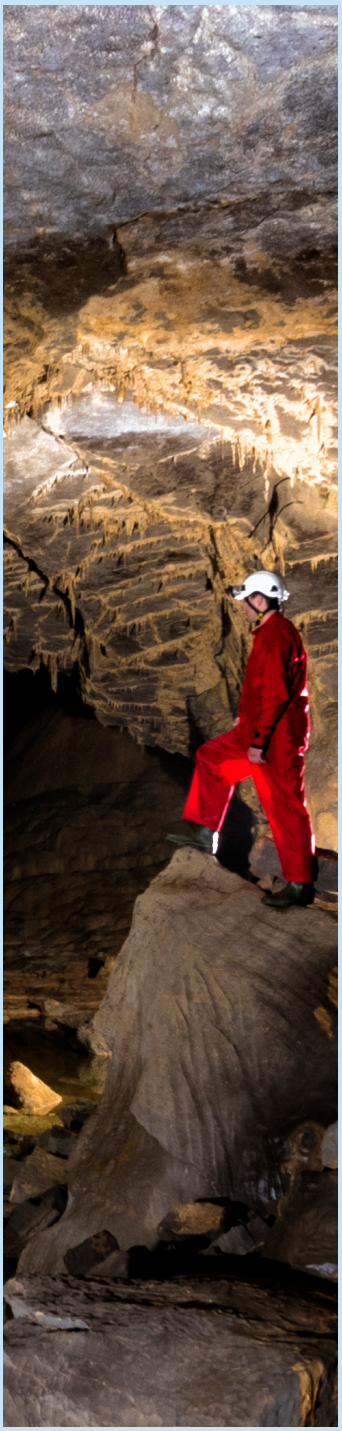
VIEW POINT



INDUSTRY 4.0: A SMART APPROACH TO MINERAL EXPLORATION

Infosys®
Navigate your next

Table of Contents

Introduction

The exploration process requires prospecting unknown mineral deposits, which involves research, target generation, target drilling, resource evaluation, resource definition, and feasibility studies. These activities help in extracting economic value for assessing the viability of potential mineral deposit sites.

In this point of view, our experts propose a digital solution combining artificial (AI) / machine learning (ML), geographic information systems (GIS), extended reality (XR), and remote sensing capabilities based on our analysis of global mining companies and industry research. Infosys proposes a Specific, Measurable, Achievable, Relevant, and Time-bound (SMART) approach based on AI, ML, GIS, XR, and remote sensing technology to improve outcomes in mineral exploration and prospecting.

Mineral exploration has been gathering momentum in the past decade due to shifts in the market landscape:

- The transition to green energy will increase annual capex in energy critical minerals from US$ 45 billion to US$ 70 billion till 2030[1].
- Increase in gold mining investment due to instability in foreign exchange markets, geopolitical issues and global inflation.
- Growth in the demand for silver used in photovoltaic cells and consumer electronics.

Total exploration spend on non-ferrous metals was US$ 13.08 billion in 2022, with an YoY increase of 16.1% and 70,008 drill holes, according to the 2022 S&P Global Market Intelligence report. Investment in gold was the highest with a budget of US$ 6.92 billion, accounting for 53% of the total share of expenditure. Copper was second with a decade-high spending of US$ 2.79 billion across USA, Canada, and Australia. The spend of US$ 612 million on nickel was primarily in Australia and Canada. At US$ 467 million, the spend on lithium was the highest since 2010 (Figure 1).

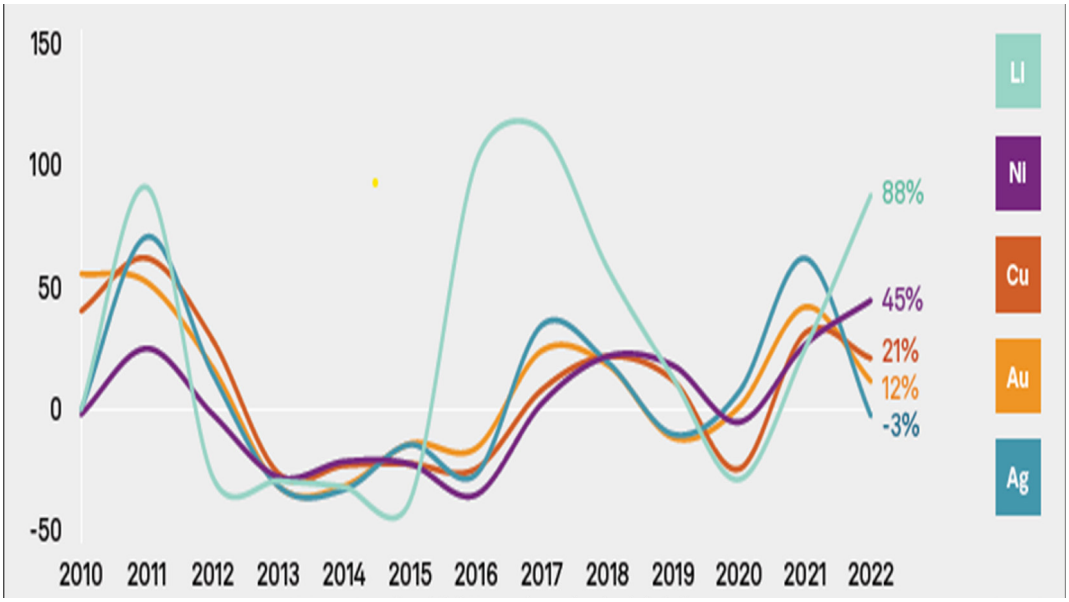


Figure 1: YoY percentage increase in exploration budget[2]

In 2022, out of 2,189 companies classified as major, intermediate, juniors, and government, the exploration budget of juniors was US$ 13.05 billion. Figure 2 reveals that majors and juniors had approximately an equal pie of the budget, but these enterprises faced challenges in raising funds. According to industry studies, only a very small number of exploratory projects accurately determine their viability, which raises the risk associated with investing and decreases investor appetite.

The primary reason for low investment is higher dependency on traditional conventional exploration methods leading to delays in the discovery of ore bodies and inaccuracy in identifying potential prospects, which affects returns on investments. Advanced technologies for geological mapping, drill target identification, core image analysis, and mineral prospecting reduce costs, improve safety and mitigate risks in exploration.

Influencing Factors

Mining enterprises need to address challenges and capitalize on opportunities for successful exploration:

Opportunities

Transitioning to environment-friendly operations

The exploration process may involve drilling, excavation, and use of chemicals such as cyanide, arsenic, sulfuric acid, and mercury, that pollute the surrounding environment.

Access remote areas

Autonomous vehicles improve access to mineral deposits in remote regions of Africa, Indonesia, etc.

Optimize exploration costs

Digital technology reduces costs by increasing the efficiency and accuracy of exploration activities.

Finding the right prospects

Introducing new technologies in interpretation and analysis of complex data sets for accurate and faster decisions in defining the right prospects.

Mitigate safety risks

IoT-enabled protective gear minimizes safety incidents in extreme working conditions and remote locations.

Threats

Reduced competitiveness

In a highly competitive mining market, enterprises lacking modern technology adoption may lose market share to competitors.

Limited accuracy

Unlike modern technology, traditional exploration methods lead to under estimating or overestimating the quantity and quality of mineral deposits.

Limited data analysis

Mining companies with limited ability to collect, analyze and process data are at a disadvantage to identify potential mineral deposits.

Technology knowledge deficit

Mining has been a late adopter of modern technology due to the nature of work and remote mining sites. In addition, reskilling of workforce requires significant time and change management.

Inadequate network coverage

Limited availability of network and communication systems in hostile terrain and remote regions impact operations.

In the next section, Infosys proposes **SMART** exploration technologies that perform a pivotal role in addressing the shifts in the mining industry.

SMART exploration

Our approach combines automation and digitization to boost operations as well as the user experience (Figure 2).

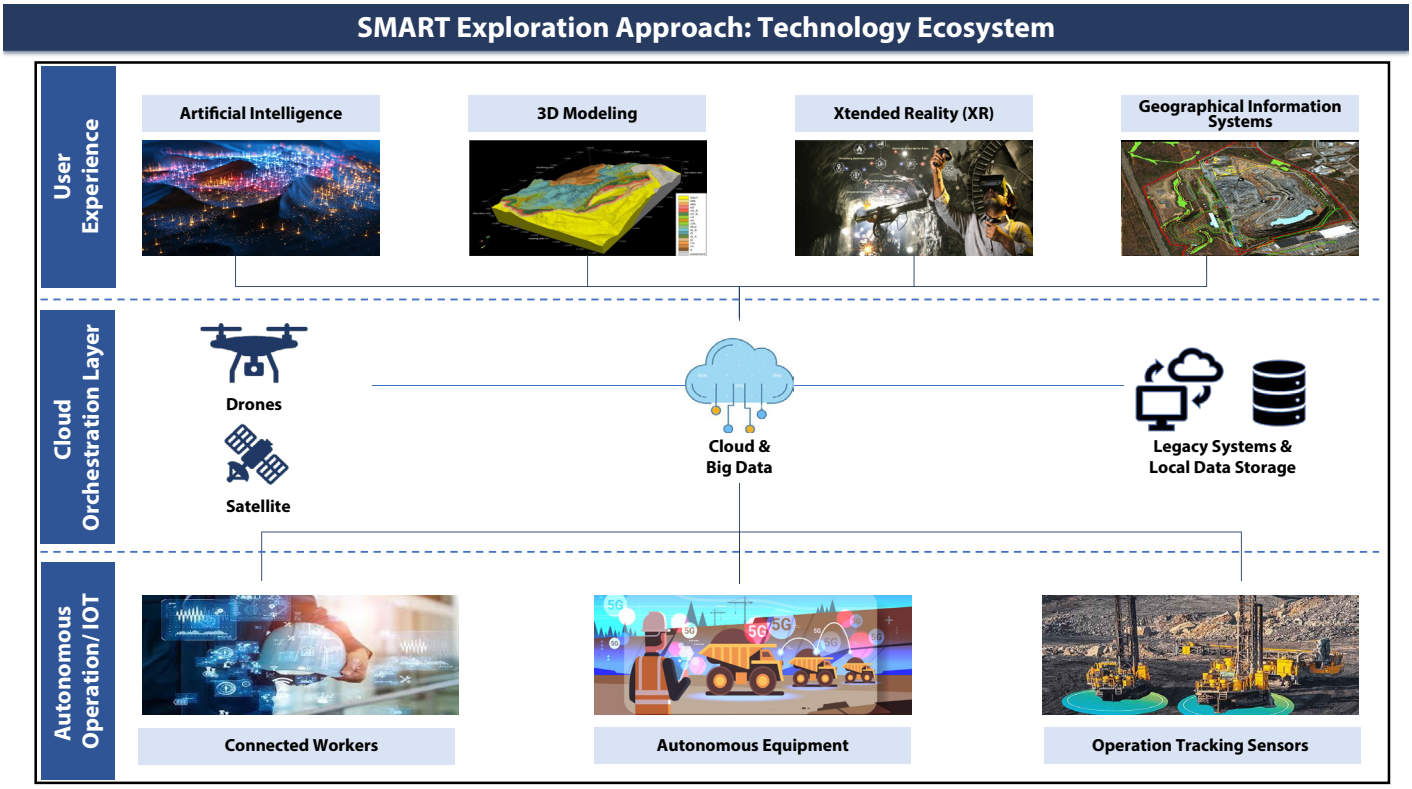


Figure 2: Technology ecosystem for mineral exploration

Industry 4.0 technologies such as artificial intelligence[3,4,5], immersive technology[6], remote sensing[6,7,9], and cloud[8,9] maximize the efficiency of machines, processes, and people. Table 1 depicts Industry 4.0 application in exploration processes such as early-stage studies, target generation, resource evaluation, and feasibility studies along with potential use cases.

Potential Use Cases Mapping for Exploration Process			
(1) Early-stage studies (2) Target generation (3) Resource evaluation (4) Feasibility			
Technology Ecosystem for Mineral Exploration		**Process Mapping**	**Potential Use Cases**
User Experience	AI for studies and target generation	1 2 3	• Prioritize targets by analyzing geospatial data to improve prospecting • Improve real-time visualization and geological modeling • Provide early warnings and recommendations to mitigate potential geological hazards during exploratory drilling
	AI for modeling and evaluation	2 3 4	• Identify mineral indicators for defining anomalies • Create 3D models of ore bodies by processing drilling data • Analyze and predict composition of ore grades for informed and faster decision making
	Generative AI	1 2 3 4	• Classification of geological features and anomalies using satellite imagery and data from remote sensors • Implement test strategies in simulated environments for better exploration planning • Evaluate strategies and outcomes in the simulated environment to improve exploration
	Three-Dimensional (3D) Modeling	1 3 4	• Detailed visualization of ore bodies, including size, shape and orientation • Comprehensive view of the subsurface by integrating data from multiple sources • Planning of drill hole locations with better precision • Better infrastructure planning for roads, tunnels and mine shafts
	Extended Reality (XR)	2 3 4	• Automated identification of rock sample and drilling data • Training platform established for training geologists and exploration teams in practicing safety procedures, drilling techniques and sample collection • Real-time collaboration between remote teams to analyze exploration data
	QGIS / ArcGIS	1 2 3 4	• Resource evaluation by creating geological maps • Identification of patterns, trends and anomalies in exploration data through spatial queries and overlays
Cloud Orchestration	Cloud / Big Data	1 2 3 4	• Categorizing and segmenting geological imagery and videos • Prevention of data loss via secure and scalable storage solutions • Real-time data collection and integration into a centralized database
Autonomous Operations	Remotely Piloted Aerial vehicle	1 2	• Collection of complex data like geophysical, geochemical and structural data for finding drill targets
	Connected Workers	1 2 3 4	• Prevention of potential hazards with safety sensors and emergency response systems
	Drilling Automation	1 2 3 4	• Collection of samples for analyzing physical properties of rock or soil and increasing drilling rate
	Smart Sorting Machines	3 4	• Segregation of extracted materials such as rock, debris and specimen based on desired criteria

Table 1: SMART exploration potential use cases

Value Propositions

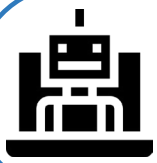
The uses cases from Infosys SMART exploration approach yield compelling value. We showcase the value propositions for use cases from our study:

Artificial Intelligence

Process optimization combined with environmental considerations results in efficient data processing that reduces risk and its impact on the environment.

Predictive insights based on real-time data enhance decision making, enabling smooth operations.

Accurate forecasting improves exploration outcomes with a streamlined process delivering higher yields.



Robotic platforms that minimize human intervention such as autonomous robots designed to operate, gather, haul and process items while scanning the environment above and below ground.

Immersive technology

Engineers and geologists visualize and understand the structure and geology of a mine by using VR apps to generate 3D models of underground mines.

Efficient planning and designing of new mines via interactive displays increases precision, reduces time-to-market, and mitigates risks.

Cloud / Big data

Cloud strategy helps in optimizing total cost of ownership by moving away from legacy system.

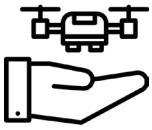
Big data allows mining corporations to find more affordable ways to manage data.

Autonomous operations / IoT

IoT machinery with edge computation capabilities enhance processes, including drilling and sorting.

Smart PPE ensures safety of the workforce.

Drones provide high-resolution orthophotos for accurate 3D mapping.



Magnetometer-equipped drones make aerial surveying more efficient and cost effective.

Figure 3 summarizes the applicable use cases and value proposition of Infosys' SMART exploration approach for geologists, a key constituent in mineral exploration.

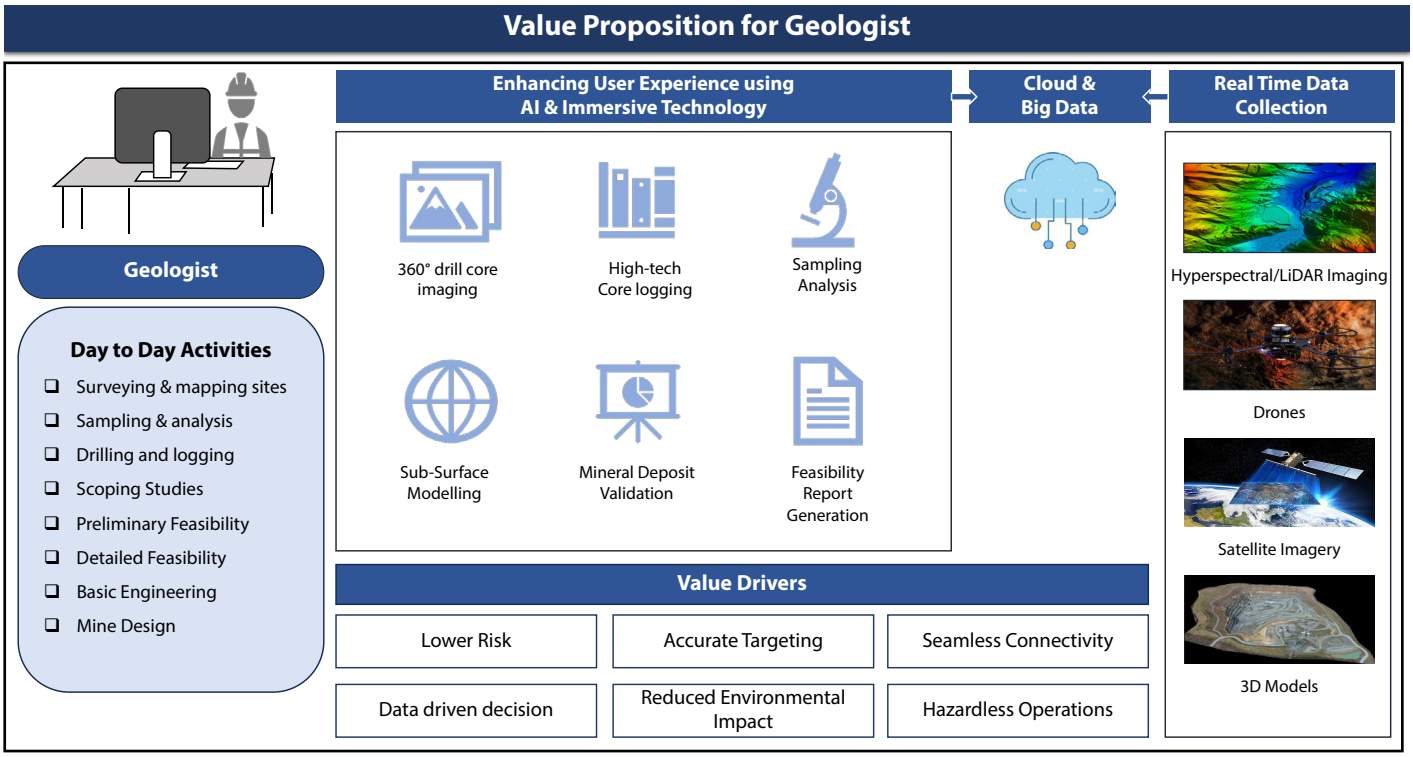


Figure 3: Value proposition for geologists

Conclusion

Technology driven by Industry 4.0 will define the future of mineral exploration. Algorithms, immersive technologies, and data analytics empower exploration teams to make informed decisions to fulfil the growing demand for minerals and precious metals. GIS and remote monitoring techniques create a safe environment for exploration. However, mining enterprises should upskill the workforce, ensure uninterrupted connectivity, and adopt robust cybersecurity measures to pivot to technology-driven exploration.

About the Authors

Vignesh Rajasekar,

Senior Associate Consultant, Mining & Resources, Manufacturing Domain Consulting Group

Vignesh holds a B.Tech and MBA with 4+ years of experience in consulting and project management across manufacturing and IT domains.

Preethi Narayanan,

Consultant, Mining & Resources, Manufacturing Domain Consulting Group

Preethi Narayanan has 5.8 years of experience in consulting and project management across manufacturing and IT domain.

Harish Yendamuri,

Consultant, Mining & Resources, Manufacturing Domain Consulting Group

Harish holds a B.Tech and MBA with 6+ years of experience in metal plant operations, planning/project management, process automation and optimization.

Joseph Michael,

Lead Consultant, Mining & Resources, Manufacturing Domain Consulting Group

Joseph holds a B.Tech with 14+ years of experience in digital transformation projects across mining and metals.

Dr. Indresh Rathore,

Principal Consultant, Mining & Resources, Manufacturing Domain Consulting Group

Dr. Indresh is an industry practitioner with 20+ years of experience in enhancing operational and business excellence across mining and metals.

Reference

1. https://iea.blob.core.windows.net/assets/afc35261-41b2-47d4-86d6-d5d77fc259be/CriticalMineralsMarketReview2023.pdf
2. https://www.spglobal.com/marketintelligence/en/news-insights/blog/infographic-2023-metals-and-mining-outlook
3. https://miningdigital.com/articles/top-10-uses-of-artificial-intelligence-in-mining
4. www.ausimm.com/bulletin/bulletin-articles/ten-mining-challenges-technology-could-solve/
5. https://ax.legal/2021/06/21/mining-exploration-technology/
6. https://www.pdac.ca/docs/default-source/priorities/access-to-land/geosciences/pdac-2020-innovation-in-mineral-exploration-v10.pdf
7. https://www.mining-technology.com/features/featureten-technologies-with-the-power-to-transform-mining-4211240/?cf-view
8. https://mining-events.com/the-future-of-exploration-trends-and-technologies-for-mining/
9. https://www.mining-technology.com/features/featureten-technologies-with-the-power-to-transform-mining-4211240/?cf-view

For more information, contact askus@infosys.com

Navigate your next