

GEOLOGICAL REPORT
ON RECONNAISSANCE SURVEY (G4 STAGE)
FOR RARE EARTH ELEMENTS (REE) & RARE METALS (RM)
IN MEGHAWAS-NAGANA AREA (18.00 SQKM)
BARMER DISTRICT, RAJASTHAN
(Under NMEDT Programme)

Submitted to



खान मंत्रालय
MINISTRY OF
MINES

National Mineral Exploration & Development Trust (NMEDT)
Ministry of Mines, Government of India

Prepared by



MINING TECH CONSULTANCY SERVICES LTD

June 2026

TABLE OF CONTENTS

EXECUTIVE SUMMARY	6-8
Executive Summary in Hindi (कार्यकारी सारांश)	6
Executive Summary	8
CHAPTER – I: INTRODUCTION	9-12
2.1 Background	10
2.2 Details of the Project	10
2.2.1 Title of the project	10
2.3 Investigating agency	11
2.4 Objectives of Investigation	11
2.5 Basis for taking up the Investigation	11
2.6 Details of Nature & Quantum of Work (Approved vs Achieved)	12
2.7 Personnel Involved	12
2.8 Mode of Operation of Different Work Components & Associated Agency	13
2.9 Acknowledgement	13
CHAPTER – II: PROPERTY DESCRIPTION	14-17
3.1 Details of the Area	14
3.2 Concerned SOI toposheet number	14
3.3 Geo-coordinates of the corner points of the investigated area	14
3.4 Cadastral details, land use/cover, forest with type of forest	14
3.5 Freehold/Leasehold	15
3.6 Location and accessibility	15
3.7 Climate	15
3.8 Flora and Fauna	16
3.9 Geomorphology & Environment	16
3.10 Local Infrastructure	16
3.11 Population	17
3.12 Archaeological & Historical sites	17
3.13 National Park	17
CHAPTER – III: PREVIOUS WORK	19-20
4.1 Previous Work Highlights	19
4.2 Previous Geophysical Survey	21
CHAPTER – V: GEOLOGY	22-32
5.1 Regional geology	22
5.2 Geology of the study area	23
5.3 Description of Litho-units	23
5.3.1 Malani Igneous Suite (MIS)	23
5.3.2 Marwar Supergroup	31
5.3.3 Thar desert formation	31
5.4 Structure	31
5.5 Mineralisation	32
CHAPTER – VI: EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION	34-50
6.1 Remote Sensing and Satellite Imagery Study	34
6.2 Large Scale Geological Mapping	34
6.3 Pitting	36
6.4 Geochemical Exploration & Sampling	39
6.5 Analysis of Samples	39
6.6 External Check Analyses	46
6.7 Interpretation of analytical results	47
6.8 Petrographic Study	50
6.9 Geophysical Exploration	51
CHAPTER – VII: INTEGRATION OF EXPLORATION DATA	52-53

7.1	Integration of Geology, Geophysics and Geochemical Exploration Data & Interpretation	52
	CHAPTER – VIII: MINERAL PROSPECT	55
8.1	Surface indication	55
8.2	Mode of occurrence	55
8.3	Strike length and width of anomalies	55
8.4	Exploration	55
8.5	Genesis of mineralisation	55
	CHAPTER – IX: EXPLORATION BY SCOUT DRILLING	56
	CHAPTER – X: RESOURCE ESTIMATION	57
	CHAPTER – XI: CONCLUSION AND RECOMMENDATION	58-59
11.1	Conclusion	58
11.2	Recommendation	58
	CHAPTER – XII: EXPENDITURE	60-61
	CHAPTER – XIII: REFERENCES	62-63
	CHAPTER – XIV: LOCALITY INDEX	64
	CHAPTER – XV: REVIEWER'S COMMENTS	65-72
	PLATES	
	Plate I: LARGE SCALE MAP ON 1:12,500 SCALE	
	Plate II: OUTCROP & SAMPLE LOCATION MAP ON 1:12,500 SCALE	
	PLATE III-V: AERO-GEOPHYSICAL MAPS	
	PLATE VI-VIII: REMOTE SENSING STUDY MAPS	
	ANNEXURES	
	ANNEXURE I-III: LOCATION DETAILS OF BEDROCK SAMPLES & PITS	
	ANNEXURE IV-VII: ANALYSIS RESULTS OF BED ROCK SAMPLES	
	ANNEXURE VIII: WHOLE ROCK (XRF) ANALYSIS RESULTS	
	ANNEXURE IX: XRD REPORT	
	ANNEXURE X: PETROGRAPHY STUDY REPORT	

TABLE OF FIGURES

Figure 3-1: Location map of Meghawas-Nagana Block	15
Figure 3-2: Historical Places	18
Figure 5-1 (A-D): Dark Reddish-Brown Rhyolite	24
Figure 5-2: Porphyritic texture under photomicrograph of the rock under PPL	25
Figure 5-3 (A-D): Dark Grey Porphyritic Rhyolite	26
Figure 5-4: Porphyritic texture under photomicrograph of the rock under PPL	26
Figure 5-5 (A-D): Dark Grey Rhyolite	27
Figure 5-6: Porphyritic texture and flow bands under photomicrograph of the rock under PPL	28
Figure 5-7 (A-D): Coarse Grained Porphyritic Rhyolite	29
Figure 5-8: Photomicrograph of the rock showing presence of Quartz, Feldspar and Magnetite	29
Figure 5-9 (A-D): Very Fine Grained Rhyolite	30
Figure 5-10: XRD study of the sample of the fine rock	31
Figure 5-11: Joint Plane within Massive Rhyolites	32
Figure 6-1: Geological map of Meghawas-Nagana Block, District- Barmer, Rajasthan	35
Figure 6-2: Outcrop map of Meghawas-Nagana Block, District- Barmer, Rajasthan	36
Figure 6-3: Photographs during site visit by Senior Geologists from GSI	36
Figure 6-4 (A-F): Pit excavation works within sand covered area	37
Figure 6-5: Pit Sections	47
Figure 6-6: Chemical Plots of BRS results of Nagana Block	47
Figure 6-7: Chemical Plots of BRS results of Meghwas Block	47
Figure 6-8: Al_2O_3/TiO_2 plots of BRS results of Meghawas-Nagana Block	47
Figure 6-9: Correlation chart of $\Sigma REE+Y+Sc$ in BRS analyses of two laboratories for Primary and Check samples	47
Figure 6-10: Comparison of $\Sigma REE+Y+Sc$ in BRS analyses of two laboratories for Primary and Check samples	47
Figure 6-11: Mean concentration values (ppm) for each element	48
Figure 6-12: XRD results of samples collected from the study area	50
Figure 7-1: REE & RM Concentration Map for Meghawas-Nagana Block	50

LIST OF TABLES

Table 2-1: Nature and Quantum of Work (Target v/s Achievement)	12
Table 5-1: Lithostratigraphy of Trans-Aravalli region (after Bhushan, 2000)	22
Table 5-2: Lithostratigraphy of the area (after Satheesh S.R. et.al, FS 2021-22).....	23
Table 6-1: Details of Excavated Pits in the area	36
Table 6-2: Comparison of Primary v/s External check sample analysis	45
Table 6-3: Summarised Table showing range of elemental concentration in Bedrock Samples .	47

Abbreviations

<u>Abbreviations</u>	<u>Description</u>
GSI	Geological Survey of India
SOI	Survey of India
TS	Toposheet
NMEDT	National Mineral Exploration & Development Trust
MoM	Ministry of Mines
TCC-II	Technical - cum- Cost Committee II
EC	Executive committee
PSC	Project Sanctioning Committee
DMG	Department of Mines and Geology
NGDR	National Geoscience Data Repository
NAGMP	National Aero-Geophysical Mapping Program
NQT	Nature, Quantum and Target
BRS	Bed Rock Sample(s)
PTS	Pit Sample(s)
REE	Rare Earth Elements
RM	Rare Metals
DGPS	Differential Global Positioning System
PPM	Parts per Million
km ²	Square Kilometre
ENE	East - North - East
WSW	West - South - West
NE	North-East
SW	South-west
NW	North-West
SE	South-East
ICP-MS	Inductively coupled plasma mass spectrometry
XRD	X-ray Diffraction
EPMA	Electron Probe Microanalysis

EXECUTIVE SUMMARY

Executive Summary in Hindi (कार्यकारी सारांश)

राजस्थान के बाड़मेर जिले के मेघवास-नागाना क्षेत्र में 18.00 वर्ग किलोमीटर क्षेत्र में दुर्लभ पृथ्वी तत्वों (आरईई) और दुर्लभ धातुओं (आरएम) के लिए एक प्रारंभिक सर्वेक्षण (जी4 चरण) गुजरात स्थित माइनिंग टेक कंसल्टेंसी सर्विसेज लिमिटेड (एमटीसीएस) द्वारा किया गया। इस अध्ययन का उद्देश्य मलानी आग्नेय चट्टानों के फेल्सिक ज्वालामुखीय चट्टानों में आरईई और संबंधित महत्वपूर्ण खनिजों की संभावना का आकलन करना था।

मलानी आग्नेय चट्टान श्रृंखला मारवाड़ सुपरग्रुप द्वारा असंगत रूप से आच्छादित है, जो मुख्य रूप से क्लैस्टिक और नॉन-क्लैस्टिक प्रकृति की है। मलानी चट्टान श्रृंखला दिल्ली सुपरग्रुप के ऊपर असंगत रूप से स्थित है, जो मलानी चट्टानों का आधार है। यह भारतीय परिपथ के पश्चिमी भाग में नवप्रोटोरोज़ोइक आग्नेय गतिविधि का प्रतिनिधित्व करती है। मलानी चट्टान श्रृंखला मुख्य रूप से बहुचरणीय आग्नेय गतिविधियों का समूह है। यह मुख्य रूप से ज्वालामुखीय अम्लीय चट्टानों से बनी है। यह क्षेत्र पांच प्रकार के रायोलाइट वेरिएंट्स द्वारा विशेषता प्राप्त है।

वर्तमान ब्लॉक मलानी चट्टान समूह का हिस्सा है और सिवाना परिसर के उत्तरी भाग में स्थित है। अन्वेषण क्षेत्र में दो उप-ब्लॉक हैं, मेघवास और नागाना ब्लॉक, जिनका क्षेत्रफल क्रमशः 8 वर्ग किमी और 10 वर्ग किमी है। अन्वेषण में 1:12,500 के पैमाने पर व्यापक भूवैज्ञानिक मानचित्रण, नमूनाकरण (बीआरएस और पिटिंग), रिमोट सेंसिंग विश्लेषण और भू-रासायनिक नमूनाकरण शामिल थे। विभिन्न रायोलाइटिक इकाइयों से 14 पिट नमूनों सहित कुल 100 बेडरॉक नमूने एकत्र किए गए, जिनमें से 10 प्रतिनिधि नमूनों को पेट्रोग्राफिक अध्ययन के लिए चुना गया। आईसीपी-एमएस का उपयोग करके 34 तत्वों का भू-रासायनिक विश्लेषण किया गया, जिसमें एक्सआरएफ का भी सहयोग लिया गया। खनिज चरणों को जानने के लिए चयनित नमूनों पर एक्सआरडी अध्ययन भी किया गया।

मेघवास ब्लॉक में 4 गड्ढे और नागाना ब्लॉक में 10 गड्ढे के नमूने हैं। दोनों ब्लॉक रेत से ढके हुए हैं और इनमें क्रमशः 8% से 10% तक चट्टानी संरचनाएं दिखाई देती हैं। शेष क्षेत्र में चट्टानी संरचनाएं नहीं हैं। केवल रायोलाइट प्रवाह ही उजागर हैं और इस ब्लॉक में कहीं भी मारवाड़ समूह की चट्टानें नहीं पाई जाती हैं। अध्ययन क्षेत्र में कोई बड़ी संरचनात्मक गड़बड़ी नहीं है। उत्तर-पश्चिम से दक्षिण-पूर्व और उत्तर-पूर्व से दक्षिण-पश्चिम दिशा में फैली हुई और उत्तर-पूर्व से दक्षिण-पश्चिम की ओर मध्यम झुकाव वाली दरारें/खंडन देखे गए।

मेघवास-नागाना क्षेत्र, जो मुख्य रूप से मलानी आग्नेय श्रृंखला की वायुजनित निक्षेपों और नीचे स्थित राईओलाइटिक इकाइयों से ढका हुआ है, वर्तमान अध्ययन के आधार पर आर्थिक रूप से व्यवहार्य आरईई या दुर्लभ धातु खनिजकरण की आशाजनक संभावना नहीं दर्शाता है। अधिकांश भू-रासायनिक मान पृष्ठभूमि स्तर के भीतर ही हैं, जिनमें केवल सीमित और स्थानीय विसंगतियाँ पाई जाती हैं। फिर भी, ज़िरकोनियम का निरंतर संवर्धन और रुबिडियम की मध्यम विसंगतियाँ राईओलाइटिक इकाइयों के भीतर स्थानीय भू-रासायनिक सांद्रता को दर्शाती हैं।

दोनों ब्लॉकों में विश्लेषणात्मक परिणामों से पता चलता है कि $\Sigma \text{REE} + \text{Y} + \text{Sc}$ की कुल सांद्रता औसतन लगभग 509.65 ppm है, जिनमें से अधिकांश मान पृष्ठभूमि से मामूली रूप से असामान्य श्रेणियों के भीतर आते हैं। यद्यपि

पृथक संवर्धन देखा गया है, अध्ययन क्षेत्र में कोई सुसंगत या महत्वपूर्ण REE खनिजकरण प्रवृत्ति स्पष्ट नहीं है। हालांकि, 17 नमूनों में ज़िरकोनियम का उल्लेखनीय संवर्धन (>1000 ppm) और 18 नमूनों में रुबिडियम की असामान्यताएं (>300 ppm) देखी गई हैं, विशेष रूप से नागाना ब्लॉक के कुछ हिस्सों में। ब्लॉक की विसंगतता के बिखरे होने के कारण खनिजकरण की स्ट्राइक लंबाई स्थापित नहीं की जा सकी।

एकीकृत भूवैज्ञानिक और भू-रासायनिक मूल्यांकन के आधार पर, इस क्षेत्र को ज़िरकोनियम और रुबिडियम युक्त क्षेत्रों के लिए आशाजनक माना जाता है, विशेष रूप से नागाना ब्लॉक में। आगे विस्तृत अध्ययन के लिए दुर्लभ धातुओं (आरईई) और उनसे संबंधित दुर्लभ धातुओं का और अधिक अन्वेषण किया जा सकता है।

Executive Summary

A Reconnaissance Survey (G4 stage) for Rare Earth Elements (REE) and Rare Metals (RM) was carried out over an area of 18.00 sqkm in the Meghawas-Nagana region, Barmer district, Rajasthan by Mining Tech Consultancy Services Limited (MTCS), Gujrat. The study aimed to assess the potentiality of REE and associated critical minerals within the felsic volcanic rocks of the Malani Igneous Suite (MIS).

The MIS is overlain nonconformably by the Marwar Supergroup which is dominantly of clastic and non-clastic in nature. The Malani Suite unconformably overlies the Delhi Supergroup, basement for the Malanis. It is representing the anorogenic (rift-related) Neoproterozoic igneous activity in the western part of the Indian shield. The Malani Suite is mainly assemblage of polyphase igneous activities. It is predominantly composed of volcanic acidic rocks.

The present block is part of Malani suite of rocks and located in the northern part of the Siwana Ring Complex. The area for exploration having two sub-blocks i.e. Meghawas & Nagana block, 8 sqkm & 10 sqkm area, respectively. The exploration involved large-scale geological mapping on 1:12,500 scale, sampling (BRS & pitting), Remote sensing analysis and geochemical sampling. A total of 100 bedrock samples were collected including 14 pit samples from various rhyolitic units, out of which 10 representative samples were selected for petrographic studies. Geochemical analysis for 34-elements was carried out using ICP-MS, supplemented by XRF. To know the mineral phases XRD studies on 10 selected samples also carried out.

Four (4) pits dug in Meghawas block and 10 pits in Nagana block. Both blocks are covered by sand and having 8% to 10% outcrops, respectively. Rest of the area is devoid of outcrops; only the Rhyolite flows are exposed. Marwar group of rocks are not observed anywhere in the block. Mainly five types of the rhyolite variants are encountered in this area. The study area is devoid of major structural disturbances. The joint/fracture planes were observed in the area trending-NW-SE & NE-SW and dipping towards NE to SW with moderate to high dip amount.

In both the blocks analytical results indicate that total concentration of $\Sigma\text{REE}+\text{Y}+\text{Sc}$ averages around 509.65 ppm, with most values falling within background to marginally anomalous ranges. Notable enrichment of Zirconium is observed in 17 samples (>1000 ppm), along with Rubidium anomalies (>300 ppm) in 18 samples, particularly within parts of the Nagana block. The strike length of the mineralization could not be established due to scattered nature of anomalous zones within the blocks.

In view of the integrated geological and geochemical evaluation, the area is considered prospective for Zirconium and Rubidium bearing zones, particularly in the Nagana block. The further exploration of REE and associated rare metals can be taken for further detailed study in these areas.

CHAPTER – I: INTRODUCTION

Rare Earth Elements (REE) are characterized by high density, high melting point, high conductivity and high thermal conductance. These unique properties i.e. distinctive electrical, metallurgical, catalytic, nuclear, magnetic and luminescent properties make them indispensable for a variety of emerging high-end and critical technology applications relevant to the country's energy security i.e. clean energy technology, defence, civilian application, environment and economic areas. Because of their usage in low carbon technology, the demand for REE is expected to increase in the coming years. Therefore, to fulfil the increasing demand of REE & Rare Metals, there is a need of exploring new REE & RM deposits in the country.

REEs are a collection of 17 elements in the periodic table: Scandium (Sc), Yttrium (Y) and 15 elements of Lanthanide Group with atomic numbers 57 to 71: Lanthanum (La), Cerium (Ce), Praseodymium (Pr), Neodymium (Nd), Promethium (Pm), Samarium (Sm), Europium (Eu), Gadolinium (Gd), Terbium (Tb), Dysprosium (Dy), Holmium (Ho), Erbium (Er), Thulium (Tm), Ytterbium (Yb) & Lutetium (Lu).

The lanthanide elements are divided into two groups: Light Rare Earth Elements (LREE) having atomic numbers 57 to 62 (La, Ce, Pr, Nd, Pm & Sm) and Heavy Rare Earth Elements (HREE) with atomic numbers 63 to 71 (Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb & Lu) and Y, Sc. Due to their geochemical properties, these rare earth elements are dispersed and not often found concentrated as rare earth minerals for economic exploitation. Generally, the LREEs are more abundant in the earth's crust and easily extractable than the HREEs.

Critical minerals can be defined as the minerals essential for the economic development and national security. These are required for the advancement of many sectors, including high-tech electronics, telecommunications, transport, defence etc. They are also vital for the low carbon emissions economy and the renewable energy technologies required to meet the 'Net Zero' commitments of various countries around the world. Hence, it has become a priority to identify and develop value chains for the minerals which are critical to our country.

As per MMDR Amendment 2023 Part D, the list of 24 *Critical* and *Strategic Minerals* is given below:

- | | |
|--|--|
| 1. Beryl and other beryllium bearing minerals | 14. Potash |
| 2. Cadmium bearing minerals | 15. Minerals of the "rare earths" group not containing Uranium and Thorium |
| 3. Cobalt bearing minerals | 16. Rhenium bearing minerals |
| 4. Gallium bearing minerals | 17. Selenium bearing minerals |
| 5. Glauconite | 18. Tantalum bearing minerals |
| 6. Graphite | 19. Tellurium bearing minerals |
| 7. Indium bearing minerals | 20. Tin bearing minerals |
| 8. Lithium bearing minerals | 21. Titanium bearing minerals & ores (ilmenite, rutile and leucosene). |
| 9. Molybdenum bearing minerals | 22. Tungsten bearing minerals. |
| 10. Nickel bearing minerals | 23. Vanadium bearing minerals |
| 11. Niobium bearing minerals | 24. Zirconium bearing minerals and ores including zircon |
| 12. Phosphate (without uranium). | |
| 13. Platinum group of elements bearing minerals. | |

This emphasizes the thrust for exploration in strategic minerals, precious metals, REEs and Platinum Group Elements within the country.

2.1 Background

The exploration for strategic, critical, rare metals, rare earths elements, PGE and precious metals has been given top priority by Govt. of India after the amendment of MMDR Act 2015. Keeping this in view, a proposal was submitted by MTCS for Reconnaissance Survey (G4 level) of REE & RM over an area of 100.00 sqkm near Meghawas-Nagana villages in Barmer district, Rajasthan.

This proposal was discussed in the 4th Technical-cum-Cost Committee-II (TCC-II) meeting held on 26th and 27th December 2024 in which the Committee advised to focus on the REE anomalous zones derived from GSI NGCM data. As per the advice of the committee and based on the NGCM data, MTCS had identified 2 blocks near Meghawas (Block-A: 8.0 sqkm) and Nagana (Block-B: 10.0 sqkm) having REE anomalies and prepared a revised proposal to carry out geological mapping, geochemical sampling (bedrock sampling) & pitting under G4 level for REE & RM. The block area has been undertaken based on the following considerations:

- The areas exhibit favourable geological settings with potential host lithologies for REE and associated critical mineralization.
- Presence of indicative geochemical anomalies and earlier reconnaissance-level inputs suggesting mineral potential.
- Strategic location within underexplored or moderately explored terrains, offering scope for new discoveries.
- Alignment with national priorities for augmenting domestic resources of REEs and critical minerals.
- Accessibility and feasibility for systematic exploration, including mapping, sampling, and subsurface investigation.

This proposal was approved in the 8th TCC-II meeting and in the 42nd Executive Committee (EC) meeting of NMEDT. Ministry of Mines has accorded approval to conduct reconnaissance survey (G4 Stage) in this block vide Office Memorandum no. 23/635/2025-NMET/187 dated 1st July 2025.

2.2 Details of the Project

2.2.1 Title of the project

Reconnaissance Survey (G4 Stage) for Rare Earth Elements (REE) & Rare Metals (RM) in Meghawas-Nagana Area (18.00 sqkm), Barmer District, Rajasthan.

2.3 Investigating agency

The name of the investigating agency is Mining Tech Consultancy Services Ltd (MTCS) which is a notified private exploration agency (NPEA) based in Ahmedabad, Gujarat and accredited by QCI-NABET (Govt. of India).

Corporate Address: Mining Tech Consultancy Services Limited, Adani Corporate House, Shantigram, SG Highway, Ahmedabad, Gujarat – 382421.

Contact No: +91 7227920401

Email id: exploration@mtcspl.com

2.4 Objectives of Investigation

The exploration work for REE & RM within Meghawas-Nagana Block has been undertaken as part of a G4-stage reconnaissance survey. The objectives of the investigation were to:

- i. Conduct Geological mapping on 1:12,500 scale & prepare a map.
- ii. Collect bedrock samples for REE & RM analysis, including pitting at required locations.
- iii. Plan further exploration based on the outcome of the above studies.

2.5 Basis for taking up the Investigation

Parts of Jodhpur, Jaisalmer and Barmer districts are intruded by the Malani Igneous Suite which is overlain by Marwar Supergroup of rocks. The Malani Suite is characterized by Basalt & Rhyolitic flows, inter banded by minor bands of pyroclastics, whereas Marwar Supergroup is represented by sandstone and pebbly sandstone. Both the rock units are mostly covered by the quaternary sediments of Thar Desert Formation.

As per previous studies undertaken by the Geological Survey of India during field season programs:

- i. REE and RM mineralization is reported within Malani Igneous Suite of rocks (mainly in Rhyolites).
- ii. Existence of 3 Rhyolite flows was reported around Chiriya, Thob-Patodi & Bagawas areas in Barmer, Rajasthan.
- iii. Low gravity values (-25.0 mGal to -11.0 mGal) were reported near to Thob-Patodi & Bagawas villages in geophysical mapping (Rajan Kumar et.al. 2022); the possible reason is due to the presence of Marwar basin (Jodhpur Formation: Sandstone, Shale, Chert) underlain by deeper basement (Malani Formation: Rhyolite porphyry, Dolerite, Gabbro & Phonolite).
- iv. NGCM program carried out during 2021-22 by Geological Survey of India indicate anomalous zones of LREEs (La, Ce, Hf, Nd) and Y & Zr within Malani Rhyolites near

Patodi, Thob & Meghawas in toposheet 45B/8 (Satheesh S.R et.al. 2022) and near Nagana & Korna villages in toposheet 45B/12 (Atish Thapa et.al. 2022).

Based on the outcome of these studies, GSI has taken up Reconnaissance Survey (G4) for REE mineralization around Patodi-Thob area within 100 sqkm area in toposheet 45B/08 during 2024-25.

Considering the above background, MTCS has identified 2 blocks in toposheet 45B/08 & 45B/12 near Meghawas (Block A: 8 sqkm) and Nagana (Block B: 10 sqkm) covering a total area of 18.00 sqkm, where the anomalous zones were reported by GSI, to carry out Reconnaissance Survey (G4) for REE & RM.

2.6 Details of Nature & Quantum of Work (Approved vs Achieved)

The quantum of approved work and the achievements are shown in Table 2-1.

Table 2-1: Nature and Quantum of Work (Target v/s Achievement)

SI No	NATURE OF WORK	UoM	TARGET ASSIGNED	ACHIEVED
A	GEOLOGICAL MAPPING & ASSOCIATED ACTIVITIES			
i	Geological mapping (1:12,500 scale)	sqkm	18.00	18.00
ii	BRS	No	100	100 (including 14 pit samples)
iii	Petrological samples	No.	10	10
B	PITTING/TRENCHING			
i	Pitting	cum	20	24.50
C	LABORATORY STUDIES			
i	Analysis of BRS (ICP-MS: 34 elements)			
a	BRS Primary samples	No	100	100
b	BRS Check samples (10% External)	No	10	10
D	Physical & Petrological Studies			
i	Preparation of thin polished section	No	10	10
ii	Study of thin polished section	No	10	10
iii	Digital Photographs	No	10	10
iv	Whole Rock Analysis (XRF Analysis)	No	10	10
v	XRD Analysis	No	10	10
vi	EPMA	No	10*	-

**Not Carried out as per the advice of TCC-II, no encouraging values of REE & RM encountered in BRS*

2.7 Personnel Involved

Responsibility Assigned	Name of officers
PC (Project Coordinator)	Mr. Shanto Mukherjee, Director
TAE (Technical Area Expert)	Mr. Deepak Rathod, Principal Consultant
Geological Report Preparation & Documentation/Author	Mr. Jagdish Pradhan, Geologist
	Mr. Suman Aich, Senior Geologist
	Mr. Santosh Kumar Sadangi, Senior Geologist
Field Geologist	Mr. Jagdish Pradhan, Geologist

Responsibility Assigned	Name of officers
Field Co-ordinator	Mr. Suman Aich, Senior Geologist
ArcGIS and AutoCAD	Mr. Ritwik Ganguly, Remote Sensing & GIS Specialist
Draftsman	Mr. Mitesh Patel, Associate Officer (Draughtsman)

2.8 Mode of Operation of Different Work Components & Associated Agency

Geological mapping on 1:12,500 scale was conducted by MTCS geologists as part of the reconnaissance survey. In addition to mapping, bed rock samples were collected from outcrops and pits for further analysis. Geochemical analyses of bedrock samples were carried out at Inspectorate Griffith India Pvt. Ltd. (IGI) whereas analysis of 10% check samples was conducted at Shiva Analyticals (India) Private Limited. Petrography (thin section) & XRD studies were also outsourced.

2.9 Acknowledgement

Authors from Mining Tech Consultancy Services Limited (MTCS) sincerely thank the Ministry of Mines, Government of India and the National Mineral Exploration & Development Trust (NMEDT) & their whole team for their valuable assistance & funding for the project titled “Reconnaissance Survey (G4 Stage) for Rare Earth Elements (REE) & Rare Metals (RM) in Meghawas-Nagana Area (18.00 sqkm) Barmer District, Rajasthan.” Authors are grateful to the TCC-II Committee, NMEDT for giving them the opportunity to work in this block and for the support extended by the committee members throughout the investigation. Besides, the authors deeply acknowledge the works conducted by all those pioneer workers who have worked in this area.

CHAPTER – II: PROPERTY DESCRIPTION

3.1 Details of the Area

The Meghawas-Nagana area proposed for reconnaissance exploration (G4 stage) is located in and around Meghawas and Nagana villages, Barmer district of Rajasthan.

3.2 Concerned SOI toposheet number

Meghawas & Nagana blocks fall under Survey of India toposheets 45B/08 and 45B/12 respectively.

3.3 Geo-coordinates of the corner points of the investigated area

Block-A (near Meghawas; part of toposheet no. 45B/08)

Boundary Points	WGS-84	
	Latitude	Longitude
A-1	26° 10' 32.279" N	72° 27' 41.518" E
A-2	26° 10' 33.718" N	72° 29' 07.189" E
A-3	26° 08' 57.213" N	72° 29' 04.694" E
A-4	26° 08' 48.414" N	72° 28' 41.334" E
A-5	26° 08' 33.682" N	72° 28' 28.575" E
A-6	26° 08' 33.601" N	72° 27' 44.156" E

Block -B (near Nagana; part of toposheet no. 45B/12)

Boundary Points	WGS-84	
	Latitude	Longitude
B-1	26° 10' 03.999" N	72° 33' 54.718" E
B-2	26° 10' 03.840" N	72° 34' 47.016" E
B-3	26° 09' 19.454" N	72° 34' 47.971" E
B-4	26° 07' 23.558" N	72° 32' 34.895" E
B-5	26° 07' 22.986" N	72° 31' 55.186" E
B-6	26° 07' 53.562" N	72° 31' 57.521" E
B-7	26° 08' 12.050" N	72° 32' 19.769" E
B-8	26° 08' 24.229" N	72° 32' 09.649" E

3.4 Cadastral details, land use/cover, forest with type of forest

The land use pattern in the block is varied, roughly 70% of the area falls under seasonal agricultural land & barren land/ sand dunes with small vegetation (bushes & shrubs), around 20% is covered by scattered hillocks & stony landforms and the remaining 10% comprises settlements, including villages and scattered habitations.

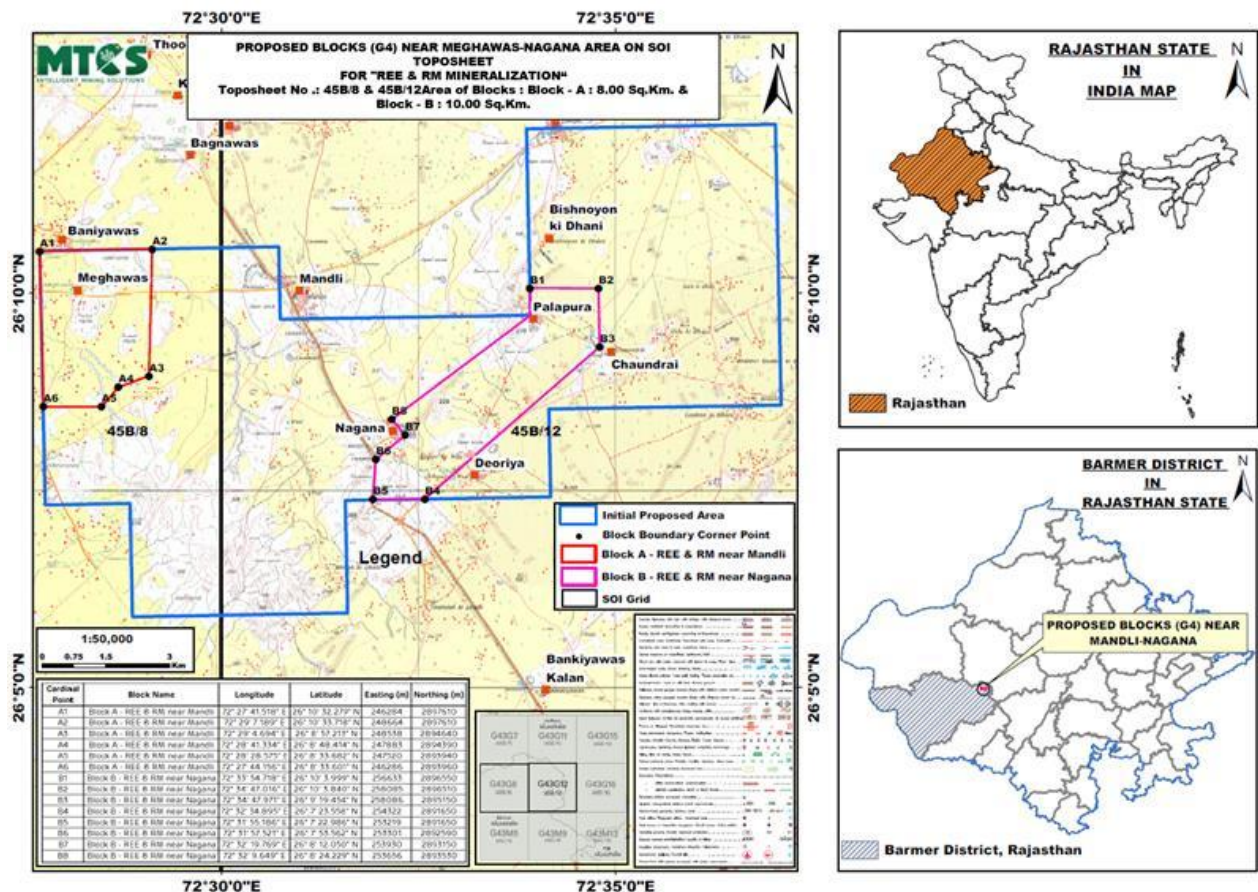


Figure 3-1: Location map of Meghawas-Nagana Block superimposed on SOI toposheet no 45B/08 and 45B/12

3.5 Freehold/Leasehold

The block area is mostly dominated by agricultural land & barren land, which accounts for approximately 70% of the total area. 20% area is covered by scattered hillocks & stony landforms and 10% falls under settlements indicating that smaller portion of the block area falls under free hold category i.e. hillocks & stony landform parts.

3.6 Location and accessibility

The area lies approximately 350 km from Jaipur and is well connected by metaled roads. The Amritsar-Jamnagar Expressway passes through the western part of Block-A, providing excellent road connectivity. The nearest railway stations are Phalodi & Jodhpur (75 km away) and nearest Airport in Jodhpur (located about 80 km away), ensuring convenient access for personnel and equipment's.

3.7 Climate

The Meghawas-Nagana area experiences an arid to semi-arid climate typical of the Thar Desert region. Both day and night temperatures increase gradually and reach their maximum in May & June respectively with maximum temperature reaching upto 49°C in June whereas the minimum

temperature reaches to 1°C in winter. Atmosphere is generally dry except in the monsoon period. Highest humidity is recorded during August with mean daily relative humidity of 81%. The mean annual rainfall is approximately 374 mm (based on data from 1971-2012), indicating very low precipitation. Almost 80% of the total annual rainfall is received during the south-west monsoon, which starts in the first week of July and withdraws during mid-September in this region.

3.8 Flora and Fauna

The area falls under typical arid climate where only rain crops, such as millet, jowar or bajra are grown. Both the block area do not have any forest cover; vegetation includes different types of euphorbias or thorny bushes, such as Khejri (*Prosopis cineraria*), Babool (*Vachellia nilotica*), Ber (*Ziziphus mauritiana*) & Okra (*Abelmoschus esculentus*) and trees like Neem (*Azadirachta indica*), Jal (*Salvadora oleoides*), Kharijal (*Salvadora persica*), Lora (*Laurus nobilis*), Rohida (*Tecomella undulate*), Van (*Vachellia nilotica*) & Kumbhar (*Calotropis gigantean*). Wild animals like Chinkara (*Gazella bennettii*), Blackbuck (*Antilope cervicapra*) and carnivores such as Jackal (*Canis aureus*), Indian Fox (*Vulpes bengalensis*), Desert Fox (*Vulpes zerda*), Desert Cat (*Felis margarita*) and Caracal (*Caracal caracal*) are found in this region.

3.9 Geomorphology & Environment

The Meghawas-Nagana area, located within the Thar Desert region, geomorphologically exhibits features of both denudational and aeolian origin with barren and undulating terrain. The landscape is characterized by sand dunes and small hillocks, interspersed with scattered rock outcrops and patches of agricultural or barren land. The elevation in the area ranges from a minimum of 140m to a maximum of 285m above mean sea level, indicating moderate relief. The overall morphology suggests an arid desert environment with aeolian deposits dominating the surface cover.

There are no major rivers or tributaries in the region, streams present in the area are seasonal and have flowing water in the event of heavy rainfall. The regional slope of the area is towards west-southwest. A dendritic to sub-dendritic drainage pattern (Sehgal et al., 1995; Krishnan, 1982; Sharma, 1998) is observed here characterized by numerous small streams originating from isolated hillocks and terminating within sandy tracts of the Thar Desert. This pattern reflects limited surface water flow and high infiltration rates, typical of desert environments.

3.10 Local Infrastructure

The region is supported by moderate infrastructure and is connected with other cities of Rajasthan by good road network. Adjacent villages are linked via fair-weather roads, ensuring basic access across the area. Agriculture is the predominant occupation in the region, with a significant portion of the population also engaged in mining & crushing of aggregates used for road & building materials. Fundamental amenities such as electricity, potable water, educational institutions and a primary health center are available across the region. The local community is known for its

cooperative and welcoming nature, fostering a peaceful and supportive environment for the exploration activities and operations.

3.11 Population

Barmer district (Rajasthan) has a population of about 2.60 million (Census 2011), with the vast majority living in rural areas (~93%) and only a small share in urban centres (~7%). A notable segment belongs to Scheduled Castes (~16.8%) and Scheduled Tribes (~6.8%), and most livelihoods are tied to agriculture & allied activities in the district's arid landscape. The district's sex ratio is ~902 and literacy ~56.53%, with urban literacy significantly higher than rural, indicating gradual improvement.

In the Meghawas-Nagana village (Pachpadra tehsil), settlements are small and primarily agrarian. Meghawas has about 1,240 people with an evenly split male-female population and a high sex ratio (~1000), while Nagana has about 1,262 people with a lower sex ratio (~915) and a relatively higher tribal (ST) share (~29%). Literacy remains modest around 51% in Meghawas and ~41% in Nagana and work participation is largely linked to cultivation/farm-based work.

3.12 Archaeological & Historical sites

Barmer district is known for its desert heritage, forts, temples and vibrant folk culture. Barmer Fort (Barmer Garh), built by Rawat Bhima in 1552 AD, stands on a hillock overlooking the town and reflects the region's Rajput-era history. The district is also famous for the Kiradu Temples, a ruined group of five Hindu temples (mainly dedicated to Shiva and Vishnu) noted for their intricate carvings and dated to the 11th-12th centuries. For religious tourism, Nakodaji (Shri Nakoda Parshwanath Tirth) a major Śvetāmbara Jain pilgrimage site dedicated to Tirthankara Parshvanatha located in Barmer district and attracts pilgrims widely. Nagnechya Mata temple, located in Nagana village, has been a centre of devotion for centuries. Culturally, Barmer is closely associated with the Manganiyar folk musician tradition, with Rajasthan Tourism noting "Village of Manganiyars" in the Barmer-Jaisalmer region as a heritage of world-famous desert musicians. Nearby natural landscapes like the Mahabar Sand Dunes offer classic Thar Desert scenery and are often visited for sunrise/sunset views.

3.13 National Park

No national park exists in the immediate proximity zone around the investigation area.

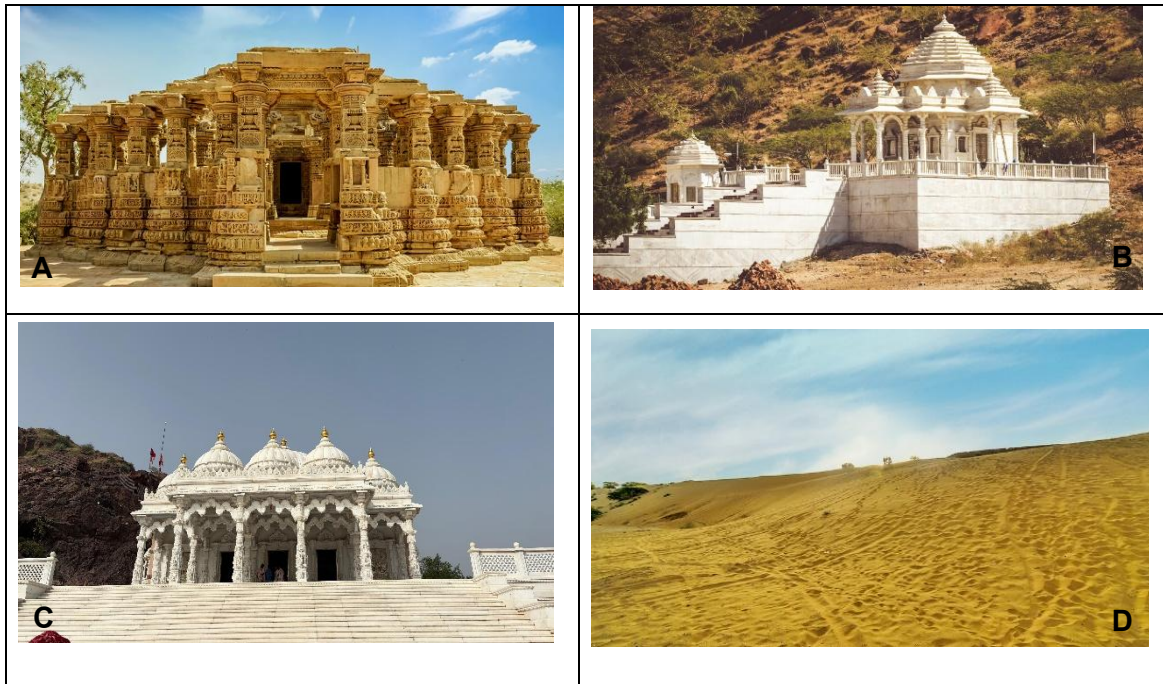


Figure 3-2: Historical Places
A: Kiradu temples, B: Shri Nakoda Jain temple,
C: Nagnechya Mata temple, D: Malabar sand dunes

CHAPTER – III: PREVIOUS WORK

4.1 Previous Work Highlights

Blanford (1877) introduced the name “Malani beds” for a series of volcanic rocks in the then Malani area of Marwar (now Jodhpur state). Hackett (1881) considered the Malani Lavas doubtfully of Lower Vindhyan Age, on which rest the Trans-Aravalli Vindhyan, and confirmed the unconformable relation between Aravallis and Malanis. McMahon (1886) presented the microscopical characters of Malani Rhyolites from Barmer district and compared them with felsites of Tusham Hill, on the northern borders of Bikaner. La Touche (1902) described lavas and associated rocks from Jodhpur to west of Barmer and from Pokharan to Sirohi as “Malani volcanic series”. A sequence of acid and basic andesitic tuff, interbanded with basalt and rhyolite was established by Ghosh (1931). The unusual association led him to conclude that rhyolite and more basic magmas were in existence during the Malani Volcanic Epoch. The term “Malani System” was introduced by Coulson (1933) to include all the plutonic, hypabyssal, volcanic and tuffaceous rocks that are intermediate in age between the Delhi and Vindhyan System. Krishnan and Jacob (1956) reclassified all the rhyolites and associated granites of this region under “Malani Igneous Suite”. Mukherjee (1962) reported peralkaline trachyte, quartz-trachytes and rhyolites from western Rajasthan. Viswanathan (1968) suggested consanguinity between the Erinpura granite and the Jalore granite on the basis of zircon morphometry. In 1971, the Rajasthan circle initiated a systematic programme of sheet mapping, and a field party comprising E.A. Khan, A.K. Mukhopadhyay and A.K. Sinha mapped the Jodhpur-Kailana Talav, Agolai & Undrio hill areas and differentiated three flows of rhyolites. Five phases of igneous activity, represented by tuff (I), aphanitic to magnaphyric rhyolite (II), intrusive rock (III), red aphanitic rhyolite (IV) and basalt (V) were deciphered. The nature of flows and associated ash flows are indicative of fissure type of eruption.

In 1975-76, S. K. Bhushan & S. R. Sengupta from GSI carried out systematic geological mapping and geo-chemical sampling in parts of Jodhpur, Jaisalmer and Barmer districts covering an area of 3550 sqkm in toposheets 40N/15, 45B/3, B/4, B/7 and B/8. A total of 200 geochemical samples were collected for chemical analysis and 150 rock chips were taken for microscopic studies on thin sections; the studies revealed that the area is dominated by rhyolites of the Malani Igneous Suite, overlain by sandstones of the Marwar Supergroup and these rhyolitic flows have potential for rare metal mineralization. Geochemical analysis indicated significant anomalies for Zirconium (>5000 ppm), Titanium (>5000 ppm) and Yttrium (1000 ppm) with three rhyolitic flows identified near Chiriya, Thob-Patodi and Bagawas.

Bhushan & Yagi (1981), Bhushan & Chandrasekharan (2002) discussed the nature of various components of the Malani volcanics including their geochemistry and genetic relationship. Malani Igneous Suite has also been studied by consequent workers viz. Kochhar (1984), Bhushan (1985, 1995, 2000).

Recently, during FS 2021-22, geochemical mapping was carried out by GSI (Satheesh S.R & Neethu Asokan) in toposheet no. 45B/07 & 45B/08 in parts of Jodhpur & Barmer districts as a part of National Geochemical Mapping Program (NGCM). A total of 1382 sqkm area in toposheet no. 45B/07 & 45B/08 was geochemically mapped with collection of 350 no. of stream sediment/slope wash samples, 16 duplicate samples, 36 soil samples (both from R and C horizon), 12 no. of petrographic sample and 18 samples of pan-concentrate.

The following recommendations were made based on the analytical results:

- i. Threshold values of elements SiO_2 , CaO , MgO , Na_2O , TiO_2 , Cr, Nb, Sr, Y, Zr, Be, Ge, Rb, Sn, Hf, Ta, REE, Th and U are anomalous as compared to the upper continental crustal values (UCC).
- ii. Anomalous REE and its very strong positive correlation with Nb, Y & Zr are observed near Balesar, Siyadhan, Khirjan & Balau Jati (TS 45B/07) and Meghawas, Thob and Patodi (TS 45B/08) indicating Malani Igneous Suite is a proven source of REE deposit.
- iii. Heavy mineral studies of pan concentrate samples consist of ilmenite, magnetite, monazite, rutile, tourmaline, garnet, apatite, leucosene, epidote and pyriboles (pyroxene and amphibole) as major heavy mineral assemblages. Based on the heavy mineral assemblage it can be inferred that sediments present in the area derived from a felsic igneous source and high-grade metamorphic rocks.

Further in the same year, Atish Thapa & Parag Porwal carried out geochemical mapping in toposheet no. 45B/11 & 45B/12 (parts of Barmer and Jodhpur districts) as part of NGCM program. A total of 1384 sqkm area was geochemically mapped with collection of 350 no. of stream sediment/slope wash samples, 16 duplicate samples and 18 no. of regolith & C-horizon soil samples.

The following recommendations were made based on these analytical results:

- i. Threshold values of most REEs such as La (66.23 ppm), Ce (116.67 ppm), Pr (14.98 ppm), Nd (52.99 ppm), Eu (1.61 ppm), Tb (1.35 ppm), Ho (1.38 ppm), Er (2.64 ppm), Yb (4.35 ppm) and Sn (8.56 ppm), Hf (24.36 ppm), Ge (1.48 ppm), As (11.53 ppm), Th (24.7 ppm) & U (3.55 ppm) are anomalous as compared to the upper continental crustal values (UCC) and the anomalous zones are reported near Agolai, Belwa & Gopalsar in toposheet 45B/11 and Nagana, Mandli & Korna in toposheet 45B/12.
- ii. In both the toposheets it is seen that almost all REEs show strong positive correlation with each other.

During the 2021-22, Specialised thematic mapping carried out in the parts of Patodi-Korna area of Barmer District. The proposed blocks Nagana and Meghawas are having the Rhyolitic flow no. 02, 03 and Pyroclastic flow 01. The REE concentration of the Rhyolite flow no 02 ranges between

386.53 to 597.57ppm, for flow no. 03 337.43 to 625.74ppm and for the pyroclastic flow no. 456.59 to 598.39ppm. Overall, the flows are showing the tREE upto the 625ppm.

4.2 Previous Geophysical Survey

Geophysical reports for the area are not available on the National Geoscience Data Repository (NGDR) portal. However, the NGPM datasets downloaded from NGDR have been instrumental in delineating prospective target zones for REE and RM mineralization, particularly on the basis of subdued magnetic anomalies.

The downloaded NGPM data was processed in-house, leading to the identification of several high-magnetic zones within the region. Notably, some of these anomalous zones fall within the Meghawas-Nagana Block, which is part of NAGMP Block-1 under the National Aero-Geophysical Mapping Program (NAGMP). Block-1 represents one of the priority surveyed regions where high-resolution aeromagnetic and radiometric datasets were acquired to enhance subsurface geological understanding and support exploration targeting.

CHAPTER – V: GEOLOGY

5.1 Regional geology

The Aravalli craton occupies the north-western part of the Indian shield and is constituted by three major geological units viz. Banded Gneissic Complex (BGC) and two Proterozoic fold belts: Aravalli Supergroup and Delhi Supergroup which evolved around BGC (Heron, 1953). BGC occupies the large tracts in the Mewar plains of south & east of Rajasthan and includes various types of gneisses, migmatites, high grade schist & meta basic rocks. Metamorphic and structural data along with the geochronological data demonstrated that the BGC was a crystalline basement upon which the Aravalli and the Delhi Supergroups were deposited.

The Malani Igneous Suite (MIS) being Neoproterozoic felsic volcanics, felsic intrusives, minor basaltic flows and mafic dykes exposed over a large area in SW Rajasthan (Bhushan, 2000; Torsvik et al., 2001a; Gregory et al., 2009; Meert et al., 2013). The initial igneous activity started with major felsic and minor mafic flows and was followed by the emplacement of granitic bodies. The final phase of igneous activity is represented by felsic and mafic dykes. Age constraints for the MIS range from 750 Ma to 770 Ma (Torsvik et al., 2001a,b; Gregory et al., 2009; van Lente et al., 2009; Pradhan et al., 2010; Meert et al., 2013). The Marwar Supergroup, unconformably overlying the MIS, is composed of un-metamorphosed and relatively un-deformed succession of sandstones, shales, carbonates and evaporites. Lithostratigraphically, the sediments are divided into three groups; the lowermost Jodhpur Group, the middle Bilwara Group and the uppermost Nagaur Group (Khan, 1971; Pareek, 1984). The oldest unit of the Jodhpur Group (Sonia sandstone) unconformably overlies the Neoproterozoic Malani Igneous Suite. The Jodhpur Group is a fluvio-marine succession of cross-bedded, white to reddish sandstone and maroon shale. The Bilwara Group consists of dolomitic and stromatalitic limestone that conformably overlies the Jodhpur Group (Khilnani, 1968; Barman, 1987; Pandit et al., 2001). Nagaur Group consists of a sequence of fine to coarse grained, cross-bedded, reddish brown, sandstone and siltstone (Pandey and Bahadur, 2009).

Table 5-1: Lithostratigraphy of Trans-Aravalli region (after Bhushan, 2000)

Group / Super Group	Age	Lithology
Marwar Supergroup (Jodhpur Group)	Vendian to Lower Cambrian	Maroon and golden sandstone, siltstone and shale
----- Unconformity -----		
Pokharan Boulder Bed	Vendian	Scattered boulders and pebbles of glacial origin
----- Unconformity -----		
Malani Igneous Suite	Neo-Proterozoic	Bimodal volcanics, granites and dyke swarm

Group / Super Group	Age	Lithology
----- Unconformity -----		
Delhi Supergroup (Basement)	Meso to Neo-Proterozoic	Abu and Erinpura Granite; Metasediments of Sirohi and Pali area. Unspecified gneisses of Balewa-Harsani area; (Archaean Supracrustals?)

5.2 Geology of the study area

Geologically, the volcanic rocks of MIS of Upper Proterozoic age are present in the area overlain by quaternary sediments comprising aeolian deposits that cover major part of both blocks. However, the sedimentary rocks (sandstone and pebbly sandstone) of Sonia Formation of Jodhpur Group (Marwar Supergroup) are not observed in this region.

The Malani Igneous Suite is represented by basalt & rhyolitic flows inter bedded with the minor occurrences of pyroclastics. The stratigraphic succession of the area is given Table 5-2.

Table 5-2: Lithostratigraphy of the area (after Satheesh S.R. et.al, FS 2021-22)

Super Group	Group	Formation	Lithology
Thar Desert			Fine aeolian sand with occasional Kankar
----- Unconformity -----			
Malani Igneous Suite	Jodhpur Volcanics	Kailana felsic volcanics	Rhyolite
		Barmer basic volcanics	Basalt

5.3 Description of Litho-units

5.3.1 Malani Igneous Suite (MIS)

The Malani Igneous Suite of Neoproterozoic age represented by Basalt, Rhyolitic flows inter bedded with the minor occurrences of pyroclastics. In both blocks, rocks of MIS are mainly exposed in variants in terms of color, grain size of the Rhyolites. These rhyolites show pronounced variation in color, texture, fabric and mineralogy, indicating multiple eruptive phases, variable cooling histories and localized post-emplacement deformation. The variants of rhyolite with minor variation in the color and grain size clubbed under one flow. The variation in the field has been given on the basis of color & grain size, texture only, not on the basis of chemical analysis.

Since the eruption took from the same tectonic setting, the discrimination of the different bands is very difficult at outcrop scale so that the map is showing flows which are disposed on the mappable scale. There are five different rhyolites have been identified in the area during the LSM mapping.

i. Dark Reddish Brown-Maroon Rhyolite

These Rhyolites exhibit a dark reddish brown to brick red (maroon) colour, fine-grained to aphanitic texture and are massive, with occasional weak flow banding visible as subtle colour variations. Fresh surfaces appear compact and dense, while outer surfaces are stained due to oxidation. Vesicles are rare or absent, indicating high-viscosity lava with limited volatile escape. Several fracture planes are present within this rock, and it forms prominent ridges & low hills around the Meghawas area. This type of rhyolite occurs mainly in the Meghawas block and in pocket nature in the Nagana block. The reddish-brown to maroon colour is attributed to high iron content and oxidation (hematitization), either during cooling or subsequent weathering. These rhyolites likely represent subaerial lava flows emplaced in an oxidizing environment.

Under the microscope, the rock is found to be very fine-grained, with random phenocrysts of quartz, feldspar & magnetite and a groundmass composed of a very fine-grained aggregate of quartz and feldspar. Amygdule's of quartz is very common. The overall texture is aphanitic, and locally it is porphyritic, exhibited by large grains of quartz, feldspar and hematite randomly enclosed within a cherty groundmass. Feldspar is mainly orthoclase, which is mostly altered to clay minerals (Ref. Annexure X: Petrography Study Report).

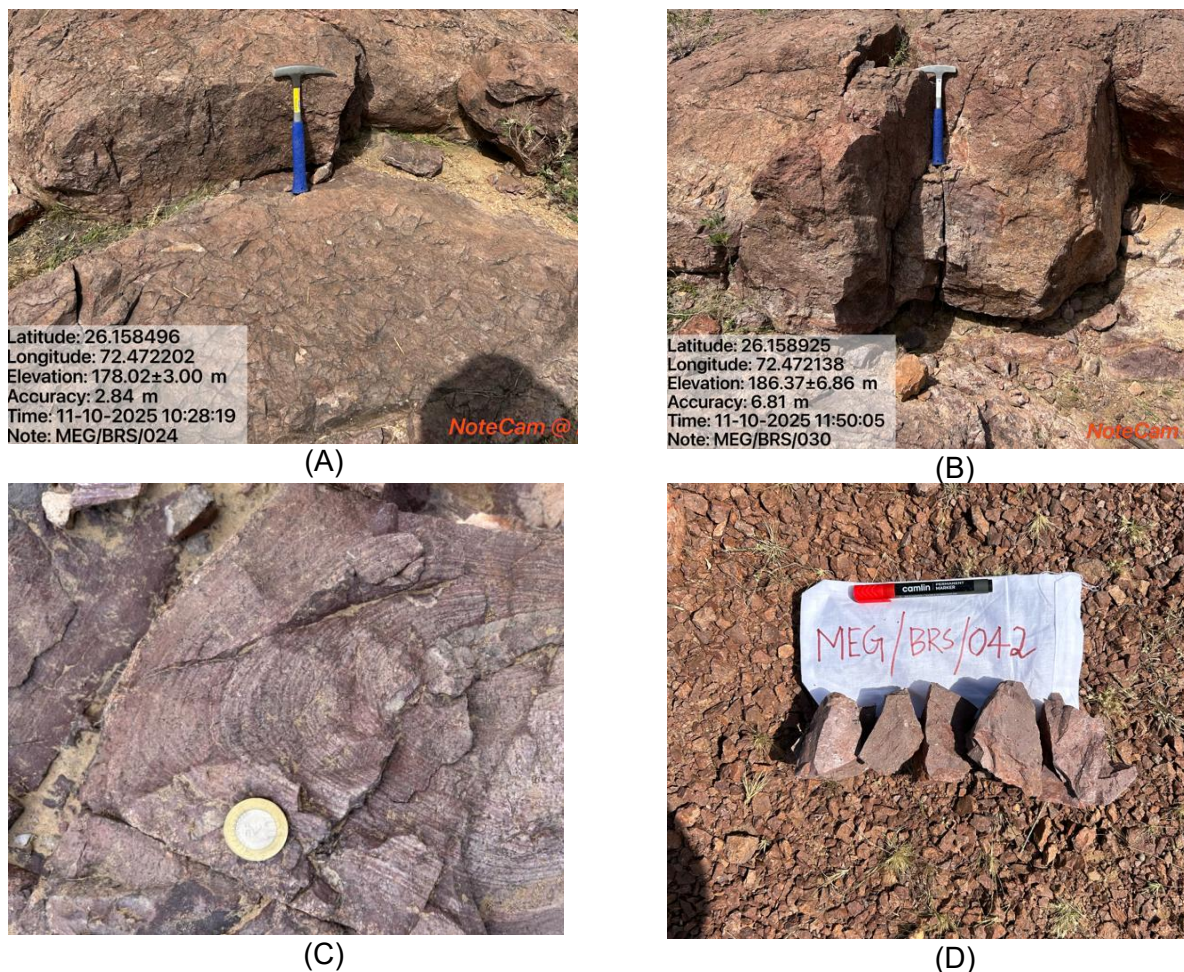
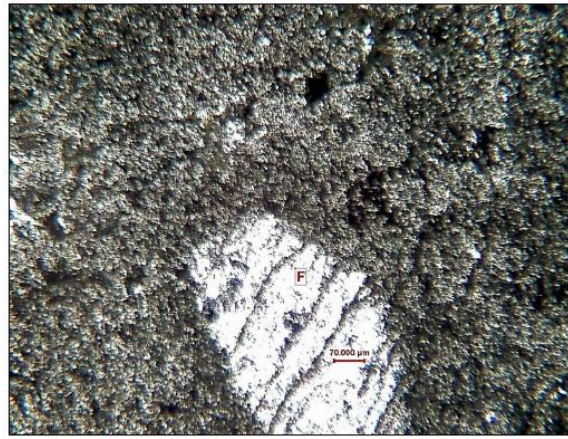


Figure 5-1 (A-D): Dark Reddish-Brown Rhyolite

A & B: Massive Rhyolite, C: Flow Banding within dark brown Rhyolite, D: Sample No MEG/BRS/042 collected from this rock type



**Fig. 5-2: Porphyritic texture under photomicrograph of the rock under PPL
(Sample Id. MEG/PS/05)**

ii. Dark Grey Porphyritic Rhyolite

These rhyolites are characterized by a dark grey to purplish grey colour, making them easily distinguishable from other variants. Phenocrysts are clearly identifiable on freshly broken surfaces. The rock exhibits a porphyritic texture, with well-developed euhedral to subhedral phenocrysts of quartz and alkali feldspar (likely sanidine/orthoclase); the groundmass is fine-grained to cryptocrystalline. The porphyritic nature indicates two-stage cooling - initial slow cooling at depth allowing crystal growth, followed by rapid cooling during eruption. The grey colour may be linked to variations in oxidation state or trace element content. This rock type is predominantly seen in the north-east part of Nagana block.

The rock is seen as very fine-grained and porphyritic under the microscope and is mainly composed of quartz (50% VE) and alkali feldspar (40% VE), with a minor amount of magnetite, biotite, and glass. Brown glass is very common in the groundmass, with amygdule's mainly composed of quartz. Feldspar phenocrysts are of orthoclase composition. Magnetite grains are altered to secondary biotite and hematite at the margins. The rock exhibits a typical porphyritic texture with phenocrysts of oversized quartz and feldspar (Ref. Annexure X: Petrography Study Report).



(A)



(B)



(C)



(D)

Figure 5-3 (A-D): Dark Purple Porphyritic Rhyolite

A, B & C: Dark Purple Porphyritic Rhyolite, D: Sample No NAG/BRS/028 collected from this rock type



**Fig. 5-4: Porphyritic texture under photomicrograph of the rock under PPL
(Sample Id: NAG/PS/020)**

iii. Dark Grey Rhyolite

In this type of rock, the grey color flows observed as laminations. The flow band(?) / laminated variant observed in the larger part of the south-west of the Nagana block and is mostly dark grey in colour. Prominent lamination(?) or planar fabric is visible even from a distance, and these rocks often break along planar surfaces. It is characterized by a fine-grained groundmass with well-defined planar alignment of minerals or bands; laminations are parallel to flow banding or the tectonic stress direction. These rhyolites record syn- or post-emplacement deformation, possibly related to regional tectonism. The fabric strongly influences rock strength and weathering patterns.

Under the ore microscope, it is seen that the groundmass is mainly made up of fine grains of cherty quartz and some feldspar, with oversized grains of sub-rounded quartz and feldspar embedded in the groundmass, resulting in a porphyritic texture. Apart from quartz and feldspar, iron ore minerals (~20% by volume, mainly hematite and magnetite) are present. The feldspar is of alkali type (K/Na feldspar) and is mostly deformed and altered (Ref. Annexure X: Petrography Study Report).



(A)



(B)



(C)



(D)

Figure 5-5 (A-D): Dark Grey Rhyolite
A, B & C: Dark Grey Rhyolite, D: Sample No NAG/BRS/014 collected from this rock type

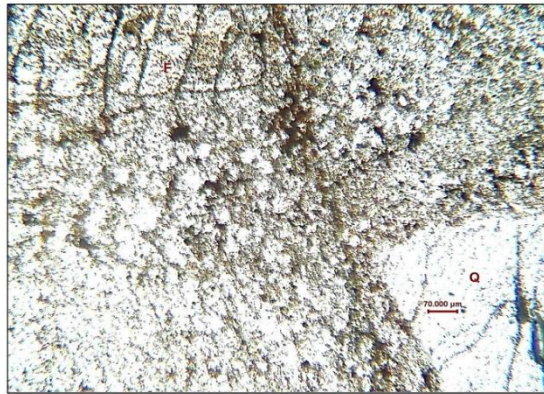


Fig. 5-6: Porphyritic texture and flow bands under photomicrograph of the rock under PPL (Sample id: NAG/PS/014)

iv. Coarse-Grained Porphyritic Rhyolite

These rhyolites exhibit orange to pinkish-grey in color, coarse grained, massive with large and conspicuous phenocrysts of Quartz & Alkali feldspar visible megascopically; groundmass remains comparatively fine-grained. Phenocryst size and abundance are higher than the other rhyolite types. This type of rock indicates prolonged crystallization at shallow crustal levels; possibly represents magma emplaced as lava domes or shallow intrusive equivalents prior to eruption or extrusion.

The rock is found vitrophyric under microscope with fine to very fine-grained groundmass in which numerous angular large grains of Quartz, altered Feldspar and Magnetite are floating like pyroclastic debris. Brown glass is about 40% in the groundmass. Feldspar phenocryst is Orthoclase in composition. Amygdule of Quartz with multigrain aggregate is very common. Overall texture is porphyritic (Ref. Annexure X: Petrography Study Report). In the area, these rock observed only in the Meghawas block as an isolated pocket within the brown to maroon colored rock.

The angular nature of quartz, feldspar and magnetite grains is primarily of magmatic origin, representing early formed phenocrysts preserved within a fine to very fine-grained groundmass (vitrophyric texture). Their sharp outlines are due to rapid quenching of magma, rather than tectonic deformation. The apparent 'floating' nature of these grains reflects their suspension in the matrix rather than a pyroclastic origin.

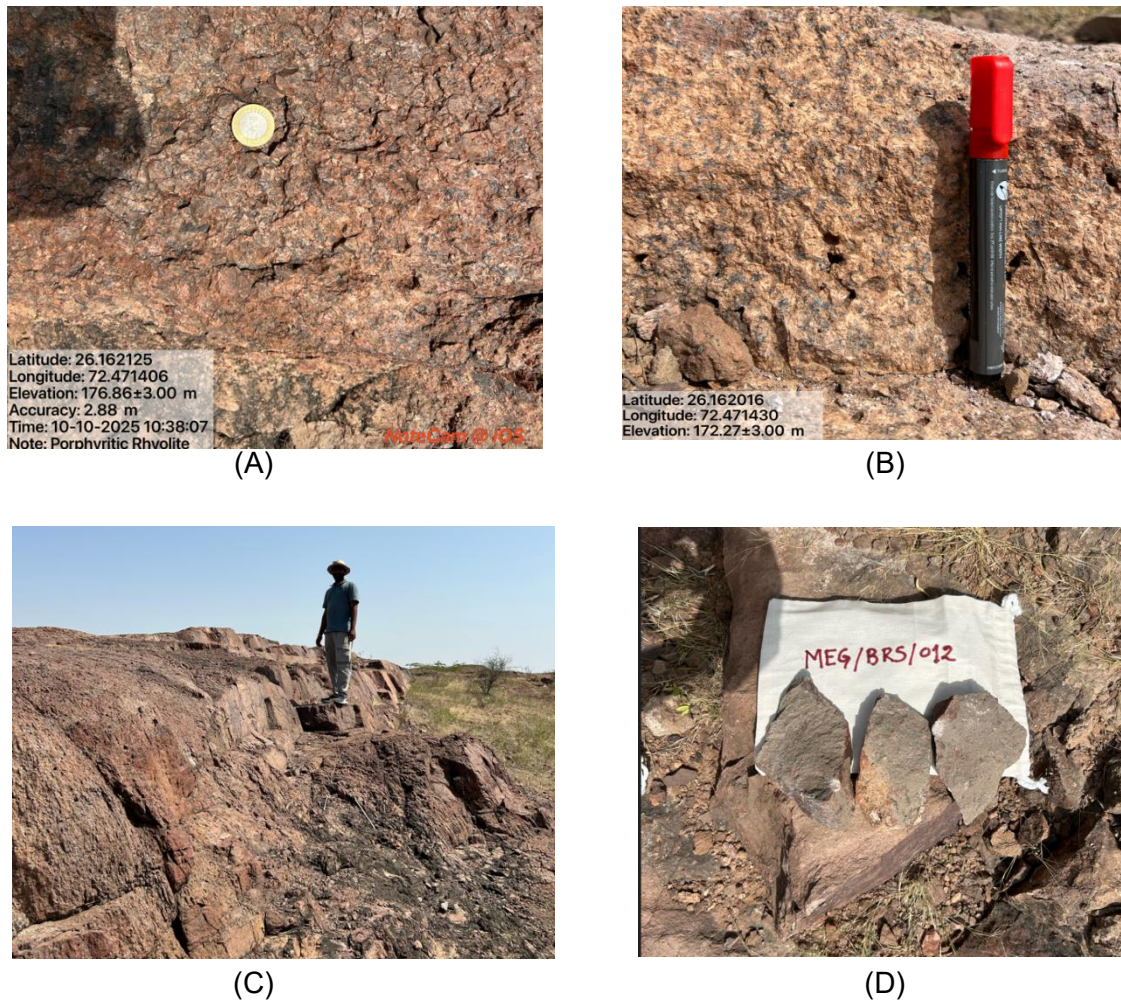


Figure 5-7 (A-D): Coarse Grained Porphyritic Rhyolite
A, B & C: Coarse Grained Porphyritic Rhyolite, D: Sample No MEG/BRS/012 collected from this rock type

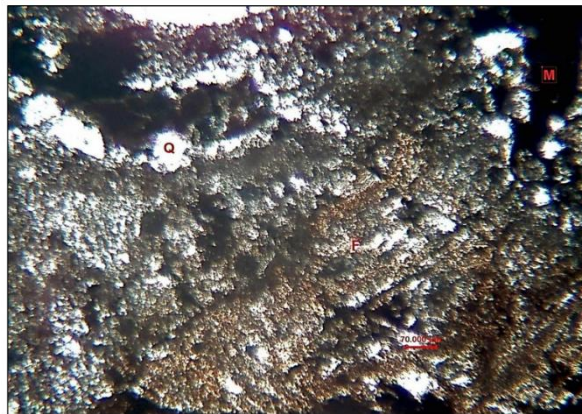


Figure 5-8: Photomicrograph of the rock showing presence of Quartz, Feldspar and Magnetite under PPL (Sample id MEG/PS/39)

v. Very Fine to Fine Grained Rhyolite

This rock type is found in a small area on the north-western part of the Meghawas block only. It shows dark red to dark pink colour and a highly compact appearance, with smooth surfaces having a conchoidal fracture, resembling chert or obsidian. The rock texture is very fine grain to cryptocrystalline and it is extremely hard & brittle in hand specimen. The fine grain variety

of rhyolite represents rapid cooling of silica-rich lava, preventing crystal growth. These rocks likely formed under conditions of sudden heat loss, producing volcanic glass texture(?), later partially devitrified in places.

The XRD study of the sample MEG/BRS/002 showing the prominent presence of quartz followed by the feldspar and biotite (Fig. 5.10). The peaks of the quartz area showing the intensity in the sample. No presence of glass seen in the sample. Whereas, during the field study the aphanitic type of cryptocrystalline texture, appears as glassy texture due to its fine to very fine grain size (Fig. 5.9).

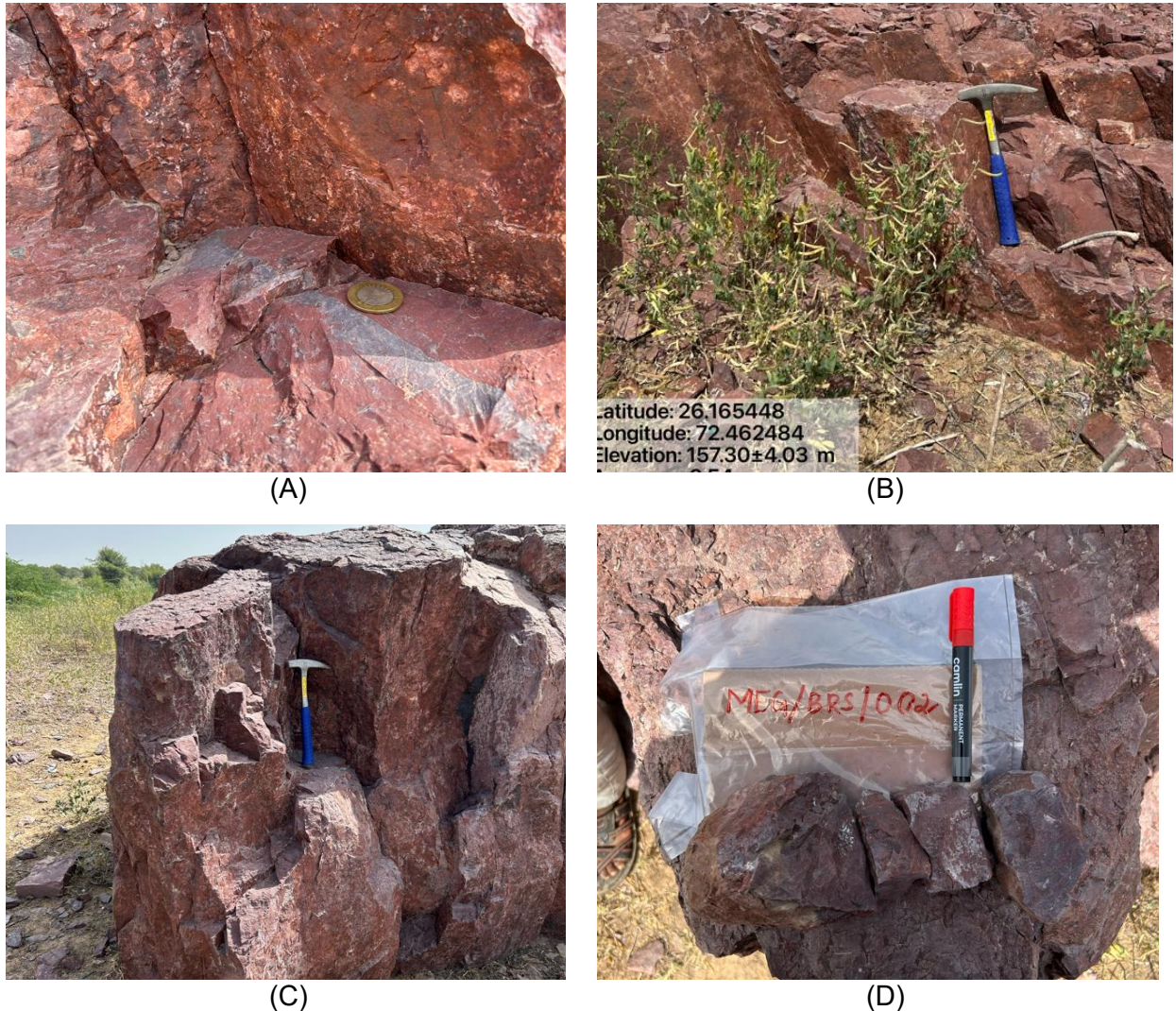


Figure 5-9 (A-D): Very Fine Grained Rhyolite

A, B & C: Very Fine Grain/Glassy Rhyolite, D: Sample No MEG/BRS/002 collected from this rock type]

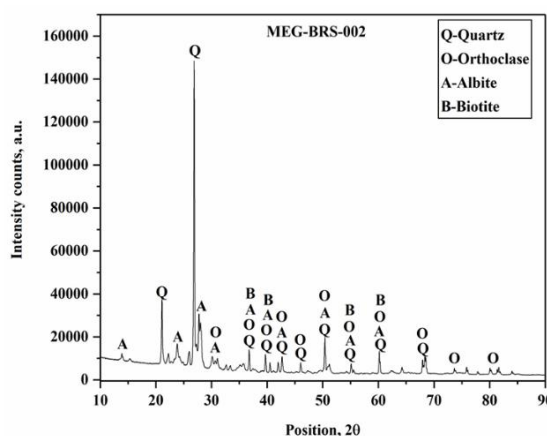


Figure 5-10: XRD study of the sample of the fine rock.

5.3.2 Marwar Supergroup

Since the area is covered by the transported sand cover comes under the Thar desert (the great desert) and only the projected outcrops of rhyolite Rocks are exposed. The Marwar Supergroup of rocks do not crop out in this area and hence not observed.

5.3.3 Thar desert formation

Thar Desert Formation is the youngest litho-unit present in the study area. They occur as stable dunes composed of alluvium and windblown sands and kankar units. A large part of the study area is covered by aeolian sand and alluvium of Thar Desert Formation.

5.4 Structure

The local structural configuration of the Meghawas-Nagana region is primarily influenced by volcanic processes associated with the Malani Igneous Suite. The rhyolite flows exhibit flow banding, cooling joints and columnar fractures which collectively define the mesoscale structural fabric of the area. Several NW-SE & NE-SW trending fractures & lineaments can be inferred from exposed lithologies having NE to SW dips with moderate to high dip amount. These structural features are consistent with regional extensional tectonics active during the emplacement of the Malani magmatic suite. Mainly emplacement structures are observed in the area not the tectonic deformation. The secondary structures like fractures, joints and other linear alignment were produced by the igneous activity.



Figure 5-11: Joint Plane within Massive Rhyolites

5.5 Mineralisation

Previous exploration by Geological Survey of India during Field Season Programs (1975-76), NGCM surveys (2021-22) and STM mapping (2020-21) has shown the presence of anomalous REE & Zr zones within the rhyolitic flows of this region. These felsic volcanic rocks were reported to host elevated concentrations of critical elements such as Lanthanum (La), Cerium (Ce), Neodymium (Nd), Hafnium (Hf), Yttrium (Y) and Zirconium (Zr) compared to Upper Continental Crust values of these elements. It was reported that the mineralization is associated with rhyolite flows, often concealed beneath Quaternary sand cover and shows strong geochemical correlation among REEs, indicating a common source and favorable conditions for enrichment. Prominent anomaly zones have been delineated near Patodi, Thob, Meghawas (Toposheet 45B/08) and Nagana & Korna (Toposheet 45B/12).

Based on the geological report and the previous investigations by the Geological Survey of India, the following chemical analysis and findings support the anomaly zones in the study area:

- Chemical Analysis & Anomaly Zone Dimensions

Previous systematic mapping and geochemical sampling (1975-76 and 2021-22) delineated prominent anomaly zones near **Patodi, Thob, and Meghawas** (Toposheet 45B/08).

- Chemical Support (Previous GSI Findings):
 - **REE Correlation:** Analytical results from the NGCM program (2021-22) confirmed REE anomalous zones with a very strong positive correlation with **Niobium (Nb), Yttrium (Y), and Zirconium (Zr)**.

- **Thresholds:** Elements such as La, Ce, Pr, Nd, Eu, Tb, Ho, Er, Yb, Sn, and Hf were found to be anomalous compared to Upper Continental Crust (UCC) values.
- Dimensions:
 - The previous exploration identified **three specific rhyolitic flows** as the primary hosts for this mineralization near Chiriya, Thob-Patodi, and Bagawas.
 - The current G4 reconnaissance survey was restricted to a total area of **18.00 sq. km**, specifically targeting Block-A (Meghawas: 8 sq. km) and Block-B (Nagana: 10 sq. km).
- **Actual Mineralization Findings (Present Study)**

On the basis of previous findings, the G4 block has been proposed in the area showing highly positive anomalies. The surface indication for the mineralization is only the presence of rhyolite of different color and grain size. The TREE observed in the dark grey color rhyolite (Nagana area) is little higher than the dark reddish-brown colored rhyolites of Meghawas area. The actual findings from the G4 stage investigation in the **Meghawas-Nagana block** are as follows:

- ✓ **Total REE Potential:** The total concentration of **ΣREE+Y+Sc** in the block averages **509.65 ppm** (varying from 182.13 ppm to 694.39 ppm). Most analyzed samples fall within or near background values rather than anomalous ones.
- ✓ **Zirconium Enrichment:** Isolated enrichment was recorded in **17 samples** from the Nagana area, which showed Zirconium values exceeding **1000 ppm**.
- ✓ **Rubidium Anomaly:** Anomaly values for Rubidium (**>300 ppm**) were recorded in **18 samples**, primarily near the Nagana area, with the highest value reaching **379.43 ppm**.
- ✓ The Nagana block is showing the potentiality for the Zirconium and Rubidium
- **Lithological Association:** Mineralization (where present) is associated with felsic volcanic rocks of the Malani Igneous Suite, specifically varieties of rhyolites (such as dark reddish-brown, dark grey & porphyritic types). The dark grey rhyolites of Nagana area showing comparatively higher REE values than the other litho-unites of the block. However, a large portion of the bedrock is concealed under aeolian sand having variable thickness at places.

CHAPTER – VI: EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

6.1 Remote Sensing and Satellite Imagery Study

Remote sensing and satellite imagery studies were carried out as a preliminary component of the present exploration work carried out in Meghawas-Nagana block. Multispectral satellite data were analyzed to obtain an integrated understanding of lithology, geomorphology and structural architecture of the study area. Visual interpretation supported by digital image processing techniques such as false colour composites, band ratios and principal component analysis was undertaken to delineate lithological boundaries, lineaments and possible alteration zones. Lineament mapping was used to identify major faults and fracture systems that may have controlled magma emplacement and fluid movement relevant to REE mineralization. The results of the remote sensing study were integrated and relevant maps have been generated (Plate VI-VIII). No ASTER alteration mapping has been attempted in the area due to maximum coverage of sand.

6.2 Large Scale Geological Mapping

The Geological Mapping on 1:12,500 scale was carried out over 18.00 sqkm area within the Meghawas & Nagana Blocks located in parts of survey of India toposheet no 45 B/08 and 45 B/12, respectively. Survey of India toposheet was used to understand the topography, local infrastructure including roads and drainage of the mapped area. The mapped area having about 8 to 10% outcrops in the Meghawas and Nagana area, respectively; rest of the area is covered by aeolian sand and devoid of in-situ outcrops (Plate II: Outcrop map).

The outcrop contacts, geological data and the location of the samples have been located by handheld GPS (Model: Garmin GPSMAP 64s) in the outcrop map (Figure 6.2) during the field work. 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 the final geological map was prepared (Plate I: LSM map, Figure 6.1).

The LSM map is presenting the rhyolite pockets, sand cover, structural data, location of BRS and pits within the working area. The variants of rhyolite have been observed during the mapping on the basis of color and grain size but the individual bands and small variation in the flow could not be mapped due to intermixing nature and dimensions of the exposed body. The possible flows were grouped and shown in the LSM map. The rhyolite of Meghawas comes under the Flow No. 02 of the flow classification of the area whereas, the Nagana having Flow no. 02 in the south-western part and flow no. 03 is in the north-eastern part of the block. This are grouped on the basis of color and textures. Moreover, the area is covered by sand of Thar desert and the Marwar group of rocks are not exposed. The area is showing flat topography except projected outcrops of the rhyolites. The drainage pattern is scattered and dry.

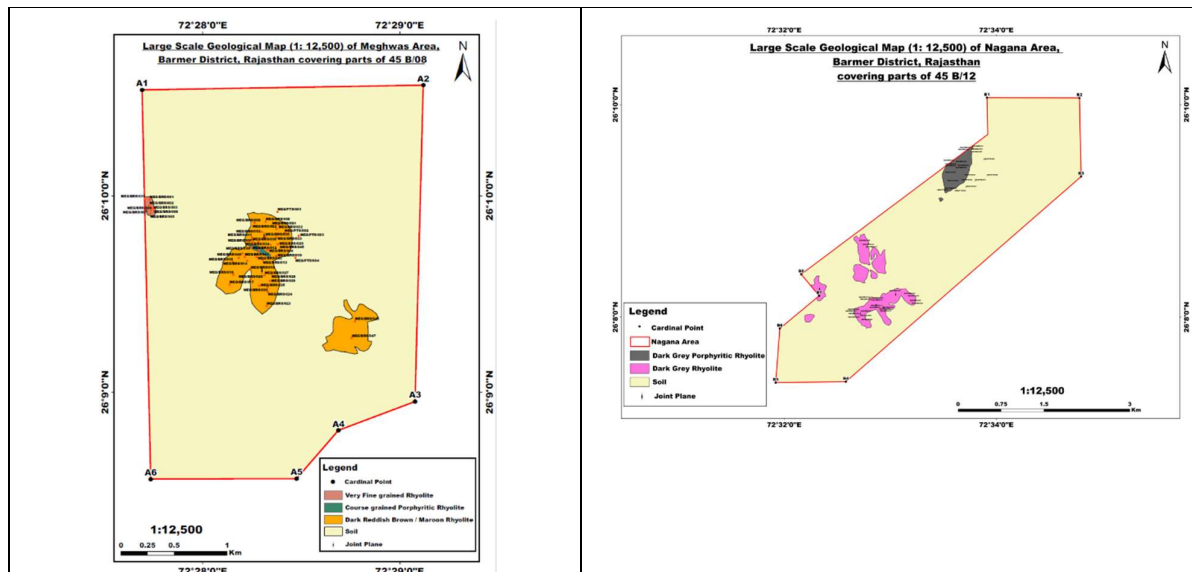


Figure 6-1: Geological map of Meghawas-Nagana Block, District- Barmer, Rajasthan

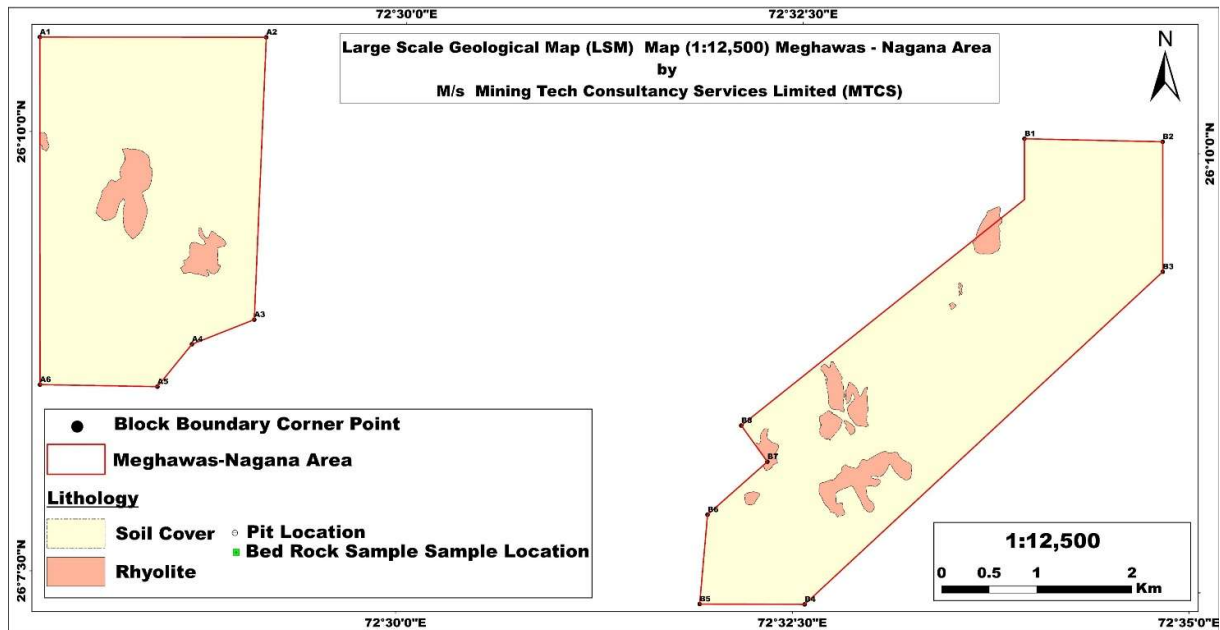


Figure 6-2: Outcrop with sample location map of Meghawas-Nagana Block, District- Barmer, Rajasthan

During mapping, different rock formations i.e. strata of Thar desert and Rhyolites were encountered. The description of lithology, structure & mineralization have been furnished in Chapter V.



Figure 6-3: Photographs during site visit by Senior Geologists from GSI

6.3 Pitting

The covered parts of the possible potential area have been exposed with the help of pitting activity. 10 nos of pits open in Nagana block and 4 nos. of pits open in the Meghawas block. The inter pit spacing varies from 300m to 100m on the ground with the 2m maximum depth. Rest area has not been looked by the pitting activity due to greater thickness of the sand cover. The pits with dimension 1m x 1m x 2m was excavated using JCB and samples has been collected by cutting channels within the soil/regolith zones exposed in the pit. The re-presentative homogenous samples have been collected from each pit. Total 24.50 cubic meters of material has been excavated by digging 14 pits. Subsequently, 14 nos. samples (one from each pit) have been collected. Details of all the pits excavated in the area are shown in Table 6.1.

Table 6-1: Details of Excavated Pits in the area

Sl. No.	Pit Number	Lat	Long	Elevation (m)	Land use	Depth of Pit (m)	Excavation (cum)	Remarks
1	MEG/PTS/001	26.1653 °N	72.4730 °E	159.82	Barren	2.00	2.00	No bed rock encountered upto 2m, only soil/regolith
2	MEG/PTS/002	26.1635°N	72.4736°E	163.93	-do-	0.70	0.70	Maroon Rhyolite encountered at 0.70m depth
3	MEG/PTS/003	26.1633 °N	72.4748 °E	161.43	-do-	2.00	2.00	No bed rock encountered upto 2m, only soil/regolith
4	MEG/PTS/004	26.1614 °N	72.4745 °E	168.49	-do-	2.00	2.00	-do-

Sl. No.	Pit Number	Lat	Long	Elevation (m)	Land use	Depth of Pit (m)	Excavation (cum)	Remarks
5	NAG/PTS/001	26.1555 °N	72.5617 °E	182.06	-do-	1.70	1.70	Dark Grey Porphyritic Rhyolite encountered at 1.70m depth
6	NAG/PTS/002	26.1547 °N	72.5612 °E	176.79	-do-	1.60	1.60	Dark Grey Porphyritic Rhyolite encountered at 1.60m depth
7	NAG/PTS/003	26.1532 °N	72.5601 °E	174.08	-do-	2.00	2.00	No bed rock encountered upto 2m, only soil/regolith
8	NAG/PTS/004	26.1535 °N	72.5591 °E	180.35	-do-	1.25	1.25	Dark Grey Porphyritic Rhyolite encountered at 1.25m depth
9	NAG/PTS/005	26.1546 °N	72.5594 °E	176.72	-do-	2.00	2.00	Dark Grey Porphyritic Rhyolite encountered at 2.00m depth
10	NAG/PTS/006	26.1559 °N	72.5586 °E	180.74	-do-	1.25	1.25	Grey Rhyolite encountered at 1.25m depth
11	NAG/PTS/007	26.1537 °N	72.5619 °E	176.31	-do-	2.00	2.00	No bed rock encountered upto 2m, only soil/regolith
12	NAG/PTS/008	26.1555 °N	72.5652 °E	178.88	-do-	2.00	2.00	-do-
13	NAG/PTS/009	26.158 °N	72.5647 °E	174.21	-do-	2.00	2.00	-do-
14	NAG/PTS/010	26.1547 °N	72.5633 °E	175.63	-do-	2.00	2.00	-do-



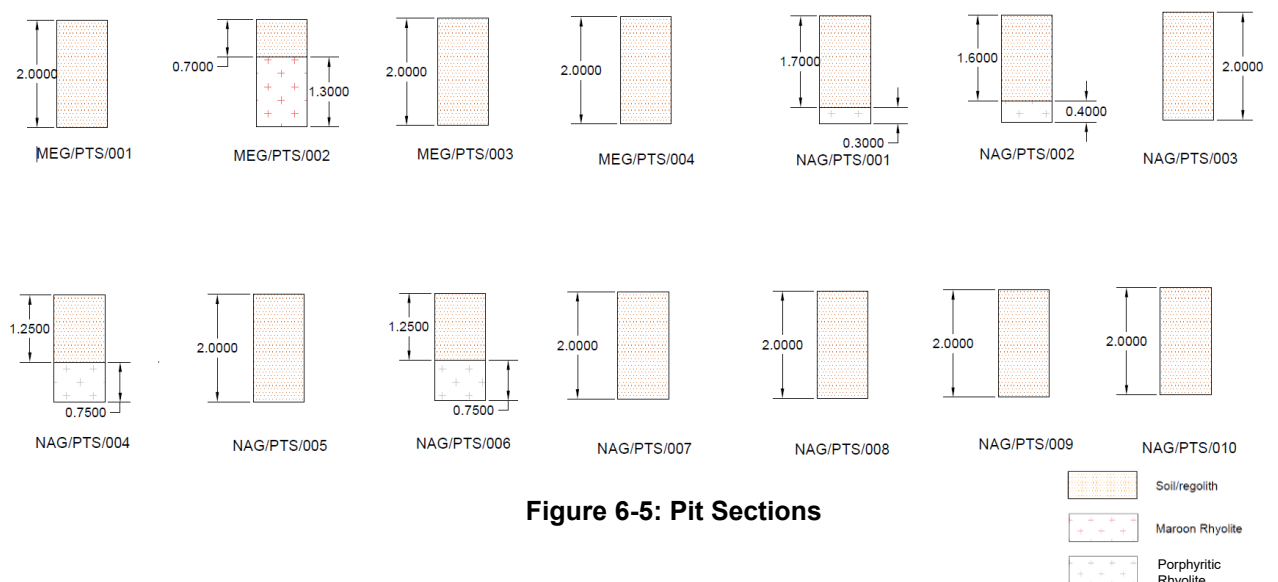
(A)



(B)



Figure 6-4 (A-F): Pit excavation works within sand covered area
A & B: MEG/PTS/001: 26.1653°N, 72.4730°E, C & D: NAG/PTS/007: 26.1537°N, 72.5619°E,
E & F: NAG/PTS/010: 26.1547°N, 72.5633°E



6.4 Geochemical Exploration & Sampling

To characterise the rhyolite, systematic sampling has been attempted in the exposed outcrops and covered areas have been sampled by pitting activities. All samples have been collected as Bed Rock Samples (BRS). A total of 86 nos. of BRS and 14 pit samples (total 100 nos. from the area) have been collected systematically from different variety of Rhyolites in both blocks. The samples were collected by chipping exposed rock units in 1m radius using sledgehammer and chisel. The sampling has been carried out to take control over the different bands of exposed rhyolite; few samples of the pits are regolith in nature.

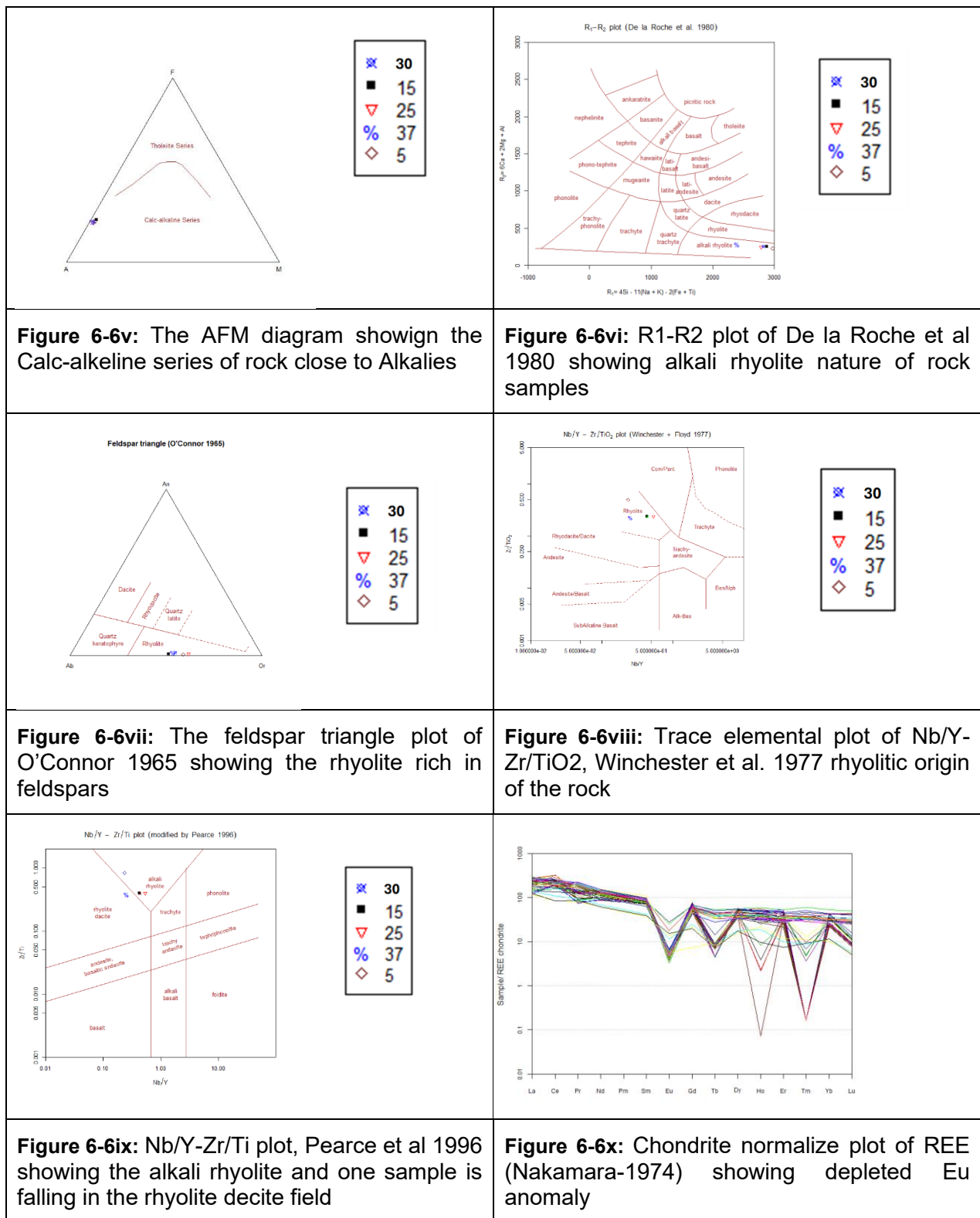
The chemical exploration on regular grid pattern could not be carried out in the area due to rock type constraints and non-availability of adequate outcrops. However, the BRS and pit samples have been collected as per the potentiality/anomaly of the area as indicated in previous reports of GSI. The distribution of samples is not in regular pattern.

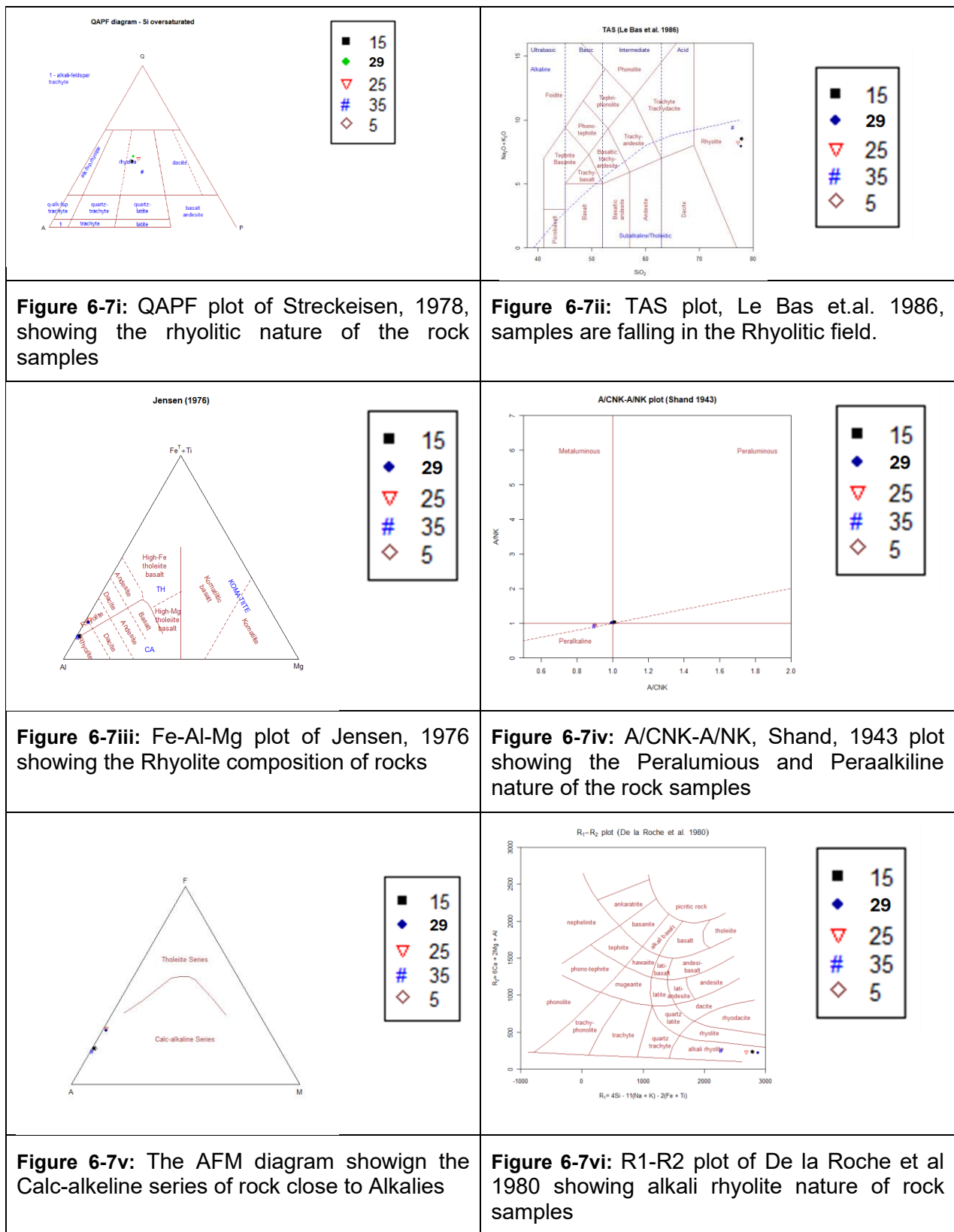
The bed rock sample locations are plotted on geological map (Plate I) and the same has been annexed as Annexure I-III. Besides, 10 samples each were taken for whole rock analysis, petrographic study and XRD analysis.

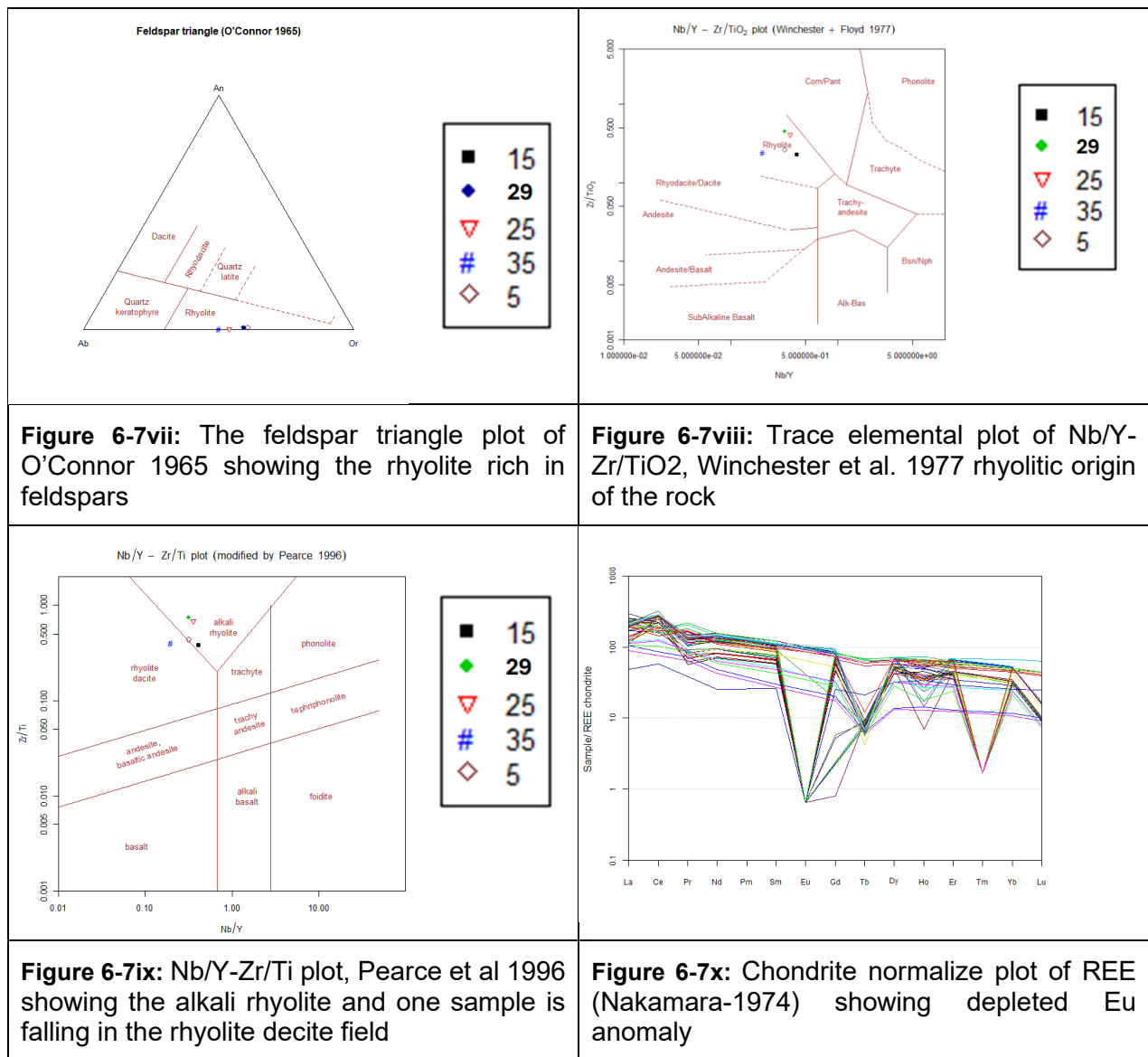
6.5 Analysis of Samples

The collected samples have been processed and after homogenising by coning & quartering sent for the analysis. The analysis of the samples for 34-elements has been done at Inspectorate Griffith India Pvt. Ltd. (IGI) Lab, Gandhidham, Gujarat (NABL accredited). ICP-MS (inductively coupled plasma-mass-spectrometry) method has been used to detect the trace elements, i.e. Zr, Rb, Ba, Be, Ga, Ge, Mo, Sn, Hf, Ta, Nb, W, Ni, V, Li, Sb, Th, U and REEs (La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Sc, Y). In addition, 10 bedrock samples were analysed for major oxides, i.e. SiO₂, Al₂O₃, Fe₂O₃, TiO₂, MnO, CaO, MgO, Na₂O, K₂O, P₂O₅, Cr₂O₃, SrO by XRF method and 10 No. of selected samples were analysed for mineral phase identification by XRD techniques. The results of sample analysis are given in Annexure IV-VII, Whole rock (XRF) analysis given in Annexure VIII and XRD & Petrography studies are annexed as Annexure IX & X respectively.

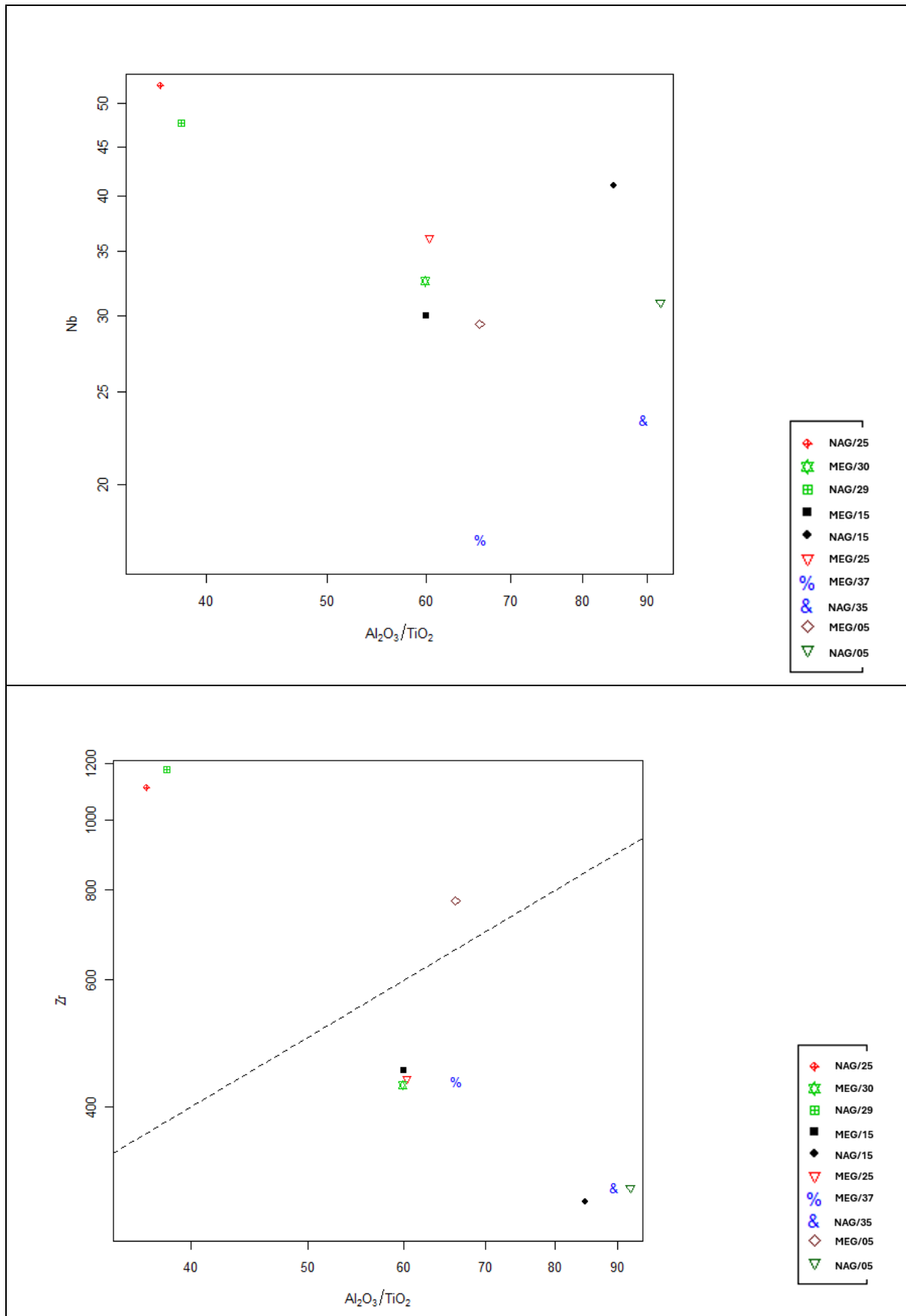
The data has been plotted for the classification of rock using TAS, A/CNK A/NK diagram, AFM diagram and Jensen diagram. The wt% of oxide data do not always represent the cation distribution in a sample, and it has to recalculate the rock composition as cations. De la Roche et al. (1980) proposed a classification scheme for volcanic and plutonic rocks based on their cation proportions, expressed as milli cations. Here the parameters are plotted as R1 and R2 where $R1 = 4Si - 11(Na + K) - 2(Fe + Ti)$, $R2 = 6Ca + 2Mg + Al$. The acidic rock classification also carried out by the Nb/Y vs Zr/Ti after Pearce et al., 1996 and the rock samples are falling in the alkali rhyolite field. The degree of alumina saturation is shown in a plot of molar A/CNK vs. A/NK ($(Al_2O_3 / (CaO + Na_2O + K_2O))$ vs. $Al_2O_3 / (Na_2O + K_2O)$) (mol.%) after Shand (1943), and it has plotted as a cluster in the Peraluminous fields for Meghawas and both i.e for Peraaluminous and







$\text{Al}_2\text{O}_3/\text{TiO}_2$ plots for Nagana and Meghawas blocks are given in the Figure no. 6-8.



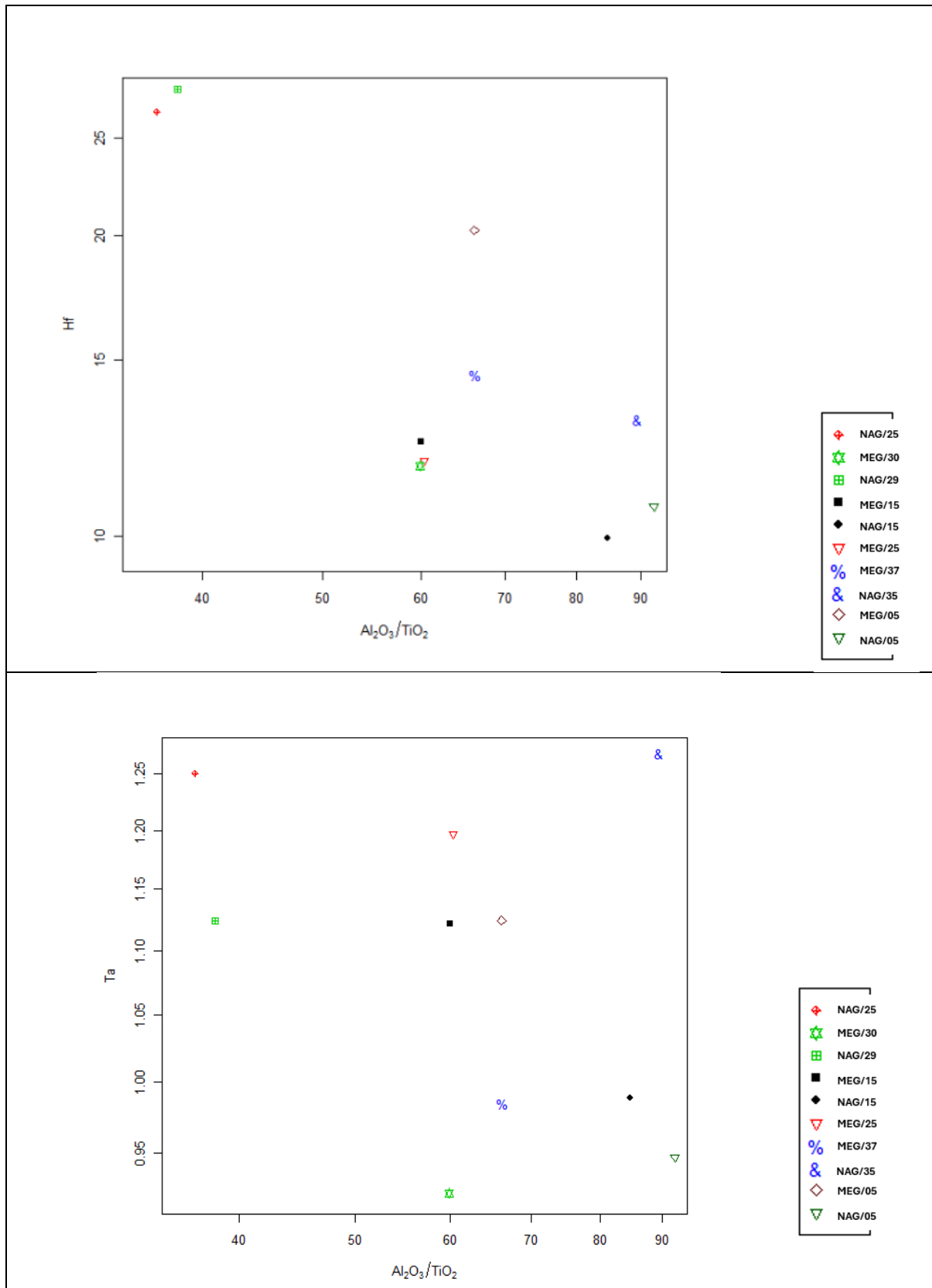


Figure 6-8: $\text{Al}_2\text{O}_3/\text{TiO}_2$ plots for the samples of Meghawas-Nagana block

Rhyolites are normally enriched in LILE (Rb, Ba, U) & HFSE (Zr, Hf, Nb, Ta) and shows evolved signatures. Fractionation of alkali feldspar during magmatic evolution decreases $\text{Al}_2\text{O}_3/\text{TiO}_2$ and increases ΣREE , Nb, Zr and HFSE. During the magmatic evolution, hydrothermal activities enrich ΣREE , Nb, Zr and HFSE within a low narrow range of $\text{Al}_2\text{O}_3/\text{TiO}_2$ by releasing these elements from

parent unaltered rhyolites (Wang et al, 2023). In the block area the Dark Grey rhyolite samples are showing the similar characteristics.

Al_2O_3/TiO_2 plots are showing the fractionation evolution i.e. magmatic fractionation and hydrothermal alteration by the presence of magnetite (Fe minerals), in the grey rhyolite in the area. It is showing comparatively more REE than the other variants present in the area.

6.6 External Check Analyses

In accordance with the standard practice of quality assurance and quality control, 10 numbers of primary samples have been sent to Shiva Lab, Bangalore (NABL accredited) as external check samples.

The statistical analysis of $\Sigma REE+Y+Sc$ has been prepared to check the reliability of assay. The scatter plots of aforesaid radicals show the correlation coefficient more than 0.8, which is very close to 1 showing homogeneity of the sample prepared as well as reliability of chemical analysis. Comparison of $\Sigma REE+Y+Sc$ of Primary and external check samples furnished in Table No. 6-2.

Table 6-2: Comparison of Primary v/s External check sample analysis

Comparison Index	Primary Samples (IGI Lab)	Check Samples (Shiva Lab)
No. of samples	10	10
Minimum	478.82	413.68
Maximum	694.39	609.36
Mean	622.78	554.04
Standard Deviation	65.58	59.81
Standard Error	20.74	18.91
Median	618.18	570.06
Standard Error	122.257	
Correlation Co-efficient	0.824	
Paired T-value	5.783	
F-test	1.202	

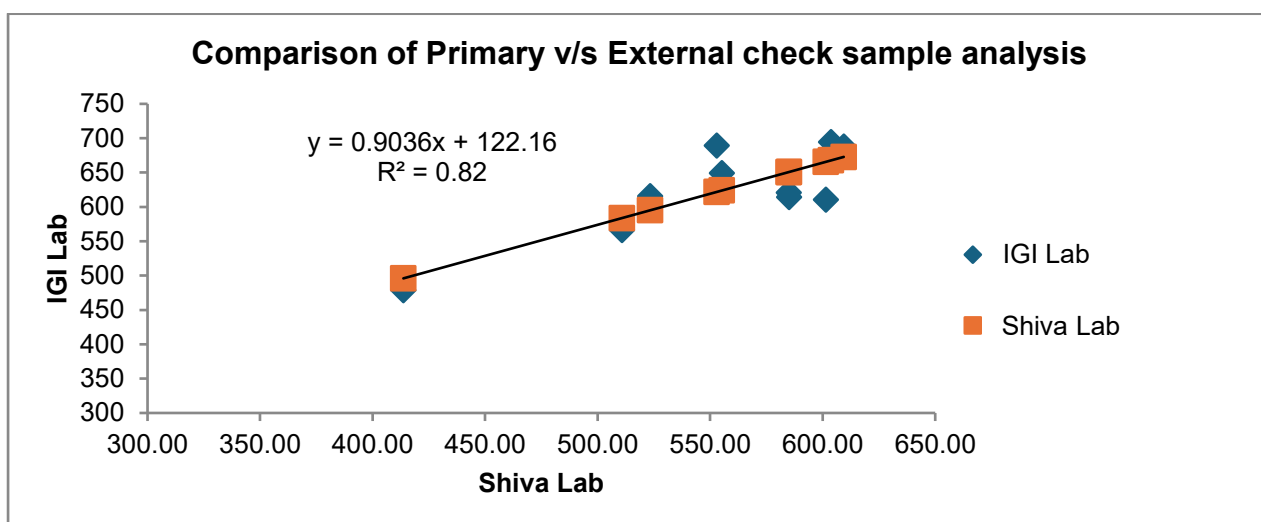


Figure 6-9: Correlation chart of $\Sigma\text{REE}+\text{Y}+\text{Sc}$ in BRS analyses of two laboratories for Primary and Check samples

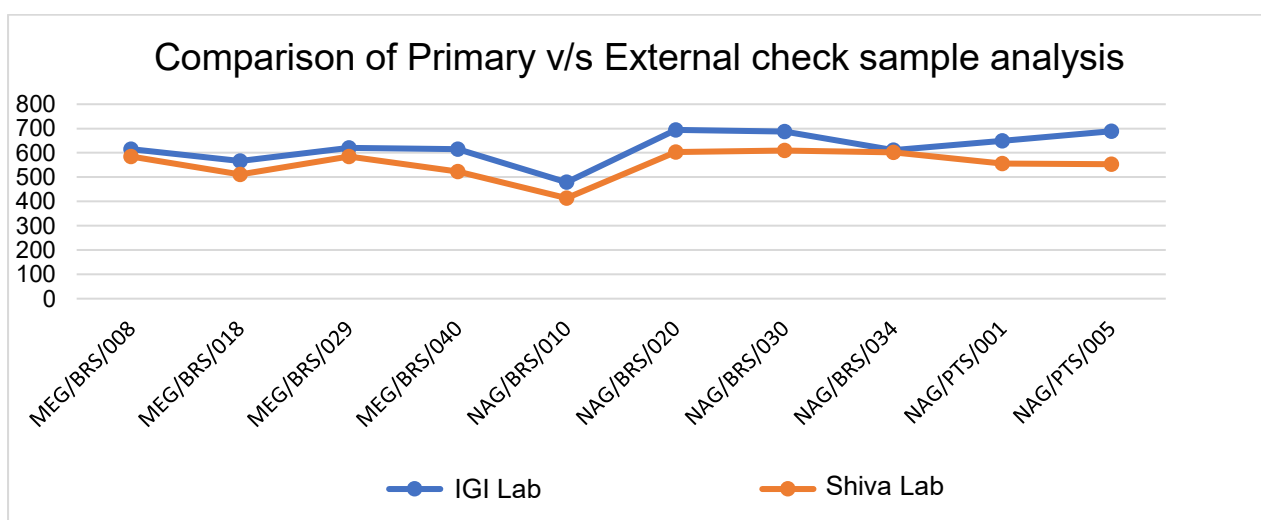


Figure 6-10: Comparison of $\Sigma\text{REE}+\text{Y}+\text{Sc}$ in BRS analyses of two laboratories for Primary and Check samples

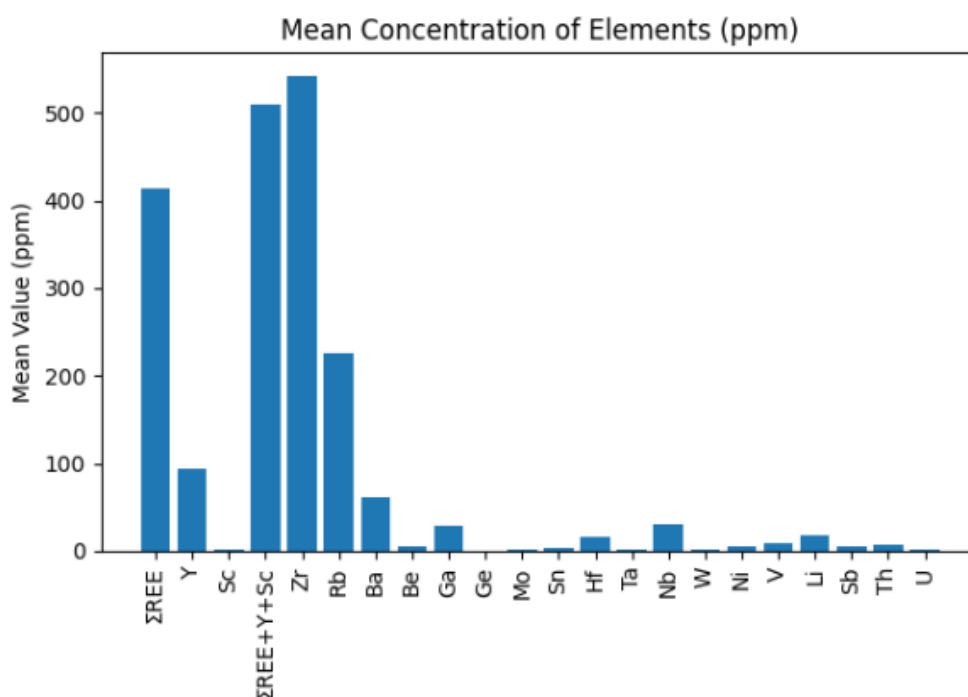
6.7 Interpretation of analytical results

A total of 100 Bedrock samples (including 14 pit samples) were collected from both blocks and analyzed for REE & RM content. The element wise interpretation is furnished below:

- Rare Earth Elements (REE):** REEs are a set of seventeen chemical elements in the periodic table, specifically the fifteen lanthanides plus Scandium (Sc) and Yttrium (Y). Sc and Y are considered REEs since they tend to occur in the same mineral deposits as the lanthanides and exhibit similar chemical properties, which includes being malleable with high melting and boiling points. The $\Sigma\text{REE}+\text{Y}+\text{Sc}$ values in Meghawas-Nagana Block are varying from 182.13 ppm to 694.39 ppm with an average value of 504.65 ppm.

Table 6-3: Summarised Table showing range of elemental concentration in Bedrock Samples

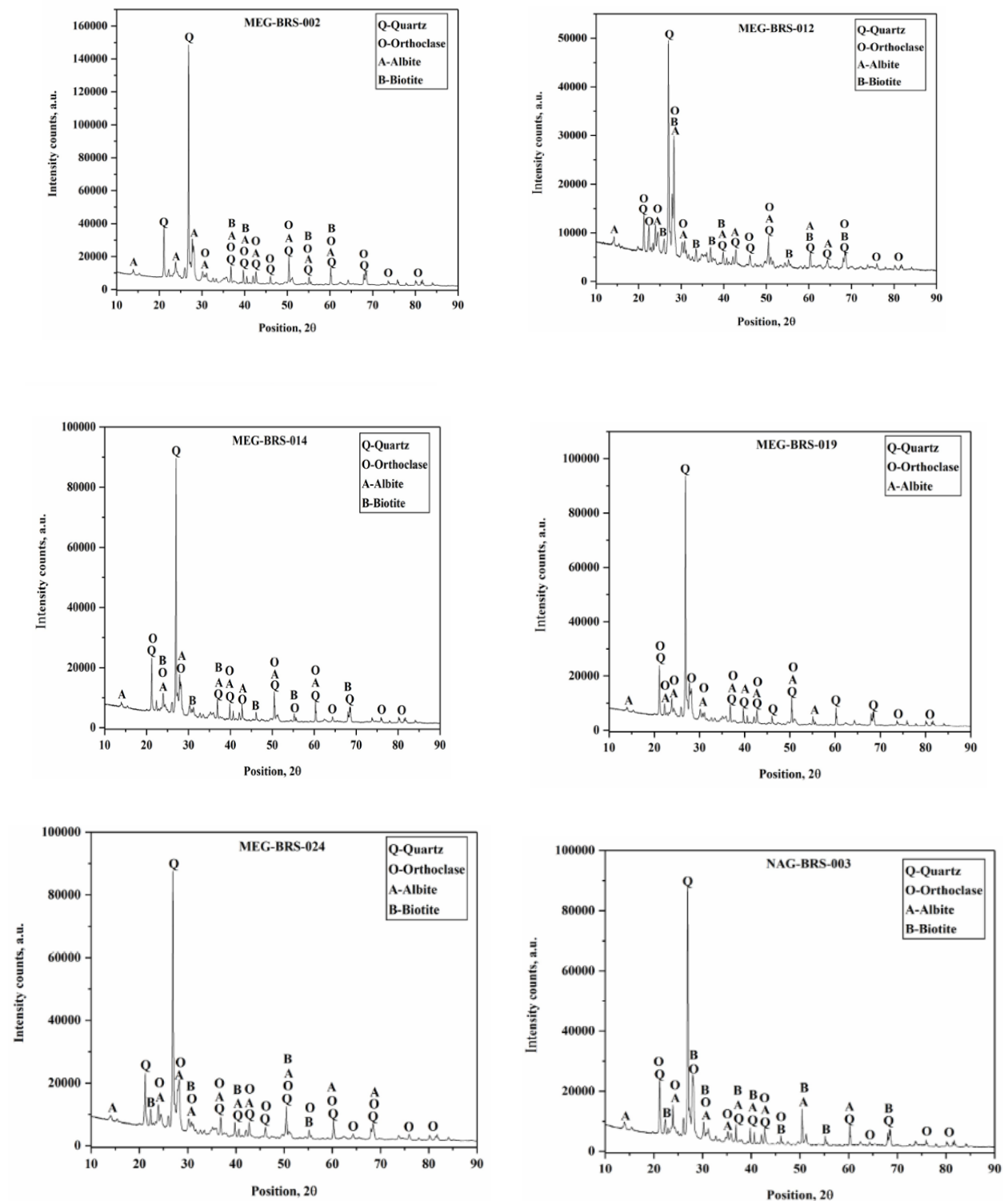
Elements	Minimum Value (ppm)	Maximum Value (ppm)	Mean Value (ppm)
ΣREE	127.77	546.16	414.14
Y	23.56	153.53	93.34
Sc	0.53	11.55	2.18
ΣREE+Y+Sc	182.13	694.39	509.65
Zr	48.49	1179.08	541.36
Rb	50.77	379.43	225.53
Ba	3.05	407.33	61.64
Be	1.74	7.32	4.90
Ga	10.11	39.44	28.97
Ge	0.10	1.38	0.43
Mo	0.13	3.01	1.37
Sn	0.89	7.57	2.62
Hf	1.57	32.38	15.41
Ta	0.60	1.61	1.08
Nb	8.66	52.25	31.01
W	0.11	23.43	1.77
Ni	1.59	47.50	5.87
V	0.51	80.03	7.95
Li	4.20	47.05	17.06
Sb	0.06	11.65	4.34
Th	2.14	23.10	7.76
U	0.17	5.00	1.17

**Figure 6-11: Mean concentration values (ppm) for each element**

Overall, the bedrock samples show concentration of ΣREE+Y+Sc with an average value of 509.65 ppm in Meghawas-Nagana block. Besides, 17 samples collected from Nagana area shows

Zirconium value more than 1000 ppm with an average value of 541.36 ppm. Additionally, Rubidium anomaly (>300 ppm) is observed within 18 samples with an average of 225.53 ppm.

The XRD analysis of 10 nos. of samples have been carried out to know the mineral phase in the rhyolites. The dominant minerals are Orthoclase, Quartz, Albite and Biotite as observed in the analysis. The results indicate K-feldspar rich acidic granites and its variants like Rhyolite which is a known-host for the REE mineralization. The results are given below:



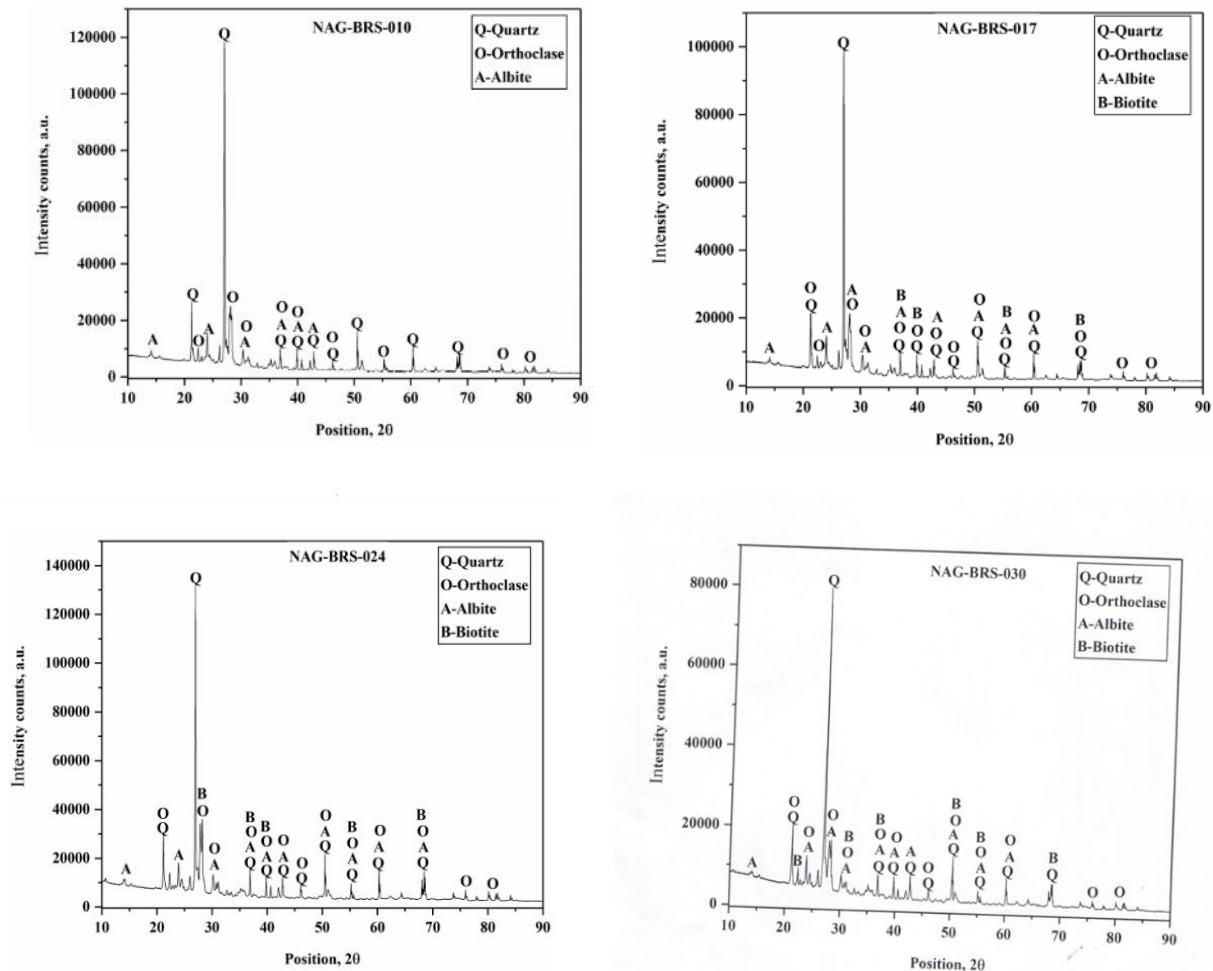


Figure 6-12: XRD results of samples collected from the study area

6.8 Petrographic Study

Ten (10) samples have been identified for thin polished section preparation & petrography study (5 samples from each block). The petrographic analysis of all examined samples (NAG/PS/31, NAG/PS/14, NAG/PS/07, NAG/PS/20, NAG/PS/21, MEG/PS/15, MEG/PS/03, MEG/PS/39, MEG/PS/23 and MEG/PS/05) reveals a dominant assemblage of Quartz and Alkali Feldspar with variable proportions of iron ore minerals (Magnetite and Hematite), brown volcanic Glass, and accessory Biotite and altered Garnet. This study verifies the XRD results of the blocks. The samples show well-developed porphyritic and vitrophyric textures, with abundant phenocrysts of Quartz and Feldspar set within very fine grained cherty or glassy groundmass. The common presence of amygdules filled with Quartz and Chert, along with glassy matrix and flow structures, confirms a clear volcanic origin with strong indication of subaerial or shallow-subvolcanic emplacement.

The rocks collectively represent volcano-sedimentary to volcanic lithologies dominated by Rhyolite with cherty Quartzite interlayers, reflecting alternating episodes of explosive acidic volcanism and

sedimentary reworking. The observed textural and mineralogical relationships such as undulose extinction in Quartz, deformation and alteration of Feldspar, conversion of Magnetite to Biotite/Hematite, and pseudomorphing of vesicles indicate low-grade metamorphism and post-emplacement hydrothermal alteration. The presence of volcanogenic quartzites and pseudoporphyrific cherty facies further indicates syn-volcanic sedimentation associated with rhyolitic lava flows or pyroclastic precursors.

Overall, the petrographic characteristics suggest that the studied sequence represents an acid volcanic terrain comprising Rhyolitic lava flows, vitrophyric volcanic rocks and interlayered volcanogenic cherty quartzites, later subjected to deformation, fluid activity, and low-grade metamorphic overprinting at few places. This supports a tectono-magmatic environment likely related to an ancient continental volcanic arc or rift-associated felsic volcanism. The regional disposition of the rocks also suggested the similar set-up.

6.9 Geophysical Exploration

Detailed ground geophysical survey was not carried out in the blocks; however, the previous baseline geophysical data (regional scale) have been consulted, processed in-house and also considered during the course of G4 work in the area. The output maps of geophysical data processing are given as Plate III-V.

CHAPTER – VII: INTEGRATION OF EXPLORATION DATA

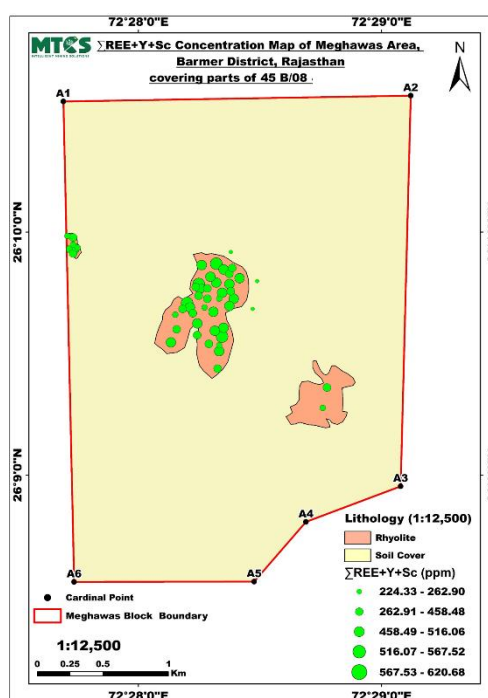
7.1 Integration of Geology, Geophysics and Geochemical Exploration Data & Interpretation

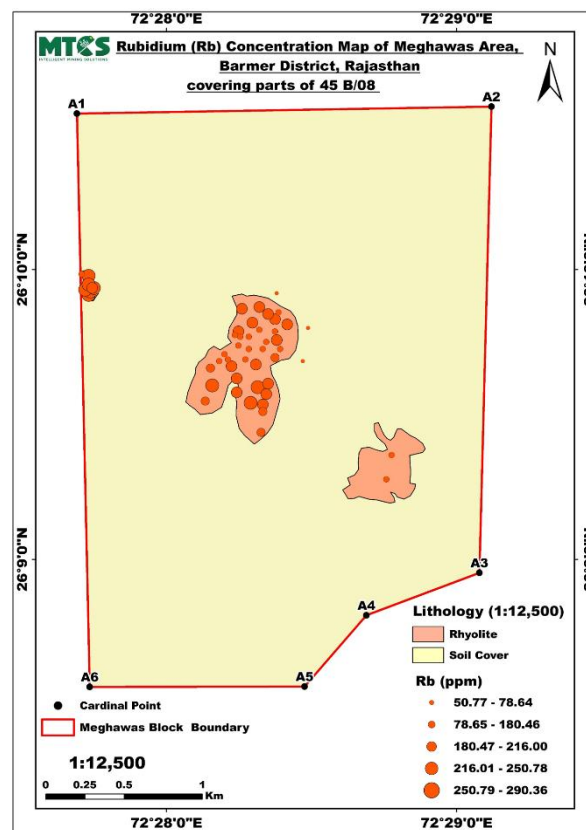
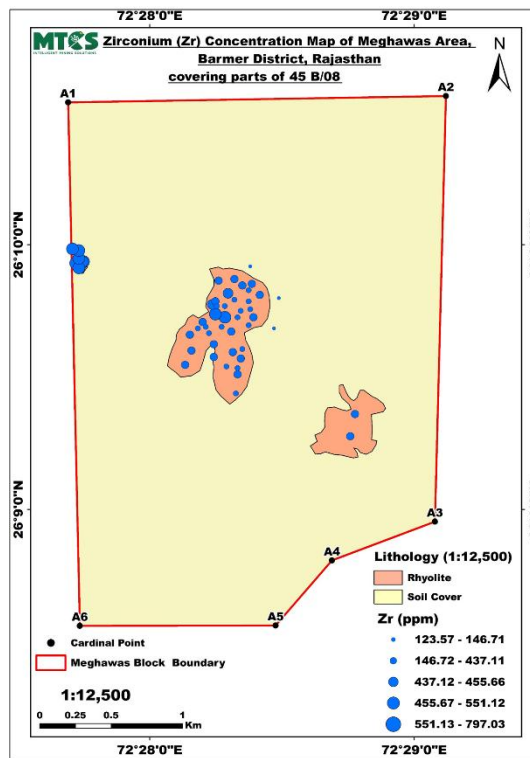
The surface exploration by the sampling and the pitting have been carried out in the areas. No semi-regional or detailed ground geophysical work has been carried out in the blocks. The available regional scale NGCM & NGPM data has been consulted for the formulation of exploration plan and for targeting the sampling locations.

The generated chemical, petrological and XRD data have been integrated for better interpretation of mineralization, host rock potentiality and other tectonic aspects of the terrain. The terrain is tectono-magmatic in nature showing partially sedimentation and the volcanic eruption of the granitic composition followed by the low grade of metamorphism. These findings are being seen in the XRD, petrological and chemical analysis of the samples collected from the blocks.

The rhyolite is conformed as a host for the REE, Zr & Rb in the area. However, the concentration of the Σ REE is not economical in the blocks as evident by the available chemical data. The analysis of the Zr & Rb are showing the anomalous values for further exploration to target these two elements. Figure 7-1 shows concentrations of Σ REE+Y+Sc, Zr & Rb within the study area.

The details of the chemical analysis have been discussed in the Chapter VI and it has concluded that the rhyolites are the prominent litho-units of the area hosting the REE. The overlay of the LSM with the bubble plot of elements are indicating that the both types of rhyolites are hosting the REEs, Zr and Rb. However, the Nagana block which is having grey rhyolite dominantly having the more values of Σ REE, Zr & Rb than the reddish-maroon color rhyolite of Meghawas block. The Nagana area is having the broad range of rhyolite than the Meghawas area.





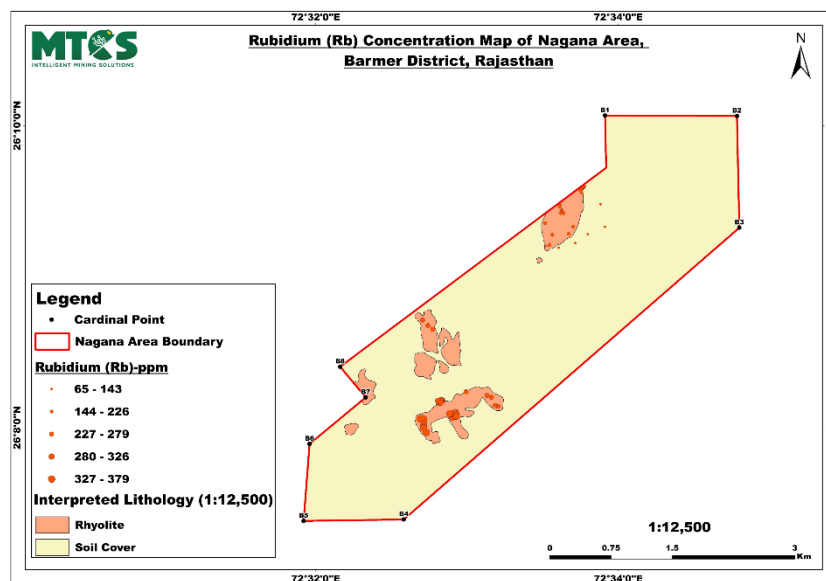
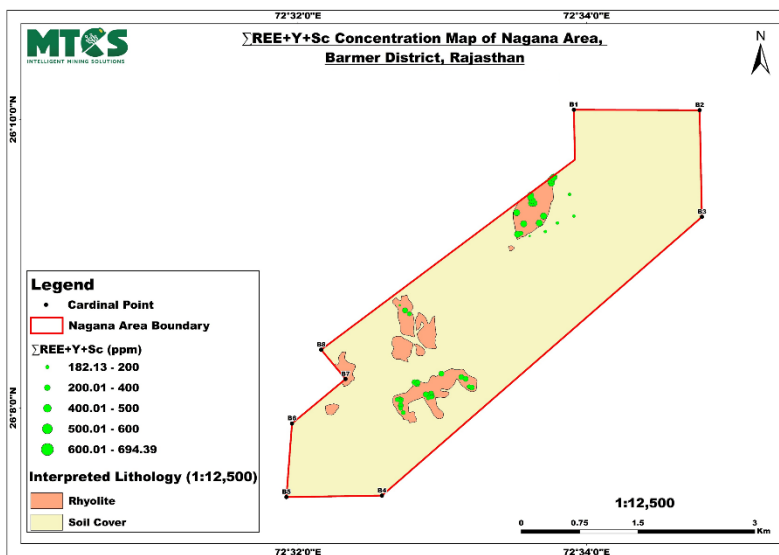
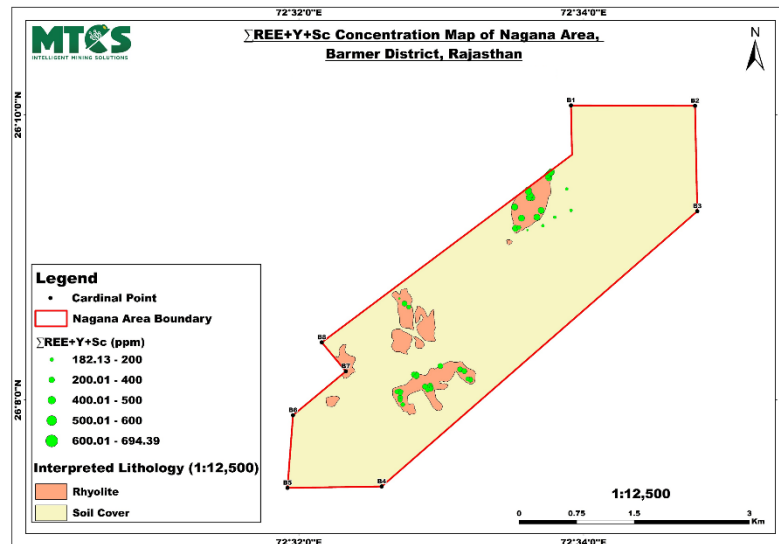


Figure 7-1: Σ REE & Rare Metal Concentration map in the study area

The area may be looked in detail for the Zr & Rb exploration through geophysical exploration and ground validation in the Nagana area.

CHAPTER – VIII: MINERAL PROSPECT

8.1 Surface indication

The area is covered by the sand and only few outcrops are exposed. Around 1.70 sqkm area is exposed and studied through the sampling and pitting. The LSM map is showing the distribution of the rhyolites. The outcrop scale alteration has been observed but the regional scale alteration by satellite data is difficult to interpret.

8.2 Mode of occurrence

The outcrop pattern is showing as ring like structure; the disposition of the plugs is scattered and limited.

8.3 Strike length and width of anomalies

The rock outcrops are irregular in shape. The strike length established by the available data is very limited and irregular. Width of anomaly zones could not be identified for mineral continuity.

8.4 Exploration

Zr & Rb can be explored further as they are showing the anomalous value in the Nagana block but the concentrations of these elements are limited at a certain location.

8.5 Genesis of mineralisation

The available datasets indicate that the mineralization anomalies hosted in tectono-magmatic nature. In between rhyolites, thin layers of partially sedimentation have been observed at thin section level. The low grade of metamorphism is also observed in the thin section study. The rhyolite is conformed as a host for the REE, Zr & Rb in the area.

CHAPTER – IX: EXPLORATION BY SCOUT DRILLING

No scout drilling has been carried out during the exploration work.

CHAPTER – X: RESOURCE ESTIMATION

No reconnaissance resources have been estimated during the course of exploration.

CHAPTER – XI: CONCLUSION AND RECOMMENDATION

11.1 Conclusion

The project was approved by NMEDT for G4 exploration for REE & RM in the part of Malani Suite of rocks. Initially, the block area was 100 sqkm but after the review by NMEDT and considering NGCM anomaly zones, the block area has been reduced to 18.00 sqkm in two parts i.e. Meghawas & Nagana blocks. The Large-Scale Mapping on 1:12,500 scale was carried out within both blocks. A total of five litho-variants of rhyolites has been established in the area on the basis of color, grain size and texture. A total of 86 BRS and 14 pit samples have been collected from the area. XRD study has been carried out for 10 samples with additional 10 samples taken for petrography study.

The area has identified as tectono-magmatic terrain. The rhyolites are hosting REE and Zr & Rb mineralization in the blocks. The study area is mostly covered by the sand of Thar Desert with 8 to 10% of outcrops.

Among both the blocks, Nagana block is showing relatively higher REE and Zr & Rb values than Meghawas block. The analytical result of the blocks for $\Sigma\text{REE}+\text{Y}+\text{Sc}$ ranges from 182.13 ppm to 694.39 ppm and showing averages around 509.65 ppm. Although anomalous concentration of REE mineralization is not evident across the study area, but notable enrichment of Zirconium is observed in 17 samples (>1000 ppm), with the average 541.36 ppm along with Rubidium anomalies (>300 ppm) in 18 samples with the average 225.53 ppm, particularly within parts of the Nagana block. The strike length of the mineralization could not be established due to scattered nature of anomaly in the blocks.

In view of the integrated geological and geochemical evaluation, the area can be considered prospective for Zirconium and Rubidium, particularly the zones located in the Nagana block. This area can be considered for further exploration in terms of detailed ground geophysical survey followed by scout drilling for the validation of the geophysical data.

11.2 Recommendation

- The G4 stage reconnaissance exploration undertaken in the Meghawas-Nagana Block was primarily aimed at assessing the potential for Rare Earth Elements (REE) and Rare Metals (RM). However, a holistic geological evaluation approach was adopted, integrating geological mapping, surface geochemical sampling and analytical results to comprehensively assess the area's mineral potential.
- The detailed ground geophysical can be recommended for subsurface lithological mapping and further drilling for the ground validation.

- The area is sand/aeoline covered and outcrops are limited. Sampling from the remaining area can be proposed to know the covered rock type.
- Parts of the Nagana block is more promising for the Zr & Rb as well as for the REE, so systematic sampling can be recommended in these zones.

CHAPTER – XII: EXPENDITURE

Expenditure of Reconnaissance Survey (G4 Stage) for Rare Earth Elements (REE) & Rare Metals (RM) in Meghawas-Nagana Area (18.00 Sqkm) Barmer District, Rajasthan

Sl. No.	Item of Work	Unit	Rates as per NMET SoC 2020-21		Charged Rates (a)	Achieved Qty. (b)	Total Amount (Rs) (a * b)
			SoC-Item No.	Rates as per SoC			
A	Geological Mapping Other Geological Work & Surveying						
	Geological mapping (1:12,500 scale), pitting & geochemical sampling						
1	Charges for Geologist per day (Field) for geological mapping, pitting & geochemical sampling	day	1.2	11,000	11,000	60	660,000
2	Labours Charges; Base rate	day	5.7	541	541	120	64,920
3	Charges for one Sampler per day (1 Party)	one sampler per day	1.5.2	5,100	5,100	14	71,400
4	Labours (4 Nos) for sampling	day	5.7	541	541	56	30,296
5	Charge for procurement of Satellite Imagery (CartoDEM, 2.5m posting, DSM, 14km x 14km scene) for Remote sensing, multispectral and DEM data analysis)	day	1.1	Satellite imagery/ Aerial Photo		1	6,290
6	Geologist (HQ)	day	1.2	9,000	9,000	40	360,000
	Sub Total- A						1,192,906
B	Trenching/Pitting						
1	Excavation of Pits (upto 2m depth)	per cum	2.1.2	3,800	3,800	20	76,000
	Sub-Total B						76,000
C	LABORATORY STUDIES						
1	Chemical Analysis (ICP-MS: 34 elements)						
i.	Geochemical Sampling-Surface samples (BRS)						
	a. ICP-MS (34 elements)	Nos	4.1.14	7,731	3,550	100	355,000
ii.	Surface Check samples (10% External)						

Sl. No.	Item of Work	Unit	Rates as per NMET SoC 2020-21		Charged Rates (a)	Achieved Qty. (b)	Total Amount (Rs) (a * b)
			SoC-Item No.	Rates as per SoC			
	a. ICP-MS (34 elements)	Nos	4.1.14	7,731	4,250	10	42,500
2	Physical & Petrological Studies						
i	Preparation of thin polished section	Nos	4.3.1	2,353	2,353	10	23,530
ii	Study of thin polished section	Nos	4.3.4	4,232	4,232	10	42,320
iii	Digital Photographs	Nos	4.3.7	280	280	10	2,800
iv	Whole Rock Analysis (XRF Analysis)	Nos	4.1.15a	4,200	925	10	9,250
v	XRD Analysis	Nos	4.5.1	4,000	4,000	10	40,000
	Sub Total C						515,400
D	Total A to C						1,784,306
E	Geological Report Preparation	5 Hard copies with a soft copy	5.2	5.2 (i/ii/iii/iv)			150,000
F	Peer review Charges		As per EC decision				30,000
G	Preparation of Exploration Proposal (5 Hard copies with a soft copy)	5 Hard copies with a soft copy	5.1	2% of the Cost or Rs. 3.8 Lakhs whichever is less			35,686
H	Total Estimated Cost without GST						19,99,992
I	Provision for GST (18% of K)						3,59,999
J	Total Estimated Cost with GST						23,59,991
	or Say Rs. In Lakhs						23.60

CHAPTER – XIII: REFERENCES

Carter, H.J. (1854): Geological papers on Western India. Journal of the Bombay branch, Government of India, Vol 237.

McMahon, C.A. (1886): Notes on the microscopic structures of some specimens of the Malani rocks of the Aravalli region. Rec. Geological Survey of India, v.19, pp. 161 -167.

Basudev Sural (1976-77): Report on the Geomorphological Mapping Quaternary studies in middle Luni Basin around Luni village covering parts of Jodhpur and Pali district, Rajasthan (report for field season 1976-77)

Bhushan, S.K. and Sengupta, S. R. (1975-76): Report on Geological Mapping in parts of Jaisalmer, Barmer and Jodhpur Districts with special reference to Malani Igneous Suite.

Bhushan, S. K., (1985): Malani volcanism in western Rajasthan; Ind. Jou. Earth Sci., 12(1), pp. 58-71.

Bhushan, S. K.,(1995): Late Proterozoic continental growth: Implications from geochemistry of acid magmatic events of West Indian craton, Rajasthan; Mem. Geol. Soc. Ind.,34, pp. 339-355.

Bhushan, S.K.,(2000): Neoproterozoic magmatism of the Malani Igneous Suite, Rajasthan, India; G.S.I. Spl. Pub., 55, pp. 319-332.

Bhushan, S. K and Chandrasekharan V., (2002): Geology and geochemistry of the magmatic rocks of the Malani Igneous Suite and Tertiary Alkaline Province of western Rajasthan; Mem. G.S.I.,126, 181 p.

Bhushan. S. K. and Chittora, V. K., (1993): Volcanic stratigraphy of Malani Igneous Suite around Siwana in Barmer district, Rajasthan; Rec. G.S.I, 26, pp. 10- 11.

Bhushan, S. K. and Mohanty, M., (1988): Mechanics of intrusion and geochemistry of alkaline granites from Siwana district, Rajasthan; Ind. Jou. Earth Sci., 15 (2), pp. 103- 115.

Bhushan, S. K and Yagi, K., (1981): Malani volcanism of the Proterozoic in the western Rajasthan, India; In: Symp. On 'Arc Volcanism ' IAVCEI, Tokyo, pp. 39-40.

Bhuvan.nrsc.gov.in: ISRO's web portal

Blandford, W. T. (1877): Geological note on the Great Indian Desert between Sind and Rajputana. Record Geological Survey of India, Vol. 10, pp. 10-21.

Hacket C.A. (1880) Record G.S.I. Vol. XIII P- 4. (1881): Record G.S.I. VOL. XIV P-4

Hacket, C. A. (1881): On the geology of Aravalli Region Central and Eastern Rajputana. Record GSI Vol. 15.

Heron A.M. (1922-23): Record G.S.I. VOL. LIV P-4. (1917, 1953) Memoir G.S.I. Vol. 45 & 79

Heron, A. M. (1932): The Vindhya of Western Rajputana, Records Geological Survey of India, 65 (4), p. 457-489.

Heron, A.M. (1932): The Vindhya of western Rajputana. Rec. Geol. Surv. India, 65(4), 457-489.

HERON, A.M. (1953): The Geology of central Rajputana. Mem . G.S.I. Vol. 79.

H. Pareek and S. R. Sengupta (1977): Stratigraphy, Petrography, Petrochemistry and Petrogenesis of Malani Volcanics in Jodhpur, Kailana Talav, Agolai and Undrio areas, district

Jodhpur, Rajasthan.

Imd.gov.in: India Meteorological Department, Ministry of Earth Sciences Government of India.

Kochhar, N., (1984): Malani Igneous Suite, India; Jou. Geol. Soc. Ind., 25 (3), pp. 155- 161.

Krishnan, M. S. and Jacob, K., (1956): Malani Beds Stratigraphy; Intern. Dcong. Geol. Intern. Commn. De. Start, 1/1, ASIE, Fasc.8.

La Touche, T. H. D., (1902): Geology of western Rajputana; Mem. GS.I, 35, pp. I-116

Maheshwari, A., Coltori, M., Sial, A. N. and Mariano, G., (1996): Crustal influences in the petrogenesis of the Malani rhyolites, southeastern Rajasthan, combined trace element and oxygen isotope constraints; Jou. Geol. Soc. Ind., 47, pp. 611 -619.

Mukherjee, A.B. (1958): Structure of the Malani Rhyolite and apart of the Siwana Granite around Siwana, Western Rajasthan. Quart J. Geol. Min. Met. Sec. Ind. 30 - 159-161.

Mukherjee, B. & Pyne, T.K. (1977): Report on the systematic geological mapping of Malani igneous suite in Barmer district, Rajasthan, (Progress Report for F.S. 1977-78).

Murthy, M. V N. (1962): The significance of the ring pattern of Siwana granite bosses in western Rajasthan. Ind. Minerals, V. 16, pp. 297-298

Satheesh, S.R. and Asokan, N (2021-22): Geochemical Mapping in Toposheets 45B/07 & 45B/08 covering parts of Jodhpur and Barmer Districts of Rajasthan.

Thapa, A and Porwal, P (2021-22): Geochemical Mapping in Toposheet Nos. 45B/11 & 45B/12 covering parts of Barmer and Jodhpur districts of Rajasthan.

CHAPTER – XIV: LOCALITY INDEX

Sl. No.	Village Name	Latitude	Longitude
1	Meghawas	26° 10' 01" N	72° 28' 09" E
2	Bagawas	26° 10' 04" N	72° 26' 39" E
3	Balau Jati	26° 17' 00" N	72° 28' 22" E
4	Bamawa	26° 11' 38" N	72° 17' 42" E
5	Khanaura	26° 08' 27" N	72° 19' 28" E
6	Madhpura	26° 10' 59" N	72° 24' 41" E
7	Patodi	26° 05' 04" N	72° 16' 23" E
8	Rewara	26° 00' 39" N	72° 22' 55" E
9	Sarwari	26° 00' 25" N	72° 28' 44" E
10	Thob	26° 03' 17" N	72° 23' 26" E
11	Hingola	26° 13' 12" N	72° 43' 12" E
12	Chandrai	26° 06' 16" N	72° 34' 38" E
13	Korna	26° 12' 00" N	72° 35' 24" E
14	Radwa Khurd	26° 13' 48" N	72° 31' 12" E
15	Chinchali	26° 11' 24" N	72° 42' 00" E
16	Mandli	26° 10' 12" N	72° 31' 12" E
17	Nagana	26° 08' 24" N	72° 32' 24" E
18	Doli	26° 03' 36" N	72° 39' 36" E
19	Kalyanpura	26° 01' 12" N	72° 34' 48" E
20	Mool Ki Dhani	26° 09' 15" N	72° 34' 57" E

CHAPTER – XV: REVIEWER’S COMMENTS

Review comments on GEOLOGICAL REPORT ON RECONNAISSANCE SURVEY (G4 STAGE) FOR RARE EARTH ELEMENTS (REE) & RARE METALS (RM) IN MEGHAWAS-NAGANA AREA (18.00 SQKM), BARMER DISTRICT, RAJASTHAN By Dr S. K. Som, DDG (Retd.), GSI		
General Comments		
Sl. No.	Comment	MTCS Reply
1	Executive summary should be given separately, not as chapter.	<i>Complied and removed the from the “Chapter”.</i>
2	Re-organise the chapters – Chapter- I > keep it as it is with inclusion of previous work; Chapter- II > Integration of earlier geological, geophysical and geochemical data; Chapter- III > Remote sensing and satellite imagery studies; Chapter- IV >include Regional geology and geology of the studied area (including field outcrop description and LSM mapping details); Chapter – V > Petrology (should include mesoscopic and microscopic studies giving sampling details as well as XRD studies); Chapter – VI > Geochemistry – Describe separately Major oxides, Trace elements and REE behaviours.	<i>Complied as per the G4 report format of NMEDT.</i>
3	The above chapters should follow by other chapters as given in the report.	<i>Complied as per the G4 report format of NMEDT.</i>
4	All petrological, XRD and chemical analysis samples must have correlation. One should be able to understand which sample is from where.	<i>Complied as suggested in the modified report.</i>
5	The report needs thorough revision before its circulation.	<i>Complied in the modified report, as suggested.</i>

Detailed comments		
Integration of exploration data (Chapter-VII)		
Sl. No.	Comment	Reply
1	At chapter-VII, 7.1 heading states "Integration of Geology, Geophysics and Geochemical data & interpretation". Unfortunately, neither the integrated map nor any interpretation result has been presented. Plates III – V shows two nos. magnetic map and one no. anomaly map (of what?). If these maps were prepared by MTCS (as claimed by using the logo of MTCS in maps), then clearly state that in Chapter VII or else give the source, removing MTCS logo from the maps. Where is the geological map?	<i>i. Plate III-V are the aero-magnetic, geophysical baseline geoscience data used for the project work by the exploration agency. The source of data has been given and the logo is revised in the modified report.</i> <i>ii. The geophysical data has been discussed in the Geophysical exploration in chapter VI.</i> <i>iii. Modified Geological map as suggested has been given in the Plate-I, IA & IB.</i> <i>Comment has been complied.</i>
Description of litho-units (Section- 5.3)		
2	It has been stated that "These rhyolites show pronounced variation in color, texture, fabric and mineralogy, indicating multiple eruptive stages.....", then why it is difficult to discriminate the bands when multiple eruption phases are present? Even if it is not observable in a single small outcrop, but it should be observable at different outcrops and then how it is not mappable? If you can show a outcrop at your map scale, you can definitely show at least few different variants at map (not shown in LSM), if not all outcrops are of same variant.	<i>Complied.</i> <i>The lateral extension of the flow bands have been clubbed as per the color and grain size variation, as suggested in the modified report. Outcrop to outcrop, the color and grain size variation have been clubbed and the dimensions of the different bands have been mentioned in the report and map has been modified accordingly. The sample number of different flows also mentioned in the report. Analytical data also clubbed accordingly.</i>
<u>Dark grey laminated rhyolite</u> (P-26, Annexure-X).		
2a	Do you have any supportive evidences of tectonic stress? If not, remove the words. Did you recorded any structural	<i>Complied.</i>

	deformational features? If yes, please give attitudes in map. Probably, sample ID NAG/PS/14 represent the same sample. It is described as volcano-sedimentary rock. Do you have any evidence of rock fragments in hand specimen or thin section?	<i>The structural features are recorded are emplacement structures only. The same has been updated in the LSM.</i> <i>The “ore microscopy” work has been corrected. Further corrections also attended as suggested in the modified report.</i>
Coarse grained porphyritic rhyolite (P- 27, Annexure-X)		
2b	Probably sample ID NAG/PS/20 represent it. It is stated that about 5% magnetite present and commonly altered to secondary glass. How have you differentiated between primary and secondary glasses in thin section? How can magnetite alter to glass ? Do you indicate rapid quenching of magnetite? In that case what are the evidences for other minerals as the description already stated for prolonged crystallisation period.	<i>Complied.</i> <i>The suggested correction has been attended in the modified report.</i>
Very fine grain / Glassy rhyolite (P-28, Annexure-X)		
2c	It has been stated the rock type is exposed in part of Meghawas block. It is stated that in hand specimen, the rock is glassy to cryptocrystalline without visible mineral grain. The outcrop photos given (Fig- 5.5 A to D) clearly shows presence of some coarse visible minerals. Similarly, microscopic studies of all MEG/PS/.... Series shows presence of quartz and feldspar phenocrysts. These statements are ambiguous.	<i>Complied.</i> <i>The draft has been modified and corrected as suggested in the report.</i>
Structure (Section-5.4)		
	It has been stated that “ Several NW-SE & NE-SW trending fractures & lineaments having NE to SW dips.....” . Can you measure dip of non-fractured lineaments ? What are these linear structures ?	<i>Complied.</i> <i>Discussed the linear nature in the report and mention the available data in the LSM map as suggested in the modified report.</i>

Exploration undertaken (Chapter- VI)		
3	Background (section- 6.1) and objectives (section-6.2) are already given in Sections 2.1 and 2.4.	<i>Complied.</i> <i>Repetition text removed from the not relevant sections.</i>
Remote sensing and satellite imagery study (Section- 6.3)		
4	Three maps are given (PI- VI, VII and VIII) showing Forest / Tree cover, Landuse – Landcover and geomorphological maps (1:50,000). It has been claimed that based on remote sensing & satellite imagery studies, the workers could delineate lithological boundaries, lineaments and possible alteration zones (P-32). However, no maps are presented on these regards. Only NW corner of PI-VIII shows presence of one lineament (Fault) and one structural discontinuity (Minor lineament).	<i>Complied.</i> <i>The available data has been presented in the plate- VI & VII and placed in the relevant section after modification in the report.</i>
Large Scale Geological Mapping (Section – 6.4).		
5a	Although four maps are presented (PI- I, II, 1A, 1B), all are basically the same outcrop map with different titles. It seems that no attempt has been made to prepare a logical interpreted geological map assembling data from outcrops, pits, earlier available maps, remote sensing etc.	<i>Complied.</i> <i>The interpreted geological map has been prepare as per the section 5.3 litho-unites. Along with geological map, outcrop map is also prepared for more control over the ground condition.</i> <i>The field and analysis data have been used for the preparation of the interpreted geological map.</i> <i>Since, the initial blocks have been split in two blocks with big gap in between so that the two more extra plates have been prepared to show these two small sub-blocks.</i>
5b	It has been stated that “variation of lithologies along with the structural elements were systematically recorded and the final	<i>Complied.</i>

	geological map was prepared (Pl- I, P-33). Presented map does not show these. Even, GSI 1:25000 scale map shows structural data.	<i>Rectified as suggested in the 5a in the final modified report.</i>
5c	BRS and pit locations are shown in maps, but without any annotation.	<i>Complied.</i> <i>Annotated The samples in the LSM.</i>
5d	Northern most outcrop of Nagana area is partly outside block boundary.	<i>Complied.</i> <i>Removed the outside boundary from the LSM map.</i>
Pitting (Section – 6.5)		
6	It is not understood on what logic the pit locations were chosen. The pits are done to uncover the top soil for exposing the bedrock/ regolith. Both Meghawas and Nagana areas have more than 80% soil cover. The pits could have been planned for the entire area (may be in wide separation) to bring out a logical interpreted map having more wide petrological and geochemical aspects. Detailed pit logs are also not presented.	<i>Complied.</i> <i>The pit logs have been given in the report.</i> <i>Due to great thickness of soil cover the bedrock were not exposed in the pit and in some pockets only the thickness is allowing the win the sample though pitting so that this type of distribution has been observed.</i>
<u>Geochemical exploration & sampling</u> (Section-6.6)		
7a	From annexure- I, II & III, it has been found that total 11 types of rhyolites were sampled (Rhyolite (Cherty/Glassy), Grey rhyolite, Rhyolite (light maroon) ,..... etc.), while section 5.3 described only 5 type of rhyolites. Probably, workers have collected samples from different parts of the same unit. There are lot of ambiguities in sample description (Annex. I, II, III). For example at section 5.3 only Dark Grey Laminated Rhyolite	<i>Complied.</i> <i>The parity in litho description and collected samples are made in the report.</i> <i>The discrepancy about the pink rhyolite has been addressed.</i>

	has been described, while samples were taken from Grey Rhyolite, Laminated grey rhyolite, Dark grey rhyolite with amygdules (no amygdule described in sec-5.3 for this variety), Light grey porphyritic rhyolite, Rhyolite with flow banding. No Pink rhyolite was described in section 5.3.	
7b	It has been stated that the samples have been collected as per potentiality/ anomaly of the area. For a fine grained rock, how anomaly could be established before petrological/chemical results ?	<i>Complied.</i> <i>The potentiality/anomaly of the area has been defined by the NGCM baseline data. The draft has been included the proper explanation for that.</i>
7c	For major oxide analysis, from sample nos., it has been found 06 nos. of samples were collected from Maroon colored rhyolite and 04 nos. from variants of Dark grey rhyolite, i.e. only two type rhyolites (as per section 5.3) were sampled without considering the other type of rhyolites. This is unfair. Every described rhyolite should have been sampled for major oxides to understand the evolutionary trend of rhyolites, significant for targeting the potential REE zones. For example, Maroon colored rhyolite in general shows ≤ 500 ppm of $\sum \text{REE} + \text{Y} + \text{Sc}$, while Dark grey rhyolites have ≥ 600 ppm of $\sum \text{REE} + \text{Y} + \text{Sc}$, going upto 694.39 ppm in Nagana area, indicating more potentiality of this type of rhyolite.	<i>Complied.</i> <i>The chemical data grouped as per the section 5.3 and prepared the geochemical maps to demarcate the variation in the flows and included in the report as suggested.</i>
7d	As modal calculation is not possible in this fine grained porphyritic rock, it is important to calculate normative minerals (%) to understand the nature of fractionation of the melt.	<i>Complied.</i> <i>All the sample plotted in the QAPF plot to show the discrimination. The enrichment and depletion of the REE content have been discussed in the report.</i> <i>Further, the normative minerals calculation has been incorporated in the geochemical exploration in the report.</i>

7e	Delineation of more evolved variety of rhyolite is important as it is likely to have enhanced Σ REE. This can be done by Differentiation Index (D.I), Peralkaline Index (P.I.) and Alumina Saturation Index (ASI). This is not done in the present report.	<i>Complied.</i> <i>The samples plotted in the Differentiation Index (D.I), Peralkaline Index (P.I.) and Alumina Saturation Index (ASI) and discussed in the geochemical exploration in the report.</i>
7f	Although several trace elements were analysed, no attempt has been made on their interpretation for significance in REE enrichment. Unless it is done, why to analyse these elements?	<i>Complied.</i> <i>The evolutionary signature has been studied to find REE rich rhyolite type of the area.</i>
7g	Normalisation of REE and trace elements are not done, which are essential for this type of report.	<i>Complied.</i> <i>The chondrite normalised REE and primitive mantle normalised trace element data have been studied and included in the report.</i>
Integration of exploration data (Chapter- VII)		
8	I did not find any attempt of integration based on present or earlier studies. What for this chapter is made? No integrated map, irrational comments (ex. Showing partially sedimentation, Σ REE is not economical in these blocks, etc. P- 43).	<i>Complied.</i> <i>The chapter has been recast as per the suggestion and included in the report.</i>
Mineral prospect (Chapter- VIII)		
9a	It has been stated that “ no alteration has been identified “. If this the case, how regoliths are formed with > 200 ppm Σ REE+Y+Sc ? How higher concentration of Fe minerals are formed.	<i>Complied.</i> <i>The outcrop scale alteration has been observed but the regional scale alteration by satellite data is difficult to interpreted. As per the presence of mineral the alteration has been discussed in the report.</i>

9b	It has been stated that the rocks are in the form of ring like plugs—How it is documented?	<i>Complied.</i> <i>The outcrop pattern is showing the ring like structure. This observation has been discussed in the modified report.</i>
9c	It has been stated that “In view of low concentration of Σ REE the exploration has not been taken”. How is this type of statement given? Could the workers sample the entire block areas? Based in some scanty exposers (8% to 10%) and pit data, this statement is pre-matured. The area has not been explored properly with very poor planning of pits. In fact, the low grade REE deposit have large tonnage with TREO (Total Rare Earth Oxides) ranging from 0.05% to 0.5%. The workers have already reported no of samples with >500 ppm Σ REE+Y+Sc. Potentiality depends not only on REE%, but its volume also.	<i>Complied.</i> <i>It has recast as per the suggestions. The analysis of the samples has been discussed as per the geochemical analysis of the rhyolite samples. The trace element geochemistry also discussed.</i>
Conclusion and recommendation (Chapter- XI)		
10	Conclusion and recommendation in its present form is not acceptable.	<i>Complied.</i> <i>After attending all the modifications, corrections and suggestions the conclusion, accordingly modified.</i>

Plate I

*LARGE SCALE MAP ON 1:12,500 SCALE OF
MEGHAWAS-NAGANA BLOCK, BARMER DIST,
RAJASTHAN*

72°28'0"E

72°29'0"E

**Large Scale Geological Map (1: 12,500) of Meghwas Area,
Barmer District, Rajasthan covering parts of 45 B/08**



A1

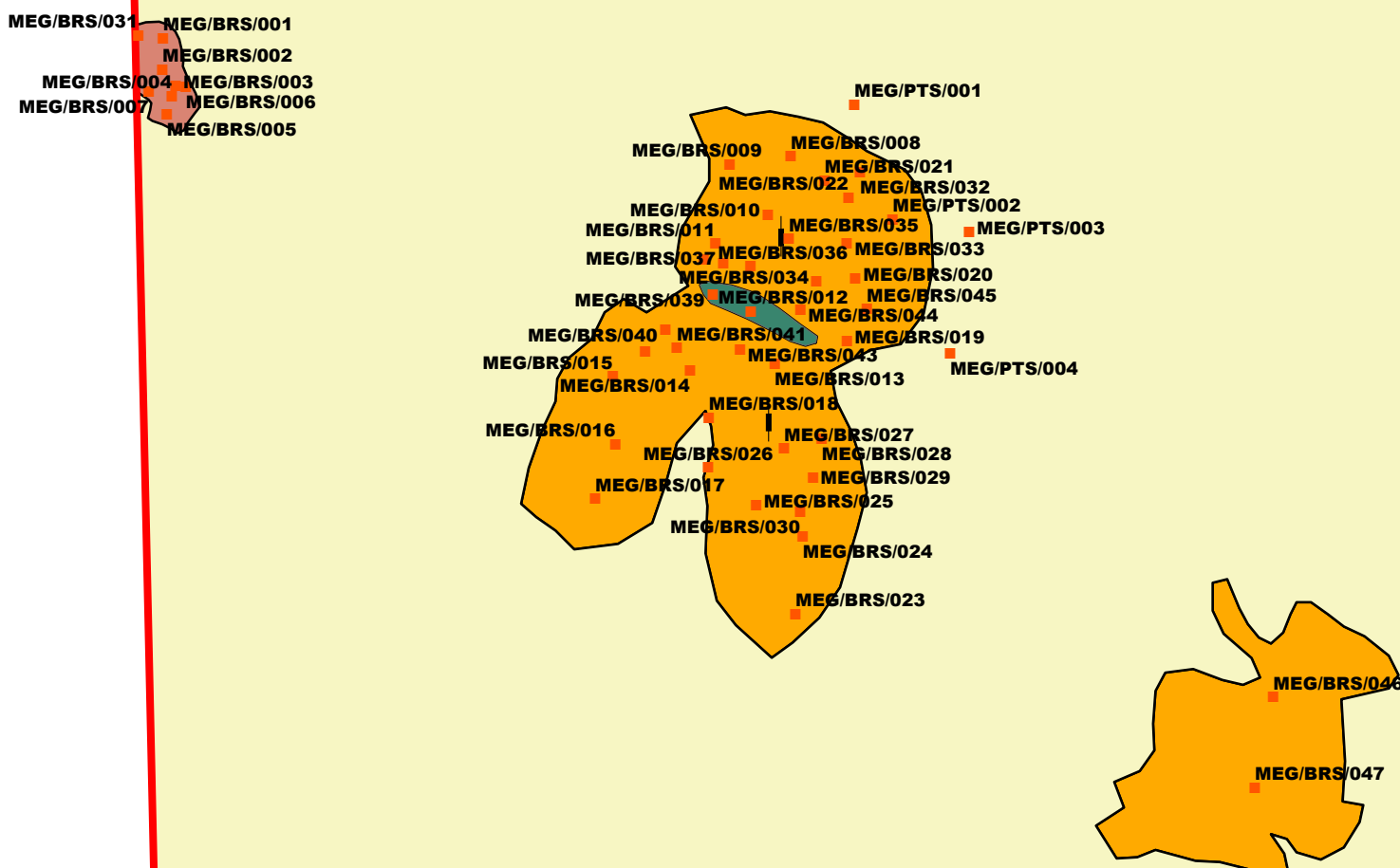
A2

26°10'0"N

26°10'0"N

26°9'0"N

26°9'0"N



Legend

- Cardinal Point
- Very Fine grained Rhyolite
- Course grained Porphyritic Rhyolite
- Dark Reddish Brown / Maroon Rhyolite
- Soil
- | Joint Plane

1:12,500

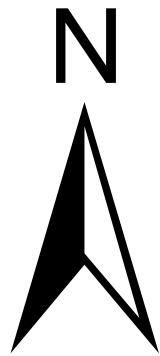
0 0.25 0.5 1 Km

72°28'0"E

72°29'0"E

72°32'0"E 72°34'0"E

Large Scale Geological Map (1: 12,500) of Nagana Area,
Barmer District, Rajasthan
covering parts of 45 B/12



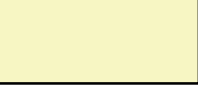
26°10'0"N

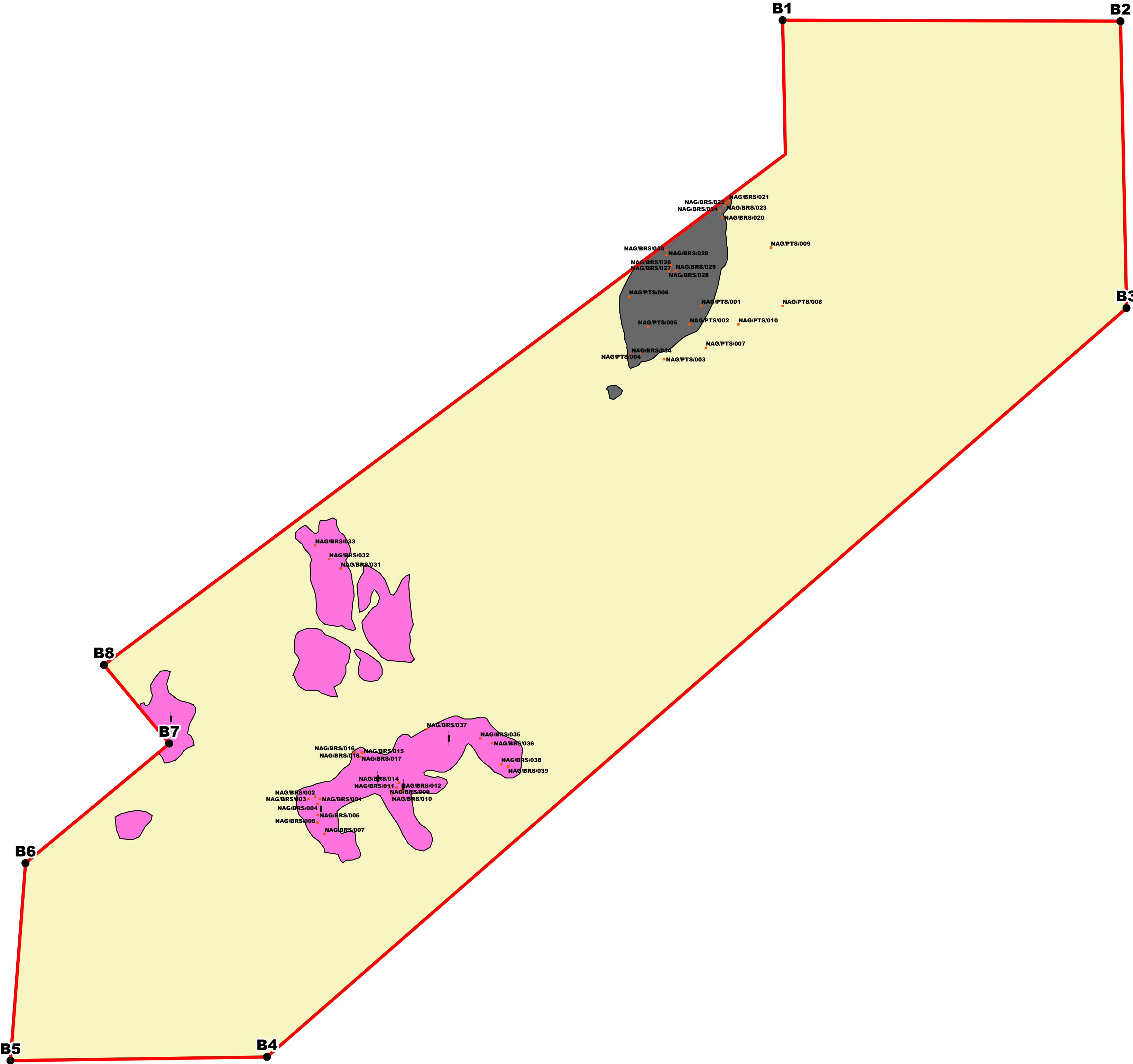
26°10'0"N

26°8'0"N

26°8'0"N

Legend

- Cardinal Point
-  Nagana Area
-  Dark Grey Porphyritic Rhyolite
-  Dark Grey Rhyolite
-  Soil
-  Joint Plane



1:12,500

0 0.75 1.5 3 Km

72°32'0"E

72°34'0"E

Plate II

*OUTCROP MAP ON 1:12,500 SCALE OF MEGHAWAS-
NAGANA BLOCK, BARMER DIST, RAJASTHAN*

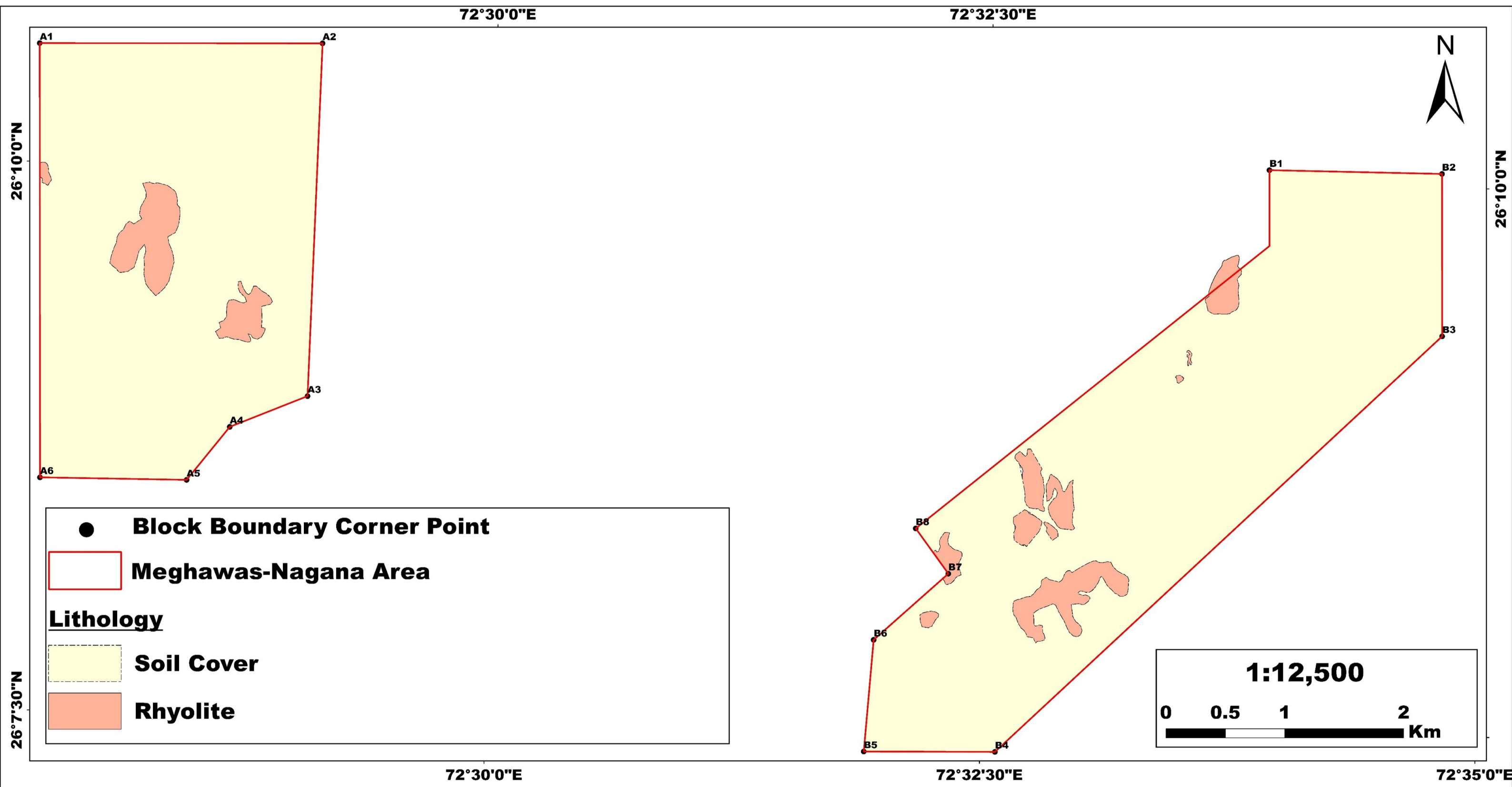


Plate III - V

*EXISTING AERO-GEOPHYSICAL DATASET MAPS OF
MEGHAWAS-NAGANA BLOCK, BARMER DIST,
RAJASTHAN*

72°28'0"E

72°32'0"E

72°36'0"E

Plate : III



FIRST VERTICAL DERIVATIVE OF THE POLE-REDUCED MAGNETIC FIELD MAP OF

PROPOSED BLOCKS (G4) NEAR MEGHAWAS-NAGANA AREA ON SOI TOPOSHEET

FOR "REE & RM MINERALIZATION"

Toposheet No. : 45B/8 & 45B/12 Area of Blocks : Block - A : 8.00
Sq.Km. & Block - B : 10.00 Sq.Km.

26°12'0"N

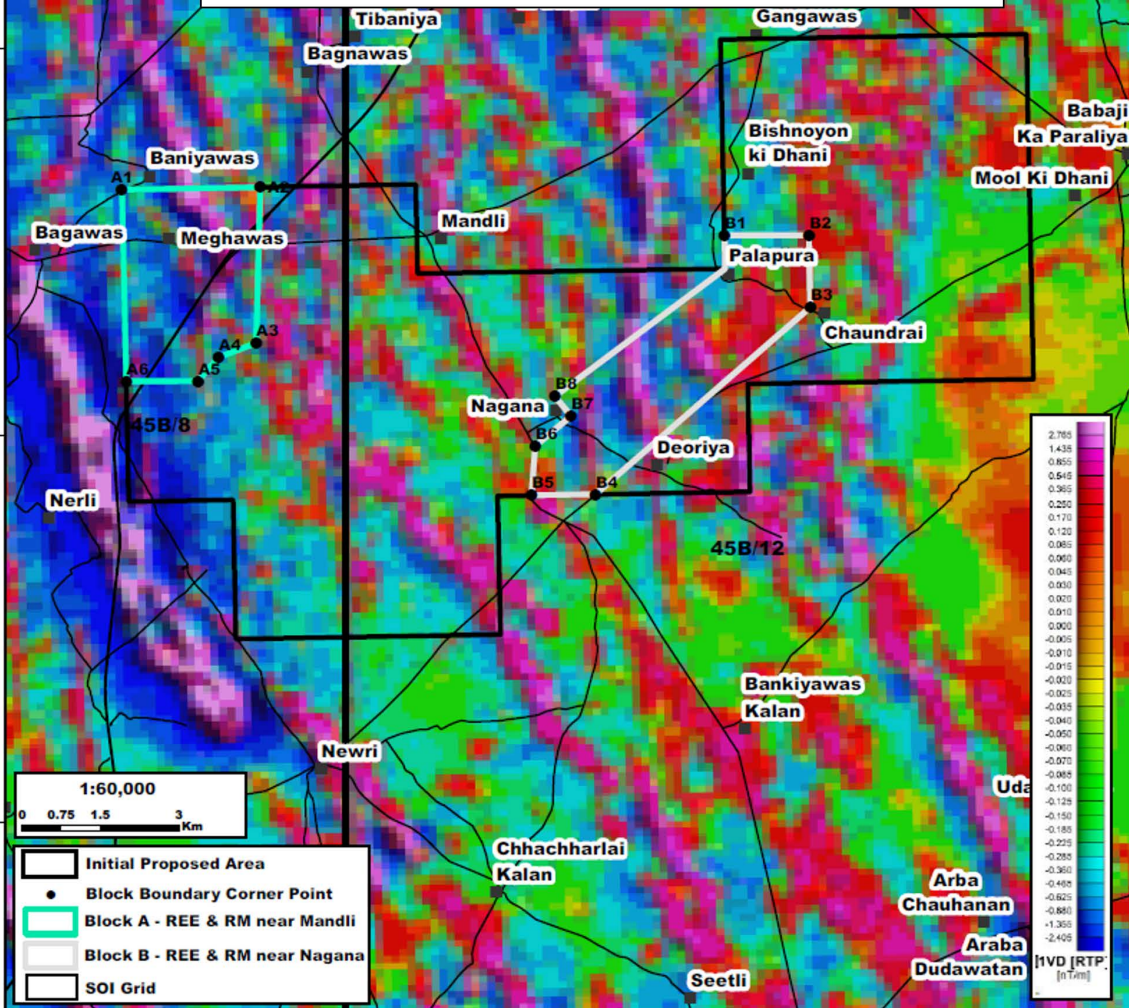
26°8'0"N

26°4'0"N

26°12'0"N

26°8'0"N

26°4'0"N



72°28'0"E

72°32'0"E

72°36'0"E

72°28'0"E

72°32'0"E

72°36'0"E

Plate : IV



POLE-REDUCED MAGNETIC FIELD MAP OF

PROPOSED BLOCKS (G4) NEAR MEGHAWAS-NAGANA AREA ON SOI TOPOSHEET

FOR "REE & RM MINERALIZATION"

Toposheet No. : 45B/8 & 45B/12 Area of Blocks : Block - A : 8.00

Sq.Km. & Block - B : 10.00 Sq.Km.

26°12'0"N

26°8'0"N

26°4'0"N

26°12'0"N

26°8'0"N

26°4'0"N



Dhani

Korna

Gangawas

ki Dhani

Tibaniya

Bagnawas

Knera

Babaji

Ka Paraliya

Mool Ki Dhani

Bishnoyon

ki Dhani

B1

B2

Palapura

Chaundrai

45B/12

Nagana

Deoriya

Bankiyawas

Kalan

Uda Ka Bas

Seetli

Chhachharlai

Kalan

Newri

Bagawas

Baniyawas

Meghawas

Nerli

45B/8

A1

A2

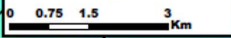
A3

A4

A5

A6

1:60,000



- Initial Proposed Area
- Block Boundary Corner Point
- Block A - REE & RM near Mandli
- Block B - REE & RM near Nagana
- SOI Grid

RTP (nT)

Value

High : 20678

Low : -845

72°28'0"E

72°32'0"E

72°36'0"E

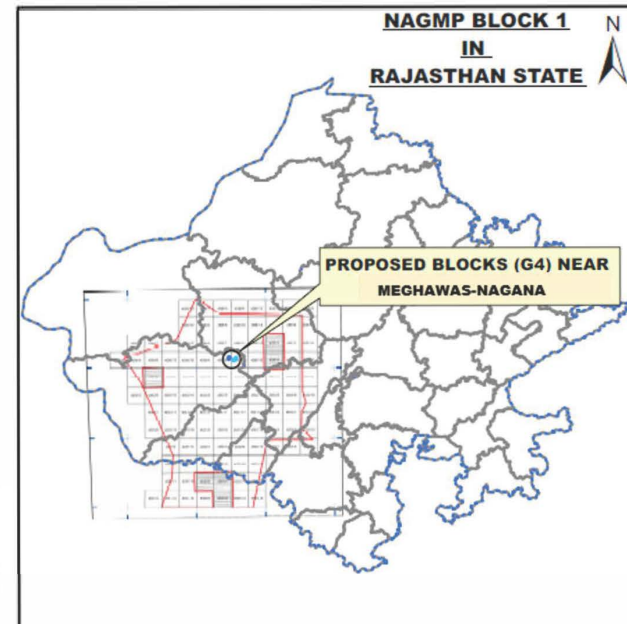
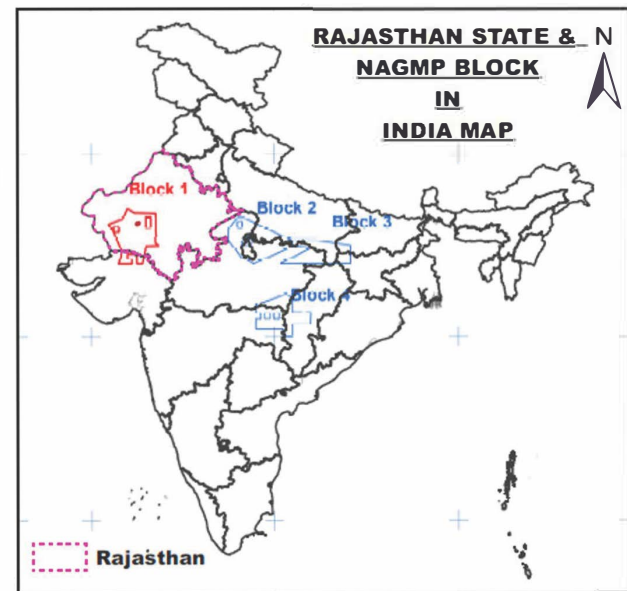
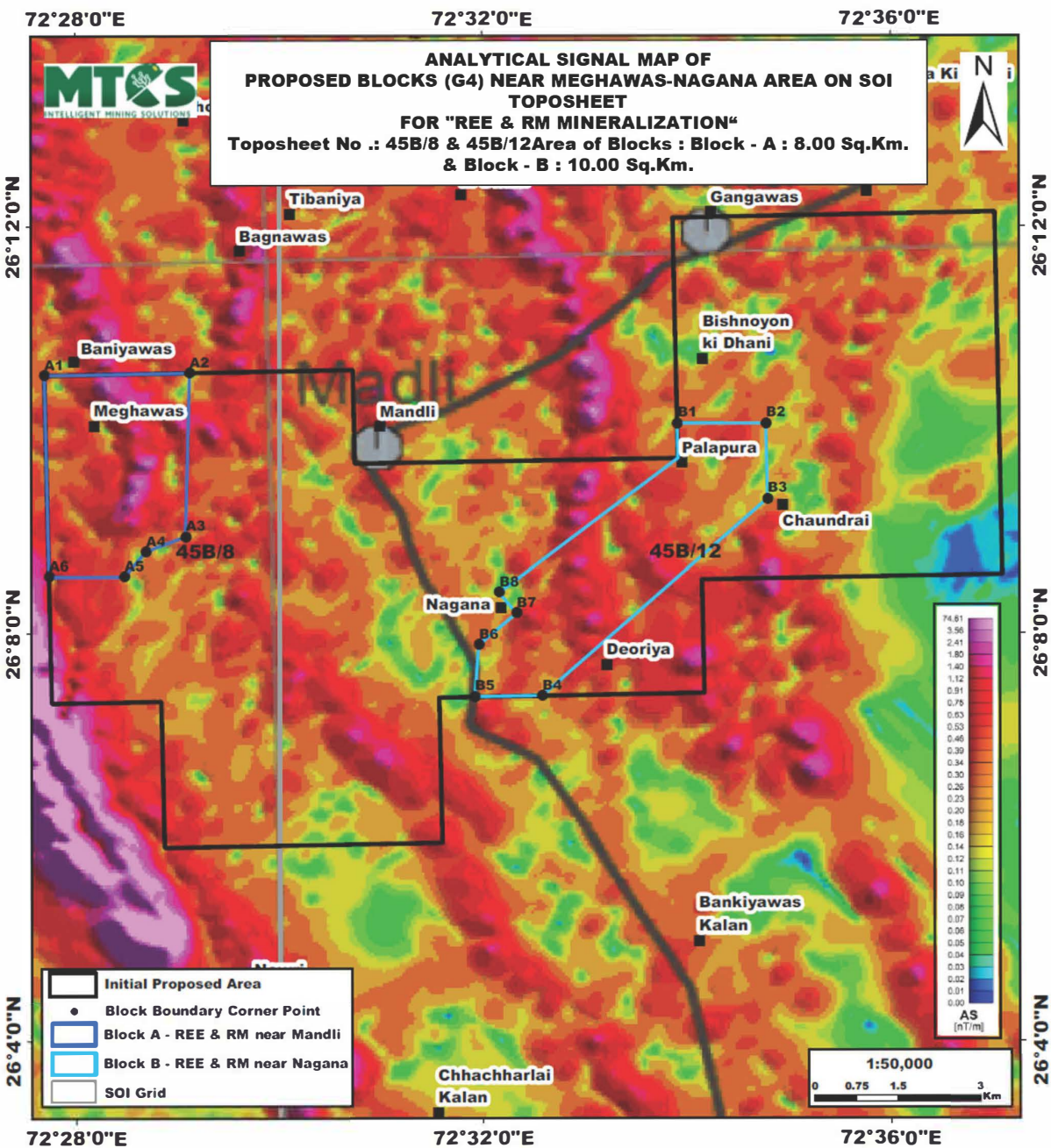


Plate VI-VIII

*REMOTE SENSING STUDY MAPS OF MEGHAWAS-
NAGANA BLOCK, BARMER DIST, RAJASTHAN*

72°28'0"E

72°32'0"E

72°36'0"E



FOREST/TREE COVER MAP OF PROPOSED BLOCKS (G4) NEAR MEGHAWAS-NAGANA AREA ON SOI TOPOSHEET

FOR "REE & RM MINERALIZATION"
Toposheet No. : 45B/8 & 45B/12 Area of Blocks : Block - A : 8.00 Sq.Km.
& Block - B : 10.00 Sq.Km.



26°12'0"N

26°12'0"N

26°8'0"N

26°8'0"N

26°4'0"N

26°4'0"N

72°28'0"E

72°32'0"E

72°36'0"E

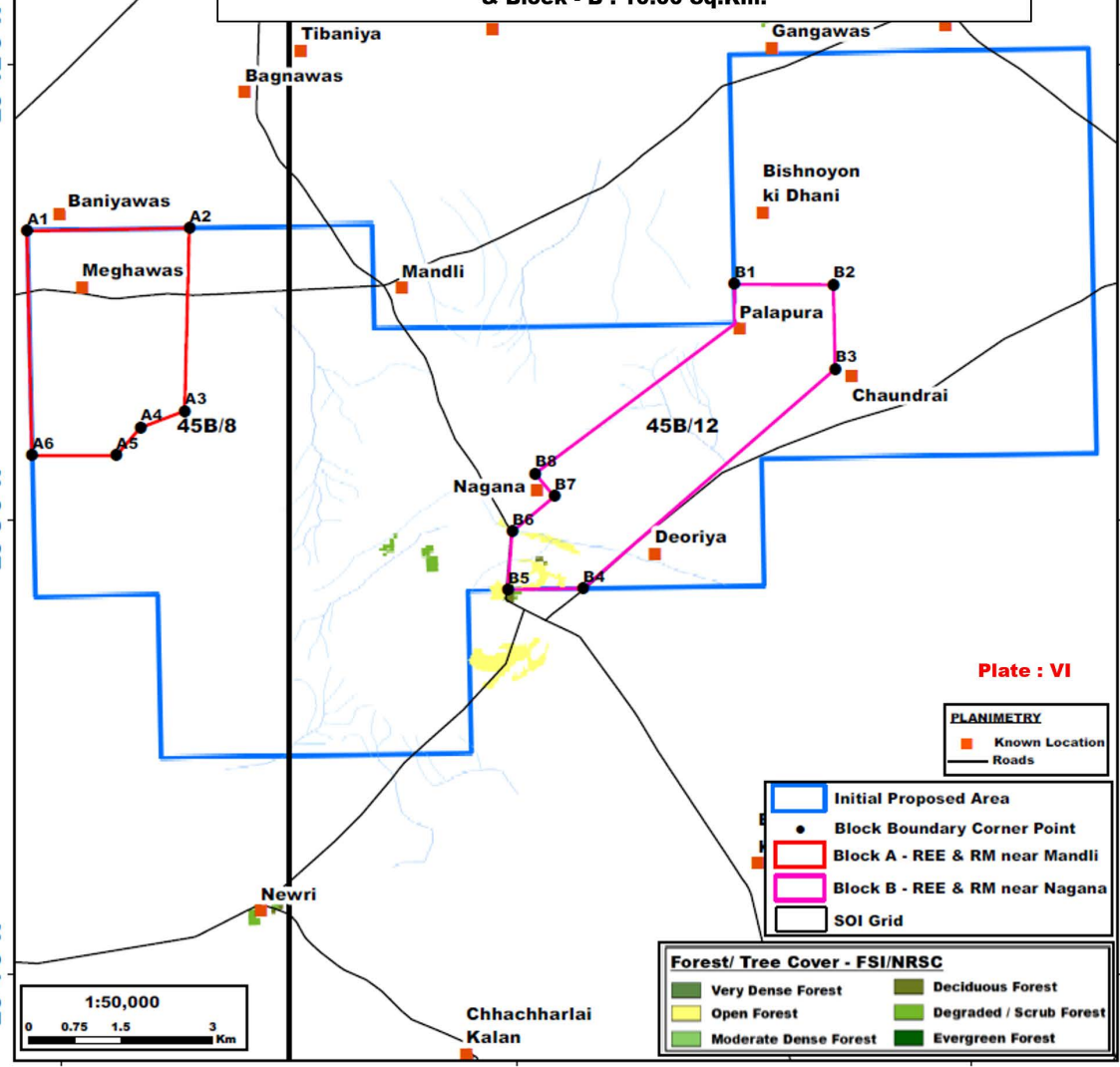


Plate : VI

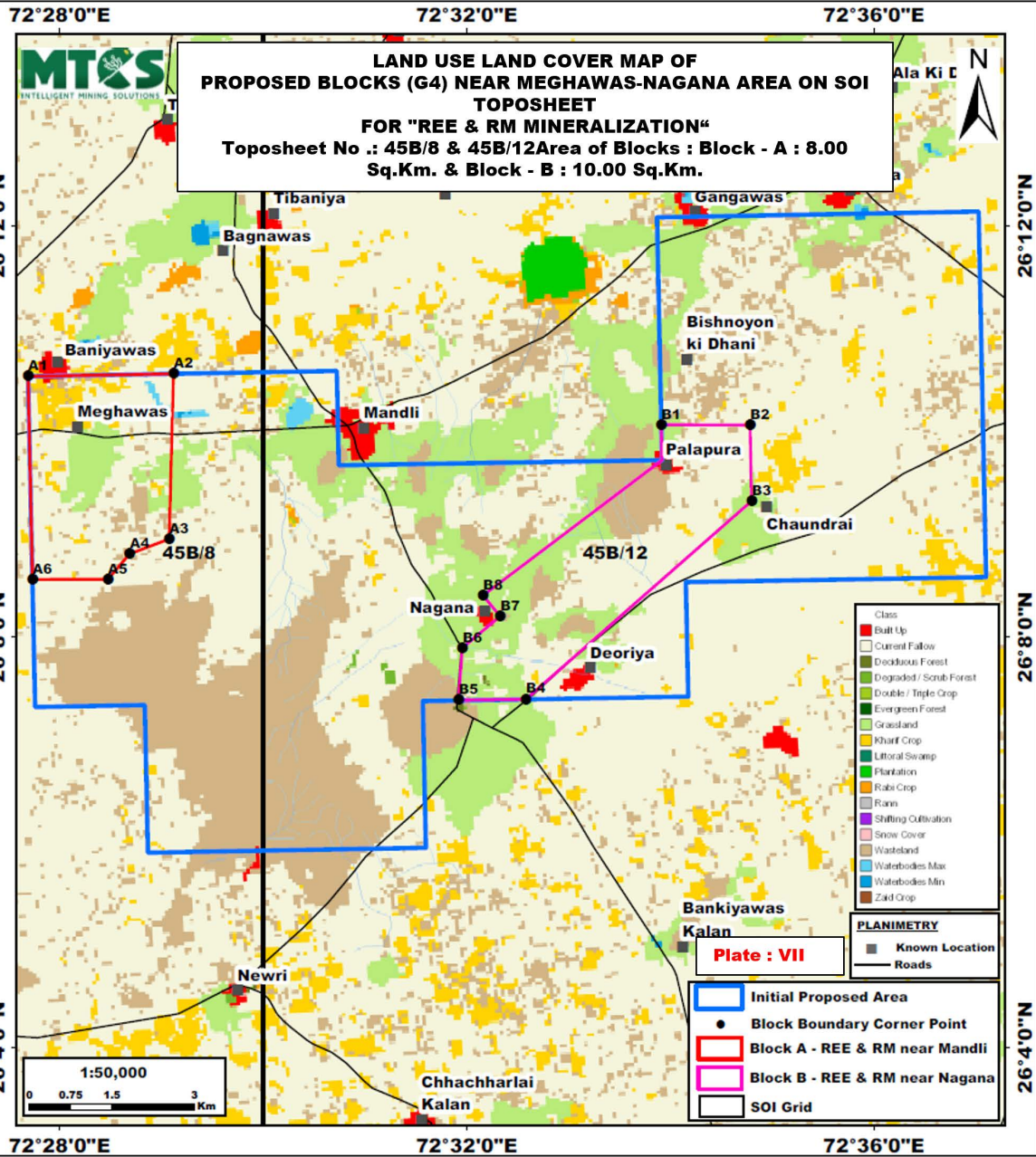
PLANIMETRY

- Known Location
- Roads

- Initial Proposed Area
- Block Boundary Corner Point
- Block A - REE & RM near Mandli
- Block B - REE & RM near Nagana
- SOI Grid

Forest/ Tree Cover - FSI/NRSC

- Very Dense Forest
- Open Forest
- Moderate Dense Forest
- Deciduous Forest
- Degraded / Scrub Forest
- Evergreen Forest



72°28'0"E

72°32'0"E

72°36'0"E



**REGIONAL GEOMORPHOLOGICAL MAP OF
PROPOSED BLOCKS (G4) NEAR MEGHAWAS-NAGANA AREA ON SOI
TOPOSHEET**

FOR "REE & RM MINERALIZATION"
Toposheet No. : 45B/8 & 45B/12 Area of Blocks : Block - A : 8.00 Sq.Km.
& Block - B : 10.00 Sq.Km.



26°12'0"N

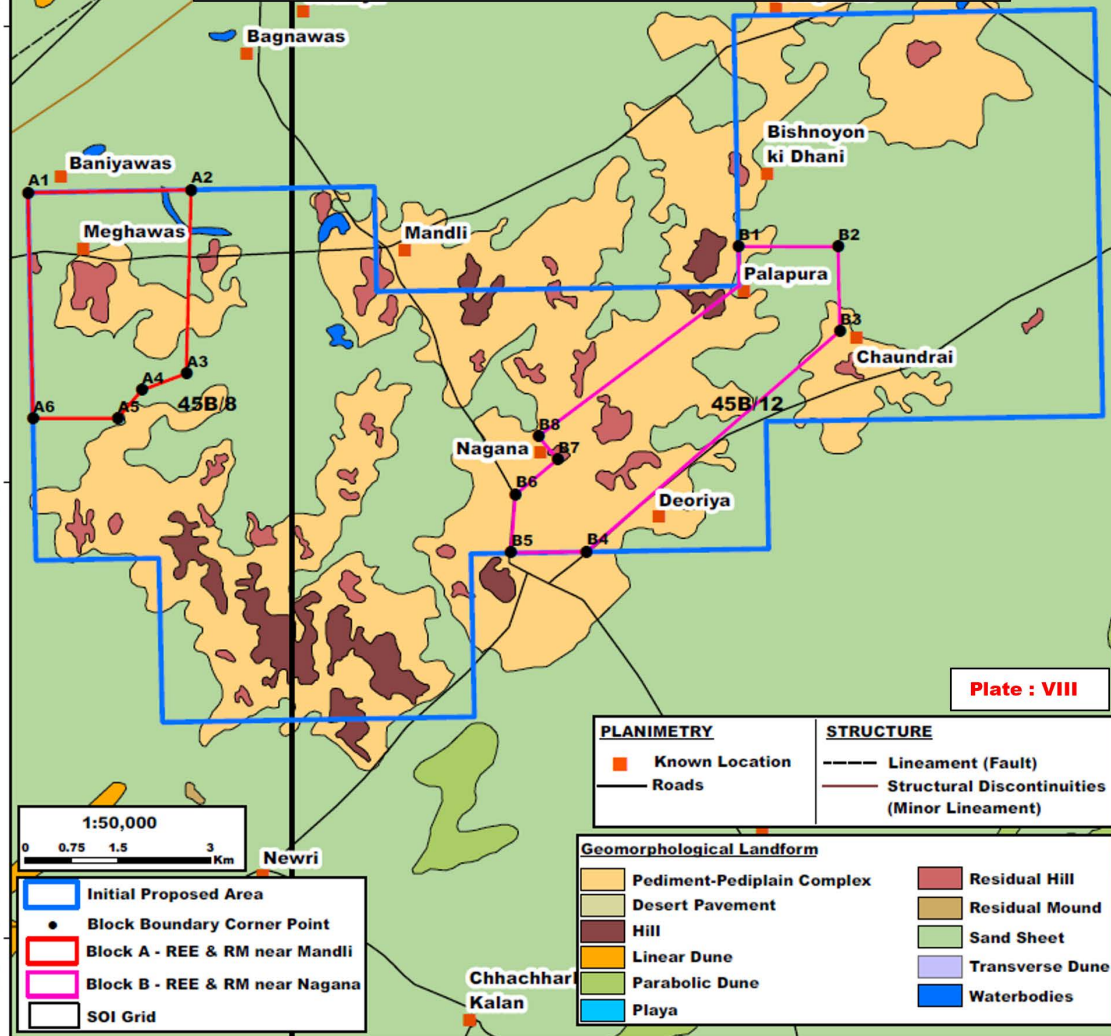
26°12'0"N

26°8'0"N

26°8'0"N

26°4'0"N

26°4'0"N



72°28'0"E

72°32'0"E

72°36'0"E

Annexure I - III

LOCATION DETAILS OF BED ROCK SAMPLES & PITS OF MEGHAWAS-NAGANA BLOCK, BARMER DIST, RAJASTHAN

Bedrock Sample Details of Meghawas Area (TS No. 45B/08), Barmer district of Rajasthan

S. No.	Sample Id	Latitude	Longitude	Elevation (m)	Sample Type	Lithology	Land use	Mineralisation	Contamination	Landscape/ Site/ Photo	Depth of sample	Geology/ Formation	Area/ District/State	Date of Collection of Sample
1	MEG/BRS/001	26.166	72.462	167.0	Bed Rock Sample	Rhyolite (Very Fine Grained)	Barren	Irregular shaped	No	Undulating	Surface	Kailana felsic volcanics	Meghawas, Barmer dist, Rajasthan	09.10.2025
2	MEG/BRS/002	26.166	72.462	175.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	09.10.2025
3	MEG/BRS/003	26.166	72.462	188.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	09.10.2025
4	MEG/BRS/004	26.165	72.462	181.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	09.10.2025
5	MEG/BRS/005	26.165	72.462	180.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	09.10.2025
6	MEG/BRS/006	26.166	72.463	178.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	09.10.2025
7	MEG/BRS/007	26.166	72.462	177.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	09.10.2025
8	MEG/BRS/008	26.164	72.472	158.0	-do-	Rhyolite (Maroon colored)	-do-	-do-	No	-do-	-do-	-do-	-do-	09.10.2025
9	MEG/BRS/009	26.164	72.471	165.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	09.10.2025
10	MEG/BRS/010	26.164	72.472	176.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	09.10.2025
11	MEG/BRS/011	26.163	72.471	176.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	10.10.2025
12	MEG/BRS/012	26.162	72.471	196.0	-do-	Rhyolite (Coarse Grained Porphyritic)	-do-	-do-	No	-do-	-do-	-do-	-do-	10.10.2025
13	MEG/BRS/013	26.161	72.472	186.0	-do-	Rhyolite (Maroon colored)	-do-	-do-	No	-do-	-do-	-do-	-do-	10.10.2025
14	MEG/BRS/014	26.161	72.470	185.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	10.10.2025
15	MEG/BRS/015	26.161	72.469	181.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	10.10.2025
16	MEG/BRS/016	26.160	72.469	177.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	10.10.2025
17	MEG/BRS/017	26.159	72.469	187.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	10.10.2025
18	MEG/BRS/018	26.160	72.471	200.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	10.10.2025
19	MEG/BRS/019	26.162	72.473	196.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	10.10.2025
20	MEG/BRS/020	26.163	72.473	173.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	10.10.2025
21	MEG/BRS/021	26.164	72.473	175.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	11.10.2025
22	MEG/BRS/022	26.164	72.473	178.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	11.10.2025
23	MEG/BRS/023	26.157	72.472	180.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	11.10.2025
24	MEG/BRS/024	26.159	72.472	182.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	11.10.2025
25	MEG/BRS/025	26.159	72.471	186.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	11.10.2025
26	MEG/BRS/026	26.160	72.471	185.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	11.10.2025
27	MEG/BRS/027	26.160	72.472	188.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	11.10.2025
28	MEG/BRS/028	26.160	72.472	187.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	11.10.2025
29	MEG/BRS/029	26.159	72.472	189.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	11.10.2025
30	MEG/BRS/030	26.159	72.472	189.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	14.10.2025
31	MEG/BRS/031	26.166	72.462	168.0	-do-	Rhyolite (Very Fine Grained)	-do-	-do-	No	-do-	-do-	-do-	-do-	14.10.2025
32	MEG/BRS/032	26.164	72.473	167.0	-do-	Rhyolite (Maroon colored)	-do-	-do-	No	-do-	-do-	-do-	-do-	14.10.2025
33	MEG/BRS/033	26.163	72.473	176.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	28.10.2025
34	MEG/BRS/034	26.163	72.472	182.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	28.10.2025
35	MEG/BRS/035	26.163	72.472	184.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	28.10.2025
36	MEG/BRS/036	26.163	72.471	110.7	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	28.10.2025
37	MEG/BRS/037	26.163	72.471	173.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	28.10.2025
38	MEG/BRS/038	26.163	72.471	177.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	29.10.2025
39	MEG/BRS/039	26.162	72.471	180.0	-do-	Rhyolite (Coarse Grained Porphyritic)	-do-	-do-	No	-do-	-do-	-do-	-do-	29.10.2025
40	MEG/BRS/040	26.162	72.470	180.0	-do-	Rhyolite (Maroon colored)	-do-	-do-	No	-do-	-do-	-do-	-do-	29.10.2025
41	MEG/BRS/041	26.161	72.470	182.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	29.10.2025
42	MEG/BRS/042	26.161	72.470	165.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	29.10.2025
43	MEG/BRS/043	26.161	72.471	168.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	16.11.2025
44	MEG/BRS/044	26.162	72.472	173.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	16.11.2025
45	MEG/BRS/045	26.162	72.473	173.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	17.11.2025
46	MEG/BRS/046	26.156	72.480	175.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	17.11.2025
47	MEG/BRS/047	26.155	72.479	175.0	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	17.11.2025

Bedrock Sample Details of Nagana Area (TS No. 45B/12), Barmer district of Rajasthan

S. No.	Sample Id	Latitude	Longitude	Elevation (m)	Sample Type	Lithology	Land use	Mineralisation	Contamination	Landscape/ Site/ Photo	Depth of sample	Geology/ Formation	Area/ District/State	Date of Collection of Sample
1	NAG/BRS/001	26.134	72.545	178	Bed Rock Sample	Rhyolite (Dark Grey)	Barren	Irregular shaped	No	Rugged	Surface	Kailana felsic volcanics	Nagana, Barmer dist, Rajasthan	12.10.2025
2	NAG/BRS/002	26.134	72.545	187	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	12.10.2025
3	NAG/BRS/003	26.134	72.545	190	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	12.10.2025
4	NAG/BRS/004	26.134	72.545	195	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	12.10.2025
5	NAG/BRS/005	26.134	72.545	199	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	12.10.2025
6	NAG/BRS/006	26.133	72.545	199	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	12.10.2025
7	NAG/BRS/007	26.133	72.546	198	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	12.10.2025
8	NAG/BRS/008	26.135	72.548	183	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	12.10.2025
9	NAG/BRS/009	26.135	72.548	189	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	12.10.2025
10	NAG/BRS/010	26.135	72.548	193	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	12.10.2025
11	NAG/BRS/011	26.135	72.549	189	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	12.10.2025
12	NAG/BRS/012	26.135	72.549	194	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	13.10.2025
13	NAG/BRS/013	26.135	72.549	191	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	13.10.2025
14	NAG/BRS/014	26.135	72.549	196	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	13.10.2025
15	NAG/BRS/015	26.136	72.547	199	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	13.10.2025
16	NAG/BRS/016	26.136	72.547	183	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	13.10.2025
17	NAG/BRS/017	26.136	72.547	187	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	13.10.2025
18	NAG/BRS/018	26.136	72.547	190	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	13.10.2025
19	NAG/BRS/019	26.136	72.547	191	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	13.10.2025
20	NAG/BRS/020	26.159	72.563	166	-do-	Rhyolite (Dark Grey Porphyritic)	-do-	-do-	No	-do-	-do-	-do-	-do-	13.10.2025
21	NAG/BRS/021	26.160	72.563	184	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	13.10.2025
22	NAG/BRS/022	26.160	72.563	195	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	15.10.2025
23	NAG/BRS/023	26.160	72.563	214	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	15.10.2025
24	NAG/BRS/024	26.160	72.563	200	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	15.10.2025
25	NAG/BRS/025	26.157	72.561	199	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	16.10.2025
26	NAG/BRS/026	26.157	72.560	201	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	16.10.2025
27	NAG/BRS/027	26.157	72.560	209	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	16.10.2025
28	NAG/BRS/028	26.157	72.560	205	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	16.10.2025
29	NAG/BRS/029	26.158	72.560	208	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	29.10.2025
30	NAG/BRS/030	26.158	72.560	226	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	29.10.2025
31	NAG/BRS/031	26.144	72.546	189	-do-	Rhyolite (Dark Grey)	-do-	-do-	No	-do-	-do-	-do-	-do-	30.10.2025
32	NAG/BRS/032	26.145	72.546	175	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	30.10.2025
33	NAG/BRS/033	26.145	72.545	180	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	30.10.2025
34	NAG/BRS/034	26.153	72.559	188	-do-	Rhyolite (Dark Grey Porphyritic)	-do-	-do-	No	-do-	-do-	-do-	-do-	31.10.2025
35	NAG/BRS/035	26.137	72.552	170	-do-	Rhyolite (Dark Grey)	-do-	-do-	No	-do-	-do-	-do-	-do-	23.11.2025
36	NAG/BRS/036	26.137	72.553	165	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	23.11.2025
37	NAG/BRS/037	26.137	72.550	175	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	23.11.2025
38	NAG/BRS/038	26.136	72.553	160	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	24.11.2025
39	NAG/BRS/039	26.136	72.553	169	-do-	-do-	-do-	-do-	No	-do-	-do-	-do-	-do-	24.11.2025

Pitting Details of Meghawas-Nagana Area, Barmer district of Rajasthan

Sl. No.	Pit Number	Latitude	Longitude	Elevation (m)	Land use	Landscape/ Site/ Photo	Depth of Pit (m)	Excavation (cum)	Area/ District/State	Date of Pitting	Remarks
1	MEG/PTS/001	26.1653	72.473	159.82	Barren	Plain	2.00	2.00	Meghawas, Barmer dist, Rajasthan	14.10.2025	No bed rock encountered upto 2m, only soil/regolith
2	MEG/PTS/002	26.1635	72.4736	163.93	-do-	-do-	0.70	0.70	-do-	14.10.2025	Maroon Rhyolite encountered at 0.70m depth
3	MEG/PTS/003	26.1633	72.4748	161.43	-do-	-do-	2.00	2.00	-do-	14.10.2025	No bed rock encountered upto 2m, only soil/regolith
4	MEG/PTS/004	26.1614	72.4745	168.49	-do-	-do-	2.00	2.00	-do-	14.10.2025	-do-
5	NAG/PTS/001	26.1555	72.5617	182.06	-do-	-do-	1.70	1.70	Nagana, Barmer dist, Rajasthan	15.10.2025	Dark Grey Porphyritic Rhyolite encountered at 1.70m depth
6	NAG/PTS/002	26.1547	72.5612	176.79	-do-	-do-	1.60	1.60	-do-	15.10.2025	Dark Grey Porphyritic Rhyolite encountered at 1.60m depth
7	NAG/PTS/003	26.1532	72.5601	174.08	-do-	-do-	2.00	2.00	-do-	15.10.2025	No bed rock encountered upto 2m, only soil/regolith
8	NAG/PTS/004	26.1535	72.5591	180.35	-do-	-do-	1.25	1.25	-do-	15.10.2025	Dark Grey Porphyritic Rhyolite encountered at 1.25m depth
9	NAG/PTS/005	26.1546	72.5594	176.72	-do-	-do-	2.00	2.00	-do-	15.10.2025	Dark Grey Porphyritic Rhyolite encountered at 2.00m depth
10	NAG/PTS/006	26.1559	72.5586	180.74	-do-	-do-	1.25	1.25	-do-	16.10.2025	Dark Grey Porphyritic Rhyolite encountered at 1.25m depth
11	NAG/PTS/007	26.1537	72.5619	176.31	-do-	-do-	2.00	2.00	-do-	16.10.2025	No bed rock encountered upto 2m, only soil/regolith
12	NAG/PTS/008	26.1555	72.5652	178.88	-do-	-do-	2.00	2.00	-do-	16.10.2025	-do-
13	NAG/PTS/009	26.1580	72.5647	174.21	-do-	-do-	2.00	2.00	-do-	16.10.2025	-do-
14	NAG/PTS/010	26.1547	72.5633	175.63	-do-	-do-	2.00	2.00	-do-	16.10.2025	-do-

Annexure IV - VII

ANALYSIS RESULTS OF BED ROCK SAMPLES OF MEGHAWAS-NAGANA BLOCK, BARMER DIST, RAJASTHAN

Analytical Results of >REE+Y+Sc for Bedrock Samples of Meghawasa Area (TS No. 45B/08), Barmer district of Rajasthan

SI No	Sample ID	Latitude	Longitude	La ppm	Ce ppm	Pr ppm	Nd ppm	Sm ppm	Eu ppm	Gd ppm	Tb ppm	Dy ppm	Ho ppm	Er ppm	Tm ppm	Yb ppm	Lu ppm	Y ppm	Sc ppm	ΣREE+Y+Sc ppm
1	MEG/BRS/001	26.1663	72.4622	52.89	161.76	11.11	66.14	17.47	0.46	21.40	0.22	17.46	3.65	10.19	<0.1	7.79	0.39	100.42	1.03	472.38
2	MEG/BRS/002	26.1658	72.4622	42.94	168.93	8.96	54.40	14.84	0.46	17.99	0.21	16.74	0.27	9.73	<0.1	7.96	0.39	100.46	0.99	445.26
3	MEG/BRS/003	26.1656	72.4624	53.01	168.81	10.58	63.76	16.41	0.43	12.67	0.21	17.85	3.51	10.64	<0.1	8.76	0.43	103.66	0.84	471.58
4	MEG/BRS/004	26.1654	72.4623	51.73	183.48	9.97	60.36	16.43	0.49	19.67	0.21	18.45	3.07	10.82	0.14	8.72	0.42	112.61	0.90	497.47
5	MEG/BRS/005	26.1652	72.4622	38.66	174.55	8.25	57.10	16.55	0.46	20.37	0.22	19.28	3.49	11.97	<0.1	9.49	0.45	125.52	0.88	487.24
6	MEG/BRS/006	26.1656	72.4625	48.38	151.00	9.34	56.94	15.81	0.42	15.25	0.22	18.72	3.45	10.99	<0.1	9.03	0.44	115.99	0.89	456.86
7	MEG/BRS/007	26.1655	72.4620	41.28	182.49	8.47	55.56	16.70	0.50	17.92	0.22	19.84	3.12	11.62	<0.1	9.72	0.45	127.29	0.88	496.07
8	MEG/BRS/008	26.1645	72.4720	94.27	255.23	16.05	95.21	22.17	0.44	<0.1	0.44	16.97	2.18	8.52	0.39	7.09	0.35	94.21	1.01	614.52
9	MEG/BRS/009	26.1644	72.4710	79.75	225.64	14.32	82.37	18.53	0.38	15.61	0.39	14.13	2.00	6.05	<0.1	5.44	0.28	73.63	0.95	539.47
10	MEG/BRS/010	26.1636	72.4716	85.45	214.70	15.19	86.62	18.45	0.34	15.54	0.35	13.26	2.68	6.27	<0.1	5.32	0.28	70.70	1.00	536.15
11	MEG/BRS/011	26.1631	72.4708	57.45	284.89	10.23	64.45	15.03	0.39	19.65	0.41	16.77	2.84	8.53	<0.1	7.54	0.38	112.04	0.95	601.55
12	MEG/BRS/012	26.1621	72.4714	48.37	154.46	13.86	70.70	16.91	2.16	18.06	0.67	18.04	3.34	10.68	<0.1	9.16	0.54	113.20	6.30	486.46
13	MEG/BRS/013	26.1612	72.4718	86.60	215.03	13.92	84.95	17.88	0.36	14.44	0.35	12.94	2.32	6.93	<0.1	5.57	0.29	71.79	0.99	534.36
14	MEG/BRS/014	26.1611	72.4704	83.85	211.60	13.92	85.10	18.59	0.30	14.74	0.36	12.33	<0.1	5.94	<0.1	4.84	0.26	63.31	0.92	516.06
15	MEG/BRS/015	26.1610	72.4692	66.86	178.68	12.18	72.39	16.06	0.32	12.12	0.34	12.46	2.64	7.14	<0.1	6.17	0.32	69.88	0.92	458.48
16	MEG/BRS/016	26.1600	72.4693	84.20	182.09	14.32	81.91	17.58	0.35	13.83	0.35	12.85	<0.1	6.26	<0.1	5.60	0.29	70.31	0.96	490.90
17	MEG/BRS/017	26.1591	72.4689	83.36	219.04	14.65	83.26	18.00	0.32	14.61	0.40	13.95	2.87	5.79	<0.1	5.87	0.30	74.21	0.94	537.58
18	MEG/BRS/018	26.1604	72.4707	96.77	229.16	16.13	93.85	20.14	0.29	16.54	0.35	13.15	2.62	6.40	<0.1	5.35	0.28	64.29	0.99	566.31
19	MEG/BRS/019	26.1616	72.4729	91.52	209.68	15.05	90.07	19.97	0.33	17.27	0.38	13.61	2.75	5.86	0.21	5.18	0.28	72.36	0.97	545.48
20	MEG/BRS/020	26.1626	72.4730	76.62	209.53	13.53	78.90	17.70	0.34	16.50	0.38	13.29	2.37	6.80	<0.1	5.21	0.27	70.74	1.01	513.19
21	MEG/BRS/021	26.1641	72.4725	84.89	216.75	14.33	85.65	18.25	0.33	15.24	0.38	13.56	2.52	7.34	0.11	5.54	0.29	73.39	0.96	539.52
22	MEG/BRS/022	26.1638	72.4729	69.46	208.64	12.25	71.82	15.38	0.30	13.75	0.31	12.39	2.72	6.22	<0.1	5.28	0.27	66.50	0.97	486.26
23	MEG/BRS/023	26.1573	72.4721	82.29	192.71	13.73	82.76	18.37	0.38	15.18	0.36	12.41	2.33	5.42	<0.1	5.19	0.28	61.86	0.91	494.17
24	MEG/BRS/024	26.1585	72.4722	83.87	202.83	14.42	84.78	18.99	0.39	16.39	0.38	13.74	0.16	6.90	<0.1	5.58	0.30	73.18	0.93	522.83
25	MEG/BRS/025	26.1590	72.4715	93.40	164.83	15.86	90.97	19.70	0.25	14.35	0.40	13.39	0.58	5.78	<0.1	4.95	0.26	67.73	0.94	493.39
26	MEG/BRS/026	26.1596	72.4707	78.16	201.13	13.42	77.38	16.17	0.36	14.32	0.35	11.69	<0.1	4.83	<0.1	4.93	0.26	62.49	1.51	487.00
27	MEG/BRS/027	26.1599	72.4719	85.09	205.14	15.27	86.58	19.42	0.35	16.53	0.43	16.16	1.76	8.90	0.15	7.27	0.37	95.16	0.98	559.56
28	MEG/BRS/028	26.1601	72.4725	86.39	216.40	15.16	87.72	19.61	0.35	16.64	0.38	14.82	2.59	8.81	<0.1	6.17	0.32	86.00	0.91	562.26
29	MEG/BRS/029	26.1595	72.4724	91.82	277.70	15.40	92.84	20.03	0.40	19.40	0.39	14.08	0.15	7.85	<0.1	5.80	0.31	73.56	0.96	620.68
30	MEG/BRS/030	26.1589	72.4722	60.37	186.39	10.51	65.22	14.76	0.33	13.58	0.37	13.36	<0.1	7.48	0.29	5.48	0.28	74.86	0.91	454.17
31	MEG/BRS/031	26.1664	72.4618	47.60	115.86	14.44	57.90	14.92	0.52	15.84	2.01	15.49	3.07	9.64	1.37	9.47	1.42	79.67	6.06	395.27
32	MEG/BRS/032	26.1642	72.4731	77.53	165.53	20.82	79.84	17.71	0.41	15.36	1.75	13.46	2.56	7.32	1.09	6.82	1.00	64.99	4.23	480.41
33	MEG/BRS/033	26.1631	72.4729	70.86	210.91	19.93	75.62	17.45	0.43	17.04	2.11	15.66	3.05	8.58	1.26	7.72	1.17	75.09	4.95	531.84
34	MEG/BRS/034	26.1625	72.4724	84.19	203.42	22.63	87.08	17.65	0.44	16.41	1.92	14.08	2.61	7.52	1.06	6.44	0.96	66.56	5.07	538.03
35	MEG/BRS/035	26.1632	72.4720	94.98	181.94	25.03	96.79	19.73	0.41	16.19	1.73	13.42	2.52	6.95	1.01	6.50	0.96	66.42	3.90	538.48
36	MEG/BRS/036	26.1628	72.4714	54.08	224.28	15.75	60.66	14.00	0.41	14.32	1.59	12.56	2.35	6.68	0.88	6.32	0.88	59.62	4.73	479.13
37	MEG/BRS/037	26.1628	72.4709	85.88	176.85	23.16	89.08	17.75	0.45	15.96	1.84	14.03	2.85	8.51	1.15	7.40	1.08	69.24	4.53	519.76
38	MEG/BRS/038	26.1629	72.4706	65.71	161.60	18.72	76.02	17.30	1.39	16.58	2.00	17.55	3.87	9.10	1.09	9.24	1.51	97.01	5.69	504.37
39	MEG/BRS/039	26.1623	72.4708	48.36	136.17	17.00	68.70	16.99	1.91	18.28	2.51	19.31	4.10	12.11	1.82	11.75	1.71	109.82	8.17	478.70
40	MEG/BRS/040	26.1618	72.4700	92.03	217.34	24.74	97.30	19.71	0.51	18.90	2.35	18.56	3.55	10.32	1.52	9.60	1.37	92.54	5.33	615.68
41	MEG/BRS/041	26.1615	72.4702	89.19	194.47	23.52	90.70	19.22	0.45	18.07	1.88	14.08	2.83	8.04	1.15	7.91	1.15	70.73	3.65	547.04
42	MEG/BRS/042	26.1614	72.4697	82.37	188.40	22.04	84.49	16.96	0.44	14.87	1.55	11.80	2.34	6.73	0.92	6.32	0.85	58.30	4.20	502.59
43	MEG/BRS/043	26.1615	72.4712	72.29	147.82	19.37	75.13	15.94	0.32	14.15	1.56	13.08	2.61	7.76	1.10	7.08	1.02	67.20	4.89	451.33
44	MEG/BRS/044	26.1621	72.4722	61.33	170.11	17.12	63.77	12.95	0.36	12.86	1.42	11.85	2.29	6.29	0.92	5.97	0.84	60.40	4.18	432.67
45	MEG/BRS/045	26.1621	72.4732	82.72	203.15	22.28	84.95	18.71	0.44	17.33	2.03	15.47	2.97	8.42	1.13	7.27	1.08	78.60	4.33	550.88
46	MEG/BRS/046	26.1560	72.4796	74.28	184.25	20.30	78.30	15.63	0.44	15.23	1.74	13.92	2.71	7.50	1.00	6.52	0.93	68.39	4.38	495.53
47	MEG/BRS/047	26.1546	72.4793	60.72	143.29	16.95	62.50	12.86	0.39	11.68	1.30	11.32	2.26	6.50	0.98	6.60	0.91	56.58	4.90	399.74
48	MEG/PTS/001	26.1653	72.4730	45.19	95.44	10.50	43.28	8.59	0.89	6.98	0.41	6.22	1.31	2.24	0.26	2.53	0.20	32.32	6.54	262.90
49	MEG/PTS/002	26.1635	72.4736	77.67	244.76	14.31	81.16	18.59	0.38	18.39	0.39	14.95	2.33	7.15	<0.1	5.61	0.30	80.52	1.01	567.52
50	MEG/PTS/003	26.1633	72.4748	39.51	73.34	9.32	39.10	7.46	1.07	5.89	0.38	5.23	1.51	2.65	<0.1	2.29	0.19	28.47	7.92	224.33
51	MEG/PTS/004	26.1614	72.4745	40.97	72.29	9.69	39.20	8.01	1.20	5.53	0.34	6.08	0.68	1.67	<0.1	2.59	0.17	33.93	6.19	228.54

Analytical Results of Trace Elements for Bedrock Samples of Meghawas Area (TS No. 45B/08), Barmer district of Rajasthan

Sl No	Sample ID	Latitude	Longitude	Zr ppm	Rb ppm	Ba ppm	Be ppm	Ga ppm	Ge ppm	Mo ppm	Sn ppm	Hf ppm	Ta ppm	Nb ppm	W ppm	Ni ppm	V ppm	Li ppm	Sb ppm	Th ppm	U ppm
1	MEG/BRS/001	26.1663	72.4622	725.57	266.95	32.52	4.97	26.67	0.75	1.21	2.44	19.89	0.96	47.84	1.85	5.14	3.61	6.97	4.41	3.73	0.60
2	MEG/BRS/002	26.1658	72.4622	735.44	257.90	35.79	4.89	25.13	0.56	1.36	2.13	19.75	0.91	41.11	1.85	5.65	3.27	5.25	3.98	3.67	0.51
3	MEG/BRS/003	26.1656	72.4624	778.13	238.78	44.11	4.43	24.48	0.49	1.30	2.13	20.84	1.19	32.85	2.89	4.38	2.92	6.17	3.93	3.67	0.47
4	MEG/BRS/004	26.1654	72.4623	789.07	284.15	37.32	4.84	27.19	0.59	0.18	2.27	20.77	1.06	40.70	2.84	4.65	3.17	4.20	3.55	3.72	0.60
5	MEG/BRS/005	26.1652	72.4622	772.79	290.36	37.83	3.75	27.19	0.71	0.92	1.99	20.24	1.12	29.38	2.89	5.81	3.62	7.02	1.85	3.60	0.53
6	MEG/BRS/006	26.1656	72.4625	797.03	265.81	32.85	4.71	25.64	0.44	0.54	2.17	21.48	1.27	40.74	3.35	8.97	4.79	6.32	3.24	3.85	0.57
7	MEG/BRS/007	26.1655	72.4620	788.94	264.75	32.37	4.23	25.52	0.57	0.72	2.17	20.50	1.13	39.96	3.62	5.94	3.12	4.99	3.33	3.72	0.52
8	MEG/BRS/008	26.1645	72.4720	453.87	238.47	39.12	4.38	26.07	0.22	1.77	2.18	12.45	0.95	38.79	2.98	5.28	7.01	9.27	3.35	3.66	0.52
9	MEG/BRS/009	26.1644	72.4710	441.76	235.21	41.11	4.75	27.44	0.26	1.55	2.12	11.89	0.97	34.89	2.78	4.23	4.54	9.56	1.28	3.58	0.33
10	MEG/BRS/010	26.1636	72.4716	510.48	241.63	42.23	4.72	26.73	0.26	1.91	2.15	13.12	0.83	34.63	2.23	3.90	4.36	10.12	1.32	3.69	0.31
11	MEG/BRS/011	26.1631	72.4708	447.66	225.03	48.93	4.43	26.23	0.33	1.86	2.14	12.33	0.94	38.42	1.72	5.21	8.12	10.17	0.82	3.57	0.49
12	MEG/BRS/012	26.1621	72.4714	781.86	180.46	407.33	4.71	32.88	0.89	1.57	1.80	19.27	1.04	28.47	2.17	4.50	10.42	11.97	<0.1	4.39	1.10
13	MEG/BRS/013	26.1612	72.4718	445.64	230.83	67.22	3.76	25.88	0.44	2.30	1.97	12.86	1.19	29.93	2.58	4.58	3.93	9.49	1.43	3.53	0.33
14	MEG/BRS/014	26.1611	72.4704	429.53	233.61	91.42	3.37	26.66	0.18	2.07	1.95	11.68	1.02	37.67	2.17	4.80	5.32	12.43	1.52	3.61	0.40
15	MEG/BRS/015	26.1610	72.4692	449.04	196.49	56.35	3.94	25.28	0.36	1.08	2.01	12.44	1.12	30.00	1.91	4.40	7.05	10.32	3.59	3.59	0.53
16	MEG/BRS/016	26.1600	72.4693	450.45	261.73	36.70	3.61	28.23	<0.1	1.53	2.05	11.66	1.04	30.80	1.80	5.03	4.04	15.70	1.85	3.70	0.37
17	MEG/BRS/017	26.1591	72.4689	455.66	198.87	43.25	3.90	25.35	0.31	1.50	2.08	12.14	1.18	32.82	1.37	3.81	8.14	9.99	1.76	3.56	0.33
18	MEG/BRS/018	26.1604	72.4707	444.07	230.66	78.41	4.71	27.04	0.30	1.90	1.92	12.12	0.92	34.37	1.05	4.65	4.05	10.83	1.03	3.67	0.46
19	MEG/BRS/019	26.1616	72.4729	436.10	216.00	80.89	3.72	23.81	0.55	1.60	2.01	12.61	1.19	33.74	3.74	4.29	6.10	8.17	1.22	3.62	0.44
20	MEG/BRS/020	26.1626	72.4730	436.93	250.56	46.49	4.53	25.80	0.54	1.32	1.95	12.32	1.11	31.86	1.99	4.59	4.82	10.18	1.11	3.58	0.41
21	MEG/BRS/021	26.1641	72.4725	441.33	229.01	31.10	3.93	26.10	0.57	1.08	1.71	12.07	0.96	34.26	1.70	4.83	5.77	10.43	2.39	3.59	0.30
22	MEG/BRS/022	26.1638	72.4729	434.74	232.34	32.73	4.09	24.25	0.50	2.04	2.31	11.85	1.12	39.98	2.36	5.20	4.38	9.58	2.32	3.52	0.41
23	MEG/BRS/023	26.1573	72.4721	431.72	199.88	60.22	4.30	25.91	0.12	1.56	2.16	12.82	1.04	33.65	3.76	4.13	4.00	9.52	3.01	3.51	0.42
24	MEG/BRS/024	26.1585	72.4722	448.38	205.52	30.38	4.23	26.01	0.21	1.26	2.02	12.62	0.89	32.35	2.56	4.77	3.93	10.90	0.31	3.53	0.36
25	MEG/BRS/025	26.1590	72.4715	436.62	262.55	43.70	4.23	25.32	0.14	1.82	2.05	11.91	1.20	36.17	2.43	4.02	5.37	11.55	0.60	3.63	0.46
26	MEG/BRS/026	26.1596	72.4707	445.00	235.36	56.89	3.64	28.60	0.51	2.31	1.90	12.32	0.89	26.75	3.40	4.52	7.06	13.27	1.68	3.48	0.51
27	MEG/BRS/027	26.1599	72.4719	453.36	266.19	49.65	4.52	29.55	0.43	2.00	2.23	13.03	1.06	37.54	1.40	4.23	3.88	12.39	0.40	3.61	0.33
28	MEG/BRS/028	26.1601	72.4725	435.94	250.78	43.11	4.70	26.76	0.25	1.13	2.07	11.66	0.96	35.70	3.00	4.49	2.84	13.39	2.24	3.56	0.31
29	MEG/BRS/029	26.1595	72.4724	444.72	247.55	73.21	3.80	29.17	0.10	1.57	1.99	12.83	0.99	33.26	1.81	5.01	5.81	12.14	0.06	3.72	0.56
30	MEG/BRS/030	26.1589	72.4722	428.15	222.96	38.02	3.83	26.30	<0.1	2.11	2.00	11.77	0.92	32.58	1.22	4.51	3.67	12.46	0.92	3.68	0.51
31	MEG/BRS/031	26.1664	72.4618	680.50	171.66	17.30	4.31	32.19	<0.1	<0.1	5.90	23.17	1.30	18.85	0.19	2.58	2.98	7.38	9.78	16.18	1.79
32	MEG/BRS/032	26.1642	72.4731	451.57	158.19	32.99	4.59	36.52	0.16	0.19	3.66	15.34	1.01	17.40	0.32	1.59	1.48	19.49	9.94	18.56	3.29
33	MEG/BRS/033	26.1631	72.4729	436.73	163.29	38.41	4.25	37.58	0.11	0.61	3.57	15.06	1.03	17.19	1.41	2.61	3.58	8.16	11.17	18.66	3.52
34	MEG/BRS/034	26.1625	72.4724	437.11	165.19	49.88	3.60	38.38	0.13	0.70	3.49	15.19	1.12	17.46	1.15	3.71	8.86	16.32	10.93	18.29	3.42
35	MEG/BRS/035	26.1632	72.4720	436.17	156.45	44.95	3.56	36.98	0.16	0.35	3.82	15.04	0.92	16.95	0.74	1.90	5.34	12.66	10.93	18.44	3.18
36	MEG/BRS/036	26.1628	72.4714	430.44	155.45	58.02	3.43	34.56	<0.1	0.86	3.11	14.70	1.03	17.36	0.66	3.48	5.29	12.60	10.81	18.14	2.43
37	MEG/BRS/037	26.1628	72.4709	434.72	159.16	47.04	4.01	33.89	0.12	1.37	3.15	14.50	0.99	17.50	0.55	4.62	5.81	14.15	10.80	18.32	3.07
38	MEG/BRS/038	26.1629	72.4706	551.12	150.50	40.34	4.19	34.66	0.12	0.67	4.00	17.61	0.98	16.93	0.26	3.27	3.43	6.89	10.93	15.88	2.96
39	MEG/BRS/039	26.1623	72.4708	683.68	148.39	270.83	5.12	30.93	<0.1	0.45	5.83	21.15	0.94	16.61	0.11	5.22	5.72	8.71	10.15	10.69	2.63
40	MEG/BRS/040	26.1618	72.4700	442.02	163.92	67.17	4.13	38.88	0.14	0.91	3.40	14.82	1.04	17.78	0.84	3.16	7.63	8.21	10.71	18.50	2.93
41	MEG/BRS/041	26.1615	72.4702	411.07	165.76	78.89	3.91	33.85	0.11	0.54	2.86	14.00	0.61	16.13	0.55	2.82	2.48	7.31	10.95	17.81	2.66
42	MEG/BRS/042	26.1614	72.4697	435.73	157.84	51.14	3.38	37.22	0.15	0.33	3.52	15.05	0.91	17.00	0.47	2.60	3.29	10.44	10.47	18.28	2.57
43	MEG/BRS/043	26.1615	72.4712	436.00	157.70	72.90	3.07	35.95	0.12	0.76	3.22	14.59	0.82	16.08	1.35	2.70	1.91	7.33	11.13	17.78	3.02
44	MEG/BRS/044	26.1621	72.4722	437.00	160.86	76.17	3.74	32.98	0.10	2.05	4.26	14.37	1.02	17.56	1.30	18.65	5.07	7.24	11.35	17.75	2.92
45	MEG/BRS/045	26.1621	72.4732	447.42	160.23	56.85	4.26	36.68	0.14	0.93	3.52	15.09	1.04	17.85	1.26	3.58	9.18	13.03	11.34	18.17	3.30
46	MEG/BRS/046	26.1560	72.4796	441.37	163.48	58.07	3.63	36.36	0.10	0.30	3.12	14.15	0.80	17.27	1.05	2.98	7.21	9.44	10.87	17.99	3.45
47	MEG/BRS/047	26.1546	72.4793	442.15	157.91	35.77	3.41	31.30	<0.1	0.53	3.12	14.50	0.93	17.72	1.07	1.95	3.83	7.39	10.91	18.27	2.88
48	MEG/PTS/001	26.1653	72.4730	145.39	78.64	298.33	2.07	12.42	<0.1	0.78	1.65	4.40	1.07	22.65	1.85	39.94	76.40	27.50	2.73	2.89	0.47
49	MEG/PTS/002	26.1635	72.4736	450.65	233.04	73.73	4.06	26.95	0.71	1.99	2.11	13.05	1.02	32.45	1.93	5.17	9.10	11.73	<0.1	3.54	0.27
50	MEG/PTS/003	26.1633	72.4748	123.57	68.99	332.69	1.89	12.46	<0.1	1.59	1.87	2.87	1.07	21.59	0.81	47.50	80.03	28.95	2.03	2.98	0.63
51	MEG/PTS/004	26.1614	72.4745	146.71	50.77	342.14	1.74	10.11	<0.1	0.96	1.81	3.60	1.11	15.69	0.91	30.83	65.66	17.59	1.20	2.43	0.27

Analytical Results of Σ REE+Y+Sc for Bedrock Samples of Nagana Area (TS No. 45B/12), Barmer district of Rajasthan

Sl No	Sample ID	Latitude	Longitude	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Y	Sc	Σ REE+Y+Sc
				ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
1	NAG/BRS/001	26.1343	72.5453	45.12	196.74	7.67	52.45	13.17	<0.1	15.59	0.37	17.71	0.49	10.20	0.19	7.63	0.35	100.18	0.56	468.42
2	NAG/BRS/002	26.1344	72.5451	36.80	234.89	6.43	44.42	11.86	<0.1	17.57	0.33	18.32	2.68	9.69	<0.1	7.34	0.34	102.86	0.58	494.10
3	NAG/BRS/003	26.1343	72.5448	47.50	165.49	8.00	51.58	13.38	<0.1	13.42	0.31	14.52	2.37	8.12	<0.1	6.38	0.30	77.11	0.53	409.01
4	NAG/BRS/004	26.1341	72.5452	56.28	187.16	9.24	59.25	14.69	<0.1	<0.1	0.35	15.85	2.57	9.53	0.12	6.70	0.31	88.34	0.63	451.04
5	NAG/BRS/005	26.1336	72.5452	72.61	235.00	11.66	78.55	20.40	<0.1	1.44	0.44	20.22	3.54	9.26	<0.1	7.18	0.33	97.37	0.53	558.52
6	NAG/BRS/006	26.1333	72.5452	76.91	143.66	13.58	78.62	20.13	<0.1	<0.1	0.39	16.40	2.61	8.99	<0.1	6.81	0.32	85.49	0.62	454.53
7	NAG/BRS/007	26.1328	72.5455	76.68	143.95	12.95	76.16	19.59	<0.1	<0.1	0.37	15.89	2.73	8.20	<0.1	6.74	0.32	87.74	0.57	451.90
8	NAG/BRS/008	26.1349	72.5481	69.10	189.41	13.22	73.45	17.96	<0.1	<0.1	0.38	17.60	2.49	9.03	0.19	7.15	0.33	102.29	0.65	503.25
9	NAG/BRS/009	26.1348	72.5483	72.94	190.03	12.45	76.03	19.48	<0.1	<0.1	0.41	18.53	3.83	9.95	0.12	7.37	0.34	103.93	0.64	516.04
10	NAG/BRS/010	26.1345	72.5484	41.59	216.11	8.62	52.03	13.56	<0.1	16.53	0.35	16.60	2.39	10.11	<0.1	6.87	0.32	93.14	0.59	478.82
11	NAG/BRS/011	26.1348	72.5486	74.97	189.70	13.09	77.70	19.85	<0.1	19.00	0.44	18.08	2.54	10.28	0.11	7.16	0.34	103.66	0.60	537.50
12	NAG/BRS/012	26.1347	72.5488	84.33	196.73	14.41	84.04	21.28	<0.1	<0.1	0.37	18.03	3.46	8.88	<0.1	7.10	0.33	101.17	0.61	540.72
13	NAG/BRS/013	26.1346	72.5488	57.85	173.04	10.29	60.76	15.39	<0.1	17.22	0.36	16.95	2.07	10.14	<0.1	7.27	0.34	99.83	0.56	472.07
14	NAG/BRS/014	26.1350	72.5487	98.53	191.86	16.96	96.64	24.60	<0.1	0.22	0.42	18.34	2.36	10.25	<0.1	7.15	0.33	101.69	0.61	569.96
15	NAG/BRS/015	26.1363	72.5471	81.42	215.21	15.25	86.09	21.97	<0.1	1.60	0.40	17.44	2.89	9.16	<0.1	6.82	0.32	99.31	0.62	558.52
16	NAG/BRS/016	26.1363	72.5468	78.70	197.21	13.85	80.41	19.53	<0.1	20.44	0.41	18.31	3.39	9.96	<0.1	7.35	0.34	102.17	0.61	552.67
17	NAG/BRS/017	26.1361	72.5470	39.63	173.33	6.95	45.88	11.97	<0.1	12.49	0.36	16.45	2.47	9.42	<0.1	7.08	0.33	98.06	0.63	425.04
18	NAG/BRS/018	26.1361	72.5471	72.22	279.08	11.93	75.82	18.55	0.11	<0.1	0.40	17.66	1.65	9.11	<0.1	6.99	0.33	99.12	0.62	593.59
19	NAG/BRS/019	26.1363	72.5472	55.69	142.78	9.19	58.39	14.37	<0.1	12.82	0.32	14.22	3.19	7.85	0.15	6.36	0.31	82.37	0.60	408.60
20	NAG/BRS/020	26.1593	72.5626	75.33	251.41	16.45	96.83	23.64	1.03	21.99	0.31	24.75	1.85	14.96	<0.1	11.70	0.56	152.68	0.91	694.39
21	NAG/BRS/021	26.1600	72.5629	74.66	243.43	16.76	98.04	24.81	1.13	22.86	0.28	24.64	1.02	14.27	<0.1	11.81	0.59	148.69	1.00	683.98
22	NAG/BRS/022	26.1599	72.5628	67.72	234.10	15.56	90.26	21.99	0.95	23.73	0.26	22.94	4.46	13.89	<0.1	11.17	0.54	137.82	0.98	646.37
23	NAG/BRS/023	26.1598	72.5627	73.56	248.85	16.01	96.72	23.01	0.98	24.67	0.28	24.52	1.71	15.72	<0.1	11.84	0.57	149.88	0.99	689.30
24	NAG/BRS/024	26.1596	72.5625	69.51	247.20	15.93	93.39	23.10	1.07	21.98	0.30	24.02	3.77	14.15	0.25	11.59	0.56	144.68	0.92	672.42
25	NAG/BRS/025	26.1570	72.5606	66.54	237.41	15.76	91.83	22.54	1.14	23.61	0.33	24.01	4.05	14.59	<0.1	11.50	0.57	146.27	1.22	661.36
26	NAG/BRS/026	26.1572	72.5604	69.49	244.01	15.60	93.35	22.78	1.05	23.69	0.30	24.21	4.44	14.77	0.29	11.59	0.56	146.89	1.17	674.20
27	NAG/BRS/027	26.1573	72.5604	66.39	234.96	15.10	91.10	22.21	1.09	25.66	0.28	24.00	1.19	13.92	0.31	11.57	0.56	144.61	1.27	654.23
28	NAG/BRS/028	26.1570	72.5603	69.29	240.50	15.60	91.95	22.51	1.05	21.22	0.29	23.71	3.57	14.33	<0.1	11.64	0.56	142.32	1.03	659.59
29	NAG/BRS/029	26.1577	72.5602	67.03	226.54	14.99	90.51	23.02	1.02	21.69	0.30	24.60	5.15	14.26	<0.1	11.91	0.58	150.33	0.98	652.91
30	NAG/BRS/030	26.1579	72.5602	70.65	248.71	15.78	94.75	23.62	1.03	26.53	0.31	24.51	4.61	14.33	<0.1	11.84	0.57	149.79	0.96	687.98
31	NAG/BRS/031	26.1442	72.5462	63.13	148.46	18.17	69.52	17.63	<0.1	18.61	2.59	19.45	3.97	11.24	1.61	9.83	1.35	103.88	2.42	491.85
32	NAG/BRS/032	26.1446	72.5457	84.56	156.98	24.61	98.89	24.79	<0.1	23.55	3.06	22.55	4.16	11.79	1.66	10.50	1.50	101.27	2.84	572.72
33	NAG/BRS/033	26.1452	72.5451	16.01	50.69	4.34	15.97	5.26	<0.1	7.07	1.00	11.02	2.37	6.64	0.93	5.60	0.85	63.24	2.64	193.65
34	NAG/BRS/034	26.1534	72.5587	70.84	160.33	22.76	91.91	22.61	1.20	22.66	3.14	24.77	5.15	15.51	2.33	14.69	2.17	139.17	11.55	610.77
35	NAG/BRS/035	26.1369	72.5522	68.47	159.18	18.89	74.75	19.40	0.11	20.82	2.92	22.53	4.49	12.84	1.78	11.17	1.50	118.51	2.53	539.87
36	NAG/BRS/036	26.1367	72.5527	64.49	155.67	18.76	72.56	20.14	0.12	20.20	2.81	21.58	4.45	13.06	1.78	10.61	1.47	116.62	2.92	527.26
37	NAG/BRS/037	26.1373	72.5499	71.15	152.11	20.59	82.26	20.50	<0.1	21.80	2.90	21.35	4.18	12.24	1.77	10.16	1.38	107.03	2.12	531.52
38	NAG/BRS/038	26.1358	72.5531	64.19	125.15	18.61	73.06	19.02	<0.1	20.08	2.77	21.74	4.37	11.99	1.76	10.23	1.40	109.63	2.66	486.66
39	NAG/BRS/039	26.1357	72.5534	71.26	135.33	20.10	80.01	21.75	<0.1	22.36	3.21	24.25	4.67	13.40	1.93	11.01	1.53	122.24	2.23	535.27
40	NAG/PTS/001	26.1555	72.5617	65.18	237.25	14.54	88.55	21.56	0.99	22.45	0.30	23.66	1.86	14.81	0.23	11.40	0.53	144.96	0.90	649.16
41	NAG/PTS/002	26.1547	72.5612	68.93	247.95	15.75	93.16	23.03	1.12	24.85	0.29	24.27	4.42	15.20	0.29	11.76	0.56	149.62	0.96	682.17
42	NAG/PTS/003	26.1532	72.5601	29.48	66.20	7.18	26.90	5.48	0.80	4.87	0.28	4.57	0.91	2.79	0.41	2.34	0.31	23.56	6.06	182.13
43	NAG/PTS/004	26.1535	72.5591	37.71	174.58	9.52	59.36	16.25	0.83	14.58	0.20	19.01	2.32	11.94	<0.1	9.78	0.48	118.29	1.13	475.96
44	NAG/PTS/005	26.1546	72.5594	69.81	250.03	15.88	94.30	23.64	1.10	21.23	0.29	25.08	5.02	15.74	0.13	12.12	0.58	153.53	0.98	689.46
45	NAG/PTS/006	26.1559	72.5586	62.24	240.83	14.68	85.41	20.67	1.02	20.19	0.57	22.98	4.54	14.36	<0.1	11.28	0.55	143.40	0.95	643.67
46	NAG/PTS/007	26.1537	72.5619	34.85	89.71	9.73	37.15	8.64	0.68	7.82	0.27	9.69	1.25	5.35	<0.1	4.69	0.25	59.59	2.28	271.96
47	NAG/PTS/008	26.1555	72.5652	34.63	73.99	8.25	30.20	6.16	0.77	5.67	0.30	4.69	0.99	2.91	0.37	2.56	0.34	25.50	6.06	203.38
48	NAG/PTS/009	26.158	72.5647	38.88	110.45	9.95	43.36	10.38	0.78	8.49	0.34	11.35	1.90	6.10	0.38	5.44	0.28	69.11	2.53	319.72
49	NAG/PTS/010	26.1547	72.5633	36.92	106.28	10.15	40.14	9.91	0.70	9.11	0.31	10.92	<0.1	6.29	<0.1	5.31	0.26	67.08	1.95	305.33

Analytical Results of Trace Elements for Bedrock Samples of Nagana Area (TS No. 45B/12), Barmer district of Rajasthan

Sl No	Sample ID	Latitude	Longitude	Zr ppm	Rb ppm	Ba ppm	Be ppm	Ga ppm	Ge ppm	Mo ppm	Sn ppm	Hf ppm	Ta ppm	Nb ppm	W ppm	Ni ppm	V ppm	Li ppm	Sb ppm	Th ppm	U ppm
1	NAG/BRS/001	26.1343	72.5453	306.81	322.03	10.44	5.30	28.06	0.39	1.73	1.89	11.06	0.88	29.05	0.84	3.87	1.82	25.01	1.75	3.60	0.39
2	NAG/BRS/002	26.1344	72.5451	308.09	294.04	9.20	5.86	28.18	<0.1	2.61	1.88	11.36	1.01	29.78	0.77	4.50	1.66	18.32	2.01	3.56	0.35
3	NAG/BRS/003	26.1343	72.5448	294.27	339.19	11.48	6.37	28.28	<0.1	1.01	1.86	10.17	1.38	33.78	0.94	3.43	1.63	14.67	0.54	3.67	0.44
4	NAG/BRS/004	26.1341	72.5452	300.90	333.80	15.53	5.33	27.83	0.36	2.49	2.10	10.80	1.16	35.49	23.43	3.97	2.30	12.20	0.92	3.61	0.36
5	NAG/BRS/005	26.1336	72.5452	308.49	379.43	16.16	7.11	29.22	0.23	1.82	1.91	10.72	0.95	30.94	0.58	3.42	2.18	11.90	0.24	3.70	0.41
6	NAG/BRS/006	26.1333	72.5452	299.63	339.01	10.26	6.18	28.94	<0.1	2.91	2.20	10.17	1.00	38.97	1.32	4.22	1.58	14.48	1.17	3.67	0.28
7	NAG/BRS/007	26.1328	72.5455	313.98	341.52	11.83	5.22	28.46	0.60	3.01	2.06	10.30	1.03	37.41	1.74	4.72	1.61	12.77	<0.1	3.69	0.32
8	NAG/BRS/008	26.1349	72.5481	296.54	332.59	12.47	5.72	28.60	0.36	2.57	2.04	10.44	0.99	35.15	1.86	4.17	1.41	15.46	1.06	3.60	0.38
9	NAG/BRS/009	26.1348	72.5483	318.24	339.97	11.99	5.97	29.49	0.20	2.28	1.99	9.83	1.09	31.10	1.30	4.99	1.78	26.35	<0.1	3.36	0.37
10	NAG/BRS/010	26.1345	72.5484	321.67	334.00	16.10	5.01	28.59	0.13	2.84	2.04	11.28	1.09	33.15	0.89	4.76	1.91	17.60	1.41	3.62	0.40
11	NAG/BRS/011	26.1348	72.5486	309.58	333.65	10.12	5.64	28.50	<0.1	2.57	1.70	10.93	1.02	28.46	0.49	4.50	1.37	34.60	0.25	3.61	0.33
12	NAG/BRS/012	26.1347	72.5488	326.07	332.57	10.81	5.72	29.57	0.42	2.30	1.96	10.03	1.09	35.48	1.47	4.26	1.68	34.68	1.21	3.62	0.17
13	NAG/BRS/013	26.1346	72.5488	323.31	331.59	9.48	4.97	29.09	0.10	1.89	2.01	10.09	0.89	36.43	0.84	3.66	1.18	32.57	0.39	3.64	0.36
14	NAG/BRS/014	26.1350	72.5487	321.69	344.77	11.98	4.95	28.95	<0.1	2.45	2.04	10.66	1.03	35.28	0.78	3.87	1.52	19.41	1.74	3.64	0.25
15	NAG/BRS/015	26.1363	72.5471	295.45	337.84	21.19	5.67	27.67	<0.1	1.80	2.00	9.96	0.99	41.07	1.79	4.72	2.13	12.17	1.92	3.72	0.35
16	NAG/BRS/016	26.1363	72.5468	324.05	325.85	24.59	5.85	28.39	0.37	2.00	2.05	10.78	1.08	40.18	0.46	4.45	2.11	10.63	0.52	3.66	0.26
17	NAG/BRS/017	26.1361	72.5470	328.61	340.98	16.84	5.57	29.89	<0.1	1.68	1.87	12.07	0.93	28.55	0.87	4.46	1.55	11.36	0.76	3.56	0.30
18	NAG/BRS/018	26.1361	72.5471	324.54	315.04	23.72	5.31	28.50	0.32	2.09	2.01	10.80	1.02	36.79	1.75	3.90	1.95	11.26	1.71	3.65	0.30
19	NAG/BRS/019	26.1363	72.5472	324.63	339.28	17.85	5.17	28.37	0.60	2.32	1.91	10.88	1.06	32.81	1.14	3.57	1.92	12.63	0.84	3.59	0.46
20	NAG/BRS/020	26.1593	72.5626	1145.72	225.83	27.74	6.92	31.30	1.01	0.85	2.28	27.18	1.39	47.68	2.73	5.24	3.13	46.27	0.94	4.07	0.44
21	NAG/BRS/021	26.1600	72.5629	1142.89	165.88	31.00	6.91	30.15	1.04	1.18	1.82	26.71	1.22	37.34	2.00	4.38	7.61	9.62	0.13	4.26	0.77
22	NAG/BRS/022	26.1599	72.5628	1105.81	205.94	28.68	6.84	31.14	0.56	1.26	1.88	26.27	1.21	43.57	2.36	4.69	3.88	33.47	0.34	3.97	0.48
23	NAG/BRS/023	26.1598	72.5627	1164.14	221.56	33.51	7.30	31.41	0.47	1.45	2.16	28.09	1.25	45.61	2.74	4.78	4.29	39.94	<0.1	3.96	0.57
24	NAG/BRS/024	26.1596	72.5625	1141.78	233.42	26.70	7.32	29.58	0.95	0.94	2.23	26.49	1.18	43.86	2.70	3.82	2.78	32.86	<0.1	3.98	0.53
25	NAG/BRS/025	26.1570	72.5606	1110.94	222.59	30.77	7.22	31.36	0.60	1.96	2.18	26.56	1.25	52.25	2.55	6.93	5.22	39.67	0.18	4.13	0.67
26	NAG/BRS/026	26.1572	72.5604	1126.25	199.91	23.19	6.98	30.06	0.91	1.09	2.16	27.31	1.49	51.53	2.53	5.00	3.35	47.05	1.21	4.09	0.72
27	NAG/BRS/027	26.1573	72.5604	1132.14	209.69	34.78	7.02	31.27	0.99	0.94	2.22	27.14	1.09	44.12	2.58	5.56	4.13	39.05	<0.1	4.11	0.63
28	NAG/BRS/028	26.1570	72.5603	1150.54	196.50	32.15	7.15	32.26	1.14	1.08	2.32	27.09	1.35	46.33	2.08	4.30	4.32	37.69	2.33	4.05	0.81
29	NAG/BRS/029	26.1577	72.5602	1175.71	216.25	39.04	6.94	32.19	1.38	1.52	2.37	27.99	1.12	47.74	3.42	4.61	4.56	24.45	1.88	4.04	0.67
30	NAG/BRS/030	26.1579	72.5602	1168.91	207.47	35.95	7.28	30.89	0.64	1.48	2.30	27.64	1.51	48.92	2.16	4.54	4.78	33.11	3.32	4.14	0.48
31	NAG/BRS/031	26.1442	72.5462	296.09	234.62	7.96	6.24	34.66	0.12	1.34	3.93	12.13	1.31	22.14	0.37	2.36	2.39	26.25	11.13	21.91	3.72
32	NAG/BRS/032	26.1446	72.5457	305.72	249.11	7.06	6.10	38.63	0.15	0.76	3.90	12.99	1.21	22.12	0.20	1.91	0.51	17.14	11.01	21.96	3.82
33	NAG/BRS/033	26.1452	72.5451	305.50	238.95	10.13	5.25	29.46	<0.1	0.93	4.17	13.01	1.35	22.24	0.29	1.66	1.15	8.53	10.80	21.69	2.07
34	NAG/BRS/034	26.1534	72.5587	1148.00	142.75	31.45	5.77	39.01	0.17	<0.1	7.57	32.38	0.90	22.14	0.28	3.13	3.16	18.94	10.70	12.84	3.28
35	NAG/BRS/035	26.1369	72.5522	308.94	243.99	12.25	6.68	35.03	0.12	1.30	5.38	13.10	1.27	23.39	0.19	5.70	2.09	21.68	11.29	22.46	3.91
36	NAG/BRS/036	26.1367	72.5527	311.40	259.66	5.83	6.53	37.34	0.12	0.74	5.71	13.25	1.53	24.12	0.16	1.76	0.62	18.95	10.90	22.58	5.00
37	NAG/BRS/037	26.1373	72.5499	278.71	278.52	14.94	6.35	39.37	0.14	1.15	5.37	12.05	1.61	25.57	0.15	2.36	1.07	12.63	11.65	23.10	3.59
38	NAG/BRS/038	26.1358	72.5531	275.99	259.11	13.28	6.07	39.44	0.12	1.27	7.47	12.00	1.61	25.12	0.43	3.48	2.38	13.63	11.44	22.80	2.72
39	NAG/BRS/039	26.1357	72.5534	246.40	265.59	3.05	6.26	37.98	0.13	0.88	5.65	10.55	1.57	25.05	0.40	3.21	1.39	13.84	11.33	23.04	4.12
40	NAG/PTS/001	26.1555	72.5617	1111.35	203.43	<0.1	6.78	29.98	1.11	0.99	2.28	29.49	1.11	47.04	1.48	4.76	12.80	34.87	0.38	3.80	0.39
41	NAG/PTS/002	26.1547	72.5612	1167.96	197.06	<0.1	6.90	31.61	1.14	0.95	2.44	29.06	1.44	51.53	3.26	5.03	12.06	42.26	0.72	4.02	0.50
42	NAG/PTS/003	26.1532	72.5601	53.32	79.27	278.02	2.36	15.46	<0.1	<0.1	1.04	1.57	0.60	8.66	0.50	15.48	43.57	12.32	10.69	11.50	1.43
43	NAG/PTS/004	26.1535	72.5591	1141.51	224.49	67.59	5.34	30.86	1.03	0.13	1.86	28.18	0.94	26.80	0.99	5.61	8.48	16.47	0.24	3.64	0.52
44	NAG/PTS/005	26.1546	72.5594	1179.08	201.10	<0.1	7.20	30.89	1.03	0.96	2.06	29.55	1.25	47.04	2.03	5.02	16.94	45.87	0.75	4.15	0.63
45	NAG/PTS/006	26.1559	72.5586	1150.46	196.23	229.15	6.78	30.15	0.46	0.83	2.28	28.22	1.12	44.29	2.16	6.20	22.80	44.66	0.84	3.86	0.58
46	NAG/PTS/007	26.1537	72.5619	424.64	65.13	203.93	2.16	10.49	<0.1	0.32	1.74	10.75	1.22	16.61	1.01	11.25	26.37	14.51	1.24	2.14	0.24
47	NAG/PTS/008	26.1555	72.5652	48.49	82.42	281.18	2.64	15.36	<0.1	<0.1	0.89	1.61	0.70	9.06	0.50	15.72	43.54	8.06	10.74	13.23	1.54
48	NAG/PTS/009	26.158	72.5647	499.05	85.64	135.47	2.74	14.53	<0.1	0.16	1.66	12.35	0.83	20.58	0.78	12.15	23.46	24.18	1.55	2.53	0.24
49	NAG/PTS/010	26.1547	72.5633	501.10	75.95	127.58	2.64	12.35	<0.1	0.77	1.92	12.22	1.01	21.80	0.65	10.58	25.73	23.02	0.23	2.22	0.19

Annexure VIII

WHOLE ROCK (XRF) ANALYSIS RESULTS OF BED ROCK SAMPLES OF MEGHAWAS-NAGANA BLOCK, BARMER DIST, RAJASTHAN

Annexure-VIII

Analytical Results of Major Oxides for Bedrock Samples of Meghawas-Nagana Area (TS No. 45B/08 & 45B/12), Barmer district of Rajasthan

Sl No	Sample ID	Al ₂ O ₃	SiO ₂	Fe ₂ O ₃	Na ₂ O	K ₂ O	P ₂ O ₅	BaO	CaO	Cr ₂ O ₃	MgO	MnO	SrO	TiO ₂	V ₂ O ₅
		%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	MEG/BRS/005	10.27	77.52	2.51	2.541	5.223	0.04	0.004	0.13	0.010	0.22	0.04	0.004	0.155	<0.001
2	MEG/BRS/015	11.29	76.15	2.60	3.000	4.533	0.04	0.006	0.17	0.012	0.26	0.04	0.005	0.188	0.001
3	MEG/BRS/025	11.02	76.34	2.56	2.479	5.759	0.05	0.004	0.16	0.015	0.18	0.03	0.004	0.183	0.001
4	MEG/BRS/030	10.86	76.46	2.55	2.879	5.014	0.05	0.004	0.26	0.014	0.19	0.04	0.004	0.181	0.001
5	MEG/BRS/037	12.78	73.63	2.73	3.293	5.422	0.02	0.002	0.22	0.008	0.12	0.04	0.005	0.193	0.002
6	NAG/BRS/005	10.89	77.21	2.11	2.609	5.830	0.04	0.002	0.13	0.008	0.13	0.02	0.002	0.118	<0.001
7	NAG/BRS/015	11.01	77.19	2.08	2.721	5.698	0.04	0.002	0.13	0.016	0.10	0.04	0.003	0.130	<0.001
8	NAG/BRS/025	10.01	76.39	3.61	3.289	4.847	0.05	0.003	0.25	0.023	0.13	0.07	0.003	0.273	0.001
9	NAG/BRS/029	10.07	76.54	3.31	2.528	5.280	0.04	0.004	0.14	0.019	0.16	0.04	0.003	0.264	0.001
10	NAG/BRS/035	11.55	75.33	2.13	4.142	5.176	0.01	0.002	0.25	0.016	0.07	0.02	0.003	0.129	0.001

Annexure IX

TEST REPORT ON XRD OF ROCK SAMPLES OF MEGHAWAS-NAGANA BLOCK, BARMER DIST, RAJASTHAN



सीएसआईआर – खनिज एवं पदार्थ प्रौद्योगिकी संस्थान
(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद)
भुवनेश्वर – 751013, ओडिशा, भारत
CSIR-INSTITUTE OF MINERALS & MATERIALS TECHNOLOGY
(Council of Scientific & Industrial Research)
Bhubaneswar – 751013, Odisha, INDIA

Test Report

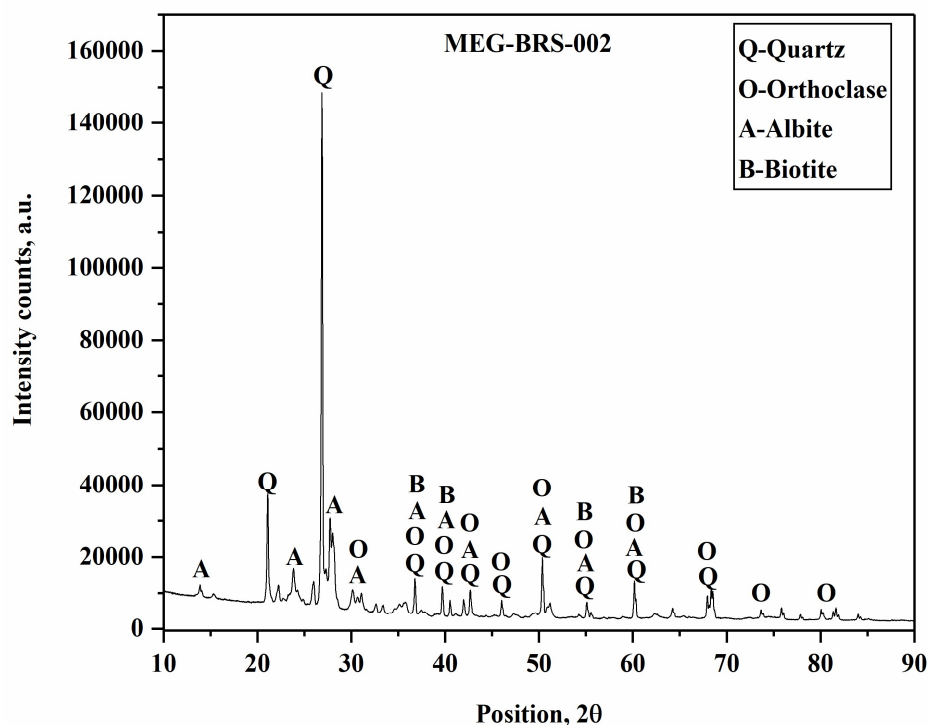
Ref No: MMC/PI/2025/IGI/02

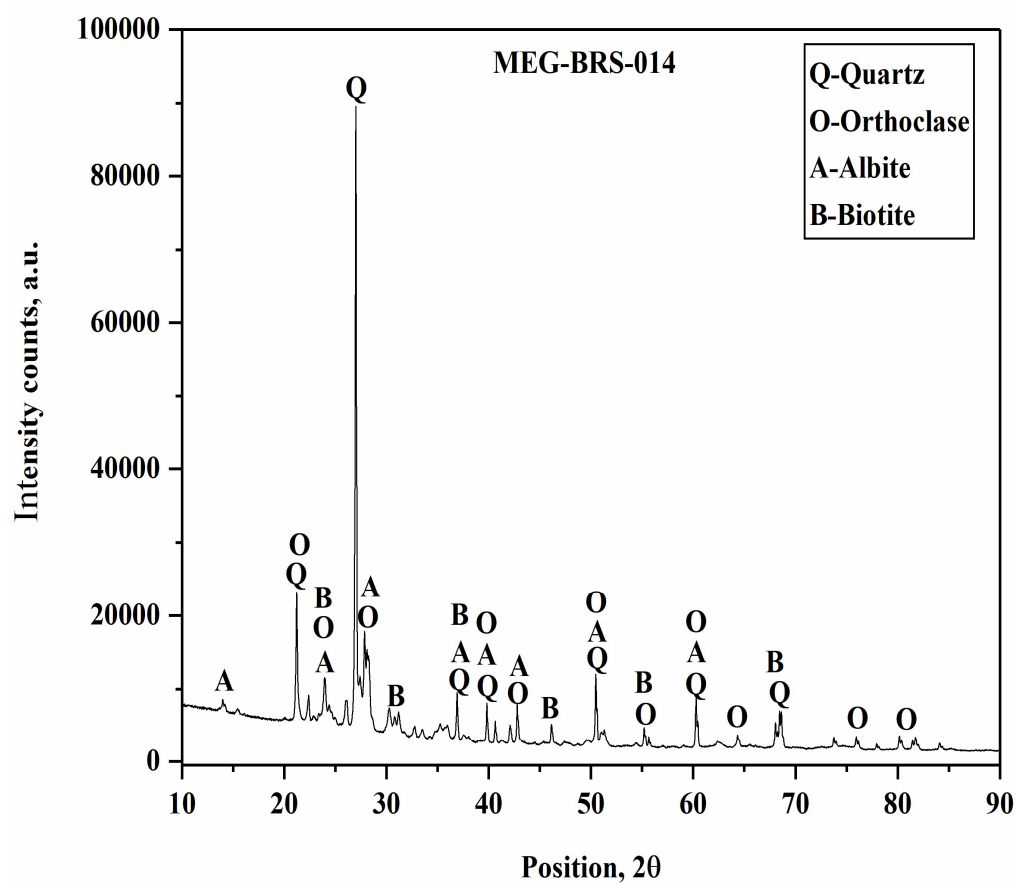
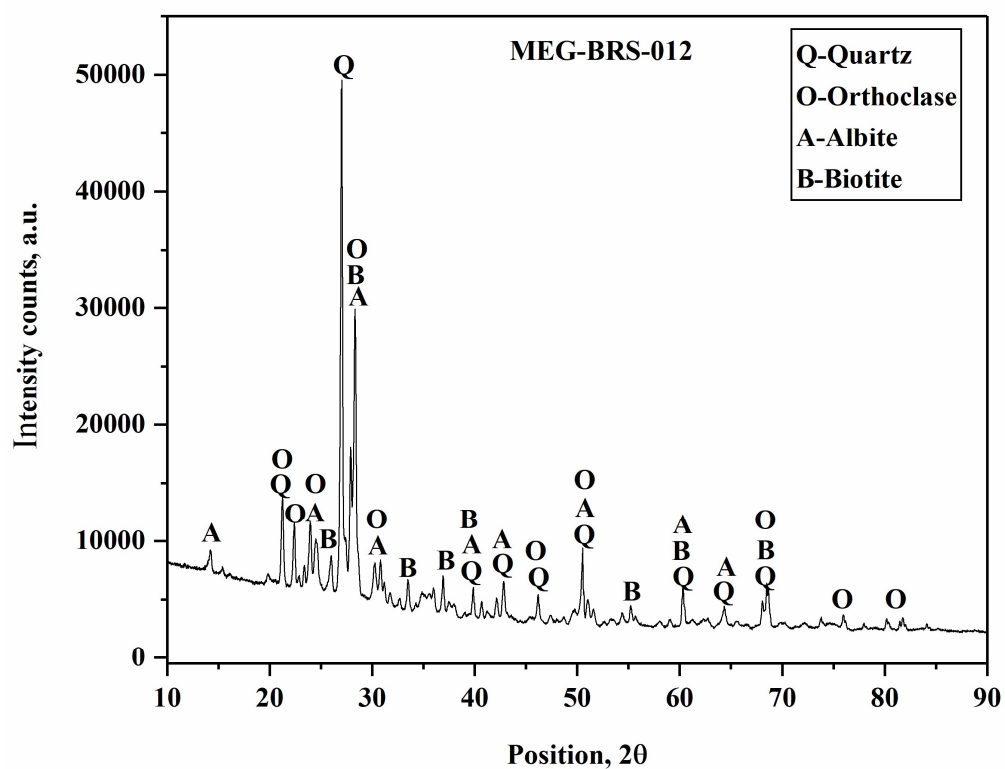
Date: 18.12.2025

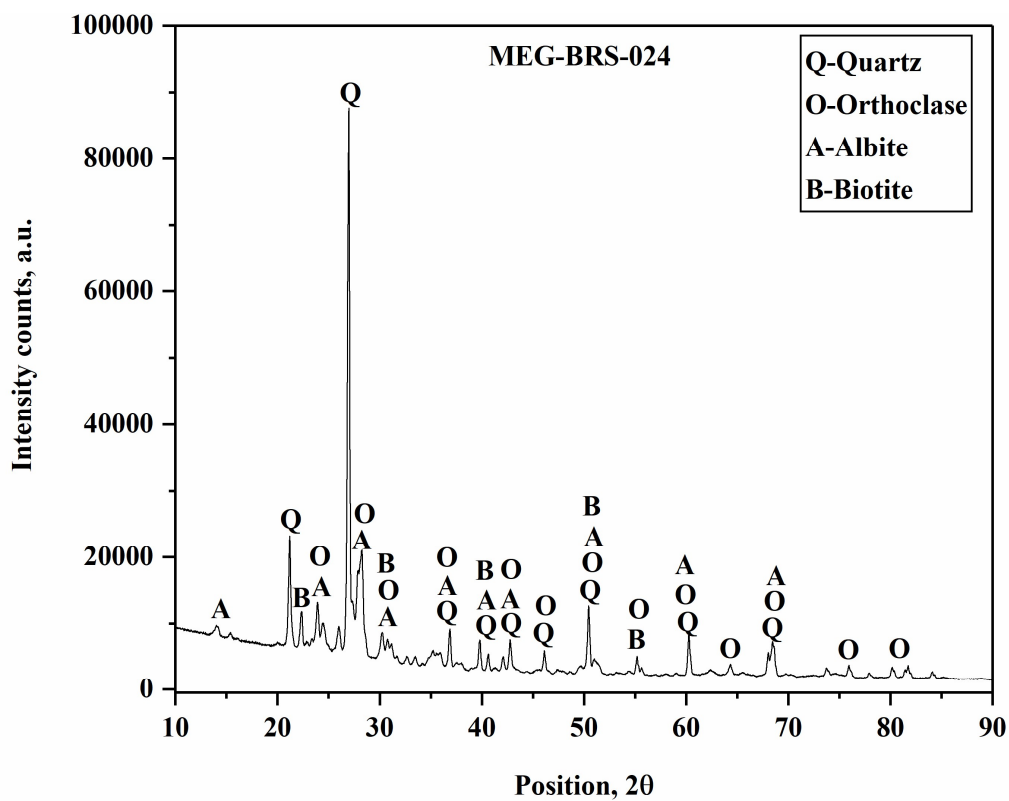
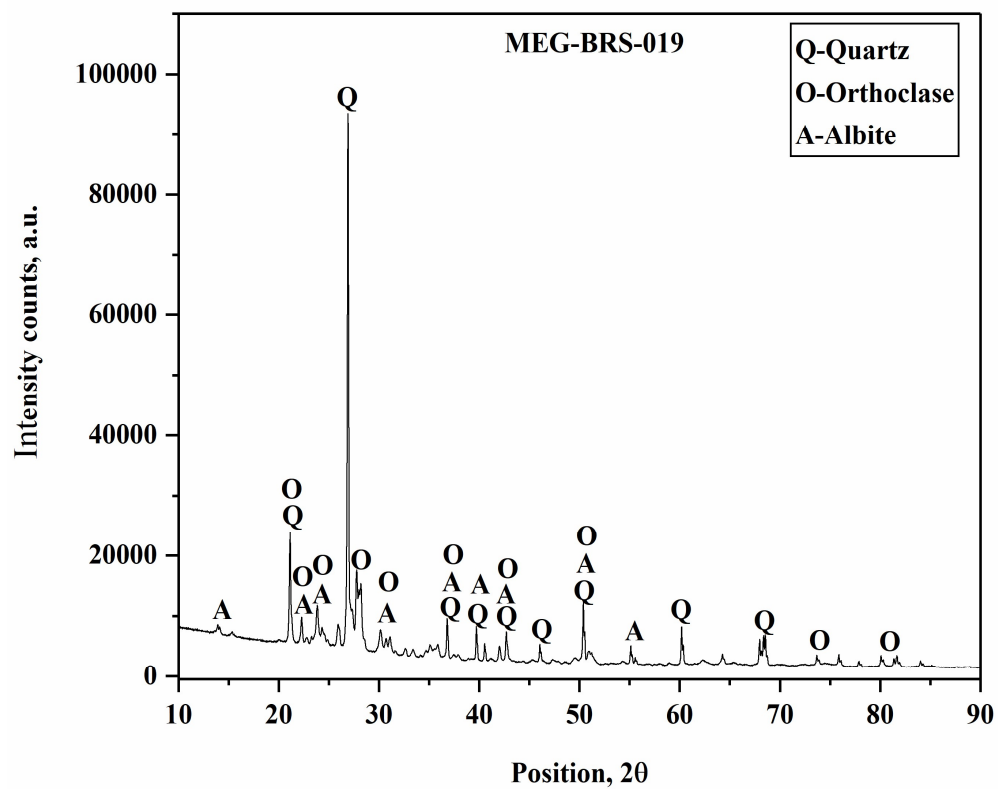
Name and Address of the Party: Mining Tech Consultancy Services Ltd (MTCS),
 Ahmedabad, Gujarat

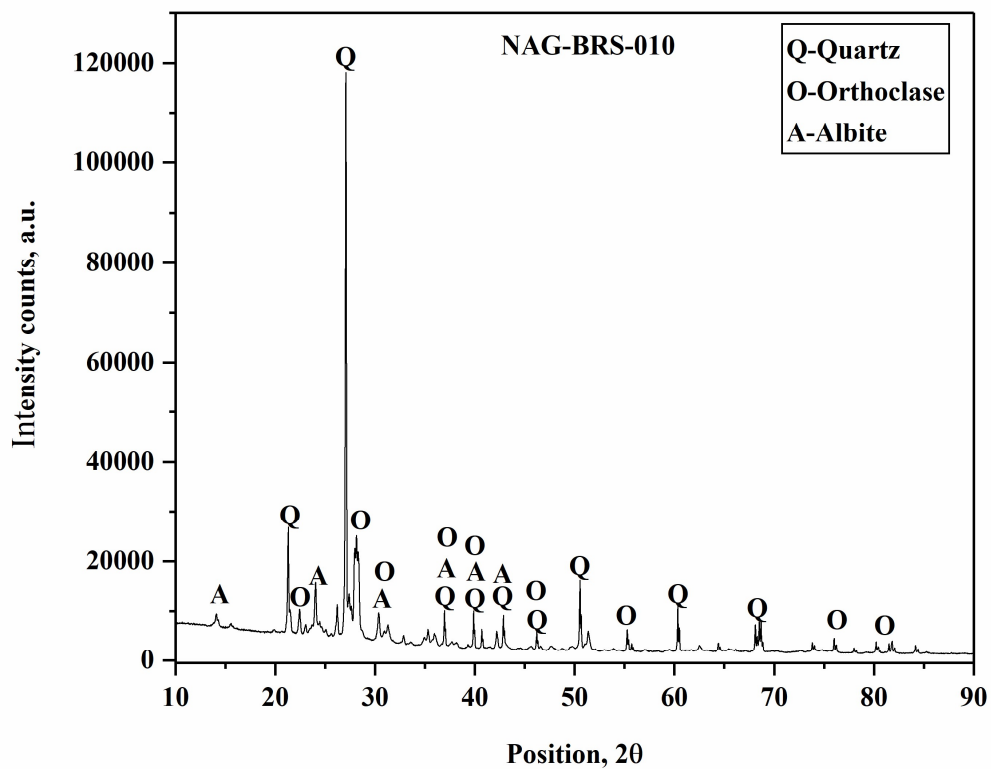
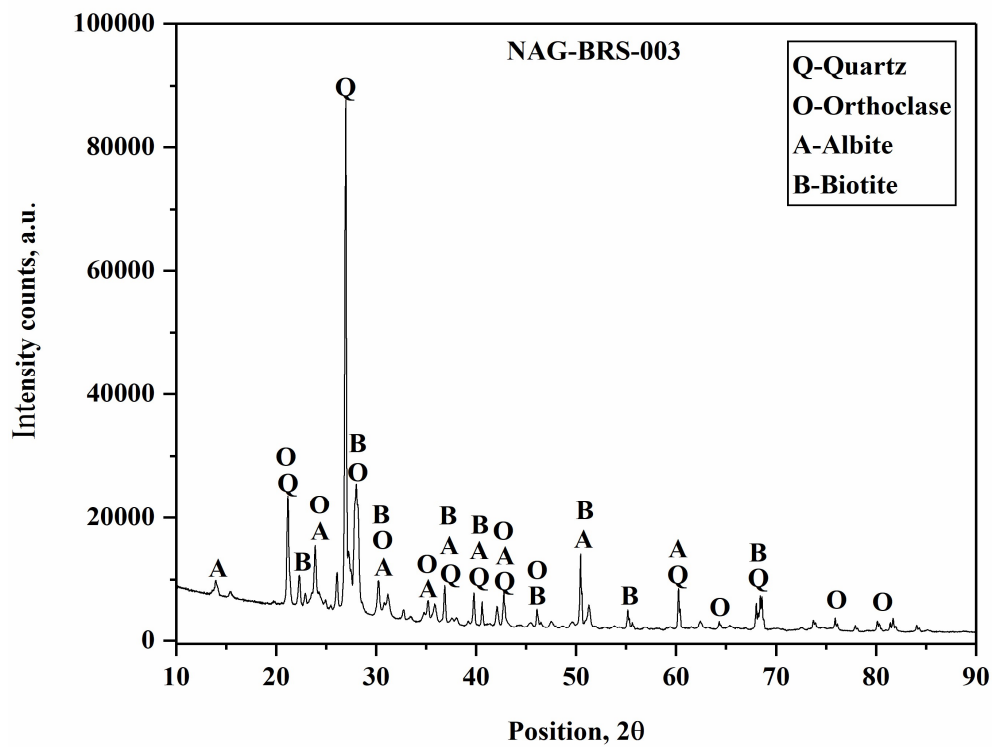
Sample details : Fine powder sample (10 Nos)
 Date of receiving : 17.11.2025
 Date of conducting Test : 18.11.2025
 Date of completion of test : 17.12.2025
 Method adopted/Equipment : XRD

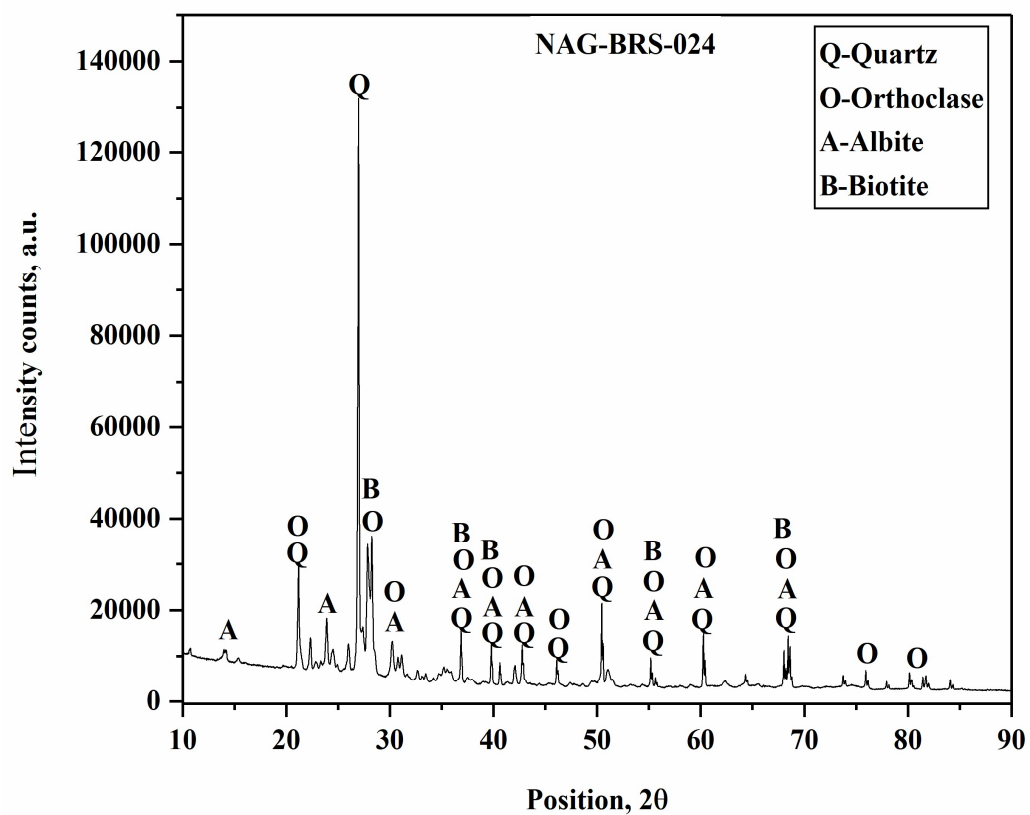
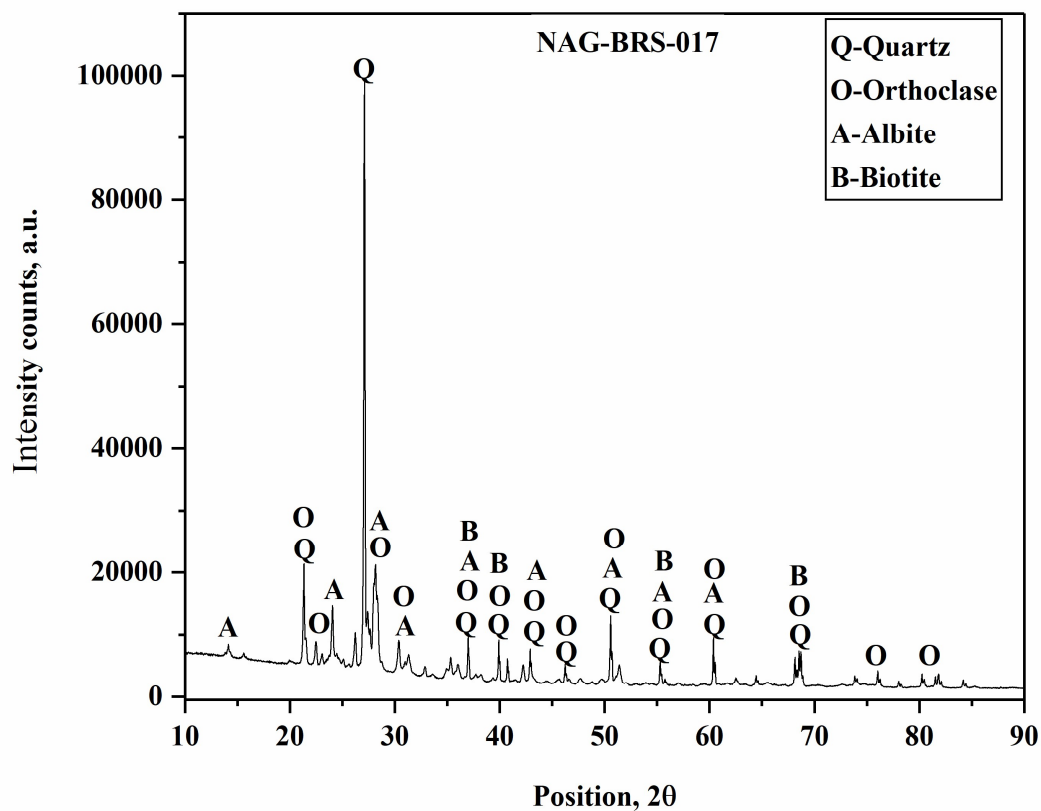
Observations: The as-received powder sample has been characterized by XRD. The mineral phases identified in each sample are shown in the following XRD pattern.

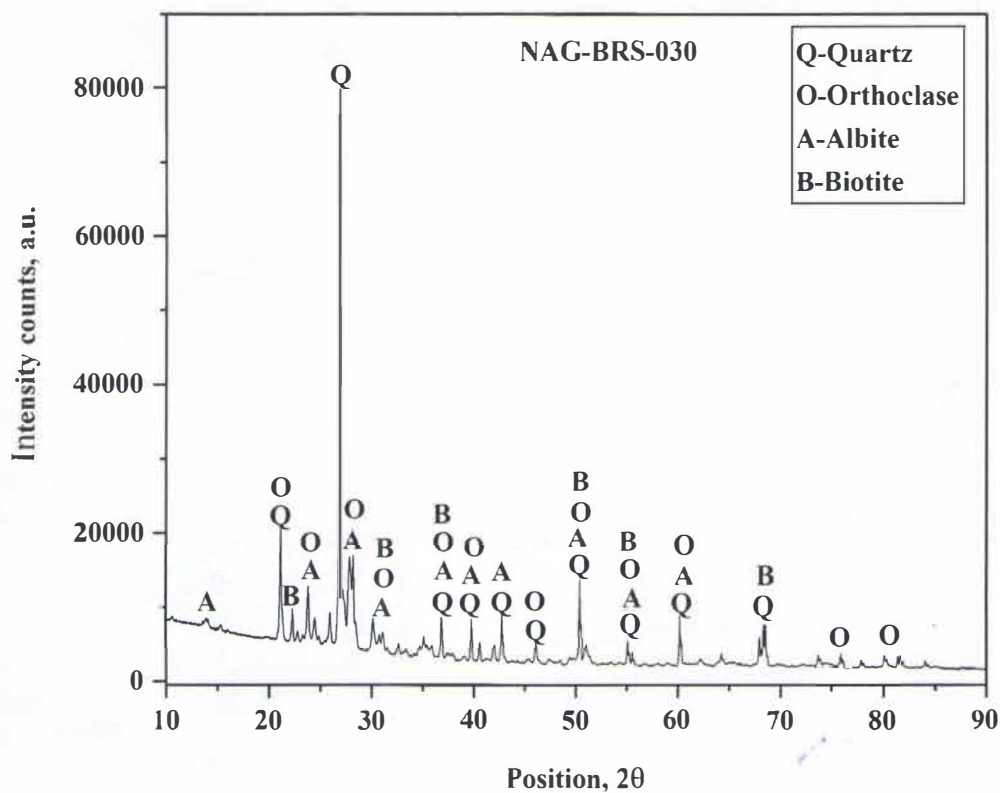












[Signature]
 18/12/25
 Dr. B. Nayak
 Chief Scientist & Head
 MMC Department

[Signature]
 18.12.25
 Dr. Sasmita Prusty
 Principal Scientist
 MMC Department

NB: The samples are not drawn by this institute. Liability if any for CSIR/IMMT arising in connection with the testing shall be subject to ceiling amount received by this institute from the client. The report should not be interpreted in part.

Annexure X

REPORT ON PETROGRAPHIC STUDY OF THE ROCK SAMPLES OF MEGHAWAS-NAGANA BLOCK, BARMER DIST, RAJASTHAN

REPORT ON PETROGRAPHIC STUDY OF THE ROCK SAMPLES OF MEGHAWAS-NAGANA BLOCK, BARMER DIST, RAJASTHAN

Prepared by



Mining Tech Consultancy Services Ltd.
Ahmedabad, Gujarat

December 2025

TABLE OF CONTENTS

A. BACKGROUND	Page 1- 1
B. HAND SPECIMEN STUDY	Page 1- 10
C. PETROGRAPHIC STUDY	Page 11 - 21
D. CONCLUSION	Page 22 - 22

A. BACKGROUND

Hand specimen study and Petrographic thin section study have been carried out for 10 bed rock samples collected from Meghawas-Nagana area located in Barmer district, Rajasthan. The detailed study procedures and outcome are described in subsequent paragraphs.

B. HAND SPECIMEN STUDY

Hand specimen study is the examination of minerals and rocks to identify them by their physical properties. The criteria are as follows:

- Colour
- Streak
- Transparency
- Luster
- Crystal Habit
- Hardness
- Cleavage Habit

1. SAMPLE ID. – NAG/PS/31

Megascopic study: The rock is brownish grey, very fine grained, finely laminated **Cherty Rhyolite**. Major minerals are fine grained cherty Quartz, reddish brown Garnet and Iron Ore minerals (mainly Hematite and minor Magnetite. The rock appears to be volcano sedimentary. Specific gravity is little high. It is very hard and compact.



Picture 1.1: Hand Specimen of Sample ID.-NAG/PS/31

2. SAMPLE ID. – NAG/PS/14

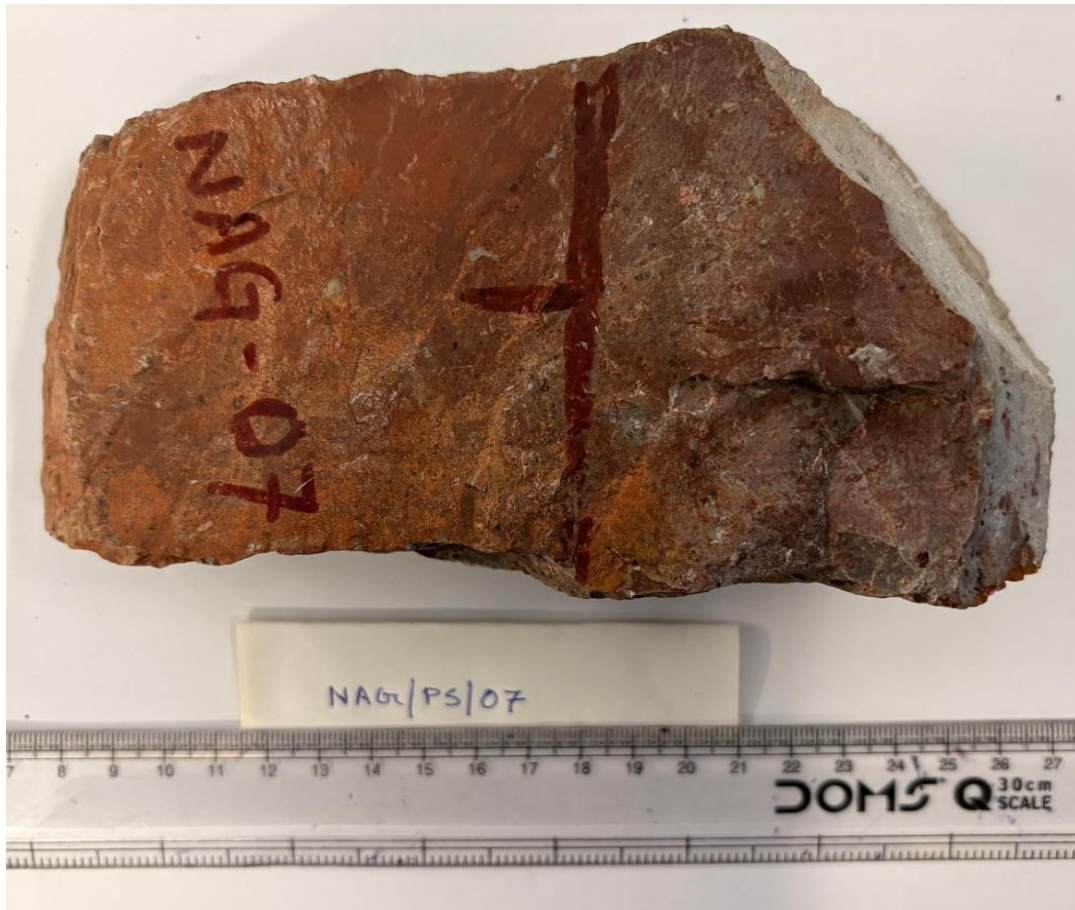
Megascopic study: The rock is medium-grained, brownish grey **Cherty Rhyolite**. Major minerals are Quartz, light brown Feldspar and black Chert grains. The black Chert grains, some brown Garnet and Feldspar grains are embedded within cherty fine Quartz groundmass. It is crudely banded and has joints. Some Rhyolitic lava could have produced such volcanogenic sedimentary rock. Some amygdules of black Chert are also present. It is very hard and compact. Specific gravity is little high.



Picture 1.2: Hand Specimen of Sample ID. – NAG/PS/14

3. SAMPLE ID. – NAG/PS/07

Megascopic study: It is a brownish grey very fine-grained **Rhyolite**. The groundmass is locally light grey and contains softer material formed possibly by alteration of Feldspar. It looks like rhyolitic lava rock with numerous phenocrysts of Quartz, Feldspar, altered Magnetite and some amygdules of Chert. It is a volcanogenic sedimentary rock derived from rhyolitic lava flow. The altered part is partly kaolinized. Specific gravity is little high. It is hard and compact.



Picture 1.3: Hand Specimen of Sample ID. – NAG/PS/07

4. SAMPLE ID. – NAG/PS/20

Megascopic study: It is a dark brown porphyritic lava rock mainly composed of Quartz, Feldspar and amygdules of Chert. It may be called **Rhyolite**. Feldspar and amygdules occur as larger grains (phenocrysts) within the fine-grained Quartz-rich groundmass. Some fracture-filling thin layers of Carbonate (Calcite) are also occasionally present. The rock is massive, hard and compact. Specific gravity is little high.



Picture 1.4: Hand Specimen of Sample ID. – NAG/PS/20

5. SAMPLE ID. – NAG/PS/21

Megascopic study: It is a brownish grey fine-grained porphyritic lava rock. Major minerals are Quartz and Feldspar. Feldspar occurs as disseminated phenocrysts along with amygdules of Quartz and Chert in the largely Quartz-rich groundmass. It is a volcanic rock and may be called porphyritic **Rhyolite**. It is massive, hard and compact. Specific gravity is little high.



Picture 1.5: Hand Specimen of Sample ID. – NAG/PS/21

6. SAMPLE ID. – MEG/PS/15

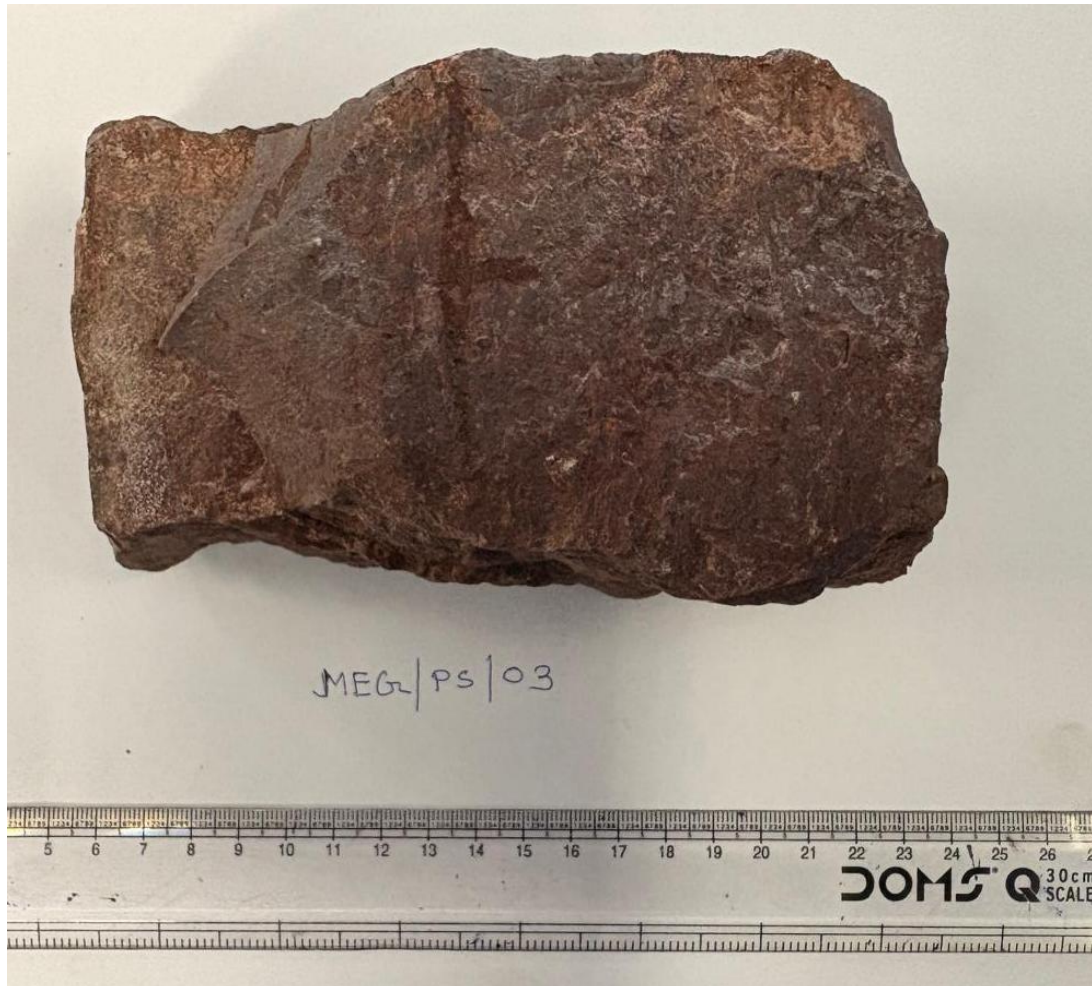
Megascopic study: The rock is very fine -grained, dark brown, Cherty volcanic one (**Rhyolite**) with numerous phenocrysts of Feldspar, Garnet and sporadic amygdules of spherical black Chert. It is a massive volcanogenic sedimentary rock. Major minerals are Quartz, Garnet, Feldspar and amygdules of black Chert. Specific gravity is high. It is very hard and compact.



Picture 1.6: Hand Specimen of Sample ID. – MEG/PS/15

7. SAMPLE ID. – MEG/PS/03

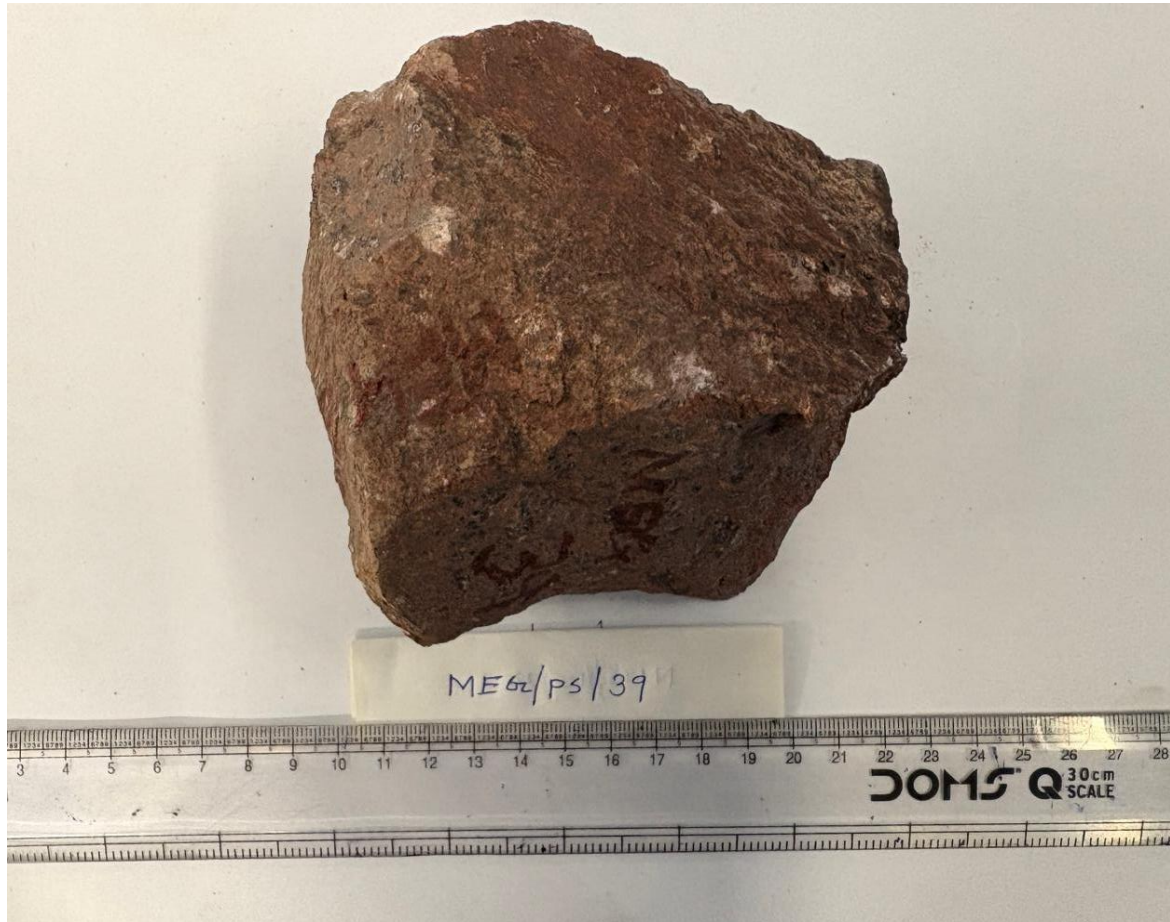
Megascopic study: The rock is very fine-grained, dark brown and massive **Rhyolite**. It is mainly composed of Quartz, Iron ore (Hematite-rich) and Feldspar with Chert amygdules. It is possibly derived from Rhyolitic lava and at present looks like cherty quartzite. Phenocrysts of Feldspar and amygdules of Quartz and black Chert are very common. It is very hard and compact with high specific gravity.



Picture 1.7: Hand Specimen of Sample ID. – MEG/PS/03

8. SAMPLE ID. – MEG/PS/39

Megascopic study: It is a dark brown, massive, cherty rock composed of Quartz, Feldspar and Iron ore (both Magnetite and Hematite) with fine-grained Cherty groundmass. Quartz and Feldspar grains occur as phenocrysts in the fine-grained groundmass. Amygdule of Chert is very common in the rock. It is a porphyritic lava rock called **Rhyolite**. The rock has joints, but it is hard and compact. Specific gravity is little high.



Picture 1.8: Hand Specimen of Sample ID. – MEG/PS/39

9. SAMPLE ID. – MEG/PS/23

Megascopic study: It is a dark brown, fine-grained, amygdular lava rock principally composed of Quartz, Feldspar and Cherty groundmass. It may be called **Rhyolite**. Amygdules of Quartz and black Glassy material are very common. Some altered surfaces show presence of Carbonate material. Quartz and Feldspar phenocrysts in the Cherty groundmass are very common. It is hard and compact with little high specific gravity.



Picture 1.9: Hand Specimen of Sample ID. – MEG/PS/23

10. SAMPLE ID. – MEG/PS/05

Megascopic study: It is brownish grey, massive, fine-grained rock mainly composed of Quartz, Feldspar and Iron ore mineral (Hematite). It contains amygdulites of quartz and black chert. It is a lava rock **Rhyolite** where phenocrysts of Quartz and Feldspar are very common. Overall texture is porphyritic. Clastic texture is also present in some places indicating minor recycling of the lava material by sedimentary process. It is hard and compact with little high specific gravity.



Picture 1.10: Hand Specimen of Sample ID. – MEG/PS/05

C. PETROGRAPHIC STUDY

Microscopic Study (in transmitted light)

Microscopic study: Under a Stereoscopic Compound Microscope, Model No. 1111733 Motic Type 107M with GT 5.0 camera attachment.

Slide Preparation:

- Cutting a Slab from the Rock Sample
- Initial Lapping of the Slap
- Glass Slide is added
- Slab is sectioned
- Final Lapping
- Polishing

1. SAMPLE ID. - NAG/PS/31

Microscopic study: The rock is extremely fine-grained and laminated. Major minerals are Quartz (70-80% by volume) and Iron ore minerals (20%, mainly Hematite and Magnetite). Altered Garnet and Biotite are also associated in minor amounts. The fine laminae of cherty Quartz contain interbands of relatively coarse Quartz and Magnetite grains. The rock is probably volcanogenic sedimentary Quartzite. It has been subjected to low grade metamorphism. The larger Quartz grains are deformed and show undulose extinction. Magnetite and Garnet grains are mostly altered to Hematite at the margins.

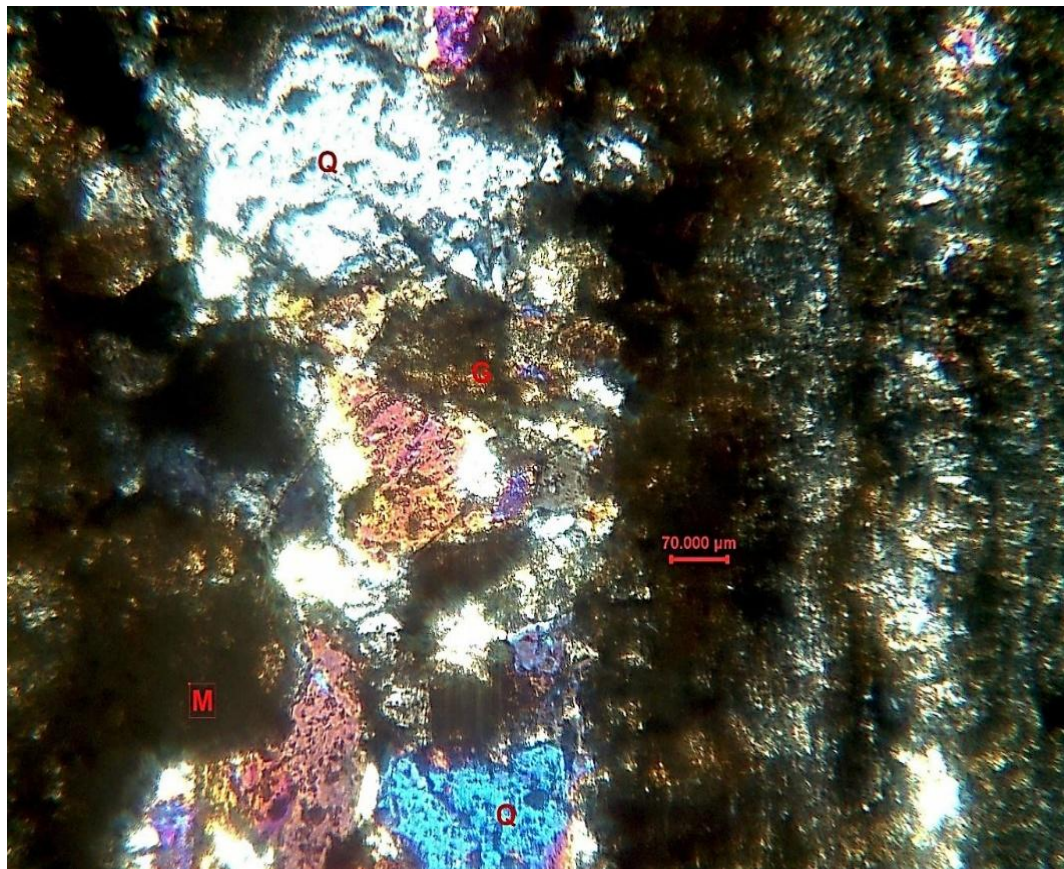


Figure 2.1A (NAG/PS/31): Interbands of fine-grained cherty Quartz and coarse- grained Quartz (Q) with large partly altered grains of Magnetite (M) and Garnet (G) (Under cross polarized light)

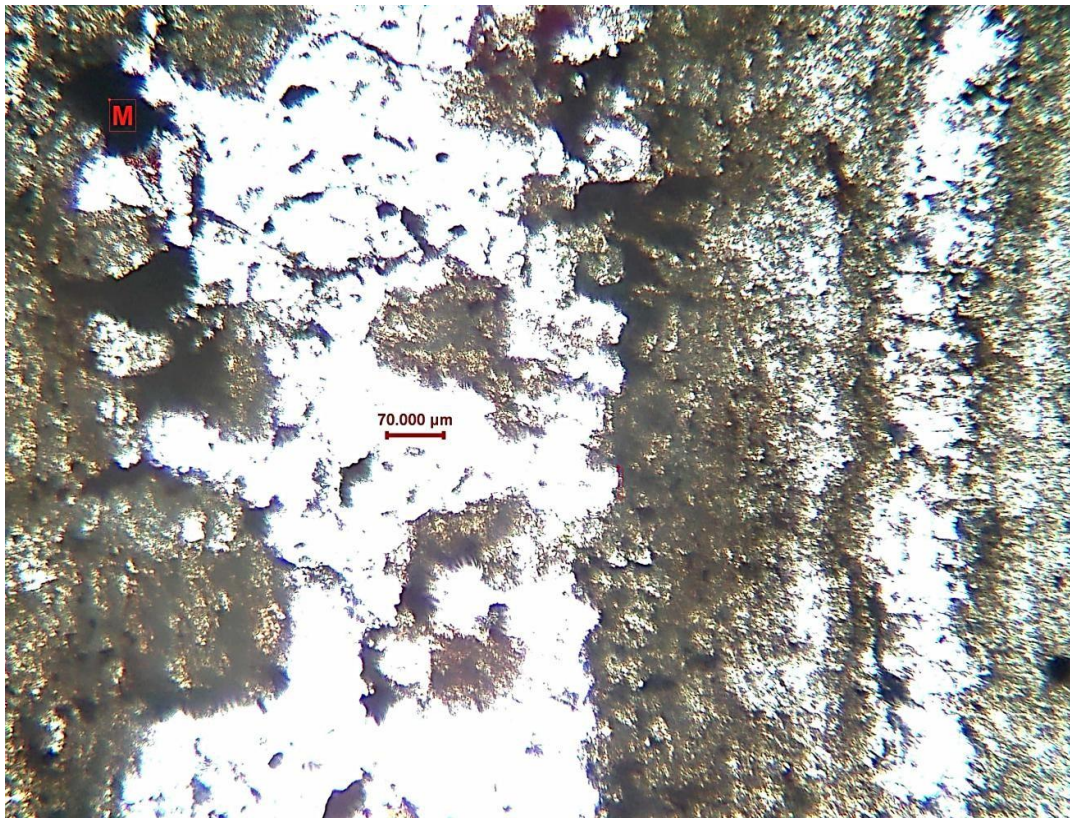


Figure 2.1B (NAG/PS/31): Same Photomicrograph (Under plane polarized light)

2. SAMPLE ID. - NAG/PS/14

Microscopic study: The rock is very fine-grained Cherty Rhyolite. The groundmass is mainly made of fine grains of cherty Quartz and some Feldspar. Oversize grains of sub round Quartz and Feldspar grains are embedded in the fine cherty groundmass. Feldspar grains are mostly deformed and altered. The large grains of Quartz and Feldspar occur as oversize clasts in the volcanogenic cherty groundmass. It is a volcano-sedimentary rock closely associated with some Rhyolitic lava flow. A pseudo-porphyrific texture is exhibited.

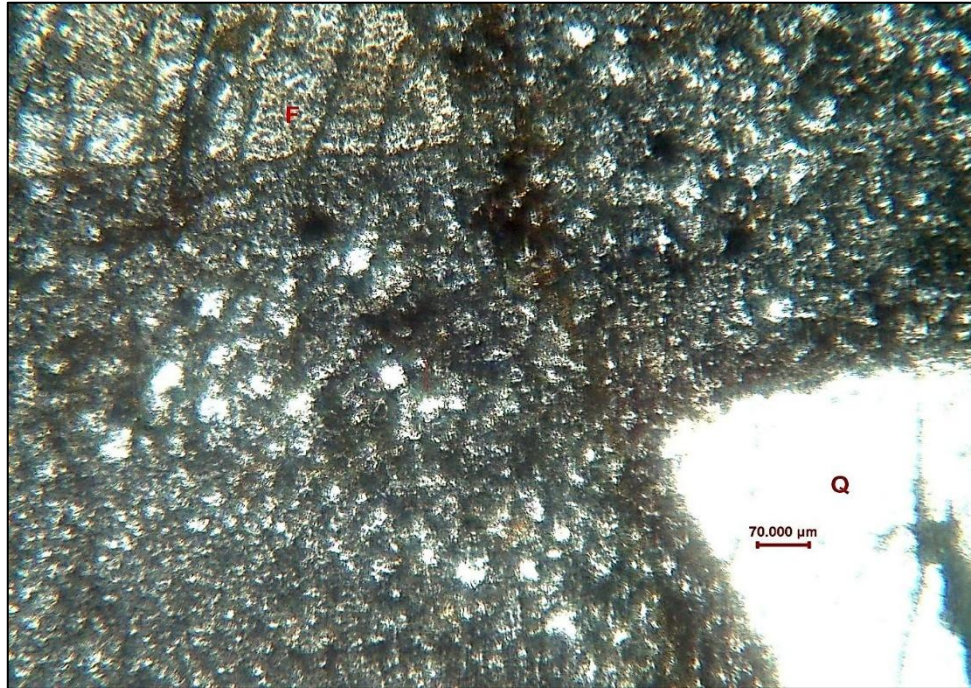


Figure 2.2A (NAG/PS/14): Deformed oversize clasts of Quartz (Q) and Feldspar (F) in the fine groundmass of cherty quartz (Under cross polarized light)

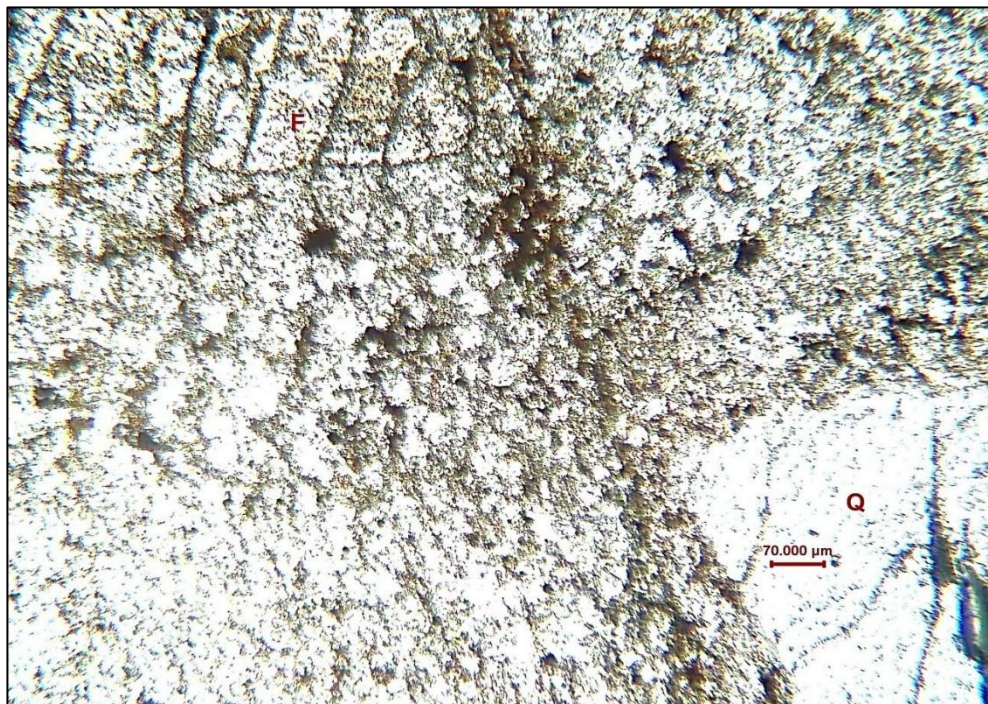


Figure 2.2B (NAG/PS/14): Same Photomicrograph (Under plane polarized light)

3. SAMPLE ID. - NAG/PS/07

Microscopic study: The rock is very fine-grained porphyritic **Rhyolite**. The fine-grained groundmass is mainly composed of cherty Quartz and Feldspar. The Feldspar is alkali type (K/Na Feldspar). Oversized grains of Quartz and partly altered Feldspar occur as phenocrysts resulting in porphyritic texture. Magnetite is altered to secondary Biotite at the margin. Quartz amygdules show marginal growth of fine Quartz.



Figure 2.3A (NAG/PS/07): Oversized phenocrysts of Quartz (Q) and altered Feldspar (F) in the fine-grained cherty groundmass (Under cross polarized light)

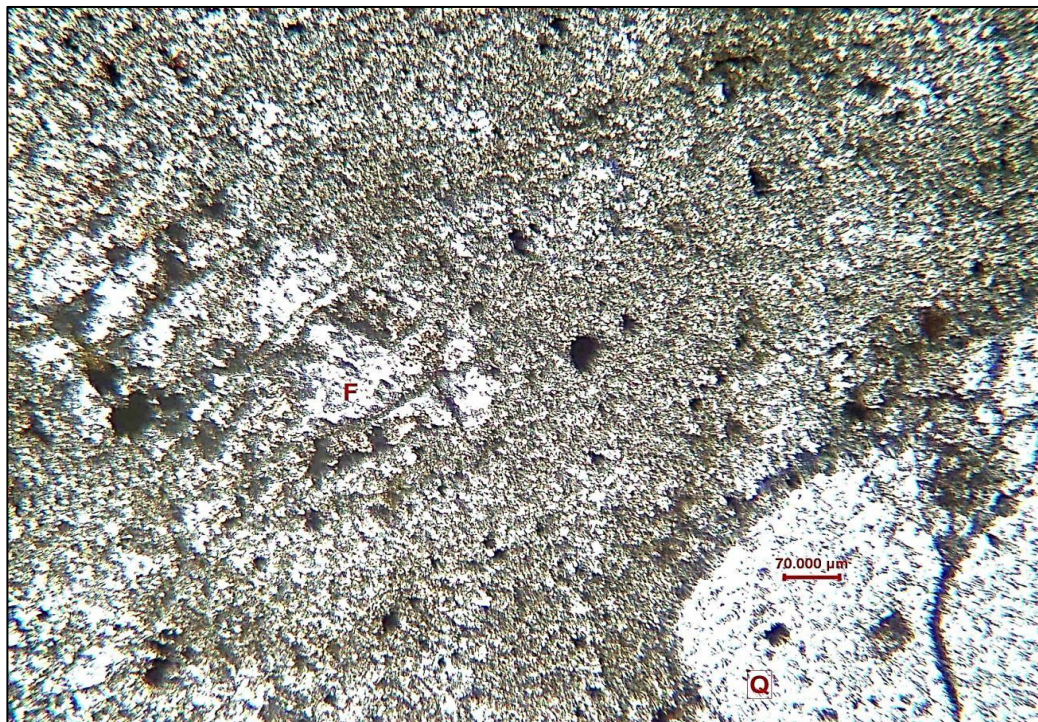


Figure 2.3B (NAG/PS/07): Same Photomicrograph (Under plane polarized light)

4. SAMPLE ID. - NAG/PS/20

Microscopic study: The rock is principally composed of Quartz (60%) and Feldspar (35%) both of which occur as large phenocrysts and as fine- grained groundmass material. Brown Glass is also present in the intergranular spaces of the fine- grains. Feldspar phenocryst is of Orthoclase composition. Magnetite is about 5% and it is commonly altered to secondary glass is very common in the groundmass. Overall porphyritic texture is exhibited. The rock is Rhyolite having Quartz amygdules.

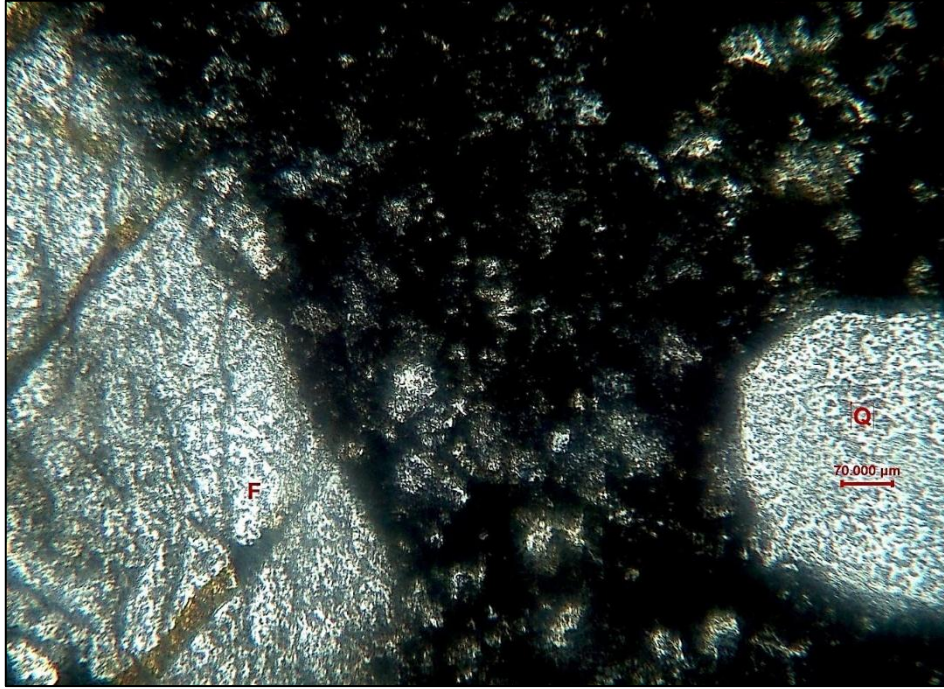


Figure 2.4A (NAG/PS/20): Phenocrysts of Quartz (Q) and Feldspar (F) are enclosed within the fine groundmass of Quartz-Feldspar aggregate exhibiting porphyritic texture. (Under cross polarized light)

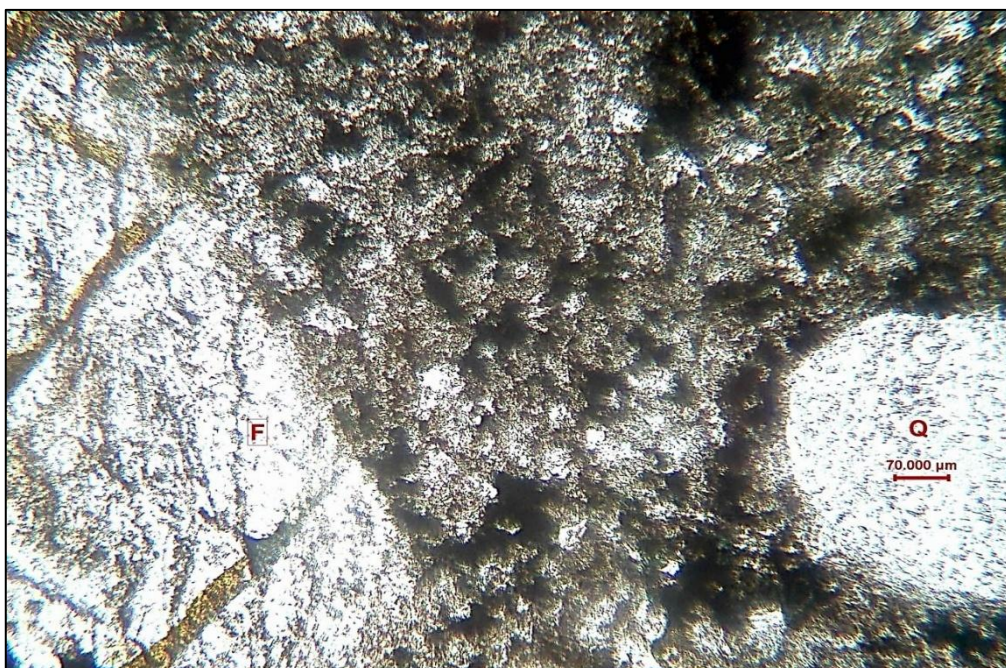


Figure 2.4B (NAG/PS/20): Same Photomicrograph (Under plane polarized light)

5. SAMPLE ID. - NAG/PS/21

Microscopic study: It is very fine-grained porphyritic lava rock mainly composed of Quartz (50%) and Alkali Feldspar (40%) with minor amount of Magnetite, Biotite and Glass. The brown Glass is very common in the groundmass. Amygdules are made of Quartz mainly. Magnetite grains are altered to secondary Biotite and Hematite at the margin. The rock exhibits a typical porphyritic texture with phenocrysts of oversize Quartz and Feldspar mainly.

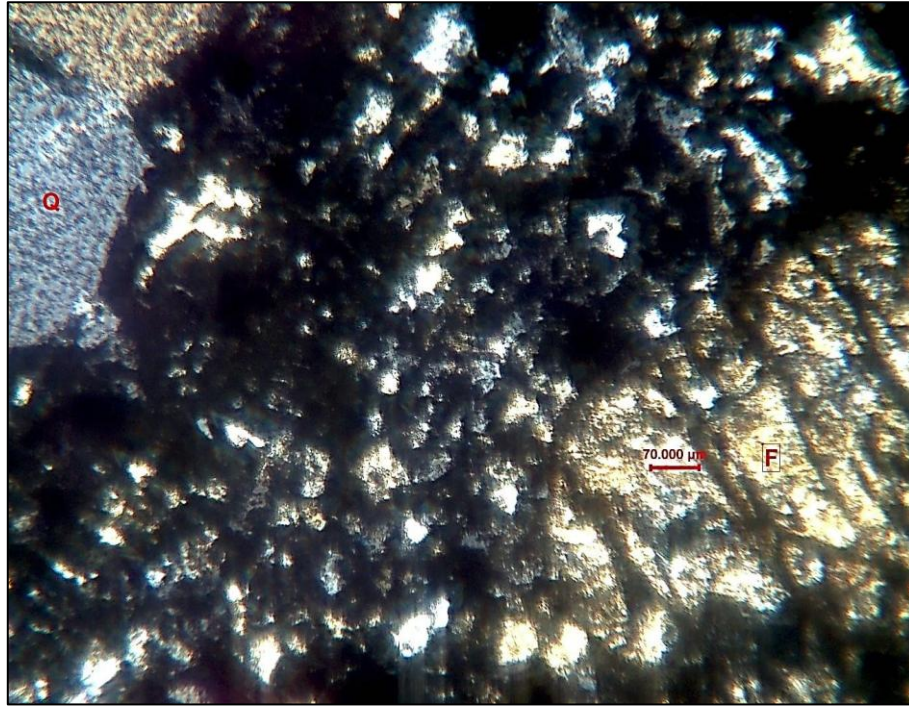


Figure 2.5A (NAG/PS/21): Porphyritic texture is exhibited by large Quartz phenocrysts (Q) and Feldspar phenocrysts (F); the black grains are Magnetite (Under cross polarized light)

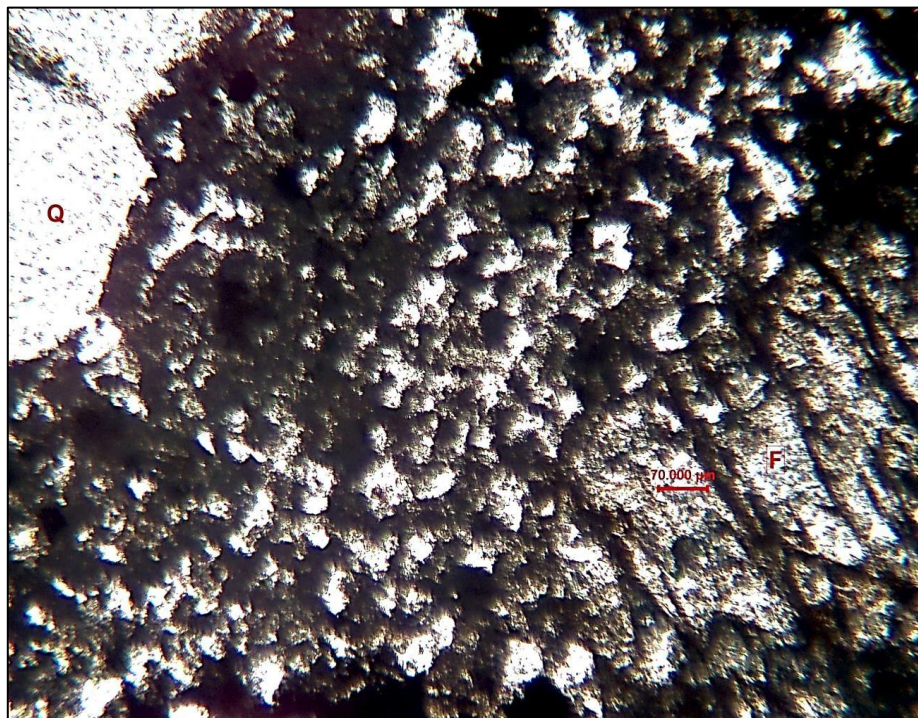


Figure 2.5B (NAG/PS/21): Same Photomicrograph (Under plane polarized light)

6. SAMPLE ID. - MEG/PS/15

Microscopic study: The rock is amygdular and comprises numerous round or sub-round amygdules of Quartz and Chert. The Quartz amygdules show typical corona-like rims. Oversize grains of altered Feldspar and fresh large grains of Quartz occur as phenocrysts in the very fine-grained cherty groundmass forming porphyritic texture. Brown Glass and patchy Iron ore (mainly Hematite) are common in the groundmass. The rock may be called **Rhyolite**.

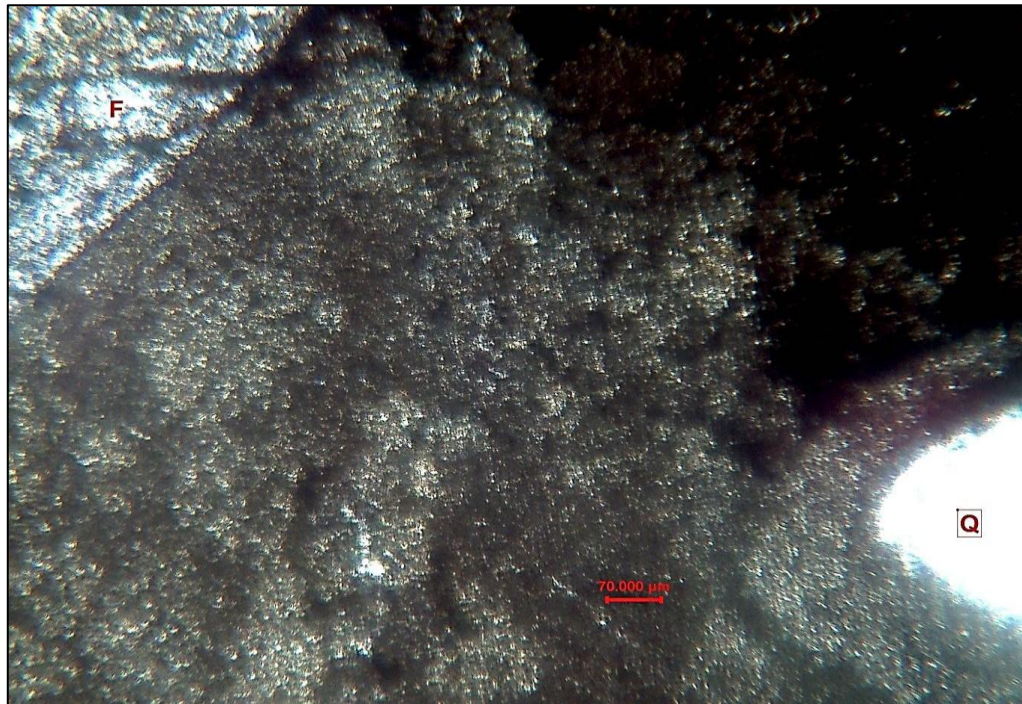


Figure 2.6A (MEG/PS/15): Large phenocryst of Feldspar (F) and quartz (Q) amygdule in the fine-grained Cherty groundmass (Under cross polarized light)

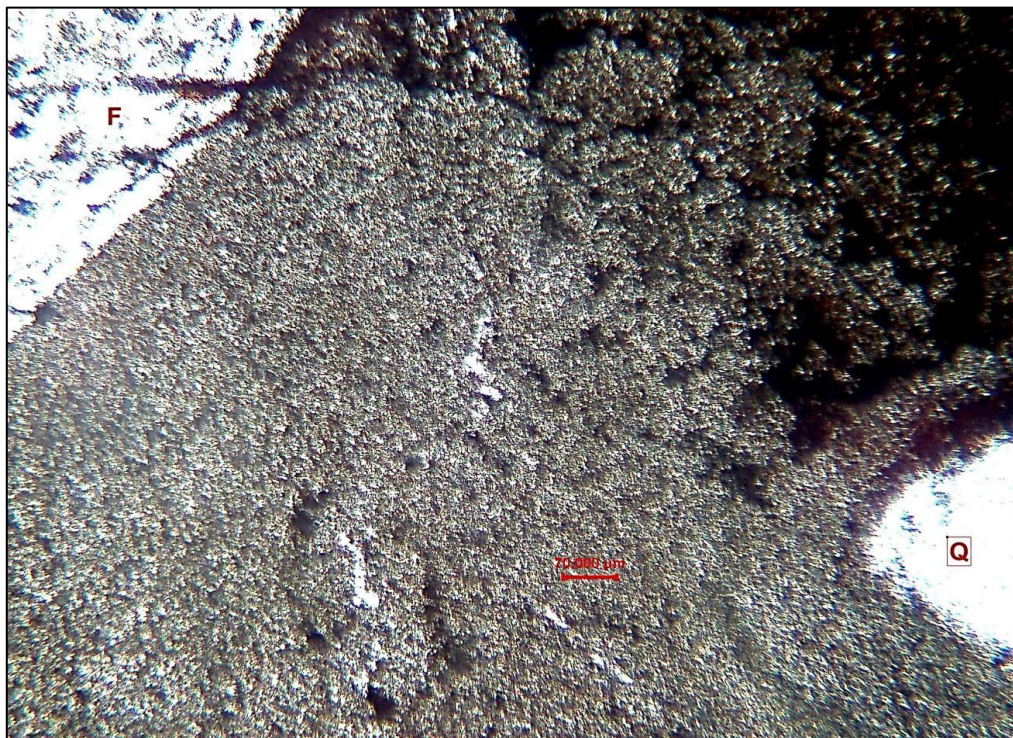


Figure 2.6B (MEG/PS/15): Same Photomicrograph (Under plane polarized light)

7. SAMPLE ID. - MEG/PS/03

Microscopic study: The rock is principally composed of Quartz (60%), Alkali Feldspar (25%) and brown Glass (15%). It is very fine-grained volcanic rock and may be called **Rhyolite**. Flow structure is present. Porphyritic texture is shown by large phenocrysts of Quartz and Feldspar embedded in the fine groundmass of Quartz-Feldspar-brown Glass aggregate. Quartz amygdule shows brown alteration rim. Feldspar is mainly Orthoclase, and the grains are euhedral/subhedral prismatic but commonly fractured.

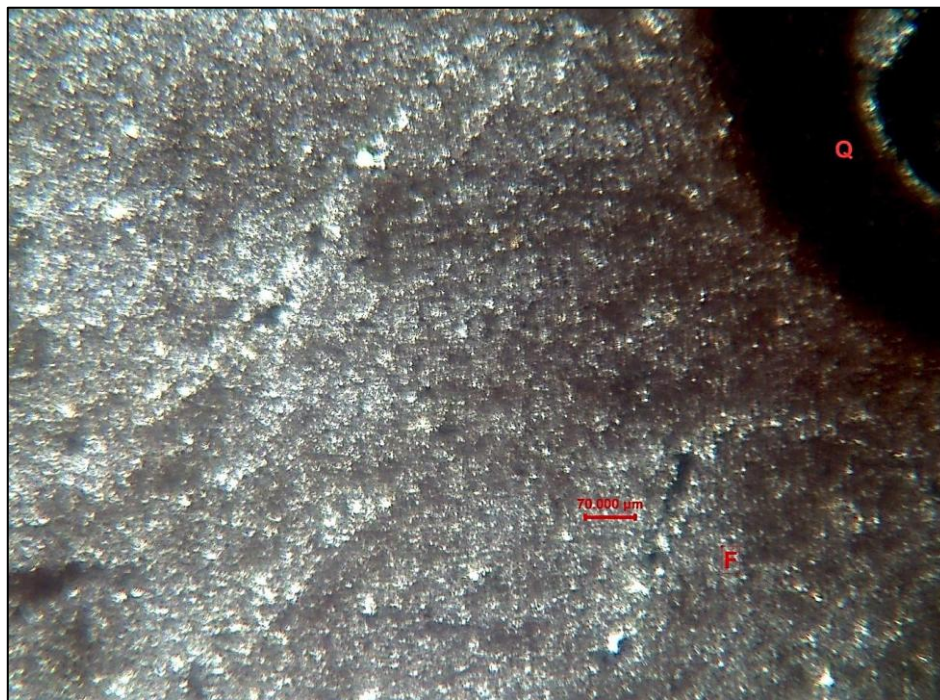


Figure 2.7A (MEG/PS/03): Quartz (Q) amygdule with brown alteration rim and prismatic Feldspar phenocryst embedded in the fine-grained groundmass of Quartz-Feldspar-Glass aggregate (Under cross polarized light)

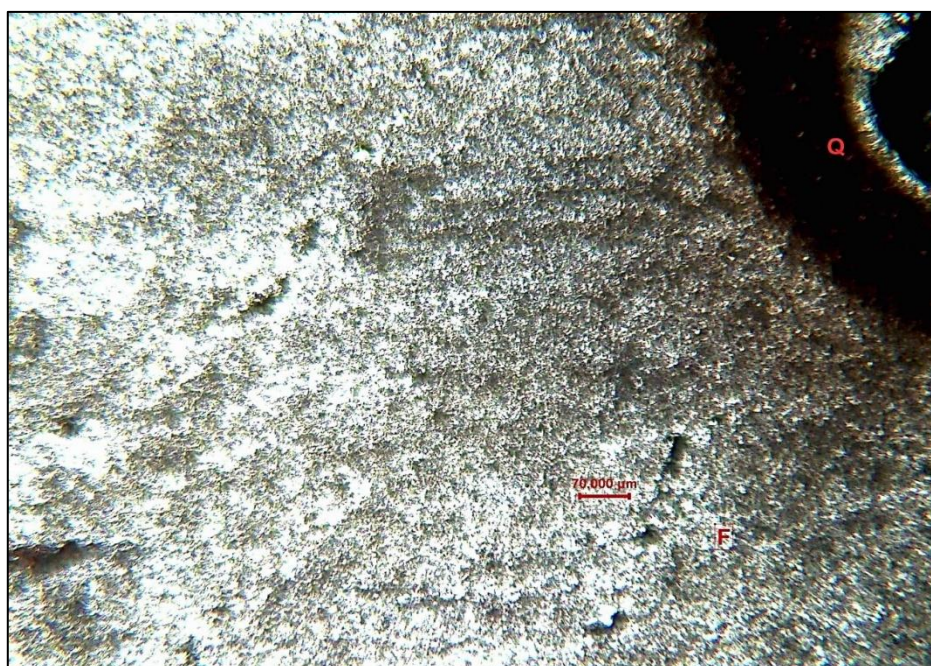


Figure 2.7B (MEG/PS/03): Same Photomicrograph (Under plane polarized light)

8. SAMPLE ID. - MEG/PS/39

Microscopic study: The rock is vitrophyric with Glassy groundmass in which numerous angular large grains Quartz, altered Feldspar and Magnetite are floating like pyroclastic debris in Cherty/Glassy groundmass. Brown Glass is about 40% in the groundmass. Feldspar phenocryst is Orthoclase in composition. Amygdule of Quartz with multigrain aggregate is very common. Overall texture is porphyritic. It may be called **Rhyolite**.

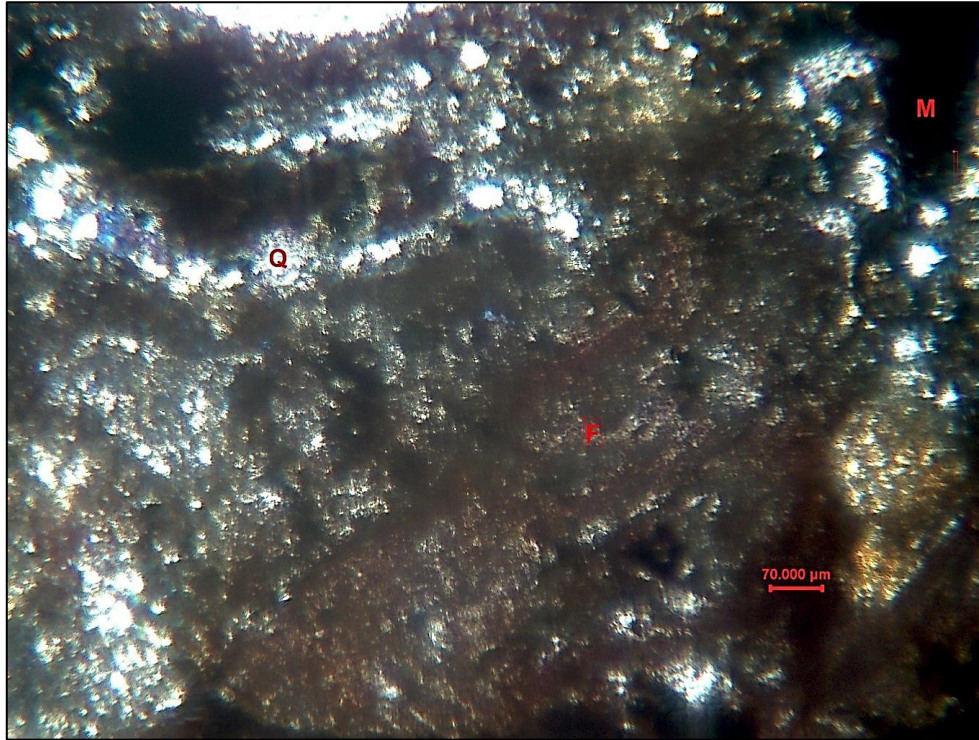


Figure 2.8A (MEG/PS/39): Large grains of Quartz (Q), Feldspar (F) and Magnetite (black) in the Cherty groundmass (Under cross polarized light)

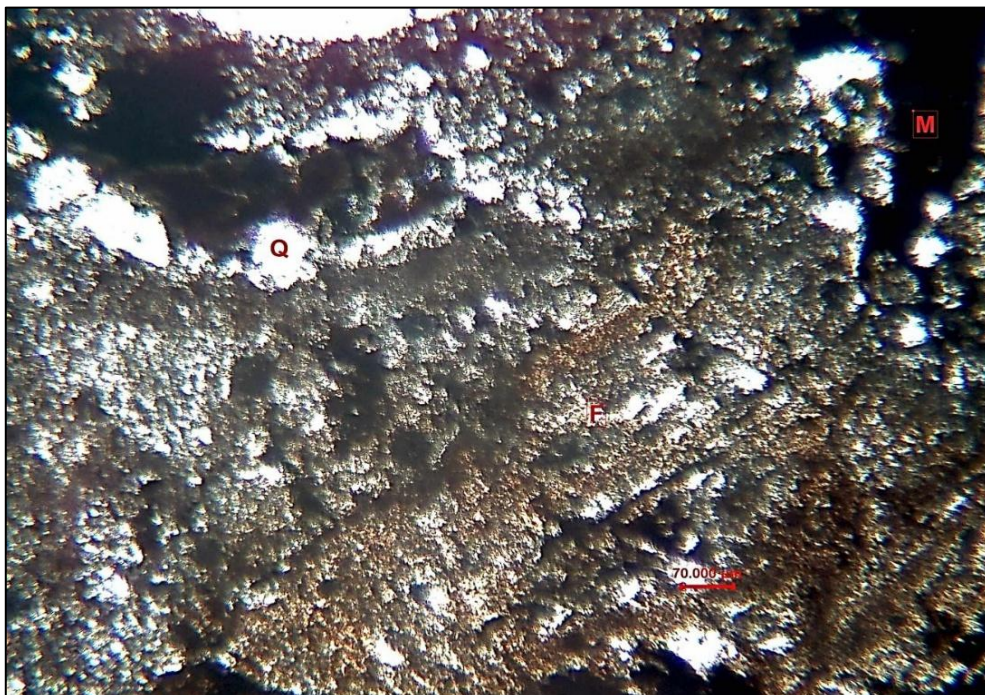


Figure 2.8B (MEG/PS/39): Same Photomicrograph (Under plane polarized light)

9. SAMPLE ID. - MEG/PS/23

Microscopic study: The rock is very fine-grained with random phenocrysts of Quartz, Feldspar and Magnetite. Amygdules of Quartz and Glass are very common. Quartz is about 50% and Feldspar is about 25%. The residual part is mainly made of brown Glass and Iron ore mineral (mainly Magnetite and Hematite). Overall texture is aphanitic and locally it is porphyritic. Feldspar is mainly Othoclase which is mostly altered to Clay minerals.



Figure 2.9A (MEG/PS/23): Feldspar (F) phenocryst is trapped in a large glass amygdale; the Glass is going to be devitrified with growth of tiny crystals (Under cross polarized light)

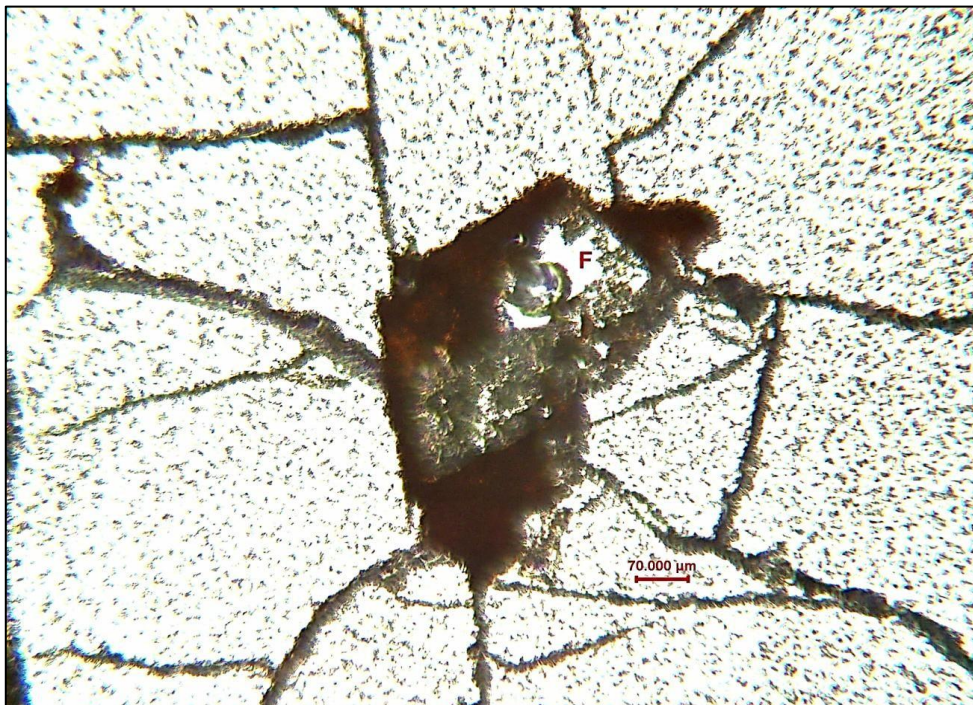


Figure 2.9B (MEG/PS/23): Same Photomicrograph (Under plane polarized light)

10. SAMPLE ID. - MEG/PS/05

Microscopic study: It is very fine-grained volcanic rock mainly composed of Quartz (60%), Feldspar (30%) and Hematite (10%). The ground mass material is very fine-grained aggregate of Quartz and Feldspar. Large grains of Quartz and Feldspar occur as phenocrysts within the fine-grained a Cherty groundmass. Porphyritic texture is exhibited by large grains of Quartz, Feldspar and Hematite randomly enclosed within Cherty groundmass. The original rock was amygdular **Rhyolite** which was subjected to later sedimentary process.

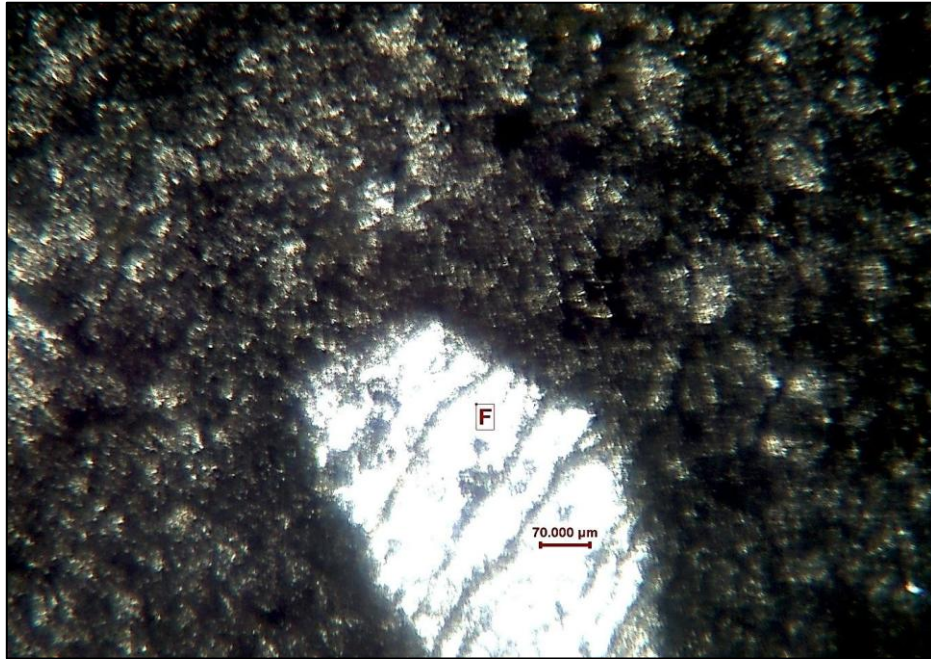


Figure 2.10A (MEG/PS/05): Large Feldspar phenocryst (F) and some altered Hematite (black) are embedded in the fine-grained Cherty groundmass (Under cross polarized light)



Figure 2.10B (MEG/PS/05): Same Photomicrograph (Under plane polarized light)

D. CONCLUSION

Petrographic analysis of all examined samples (NAG/PS/31, NAG/PS/14, NAG/PS/07, NAG/PS/20, NAG/PS/21, MEG/PS/15, MEG/PS/03, MEG/PS/39, MEG/PS/23 and MEG/PS/05) reveals a dominant assemblage of Quartz and Alkali Feldspar with variable proportions of iron ore minerals (Magnetite and Hematite), brown volcanic Glass, and accessory Biotite and altered Garnet. The samples show well-developed porphyritic and vitrophyric textures, with abundant phenocrysts of Quartz and Feldspar set within very fine-grained cherty or glassy groundmass. The common presence of amygdules filled with Quartz and Chert, along with glassy matrix and flow structures, confirms a clear volcanic origin with strong indication of subaerial or shallow-subvolcanic emplacement.

The rocks collectively represent volcano-sedimentary to volcanic lithologies dominated by Rhyolite with cherty Quartzite interlayers, reflecting alternating episodes of explosive acidic volcanism and sedimentary reworking. The observed textural and mineralogical relationships—such as undulose extinction in Quartz, deformation and alteration of Feldspar, conversion of Magnetite to Biotite/Hematite, and pseudomorphing of vesicles—indicate low-grade metamorphism and post-emplacement hydrothermal alteration. The presence of volcanogenic quartzites and pseudo-porphyritic cherty facies further indicates syn-volcanic sedimentation associated with rhyolitic lava flows or pyroclastic precursors.

Overall, the petrographic characteristics suggest that the studied sequence represents an acid volcanic terrain comprising Rhyolitic lava flows, vitrophyric volcanic rocks, and interlayered volcanogenic cherty quartzites, later subjected to deformation, fluid activity, and low-grade metamorphic overprinting. This supports a tectono-magmatic environment likely related to an ancient continental volcanic arc or rift-associated felsic volcanism.