A REPORT OF

MINOR PROJECT

ON

PETROPHYSICAL STUDY OF ALKALINE ROCKS IN KAMTHAI,BARMER,RAJASTHAN

SUBMITTED TO

DEPARTMENT OF PETROLEUM ENGINEERING & EARTH SCIENCES
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "PETROPHYSICAL STUDY OF ALKALINE ROCKS IN KAMTHAI,BARMER,RAJASTHAN" submitted by Ankit Kumar and Parry arora in partial fulfillment of the requirements for the degree of Bachelor Of Technology in Geosciences.

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Place:

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We have been fortunate to have completed this work at the Department of Petroleum and Earth Sciences at the University of Petroleum and Energy Studies, Dehradun. It is the knowledge and mendship that we have gained during our tenure here that will always remain with us.

We would like to thank Dr. K.S.MISRA, our mentor, for his continued support throughout our time here. He was the person who raised our interest in Mineral Exploration and helped us to complete the work on Petrophysical study of alkaline rocks in Kamthai, Barmer, Rajasthan.

Abstract

The rare earth elements (REEs), which include the 15 lanthanide elements (Z = 57 through 71) and yttrium (Z = 39), are so called because most of them were originally isolated in the 18th and 19th centuries as oxides from rare minerals. Cerium, the most abundant REE comprises more of the earth's crust than copper or lead. The industrial applications of rare earth elements include the making of strongest magnets, polishing glass. These are primarily used in phosphors, in MRI scans, auto catalyst, fluid cracking catalyst, as a glass additives and in rechargeable batteries.

The geology of REE deposits includes Iron-REE deposits, Carbonatite deposits, Lateritic deposits, Placer deposits. This project constitutes the petrographic study of the alkaline rocks associated with the carbonatites in the Barmer district of Rajasthan (India). Alkaline rocks and associated carbonatite are very well known in the Sarnu-Dandali area from the work conducted by many researchers. Based on the geological mapping and grid channel geochemical sampling, a carbonatite plug hosted REE deposit was discovered at Kamthai, Barmer district, Rajasthan. The basement of the Sarnu-Dandali area is characterized by the Malani Rhyolites and Rhyolitic tuff that was a result of late Proterozoic bimodal volcanism that occurred around 745 million years ago and the last magmatic activity occurred during tertiary period around 55 million years ago. For the achievement of the purpose of the project a geological map of the area is to be plotted and core plugs from the samples will be done. Then the cores will be converted to thin section and will be analysed using microscope.

These rocks are magmatic carbonate rocks which are rich in carbonates (50% or more) but are not of sedimentary or metamorphic origin. They are mainly intrusive and are closely associated with alkaline igneous rocks although being alkali poor or alkali free. This association is considered to be characteristic and has been included in definition of the carbonatites. The common associates of carbonatites are nephelinite, melanephlinite or their plutonic equivalents namely ijolite series. These mafic alkaline rocks usually form the core of ring or sheet complexes and are fringed by carbonatites. Some complexes may also show core of carbonatites surrounded by syenites, nepheline syenites, in other cases by ultramafic suits. An important petrological feature associated with carbonatites is their metasomatic effect over contact rocks. The main fenitisation process in these carbonatites is a shallow level potassium fenitisation resulting in development of carbonated orthoclastic dykes and orthoclase phenocrysts and feldspathic xenoliths in the late stage of alvikites and ferrocarbonatites

Chapter – 1
Introduction

Alkaline rocks and associated carbonatite are very well known in the Sarnu-Dandali area from the work conducted by many researchers (Bhushan et al).

Recently work has shown a detailed account of the Geology and REE potential of the area. Based on the geological mapping and grid channel geochemical sampling, a carbonatite plug hosted REE deposit was discovered at Kamthai, Barmer district, Rajasthan. The carbonatite plug covers 19475 sq. meters and the main REE minerals hosted by carbonatite plug are Bastanesite (La), Basnaesite (Ce), Carbocernaite (Ce) and Cerianite (Ce).

The basement of the Sarnu-Dandali area is characterized by the Malani Rhyolites and Rhyolitic tuff that was a result of late Proterozoic bimodal volcanism that occurred around 745 million years ago and the last magmatic activity occurred during tertiary period around 55 million years ago.

For the achievement of the purpose of the project a geological map of the area was plotted using exposure mapping technique and petrophysical analysis will be carried out by making core plugs from collected samples and further studying the thin sections made from them.

Alkaline Rocks and associated carbonatites

Alkaline rocks are a set of petrographically distinct group of rocks deficient in silica and alumina as compared to alkali and have nepheline or alkali pyroxene in their norms. Hence, the alkali silica and alkali alumina relations are crucial for characterization of the rock types.

Generally the reference to standard composition of alkali feldspar appears to be widely accepted by the petrologists. Thus alkaline rocks can be grouped as;

1. Rocks having adequate or excess silica (i.e., silica saturated or oversaturated rock but deficient in alumina. The excess alkalies which can not constitute feldspars, enter into alkaline mafic minerals. The rocks are then characterized by alkali feldspar, sodic pyroxene and/or sodic amphibole. Silica oversaturated alkaline rocks thus carry quartz or silica rich glass.
2. Rocks in which alumina is adequate to saturate feldspar composition or in excess but silica is deficient the rocks are then composed of feldspar and feldspathoids along with mica, hornblende, corundum etc. Representative rocks are nepheline syenite, leucite monzonites (sommaites).
3. Rocks deficient in both silica and alumina relative to feldspar composition. The rocks contain besides alkali feldspar, both silica under saturated minerals e.g., feldspathoids as also alkali rich mafic minerals. Aegirine and/or riebeckite bearing nepheline syenite is a typical example.

Mainly silica undersaturated alkaline rocks are as prominent occurrences in Rajasthan such: **(1)** The Kishangarh nepheline syenites and associated essexitic rocks; **(2)** The Mundwara basanite, theralite, essexite, foidal syenite and carbonatite and **(3)** the Sarnu-Dandali nephelinite-carbonatite association rocks. Besides these major occurrences there are also small plug like bodies and dykes of ijolitic rocks and carbonatites to the southwest of Barmer.

Our study area falls under the Sarnu-Dandali alkaline complex which is located at the eastern edge of the Barmer Graben, where variety of rocks association exposed as acidic, intermediate and alkaline rocks. The main rock types are rhyolites and rhyolites tuffs forming the country rocks. These, at places are overlain by intermediate alkaline rocks such as alkali olivine basalts, hawaiites, trachy andesites, trachytes and intruded by bosses of alkali syenites.

The alkaline rocks are represented by isolated plug like bodies of micromelteigites, ijolites, feldspathic ijolites, fodal syenites, besides numerous dykes of foidal syenites, phonolites and carbonatites and flows of melanephilinite. Phonolite dykes mark the last phase of alkaline activity in the area (Narayan Das *et al*., 1978; Chandrasekaran, 1987).

Carbonatite association with alkaline rocks

These rocks are magmatic carbonate rocks which are rich in carbonates (50% or more) but are not of sedimentary or metamorphic origin. They are mainly intrusive and are closely associated with alkaline igneous rocks although being alkali poor or alkali free. This association is considered to be characteristic and has been included in definition of the carbonatites. The common associates of carbonatites are nephelinite, melanephlinite or their plutonic equivalents namely ijolite series. These mafic alkaline rocks usually form the core of ring or sheet complexes and are fringed by carbonatites. Some complexes may also show core of carbonatites surrounded by syenites, nepheline syenites, in other cases by ultramafic suits. An important petrological feature associated with carbonatites is their metasomatic effect over contact rocks. The country rocks that normally suffer alkali metasomatism are named fenites and the related alkali metasomatic process is called fenitisation.

The Sarnu-dandali and Barmer carbonatites are mainly occurring as alvikites and ferrocarbonatites as thin dykes and bands varying in width from 2 to 40 cms. A majority of them are within melanphlinite to the north of the Kamathai. Some are found as intrusive within rhyolites and olivine basalts. Often they are cut by late stage thin carbonatites veins of foidal syenitic composition.

The main fenitisation process in these carbonatites is a shallow level potassium fenitisation resulting in development of carbonated orthoclastic dykes and orthoclase phenocrysts and feldspathic xenoliths in the late stage of alvikites and ferrocarbonatites. The trains of small crystals of biotite indicate that the fenitisation in these rocks was hydrous (Bailey, 1966).

Chapter – 2
Geology of Area

2.1 Regional Geology

The late proterozoic malani bimodal volcanism constitute the largest suit of anorogenic acid volcanics in India.The volcanism took place during approximately 745 million years ago, succeeding the granitic activity of Abu pluton and ceased before the onset of Marwar sedimentation.

The work of many researchers suggests a well-recognized three stage igneous activity in the volcanism. Volcanics of the first stage are mostly basalt with occasional andesite or trachy basalt. These are subsequently covered by the voluminous outpouring of peralkaline and peraluminous rhyolite, basalt, dacite and trachyte flows. The third stage ceased with the outburst of ash flow deposits.

The dominant felsic volcanics are rhyolites and rhodacites spread over an area of about 31,000 km^2. The other rock types associated with rhyolite are trachyte, dacite, pitchstone, welded tuff, lithic and crystal ash, ignimbrite, obsidian, pyroclastic slates, agglomerate, volcanic breccias and volcanic conglomerates. Major of the acid volcanic are high potassic and a few are calcalkaline or low potassic in composition.

Malani volcanism was essentially under the terrestrial conditions, although deposition by aqueous conditions are also indicated. The volcanic eruptions have been through fissures, shield volcanos and central cones. The volcanic was triggered in an extensional tectonic regime of continental crust, where geothrem was raised by the repeated influx of basic magma. The initial basaltic magma was possibly generated at deeper depth by 'hot spot' activity. This magma while migrating upwards supplied additional heat for the partial melting of lower sialic crust resulting in the generation of felsic magma. The crustal extension has helped in the upper advancement of the felsic magma.

Malani igneous suit occurs as residual hill tors, insellburgs and scattered hummocks over 51,000 km^2 area in western Rajasthan covering parts of Jaisalmer, Barmer, Jodhpur, Pali, Jalore, Bikaner and Sirohi districts. More than 95% of the area is blanketed by wind blown sand and sand dunes of the Thar desert, leaving only a small portion of rhyolites can be observed at Siwana, Barmer, Pokaran, Jodhpur, Taratara, Bisla and Mandli.

The volcano plutonic association of Malani igneous suit occurs in side by side with middle to late proterzoic Delhi Supergroup of rocks in its eastern limits. Stratigraphic succession of the MIS directly underlain by metasediments or granitoids of the mesoproterozoic Delhi supergroup. MIS is unconformably overlain either by Pokaran boulder bed of glacial origin of Vendian age, (680 to 580 Ma) or by sediments of Marwar Supergroup (Vendian to lower Cambrian). Therefore the MIS represents a post Abu granite and pre-Vendian glaciations episode (Bhushan,1988).

Work of many researchers describes the mode and type of magmatism, texture and compositions, three phases of igneous activity have been recognized in MIS. The first phase commenced with the eruption of basic flows, followed by voluminous acid flows which culminated with ash flow deposits.

The second phase experienced intrusion of discordant peraluminous and peralkaline granites as plutons, ring dykesand bosses and the third phase registered and prolific intrusion of mafic and felsic dyke swarms.

A generalized classification of Malani Igneous Suite

Supergroup	Group	Formation	Mode of magmatism	Lithology
Marwar Supergroup (Vendian-Lower Cambrian)				Sandstone, Shale, Limestone & Evaporites
		Unconformity		
MIS (Upper proterozoic)	Dyke swarms	Basic dykes, Acid dykes, Trachyte porphyry dykes, Aplite and diorite plugs.	Intrusive dyke Phase	Gabbro, dolerite, basalt, granite, rhyolite porphyry, trachyte porphyry andesite dykes & boss and aplite viens
	Grantoid plutonism	Malani granite, Siwana granite, Jalore granite	Intrusive phase	Hornblende granite riebeckite/aegirine granite biotite/ hornblende granite
	Bimodal volcanism	Rhyolite, Trachyte and Basalt flows	Extrusive phase	Rhyolite, dacite, trachyte and rhyodacite flows.
		Unconformity		
Pre Malani Basement (middle to lower proterozoic)	Aravalli & Delhi Supergroup			

Table 1- Generalized Stratigraphic succession of Malani igneous suite

2.2 Local Geology

Our study area Kamathai is located on eastern side of barmer graben. Geographic location of Kamathai falls under Sindhari which is a City in Barmer district of Rajasthan state and belongs to Jodhpur Division. Kamathai is approximately 11 km away and trends SE from Sindhari, which is as a part of Sarnu-Dandali alkaline complex covering a wide range of igneous rocks. A broad literature and field relationships suggest a prominent acidic volcanism in the area. A number of alkaline rocks followed by the stratigraphy of Malani igneous suit are exposed as elongated and wide outcrops.

Rocks distribution in alkaline complex includes ultrabasic alkaline rocks, ijolites, nepheline syenites, phonolites, rhyolites and also REE bearing carbonatites. Here, the alkaline rocks are represented by isolated plug like bodies of micro-melteigites, ijolites, feldspathoc ijolites, foidal syenites, besides numerous dykes of foidal syenites, nepheline syenites, phonolite, trachytic phonolite and carbonatite and flows of melanephelinite.

The voluminous part of the area is covered by the blown sand of Thar Desert, however an area of 0.5 sq km was mapped to describe the distribution of the rocks in the area.

As a generalization of the study area some outcrops of volcanic ijolite braccia is exposed in the area which are also penetrated with phonolites somewhere, Carbonatites including calcio carbonatites and ferrocarbonatites occurs as plugs, dykes, sills and veins. There are two dykes of 4 m and 2 m width, apart from 246 smaller carbonatite veins in the area having widths varying from 0.5 cm to 8 cm, and often occur in clusters. Area covers exposures of nepheline syenite as plugs and dykes which are adjacent to phonolites and later intrusive phonolite dykes which are approximately 20 in numbers are NNW-SSE trending.

This tertiary alkaline complex associated with carbonatite is intrusive into Malani rhyolites. The alkaline suite is represented by plugs of alkali pyroxenite, micro-melteigite, mela-nephelinite and ijolite. These are further intruded by dykes and dykelets of carbonatite, nepheline syenite and phonolite (Bhushan and Chandrasekharan, 2002).

2.2.1 Rock types found in Study Area

Various rock types occurs in Kamthai region which are:

- Nephelinite
- Ijolite
- Phonolite
- Nepheline synite
- Rhyolite
- Carbonatite

Nephelinite

Nephelinite is a fine-grained or aphanitic igneous rock made up almost entirely of nepheline and clinopyroxene (variety augite). If olivine is present, the rock may be classified as an olivine nephelinite. Nephelinite is dark in color and may resemble basalt in hand specimen.

Basalt, alkali basalt, basanite, tephritic nephelinite, and nephelinite differ partly in the relative proportions of plagioclase and nepheline.. A critical ratio in the classification of these rocks is the ratio nepheline/(nepheline plus plagioclase. Tephritic nephelinite has a value between 0.6 and 0.9. Nephelinite has a value greater than 0.9. Nephelinite is an example of a silica-undersaturated igneous rock.

Genesis of nephelinite is usually ascribed to more than one of the following three causes:

- relatively high pressure of melting;
- relatively low degree of fractional melting in a mantle source;
- relatively high dissolved carbon dioxide in the melt.

Nephelinites and similar rocks typically contain relatively high concentrations of elements such as the light rare earths, as consistent with a low degree of melting of mantle peridotite at depths sufficient to stabilize garnet. Nephelinites are also associated with carbonatite in some occurrences, consistent with source rocks relatively rich in carbon dioxide.

Ijolite

Ijolite is an igneous rock consisting essentially of nepheline and augite. Ijolite is a rare rock type of considerable importance from a mineralogical and petrological standpoint. The pyroxene is morphic, yellow or green, and is surrounded by formless areas of nepheline. The accessory minerals are apatite, cancrinite, calcite, titanite and iivaarite, a dark-brown titaniferous variety of melanite-garnet. This rock is the plutonic and holo-crystalline analogue of the nephelinites and nepheline-dolerites; it bears the same relation to them as the nepheline syenites have to the phonolites. Leucite-augite rock, resembling ijolite except in containing leucite in place of nepheline is called missourite.

Fig.1 Ijolite hosting veins of carbonatite & nepheline syenite

Phonolite

Phonolite is a rare extrusive volcanic rock of intermediate chemical composition between felsic and mafic, with texture ranging from aphanitic (fine-grain) to porphyritic (mixed fine- and coarse-grain). Phonolite produces metallic sound if an unfractured plate is hit.

Phonolite is a fine-grained equivalent of nepheline syenite. They are products of partial melting, are silica undersaturated, and have feldspathoids in their normative mineralogy. Mineral assemblages in phonolite occurrences are usually abundant feldspathoids (nepheline, sodalite, hauyne, leucite and analcite) and alkali feldspar (sanidine,anorthoclase or orthoclase), and rare sodic plagioclase. Biotite, sodium rich amphiboles and pyroxenes along with iron rich olivine are common minor minerals. Accessory phases include titanite, apatite, corundum, zircon, magnetite and ilmenite.

Unusually, phonolite forms from magma with a relatively low silica content, generated by low degrees of partial melting (less than 10%) of highly aluminous rocks of the lower crust such as tonalite, monzonite and metamorphic rocks. Melting of such rocks to a very low degree promotes the liberation of aluminium, potassium, sodium and calcium via melting of feldspar, with some involvement of mafic minerals. Because the rock is silica undersaturated, it has no quartz or other silica crystals, and is dominated by low-silica feldspathoid minerals more than feldspar minerals. A-type granites and alkaline igneous provinces usually occur alongside phonolites. Low-degree partial melting of underplates of granitic material in collisional orogenic belts may also produce phonolites.

Fig.2 Phonolite occurring with trachytic texture

Fig.3 Dyke of phonolite

Rhyolite

Rhyolite is an igneous, volcanic rock, of felsic (silica-rich) composition (typically > 69% SiO_2). It may have any texture from glassy to aphanitic to porphyritic. The mineral assemblage is usually quartz, sanidine and plagioclase (in a ratio > 2:1). Biotite and hornblende are common accessory minerals.

Rhyolite can be considered as the extrusive equivalent to the plutonic granite rock, and consequently, outcrops of rhyolite may bear a resemblance to granite. Due to their high content of silica and low iron and magnesium contents, rhyolite melts are highly polymerized and form highly viscous lavas. They also occur as breccias or involcanic plugs and dikes. Slower cooling forms microscopic crystals in the lava and results in textures such as flow foliations, spherulitic, nodular, and lithophysal structures. Some rhyolite is highly vesicular pumice. Many eruptions of rhyolite are highly explosive and the deposits may consist of fallout tephra/tuff or of ignimbrites.

Carbonatite

The term carbonatite include those rocks which are rich in carbonates (50% or more) but are not of sedimentary or metamorphic origin.
Carbonatite are associated with alkaline igneous rocks and usually occur in stable cratonic region which have been affected by rift faulting, elements associated with Carbonatite include niobium, REE, Cu, Zr, U and Th and also economic mineral includes magnetite, fluorite, barite etc.
The Carbonatite are grouped on compositional basis with obvious emphasis on carbonate mineralogy. The four main groups recognized are
Calcite Carbonatite which may be further divided into coarse sovite and fine grained Alvikite, The Carbonatite associated with Sarnu-Dandali alkaline rocks are sovititic alvikite and Ferro Carbonatite which are generally high Sr and Ba contents.

- Magneso Carbonatite formed of dolomite and or ankerite.
- Ferro Carbonatite formed of iron rich carbonate mineral like siderite.
- Natrocarbonatite composed of sodium-Potassium and calcium carbonate.

For generation of Carbonatite magmas a dolomite bearing mantle peridotite (i.e. olivine, opx, cpx, garnet, and dolomite assemblage) is considered to be the source rock. The carbonate rich melt produced by melting of mantel peridotite on rising and crossing 30 kb pressure i.e. 90 km depth will start librating Co_2 vapors.

In kamthai region Carbonatite occurs as

1. Intrusion within country rocks (Melanephelinite)
2. Intrusion within quaternary soil
3. As surface flow of country rock

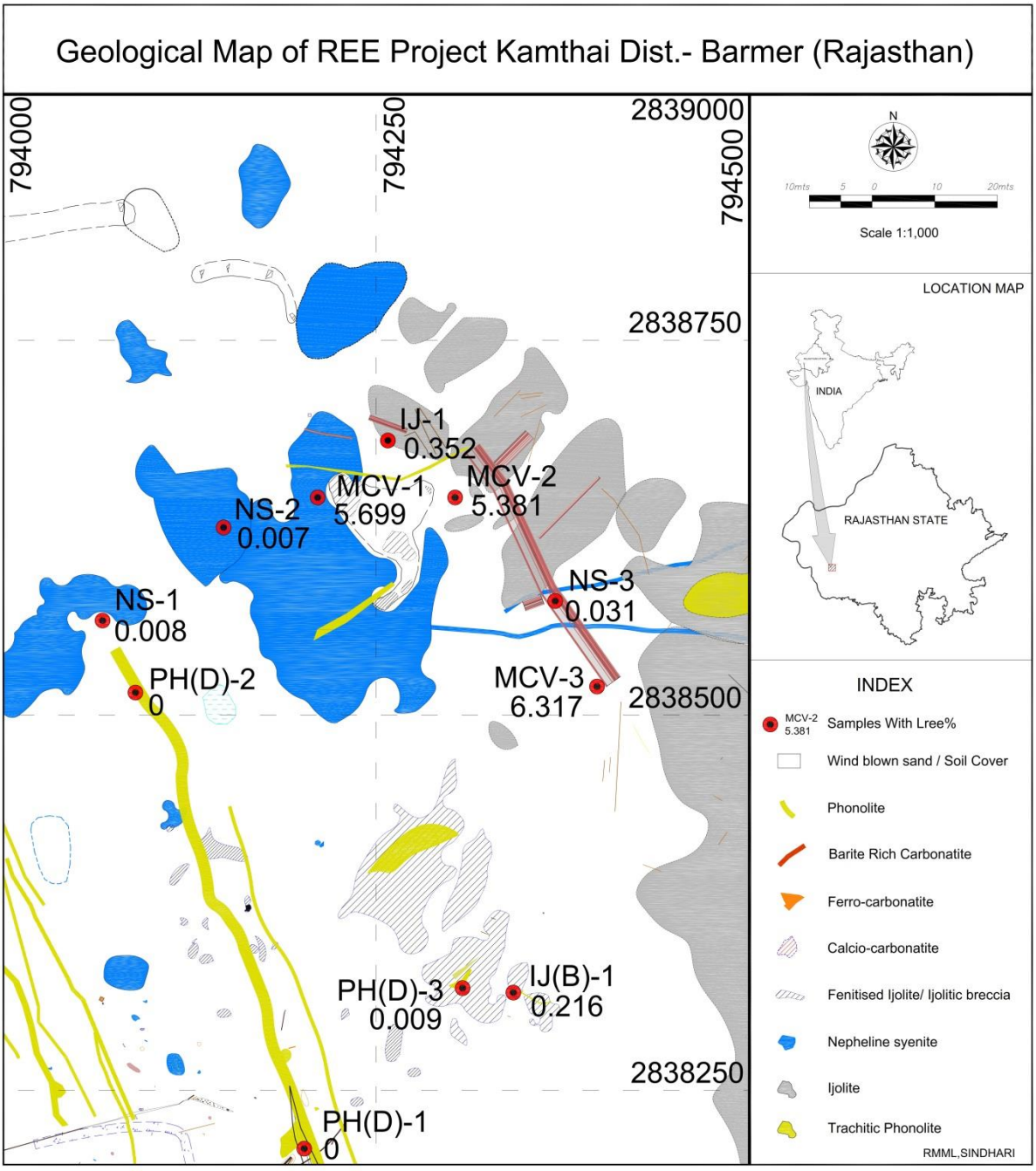
Fig.4 Carbonatite vein hosted by Melanephelinite

Fig.5 Carbonatite as intrusion in Ijolite

Nepheline Syenite

The rocks are then composed of feldspar and feldspathoids alond with mica, hornblende, corundum etc. Nepheline syenites in which alumina is in excess after saturating alumino-silicate minerals and $(Na_2O+K_2O)/Al_2O_3$ is less than 1 are called miaskites.

Fig.6 Nepheline Syenite



Geological map of Kamathai, Barmer, Rajasthan depicting various rock types present in the area.

Chapter – 3
Literature review

3.1 Petrography

Petrography is the microscopic study of rocks, minerals or man-made materials. It is a powerful tool for investigating the composition, microstructure and inter-component relationships of a wide variety of natural and synthetic materials. Used alone, or in combination with other investigative techniques, it can be of tremendous value in many areas of the minerals and construction industries.

Petrological microscopy can be used as a simple descriptive or analytical tool, for example:

- identification and quantification of valuable and gangue minerals in ores
- establishing mineral parageneses
- establishing degradation mechanisms in concrete
- predicting the behavior of minerals during ore processing
- assessing the potential stability of concrete aggregates

Petrographic descriptions start with the field notes at the outcrop and include megascopic description of hand specimens. However, the most important tool for the petrographer is the petrographic microscope. The detailed analysis of minerals by optical mineralogy in thin section and the micro-texture and structure are critical to understanding the origin of the rock. Electron microprobe analysis of individual grains as well as whole rock chemical analysis by atomic absorption or X-ray fluorescence is used in a modern petrographic lab. Individual mineral grains from a rock sample may also be analyzed by X-ray diffraction when optical means are insufficient. Analysis of microscopic fluid inclusions within mineral grains with a heating stage on a petrographic microscope provides clues to the temperature and pressure conditions existent during the mineral formation.

Characteristics observed under the microscope include color, color variation under plane polarized light, fracture characteristics of the grains, refractive index and optical symmetry. In brief, these characteristics are sufficient to identify the mineral, and often to quite tightly estimate its major element composition. The process of identifying minerals under the microscope is fairly subtle, but also mechanistic - it would be possible to develop an identification key that would allow a computer to do it. The more difficult and skillful part of optical petrography is identifying the interrelationships between grains and relating them to features seen in hand specimen, at outcrop, or in mapping.

3.1.1 Igneous Petrography

The main rock types are principally distinguished by the presence or absence of the main minerals plagioclase, clinopyroxene, orthopyroxene, olivine, Fe-Ti oxides, and apatite. Sulfide minerals, brown hornblende, and biotite are additionally present in many of the examined samples in total proportions <1%-2%.

3.2 Petrographic microscope

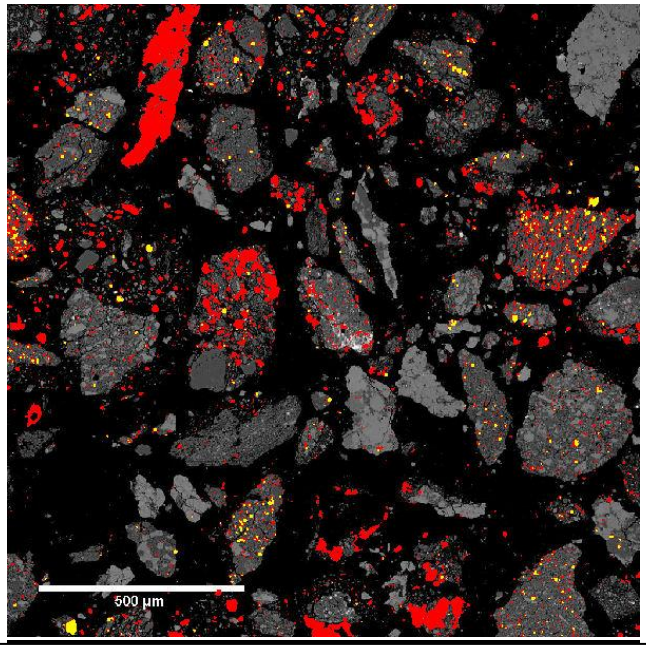
A **petrographic microscope** is a type of optical microscope used in petrology and optical mineralogy to identify rocks and minerals in thin sections. The microscope is used in optical mineralogy and petrography, a branch of petrology which focuses on detailed descriptions of rocks. The method is called "polarized light microscopy" (PLM).

Depending on the grade of observation required, petrological microscopes are derived from conventional bright field microscopes of similar basic capabilities by:

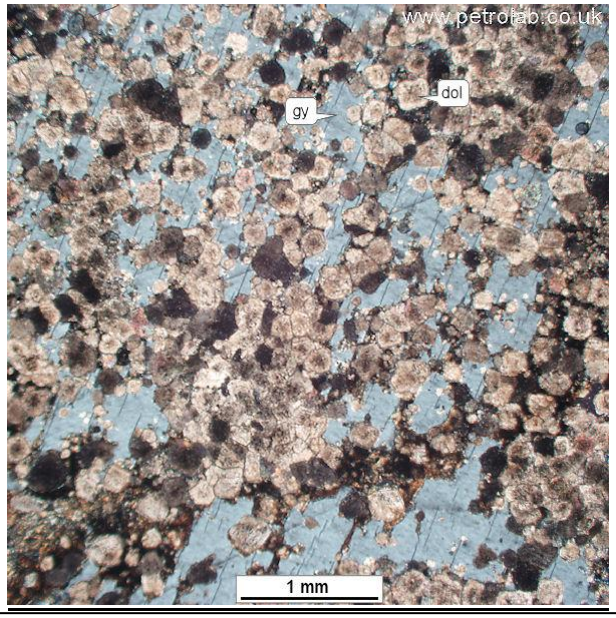
- adding a polarizer filter to the light path beneath the sample slide
- replacing the normal stage with a circular rotating stage (typically graduated with vernier scales for reading orientations to better than 1 degree of arc)
- adding a second rotatable and removable polarizer filter, called the analyzer, to the light path between objective and eyepiece
- adding a Phase telescope, also known as a Betrand Lens, which allows the viewer to see conoscopic interference patterns
- adding a slot for insertion of wave plates

Leica DMRX incident light microscope

Examples of Petrographical Images:



Electron microprobe map for sulphur (red) and sulphur + iron (yellow). The false color overlays show the respective distributions of sulphates and pyrite in a siliceous limestone and silicified mudstone host rock.



Photomicrograph of a thin section of exploration rock core (dolomitic marble) showing fine grained equi-granular recrystallised dolomite and interstitial gypsum (gy).

Chapter – 4

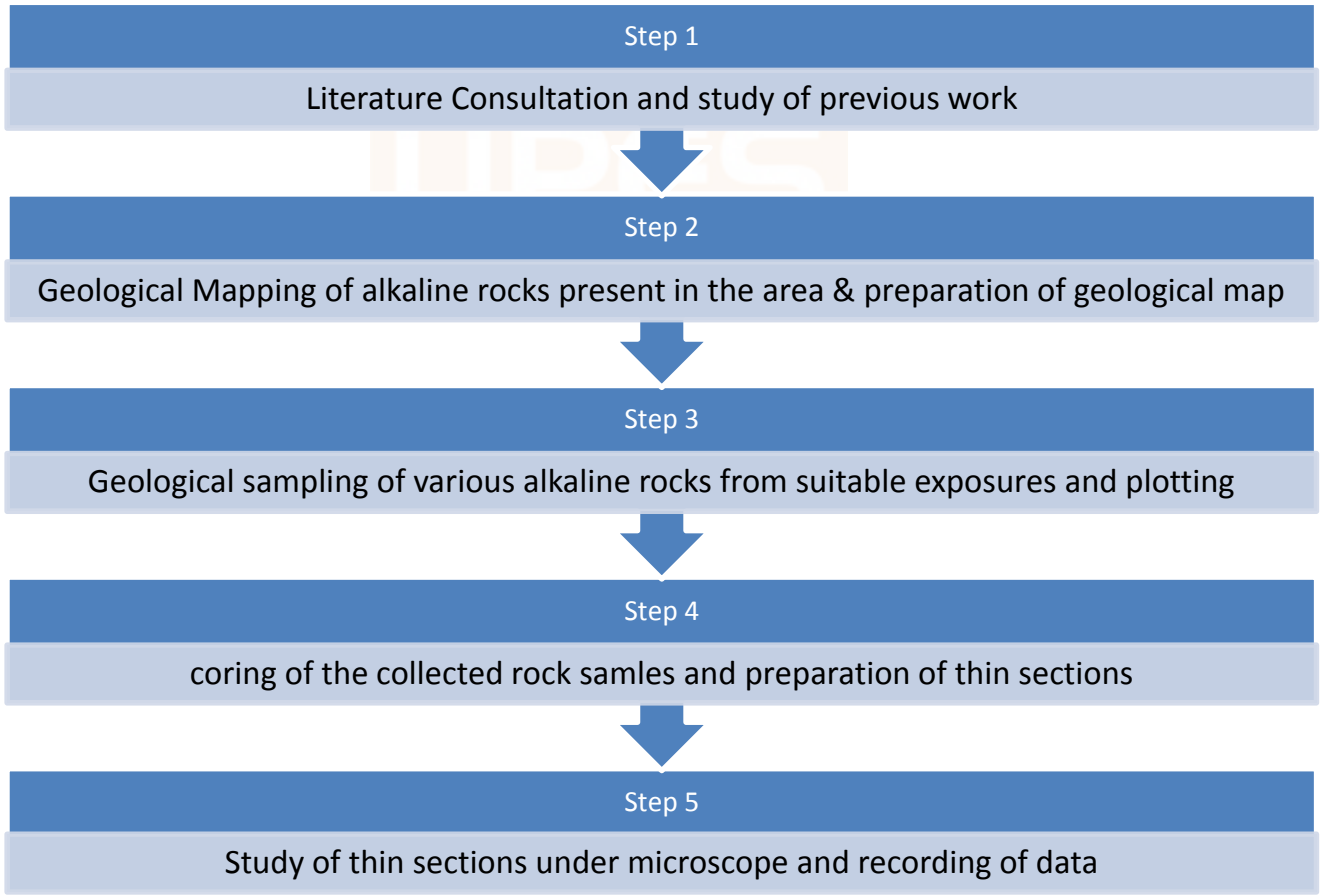
Methodology

4.1 Objectives

Objectives of the project are following as;

- Geological mapping of the study area and understanding of present alkaline rocks
- Sampling of alkaline rocks associated with carbonatites
- Petrophysical analysis of collected samples using thin section from the core plugs.

4.2 Methodology



4.2.1 Geological mapping

The Geological mapping procedues were done by using “Exposure Mapping” method. At first the least weathered, most exposed and easily accessible exposures were selected in the area. The next step required to identify the rock types present in the exposures.

The mapping process was then carried out by taking co-ordinate points around the periphery of the exposures using a GPS and then plotting the eastings and westings readings on a graph sheet. Later the points are used to make a map on CAD.

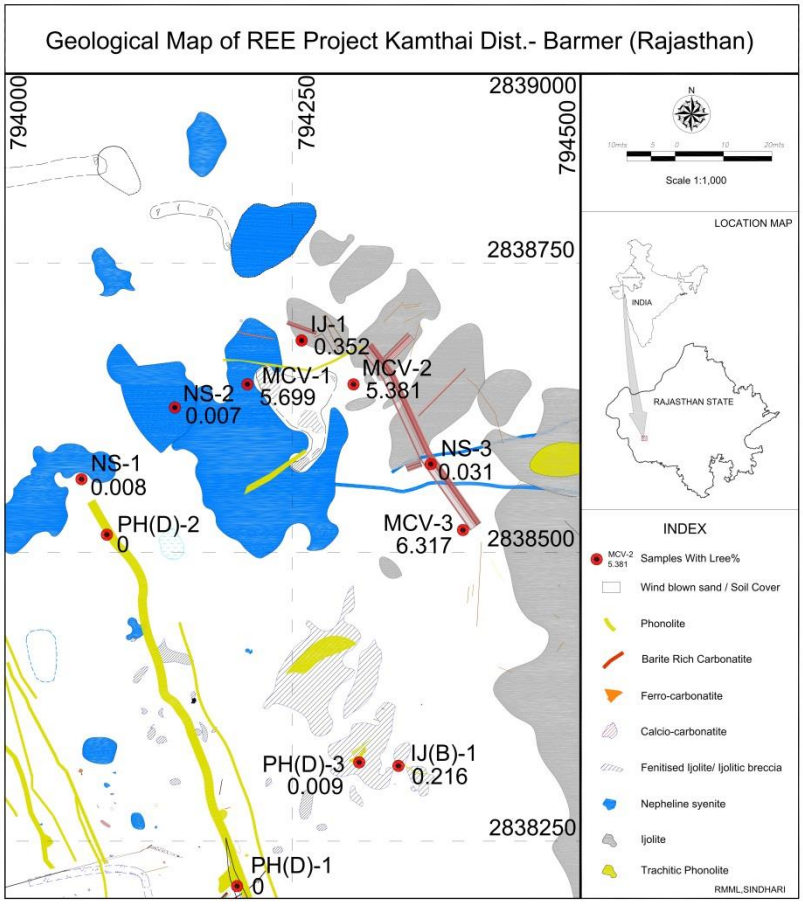


Fig.7 Geological map showing the sampling points

Chapter – 5

Results and Future Scope

The Geological map has been prepared and representative rock samples of various rock types have been collected so far. Based upon geological mapping a carbonatite plug hosted REE deposit has been found in the area. Exposures and several veins of carbonatite are identified with REE minerals such as bastanesite (La), basnaesite (Ce), synchysite (Ce), carbocernaite (Ce), ancylite and parasite. The highest value of LREE is 17.31%, whereas, mean works out 3.33% and weighted average is 2.97%. The carbonatite plug covers 19475 m^2 and the total resource estimation for carbonatite plug and other carbonatite plug and other carbonatite sills, dykes and veins is 4.91 million tones making it as truly world class deposit.

The future scope holds the final study of the petrophysical properties of the alkaline rocks associated with carbonatite which will be done in continuation to the above accomplished work in major project 2.

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