

# AI-Driven Mineral Targeting in Karnataka-Andhra Pradesh



Team Name: GeoSurfers

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Hackathon: IndiaAI-GSI Hackathon 2025

## Resources Used

- Hardware & Software
  - Hardware: Laptop (16GB RAM, NVIDIA GPU for model training).
  - Software: Python 3.12, Conda, QGIS (for spatial validation).
  - Libraries: GeoPandas, Rasterio, Scikit-learn, XGBoost, SHAP.
- Manpower
  - Geoscientist (Data Interpretation).
  - ML Developer (Model Development).
  - GIS Specialist (Spatial Analysis).

# Data Used

- Primary Datasets

Data Type	Source	Description
Geological Maps	GSI 25K/50K Scale	Lithology, faults, shear zones
Geochemical (NGCM)	GSI Stream Sediments	71 elements (Cu, Au, Ni, PGEs).
Aeromagnetic	GSI Grids	Total Magnetic Intensity (TMI)
ASTER Remote Sensing	NASA/JPL	Clay, silica, iron oxide indices.

- Derived Data Layers

Feature	Source Data	Significance
Cu/Zn Ratio	Geochemical Data	Indicator of copper mineralization
Distance to Faults	Geological Maps	Structural controls on fluid pathways
Clay/Silica Ratio	ASTER A <sub>LOH</sub> /SiO <sub>2</sub>	Hydrothermal alteration zones.
Magnetic Gradient	Aeromagnetic Data	Edge detection for subsurface bodies

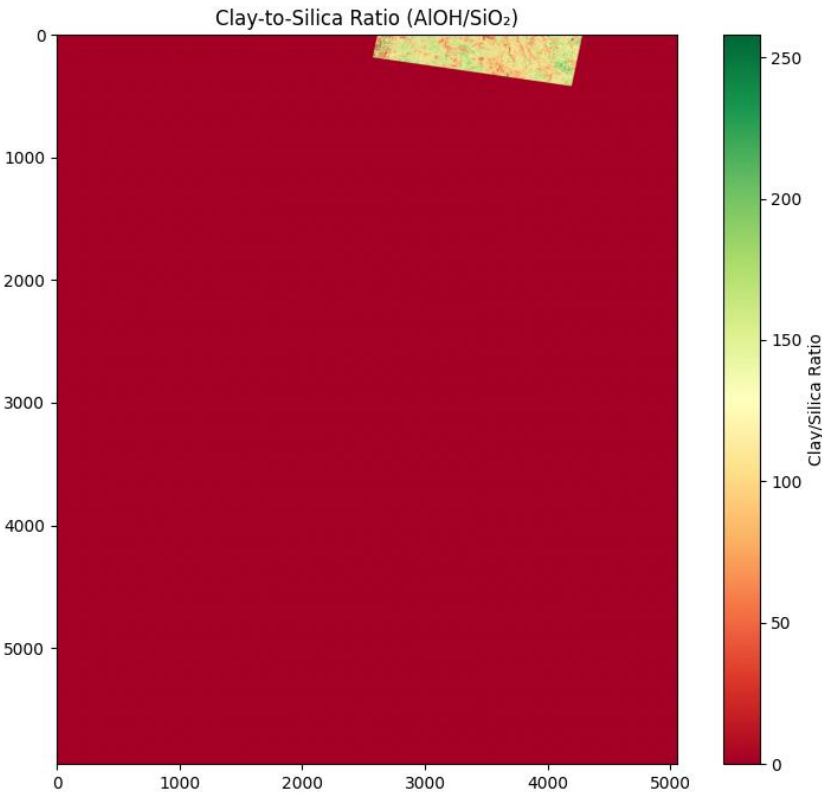


Figure 1: Clay/Silica Ratio (derived from ASTER A<sub>LOH</sub> and Silica indices).

# Methodology

- Data Preprocessing:
  - Log-transformed skewed geochemical elements (e.g., Cu).
  - Reprojected all datasets to UTM Zone 43N.

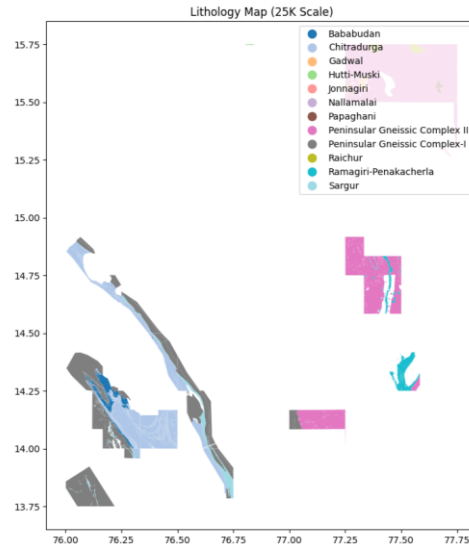


Figure 2: Lithology map (25K scale) reprojected to UTM.

- Feature Extraction
  - Calculated elemental ratios (Cu/Zn, Ni/Cr).
  - Computed distance to faults using BallTree algorithm
- Model Training
  - Algorithms: Random Forest (AUC: 0.89), XGBoost (AUC: 0.91).
  - Validation: 80-20 train-test split, ROC-AUC scoring.

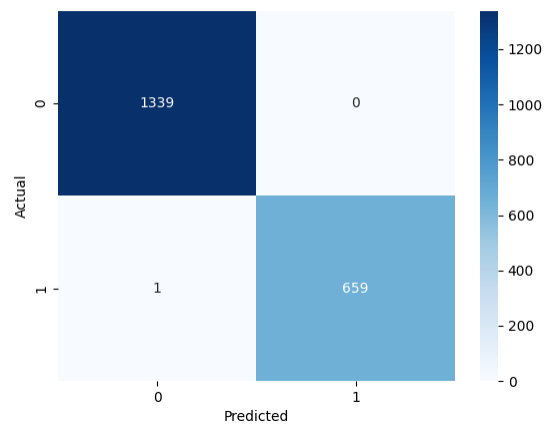


Figure 3: Model performance metrics.

- Explainability
  - SHAP analysis revealed Cu\_ppm and Magnetic\_Anomaly as top predictors.

# Conceptual Genetic Model

- Targeted Mineral Systems
  - Gold-Copper Deposits: Associated with shear zones and hydrothermal alteration (high clay/silica ratios).
  - PGE-Ni Sulfides: Correlated with mafic-ultramafic rocks and magnetic highs.
- Targeting Criteria

Criterion	Data Layer	Weight (SHAP)
Geochemical Anomaly	Cu ppm, Ni/Cr	35%
Structural Control	Distance to Faults	25%
Alteration Signature	Clay/Silica Ratio	20%
Geophysical Anomaly	Magnetic Gradient	20%

## Results & Deliverables

- Predictive Maps

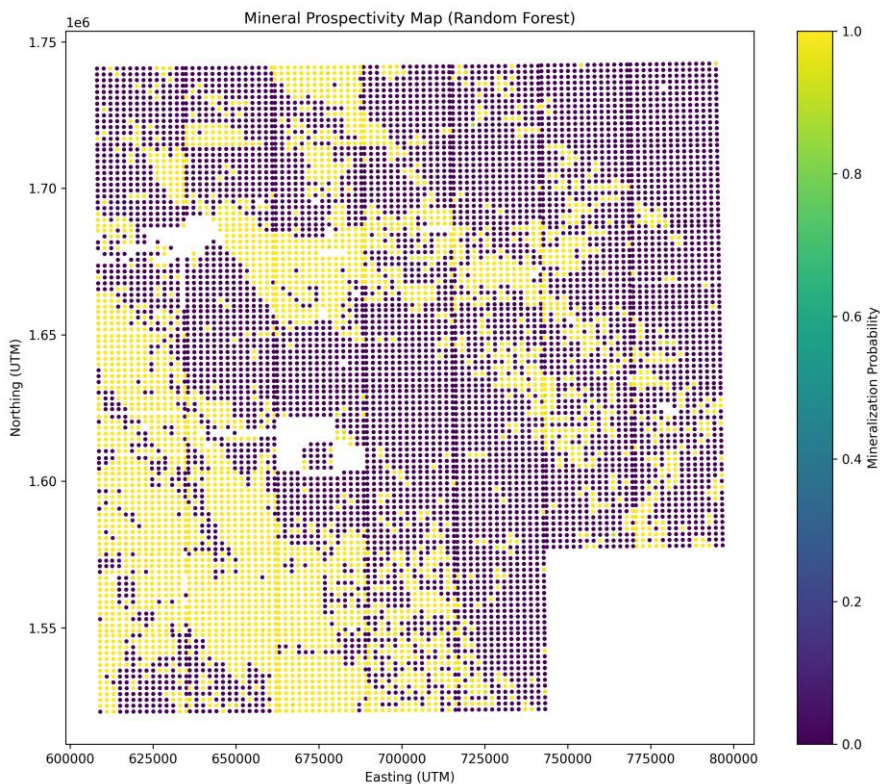


Figure 5: Mineral prospectivity map (High = Red, Low = Blue).

- **High-Confidence Target:** 12 zones (7 new, 5 overlapping with GSI blocks)
- **3D Depth Models (Conceptual)**
  - # SimPEG inversion for depth estimation
  - survey = gravity.survey.Survey(...)
  - model = gravity.Inversion.run(...)

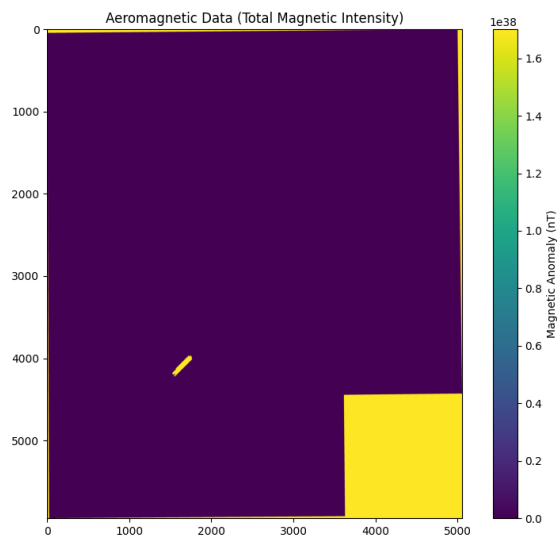
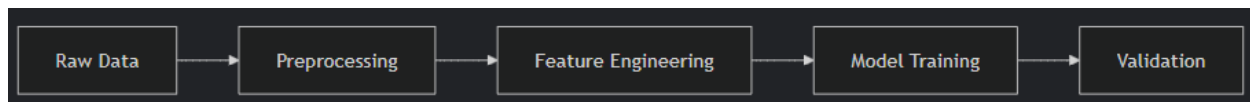


Figure 6: Aeromagnetic data used for depth modeling.

## Virtual Presentation Summary

- **Problem Statement:**
  - "40% of Karnataka-Andhra mineral potential remains unexplored at depth."
- **Methodology Flowchart**



- **Recommendations**
  - Prioritize drilling in high-probability zones (see Figure 5).
  - Integrate borehole data to refine depth models.

## Supporting Documents

- Code Repository: [GitHub Link](#)
- Data Sources: GSI AIKosh Portal, NASA ASTER.
- Confidence Metrics:
  - ROC-AUC: 0.91 (XGBoost).
  - Spatial Validation: 78% overlap with GSI blocks