SCHOOL OF EARTH, OCEAN AND ATMOSPHERIC SCIENCES

GOA UNIVERSITY

Exam:

Roll No: 21P045024

LABORATORY CERTIFICATE

This is to certify that Mr. /Ms. SIDDHI SHRIPAD SHIRODKAR has satisfactorily completed the course of practical for M.Sc in Applied Geology.

Experiments conducted are pertaining to paper Geological Field Training Practicals prescribed by the University for MSc Part-II class, during the academic year 2022-2023

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Gujarat-Rajasthan Field Visit Report

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Abstract

The Report focuses on the geological study and industrial training in Gujarat and Rajasthan states mainly in and around Ahmedabad city and Udaipur city. Gujarat and Rajasthan lie to the westward of India with the two major deserts of India i.e The Great Indian desert and the white salt desert of Kutch lying to the western side of the two states and the Arabian sea adjoining the Gujarat State.

The Ahmedabad region experiences a tropical monsoon-type climate which is hot and dry with the extremely hot summer season whereas Udaipur City has a hot semi-arid climate. Being in the desert lands of Rajasthan, the climate and weather of Udaipur are usually hot.

Ahmedabad region is covered with westward-flowing rivers like river Bhogavo and river Sabarmati drain into the gulf of Khambat. Udaipur City is surrounded by eastward-flowing rivers. River Banas have source at Nathdwara and its sub-tributaries, river Berach and river Gambhiri have their source at the Chittorgarh region. They drain into the lakes around the region.

The field visit was mainly carried out to understand the scope of geologists in various sectors of the industry and to understand the working, benefits, and consequences especially at the mining and the oil well sites. To give knowledge about various research opportunities in geoscience and also to study and understand the geology and stratigraphy of the regions mainly around Udaipur city. I helped us to understand the geological past event that impacted dinosaur extinction and even the marine sea transgression that led to the submerging of the city.

Introduction

Geology of Gujarat

The Gujarat State bounded by N 20°02' and 24°42' and E 68°04' and 74°30' has an aerial extent of 1,96,024 sq km. The western and southern parts of the State are bordered by the coastal tract along the Arabian Sea. The State of Gujarat has a long coastline (approx. 1550 km) The coastal tract borders the Kachchh Peninsula, the Saurashtra Peninsula and the Central Plains of Gujarat. The south-eastern part is occupied by the Deccan Plateau whereas the southwestern part forms the Saurashtra (Kathiawar) Peninsula. In the southward continuation of the Aravalli Range. The Kachchh Peninsula and the Rann of Kachchh occupy the north-western part of the State. The area extending in north-south direction and lying between Aravalli Range and Saurashtra-Kachchh Peninsulas is covered by a alluvial tract. The State exposes a wide variety of lithological assemblages belonging to Precambrian, Mesozoic and Cenozoic Eras and is endowed with rich mineral wealth. Extensive exploration leading to the production of oil and natural gas in Ankleshwar, Khambhat and Kalol have put Gujarat prominently on the country's oil map. Minerals of commercial significance found in the State are those of base metals, lignite, bauxite, bentonite, dolomite, fireclay, fluorite, fuller's earth, kaolin, ball clay, limestone, chalk, calcareous sand, quartz and silica sand. Gujarat is the only State where potash is produced as a by-product in the process of manufacturing common salt from brine.

The geology of Gujarat State is characterized by hard rock terrain which cover 49% of the total area of Gujarat, the rest being occupied by sediments of Quaternary Period. The hard rock comprise Precambrian metamorphites and associated intrusives, sedimentaries of Jurassic, Cretaceous and Tertiary Periods and the traps/flows of Deccan Volcanics of Cretaceous-Eocene age.

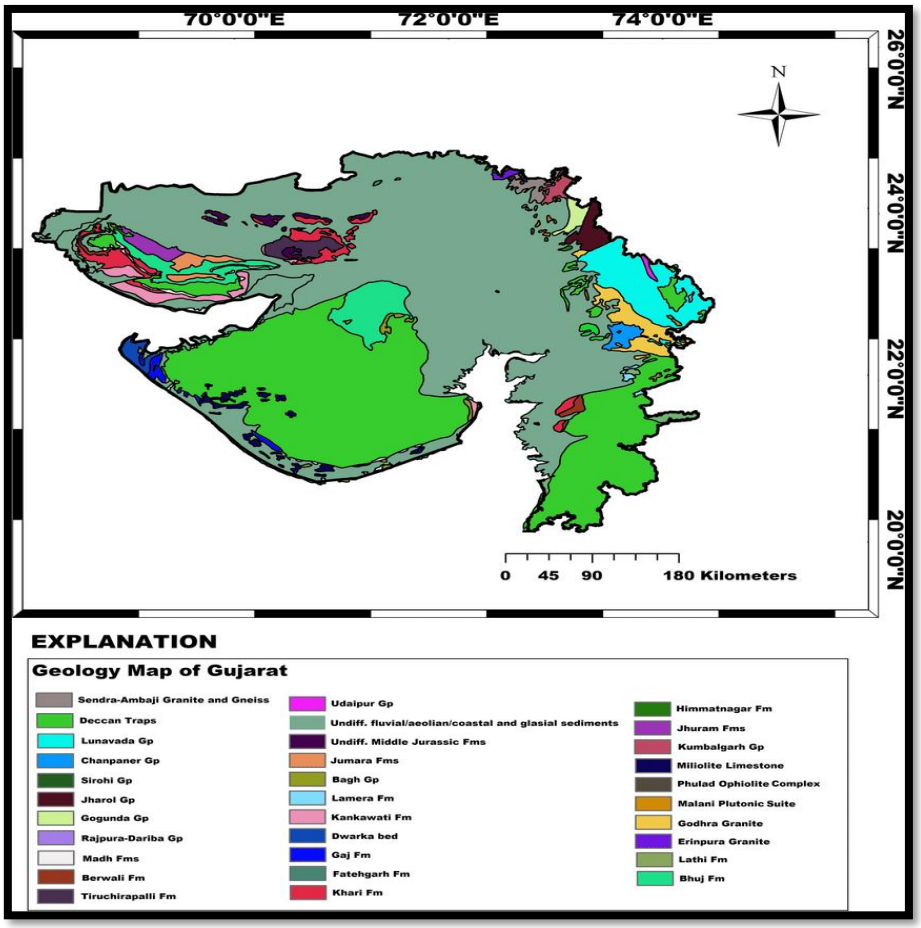

Figure 1- Stratigraphic Map of Gujarat State

Geology of Rajasthan

Rajasthan occupies 3,42,239 sq km area covering 10.74% of the Indian Territory and is the largest State of India. The State is located within 23 03'-30 12'N and 69 29'-78 17'E. The northwestern part of the State is occupied by the Thar Desert covering 32% area of the total area. The Aravalli hill range extending from Delhi in the northeast to the plains of north Gujarat in the southwest, divides the State into two unequal parts. The area to the east of the hills is covered by the eastern plains and the Vindhyan plateau. Rajasthan forms north-western part of the Indian Shield. The rock sequences of the region cover a time span of about 3500 to 0.5 Ma. The State exposes a variety of lithological and tectonic units ranging in

age from Archaean to Recent times. The basement rocks - the Sandmata Complex, Mangalwar Complex and Hindoli Group of Bhilwara Supergroup - occupy central and south-eastern plains. They are Archaean in age and comprise in general, granulite-gneiss; amphibolite, metapelite, paragneiss, calc-silicate rocks and greywacke (the older granite-greenstone belt) and metavolcanic, metagreywacke (the younger granitegreenstone belt) respectively. The Lower Proterozoic supracrustal rocks of the Jahazpur, Rajpura-Dariba, Pur-Banera and Sawar Groups of Bhilwara Supergroup rest on the basement rocks of the Mangalwar Complex and host a number of lead, zinc and copper deposits. The Bhilwara Supergroup of rocks is intruded by the Untala-Gingla Granite, Berach Granite, basic and ultramafic bodies. The Lower Proterozoic supracrustal rocks of the Jahazpur, Rajpura-Dariba, Pur-Banera and Sawar Groups of Bhilwara Supergroup rest on the basement rocks of the Mangalwar Complex and host a number of lead, zinc and copper deposits. The Bhilwara Supergroup of rocks is intruded by the Untala-Gingla Granite, Berach Granite, basic and ultramafic bodies. The Proterozoic fold belts, viz., the Aravalli fold belt (the Aravalli Supergroup) and the Delhi fold belt (the Delhi Supergroup) occupy the southern and southeastern, and south-western and north-eastern Rajasthan respectively. The Aravalli Supergroup is represented by metamorphosed and complexly folded clastic sediments with minor chemogenic and organogenic assemblages with interlayered basic volcancics, whereas the Delhi Supergroup comprises mainly carbonates, metavolcanics, metasammites and metapelites, intruded by magmatic rock of Phulad Ophiolite Suite and syn-orogenic granites of SendraAmbaji, Bairath, Dadikar, Harsora, etc. A number of base metal deposits are located in these belts as also other minerals. The isolated hillocks of western Rajasthan constitute the Upper Proterozoic Malani Igneous Suite and the Erinpura Granite pluton. Eastern Rajasthan is characterised by the vast sedimentary stretch constituting the Vindhyans, which is juxtaposed against the rocks of the Bhilwara Supergroup along the Great Boundary Fault. The northern and north-western parts of the State exhibit Upper Proterozoic-Early Cambrian (?) rocks of the Marwar Supergroup which are overlain by sedimentary rocks of different ages of Palaeozoic and Mesozoic Era. Many industrial mineral deposits are found in these rocks. The Deccan Traps are restricted to the south-eastern part of the State in Chittaurgarh Banswara area. The Cenozoic rocks are manifested in Barmer and Jaisalmer basins in the west and Ganganagar-Palana shelf in the north. The Quaternary sediments of aeolian and fluvial origin constitute the Thar Desert of Rajasthan.

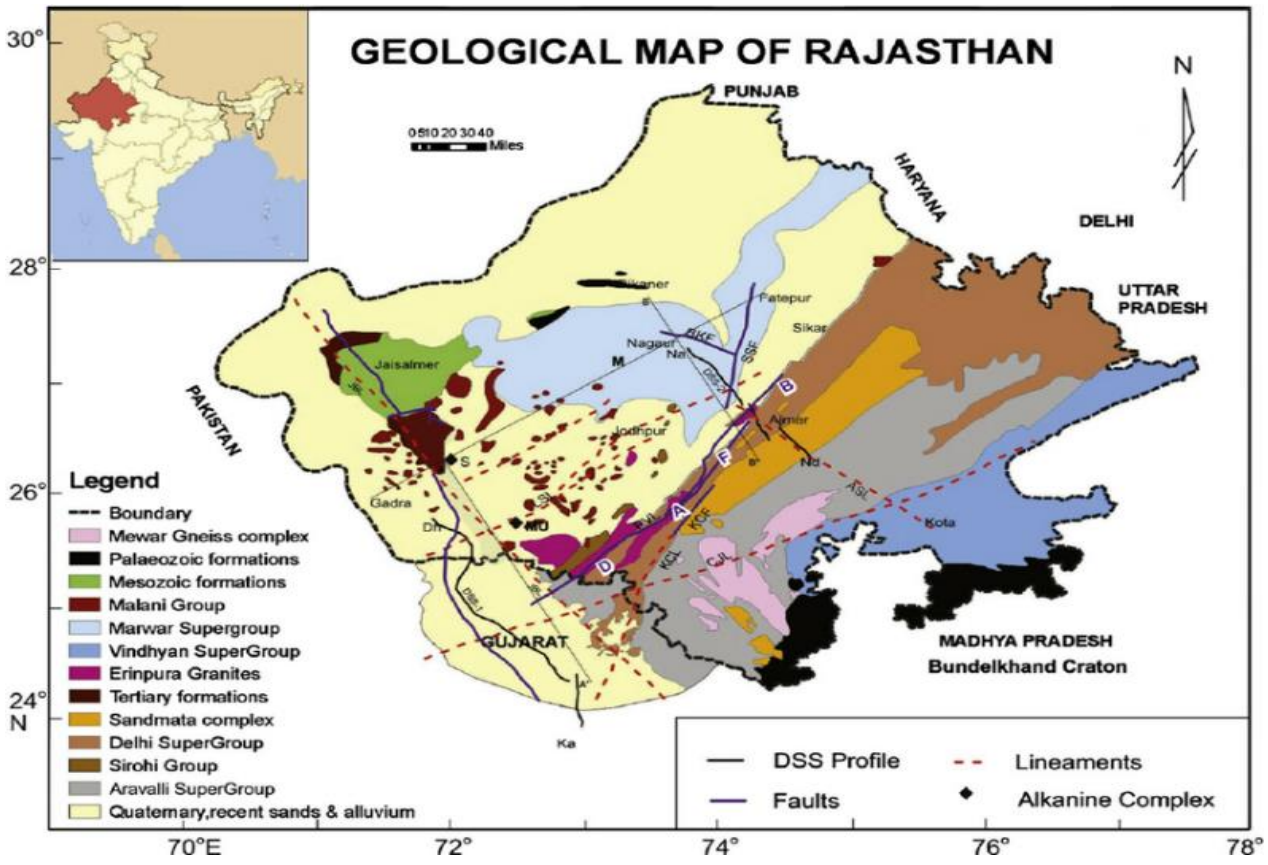

Figure 2 -Geological map of Rajasthan

Regional Geology

Growth of the Precambrian crust in the north western part of the Indian Shield evolved through accretion of several sedimentary sequences, which were deposited at intervals around a nucleus of gneissic rocks; here it is a heterogeneous rock assemblage known as the Banded Gneissic Complex (3500 my.) and the Berach Granite, as a result of tectonic changes and subsequent marine transgressions and regressions. The oldest sedimentary sequence which overlies the gneissic basement with a profound erosion unconformity is the Aravalli Supergroup. The Raialo, the Delhi, and the Vindhyan Supergroups are the successively younger sedimentary units. The field visit regions mostly covered the rock sequences belonging to the Vindhyan Supergroup and the Aravalli Supergroup.

Aravalli Supergroup

The Aravalli craton is located in the northwestern part of peninsular India, bounded on the north by the Himalaya Mountain chain, the Cambay graben in the southwest, and the Narmada-Son lineament on the south and southeast. Young sediments cover the western boundary and may extend farther into Pakistan.

Rocks of the Aravalli craton are quite different from the Dharwar and other cratons of the Indian shield. They consist mostly of Proterozoic phyllites, graywackes, quartzites, and carbonates, with minor mafic and ultramafic schists. Stromatolites are common in the carbonates and are associated with phosphorite deposits. Banded-iron formations are almost totally absent from the Aravalli craton but common in other cratonic blocks of the Indian shield.

Major structures of the Aravalli craton include the Great Boundary fault on the eastern edge of the Aravalli-Delhi belt, the Delhi-Haridwar ridge, and the Faizabad ridge, which is an extension of the Bundelkhand massif under the Indo-Gangetic Plain. The Aravalli-Delhi belt contains a large number of granitic rocks emplaced over a wide range of time from 3.5 billion

to 750 million years ago. Ages of the Aravalli Supergroup range between 2.5 and 2.0 billion years.

Aravalli orogen		
South Delhi Supergroup		
Gogunda Group	Siliciclastic dominated	1.2-1.0 Ga[3], <1.0 Ga[5]
Kumbhalgarh Group	Mixed siliciclastic-carbonate	<1.0 Ga[5]
North Delhi Supergroup		
Ajabgarh Group	Mixed siliciclastic-carbonate	<1.74 Ga[5]
Alwar Group	Siliciclastic dominated	<1.7 Ga[6], <2.1 Ga[5]
Raialo Group	Mixed carbonate-siliciclastic	<2.3 Ga[5]
Aravalli Supergroup		
Upper Aravalli Group		
Lakhawali Formation	Siliciclastic dominated	
Kabita Formation	Carbonate dominated	
Debari Formation	Siliciclastic dominated	<1.67 Ga[4]
Middle Aravalli Group		
Tidi Formation	Siliciclastic dominated	
Bowa Formation	Siliciclastic dominated	<1.73 Ga[4]
Mochia Formation	Mixed carbonate-siliciclastic	
Udaipur Formation	Siliciclastic dominated	1.6 Ga[3], <1.80 Ga[4]
Lower Aravalli Group		
Jhamarkotra Formation	Carbonate dominated	1.7 Ga[3]
Delwara Formation	Mafic volcanics and sandstone	<2.45 Ga[4]
---------- **Unconformity** ----------		
Sandmata complex	Gneisses, granitoids and charnockites	2.9-1.7 Ga[2]
Banded Gneissic Complex	TTGs and granitoids	3.31-2.49 Ga[1]

Fig 3- Stratigraphic Sequence of the Aravalli Supergroup

Vindhyan Supergroup

The Vindhyan Supergroup is the thickest Precambrian sedimentary succession of India and the duration of its deposition is one of the longest in the world. The importance of the Vindhyan sequences lies in the notion that because of its vastness in time and space they

contain important information on the evolution of the Earth's atmosphere, climate, sedimentary cover and life. The Vindhyan basin is bounded to the west by the Aravalli Mountains along the Great Boundary Fault but is believed to continue uninterrupted beneath the Gangetic alluvial plain beyond the present northern outcrop limit and below the Deccan Traps in the southwest. The rocks of the Supergroup are exposed in two sectors: Rajasthan in the west and Son valley in the east. The Vindhyan strata are unmetamorphosed and mostly undeformed. However, there exist largescale folds in the Son valley and several post depositional faults in Rajasthan. The Vindhyan Supergroup is composed mostly of low dipping formations of sandstone, shale and carbonate, with a few conglomerate and volcaniclastic beds, separated by a major regional and several local unconformities . It is generally believed that the Vindhyan basin was a vast intra-cratonic basin formed in response to intraplate stresses.

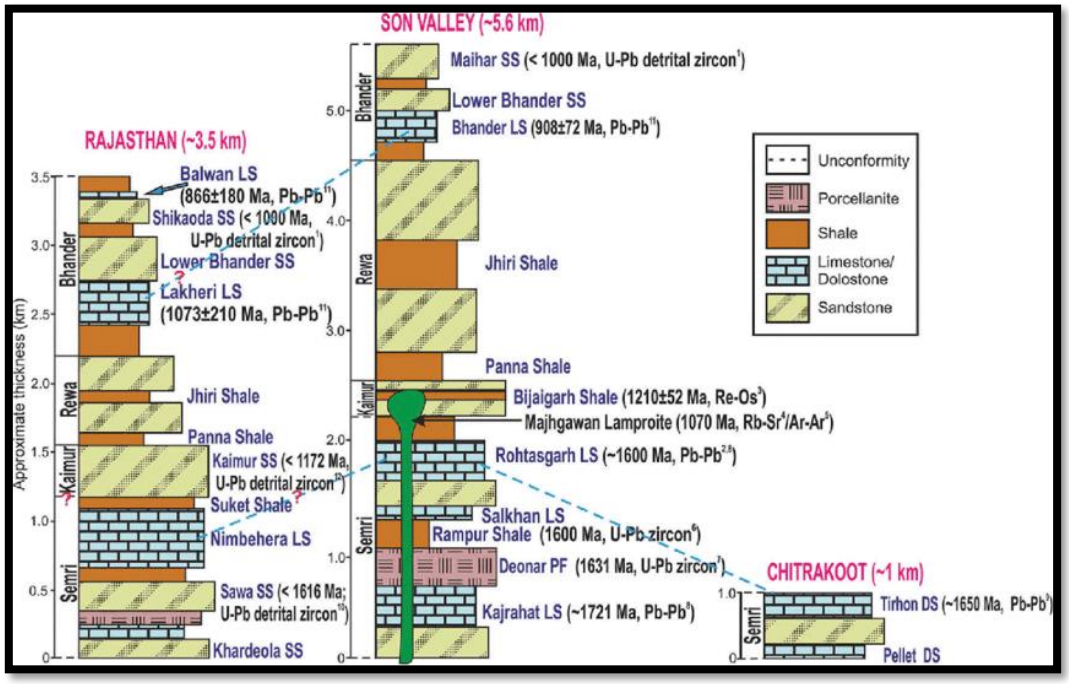

Figure 4- Stratigraphic logs of the Vindhyan Supergroup in Rajasthan (West), Son Valley (Southeast), and Chitrakut (Northeast).

Field Visit Sites

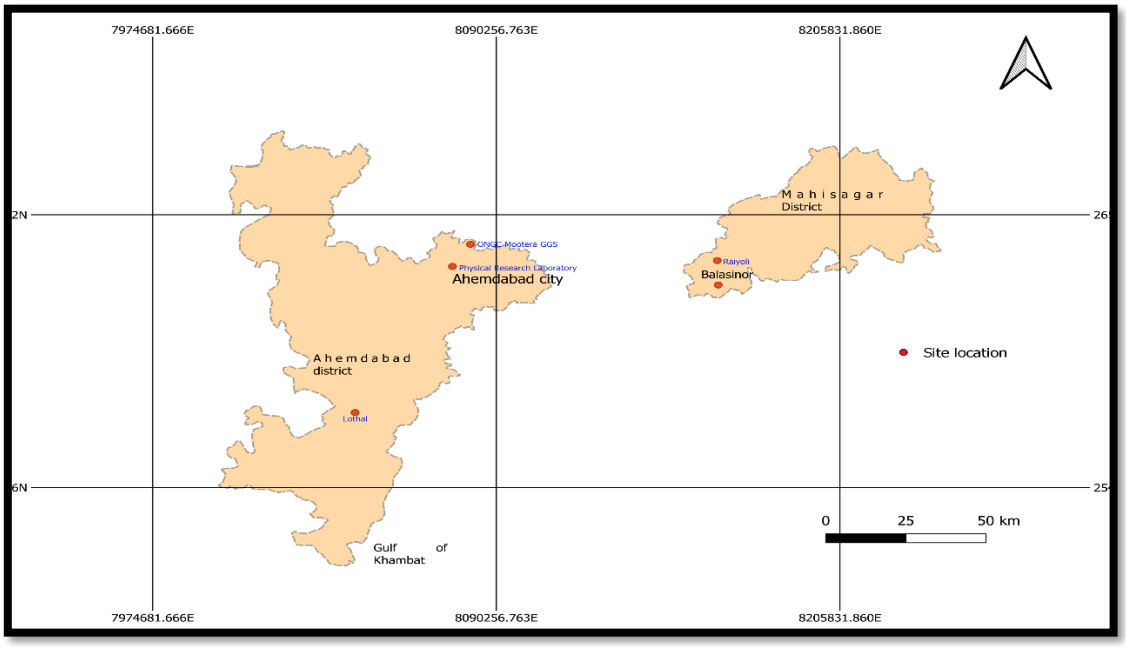

Figure 5- location sites of the field visit At Gujarat

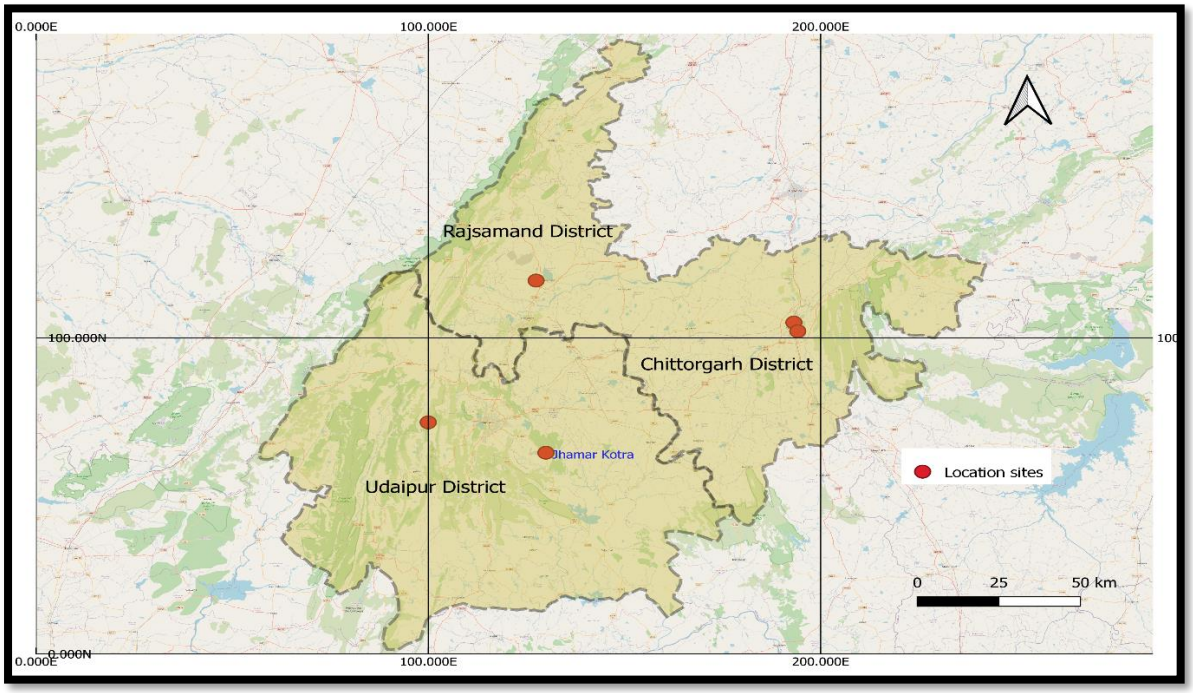

Figure6– Location site of the field visit At Rajasthan

1) Site location – Lothal

Geographical distribution: - Latitude- 22.5229 ° N Longitude- 72.2494 ° E

Day- 1

Date of Visit- 22/01/2023

Lothal is a small mature Harappan settlement near Gulf of Khambat in Dhalka taluk of Ahmadabad in Gujrat. It was first excavated in 1957 by S R Rao. Lothal, one of the most fascinating remnants of the ancient Harappan civilisation, covers an area of 64752m(Rao 1985). The essential components of the town are a dockyard 37m in length and 21.8m wide to the west of which are located an 'acropolis', 'lower town' and acemetery . Harappan Lothal has been interpreted to be primarily a port. It is suggested that the modern silted creek extending up to Lothal represented the ancient river that was used by the Harappan people. This creek joins the river Bhogavo towards the south but can be seen today only as far as the town of Saragwala, south of Lothal. Satellite multispectral data can help in mapping ancient palaeochannels and understanding past geography .

Lothal lies in a level plain between the Bhogava and Sabarmati Rivers and at present is some twelve miles distant from the Gulf of Cambay coast. The siltation rate of the Sabarmati delta is known to be rapid, so that in former times the site may actually have been nearer the sea. Lothal today is not linked with the Gulf by a waterway. The Harappan nature of the Lothal settlement is clearly established, with all the typical elements present, such as steatite seals bearing the characteristic script and designs, painted pottery, long chert blades, weights, some copper artifacts, architecture in burnt brick, and an excellent drainage system. There is evidence that copper, semi-precious stones, and possibly shell and ivory were worked at Lothal.

to interpret the purpose of this structure, two different opinions were advanced by galaxies of Indian and foreign archaeologists. One school proposed the possible use as 'dockyard' for maritime activities whereas, other school opined in favour of 'fresh water storage tank' for agriculture and bathing. This controversy was finally solved with the help of foraminifera studies Since foraminifera are almost exclusively marine organisms, their presence and absence could be a decisive factor in interpreting whether any ancient water body was filled with fresh or marine (brackish) water. The presence of foraminifera concluded that there was marine sea transgression in the area and the structures is the dockyard associated with the maritime activities.

Fig 7 -warehouse

Fig 8 -Drainage System

Fig 9 -well made up of Bricks

Fig 10 -Dockyard

2) Site Location-Physical Research Laboratory

Geographical distribution: - Latitude- 23.0356 ° N Longitude- 72.5435 ° E

Day -2

Date-23/01/2023

The Physical Research Laboratory (PRL), Ahmedabad is a premier research institute engaged in basic research in the areas of Astronomy and Astrophysics, Solar Physics, Planetary Science and Exploration, Space and Atmospheric Sciences, Geosciences, Theoretical Physics, Atomic, Molecular and Optical Physics and Astro-chemistry.

This division runs several research programs, particularly aerosol chemistry, hydrology, paleoclimatology, oceanography, etc. The experimental facilities of this division incorporate accelerator mass spectrometer(AMS), aethalometer, isotope ratio mass spectrometer(IRMS), ion chromatographs, and many more.

In the geosciences field the study Studies that are particularly related to geochronology, geochemistry, glaciology, oceanography and palaeoclimatology are carried out in this department. The major focus is on studying Earth and its components' origin and evolution. Isotope geology is one of the most researched subjects. Their research is based on measurements of the abundances of radioactive isotopes, elements, etc.

Fig 11 - ICP-AES inductively coupled plasma atomic emission spectrometry

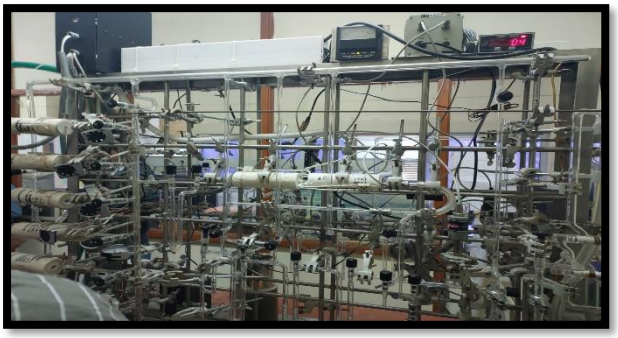

Fig 12 - instrument for radiometric dating of Carbon

3) Mahadev Temple, Balasinor

Geographical distribution:- Latitude- 22.97075 ° N Longitude- 73.3464 ° E

Day-3

Date – 24/01/2023

In this region rocks are **Godra granites** exposed over a hill in form of tors covering a large area. Godra granites are Neoproterozoic in age. Granites texturally are coarse grain, Phaneritic, Porphyritic and with leucocratic colour index of the. It is mineralogically composed of large grains of plagioclase ranging in size from ~2.5-1.5cm and matrix minerals of plagioclase, quartz, orthoclase and biotite. Due slow rate of cooling of biotite large sized cluster of biotite is seen in the rock. The Godra granites are also comprised of enclaves that exhibits gneissic texture with the alternate felsic and mafic bands. The enclaves ranging in size from ~2.5-2 cm. The banded gneiss occurs as enclaves in the granite. Therefore, it is suggested that the banded gneiss of the region is older than Godhra Granite. ((Manish A. Mamtani a, 2002)

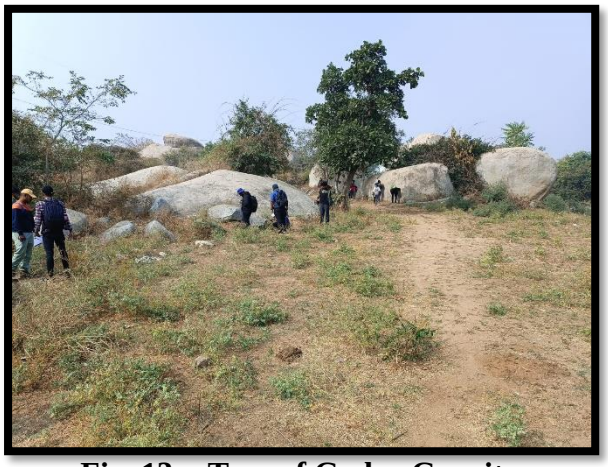

Fig. 13- Tors of Godra Granite

Fig.14- Gneissic enclave within the Godra

Fig.15- plagioclase porphyroblasts in the Granite

Fig. 16 - N-S trending weakness plain that has undergone excessive weathering

4) Raiyoli, Balasinor

Geographical distribution: - Latitude- 23.0562 ° N Longitude- 73.3435° E

Day- 3

Date -24/01/2023

In the year 1981 geologists from the Geological Survey of India who were surveying the area about 16 km NNE of the village Balasinor in the District Kheda, Gujarat for minerals stumbled upon remains of dinosaur bones and fossils. Some 65.5 million years ago during the Cretaceous period, the topography of Gujarat and specifically of Raioli in Balasinor was different than what it is today. The plains of the river Narmada that extended from its basin proved an ideal breeding ground for the Indian Titanosaurid Sauropods and Abelisaurid Theropods. The land proved to be the perfect hatchery for dinosaurs from the late Jurassic period to throughout the Cretaceous period are the basal part of these sections comprises the Aravalli Super Group, including quartzites and phyllites, which are further enveloped by Godhra granitoids. These sections expose an approximately 2-m thick, greenish-coloured conglomerate with numerous sauropods and theropod bones. The conglomerate is further encrusted by an 1.5-m-thick calcareous sandstone, which has also yielded a few fragmentary dinosaur teeth and bones. The topmost part of these sections is composed of the 2.5–3-m-thick Lameta Limestone. These sections are some of the most productive sections for dinosaur nests and eggs and have yielded hundreds of beautifully preserved eggshell fragments belonging to five oospecies.

The **Rajasaurus Narmadensis,** an Abelisaurid Theropod Dinosaur with a single horn on its head that roamed the Narmada valley during the late Cretaceous period. This dinosaur is believed to have a massive dimension with a length of 9 meters, and a height of 2.4 meters and weighing a staggering 4000 kilograms. The bones of the Rajasaurus were excavated and it named because of the horn on its head which gave it the appearance of wearing a crown and the fact that it thrived on the Narmada Valley.

Fig 17 - Left Femur in Medial View and Caudal Vertebrate of Saurapod

Fig 18 - Adjoining caudal Vertebrate of Abelisaurid Therapod and an Intermediate

Fig 19 - Eggs of the dinosaurs

5) Location Site-ONGC Motera GGS

Geographical distribution: - Latitude- 23.11310742 ° N Longitude- 72.59790913 ° E

Day-4

Date- 25/01/2023

At this center the crude oil is collected for refining of the total 59 wells with the radius around ~17m and are connected by a pipeline. It has water injection plant with two water injection pumps. Booster gas compressor which is being used for compressing the gas. This pipelines are underground which is connected to separator and then oil is received to the tank of ~41,000 lit capacity. The pipeline fluid pressure is maintained by the Hydrotest.

So the process as follows crude oil transported to bath heater---separator -----compressor---storage tank.

6) Location Site- Jamarkotra Phospherite Mine

Geographical distribution: - Latitude- 24.58259° N Longitude- 73.51719° E

Day-6

Date-27/01/2023

A large deposit of rock phosphate was discovered by the State Department of Mines and Geology, Rajasthan, in the year 1968 at Jhamarkotra near Udaipur. Nitrogen, potash and phosphorous are the three products of the mine but the rock phosphate contribute to the 90% of the phosphorous of the country and hardly 10% is imported. Some other phospherite mines are Fatasar Lake , padagaon rock phosphate mine and Kanpur rock phosphate mine. Some phosphorite is confined to algal stromatolitic columns such kind of deposits are found in Jammu and Madhya Pradesh.

The late Precambrian phosphorite deposits of the Aravalli Mountain belt occur as discontinuous outcrops within dolomitic limestone and silicified dolomite of the Aravalli Supergroup. They extend from Udaipur in the north to Jhabua in the south. (Banerjee, Basu, & Srivastava, 1980).

Jhamarkotra phosphorite displays a larger spectrum of petrographic types, including algal microsphorite in a micritic of the ore in the market. The ore to overburden ration is 1:16. Groundmass, fragmental phosphatic intraclasts with recrystallized calcareous cement, and microsphorite clasts embedded in silt-sized quartz and pelitic intercalations. The mine strike length is about 16km forming a zig-zag basin and the ore body is in horse- shoe shaped striking in the E-W direction and with 5-15m thickness and 55m average depth. It is an open cast mine with bench and faces and its depth is about 180m from the original topography. The bench heigh is around 10m and face height in a sequence 7m, 7m, 12m.There are two types of the ore 1) high grade ore 2) low grade ore. The high grade ore with P_2O_5 content (35-36%) and this high grade material supplied to the manufacture of the fertilizers. Low grade ore consist of 29% of P_2O_5 . The total tonnage od the geological reservoir is 39m tonnes and mining reservoir is 18m tonnes. The tonnage and area of mining reservoir depends upon the demand.

In the area oldest basement rock is the banded gneissic complex and the Aravalli supergroup with the Jhamarkotra Formation belonging to the lower Aravalli Supergroup unconfirmably overlying the basement rock. The Jhamarkotra Formation evidences the presence of earlier life with the basin 2000-2300 m years. The shallow marine environment of the area in the geological past led the growth of algae and dissolution of the phosphate. The host ore rock is Dolomite.

Fig 20 - Overview of the Jhamarkotra Phosphorite Mine

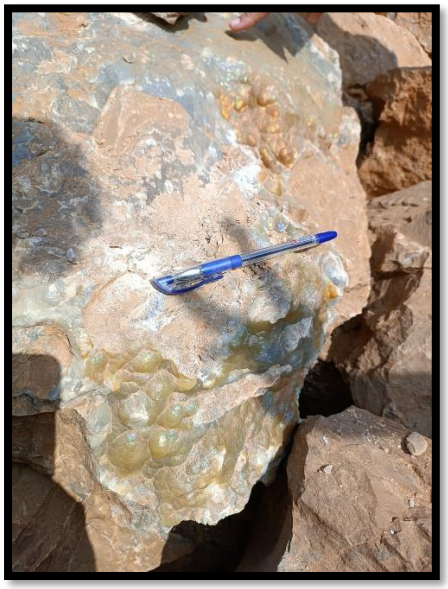

Fig 21 - Botryoidal Structure of the Apatite Mineral

7) Location Site- Berach River, Chittorgarh

Geographical distribution: - Latitude- 24.903591° N Longitude- 74.6231663° E

Day- 7

Date – 28/01/2023

The rocks of this spot are exposed along the banks of the river Berach. This are fine grain sedimentary rock texturally foliated and with the slaty cleavage structure. Quartz veins are concordant to the folding. The is grey coloured with red and white layers.

The rock is the Suket Shale that stratigraphically belong to the Semri Group of the Vindhyan Supergroup overlain by the Kaimur group and underlain by the Nimbara Limstones of the Semi Group.

The structural data from Table.1 shows that the area has undergone two generations of deformation that is evidenced by the presence of two generations fold with F1 fold forming synform and antiform structure striking $N50^0$ and the F2 fold striking along $N120^0$. A pair of conjugate shear joints are present, J1 trending N50 and J2 trending N300. Limbs of the fold dipping in the opposite direction reveals that the area is folded.

F1 fold data		
Strike Direction	Dip Direction	Dip Amount
$N50^0$	$N145^0$	45^0
$N210^0$	$N240^0$	40^0
$N50^0$	$N320^0$	58^0
$N50^0$	$N140^0$	67^0
$N40^0$	$N130^0$	58^0

F2 Fold Data		
Strike Direction	Dip Direction	Dip Amount
$N220^0$	$N40^0$	45^0
$N200^0$	$N30^0$	32^0
$N302^0$	$N210^0$	43^0
$N330^0$	$N60^0$	41^0

Table 1- showing structural data of the region

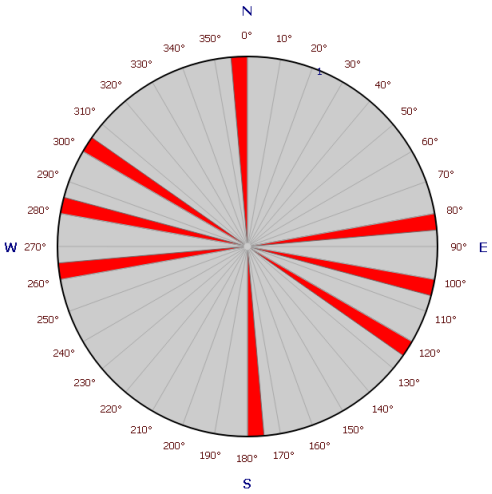

Fig. 22- Suket Shale showing two generations of fold with dip direction of both the sets dipping in opposite direction.

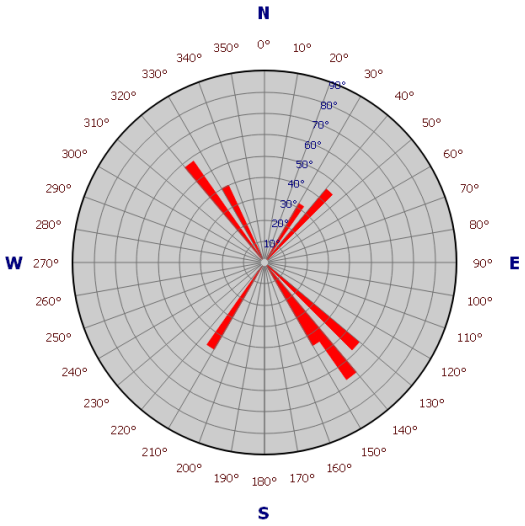

Fig. 23 - strike direction of both the limbs of the in same direction.

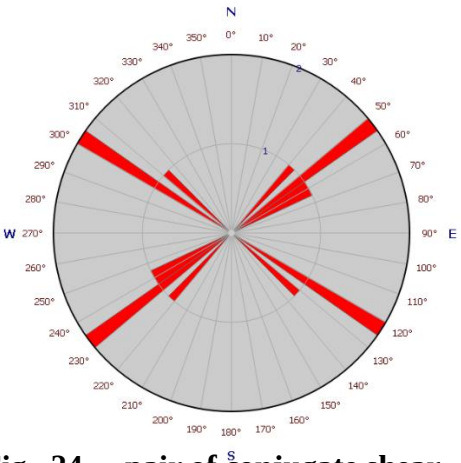

Fig. 24 - pair of conjugate shear

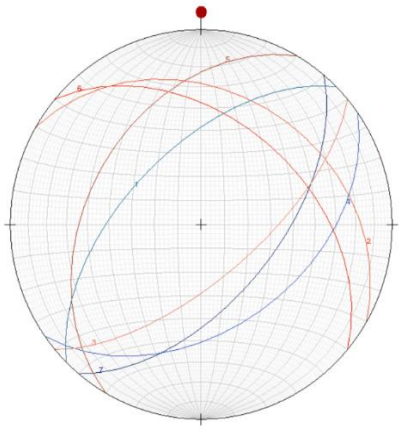

Fig.25- Stereographic projection of structural data

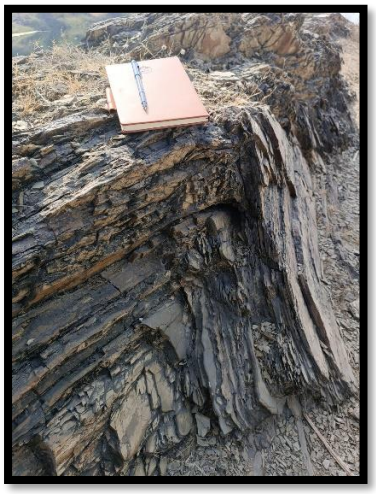

Fig26- F2 generation Fold

Fig 27-F1 generation Fold forming Synform

8) Location Site- Gambhiri River, Chittorgarh

Geographical distribution:- Latitude- 24.8738889 ° N Longitude- 74.63416 ° E

Day-7

Date- 28/01/2023

Rocks are exposed along the Gambhiri river which are dipping almost vertical. They are Nimbara Limestone of the Semri Group of the Vindhyan Supergroup. These limestones are striking N 180^0 and Dipping N 274^0. The rock is highly jointed. orthogonal joints are present trending N170^0 and N 80^0. the Nimbara Limestone is dominantly composed of micritic to microsparitic calcite that preserves largely marine isotopic and trace element signatures.

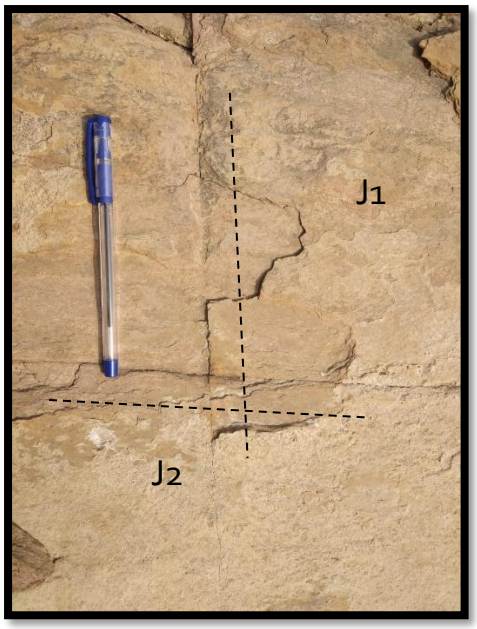

Fig 28- orthogonal joints

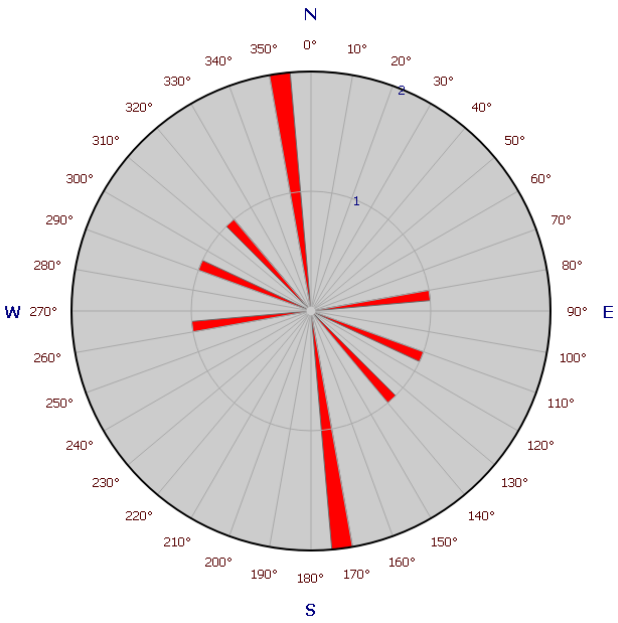

Fig 29- joints orientation of the Nimbara limestone

9) Location Site- Nathdwara

Geographical distribution: - Latitude- 25.0575278° N Longitude- 73.850805° E

Day-8

Date-29/01/2023

The exposed rocks are in a sequence , Here the grey marble overlain by the schistose rock followed by the marble with the joint $N115^0$ passing through all three different lithology. The schistose rock is very dark in colour and defined by schistosity which are striking 130, dipping $N320^0$ by 40^0. At some spots micas are present so the rock is highly weathered Chlorite Mica Schist.

Grey Marble underlain the schist is banded with grey bands, shows Porphyroblast texture with the presence of Amphibole with prismatic habit. It strikes N-S, dipping East by 26^0

Fig 30- bedrock overlying one

Fig31- grey and white laminations in the Marble.

Fig32- amphibole porphyroblasts in the Marble

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