SCHOOL OF EARTH, OCEAN AND ATMOSPHERIC SCIENCES

GOA UNIVERSITY

Exam: Roll No: 21P045010

LABORATORY CERTIFICATE

This is to certify that Mr. /Ms. GAJANAN U. MALGAONKAR

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

Experiments conducted are pertaining to paper GLC-122 Geological field Training

Practicals prescribed by the University for ----------class, during the academic year 2022-2023

DEAN
SEOAS

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GUJARAT AND RAJASTHAN FIELD REPORT

GAJANAN U. MALGAONKAR

MSC PART 2 (SCHOOL OF EARTH ,OCEAN AND ATMOSPHERIC SCIENCE, APPLIED GEOLOGY)

21P045010

INDEX

Sr. no.	Title	Page no
1	Acknowledgement	3
2	Geology of India	4
3	Geology Of Gujarat	7
4	Day 1	10
5	Day 2	12
6	Day3	15
7	Day4	18
8	Geology of Rajasthan	21
9	Day6	23
10	Day 7	28
11	Day 8	31
12	References	32

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I also want to thank Dr. Niyati Kalangutkar, program director for school applied geology, and Dr. Pooja Ghadi and Dr. Mahesh Mayekar for accompanying us, providing moral support, guidance and expressing concern to us. The trip became successful and knowledgeable because of your company.

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.

Finally, I would like to thank my parents for their allowing me to the field trip and as well as for their support throughout the journey

GEOLOGY OF INDIA

The geology of India is diverse. Different regions of India contain rocks belonging to different geologic periods, dating as far back as the Eo archean 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 DeccanTraps ,Gondwana and Vindhyan.

The Deccan Traps covers almost all of Maharashtra, apart of Gujarat, Karnataka, MadhyaPradesh 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 Réunion 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 DeccanTraps. It is also thought that the 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 Sone river valleys and Rajmahal hills in eastern India Contain a record of the Gondwana rocks.

The Indian Craton was once part of the super continent of Pangaea. At that time, what is now India's south west coast was attached to Madagascar and southern Africa, and what is now its east coast was Attached to Australia. During the Jurassic Period about 160Ma(ICS 2004), rifting caused Pangaea to break apart into two super continents, Namely Gondwana (tothesouth) and Laurasia (to the north). The Indian

Craton remained attached to Gondwana, until the super continent began to rift apart about in the early Cretaceous, about 125 million years ago (ICS2004). The Indian Plate then drifted northward towards 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 (ICS2004), however some biogeographical and geological evidence suggests that the connection between Madagascar and Africa was retained at the time when the Indian Plate collided with the Eurasian Plate about 50 Million years ago (ICS2004). This orogeny, which is continuing today, is related to closure of the Tethys Ocean. The closure of this ocean which created the Alpsin 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 Plates utured on to the adjacent Australian Plate, for minga new larger plate, the IndoAustralian 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 orogeny called the Aravali-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.

Early Paleozoic rocks are found in the Himalayas and consist of southerly derived sediment seroded from the crystalline craton and deposited on the Indian platform.During the Jurassic, as Pangea began to rift apart, large grabens formed in central India filling with Upper Jurassic and LowerCretaceous 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 southern India resulted in sedimentation in the adjacent Indian Ocean. Exposures of these rocks occur along the south Indian coastat Pondicherry and in TamilNadu. At the close of the Mesozoic one of the greatest volcanic eruptions in earth's history occurred, the Deccan lava flows. Covering more than 500,000 square kilometres (193,051 sq mi) area, the sea mark the final break from Gondwana.

GEOLOGY OF GUJARAT

Geomorphologically, the State can be divided into three distinct divisions, viz.:

a) Gujarat-Mainland.

b) Saurashtra-Kathiawar Peninsula, and

c) Kutch Peninsula.

a) Gujarat-Mainland.

The wellknown 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 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 lava-flows 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 7 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.

LITHOSTRATIGHRAPHIC TABLE

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.	

DAY 1 22/01/2023

Lothal

Latitude :-22⁰31’23’’N
Longitude:-72⁰14’57’’E

Archaeological Survey of India (ASI), the official Indian government agency for preservation of ancient monuments, discovered Lothal in 1954. Excavation work in Lothal commenced on 13 February 1955 and continued till 19 May 1960. According to the ASI, arguably Lothal had the world's earliest known dock, which connected the city to an ancient course of the Sabarmati river on the trade route. This trade route stretched between Harappan cities in Sindh (Pakistan) and the peninsula of Saurashtra where the surrounding Kutch desert of today was a part of the Arabian Sea. However, this interpretation has been challenged by other archaeologists, who argue Khufu's Red Sea harbour at Wadi al-Jarf (Egypt) is older, dating its construction to between 2580 to 2550 BCE and that Lothal was a comparatively small town, and that the "dock" was primarily an irrigation tank.

The National Institute of Oceanography in Goa discovered foraminifera (marine microfossils) and salt, gypsum crystals in the rectangular structure clearly indicating that sea water once filled the structure and it was definitely a dockyard.

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 4000 years.

Resuming excavation in 1961, archaeologists unearthed trenches sunk on the northern, eastern and western flanks of the mound, bringing to light the inlet channels and *nullah* ("ravine", or "gully") connecting the dock with the river. The findings consist of a mound, a township, a marketplace, and the 'dock'. Adjacent to the excavated areas stands

the Archaeological Museum, where some of the most prominent collections of Harappa-era antiquities in India are displayed.

The Lothal site was nominated, in April 2014, as a UNESCO World Heritage Site, and its application is pending on the tentative list of UNESCO.

FIG: 1 - GROUP PHOTO WITH ANCIENT CHANNELS

FIG: 2- UPPER AREA TOWN

FIG:3 LOWER AREA TOWN

DAY 2 23/01/2023

Physical Research Laboratory (PRL) AHMEDABAD

Latitude:- 23.1688° N

Longitude:- 72.5451° E

The Geosciences division of the physical research Laboratory (PRL) in India is an critical studies institution that focuses on the observe of the earth and its numerous additives. It is one in all the largest and maximum prestigious groups in the country committed to the sector of geosciences.

Set up in 1947, 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 group of highly qualified and skilled researchers who paintings on diverse components of earth science, consisting of seismology, geodynamics, geodesy, atmospheric technological know-how, oceanography, and paleoclimate.

The Geosciences department of PRL has a wide range of research facilities and ultra-modern equipment that are used to conduct cutting-edge research.

(be aware – Write the names of the 3 human beings (Kumar,Kadlagi and Goswami who defined us the instruments) .

MC-ICPMS

MC-ICPMS stands for "multi-collector inductively coupled plasma mass spectrometry" and it is a effective analytical approach used for high precision isotopic analysis of a huge range of elements.

Here's a short clarification of the way MC-ICPMS works:

1. Pattern introduction: A small amount of sample fabric is added into an inductively coupled plasma (ICP) source, where it's far vaporized and ionized.

2. Ionization: The ions produced inside the ICP are extracted and centered into a beam, that is then sent via a sequence of magnetic fields. The magnetic fields reason the ions to bend, and the degree of bending relies upon on their mass-to-rate ratio (m/z).

3. Separation: The ion beam is separated into its various isotopes by a mass spectrometer. This permits the distinct isotopes of an element to be measured one at a time.

4. Detection: The ion beam is then directed toward a detector machine which consists of a couple of creditors, every of which collects a particular isotope of hobby. Through measuring the isotopic ratios of the one-of-a-kind collectors, the relative abundances of the distinct isotopes may be decided with excessive precision.

Usual, MC-ICPMS is a tremendously sensitive and specific analytical technique that is utilized in a huge range of programs, from studying the geochemistry of rocks to reading trace factors in biological samples.

TIMS

TIMS stands for "thermal ionization mass spectrometry" and it's miles a powerful analytical approach used for high precision isotopic evaluation of a huge range of elements.

Here's a quick clarification of the way TIMS works:

1. Pattern creation: A small quantity of pattern material is loaded onto a filament, that is then heated to a excessive temperature. The heat reasons the pattern to vaporize and shape ions.

2. Ionization: The vaporized pattern is ionized by using bombarding it with electrons. The ionized pattern is then increased thru a sequence of electric fields and despatched toward a mass spectrometer.

3. Separation: The ion beam is separated into its numerous isotopes by using a mass spectrometer. This permits the special isotopes of an element to be measured one after the other.

4. Detection: The ion beam is then directed toward a detector device which measures the variety of ions hitting it. By using measuring the isotopic ratios of the exceptional ions, the relative abundances of the special isotopes can be determined with high precision.

Universal, TIMS is a exceedingly sensitive and precise analytical method that is used in a extensive variety of packages, from analyzing the geochemistry of rocks to analysing trace elements in organic samples. TIMS is frequently used for measuring isotopic ratios of elements which have low natural abundance, including uranium and lead.

FIG :4 Physical Research Laboratory (PRL) AHMEDABAD

DAY3 24/01/2023

Latitude : 22° .97.075N
Longitude:- 73° 34.629E

Ahmedabad – Mahadev Temple Lithology – Granitoid (Godra Granite)

Aravalli craton covers almost entire state of Rajasthan, part of Gujarat, Madhya Pradesh and fringes of Delhi and Haryana.
Aravalli supergroup is ~2.5Ga old. General trend of Aravalli sediment 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 intrusions that took place 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. Muscovite and biotite are present as phenocryst 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.

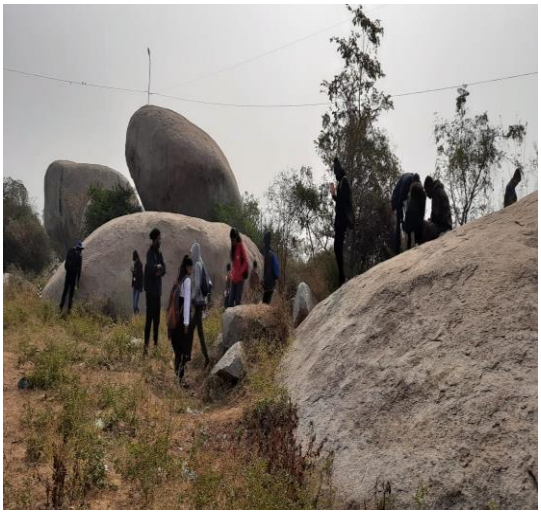

FIG : 7GODHRA GRANITE

FIG: 8 GODHRA GRANITE WITH XENOLITH

Rhyoli

Latitude:-23 05’ 62” N
Longitude:-73 34 35” E
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.

The Raiyoli Dinosaur Fossil Park is a popular tourist attraction in Gujarat and draws visitors from all over the world. It provides a unique opportunity for visitors to witness the rich and diverse geological history of India and explore the ancient world of dinosaurs.

Rhyoli Dinosaur Museum (Need to paraphrase and remove unnecessary Details)
In 1980s Paleontologists accidently came across the fossil remains and bones in the village of Rayioli in Balasinor. Since then, the place has

been flooded with researchers and a number of excavations have taken place in the area the findings of which revealed the fact that there were more than 13 species of dinosaurs that thrived around 65 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, (the first half of the name comes from Raja or King due to the crested horn and the second half of the name originates due to its geographical location which was near the river Narmada). This creature belonged to the carnivore family of Tyrannosaurus Rex.

A visit to the fossil park will surely make you dig deep into the history of dinosaurs in Gujarat. And in order to quench your thirst for the same, state government came up with a Dinosaur Museum. The museum is spread in an area of over 25,000 sq. feet with 10 galleries spread in the basement and the ground floor depicting various forms of displays (films and exhibitions). An exclusive 3-D film is prepared on Rajasaurus Narmadensis. Other galleries display details on Dinosaurs of India and Gujarat, Fossil Exhibits and many other features that will bring out the child in you. One can relish this museum through digital, print and static form. The state government has not only catered to those seeking information on dinosaurs and their fossils, but also a Time Machine, 3-D film, an Interactive and amusing Dino fun for kids area, a vivid display of Mesozoic times, souvenir shop etc. The museum will depict as many as 40 sculptures that will throw on a light on their size, shape, habits and habitat. The atrium features an exact replica of the habitat of these creatures. A step in the atrium will transport you 65 million years back.

FIG :9 DINOSAUR EGGS

FIG :10 RAIOLIM DINOSAUR FOSSIL PARK

DAY4 25/01/2023

ONGC Ahmedabad Asset GGS-Motera

Latitude:-23 11 31 N
Longitude:-72 59 79 E.

FIG: 11 ONGC,MOTERA

ONGC GGS Motera is a gas gathering station located in Motera, Gujarat, India, operated by the Oil and Natural Gas Corporation (ONGC). The primary function of the station is to collect and process natural gas from nearby oil fields and deliver it to various customers such as fertilizer plants, power plants, and city gas distribution networks.

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.

In addition to gas gathering, ONGC GGS Motera also undertakes maintenance and repair work on pipelines and other equipment, as well as implementing various environmental and safety measures to minimize the impact of its operations on the surrounding environment.

Mr. Gaurav Kumar, Safey Inspector at this facility was kind enough to show us around and explain the kind of work that they undertake.

ONGC GGS Motera uses advanced technology and equipment to ensure safe and efficient gas gathering and transmission. Some of the key technologies used at the station are:

1. Gas Chromatography: 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.

2. Compressors: 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.

3. SCADA System: SCADA (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.

4. 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.

5. Environmental Monitoring: ONGC GGS Motera also 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.

Overall, the advanced technologies used at ONGC GGS Motera help to ensure safe, reliable, and efficient gas gathering and transmission, while also minimizing the environmental impact of the station's operations.

Geology of Rajasthan

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.

Geological Timeline of Rajasthan

Rajasthan is endowed with a continuous geological sequence of rocks from the oldest Archaean Metamorphic, represented by Bhilwara Supergroup (>2500 m. y.) to sub-recent alluvium & wind blown 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.

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

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

The Proterozoic fold belts, viz., the Aravalli fold belt (the Aravalli Supergroup) and the Delhi fold belt (the Delhi Supergroup) occupy the southern and south- eastern, and south-western and north-eastern Rajasthan respectively. The Aravalli Supergroup is represented by metamorphosed and complexly folded clastic sediments with minor chemogenic and organogenic assemblages with interlayered basic volcancics, whereas the Delhi Supergroup comprises mainly

carbonates, metavolcanics, metasammites and metapelites, intruded by magmatic rock of Phulad Ophiolite Suite and syn-orogenic granites of Sendra- Ambaji, Bairath, Dadikar, Harsora, etc. A number of base metal deposits are located in these belts as also other minerals.

The isolated hillocks of western Rajasthan constitute the Upper Proterozoic Malani Igneous Suite and the Erinpura Granite pluton. Eastern Rajasthan is characterised by the vast sedimentary stretch constituting the Vindhyans, which is juxtaposed against the rocks of the Bhilwara Supergroup along the Great Boundary Fault.

The northern and north-western parts of the State exhibit Upper Proterozoic-Early Cambrian rocks of the Marwar Supergroup which are overlain by sedimentary rocks of different ages of Palaeozoic and Mesozoic Era. Many industrial mineral deposits are found in these rocks. The Deccan Traps are restricted to the south-eastern part of the State in Chittaurgarh- Banswara area.

The Cenozoic rocks are manifested in Barmer and Jaisalmer basins in the west and Ganganagar-Palana shelf in the north.

The Quaternary sediments of aeolian and fluvial origin constitute the Thar Desert of Rajasthan.

GEOLOGY

Archaean

BHILWARA SUPERGROUP

Sand Mata Complex, Mangalwar Complex, Hindoli Group

Proterozoic

BHILWARA SUPERGROUP

Rajpura-Dariba Group, Pur-Banera Group, Jahazpur Group, Sawar Group; Ranthambor Group

ARAVALLI SUPERGROUP

Debari Group, Udaipur Group, Bari Lake Group, Kankroli Group; Jharol Group, Dovda Group, Nathdwara Group; Lunavada Group

DELHI SUPERGROUP

Railo Group; Alwar Group, Ajabgarh Group, Gogunda Group, Kumbhalgarh Group, Sirohi Group; Punagarh Group, Sindreth Group

VINDHYAN SUPERGROUP

Lower Vindhyan Group, Upper Vindhyan Group

MALANI IGNEOUS SUITE

MARWAR SUPERGROUP

Jodhpur Group, Bilara Group, Nagaur Group

Palaeozoic

Mesozoic and Cenozoic

Deccan Traps; Tertiary Alkaline Complex; Sedimentaries; Quaternary

DAY 6 27/01/2023

Spot 1:- Jhamarkotra Opencast Mine

Latitude:-24 58 25 N
Longitude:-73 51 71 E

(commenced 1968, has 4 strategic devices – Phosphate, Limestone Lignite and Gypsum. In which Phosphate is used for chemical fertilization. 16 km Strike, has a zigzag string and the ore frame is located in East-West direction. Ore frame is believed that it isn't always ending since comparable pattern is discovered in Jabuar MP. Stromatolites)

Rajasthan nation Mines & Minerals constrained (RSMML) is a public zone corporation of the authorities of Rajasthan and typically engaged in Mining and advertising of high-Grade Rock phosphate, Lignite, Limestone & Gypsum (Non-steel minerals) through its mines positioned at various places 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 Rock phosphate ore. It operates one of the biggest and completely mechanised mines within the u . S . At Jhamarkotra, 26 Kms. From Udaipur. Jhamarkotra performs an crucial role through contributing ninety eight% of rock phosphate production of India. With an annual rock dealing with 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 frame i.E thin and sharply dipping had resulted in long and slim pits with outstanding intensity extension, which involves very excessive stripping ratio with excessive lead and lift for waste and mineral.
If an entity starts falling down the 12m bench stops it from rolling further down. The rock phosphate happens in metasedimentary rocks

of Aravalli Supergroup (Precambrian age). It's miles of algal foundation. The deposit extends over a strike period of sixteen kms in horse-shoe shape with average thickness of 15 meters. A reserve of seventy seven million tonnes of rock phosphate has been proved on the basis of 60,000 mts. Drilling in 500 boreholes. Out of those 17 million tonnes is of +30% P2O5 grade and rest is of 12 zero 30% P2O5 grade. A beneficiation plant of 1500 TPD (Tonnes per Day) potential has been established to upgrade the low-grade phosphate ore.

Extent of Jhamarkotra Deposit

General hire area is 13sqkm2. In Jhamarkotra, the strike duration of the phosphorite bed which includes the discontinuous outcrop extending over a linear distance of 16 km. The best point of the phosphate bed outcrop at six hundred MRL at Jhamarkotra and along the downdip route the extension of the phosphate has been proved up to a bit under 250 MRL. Ore frame dips at perspective of forty five-fifty five°.The phosphate mattress indicates an extremely variable thickness displaying persistence best over a constrained strike length. Consequently, in Jhamarkotra, the 15 km average thickness of the phosphate bed may be traced over 6 km of continuous strike length. In a few portions, ore body suggests pinching and swelling shape, as a result the thickness of ore frame varies from 5-35m. For the sake of convenience in prospecting and mining the deposit has been divided into 12 blocks viz. A-Extension, A, B, C, D, E, F, G, H, I, J and k.
The ore to overburden ratio within the Jhamarkotra Phosphate Mine is stored as 1:sixteen.

Grade of the Deposit

At Jhamarkotra deposit, typically a Bi-modal grade distribution pattern viz.+30 % (37- 38%) P2O5 designated as high-Grade Ore (HGO) and 16 to 22 % P2O5 exact as Low-Grade Ore (LGO) will be deciphered. However, at locations near the contacts of the above grade of phosphate mattress, a few transitional zones exist which might be designated as

mixed / Medium Grade Ore (MGO). The marketable grade of ore is 31.5% & 30% P2O5, but a massive resource of low-grade ore additionally occurs inside the location. Searching at notable call for of phosphate fertilizer and to reduce its import, the low-grade ore is being upgraded thru froth flotation in beneficiation plant.

Beneficiation

For usage of low grade ore resources, which are plentiful at Jhamarkotra but require beneficiation earlier than its utilization by using fertiliser industries as uncooked cloth.

Commercial beneficiation plant

The plant produces Beneficiated Rock Phosphate concentrate (Avg. 31.5% and 34% P2O5 on demand for SSP & DAP manufacturing gadgets)

- original capability: 1500 TPD
- elevated capability: 3000 TPD
- Capital funding: Rs. 357.70 million

Genesis of rock phosphate at Jhamarkotra

The mineral phase of apatite, which makes phosphorite, is taken into consideration to have formed through three mechanisms

(i) direct inorganic precipitation,

(ii) number one biogenic precipitation,

(iii) diagenetic precipitation/replacement.

Diagenetic precipitation of apatite is considered as an vital mechanism involved in phosphorite formation. Apatite of this starting place normally takes place as void filling and cementing material in the related sediments. It's miles said that the organic rely, which collects at the shelf areas, on decay, reasons very high awareness of phosphorous under the sediment water interface, main to precipitation of apatite. For the duration of this system carbonate constituents of the sediment are also phosphatised because of the substitute

Mining technique: The open pit mining approach is being accompanied at Jhamarkotra Mine for exploitation of the mineral. The working stages are saved dry by way of continuous pumping of ground water via tube-wells built on periphery of the pit restriction. The bench height on this extent of mine is given at 7m consecutively for multiple times with alternating 12 m heighted bench. (7m,7m,12m).

FIG:12 MINERAL APATITE

FIG: 13 Jhamarkotra Opencast Mine

Spot 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 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.

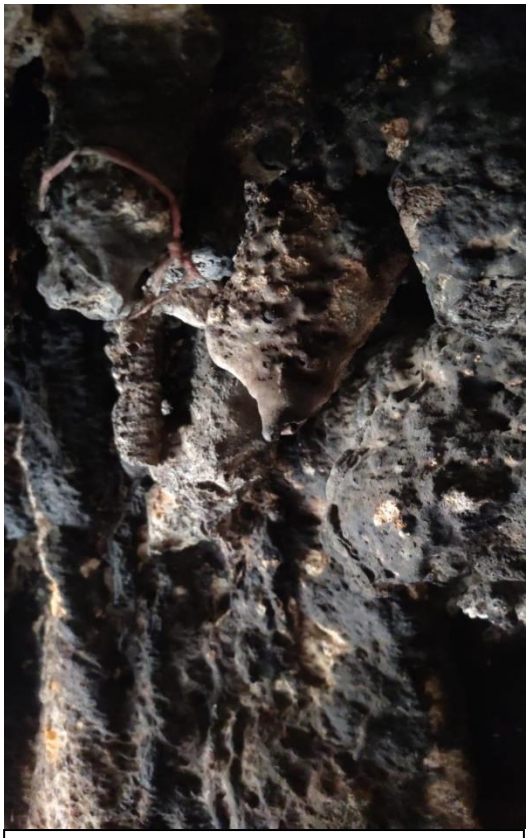

FIG :14 Stalactites

DAY7 28/01/2023

Chittor

Rock Type – Suket Shale- Phyllite
Latitude:- 24 47 40 N
Longitude:- 73 51 71 E

Spot 1

Chittorgarh district is generally characterised by undulating topography with hills belonging to the Aravalli range. The district comprises of rocks of Bhilwara supergroup, Vindhyan supergroup and Deccan traps. The field area is occupied by Vindhyan sediments like conglomerates 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 which may be either syngenetic or post genetic. The Suket Shale-Phyllite shows various stages of predominant folding from which possible readings were taken with respect to the hinge plane-

	Strike Direction	**Dip Amount with Direction**
Hinge Plane	200° N	29° N (Plunge)
Limb 1	200° N	36° E
Limb 2	125° N	54° W

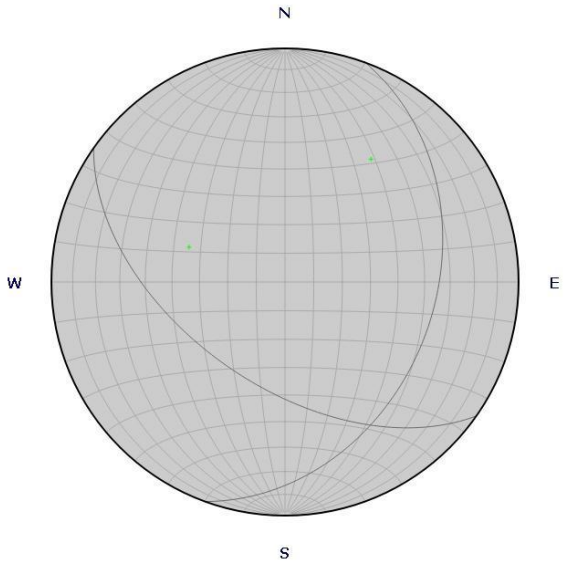

FIG: 15 SUKET SHALE PHYLITE

Joint Sets

	Strike Direction
Joint Set 1	145° N
Joint Set 2	100° N

FIG: 16 FOLDING SEQUENCE

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. We had the opportunity to take the readings of the Nimbara Limestone near Chittorgarh Fort and here are some readings: -

Strike Direction	Dip Amount with Direction
Spot 1	N 40° W
Spot 2.	N 64° W

FIG:17 Nimbara Limestone

DAY8 **29/01/2023 :** Nathwara Limestone/Marble

Latitude:- 25 05’ 76” N

Longitude:- 73 85 08” E

Nathwara Limestone is a type of limestone that is found in the state of Rajasthan, India. It is named after the town of Nathwara, which is located in the Udaipur district of Rajasthan.

This limestone is a light-colored, fine-grained rock that is composed mainly of calcium carbonate. It is quarried extensively in the Nathwara area and is used in a variety of construction and decorative applications.

Spot 1

Lithology - Marble, Schist

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.

FIG : 18 Nathwara Limestone/Marble

Marble	**Strike Direction**	**Dip Amount with Direction**
Spot 1	130° N	32° SW
Spot 2	360° N	26° E

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