

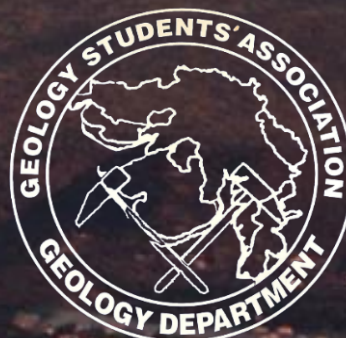
2022-23

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THE AHMED ABAD EDUCATION SOCIETY

# GEOLOGY NEWSLETTER



M G SCIENCE INSTITUTE

GEOLOGY DEPARTMENT  
M. G. SCIENCE INSTITUTE



## **Dr. NISHITH Y. BHATT**

Retd. on 30/11/2022 as  
HOD of Geology Department



### • **HISTORY OF DEPARTMENT**

*First Geology Department of Gujarat. Establishment of Undergraduate Department – in the year of 1948 by Prof. S. Mukharjee. Geology Department was affiliated to Bombay University till 1949. Establishment of Postgraduate Department in 1950-51.*

### • **VISION**

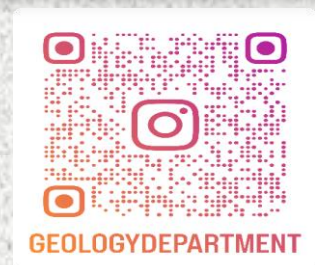
*The Department of Geology strives to foster an environment in which students learn to think, conduct research, apply knowledge in order to prepare/turnout well-trained, competent, academic and professional geoscientists capable of responding societal needs*

### • **MISSION**

*Prepare students for professional positions in industry and government and for career in academic research and teaching. We try to make students to understand and safely manage Earth and its resources for the future. Establish the Department of Geology as the center for research in Earth Sciences and nationally recognized. Develop a greater awareness of Earth Sciences in the general public through outreach programs.*

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***Faculty and Staff:***



**Dr. P. M. Solanki**  
**Head of the Department**



**Dr. H. V. Majethiya**  
**Associate Professor**



**Dr. Rahul Gayakvad**  
**Teaching Faculty**



**Ms. Pooja Mishra**  
**Project Fellow**



**Mr. Purvesh Muniya**  
**Laboratory Assistant**



**Mr. Jagdish Makwana**  
**Peon**

## *Faculty Achievements:*

1. **Dr. P. M. Solanki** participated and judged the event of “Geological Photo competition” in one day programme under the aegis of “Aazadi ka Amrut Mahotsav” organized by Geological Survey of India (GSI), Gandhinagar on 15<sup>th</sup> July 2022.
2. Geology Department has launched a “Geology Newsletter” for the academic year 2021-22. A programme of launching was held on 27<sup>th</sup> August 2022.
3. **Dr. P. M. Solanki** worked as “External Research Expert” in the DC (review) meeting of the Ph. D. scholar, at the Earth Science Laboratory of the Pandit Dindayal Energy University (PDEU), Gandhinagar on 27<sup>th</sup> September 2022.
4. **Dr. N. Y. Bhatt, Dr. P. M. Solanki** and **Dr. H. V. Majethiya** becomes the member of the “Interview Panel – Committee” at “R. R. Mehta College of Science, Palanpur” for the appointment of the post of Assistant Professor for the B. Sc. course on 1<sup>st</sup> October 2022.
5. **Dr. N. Y. Bhatt** and **Dr. P. M. Solanki** of the Geology department received a research project on “Spatial and Temporal Variations in Polar Land Ice Surface Morphology, Melting and Energy Balance Components”, sponsored by SAC-ISRO, Ahmedabad. Project started in January 2021 and Ms. Pooja Mishra has been selected as a Project Fellow in the project.

6. **Dr. N. Y. Bhatt** and **Dr. P. M. Solanki** of the Geology Department received the extension of research project on “Source-to-Sink spatio-temporal variability in sediment fluxes and their control on coastal sediment dispersal systems in Gujarat”, sponsored by Ministry of Earth Sciences (MoES), New Delhi, worth Rs. 21,18,360/- for the period of three years (2019-20 to 2022-2023). Mr. Rahul G. Gayakvad has been working as a SRF in the project.
7. **Dr. H. V. Majethiya** organized a lecture on “education and religion” on teachers day- 2022 which was delivered by the Sadguru Shri Gyanbhusandasji Swami of Maninagar Shree Swaminarayan Gadi Sansthan Ahmedabad.
8. **Dr. H. V. Majethiya** working as a coordinator in IIRS Outreach Programme which focuses on strengthening the academia and user segments in space technology and its applications using online learning platforms since 2019.

1. Gayakvad, R. G. and **Solanki, P. M.** (2022) Palaeoenvironmental interpretation based on lithofacies derived from Keera Dome, Kachchh, western India. *Journal of Scientific Research*, 66 (1), 11-21.
2. Morya, J. S., Shah, A. K. and **Majethiya, H. V.** (2022) Monitoring and Evaluation of Shoreline Alterations along the Gulf of Khambhat (western India): A Remote Sensing and GIS Approach. *Science, Technology and Development*, 11(09), 375-386.
3. Patel, Rinku A., Sabhaya, Mehula B. and **Solanki, Paras M.** (2022) Oxfordian ammonites from Dhosa Oolite of Jara Dome, western Kachchh, India. *Journal of the Palaeontological Society of India*, 67(2), 251-261.
4. Patel, Shreekumari M., Satyakumar, V. A., El-Maarry, M. R. and **Solanki, Paras M.** (2023) Compositional variations in ohm ray crater on the farside of the moon: Implications for mafic anomaly. *Planetary and Space Science*, 229 105674.
5. Patel, Shreekumari M., Harish, Patel, Deep, **Solanki, P. M.** and El-Maarry, M. R. (2023) Hybrid Volcanic Episodes within the Orientale Basin, Moon. *Remote Sensing*, 15, 1801.

**Research Articles:****Lignite mines of Kachchh district, Gujarat****Uma V. Patel, Vishwa B. Bharai, Dhrupika P. Mori**

M.Sc. Geology Department, M. G. Science Institute, Ahmedabad

**1. Introduction:****Lignite**

Lignite (derived from Latin *lignum* meaning 'wood') often referred to as brown coal, is a soft, brown, combustible, sedimentary rock formed from naturally compressed peat. It has a carbon content around 25–35%, and is considered the lowest rank of coal due to its relatively low heat content. When removed from the ground, it contains a very high amount of moisture which partially explains its low carbon content. Lignite is mined all around the world and is used almost exclusively as a fuel for steam-electric power generation. Lignite forms from peat that has not experienced deep burial and heating. It forms at temperatures below 100 °C (212 °F), primarily by biochemical degradation.

Lignite deposits are typically younger than higher-ranked coals, with the majority of them having formed during the Tertiary period.

Lignite mines, which were developed in early 1970s and are run by Gujarat Mineral Development Corporation Limited.

Five lignite mines in kachchh District:

1. Panandhro lignite mine
2. Lakhpat-punrajpur lignite mine
3. Umarsar lignite mine
4. Mata no madh lignite mine
5. Panandhro extension lignite mine.

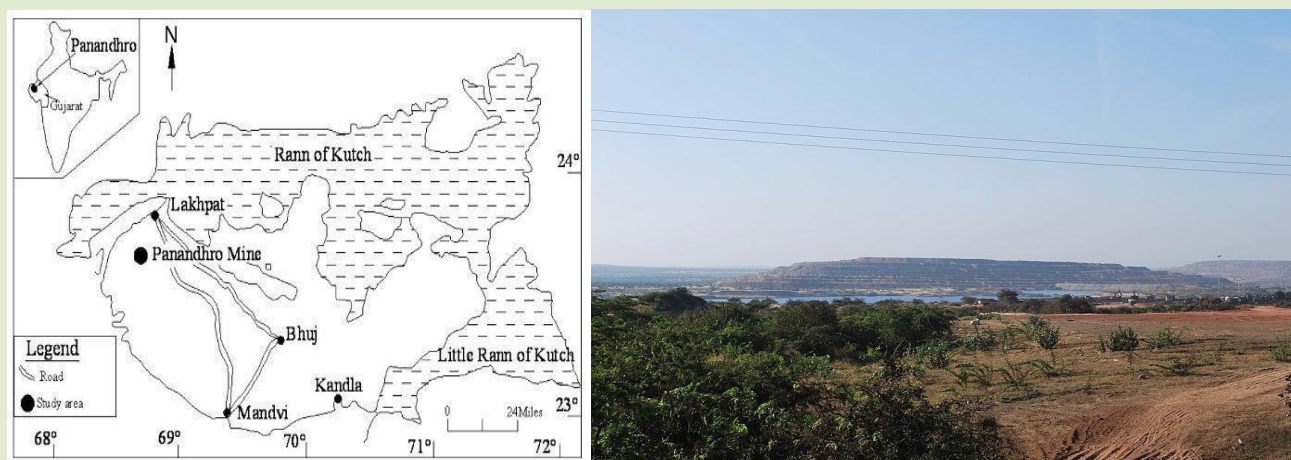


Figure 1. Panandhro lignite mine (field photograph)

### **Panandhro Lignite Mine:**

Panandhro is a village located in Lakhpat Taluka of Kutch District of Gujarat. The mine started in 1974 and has become the biggest mine in Gujarat. Different technological upgradation has been successfully right from manual mining to bucket wheel excavator. Panandhro lignite field has an extent of 8.50 sq. km. It was discovered in the year 1965-66 while undertaking drilling in western Kutch by the Directorate of Geology and Mining. Lignite encountered here is dark brown in color, hard and compact uniform in texture. The state-run Gujarat Mineral Development Corporation Ltd (GMDC) — the largest seller of lignite in the country — has seen a 24% decline in production of lignite during 2019-20, especially after it closed one of its biggest mines at Panandhro in Kutch. The company also stated that it is left with five lignite mines after it closed the Panandhro mine.

### **Geology and Lignite deposits:**

The Panandhro lignite field (latitude: 23°41'N, longitude: 68°45'E) encompasses the second largest lignite mine in India after the Neyveli (in the state of Tamil Nadu). It is located in the Lakhpat Taluka of Bhuj district (Gujarat) and extends over an area of 11.33 km. It represents a valley base surrounded by hills formed by the traps, and is practically devoid of vegetation. It falls under the semi-arid climatic belt of the country. The lignite-bearing Cenozoic sediments are disposed as a plunging syncline in the Kutch basin with edges of Traps.

The Lignite deposits are huge in thickness and extend in the basin associated with the Naredi Formation. The Panandhro mine consists of five seams ranging in thickness from few centimeters to meters (~23). The two main working seams are of about 4.64 m (lower seam) and 8.06 m (upper seam) thick. These seams are further separated by mudstone/clay and shale intercalations. However, recent dinocysts based biostratigraphic analysis suggests Lutetian to Bartonian (late middle Eocene) age to these lignite deposits (Sharma and Saraswati, 2015).

### **Kutch Lignite Thermal Power Station:**

Kutch Lignite Thermal Power Station is Gujarat State Electricity Corporation Limited's only lignite based power plant. Kachchh Lignite Thermal Power Station is located near Panadhro village in Lakhpat Taluka, Kutch district, Gujarat, India. The plant is adjacent of lignite mines (operated by Gujarat Mineral Development Corporation) and receives lignite direct from the mines. There are four units presently in operation. It is a Steam Turbine power plant that is used for Base load. The fuel is procured from Panandhro Lignite Mine. The project generated 1,523 MWh of electricity. Coal is transferred by the long belt we seen in fig. 2 (b) and reached in fires boiler and generate high pressure steam and electricity.



Figure 2. (a) At Kachchh lignite thermal power station (b) transfer of coal by long belt (field photograph)

### Lakhpat- Punrajpur Lignite Mine:

The company is seeking terms of reference from the environmental clearance authority for Lakhpat & Punrajpur Lignite Block with production capacity 3.0/4.5 MTPA Lignite (N/P) [&29.81 MTPA limestone in project area of 2959.6715 Ha, located near village Punrajpur and Lakhpat, Taluka: Lakhpat, District Kutch, Gujarat.

The Lakhpat & Punrajpur Lignite Block is a part of Kutch Lignite deposit and is situated in the western fringe of the Kutch district, in Lakhpat Taluka of Gujarat State.

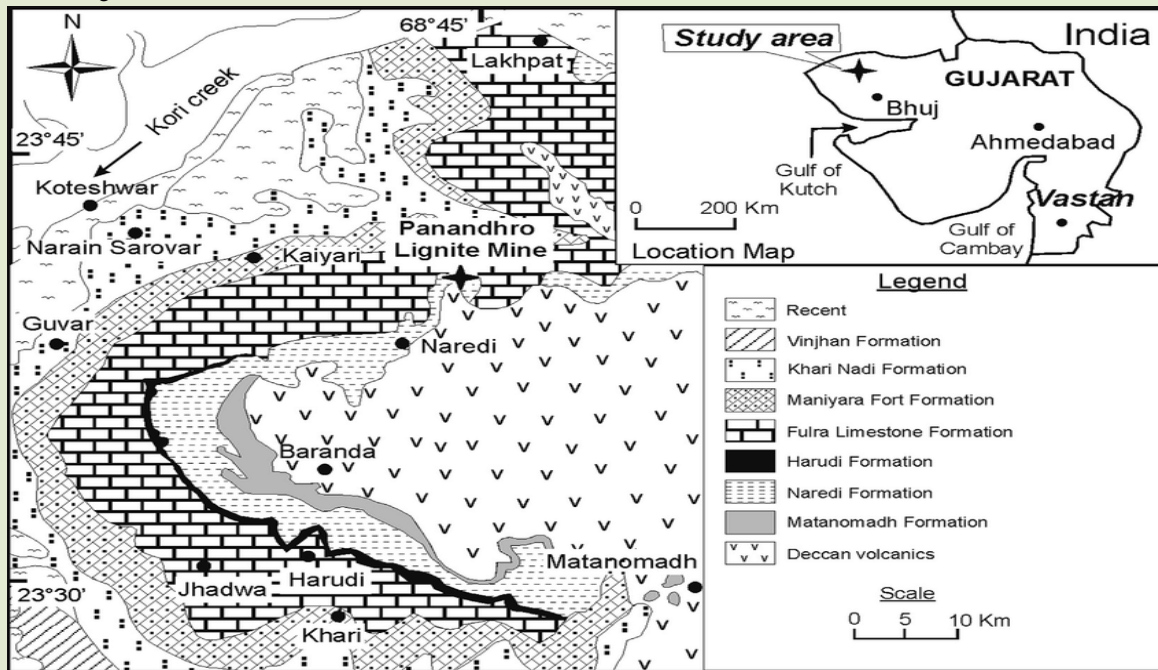


Figure 3. Geological map of the study area

Gujarat Mineral Development Corporation (GMDC) had applied for a lignite and Limestone mine lease over an area of 3389 ha which was granted in the year 1996.

The proposed project is located near village: Punrajpur and Lakhpat, Taluka- Lakhpat, Dist- Kutch, Gujarat, over an area of 2959.6715 Ha. Gross geological reserve and net geological reserve of the block are 161.59 million tons (MT) and 145.43 MT respectively whereas only 105.52 MT reserve is mineable.

Gross geological reserve and net geological reserve of the block are 161.59 million tons (MT) and 145.43 MT respectively whereas only 105.52 MT reserve is mineable. Out of 105.52 MT mineable reserves, 100.25 MT lignite is extractable. Only 3.66 MT lignite will be extracted within first five years of plan period. Life of the mine is 39 years including one year of pre-mining development works.

Table 1: Geology of the study area

<b>LITHOLOGY</b>	<b>FORMATION</b>	<b>GROUP</b>	<b>AGE</b>
Younger tidal flat and marsh deposit	Mahuva Formation (ME)		Holocene
Older tidal flat and marsh deposit	Rann Clay Formation (ME)		
Rann clay and mud deposit	Rann Clay Formation (FME)		
Younger flood plain, channel fill and deltaic deposits	Varahi Formation (FE)		
Older flood plain, channel fill deposits	Katpur Formation (FE)		
Unstabilised sand sheet and sand dune deposits	Jantral Formation (AE)		
Miliolite limestone, shall limestone, calcareous sandstone, pebbly limestone and conglomerate	Miliolite Formation	Porbandar Group	Lr. Pleistocene
Pebbly sandstone, conglomerate gravel and sand	Kothata Formation;		
Micaceous sandstone, mottled clay, siltstone, conglomerate and calcareous clay with marl	Sandhan Formation		Pliocene
Shale interbedded with fossiliferous marl	Bhuj Formation		Lr. To mid. Pliocene
Variiegated siltstone and gypseousclaystone	KhariNadi Formation		Lr. To mid. Miocene
Calcareous and gypseousclaystone/siltstone. Clay. Coral limestone and sandstone	Maniara Fort Formation		Mid. To Upper Oligocene
Foraminiferal limestone, glauconitic shale and clay	Fulra Formation		Mid. Eocene
Gypseous lignite bearing shale, fossiliferous nodular limestone and clay,	KakdiNadi Formation		Lr. Eocene

LITHOLOGY	FORMATION	GROUP	AGE
ferruginous shale and clay with intercalated marl			
Laterite, sandstone, conglomerate and bentonitic and kaolinitic clay	Matanomadh Formation		Palaeocene
Andesitic Trachyte	Extrusive	Deccan Traps	Up. Cretaceous to Eocene
Olivine Gabbro	Intrusive		
(a) Basalt and dolerite dyke, (b) plug and sill			
Basalt flows with inter-trappean sediments	Extrusive		
Alkali gabbro and basalt			
Glauconitic and burrowed sandstone, siltstone, shale, limestone, marl, conglomerate, ironstone and clay with marine and plant fossil	Bhuj Formation		Cretaceous
Shale, fossiliferous sandstone, marl and conglomerate	Katrol Formation		Up. Jurassic to Lr. Cretaceous
Gypseous shale, siltstone and conglomerate with phosphatic nodules, oolitic, limestone	Chari Formation		Mid. To Up. Jurassic
Gypseous shale, siltstone, limestone, sandstone and conglomerate	Pachchham Formation		Mid. Jurassic



Figure 4. Drilling process and drilling bit from Lakhpat Punrajpur mine 11

During the visit in the mine the drilling, logging and Sampling processes were observed. Drilling is mainly double core band diamond core drilling Conventional diamond core non-Conventional diamond core and Wire line drilling.



Figure 5. Logging of core placed in core boxes at Lakhpat Punrajpur mine

### **Umarsar Lignite Mine:**

- **Geology:**

The Harudi marker Coquina limestone bed has been discovered from the open cast lignite deposit of the umarsar lignite mine approximately ten kilometers from the panandhro lignite mine in the south west. The Umarsar mine has four lignite seams ranging from a few centimeters to roughly two meters. The upper lignite seams are thinner than the basal seams. Shale and sandy clay sedimentary strata alternate with lignite seams incorporating amber nodules. The Harudi marker Coquina limestone bed has been recovered between the grey shale strata above lignite seam 3 during section measurement in the year 2022. This provides strong support to assign the Umarsar lignite sequence under the Harudi Formation, overlying the Naredi Formation.

The Umarsar Lignite mine commenced in year 2015 with a total lease area of about 2186 hectares. The lease period is for 19 years, with deepest digging permission up to only 50m. There are 3 seams of lignite with thickness of 1 to 1.5 m along with 15 m overburden and 12-15 m of under burden. The height and width ratio for the bench is 1:2 for the safety purpose. The color of the lignite is brownish black with a friable nature while its quality is better than that of Mata no Madh Formation.

Table 2: Lignite Quality parameters of Umarsar Lignite mine

<b>Content</b>	<b>Received base analysis</b>
Total Moisture (%)	28-40
Ash (%)	18-20
Volatile matter (%)	30-35
Fixed carbon(%)	17-25
Calorific value (Kcal/Kg)	3000-3600
Total sulphur (%)	Upto 3



Figure 6. Fault present in lignite (source: field photograph)

These mines supply the materials to companies such as Sanghi cement, UltraTech cement and GEB.



Figure 7. Lignite Mine of Mata no madh (source: field photograph)

Table 3: Geology of the Matano madh lignite mine

<b>Geological Period</b>	<b>Series</b>	<b>Geological Formation</b>
Recent	Alluvium	Top Soil Cover
Oligocene	Narj	Sandstone
Miocene	Gaj	Siliceous Limestone, Maris
Upper Eocene	Kirthar	Nummullitic Limestone & Calcareous day
Lower Eocene	Laki	Clay, Shale, Carbonaceous Shale, Clay, Lignite, Siderte
Eocene	Ranikot	Lithomergic clay/Bauxite Laterite Variagated clays
Upper Cretaceous		Decan Trap
Jurassic		Sandstone

Table 4: Lignite Quality parameters of Mata no Madh Lignite mine

Content	Received base analysis
Total Moisture (%)	32-40
Ash (%)	18-23
Volatile matter (%)	30-35
Fixed carbon(%)	15-25
Calorific value (Kcal/Kg)	2800-3300
Total sulphur (%)	Upto 3

### **Panandhro extension project:**

Panandhro extension block is in continuation with existing Panandhro Lignite mine of GMDC. Currently, well established mining practices with necessary infrastructure are at Panandhro Lignite mine. GMDC is planning to divert these manpower and machinery for development of panandhro extension block so that lignite production can be at competitive rates by utilization of existing infrastructures and manpower.

### **Geology:**

The Kutch region attains special position in Indian stratigraphy owing to the presence of strato-type sequences of Mesozoic (Jurassic) and Cenozoic eras. First report on Geology of Kachchh was produced by Grant with different maps and list of fossils. Although the report was too generalized it has provided platform for further investigations. Blanford (1869) was the first who presented proper ideas about the geological architecture of the region. He envisaged presence of E-W trending faults along the northern margin of major uplift of the basin. Wynne (1869 & 1872) published the first report, along with a map, on the geology of Kutch. The classification proposed by him was broad based and he divided the sequence into two unit viz. the Lower Jurassic (marine) and Upper Jurassic (non-marine).

Stolickza (1871-1873) based on paleontological, physical and geological relationships has established four stratigraphic groups namely Pachchham, Chari, Katrol and Umin in ascending order. Waagen (1875) studied in detail the fossil ammonites, and endorsed fourfold classification put forth by Stolickza. However, according to him, the Pachchham, Chari, Katrol and lower part of Umin corresponded with the "Lower Series" and the upper part of the Umin with the "Upper Series" of Wynne (1869). Later, Oldham (1893) modified Waagen's classification and included the beds of Ultra hills into Umin Series.

After evaluating the available geological database and other surface information of Panandhro Extension Limestone and Lignite Block of Kutch district, Gujarat, following relevant points may be cropped up as briefed below:

The revised area of the limestone & lignite block of Panandhro Extension is 1088.17 Hect. All total 146 numbers of boreholes were drilled within the Panandhro Extension block. Survey of the block boundary reveals that, almost 62 numbers of boreholes are falling outside the revised block boundary, has been eliminated for consideration of resource estimation. 2 numbers of boreholes are found with erroneous in database, have not been considered for resource estimation. Remaining 82 number of drill holes have been considered for preparation of this Geological Report & Resource Evaluation. Lignite beds were identified and standard seam nomenclature procedure is followed for preparation of Geological Model. Cut off thickness of 0.50 meter for limestone and 0.30 meter for Lignite has been considered for resource modeling. Cao (%) percentage and GCV values (in Kcal/Kg) were considered for the basis of grading of Limestone and Lignite respectively.

### **REFERENCES:**

- GMDC official website.

## **Occurrences of Dinosaur Fossils from Lameta Formation of Raiyoli, Mahisagar District, Gujarat**

**Priya Dabhi, Kanishka Dhaduk, Jaydeep Kalotra, Raj Desai**

T.Y. B.Sc. Geology Department, M G Science Institutes, Ahmedabad.

### **ABSTRACT**

Dinosaurs are full blown in Jurassic and Cretaceous period of Mesozoic era. India at this time was an Island, due to the break-up of the Supercontinent Gondwana, though it is possible animals still were able to migrate to and from nearby Continents. The Lameta Formation of Late Cretaceous Period Dinosaurs was exterminated. In 1983, Paleontologist found very good exposures of fossils Dinosaurs in Balasinor. Climate of Lameta Formation was generally warmer and more humid than today, probably because of very active volcanism associated with unusually high rates of seafloor spreading. The plains of the river Narmada that extended from its basin proved an ideal breeding ground for the Indian *Titanosaurid Sauropods* and *Abelisaurid Theropods*. In Lameta Formation fossils of species like eggs, limb, skeleton, bone, etc. The Nests provided an ideal incubating environment for the eggs.

**KEYWORDS:** Lameta formation, Dinosaur Fossils, Raiyoli

### **INTRODUCTION:**

The small town of Balasinor is situated in the Mahisagar District in the Western Indian state of Gujarat is at a Distance of about 102 Kilometers from Gandhinagar, the Capital of Gujarat state, which had been relegated to an obscure corner of history suddenly sprang into the spotlight in the Early 1980's for a most unlikely and unimaginable reason, dinosaurs. Dinosaurs are divided mainly in two parts: Carnivorous and Herbivores based on their eating habits, both are found in Balasinor. Founded Dinosaur remains' age is Lameta Formation of Cretaceous period.

There is an unconformity of conglomerate between Bagh and Lameta Formations, so Lameta is younger than Bagh and it contains other two beds, Sandstone and Limestone. Fossils are mainly found in Limestone bed. New species of Dinosaur called *Rajasaurus Narmandensis* is found in Raiyoli and it is famous for its horn. Also, various type of dinosaurs found in this area.

### **STATIGRAPHY:**

#### **Lameta Formation:**

The Lameta Formation was first discovered in 1981 by Geologists working for the Geological Survey of India (GSI), G. N. Dwivedi and Dhananjay Mahendrakumar Mohabey, after being given Limestone structures later recognized as Dinosaur eggs. This formation is named after the Lameta-Ghat near Jabalpur town in Madhya Pradesh as well as represented in Gujarat & consists of a widely distributed succession of Estuarine of Fluvial deposits. Very good exposures of this formation are recorded near the Balasinor town in Mahisagar districts. The Lameta Formation has been assigned a Turonian Maestrichtian age on the basis of Dinosaur remains. The observed thickness of Lameta varies from 10 to 15 mts. The beds are mostly horizontal but west of Balasinor they show a dip of 10° due southwest, possibly on account of a N-S Fault. It appears that the lower part of this formation is equivalent of Bagh formation where as the upper part is definitely younger in Age (Chiplonkar, 1970). Raiyoli and Dahod have yielded not only fossil bones, but also numerous eggs clutches indicating that nesting sites have been discovered also famous for its faunal content, especially vertebrate fossil which include mostly Dinosaurian reptiles, Turtles and some Fish remains. The Lameta Formation of Mahisagar consists Conglomerate, Sandstone & Limestone beds Deposits.

Conglomerates are white to off-white in color hard having thickness varying from 0.5 to 2 mts with fossil Dinosaurian bones and foot-prints of Dinosaurs. The Pebbles are angular to sub- angular having size from 4 to 30 mm.

resting conformably over the Bagh Group, the Lameta Formation comprises arenaceous, argillaceous, and calcareous Green Sandstone underlying the Conglomerate.

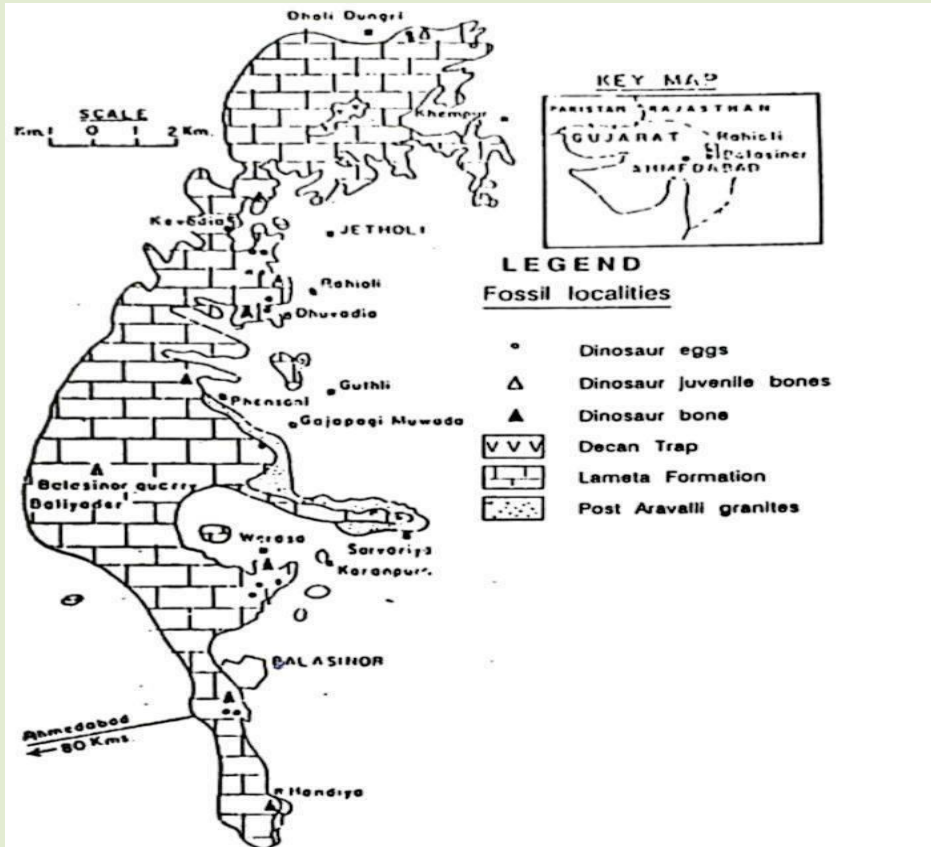


Figure 1. Geological Map of Part of Kheda and Mahisagar District, Gujarat.

The Lameta Limestone is mainly pale greenish or black massive Limestone with occasional pink Brecciated, silicified, hard and compact as well as earthy, nodular, cherty, sandy Limestone with occasional gritty sandy Sandston on the basis of lithological and sedimentology studies Joshi has Envisaged shallow fresh Water pools for the deposition of Lameta of Gujarat and Has invoked a process of Bio-induced inorganic precipitation of Cherts. The Lameta Formation of Gujarat thus, affords an ideal Geological unit for further investigations.

### Fossils Resources of Raiyoli:

In 1980s Paleontologists accidently came across the fossil remains and Bones in the village of Raiyoli in Balasinor.

It is considered home to at Least 13 Species of Dinosaur and ten- thousand Dinosaur fossils for more than 100 million Years until they became extinct 66 million Years Ago.

It has not only yielded skeletal parts of Dinosaurs hitherto unknown in the upper Cretaceous of India but also well-preserved nursery of numerous Dinosaurian eggs within their clutches. The excavations yielded quite a rich collection of Fossil bones and eggs. Dinosaur bones are almost inseparably joined with the rock matrix and it was extremely difficult to excavate the bones free of the rock material.

Out of 43 Dinosaurian teeth, nine are *Carnosaurian* and 34 *Sauropodian* teeth have been reported for the first time from India. Sauropod teeth have been correlated with the genus *Titanosaurus* and the Theropod teeth are closely comparable with that of *Majungasaurus* (*Megalosaurus*) *Crenatissimus* from upper Cretaceous of Madagascar. The other *Megalosaurid* teeth have been classified into 5 types on the basis of their Morphology.

In Raiyoli area most of the Dinosaurian eggs are spheroidal and are having diameter of 15 cm to 20 cm. Morphological, microstructural and ultra-structural studies of the several spheroidal eggs and egg clutches from Raiyoli area (Plate 2 a, b, c) have indicated two type of eggs (Kheda type 'A' & Kheda type 'B') belonging to Sauropod Dinosaurs.

Kheda type 'A' Shells are thin (about 1mm), the nodes are densely packed on the external surface. The Kheda type 'B' Egg Shells are thicker (over 2mm). The nodes are larger. Kheda type 'A' and Kheda type 'B' shells have close resemblance to Angusticanaliculate and Tubocanaliculate structure respectively.

The *Rajasaurus Narmadensis* an Abelisaurid Theropod Dinosaur with a single horn on its head that roamed the Narmada Valley during the late Cretaceous Period (The Generic name *Rajasaurus* derives from the Sanskrit *raja*, meaning 'King, Sovereign, Chief, or best of its kind' and ancient Greek *Sauros*, meaning 'lizard' and its specific name *Narmadensis*

refers to the Narmada River in Central India near where it was Discovered). This Dinosaur is believed to have a massive dimension with a Length of 9 Meters, and a Height of 2.4 Meters and Weighing a Staggering 4000 Kilograms. The bones of the *Rajasaurus* were Excavated and Paleontologist Jeffrey. A. Wilson and His team Reconstructed and described the dinosaur in 2003. *Rajasaurus* was Probably an Ambush Predator.



Figure 2. *Rajasaurus Narmadensis*

Another very interesting fossil finding in the region is highlighted in this area. This is a unique Snake fossil discovered in the region that dates back to the late Cretaceous period. This is of a snake named *Sanajeh Indicus* (*Serpentes*), that lived in those times. What is remarkable is the fact that fossil remains show the snake inside a Sauropod Dinosaur nest coiled around a crushed Dinosaur egg. This remarkable finding throws light on the feeding ecology of these snakes and the risk they posed as predators to the Sauropod Dinosaurs.

*Titanosaurus* which are considered to have been the heaviest animals to have walked the earth were actually herbivores and survived on plants. They had a length ranging between 12 to 18 meters, and a height of 3 meters and weighed around 14,700 kilograms.

Another dinosaur similar to the *Rajasaurus* but of a slenderer build is the *Rahiolisaurus Gujaratensis*, named after Raioli. This species is believed to have had a length of 8 meters, a height of 3 meters, and weighed about 2 tons.



### CONCLUSION:

The Lameta Formation belongs to late Cretaceous age of Mesozoic era. Thickness of Lameta Formation is 10-15mts, and it consists of Conglomerate, Sandstone & Limestone beds. 13 Species of Dinosaur found in Balasinor, of which *Rajasaurus Narmadensis*, *Rahiolisaurus Gujaratensis*, *Tyrannosaurus*, Triceratops (three horned face), *Megalosaurus* are famous. World's third largest Dinosaur fossils excavation site located at Balasinor in Gujarat.

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# MAGMATIC DIFFERENTIATION OF PAVAGADH HILL

**Saguna S. Oza**

M.Sc. Geology Department, M. G. Science Institute, Ahmedabad

## **INTRODUCTION:**

Pavagadh hill is situated in Halol Taluka of Panchmahal district of Gujarat and is about 48 kilometres from Baroda in NE direction. The hill shows a series of horizontal lava flows of Deccan trap age and is a conspicuous landmark of Halol Taluka, where the terrain otherwise is gently undulating. The altitude of the peak of the hill is 843.3 metres above the mean sea level whereas the height of the hill is about 720 metres above the ground level. The main peak can be reached easily from the N Eastern slopes, where a zigzag foot path with steps leads from the ST Bus stand up to the top of the hill. A part of the height of the hill can be covered also by road, up to the village Machi. This hill is one of the very few localities in India where field evidence of Magmatic differentiation is clearly seen.

The patterns of eruption and dispersal of flood basalt lavas on the surface, or as magmas in dykes and sills within the crust, determine the volcanological and stratigraphic development of flood basalt provinces. Most of the 550-m thick exposed section at Pavagadh is made up of subalkalic basalts rich in the incompatible elements (particularly Nb, Ba, and Sr). Picrite and rhyolite–dacite flow also occur, the latter capping the sequence. Basalts exposed in sections closer to Pavagadh (150–200 km), in the Toranmal, Navagam, and Barwani–Mhow areas, have several flows with some similar chemical characteristics. However, the Pavagadh sequence is significantly different from all of these sequences geochemically, petrogenetically, and in magnetic polarity, to be considered independently built. This result is significant in terms of eruptive models for the Deccan Traps, as it is increasingly apparent that

there were separate but possibly coeval eruptive centres with their own distinctive chemistries developed in various areas of this vast province.

Continental flood basalt (CFB) provinces are vast and thick accumulations of tholeiitic basalt lavas, and often also include variable volumes of alkalic and silicic rocks. The Karoo, the Parana', and the Deccan CFB provinces are good examples. The lavas are also usually horizontally disposed over vast areas, and the techniques of geochemical and magnetic stratigraphy – long-distance correlation of lavas and lava piles based on their geochemical signatures and magnetic polarity – have been successfully used to understand the stratigraphic and structural make-up of these provinces.

**PAVAGADH SECTION**

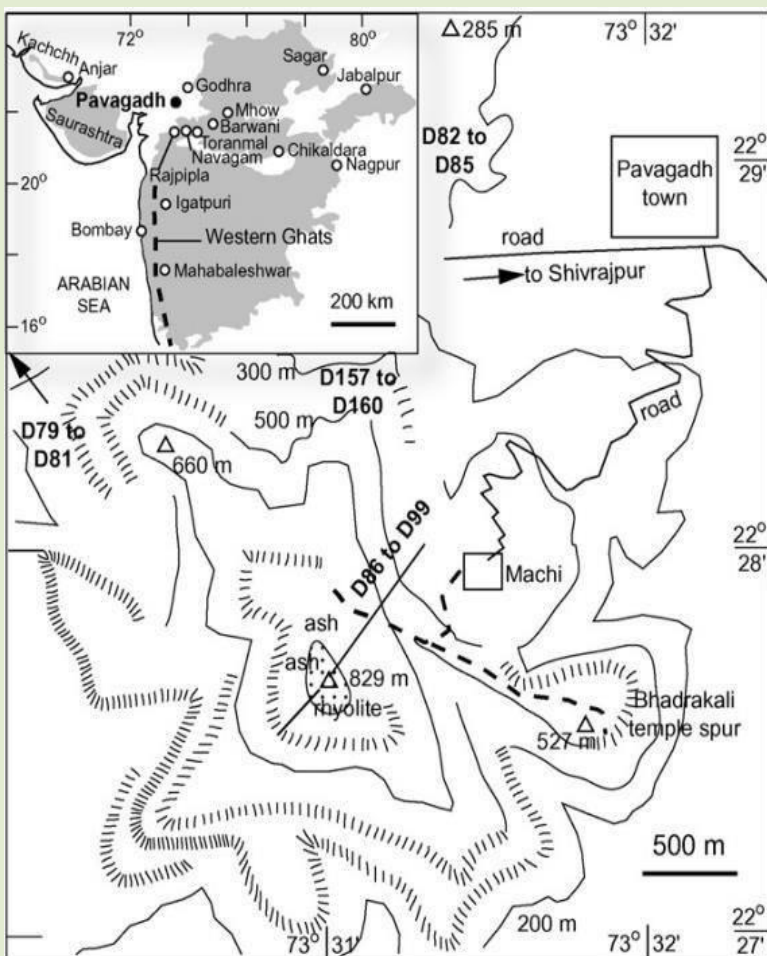


Fig.1 Topographic sketch-map of Mount Pavagadh. Fence-like linear patterns mark near-vertical cliffs. The pilgrim route from Machi to the summit is shown as a dashed line. Inset shows the outcrop of the Deccan flood basalt province (shaded), and the locations

The imposing mountain of Pavagadh (829 m, Fig. 1), rising nearly 700 m above the surrounding plains, constitutes an important lava sequence in the Deccan Traps. It is separated from the main Deccan outcrop by post-Deccan tertiary and quaternary alluvium and a complex Precambrian basement made up of granites, gneisses, and quartzites. Pavagadh shows a 550-m thick exposed sequence made up of perfectly horizontal flood basalt lavas and rhyolitic lavas, the latter at the top.

### **PETROGRAPHY:**

Pavagadh is approximately 829 m high hill having near horizontal flows of volcanic igneous rocks (namely Basalt, andesite, trachyte and rhyolite). Based on the petrography here were series of rocks varying from mafic to acidic in nature as one climbs from Machi (300 m) to top of Pavagadh hill (829m) which suggested that the difference in mineralogy was probably based on the differentiation processes of rising magma during the geological past. During the investigation it was found that samples collected from Mahakali peak (829 m) were more acidic and richer in minerals like orthoclase feldspar, albite; while those samples collected particularly from Bhadrakali peak (527 m), were rich in mafic minerals like olivine, pyroxene etc. The volcanic rocks occurring in the hill are dominantly Basalts of Tholeitic composition, which show Amygdaloidal structure and their derivatives like Andesites, Dellenites and Rhyolite etc. There are also rocks belonging to the alkaline olivine basalt family and include Olivine basalts, Olivine dolerites, Mugearites, Latites and Phonolites.

### **REFERENCES:**

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## **COMPOSITIONAL AND MORPHOLOGICAL ANALYSIS OF SCHLUTER CRATER**

**Parmar Taksh, Thakor Falguni, Parmar Simran, Milan Barot**

M.Sc. Geology Department, M. G. Science Institute, Ahmedabad

### **1. Introduction:**

One of most fundamental of all processes that have occurred on the terrestrial planets is the impact of solid bodies on their surface (Shoemaker, 1977). This forms a depression called impact crater which are generated by the hypervelocity impact of a smaller body on the surface of a planet, moon, or other solid body in the Solar System or elsewhere. Craters are useful features to determine age of a planetary surface and even the nature of its interior. Study of such impact crater mechanics also is important to understand the mineral variation within a planetary body, its geological evolution as well as the morphological features produced due to impact cratering provide aid the study of the behaviour of the terrestrial planetary crust. Based on the structural and morphological characters, impact craters have been classified into main types, (a) simple and (b) complex.

Schlüter is a lunar impact crater that is located near the western limb of the Moon's near side. It lies along the northwestern face of the Montes Cordillera mountain range that encircles the Mare Orientale. Nearly attached to the eastern rim is the damaged crater Hartwig.

Schlüter has an irregular outer rim that is roughly circular, with small outward bulges to the north and southeast. The former section displays a slumped appearance along the inner wall. The southern rim contains a small double-crater that lies long the inner wall. The rim is otherwise not significantly eroded, and contains a system of terraces along the inner sides. The interior floor has a curved patch of low-albedo material along the northern inner wall, nearly matching the dark shade of the Lacus Autumni to the south of the Montes Cordillera range.

The remainder of the floor has the same albedo as the surrounding terrain. In the midpoint of the floor is a central peak, consisting of an elongated ridge with the long dimension aligned in a northerly direction. There is a slender rille near the northwestern inner wall.

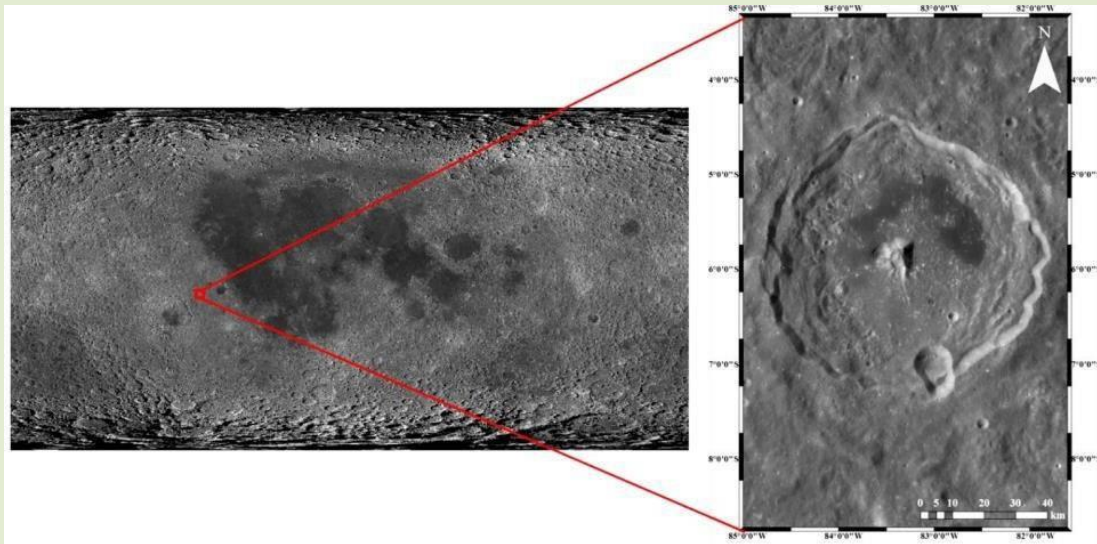


Figure 1. Location of Schluter Crater highlighted with the red colour box on LROC WAC GLOBAL MAP (SOURCE: NASA/GSFC/ASU; PROJECTION: SIMPLE CYLINDRICAL, INBOX PROJECTION: STEREOGRAPHIC).

## 2. Study Area:

The study area is shown on the LROC WAC (Wide Angle Camera) global morphology mosaic in Figure 1. Schluter ( $5.9^{\circ}$  S  $83.3^{\circ}$  W) is a lunar impact crater with a diameter of 89 km, located near the western limb of the Moon's near side [3]. The crater lies along the NE face of the Montes Cordillera Mountain range that encircles the Mare Orientale and near the eastern rim of the crater a damaged crater named Hartwig is attached to the crater. Schluter has a prominent central peak, floor fractures, flat hummocky crater floor, multiple tiers of wall terraces and sporadic roundabout rim. It is located on a highland area and is of Late Imbrian age (Thaker et al., 2019).

## 3. Data Acquisition:

### 3.1 Moon Mineralogy Mapper ( $M^3$ )

In this study three different types of data have been used to analyse the crater. The compositional analysis has been carried out from the Moon Mineralogy Mapper (M3) Data onboard ISRO's Chandrayaan – 1. Morphological study was done from the two instruments, Wide-Angle Camera (WAC). For Topographical studies, LRO LOLA – SELENE Kaguya TC DEM merge was utilised.

### 3.2 Wide Angle Camera (WAC)

The morphological analysis of Schluter crater is done using Wide Angle Camera (WAC) onboard Lunar Reconnaissance Orbiter (LRO) of NASA.

## **4. Methodology:**

### 4.1 Mineral Mapping:

Lunar minerals are recognized in spectral range of visible to near-infrared reflectance spectra by absorption bands. The absorption features of most rock-forming minerals originate from the presence of transition elements in their crystal structure and are controlled by mineral composition, grain size, space weathering, regolith cover etc. Image processing software ENVI (Environment for Visualising Images) was used to perform geo-referencing, mosaicking, spectral sample collection (4x4 pixel average) and continuum removing of the spectral profiles for a better understanding of absorption channels. Here, similar or overlapping samples spectra are not considered and only representative samples are used for final analysis. The collected spectral profiles were later compared to known published spectra.

### 4.2 Band shape algorithms:

The band shape algorithms such as band strength (bs), band curvature (bc), band tilt (bt) and band ratio (br) are employed at crucial wavelengths to delineate the abundance of minerals such as olivine, low-Ca pyroxene, high-Ca pyroxene and plagioclase on the Lunar surface. The bs, bc, bt and br at crucial wavelengths (approximate) are calculated, with ratios between

1009/750 nm, 750/910 nm & 1009/910 nm, 910/1009 nm and 2018/1009 nm respectively.

#### 4.3 Morphology Mapping:

Schluter is a complex crater with prominent central peak, complex wall-terrace system and has rather large diameter. Various feature has been formed in this crater. For profile topographic section LROC GLOBAL DTM(GLD100) is used. For topography and contour analysis, Moon LRO LROC WAC Global Morphology Mosaic 100m v3 data has been used.

3-D model of crater has been made from Lunar LRO LROC-WAC Mosaic global DEM Data using ArcGIS.

Additionally, topography profile has created using LROC-WAC- DEM data showing morphological features such as Central Mound, Floor, Wall Terrace.

### **5. Result and Discussion:**

#### 5.1 Compositional Analysis:

For the compositional analysis, spectral samples were collected from four different locations including the mare patch of Schluter. Minerals like Olivine, High-Ca Pyroxene (HCP), Mg- Spinel and mixed composition of HCP + plagioclase were found exposed.

At location-1, the spectra show strong absorptions near 1000 nm and 2000 nm revealing the presence of High-Ca Pyroxene (HCP) indicating the material might have originated from relatively shallower regions of the lunar crust. An unusual spectrum is observed at location-2, showing a strong absorption band near 2000 nm and a rather weak absorption near 1000 nm. These distinct absorptions are indicating the presence of Mg-spinel mineral suggesting deep-seated lithological exposure. Apart from these minerals, a mixture of HCP and plagioclase was found at location-3 showing diagnostic absorption characters of both, HCP and Plagioclase. Such mixed lithology represents the region between upper and

lower lunar crust. Location-4, the spectra show the strong absorption at 1000 nm and weak absorption near 2250 nm revealing the presence of olivine exposures on the Moon which are limited to concentric regions around the impact basins that have thinner crusts. Fig. 2 shows M<sup>3</sup> FCC-False Colour Composite with R: 930 nm, G: 1249 nm and B: 2018 nm and sampled spectral profiles.

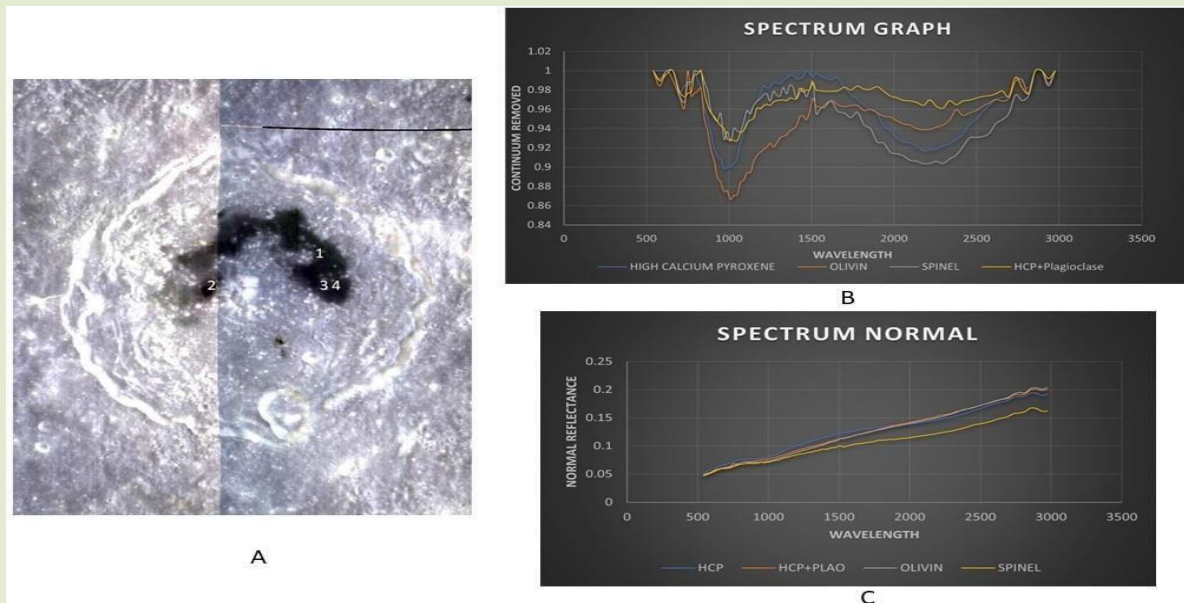


Figure 2 (A) M<sup>3</sup> FCC (R: 930 nm, G: 1249 nm and B: 2018 nm) with reflectance spectra locations. 1- High Calcium Pyroxene, 2-Mg-Spinel, 3- HCP+PLG, 4-Olivine, (B) Reflectance spectra and (C) Continuum removed reflectance spectra of 1- High Calcium Pyroxene, 2-Mg-Spinel, 3- HCP+PLG, 4-Olivine.

### 5.1.1 Band shape algorithms analysis

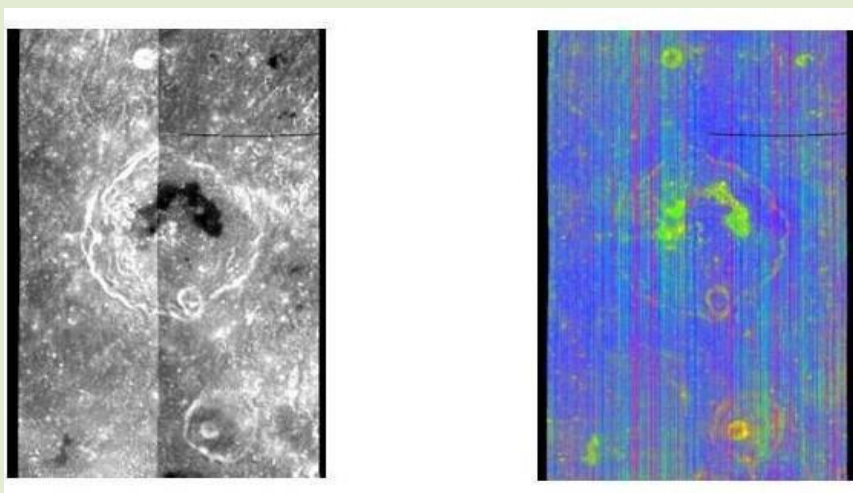


Figure 3 (a) Grayscale image (right panel) shows the ratio of 2018 nm/1008 nm; (b) RGB composite (right panel) of bs, bc and bt.

## 5.2 Morphological

### 5.2.1 3d model of crater:

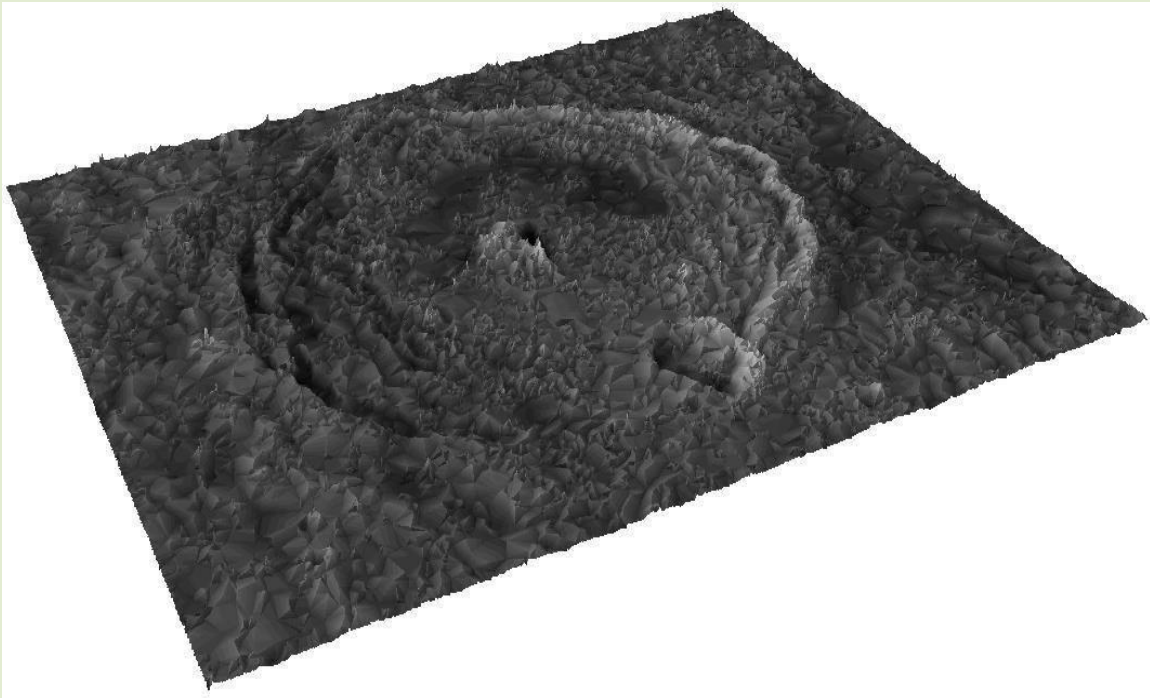


Figure 4 3d model of crater has been made from Lunar LRO LROC-WAC Mosaic global DEM Data

### 5.2.2 Profile Topographic Sections:

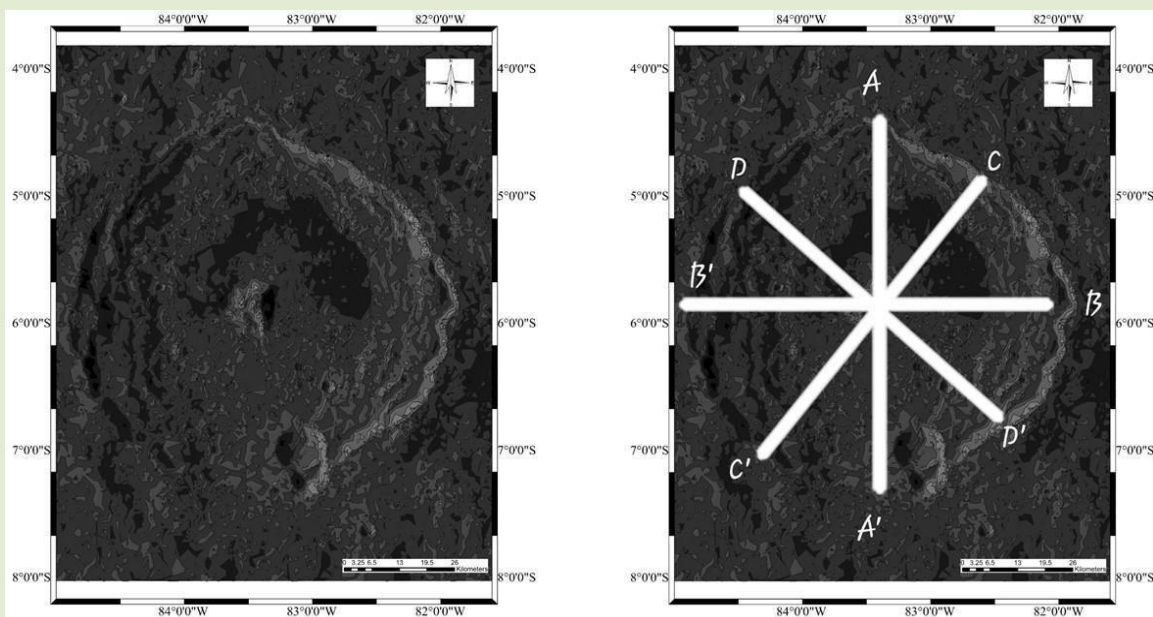


Figure 5 LROC WAC DEM image featuring four topographic sections A-A', B-B', C-C' and D-D' (Projection Stereographic).

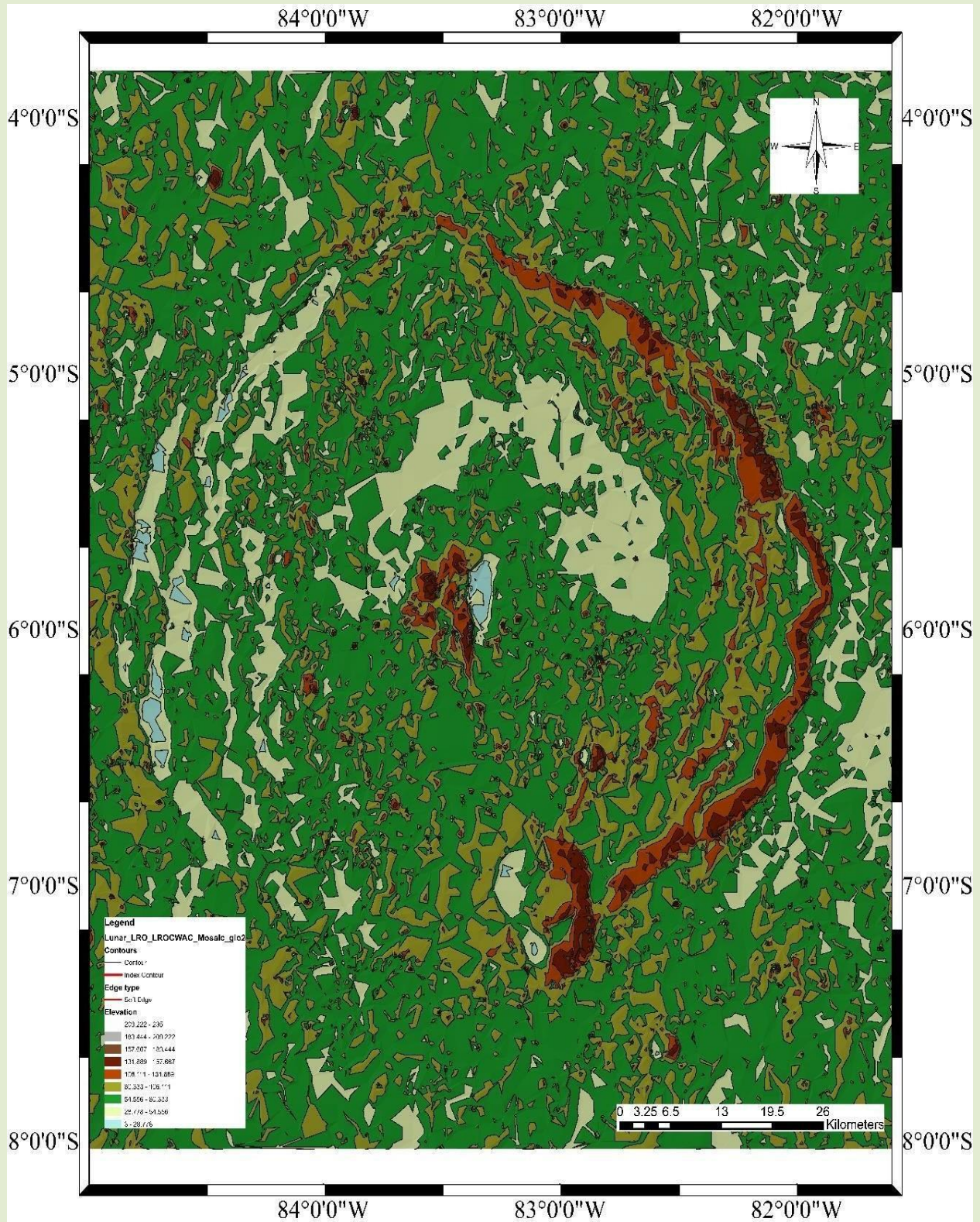


Figure 6 Topographical map of crater made using ArcGIS and LROC LRO DEM DAT showing topographical feature.

### 5.2.3 Elevation Graph of Topographic Profile:

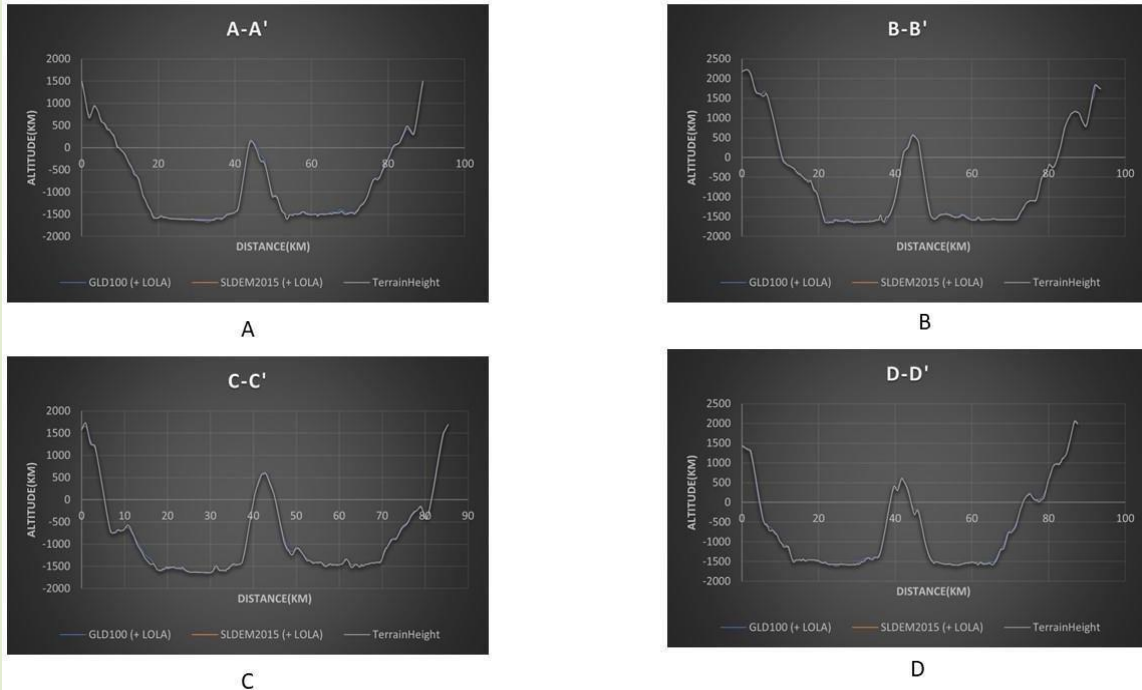


Figure 7 Elevation graph topography profile has created using LROC-WAC-DEM data showing morphological features such as Central Mound, Floor, Wall Terrace

### 5.2.3 Contour map of crater:

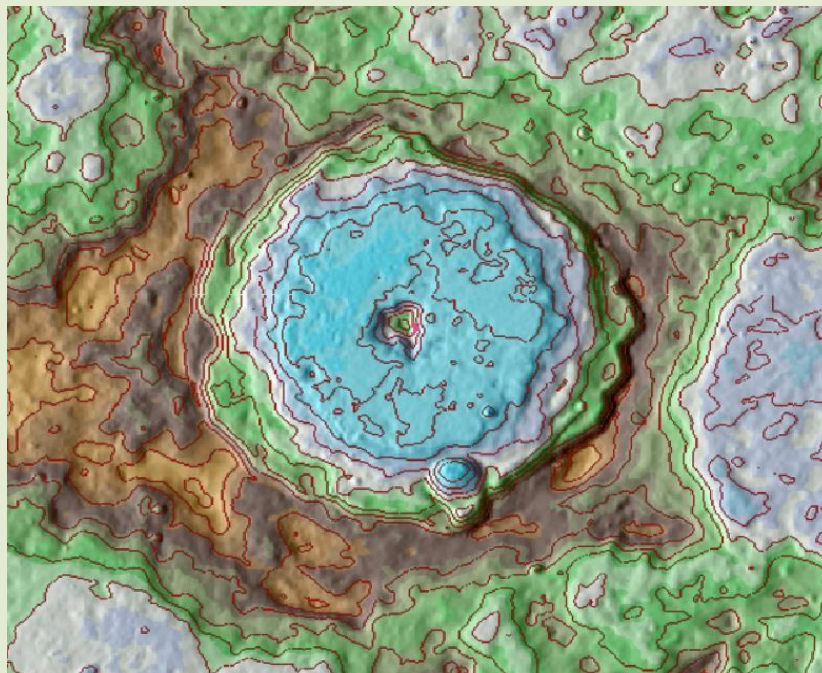


Figure 8 derived from the Global WAC digital terrain model (GLD100). 250 meters at resolutions < 32 m/pix

## **6. Conclusion**

On the basis of compositional analysis of Schluter, we concluded that it's heterogeneous in nature. Presence of plagioclase and the presence of high-Ca pyroxene may suggest lower crustal composition as the crater is in the highland area. The traces of Mg-spinel indicate exposure of deep-seated lithological material. Morphologically, the WAC data of Schluter suggests it has a prominent but asymmetrical central peak, which might have been formed as a result of elastic rebound caused by compressional shock wave during the impact event. The sporadic rim, multiple tiers of wall terraces, flat hummocky crater floor, radial and concentric floor fractures and double impact crater suggest Schluter is a complex crater.

## **7. References**

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## *Participation and presentation:*

**Dr. P. M. Solanki** and nine students of M. Sc. Final year attended the seminar on “Unearthing Mineral Treasures of Gujarat” and B. K. Antia memorial lecture organized by Mining Engineers Association of India (MEAI) at Ahmedabad on 14<sup>th</sup> June 2022.



**Dr. P. M. Solanki** and nine students of M. Sc. Final year participated in National Symposium on “Understanding and combating Earthquakes and Landslide hazards” with special reference to Bhuj earthquake, organized by Institute of Seismological Research (ISR), Raisan, Gandhinagar during July 21-23, 2022.



**Dr. P. M. Solanki** presented a paper on “Folded and Faulted Dhosa Oolite band (Oxfordian) adjacent to Katrol Hill Fault near Wandhaya village, southwest of Bhuj, Kachchh, Gujarat”..



**Dr. P. M. Solanki** along with one Ph. D. student and one student of M. Sc. Final year participated in the one day workshop “Science Meet” on “Frontiers in Remote Sensing of Cryosphere” organized by Space Applications Centre (ISRO), Ahmedabad on 03<sup>rd</sup> August 2022.



## *Educational Visits :*

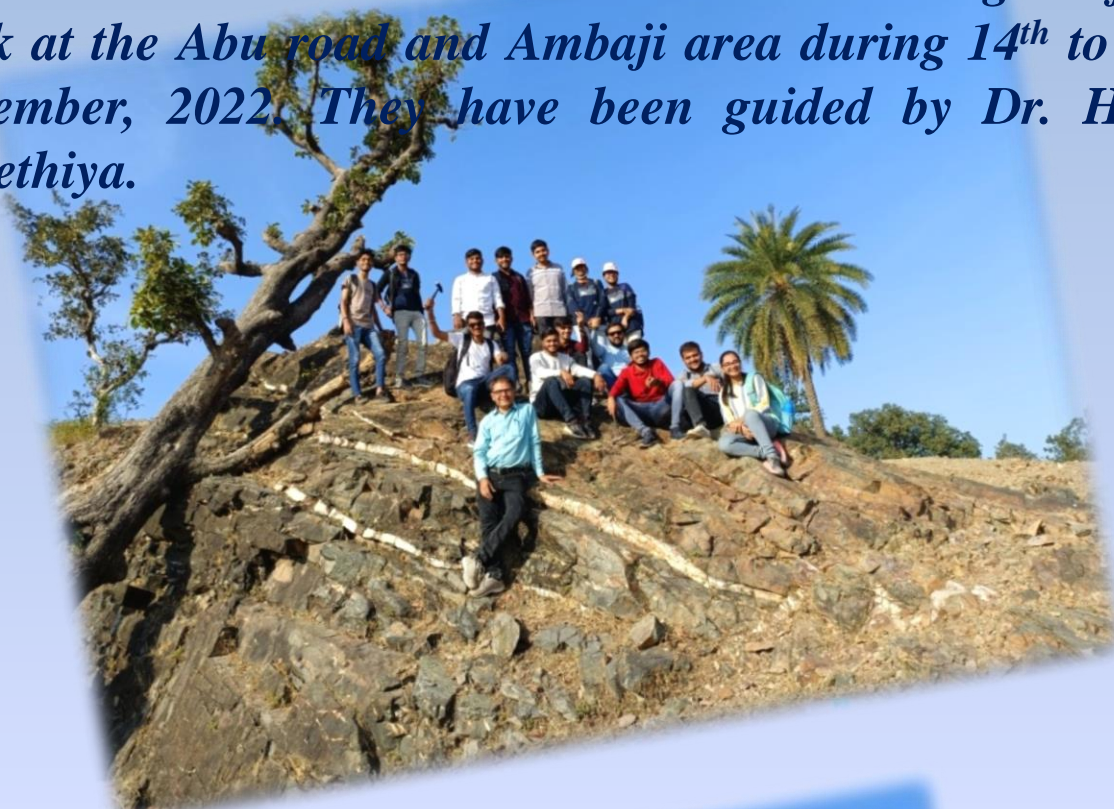
*Dr. H. V. Majethiya along with B.Sc. and M. Sc. students had visited the ISRO- Ahmedabad as a part of educational excursion on 16 September 2022*



*Dr. P. M. Solanki along with B. Sc. And M. Sc. students had visited Lasundra and Rhaioli area as a part of field excursion on 03<sup>rd</sup> September 2022.*



*B. Sc. Sem VI students have carried out Geological field work at the Abu road and Ambaji area during 14<sup>th</sup> to 17<sup>th</sup> December, 2022. They have been guided by Dr. H. V. Majethiya.*



*Dissertation field work of M. Sc. Sem IV students have carried out in parts of Kachchh district during 21<sup>st</sup> and 24<sup>th</sup> December, 2022 under the guidance of Dr. P. M. Solanki.*

*B. Sc. Sem IV students have carried out Geological field work at Himmatnagar, Bhiloda and Shamlaji area on 26<sup>th</sup> December 2022. They have been guided by Dr. P. M. Solanki and Dr. H. V. Majethiya.*



*Dr. P. M. Solanki and Dr. R. G. Gayakvad (SRF) along with one M. Sc. Sem IV student have carried out their project field work in the mouth region of Dhadhar River during 28<sup>th</sup> to 30<sup>th</sup> December 2022.*



*M. Sc. students have carried out their geological field work in various parts of the Vadodara, Panchmahal, Chotaudepur and Narmada district during 02<sup>nd</sup> to 07<sup>th</sup> January, 2023 under the guidance of Dr. P. M. Solanki.*



**GEOLOGIST**  
**Nutritional Facts**  
Serving Size: 1 Fossil Hunting Geologist\*

Amount Per Serving	% Daily Value**
Rock Collecting	1000%
Fault Finding	400%
Being Gneiss	750%
Being Taken for Granite	0%
Easily Distracted by Rocks	500%

\* Significant Source of Geology Puns  
\*\* Percent Daily Values are Based on Size of Your Rock collection

**DON'T TAKE  
GEOLOGISTS  
FOR GRANITE**



## Students' Achievements:

September 2022 ☒ Vol 2 ☒ 2022-23



Ms. **Maitri Maheshwari** (M. Sc. Sem I) and Mr. **Mihir Chaudhary** (M. Sc. Sem III) secured 1<sup>st</sup> and 3<sup>rd</sup> rank respectively in the “Quiz Competition” organized by Geological Survey of India (GSI), Gandhinagar on 15<sup>th</sup> July 2022.



Ms. **Janki P. Chaudhari** of M. Sc. final year has attended the training course on “Cryospheric Applications using Space Based Observations” of Earth Eco-System (**TREES**), an initiative of Space Applications Centre (SAC), ISRO, Ahmedabad during 25 July to 02 SEPTEMBER 2022.

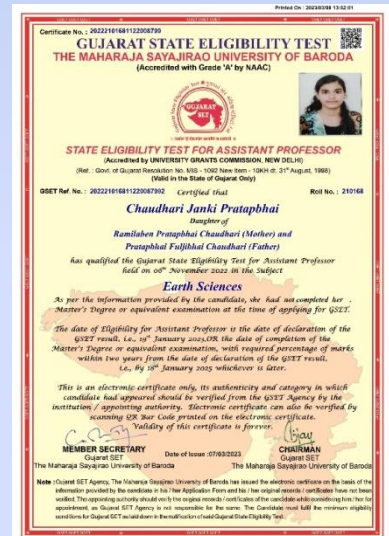
Mr. **Deep D. Patel** received the “**Gold Medal**” for securing the highest marks in the M. Sc. examination, in the convocation of Gujarat University on 05<sup>th</sup> January 2023.





Ms. **Janki P. Chaudhari** of M. Sc. final year presented a paper on “Eocene-Oligocene Molluscs and Echinoids reveal from the Fulra Limestone Formation of Western Kachchh, Gujarat, India” and won the “**Best Paper Presentation**” award in the GEOYOUTH-2023 - 11<sup>th</sup> All India students Symposium on Geology organized by Department of Geology, Mohanlal Sukhadia University, Udaipur during 25-26 February 2023 under the guidance of **Dr. P. M. Solanki**.

Ms. **Janki P. Chaudhari** of M. Sc. Sem IV has cleared the “Gujarat State Eligibility Test (**GSET**)” examination in March 2023.



Ms. **Maitri Maheshwari** secured the highest marks in the final year of B. Sc. and becomes the topper of Gujarat University in Geology subject.

**Viveksingh Tomar** (S. Y. B.Sc.) is selected in Indian NAVY as ‘AGNIVEER’.





**Mr. Raj Desai, Ms. Priya Dabhi and Mr. Jayesh Rathod** of B. Sc. Sem IV secured 1<sup>st</sup> 2<sup>nd</sup> and 3<sup>rd</sup> rank respectively in the “Quiz Competition” organized by Geological Survey of India (GSI), Gandhinagar on 04<sup>th</sup> March 2023. Total 10 students of Geology department were participated in one day workshop along with students of other college.

Third year B. Sc. Geology students have discovered 3 asteroids under the aegis of International Astronomical Search Collaboration (IASC) in association with NASA and Pan-STARRS during 25 July to 18 August 2022. Names of 8 students: **Falguni Thakor, Simran Parmar, Taksh Parmar, Gaurav Devani, Kaushik Dobariya, Rahul, Aditya and Het Patel.**

Two posters presented by Ph. D. students - **Mr. Aagam K. Shah** and **Ms. Jyoti S. Morya** in the International Conference on Climate Change and Law, GLS University Ahmedabad in November 2022 under the guidance of **Dr. H. V. Majethiya**.

Abstract of Dr. Shreekumari M. Patel and Mr. Deep D. Patel under the guidance of **Dr. P. M. Solanki** are accepted for the poster presentation in the “Lunar and Planetary Science Conference (LPSC) 2023” organized at the Houston, US.



**Dr. Rahul G. Gayakvad** presented a poster on “Palaeoenvironmental interpretation based on Ichnocoenoses of Keera dome, western Kachchh, Gujarat” in the Protolith-2023 organized by Indian Institute of Technology (IIT) **Bombay** during 17-19 March 2023 under the guidance of **Dr. P. M. Solanki**. He received the “**Winner (1<sup>st</sup> Prize)**” award for his presentation.

# Departmental Activity:

September 2022 ☒ Vol 2 ☒ 2022-23



Popular Lecture given by A. L. Thakur, GSI

Gurupurnima Celebration-2022



News Letter Launching-2022



*Azadi ka  
Amrit  
Mahotsav*



*Teacher's Day Celebration*



*Garba  
Celebration*



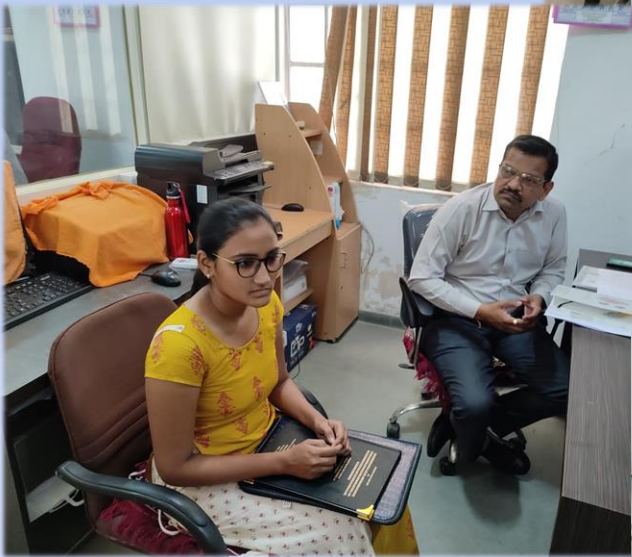
*B.Sc. Students at Science City*

*MoU between Geology Dept and Nascent Info Technologies Pvt. Ltd.*



*Career Guidance by Alumni-Tariq Shaikh & Maulik Patel*

*Campus Placement*





*Farewell to beloved  
Bhatt Sir...*





## ***Editorial Team***

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***Offgn. Principal***

***Dr. P. M. Solanki***  
***HOD***

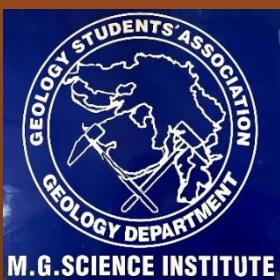
***Dr. H. V. Majethiya***

***Dr. Rahul Gayakvad***

***Purvash Muniya***

***Aditya Rathod***

***Taksh Parmar***



**GEOLOGY DEPARTMENT,  
M. G. SCIENCE INSTITUTE,  
DADASAHEB MABLANKAR CAMPUS,  
NAVRANGPURA, AHMEDABAD-09.**

