



SUTGM PROGRAMME

Server based Unified Thematic Geological Mapping

The SUTGM PROGRAMME

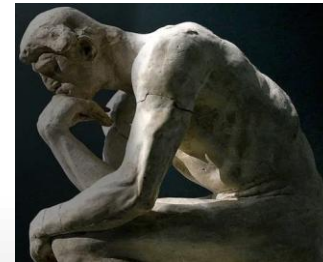
The Server-based Unified Thematic Geological Mapping Programme (SUTGM) represents a bilateral and international multidisciplinary initiative focused on advanced geological mapping utilizing cloud computing, machine learning, and artificial intelligence. Sponsored by the, this innovative programme aims to produce high-precision, server-based thematic geological maps in scale 1:100,000 and 1:50,000 over a two-year period.

The SUTGM brings together a diverse team of specialists with expertise spanning geology, remote sensing, programming, machine learning, and artificial intelligence. A key feature of the programme is its emphasis on knowledge and technology transfer, fostering close collaboration under the umbrella of the UNESCO Chair on Coastal Geo-Hazard Analysis (UCCGHA). This collaboration is further strengthened through joint fieldwork and a series of workshops organized throughout the programme, ensuring the exchange of cutting-edge methodologies and the development of long-term professional relationships.

By integrating advanced technologies and fostering international cooperation, the SUTGM aims to deliver state-of-the-art geological mapping solutions while promoting capacity building and sustainable development in the field of geosciences.



OBJECTIVES



The **SUTGM** program is ultimately designed to (1) provide new and modern information on server-based integrated thematic geological maps through collaboration with regional specialists, and (2) to develop and evaluate a comprehensive and implement machine learning and AI in geological mapping in different aspects of geology.

BASIC IDEA OF THE SUTGMO PROGRAMME

The basic idea is, drawing inspiration from the abundant geological documents, (1) to establish a synthesis of the complex polyphase tectonic and stratigraphic evolution of the main sedimentary and orogenic basins which developed in the domain of....., and (2) provide an appropriate algorithm, compatible with the field of machine learning and cloud computing for segmentation and clustering of object bases, and (3) generate an integrated set of thematic maps in geology, environmental geology, mineral exploration, and (4) data sharing and knowledge and technology transfer.

ZONE OF INTEREST

The SUTGM Programme aims to cover all lands without dense vegetation within two years, spanning up to 90,000 square kilometers across Central Asia, West Asia, the Middle East, and parts of Africa. The SUTGM Programme aims to cover all lands without dense vegetation within two years, spanning up to 90,000 square kilometers across Central Asia, West Asia, the Middle East, and parts of Africa. This ambitious initiative will utilize advanced technologies, including high-resolution satellite imaging and machine learning algorithms, to identify and map areas of potential mineral resources. The programme's findings will be made available to local governments, research institutions, and other stakeholders, enabling data-driven decision-making and collaborative efforts to address the region's pressing economic challenges. With its focus on empowering communities and promoting environmental stewardship, the SUTGM Programme is poised to make a lasting impact on the region's ecological and socioeconomic trajectory.

WORKING METHODE

Server-Based Thematic Mapping and Its Role in Modern Geological Applications:

Server-based thematic mapping is an advanced process that involves creating and displaying maps to illustrate the spatial distribution of specific themes or topics, such as population density, climate patterns, or land use. This process relies on servers that host both the data and the mapping software, enabling efficient and scalable map generation. When combined with **cloud computing**—the delivery of computing services like servers, storage, databases, networking, software, analytics, and intelligence over the internet—thematic mapping becomes a powerful tool for handling large datasets and complex analyses. Cloud computing provides the infrastructure necessary to support high-performance computing, ensuring seamless integration and accessibility of geological data.

Artificial Intelligence (AI) and Machine Learning (ML) further enhance this process by enabling computer systems to perform tasks that traditionally require human intelligence, such as data analysis, image recognition, natural language processing, and decision-making. In geology and hazard assessment, AI and ML offer transformative applications, including improved data collection and handling, enhanced modelling and prediction capabilities, and more effective communication of results. These technologies are particularly valuable for precise identification and mapping of geological formations, which are critical for geological research, environmental conservation, and natural resource exploration.

Traditional geological mapping techniques often rely on manual digitization of aerial photographs or digital images, or pixel-based classification using spectral characteristics. While these methods are faster and simpler than advanced techniques, they can result in misclassified pixels, especially in regions with similar spectral properties. This limitation often leads to less accurate mapping, particularly when dealing with expansive areas.

In recent years, the integration of server-based cloud computing and Object-Based Image Analysis (OBIA) has revolutionized geological mapping. OBIA, in particular, has emerged as a cost-effective and efficient solution, especially within cloud computing environments. This approach excels at integrating data from diverse sources and managing complex geological features across large regions. By considering the spatial context of objects, OBIA can accurately distinguish between different geological formations, enabling precise identification and mapping.

Geological thematic maps, often referred to as the second generation of geological maps, represent a significant advancement in the field. These maps facilitate rapid and efficient studies, integrate legends and geological units seamlessly, and significantly reduce the time required for data analysis and updates to meet global standards. In essence, they provide a faster, more comprehensive understanding of geological data, making it easier to analyze and update information on a global scale.

Server-based unified thematic geological mapping in cloud computing represents the cutting edge of modern geological mapping. By leveraging cloud-based servers to store and process geological data, this approach ensures scalability, efficiency, and precision. It combines the strengths of cloud computing, AI, and OBIA to deliver accurate, high-resolution geological maps that are essential for research, resource exploration, and environmental management. This innovative methodology not only enhances the accuracy of geological mapping but also supports the development of sustainable solutions for geological and environmental challenges.

Key Advantages of Server-Based Unified Thematic Geological Mapping

1. Integration of Diverse Datasets: This approach combines geological data from multiple sources, creating comprehensive and highly accurate maps. It enables geologists to uncover new patterns and trends, enhancing the depth and quality of geological analysis.
2. Real-Time Data Access and Analysis: Cloud-based servers allow real-time access and analysis of geological data, accelerating decision-making during surveys, especially in time-sensitive or emergency scenarios.
3. Advanced Analytical Tools: Advanced tools in cloud environments help identify relationships between geological features, such as rock formations and fault lines, and pinpoint areas with potential mineral deposits or resources. This supports detailed mapping for exploration, environmental management, and land-use planning.
4. Cost and Time Efficiency: Compared to traditional methods, server-based mapping offers high precision, rapid implementation, and cost reductions of up to 10 times, making it ideal for large-scale surveys and resource exploration.

Process and Quality of Server-Based Thematic Mapping

The quality of thematic maps depends on input data, including pre-existing and newly generated datasets. Key factors include:

- Data Selection: Choosing the right platform, spectral data, radar, and aerial photographs ensures accurate initial maps.
- Field Observations and Laboratory Analysis: Field sampling and lab results refine maps by integrating age, lithological, and geochemical data.
- Field Verification: Targeted observations of rock units, based on processed data and satellite imagery, ensure reliability, even beyond the study area.
- Layered and Iterative Processing: Iterative spatial data processing and integration with pre-existing data reduce uncertainty and quantify errors for each unit.

Second-Generation Geological-Thematic Maps

These maps are characterized by rapid production, integrated legends and units, and reduced reliance on instrumental analysis. They adhere to global standards and are particularly useful in geopolitically sensitive or inaccessible areas.

Conclusion

Server-based unified thematic geological mapping in cloud computing represents a paradigm shift, combining advanced technologies like AI and machine learning with traditional methods. It delivers high precision, rapid implementation, and cost efficiency, enhancing data accuracy and accessibility while supporting sustainable resource management and environmental conservation. This innovative approach addresses modern geological challenges, offering a powerful solution for research and exploration.

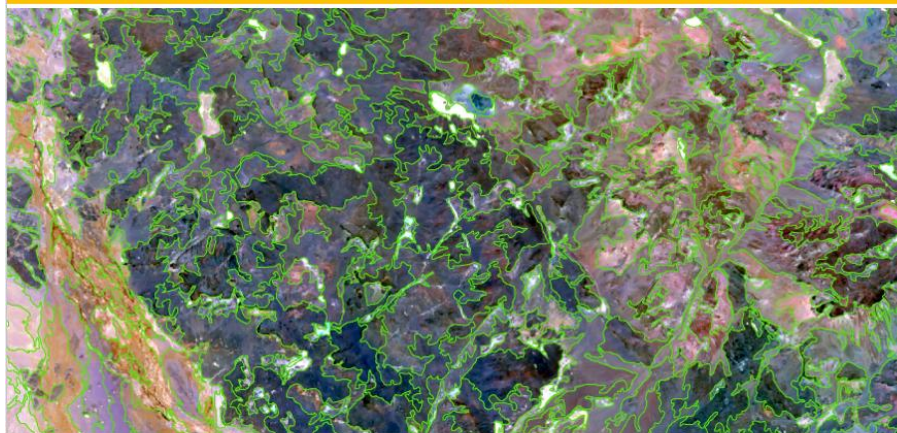
PILOT PROJECT

Our research introduces an innovative method for rock unit mapping, utilizing OBIA techniques in a cloud computing environment. By integrating clustering, field checking, and Random Forest (RF) machine learning algorithms, we extracted relevant features from various Remote Sensing datasets. Our study achieved a % overall accuracy of 82.1% in mapping geological rock units in Iran's Lut Desert (~30000km²), and also recently in ~ 6000km² SE Iran in Makran area. The aim of both of the pilot projects was to formulate and use the new methodologies to prepare geological thematic maps based on pre-existing data such as satellite imagery and cloud computing process on public servers such as Google Earth Engine (GEE) combined with field and laboratory controls. Implementing our RF methodology in a cloud computing environment allowed us to handle vast datasets and enhance computational efficiency. This approach provides a precise and efficient alternative to traditional geological mapping, supporting natural resource exploration and environmental management. Our research yields valuable insights into geological evolution, while also improving the scalability and efficiency of the thematic mapping procedure. The project's achievements in the preparation of an integrated and homogeneous geological map in the western Lut and also in Makran area in the Coastal and Outer Makran zones include innovation in methods and procedures, fast and accurate data production, an integrated method for online geological studies, cost and time savings in engineering, exploration, and geology projects, optimization of geological-exploratory study costs with unlimited capability for simultaneous loading and processing of large data, and hardware/ software platforms for three-dimensional geological maps. The research was conducted using international standards and the latest scientific achievements in the field of Machine Learning. In addition, it offers unlimited capabilities for simultaneous loading and processing of large data, preparing a suitable platform for the encyclopaedia of earth sciences, and providing hardware and software platforms for the preparation of three-dimensional geological maps.

This research satisfied four counters of artificial intelligence in the field of machine learning: transfer learning, few-shot learning, reinforcement learning, and meta-learning.

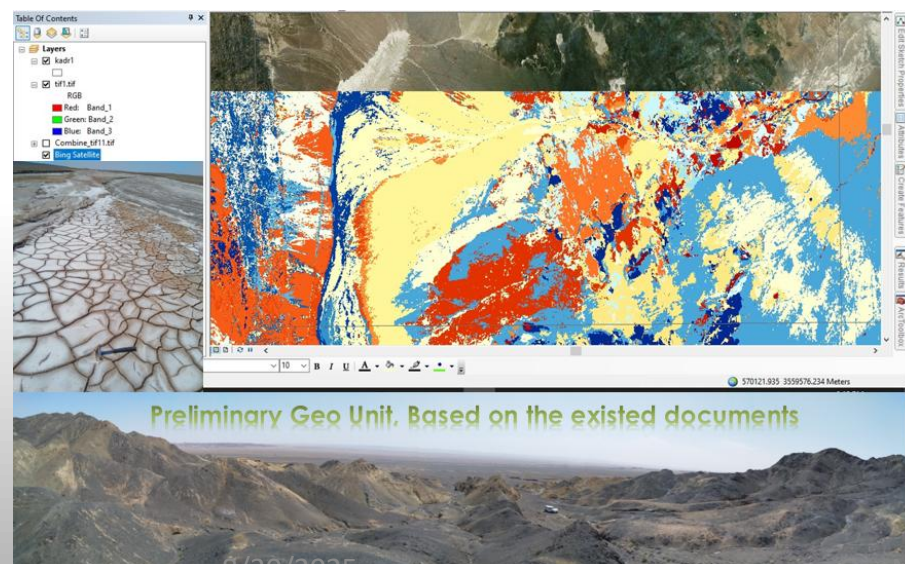


Formal editing of outcrops based on quantitative error computational simulation by segmentation method



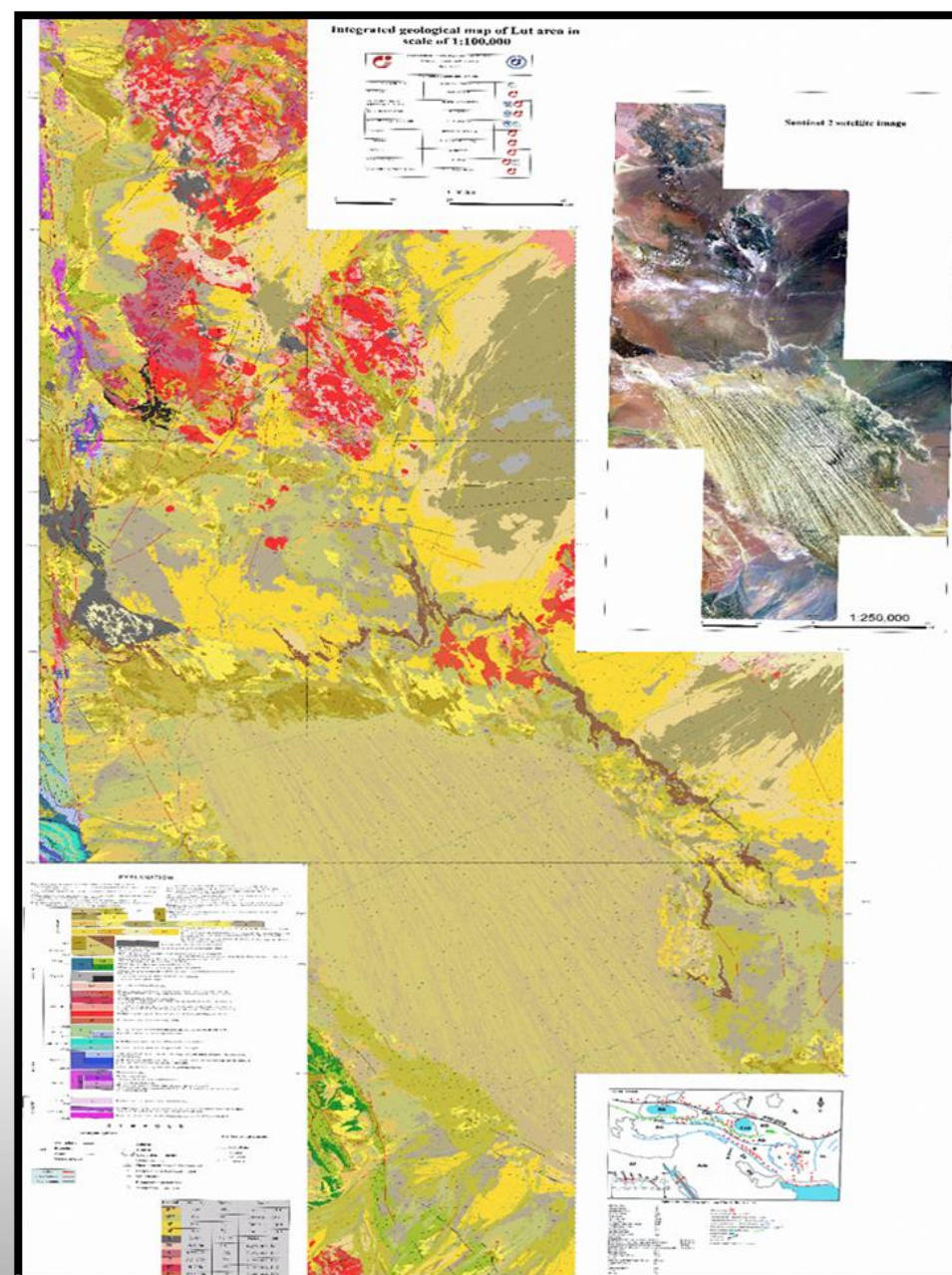
Segmentation factor 600 to 200, ~scale 1:250000 to 1:50000

Based on field observation by using 64 physical and chemical indices



8/30/2025

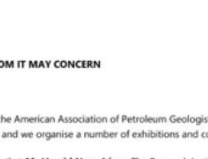
Geonexus



8

RELEVANT PUBLICATIONS

- **Hamid Nazari**, (2025). Next-Gen Onshore Geological Mapping: The Power of AI for Faster, More Precise Results; 11th conference Minerals of the Ocean, June 3-5th, ST. Petersburg, Russia.
- **Hamid Nazari**, Jalal Karami, Saied Arefipour, Aram Fathian, Mohammad Fonodi, (2025). GeoNexus: Leveraging Cloud and AI for Server-Based Unified Thematic Geological Mapping, FIRST ARTIFICIAL INTELLIGENCE IN MARITIME INDUSTRIES CONFERENCE, May 6-7th, Tehran-Iran.
- **Hamid Nazari**, Jalal Karami, Saied Arefipour, Aram Fathian, (2025). Geological Mapping in the Era of AI: Leveraging Innovation for Precision and Speed! UNESCO Chair on Coastal Geo-Hazard Analysis, UCCGHA 033, ISBN:978-622-8423-35-7.
- **Hamid Nazari**, Jalal Karami, Saied Arefipour, (2024). SUTGM PROGRAMME: A New Protocol for Server-Based Unified Thematic Geological Mapping (GeoNexus), UNESCO Chair on Coastal Geo-Hazard Analysis, UCCGHA 027, ISBN: 978-622-8423-21-0.
- **Hamid Nazari**, Jalal Karami, Saied Arefipour, (2024). Geological Mapping in the Era of AI: Leveraging Innovation for Precision and Speed, Barcelona, Catalonia, Spain.
- **Hamid Nazari**, Jalal Karami, Saied Arefipour, Mohammad Fonoudi, Afshin Akbarpour, (2024), Server Based Unified Thematic Geological Mapping, GEOKURDISTAN VI The 6th International Geological Conference of Kurdistan, November 5th -7th, Iraq.
- **Nazari H.**, Karami J., Arefipour S., (2023). The Server based unified thematic Geological mapping in cloud computing, approach: Deep Machin Learning, Regional symposium on Geospatial Information Exchange and Research (GIER), March 07-08, Muscat-Oman.
- **Nazari H.**, Karami J., Arefipour S., Aghaali E., (2023). Using artificial intelligence and Machine learning in the mapping of quaternary units, Quaternary of Iran, Vol. 8, No. 3-4, pp. 379-403 (in Persian).
- **Nazari H.**, Karami J., Arefipour S., (2022). The Server based unified thematic Geological mapping in cloud computing, AAPG Europe Regional Conference: [Revitalizing Old Fields and Energy Transition in Mature Basins](#), 3 – 4 May 2022, Budapest, Hungary.



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AAPG
EUROPE REGIONAL
CONFERENCE 2022
16-18 JULY 2022 • BUDAPEST, HUNGARY

The Server based unified thematic Geological mapping in cloud computing
Hamid Nazari, Jalal Karami, Saeed Arefpour, Elnaz Aghaali

TO WHOM IT MAY CONCERN

Friday, 29 April 2022

We are the American Association of Petroleum Geologists; our European headquarters is in London, and we organise a number of exhibitions and conferences around Europe.

I confirm that **Mr Hamid Nazari** from The Research Institute for Earth Sciences, Geological Survey of Iran has registered and will be attending the **AAPG Europe Region Conference** which is taking place in **Budapest, Hungary on 3 & 4 May 2022.**

Mr Hamid Nazari abstract "The Server based Unified Thematic Geological Mapping in Cloud Computing will be presented at the conference in the section: Digital Transformation: Machine Learning, Artificial Intelligence and Innovative Digital Solutions"

I confirm that his conference registration has been processed and his attendance confirmed.

Yours Faithfully



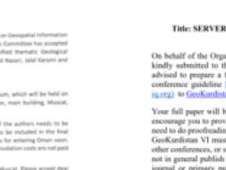

International Earth Resources Institute
Geological Survey of Iran

With the advances of knowledge and technology, the use of cloud computing and artificial intelligence to explore and map subsurface resources has become a reality. This research is to determine the ability to use machine learning to learn and use in public applications and provide for research, processing and visualization.

Scientific means to providing background data, the ability to schedule and process very large data in the server-based environment with pre-processed images and data to find data in addition to what is available in the server, open a new perspective on reducing the use of traditional and server-based data storage.

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Geological Map of the Study Area

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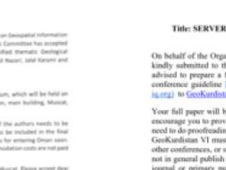

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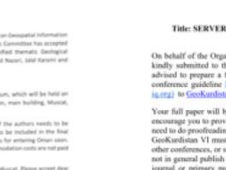

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Geological Map of the Study Area

Abstract

The Server-based Unified Thematic Geological Mapping (SUTGM) program is an interdisciplinary global geological research initiative that unites experts in geology, remote sensing, programming, machine learning, and artificial intelligence (AI) to capitalize on cloud computing and machine learning advancements. Its core goals are to deliver current information via integrated geological maps and to enhance the utilization of machine learning and AI in geological mapping. The program emphasizes server-based thematic mapping and cloud computing for efficient management of extensive geological datasets, employing object-based image analysis (OBIA) to precisely identify geological formations. Within the SUTGM program, AI and machine learning are pivotal in boosting the efficiency and accuracy of geological mapping. These technologies assist in processing vast geological datasets, integrating data from diverse sources, and uncovering patterns and trends that may otherwise go unnoticed. The outcomes of SUTGM comprise integrated thematic geological maps that expedite surveys, incorporate time unit legends, and notably lessen reliance on instrumental analyses. This methodology enables nationwide coverage with heightened precision and speed at reduced costs compared to traditional methods. The program's objectives include the precise rectification of satellite images, assessing the effectiveness of multispectral and hyperspectral images, and establishing a unified geoscience database. Thematic geological maps, recognized as the second generation of geological maps, provide swift and effective analyses, integrate legends and geological units, and dramatically decrease the time needed for analyzing and updating information to adhere to global standards. These maps strive to offer a quicker and more comprehensive insight into geological data, streamlining the analysis and updating of information on a global scale. Conversely, SUTGM epitomizes a contemporary approach to geological mapping that harnesses cloud-based servers for storing and processing geological data. A pilot project carried out in Iran's Lut and Makran regions successfully implemented this approach across areas spanning 30,000 km² and 5,000 km², achieving an accuracy rate $\geq 90\%$ in mapping rock units, underscoring the effectiveness of incorporating AI and machine learning in geological mapping. These studies progressed through three primary phases involving documentary and unlocking trapped data on paper, satellite imagery analysis, image processing and machine learning, and field observations adhering to a new protocol.

ISBN : 978-622-8423-21-0



2024



SUTGM PROGRAMME: A New Protocol for Server-Based Unified Thematic Geological Mapping (GeoNexus)

UCCGHA 027

2024

Abstract

The Server-Based Unified Thematic Geological Mapping of Makran (SUTGMM) is a comprehensive geospatial study conducted at a scale of 1:50,000, focusing on the Makran region, located in southeastern Iran along the northern margin of the Oman Sea. This region is characterized by diverse geological formations resulting from the collision of the Arabian and Eurasian plates, including volcanic and sedimentary sequences, turbidite basins, and Quaternary deposits. Makran's rich geological heritage, coupled with its historical importance, makes it a prime subject for advanced geoscientific research and mapping.

Utilizing a novel approach combining cloud computing, machine learning, and object-based image analysis, the project leverages the power of Google Earth Engine for the processing and analysis of large datasets. The random forest algorithm, used for geological classification, has enabled the creation of a unified geological map with an accuracy of 85%, highlighting the effectiveness of this integrated approach.

This project has provided valuable insights into the complex geological context of the Makran region. The geological units mapped in SUTGMM represent a time range from the Oligocene to the Quaternary period. This includes older formations from the Oligocene and Miocene, as well as more recent Pleistocene and Quaternary deposits. The units highlight the region's complex geodynamic evolution, influenced by both tectonic activity and sedimentary processes.

The GeoNexus geodatabase, as the final product of the SUTGMM project, represents a major advancement in geological mapping by using cloud computing, machine learning, field surveys, and multi-source data integration to enhance the accuracy, efficiency, and comprehensiveness of geological outputs. Ultimately, the findings from this study are expected to support sustainable development efforts and foster a deeper understanding of the Makran region's geodynamic processes.

ISBN : 978-622-8423-35-7



2024



Geological Mapping in the Era of AI: Leveraging Innovation for Precision and Speed



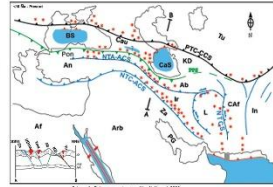
UCCGHA 033

2024



Geological symbols

- Tertiary rocks, unconsolidated
- Quaternary deposits
- Alluvium
- Sand
- Gravel
- Clay
- Silt
- Shale
- Sandstone
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SERVER BASED UNIFIED THEMATIC GEOLOGICAL MAP
OF THE MAKRAN

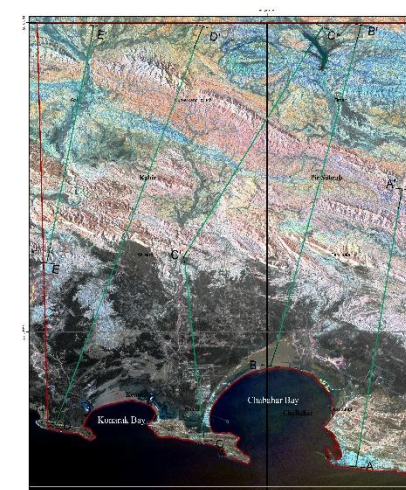
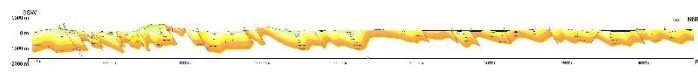
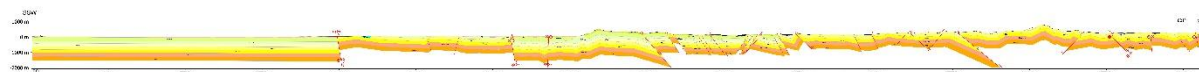
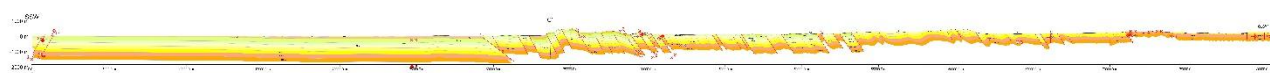
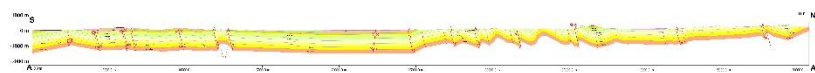
MAKRAN PROJECT GEOLOGICAL MAP
1:100,000

    	Conference: Nazari & Arefpour & S. Fatoori Structural Behavior Series: H. Nazari & S. Arefpour Executive supervisor: A. Zaremski & H. Zaremski M. S. Nazari	Supervisor: H. Nazari & S. Fatoori Photography: S. H. Nazari Publication: S. H. Nazari & S. Fatoori GIS & Digital Cartography: S. H. Nazari
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SUTGMM Programs
Structural Balanced Section
Green lines on the SUTGMM map (scale 1:100,000)
from east to west show
Structural Balanced Sections traces (A-F')

Note:
The SUTGMM Programme offers balanced structural sections through the 3D Move software (<https://www.petras.com/>), combining the Fault Bend Fold model with parallel and similar geometric simulations for constructing horizons. The approach ensures geometric and mass consistency in the modelled structures, capturing fault-related folds and deformation accurately. Both vertical and horizontal scales are set to 1:100,000, providing a detailed and realistic representation of subsurface geology.



Geological Map of ZIRDAN

Abstract:

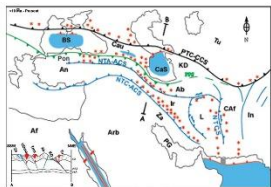
The Server-Based Unified Thematic Geological Mapping of Mahran (SUTGMM) is a comprehensive geospatial study conducted at a scale of 1:50,000, focusing on the Mahran region located in southwestern Iran along the northern margin of the Oman Sea. The Mahran region is characterized by diverse geological formations resulting from the collision of the Arabian and Eurasian plates, including volcanic and sedimentary sequences, tectonic basins, and Quaternary sediments. Mahran's rich geological heritage, coupled with its historical importance, makes it a prime subject for advanced geoscientific research and mapping.

The Zirdan sheet (Sheet No. 8141-4) is a 1:50,000 geological map produced as part of the SUTGMM project, which aims to provide a detailed geological map of the Mahran region. This sheet encompasses 600.39 square kilometers and covers a diverse range of geological features, including altered igneous, volcanic, and sedimentary sequences, as well as tectonic structures that are integral to understanding the region's geodynamic evolution. The map uses UTM coordinates ranging from 50°50'N to 50°55'N and 50°50'E to 50°55'E.

This project integrates data from multiple remote sensing sources such as Sentinel-1, Sentinel-2, Landsat 8, and ASTER, as well as digital elevation models (DEM) to capture spectral, geological, and topographical information in various resolutions. By employing a novel approach that combines cloud computing, machine learning, and object-based image analysis, the SUTGMM project utilizes Google Earth Engine for processing and generating the datasets. The random forest algorithm employed for geological classification has revealed the accuracy of a unified geological map with an accuracy of 85%, enhancing the efficiency and reliability of this integrated methodology.

The geological units mapped in the Zirdan sheet represent a time range from the Cretaceous to the Quaternary period. The Quaternary formations from the Pliocene and Holocene as well as more recent Pleistocene and Quaternary deposits. These units are crucial for understanding the tectonic activity and sedimentary processes that have shaped the Mahran region over millions of years.

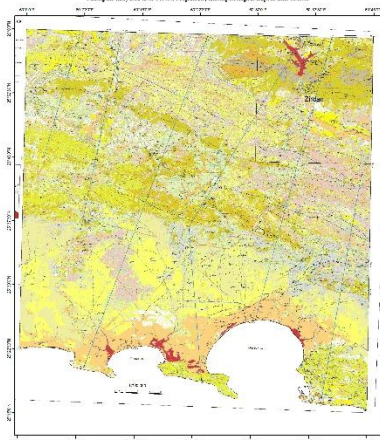
The Geospatial geodatabase as the first product of the SUTGMM project, serves as a major advancement in geological mapping by incorporating cloud computing, machine learning, field surveys, and multi-source data integration to enhance the accuracy, efficiency, and comprehensiveness of geological mapping. Ultimately, the findings from this study are expected to support sustainable development efforts and foster a deeper understanding of the region's geodynamic processes.



Legend

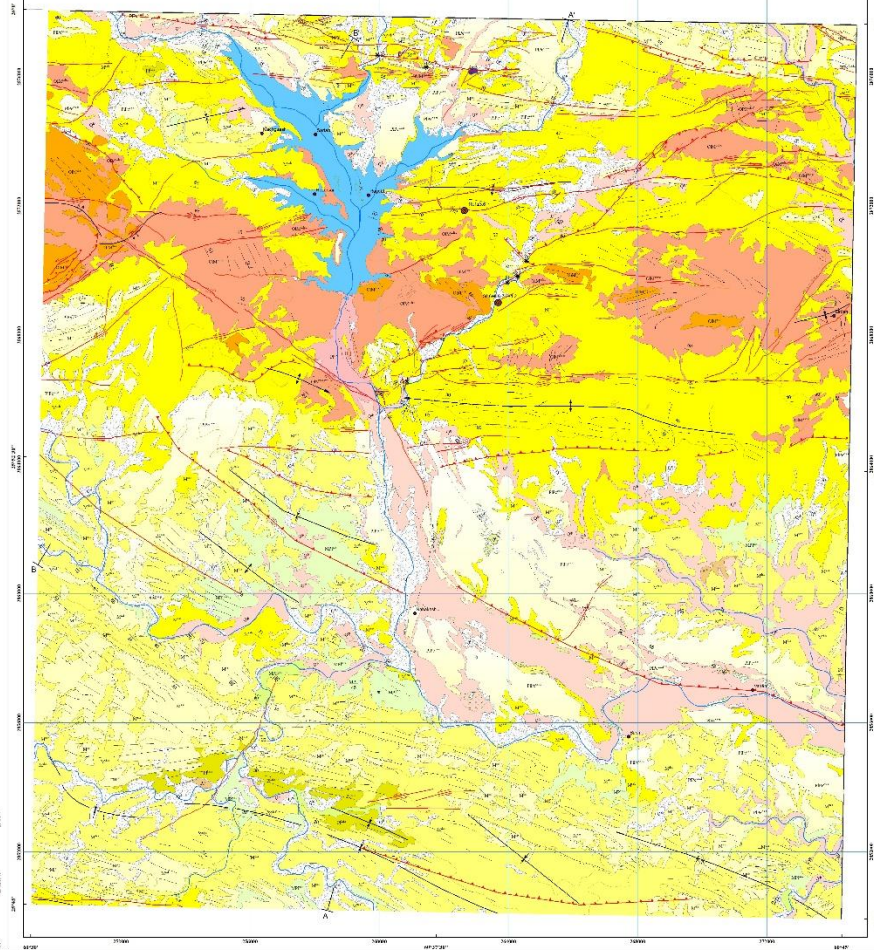
Geological Unit	Description
Q1	Quaternary (Holocene)
Q2	Quaternary (Pleistocene)
P1	Pliocene
P2	Pliocene (Basal)
P3	Pliocene (Middle)
P4	Pliocene (Top)
P5	Pliocene (Base)
P6	Pliocene (Top)
P7	Pliocene (Middle)
P8	Pliocene (Base)
P9	Pliocene (Top)
P10	Pliocene (Middle)
P11	Pliocene (Base)
P12	Pliocene (Top)
P13	Pliocene (Middle)
P14	Pliocene (Base)
P15	Pliocene (Top)
P16	Pliocene (Middle)
P17	Pliocene (Base)
P18	Pliocene (Top)
P19	Pliocene (Middle)
P20	Pliocene (Base)
P21	Pliocene (Top)
P22	Pliocene (Middle)
P23	Pliocene (Base)
P24	Pliocene (Top)
P25	Pliocene (Middle)
P26	Pliocene (Base)
P27	Pliocene (Top)
P28	Pliocene (Middle)
P29	Pliocene (Base)
P30	Pliocene (Top)
P31	Pliocene (Middle)
P32	Pliocene (Base)
P33	Pliocene (Top)
P34	Pliocene (Middle)
P35	Pliocene (Base)
P36	Pliocene (Top)
P37	Pliocene (Middle)
P38	Pliocene (Base)
P39	Pliocene (Top)
P40	Pliocene (Middle)
P41	Pliocene (Base)
P42	Pliocene (Top)
P43	Pliocene (Middle)
P44	Pliocene (Base)
P45	Pliocene (Top)
P46	Pliocene (Middle)
P47	Pliocene (Base)
P48	Pliocene (Top)
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P60	Pliocene (Top)
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P84	Pliocene (Top)
P85	Pliocene (Middle)
P86	Pliocene (Base)
P87	Pliocene (Top)
P88	Pliocene (Middle)
P89	Pliocene (Base)
P90	Pliocene (Top)
P91	Pliocene (Middle)
P92	Pliocene (Base)
P93	Pliocene (Top)
P94	Pliocene (Middle)
P95	Pliocene (Base)
P96	Pliocene (Top)
P97	Pliocene (Middle)
P98	Pliocene (Base)
P99	Pliocene (Top)
P100	Pliocene (Middle)

Figure 1: Study area in the Mahran region, showing the location of the Zirdan sheet.



IRAN 1:50,000 SERIES

Sheet No. 8141-4



EXPLANATION

Q1 Quaternary (Holocene) and Q2 Quaternary (Pleistocene) are shown in the north of the study area.

Q3 Quaternary (Holocene) and Q4 Quaternary (Pleistocene) are shown in the south of the study area.

Q5 Quaternary (Holocene) and Q6 Quaternary (Pleistocene) are shown in the south of the study area.

Q7 Quaternary (Holocene) and Q8 Quaternary (Pleistocene) are shown in the south of the study area.

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Q243 Quaternary (Holocene) and Q244 Quaternary (Pleistocene) are shown in the south of the study area.



SUTGMM PROGRAMME Server Based Unified Thematic Geological Mapping in Mafkan **Geological Map of KUH-E-KAND KORUCH**

Abstract:

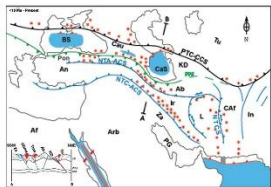
The Server Based Unified Thematic Geological Mapping of Mafkan (SUTGMM) is a comprehensive geospatial study conducted at a scale of 1:50,000, focusing on the Mafkan region, located in southeastern Iran along the northern margin of the Chah Block. The Mafkan region is characterized by diverse geological formations resulting from the collision of the Arabian and Eurasian plates, including volcanic and sedimentary sequences, turbidite basins, and Quaternary sediments. Mafkan's rich geological heritage, coupled with its tectonic importance, makes it a prime subject for advanced geoscientific research and mapping.

The Kuv-e-Kand Koruch sheet (Sheet No. 8841-1) is a 1:50,000 geological map produced as part of the SUTGMM project, which aims to provide a detailed geological map of the Mafkan region. This sheet encompasses 698.38 square kilometers and covers a diverse range of geological features, including alluvial deposits, volcanic and sedimentary sequences, as well as tectonic structures that are integral to understanding the region's geodynamic evolution. The mapped area lies within localities ranging from 60°25' E to 60°30' E and 28°00' N to 28°05' N.

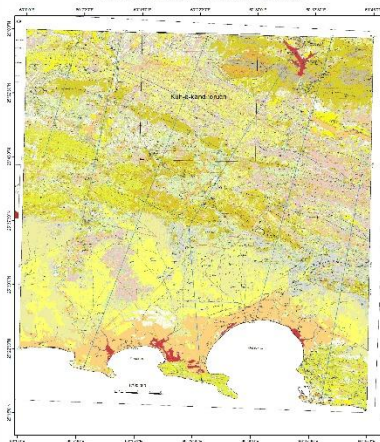
The project integrates data from multiple remote sensing sources such as Sentinel-1, Sentinel-2, Landsat 8, and ASTER, as well as digital elevation models (DEM) to capture spectral, geological, and topographical information at various resolutions. By leveraging a cloud-based approach that combines cloud computing, machine learning, and object-based image analysis, the SUTGMM project utilizes Google Earth Engine for processing and analyzing large datasets. The machine learning algorithm employed for geological classification has enabled the creation of a unified geological map with an accuracy of 85%, representing the efficiency and reliability of this integrated methodology.

The geological units mapped in the Kuv-e-Kand Koruch sheet represent a time range from the Quaternary to the Quaternary period. This includes units from the Quaternary and Miocene, as well as more recent Pleistocene and Quaternary deposits. These units are crucial for understanding the tectonic activity and sedimentary processes that have shaped the Mafkan region over millions of years.

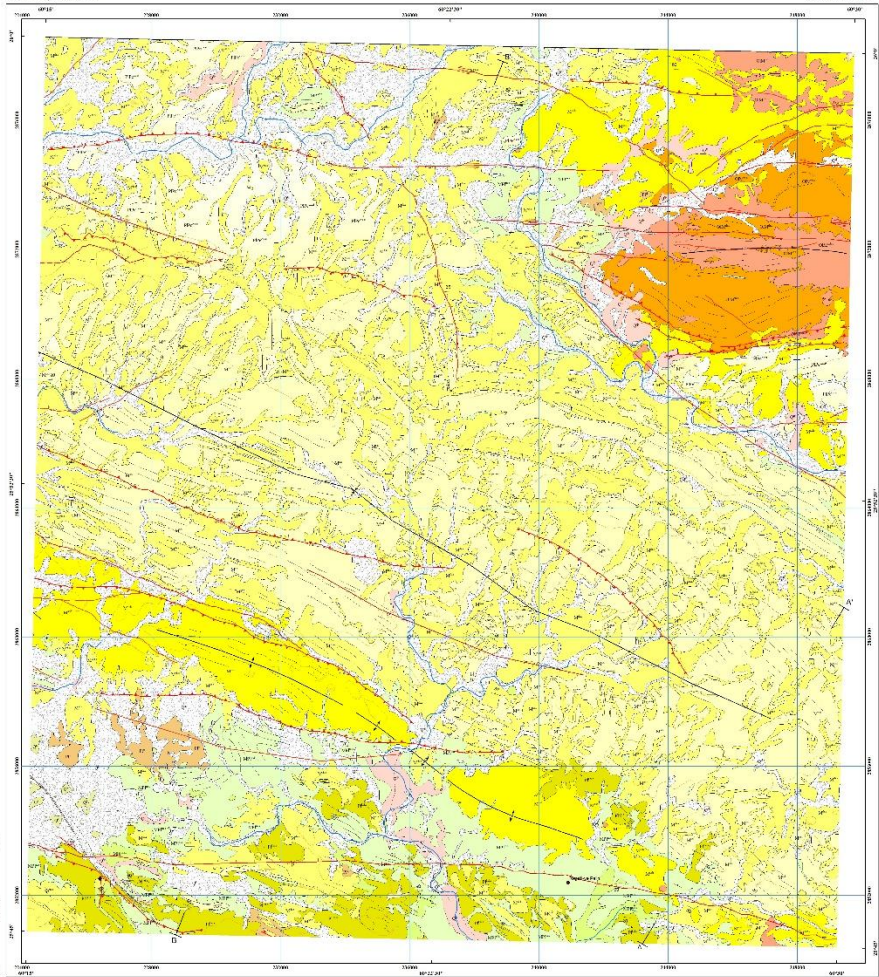
The GeoNeve geodatabase, as the final product of the SUTGMM project, represents a major advancement in geological mapping by incorporating cloud computing, machine learning, field surveys, and multi-source data integration to enhance the accuracy, efficiency, and comprehensiveness of geological mapping. Ultimately, the findings from this study are expected to support sustainable development efforts and foster a deeper understanding of the region's geodynamic processes.



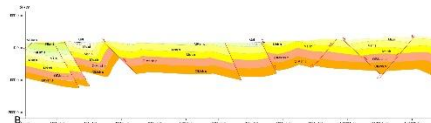
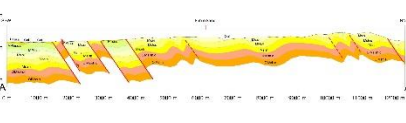
During the study area, the SUTGMM Programme, using Geological maps at a scale of 1:50,000.



IRAN 1:50,000 SERIES



Scale: 1:50,000



The map is a product of the SUTGMM Programme, which is a part of the SUTGMM Programme. The map is a product of the SUTGMM Programme, which is a part of the SUTGMM Programme.

EXPLANATION

Q4: Q4 is a geological unit, representing the Quaternary period, which is the most recent geological period. It is characterized by the presence of the Holocene and Pleistocene stages. The Q4 unit is the most recent geological unit, representing the Quaternary period, which is the most recent geological period. It is characterized by the presence of the Holocene and Pleistocene stages. The Q4 unit is the most recent geological unit, representing the Quaternary period, which is the most recent geological period. It is characterized by the presence of the Holocene and Pleistocene stages.

Q3: Q3 is a geological unit, representing the Pleistocene period, which is the second most recent geological period. It is characterized by the presence of the Pleistocene stage. The Q3 unit is the second most recent geological unit, representing the Pleistocene period, which is the second most recent geological period. It is characterized by the presence of the Pleistocene stage. The Q3 unit is the second most recent geological unit, representing the Pleistocene period, which is the second most recent geological period. It is characterized by the presence of the Pleistocene stage.

Q2: Q2 is a geological unit, representing the Pleistocene period, which is the second most recent geological period. It is characterized by the presence of the Pleistocene stage. The Q2 unit is the second most recent geological unit, representing the Pleistocene period, which is the second most recent geological period. It is characterized by the presence of the Pleistocene stage. The Q2 unit is the second most recent geological unit, representing the Pleistocene period, which is the second most recent geological period. It is characterized by the presence of the Pleistocene stage.

Q1: Q1 is a geological unit, representing the Pleistocene period, which is the second most recent geological period. It is characterized by the presence of the Pleistocene stage. The Q1 unit is the second most recent geological unit, representing the Pleistocene period, which is the second most recent geological period. It is characterized by the presence of the Pleistocene stage. The Q1 unit is the second most recent geological unit, representing the Pleistocene period, which is the second most recent geological period. It is characterized by the presence of the Pleistocene stage.

Q0: Q0 is a geological unit, representing the Pleistocene period, which is the second most recent geological period. It is characterized by the presence of the Pleistocene stage. The Q0 unit is the second most recent geological unit, representing the Pleistocene period, which is the second most recent geological period. It is characterized by the presence of the Pleistocene stage. The Q0 unit is the second most recent geological unit, representing the Pleistocene period, which is the second most recent geological period. It is characterized by the presence of the Pleistocene stage.

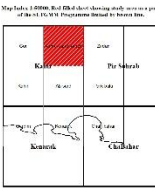
SYMBOLS



Geological Unit	Abbreviation	Parent/Geological Unit	Reference
Q4	Q4	Quaternary	Quaternary, Pleistocene, Holocene
Q3	Q3	Pleistocene	Pleistocene, Pleistocene
Q2	Q2	Pleistocene	Pleistocene, Pleistocene
Q1	Q1	Pleistocene	Pleistocene, Pleistocene
Q0	Q0	Pleistocene	Pleistocene, Pleistocene
Q4	Q4	Quaternary	Quaternary, Pleistocene, Holocene
Q3	Q3	Pleistocene	Pleistocene, Pleistocene
Q2	Q2	Pleistocene	Pleistocene, Pleistocene
Q1	Q1	Pleistocene	Pleistocene, Pleistocene
Q0	Q0	Pleistocene	Pleistocene, Pleistocene
Q4	Q4	Quaternary	Quaternary, Pleistocene, Holocene
Q3	Q3	Pleistocene	Pleistocene, Pleistocene
Q2	Q2	Pleistocene	Pleistocene, Pleistocene
Q1	Q1	Pleistocene	Pleistocene, Pleistocene
Q0	Q0	Pleistocene	Pleistocene, Pleistocene

SERVER BASED UNIFIED THEMATIC GEOLOGICAL MAP OF THE MAFKAN KUH-E-KAND KORUCH GEOLOGICAL MAP 1:50,000

Geological Map of Kuv-e-Kand Koruch, Mafkan, Iran. The map is a product of the SUTGMM Programme, which is a part of the SUTGMM Programme. The map is a product of the SUTGMM Programme, which is a part of the SUTGMM Programme.



Geological Map of AB SARD

Abstract:

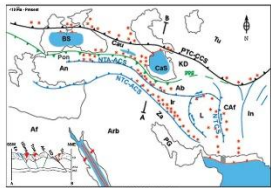
The Server-Based Unified Thematic Geological Mapping of Matlab (SUTGMM) is a comprehensive geospatial study conducted at a scale of 1:50,000. Located on the Matran region, located in the southern part of the Matran region, the Matran region is characterized by diverse geological formations resulting from the collision of the Arabian and Eurasian plates, including volcanic and sedimentary sequences, mafic basins, and Quaternary sediments. Matlab's role in geological mapping, coupled with its historical importance, makes it a prime subject for advanced geospatial research and mapping.

The AB SARD sheet (Sheet No. 8041-2) is a 1:50,000 geological map produced as part of the SUTGMM project, which aims to create a detailed geological map of the Matran region. The sheet encompasses 00°47' north latitude and covers a diverse range of geological features, including alluvial and basalt deposits, volcanic and sedimentary sequences, as well as various structures that are integral to understanding the region's geodynamic evolution. The mapped area has within the coordinates ranging from 60°25' to 60°30' E and 20°15' N to 20°18' N.

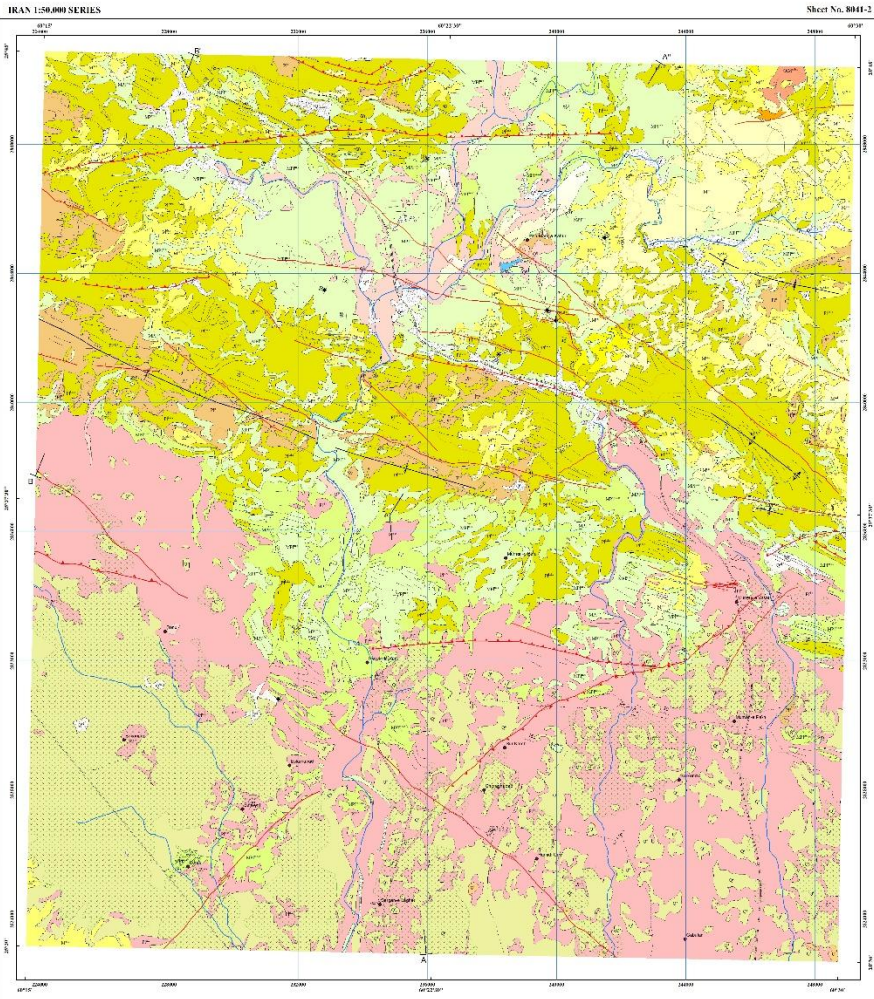
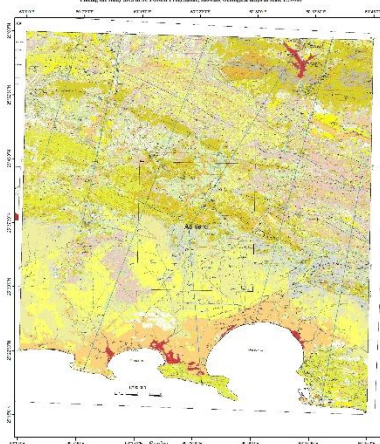
This project integrates data from multiple remote sensing sources such as Sentinel-2, Sentinel-1, Landsat-8, and ASTER, as well as digital elevation models (DEM) to capture spectral, geological, and topographical information at various resolutions by leveraging a novel approach that combines cloud computing, machine learning, and open-source image analysis. The SUTGMM project utilizes Google Earth Engine for processing and analyzing large datasets. The random forest algorithm employed for geological classification has enabled the creation of a unified geological map with an accuracy of 80%, emphasizing the efficiency and reliability of the integrated methodology.

The geological units mapped in the AB SARD sheet represent a time range from the Oligocene to the Quaternary period. The volcanic units, including the Oligocene and Miocene, as well as more recent Pleistocene and Quaternary deposits. These units are crucial for understanding the tectonic activity and sedimentary processes that have shaped the Matran region over millions of years.

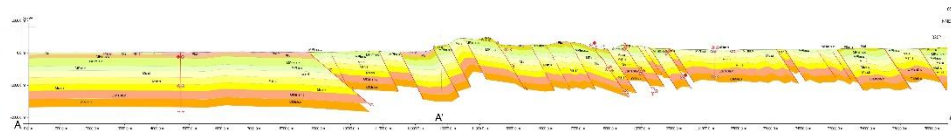
The Geospatial geodatabase, as the final product of the SUTGMM project, represents a major advancement in geological mapping by incorporating cloud computing, machine learning, field surveys, and multi-source data integration to enhance the accuracy, efficiency, and comprehensiveness of geological analysis. Ultimately, the findings from this study are expected to support sustainable development efforts and foster a deeper understanding of the region's geodynamic processes.



Showing the study area in the SUTGMM Programme, showing Geological units in scale 1:50,000



Scale: 1:50,000



The SUTGMM Programme offers a unique insight into the Matran region's geological evolution, providing a detailed view of the region's geological structure and topography. The map is a valuable resource for understanding the region's geodynamic processes and for supporting sustainable development efforts.

EXPLANATION

1. The SUTGMM Programme is a comprehensive geospatial study conducted at a scale of 1:50,000. Located on the Matran region, located in the southern part of the Matran region, the Matran region is characterized by diverse geological formations resulting from the collision of the Arabian and Eurasian plates, including volcanic and sedimentary sequences, mafic basins, and Quaternary sediments. Matlab's role in geological mapping, coupled with its historical importance, makes it a prime subject for advanced geospatial research and mapping.
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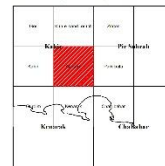
SYMBOLS

- | Geological Symbols | Key Geographical Features |
|-----------------------|---------------------------|
| 1. Alluvial deposits | 2. Volcanic units |
| 3. Basaltic units | 4. Quaternary deposits |
| 5. Oligocene units | 6. Miocene units |
| 7. Pleistocene units | 8. Quaternary deposits |
| 9. Volcanic units | 10. Quaternary deposits |
| 11. Basaltic units | 12. Quaternary deposits |
| 13. Oligocene units | 14. Miocene units |
| 15. Pleistocene units | 16. Quaternary deposits |
| 17. Volcanic units | 18. Quaternary deposits |
| 19. Basaltic units | 20. Quaternary deposits |
| 21. Oligocene units | 22. Miocene units |
| 23. Pleistocene units | 24. Quaternary deposits |
| 25. Volcanic units | 26. Quaternary deposits |
| 27. Basaltic units | 28. Quaternary deposits |
| 29. Oligocene units | 30. Miocene units |
| 31. Pleistocene units | 32. Quaternary deposits |
| 33. Volcanic units | 34. Quaternary deposits |
| 35. Basaltic units | 36. Quaternary deposits |
| 37. Oligocene units | 38. Miocene units |
| 39. Pleistocene units | 40. Quaternary deposits |
| 41. Volcanic units | 42. Quaternary deposits |
| 43. Basaltic units | 44. Quaternary deposits |
| 45. Oligocene units | 46. Miocene units |
| 47. Pleistocene units | 48. Quaternary deposits |
| 49. Volcanic units | 50. Quaternary deposits |
| 51. Basaltic units | 52. Quaternary deposits |
| 53. Oligocene units | 54. Miocene units |
| 55. Pleistocene units | 56. Quaternary deposits |
| 57. Volcanic units | 58. Quaternary deposits |
| 59. Basaltic units | 60. Quaternary deposits |
| 61. Oligocene units | 62. Miocene units |
| 63. Pleistocene units | 64. Quaternary deposits |
| 65. Volcanic units | 66. Quaternary deposits |
| 67. Basaltic units | 68. Quaternary deposits |
| 69. Oligocene units | 70. Miocene units |
| 71. Pleistocene units | 72. Quaternary deposits |
| 73. Volcanic units | 74. Quaternary deposits |
| 75. Basaltic units | 76. Quaternary deposits |
| 77. Oligocene units | 78. Miocene units |
| 79. Pleistocene units | 80. Quaternary deposits |
| 81. Volcanic units | 82. Quaternary deposits |
| 83. Basaltic units | 84. Quaternary deposits |
| 85. Oligocene units | 86. Miocene units |
| 87. Pleistocene units | 88. Quaternary deposits |
| 89. Volcanic units | 90. Quaternary deposits |
| 91. Basaltic units | 92. Quaternary deposits |
| 93. Oligocene units | 94. Miocene units |
| 95. Pleistocene units | 96. Quaternary deposits |
| 97. Volcanic units | 98. Quaternary deposits |
| 99. Basaltic units | 100. Quaternary deposits |

Legend of the SUTGMM Programme, showing Geological units in scale 1:50,000

Geological Unit	Geological Unit	Reference
Q1	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q2	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q3	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q4	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q5	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q6	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q7	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q8	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q9	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q10	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q11	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q12	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q13	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q14	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q15	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q16	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q17	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q18	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q19	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q20	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q21	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q22	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q23	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q24	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q25	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q26	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q27	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q28	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q29	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q30	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q31	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q32	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q33	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q34	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q35	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q36	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q37	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q38	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q39	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q40	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q41	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q42	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q43	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q44	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q45	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q46	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q47	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q48	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q49	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q50	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q51	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q52	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q53	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q54	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q55	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q56	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q57	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q58	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q59	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q60	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q61	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q62	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q63	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q64	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q65	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q66	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q67	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q68	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q69	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q70	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q71	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q72	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q73	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q74	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q75	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q76	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q77	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q78	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q79	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q80	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q81	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q82	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q83	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q84	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q85	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q86	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q87	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q88	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q89	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q90	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q91	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q92	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q93	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q94	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q95	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q96	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q97	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q98	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q99	Quaternary deposits	Chakraborty, 2018; Singh, 2018
Q100	Quaternary deposits	Chakraborty, 2018; Singh, 2018

Map Scale: 1:50,000. Red line shows study area in the SUTGMM Programme. Scale is in km.



SERVER BASED UNITED THEMATIC GEOLOGICAL MAP OF THE MATRAN			
AB SARD GEOLOGICAL MAP 1:50,000			

Geological Map of GURDIM

Abstract:

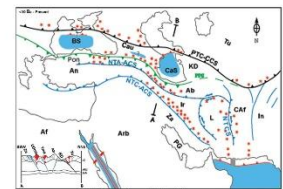
The Server-Based Unified Thematic Geological Mapping of Makran (SUTGMM) is a comprehensive geospatial study conducted at a scale of 1:50,000, focusing on the Makran region, located in southeastern Iran along the northern margin of the Oman Sea. The Makran region is characterized by diverse geological formations resulting from the collision of the Arabian and Eurasian plates, including volcanic and sedimentary sequences, shielded basins, and Quaternary sediments. Makran's rich geological heritage, coupled with its historical importance, make it a prime subject for advanced geospatial research and mapping.

The Gurdim sheet (Sheet No. 8090-4) is a 1:50,000 geological map produced as part of the SUTGMM project, which aims to provide a detailed geological map of the Makran region. The sheet encompasses 690.33 square kilometers and covers a diverse range of geological features, including alluvial and beach deposits, volcanic and sedimentary sequences, as well as tectonic structures that are integral to understanding the region's geodynamic evolution. The mapped area lies within the coordinates ranging from 60.00° E, 25.25° N to 60.25° E, 25.50° N.

This geospatial map was derived from multiple remote sensing datasets such as Sentinel-1, Sentinel-2, Landsat-8, and ASTER, as well as digital elevation models (DEMs) to capture spatial, geological, and topographical information at various resolutions. By leveraging a novel approach that combines cloud computing, machine learning, and object-based image analysis, the SUTGMM project utilized Google Earth Engine for processing and analyzing large datasets. The random forest algorithm employed for geological classification has validated the creation of a user-friendly geological map with an accuracy of 85%, emphasizing the efficiency and reliability of this integrated methodology.

The geological units mapped in the Gurdim sheet represent a time range from the upper Miocene to the Quaternary period. This includes older formations from the upper Miocene and Pliocene, as well as more recent Tertiary and Quaternary deposits. These units are critical for understanding the tectonic activity and sedimentary processes that have shaped the Makran region over millions of years.

The GeoNeous geodatabase, as the final product of the SUTGMM project, represents a major advancement in geological mapping by incorporating cloud computing, machine learning, field surveys, and multi-source data integration to enhance the accuracy, efficiency and comprehensiveness of geological outputs. Ultimately, the findings from this study are expected to support sustainable development efforts and foster a deeper understanding of the region's geodynamic processes.



Legend

Geological Unit	Color	Age
Quaternary	Light Blue	Q1, Q2, Q3, Q4
Pliocene	Light Green	P1, P2, P3
Miocene	Light Yellow	M1, M2, M3, M4, M5, M6, M7, M8, M9, M10, M11, M12, M13, M14, M15, M16, M17, M18, M19, M20, M21, M22, M23, M24, M25, M26, M27, M28, M29, M30, M31, M32, M33, M34, M35, M36, M37, M38, M39, M40, M41, M42, M43, M44, M45, M46, M47, M48, M49, M50, M51, M52, M53, M54, M55, M56, M57, M58, M59, M60, M61, M62, M63, M64, M65, M66, M67, M68, M69, M70, M71, M72, M73, M74, M75, M76, M77, M78, M79, M80, M81, M82, M83, M84, M85, M86, M87, M88, M89, M90, M91, M92, M93, M94, M95, M96, M97, M98, M99, M100

Figure 1: The study area in the SUTGMM Programme during Geological mapping at 1:50,000

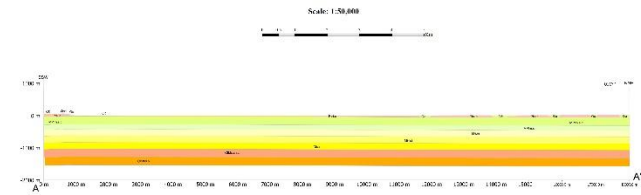
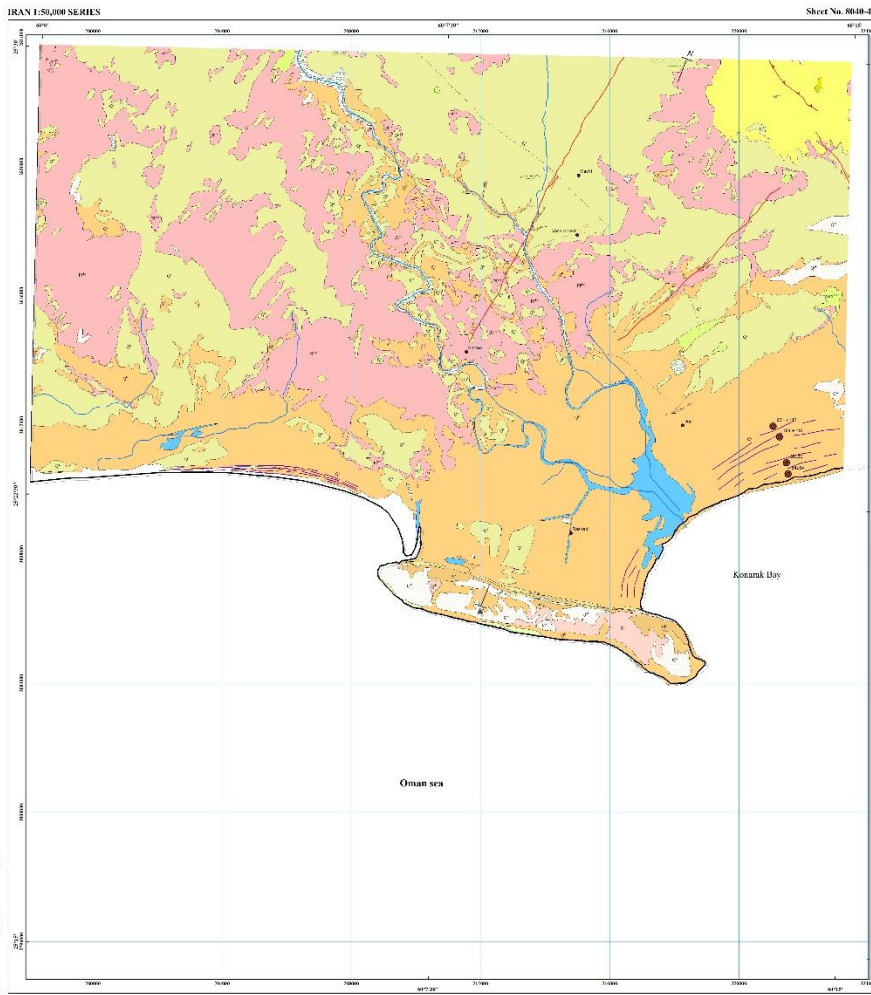
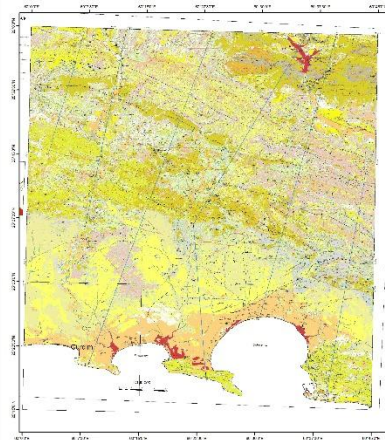


Figure 2: Cross-section A-A' showing the geological profile of the Gurdim area, illustrating the subsurface geological structure.

EXPLANATION

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SYMBOLS

Geological symbols	Non-Geological symbols
- Geological Unit - Geological Boundary - Geological Feature - Geological Structure - Geological Unit - Geological Boundary - Geological Feature - Geological Structure	- City - Village - Water Body - Transportation - Topography - Vegetation - Soil - Land Use

Geological Unit	Stratigraphic Unit	Geological Unit	Stratigraphic Unit
Q1	Quaternary	M1	Miocene
Q2	Quaternary	M2	Miocene
Q3	Quaternary	M3	Miocene
Q4	Quaternary	M4	Miocene
Q5	Quaternary	M5	Miocene
Q6	Quaternary	M6	Miocene
Q7	Quaternary	M7	Miocene
Q8	Quaternary	M8	Miocene
Q9	Quaternary	M9	Miocene
Q10	Quaternary	M10	Miocene
Q11	Quaternary	M11	Miocene
Q12	Quaternary	M12	Miocene
Q13	Quaternary	M13	Miocene
Q14	Quaternary	M14	Miocene
Q15	Quaternary	M15	Miocene
Q16	Quaternary	M16	Miocene
Q17	Quaternary	M17	Miocene
Q18	Quaternary	M18	Miocene
Q19	Quaternary	M19	Miocene
Q20	Quaternary	M20	Miocene
Q21	Quaternary	M21	Miocene
Q22	Quaternary	M22	Miocene
Q23	Quaternary	M23	Miocene
Q24	Quaternary	M24	Miocene
Q25	Quaternary	M25	Miocene
Q26	Quaternary	M26	Miocene
Q27	Quaternary	M27	Miocene
Q28	Quaternary	M28	Miocene
Q29	Quaternary	M29	Miocene
Q30	Quaternary	M30	Miocene
Q31	Quaternary	M31	Miocene
Q32	Quaternary	M32	Miocene
Q33	Quaternary	M33	Miocene
Q34	Quaternary	M34	Miocene
Q35	Quaternary	M35	Miocene
Q36	Quaternary	M36	Miocene
Q37	Quaternary	M37	Miocene
Q38	Quaternary	M38	Miocene
Q39	Quaternary	M39	Miocene
Q40	Quaternary	M40	Miocene
Q41	Quaternary	M41	Miocene
Q42	Quaternary	M42	Miocene
Q43	Quaternary	M43	Miocene
Q44	Quaternary	M44	Miocene
Q45	Quaternary	M45	Miocene
Q46	Quaternary	M46	Miocene
Q47	Quaternary	M47	Miocene
Q48	Quaternary	M48	Miocene
Q49	Quaternary	M49	Miocene
Q50	Quaternary	M50	Miocene
Q51	Quaternary	M51	Miocene
Q52	Quaternary	M52	Miocene
Q53	Quaternary	M53	Miocene
Q54	Quaternary	M54	Miocene
Q55	Quaternary	M55	Miocene
Q56	Quaternary	M56	Miocene
Q57	Quaternary	M57	Miocene
Q58	Quaternary	M58	Miocene
Q59	Quaternary	M59	Miocene
Q60	Quaternary	M60	Miocene
Q61	Quaternary	M61	Miocene
Q62	Quaternary	M62	Miocene
Q63	Quaternary	M63	Miocene
Q64	Quaternary	M64	Miocene
Q65	Quaternary	M65	Miocene
Q66	Quaternary	M66	Miocene
Q67	Quaternary	M67	Miocene
Q68	Quaternary	M68	Miocene
Q69	Quaternary	M69	Miocene
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Q80	Quaternary	M80	Miocene
Q81	Quaternary	M81	Miocene
Q82	Quaternary	M82	Miocene
Q83	Quaternary	M83	Miocene
Q84	Quaternary	M84	Miocene
Q85	Quaternary	M85	Miocene
Q86	Quaternary	M86	Miocene
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Q88	Quaternary	M88	Miocene
Q89	Quaternary	M89	Miocene
Q90	Quaternary	M90	Miocene
Q91	Quaternary	M91	Miocene
Q92	Quaternary	M92	Miocene
Q93	Quaternary	M93	Miocene
Q94	Quaternary	M94	Miocene
Q95	Quaternary	M95	Miocene
Q96	Quaternary	M96	Miocene
Q97	Quaternary	M97	Miocene
Q98	Quaternary	M98	Miocene
Q99	Quaternary	M99	Miocene
Q100	Quaternary	M100	Miocene

SERVER BASED UNIFIED THEMATIC GEOLOGICAL MAP OF THE MAKRA

GURDIM GEOLOGICAL MAP 1:50,000

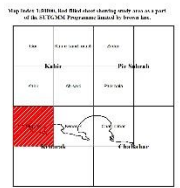
Geological Unit: Quaternary, Miocene, Pliocene, Oligocene, Eocene, Paleocene, Cretaceous, Jurassic, Triassic, Permian, Carboniferous, Devonian, Silurian, Ordovician, Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Paleocene, Eocene, Oligocene, Miocene, Pliocene, Quaternary.

Geological Boundary: Fault, Fold, Unconformity, Discontinuity, etc.

Geological Feature: River, Lake, Sea, etc.

Geological Structure: Tectonic, Structural, etc.

Geological Unit: Quaternary, Miocene, Pliocene, Oligocene, Eocene, Paleocene, Cretaceous, Jurassic, Triassic, Permian, Carboniferous, Devonian, Silurian, Ordovician, Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Paleocene, Eocene, Oligocene, Miocene, Pliocene, Quaternary.



DESIRED AND NEEDS

Desired goals and achievements:

- Accurate correction of satellite images through modeling in the Google Earth Engine environment and the simultaneous launch of the national parallel processor system.
- High atmospheric modeling of images and with the help of spectral samples.
- Determining the added value of satellite images (multispectral and hyperspectral) based on spectral samples and determining the efficiency of different images.
- Creating ground scale results based on different images.
- Validation of the results of different radar and optical image sources in the preparation of integrated geological and engineering maps.
- Comprehensive geological information, mineralogical analysis, soil mechanics and rock mechanics of the samples in the form of a geoportal (GIS system).
- Presenting a new and up-to-date method in preparing thematic geological maps.
- Preparation of an integrated map of geology, Environment Geology, Mineral resources as well as Engineering geology and Seismotectonics at a scale of 1: 50,000.
- Creating an integrated database of geology, engineering and earthquake-construction
- Equipping and setting up a parallel processing system.
- Equipping and setting up the drone system for high precision coastal mapping.
- Earthquake hazard assessment and tsunami modeling.
- Conducting educational workshops.

The need for work and the economic approach of the plan:

- The possibility of better detection and more accurate determination of outcrops using accurate ground and satellite information.
- Reducing the high costs of ground sampling.
- Significant reduction of errors in map preparation.
- Detailed analysis of minerals in a superficial and broad way, instead of point analyses.
- Lack of proper development in infrastructure.
- Determining a precise scientific framework in geological studies with satellite data.
- Absence of a local spectral library based on the geological conditions of the country.
- Examining the capabilities and added value of existing satellite images.
- Determining the exact ground scale for spectral measurements.
- Creating a geoportal for geoscience researchers and professionals.
- Knowledge and technology transfer.

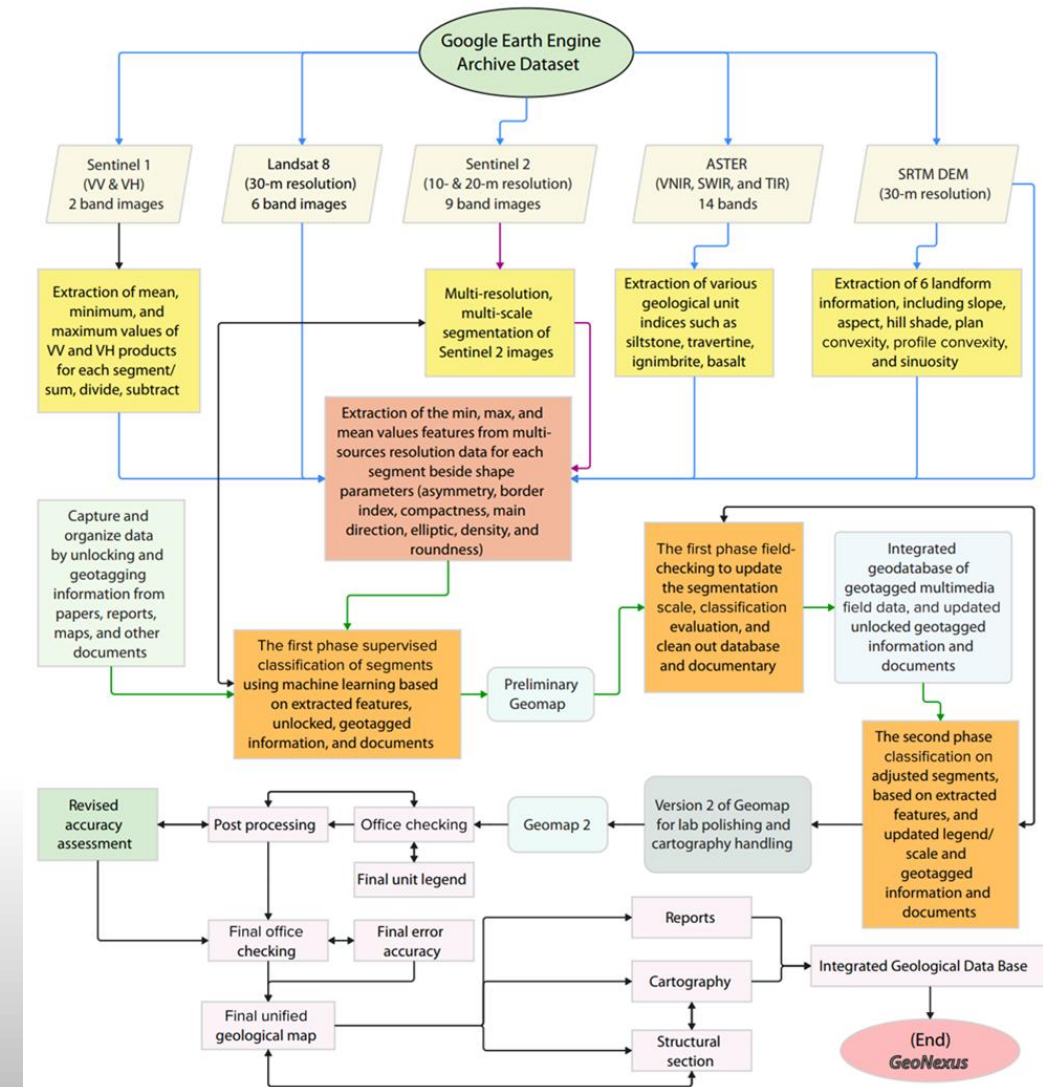


Procedure:

- Unlocking Trapped data on Paper: Collecting information and reviewing past studies
- Checking the collected information and preparing basic geological maps and GEE platform
- Segmentation
- Field opening training workshop of the project
- Presentation of the initial report
- Conducting online field operations and controlling and editing basic maps
- Necessary surveys and sampling
- Preparation of integrated legend during field studies
- Preparation and laboratory studies on samples
- Presentation of the second report
- Modeling and processing of satellite images and reproduction of integrated maps with optimal clustering Preparation of integrated maps at a scale of 1:100,000 with legends and signs
- Transverse Structural Section in the MOVE
- Final control of the map on the ground and additional sampling
- Modification of integrated maps on a scale of 1:50,000 with a legend
- Compilation of the report of thematic geological maps
- Cartography, GIS and final digitization
- Preparation of database
- Designing and setting up a parallel processing system
- Using and operationalizing the drone system for accurate coastal mapping
- Presentation of final reports and maps
- Making referee corrections
- Seminar at the end of the project
- The final training workshop of the project
- WebGIS backup

8/30/2025

TASK FORCES ACTIVITIES



GeoNexus

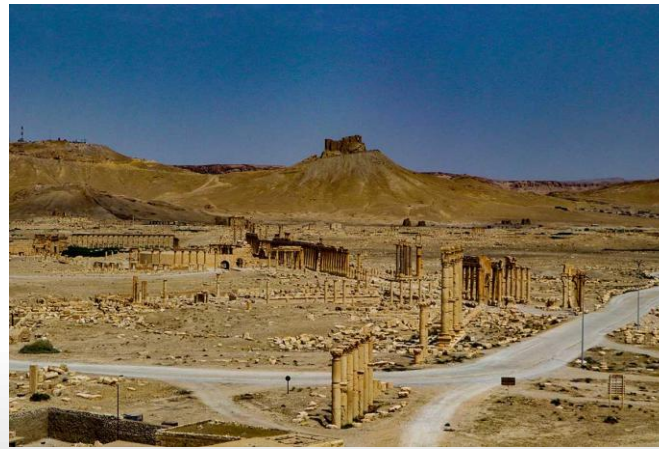
13

PARTICIPANTS



*UNESCO Chair on
Coastal Geo-Hazard Analysis*

*Research Institute for Earth Sciences
Geological Survey of Iran*



COST

- Personnel expenses
- The cost of necessary trips, including the cost of tickets, accommodation, food and transportation
- Laboratory costs
- The cost of devices, equipment, and materials needed to be purchased from the project credit facility
- Parallel processing system cost
- The cost of the drone system
- Short Well drilling costs
- Meeting and workshops
- Other expenses
- Total costs
- Tax and other Statutory deductions

Estimated Cost per kilometer square 25 US \$



DESIGNER AND SCIENTIFIC PERFORMER

Biography

Born on February 18, 1968, in Tehran, Iran, the candidate is a highly accomplished geologist with proficiency in Persian, French, and English. Since 2021, he has held the prestigious position of UNESCO Chairholder in Coastal Geo-Hazard Analysis, reflecting his expertise and leadership in the field. His academic and professional journey includes serving as Vice-Director and Deputy of Research (2009–2021) at the Research Institute for Earth Sciences (RIES), where he currently heads the Innovation Department.

He holds a Bachelor's and Master's degree in Geology from Iranian universities, followed by a PhD in Paleoseismology from Université Montpellier II, France (2002–2006). His academic pursuits continued with a Post-Doctorate in Active Tectonics at the University of Cambridge, UK (2007–2011), and culminated in the attainment of the Habilitation à Diriger des Recherches (HDR) in Science of the Universe from Université de Montpellier, France, in 2015.

With over three decades of professional experience at the Geological Survey of Iran (GSI) and RIES, he has established himself as a leading expert in geohazards, geo-archaeology, paleoclimatology, and, more recently, the application of machine learning and artificial intelligence in geological mapping. His extensive international scientific collaborations and close engagement with the United Nations Educational, Scientific and Cultural Organization (UNESCO) underscore his global impact in the field. He has authored numerous publications indexed in the Web of Science (WOS), further solidifying his contributions to the scientific community.

In addition to his scientific endeavors, he is a recognized social activist and critical socio-political analyst in Iranian media. Since 2025, he has been the founder and CEO of Intelligent Geo-Mine Co., a pioneering enterprise leveraging advanced technologies in geological and mining applications.

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