SCHOOL OF EARTH OCEAN AND ATMOSPHERIC SCIENCES

GOA UNIVERSITY

CERTIFICATE

This is to certify that Mr. Ansifshah K A 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.

Faculty member in-charge

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Program officer SEOAS

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

Submitted by

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MSc Part 2

21P045005

School of Earth Ocean and Atmospheric Sciences

Goa University

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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 Deccan Traps ,Gondwanna and Vindhyan.

The Deccan Traps covers almost all of Maharashtra, apart of Gujarat, Karnataka, Madhya Pradesh and Andhra Pradesh marginally. During its journey northward after breaking off from the rest of Gondwana, the Indian Plate passed over a geologic hotspot, the Réunion hotspot, which caused extensive melting underneath the Indian Craton. The melting broke through the surface of the craton in a massive flood basalt event, creating the Deccan Traps. It is also thought that the Reunion hotspot caused the separation of Madagascar and India.

The Gondwana and Vindhyan include within its fold parts of Madhya Pradesh, Chhattisgarh, Odisha, Bihar, Jharkhand, West Bengal, Andhra Pradesh, Maharashtra, Jammu and Kashmir, Punjab, Himachal Pradesh, Rajasthan and Uttarakhand. The Gondwana sediments form a unique sequence of fluviatile rocks deposited in Permo-Carboniferous time. The Damodar and Sone river valleys and Rajmahal hills in eastern India Contain a record of the Gondwana rocks.

The Indian Craton was once part of the super continent of Pangaea. At that time, what is now India's south west coast was attached to Madagascar and southern Africa, and what is now its east coast was Attached to Australia. During the Jurassic Period about 160Ma(ICS 2004), rifting caused Pangaea to break apart into two super continents, Namely Gondwana (to the south) 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 5 years ago (ICS2004). The Indian Plate then drifted northward towards the Eurasian Plate, at a pace that is the fastest known movement of any plate. It is generally believed that the Indian Plate separated from Madagascar About 90 Million years ago (ICS2004), however some biogeographical and geological evidence suggests that the connection between Madagascar and Africa was retained at the time when the Indian Plate collided with the Eurasian Plate about 50 Million years ago (ICS2004). This orogeny, which is continuing today, is related to closure of the Tethys Ocean. The closure of this ocean which created the Alps in 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 Aravalli-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 sediments eroded 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 Lower Cretaceous 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 coast at Pondicherry and in Tamil Nadu. 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 Gondwanna.


INDIA
Geological Map
N
TAJIKISTAN
AFGHANISTAN
PAKISTAN
CHINA (TIBET)
NEPAL
BHUTAN
BANGLADESH
MYANMAR (BURMA)
SRI LANKA
ARABIAN SEA
BAY OF BENGAL
Vindhyan
Siwalik
Alluvial Upland (Old)
Alluvium
Aravalli
Dharwar
Granities (Old)
Deccan Trap
Lower Gondwana
Cuddapah
Granites
Un-Classified Crystalline
Marine Tertiaries
LEGEND
Recent and Pleistcene
Tertiary
Deccan Trap
Gondwana & Vindhyan
Pre-Cambrian
Cuddapah
Map not to Scale

GEOLOGY OF GUJARAT

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

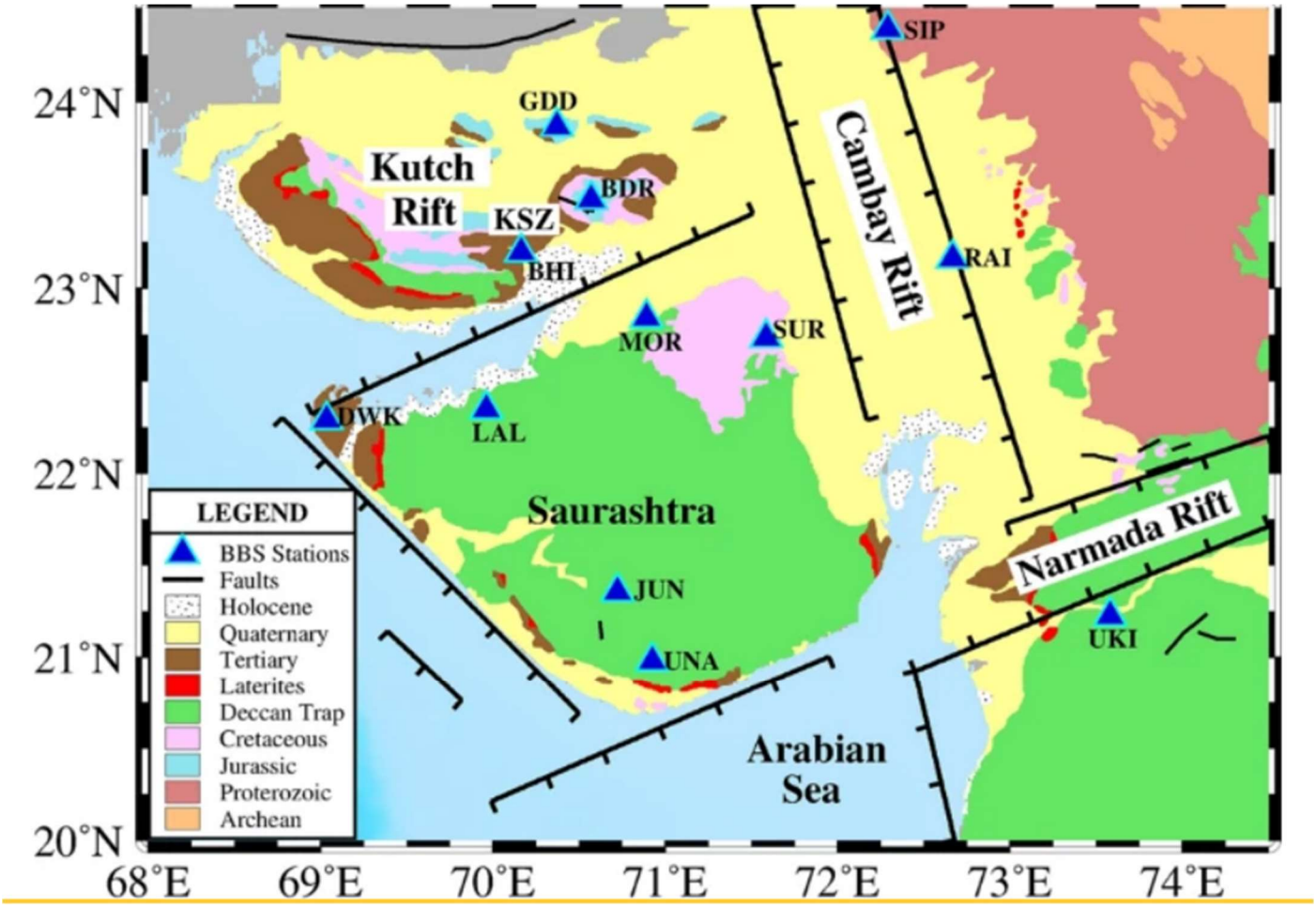
a) Gujarat-Mainland.

b) Saurashtra-Kathiawar Peninsula.

c) Kutch Peninsula.

a) Gujarat-Mainland.

The well known 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 trap scenery up to Narmada valley. The hills are formed by circumdenudation leaving wide plateau at top, and a step like feature because of horizontal lava-flows and their differential weathering.



b) Saurashtra-Kathiawar Peninsula:

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

into the coastal plains and the great alluvial tract stretches to NE and east. The sedimentary rocks along the coast form almost a low flat country.

c) Kutch Peninsula

The mainland of Kutch is isolated by the Great Rann of the north and east, Little Rann on the SE, Gulf of Kutch on the south and rest by the Arabian sea. The central portion of Kutch 7 forms a table-land sloping on all sides, the shape of the region is like a tortoise and hence the name. In general, there are three hill ranges, trending almost east-west. North-flowing rivers disappear in the Rann; others join the sea. The Banni is formed by sediments deposited by northern border of the main land and is composed of fairly good soil. The Rann is a dry bed of the remnant of an arm of the sea, which formally connected the Narmada rift with Sind and separated Kutch from the mainland.

LITHOSTRATIGHRAPHIC TABLE

Group	System	Rock Type	Localities	Age in millions of years
Quaternary	Recent and subrecent	Alluvium, Blown sand, Silts of Rann and Banni, Tidal flats and raised beaches.	Alluvial plains of Gujarat, Rann, Banni & Coastal deposits.	0.01
	Pleistocene	Miliolites	(i) Saurashtra coast from Gopnath northwards extending beyond Porbandar. (ii) Kutch area.	1
Tertiary or Kainozoic	Pliocene	Dwarka beds, Manchhar beds, Gypsiferous clays and sandy foraminiferal limestones.	Dwarka, Okha, Piram Island, Kutch.	12
	Miocene	Gaj beds-Highly fossiliferous clays and limestones. Agate Bearing conglomerates. Kand formations.	Saurashtra coast, Kutch	25
	Oligocene	Tarkeshwar clays.	Tarkeshwar (District:Surat) and Kutch.	40
	Eocene	Nummulitic limestones and clays.	Tarkeshwar area and Kutch.	60
Secondary or Mesozoic.	Cretaceous Eocene	Deccan traps with inter trappeans.	Parts of Sabarkantha, Panchmahals, Baroda, Broach, Surat and major part of Bulsar and Dangs Districts. Major part of Saurashtra and small part of Kutch.	
	Cretaceous	Himatnagar sandstones, Lameta (limestones). Bagh beds. Songir sandstones, Nimar sandstones,Wadhavan sandstone (Infratrappeans), Bhuj and Umia series sandstones	Himatnagar, Kapadvanj, Balasinor, Parabia, Dohad, Gabat, Narmada valley, Songir.Near pavagadh. Wadhavan,Dhrangadhra,Bhuj etc.	110
	Jurassic	Katrol series, Chari series, Patcham series (sand-stones, shales and limestones).	Kutch.	150
	Purana (Algonkian & Part of Cambrian)	Erinpura granite (Post-Delhi).	Palanpur, Danta, Idar, Modasa, Taranga, Dharoi, Virpur, Wanakbori, Godhra, etc.	1500
		Delhi System-Alwar quartzites, schists, and calc-gneisses, calcschists of Ajabgarh series.	Parts of Sabarkantha and Banaskantha, and Mehsana Districts.	
Archaean or Azoic		Aravali System-Micaschists, Phyllites, quartzites, etc.	Sabarkantha, Panchmahals, Baroda, Banaskantha.	4000
		Banded gneissic complex.	Baroda District.	

GEOLOGY OF RAJSTHAN

Rajasthan is endowed with a continuous geological sequence of rocks from the oldest Archaean Metamorphic, represented by Bhilwara Super-group (>2500 m. y.) to sub-recent alluvium & windblown sand. The geological sequence of the state is highly varied and complex, revealing the co-existence of the most ancient rocks of the Pre-Cambrian age and the most recent alluvium as well as windblown sand.

Rajasthan forms north-western part of the Indian Shield. The State exposes a variety of lithological and tectonic units ranging in age from Archaean to Recent times. Before going into details of Geology of Rajasthan, let us first see, geology time in general to make sense of terms in geology.

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

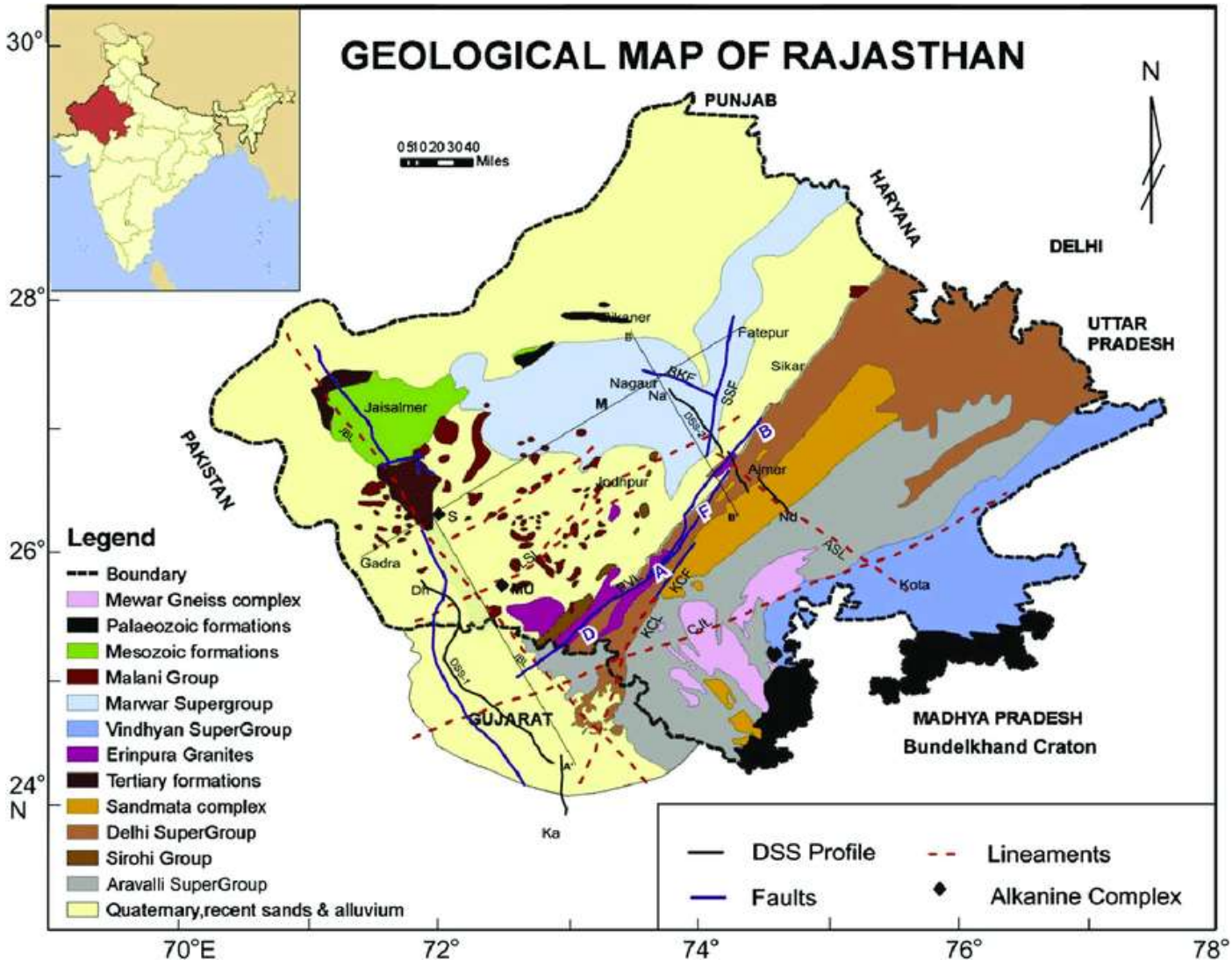
The Lower Proterozoic supracrustal rocks of the Jahajpur, Rajpura-Dariba, PurBanera and Sawar Groups of Bhilwara Super-group rest on the basement rocks of the Mangalwar Complex and host a number of lead, zinc and copper deposits.

The Proterozoic fold belts, viz., the Aravalli fold belt (the Aravalli Super-group) and the Delhi fold belt (the Delhi Super-group) occupies the southern and south eastern, and south-western and north-eastern Rajasthan respectively. The Aravalli Super-group is represented by metamorphosed and complexly folded clastic sediments with minor chemogenic and organogenic assemblages with interlay red basic volcanic, whereas the Delhi Super group comprises mainly carbonates, metavolcanics, metasammites and metapelite, intruded by magmatic rock of Phulad Ophiolite Suite and syn-orogenic granites of Sendra- Ambaji, Baraith, Dadikar, Harsora, etc.

A number of base metal deposits are located in these belts as also other minerals. The isolated hillocks of western Rajasthan constitute the Upper Proterozoic Malani Igneous Suite and the Erinpura Granite pluton. Eastern Rajasthan is characterised by the vast sedimentary stretch constituting the Vindhyan, which is juxtaposed against the rocks of the Bhilwara Supergroup along the Great Boundary Fault.

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

The Cenozoic rocks are manifested in Barmer and Jaisalmer basins in the west and Ganganagar Palana shelf in the north. The Quaternary sediments of Aeolian and fluvial origin constitute the Thar Desert of Rajasthan.


GEOLOGICAL MAP OF RAJASTHAN
N
0 5 10 20 30 40
Miles
PUNJAB
HARYANA
DELHI
UTTAR PRADESH
MADHYA PRADESH
Bundelkhand Craton
PAKISTAN
GUJARAT
Bikaner
Fatepur
Sikar
Nagaur
Jaisalmer
Jodhpur
Ajmer
Kota
Gadra
Legend
Boundary
Mewar Gneiss complex
Palaeozoic formations
Mesozoic formations
Malani Group
Marwar Supergroup
Vindhyan SuperGroup
Erinpura Granites
Tertiary formations
Sandmata complex
Delhi SuperGroup
Sirohi Group
Aravalli SuperGroup
Quaternary,recent sands & alluvium
DSS Profile
Faults
Lineaments
Alkanine Complex
30°
28°
26°
24° N
70°E
72°
74°
76°
78°

FIELD OBSERVATIONS

DAY 1

DATE: 22/1/2023

LOCATION 1: Lothal Archaeological site

TIME:3.00 PM

LATITUDE- N 22°31'17"

LONGITUDE- E 72°14'58

The location was one of the southernmost sites of the ancient Indus Valley civilisation, located in the Bhal region of the Indian state of Gujarat. It was a Dockyard in the past. It was connected to Indus river. The Dockyard is 20km away from Gulf of Khambhat. The dockyard is fed by Sabarmati and Boga River. Steatite seal was found here which is related to Gulf Countries.

The city was divided into upper town known as Acropolis or Citadel and lower town. A well was built with bricks with a length of 4 inches in front and 6 inches in the back. The well was a source for the people living in the lower town. The location was excavated between 1953-1954.

Well

Ware house where good were kept

3 metres from the dockyard the luggage and the transported goods were kept on a berth. Earlier the place had a wooden roof but now it is not found. Foraminifera were discovered indicating that sea water once filled the structure and it was definitely a dockyard.

Dockyard

The upper town known as Acropolis had its common kitchen inside and bathroom. The bathroom was common for all the people in the city and had canals for the drainage.

Bathroom

Bead factory

The red bricks found in the city were old ones and other bricks found were built in the renovation.

Beads were found in the upper town. There were evidence of trade of beads and bead factory where beads and other golds were heated.

The market area was found where silk, beads, gems and other goods were sold. Lower town were for labours for working.

Market or trade area

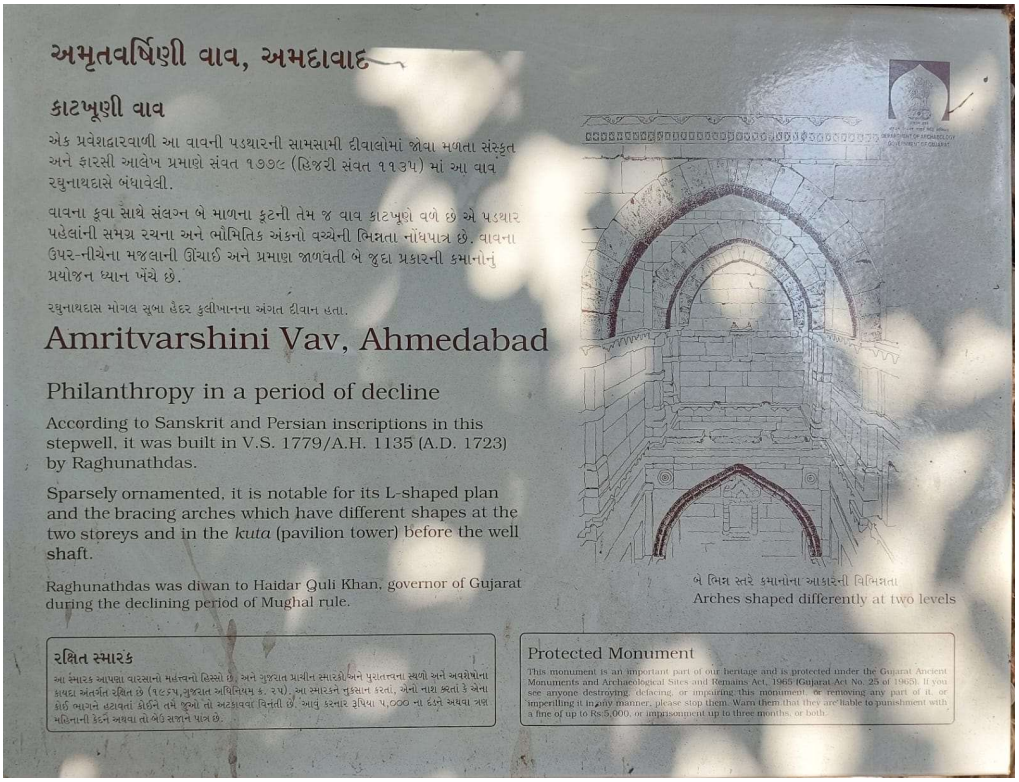
DAY 2

23/1/2023

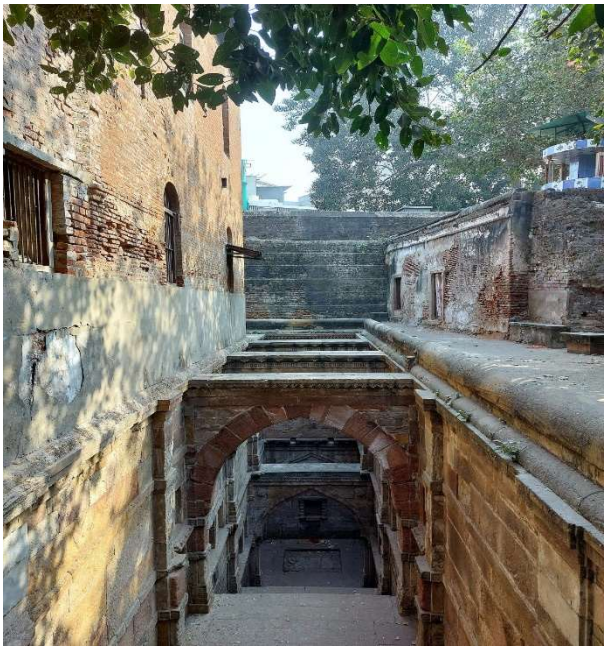
LOCATION 1: Amrutvarshini Vav Paanchkuva

LATITUDE- N 23°29'11"

LONGITUDE- E 72°35'49"



The stepwell is situated 500m away from Ahmedabad railway station.It has a three storey and is more than 50ft deep.It is one among the 5 wells which was built on 1723.



LOCATION 2:

Physical Research Laboratory, Ahmedabad, Gujarat.

23.1688° N, 72.5451° E.

The Geosciences Division of the Physical Research Laboratory (PRL) in India is an important research institution that focuses on the study of the earth and its various components. It is one of the largest and most prestigious organizations in the country dedicated to the field of geosciences.

Established in 1947, the Geosciences Division of PRL is located in Ahmedabad, Gujarat, and has been instrumental in advancing our understanding of the earth's structure, composition, and dynamics. The division is home to a team of highly qualified and experienced researchers who work on various aspects of earth science, including seismology, geodynamics, geodesy, atmospheric science, oceanography, and paleoclimate.

The Geosciences Division of PRL has a wide range of research facilities and state-of-the-art equipment that are used to conduct cutting-edge research. We thank the faculty for guiding us around the labs of the PRL.

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 analysing 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.

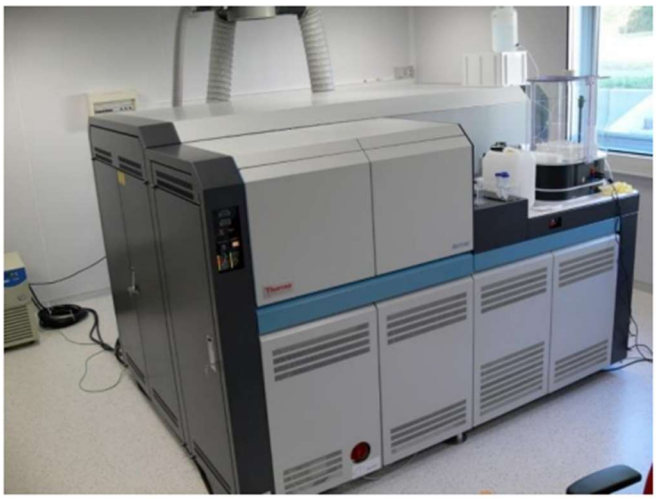
2. Ionization: The vaporized sample is ionized by bombarding it with electrons. The ionized sample is then accelerated through a series of electric fields and sent towards a mass spectrometer.

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.

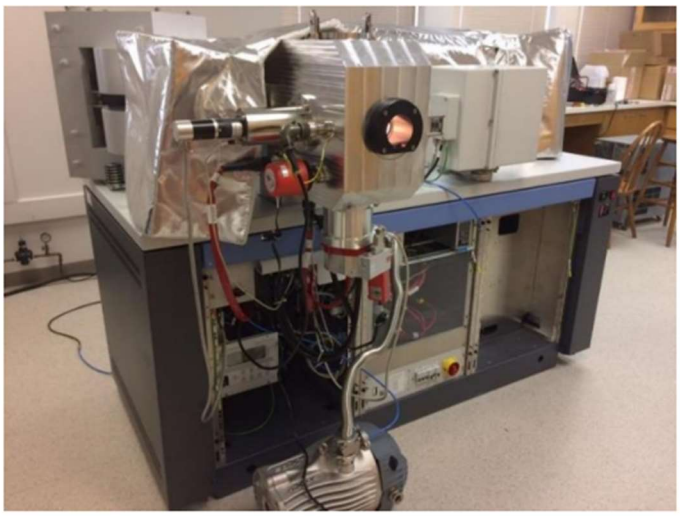
4. Detection: The ion beam is then directed towards a detector system which measures the number of ions hitting it. By measuring the isotopic ratios of the different ions, the relative abundances of the different isotopes can be determined with high precision.

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.

RADIO CARBON DATING



1 MC-ICPMS



2 TIMS

DAY 3

24/1/2023

LOCATION 1: Mahadeva temple

The Location is situated 4km from Balasinor town. The location is exposed with large massive and rounded outcrop of granites known as Godhra granites, which are spread in Panchmahals, Baroda and Sabarkantha districts of Gujarat. The outcrops are in the form of Tors. Tors are described as free standing rock outcrops that rises abruptly from the surrounding smooth and gentle slopes of a rounded hill summit or ridge crest. They are thought to be formed either by freeze-thaw weathering or by groundwater weathering before exposure.

The granites were of the age 925-940 Mya of Neoproterozoic age. The granites were of medium to course grained and was pink and grey in colour. The granite was feldspar dominant with veins of quartz. Large phenocrysts of Feldspar of about 2-5 cm were surrounded by finer matrix mainly composed of biotite and quartz. This granite is not showing any foliation. Xenolith is present. rich in biotite and at some places needles of hornblende are also seen. These xenoliths are aligned, some showing crenulations.

XENOLITH IN GRANITE

PHENOCRYST OF FELDSPAR

EXFOLIATED SURFACE ON GRANITES(TORS)

LOCATION 2: Balasinor

LATITUDE- N 23°20'18"

LONGITUDE- E 73°11'25"

The location was exposed with outcrops of Conglomerate with different sized clasts ranging 2-3 cm, and Sandstone. Fine grained pinkish jaspers were found as clasts in Limestones. Teeth and Bones of Dinosaurs are found in sandstones, while their Eggs are found in Limestone.

Conglomerates

Jasper clasts in Limestone

LOCATION 3: Raiyoli Balasinor Dinosaur Fossil Park

The location is was discovered in 1981 and found that the fossils are 65 million years old. It is said to be the world's 3rd largest Dinosaur Fossil excavation site and 2nd largest hatchery. The location is said to be the nesting site of dinosaurs in the past. The place contain bone fossils of different parts of different species.

Fossils present are the left ulna of sauropod, scapula coracoid of titanosaurus, adjoining caudal vertebrae of abelisauroid theropod and an indeterminate limb bone, dorsal vertebrae abelisauroid theropod with indeterminate limb bone, left femur in medial view and caudal vertebrae of sauropod.

EGGS OF DINOSAUR

SKELETAL PARTS OF DINOSAURS

LOCATION 4: Raiyoli Dinosaur Park and Museum

In 1980s Paleontologists accidently came across the fossil remains and bones in the village of Rayioli in Balasinor. Since then, the place has been flooded with researchers and a number of excavations have taken place in the area the findings of which revealed the fact that there were more than 13 species of dinosaurs that thrived around 65 million years ago. The fossil park here contains life sized statues of those giant creatures and further excavations have found that a squat, thick-legged, heavy-bodied carnivorous dinosaur with a crested horn, Rajasaurus Narmandensis, King of Narmada, (the first half of the name comes from Raja or King due to the crested horn and the second half of the name originates due to its geographical location which was near the river Narmada). This creature belonged to the carnivore family of Tyrannosaurus Rex.

DAY 4

DATE:25-01-2023

LOCATION 1: Oil and Natural Gas Corporation

ONGC is the largest government-owned-oil and gas explorer and producer in the country, and produces around 70% of India's crude oil and around 84% of its natural gas.

We were given instructions and other informations about the plant by Mr Gaurav Kumar ,safety officer. There are 59 installation wells in a radius of about 17 km which are all connected.

We came across the water injection plant nearby which functions for increasing the reservoir pressure to enhance the production. Following this there is the Booster gas compression plant for compressing the gas and maintain the pressure level.

All the pipelines are underground with 10-15 kms. These pipelines are connected to the oil wells which are then taken to the seperators to set apart oil and gas according to the pressure .Oil is taken into 3 tanks each of 45000 litre while Gas is taken to the compressor.

The new version of booster compressor was also installed there whose aim is increasing the pressure and had more advantages as it can handle more pressure and gas.

We came across bath heater which increases the mobility when the crude oil recovered have an increased temperature, which make it difficult to get compress.CO2 flooding system is a fire fighting system in which CO2 is released in case of emergency of sudden leaking of the fuel is detected and reducing the amount of Oxygen which promotes fire.

SCADA-supervisory control and data acquisition is a category of software applications for controlling industrial processes. This system manages and monitors all the plants and their functioning.

FIELD OBSERVATIONS

Rajasthan

DAY 5

DATE:27-01-2023

LOCATION 1: Jhamar Kotra Mine Udaipur

TIME:11.17 AM

LATITUDE- N 24°28'21"

LONGITUDE- E 73°51'34"

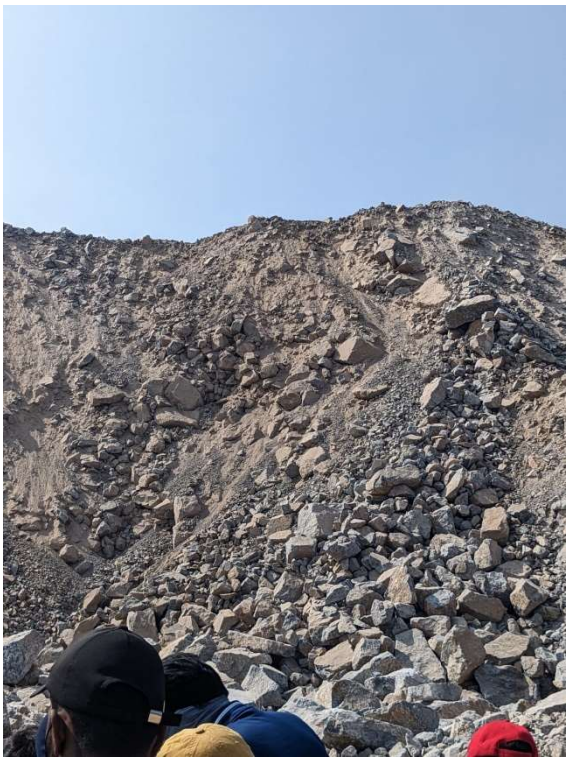
Jhamar Kotra Mine was started in 1968 is an open cast mine.It is a rock phosphate ,lignite limestone and gypsm also found here. **stromatolite**, layered deposit, mainly of limestone, formed by the growth of blue-green algae. The area belongs to lower Aravalli supergroup.Jhamar Kotra deposits are found in the lower Aravalli supergroup below an unconformity and lies above the Banded Gneissic Complex of Archean age.

The major activity of RSMML is the mining of Rock phosphate ore. It operates one of the largest and fully mechanised mines in the country at Jhamarkotra, 26 Kms. from Udaipur and Kanpur Group of Mines located 15 Kms. from Udaipur.
In India the economy being predominantly based on agriculture, the fertiliser production plays a pivotal role. Only about 35% to 40% of the requirement of raw material for phosphatic fertilzer production are being met through indigenous sources and the rest is met through import in the form of rock phosphate, phosphoric acid & direct fertilisers. In such a situation Jhamarkotra plays an important role by contributing 98% of rock phosphate production of India.
Rock Phosphate mines at Jhamarkotra & Kanpur Group of Mines are complex deposits. Mining these rock phosphate deposits is far more difficult than that in most parts of the world. Despite the complexities of the deposit, excellent results have been achieved by continuous innovations. With an annual rock handling of about 20 million tonnes, Jhamarkotra is probably the largest open cast mine in India outside the steel and coal sectors. On 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 i.e thin and sharply dipping had resulted in long and narrow pits with great depth extension, which involves very high stripping ratio with high lead and lift for waste and mineral. 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.
The open pit mining method is being followed at Jhamarkotra Mine for exploitation of the mineral. The working levels are kept dry by continuous pumping of ground water through tube-wells constructed on periphery of the pit limit.

BGC lacked life evidences while these Aravalli supergroup.The horizon marker is the jhamar deposits of 2000mya sedimentary deposits.During the sedimentation,there occurred a favourable environment for the growth of blue green algae.It was a shallow deposit where there was dissolved phosphate for algae to grow and get deposited when phosphate was being deposited to the basin from the flowing water from 500km.When the sedimentation stopped due to the water dry up,the algae process also stopped.

The host rock are 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 for deposition.The ore to overburden ratio is 1:16. The transition from low to high grade ore might be because of meteoric rain which dissolved dolomite increasing the grade of ore.

High Grade ore



Low grade Ore

The ore body is zig-zag with faults and folds. the average dip is 55 ^{o}and thickness of 5-15km. The rock phosphate occurs in dolomitic limestone associated with stromatolites appearing in grey to bluish grey colour shades and in variable forms and shape.

The ore body is of Horse shoe shaped which is sandwiched in between the hanging wall and the foot wall .Magma has got injected inside the Dolomite forming Secondary phosphate Apatite. The water flow trend NW-SE.

Apatite

Stromatolites (grey) and Phosphate (white)

LOCATION 2: Jhameshwar Mahadev temple

Stalactites

Formation of stalactites are observed in side the temple cave hanging from the top.

A stalactite is an elongated structure of minerals formed and hanging from the ceilings of caves, hot springs, or man-made structures such as bridges and mines. They are deposited from a solution of minerals in the water, slowly dripping from the ceilings. Stalactites are formed by materials that are soluble and can be deposited as colloids, or in suspension and have the capacity to be melted. The stalactite can be made up of lava, minerals, mud, peat, pitch, sand, sinter, and amberat (crystallized urine of packrats). The most abundant forms of stalactites are found in limestone caves just because of sheer numbers. Thus, one may find most stalactites in stalactite and stalagmite caves.

DAY 6

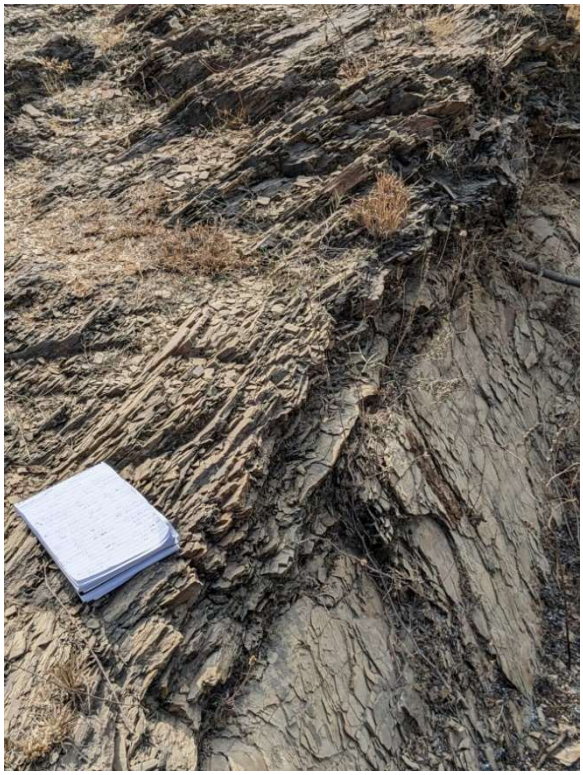
DATE:28-01-2023

LOCATION 1: Banks of Berach river

LATITUDE- N 24.9038

LONGITUDE- E 74.6231

Suket shales were found belonging to the Semri group of Vindhyan Supergroup.The rocks were highly folded and highly compressed joints.The river flows parallel to the great boundary gault.Strikes varies from place to place.The area is highly deformed and had multiple joints.



Suket Shale

Suket shale with multiple folds

SI NO	STRIKE	DIP
1	N 48°E	59°
2	N 49°E	51°
3	N 52°E	56°
4	N 55°E	42°
5	N 45°E	59°

Quartz veins are seen in between the shales, the Quartz veins are also folded. Minor foldings are also seen. In some area of the exposure ripple marks are observed .Continuity of the strata is barely seen across the area. Vertical and horizontal folds are clearly seen. Some parts are highly weathered.In SE direction of the field a fault vein can be clearly seen. Joint sets are seen with a general trend of N40˚E .Assymetrical fold is observed with anticline plunging 25˚ and syncline 35˚

Suket shale showing multiple folds

In the other bank of the river,an unconformity between the contact of shale and conglomerate was observed. STRIKE: N42°, DIP AMOUNT: 47°

LOCATION 2

LATITUDE- N 24.8740

LONGITUDE- E 74.6332

The outcrop observed here is Nimbara Limestone. Nimbara Limestone is a type of sedimentary rock that is primarily composed of calcium carbonate. It is commonly found in the Nimbara region of Rajasthan, India, and is a popular building material due to its durability, strength, and natural beauty. This limestone is typically light gray in color and contains fossilized marine organisms, including shells and corals, which are visible on its surface. It is formed through the accumulation of calcium carbonate-rich sediment that has been compressed over millions of years, often in marine environments.

STRIKE DIRECTION : N40˚E
DIP AMOUNT AND DIRECTION: 40° W

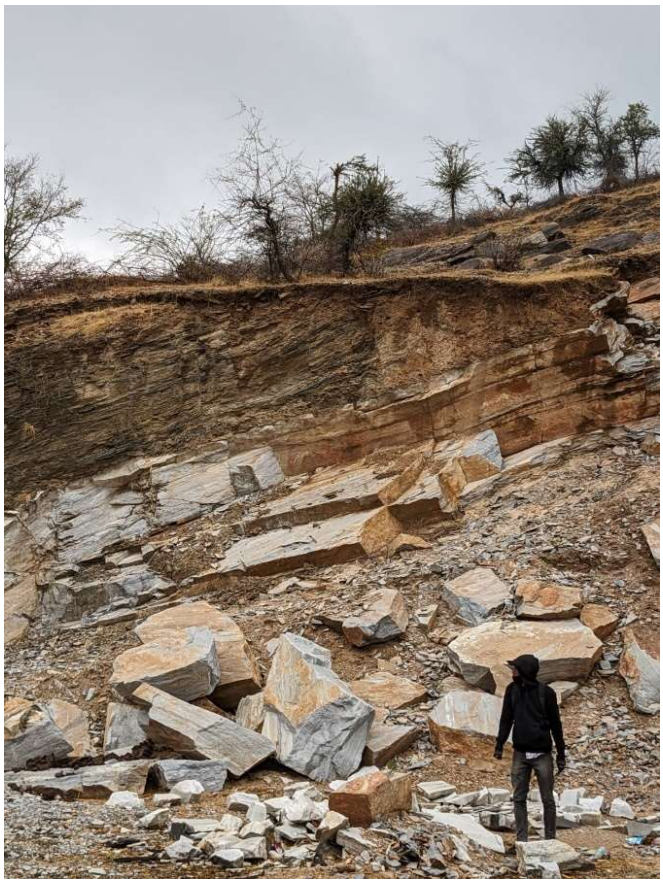
DAY 7

DATE:29-01-2023

LOCATION 1: Mica Schist Marble

The area is exposed with weathered marbles. Minor folds are observed .Schistosity is observed in one area. Prismatic needle like structure is observed may be the presence of actinolite or tremolite crystals. Boundinages are clearly seen in the field .Cylinder like structure making up a layer of deformed rocks. presence of serpentine with deformed crystals .Inclined beds are largely exposed in these area .Large and also minor folds are seen .Presence of garnet is still a question mark. The outcrop is incompetent layer of marble between schists .Mylonitic structure is observed in the marble which is a stress indicator. The mica schist was highly weathered .The outcrop is highly deformed and appears a fold due to a curvature but has the same strike-dip reading all over the outcrop, which leads to suspicion on being a large anticline fold.

1. Strike direction-135˚SE
   Dip amount- N30˚
   Dip direction-230˚
2. Strike direction-N120˚
   Dip amount-N36˚
   Dip direction-210˚

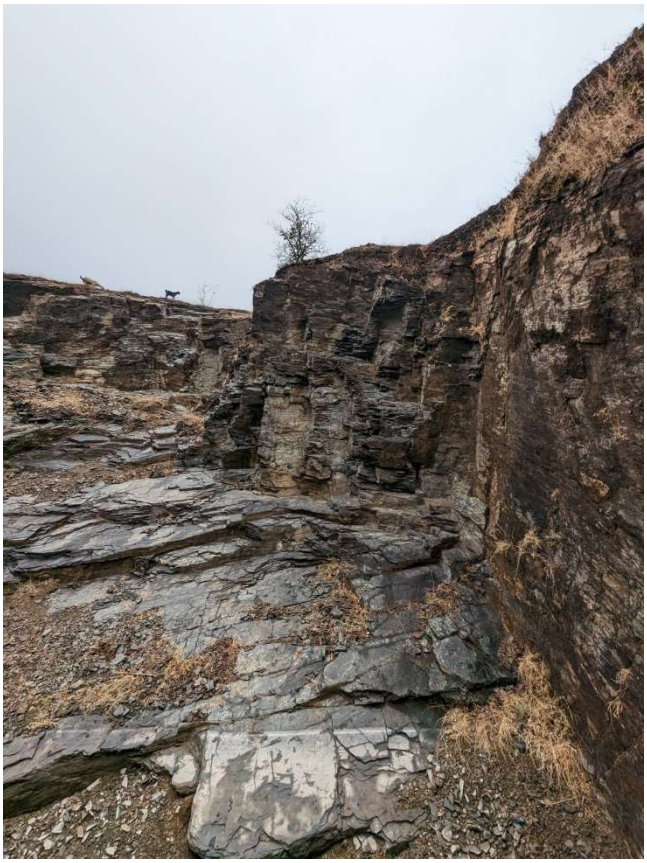


Marble is identified with its sugar structure. Elongated minerals with acicular texture are observed which can be either Tremolite or Actinolite. Some rocks contain green coloured minerals which may be serpentine.

Garnet

LOCATION 2

The outcrop is found 100 metres away from the Spot 1. The surfaces are fresh and not much weathered.



Augen structures were observed which may be an indicator of stress. The augen is assumed to be of Pink Garnet. STRIKE: 120°-140°, DIP AMOUNT: 28°-32°

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