SCHOOL OF EARTH, OCEAN AND ATMOSPHERIC SCIENCES

GOA UNIVERSITY

Exam: Roll No: 21P0450016

LABORATORY CERTIFICATE

This is to certify that Mr. /Ms. ---- NANDITHA DAS ----

has satisfactorily completed the course of practical for M.Sc in Applied Geology.

Experiments conducted are pertaining to paper ---- GLC -122 ----

Practicals prescribed by the University for ---- M.Sc APPLIED GEOLOGY ----class, during the academic year 20 - 20 .

DEAN
SEOAS

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Goa - 403 206.

REPORT ON THE GEOLOGICAL FIELDWORK CARRIED OUT IN GUJARAT AND RAJASTHAN

Submitted by

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MSc. II

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Certificate

This is to certify that Ms. NANDITHA DAS 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

PROGRAM OFFICE

SEOAS

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I would like to thank the administrative staff, SEAOS, Goa University for being cooperative and providing necessary facilities needed so as to complete the field studies. I would also like to thank my classmates for being caring and supportive throughout the field work

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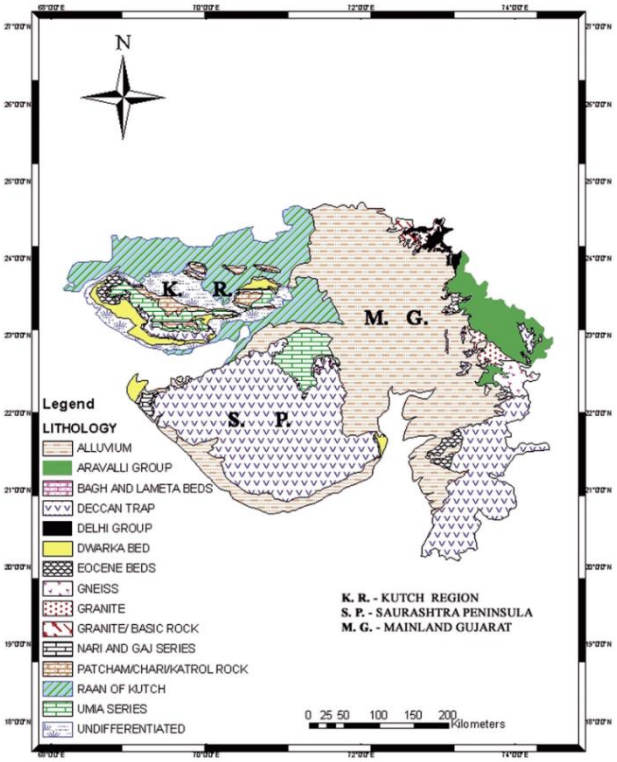
GEOLOGY OF GUJARAT

The state of Gujarat comprises an area of approximately 1,96,000 sq.km and is enclosed within North Latitude 200 100 to 240 500 and East Longitude 680 400 to 740 400 . Geologically Gujarat provides a wide spectrum of rock types of different ages. Whereas the Aravalli's in the NE is as old as 2500 million years, the unconsolidated alluvium and beach materials 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 of Gujarat comprises the following three district zone: a) Mainland Gujarat, b) Saurastra and c) Kachchh. The Gujarat state exposes rocks belonging to the Pre- Cambrian, Mesozoic and Cenozoic era. The hard rocks cover about 49% of the total area of Gujarat, the rest being occupied by sediments of Quaternary period. The hard rock comprises Pre Cambrian metamorphosed and associated intrusive, sedimentary rocks of Mesozoic and Cenozoic eras and the traps/ flow constituting Deccan volcanic of Cretaceous Eocene age.

Gujarat Mainland is agriculturally rich alluvial basin of Gujarat rises from the estuarine tracts between Narmada and Tapi rivers, and extends 250 miles (402 km) northwards merging into the desert plains of Rajasthan and the Rann of Kutch. It is roughly 75 miles (121 km) wide. The eastern border of the basin is bounded by Aravalli, 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 Traps scenery up to Narmada valley. The hills are formed by circumdenudation leaving wide plateau at top, and a step like feature because of horizontal lava – flows and their differential weathering. On north of Narmada, areas which are occupied by sedimentaries of Baghs or lametas in patches, from table lands with low hills. Granites typically form low to high hills with loose boulders of large dimensions standing insitu; thus, granite exposure can easily be recognized from a distance.

Saurashtra – Kathiawar Peninsula is bounded by Gujarat plains in 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 tractstretches to NE and east. The sedimentary rocks along the coast form almost a low and straight hill ranges running parallel, a characteristic feature of this country. On account of several radially intruded basic dykes cutting through traps, there are low and straight hill ranges running parallel, a characteristic feature of this country. Kutch Peninsula is 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 tortoise. In general, there are three hill ranges, trending almost east-west. North – flowing rivers disappear in the Rann; others join the sea. The Banni (made up land) is formed by sediments deposited by northern border of the mainland 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 main-land. The Rann is divided into two, which are Great Rann and Little Rann; they do not differ from each other expect in size.



STATIGRAPHY OF GUJARAT

Gujarat is a state located in western India, and its stratigraphy is primarily composed of sedimentary rocks. These rocks were deposited over millions of years as a result of various geological processes such as erosion, weathering, and tectonic activity.

The stratigraphy of Gujarat can be divided into several major geological formations, each with their own unique characteristics and features. Here are some of the most important formations:

Deccan Trap: This is a large igneous province that covers a significant portion of western and central India, including parts of Gujarat. The Deccan Traps were formed as a result of massive volcanic eruptions that occurred around 60 million years ago.

Cambay Basin: This sedimentary basin is located in the western part of Gujarat and is known for its rich oil and gas reserves. The Cambay Basin is composed of several layers of sedimentary rocks that were deposited over millions of years.

Cretaceous rocks: The Cretaceous period lasted from about 145 to 66 million years ago and is characterized by the presence of dinosaurs. In Gujarat, the Cretaceous rocks are primarily composed of sandstones, shales, and limestones.

Tertiary rocks: The Tertiary period lasted from about 66 to 2.6 million years ago and is characterized by the diversification of mammals. In Gujarat, the Tertiary rocks are primarily composed of sandstones, shales, and limestones.

Quaternary deposits: These are the most recent geological deposits in Gujarat, and they include alluvial and aeolian deposits, as well as volcanic rocks. The Quaternary deposits are primarily composed of sand, silt, and clay.

Overall, the stratigraphy of Gujarat is very complex and diverse, reflecting the state's long and rich geological history.

FIELD OBSERVATIONS

DAY 1

LOCATION 1

LOTHAL

LATITUDE: 22º31’17”N

LONGITUDE: 72º12’53”

The archaeological remains of the Harappa port-town of Lothal is located along the Bhogava river, a tributary of Sabarmati, in the Gulf of Khambat. Measuring about 7 HA, Lothals thick (12-21 meter) peripheral walls were designed to withstand the repeated tidal flood, which probably resulted in the bringing the city to an end.

Within the quadrangular fortified layout, Lothal has two primary zones – the upper and the lower town. The citadel or the upper town is located in the south eastern corner and is demarcated by platforms of mud-brick of 4 meters in height instead of a fortification wall. Within the citadel are wide streets, drains and rows of bathing platforms, suggested a planned layout. In this enclosure is a large structure, identified as a warehouse with a square platform and whose partly charred walls retains the impression of sealings, which were probably tied together, awaiting export.

The remains of the lower town suggest that the area had a bead-making factory. In close proximity to the enclosure identified as a warehouse, along the eastern side where a wharf-like platform, is a basin measuring 217 m long and 26 meters in width, identified as a tidal dock-yard. At the north and southern end of the basis are identified an inlet and an outlet which would have aided in maintaining the adequate water level to facilitate sailing. Stone anchors, marine shells and seals possibly belonging to the Persian Gulf corroborate the use of this basin as a dockyard where boats would have been sailed upstream from the Gulf of Cambay during high tide.

Set in the dried river bed, along a silted bed of the channel (where ocassional) tidal water can still be seen, in the archaeological site of Lothal the typical heirarchial town planning systems and the dockyard is discernable. The remains have been consolidated post excavation and is in stable state of conservation.

The dominant sight at Lothal is the massive dockyard which has helped make this place so important to international archaeology. Spanning an area 37 meters from east to west and nearly 22 meters from north to south, the dock is said by some to be the greatest work of maritime architecture before the birth of Christ. To be sure, not all archaeologists are convinced that the structure was used as a dockyard and some prefer to refer to it as a large tank that may have been a reservoir.

An inlet channel 1.7 meters above the bottom level of the 4.26 meter deep tank allowed excess water to escape. Other inlets prevented siltation of the tanks and erosion of the banks. After a ship would have unloa22ded its cargo, the gates would have opened and allowed it to return to the Arabian sea waters in the Gulf of Combay.

Figure1 lothal dockyard

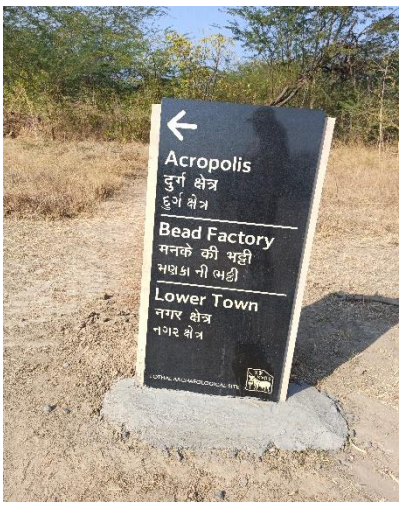


Figure 2 lothal seal

Figure 3 lothal well

DAY 2

LOCATION 1

PRL (PHYSICAL RESEARCH LABORATORY)

The focus is to understand the origin and evolution

Department of space 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.

The Physical Research Laboratory was founded on 11 November 1947 by Dr. Vikram Sarabhai. The laboratory had a modest beginning at his residence, with research on cosmic rays.

Dr.sajeev kumar (geoscience professor) and yogita (assistant professor) were taking class and explaining about the machines uses there.

They have seven divisions which include Astronomy and Astrophysics,Atomic, Molecular and Optical Physics,_Planetary Sciences,_Theoretical Physics,Space and Atmospheric Sciences,Geosciences.they have upto 10-12 core faculty. Processes are isotope characteristic,chemical composition, and field observations. Radiometric dating and uranium series. Paleoclimate studies explained through ocean biogeochemistry.

LABORATORY 1

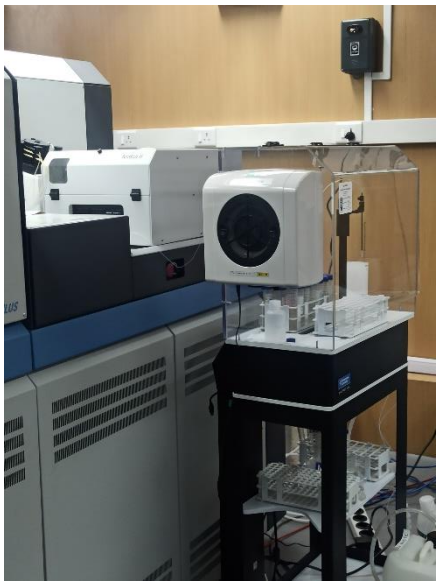
MC-IPMS

This machine is used to determine the isotope of the element. MC-ICPMS is an instrument that measures isotopic ratios that are used in geochemistry, geochronology, and cosmochemistry. A MC-ICPMS is a 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 primary advantage of the MC-ICPMS is its ability to analyze a broader range of elements, including those with high ionization potential that are difficult to analyze by TIMS. The ICP source also allows flexibility in how samples are introduced to the mass spectrometer and allows the analysis of samples introduced either as an aspirated solution or as an aerosol produced by laser ablation.

Modern MC-ICPMS are composed of three primary components:

1. n inductively coupled plasma ion source, where ions are produced, accelerated, and focused;
2. an analyzer, where a) the ions are focused and filtered to produce a beam where the ions have the same approximate energy and can be separated based on their mass/charge ratios; and
3. a series of collectors, where the ion beams are measured simultaneously.

The electronics of these instruments must operate to very close tolerances in order to produce isotope ratios that are precise to 0.01-0. **a**001%. In addition, a high vacuum needs to be maintained along the path of the ion beam in order to avoid scattering of the ions due to interaction with air molecules.



LABORATORY 2

TIMS

Thermal Ionization Mass Spectrometer (TIMS) is an analytical tool for accurate isotopic ratio measurement of elements. It consists of a thermal ionization source for ionization of the sample, sector magnet for separation of ions and Faraday collectors for the measurement of ion current. Owing to the sensitivity, selectivity and precision of TIMS, it finds extensive applications in the field of nuclear industries for isotopic analysis of reactor fuel, spent fuel and reprocessed fuel, exploration studies in Geo-chronology, concentration measurements using isotopic dilution and for isotopic signature studies of soil samples in earth science.

APPLICATION

- Isotope analysis of reactor fuel, spent fuel and reprocessed fuel in nuclear industry.
- Exploration studies in Geo-chronology.
- Concentration measurements using isotope dilution.
- Isotope signature studies of soil samples in earth science

LABORTARY 3 (HEAVY ELEMENT)

Biogeochemical trace element in seawater. Trace elements are released into the environment through both natural processes and anthropogenic activities. Some trace elements are considered potential soil contaminants, such as **arsenic (As), antimony (Sb), cadmium (Cd), chromium (Cr), or lead (Pb)**.sample introduction system.

LABORATORY 4

IRMS

Isotope ratio mass spectrometry (IRMS) is the study of natural and synthetic samples based on their isotope ratios. The isotope ratio of a material will vary depending on its source and origin as well as on processes that may occur during the lifetime of that material. While IRMS is widely used in Earth sciences to understand Earth's geological history, it is also used in food authenticity, forensics, medical research, and antidoping testing.

We offer a comprehensive portfolio of isotope ratio mass spectrometers. With more than 70 years of experience building cutting edge analytic instrumentation, frequent new innovations across the portfolio, and a commitment to a sustainable future, our isotope ratio mass spectrometers are the obvious choice for your analytical needs. All sample convert to gas,maximum abundance is 44.

LABORATORY 5

For water and air vaccum this machine is used. Solid samples are burnt and carbon is changed to graphite and dated.vaccum pumps.

DAY 3

LOCATION 1

LATITUDE: 22º58’240’’

LONGITUDE: 73º20’765’’

APPROCHED : Travelled 4km from balasinor

In this location the exposed rock is coarse grained granite (Godhra granite), which exhibit exfoliations weathering.It had tor structure. It composed of Quartz, feldspar and mica in hand specimen. These are compact & massive, medium grained grey in colour. The trend of these granitoids is N-S. Large phenocrysts of Feldspar of about 2-5 cm were surrounded by finer matrix mainly composed of biotite and quartz.

Aravalli supergroup is ~2.5Ga old. General trend of aravalli sendiment is NE-SW. The closing phase o Aravalli craton is marked with large scale granitic activity. Most of Granitic bodies have intruded in the time span of 730 to 830 Ma, as evidenced by a cluster of Rb- Sr ages. Godhra granite is one of the granitic intrusion that took plae during the closing phase of Aravalli craton. Godhra granite have intruded the Champaner and Lunavada group of Aravalli supergroup. Godhra granite is porphyritic granite to granodiorite with associated pegmatite. It shows presence of feldspar, quartz, micas (biotite & muscovite) minerals.

In this location the exposed rock is coarse grained granite (Godhra granite), which exhibit exfoliations weathering. It composed of Quartz, feldspar and mica in hand specimen. These are compact & massive, medium grained grey in colour. The trend of these granitoids is N-S. Large phenocrysts of Feldspar of about 2-5 cm were surrounded by finer matrix mainly composed of biotite and quartz. This granite is not showing any foliation, so o deformation occurred. Some places feldspar is aligned as stacks.

Muscovite and biotite are present as phenocyst of appx 0.5- 5cm. MMEs were also present. Mafic magma enclaves are formed due to the process of co-genetic mixing of magma. Also perthite texture was seen.

Xenoliths are also present which are mafic in nature.gneissic rock is seen as xanolites. Cave structure in the outcrops can be seen which is formed due to removal of xenoliths by weathering. Joints were also seen.

Figure 1 lath shaped plagioclase

Figure 2 xenolith

LOCATION 2

RAIOLI

Near dinasour fossil museum

LATITUDE:23º4’12’’N

LONGITUDE:73º11’25’’E

In this location we found limestone,sandstone and some conglomerate. We found some dinasour fossils there. teeth and bones are seen in sandstone and egg clusters are seen in limestones.egg shells are of oval shape, they are carnivorous. This shells got leached and calcified and flowed.

LOCATION 3

In the early 1980s, palaeontologists stumbled upon dinosaur bones and fossils during a regular geological survey of this mineral-rich area. They found dinosaur egg hatcheries and fossils of at least 13 species of which the most important discovery was that of a carnivorous abelisaurid named Rajasurus narmadensis which lived in the Late Cretaceous period. The find sent ripples of excitement through neighbouring villages and many residents picked up fossilised eggs, brought them home and worshipped them. Since then excavations have thrown up a veritable trove of dinosaur remains—eggs, bones, a skeleton which is now kept in a Calcutta (Kolkata) museum—bringing hordes of scientists and tourists to Balasinor. Piecing together the evidence in Raiyoli, researchers now believe that Gujarat is home to one of the largest clutch of dinosaur hatcheries in the world. At least 13 species of dinosaurs lived here, possibly for more than 100 million years until their extinction some 66 million years ago. The soft soil made hatching and protecting eggs easier for the animals. So well-protected are the fossilised eggs found here that many researchers call them the best-preserved eggs in the world after the ones found in Aix-en-Provence in France.

These fossilised dinosaur remains have triggered what tourism officials of the Gujarat state call "Dinosaur Tourism". Princess Aaliya also called the Dinosaur Princess conducts guided tours of the fossil park.

Dr Mohabey took one of these balls to Dr Ashok Sahni, a prominent paleontologist who was visiting Ahmedabad for a conference. From the texture on the outer layer, Dr Ashok identified the object as the egg of a Sauropod dinosaur. Sauropods are quadrupedal herbivorous dinosaurs. After this discovery, a report was then sent to the GSI and the place was documented as a fossil site.

A few years later, another team comprising of members from the GSI, the Indian Statistical Institute and Texas Tech University conducted another excavation and they found fossilized remains of what seemed to be an entire herd belonging to one family. They were also carnivores but unlike the Rajasaurus, they were slightly smaller at 28 feet in length and much more slender. And thus in 2010, the village of Raiyoli was immortalized in the name of this species, with due credit to Gujarat and this species was called the Rahiolisaurus gujaratensis. 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. The large tracts of sedimentary rock layers called the Lameta formation exposed in this area.

Figure 1 egg of dinosaur fossil

Figure 1 thigh bone of dinosour

DAY 4

ONGC (Ocean and Natural Gas corporation)

The **Oil and Natural Gas Corporation** (**ONGC**) is an Indian central public sector undertaking under the ownership of Ministry of Petroleum and Natural Gas, Government of India. It is headquartered in Dehradun. ONGC was founded on 14 August 1956 by the Government of India. It is the largest government-owned-oil and gas explorer and producer in the country, and produces around 70% of India's crude oil (equivalent to around 57% of the country's total demand) and around 84% of its natural gas In November 2010, the Government of India conferred the *Maharatna* status to ONGC. ONGC supplies crude oil, natural gas, and value-added products to major Indian oil and gas refining and marketing companies. Its primary products crude oil and natural gas are for the Indian market.

We were greeted by Gaurav kumar (safty officer) and accompanied us to the ongc plant . we visited the crude oil treatement plant which is connected with 59 wells with 17km distance connected directly to tankers. All are underground pipeline. from 10-15km pipelines are connected to the well.we receive gas and separate it through different ways

In control room a person sit and resolve the problem. SCAD software is used in ONGC. Parameters can be seen through or observe through the software continuously.oil we receive are send to a tanker with 45000liters. PPE kit is used while working.canopy are instrument used to check temperatue and pressure.canopy are instrument used to check the temperature and pressure. There are two stage of compressor.lubrication oil is used. Carbondioxide flooding system will operate detect flame and spead the carbondioxide which stop fire and damages.50000- 60000liter of oil are transported per day but they have double the capacity to transport the oil.

Water injection plant is use to increase reservoir pressure which increase the production of the oil,Booster gas compressor plant is used to increase the pressure of the gas. From well they are carried through pipeline,storage,sperator,bathator,compressor.

GEOLOGY OF RAJASTHAN

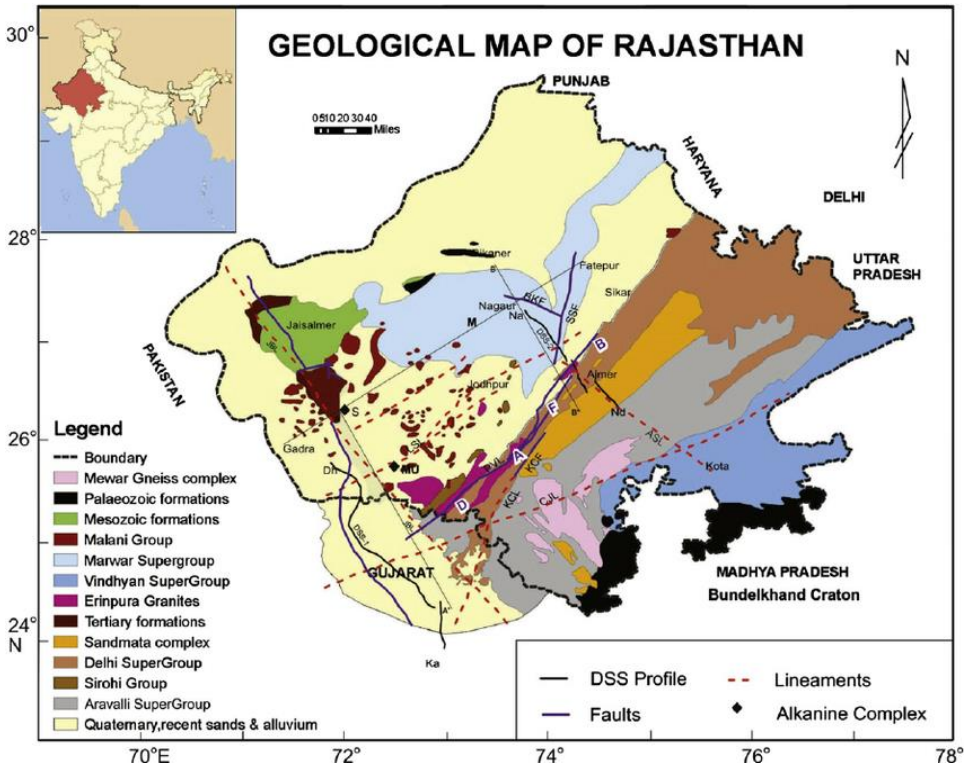
Rajasthan is the largest state in India in terms of land area and is known for its unique and diverse geology. The state is located in the northwestern part of India and is bordered by Pakistan to the west.The geology of Rajasthan is complex and is characterized by a variety of rock formations that have been formed over millions of years. The state can be broadly divided into three regions based on their geological features:

Aravalli Range: The Aravalli range is the oldest mountain range in India and runs through the western part of Rajasthan. It is composed of rocks that are over 2.5 billion years old and are primarily made up of gneisses, schists, and quartzites. The range is also known for its rich mineral deposits, including zinc, lead, silver, and copper.

Thar Desert: The Thar desert covers a large part of Rajasthan and is characterized by its sandy terrain and arid climate. The desert is believed to have formed around 4,000 years ago and is primarily made up of sedimentary rocks like sandstone, limestone, and shale.

Vindhyan Range: The Vindhyan range runs along the southeastern part of Rajasthan and is primarily composed of sedimentary rocks like sandstone, shale, and limestone. These rocks were formed during the Mesozoic era and are believed to be between 145 and 200 million years old.

Overall, the geology of Rajasthan is significant because of its mineral wealth, its impact on the state's economy, and its rich history. The state has several mines and quarries that produce a variety of minerals and building materials, including marble, granite, limestone, sandstone, and gypsum. Additionally, the state is home to several ancient rock formations and structures, such as the Chittorgarh Fort and the Kumbhalgarh Fort, which are examples of the state's rich geological heritage.



STATIGRAPHY OF RAJASTHAN

The state of Rajasthan in India has a complex geological history spanning over several million years. The stratigraphy of Rajasthan is characterized by a variety of rock formations and sedimentary deposits that record the evolution of the region's geology over time. Here is a brief overview of the major stratigraphic units present in Rajasthan:

Aravalli Supergroup: The Aravalli Supergroup is the oldest stratigraphic unit in Rajasthan, consisting of sedimentary rocks that were deposited between 2.5 and 1.6 billion years ago. These rocks are dominated by quartzite, schist, and phyllite, and are found in the Aravalli Range.

Delhi Supergroup: The Delhi Supergroup is a sequence of sedimentary rocks that were deposited between 1.6 and 900 million years ago. It includes the Bhander Group, Vindhyan Supergroup, and Malani Igneous Suite. These rocks are found in the western part of Rajasthan and are dominated by sandstone, shale, and limestone.

Marwar Supergroup: The Marwar Supergroup is a sequence of sedimentary rocks that were deposited between 900 and 650 million years ago. It includes the Jodhpur Group and Bilara Group, and is characterized by sandstone, shale, and limestone. These rocks are found in the central part of Rajasthan.

Phanerozoic: The Phanerozoic is the most recent era of geological time, covering the past 541 million years. It includes the Paleozoic, Mesozoic, and Cenozoic eras. In Rajasthan, the Phanerozoic is represented by sedimentary rocks of the Jaisalmer Group and Barmer Group, which were deposited during the Mesozoic and Cenozoic eras. These rocks are primarily sandstone and shale, and are found in the western part of Rajasthan.

Overall, the stratigraphy of Rajasthan reflects a long and complex history of geological processes, including deposition, erosion, and tectonic activity. These processes have created a diverse range of rock formations and sedimentary deposits that provide valuable insights into the evolution of the region's geology over time.

DAY 5

LOCATION 1

JHAMARKOTRA OPENCASTMINE

RAJASTHAN,UDAIPUR

LATITUDE:24º28’56’’

LONGITUDE:73º51’13’’

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 (Non-Metallic minerals) through its mines located at various locations in Rajasthan. 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 Rockphosphate 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. The rock phosphate occurs in metasedimentary rocks of Aravalli Supergroup (Precambrian age). It is of algal origin. The deposit extends over a strike length of 16 kms in horse-shoe shape with average thickness of 15 meters. A reserve of 77 million tonnes of rock phosphate has been proved on the basis of 60,000 mts. drilling in 500 boreholes. Out of these 17 million tonnes is of +30% P2O5 grade and rest is of 12 0 30% P2O5 grade. A beneficiation plant of 1500 TPD (Tonnes Per Day) capacity has been installed to up grade the lowgrade phosphate ore.

Figure 1 jhamarkotra opencast mine

Figure 2 lowgrade phosphate(apatite)

Figure 3 mediumgrade phosphate

Figure 4 high grade phosphate with stromatolite

Extent of Jhamarkotra Deposit

Total lease area is 13sqkm2. In Jhamarkotra, the strike length of the phosphaorite bed including the discontinuous outcrop extending over a linear distance of 16 km. The highest point of the phosphate bed outcrop at 600 MRL at Jhamarkotra and along the downdip direction the extention of the phosphate has been proved upto a little below 250 MRL. Ore body dips at angle of 45-55°. They are also seen in jamalpur of madhyapradhesh .they are seen as stromatolites.metabolic activity of algae(blue green algae)which in developed in aravalli hills. The deposit is shallow environment is favourable for algae growth. The phosphate bed shows an extremely variable thickness showing persistence only over a limited strike length. Thus, in Jhamarkotra, the 15 km average thickness of the phosphate bed could be traced over 6.

Grade of the Deposit

At 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.

Genesis of rock phosphate at Jhamarkotra

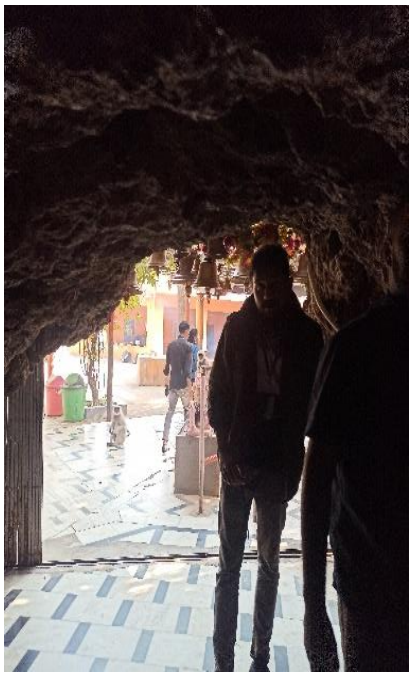
The old rock is BGC banded gneiss and unconformity which are above the supergroup The mineral phase of apatite, which makes phosphorite, is considered to have formed by three mechanisms (i) direct inorganic precipitation, (ii) primary biogenic precipitation, and (iii) diagenetic precipitation/replacement. Diagenetic precipitation of apatite is considered as an important mechanism involved in phosphorite formation. Apatite of this origin commonly occurs as void filling and cementing material in the associated sediments. It is said that 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 phosphatised due to the replacement phenomenon. Mining Method: The open pit mining method is being followed at Jhamarkotra Mine for exploitation of the mineral. The working levels are kept dry by continuous pumping of ground water through tube-wells constructed on periphery of the pit limit. The bench width is 12m & 10m and bench height is 10m. stripping ratio is 10:1 & 11:1

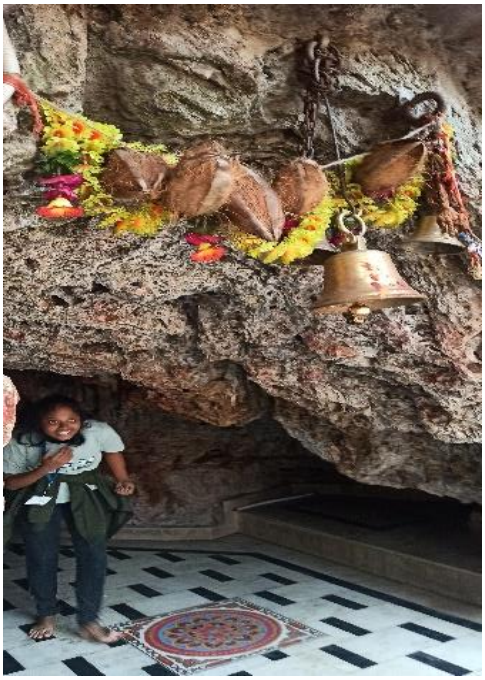
LOCATION 2

JHAMESHWAR MAHADEV TEMPLE, JHAMARKOTRA

Stalactites are type of formation that hangs from the ceiling of caves, hot springs. They are developed downwards, 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 overplate the sheath, creating tapered (carrot-like) stalactites up to one metre in diameter and several in length. Accelerated deposition on protruberances can add a myriad of subsidiary forms such as crenulations, corbels, drapes and lesser stalactites. A ‘column’ is a stalactite–stalagmite pair grown together





DAY 6

LOCATION 1

CHITTOR

LATITUDE:24º54’13”

LONGITUDE:74º37’24”

Chittorgarh district is generally characterised by undulating topography with hills belonging to the aravalli range. The district comprises of rocks of Bilwara supergroup, Vindhyan supergroup and Deccan traps. The field area is occupied by vindhyan sediments like conglomarates and rocks of Bilwara supergroup, both separated from each other by great boundary fault. 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. 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.

To the east of the river vindhyan sediments vindhyand sediment that is conglomerate rests on hindoli group by nonconformity. Matrix supported conglomerate is present. It consists of rounded to sub rounded pebbles of varying size from 2-6cm.Some folds can be observed.shale are sedimentary rock which has fine grain size with foliated fractures.

Stratigraphy describes as suket shale but it shows good slaty cleavage.so it can be slate. Which is brown in colour. fine platy minerals are seen.syngenitic and postgenetic quartz veins are seen.

Figure 1 folded structure

DAY 7

LOCATION 1

NATHDWARA

LATITUDE:25’1’33”

LONGITUDE:73’48’29”

The marble formation is fully deformed they are dipping in same direction.some curvature is observed. Outer surface is fully weathered it has foliated surface.it is seen as incombitent layers. stress indicators like mylonitic structure are observed. In some places green colour acicular texture is observed which will be tremolite or actinolite.garnet crystals are also seen.

Figure 1 garent

Geological datas :-

Strike 135SE, dip direction 225, dip 35

Strike 122SE, dip 36

Strike 123SE, dip 35

LOCATION 2

Schistosity, gneissosity is seen in ,lensoidal structure is seen which is also called augen structure they are indicator of stress. garnet is seen in some rocks.The marble bed which was inclined had minor crenulation folding sequence which intiated few joints present in marble.the recrystalliesed silica grains in the marble suggested the following sequence having undergone contact metamorphism.

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