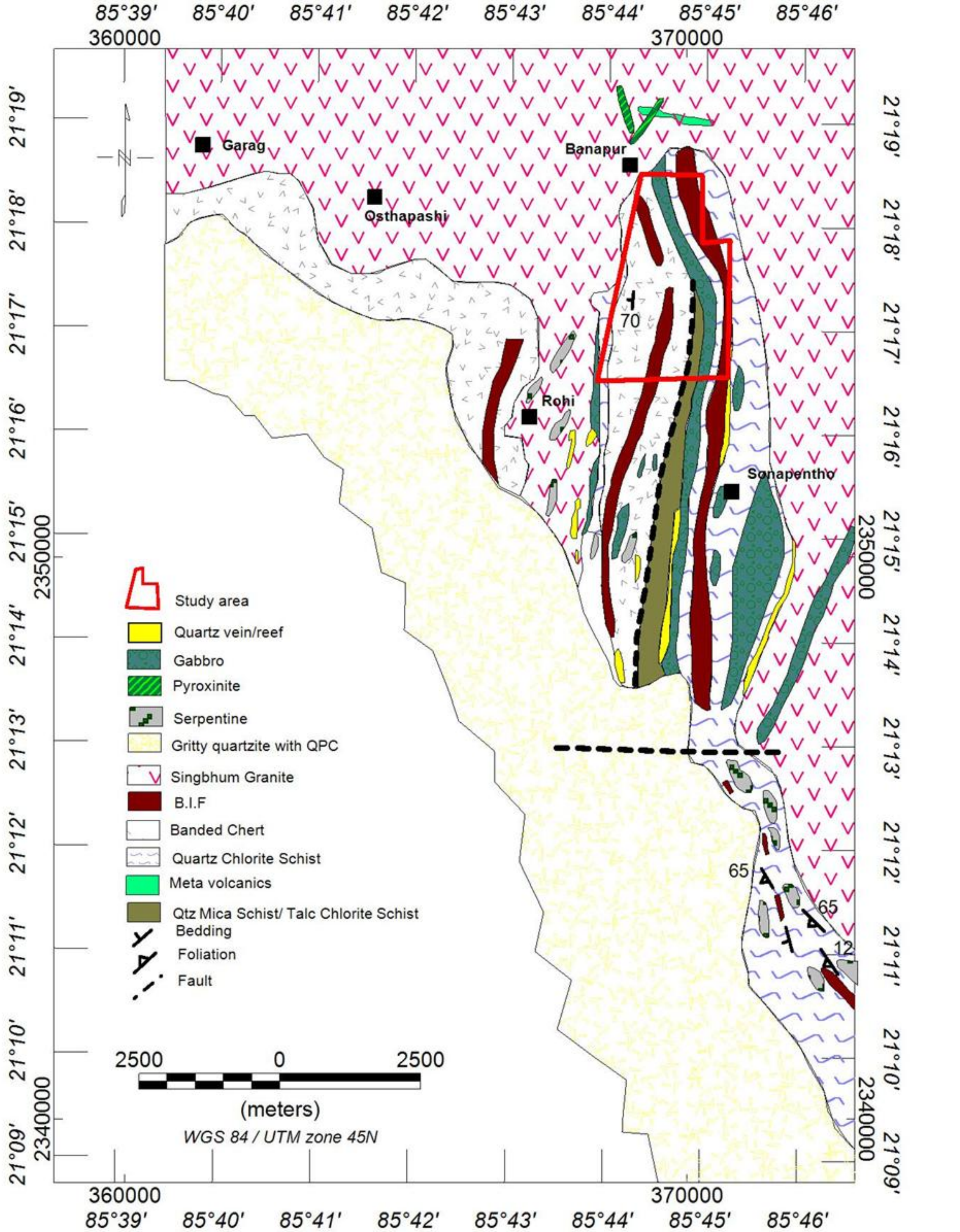


Figure 9: Madhyapur area falling over regional geological map (Patra, R.N., Pasayat, R.N., 2002). The study area falls in the northeastern corner of the regional map prepared. The bounds of the regional map were chosen such that it covers the doubly plunging N-S trending fold structure.

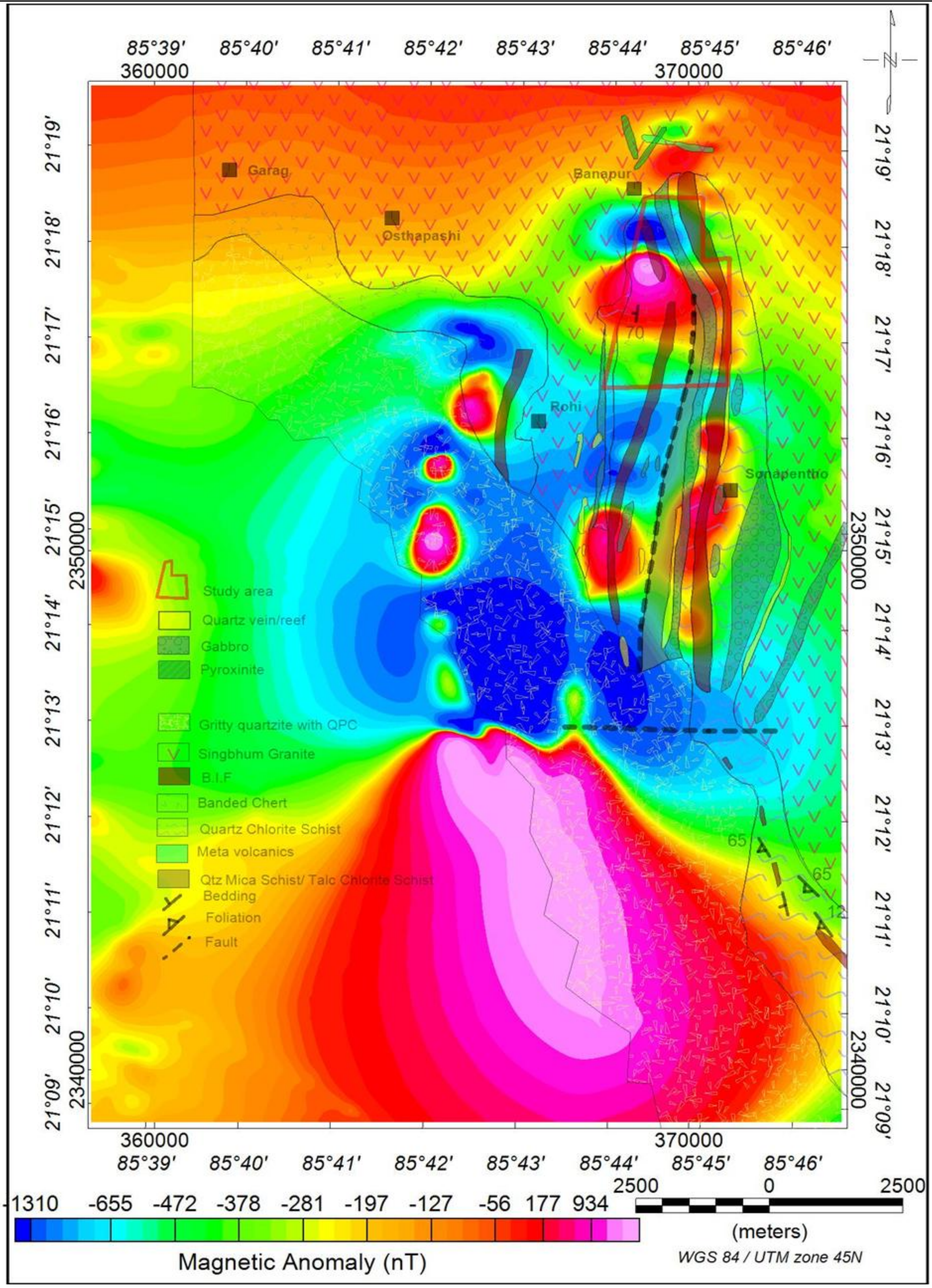


Figure 10: Aero-magnetic anomaly grid image overlaid on the regional geology map (Patra, R.N., Pasayat, R.N., 2002). 2500 nT bipolar anomaly is observed. The intensity of the anomaly indicates the presence of high susceptibility mineral in the region.

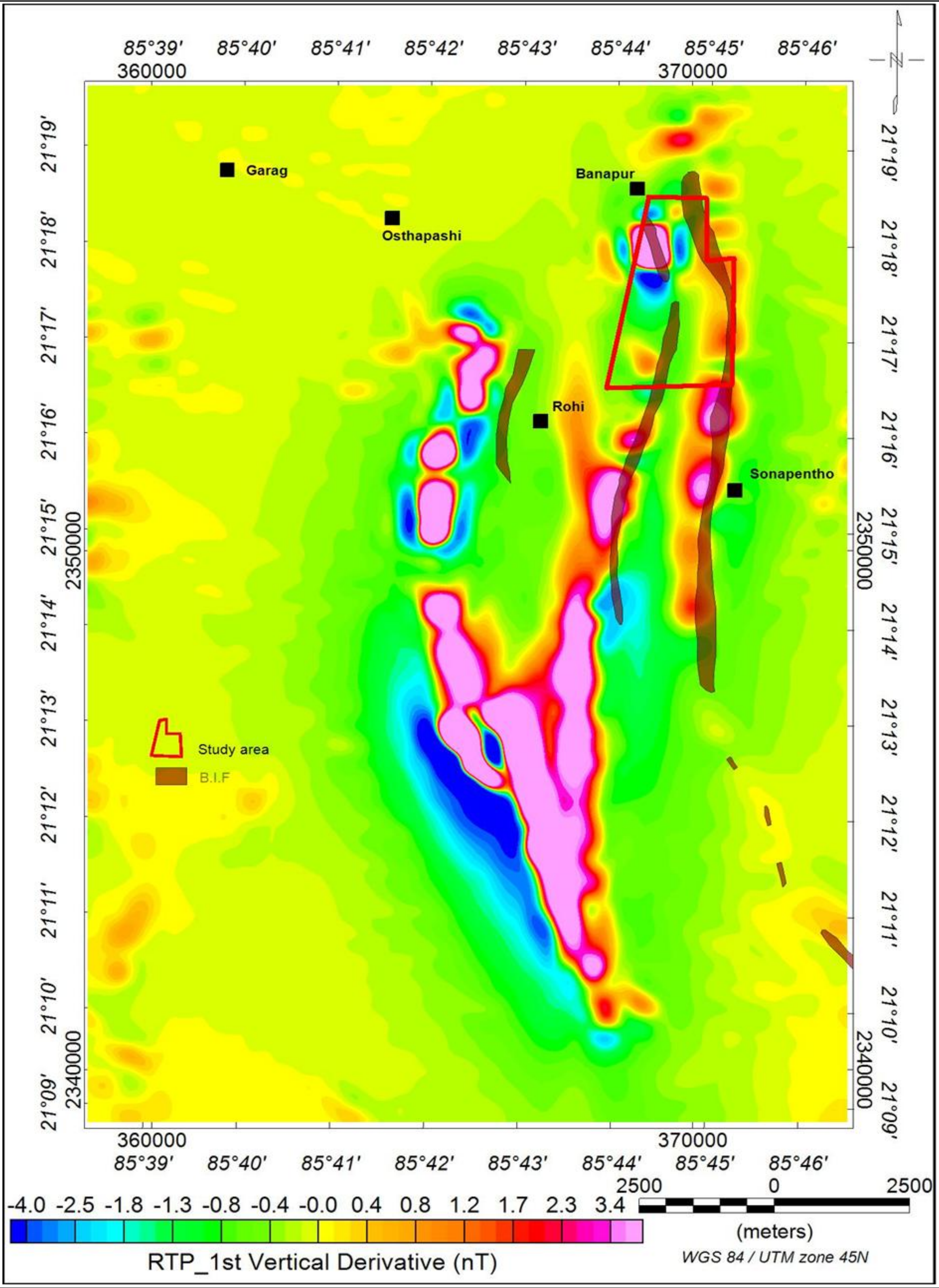


Figure 11: RTP first vertical derivative image is used to interpret the edges of the high susceptibility body. As observed, there is a correlation between the mapped BIF bodies from the geological map with the RTP first vertical derivative image.

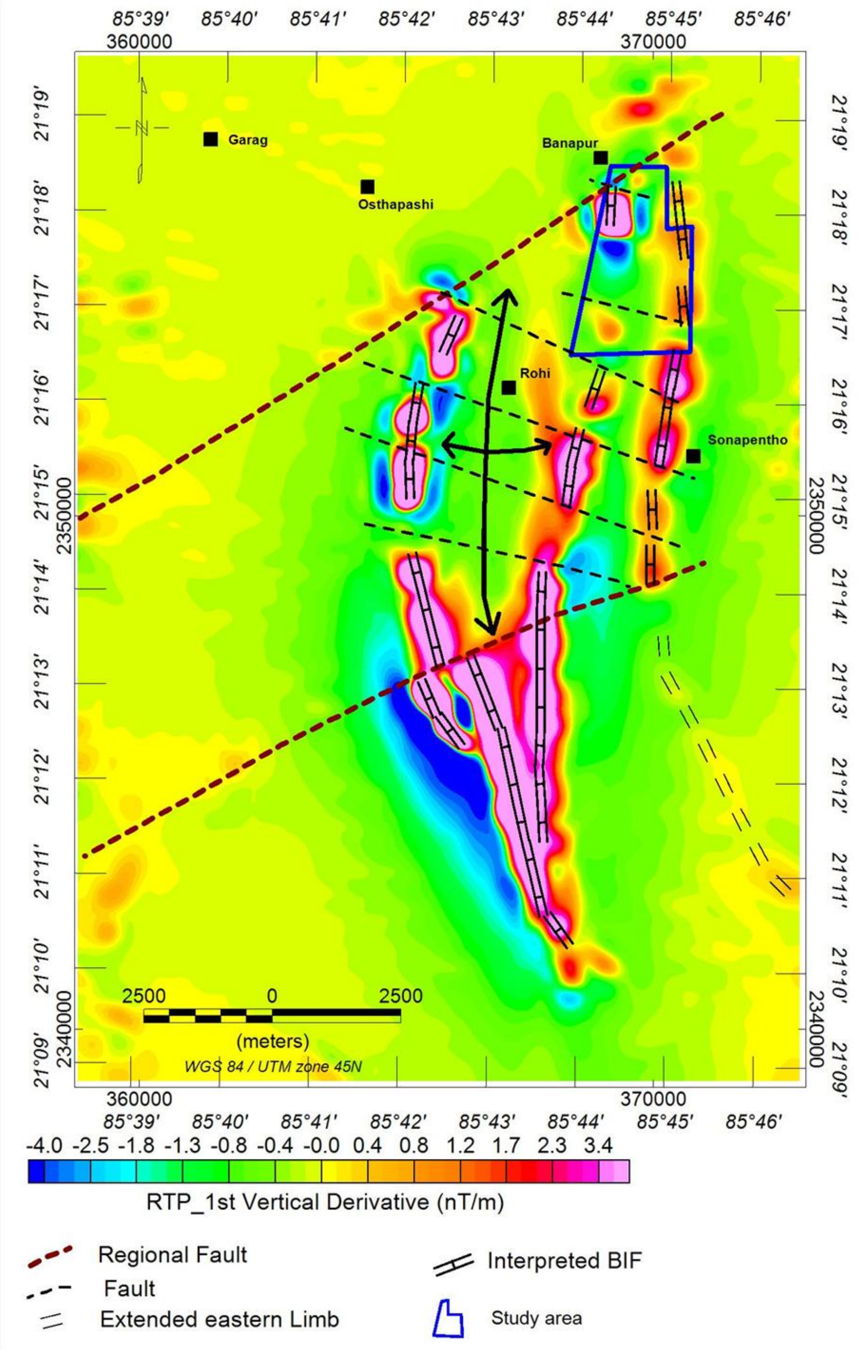


Figure 12: The interpretation of legacy airborne magnetic data with reference to Madhyapur area

The interpretation of legacy airborne magnetic data (Figure-12) reveals presence of two parallel bands of high susceptibility bodies in the east probably depicting limbs of the doubly plunging fold structure. This doubly plunging fold structure is disturbed by NE-SW trending regional faults and NW-SE trending minor faults. The missing outer limb of the fold structure is shown for understanding. The study area falls over the eastern limb as inferred from the magnetic data. No BIF or iron rich body can be mapped to the north of the northern NE-SW trending regional fault.

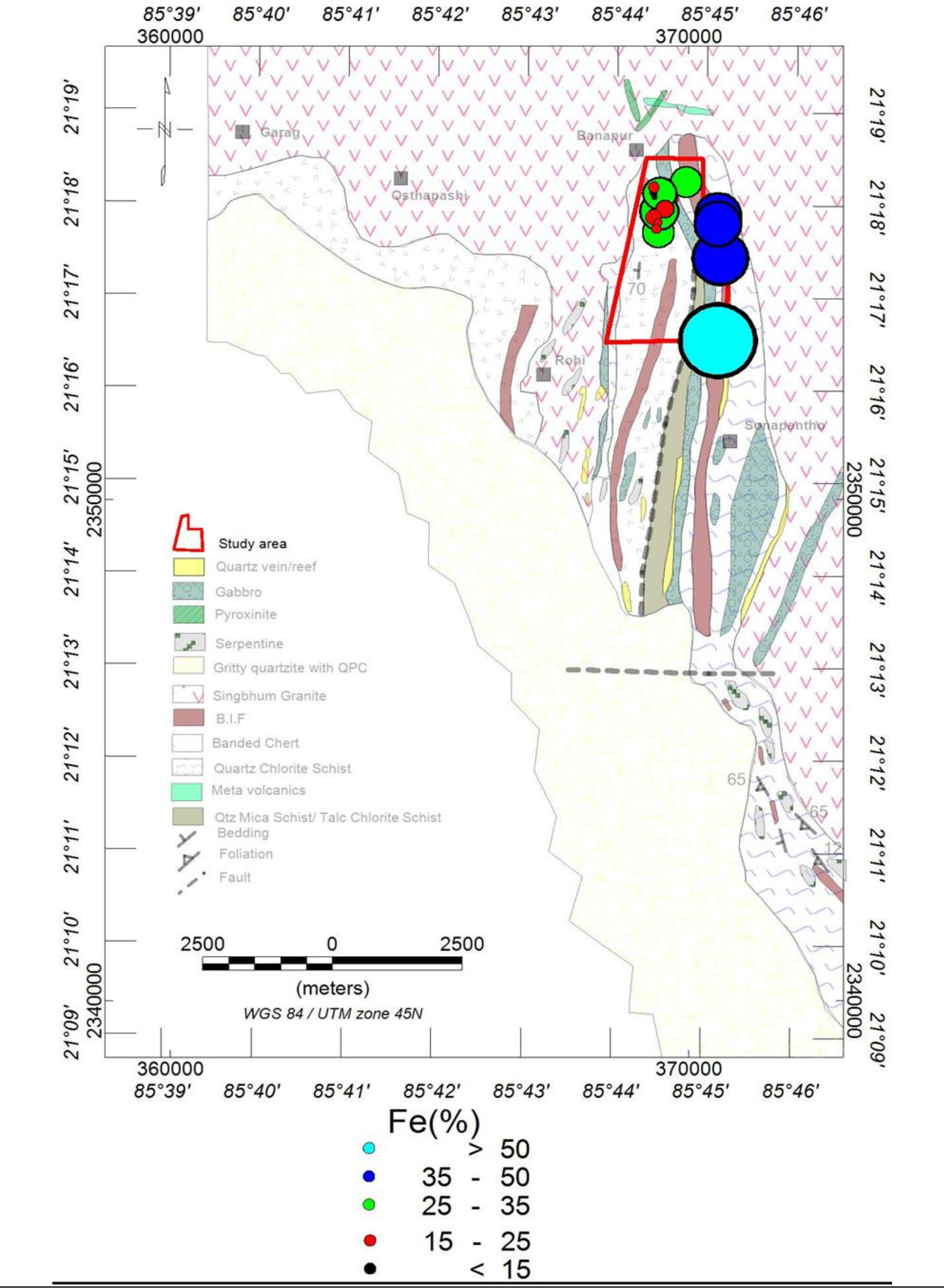


Figure 13: Bed rock samples were collected during field work, the analytical data resulted in three samples averaging above 45% of Fe. These samples having higher concentration are restricted to the eastern limb as observed from the image.

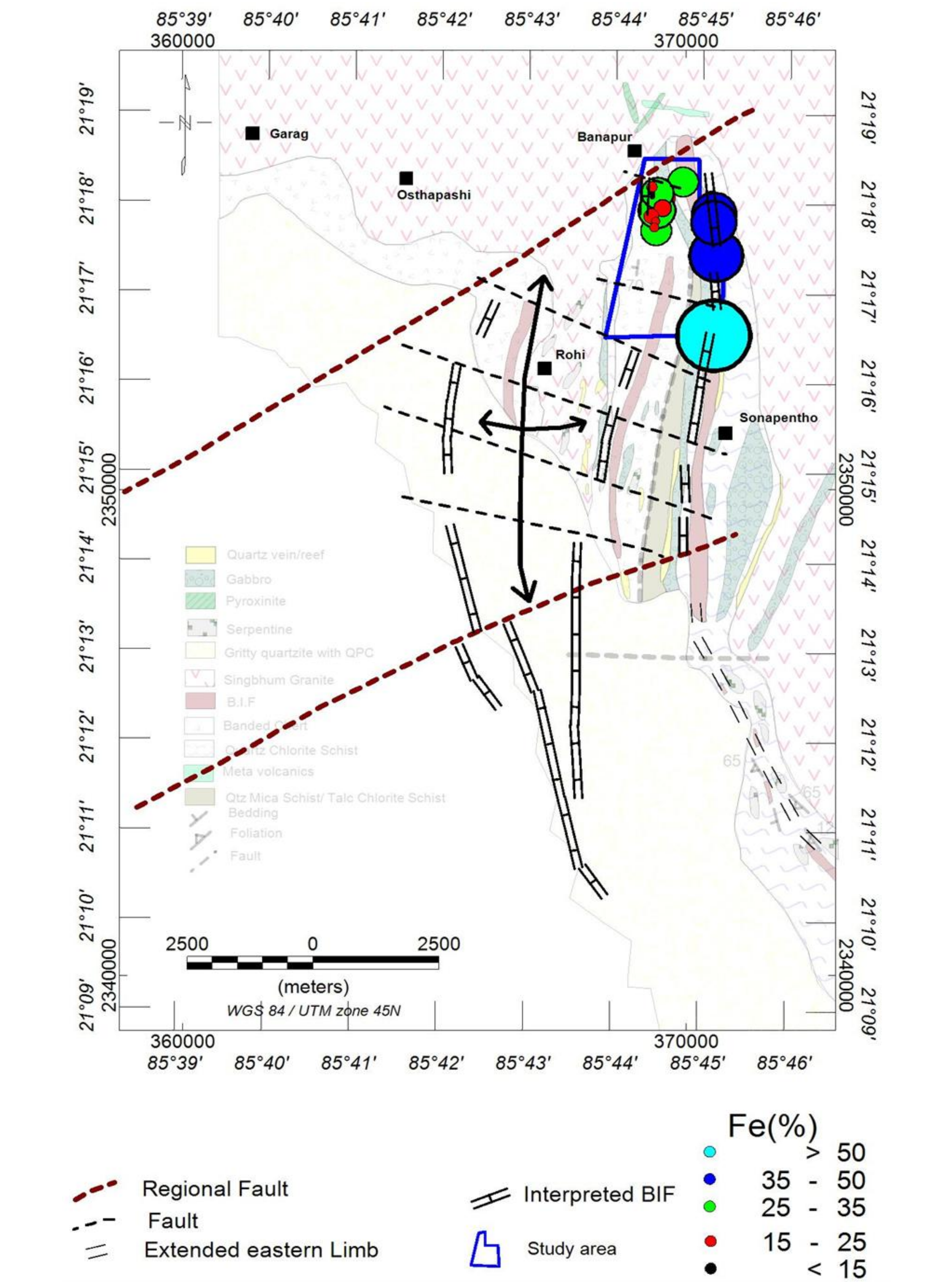


Figure 14: Overlaying of the Aero-magnetic data interpretation and analytical data of BRS indicates that there is no extension of the high Fe rich limb below the southern gritty quartzite. The inner limb of the doubly plunging fold is observed to be extending below the gritty quartzite in the south.

CHAPTER 7. INTEGRATION OF GEOLOGY, GEOPHYSICS AND GEOCHEMICAL EXPLORATION DATA AND THE INTERPRETATION

Geological Exploration

A two parallel BHQ bands are present in the Madhyapur area. The western band is continuous and attains a greater elevation up to 708m whereas the eastern band is discontinuous and forms lower mounds. Both band's trends in N-S to NNE-SSW direction. The eastern band shows Fe (%) more than 45% and at places HMO is present. Each band shows sub vertical dip towards west. The supergene enrichment process may have played a better role in the eastern BHQ bands owing to lower elevation of the band as well as field observation shows high fracture density in that part. Also, the western BHQ band is dominated by Quartzite and Hematite bands are only of mm to cm in size.

Geochemical Exploration

BHQ bands of Madhyapur area were systematically sampled in 100m*100m grid interval. A total of 44 nos. of bed rock samples were collected and analysed for Fe% and other radicals. The geochemical anomalies were interpreted w.r.t. Fe% and other radicals vis-a-vis disposition of BHQ bands and their geological characteristics influencing the concentration. The eastern discontinuous BHQ bands shows higher Fe (%) values as compared to western continuous BHQ band. However, out of 12 samples, only 3 sample shows values higher than 45% Fe (above threshold value and of Beneficiable grade).

Geophysical Exploration

The fold structure which was interpreted from Aero-magnetic data and ground validated by previous workers and BRS sample analysis of current work (Figure-15), indicates that the eastern limb (Figure-11, partly exposed in Madhyapur area and remaining part is falling outside the southern boundary of the area) is comparatively Fe rich and intermittently exposed between the NE-SW inferred faults (interpreted from Aero-Magnetic data at regional scale, Figure-12). The extension of this limb is not observed below the gritty quartzite south of the fault. Minor magnetic anomalies are observed which indicates not much encouraging results can be expected. However, the inner limb of the doubly plunging fold has an extension and fold closure is mapped south the regional fault (interpreted from Aero-Magnetic data at regional scale, Figure-12).

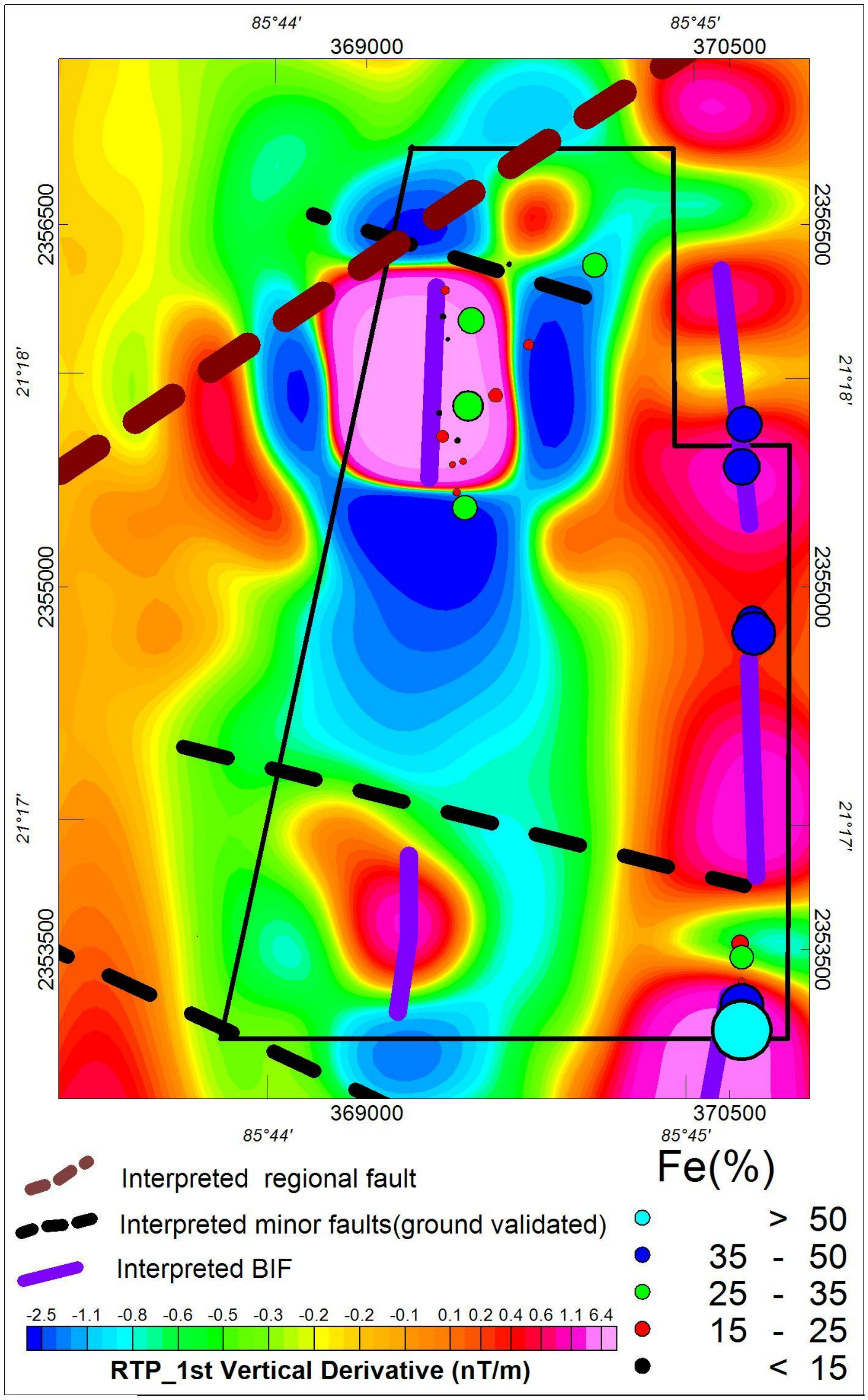


Figure 15: Detailed interpretation of the Aero-magnetic data and analytical data of BRS samples plotted on the RTP-1st Vertical derivative image.

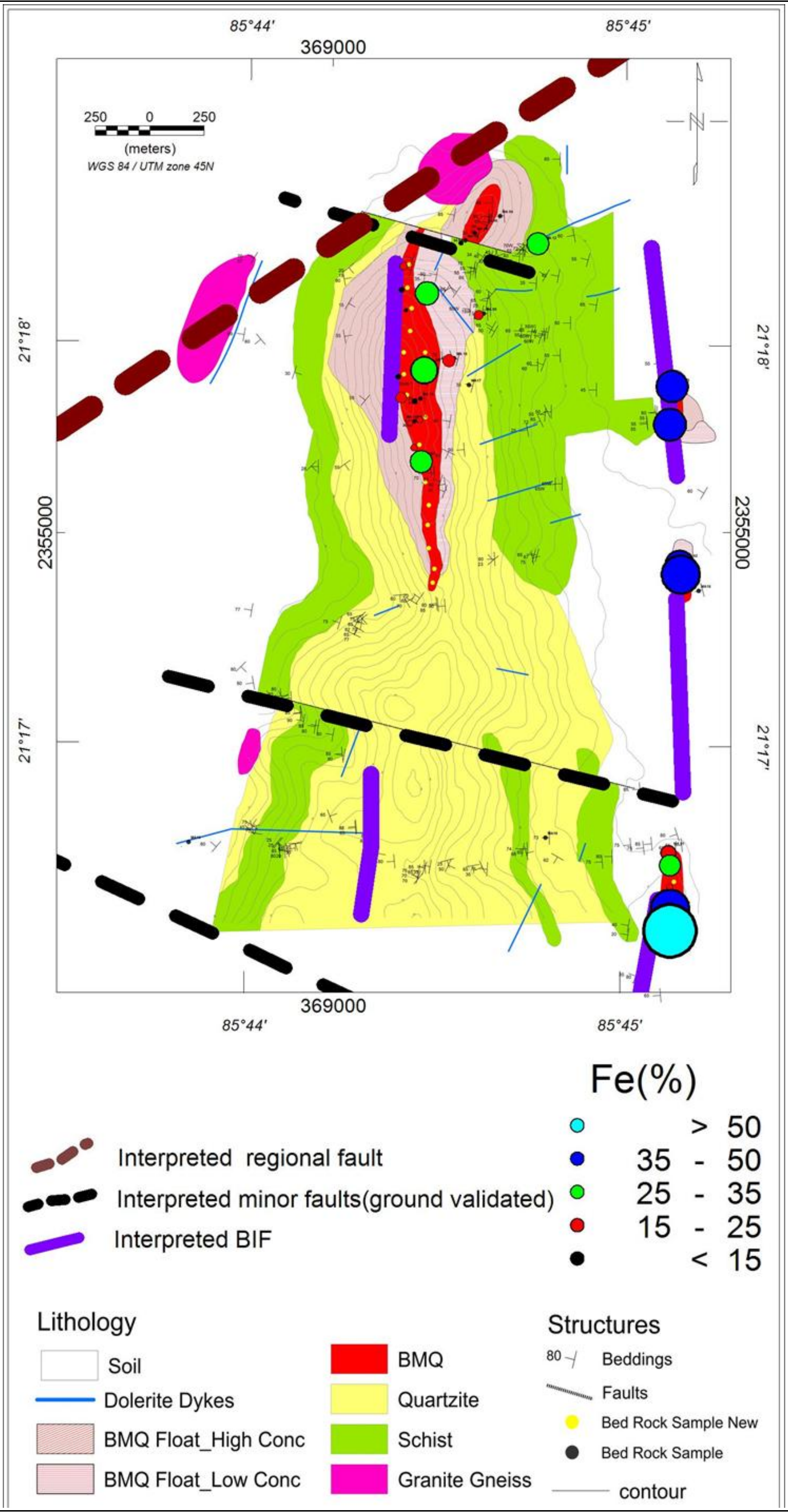


Figure 16: Detailed interpretation of the discontinuities interpreted from Aero-magnetic data and analytical data of BRS samples plotted on geological map of Madhyapur area.

CHAPTER 8. MINERAL PROSPECT

The iron ore bodies are formed by surface alteration of BHJ/BHQ by prevailing climate, selective leaching out of silica and resultant enrichment of the iron. The later enrichment leading to richer grade is related to structural deformation of the Iron Ore Group (IOG) host rocks of this belt. The close association of the iron ores with the banded hematite jasper which indicates a litho and stratigraphic control of the mineralization. Structures like fractures, fault and joint planes pave the way for the mobilization of fluids for supergene processes. In addition, the paleoclimatic conditions might have played a role for the enrichment of mineralization. Thus, the main controls of ore localization are lithologic, stratigraphic, structure and paleoclimatic.

To locate iron ore bodies in the study area, the BHQ band exposed has been thoroughly searched. The study reveals that there is no so significant concentration of iron ore bodies of economic importance exist in the Madhyapur area.

8.1 Surface Indication

Origin of iron ores is attributed to supergene enrichment (Morris, 1980, 1985; Lascelles, 2006) or hydrothermal mineralization processes (Barley et al. 1999; Powell et al. 1999). However, it remains very difficult to reliably assess the relative importance of hydrothermal versus supergene enrichment processes (Nicolas J. Beukes et al. 2008). The different varieties of ores found are hard ore (massive & laminated), moderately hard ore (laminated), soft ore (flaky, friable and powdery) and lateritic ore. Clear cut distinction between different types of iron ore is difficult as one type of ore gradually merges into the other varieties. The ore minerals predominantly consist of haematite (martite) with subordinate amount of magnetite and other oxides/hydrated oxides (goethite).

8.2 Mode of Occurrence

The Iron ore occurs as lenses and pockets of much smaller dimension within BHQ unit conformable to the bedding. Major portion of the BHQ unit is quartzite. Iron ore is discontinuous in nature and shows pinch and swell characters along the strike. At places, HMO is present in the eastern discontinuous bands of BHQ. Ferrugenization though observed along the fractures and joints near the contact with actinolite-chlorite schist, cherty quartzite, etc. of the study area, has little significance in forming ore bodies. The supergene enrichment signatures are not observed in the study area, due to which Iron Ore may not have concentrated/loci in the study area.

8.3 Alteration Zone

Goethite is the alteration product of Hematite in the study area. Goethite is identified based on botryoidal structure and yellow-orange streak colour. Goethite is observed in the eastern discontinuous BHQ bands as compared to western continuous BHQ band.

CHAPTER 9. EXPLORATION BY SCOUT DRILLING

Exploration drilling was not carried out in the Madhyapur area as no mineralized zone was established with the help of Geological mapping and interpretation of analytical data.

CHAPTER 10. RESOURCE ESTIMATION

The Madhyapur area is barren with respect to Iron ore, hence sub-section on resource estimation as per NMET GR format, is not dealt with.

CHAPTER 11. CONCLUSION & RECOMMENDATION

The Madhyapur area forms an isolated part of BIF-II (Tomka-Daitari belt). The area was explored with an objective to search Iron Ore mineralization and on establishment of Iron ore bands to assess its sub surface continuity. The area was initially proposed in 58th TCC NMET as a G4 stage of exploration, however owing to overlapping of parts of the area with explored area by GSI during FS 2005-06 and FS 2006-07, it was recommended to carry out G3 stage of investigation with incorporation of drilling component.

Subsequently, mapping was carried out at 1:4000 scale covering 6.5 sq. km of area. The litho-units demarcated during the mapping comprises of Granite, BHQ, Chlorite schist, Quartzite, Dolerite dykes and floats of BHQ. The BHQ shows weak magnetism as checked with the help of Tungsten carbide scriber pen having Neodymium magnet and reddish-brown streak colour. Two parallel BHQ bands trending in N-S to NNE-SSW direction with sub vertical dip were targeted for search of Iron ore mineralization. The strike length of the western BHQ is around 1900m with width varying from 30m to 70m. The western BHQ band dominantly shows the presence of Quartzite whereas Hematite bands are restricted to 5-10% of the total volume showing width of around 0.20 to 0.40 cm. The eastern BHQ band has good thickness of Hematite bands which are more than 50% of the total volume as compared to quartzite. Also, HMO (hard massive ore, a variety of Hematite) is present discontinuously in all three nos. of eastern BHQ band. The cumulative strike length of eastern BHQ is around 1000m strike length and 20m to 40m width (Plate IV and Figure 6).

Government of Odisha in the year 1993-97, conducted an Aero-Magnetic and Aero-Radiometric survey in the northern part of Odisha with a line spacing of 300m in NS survey direction. The magnetic data was studied for litho-structural interpretation. The interpretation of legacy airborne magnetic data with reference to Madhyapur area reveals presence of two parallel bands of high susceptibility bodies in the east probably depicting limbs of the doubly plunging fold structure. This doubly plunging fold structure is disturbed by NE-SW trending regional faults and NW-SE trending minor faults.

A total of 44 nos. of BRS samples were collected in 100m*100m grid interval, from both the bands, however analytical data of only 3 nos. of samples in eastern BHQ band are above the threshold value (Fe 45%) and of beneficiable grade. No mineralized zone is formed of the anomalous samples. Minor part of the eastern limb which has the highest concentration w.r.t. Fe% is present in the study area, whereas remaining part of this limb is traced to the south and was observed to be truncated at the southern NE-SW trending regional fault mapped from Aero-magnetic data.

Owing to Field observations and data integration studies involving Geology, Geophysics and Geochemistry, the study area was found to be of barren w.r.t. Iron Ore mineralization.

No further exploration activities are recommended in the Madhyapur area.

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CHAPTER 13. LOCALITY INDEX

Locality	Latitude				Longitude		
	Degree	Minute	Second		Degree	Minute	Second
Madhyapur	21	17	58.45		85	45	14.12
Banabir	21	17	57.23		85	43	59.99
Burhipada	21	13	13.00		85	44	30.00
Sunapentha	21	15	29.25		85	45	13.79
Pangaposhi	21	14	54.00		85	44	58.00