Petrographical Investigation of Volcano-Plutonic Rocks Around Deora, Siwana Ring Complex, Western Rajasthan

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INTRODUCTION

Petrography is the study of rocks in which mineral content and textural relationship within rock are described. Petrographical analysis suggest the classification group of rocks. Petrographic descriptions includes with the field records at the outcrop and macroscopic study of hand-sized specimens in thin sections. The detailed analysis of minerals by optical mineralogy in thin section and the micro-texture and structure are needs to understanding the origin of the rock. The Siwana Ring Complex (SRC) is a collapsed caldera structure, an anorogenic, rift-related, bimodal volcano-plutonic rock association belonging to the Malani Igneous Suite which spread over 800 sq. km. area in south western Rajasthan. It comprises of felsic and basic volcanic lava flows, rhyolite, peralkaline granite, pyroclastics, tuff and later microgranite, aplite and felsite dykes. (Imran, et al., 2023). Volcano-plutonic associations, anorogenic setting of Siwana ring complex have a potential for rare earths and rare metals (Kochhar, 1992; Jain et al., 1996; Vallinayagam and Kochhar, 1998; Bhushan and Chittora, 1999; Kochhar, 2000; Vallinayagam, 2001; Vallinayagam, 2004; Singh and Vallinayagam, 2009, Singh and Vallinayagam, 2013). Volcano-plutonic rocks around Deora area may have a plenty scope for potential rare earth elements and rare metals. Mainly the rock types exposed in the area around Deora, Meli, Bhati Khera, Mangla, Balu, Rakhi and Dantala of Siwana Ring Complex are granite, microgranite, rhyolite, trachyte, trachy–dacite, basalt and dolerite etc. Hence it is proposed to conduct a geological investigation on petrological studied of rocks to evaluate its bearing mineralization potential in the area around Deora, Siwana Ring Complex, western Rajasthan.

REGIONAL GEOLOGY

The Siwana Ring Complex (SRC) forms a part of the MIS and occupies an area of about 1100 km^2. It displays important features namely volcano-plutonic associations, anorogenic setting and potentials for rare earths and rare metals (Kochhar 1992, 2000; Jain et al. 1996; Vallinayagam and Kochhar 1998; Bhushan and Chittora 1999; Vallinayagam 2001, 2004; Singh and Vallinayagam 2009). The intrusive nature of Siwana Granite was indicated by La Touche (1902) and Coulson (1933).Around Siwana, granitoids and lava flows constitute a classical example of ring complex formed by the collapse of volcanic caldera and subsequent intrusion of granites. At Siwana, granite occurs as a discontinuous elliptical ring dyke covering 290 sq. km area. The granite intrudes along a collapse structure as a low – angle cone intrusion (Bhushan and Mohanty, 1988). Bhushan and Chittora (1999) identified 45 flows between the periphery of the subsidence structure and the central axis of the projected caldera. Geological map of the Siwana Ring Complex are shown in **Fig. 1.1.**

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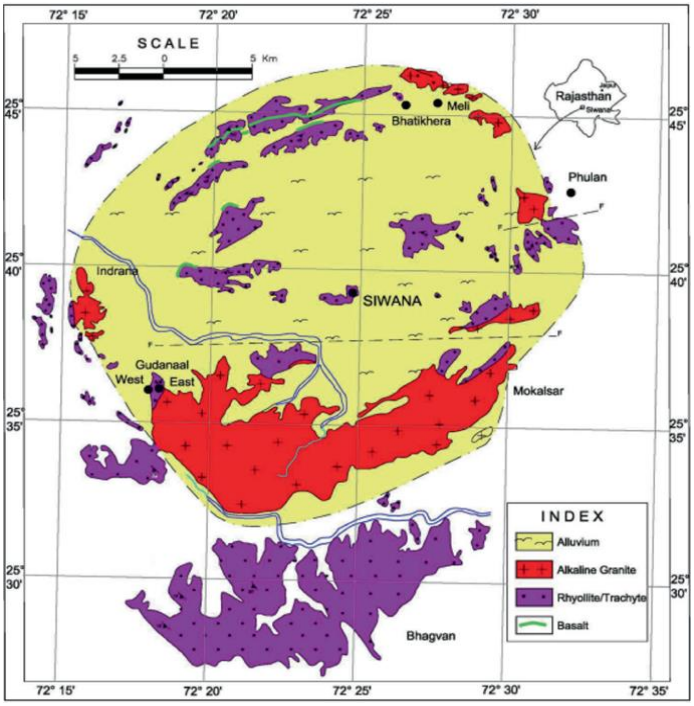

Fig. 1.1 Geological map of the Siwana Ring Complex (After Bhushan and Mohanty, 2019)

STUDY AREA

The study area includes at and around Deora, Meli, Bhati Khera, Mangla, Balu, Rakhi and Dantala are located about 30 km. south-east of Balotra district headquarter. The study area falls in Survey of India Toposheet No. 45 C/6 and C/10 and lies between 25° 46' 52" to 25° 39' 45" North Latitudes and 72° 22' 54" to 72° 35' 23" East Longitudes as shown in location map **Fig. 1.2**

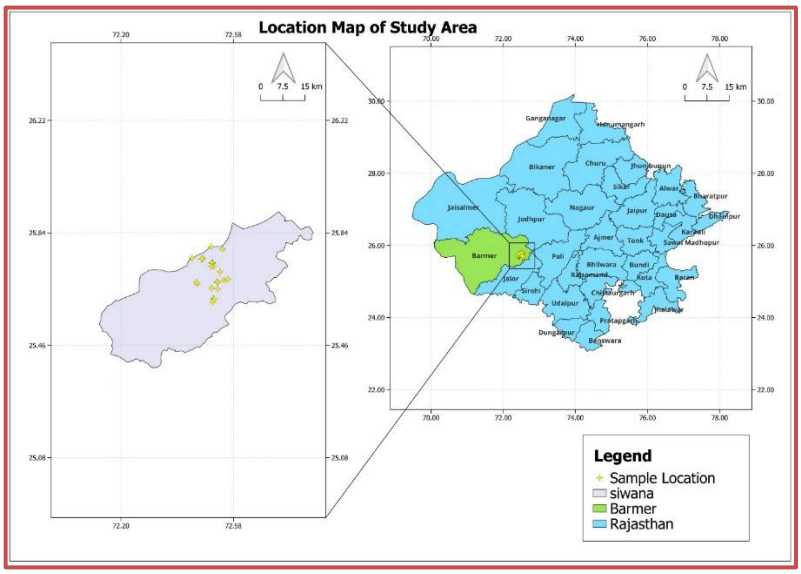

Fig. 1.2 Map showing location map of the study area.

MATERIALS AND METHEDOLOGY

Extensive field work have been carried out in the study area to delineate topography and then litho-units. During the course of the field work all the field data have been recorded and selective rock samples have been collected (**Fig.1.3**). Codes and name marked on collected rock samples of various litho units. Megascopic and microscopic study was carried out in the laboratory. Megascopic analysis of rocks consists of all the observations that are noticeable in hand specimens by unaided eyes. Thin sections of selective rock samples have been prepared for microscopic studies of mineralogy, texture and petrogenetic interpretations

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and have also been photographed as photomicrographs. The microscopic study have been carried out using using RADICAL RXLr-5POL, polarizing petrographic microscope under transmitted and reflected light in different magnifications i.e., 2.5x, 10x, 20x, 50x and 100x at Petrology laboratory, Department of Earth and Environmental Sciences, IISER, Mohali. During the microscopic study, photomicrographs were captured using camera Gryphax.

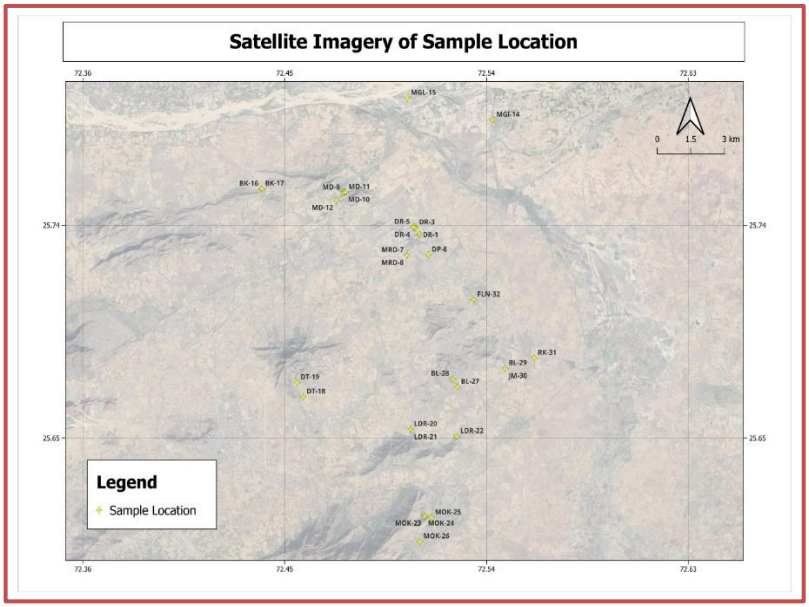

Fig.1.3 Map showing sample location map of the study area.

FIELD RELATIONS AND PETROGRAPHY

Volcano-plutonic associations of the Malani Igneous Suite belongs to three different phase. First phase is initiated by flow of minor basic volcanic rocks and then major felsic flows followed by intrusive phase. Third phase represents dykes which are intruded in the earlier phases.

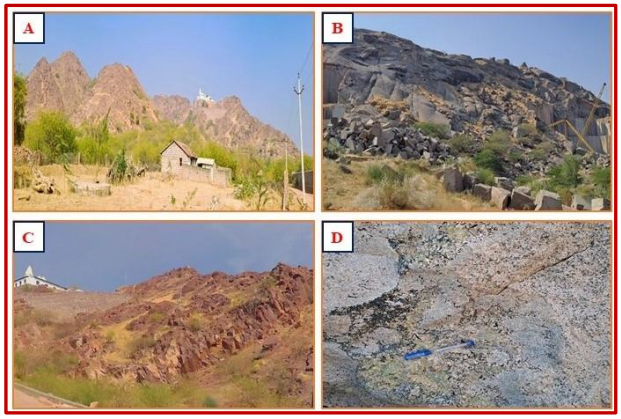

Plate. 1.1 Field photograph showing massive rhyolite outcrop west of Mangla village (A). Field photograph showing massive Granite outcrop at west of Deora village (B). Photograph showing columnar jointing in Rhyolite outcrop behind The Hinglaj Mata tample, Mangla(C). Field photograph showing riebeckite-aegirine needles and epidotization in riebeckite-aegirine bearing Granite (D).

Rhyolite is mainly dark brown in colour with various hues of light brown, brick red, grey and purple etc. They are observed as porphyritic and non-porphyritic in nature and have sharp contact to each other. The rhyolitic rocks are generally siliceous and are interstratified with tuffs, representing the explosive phases of eruption (**Plate1.1 A**). Columnar joints formed by cooling and contraction of lava. Cooling causes contraction which in turn causes fracturing. Fractures propagate from the top and bottom of flows inward towards the center are observed at east of Rakhi railway station near Hinglaj mata tample, Mangla (**Plate 1.1C**). Massive granite outcrops are exposed west of Deora village showing joints, sheet like structures with

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spheroids (**Plate 1.1 B**). Riebeckite-aegirine needles and epidotization in riebeckite-aegirine in granites are observed in the area (**Plate1.1 D**).

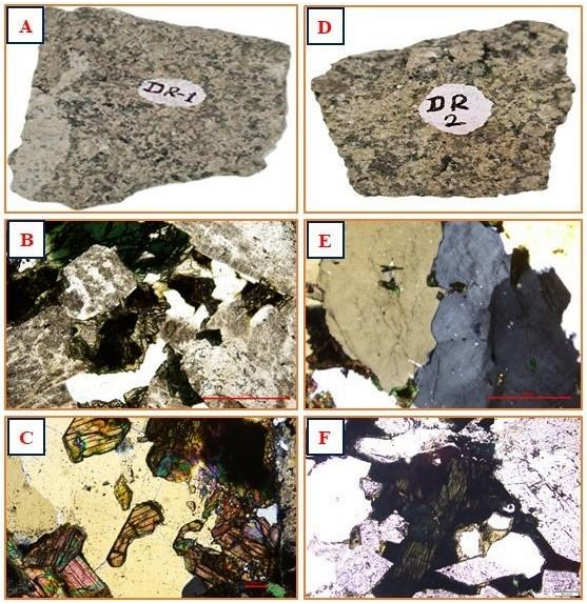

Plate 1.2 Showing hand specimen of sample DR/01 and DR/02 with photomicrograph in PPL and XPL.

Quartz and feldspars are dominant minerals present in granite having translucent grey colour of quartz and euhedral in shape. Feldspar phenocrysts (large crystals) are surrounded by fine grained groundmass comprising quartz grains, feldspar and mica. Muscovite (shining silvery colour, flaky), Biotite (blackish brown, flaky), Hornblende (blackish green, prismatic) are present as accessory minerals (**Plate 1.2 A, D**). Petrographically, Deora granites show hypidomorphic, granophyric and microgranophyric textures. Replacement of augite by aegirine in granite reveals patch perthite **(Plate 1.2 B)**. Rectangular crystals of orthoclase, altered to clay minerals in plane polarized light. Kaolinization is very common for orthoclase. Zoned aegirine cogenetic with quartz and alkali feldspar. Aegirine-acmite phenocryst in porphyritic rhyolite from Meli dam area plane polarized light and cross-nicols. (**Plate 1.2 C**). Quartz with many fluid inclusions and cloudy or turbid appearance seen in orthoclase due to alteration. Green hexagonal crystal of aegirine with oscillatory zoning. Photomicrograph shows quartz in a range of crystal orientations, all having low-first order interference colours and with aegirine inclusions (**Plate 1.2 E**). Aegirine, arfvedsonite, plagioclase, K-feldspar minerals are present (**Plate 1.2 F)**.

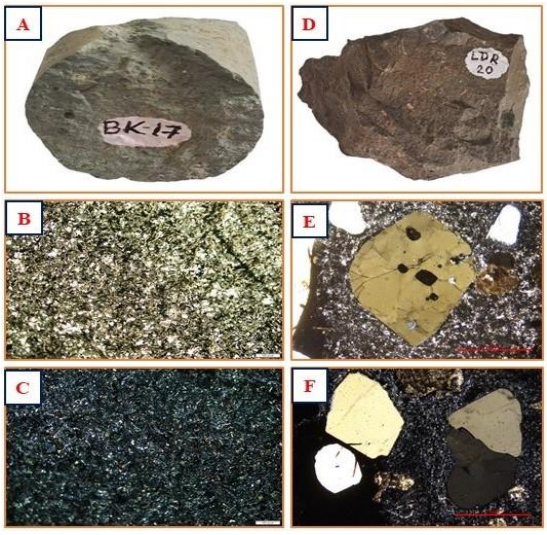

Plate 1.3 Showing hand specimen of sample BK/17 and LDR/20 with photomicrograph in PPL and XPL.

Aplites are the fine-grain equivalent of granite and composed only of quartz and alkali feldspar, and very small amounts of muscovite and biotite. They are mostly fine grain, white to light grey in colour. They are

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found only in felsic intrusive like granites and granodiorites (**Plate 1.3 A)**. Photomicrigraph showing fine needle of aegirine randomly oriented in thin section of microgranite under plane polarized light and cross-nicols. (**Plate 1.3 B, C)**. Rhyolite is fine-equigranular, compact, homogeneous and devoid of any phenocryst. It shows colour variation grey to reddish pink. Ferrugenised bands are also observed (**Plate 1.3 D)**. Magnetite inclusion in quartz phenocryst of quartzofeldspathic groundmass of porphyritic rhyolite in under plane polarized light and cross-nicols (**Plate 1.3 E)**. Quartz and feldspar phenocryst in felsic (devitrified) groundmass in porphyritic rhyolite (**Plate 1.3 F).**

CONCLUSIONS

Study area around Deora forms a part of the Siwana Ring Complex (SRC) which is characterised by close association peralkaline granites with acidic volcanics (rhyolite, trachyte) and minor amount of microgranite and aplite dykes. Petrographical studies reveal that the granites and associated volcanic rocks shows alkaline magmatism. Granites of study area shows hypidiomorphic and granophyric textures having alkali feldspar, quartz, arfvedsonite, riebeckite and aegirine as essential minerals. Aegirine-acmite phenocryst with ferruginous band are present in maroon to light pinkish coloured, porphyritic rhyolite. However, mineralogical characteristics of the volcano-plutonic rocks exposed around Deora area, propose that they have potential for rare metal and rare earth mineralization.

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