SCHOOL OF EARTH, OCEAN AND ATMOSPHERIC SCIENCES

GOA UNIVERSITY

Exam: Roll No:

LABORATORY CERTIFICATE

This is to certify that Mr. /Ms. Adithi AS

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

Experiments conducted are pertaining to paper GLC -122

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

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REPORT ON THE GEOLOGICAL FIELDWORK CARRIED OUT IN AND AROUND GUJARAT AND RAJASTHAN

Submitted by

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CERTIFICATE

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

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TABLE OF CONTENTS

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 breakingoff 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 Damodarand 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 apace 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 Indo- Australian 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

The state of Gujarat comprises an area of approximately 1,96,000 sq.km and is enclosed within North Latitude 20^0 10^0 to 24^0 50^0 and East Longitude 68^0 40^0 to 74^0 40^0. Geologically Gujarat provides a wide spectrum of rock types of different ages. Whereas the Aravalli's in the NE is as old as 2500 million years, the unconsolidated alluvium and beach materials in its central and western parts, date back to a few thousand years only. All the important lithological types Igneous, Sedimentary and Metamorphic occur within the state.

Geomorphologically the state of Gujarat comprises the following three district zone: a) Mainland Gujarat, b) Saurastra and c) Kachchh. The Gujarat state exposes rocks belonging to the Pre- Cambrian, Mesozoic and Cenozoic era. The hard rocks cover about 49% of the total area of Gujarat, the rest being occupied by sediments of Quaternary period. The hard rock comprises Pre Cambrian metamorphosed and associated intrusive, sedimentary rocks of Mesozoic and Cenozoic eras and the traps/ flow constituting Deccan volcanic of Cretaceous Eocene age.

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

Saurashtra – Kathiawar Peninsula is bounded by Gujarat plains in East and NE, by gulf of Kutch and little Rann on the north, and on the SE by the Gulf of Cambay. The Arabian Sea borders the entire southern seaboard. The Central part of the region forms an elevated table land, from where most of the rivers rise and flow radially. The terrain generally slopes gently

towards the peninsular margin to merge into the coastal plains and the great alluvial tract stretches to NE and east. The sedimentary rocks along the coast form almost a low and straight hill ranges running parallel, a characteristic feature of this country. On account of several radially intruded basic dykes cutting through traps, there are low and straight hill ranges running parallel, a characteristic feature of this country.

Kutch Peninsula is the mainland of Kutch is isolated by the Great Rann of the north and east, Little Rann on the SE, Gulf of Kutch on the south and rest by the Arabian sea. The central portion of Kutch forms a table-land sloping on all sides, the shape of the region is like tortoise. In general, there are three hill ranges, trending almost east-west. North – flowing rivers disappear in the Rann; others join the sea. The Banni (made up land) is formed by sediments deposited by northern border of the mainland and is composed of fairly good soil. The Rann is a dry bed of the remnant of an arm of the sea, which formally connected the Narmada rift with Sind and separated Kutch from the main-land. The Rann is divided into two, which are Great Rann and Little Rann; they do not differ from each other expect in si

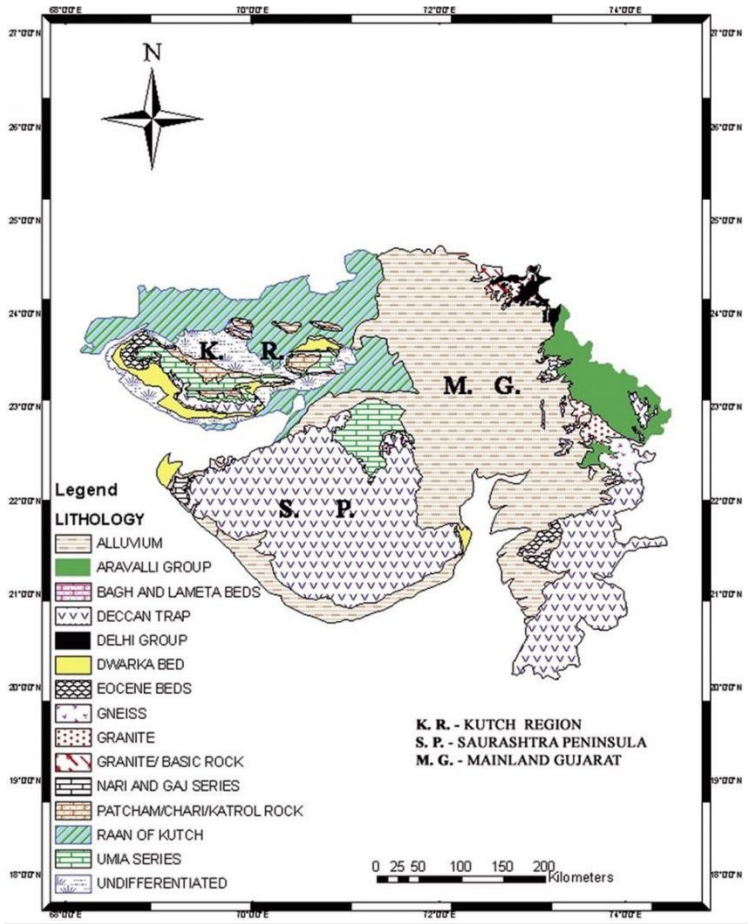


Fig 1: Lithological map of Gujarat

Group	System	Rock Type	Localities	Age in millions of years
Quaternary	Recent and subrecent	Alluvium, blown sand and Silts of Rann and Banni, Tidal flats and raised beaches.	Alluvial plains of Gujarat, Rann, Banni & Coastal deposits.	0.01
	Pleistocene	Miliolites	1) Saurashtra coast from Gopnath onwards extending beyond Porbandar. 2) Kutch area.	1
Tertiary or Kainozoic	Pliocene	Dwarka beds, Manchhar beds, Gypsiferous clays and sandy foraminiferal limestones.	Dwarka, Okha, Piram Island and 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
	Paleocene	Madh series- Supratrapean	Kutch	
	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 sand – stones, Lameta (limestones). Bagh beds (sandstones, Limestones and shales). Songir sandstones, Nimar sandstones, Wadhavan sandstone (Infratrappeans), Bhuj and Umia series sandstones.	Himatnagar, Kapadvanj, Balasinor, Parabia, Dohad, Gabat, Narmada valley, Surpan Vanji, etc. Songiri near pavagadh. Wadhavan, Dhrangadhra, Bhuj etc.	110

Secondary or Mesozoic	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, calc- schists of Ajabgarh series.	Parts of Sabarkantha and Banaskantha, and Mehsana Districts.	
Archaean or Azoic		Aravalli system-Mica-schists, Phyllites, quartzites, etc.	Sabarkantha, Panchmahals, Baroda, Banaskantha.	4000
		Banded gneissic complex	Baroda District.	

Table 1: Lithostratigraphic table of Gujarat.

ARCHEANS: These are the oldest groups of rocks forming the basement for late formations. Detailed formation under this group is Banded Gneissic Complex, are highly intricate and varied gneissic complex; they are mostly of igneous origin, but on account of interfoliar injection, they have a general northerly foliation strike, and are continuous with gneissic complex of central Mewar. These are occurred around Chhota Udepur, Bodeli and east of Sankheda. Aravalli systems are metamorphic and have been affected by tectonic forces forming folds. Basal conglomerates impure calcareous facies generally dolomitic in composition, quartzite, phyllites, slates and schists are the rocks under this system.

MESOZOIC: The rocks under Delhi system are metamorphosed and undergone deformation, having been folded. The rocks are quartzite, phyllites and mica schists, calc-schist and calc gneisses, calciphyres, limestones and marble. The strike is roughly north-south and NNE-SSW. In Post-Delhi system, Erinpura granites were first recorded. A broad belt from Bariya taluk to Lunawada taluk, trending SE-NW is occupied by granites around Godhra in Panchmahals district; this extends further across the Mahi River in Balasinor taluk in west, the Kalol taluk in South. A small out-crop of granite occurs NE of Pavagadh.

In Cretaceous system, Lameta beds are lenticular outcrops from narrow fringes along the base of the Deccan trap. These beds are fresh water deposits, consisting of a conglomeratic formation with a siliceous or calcareous matrix at the base, overlain by earthy to massive limestones with cherty and chalcedonic stringers and veinlets. It is mottled with limonitic

spots. The thickness of these formations comes to above 15ft (5m). Bagh beds are the products of marine transgression in the cretaceous age. It consists of calcareous rocks underlain by beds of sandstone, below which conglomerates are found. Marine fossils are usually found in the uppermost limestones. The thickness is normally up to 70 ft. (21m) but in Narmada valley, it is over 1000 ft.(305m). Nimar Sandstones occur SE of Pavagadh hill and were used in the construction of the Champaner Fort at the foot of Pavagadh. The rocks are pinkish sandstone with jasper pebbles associated with ferruginous conglomeratic beds containing pebbles of quartz and calcedony.

The Deccan Traps covers large area along the eastern margin of the state extending from its southern tip of Narmada; further these are scattered patches cropping out from alluvial tract of Gujarat near Kalol and Timba in Panchmahals Dist., Kapadvanj in Kaira Dist., and near Dhansura in Ahamedabad Dist. Trap comprise lava flows of amygdaloidal trap, porphyritic trap, basalt, etc. Pavagadh a mass of trap, is known to be central type eruption unlike usual fissure type, and is an example of magmatic differentiation. Other rock types in Pavagadh are pumice, pitchstone, rhyolite, felsites, quartz m- andesite etc.

TERTIARIES: The rock of this group occur between mouths of Tapi and Narmada rivers, forming a fringe along the edge of deccan traps. The basal beds of nummulitic limestone and ferruginous clays belong to Eocene, while the overlying rocks of Kand formation (yellow limestone), ferruginous sandstones, and agate bearing conglomerate are upper Gaj of Miocene age. Laterite occurs in areas near Kapadvanj as well as Tarkeshwar. Being oil bearing, the Eocene, Oligocene and Miocene formations of Tertiaries are very important. These are covered by thick mantle of alluvium on the westwards. Oil is found in Eocene, Oligocene and Miocene. Saurashtra- Kathiawar peninsula in Jura- Cretaceous are the oldest formations in the Saurashtra area, and they occur in the NE corner of the region, around Dhrangdhara. Sandstone from these formations is known as excellent building stones.

Traps have occupied almost the whole of Saurashtra region expect the coastal areas and its NE corner. Traps of Saurashtra are the extensions of Gujarat and Malwa traps, and these extend northwards in Kutch. A bed of volcanic ash, made up of fragments varying in size from gravel to large lumps of a dense trap occur in the lower part of the Chotila hill. Laterites occur along the Deccan trap border in a discontinuous linear belts or strips; the largest one is near Bhavnagar. Gaj beds occur as isolated patches, at interval in coastal areas between Bhavnagar and Jamnagar along the margins of Deccan traps, were laterites in alluvium.

These comprise of limonitic limestone, sandstone, grit, conglomerate and yellowish clays and marls with gypsum. In Piram island near Bhavnagar is know for discovery of fossil mammalian bones of age Pliocene. Dwaraka beds consist of limestone and yellow earthy, marly or clayey beds, partly gypseous with iron-stained harder bands.

QUATERNERY: Miliolite limestone are also known as Porbandar stone is a finely oolitic free stone composed of remains of foraminifer. Calcite grains are found around Miliolites. Major part of Miliolites limestones is of high grade, and used extensively for the cement manufacture, as well as in chemical industry. In recent, sand dunes, consolidated shore sand, tidal mud flates, coral reefs and fresh water alluvium are present. Saurashtra region is rich in mineral wealth also.

FIELD OBSERVATION GUJARAT

DAY 1 - 22/01/2023

LOTHAL

LATITUDE- N22^{0}32'18"

LONGITUDE- E72^{o}14'58"

Harappa port-town of Lothal is located along the Bhogava river, a tributary of Sabarmati, in the Gulf of Khambat and is 80 km away from ahmedabad. This place is situated 8 km away from the Gulf of khambat. The city that stood at this archaeological site 4500 years ago was one of the most important of the Indus Valley civilisation. The town has thick peripheral walls,which are12 to 21 meters long. This were probably built to protect town from floods. And those floods destroyed the city. Remains of stone ankers, sea shells which can be traced to persian gulf. This basin has inlet and outlet channels and this has been identified as tidal dockyard. overflow of water near port will go through channel to sea, thus flood controlled. Steatite steal is also found here. So we can connect the relation to gulf areas.

The city was divided into a upper and a lower town. The rulers of the upper town which featured houses with paved bathing platforms, underground and surface drains and potable water well.

DOCKYARD

Dockyard is located on the east of the town and away from the main river channel, to possibly avoid deposition of silt. The north–south length averages 215 metres, and east–west width of 35 metres.An inlet approximately 7 metres wide and 0.9 metres in depth survives in the north of the structure, and a 1 metre square sluice gate or spillway, that appears could have been dammed by a wooden gate, exists in the south face of the structure.When the river changed its course in 2000 BCE, a canal approximately 7 metres wide and 2 kilometres long, was dug to the new river course.

WELL

There were two wells situated in that area. one well is in the lower town and one in the upper town.

FACTORY

The bead factory, which performs a very important economic function, possesses a central courtyard and eleven rooms, a store, and a guardhouse.

TOILETS

The toilets and bathrooms are used only by acropolis the upper town peoples. The drainage is mainly based on artificial slope which they built.

Fig1. Dockyard

Fig 2. Steatite seal

Fig 3. Well

Fig 4. Toilets

Fig 5. Bead factory

Fig 6. Market

DAY 2 - 23/01/2023

LOCATION 1

AHMEDABAD

STEPWELL

LATITUDE- N23^{0}29'11"

LONGITUDE- E72^{0}35'49"

This stepwell is situated 2 km away from the ahmedabad railwaystation. It is an ancient stepwell built on the 15 th centuary.

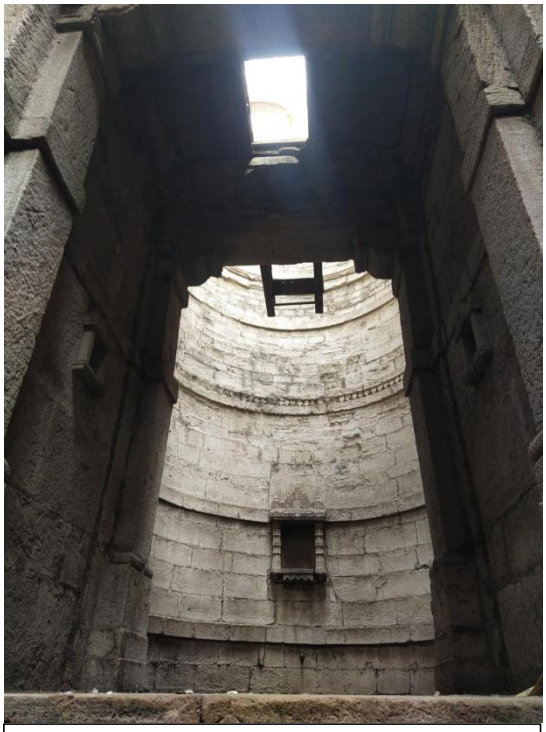


Fig 7.Step well

LOCATION 2

PHYSICAL RESEARCH LAB

LATITUDE-23.0356^0 N

LONGITUDE-72.5435^0 E

PRL is an autonomous unit of DOS and a premier research institute engaged in basic research in the areas of, Atomic, Molecular and Optical Physics ,Astro-chemistry Astronomy and Astrophysics, Solar Physics, Planetary Science and Exploration, Space and Atmospheric Sciences, Geosciences.

Sir explained us about MC-IPMS. These are instrument that measures isotopic ratios that are used in geochemistry, geochronology, and cosmochemistry. A MC-ICPMS is a hybrid mass spectrometer that combines the advantages of superior ionization of an inductively coupled plasma source and the precise measurements of a magnetic sector multicollector mass spectrometer. The primary advantage of the MC-ICPMS is its ability to analyze a broader range

of elements, including those with high ionization potential that are difficult to analyze by TIMS. The ICP source also allows flexibility in how samples are introduced to the mass spectrometer and allows the analysis of samples introduced either as an aspirated solution or as an aerosol produced by laser ablation.

TIMS- Thermal Ionization Mass Spectrometer, to precisely determine chronology of processes in Earth and Planetary Systems. Isotope Ratio Mass Spectrometer For measurements of high precision isotope ratios of H, C, N, and O in variety of samples such as plants, water, rocks and gases to understand different aspects of Earth System.

IRMS- This facility is used to measure stable isotopes of elements like Carbon, Sulphur, Nitrogen, Oxygen and Hydrogen. Applications include Geochemistry, Paleoclimatology, Oceanography, Hydrology.**Isotope-ratio mass spectrometry** (**IRMS**) is a specialization of mass spectrometry, in which mass spectrometric methods are used to measure the relative abundance of isotope in a given sample

Fig8 .PRL

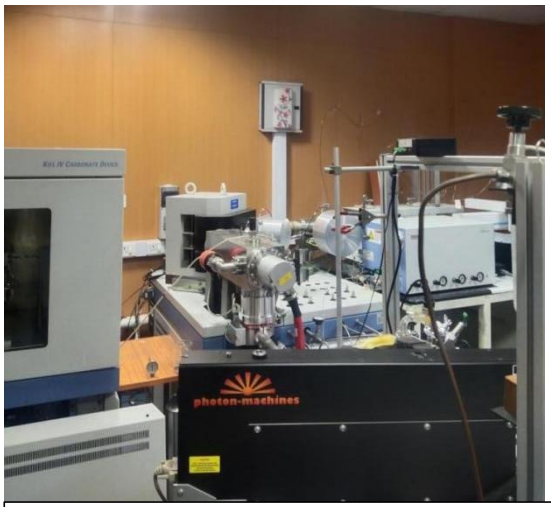


Fig9 . Instruments

DAY 3 -24/01/2023

LOCATION 1

MAHADEVA TEMPLE

LATITUDE--22 .58240^{0}N

LONGITUDE-73.20765^{0}E

Massive rounded outcrops of granites.Godhra is fully covered by Godhra granites, which is developed on the south-western part of the Panchmahal. These granites are found from medium to coarse grained and differ in color as they arrive in pink and grey color. This area is characterized by general flatness which is covered by soil in various places. Thee rocks are of 925 million years old. The low-grade regionally metamorphosed rocks have been affected by intrusive granites (Godhra Granite) of Neoproterozoic age (935 ± 20 Ma). The intrusion has resulted into superimposition of contact metamorphic effect on regionally metamorphosed rocks.

These granites are dark grey granites some are pink granites. Coarse grained and xenoliths are also can be seen in this rock.flaky black coloured mica is also present as xenolith. Plagioclase intrusions are well exposed in the granites. They were white coloured and tabular in shape.these outcrops were tors.Tors are landforms created by the erosion and weathering of rock; most commonly granites. There is often evidence of spheroidal weathering of the squared joint blocks. Xenolith are of 3-4 cm in size.

Fig10 . xenolith in granite

Fig11 .Exfoliation

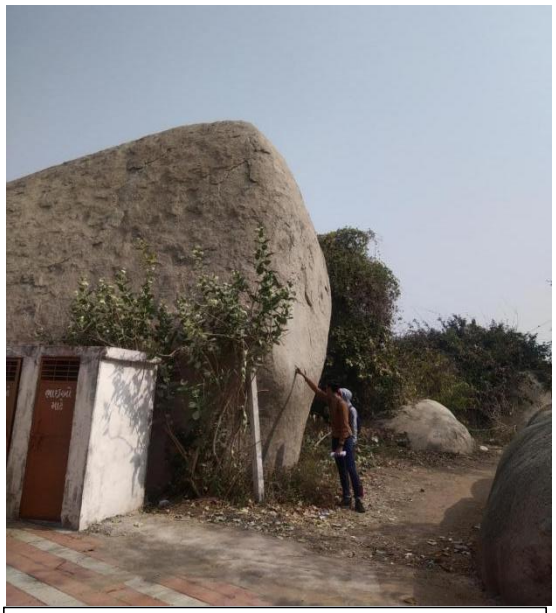


Fig12 .tor granite

LOCATION 2

BALASINOR

LATITUDE- 23^0 20’18”

LONGITUDE-$73^0$11’25”

The area contain outcrops of sandstone and conglomerates. Conglomerates are sedimentary rocks that contain different sized clasts. These clasts are of 2-3 cm in size. Jasper clasts are found inside limestone rock.these jasper is of fine grained and pinkish red in colour. The teeth and bones of dinosaurs are found in sandstone and eggs are found in limestone.

Fig13 .conglomerate

Fig14 .jasper clasts

LOCATION 3

DINOSAUR FOSSIL PARK

LATITUDE-N 23^0 20’18”

LONGITUDE--E$73^0$11’25”

It is considered home to at least 13 species of dinosaurs for more than 100 million years until they became extinct 66 million years ago. The 72-hectare park has as many as ten thousand dinosaur fossils.

One of the reasons why this area proved favorable for the survival of the dinosaurs is the soft soil found here which made the hatching of eggs easier along with the protection of the newly hatched young ones. That fossil park contains bone parts of different species dinosaurs.

There we saw left ulna of sauropod, scapula corocoid of titanosaurid, adjoining caudal vertebrae of abelisaurid theropod and an indeterminate limb bone, dorsal vertebrae abelisaurid theropod with indeterminate limb bone, left femur in medial view and caudal vertebrae of sauropod.

Fig15 . fossil of sauropod

Fig 16 . Left ulna of sauropod

Fig 17 . Abelisaurid theropod

Fig18 . Dinosaur eggs

DAY 4 - 25/01/2023

LOCATION
ONGC - OIL AND NATURAL GAS CORPORATION

We were greeted by Sir Gaurav kumar and he then accompanied us to the petroleum refinery, where we saw all the pipeline in which petroleum passes. there were 59 wells which uses to store the petroleum. All of them are in 70 km radius and all were connected by the pipelines.

Nearby that water injection plant was there. There is also seperater for oil and gas. Compressor also control the increasing and decreasing of pressure. Its all managed by a control room situated near the entrance of ONGC.

Fig19 . ONGC

GEOLOGY OF RAJASTHAN

Physiographically the state can be divided into four units:

(a) Aravalli hill ranges

(b) Eastern plains

(c) Western Sandy Plain and Sand Dunes and

(d) Vindhyan Scarpland and Deccan Lava Plateau

Aravalli Hill Ranges

The Aravalli ranges trending NE-SW are the oldest mountain chain in India. The elevation of these hill ranges varies from about 600 metres to over 900 metres above mean sea level (mamsl). They are composed of Bhilwara, Aravalli and Delhi Super group of rocks ranging in age from Archaean {2500 million year (my)} to Proterozoic (740 my). These ranges form a series of rugged hills with rounded surfaces. The quartzite however, stands out as scarps. Near Ajmer, these separate out south west wards into a number of parallel ridges. At Mount Abu, the clusters of granite peaks reach a maximum height of 1722 m amsl at Guru Sikhar.

The Eastern Plains

In the plains, east of the Aravalli ranges, the altitude varies from 150m to 450m amsl. The general trend of the slope varies from place to place. In Dungarpur and Banswara districts it is mainly from north to south, in Alwar district it is from south to north and in the remaining districts, forming the central and north eastern Rajasthan, it is from west to east.

Vindhyan plateau marks the south - eastern limit.

The Western Sandy Plains and Sand Dunes

The sandy plains in western Rajasthan, forming a part of Thar Desert, are mainly occupied by alluvium and blown sands. These plains are further sub-divided into three units:

Sandy Arid Plain (Marusthali)

Semi-arid Transitional Plain

Ghaggar Plain

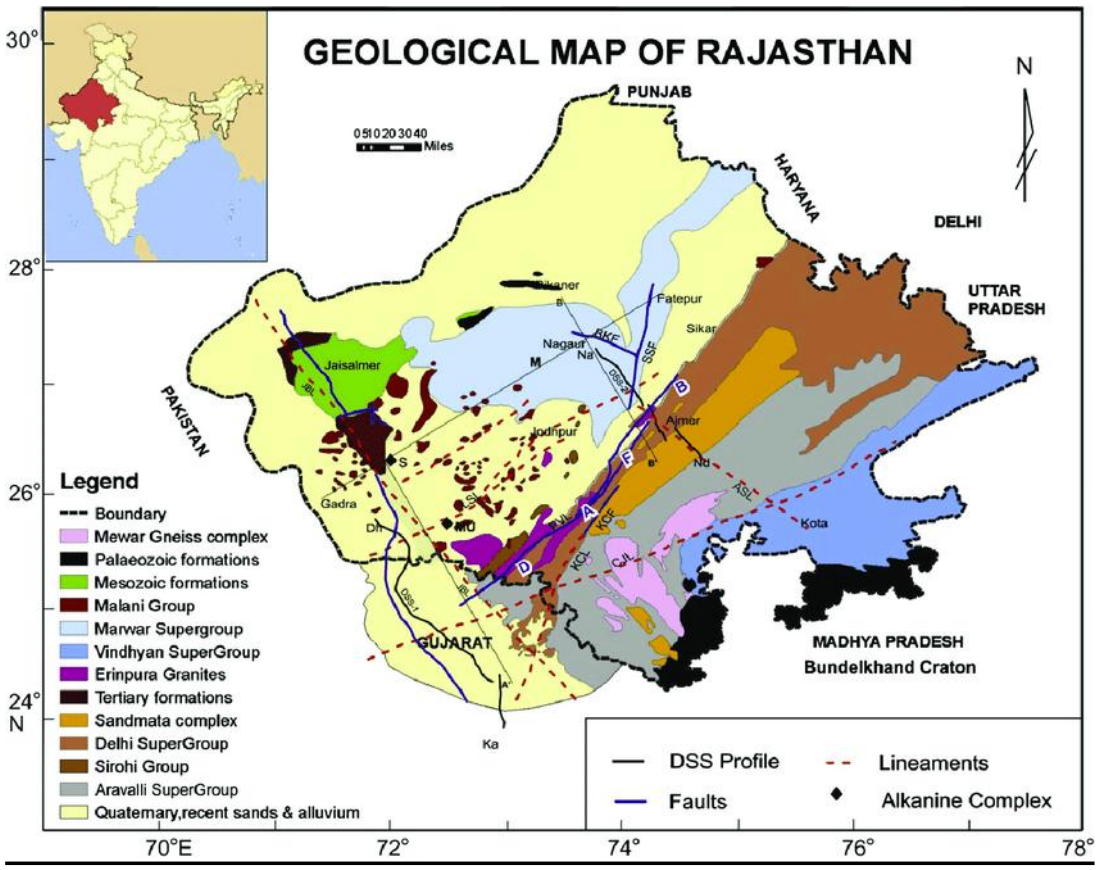
The Sandy Arid Plain is a typical desert terrain. It includes the western most districts of Jaisalmer, Bikaner and part of Barmer, Jodhpur, Nagaur, Churu and Ganganagar. The line dividing the Sandy Arid Plain and the Semi-arid Transitional Plain as well as Ghaggar Plain is based on climatic parameters and water resource availability. The eastern boundaries of the Semi-arid Transitional

Plain are the foot-hills and their extension on the western side of Aravalli ranges. Sand dunes are prominent and the terrain is punctuated with isolated hills of granites and rhyolites. The altitude varies from 30m to 300m amsl. The general slope is from northeast to southwest. The Ghaggar Plain consists mainly of former flood plains and aeolian deposits. Networks of canals cover the entire area. The southern and southeastern part is occupied by medium to high dunes. Nineteen of these interdunal depressions are being utilised for storing the diverted Ghaggar flood waters. The central part of the Ghaggar Plain is drained by the regulated flood waters of Ghaggar River.

Vindhyan Scarpland and Deccan Lava Plateau

The southeastern plains are locally characterised by plateau, scarp land and ravines. The Vindhyan scarpland are seen all along the Great Boundary Fault from Chittorgarh to the trijunction of Bharatpur, Dholpur and Sawai Madhopur districts. They have an average elevation of 300m to 580m amsl.

The Deccan Lava Plateau is mainly confined to parts of Kota, Jhalawar, Banswara and Chittorgarh districts. The elevation ranges from 300m to over 500m amsl.



Geological Time Scale

ERA	PERIOD	EPOCH /AGE	Million Years Ago	EVENTS
CENOZOIC *Age of Mammals* 65.5 mya - present day	*Quaternary*	*Holocene*	*Today - 0.01 - - 1.6 - - 5.3 - -23.7- -36.6 - - 57.8 - -65.5 - - 144 - - 208 - - 245 - - 286 - - 360 - - 408 - - 438 - - 505 - - 570 - -2500- -3800- 4600*	Ice Age ends Humans are dominant
		Pleistocene		Earliest Humans appear Ice Age begins
	Tertiary	*Pliocene*		Hominids (human ancestors) appear
		Miocene		Grass becomes widespread
		Oligocene		Mammals are dominant
		Eocene		Eocene - Oligocene extinction event
		Paleocene		First large mammals appear
MESOZOIC *Age of Reptiles* 245 mya - 65.5 mya	*Cretaceous*	*Extinction of Dinosaurs*		K-T extinction event Earth looks closer to present-day Flowering plants appear
	Jurassic			First Birds appear Pangaea splits into Laurasia, Gondwanna Dinosaurs are dominant
	Triassic	*First Dinosaurs*		Pangaea cracks First mammals appear Reptiles are dominant
PALEOZOIC 570 mya - 245 mya	*Permian*	*Age of Amphibians*		Permian -Triassic extinction event Pangaea forms
	Carboniferous			First reptiles appear First large cartilaginous fishes appear
	Devonian	*Age of Fishes*		Late Devonian extinction event First land animals appear First amphibians appear
	Silurian			First land plants appear First jawed fishes appear First insects appear
	Ordovician	*Age of*		Ordovician -Silurian extinction event First vertebrates appear

	Cambrian	*Invertebrates*		End Botomian extinction event First fungi appear Trilobites are dominant
PRECAMBRIAN 4600 mya - 570 mya	*Proterozoic Eon*			First soft-bodied animals appear First multicellular life appear
	Achean Eon			Photosynthesizing cyanobacteria appear First unicellular life appear
	Hadean Eon	*Priscoan Period*		Atmosphere and oceansform Oldest rocks form as Earth cools

FIELD OBSERVATION RAJASTHAN

DAY 5 - 27/01/2023

SULPHORITE MINE

LATITUDE-24°28'21"N

LONGITUDE-73°51'34"E

RAJASTHAN STATE MINES AND MINERALS LIMITED

JHAMAR KOTRA MINE UDAIPUR

Jhamarkotra is probably the largest open cast mine in India outside the steel and coal sectors. One technical fronts the problem of ground water had affected the mining operations, until an effective dewatering scheme was evolved and implemented. The geometry of the ore body like thin and sharply dipping had resulted in long and narrow pits with great depth extension, which involves very high stripping ratio with high lead and lift for waste and mineral. Despite all these problems Jhamarkotra project could sustain the very difficult periods because of its commitment towards scientific approach for exploitation of the deposit with planned development of the pits.

Rock phosphate,lignite limestone and gypsm also found here. stromatolite, layered deposit, mainly of limestone, formed by the growth of blue-green algae. These structures are usually characterized by thin, alternating light and dark layers that may be flat, hummocky, or dome-shaped. The alternating layers are largely produced by the trapping of sediment washed up during storms on some occasions and by limestone precipitation by the blue-green algae on others. These blue green algae indicate marine life of aravalli.

This is the largest open cast mine contains benches and faces. The primary ore is seperated to low grade and high grade. 18 billion tonnes are produced. Ore to overburden ratio is 1:16. this is mainly a sedimentary deposit basin. 2000 billion year old blue green algae is present. Carbon dioxide, water and dissolved phosphate continue lots of years and formed as a rock. Host rock is dolomite. Above 25 is high grade. 5 to 25 is low grade. Below 5 is waste material. The first bench width of mine is 10 meter , face width is 7 meter, next set is also same as this and the

other bench is slightly dipping and 12 meter width.

Fig20 . jhamar kotra mine

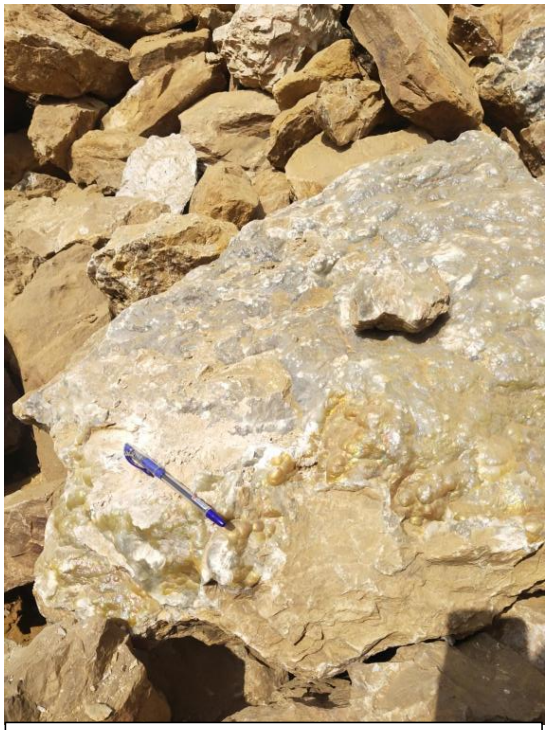


Fig21 . apatite

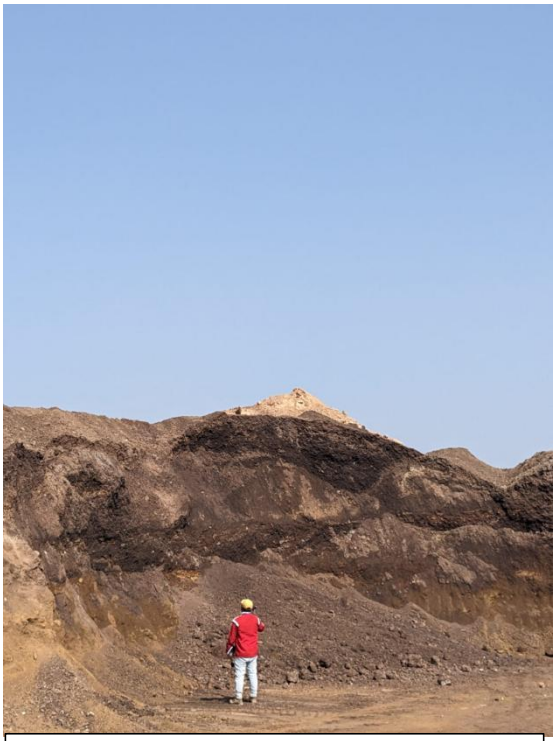


Fig22 . high grade ore

Fig23 . Benches and faces

Fig24 . stromatolites

DAY 6 - 28/01/2023

LOCATION 1

GAMBERI RIVER

LATITUDE- N 24.90380

LONGITUDE- E 74.623149

We went to shore of Gambhir river situated near chittorgarh palace. This place comes under vindhyan supergroup. Stratigraphicaly there suket shale the upper most part of semri group should present. . The areas shale was highly folded. Only one limb of the fold was found there. The other limb of most of the folds were destroyed by the flowing action of river. By measuring the dip amount of that bed it increased from top to down.prominent slaty cleavage can be seen. Its because of alignment of platy minerals in a plane

SI NO.		
1	Strike	N 50^0E
	Dip direction	N $140^{0\,E}$
	Dip amount	40^0
2	Strike	N40^0 E
	Dip direction	N$132^{0\,E}$
	Dip amount	45^0
3	strike	N 49^0 E
	Dip direction	N142^0 E
	Dip amount	47
4	strike	N50^0 E
	Dip direction	N 140^0 E
	Dip amount	52

5	strike	N 55 E
	Dip direction	N 144 E
	Dip amount	48
6	strike	N 42 E
	Dip direction	N 141 E
	Dip amount	62

The tops of folds ; crests are highly weathered. One quartz vein is intruded through the suket shale beds.

Fig25 . suket shale

Fig26 . one limb of fold

Fig27 . Folds

Fig 28. folds

LOCATION 2

OTHER SIDE OF RIVER

LATITUDE- N 24.90380

LONGITUDE- E 74.623149

1	strike	$N46^0E$
	Dip direction	$N140^0E$
	Dip amount	54^0

LOCATION 3

This rock beds are also situated near the gambhir river . the rock found here are limestones. They were grey colored fine grained carbanaceous sedimentary rocks.

1	strike	$N\ 180^0\ E$
	Dip direction	$N\ 270^0\ E$
	Dip amount	41^0

Fig29 . limestone bed

DAY 7- 29/01/2023

NATHDWARA

LATITUDE- N 24.9312^0

LONGITUDE- E 73.8193^0

This marble is physically weathered. The outer layer is fully weathered,and also foliated surface. Mylonitic structure is observed. fine-grained, compact metamorphic rock produced by dynamic recrystallization of the constituent minerals resulting in a reduction of the grain size of the rock. Mylonites can have many different mineralogical compositions; it is a classification based on the textural appearance of the rock. Stress indicators also seen. The green coloured mica schist is highly weathered. Folds are also seen in some areas. Saccharoidal texture can be seen , means having or being a fine granular texture like that of sugar lumps. Some curvatures in that rock is observed. May be it ll be part of some large folds. garnet crystal can be seen in the rock

Fig .29

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THANKYOU…