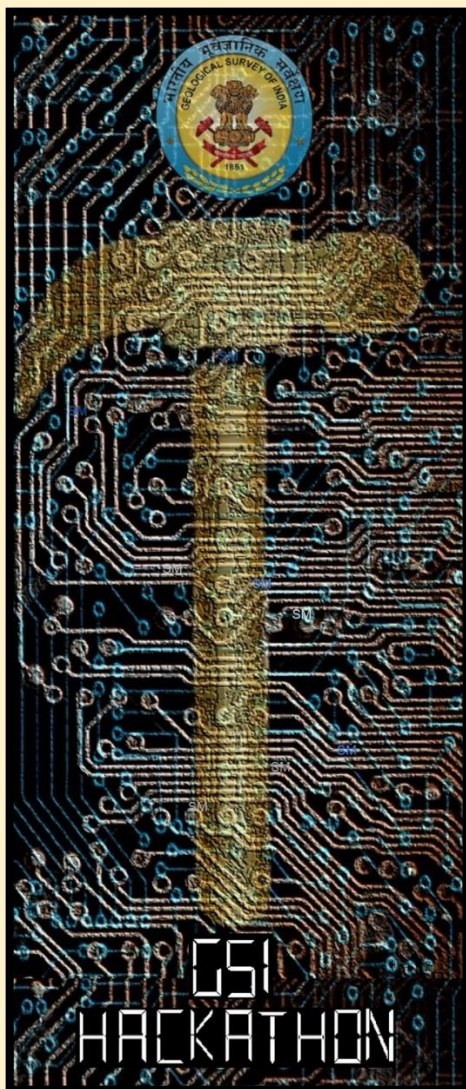


Hackathon for
INNOVATIVE MINERAL HUNT TECHNIQUES-2024



Geological Survey of India

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Introduction: Geological Survey of India, an attached office of the Ministry of Mines, Govt. of India, is organizing a Hackathon on "Innovative Mineral Hunt Techniques" for mineral prognostication using state-of-art techniques practiced globally including interpretation, modelling and integration of multi-parametric geoscience data with emerging technologies such as AI/ML. The aim is to use available geoscience data like geology, geophysics, geochemistry, remote sensing, borehole data etc to identify new target areas for mineral exploration, particularly deep seated /concealed ore bodies.

Title: "Innovative Mineral Hunt Techniques" for mineral prognostication using state-of-art techniques practiced globally including emerging technologies.

Objectives:

1. Demonstration of methodology and application of techniques, classical as well as emerging technologies, in finding exploration blocks using geoscience data
2. Identification of new potential areas for exploration of gold, basemetal, phosphorite, critical minerals such as graphite, lithium, REEs etc., within a pre-defined 14,780 sq. km area in the state of Rajasthan, India.
3. Emphasis on locating deep seated/ concealed mineralised bodies with depth modelling
4. Development of novel AI/ ML algorithms as well as codes for integration and modeling of data, and their validation.
5. Generation of predictive maps showing exploration targets visualised through maps, sections etc.

Deliverables:

The solution has to be submitted online in a structured manner. There will be two components:

1. Outcome / Result as 2D / 3D visualization, and
2. Documentation with following sections
 - Name and details of Participant / Company etc.
 - Resources used (Hardware, Software, Manpower etc.)
 - Data used in details (List of Geological, Geophysical, Geochemical, Petrological, Drill, Remote Sensing, any other datasets)
 - List of derived data layer / extracted feature, if any, from primary data
 - Description and significance of those derivative layers or extracted features vis-à-vis mineral targeting
 - Methodology in details including data preparation / cleaning / transformation operations, statistical analysis, flow chart of steps etc.
 - The AI/ML or other algorithms and codes generated/applied. Code should be readable and properly commented.
 - Supportive documents and information related to degree of confidence, relative contribution of input layers in the final output, etc.
 - Conceptual genetic model of the targeted mineral systems and the targeting criteria used.

All processed data sets (outcome / result) should be in the form of grid, tiff, jpeg, doc, xls etc. The dataset should be visualized in open source/ nonproprietary software. Only soft copy/ digital form will be accepted.

How to participate:

Participants have to register in the Hackathon Portal (<https://hackathon.gsi.gov.in>). It contains all the guidelines, rules & regulations. Names of all the team members are to be registered along with submission of required identity documents. Each team / individual has to declare an email id and mobile number for communication. Other details will be available in the Portal. There will not be any registration fee.

Screening, Shortlisting and Judgement criteria:

There will be two stage evaluation process with pre-defined set of qualification criteria as described below:

Stage1: Screening of applications: Based on the information submitted during registration and the Declaration and Concept document submitted with solution, a preliminary screening will be done. The concept document and submission of the Declaration document will play a vital role in screening process.

Stage 2: Evaluation will be initiated after the last date of solution submission is over. Contestants will be given a slot to present their solution to the Jury Board in virtual mode. Through this stage merit list will be finalized. The selected contestants will be declared and invited to the Closing workshop at GSITI, Hyderabad. In the closing workshop, shortlisted contestants will present their solution and finally, the relative ranking will be declared and awards will be handed over.

The following criteria will be used during the evaluation process:

- I. Understanding of scope, Data cleaning, Feature extraction and Documentation (30 marks)
 - Fundamental geological understanding of the targeted mineral systems.
 - Clarity of thought and innovation in analysis
 - Cleaning and preparation of data, Use of statistical tools, Extraction of relevant features to create input data layers significant for exploration targeting from geological, geochemical, geophysical, borehole, multi-spectral datasets.
 - Extraction of different features related to geophysical and geochemical data sets for depth modelling; their geological and spatial statistical validation
 - Quality and justification/ significance of extracted features.

- II. Data analysis and integration methodology, interpretation and Documentation (30 marks)
 - Innovative approach applied in Geophysical data processing using developed /relevant codes &/or other available software
 - Data integration process and its justification.
 - Creation of codes and models for specific commodities

- III. Final outputs and Documentation of (30 marks)
 - The degree of identification of prospective areas not included in the training dataset
 - Number of new prospective zones delineated in areas hitherto unexplored/reported and their justification.

- Number of constraint depth models created across newly delineated zones as well as previously reported ones, using ground and aero-geophysical, geological and alteration, borehole data.
- Process, clarity and justification in the report for deriving the final output.
- Report on error factor and degree of influence of input factors in delineating the prospective areas

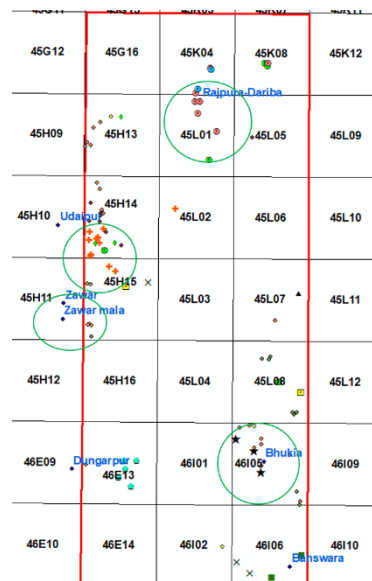
IV. Presentation and demonstration (10 marks)

While evaluating the solutions, points will be credited for

1. deriving suitable geoscientific normalisation of stream sediment data of NGCM, bedrock chemical data of primary dispersions & for mineral alterations across different ASTER scenes,
2. adding more data layers for evolving the exploration model extracted from national and international journals,
3. creation of constrained depth sections across major mineral belts and the shortlisted areas for mineral targeting,
4. recommending suitable mineral exploration follow-up activities in the delineated potential areas during the current study.
5. creation of codes that automate data cleaning, data preparation, normalization, feature extraction and delineation of different alteration minerals from all ASTER scenes.

Area: The proposed area of 14780 sq. km. for Hackathon covers part of south Rajasthan and is known for multi-metal / element deposits of different ages. The block coordinates covering 21 toposheets is as follows:

- ✓ A: 25° 15' 00"N 73° 45' 00"E
- ✓ B: 25° 15' 00"N 74° 30' 00"E
- ✓ C: 23° 30' 00"N 74° 30' 00"E
- ✓ D: 23° 30' 00"N 73° 45' 00"E

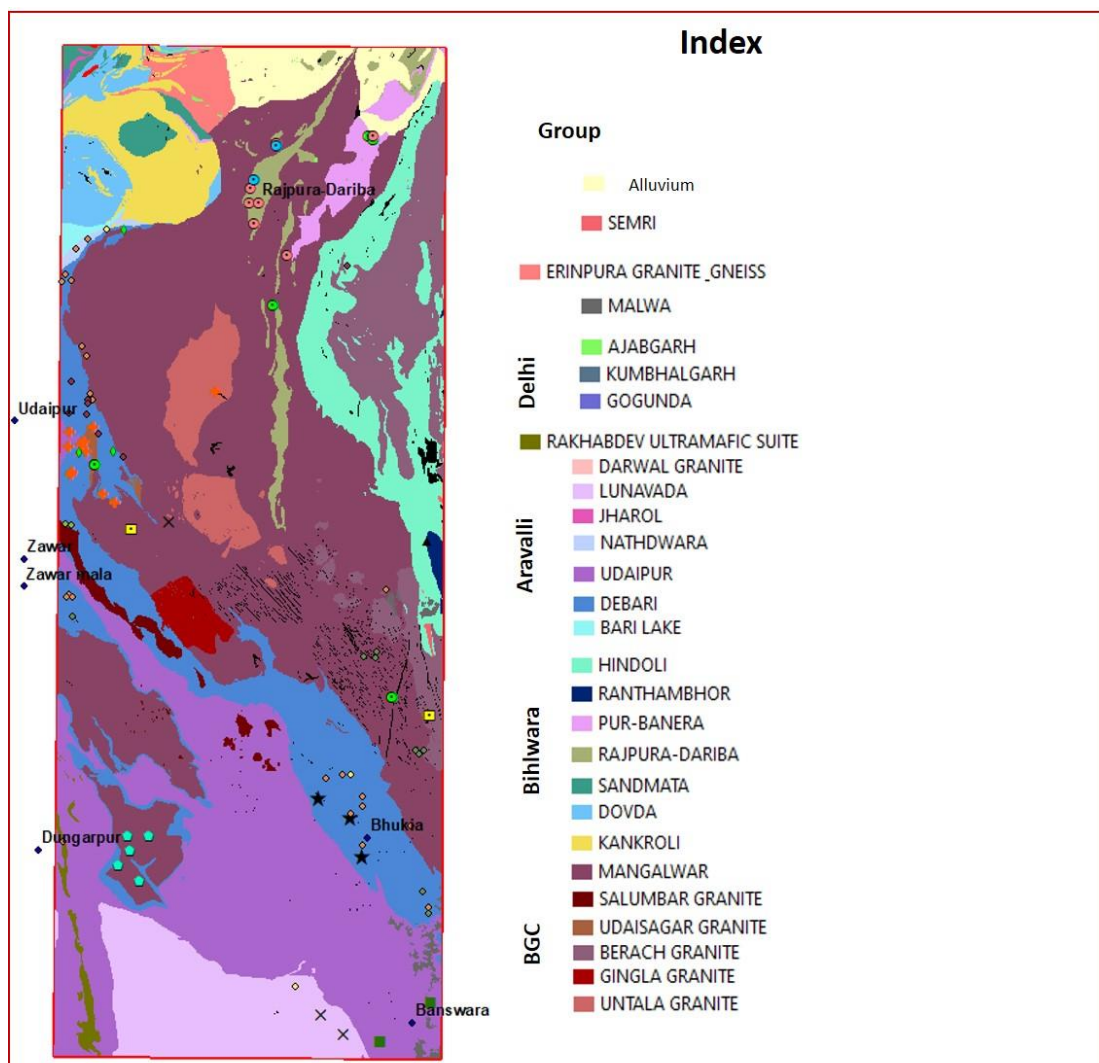


Geology of Rajasthan: Rajasthan, located in the north-western part of the Indian Shield, is endowed with geological diversity as well as complex and episodic metallogeny. The Archaean basement rocks of Bhilwara Supergroup include Sandmata Complex, Mangalwar Complex and Hindoli Group. They comprise in general, granulite-gneiss; amphibolite, metapelite, paragneiss, calc-silicate rocks, metavolcanic and metagreywacke. The Archean rocks are intruded by the Untala-Gingla Granite, Berach Granite, basic and ultramafic bodies.

Over the Archaean basement, rests Proterozoic supracrustals namely Aravalli and Delhi supergroups, Jahazpur, Rajpura-Dariba, Pur-Banera and Sawar Groups. The Aravalli Supergroup is represented by clastic sediments with minor chemogenic and organogenic assemblages with interlayered basic volcanics, whereas the Delhi Supergroup comprises mainly carbonates, metavolcanics, metasammities and metapelites, intruded by magmatic rocks of Phulad Ophiolite Suite and syn-orogenic granites of Sendra - Ambaji, Bairath, Dadikar, Harsora, etc.

These Proterozoic supracrustals host Gold, Lead, Zinc, Copper and REE mineralization.

Geology of the area demarcated for Hackathon: Primarily the area exposes the rocks of Archean basement and Proterozoic supracrustals along with intrusive granites and ultramafics. The eastern and central part of the area consists of Bhilwara Supergroup primarily consisting of gneiss and migmatites of the Mangalwar Complex and low-grade rocks with volcanics of the Hindoli group. The southern and south-western part contains rocks of the Aravalli Supergroup, basal part of which exposes



metavolcanics overlain by a thick pile of metasediments. Aravalli sequence is juxtaposed with Archean Bhilwara Supergroup having a ductile shear zone separating the two. In the Aravalli Supergroup of rocks, copper and gold occurrences are reported at number of places along 150 km long strip from Nathdwara in the north to Ghatol in the south. Berach granite and related quartz reefs with N-S strike occupy central part of the area. Rocks of Rajpura-Dariba Group are exposed in the south western to south central part within a narrow linear stretch of around 25 Km from Tana to Bhinder. The south western most corner of the area has exposed older Untala and Gingla granites.

The area exhibits different metallogenic belts like, Salumbar Bhukia Ghatol, Rajpura-Dariba-Bethumbi, Pur-Banera, Zawar, Jhamarkotra, Banswara related to copper, gold, silver, lead-zinc, chromium, nickel, manganese, PGE, iron, graphite and other important commodities like phosphorite, baryte etc. Moreover, significant geologic features like Phulad Ophiolite Suite, Rikhabdev Ultramafic Suite and Berach Granite are also present in this segment.

Data sets to be made available for Hackathon: Each of the datasets provided is described below:

Geology

The layers provided are tabulated below:

Theme	Type of layer / data	Format	Remarks
Geology	Lithology	shapefile	50K
	Structure	shapefile	50K Lineament, foliation, axial trace, fold, Fault, Shear zone, bedding, Dyke,
	Geomorphology	shapefile	50K (NGLM)
	Mineralisation	shapefile	Mineral occurrence and status map of exploration
	Exploration report	PDF	M:II- 42 (G4- 20, G3-14, G2- 3, unclassified-5)
	STM report	PDF	STM- 12 (with coordinates)

Geochemical Data:

Geochemical data is available from two domains:

- i. **Stream sediments:** Collected as part of National Geochemical Mapping Program (NGCM), the main media of NGCM sampling is stream sediment material in 2 km x 2 km cell (unit cell). All samples are analysed for major oxides and trace elements using 'Clarke's value' as the detection limit. The layers provided are tabulated below:

Theme	Type of layer / data	Format	Remarks
Geochemical data	NGCM	Excel file	21 toposheet
	Reports:	PDF	19 reports

- ii. **Petrochemical Data:** Derived from analyses of 'bed-rock' samples from mapping and exploration projects. Each of the available data is provided in the respective reports.

Theme	Type of layer / data	Format
Exploration report	PDF	M:II- 42 (G4- 20, G3-14, G2- 3, unclassified-5)
STM report	PDF	STM- 12 (with coordinates)

Exploration data:

Different stages of exploration data are available, which include G2, G3 & G4. Data set include

- Lithologs, details about mineralised zones along with location and maps of different scales.
 - Status map of the explored blocks
- iii. Reports: In PDF format are being provided.
- iv. Each of the available data is provided in the respective reports.

Theme	Type of layer / data	Format
Exploration report	PDF	M:II- 42 (G4- 20, G3-14, G2- 3, unclassified-5)

v. Geophysical data:

The geophysical data are provided in the form of (a) ground gravity data derived from National Geophysical Mapping Program (NGPM) and (b) Aeromagnetic Data.

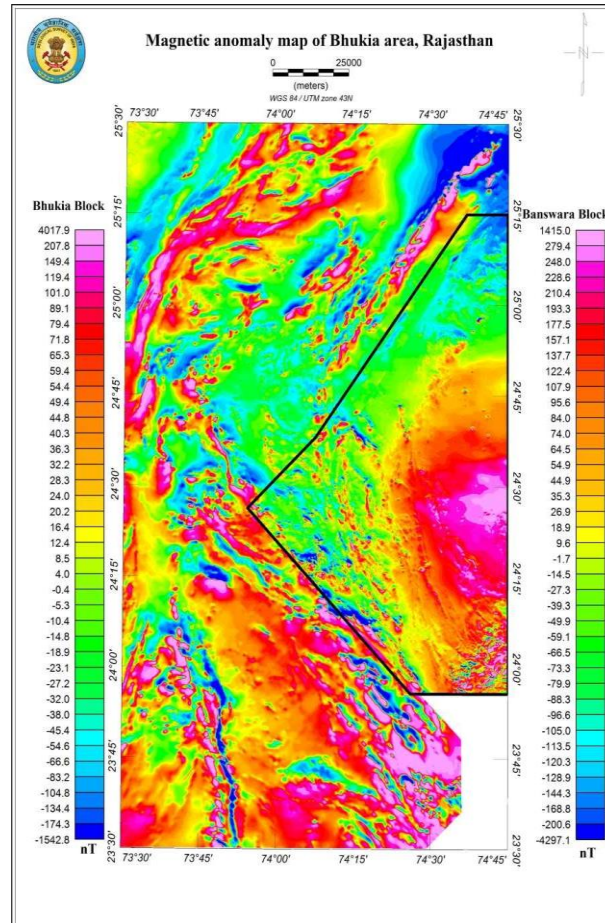
(a) Gravity data was collected along the available roads and cart tracks maintaining a station density of one station in 2.5 sq. km grid using gravimeter & DGPS sensors. The DGPS data were taken exactly at the location of gravity stations. The DGPS position was kept in an unobstructed view of at least ten satellites in the sky with a good geometric distribution above 15° cut-off angle and away from probable reflective areas such as metallic objects, fences, power lines, dense forest, canopy or buildings and vehicles to avoid the multi path signal receiving. The distance between the DGPS base and rover were kept 10-15 km and allowing a sufficient observation time of 10-15 minutes to collect a high quality elevation data. The data will be provided in grid format along with 13 nos. reports pertaining to 21 toposheets and some adjacent areas.

(b) Aeromagnetic Data The data in this area was acquired at different times by different agencies from 1968-69 to 2019-20. OHR Block: The aeromagnetic data in this block was acquired in 1968-69 under the project Operation Hard Rock with a line spacing of 500 m at the survey altitude of 61 m. BRGM Block: The aeromagnetic data in this block was acquired in 1971-72 under the project Operation Hard Rock with a line spacing of 500 m at the survey altitude of 120 m.

TOASS-1: The aeromagnetic data in this block was acquired in 1994-96 through the inhouse TOASS system with a line spacing of 500 m at the survey altitude of 120 m.

The aeromagnetic data of these blocks was brought to a common height of 122 m and was merged together to create a single grid under the Rajasthan aero-magnetic data compilation project during 2010-12.

TOASS-2: The aeromagnetic data in this block was acquired in 2019-20 using the inhouse TOASS system with a line spacing of 300 m at the survey altitude of 80 m.



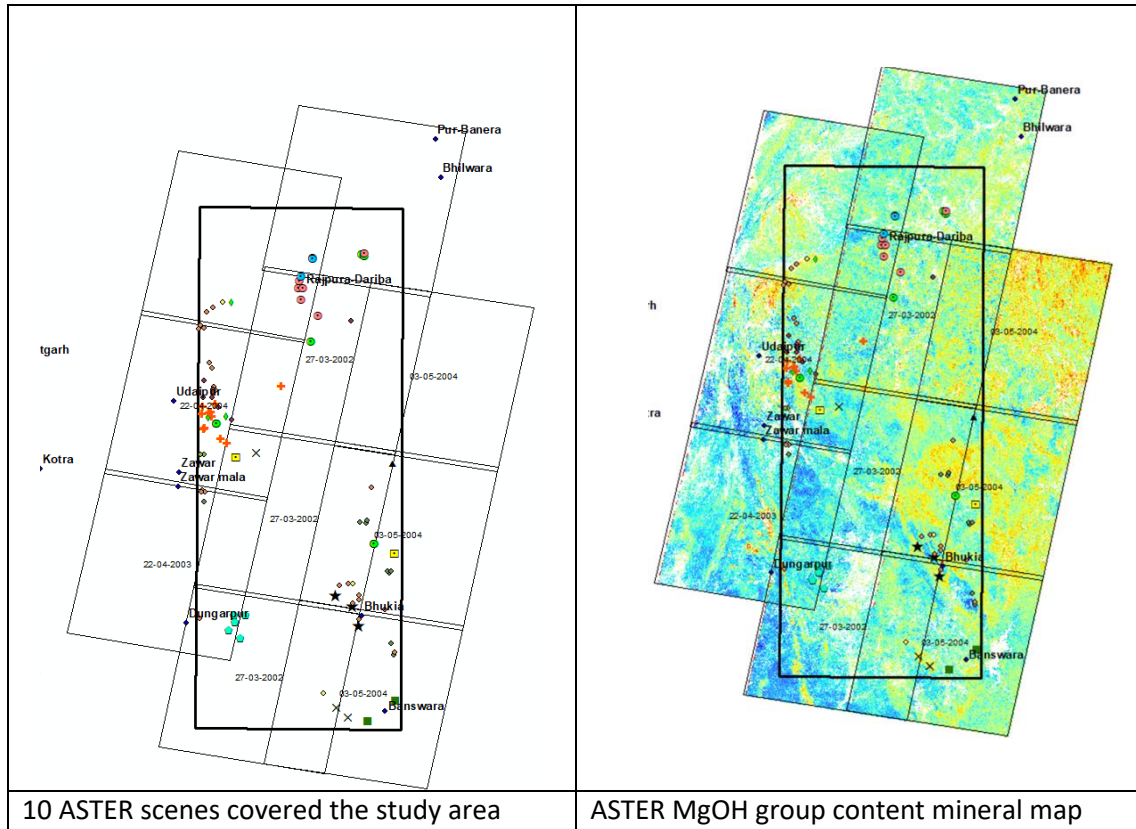
Remote sensing:

The band ratio maps generated from the 10 Advanced Space Borne Thermal Emission and Reflection Radiometer (ASTER) data are provided in Geotiff format. ASTER provides images of the planet Earth in 14 different bands of the electromagnetic spectrum, ranging from visible to thermal infrared light.

The ASTER 07XT surface reflectance VNIR and crosstalk corrected SWIR and AST 05 surface emissivity data were used to generate the thematic layers. The complete end products are 14 thematic layers (Table 1) of mineral indices derived mainly by using band ratio and Relative band depth techniques. The following are the ASTER thematic maps provided;

11 ASTER maps from AST_07XT Surface Reflectance (VNIR+SWIR) & 3 ASTER maps from AST_05 thermal emissivity (TIR)		
Sino:	Mineral map	Ratio/RBD
1	Al OH group composition	B5/B7
2	Al OH group content	(B5+B7) /B6
3	Kaolin group index	B6/B5
4	Mg OH group content	(B6+B9)/(B7+B8)
5	Mg OH group composition	B7/B8
6	Ferrous iron content in Mg OH/ carbonate	B5/B4
7	Ferric oxide content	B4/B3
8	Fe OH group content	(B6+B8)/B7
9	Ferrous iron index	B5/B4
10	Ferric oxide composition	B2/B1

11	Opaque index	B1/B4
12	Quartz index	B11/ (B10+B12)
13	Gypsum index	(B10+B12)/B11
14	Silica index	B13/B10



Rules and regulations:

Following guidelines, rules and regulations are to be followed by the participants:

1. Participant(s) may be a single person / group of persons / company / consortium of companies. Any participant cannot take part in multiple groups. Only a group leader needs to register in case of more than one participant.
2. Participants have to do online registration at Hackathon Portal (<https://hackathon.gsi.gov.in>) for participating in this Hackathon. There is no Registration fee.
3. The competition will be launched in hybrid mode during workshop at GSITI, Hyderabad on 20.07.2024. Participants may attend it physically or virtually through web. In the workshop, all Guidelines, rules, regulations as well as all technical matters will be elaborated.
4. The scope of the contest is defined by the Problem Statement, Background Information and Deliverables. Contestant(s) may use any technology or resources to provide the solution and it has to be mentioned clearly. GSI in no way will be liable in case of any dispute within the team or with any third party.
5. A time period of 60 days will be allocated to arrive at the solution.

6. At the expiry of allocated time of 60 days, participants should upload the solution in Hackathon portal. Along with these solution documents, applicants also have to submit a signed declaration form (Format available in Hackathon Portal) along with a Concept document (pdf of ppt or doc file) detailing their understanding, approach, methodology and expected outcome.
7. There will be a preliminary screening of the submitted solutions. The signed Declaration form and concept note will be evaluated in screening process.
8. After screening, successful participants have to present the solution to the Jury online as per the allocated slot. Based on the submitted solution and presentation, evaluation will be done.
9. In case of discrepancies, the final decision shall lie with the organizers.
10. Shortlisted participants will be called in the Closing workshop to present their solutions in front of the jury and the audience. If not possible, participants may present their solution over the web.
11. Participants may seek clarification / interact with the Technical Committee for better understanding of the challenge and dataset. GSI will organize open mentoring sessions with pre-defined time-slots.
12. GSI will provide a data package, downloaded and compiled from NGDR, that is to be used for arriving at the solution. Participants may use any additional data, if required, from NGDR or from outside. However, the source of the data must be declared for cross-verification by GSI.
13. Late submissions may result in disqualification
14. All code developed during the Hackathon should be the original work of the team. Participants cannot use code or assets created by someone else without proper permissions or licenses.
15. Any form of cheating, plagiarism, or unfair practices will result in immediate disqualification.
16. The Intellectual Property (IP) of the solution resides with the organizers.
17. Participants are encouraged to share their code and projects with the wider community after the Hackathon. Open-sourcing or publishing the code on GoI platforms is appreciated.
18. Participants should adhere to a code of conduct that promotes inclusivity, respect, and professionalism. Any form of harassment, discrimination, or inappropriate behavior will lead to disqualification.
19. Disputes and Arbitration: In case of any disputes or concerns, the decision of the organizers and panel of judges will be final.
20. The organizers and sponsors of the Hackathon hold no liability for any damages, losses, or injuries incurred during the event. Participants are responsible for their own safety, equipment, and actions.
21. GSI/ Ministry of Mines reserves the right to make changes to the Hackathon rules, format, or prizes at any time. Any modifications will be communicated to the participants in a clear and timely manner.

22. Consent and Media Release: Participants may be required to provide consent for their photographs, videos, or project details to be used by the organizers for promotional or media purposes.

23. There will be no TA/DA for the participants.

Prizes:

There will be eight prizes:

1. First Prize: Rs. 3 Lakhs
2. Second Prize: Rs. 2 Lakhs
3. Third Prize: Rs. 1 Lakh
4. Consolation prizes (5 nos.): Rs. 50,000 each

Timeline:

Activity	Target date
Opening workshop at Hotel Vivanta, Begampet, Hyderabad in hybrid mode: All necessary information and the data set will be presented	20 July 2024
Last date of registration by contestants	02 August 2024
Interaction/ Clarification through open session Mentoring: Participants may seek clarification/ interact with the Technical Committee in pre-defined open session	Between 10-14 August 2024 (Exact date to be declared later)
Last date of submission of solution in the hackathon web portal.	01 October 2024
Evaluation of the solutions by the Jury Board	To be announced
Concluding Workshop at Hyderabad where shortlisted candidates will present their solutions and awards will be distributed	To be announced