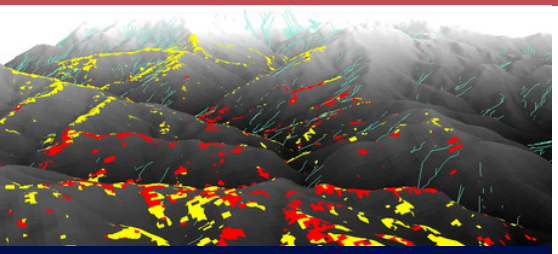
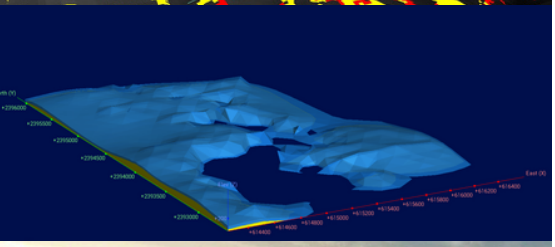
GEOVALE SERVICES- SHAPING THE FUTURE OF NATURAL RESOURCES EXPLORATION AND MANAGEMENT





OUR STORY OF INNOVATION, IMPACT, AND CAPABILITY

GEOVALE SERVICES

EXPLORE OUR BROCHURE TO LEARN MORE ABOUT OUR FULL RANGE OF CAPABILITIES

WHERE

3RD FLOOR, BLOCK GN, PLOT-38/5, SALTLAKE, SECTOR-V, KOLKATA, INDIA

VUPR0378, COMPASS BUILDING - AL HULAILA INDUSTRIAL ZONE-FZ, RAS AL-KHAIMAH, UNITED ARAB EMIRATES

CONTACT DETAILS

+91 (33) 4061 2887

info@geovale.com
www.geovale.com

Precision Earthtech and High-Fidelity Geoscience for Critical Minerals and Water Resource Security

OUR MISSION

At Geovale Services, we integrate high-fidelity geoscience and adaptive AI-ML intelligence to deliver predictive, ethical, and scalable solutions across the minerals and water value chain- enabling smarter, more sustainable decisions for governments, industries, and communities, globally.

OUR VISION

To be the Planet's trusted intelligence partner, where innovation in technology and geoscience empowers humanity to balance progress with stewardship of our planet's critical mineral and water systems.

CORE INSIGHT

Geovale Services unites geoscience expertise with adaptive AI to create intelligent, predictive solutions across the minerals and water value chain.

IMPACT

Through the fusion of Human and Artificial Intelligence, we transform exploration, resource management, and sustainability into an evolving, data-driven ecosystem.

AT YOUR SERVICE

ABOUT GEOVALE SERVICES

Geovale Services brings together 50+ experts offering integrated solutions across the mineral, water, geotech, and minor minerals domains.
With projects in 50+ countries and as one of the first Notified Private Exploration Agencies (NPEAs) of India, we set benchmarks in Greenfield exploration and the entire mineral value chain- from predictive exploration and mine planning to financials, processing, and downstream strategy.
Backed by 300+ years of cumulative expertise and collaborations with leading Centers of Excellence, we transform exploration into market-ready opportunities, driven by innovation, sustainability, and global best practices.

ONE-STOP CONSULTANCY

Geovale provides a truly comprehensive range of consulting services from grass roots exploration through to mining and getting market ready product.
Our clients range from the Government of India to globally established industry leaders, reflecting the trust we've earned at every scale.
We value our independence and are committed to delivering bespoke, science-led solutions rather than onesize-fits-all formulas.

WHO'S ON THE TEAM?

Geovale's reputation is built on the strength of its people. Our team brings together geologists, mining specialists, hydrogeologists, environmentalists, civil engineers, and more, offering truly multi-disciplinary expertise under one roof.
Over 70% of our senior domain leaders are published authors in renowned international journals and continue to contribute cutting-edge research that shapes industry knowledge.

WHY DO YOU CHOOSE US?

At Geovale Services, our track record speaks for itself:

- In Bundelkhand craton (India), once declared barren, we decoded a complex hydrothermal porphyry copper system in the Bastar Craton; unveiling a new mineral district, the first of its kind since the discovery of Malanjkhand, India.
- We discovered a major REE district in Gujarat, India, a game-changer with the potential of strengthening India's critical minerals security.

With a consistently high success rate and a commitment, personally pledged by our CEO "to discover at least one new deposit every year", Geovale has set itself apart.

Our multi-disciplinary expertise makes us a true one-stop solution, covering the entire mineral value chain; from Greenfield exploration to feasibility studies, processing, and beyond. Clients return to us because we take on challenges with confidence and deliver more than what's expected.

CORE CAPABILITIES

GEOVALE'S MINERAL VALUE CHAIN CAPABILITIES

GEOVALE'S MINERAL VALUE CHAIN CAPABILITIES: COMBINING TECHNICAL RIGOUR WITH COMMERCIAL INSIGHT

SUCCESS RATE

Across our engagements, we've consistently delivered actionable outcomes- reducing uncertainty, accelerating decision-making, and improving the quality of targets and interventions. Our approach combines domain expertise with disciplined analytics and field validation, enabling clients to move from data to confident execution with measurable efficiency gains.

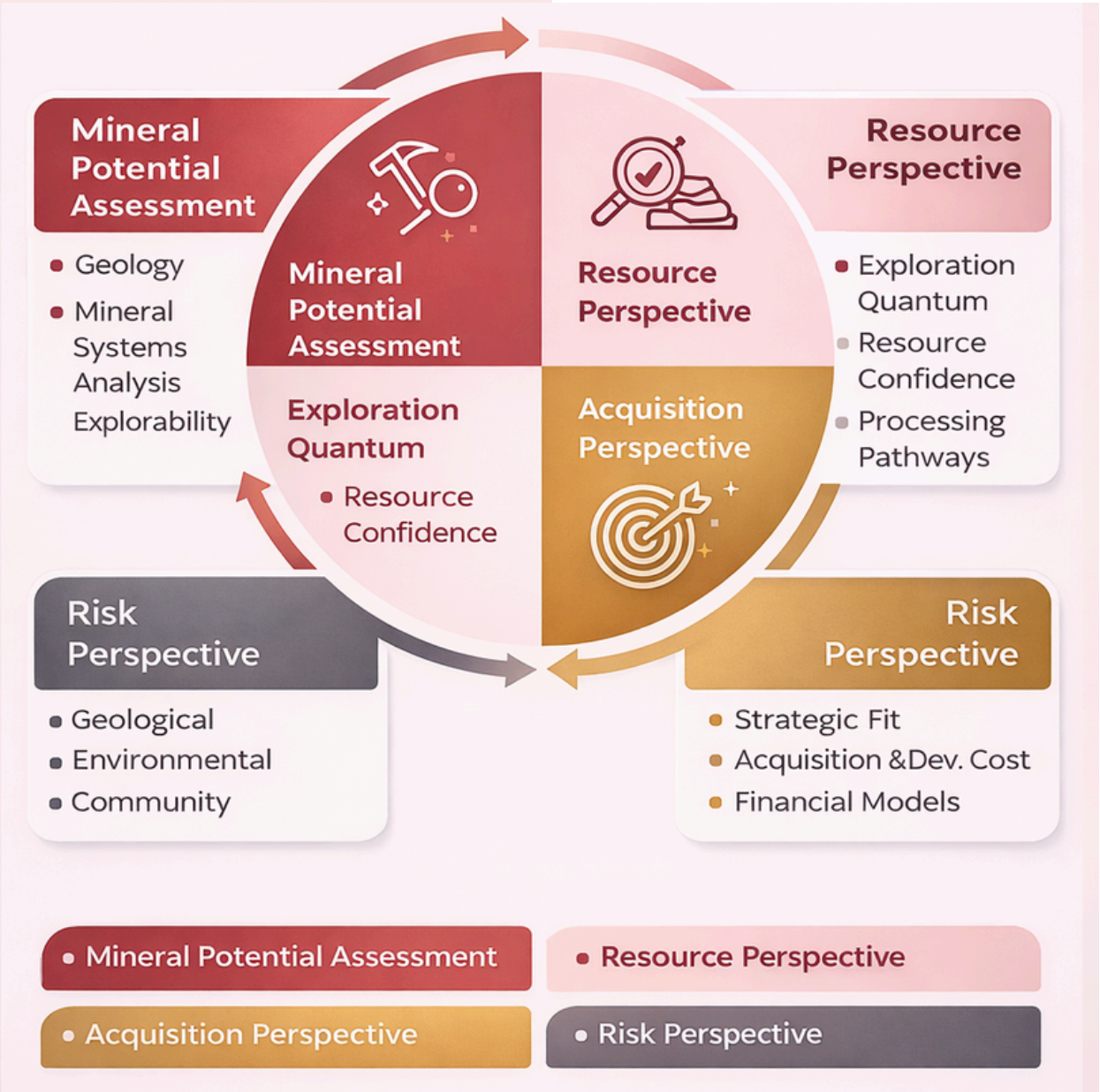
MINERAL ASSET EVALUATION STRATEGY

A 360° FRAMEWORK FOR INVESTMENT-READY MINERAL DECISIONS

Geovale provides a structured Mineral Asset Evaluation Strategy that enables confident, investment-ready decisions across the full asset lifecycle. Our approach begins with mineral potential assessment, integrating geology, Mineral Systems Analysis (MSA), and explorability to establish the technical upside.

We then evaluate assets from a resource perspective- reviewing exploration quantum, confidence in resource definition, mineability, and processing/beneficiation pathways. From an acquisition perspective, we assess strategic fit, acquisition and development costs, and develop fit-for-purpose financial models.

Finally, we deliver a comprehensive risk perspective covering geological, resource, environmental, community, and fiscal risks, ensuring balanced, decision-grade recommendations for clients and stakeholders.



TECHNOLOGY USED

ABOUT TECHNOLOGY ADAPTION

Geovale Services unites high-fidelity geoscience with adaptive artificial intelligence to deliver decision-grade solutions across the minerals and water value chain.
At its core, we integrate Human Intelligence (HI)- the interpretive depth of experienced geoscientists, with machine learning, automation, and advanced analytics. This creates a continuous learning system capable of predicting geological potential, water risk, and environmental change with precision and speed.
Through its twin frameworks- Adaptive Mineral Intelligence (AMI) and Adaptive Water Intelligence (AWI); Geovale transforms conventional resource management into an intelligent, iterative, and sustainable process, bridging science, technology, and stewardship.
At Geovale Services, technology amplifies, not replaces, Human Intelligence. This adaptive loop ensures that every outcome; whether a mineral prospectivity map or a groundwater sustainability plan, improves with each iteration.
The result is an intelligent EarthTech ecosystem that is transparent, responsive, and rooted in real science.

ADAPTIVE MINERAL INTELLIGENCE (AMI)

GAMI integrates the Mineral Systems Analysis (MSA) approach with data-driven intelligence to revolutionize Greenfield and Brownfield mineral exploration. It builds upon:

- High-fidelity geoscience models defining system fertility and mineralization style.
- AI-trained agents that extract, clean, and rank fertility indicators and vectors from large public or proprietary datasets.
- Human-in-the-loop validation, ensuring every prediction aligns with real-world geological logic.

AMI accelerates discovery by turning regional datasets into predictive exploration maps, identifying high-prospectivity corridors, and guiding investments from target generation to resource definition- faster, smarter, and with scientific integrity.

ADAPTIVE WATER INTELLIGENCE (AWI)

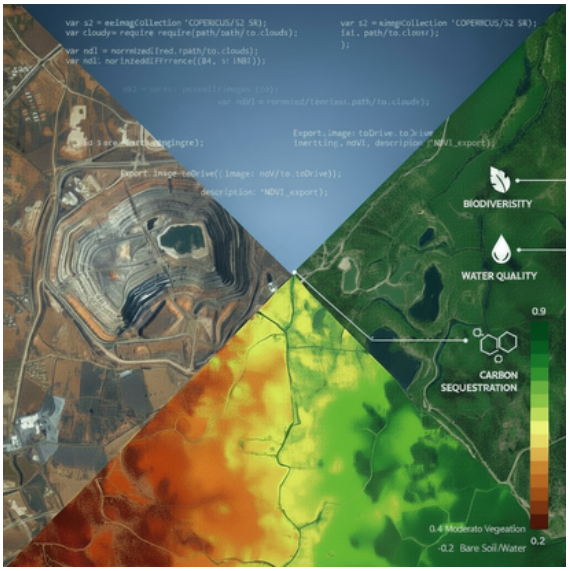
AWI is a data-intelligent framework for sustainable groundwater and water resource management. It links hydrogeological interpretation with AI-ML modeling to achieve:

- Integrated water balance modeling across surface, subsurface, and climatic systems.
- Predictive analysis of recharge, storage, and extraction stress zones.
- Science-based design of interventions from spring-shed rejuvenation and aquifer recharge to urban water resilience and catchment restoration.

AWI empowers stakeholders to make real-time, evidence-based water decisions, combining data precision with ecological and social context.

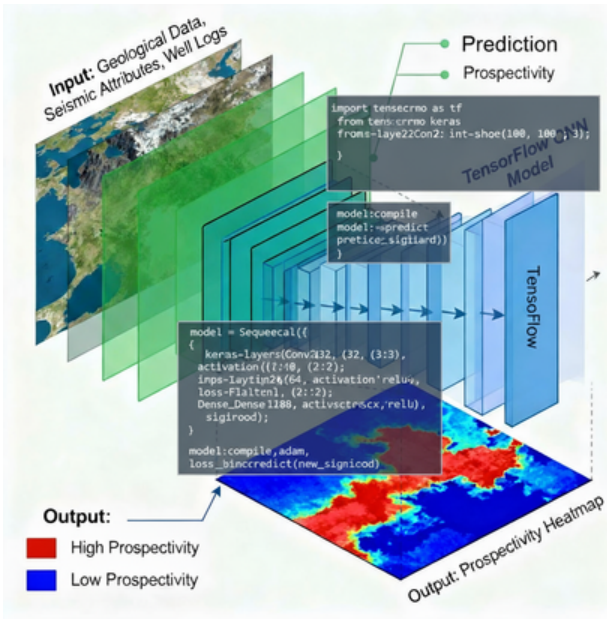
HUMAN INTELLIGENCE + ARTIFICIAL INTELLIGENCE = ADAPTIVE INTELLIGENCE

Integrated Domains of Intelligence

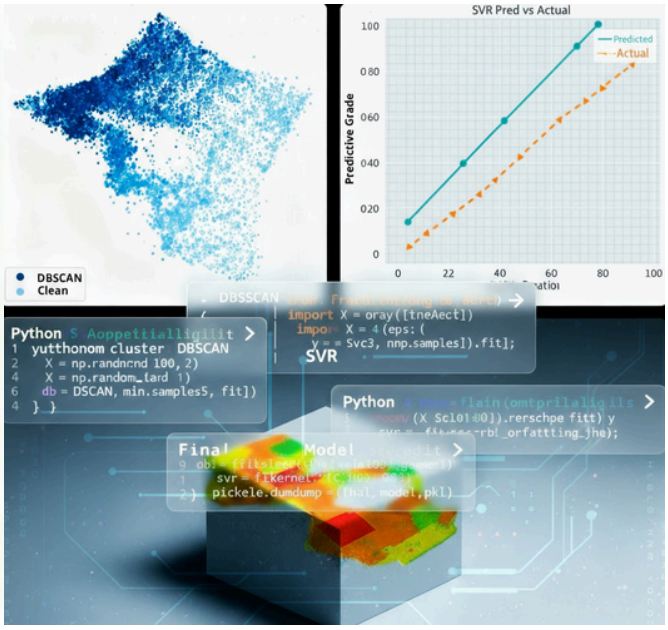


ESG Analytics

Pit to port orchestrator



Predictive exploration targeting



Dynamic resource intelligence

The integration of AI-powered ESG analytics, pit-to-port orchestration, predictive exploration targeting, and dynamic resource intelligence defines a new paradigm in Earth intelligence.
Together, these domains enable real-time insights, smarter decisions, and sustainable outcomes- transforming how the mineral and water sectors operate in the digital era.

HIGHLIGHTS OF OUR RECENT ACHIEVEMENTS

DISCOVERY-LED EXPLORATION AND INVESTMENT-GRADE ADVISORY ACROSS MINERALS AND MARKETS

India's 1st Heliborne Aero-EM Survey

India | 10 blocks

- Interpreted aero-electromagnetic datasets for targeting
- **Outcome:** First-of-its-kind national-scale national-scale deliverable

Geophysics | Targeting | Basin Insight

Inland Placer REE District Discovery (India's 1st)

India | REE-HREE

- Defined district-scale REE potential and HREE prospect
- **Outcome:** National 'first" discovery milestone

MSA | Discovery | Critical Minerals

4 New Mineral District Discoveries

Multi-region

- Built system-scale models and validated target corridors
- **Outcome:** 4 district-level discoveries

MSA | Target Gen | Critical Minerals

South Minerals Project — Transaction Support

Oman |

- Due diligence + technical-commercial support through deal cycle
- **Outcome:** RO **204M** shareholder agreement

Due Diligence | Valuation | Deal Support

Midwest Granite — Capital Market Enablement

India

- Technical diligence + market narrative support
- **Outcome:** USD 50M' successful IPO

DD | Market Studies | Financial Modelling

India's 1st State-Level Mineral Systems Framework

India

- Developed corridor ranking for REE, base metals, critical minerals
- **Outcome:** Repeatable state-scale prospectivity

Framework | Prospectivity | Strategy

Bauxite Exploration – AI-Drive Targeting

Guinea |

- Geomorph + AI modelling to prioritise lateritic plateaus
- **Outcome:** Faster drilling prioritisation and targeting confidence

Dolomite Feasibility Optimisation Dhotar, Oman

Dhofar, Oman

- Combined 3D structural modelling with logistics analytics
- **Outcome:** Optimised mine-to-port economics

Targeting | Discovery | Due Diligence | Financial Modelling | Strategy

PROJECT SUCCESS STORIES

INTELLIGENCE IN ACTION

FROM ROCK TO RIVER, EVERY GEOVALE SERVICES SUCCESS PROVES THAT WHEN HUMAN INTELLIGENCE AND EARTHTECH WORK TOGETHER, SUSTAINABILITY IS NOT AN AFTERTHOUGHT- IT'S ENGINEERED FROM THE START.

COMMITMENT TO THE VALUABLE WATER RESOURCE

Groundwater Security: Theni & Goa: Adaptive Water Intelligence (AWI) modeled recharge and extraction stress, guiding aquifer-recharge zoning and sustainable abstraction limits.
Urban Flood Management: Tiruppur & Kolkata: Integrated HydroAI simulations with terrain analytics to design blue-green infrastructure and reduce inundation risk by up to 40%.
Basin Planning: Mahanadi River System: Linked hydrological balance modeling with policy frameworks for equitable water allocation.
Spring-shed Rejuvenation: Western Ghats: Mapped hydro-geophysical corridors using infiltration modeling, restoring spring discharge resilience.
Lake Health Metric: Arkavathy Basin: Developed India's first AI-aided lake-health index integrating hydrology, ecology, and community stewardship.

AWI projects turn complex hydrology into actionable governance intelligence, making water management predictive, inclusive, and adaptive.

COMMITMENT TO THE VALUABLE MINERAL RESOURCE

Gypsum & Limestone Due Diligence- Oman: Applied Adaptive Mineral Intelligence (AMI) to integrate spectral, geochemical, and pit-design data, delivering rapid resource confidence for investment readiness.
Bauxite Exploration- Guinea: AI-driven geomorphological modeling pinpointed high-grade lateritic plateaus, accelerating drilling prioritization.
Dolomite Feasibility- Dhofar Region: Combined 3D structural modeling with logistics analytics to optimize mine-to-port economics.
Critical Mineral Assessment- India: Developed India's first state-level Mineral Systems Framework, ranking prospective REE, base-metal, and critical-mineral corridors.
Iron Ore Market Study- Senegal: Linked geological resource data with trade analytics for value-chain optimization and combined captive use and export strategy.

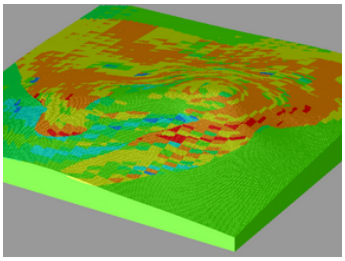
Across all mineral projects, AMI enabled faster discovery, data-driven decision-making, and scientifically defensible investment outcomes.

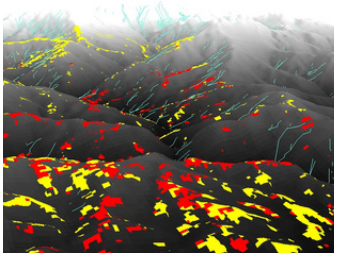
EXPLORATION

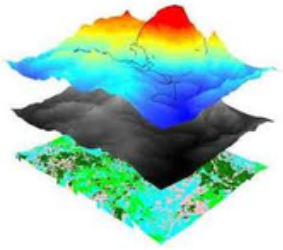
FROM OBSERVATION TO INTELLIGENCE

We don't just map where minerals occur- we decode why they exist there.

Through Adaptive Mineral Intelligence (AMI), Geovale Services transforms geological data into predictive knowledge that reveals the processes, structures, and systems behind mineral formation. By integrating Human Intelligence with AI-ML EarthTech, we bring unprecedented clarity to mineral system prediction and target generation.







OUR EXPLORATION APPROACH

Our exploration philosophy begins with the mineral system framework, identifying the geodynamic controls that govern fertility and mineralization style. Each project follows an adaptive workflow:

System Recognition: Define the mineral system in its tectonic context to establish fertility criteria.

Data Integration: Fuse geological, geochemical, geophysical, and remote-sensing datasets within our cloud-native AMI environment.

AI-Enabled Pattern Detection: Machine-learning agents extract vectors, alteration signatures, and structural controls from multi-scale data.

Human-in-the-Loop Validation: Experts refine predictions through field truthing and lab verification.

Adaptive Learning: Models update with each new dataset, refining target probabilities and prospectivity maps.

This creates a continuous-learning exploration loop, where every project makes the next one smarter.

CORE CAPABILITIES

High-Fidelity Geoscience: Field mapping and structural analysis that build the foundation of data truth.

Geochemical and Spectral Analytics: AI-assisted correlation of multi-element anomalies and hydrothermal alteration signatures.

Geophysical Intelligence: Integration of magnetic, gravity, and radiometric data for structural decoding and subsurface modeling.

Remote Sensing & Spectral AI: Automated mineral mapping using satellite and hyperspectral imagery processed through trained AI - ML agents.

Target Prioritization & Ranking: Quantitative scoring using our multi-criteria decision framework to identify the most fertile prospects.

Exploration Execution & Supervision: End-to-end project management from Greenfield exploration to target generation and testing to drilling design to core logging and QA/QC to feasibility.

Each capability feeds into our adaptive learning cycle, ensuring that data does not just describe the Earth- it interprets it.

WHAT SETS US APART?

Science-Led AI: Our AI models are trained on validated geological principles, not black-box correlations.

Adaptive Mineral Systems Framework: Applies fertility vectors and indicators specific to each deposit type.

Continuous Feedback: Every field validation updates our predictive engines-making each iteration more precise.

Decision Support for Investors and Governments: Translates complex geoscience into clear, risk-based investment intelligence.

Sustainability by Design: Predictive analytics integrate environmental constraints from the very first stage of exploration.

WATER

FROM GROUND TO GOVERNANCE

Geovale Services is India's only EarthTech platform that integrates the entire water value chain from groundwater and catchments to rivers, wetlands, and urban systems.
Through our Adaptive Water Intelligence (AWI) framework, we combine high-fidelity hydrogeoscience with AI-ML analytics to design sustainable, data-driven water management strategies. Our mission is simple yet transformative **"to ensure that every drop of water is mapped, modeled, and managed intelligently"**.

OUR WATER INTELLIGENCE ECOSYSTEM

We address the complete hydrological continuum; from the aquifer beneath to the atmosphere above; through a unified digital and scientific framework:

Groundwater Systems:
Aquifer mapping, recharge modeling, and Managed Aquifer Recharge (MAR) design.
Surface Hydrology:
River and basin-scale water balance, catchment management, and flood resilience planning.
Urban Water Systems:
Blue-green infrastructure, stormwater modeling, wastewater reuse, and circular city design.
Ecosystem Water:
Wetland rejuvenation, spring-shed restoration, and environmental flow analytics.
Governance & Policy:
Decision dashboards and digital twins supporting transparent, decentralized water management.

AWI turns complex water systems into intelligent, living models that learn and adapt- bridging hydrology, ecology, and governance.

TOOLS AND TECHNOLOGIES

Geovale Service's Adaptive Water Intelligence stack integrates field instruments, AI engines, and visualization platforms into one seamless EarthTech ecosystem:

HydroAI:
Predictive modeling of recharge, flow, and water balance across scales.
Terrain Intelligence:
High-resolution DEM and rainfall-runoff simulation for flood and catchment analysis.
EcoAI:
Assessment of wetland health, vegetation-water linkage, and ecosystem resilience.
Water Quality AI:
Contamination prediction and water chemistry modeling.
Technology Viz:
Interactive dashboards and digital twins for policy and planning.

Each project leverages cloud-based learning loops, where models improve continuously as new data streams in.

WHY GEOVALE HYDRO?

End-to-End Water Intelligence:
From aquifer to city, we integrate science, technology, and governance.

Adaptive Modeling:
Our AI systems learn from field validation and satellite data to refine predictions over time.

Scalable & Cloud-Native:
One platform for national missions or local watershed interventions.

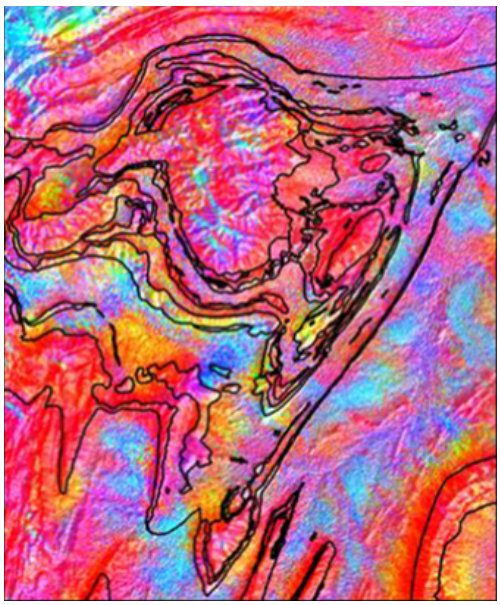
Actionable Decision Support:
Translating science into policy dashboards that empower communities and governments.

Sustainability by Design:
Every model embeds environmental, social, and climate-resilience parameters.

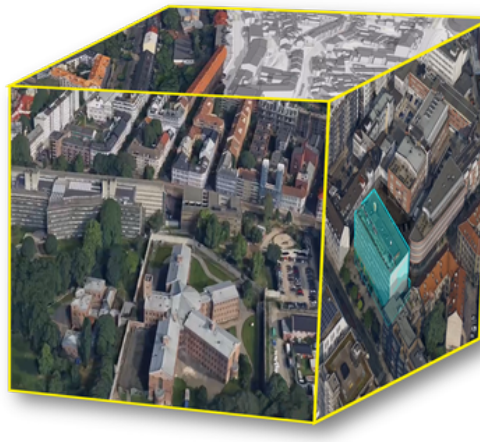
GEO-SPATIAL

FROM MAPS TO MEANING:AI/ML-POWERED GEO-INTELLIGENCE

Geovale Services transforms geospatial science into adaptive intelligence. Our platform integrates satellite imagery, drone surveys, and GIS analytics into living datasets that continuously learn from new inputs.
By merging Human Intelligence (HI) with machine vision and geospatial AI, we turn static maps into dynamic Earth models that explain not only what is visible, but why it matters.



Radiometric Ternary map shows higher values of K above the quartzite bands



3D Building Footprint using Drone Optical Image

ACROSS DOMAINS

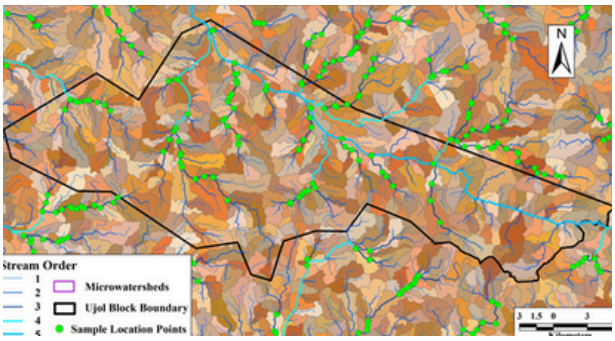
Geospatial science is the spatial backbone of Geovale Service's adaptive frameworks:
In Minerals (AMI):
Spectral and structural analytics delineate fertility indicators, alteration halos, fluid pathways and mineralization vectors.
In Water (AWI):
Terrain and drainage models simulate recharge, runoff, and catchment connectivity.
In Environment & Land Use:
Multi-temporal satellite data detect ecosystem change, vegetation stress, and anthropogenic impacts.
Every pixel becomes a decision point in our AI-ML ecosystem, linking field reality with digital foresight.

CORE CAPABILITIES

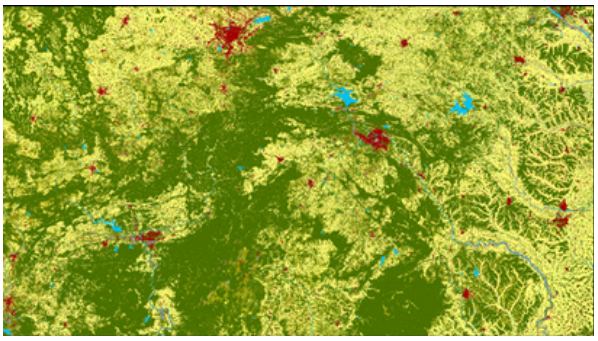
Satellite & Hyperspectral Analysis:
Automated mineral and vegetation signature extraction using AI-driven spectral unmixing.
Drone and LiDAR Mapping:
Ultra-high-resolution terrain and structural modeling for mining and hydrology.
Spatial Data Integration:
Cloud-based GIS architecture linking geoscience, hydrology, and socio-environmental layers.
Change Detection & Time-Series Analytics:
Monitoring land-use, erosion, and surface-water variability for adaptive management.
Digital Visualization:
Dashboards and 3D digital twins built using technology for interactive decision-making.
Each tool feeds into the learning loop- observe, analyze, learn, predict.

A unified EarthTech platform blending AI, RS-GIS, and field data for real-time, scalable insights- from mineral targets to flood forecasts. Turning complex geoscience into instant, actionable intelligence.

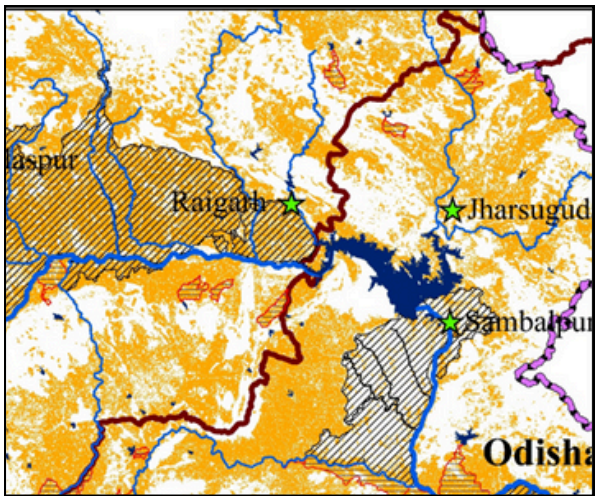
Geospatial Solutions We Deliver



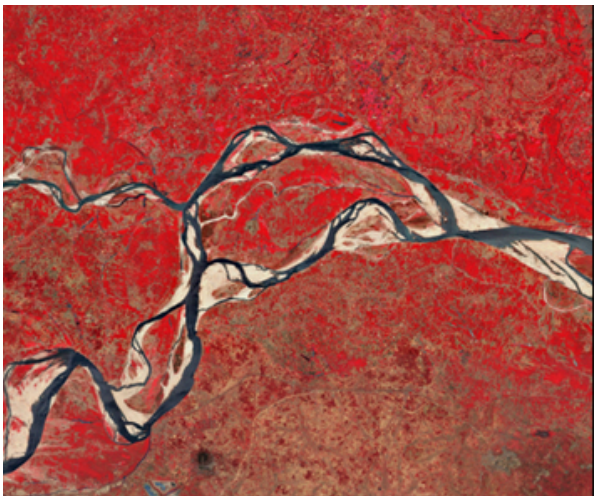
Selection of Probable Stream Sediment sample collection points considering Drainage Order



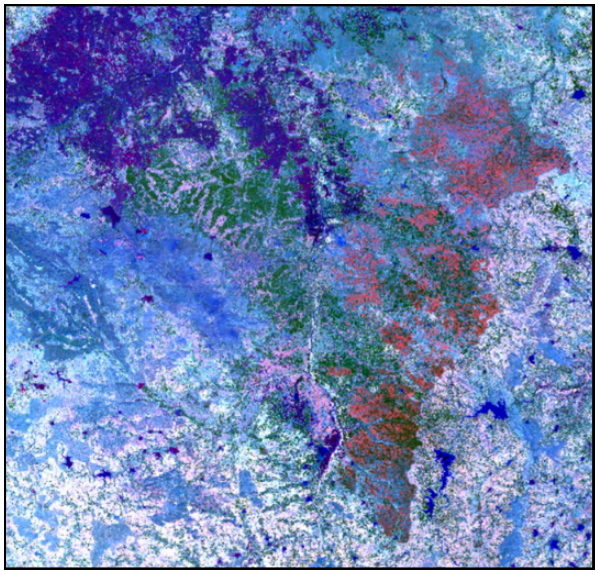
LULC using Sentinel 2A



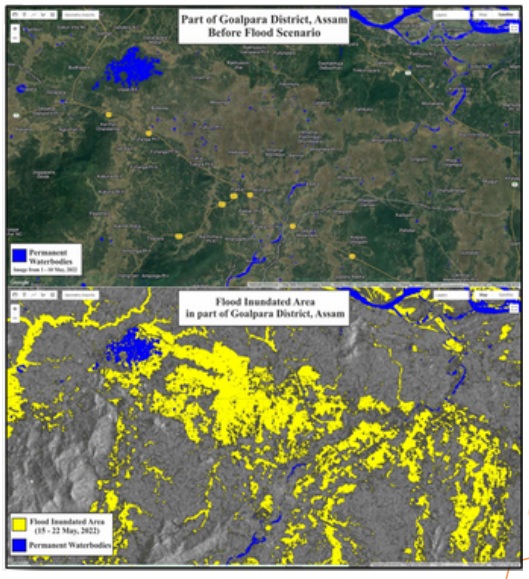
Command area with extracted Kharif crop land near Hirakud Dam



FCC of Sentinel 2A showing River Water and Sedimentation



Mineral Alteration Zone Identification using multispectral imageries



Flood Inundated Area (Yellow coloured) Extraction using Google Earth Engine

Red - Iron Oxide, Green - Chloride-Epidote changes, Blue - Ferrous Mineral

GEOTECH

ENGINEERING STABILITY, SUSTAINING GROWTH: GEOTECHNICAL SOLUTIONS FOR A SAFER TOMORROW

Geovale Service's Geotech division brings together field-tested engineering expertise and AI-driven analytics to understand, model, and stabilize the Earth.
From foundations and slopes to tunnels and dams, our approach unites Human Intelligence (HI) with Adaptive EarthTech - turning ground behavior into predictive insight.
We don't just test the Earth; we learn from it - ensuring that every design is informed by science, data, and sustainability.

GEOTECH IN THE ADAPTIVE INTELLIGENCE ECOSYSTEM

Our geotechnical practice forms the engineering spine of Geovale Service. Data collected through drilling, in-situ testing, and monitoring are integrated into the Cloud space, where AI-ML models simulate subsurface behavior under varying stress, water, and load conditions.
This adaptive approach allows:

- Early identification of foundation or slope instability.
- Real-time update of design parameters as site conditions evolve.
- Seamless data flow between geological, hydrogeological, and structural domains.

The result: smarter, safer, and more sustainable engineering solutions that evolve with data.

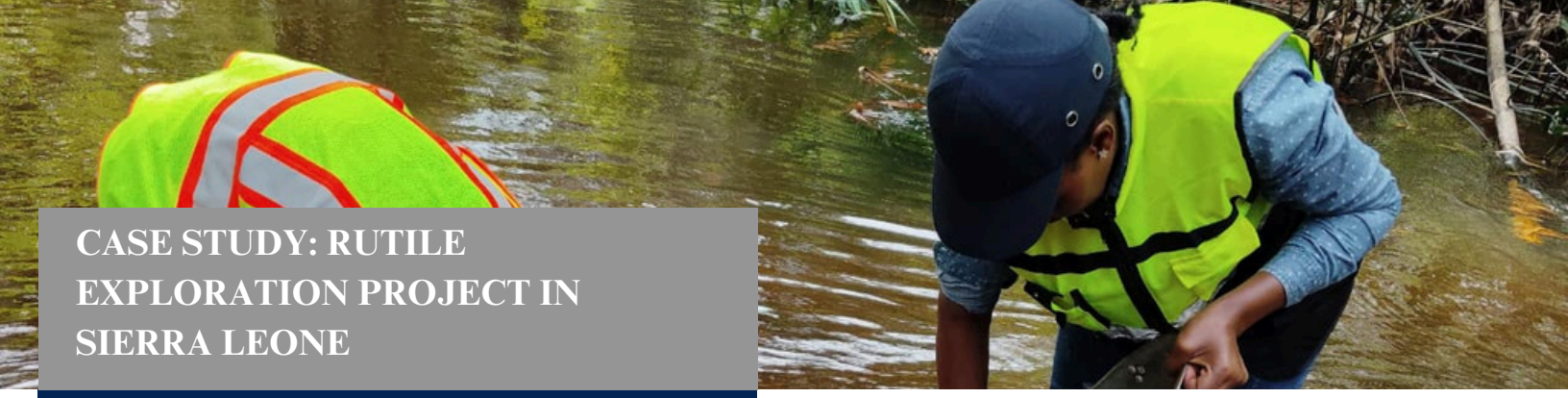
CORE CAPABILITIES

Subsurface Investigation: Borehole drilling, coring, and in-situ testing (SPT, CPT, vane shear, pressure-meter).
Laboratory Analytics: Grain size, Atterberg limits, UCS, triaxial, and consolidation testing- linked to digital result dashboards.
Slope Stability & Rock Mechanics: Numerical modeling using AI-calibrated limit equilibrium and FEM simulations.
Foundation Engineering: Bearing capacity modeling, settlement prediction, and foundation design optimization.
Ground Improvement Solutions: Design and supervision of grouting, compaction, and drainage interventions.
Instrumentation & Monitoring: Sensor-based slope and structure monitoring integrated with real-time predictive alerts.

Every dataset feeds the Geovale Services digital twin- enabling continuous learning and predictive safety management.

CASE STUDIES

THAT REDEFINE HOW DATA, MODERN TECHNOLOGY, AND GEOSCIENCE CREATE MEASURABLE IMPACT



CASE STUDY: RUTILE EXPLORATION PROJECT IN SIERRA LEONE

OBJECTIVE

To evaluate the rutile and associated heavy-mineral potential across the Bradford and Bagruwa concession blocks of Sierra Leone. The goal was to integrate classical field geomorphology and mineralogy with AI-enabled data correlation to define placer-hosting corridors, characterize sediment provenance, and identify zones ready for systematic exploration within a Mineral Systems Analysis (MSA) framework.

CHALLENGES

The study contended with complex terrace reworking, discontinuous deposits, and accessibility limits during monsoons. Differentiating original placer horizons from re-mobilized sediments required meticulous stratigraphic logging and human-led interpretation to guide AI corrections.

MODERN TECHNOLOGY USED

- **Placer Intelligence Module:** Geomorphic–spectral anomaly extraction.
- **Terrain Intelligence:** Modeling of paleo-drainage and sediment transport gradients.
- **GeoChem AI:** Heavy-mineral composition clustering and grade estimation.
- **FieldSync™:** Real-time data entry, sample tracking, and field verification.
- **Vektor Viz:** Visualization of terrace geometry, grade distribution, and transport corridors.

STUDY STRATEGY

Geovale implemented a hybrid workflow uniting traditional placer mapping with adaptive analytics:

1. System Definition & Indicators – The Rutile–Ilmenite Placer System was adopted as the target mineral system. Key fertility indicators included geomorphic terrace formations, heavy-mineral concentration, and provenance signatures derived from Kasila Group basement sources.
2. Data Extraction & Synthesis – The Vektor Placer Intelligence Module analyzed geomorphic, spectral, and sedimentological datasets to delineate paleo-channels and terrace boundaries.
3. Field Validation & Sampling – Ground reconnaissance and pit samples quantified Heavy Mineral Concentration (HMC) yields and TiO_2 grades; mineral separates were studied via panning, XRF, and ICP–MS to validate AI-inferred anomalies.
4. Iterative Refinement – Continuous feedback between field mineralogy and AI-modeled geomorphology ensured predictive accuracy and improved correlation of terrace stratigraphy and depositional continuity.

OUTCOME

Geovale's integrated HI–AI process confirmed significant secondary rutile and ilmenite potential, with Heavy Mineral Concentrate (HMC) yields of 5.5–11 wt% and TiO_2 grades between 46–70%. AI-assisted terrace modeling and field mineralogy collectively delineated multiple resource definable blocks suitable for detailed geophysical follow up and drilling.

Achievement year 2025

CASE STUDY: LITHIUM EXPLORATION PROJECT IN CAPECOAST AREA, GHANA

OBJECTIVE

To assess the lithium–cesium–tantalum (LCT) pegmatite potential of Ghana's Cape Coast region through Geovale's Adaptive Mineral Intelligence (AMI) framework; an integration of Human Intelligence (HI) and EarthTech (AI–ML and classical geoscience). The program aimed to delineate fertile pegmatite corridors, evaluate geochemical fertility signatures, and prioritize exploration targets within a Mineral Systems Analysis (MSA) context.

CHALLENGES

Sparse confirmed LCT occurrences, complex deformation, and dense vegetation limited direct field visibility. Discriminating fertile pegmatites from granitic host rocks required integrated mineralogical validation and high-fidelity human interpretation to complement AI modeling.

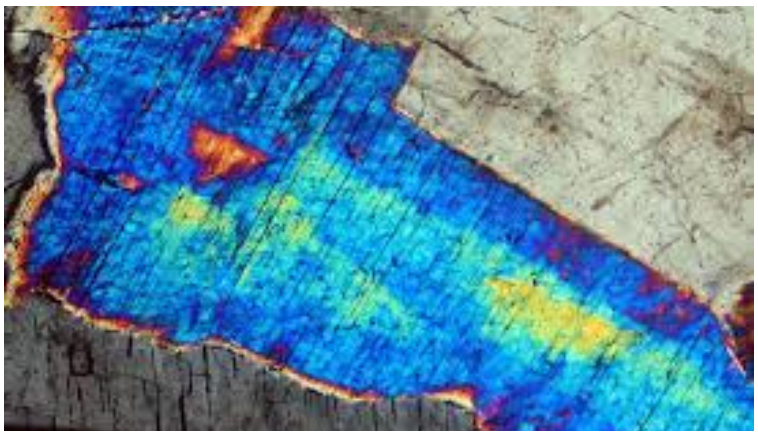
MODERN TECHNOLOGY USED

- Vektor AI Exploration Agent – Predictive fertility and anomaly detection.
- GeoChem AI – Element-ratio analysis for fertility quantification.
- Terrain Intelligence – Structural control and lineament analysis.
- FieldSync™ – Real-time field–lab data integration.
- Vektor Viz – Visualization of pegmatite trends and fertility intensity.

STUDY STRATEGY

The Greenfield exploration adopted Geovale's multi-stage adaptive workflow, combining expert geoscientific interpretation with digital intelligence:

- System Definition & Fertility Vectors – The LCT Pegmatite System was identified as the target mineral system. Key fertility indicators-Rb/K, Li/Ta, Cs/Rb ratios, and radiometric K anomalies - guided initial prediction.
- AI-Driven Extraction & Ranking - The Vektor AI Exploration Agent processed legacy soil, radiometric, and litho-structural datasets to extract and geotag fertile pegmatite vectors.
- Predictive Fertility Mapping - Multi-parameter anomalies were modeled to produce ranked fertility zones consistent with MSA architecture.
- Field Validation - Geological mapping, petrography, and mineral chemistry confirmed pegmatite fractionation levels and verified AI-predicted targets.
- Adaptive Learning Loop – Field data were fed back into the AI model, improving accuracy and enhancing predictive confidence through iterative refinement.



OUTCOME

Geovale's integrated HI–AI workflow identified 19 priority exploration blocks, confirming multiple fertile LCT pegmatite zones with Rb up to 3,349 ppm and Li up to 1,248 ppm. Elevated Rb and low K/Rb ratios confirmed advanced melt fractionation. The combined field-digital approach established a credible roadmap for pitting, mapping, and subsequent follow up drilling programs.

Achievement year 2025

CASE STUDY: DISCOVERY OF PORPHYRY HYDROTHERMAL CU-AU-MO MINERAL SYSTEM IN BUNDELKHAND

OBJECTIVE

Identify and validate the porphyry-style Cu-Au-Mo mineralization within the Bundelkhand Craton using Geovale's Adaptive Mineral Intelligence (AMI) framework, a fusion of Human Intelligence (HI) and EarthTech (AI–ML and classical geoscience). The goal was to delineate alteration halos, fluid pathways, and structurally controlled mineral zones within a Mineral Systems Analysis (MSA) context.

CHALLENGES FACED

Complex intrusive relationships, cryptic surface expressions, and overlapping alteration halos required strong human interpretation to maintain geological coherence and avoid AI over-fitting.

MODERN TECHNOLOGY USED

- Alteration Intelligence – Spectral unmixing of potassic–phyllic–argillic–propylitic zones.
- GeoChem AI – Multi-element correlation for fertility and pathfinder analysis.
- Terrain Intelligence – Structural corridor and fracture-network modeling.
- FieldSync™ – Real-time, geotagged data capture and lab integration.
- Vektor Viz – Visualization of alteration and structural convergence zones.

STUDY STRATEGY

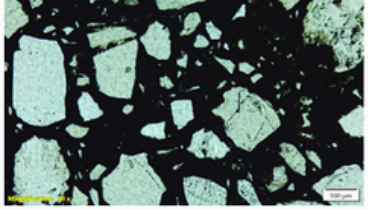
Geovale applied its Greenfield exploration workflow integrating field geoscience with the Vektor EarthTech Stack:

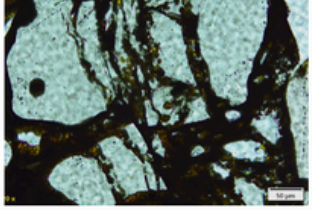
- **System Definition & Fertility Vectors:** Porphyry Cu-Au-Mo system adopted; proprietary geochemical and spectral fertility indicators deployed.
- **AI Extraction & Ranking:** Vektor AI analyzed regional geodata to extract, clean, and rank fertility indicators and structural vectors.
- **Predictive Mapping:** Multi-layer AI models produced alteration-intensity and fertility maps in the MSA framework.
- **Field Validation:** Geologists confirmed potassic-phyllic-propylitic zonation and Cu-Mo vein assemblages through mapping, spectroscopy, and petrography.
- **Adaptive Feedback:** Iterative updates between AI models and field results refined predictions and prioritization.

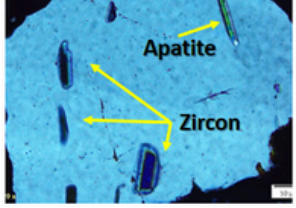
OUTCOME

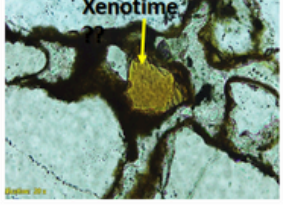
- Vein-controlled Cu mineralization was delineated within potassic alteration zones, confirming the predictive validity of the AI-derived alteration model.
- AI-integrated mapping revealed A-type quartz-sulfide vein systems aligned with key structural intersections.
- The results validated that the Mailar porphyry system hosts significant Cu-Au-Mo mineralization associated with zoned hydrothermal alteration.
- Identified targets were advanced to drill-ready status, providing a robust foundation for systematic resource evaluation.

Achievement year 2025



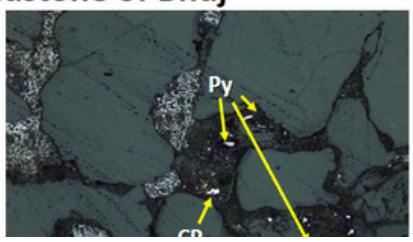


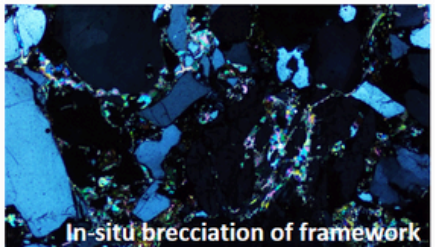




Extensive iron influx in sandstone of Bhuj

CASE STUDY: DISCOVERY OF IOCG STYLE MINERALIZATION IN BHUJ, GUJARAT





OBJECTIVE

Identification and characterization of IOCG (Iron Oxide Copper Gold) style mineralization within the Bhuj Formation of Gujarat's Kachchh Basin. The exploration aimed to evaluate hydrothermal alteration patterns, structural controls, and mineralogical assemblages associated with the Katrol Hill Fault zone using Geovale's Adaptive Mineral Intelligence (AMI) framework - merging Human Intelligence (HI) with AI–ML-driven EarthTech analytics.

CHALLENGES

Exploration within sedimentary faulted terrain required discerning hydrothermal alteration from sedimentary iron enrichment. Strong weathering, ferruginization, and brecciation often obscured diagnostic mineral assemblages. Reconciling these complex surface patterns demanded iterative interpretation between AI analytics and geological intuition

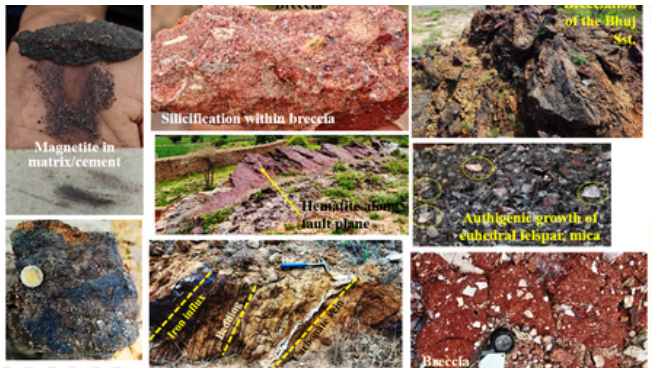
MODERN TECHNOLOGY USED

- Alteration Intelligence: Detection of hematitic–goethitic alteration halos via spectral analysis.
- GeoChem AI: Multi-element correlation for hydrothermal enrichment mapping.
- Terrain Intelligence: Fault-interaction and mineralization corridor modeling.
- FieldSync™: Real-time field data capture and lab integration.
- Vektor Viz: Visualization of structural–geochemical overlap zones.

STUDY STRATEGY

The exploration followed an adaptive, mineral-system–based workflow integrating field geology, laboratory validation, and AI-assisted pattern detection:

- System Definition: The IOCG Mineral System was adopted based on regional tectonics and evidence of fault-associated hydrothermal activity.
- Field Mapping: Geologists mapped ferruginous sandstones and brecciated zones along major fault lines, identifying goethitic–hematitic alteration and copper staining.
- AI-Driven Detection: The Alteration Intelligence Module processed hyperspectral datasets to delineate iron oxide alteration zones, while GeoChem AI analyzed Cu–Pb–Zn–Fe element associations to highlight mineralized corridors.
- Structural Modeling: The Terrain Intelligence System mapped fault–fracture geometries controlling fluid migration and mineral deposition.
- Validation & Refinement: Field and lab data were iteratively integrated into AI models to refine hydrothermal and geochemical anomaly zones for targeted follow-up exploration.



OUTCOME

The study confirmed the presence of IOCG-style hydrothermal mineralization marked by ferruginous alteration, Cu–Pb–Zn–Fe enrichment, and brecciated structures along the Katrol Hill Fault. Integrated modeling delineated multiple G3-level prospective zones, warranting detailed geophysical and drilling investigation. This discovery established Bhuj as a potential frontier IOCG province within Gujarat's Mesozoic formations.

Achievement year 2025

CASE STUDY: RECONNAISSANCE SURVEY (G4) FOR EVALUATION OF PLACER XENOTIME PROSPECT IN UJOL, GOOMA AND PANAM RIVER BASIN, GUJARAT

OBJECTIVE

Geovale Services evaluated the placer potential for Rare Earth Elements (REE) and Rare Metals (RM) in the Ujol, Gooma, and Panam river systems of Gujarat. The study aimed to identify fertile geomorphic traps, quantify heavy mineral enrichment, and establish the relationship between detrital assemblages and basement sources using Geovale's Adaptive Mineral Intelligence (AMI) framework- integrating Human Intelligence (HI) with EarthTech analytics.

CHALLENGES

Variable sediment thickness, complex terrace stratigraphy, and heterogeneous mineral sorting posed challenges in correlating geochemical anomalies with geomorphic settings. Establishing a consistent provenance link required iterative validation between mineral chemistry, AI predictions, and field mapping.

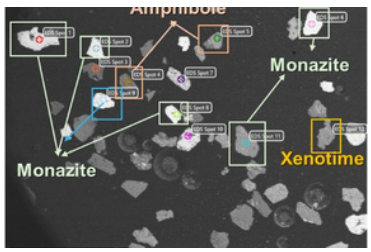
MODERN TECHNOLOGY USED

- **GeoChem AI:** Multi-element anomaly clustering and REE–RM pattern recognition.
- **Terrain Intelligence:** Fluvial geomorphology and sediment transport modeling.
- Resource Intelligence – Provenance and source fertility assessment.
- **FieldSync™:** Real-time geotagged sampling and assay data integration.
- **Vektor Viz:** 3D visualization of terrace enrichment and placer continuity.

STUDY STRATEGY

The exploration program applied a Mineral Systems based placer framework combining classical field geomorphology with adaptive AI analysis:

- **System Definition:** The REE-RM Placer System was defined to capture source-pathway-sink relationships, linking basement fertility with fluvial depositional dynamics.
- **Field Mapping & Sampling:** Geologists mapped terraces, paleochannels, and alluvial zones, conducting systematic gravel and sand sampling across the basin.
- **AI-Assisted Data Processing:** The GeoChem AI module analyzed multi-element geochemical datasets to identify REE-Ti-Zr-Th anomalies, while Terrain Intelligence modeled terrace morphology and sediment transport gradients.
- **Provenance Correlation:** The Resource Intelligence Module integrated geochemical and mineralogical data to trace heavy minerals back to their basement lithologies.
- **Feedback & Refinement:** Laboratory results (XRF, ICP-MS, SEM-EDX, EPMA) validated AI-derived patterns, continuously refining anomaly clustering and fertility mapping.



OUTCOME

The study delineated five G3-level prospective blocks (A1-A3, C1-C2) with Heavy Mineral Concentrate (HMC) contents up to 33.7 wt% and TREEY values peaking at 76,677 ppm. Four mineralization styles alluvial, colluvial, weathered clay, and basement-linked were identified, confirming multi-process placer evolution. The findings positioned the Ujol-Panam Basin as a major emerging REE placer province in western India.

Achievement year 2025

CASE STUDY: ASSESSMENT OF EXPLORATION POTENTIAL OF STRATEGIC MINERALS IN THE GUJARAT STATE, INDIA

OBJECTIVES

Evaluation of Gujarat's potential for strategic and critical minerals - a region historically perceived as non-mineralized - by applying Geovale's Adaptive Mineral Intelligence (AMI) framework. The study sought to design a science-based mineral proceptivity roadmap aligned with India's green-technology and self-reliance goals, integrating Human Intelligence (HI) and EarthTech analytics within a Mineral Systems Analysis (MSA) framework.

CHALLENGES

The diversity of lithotectonic provinces and sparse legacy data made calibration difficult. Inconsistent dataset scales demanded human-led inference to reconcile digital predictions with geological reality. Maintaining fidelity across multiple mineral systems required cross-domain validation by expert geologists.

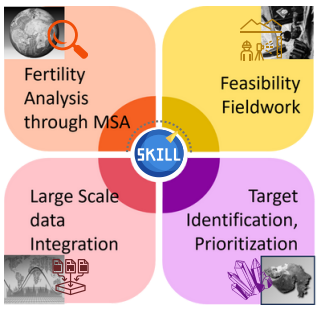
OUTCOME

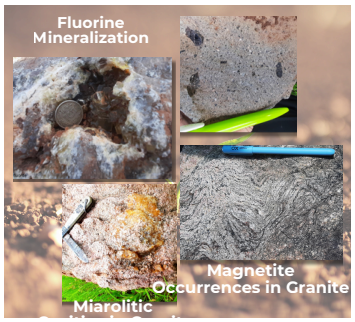
The study produced Gujarat's first mineral-system–based exploration framework, categorizing its geology into eight mineral fertility classes and four physiographic zones. AI-supported analysis identified 29 mineralized belts and eight priority G4–G3 blocks prospective for REE, base-metal, and industrial-mineral exploration. The outcome redefined Gujarat's reputation-transforming it from a "non-mineral" state to a region with credible critical-mineral potential.

APPROACH

Geovale implemented a state-scale exploration intelligence program, linking geological reasoning with AI-driven analytics in five stages:

- System Definition – Key mineral systems (REE, base-metal, industrial-mineral, and sediment-hosted types) were identified based on Gujarat's tectono-stratigraphic domains.
- Data Integration – Regional geological, geophysical, and geochemical datasets from public and institutional sources were harmonized to remove inconsistencies.
- AI-Enabled Mapping – The Vektor Resource Intelligence Module generated fertility and mineral-system maps, while Alteration and GeoChem AI correlated spectral and elemental anomalies.
- Terrain & Structure Modeling – Terrain Intelligence delineated fault–basin geometries, lineaments, and geomorphic traps associated with mineralizing processes.
- Validation & Classification – HI-led interpretation classified terrains into fertility tiers, ensuring AI outputs remained geologically coherent and decision-ready for state-level exploration planning.





GEOVALE'S MODERN APPROACH

- Resource Intelligence: Fertility mapping and system classification.
- Alteration Intelligence: Spectral anomaly detection from satellite datasets.
- GeoChem AI: Multi-element anomaly clustering and pattern recognition.
- Terrain Intelligence: Tectonic and geomorphic modeling.
- FieldSync™: Ground referencing and validation of predicted targets.
- Vektor Viz: Visualization of exploration corridors and mineral-fertility intensity.

Achievement year 2024

CASE STUDY: OMAN LIMESTONE AND GYPSUM DUE DILIGENCE STUDY

OBJECTIVE

Geovale Services conduct a comprehensive technical and economic due diligence of limestone, gypsum, and dolomite deposits across Oman. The goal was to evaluate geological integrity, mineable reserves, and logistical viability while ensuring data-backed operational and market decisions. The study embodied Geovale's Adaptive Mineral Intelligence (AMI) philosophy-combining Human Intelligence (HI) in field geology and mining economics with EarthTech analytics for precision resource evaluation.

CHALLENGES

Karstification, variable anhydrite content, and structural disturbances introduced uncertainty in resource and reserve continuity. Borehole coverage constraints and logistical constraints (haul distance, port access) required continuous calibration between human interpretation and AI refinement to maintain modeling accuracy.

MODERN TECHNOLOGY USED

- **Resource Intelligence Module:** AI-ML and classical resource modelling tool (SURPAC) based block modelling and resource - reserve reclassification.
- **Terrain Intelligence:** Haulage optimization, slope stability, and mine layout analytics.
- **HydroAnalytics AI:** Mine–aquifer interaction modeling.
- **Vektor Viz:** Visualization of grade distribution, haul routes, and reserve scenarios.

STUDY STRATEGY

The due diligence was structured around a multi-layered HI–AI workflow that linked field data, laboratory results, and digital modeling:

- **System Definition:** The Carbonate–Evaporite Mineral System was defined to evaluate ore quality, geological continuity, and mineability under arid conditions.
- **Data Reconciliation:** The Vektor Resource Intelligence Module reanalyzed borehole logs, geological cross-sections, and assay datasets to validate client-provided reserves.
- **AI Integration:** The Terrain and HydroAnalytics Modules modelled haul routes, slope stability, and groundwater–mine interactions for operational planning.
- **Validation Loop:** Field verification, pit inspection, and laboratory analysis (XRF, XRD, petrography) were integrated into the AI models to ensure decision-grade reliability.
- **Economic Modelling:** Financial and logistical datasets were layered into the model, simulating multiple mining and evacuation scenarios to support investment-level evaluation.

OUTCOME

- Geovale's reassessment reclassified resources and identified 2,251.9 MT of proved reserves, a major upgrade from the prior 570 MT estimate.
- Around 76.6% of excavation is marketable material (~1,429 MT), affirming long-term commercial viability.
- Fines generation reassessed at 18–20.5%, and mining losses revised above 2%, aligning production forecasts with realistic field conditions.
- AI-driven simulations demonstrated that crusher relocation could cut haulage lead from 6 km to ~1 km, significantly reducing OPEX and safety risks.

Achievement year 2025

CASE STUDY: FINANCIAL EVALUATION AT PFS LEVEL FOR SENEGAL IRON ORE

OBJECTIVE

To conduct a Pre-Feasibility (PFS)-level financial evaluation for an iron ore deposit in Senegal, integrating geological, logistical, and economic dimensions into a unified decision model. The study's goal was to assess project viability under multiple development pathways and to identify cost-optimized mining, transport, and export options using Geovale's Adaptive Mineral Intelligence (AMI) framework - where Human Intelligence (HI) defines the business logic and EarthTech analytics validate it with precision.

CHALLENGES

Long evacuation distances, limited rail infrastructure, and high fuel dependency created logistical and cost constraints. Geological variability and fines generation further influenced predicted product quality and blending strategy. Achieving a realistic PFS required continuous interplay between AI simulations and expert economic judgment.

MODERN TECHNOLOGY USED

- **Financial Intelligence Module** – Multi-scenario NPV and cost-sensitivity modeling.
- **Hydro-Logistics Intelligence** – Infrastructure and evacuation cost optimization.
- **Terrain Intelligence** – Route and slope analytics for transport efficiency.
- **Vektor Viz** – Visualization of cost curves and financial performance metrics.

STUDY STRATEGY

The evaluation followed a dynamic HI–AI integrated workflow emphasizing financial realism and operational adaptability:

- **System Definition** – The Iron Formation (BIF hosted) System was modeled for its resource, grade, and beneficiation characteristics to anchor economic assumptions.
- **Data Integration** – Geological block models, grade–tonnage curves, and logistics datasets were consolidated for financial simulation.
- **Scenario Modeling** – Using the Vektor Financial Intelligence Module, AI-assisted simulations evaluated CAPEX–OPEX interactions across mining, road-only, and hybrid road–rail evacuation models.
- **Sensitivity & Risk Assessment** – The models incorporated price volatility, exchange-rate variation, and haulage sensitivity to identify high-risk cost drivers.
- **Iterative Validation** – Each AI outcome was reviewed by Geovale's financial and mining experts to ensure interpretive grounding and real-world viability.

OUTCOME

The hybrid road–rail transport model emerged as the most efficient option, offering significant OPEX savings and long-term reliability. AI-based sensitivity analysis revealed that project NPV was most influenced by transport cost and fuel fluctuations. The integrated framework validated project viability under both captive (steel plant-linked) and merchant mining models, providing investors with a clear, risk-adjusted decision matrix.

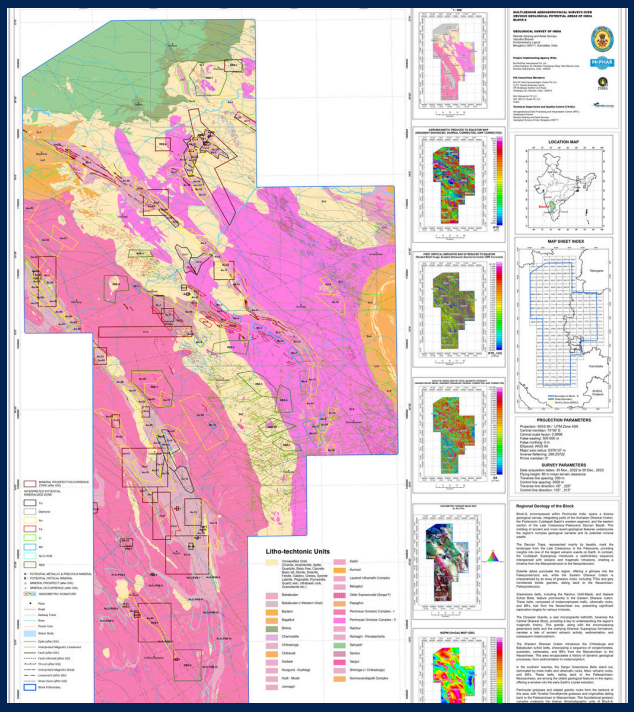
Achievement year 2025

CASE STUDY: INTERPRETATION OF MULTI-SENSOR AEROGEOPHYSICAL & BASELINE DATA FOR DHARWAR RATON, INDIA

OBJECTIVE

The study aimed to interpret airborne geophysical datasets (magnetic and radiometric) acquired by McPhar International, under the Dharwar craton, India awarded by GSI RSAS Bengaluru, to delineate potential mineralized zones.

Geovale Services, as a technical partner, integrated airborne outputs with baseline legacy datasets-including geological maps, geochemical anomalies, gravity surveys, geospatial datasets, and NGPM ground geophysical data-to produce a refined understanding of the subsurface and identify exploration targets for minerals.

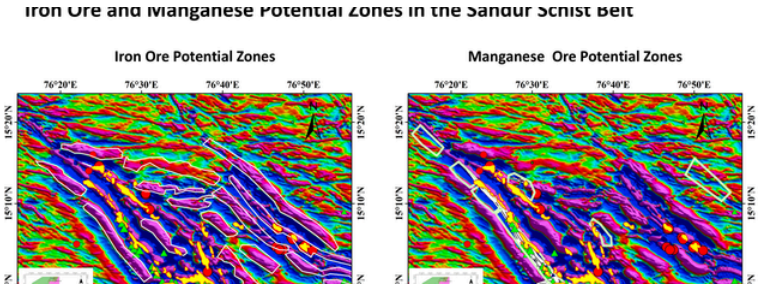


MODERN TECHNOLOGY USED

Geovale Services applied AI-based geophysical data analytics to integrate magnetic, radiometric, and geological datasets for the project. The AI models enhanced anomaly detection, refined subsurface interpretations, and pinpointed prospective mineralized zones with greater accuracy.

STUDY STRATEGY

- **Data Ingestion & Harmonization:** Qualitative analyses of airborne magnetic data (RTE, 1VD, 2VD, AS, TDR) and radiometric data (K, Th, U) and satellite images, baseline legacy datasets from GSI (geological, geochemical, geospatial, NGPM) using an appropriate geospatial platform. Standardized projections, units, and attribute schemas for seamless interpretation and cross-validation.
- **QA/QC & Gap-Filling:** Validation of spatial alignment across data themes and filling up of attribute gaps through contextual interpolation and cross-validation with ground data.
- Reinterpretation of datasets into a newer understanding of geo-tectonics.
- Utilization of Mineral Systems Analysis (MSA) and the fertility vector approach for predictive mineral corridors integrating all evidence.



OUTCOME

- Delivered upgraded lithological, structural datasets, validated against airborne signatures, multispectral satellite images.
- Delineation of geotectonic domains
- Identified some 155 potential mineralized zones, including Gold, Ni-Cr-PGE-Co, Copper, Manganese, Iron, REE-RM, and Diamond.
- Developed data-driven exploration targets to support GSI's NAGMP initiatives.
- Enabled evidence-based decision-making for future ground validation and drilling programs.
- Interpreted geological maps of the entire survey block at a scale of 1:500,000 and at 1:50,000 divided according to the Indian topographic map sheet layout.
- Established a reproducible geospatial interpretation workflow, enhancing the exploration intelligence framework for similar airborne blocks across India.

Achievement year 2024

OUR CLIENTELE

Partner Organization- MoU with Top Institutes

MAXAR TECHNOLOGIES

PARSAN indiGEO

McPHAR INTERNATIONAL

Large Data Analytics

Knowledge Lens
Accelerating Actionable Insights

Mine closure

Maheshwari ssg SUSTAINABLE SOLUTIONS GLOBAL

Mining

THRIVENI SMS SKY MINING SERVICES

Geochemistry

BUREAU VERITAS

SHIVA aem

EARTH NETWORKS

ABOUT US

Geovale Services Pvt Ltd is a leader in critical minerals exploration and mining. We are also pioneers in the fields of Hydrogeology, Geospatial, Geotech, and ESG solutions. We have been accredited and certified by numerous apex government organizations, including ISO 9001:2015 and NABET. With more than a decade of industry experience, Geovale has successfully served over 60 esteemed clients through the completion of 500+ diverse projects worldwide. Geovale transforms intricate problems into bespoke solutions that drive success.

OUR DIVISIONS

GEOVALE SERVICES

GEOVALE GLOBAL

GEOVALE HYDRO

WHERE

3rd floor, block gn, plot-38/5, saltlake, sector-v, kolkata, india

CONTACT DETAILS

+91 (33) 4061 2887

info@geovale.com
www.geovale.com