

Goa University

School of Earth and Atmospheric Sciences

Applied Geology

# Field Report

By Savio Miranda

Part 2 MSc student

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*[Signature]*

*[Signature]*

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

### **Abstract**

The study area, Ahmedabad and Udaipur, is located in the Gujarat and Rajasthan. The duration of our field work starts on 22nd and ends on 29th of February 2023. Geologically, the area is very complex and highly deformed due to the number of folds and faults and a large number of large and small mines which comes in the top list of Indian mines. Geotectonically we saw vast transition between Gujarat and Rajasthan and gain a good knowledge about it. During this field work we visited few institutions which gave us a good idea about our geological future. Geomorphologically, the area contains various alluvial fans, hot springs, mollusc deposits, and meandering streams. The study area also contains various regional and small scale folds, faults and fractures.

## Acknowledgement

First of all I pay my deepest thanks to Almighty God who enabled me to complete this field work report successfully.

I am greatly thankful to the Department of Applied Geology and professors (Dr. Anthony Vegas , Dr. Niyatikalangutkar , Ms Pooja Ghadi and Mr Mahesh Mayekar) for their utmost guidance and help. These professors were the foundation bricks of this fieldwork in terms of guidance for students and through understanding of the field area.

This field work has been a memorable excursion for me in the comprehension of enigmatic theoretical knowledge. I once again pay my thanks to my teachers who consider me able for achieving my good goals

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## Introduction

Geological field work involves collecting data about the Earth's structure and history by conducting observations, measurements, and analysis in the field. This may involve mapping rock formations, studying fossils, or analyzing the chemical composition of rocks and minerals. Field work is crucial for understanding the Earth's processes and history, as it provides direct observations and data that cannot be obtained through laboratory experiments alone. Field work requires physical stamina, patience, and attention to detail, as well as the ability to work in remote and sometimes challenging environments. Geologists who conduct field work are often able to make important discoveries and contribute to our understanding of the Earth's past and present.

Gujarat's geology is diverse, with ancient rock formations, sedimentary deposits, and volcanic activity. The state is rich in mineral resources, including limestone, lignite, bauxite, and oil and gas reserves. Gujarat's coastline has also undergone significant geological changes, with evidence of past tsunamis and earthquakes. The state's geology plays an important role in its economy and natural environment. Rajasthan's geology is characterized by vast stretches of desert and rocky terrain, with a variety of mineral deposits including copper, zinc, lead, and limestone. The region has a complex geological history, with evidence of ancient volcanoes, sedimentary formations, and tectonic activity. Rajasthan's geology has played an important role in shaping the state's culture and economy, with mining and tourism being major industries.

## Stratigraphy of Gujarat

The stratigraphy of Gujarat is a fascinating and complex geological history that spans millions of years. Gujarat is located on the western coast of India and is home to a diverse array of geological formations, from ancient Precambrian rocks to younger Quaternary sediments. The oldest rocks in Gujarat are the Precambrian basement rocks that underlie much of the state. These rocks are estimated to be between 3.6 and 2.5 billion years old and consist of gneiss, schist, and granites. These rocks have been subjected to intense metamorphism and deformation, resulting in their current complex structures. Above the basement rocks are the Proterozoic sedimentary rocks that were deposited between 2.5 and 0.54 billion years ago. These sedimentary rocks are found in the Aravalli Range and consist of sandstones, shales, and conglomerates. They were formed by the deposition of sediments in shallow seas and river deltas. The Paleozoic era in Gujarat is represented by the Cambrian and Ordovician sediments that were deposited between 541 and 443 million years ago. These sediments are found in the northern part of the state and consist of sandstones, shales, and limestone. They were formed by the deposition of sediments in shallow marine environments. The Mesozoic era in Gujarat is represented by the Jurassic and Cretaceous sediments that were deposited between 201 and 66 million years ago. These sediments are found in the Kachchh basin and consist of sandstones, shales, and limestone. They were formed by the deposition of sediments in shallow marine environments and represent a time of tectonic activity in the region.

The Tertiary period in Gujarat is represented by the Eocene to Pliocene sediments that were deposited between 56 and 2.6 million years ago. These sediments are found in the coastal areas of Gujarat and consist of sandstones, shales, and conglomerates. They were formed by the deposition of sediments in fluvial, deltaic, and shallow marine environments. The Quaternary period in Gujarat is represented by the Pleistocene and Holocene sediments that were deposited between 2.6 million years ago and the present day. These sediments are found in the coastal areas of Gujarat and consist of sand, clay, and silt. They were formed by the deposition of sediments in fluvial, deltaic, and coastal environments. The stratigraphy of Gujarat is not only important for understanding the geological history of the region but also for its economic significance. The state is rich in mineral resources such as limestone, bauxite, and lignite, which are extracted from the sedimentary rocks of the state. The sedimentary rocks of Gujarat also contain important aquifers that provide water for agriculture and domestic use.

In addition to its economic significance, the stratigraphy of Gujarat is also important for its paleontological significance. Fossils of marine organisms such as ammonites, brachiopods, and bivalves have been found in the sedimentary rocks of Gujarat, providing important insights into the evolution of marine life in the region. In conclusion, the stratigraphy of Gujarat is a rich and complex geological history that spans millions of years. The state is home to a diverse array of geological formations, from ancient Precambrian rocks to younger Quaternary sediments. The



stratigraphy of Gujarat is not only important for understanding the geological history of the region but also for its economic and paleontological significance.

### **Site 1: Lothal, Archaeological remains of a Harappa Port-Town**

Lothal is an ancient city located in the state of Gujarat, India. It was one of the most important cities of the Indus Valley Civilization and is known for its remarkable architecture and advanced urban planning. However, Lothal's geology is equally fascinating and played a crucial role in the city's rise and fall. The geology of Lothal is dominated by the alluvial plain of the Sabarmati river, which flows through the region. The Sabarmati river is an important source of water for the region and has played a significant role in shaping the landscape over the millennia. The river has deposited layers of sediment over the years, which has resulted in the formation of a fertile plain that is ideal for agriculture.

The soil in Lothal is mostly composed of alluvial clay, which is a type of sediment that is carried by rivers and deposited along their banks. The clay is rich in nutrients and is ideal for growing crops such as cotton, wheat, and rice. The availability of fertile soil and abundant water resources made Lothal an attractive location for settlement, and it quickly became a prosperous city. Another important feature of Lothal's geology is the presence of natural harbors along the coastline. Lothal was located on the Gulf of Khambhat, which provided easy access to the Arabian Sea and the wider world beyond. The city's port was one of the busiest in the region and was an important center for trade. However, Lothal's geology was also a source of vulnerability. The city was located in a low-lying area that was prone to flooding, and the Sabarmati river was known to change course frequently. The city's planners had to take these factors into account when designing the city's layout, and they built a system of drainage channels and reservoirs to mitigate the effects of flooding. Despite these precautions, Lothal's fortunes began to decline in the 2nd millennium BCE. The reasons for this decline are not entirely clear, but some scholars believe that changes in the river's course and increased salinization of the soil may have played a role. Whatever the cause, the city was eventually abandoned and fell into ruin. Today, Lothal is an important archaeological site that provides valuable insights into the Indus Valley Civilization. Excavations have uncovered a wealth of artifacts, including pottery, jewelry, and tools, which give us a glimpse into the daily lives of the city's inhabitants. The city's impressive dockyard and warehouses are also a testament to the advanced engineering and architectural skills of the people who lived there. In conclusion, Lothal's geology played a crucial role in the city's rise and fall. The fertile soil and abundant water resources made it an attractive location for settlement, while the natural harbors provided easy access to the wider world. However, the city's low-lying location and the frequent changes in the river's course also made it vulnerable to flooding and other natural disasters. Despite its eventual decline, Lothal remains an important site for archaeologists and historians, and its geology continues to provide valuable insights into the ancient past.





Figure 2: lothal city

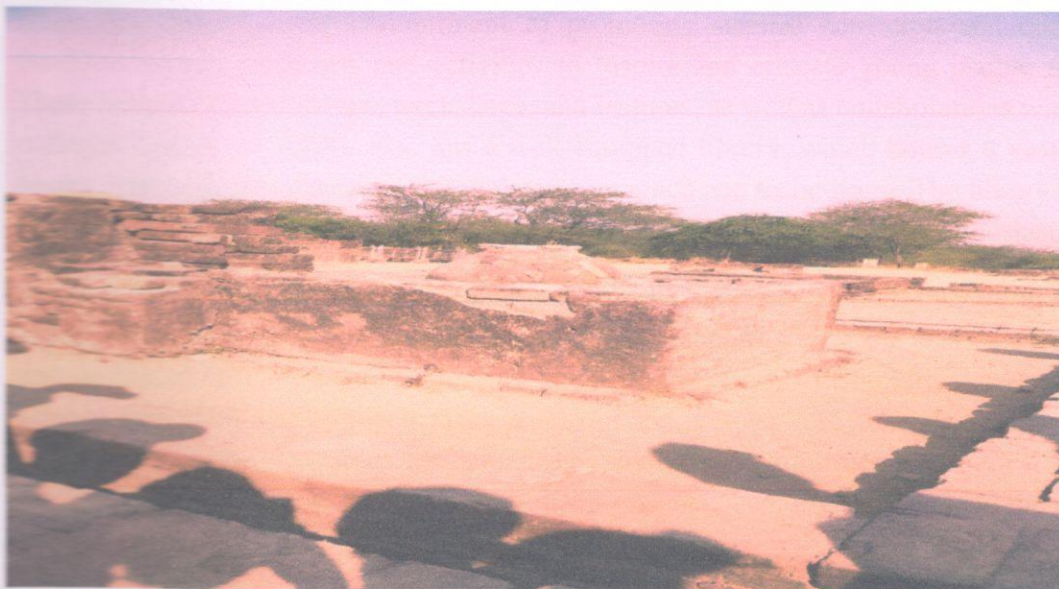


Figure 3: lothal city , cooking area

## Site 2: Physical Research Laboratory, University Area, Ahmedabad, Gujarat

Physical Research Laboratory (PRL) is a research institute located in the University Area of Ahmedabad, Gujarat. It was established in 1947 by Dr. Vikram Sarabhai, a renowned scientist



and industrialist, with the aim of advancing scientific research in India. Today, it is one of the premier research institutions in the country and is affiliated with the Indian Space Research Organization (ISRO). The institute is situated on a sprawling 72-acre campus in the heart of Ahmedabad, and it has state-of-the-art facilities for research in various fields of science and technology. Some of the areas of research at PRL include astronomy, astrophysics, atmospheric sciences, geosciences, planetary sciences, and theoretical physics. PRL has a long and illustrious history of scientific research, and it has made several significant contributions to the field of science over the years. One of its most notable achievements was the discovery of the asteroid belt between Mars and Jupiter in the 1950s. PRL scientists also played a key role in the development of India's first satellite, Aryabhata, which was launched in 1975. PRL has a highly qualified and dedicated team of scientists and researchers, who are committed to advancing scientific knowledge and understanding. The institute has several research groups, each of which focuses on a specific area of research. These groups collaborate with each other and with other research institutions around the world to conduct cutting-edge research in their respective fields. The institute has also established several centers of excellence, such as the Center for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) and the Center of Excellence in Space Sciences India (CESSI). These centers provide training and education to scientists and researchers from around the world and help to advance research in their respective fields. PRL has a strong commitment to promoting science education and outreach, and it conducts several programs and activities to inspire and educate young people about science. These include science camps, workshops, and lectures, as well as collaborations with schools and colleges in the region. PRL also has a well-equipped library, which houses a vast collection of books, journals, and other resources related to science and technology. The library is open to the public, and it is a valuable resource for researchers, students, and science enthusiasts.

In conclusion, Physical Research Laboratory is a world-class research institution that has made significant contributions to the field of science and technology over the years. Its highly qualified and dedicated team of scientists and researchers, state-of-the-art facilities, and commitment to science education and outreach make it one of the premier research institutions in India. The institute's long and illustrious history and its continued commitment to scientific research and advancement make it a valuable asset not just to Ahmedabad or Gujarat, but to the entire country.

## MC-ICPMS

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

Here's a brief explanation of how MC-ICPMS works:

1. **Sample introduction:** A small amount of sample material is introduced into an inductively coupled plasma (ICP) source, where it is vaporized and ionized.

2. Ionization: The ions produced in the ICP are extracted and focused into a beam, which is then sent through a series of magnetic fields. The magnetic fields cause the ions to bend, and the degree of bending depends on their mass-to-charge ratio ( $m/z$ ).

3. Separation: The ion beam is separated into its various isotopes by a mass spectrometer. This allows the different isotopes of an element to be measured separately.

4. Detection: The ion beam is then directed towards a detector system which consists of multiple collectors, each of which collects a specific isotope of interest. By measuring the isotopic ratios of the different collectors, the relative abundances of the different isotopes can be determined with high precision.

Overall, MC-ICPMS is a highly sensitive and precise analytical technique that is used in a wide range of applications, from studying the geochemistry of rocks to analyzing trace elements in biological samples.

## TIMS

TIMS stands for "thermal ionization mass spectrometry" and it is a powerful analytical technique used for high precision isotopic analysis of a wide range of elements.

Here's a brief explanation of how TIMS works:

1. Sample introduction: A small amount of sample material is loaded onto a filament, which is then heated to a high temperature. The heat causes the sample to vaporize and form ions.

2. Ionization: The vaporized sample is ionized by bombarding it with electrons. The ionized sample is then accelerated through a series of electric fields and sent towards a mass spectrometer.

3. Separation: The ion beam is separated into its various isotopes by a mass spectrometer. This allows the different isotopes of an element to be measured separately.

4. Detection: The ion beam is then directed towards a detector system which measures the number of ions hitting it. By measuring the isotopic ratios of the different ions, the relative abundances of the different isotopes can be determined with high precision.

Overall, TIMS is a highly sensitive and precise analytical technique that is used in a wide range of applications, from studying the geochemistry of rocks to analysing trace elements in biological samples. TIMS is often used for measuring isotopic ratios of elements that have low natural abundance, such as uranium and lead.



### **Site 3 : Dinosaur Fossil Park and Museum, Jetholi, Raiyoli, Balasinor, Gujarat**

The Dinosaur Fossil Park and Museum in Jetholi, Raiyoli, Balasinor, Gujarat, India, is a unique tourist destination that offers visitors a chance to see dinosaur fossils up close and learn about the prehistoric era. The park is located in the heart of Balasinor, a small town in the Kheda district of Gujarat, and is a must-visit destination for those interested in paleontology. The park is home to one of the largest collections of dinosaur fossils in the world. It houses the remains of various species of dinosaurs, including the *Rajasaurus Narmadensis*, a carnivorous dinosaur that lived in India during the Late Cretaceous period, about 65 million years ago. Visitors can also see fossils of other creatures that lived during the same era, such as crocodiles, turtles, and fish. The park was discovered in the 1980s by a geologist named Dr. G. N. Dwivedi, who stumbled upon a large dinosaur bone while conducting a survey in the area. Since then, many more fossils have been uncovered, and the park has become a hub for paleontologists from all over the world. In addition to the fossil park, there is also a museum on the premises that houses a wealth of information about the dinosaurs that once roamed the earth. The museum has several galleries that display a wide range of fossils, including skeletal remains of various dinosaurs and other creatures that lived during the prehistoric era. Visitors can also learn about the process of fossilization and how fossils are excavated and preserved. One of the highlights of the museum is the 3D animation show, which gives visitors an immersive experience of what life was like during the time of the dinosaurs. The show takes visitors on a journey through time, showcasing the various species of dinosaurs that once roamed the earth and the ecosystems they lived in. The park also offers visitors the opportunity to participate in guided tours that take them through the park and provide them with detailed information about the fossils on display. The guides are knowledgeable about the history of the fossils and the prehistoric era, and they are always happy to answer any questions visitors may have.

In addition to the guided tours, the park also has a souvenir shop that sells a variety of items related to the prehistoric era. Visitors can purchase dinosaur figurines, fossils, and books about the history of the dinosaurs and the process of fossilization. The park has become a popular destination for school groups and families, as it offers a unique educational experience for children and adults alike. The park's location in Balasinor makes it easily accessible from major cities such as Ahmedabad and Vadodara, and it is a great place to visit for a day trip or a weekend getaway. In conclusion, the Dinosaur Fossil Park and Museum in Jetholi, Raiyoli, Balasinor, Gujarat, is a fascinating destination for anyone interested in the prehistoric era. The park's collection of dinosaur fossils is one of the largest in the world, and the museum provides visitors with a wealth of information about the history of the dinosaurs and the process of fossilization. The park's guided tours, 3D animation show, and souvenir shop make it a great place to visit for families and school groups. Gujarat is home to a variety of dinosaur fossils, including some unique species that are found nowhere else in the world. Here are some of the different types of dinosaurs that have been discovered in Gujarat:



- 1) *Rajasaurus Narmadensis*: This carnivorous dinosaur is unique to India and was discovered in Gujarat. It lived during the Late Cretaceous period, about 65 million years ago.
- 2) *Titanosaurus*: This herbivorous dinosaur was one of the largest creatures to have ever lived on earth, measuring up to 100 feet in length. Fossils of *Titanosaurus* have been found in various parts of Gujarat.
- 3) *Stegosaurus*: This herbivorous dinosaur is known
- 4) for its distinctive back plates and spiky tail. Fossils of *Stegosaurus* have been discovered in the Kheda district of Gujarat.
- 5) *Indosuchus*: This large carnivorous dinosaur had powerful jaws and sharp teeth, and was a fearsome predator. Fossils of *Indosuchus* have been found in Gujarat, as well as in other parts of India.
- 6) *Lametasaurus*: This herbivorous dinosaur was a close relative of the more famous *Iguanodon*, and had a beak-like mouth for eating plants. Fossils of *Lametasaurus* have been discovered in the Vadodara district of Gujarat.

These are just a few examples of the different types of dinosaurs that have been found in Gujarat. Each of these species offers unique insights into the prehistoric era and the diversity of life that existed millions of years ago.

#### **Site 4: Ahmedabad ONGC Operations.**

Ahmedabad is one of the largest cities in India, located in the western state of Gujarat. The city has a rich history and a diverse cultural heritage, making it a popular destination for tourists and travelers from all around the world. However, Ahmedabad is not just known for its cultural and historical significance; it is also home to one of the largest and most prominent companies in India, the Oil and Natural Gas Corporation (ONGC). ONGC was established in 1956 and is now considered one of the largest companies in India, with its headquarters located in the city of Dehradun in Uttarakhand. However, the Ahmedabad ONGC office is also a significant hub of operations for the company, with a range of activities taking place here, including exploration, production, and refining of oil and natural gas. One of the most important aspects of ONGC's operations in Ahmedabad is its exploration activities. The company has been exploring for oil and natural gas reserves in Gujarat since the 1960s, and it has discovered some of the largest fields in the region. These include the Ankleshwar and Cambay fields, which are located near Ahmedabad and have significant reserves of oil and natural gas. ONGC has also been actively involved in the production and refining of oil and natural gas in the region. The company has several refineries and processing plants in the Ahmedabad area, which are responsible for converting crude oil and natural gas into various products, such as gasoline, diesel, and other petroleum products.



The Ahmedabad ONGC office is also a significant contributor to the local economy, providing employment opportunities to thousands of people in the region. The company has a large workforce in Ahmedabad, consisting of engineers, technicians, and other professionals who are involved in various aspects of its operations. In addition to its core operations, ONGC has also been actively involved in corporate social responsibility initiatives in Ahmedabad and the surrounding areas. The company has been working on several projects aimed at promoting education, health, and environmental sustainability in the region. For instance, ONGC has set up several schools and colleges in Gujarat to provide education to children from economically disadvantaged backgrounds. Furthermore, ONGC has also been involved in various environmental conservation initiatives in Ahmedabad and the surrounding regions. The company has been working on several projects aimed at conserving natural resources, promoting renewable energy, and reducing carbon emissions. In conclusion, Ahmedabad ONGC is a crucial hub of operations for one of the largest companies in India. The company's presence in the region has contributed significantly to the local economy, providing employment opportunities and supporting various social and environmental initiatives. With its focus on exploration, production, and refining of oil and natural gas, ONGC has played a significant role in the energy sector in India, and its contributions are likely to continue in the years to come.

Mr. Gaurav Kumar, Safety 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.

### **Stratigraphy of Rajasthan**

The stratigraphy of Rajasthan is a complex geological history that spans over 2 billion years. Located in the western part of India, Rajasthan is home to a diverse array of geological formations, from ancient Precambrian rocks to younger Quaternary sediments. The oldest rocks in Rajasthan are the Precambrian basement rocks that underlie much of the state. These rocks are estimated to be between 3.6 and 2.5 billion years old and consist of gneiss, schist, and granites. These rocks have been subjected to intense metamorphism and deformation, resulting in their current complex structures. Above the basement rocks are the Proterozoic sedimentary rocks that were deposited between 2.5 and 0.54 billion years ago. These sedimentary rocks are found in the Aravalli Range and consist of sandstones, shales, and conglomerates. They were formed by the deposition of sediments in shallow seas and river deltas.

The Paleozoic era in Rajasthan is represented by the Cambrian and Ordovician sediments that were deposited between 541 and 443 million years ago. These sediments are found in the northern part of the state and consist of sandstones, shales, and limestone. They were formed by the deposition of sediments in shallow marine environments. The Mesozoic era in Rajasthan is represented by the Jurassic and Cretaceous sediments that were deposited between 201 and 66 million years ago. These sediments are found in the Jaisalmer basin and consist of sandstones, shales, and limestone. They were formed by the deposition of sediments in shallow marine environments and represent a time of tectonic activity in the region. The Tertiary period in Rajasthan is represented by the Paleocene to Pliocene sediments that were deposited between 66 and 2.6 million years ago. These sediments are found in the western part of the state and consist of sandstones, shales, and conglomerates. They were formed by the deposition of sediments in fluvial, deltaic, and shallow marine environments. The Quaternary period in Rajasthan is represented by the Pleistocene and Holocene sediments that were deposited between 2.6 million years ago and the present day. These sediments are found in the Thar Desert and consist of sand, clay, and silt. They were formed by the deposition of sediments in fluvial, aeolian, and lacustrine environments.

The stratigraphy of Rajasthan is not only important for understanding the geological history of the region but also for its economic significance. The state is rich in mineral resources such as



limestone, gypsum, and oil, which are extracted from the sedimentary rocks of the state. The sedimentary rocks of Rajasthan also contain important aquifers that provide water for agriculture and domestic use. In addition to its economic significance, the stratigraphy of Rajasthan is also important for its paleontological significance. Fossils of marine organisms such as ammonites, brachiopods, and bivalves have been found in the sedimentary rocks of Rajasthan, providing important insights into the evolution of marine life in the region. The Aravalli Range, which runs through Rajasthan, is also home to a unique geological formation known as the Delhi Supergroup. This formation consists of rocks that were deposited during the Proterozoic and contains important mineral deposits such as copper, lead, and zinc. In conclusion, the stratigraphy of Rajasthan is a rich and complex geological history that spans over 2 billion years. The state is home to a diverse array of geological formations, from ancient Precambrian rocks to younger Quaternary sediments. The stratigraphy of Rajasthan is not only important for understanding the geological history of the region but also for its economic

#### **Site 5: RSMM (Rock Phosphate Mine) Jhamar Kotra Udaipur**

The Rock Phosphate Mine located in Jhamar Kotra, Udaipur is one of the largest and most significant phosphate mines in India. The mine, which is operated by the Rajasthan State Mines and Minerals Limited (RSMM), is known for its high-grade rock phosphate deposits and has been a significant contributor to the agricultural industry in India for several decades. Phosphate rock is an essential raw material in the production of phosphoric acid, which is used in the manufacture of fertilizers. The Jhamar Kotra mine is a significant source of high-grade rock phosphate, which is essential for the production of fertilizers in India. The mine is spread over an area of 1,200 hectares and has a proven reserve of approximately 19.5 million tonnes of rock phosphate. The Jhamar Kotra mine was first discovered in 1968 and was initially operated by the Mineral Exploration Corporation Limited (MECL). In 1982, the mine was taken over by the RSMM, a state-owned company that is responsible for the exploration, mining, and marketing of non-metallic minerals in the state of Rajasthan. The mine is situated in a remote and hilly region of Udaipur and is accessible only through narrow roads. The mine's location makes it a challenging task for the RSMM to extract the phosphate rock efficiently. The mine's mining operations involve drilling, blasting, and excavation, which are carried out using heavy machinery and equipment. The phosphate rock extracted from the mine is transported to a nearby beneficiation plant, where it is processed to remove impurities and increase the phosphate content. The beneficiation process involves crushing, grinding, and washing the rock phosphate, followed by a flotation process to separate the phosphate from other minerals. The Jhamar Kotra mine has a production capacity of 1,500 tonnes per day, and the phosphate rock produced is sold to various fertilizer manufacturers in India. The mine's location in the state of Rajasthan, which is one of the largest agricultural states in India, makes it a crucial contributor to the country's agricultural industry.



The RSMM is committed to operating the JhamarKotra mine in a sustainable and responsible manner. The company has taken several measures to minimize the mine's environmental impact and promote sustainable mining practices. The RSMM has implemented several environmental management systems to monitor and control the mine's impact on the environment. The RSMM has also initiated several community development programs to improve the lives of the people living in the surrounding areas. The company has set up schools, hospitals, and other basic infrastructure facilities to benefit the local community. The RSMM has also provided employment opportunities to the people living in the region, thereby promoting economic development in the area. The JhamarKotra mine is a significant contributor to the economic development of the state of Rajasthan and India as a whole. The mine's high-grade rock phosphate deposits and efficient mining operations have helped to meet the country's growing demand for fertilizers. The mine's sustainable mining practices and community development initiatives have also helped to promote responsible mining and sustainable development. In conclusion, the Rock Phosphate Mine located in JhamarKotra, Udaipur, is a crucial contributor to the agricultural industry in India. The mine's high-grade rock phosphate deposits and efficient mining operations have helped to meet the growing demand for fertilizers in the country. The Rajasthan State Mines and Minerals Limited's commitment to sustainable mining practices and community development initiatives has also helped to promote responsible mining and sustainable development in the region. The JhamarKotra mine is a shining example of how responsible mining can promote economic development and improve the lives of the people living in the surrounding areas

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.

At Jhamarkotra deposit, generally a Bi-modal grade distribution pattern viz.+30 % (37- 38%) P<sub>2</sub>O<sub>5</sub> designated as High-Grade Ore (HGO) and 16 to 22 % P<sub>2</sub>O<sub>5</sub> 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% P<sub>2</sub>O<sub>5</sub>, but a large resource of low-grade ore also occurs in the area. Looking at great demand of phosphate fertilizer and to reduce its import, the low-grade ore is being upgraded through froth flotation in beneficiation plant.



Figure 6 : zabarkotra mine in Rajasthan

#### **Site 6: Suket Shale in Rajasthan**

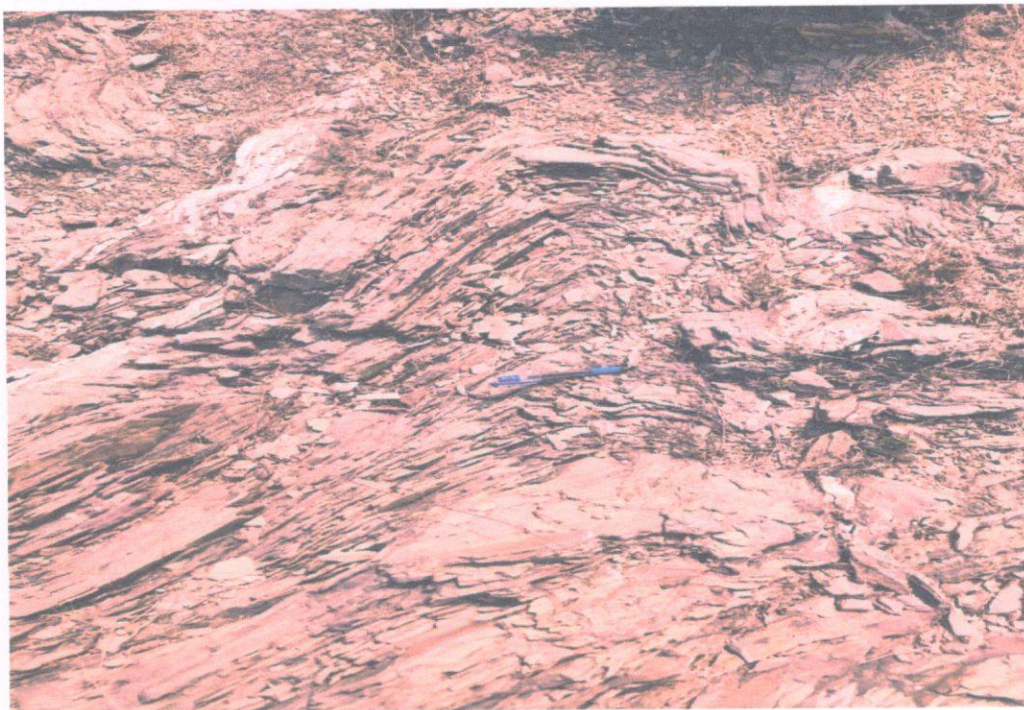
Suket Shale is a geological formation located in the state of Rajasthan, India. It is a significant geological formation that has attracted the attention of geologists, scientists, and researchers from around the world. The Suket Shale formation is a sedimentary rock formation that dates back to the Mesozoic era, around 150 to 200 million years ago. The formation is made up of black shales, which were deposited in a marine environment during the Jurassic period. The shale formation has been studied extensively by geologists because of its unique characteristics and the information it provides about the ancient environment. The Suket Shale formation is known for its rich fossil content. It contains a diverse range of marine fossils, including ammonites, bivalves, gastropods, and brachiopods. The fossils found in the Suket Shale formation have helped researchers gain a better understanding of the marine environment during the Jurassic period. The fossils provide important information about the evolution of marine life and the environmental conditions that existed at the time.

The shale formation is also known for its high organic content. The black shales contain a significant amount of organic matter, which has made the formation an important source of hydrocarbons. The shale is being explored for its potential as a source of natural gas and oil. The Suket Shale formation is also significant because of its impact on the local economy. The shale is a source of employment for many people in the region, particularly in the oil and gas industry.



The exploration and extraction of hydrocarbons from the shale formation have contributed to the economic development of the region. However, the extraction of hydrocarbons from the Suket Shale formation has also raised concerns about the environmental impact of the process. The extraction of oil and gas from shale formations involves hydraulic fracturing or fracking, a process that uses large amounts of water and chemicals. The process has been linked to environmental problems such as water pollution, air pollution, and soil contamination. Despite these concerns, the Suket Shale formation remains an important geological formation that continues to attract the attention of researchers and scientists. The formation provides valuable insights into the history of the earth and the evolution of life. It also has the potential to contribute to the economic development of the region, although this must be done in a way that minimizes the environmental impact of the extraction process.

In conclusion, the Suket Shale formation is a significant geological formation located in the state of Rajasthan, India. It is known for its rich fossil content, high organic content, and potential as a source of hydrocarbons. The formation provides valuable insights into the history of the earth and the evolution of life, as well as the potential for economic development. However, the extraction of hydrocarbons from the shale formation must be done in a way that minimizes the environmental impact of the process.



**Figure 8: image of a slaty folds**



## **Site 7: Marble Quarry, Rajasthan**

Rajasthan is one of the most prominent states in India for its rich cultural heritage and magnificent architecture. The state is also known for its marble quarries, which have been a significant source of employment and income for the local population. Rajasthan is home to some of the finest and most beautiful varieties of marble in the world. Marble quarries in Rajasthan are spread across various regions of the state, including Rajsamand, Udaipur, and Makrana. These quarries have been in operation for centuries, with some of them dating back to the Mughal era. The marble extracted from these quarries is used for a wide range of applications, including building construction, interior decoration, sculpture, and even jewelry.

The Makrana marble quarry, located in Nagaur district, is one of the most famous and oldest marble quarries in Rajasthan. This quarry has been in operation since the 17th century and has provided marble for some of the most iconic buildings in India, including the Taj Mahal. The Makrana marble is known for its whiteness, durability, and exquisite beauty, making it one of the most sought-after varieties of marble in the world. The marble quarrying industry in Rajasthan is a vital source of employment for the local population, particularly in rural areas. The industry provides direct and indirect employment opportunities to thousands of people, including miners, quarry workers, stonecutters, polishers, and transporters. Many of these workers come from impoverished backgrounds and rely on the industry for their livelihoods. However, the marble quarrying industry in Rajasthan has also faced numerous challenges in recent years. One of the primary concerns is the environmental impact of marble quarrying on the surrounding ecosystems. Quarrying activities can cause soil erosion, deforestation, and water pollution, which can have long-term implications for the local environment and biodiversity. Moreover, the working conditions of many quarry workers in Rajasthan are often poor, with low wages, long working hours, and minimal safety measures. Many workers are also exposed to hazardous working conditions, such as dust, noise pollution, and accidents, which can result in severe health problems. To address these challenges, the government of Rajasthan has introduced several measures to regulate the marble quarrying industry and improve the working conditions of workers. The government has implemented strict environmental regulations to ensure that quarrying activities are carried out in a sustainable and responsible manner. Additionally, the government has launched various social welfare schemes to improve the living standards of quarry workers and their families.

In conclusion, the Rajasthan marble quarry industry is a vital sector that provides employment opportunities and income for thousands of people in the state. While the industry has faced numerous challenges in recent years, the government's initiatives and regulations have helped to address some of these concerns. With proper management and regulation, the marble quarrying industry in Rajasthan can continue to flourish and contribute to the economic growth and development of the state while also safeguarding the environment and the rights of workers.

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