SCHOOL OF EARTH, OCEAN AND ATMOSPHERIC SCIENCES

GOA UNIVERSITY

Roll No: 21PDA5012

Exam:

LABORATORY CERTIFICATE

This is to certify that Mr. /Ms. MANSI RAJA

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

Experiments conducted are pertaining to paper ----------

Practicals prescribed by the University for MSc Part 2 class, during the academic year 2022 - 2023

DEAN
SEOAS

Faculty member in-charge

Dr. Anthony Viegas
Vice Dean (Academic),
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GUJARAT AND RAJASTHAN

FIELD TRIP REPORT

2023

MANSI RAJA

MSc PART 2

School of Earth, Ocean and Atmospheric Sciences, Applied Geology

21P045012

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Acknowledgement

I take this opportunity to thank Goa University for allowing the students to go for a field trip for the fulfilment of the course MSc Applied Geology. Thank you for providing financially and allowing us to engage in field activities. I want to pass my regards to the entire part-2 class of geology for their support and participation of the trip. My humble appreciation goes to the dean of department of 'School of Earth, Ocean, and Atmospheric Sciences' Professor Chandrashekar U. Rivonkar, and special thanks go to the vice-dean Professor Anthony Arthur A. Viegas for not only making prior arrangement for the trip but also for accompanying us and providing guidance, moral support and proper understanding of what we were taught by explaining further.

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 went 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 get involved in the field trip and as well as for their support throughout the journey.

GEOLOGY OF INDIA

The geology of India is complex and diverse, reflecting the country's geological history, which spans over 4 billion years. The country is located on the Indian Plate, which is one of the largest tectonic plates in the world, and is bordered by several other plates, including the Eurasian, African, and Australian plates. The geology of India is influenced by several major tectonic events, including the breakup of the supercontinent Gondwana, the collision of the Indian and Eurasian plates, and the on-going tectonic activity in the Himalayan region.

The following is a brief overview of the major geological features of India:

1. Precambrian rocks: The Precambrian rocks are the oldest rocks in India, dating back to over 3.5 billion years ago. They are primarily composed of granite, gneiss, and greenstone belts and are found in the southern and eastern parts of the country.

2. Proterozoic rocks: The Proterozoic rocks are the most extensive rock units in India, covering about 60% of the country's land area. They are divided into several subgroups, including the Dharwar, Cuddapah, Vindhyan, and Chhattisgarh groups. These rocks are composed of a variety of sedimentary, volcanic, and plutonic rocks, including sandstone, limestone, shale, basalt, and granite.

3. Paleozoic rocks: The Paleozoic rocks are found in limited areas of India, including the Himalayan region and the Garhwal region. They are composed of sedimentary rocks such as shale, sandstone, and limestone, as well as some volcanic rocks.

4. Mesozoic rocks: The Mesozoic rocks are found in several regions of India, including the Himalayan region, the northeast region, and the Deccan Traps. They are composed of sedimentary, volcanic, and plutonic rocks, including sandstone, shale, basalt, and granite.

5. Cenozoic rocks: The Cenozoic rocks are the youngest rocks in India, dating back to the Paleogene and Neogene periods. They are primarily found in the Deccan Traps and are composed of basalt and other volcanic rocks.

In addition to these major rock units, India also has several important geological features, including:

- The Himalayan mountain range, which is the youngest and highest mountain range in the world and is still actively growing due to ongoing tectonic activity. The region is characterized by intense seismic activity and is home to some of the world's largest earthquakes.
- The Deccan Traps, which are a large igneous province located in western and central India. The traps were formed as a result of massive volcanic eruptions that occurred over a period of about 30 million years.

- The Aravalli Range, which is the oldest mountain range in India and is composed of ancient rocks dating back to the Precambrian era. The range is known for its rich mineral deposits, including copper, zinc, lead, and silver.

- The Indo-Gangetic plain, which is a large alluvial plain that covers much of northern India. The plain is formed by the sediment deposited by several large rivers, including the Ganges and the Brahmaputra, and is one of the most agriculturally productive regions in India.

  Overall, the geology of India is a complex and fascinating subject, with a rich and diverse geological history that reflects the country's unique cultural and natural heritage. The geology of India has played a significant role in shaping its landscape, mineral resources, and groundwater potential and continues to shape the country's future.

GEOLOGY OF GUJARAT

Gujarat is a state located in western India, with a diverse geological history that has shaped its landscape and resources. The state is bounded by the Arabian Sea to the west, the states of Rajasthan to the north, Madhya Pradesh to the east, and Maharashtra to the south.

The geological history of Gujarat dates back to the Precambrian era, approximately 2.5 billion years ago, when the Aravalli Range was formed. The state also has deposits of rocks from the Proterozoic, Paleozoic, Mesozoic, and Cenozoic eras.

1. Gujarat Mainland: The Gujarat Mainland, also known as the Cambay Rift Basin, is a sedimentary basin located in the northwestern part of Gujarat. It is a major hydrocarbon-producing area in India, with significant deposits of oil and natural gas. The basin is also known for its limestone and sandstone formations, which are important sources of building materials.

2. Saurashtra-Kathiwar Peninsula: The Saurashtra-Kathiwar Peninsula, located in the southwestern part of Gujarat, is primarily composed of ancient metamorphic and igneous rocks. The region is known for its rich mineral deposits, including bauxite, limestone, and dolomite. It also has several hills and plateaus that offer scenic views and are popular tourist destinations.

3. Kutch Peninsula: The Kutch Peninsula, located in the westernmost part of Gujarat, is primarily composed of sedimentary rocks and is known for its unique geology and geomorphology. The region has a desert landscape with salt flats, sand dunes, and rocky outcrops. It also has several important geological features, including the Great Rann of Kutch and the Banni grasslands, which are home to several endemic species of plants and animals. The Kutch Peninsula is also known for its seismic activity, with several earthquakes occurring in the area over the years.

In terms of mineral resources, Gujarat is known for its rich deposits of limestone, lignite, bauxite, and copper. The state is also home to several important industrial areas, including the city of Ahmedabad, which is known for its textile industry, and the city of Surat, which is known for its diamond polishing industry.

Overall, the geology of Gujarat is a rich and diverse subject, with a long and complex history that has shaped the state's landscape, resources, and cultural heritage.

LITHOSTRAIGRAPHIC TABLE OF GUJARAT

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 Sauashtra 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, Banaskan:ha.	4000
		Banded gneissic complex.	Baroda District.	

DAY 1: 22/01/2023

PLACE: LOTHAL

Latitude :22°31’23’’N Longitude:72°14’57’’E

The name "Lothal" means "the mound of the dead" in Gujarati. This name was given to the site because local villagers believed that the mounds contained the graves of their ancestors.
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 made of copper and bronze 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.

DAY 2: 23/01/2023

PLACE: Physical Research Laboratory (PRL) AHMEDABAD

Latitude: 23.1688° N Longitude:72.5451° E

PRL was founded in 1947 by Dr. Vikram Sarabhai, who is known as the "father of India's space program". Sarabhai was a visionary scientist who played a key role in shaping India's scientific and technological development in the post-independence era.

PRL's mission is to carry out research in various fields of physics, astronomy, astrophysics, and space science. It has a number of research divisions, including the Astronomy and Astrophysics Division, the Solar Physics Division, the Planetary Sciences Division, and the Theoretical Physics Division.

PRL is affiliated with the Indian Space Research Organization (ISRO), which is India's national space agency. PRL scientists have played a key role in many of ISRO's space missions, including the Chandrayaan-1 lunar mission and the Mars Orbiter Mission (MOM).

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

MC-ICP-MS:

MC-ICP-MS (multi-collector inductively coupled plasma mass spectrometry) is an analytical technique used to measure isotope ratios in a variety of sample types, including geological, environmental, and biological samples.

Here are the basic steps involved in MC-ICP-MS analysis:

1. Sample preparation: The sample is collected and prepared for analysis, which may involve various techniques such as acid digestion, solvent extraction, or other methods.

2. Introduction to the instrument: The sample is introduced into the MC-ICP-MS instrument, usually by nebulization, which converts the sample into a fine mist.
3. Ionization: The sample mist is then introduced into an inductively coupled plasma (ICP) source, where it is vaporized and ionized by a plasma torch.
4. Mass separation: The ions are then passed through a mass spectrometer, which separates them according to their mass-to-charge ratio.
5. Collection and detection: The separated ions are then collected by multiple ion collectors, which are positioned at different angles around the instrument. The collected ions are detected and the isotope ratios are measured.
6. Data analysis: The resulting data is analyzed using software that can calculate isotope ratios, correct for interferences, and provide other analytical information.

The MC-ICP-MS process is a powerful analytical technique that allows for high precision and accuracy in isotope ratio measurements. It is widely used in a variety of scientific fields, including geology, environmental science, and biology.

TIIMS:

Thermal Ionization Mass Spectrometry (TIMS) is an analytical technique used to determine the isotopic composition of elements in a sample. It involves the vaporization and ionization of a sample followed by mass separation and detection of the resulting ions.
The technique is based on the fact that different isotopes of an element have slightly different masses. By separating these isotopes and measuring their relative abundances, scientists can gain valuable information about the history and origin of a sample.
TIMS is a highly precise and accurate technique, capable of measuring isotope ratios to within a few parts per million or even better. It is used

in a wide range of scientific fields, including geology, archaeology, environmental science, and nuclear forensics.

Here are the basic steps involved in the Thermal Ionization Mass Spectrometry (TIMS) process:

1. Sample preparation: The sample is collected and prepared for analysis, which may involve various techniques such as chemical purification, solvent extraction, or other methods.
2. Loading onto filaments: The purified sample is then loaded onto a small metal filament (usually made of rhenium or tungsten) and baked in a vacuum oven to remove any remaining impurities.
3. Vaporization: The filament is then placed into a high-temperature furnace and heated to a temperature high enough to vaporize the sample atoms.
4. Ionization: The vaporized sample atoms are then ionized by bombarding them with electrons, causing them to lose one or more electrons and become positively charged ions.
5. Mass separation: The ions are then passed through a mass spectrometer, which separates them according to their mass-to-charge ratio.
6. Collection and detection: The separated ions are then collected by a series of ion collectors, which are positioned at different angles around the instrument. The collected ions are detected and the isotope ratios are measured.
7. Data analysis: The resulting data is analyzed using software that can calculate isotope ratios, correct for interferences, and provide other analytical information.

The TIMS process is a powerful analytical technique that allows for very high precision and accuracy in isotope ratio measurements. It is widely used in a variety of scientific fields, including geology, nuclear forensics, and environmental science.

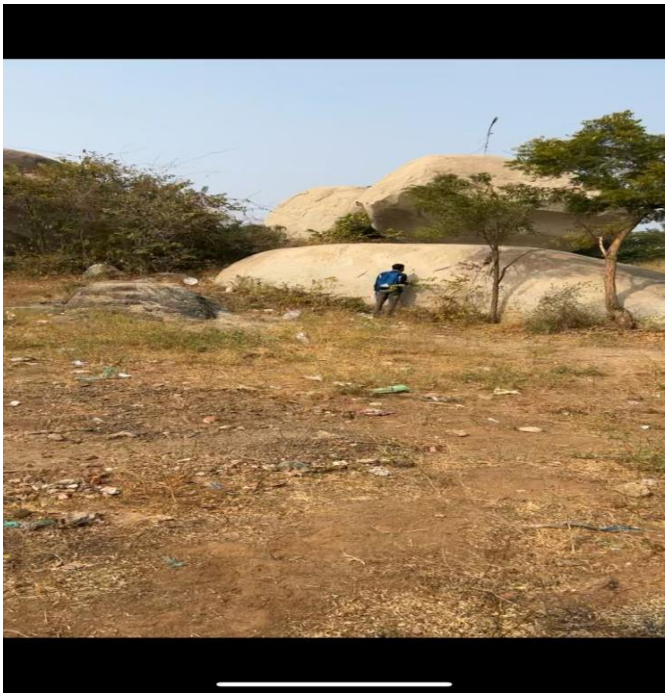
DAY 3: 24/01/2023

PLACE: Ahmedabad – Mahadev Temple Lithology – Granitoid (Godra Granite).

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

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 of 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 has 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 appox. 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.



PLACE: RAIYOLI

Latitude: 23° 05’ 62’’ N Longitude: 73° 34 35’’ E

The Balasinor Dinosaur Fossil Park and Museum in Raiyoli, Gujarat, India is an important scientific site that has yielded significant discoveries about the dinosaurs that lived in the region during the Late Cretaceous period, about 70 million years ago.

The fossils found at the site include those of the Rajasaurus narmadensis, a unique species of theropod dinosaur that is believed to have lived exclusively in India during the Late Cretaceous period. The discovery of this species has provided new insights into the evolution and diversity of the dinosaur species that lived in India.

In addition to the Rajasaurus, the fossil site has yielded bones and other remains of several other dinosaur species, as well as fossils of other animals and plants that were present in the area during the Late Cretaceous period.

The fossils are studied by paleontologists and other scientists to gain a better understanding of the biology, ecology, and evolution of the dinosaurs and their environment. The museum also serves as an important resource for educating the public about the science of paleontology and the importance of preserving and studying fossils for scientific and educational purposes.

Overall, the Balasinor Dinosaur Fossil Park and Museum is a valuable scientific site that contributes to our knowledge and understanding of the history of life on Earth.

In the 1980s, paleontologists accidentally found fossil remains and bones in the village of Rayioli in Balasinor. Since then the place has was inundated with researchers and a series of excavations were conducted in the area, the results 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-size statues of these giant creatures, and subsequent excavations have revealed a stocky, thick-legged, heavyweight 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 comes from its geographic location near the Narmada River). This creature belonged to the carnivorous family of Tyrannosaurus Rex. A visit to the Fossil Park will surely immerse you in the history of dinosaurs in Gujarat.And to quench their thirst for it , the state government has created a dinosaur museum. The museum covers an area of more than 25,000 square meters with 10 galleries spread over the basement and ground floor, displaying various forms of exhibitions (films and exhibitions). An exclusive 3D film about Rajasaurus Narmadensis is in the works. Other galleries feature details on dinosaurs from India and Gujarat, fossil displays and many other features that will bring out the kid in you. One can enjoy this museum through digital, printed and static forms. The state government has not only catered for those who seek information about dinosaurs and their fossils, but also a time machine, a 3-D movie, an interactive and entertaining dinosaur area for children, a living display of the Mesozoic era, a gift shop, etc. The Museum exhibits up to 40 sculptures that shed light on their size, shape, habits and habitat. The atrium is an exact replica of the habitat of these creatures. One step in the atrium takes you back 65 million years.

DAY 4 : 25/01/2023

PLACE: ONGC Asset GGS-Motera, Ahmedabad.

Latitude:-23° 11’ 31”N Longitude:-72° 59’ 79”E

ONGC GGS Motera Ahmedabad is a production asset of Oil and Natural Gas Corporation (ONGC), which is a leading public sector undertaking in the Indian oil and gas industry. The Motera facility is primarily involved in the production of crude oil and natural gas from the Cambay Basin in Gujarat.

The production and separation of crude oil and gas at ONGC GGS Motera Ahmedabad involve a number of processes. The following are the detailed steps involved:

1. Production: The first step is the production of crude oil and gas from the well. The oil and gas flow to the surface through the production tubing, which is connected to the wellhead. ONGC uses an electric submersible pump (ESP) to pump the crude oil and gas to the surface.

2. Separation: Once the crude oil and gas are brought to the surface, they are separated. The separation process involves using separators to separate the oil, gas, and water. The separator is a vessel that allows the oil, gas, and water to settle based on their densities. The oil, being less dense, rises to the top, while the water and gas settle at the bottom.

3. Heating: After separation, the crude oil is heated to remove any remaining water and gas. This is done using heaters that heat the oil to a temperature of around 60°C to 70°C. The heat causes the water and gas to vaporize, which is then removed from the crude oil.

4. Desalting: Once the crude oil is heated, it is sent to a desalter unit. The desalter unit removes any salt and impurities that may be present in the crude oil. The desalting process involves adding water to the crude oil, which dissolves the salt and other impurities. The water and impurities are then removed from the crude oil.

5. Stabilization: After desalting, the crude oil is sent to a stabilization unit. The stabilization unit removes any remaining gas that may be present in the crude oil. The unit also removes any light hydrocarbons that may be present in the crude oil. This is done to stabilize the crude oil so that it can be transported to refineries.

6. Gas processing: The separated gas is sent to a gas processing unit. The gas processing unit removes impurities such as hydrogen sulfide, carbon dioxide, and water vapor. The gas is then compressed and sent to a pipeline for transport.

In summary, the production and separation of crude oil and gas at ONGC GGS Motera Ahmedabad involve processes such as production, separation, heating, desalting, stabilization, and gas processing. Each step is critical to ensure that the crude oil and gas are of the required quality for transportation and further processing.

ONGC GGS Motera Ahmedabad uses various advanced technologies to increase efficiency, optimize production, and ensure safety. These technologies include advanced drilling techniques, real-time data analysis, reservoir

simulation, enhanced oil recovery techniques, advanced artificial lift technologies, and pipeline monitoring.

GEOLOGY OF RAJASTHAN

Rajasthan is a state located in northwestern India, covering an area of 342,239 square kilometers. The state has a diverse geological history, spanning from the Archean to the Quaternary periods, which has shaped its landscape, mineral resources, and groundwater potential.

The geological features of Rajasthan are diverse and include the following:

1. Aravalli Range: The Aravalli Range is a mountain range that extends through the states of Rajasthan, Haryana, and Gujarat. It is the oldest mountain range in India and is composed of ancient rocks dating back to the Precambrian era. The range is known for its rich mineral deposits, including copper, zinc, lead, and silver.

2. Vindhyan Supergroup: The Vindhyan Supergroup is a group of sedimentary rocks that cover a large part of central India, including Rajasthan. The rocks date back to the Mesoproterozoic and Neoproterozoic eras and are known for

their unique fossils, including stromatolites, which provide important information about the evolution of life on Earth.

3. Thar Desert: The Thar Desert, also known as the Great Indian Desert, is a large arid region that covers a significant part of Rajasthan. It is composed of sand dunes, interdune plains, and desert pavement, which are formed due to the wind erosion of rocks and sediments. The region is known for its unique wildlife, including the Indian bustard and the desert fox.

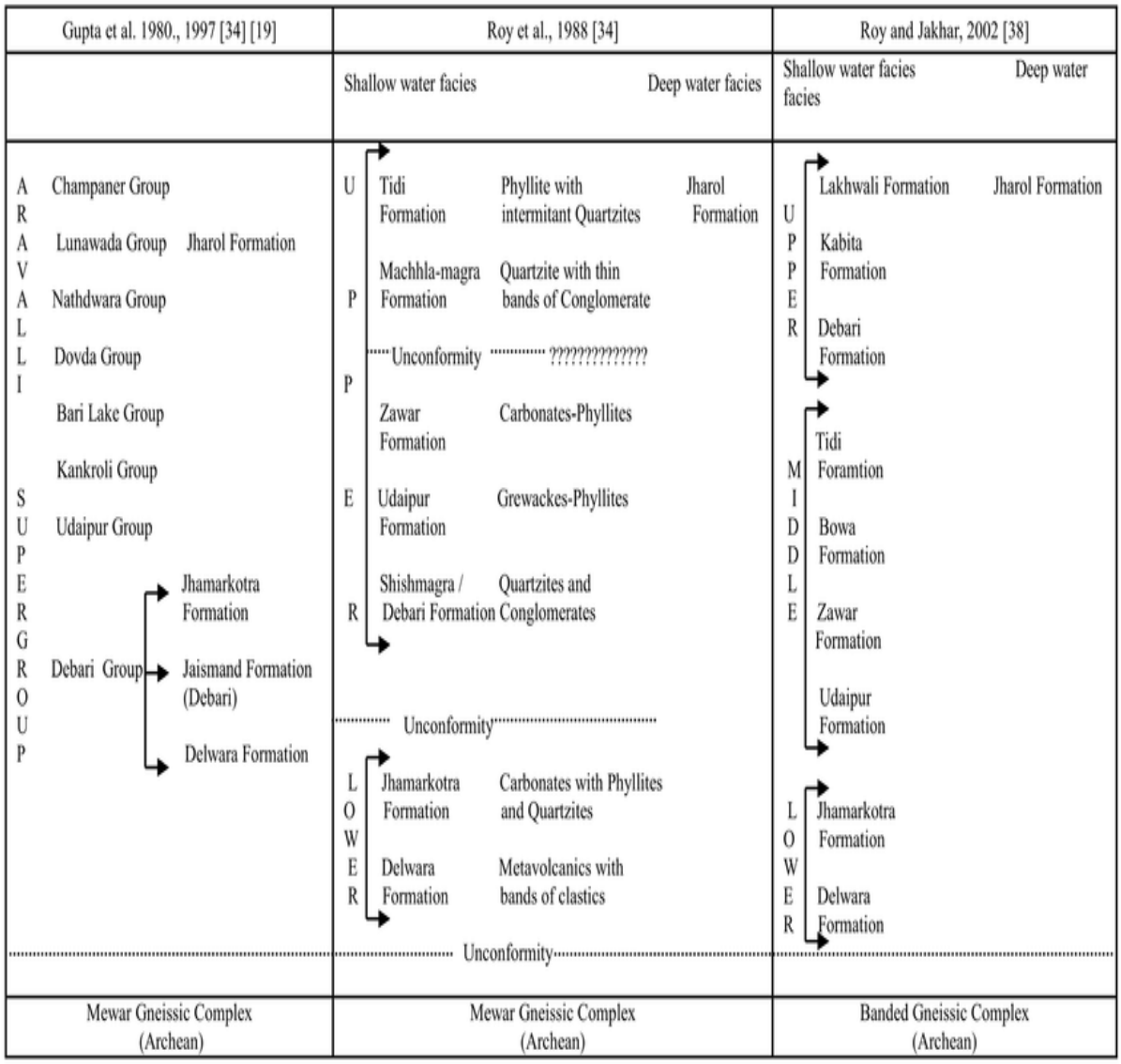
4. Sambhar Lake: Sambhar Lake is a large saltwater lake located in the eastern part of Rajasthan. It is a unique geological feature that is formed due to the evaporation of seawater over thousands of years. The lake is a major source of salt production and is also an important habitat for migratory birds.

5. Jaisalmer Formation: The Jaisalmer Formation is a geological formation that is located in the Jaisalmer district of Rajasthan. It is composed of sandstone and is known for its unique rock formations, including the famous Jaisalmer Fort, which is built entirely out of yellow sandstone.

   In terms of mineral resources, Rajasthan is known for its rich deposits of copper, zinc, lead, silver, limestone, and marble. The state is also home to several important industrial areas, including the city of Jaipur, which is known for its textile industry, and the city of Udaipur, which is known for its mining and mineral processing industry.

   Overall, the geology of Rajasthan is a rich and diverse subject, with a long and complex history that has shaped the state's landscape, resources, and cultural heritage.

LITHOSTRATIGRAPHIC TABLE OF RAJASTHAN



DAY 5: We travelled from Ahmedabad to Udaipur via Bus.

DAY 6: 27/01/2023

PLACE: Jhamarkotra Opencast Mine (SPOT 1)

Latitude: 24° 58’ 25” N Longitude: 73° 51’ 71” E

Jhamarkhotra Mine is a phosphate mine located in the city of Udaipur in the Indian state of Rajasthan. It is one of the largest phosphate mines in India and is operated by the Rajasthan State Mines and Minerals Limited (RSMML).

The mine was discovered in 1968 and has been in operation since 1974. The phosphate ore at Jhamarkhotra Mine is of sedimentary origin and is estimated to contain about 16.5 million tonnes of reserves.

The Jhamarkhotra Mine is a sedimentary phosphate deposit, which means that it was formed through the accumulation of phosphate-rich sediments over millions of years. The deposit is believed to have been formed during the Cretaceous period, around 70-100 million years ago.

During this time, the area now known as Rajasthan was covered by a shallow sea, which supported a diverse ecosystem of marine organisms. Over time, the remains of these organisms, including shells and bones, accumulated on the sea floor and became buried under layers of sediment.

As the sediments were compacted and cemented together, they formed sedimentary rocks, including the phosphate-rich rock that makes up the Jhamarkhotra deposit. The phosphate in the deposit is believed to have come from the bones and teeth of the marine organisms that lived in the area.

Over millions of years, geological processes, including uplift and erosion, exposed the phosphate deposit at the surface, making it accessible for mining. Today, the Jhamarkhotra Mine is one of the largest phosphate mines in India and plays an important role in meeting the country's demand for fertilizers and other phosphate-based products.

The phosphate ore is extracted through open-cast mining and is processed to produce various grades of phosphoric acid and fertilizers. The Jhamarkhotra Mine also produces some by-products such as rock phosphate, phosphogypsum, and fluorspar.

The mine has undergone several modernization and expansion projects over the years, including the installation of a new beneficiation plant and the introduction of new mining equipment. These efforts have helped increase the mine's production capacity and improve its efficiency.

Jhamarkhotra Mine plays a vital role in meeting the demand for phosphates in India, which is one of the largest consumers of fertilizers in the world.

The Jhamarkhotra Mine produces phosphate ore, which is graded based on its phosphorus pentoxide (P2O5) content. The mine has reserves of both high-grade and low-grade ore.

The high-grade ore at Jhamarkhotra Mine contains around 25-30% P2O5, which is considered to be of premium quality. This ore is generally used in the production of fertilizer and phosphoric acid. The high-grade ore is usually extracted from the upper layers of the deposit and requires less effort and cost to process.

The low-grade ore at Jhamarkhotra Mine contains around 16-18% P2O5, which is lower than the high-grade ore. This ore is typically found at deeper levels and requires more effort and cost to extract and process. The low-grade ore is generally used in the production of rock phosphate, which is a raw material used in the production of fertilizers.

The Jhamarkhotra Mine also produces a mix of high-grade and low-grade ore, which is referred to as medium-grade ore. This ore typically contains around 20-25% P2O5 and is used in the production of both fertilizers and phosphoric acid.

The beneficiation of phosphate ore at Jhamarkhotra Mine is carried out using a combination of crushing, grinding, scrubbing, desliming, and flotation techniques. The objective of the beneficiation process is to remove impurities from the ore and concentrate the P2O5 content to produce a high-quality product.

The beneficiation process at Jhamarkhotra Mine begins with crushing the ore to a suitable size for processing. The crushed ore is then ground in ball mills to further reduce its particle size. After grinding, the ore is scrubbed with water to remove any clay or other impurities that might interfere with the flotation process.

Next, the ore is subjected to a desliming process, which removes any fine particles and further improves the ore's quality. The deslimed ore is then subjected to flotation, which is the primary method used to concentrate the phosphate ore.

In the flotation process, a series of chemicals, including collectors, frothers, and modifiers, are added to the ore slurry to selectively float the phosphate minerals and separate them from the impurities. The flotation process results in a phosphate concentrate with a higher P2O5 content, which is further processed to produce various grades of phosphoric acid and fertilizers.

Overall, the beneficiation process used at Jhamarkhotra Mine is a combination of physical and chemical techniques that effectively removes impurities and concentrates the phosphate ore to produce high-quality products.

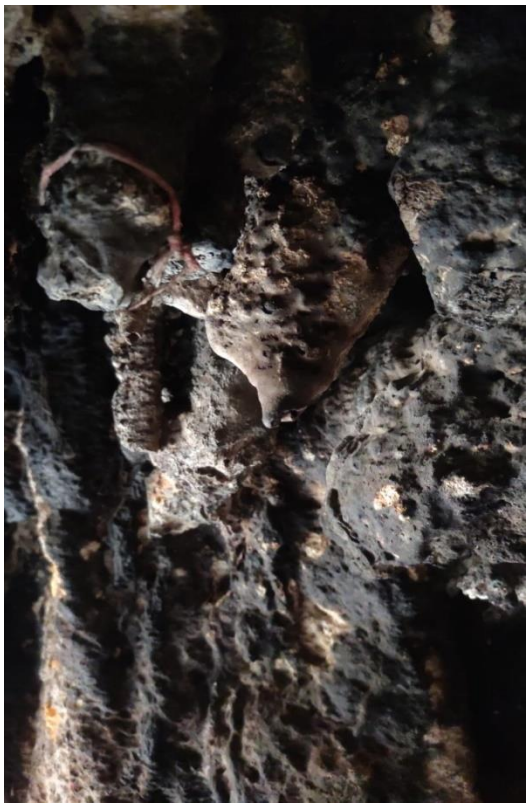
The plant produces Beneficiated Rock Phosphate concentrate (Avg. 31.5% and 34% P2O5 on demand for SSP & DAP manufacturing gadgets)

- Original capability: 1500 TPD.
- Elevated capability: 3000 TPD
- Capital funding: 357.70 Million Rupees

PLACE: Jhameshwar Mahadev Temple, Jhamarkotra(SPOT 2)

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.



DAY 7: 28/01/2023

Chittor Rock Type – Suket Shale- Phyllite

Latitude: 24° 47’ 40” N Longitude: 73° 51’ 71” E

Spot 1: BERACH RIVER

Chittorgarh is located in the Indian state of Rajasthan, which is known for its diverse geology. The region is part of the Aravalli mountain range, which is one

of the oldest mountain ranges in the world. 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	215° N	28° N (Plunge)
Limb 1	200° N	39° E
Limb 2	132° N	57° W

Joint Sets are as follows:

	Strike Direction
Joint Set 1	145° N

Joint Set 2	106° N


(ANTICLINAL PLUNGING HINGE)

Spot 2: Nimbahera

Latitude: 24°52’ 59” N Longitude: 74°37’ 57”E

Nimbahera Limestone is a type of sedimentary rock that is primarily composed of calcium carbonate mineral, which is derived from the remains of marine organisms such as coral and shellfish. It is a light-colored limestone with a fine to medium-grained texture and is found in the Nimbahera region of Rajasthan,

India. Nimbahera Limestone is widely used in the construction industry as a building material and is also used in the manufacturing of cement, lime, and other industrial products. It is known for its durability, strength, and resistance to weathering, making it a popular choice for outdoor applications such as paving and cladding.

Few possible readings were taken:

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

DAY 8: 29/01/2023

PLACE: Nathwara Limestone/Marble

Latitude: 25° 05’ 76” N Longitude: 73° 85’ 08” E

Nathdwara Limestone is a type of sedimentary rock found in the Nathdwara region of Rajasthan, India. It is primarily composed of calcium carbonate mineral, which is derived from the remains of marine organisms such as coral and shellfish. Nathdwara Limestone has a light to medium-grey color with a fine to medium-grained texture. It is known for its high strength and durability, making it a popular choice for various construction and building applications. It is often used as a building material for flooring, cladding, paving, and as a decorative stone. Nathdwara Limestone is also used in the manufacturing of cement, lime, and other industrial products.

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 that the needle like structure consists of tremolite.

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

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THANK YOU