SCHOOL OF EARTH OCEAN AND ATMOSPHERIC SCIENCES GOA UNIVERSITY

CERTIFICATE

This is to certify that Mr. GODWIN NEPPO has satisfactorily completed the course of field work pertaining to Paper GLC- 122: Geological Field Training for MSc in applied Geology as prescribed by Goa university for MSc part II class, during the academic year 2022-2023.

FACULTY MEMBER

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REPORT ON GEOLOGICAL FIELD WORK CARRIED OUT AT IN AND AROUND GUJARAT AND RAJASTHAN

SUBMITTED BY

GODWIN NEPPO

M.Sc Applied Geology

21P045008

A Report of Field Training Programme submitted to Goa University in partial fulfillment of the requirements for the Master of Science Degree in Applied Geology

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ACKNOWLEDGEMENT

Any accomplishment requires support of many people. We have completed this report according to the M.Sc Program .Completion of the report, the efforts that went in to it, the hard-work that was put in was all guided and supported by many.

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Last but not the least I would like to thank all my fellow friends for their valuable and constant support.

CONTENTS

1.1 INTRODUCTION

The present report pertains to the geological field work carried out in Gujarat and Rajasthan as a part of M.Sc. Applied Geology program. Without the ability to independently conduct geological observations and measurements on the ground, geology cannot be fully learned in the lab or in the classroom.

Geologists use evidences from fundamental units such as minerals, rocks, and fossils and recorded data from field to study the geology of an area. Based on progressive science the techniques of collection of data or information are changing rapidly from pens and compass to using space craft and satellites to explore the natural world and use the information they gain to better understand the past, present, and future.

The Program's goal was to visualise and collect data on the lithological, structural, and stratigraphic dispositions of rock units. The Programme started from 21/01/2023 and continued up to 30/01/2023.

2.1. FIELD EQUIPMENTS

BRUNTON COMPASS - It is a specialized instrument used widely by those needing to make an accurate degree and angle measurements in the field. It is properly known as the Brunton Pocket Transit. David W. Brunton, a Canadian Geologist invented it in 1894. It consists of plastic, non-chip Gray case weight 12 ounces its case is water-resistant and sealed against dust with Brunton closed it is 2 ⅝ inches wide and 3 ⅛ inches long, and 1 ⅜ height. It has a fitting clasp on one side and on the opposite side allowing the instrument to open at an angle of 180 degrees.

GEOLOGIST HAMMER - It consists of chisel head and has a rubber coated shock reduction handle. The hammer was used for cleaning the exposure, breaking rocks and also for trimming the samples

GPS (GLOBAL POSITIONING SYSTEM) - Global Positioning System (GPS) was used to find geographic coordinates of the outcrops in the field. The latitude and longitude values obtained from GPS were used to plot the outcrop points.

FIELD NOTEBOOK – All observations and interpretations were recorded in field note book. First of all, sample locations were marked on the left margin. Then include rock sample description.

HANDLENS – Preliminary examination of fresh rock surfaces to known the mineral content, grain size and shapes were done in the field itself using a magnification of 10X. A hand lens provides a quick and easy way to perform that work. The hand lens enables geologists to examine rocks closely to identify minerals, see the size and shape of grains, look for small fossils or crystals, confirm the results

of a hardness test, and much more. Many field geologists use a hand lens so frequently that they wear it on a lanyard or cord around their neck. Some tuck the lens into their button-down shirt pocket when it is not in use. A hand lens is one of the most basic tools of a field geologist.

OTHER FIELD ACCESSORIES - The other field accessories field camera, streak plate, and magnet and sample bag are also carried in the field.

3.1. 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 coastline along the Arabian Sea borders the state's western and southern regions. 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. The Aravalli Range continues southward in the northeast as the noticeable hill chains. The northwest corner of the State is occupied by the Kachchh Peninsula and the Rann of Kachchh. There is an alluvial tract that extends north to south between the Saurashtra-Kachchh Peninsula and the Aravalli Mountains. The State is blessed with vast mineral riches and exposes a wide range of lithological assemblages from the Precambrian, Mesozoic, and Cenozoic eras. Base metals, lignite, bauxite, bentonite, dolomite, fireclay, fluorite, fuller's earth, kaolin, ball clay, limestone, chalk, calcareous sand, quartz, and silica sand are among the minerals of commercial significance found in the state. The geology of Gujarat State is characterized by hard rock terrain represented by Precambrian metamorphites and associated intrusives sedimentaries of Jurassic, Cretaceous and Tertiary Periods and the traps/flows of Deccan Volcanics of Cretaceous-Eocene age. The Precambrian metamorphites, viz. the rocks belonging to Aravalli Supergroup and the Delhi

Supergroup occupy the NE part of Gujarat. Rocks of these Supergroups are confined to the north-eastern part of Gujarat, in Sabarkantha and Banaskantha districts. These Supergroups are made up of metasedimentaries and have a lot of magmatism. Gujarat's geological record shows a significant break from the Cambrian to the Triassic after the end of the Proterozoic Period.

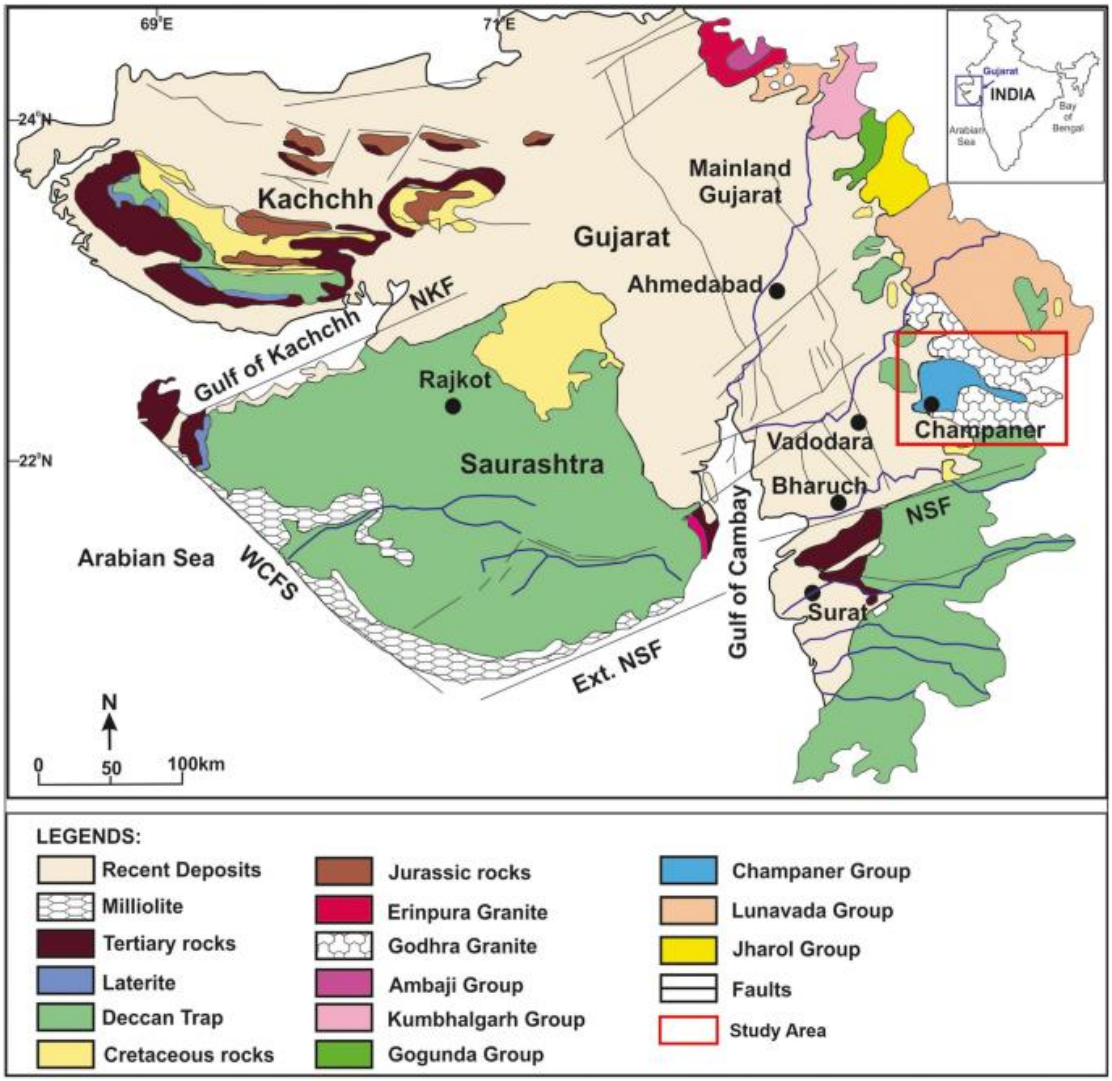

Figure 1 - Geology of Gujarat

Fossiliferous sediments are found in portions of the Kachchh, Sabarkantha, Panchmahals, Surendranagar, Kheda, Vadodara, and Rajkot districts, and they reflect the Mesozoic sequence from the Middle Jurassic to the Lower Cretaceous. Towards the end of the Mesozoic Era, large-scale volcanic activity was observed in areas of

Saurashtra, Kachchh, southern Gujarat, and the eastern Panchmahals and Vadodara districts.

3.2. GEOLOGY OF RAJASTHAN (UDAIPUR FORMATION)

The Udaipur Group is a sequence of rocks that forms a part of the Aravalli Range in western India. It is comprised of a series of sedimentary rocks that were deposited during the Proterozoic era, between approximately 1.7 and 1.4 billion years ago. The stratigraphy of the Udaipur Group is complex, and it includes several formations that provide important insights into the geological history of the region.

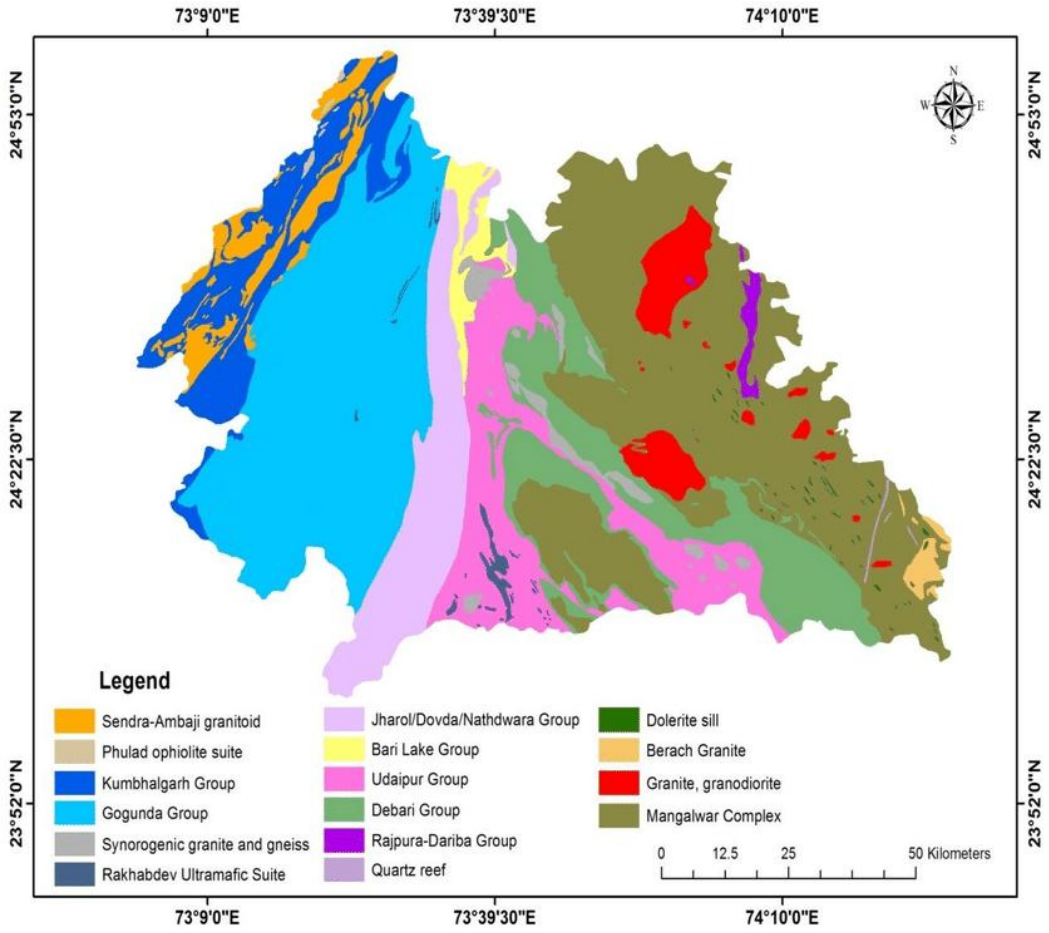

Figure 2 - Udaipur Formation

The Udaipur Group is divided into several formations, each of which represents a distinct period of deposition and geological activity. The oldest formation in the Udaipur Group is the Sumerpur Formation, which includes rocks that were deposited in a shallow marine environment. These rocks are primarily composed of sandstone and shale, and they are notable for containing fossils of stromatolites, which are layered structures formed by cyanobacteria. The Sumerpur Formation is estimated to be around 1.7 billion years old. Above the Sumerpur Formation is the Jharol Formation, which includes rocks that were deposited in a shallow marine environment. These rocks are primarily composed of limestone and dolomite, and they are notable for containing fossils of a variety of marine organisms, including algae, sponges, and brachiopods. The Jharol Formation is estimated to be around 1.6 billion years old.

The third formation in the Udaipur Group is the Raialo Formation, which includes rocks that were deposited in a shallow marine environment. These rocks are primarily composed of sandstone and shale, and they are notable for containing fossils of a variety of marine organisms, including trilobites, brachiopods, and stromatolites. The Raialo Formation is estimated to be around 1.5 billion years old. Above the Raialo Formation is the Galiakot Formation, which includes rocks that were deposited in a shallow marine environment. These rocks are primarily composed of limestone and dolomite, and they are notable for containing fossils of a variety of marine organisms, including algae, sponges, and brachiopods. The Galiakot Formation is estimated to be around 1.4 billion years old. The Udaipur Group has been subject to a number of geological processes over the years, including folding, faulting, and erosion. The rocks in the group have been folded and faulted into a series of anticlines and synclines, creating a complex geological structure. Erosion has also played a significant role in shaping the landscape, with rivers and other water bodies cutting deep valleys into the rocks over time.

4.1 FIELD OBESERVATION

DAY - 1

SITE - 1 **LATITUDE - 22°31'18"**

LOCATION - LOTHAL **LONGITUDE - 72°14'58"**

The Lothal is an ancinet port city which belongs to the Indus valley civilization, it is located near the Bhogava river a tributary of the Sabarmati river near the Gulf of Khambat. The area was excavated during 1955 and the site can be divided into upper and lower town.

The enormous dockyard at Lothal is the most striking feature, and it is a large part of why this location is so significant to archaeology. The dock, a tidal port, was operational up until the middle of the 19th century and was connected to the sea by a tributary of the Sabarmathi river, which is now dry, covering a distance of around 22 metres from north to south and 37 metres from east to west. The National Institute of Oceanography (NIO) has identified foraminifera species and the gypsum salt indicates that the area was under the ocean during this period which further confirms it as a port city. The study also confirms that the sea level was more than 6m that of now. Tides, hydraulics, and the impact of seawater on bricks were all carefully considered in the design of the building. During high tide, ships might have entered the northern end of the port by an inlet channel that was connected to an estuary of the Sabramati. The lock gates might have then been shut, causing the water level to rise just high enough for them to float. The gates would have opened

to allow a ship to return to the Arabian Sea waters in the Gulf of Cambay after it had discharged its cargo.

Figure 3 - Dockyard

The whole town is divided Into two, the upper town and the lower town, the upper town has a ware house which is Built on a raised ground (3m above the dock) which indicates the fear of flood which led to proper town planning. Building consists of small houses built with brick and stone masonry. Drainage system is a peculiar feature seen leading away from the houses. These drainage system characterize the town planning of the civilization. Many wells were built across the upper city along which ensured supply of fresh water for the houses.

Figure 4 - Warehouse

The lower town contains a commercial and residential areas. The arterial streets running from north to south were flanked by shops, merchant dwellings and artisan's workshops. Streets running from east to west .The main ornaments of harappan civilization is made up of by beads, these consists of microbeads of steatite. Seals are also produced which are used to label imports and exports passing through the dock.

Figure 5 - Market area and ancient foricae

The Bead factory was one of the major economy of this ancient civilization, the beads were made of banded agate, amethyst, onyx and other semi precious stones and faience are on display. Besides these micro beads of steatite which can be seen through magnifying glass are also seen. The excavation at Lothal has yielded the third largest collection of seals and sealing after Mohenjodaro and Harappa. The steatite seal which was found in this area is related to the middle east region. The bronze and copper objects were also seen in the area which were imported from Oman.

Scientists believe the site was originally a prosperous port city in a maritime environment that was finally drowned owing to changes in sea level. This knowledge aids our understanding of the Indus Valley Civilization's history and the manner in which humans have interacted with their environment over time.

DAY - 2

SITE - 1 **LATITUDE - 23°29’11”**

LOCATION - Amrutavarshini vav Paanchkuva **LONGITUDE - 72°35’49”**

This tiny step well is situated in the crowded Panchkuva neighbourhood close to Kalupur railway station. According to the Persian and Devanagri inscriptions found on the vaav, it was finished around 1723. Its entrance is tiny, and unless one is especially seeking for it, one almost misses it. The Panchkuva Vav, as it is known, had five wells and the Vav was created in 1723 by Raghunath Das, Diwan of Haider Quli Khan, and the ruler of Gujarat. It features a three-story depth and straightforward L-shaped construction.

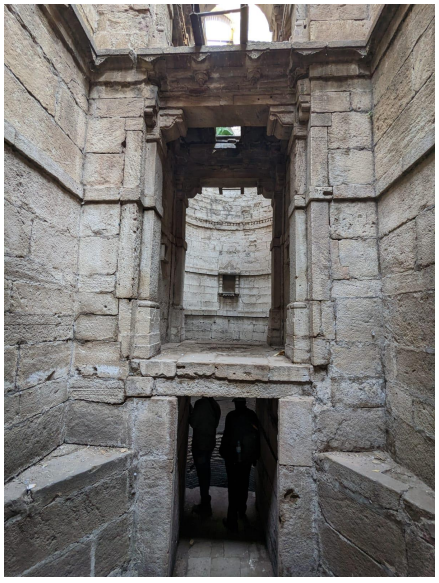

Figure 6 - Step well

SITE - 2 **LATITUDE - 23.1688° N**

LOCATION - PRL, AHMEDABAD **LONGITUDE - 72.5451° E**

A national research institute for space and related sciences, The Physical Research Laboratory (PRL) is primarily funded by the Indian government's Department of Space. Research projects in astronomy and astrophysics, atmospheric sciences and aeronomy, planetary and geosciences, Earth sciences, Solar System studies, and theoretical physics are now being conducted in this research facility. Moreover, it oversees the Mount Abu InfraRed Observatory and the Udaipur Solar Observatory. Gujarat's Ahmedabad is where the PRL is situated.

Dr. Vikram Sarabhai founded it in 1947. Ahmedabad, Gujarat-based PRL's Geosciences Division has contributed significantly to the advancement of our knowledge of the structure, composition, and dynamics of the earth. The division is home to a group of faculty members and researchers who study on numerous areas of earth science, such as seismology, geodynamics, geodesy, atmospheric science, oceanography and paleoclimate. Modern technology and a variety of research facilities are available at PRL's Geosciences Division, where cutting-edge research is carried out. Scientists Prof. Sanjeev Kumar, Dr. Vineet Goswami, and Dr. Yogita Kadlag accompanied us and quickly discussed how some of the tools they use for study work.

The intoductory class was conducted by Dr. Yogita Kadlag. The principles of mass spectrometer was taught along with its various application in the geoscience division. The ISM (Indian Summer Monsoon) and westerlies were also taught in the session. The working of various types of mass spectrometer were also taught which include the following :

Ex Terra Lab: Multi-collector Inductively Coupled Plasma Mass Spectrometer (MC ICPMS) Hybrid mass spectrometer that combines the advantages of superior ionization of an inductively coupled plasma source and the precise measurements of a magnetic sector multicollector mass spectrometer.The instrument uses a plasma (ICP) to ionize the elements in a sample and then measures the ions using a mass spectrometer (MS). Instrument :Neptune plus

Chemistry lab : Thermal Ionization Mass Spectrometer (TIMS) It provides high precision isotope ratio measurements. Best used for uranium. Instrument:: triton plus

HR-ICPMS :High Resolution Inductively Coupled Plasma Mass Spectrometer used for elemental analysis of solutions and solid samples. The superior ionization of inductively coupled plasma source is combined with a magnetic sector multicollector mass spectrometer resulting in ultimate sensitivity. The instrument can be used to find the trace elements within the water bodies. Each samples take almost 15minutes.

Accelerator mass spectroscopy mass spectrometry that accelerates ions to extraordinarily high kinetic energies before mass analysis. The special strength of AMS among the mass spectrometric methods is its power to separate a rare isotope from an abundant neighboring mass. The lab was used to produce CO2 from H2O in vaccum condition. Liquid nitrogen is used to collect the contaminants. ons are accelerated by passing them through a potential difference V. Radiocarbon dating lab.

Figure 7 - ICP -MS and TIMS

DAY - 3

SITE - 1 **LATITUDE - 22°97'07''**

LOCATION - GODHRA GRANITES **LONGITUDE - 73° 34' 64''**

About the entire state of Rajasthan, as well as portions of Gujarat, Madhya Pradesh, and the edges of Delhi and Haryana, are covered by the Aravalli Craton. It has been around for around 2.5 Ga. Sediment from the Aravalli has a NE-SW general tendency. Large-scale granitic activity characterises the Aravalli craton's concluding phase. A cluster of Rb-Sr ages shows that the majority of granitic entities invaded between 730 and 830 Ma. Godhra granites are exposed as Inselberg which is an isolated hillock rose abruptly in a plain. The rock is white in colour, leucoclastic, coarse grained and holocrystaline. The rock exhibits porphyritic textures in which phenocrysts of plagioclase is about 5cm. Surrounded by Biotite(1 set of cleavage, pearly lustre), quartz(vitreous lustre). Xenoliths are fine grained and mafic in composition. Sheets of biotite flacks are in segregating which show crenulation. Many small exposures of boulders are present one above the other forming Tors structure. Minor joints are seen which have undergone spheroidal weathering gives rise to present day structure.

Figure 8 - Biotite in Granite

Figure 9 - xenolith with gneissic banding, plagioclase xenolith

SITE - 2 **LATITUDE - 23° 05’ 62”**

LOCATION - RAYOLI FOSSIL PARK **LONGITUDE - 73° 34’35”**

Balasinor is the second-largest dinosaur fossil park in the world, and it is situated in Gujarat's Mahisagar District. Fossils of a left femur, caudal vertebrae, scapula, abelisaurid theropod dorsal vertebrae, and an intermediate limb bone were discovered. 75% of two dinosaurs were discovered during the 1977 investigation at a depth of 12 feet. Rajasaurus terapod (carnivorous) remains were discovered in 1981. According to estimates, at least 13 species may have existed here up until their extinction 100 million years ago.

The fossil park here contains life sized statues of those giant creatures and further excavations have found that a squat, thick- legged, heavy-bodied carnivorous dinosaur with a crested horn, Rajasaurus Narmandensis, King of Narmada. This creature belonged to the carnivore family of Tyrannosaurus Rex.

Figure 10 - Cerapod eggs and Tetrapod vertebra

Figure 11 - Dinosaur egg

DAY - 4

SITE - 1

LOCATION - ONGC GGS MOTERA

GGS ONGC In Motera, Gujarat, India, there is a facility for processing natural gas. Oil and Natural Gas Corporation Ltd (ONGC), an Indian state-owned oil and gas exploration and production business, is its owner and operator.

The plant, one of the main gas processing facilities in India, has a daily processing capacity of about 6.5 million standard cubic metres of natural gas. It is essential in supplying the nation's energy demands by processing and delivering

natural gas to different businesses and residences. The gas gathering process involves separating the natural gas from crude oil and water, compressing it to increase its pressure, and then transmitting it through pipelines to various consumers. The station is equipped with advanced technology and equipment to ensure safe and efficient operations. Apart from the gas processing facilities, ONGC GGS Motera also has a gas compression station, gas dehydration unit, and a sulfur recovery unit. The plant is equipped with modern technologies and is designed to operate efficiently while ensuring the safety of its workers and the environment. This ONGC (Oil and Natural Gas Corporation) hub uses advanced technology and equipment to ensure safe and efficient gas gathering and transmission. These technologies are: - Gas Chromatography: is used to separate and analyze the various components of the natural gas mixture. This technology helps to determine the quality and composition of the gas being processed, which is critical for maintaining the efficiency and safety of the gas gathering process.

- Compressors: are used to increase the pressure of the natural gas so that it can be transmitted through pipelines to various customers. The compressors used at ONGC GGS Motera are designed to operate at high efficiency and with minimal maintenance requirements.

- SCADA System: (Supervisory Control and Data Acquisition) system is used to monitor and control the various components of the gas gathering and transmission process. This system provides real-time data on gas flow rates, pressure levels, and equipment status, allowing operators to make adjustments and ensure safe and efficient operations.

- Pipeline Inspection: Regular inspection of pipelines is critical to ensure safe and reliable gas transmission. ONGC GGS Motera uses various inspection technologies, including smart pigs (devices that travel inside pipelines to detect defects) and remote sensing techniques, to detect and repair any pipeline damage.

- Environmental Monitoring: This place uses advanced environmental monitoring systems to track air and water quality around the station. This helps to ensure compliance with regulatory requirements and minimize the impact of the station's operations on the environment.

DAY - 5

SITE - 1 **LATITUDE - 24° 58’ 25”**

LOCATION - JHAMARKOTRA MINE **LONGITUDE - 73°51’71”**

The largest and one of the most significant rock phosphate mines in India is Jhamarkotra Mines. The Rajasthan State Mines and Minerals Ltd (RSMML), a company, is its owner and operator state-owned enterprise of the Rajasthani government.

It was found in 1968, and by 1972, it was running. The mines span a roughly 3.33 square kilometre area and are situated in Rajasthan's Udaipur district. Open-cast mining, a surface mining method, is used to carry out the mining process. It is well known that the Jhamarkotra Mines produce high-quality rock phosphate, a crucial raw material in the manufacture of fertilizers. The mines have an estimated reserve of about 150 million tonnes of rock phosphate.In addition to rock phosphate, the Jhamarkotra Mines also produce other minerals such as barytes, copper, and silver. The mining operation at Jhamarkotra has a significant impact on the local economy, providing employment opportunities to thousands of people in the region.

In 1969 after discovery of rock phosphate in Jhamarkotra (Udaipur), BGL took over operations at Jhamarkotra mines. The major activity of RSMML is the mining of Rock phosphate ore. It operates one of the largest and fully mechanised mines in the country at Jhamarkotra, 26 Kms. from Udaipur. Jhamarkotra plays an important role by contributing 98% of rock phosphate production of India. With an annual rock handling of about 20 million tonnes, Jhamarkotra is probably the largest open cast mine in India outside the steel and coal sectors. The geometry of the ore body i.e thin and sharply dipping had resulted in long and narrow pits with great depth extension, which involves very high stripping ratio with high lead and lift for waste and mineral. Method of Mining Used: open pit mining method is being followed. The working levels are kept dry by continuous pumping of ground water through tube-wells constructed on periphery of the pit. The bench height in this extent of mine is given at 7m consecutively for a couple of times with alternating 12 m heighted bench. (7m,7m,12m). Genesis of Phosphate Rocks: The mineral phase of apatite, which makes phosphorite, is considered to have formed by three mechanisms

(i) direct inorganic precipitation,

(ii) primary biogenic precipitation, and

(iii) diagenetic precipitation/replacement of apatite (an important mechanism).

Commonly occurs as void filling and cementing material in the associated sediments. The organic matter, which collects on the shelf regions, on decay, causes very high concentration of phosphorous below the sediment water interface, leading to precipitation of apatite. During this process carbonate constituents of the sediment are also phosphatized due to the replacement.

Figure 12 - Benches and walls of the mine

Figure 13 - High grade and low grade ore

Figure 14 - Stromatlite and phosphate

SITE - 2

LOCATION - JHAMESHWAR TEMPLE STALACTITE

Formation of stalactites. Stalactites are type of formation that hangs from the ceiling of caves, hotsprings. They are developed downwards, grow from dripping walls and ceilings. They are very good archives for the paleoclimate records. India is having a tropical climate hence they can be used to study the past ISM system which we have discussed at the PRL. Mostly stalacmites are usually used as the paleoclimate proxy, the isotope of oxygen, hydrogen are studied from them.

Figure 15 - Cave deposits from the temple

DAY - 6

SITE - 1 **LATITUDE - 24.9038**

LOCATION - Banks of Berach river **LONGITUDE - 74.6231**

Chittorgarh is a district in a Rajasthan characterised by having undulating topography with hills belonging to Aravalli range. The district comprises of rocks of Bhilwara supergroup, Vindhyan supergroup and Deccan traps. The great boundary fault which is present separates Vindhyan sediments like conglomerates and rocks of Bilwara supergroup. Berach River flows parallel to the great boundary fault. Bilwara supergroup is present at the west side of the river. Bilwaa supergroup is divided into 3 tectono-stratigraphic units which are Hindoli group, Mangalwar complex together with isolated mineralised belts and Sandmata complex. Hindoli group mainly consists of greywackes and phyllites. These phyllites haves been folded into large- scale low plunging folds trending parallel to the GBF.

Suket shale belongs to semri group of Vindyan supergroup. The area was highly folded and had various types of folds- Primary and secondary folds.2 Sets of joints were also observed. Quartz veins were exposed as cutting and along with the folds. The quartz veins lies east west and parallel to the fold axis. The area is highly deformed and the M type folds are clearly seen.

STRIKE	**N45°E**	**N48°E**	**N54°E**	**N55°E**
DIP AMOUNT	**40°**	**59°**	**56°**	**42°**

Figure 16 - Fold and 2 set of joints

On the other side of the bridge unconformity can be seen with the conglomerates lying above the shale.

Figure 17 - unconformity with conglomorate on top

SITE - 2

LOCATION - NIMBARA LIMESTONE

This 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. We had the opportunity to take the readings of the Nimbara Limestone near Chittorgarh Fort.

STRIKE	**190°**	**170°**	**180°**
DIP	**54°**	**50°**	**45°**

Figure 18 - Nimbara limestone

DAY - 7

SITE - 1 **LATITUDE - 5°05'76"N**

LOCATION - NATHWARA LIMESTONE **LONGITUDE -73°85'08"E**

The outcrop was fully weathered and foliated.there were competent and incompetent layer : marble was sandwiched between schist. The schist could be mica chlorite schist because of the presence of flaky minerals but could not be properly identified due to weathering. Mylonitic structure were observed which were stress indicators. Certain acicular structure were found which might be tremolite or actinolite. Green colored fibrous minerals were seen-

serpentine. Small garnet crystals were also seen which were less than1cm size. The area could be a single large anticlinal fold.

	LEFT SIDE	MIDDLE	RIGHT SIDE
STRIKE	**142°**	**135°**	**123°**
DIP AMOUNT	**29°**	**35°**	**35°**

Figure 19 - weathered limestone and augen structure

5. CONCLUSION

Rajasthan and Gujarat are an ideal places to study geological field mapping with preservation of important primary volcanic, metamorphic, sedimentary and deformational structures. The field study was mainly conducted Gujarat and Udaipur. The ancient city of Lothal gives us the importanve of archeology and its uses In the field of geology by the foraminifera fossil and the dating techniques, the godhra granites and fossil park also gave us great knowledge about the different types of fossil present in India along with the visit in PRL and ONGC. Rajasthan is a state contributing a lot to the economy of our country. It has economically valuable mineralisation . Sulfide mineralisation like Pb-Zn. Stromalite park of Jhamarkotra holds lots of importance as stromatolites are the first evidences of life.

6. REFERENCE

Joshi, A.U., Gorania, P., Limaye, M.A. et al. Geoheritage Values of the ChampanerPavagadh Archaeological Park, UNESCO World Heritage Site, Gujarat, Western India.

Foraminifera [Marine Microfossil] as an additional tool for archaeologists - Examples from the Arabian Sea- Rajiv nigam (2006)

Kumar S Singh M P., Mohabey D M. 1999. Lameta and Bagh beds. Central India Palaeontological society of India

Gujarat state mineral policy 2003

Deb, M. (2014). Precambrian geodynamics and metallogeny of the Indian shield. Ore Geology Reviews, 57, 1-28.