# SCHOOL OF EARTH, OCEAN AND ATMOSPHERIC SCIENCES

# GOA UNIVERSITY

Exam Roll No: 21P0450023

## LABORATORY CERTIFICATE

This is to certify that Mr. Sairaj Alias Gurudas Mangaldas Shet Verenkar has satisfactorily completed the course of practical for M.Sc. in Applied Geology.

Experiments conducted are pertaining to paper GLC-122 Geological Field Training. Practical prescribed by the University for Part II class, during the academic year 2022-2023.

Faculty member in-charge

Dr. Anthony Viegas
Vice Dean (Academic),
School of Earth, Ocean
& Atmospheric Sciences,
Goa University,
Goa - 403 206.

DEAN

SEOAS

GOA UNIVERSITY

# Report on the Geological Field Training Carried Out In Gujarat And Rajasthan.

Field Report submitted by:
**Sairaj Alias Gurudas Mangaldas Shet Verenkar**

**Course of study: MASTER OF SCIENCE**
**Year: 2022-2023**

**School Of Earth, Ocean and Atmospheric Science.**
**Goa University**
**Taleigao Plateau-Goa**

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# ACKNOWLEDGEMENT

**Any accomplishment requires support of many people. This report was no different event. Through the completion of the field work and the report, the efforts that went in to it, the hard work that was put in was all guided and supported by many. I would like to take this opportunity to extend my gratitude to all of them.**

**I am also grateful to Dr. Anthony Viegas, Dr. Niyati Kalangutkar, Dr. Poornima Sawant, Dr. Nicole Sequeira and all the other faculties of the Applied Geology discipline of Goa University. This field trip would not have been a success without the Teachers who accompanied with us, they were Dr. Anthony Viegas, Dr. Niyati Kalangutkar, Prof. Mahesh Mayenkar and Prof. Pooja Ghadi. Their friendly nature, humble attitude and sweet behaviour help us throughout the field trip. I appreciate the help received from the Laboratory Attendant Ms. Heena Maam for providing materials required to carry for the field trip and also for moral support.**

**I thank all the people that we met at different institutes like ONGC, Physical Research Lab (PRL), and Jhamarkotra Mine among others for giving us detailed information about the firms. I personally learnt a lot about phosphate/open cast mines. I extend my appreciation to my classmates and friends for their cooperation in discipline and adhering to the instructions. All this made the trip the most successful one.**

**I would like to express my gratitude towards my fellow classmates for helping me wherever and whenever their help was needed during the field trip.**

**Lastly, I would like to thank my parents for allowing me to go for the field trip and providing financial and moral support.**

# INDEX

# INTRODUCTION
# GEOLOGY OF INDIA

The geology of India is diverse. Different regions of India contain rocks belonging to different geologic periods, dating as far as back as the Eoarchean Era. Some of the rocks are very deformed and altered. Other deposits include recently deposited alluvium that has yet to undergo diagenesis. Mineral deposits of great variety are found in the Indian subcontinent in huge quantity. Even India's fossil record is impressive in which stromatolites, invertebrates, vertebrates and plant fossils are included. India's geographical land area can be classified into the Deccan Traps, Gondwana and Vindhyan.

The Deccan Traps covers almost all of Maharashtra, a part of Gujarat, Karnataka, Madhya Pradesh and Andhra Pradesh marginally. During its journey northward after breaking off from the rest of Gondwana, the Indian Plate passed over a geologic hotspot, the Reunion hotspot, which caused extensive melting underneath the Indian Craton. The melting broke through the surface of the craton in a massive flood basalt event, creating the Deccan Traps. It is also thought that Reunion hotspot caused the separation of Madagascar and India.
The Gondwana and Vindhyan include within its fold parts of Madhya Pradesh, Chhattisgarh, Odisha, Bihar, Jharkhand, West Bengal, Andhra Pradesh, Maharashtra, Jammu and Kashmir, Punjab, Himachal Pradesh, Rajasthan and Uttarakhand. The Gondwana sediments form a unique sequence of fluviatile rocks deposited in Permo-Carboniferous time. The Damodar and Son rivers valleys and Rajmahal hills in Eastern India contain a record of the Gondwana rocks.

The Indian Craton was once part of the supercontinent of Pangaea. At that time, what is now India's southwest coast was attached to Madagascar and Southern Africa, and what is now its east coast was attached to Australia. During the Jurassic Period about 160 Ma (ICS 2004), rifting caused Pangaea to break apart into two supercontinents, namely Gondwana (to the south) and Laurasia (to the north). The Indian Craton remained attached to Gondwana, until the supercontinent began to rift apart about in the early Cretaceous, about 125 million years ago (ICS 2004). The Indian Plate then rifted northward toward the Eurasian Plate, at a pace that is the fastest known movement of any plate. It is generally believed that the Indian Plate separated from Madagascar about 90 Million years ago (ICS 2004). This orogeny, which is continuing today, is related to closure of the Alps in Europe, and the Caucasus range in western Asia, created the Himalaya Mountains and the Tibetan Plateau in South Asia. The current orogenic event is causing parts of the Asian continent to deform westward and eastward on either side of the orogen. Concurrently with this collision, the Indian Plate sutured on to the adjacent Australian Plate, forming a new larger plate, the Indo-Australian Plate.

The earliest phase of tectonic evolution was marked by the cooling and solidification of the upper crust of the earth's surface in the Archaean Era (prior to 2.5 billion years) which is represented by the exposure of gneisses and granites especially on the Peninsula. These form the core of the Indian Craton. The Aravalli Range is the remnant of an early Proterozoic orogen called the Aravalli-Delhi Orogen that joined the two older segments that make up the Indian Craton. It extends approximately 500 kilometres (311mi) from its northern end to isolated hills and rocky ridges into Haryana, ending near Delhi. Minor igneous intrusions, deformation (folding and faulting) and subsequent metamorphism of the Aravalli Mountains represent the main phase of orogenesis. The erosion of the mountains, and further deformation of the sediments of the Dharwarian group (Bijawars) marks the second phase. The volcanic activities and intrusions, associated with this second phase are recorded in the composition of these sediments.

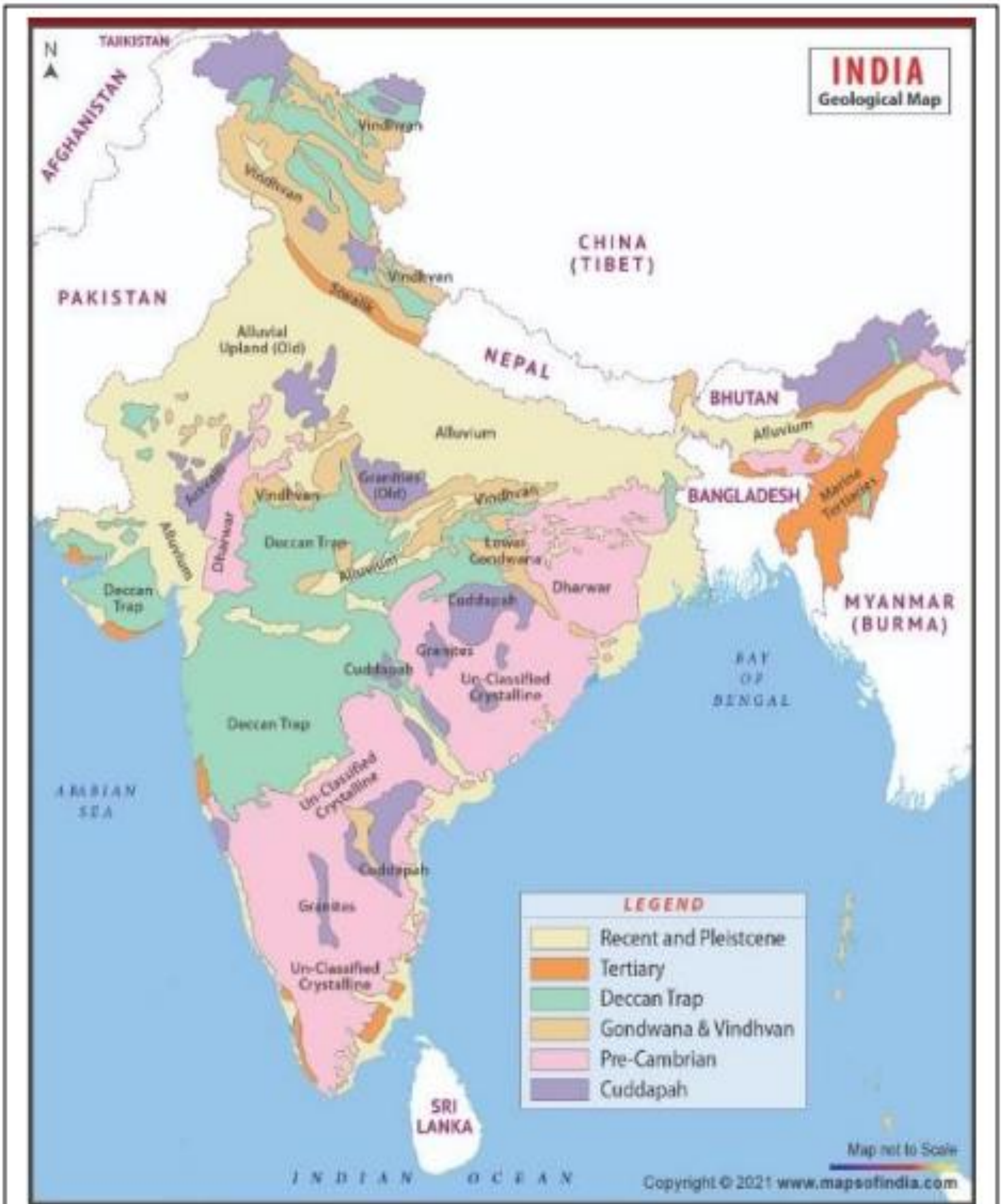
Early to Late Proterozoic (2.5 to 0.54 billion years) calcareous and arenaceous deposits, which correspond to humid and semi-arid climatic regimes, were deposited the Cuddapah and Vindhyan basins. These basins which bordered or lie within the existing crystalline basement, were uplifted during the Cambrian (500 Ma (ICS 2004)). The sediments are generally undeformed and have in many places preserved their original horizontal stratification. The Vindhyan are believed to have been deposited between ~1700 and 650 Ma (ICS 2004).

Early Paleozoic rocks are found in the Himalayas and consist of southerly derived sediments eroded from the crystalline craton and deposited on the Indian platform. In the Late Paleozoic, Permo-Carboniferous glaciation left extensive glacio-fluvial deposits across Central India, in new basins created by sag/normal faulting. These tillites and glacially derived sediments are designated the Gondwanas series. The sediments are overlain by rocks resulting from a Permian marine transgression (270 Ma (ICS 2004)). The Late Paleozoic coincided with the deformation and drift of the Gondwana supercontinent. To this drift, the uplift of the Vindhyan sediments and the deposition of northern peripheral sediments in the Himalayan Sea, can be attributed.

During the Jurassic, as Pangea began to rift-apart, large grabens formed in Central India filling with Upper Jurassic and Lower Cretaceous sandstones and conglomerates.

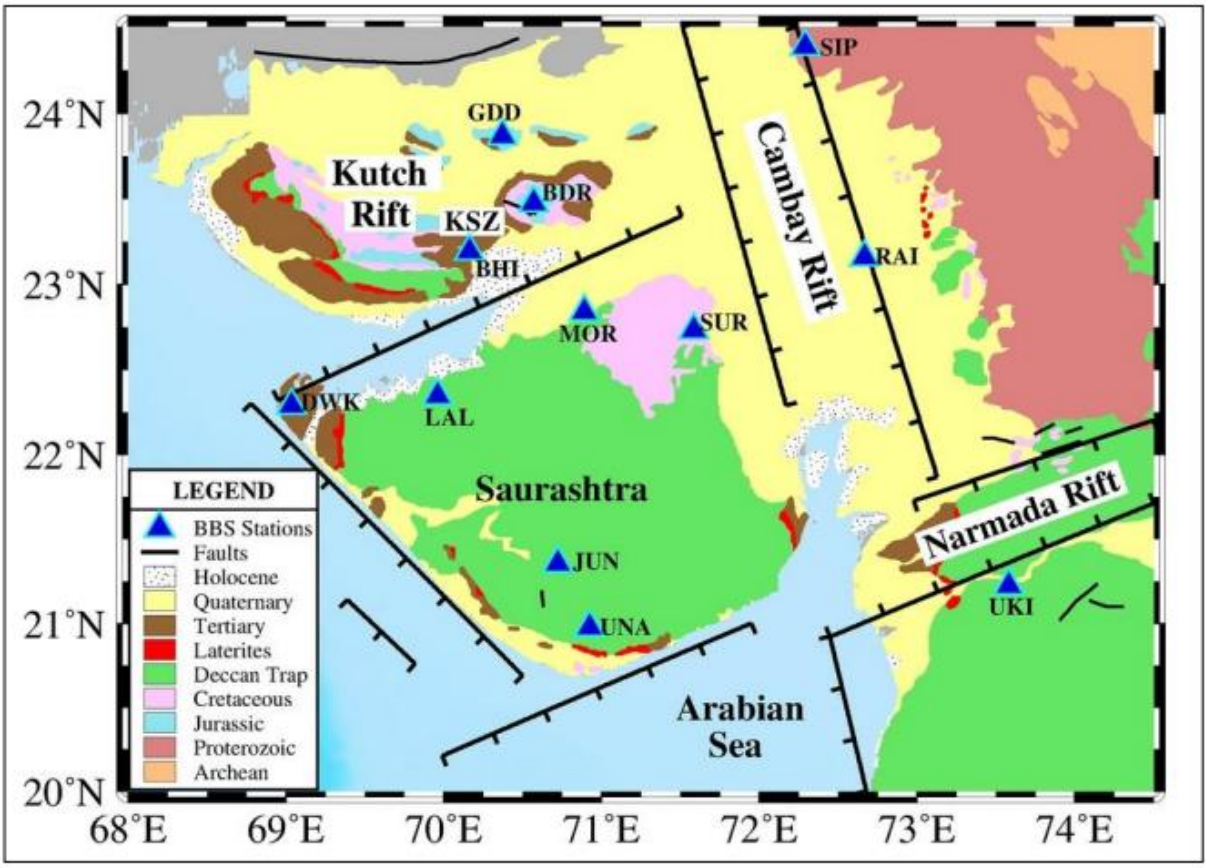
By the Late Cretaceous India had separated from Australia and Africa and was moving northward towards Asia. At this time, prior to the Deccan eruptions, uplift in the Southern India resulted in sedimentation in the adjacent nascent Indian Ocean. Exposures of these rocks occur along the South Indian coast at Pondicherry and in Tamil Nadu.

At the close of the Mesozoic one of the greatest volcanic eruptions in the earth's history occurred, the Deccan lava flows. Covering more than 500,000 square kilometres (193,051 sq. mi) area, these mark the final break from Gondwana.


INDIA
Geological Map
AFGHANISTAN
PAKISTAN
CHINA (TIBET)
NEPAL
BHUTAN
BANGLADESH
MYANMAR (BURMA)
SRI LANKA
BAY OF BENGAL
INDIAN OCEAN
Vindhyan
Siwalik
Alluvial Upland (Old)
Alluvium
Granites (Old)
Vindhyan
Dharwar
Deccan Trap
Lower Gondwana
Dharwar
Cuddapah
Granites
Un-Classified Crystalline
Cuddapah
Deccan Trap
Marine Tertiaries
Un-Classified Crystalline
Cuddapah
Granites
Un-Classified Crystalline
LEGEND
Recent and Pleistcene
Tertiary
Deccan Trap
Gondwana & Vindhvan
Pre-Cambrian
Cuddapah
Map not to Scale
Copyright © 2021 www.mapsofindia.com

# GEOLOGY OF GUJARAT

The state of Gujarat comprises an area of approximately 1,96,000 sq.km and is enclosed within the North Latitude 20°10° to 24° 50° and East Longitude 68° 40° to 74° 40°. Geologically Gujarat provides a wide spectrum of rock types of different ages. Whereas the Aravalli in the NE is as old as 2500 million years, the unconsolidated alluvium and beach material in its Central and Western parts, date back to a few thousand years only. All the important lithological types Igneous, Sedimentary and Metamorphic occur within the state. Geomorphologically, the State can be divided into three distinct divisions, viz.: a) Gujarat-Mainland: The well-known agriculturally rich alluvial basin of Gujarat rises from the estuarine tracts between Narmada and Tapi rivers and extends 402 km northwards merging into the desert plains of Rajasthan and the Rann of Kutch. It is roughly 121 km wide. The eastern border of the basin is bounded by Aravali, Vindhya, Satpura, and Sahyadri hill ranges. The topography of the land is obviously controlled by the geological formations. The eastern part of the south Gujarat bordering the alluvial tract has a typical Deccan trap scenery up to Narmada valley. The hills are formed by circumdenudation leaving wide plateau at top, and a step like feature because of horizontal lavaflows and their differential weathering. b) Saurashtra-Kathiawar Peninsula: The Saurashtra is bounded by Gujarat plains in the East and NE, by gulf of Kutch and Little Rann on the north, and on the SE by the Gulf of Cambay. The Arabian Sea borders the entire southern seaboard. The Central part of the region forms an elevated table land, from where most of the rivers rise and flow radially. The terrain generally slopes gently towards the peninsular margin to merge into the coastal plains and the great alluvial tract stretches to NE and east. The sedimentary rocks along the coast form almost a low flat country. c) Kutch Peninsula: The mainland of Kutch is isolated by the Great Rann of the north and east, Little Rann on the SE, Gulf of Kutch on the south and rest by the Arabian sea. The central portion of Kutch forms a table-land sloping on all sides, the shape of the region is like a tortoise and hence the name. In general, there are three hill ranges, trending almost east-west. North-flowing rivers disappear in the Rann; others join the sea. The Banni is formed by sediments deposited by northern border of the main land and is composed of fairly good soil. The Rann is a dry bed of the remnant of an arm of the sea, which formally connected the Narmada rift with Sind and separated Kutch from the mainland.


24°N
23°N
22°N
21°N
20°N
68°E
69°E
70°E
71°E
72°E
73°E
74°E
Kutch Rift
Cambay Rift
Narmada Rift
Saurashtra
Arabian Sea
KSZ
GDD
BDR
BHI
SIP
RAI
MOR
SUR
DWK
LAL
JUN
UNA
UKI
LEGEND
BBS Stations
Faults
Holocene
Quaternary
Tertiary
Laterites
Deccan Trap
Cretaceous
Jurassic
Proterozoic
Archean

# Litho-Stratigraphic Table of Gujarat Region.

| Group | System | Rock Type | Localities | Age in millions of years |
|---|---|---|---|---|
| Quaternary | Recent and subrecent | Alluvium, Blown sand, Silts of Rann and Banni, Tidal flats and raised beaches. | Alluvial plains of Gujarat, Rann, Banni & Coastal deposits. | 0.01 |
| | Pleistocene | Miliolites | (i) Saurashtra coast from Gopnath northwards extending beyond Porbandar. (ii) Kutch area. | 1 |
| Tertiary or Kainozoic | Pliocene | Dwarka beds, Manchhar beds, Gypsiferous clays and sandy foraminiferal limestones. | Dwarka, Okha, Piram Island, Kutch. | 12 |
| | Miocene | Gaj beds-Highly fossiliferous clays and limestones. Agate Bearing conglomerates. Kand formations. | Saurashtra coast, Kutch | 25 |
| | Oligocene | Tarkeshwar clays. | Tarkeshwar (District Surat) and Kutch. | 40 |
| | Eocene | Nummulitic limestones and clays. | Tarkeshwar area and Kutch. | 60 |
| Secondary or Mesozoic. | Cretaceous Eocene | Deccan traps with inter trappeans. | Parts of Sabarkantha, Panchmahals, Baroda, Broach, Surat and major part of Bulsar and Dangs Districts. Major part of Saurashtra and small part of Kutch. | |
| | Cretaceous | Himatnagar sandstones, Lameta (limestones). Bagh beds. Songir sandstones, Nimar sandstones,Wadhavan sandstone (infratrappeans), Bhuj and Umia series sandstones | Himatnagar, Kapadvanj, Balasinor, Parabia, Dohad, Gabat, Narmada valley. Songir.Near pavagadh. Wadhavan,Dhrangadhra,Bhuj etc. | 110 |
| | Jurassic | Katrol series, Chari series, Patcham series (sand-stones, shales and limestones). | Kutch. | 150 |
| | Purana (Algonkian & Part of Cambrian) | Erinpura granite (Post-Delhi). | Palanpur, Danta, Idar, Modasa, Taranga, Dharoi, Virpur, Wanakbori, Godhra, etc. | 1500 |
| | | Delhi System-Alwar quartzites, schists, and calc-gneisses, calcschists of Ajabgarh series. | Parts of Sabarkantha and Banaskantha, and Mehsana Districts. | |
| Archaean or Azoic | | Aravali System-Micaschists, Phyllites, quartzites, etc. | Sabarkantha, Panchmahals, Baroda, Banaskantha. | 4000 |
| | | Banded gneissic complex. | Baroda District. | |

# GEOLOGY OF RAJASTHAN

Rajasthan is endowed with a continuous geological sequence of rocks from the oldest Archaean Metamorphic, represented by Bhilwara Super-group (>2500 m. y.) to sub-recent alluvium & windblown sand. The geological sequence of the state is highly varied and complex, revealing the co-existence of the most ancient rocks of the Pre-Cambrian age and the most recent alluvium as well as windblown sand.

Rajasthan forms north-western part of the Indian Shield. The State exposes a variety of lithological and tectonic units ranging in age from Archaean to Recent times. Before going into details of Geology of Rajasthan, let us first see, geology time in general to make sense of terms in geology.

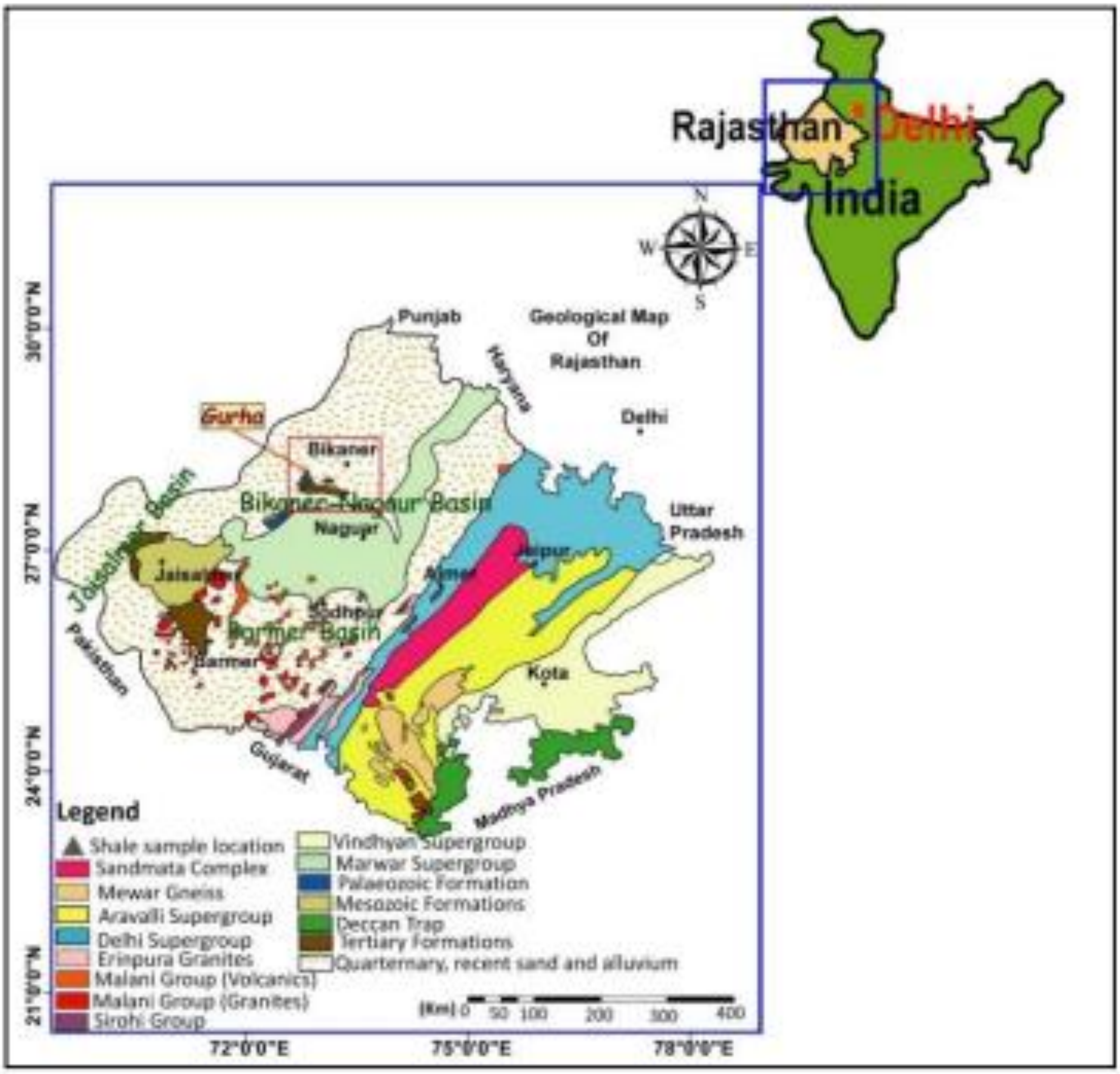
The basement rocks – the Sandmata Complex, Mangalwar Complex and Hindoli Group of Bhilwara Super group – occupy central and south-eastern plains. They are Archaean in age and comprise in general, granulite-gneiss; amphibolites, metapelite, paragneiss, calc-silicate rocks and greywacke (the older granite-greenstone belt) and metavolcanic, met greywacke (the younger granite- greenstone belt) respectively.

The Lower Proterozoic supracrustal rocks of the Jahajpur, Rajpura-Dariba, Pur-Banera and Sawar Groups of Bhilwara Super-group rest on the basement rocks of the Mangalwar Complex and host a number of lead, zinc and copper deposits.

The Proterozoic fold belts, viz., the Aravalli fold belt (the Aravalli Super-group) and the Delhi fold belt (the Delhi Super-group) occupies the southern and south- eastern, and south-western and north-eastern Rajasthan respectively. The Aravalli Super-group is represented by metamorphosed and complexly folded clastic sediments with minor chemogenic and organogenic assemblages with interlay red basic volcanic, whereas the Delhi Super group comprises mainly carbonates, metavolcanics, metasammites and metapelite, intruded by magmatic rock of Phulad Ophiolite Suite and syn-orogenic granites of Sendra- Ambaji, Baraith, 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 Vindhyan, 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 Super group which are overlain by sedimentary rocks of different ages of Paleozoic 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 Chittorgarh- Banswara area. The Cenozoic rocks are manifested in Barmer and Jaisalmer basins in the west and GanganagarPalana shelf in the north. The Quaternary sediments of Aeolian and fluvial origin constitute the Thar Desert of Rajasthan



# FIELD REPORT

Day 1

Date:- 22/01/2023

## LOTHAL-ARCHAEOLOGICAL REMAIN OF A HARRAPPAN PORT-TOWN.

Lat- 22° 31’ 18” N

Long- 72° 14’ 58” E

Lothal is Archaeological remains of a Harappa Port-Town, a site located in the state of Gujarat, India. Lothal was a vital and thriving trade Centre in ancient times, with its trade of beads, gems and valuable ornaments reaching the far corners of West Asia and Africa. The techniques and tools they pioneered for bead-making and in metallurgy have stood the test of time for over 4500 years.

The discovery foraminifera have led to enhancement in knowledge of geological history of Lothal. These are tiny marine organisms that secrete a calcareous shell, and they are commonly used as bio-indicators in paleo-environmental studies. Their presence at Lothal suggests that the site was once a marine environment, with the Indus River delta located nearby. The foraminifera also indicate that the sea level was higher in the past, and that the site was submerged under water at one point, and this info is even more ensured after noting the presence of marine sediments at the site, which contain fossils of marine animals such as mollusks and crustaceans.

According to Archaeological Survey of India (ASI), Lothal had the world's earliest known dock, connecting the city to an ancient course of the Sabarmati River. The site was once a thriving port city located in a marine environment, which was eventually submerged under water due to changes in sea level. This information helps us to better understand the history of the Indus Valley Civilization, and the ways in which humans have interacted with their environment over time.

S. Rao started excavation in early 1955 and this excavation was continued till 1962. He found that there was a not only a dockyard but a market which was 50 mts away. The market had many shops which were used for business purposes of precious stones, pearls, seals and many other ancient things. They are kept in the Museum which was under renovation so we couldn’t visit it.

The dockyard was about 214 mts in length, 36 mts wide and 3.5 mts deep which was constructed in such a way that ship would travel easily. There were 2 different towns which was constructed for upper caste (acropolis) and lower caste and workers with different wells and toilets. The toilets were constructed in such a way that there was a proper drainage system. They were at a distance of about 100 mts from the dockyard.


**Figure 1/Lothal Entrance.**

**Figure 2/ the dockyard at Lothal**

Figure 3/ well at acropolis

Figure 4/ the furnance

Day 2

Date:- 23/01/2023

# PHYSICAL RESEARCH LABORATARY

The Physical Research Laboratory is a National Research Institute for space and allied sciences, supported mainly by Department of Space, Government of India. PRL carries out fundamental research in selected areas of Physics, Space & Atmospheric Sciences, Astronomy, Astrophysics & Solar Physics, and Planetary & Geo-Sciences.

Dr. Vikaram Sarabhai founded in 1947. The Geosciences Division of the Physical Research Laboratory (PRL) in India is an important research institution that focuses on the study of the earth and its various components. It is one of the largest and most prestigious organizations in the country dedicated to the field of geosciences. The Geosciences Division of PRL is located in Ahmedabad, Gujarat, and has been instrumental in advancing our understanding of the earth's structure, composition, and dynamics. The division is home to a team of highly qualified and experienced researchers who work on various aspects of earth science, including seismology, geodynamics, geodesy, atmospheric science, oceanography, and paleoclimate.

Dr. Sanjeev Kumar (Geo-science Professor) explained us the focus of the research lab and briefly told about the working of the laboratory.

The Geosciences Division of PRL has a wide range of research facilities and state-of-the-art equipment that are used to conduct cutting-edge research. We thank the faculty for guiding us around the labs of the PRL.

## MC-ICPMS

MC-ICPMS stands for "multi-collector inductively coupled plasma mass spectrometry" and it is a powerful analytical technique used for high precision isotopic analysis of a wide range of elements. MC-ICPMS is a highly sensitive and precise analytical technique that is used in a wide range of applications, from studying the geochemistry of rocks to analyzing trace elements in biological samples.

## TIMS

TIMS stands for "thermal ionization mass spectrometry" and it is a powerful analytical technique used for high precision isotopic analysis of a wide range of elements. TIMS is a highly sensitive and precise analytical technique that is used in a wide range of applications, from studying the geochemistry of rocks to analysing trace elements in biological samples. TIMS is often used for measuring isotopic ratios of elements that have low natural abundance, such as uranium and lead.

Figure 5/ Dr. Sarabhai Statue at PRL

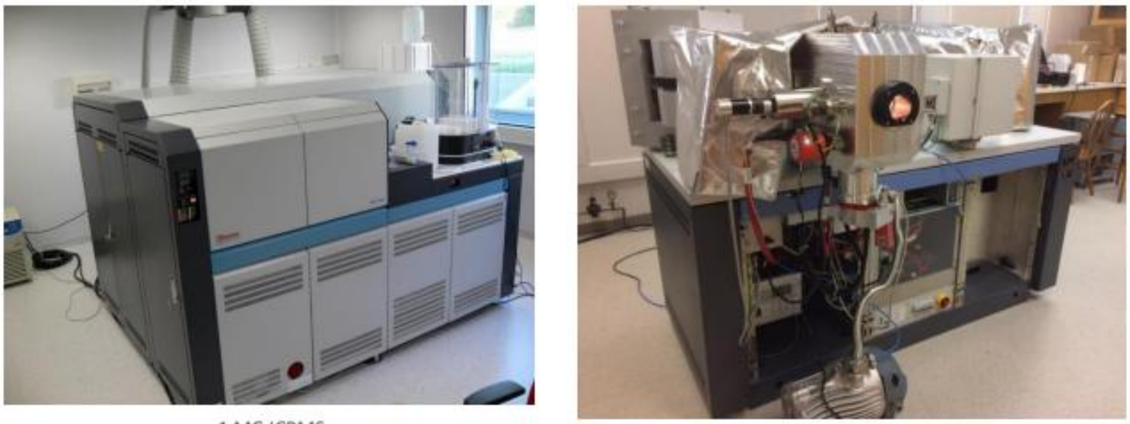


Figure 6 Machines at PRL

Day 3

Date:- 24/01/2023

Spot No. 1

**BALASINOR (MARUTI TEMPLE)**

Latitude: 22.970785
Longitude: 73.346296

The location was at a little higher elevation were there were domes of granite. The age of the granites are 925- 945 million years and there is no paleozoic succession in Gujarat statrigraphic table. Granite shows tors and domes topography. Tors are large rounded boulders of granite that may be formed from the action of weathering and erosion. The presence of exfoliated domes caused by expansion of rock due to change in temperature. The colour of the rock is greyish and grain size range between medium to coarse, is crystalline in nature, rock consist dominantly of feldspar and quartz minerals classify as essential minerals and biotite as accessory mineral. segregated quartz and biotote fragments were seen in the rock at several places. euhedral crystals of plagioclase can also be seen oriented in particular direction. The rock is classified as plutonic felsic igneous rock. named as Grey Granite.

**Figure 7 Ghodra Granites**

Spot no. 2

## The Raiyoli Dinosaur Fossil Park

The first place were the dinosaur eggs were found. There were fossil imprints which was like circular in shape and can be easily identified as eggs. The conglomerate is slowly transforming into limestone. More than 10 cm Jasper/Chert were seen in the conglomerate. They were more of a pinkish in colour.

**Figure 8/ fossil imprints**

**Figure 9/ Chert in conglomerate**

Spot No.3

The Raiyoli Dinosaur Fossil Park is a dinosaur museum and fossil park located in Balasinor, Gujarat, India. It is also known as the Balasinor Dinosaur Fossil Park. The park is situated about 80 km from Ahmedabad and covers an area of approximately 72 acres.

The Raiyoli Dinosaur Fossil Park is home to one of the largest dinosaur egg hatcheries in the world, and the largest dinosaur fossils site in India. The park is believed to have been inhabited by dinosaurs about 65 million years ago. It has over 10,000 dinosaur fossils, including bones, eggs, and other remains that were found during excavations conducted by the Geological Survey of India (GSI) and the Gujarat Ecological Education and Research (GEER) Foundation.

The park features a museum where visitors can see life-sized dinosaur models, skeletons, and various exhibits about the evolution of dinosaurs. Visitors can also take a guided tour of the park to see the actual excavation sites and learn about the different types of dinosaurs that once roamed the area. The park offers a unique experience for visitors to explore the prehistoric world and learn about the history of these magnificent creatures

Shankar Chatterji a geo-science abd paleo-scientist was the first who started excavating the ground, the ground was dugged till 50 feet deep and the 2 dinosaur fossils were found which was 75% bone. The two dinosaur were (1) Therapod (2)Titanosaur.

All the fossils are silicified into bone. This replacement is happen at a cellular level that's why there are striations.

Chauhan Dhayabhai who was our guide had worked with Shankar chatterji and he showed the dinosaur eggs which they found and are kept in the museum. Some of the fossils are taken to Jaipur Museum.


**Figure 10/ Dinosaur fossil park**

Day 4

Date:- 25/01/2023

## GAS GATHERING SYSTEM - MOTERA
## OIL AND NATURAL GAS CORPORATION LTD (ONGC)

The mine code is 100180

We visited oil and crude gas gathering plant which was connected to 59 oil wells in a radius of 17 kms which were connected through underground pipelines. 50 to 60 thousand liters of oil and crude is being transported to the Kayoli IOCL Refinery everyday.
Mister Gaurav kumar who was Safety Officer there, guided us and show us the plant.
Firstly, we went to the main processing plant where oil and gas is received through underground pipelines which comes to a booster gas compressor plant which passes to the low pressure separator which separate Oil and Gas based on the density. Which is directly stored in a tanker which is 45 cubic metre.

Based on the pressure received there are two separator present.
1.) Low pressure separator
20.60kg/cm2
Hydro test pressure - 9.0 kg/cm2
Safety valve test pressure -6.-kg/cm2

2) High Pressure separator
40 kg/cm2
Hydro test pressure- 60 kg/cm2
Safety valve test pressure- 43 kg/cm2

Through this separator, oil and gas is directly stored in the storage tank.
Corrosion inhibitors are used to prevent rusting of pipelines.2 liters per day in each pipeline.
There are 2 new gas booster plants with high capacity. This are 2 stage compressor which makes the machine smaller in size.
The bath heaters are used to increase the temperature of crude if it gets solidifies in the pipelines which works on the idea of heat exchanges. This new booster plant have a safety measure feature which is $CO_2$ flooding which prevents fire.
They used SCADA software to check and maintain the pressure temperature and flow meter.
Lastly, Gaurav Sir briefly explained us the processing and working of the plant.


Figure 11/G.G.S. Motera

Day 5

Date:- 27/01/2023

Spot 1

## Rajasthan State Mines & Minerals Limited, Jhamarkotra

Latitude: 24° 58’ 25’’ N

Longitude: 73° 51’ 71’’ E

The rock phosphate mine in Jhamarkotra is looked after Rajasthan State Mines & Minerals Limited. Rajasthan State Mines & Minerals Limited (RSMML) is a public sector enterprise of the Government of Rajasthan and primarily engaged in Mining and Marketing of High-Grade Rock phosphate, Lignite, Limestone & Gypsum (NonMetallic minerals) through its mines located at various locations in Rajasthan. This is the largest rock phosphate mine in the country which extends from Jhamarkotra Udaipur till Jamua District of Madhya Pradesh. This mine was started in 1968.

Mr. Khotari who is General Manager of the mine since last decade gaved us a detailed idea about the working of the mine.

The deposits are 2000 million years old. His deposits are sedimentary deposits which were deposited in a shallow environment, which has blue green algae which dissolved the phosphate in the water and deposited. The host rock is Dolomite, these are Zigzag deposits and has a average thickness of 5-15mts. The stromatolites are the proofs that there was a marine life in the Aravali.

Jhamarkotra deposit, generally a Bi-modal grade distribution pattern viz.+30 % (37- 38%) P2O5 designated as High-Grade Ore (HGO) and 16 to 22 % P2O5 designated as Low-Grade Ore (LGO) could be deciphered. However, at places near the contacts of the above grade of phosphate bed, some transitional zones exist which are designated as Mixed / Medium Grade Ore (MGO). The marketable grade of ore is 31.5% & 30% P2O5, but a large resource of low-grade ore also occurs in the area. Looking at great demand of phosphate fertilizer and to reduce its import, the low-grade ore is being upgraded through froth flotation in beneficiation plant.

Figure 12/ veiw point at Jhamarkotra Mine

Figure 13/ Stromatolites

Figure 14/ Apatite

Spot 2

## Jhameshwar Mahadev Temple, Jhamarkotra

Stalactites are type of formation that hangs from the ceiling of caves, hot springs. They are developed downward, grow from dripping walls and ceilings. The fundamental form is the 'straw' stalactite, a monolayer crystal sheath enclosing a feedwater canal and growing downwards only. Leakage from the canal may over plate the sheath, creating tapered (carrot-like) stalactites up to one metre in diameter and several in length. Accelerated deposition on protuberances can add a myriad of subsidiary forms such as crenulations, corbels, drapes and lesser stalactites. A 'column' is a stalactite–stalagmite pair grown together.

**Figure 15/Stalactites**

Day 6

Date:- 28/01/2023

Spot 1

## Chittorgarh (banks of the Berech River)

Latitude: 24 47 40 N,

Longitude: 73 51 71 E.

Rock Name- Suket Shale

The shale/phylites are part of the Vindhyan Supergroup and Semri group. The age of the rock is protozoic and they are highly structurally deformed. They are fine grained, has a Slaty cleavage with brown to black colour and have a high amount of clay minerals.

The phyllites have been folded into large- scale low plunging folds trending parallel to the GBF. Increase in the tightness and asymmetry of the folds near the fault suggests that these are fault related folds. They are highly compressed and joint sets are closely spaced than the joints present away from the river that is away from the GBF. Slicken sides are observed, which indicates the presence of fault and quartz veins are also present which may be either syngenetic or post genetic. The Suket Shale/Phyllite shows various stages of predominant folding, mainly 2 series.

Structural Data

| | | | | | |
|---|---|---|---|---|---|
| Strike Direction | N45° | N57° | N45° | N39° | N32° |
| Dip Direction | N139° | N150° | N140° | N130° | N134° |
| Amount of Dip | 56° | 43° | 52° | 58° | 49° |

Figure 16/folding of the Suket Shale

Figure 17/ 2 series of folding

Spot 2

## Nimbara Limestone

Nimbara Limestone is a type of sedimentary rock that is primarily composed of calcium carbonate. It is commonly found in the Nimbara region of Rajasthan, India, and is a popular building material due to its durability, strength, and natural beauty. This limestone is typically light gray in color and contains fossilized marine organisms, including shells and corals, which are visible on its surface. It is formed through the accumulation of calcium carbonate-rich sediment that has been compressed over millions of years, often in marine environments.

## Structural Data

| | | | | |
|---|---|---|---|---|
| Strike Direction | N6° | N3° | N8° | N2° |
| Dip Direction | N276° | N273° | N278° | N272° |
| Amount of Dip | 40° | 63° | 45° | 60° |

Day 7

Date-29/01/2023

Spot 1

## Nathdwara Limestone/Marble

Latitude: 25 05’ 76” N

Longitude: 73 85 08” E

Large beds of marble and Mica chloride schist were seen which were dipping at a dip of 30° to 40°. The dipping beds of marble and mica chloride schist were seen at a larger scale. The mica chloride schist was highly metamorphosed and weathered in which Biotite can be seen prominently throughout the bed. At places distinct Augen structures were seen. Sinsodal structure were observed in marble. Termolite and Actinolite were seen in the marble.

The marble strata were inclined with the overlying bed of schist. The schist present was heavily weathered. The marble bed which was inclined had minor crenulation folding sequence which initiated few joints present in the marble. The recrystallised silica grains in the marble suggested the following sequence have undergone contact metamorphism. The schist present had alternate augen gneiss structure with minerals like chlorite and tremolite dominating into the rock, which suggested the name of the schist as mica schist. Elongated acicular structure is also seen in the mica schist in which the needle like structure consists of tremolite.

**Figure 18/Dipping beds**

Figure 19/ Plagioclase standing out

Figure 20/ Augen Structure

Figure 21/ Actinolite in Marble

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