



UNEARTHING HIDDEN VALUE IN MINING WITH AI

Abstract

Mining and metals enterprises need a new technological approach that can reimagine ways of working. It must support business growth amid declining ore grades, cost-intensive operations, and rising mineral demand. Manual, repetitive, and high-risk processes must be replaced with automated, smarter, and compliant practices that uphold trust and safety. The new technologies used should also be able to deliver sustainable and measurable outcomes, such as faster insights for decisions, predictive maintenance for equipment health, and safer mines for operators.

This paper explores how mining enterprises can leverage Infosys AI First Value Framework for mining and metals operations. The purpose-built framework comprises six interconnected AI pillars that address critical gaps in safety, performance, exploration, and workforce readiness across the entire mine-to-market value chain. The paper also discusses real-world case studies of AI implementations in the mining sector.

Introduction

The mining industry is witnessing significant change. Surging demand for critical minerals, driven by sustainability pressures and the rapid growth of data centers for artificial intelligence (AI), is pushing miners to reshape their value chains. The new goal is smarter, cleaner, and more predictive operations, from mine exploration to logistics. Agentic AI and generative AI (GenAI), when implemented effectively, have the potential to reimagine mining operations. However, this calls for strong data

management and trust in AI models.

What enterprises need is a way to strategically implement AI through value-based approaches. Infosys AI First Value Framework is a purpose-built framework, guided by six principles: orchestration, data-driven insights, modernization, transformation, innovation, and trust. It provides a systematic approach with defined tools that can help mining enterprises harness AI for greater success.

Overview of Mining Challenges

By 2040, global demand for rare earths and critical minerals, such as copper, nickel, lithium, and cobalt, is expected to increase by 30–50%, driven by electrification, the energy transition, and the growth of data centers for artificial intelligence (AI)^{1,2}. Despite rising demand, revenue from mining operations fell by 6% in 2024, reaching around US \$3 trillion³. At the same time, the industry runs on a high-cost, capital-intensive model and is increasingly constrained by declining ore grades⁴.

Mining operations generate vast amounts of data that is generated from exploration to logistics. But without the right infrastructure and tools, mining companies are unable to effectively leverage this data for smarter operations. Moreover, AI adoption remains fragmented, delivering value through isolated use cases but falling short of system-wide transformation.

The real opportunity lies in connecting mining data to scale AI across the enterprise. This will enable integrated, predictive, and optimized decision making from pit to port.

Infosys AI First Value Framework: Unlock AI Value in Mining

Infosys AI First Value Framework comprises six key pillars,

helping organizations prioritize areas for AI investment, enhance data quality, embed AI into operations, deploy AI agents, enable autonomous decision making, and modernize legacy systems. Together, these pillars form a cohesive, end-to-end roadmap based on a core principle: For AI to be transformative, it must be trusted.

Mining enterprises looking to scale AI across critical operations must first lay the foundation for ethical, transparent, and accountable design. They need explainable decision making and human-in-the-loop (HITL) governance to ensure safety, compliance, and environmental, social, and governance (ESG) alignment. Further, practicing responsible AI emphasizes trust alongside autonomy.

Leveraging industry experience spanning more than 20 years and strategic partnerships with top global mining enterprises, Infosys has contextualized the Infosys AI First Value Framework for the mining industry. The framework addresses pressing mining challenges and delivers specific, measurable value from AI adoption.

With this approach, miners can focus on decarbonizing operations, accelerating exploration, and deploying autonomous fleets. Further, they can unlock value with AI that converts data into insight, enables outcome-driven automation, and embeds safety as a built-in engineering principle.

Strengthening Mining Operations with the Six AI Pillars

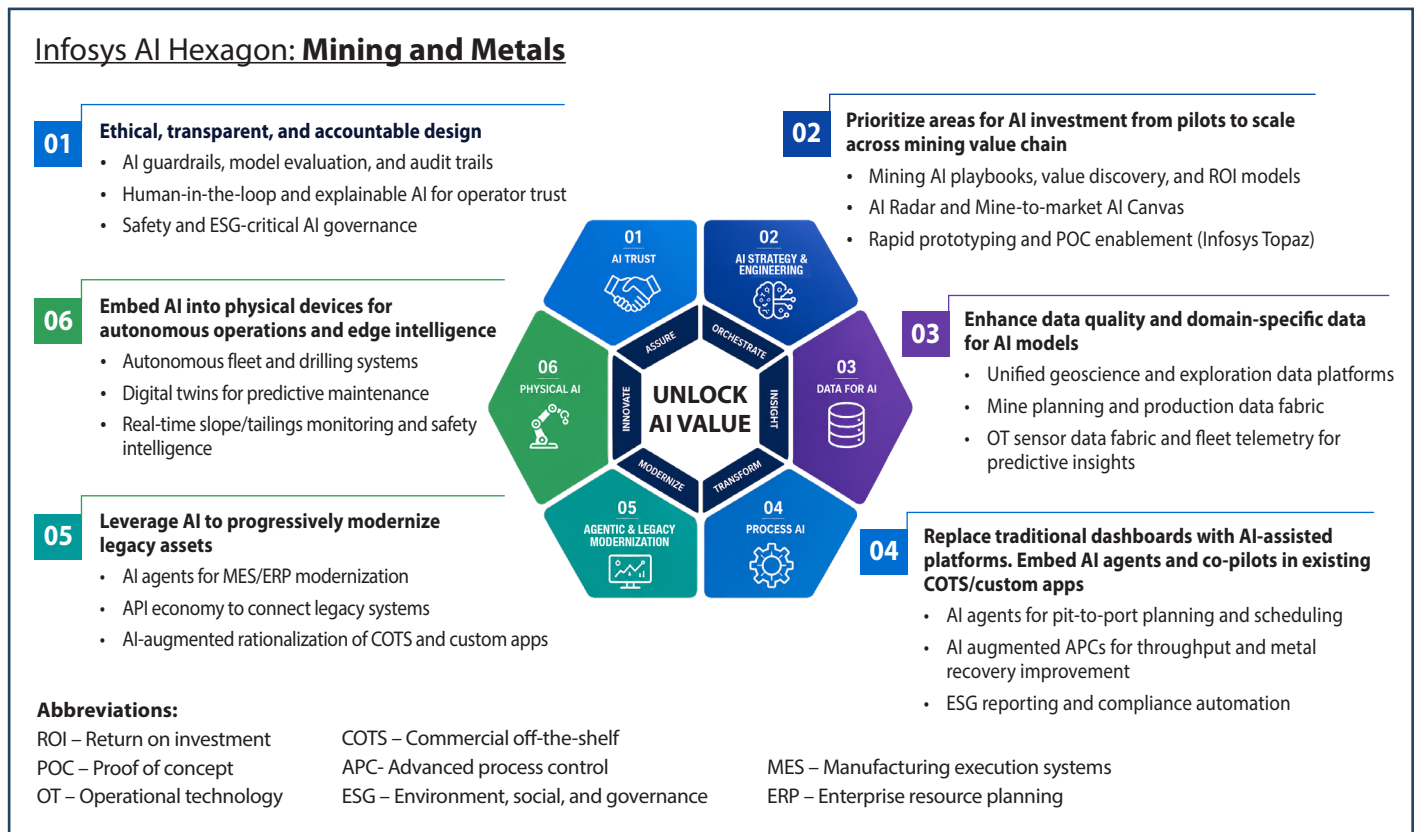


Fig 1: Infosys AI First Value Framework for the mining and metals industry

As showing in Figure 1, Infosys AI First Value Framework helps mining and metals organizations unlock AI value across six value pools. These are described below:

1. Assure: AI trust

Safe operations are critical for all mining personnel, engineers, and operators. Moreover, safety incidents, regulatory breaches, and ESG non-compliance can result in steep penalties and reputational damage. Thus, it is vital for miners to understand and trust the predictions and decisions of AI systems.

The 'Assure' pillar governs every AI deployment across the Infosys AI First Value Framework. It provides guardrails, explainability, and human oversight in all safety and sustainability-critical environments.

Infosys offerings that drive AI assurance for mining and metals enterprises are:

- AI guardrails, model evaluation, and audit trails for every production deployment
- HITL designs for operator oversight in safety-critical decisions

- Explainable AI to help operators understand, validate, and trust model outputs
- Safety and ESG-critical AI governance frameworks aligned to regulatory requirements
- Responsible AI principles embedded across all six pillars of the Infosys AI First Value Framework

2. Orchestrate: AI strategy and engineering

Transforming mining operations with AI technologies requires strategic vision and clear direction. Typically, miners test several disconnected pilots that offer limited visibility into true return on investment (ROI), and lack a clear path to scale across the enterprise.

The 'Orchestrate' pillar moves AI from experiments to enterprise-wide deployment with clarity and speed. Through strategic scaffolding, it identifies the highest-value use cases across the value chain, builds contextualized business cases, and enables rapid prototyping.

Infosys offerings that drive AI orchestration for mining and metals enterprises are:

- Mining AI playbooks and value discovery workshops
- ROI frameworks tailored to mining key performance indicators (KPIs), such as overall equipment effectiveness (OEE), metal recovery, and safety incidents
- AI Radar for prioritized investment decisions
- Mine-to-market AI Canvas that maps use cases across the value chain
- Rapid proof of concept (POC) enablement through Infosys Topaz

3. Insight: Data for AI

AI models need high-quality data. Mining data is highly complex and fragmented. Geoscience platforms, supervisory control and data acquisition (SCADA) systems, fleet telemetry, enterprise resource planning (ERP) platforms, and laboratory systems often exist in silos. Moreover, such data is typically characterized by inconsistent formats, poor quality, and limited accessibility.

The 'Insight' pillar consolidates fragmented data into a unified, domain-specific data platform. This acts as the key foundation for accurate, scalable AI models.

Infosys offerings that support AI insights for mining and metals enterprises include:

- Unified geoscience and exploration data platforms that integrate geological, geophysical, and geochemical data
- Mine planning and production data fabric, including ore reconciliation
- Time-series operational technology (OT) sensor data from plant equipment and processing lines
- Fleet telemetry data pipelines for predictive and prescriptive maintenance
- Clean, labeled, domain-specific datasets that power reliable AI model training

4. Transform: Process AI

Typically, mining operations rely heavily on rule-based systems, manual scheduling, and reactive decision making.

The 'Transform' pillar augments existing workflows and applications with AI agents and co-pilots, driving predictive and intelligent operations. It transforms key mining areas such as throughput, metal recovery, pit-to-port efficiency, and ESG compliance.

Infosys offerings that drive AI transformation for mining and metals enterprises are:

- Autonomous AI agents for pit-to-port planning and logistics scheduling
- Intelligent advanced process control (APC) systems that optimize throughput, maximize metal recovery, and reduce energy consumption
- Automation of ESG reporting and regulatory compliance workflows
- AI co-pilots embedded in existing commercial-off-the-shelf (COTS) and custom mining applications

5. Modernize: Agentic AI legacy modernization

Many mining companies rely on aging manufacturing execution systems (MES), ERP platforms, and custom-built systems that are expensive to replace and risky to decommission. Such systems are barriers to AI adoption due to difficult integrations and low-quality data, limiting operational agility.

The 'Modernize' pillar uses AI agents to upgrade legacy assets progressively. Rather than disrupting business operations with a rip-and-replace approach, it connects siloed systems using an application programming interface (API) economy.

Infosys offerings that support agentic AI modernization for mining and metals enterprises are:

- AI agent-led MES and ERP modernization on existing platforms
- API-led integration architecture to connect disparate legacy systems
- AI augmentation of COTS and custom mining applications
- Rationalized application landscapes that reduce technical debt while preserving operational continuity

6. Innovate: Physical AI

In future, a significant percentage of mining operations is expected to become fully autonomous. Critical activities like drilling and blasting, haul fleet management, slope monitoring, and equipment health tracking are increasingly moving toward AI-embedded, edge-intelligent systems that can make real-time decisions with minimal human intervention.

The 'Innovate' pillar embeds AI directly into physical mining equipment and edge infrastructure. This allows mines to shift from reactive to self-optimizing operations.

Infosys offerings that drive AI innovation for mining and metals enterprises are:

- Autonomous haul fleet systems and automated drilling platforms
- Digital twins for fixed and mobile asset predictive maintenance
- Real-time slope stability and tailings dam monitoring
- AI-powered safety surveillance at the mine face and processing facilities
- Edge intelligence for remote and underground mine environments

Real-World Success Stories of AI in Mining

1. Insight (Data for AI) + Transform (Process AI) 	GenAI assistants for geologists at a global metals and mining corporation Geologists at a multinational mining corporation operating across six continents had to manually trawl through a vast repository of documents and press releases to determine what to mine and where. Infosys developed a digital assistant, powered by generative AI (GenAI), using retrieval augmented generation (RAG), OpenAI large language models (LLMs), and LangChain. With this solution, geologists can query institutional knowledge in natural language and access relevant information instantly.	Outcomes achieved: • 50% reduction in time spent on searches • 30% improvement in search efficacy
2. Transform (Process AI) + Modernize (Agentic legacy modernization) 	Large steel producer uses GenAI for omnichannel purchase order processing A European steel manufacturing corporation operating in 15 countries wanted to automate purchase order (PO) intake and processing across the organization. The existing POs were saved in multiple, complex formats. Infosys built a GenAI solution using Azure OpenAI, Azure Cognitive Services, and Azure Bot Service. The system validates POs against enterprise business rules and integrates these with downstream supply chain, manufacturing, and logistics systems.	Outcomes achieved: • 70% reduction in PO processing time • 60% reduction in manual PO validation time
3. Innovate (Physical AI) + Assure (AI trust) 	Global mining enterprise uses AI anomaly detection to scale safety A global mining enterprise faced significant safety risks from undetected water accumulation across multiple sites. Infosys deployed unsupervised AI models for anomaly detection based on principal component analysis (PCA). The models were also integrated with automated alert systems and real-time dashboards. The solution was deployed across multiple locations, enabling proactive hazard identification at scale.	Outcomes achieved: • Reduced safety incidents • Released geologists and operators to focus on higher-value activities

4. Innovate (Physical AI) + Assure (AI trust) 	AI monitoring for underground mine water management Water accumulation in underground mines poses severe risks such as flooding, hazardous in-rushes, and compromised infrastructure. Traditional prediction models based on empirical equations struggle with geological and hydrological complexity. Infosys deployed a PCA-based monitoring solution using AI and machine learning (ML) to detect anomalies in dewatering systems in real time. The solution helps mining enterprises track water levels, flow rates, and pump power consumption through sensors. It also generates actionable early warnings for maintenance personnel.	Outcomes achieved: • Early alerts for pump failures and excessive groundwater inflow • Enhanced monitoring with parameter-level specificity • Empirical rules to improve interpretability and enhance operator trust in AI alerts
5. Innovate (Physical AI) + Transform (Process AI) 	Global iron and nickel producer uses video analytics for bucket load calculation A South American mining corporation wanted a scalable solution to automatically calculate scoop bucket volumes in real time and flag operator non-compliance across different mine sites. Infosys built an ML-powered video analytics platform using Azure and Azure ML. The solution can process live camera feeds to measure fill factors and generate compliance dashboards for operational oversight.	Outcomes achieved: • 8% improvement in operator productivity • 11% reduction in non-compliance instances • Scalable across different mine sites and equipment
6. Innovate (Physical AI) + Insight (Data for AI) 	Predictive maintenance at global mining company yields major cost savings A global mining company was incurring high costs from unplanned equipment failures and reactive maintenance cycles. Infosys implemented an AI-led predictive maintenance solution integrating telemetry and oil analytics data with ML models on Azure. The system can predict failures early and trigger intelligent alerts for parts procurement. It also provides validation dashboards for maintenance teams.	Outcomes achieved: • Saved US \$1.6 million annually from lower repair costs • 6.6% improvement in machine reliability • 48% reduction in engine-related downtime
7. Innovate (Physical AI) + Insight (Data for AI) 	ML-based prescriptive maintenance of trucks and loads for iron and nickel producer Unplanned maintenance on haul trucks was costing a world-leading iron ore and nickel producer approximately US \$550 per hour per truck. Further, repair events were increasing operating costs by nearly 30%. Infosys developed an ML-based prescriptive maintenance solution using Azure and Azure ML. The solution integrated oil sample analysis, telemetry data, and historical failure records to predict component failures early, prioritize replacements, and trigger timely procurement alerts.	Outcomes achieved: • 48% decrease in downtime hours • 6.6% increase in equipment reliability, saving US \$1.7 million

Infosys Differentiators: Key Takeaways for Mining Leaders

With over 20 years of mining industry experience and over 5,000 specialists in more than 15 countries, Infosys has deep domain knowledge of the sector. Further, we have built strategic partnerships with leading global mining enterprises, including the world's top ferrous metals miners, base metals miners, and mining and metals organizations.

Leveraging deep industry experience and technological expertise, Infosys brings depth and scale to drive successful AI-first transformations with measurable and scalable value.

Infosys AI First Value Framework for the mining sector helps enterprises achieve the following outcomes:



Scale AI beyond pilots:

Provides clients with a systematic and prioritized path from AI strategy to autonomous operations by delivering predictable, accountable, and well-governed AI deployments



Leverage AI across the value chain:

Embeds AI at every stage of mining operations, enabling intelligence-driven processes from mine to market



Embed safety into operations:

Integrates safety and environmental accountability into each layer, ensuring model explainability and building operator trust.



Modernize without disruption:

Enables progressive agentic AI modernization of legacy platforms, maintaining business continuity while unlocking agility for AI-first operations.

Conclusion

As mining enterprises race to meet the surging demand for critical minerals, they are also struggling with cost-intensive operations and plateauing revenues. To succeed, they must upgrade existing systems, integrate advanced technologies, and reimagine operations for predictability, efficiency, and safety. Agentic AI and GenAI can be game-changers in this journey, provided they are adopted using a value-based transformation framework.

Infosys AI First Value Framework is a purpose-built framework of six interconnected AI pillars, designed to address critical challenges in mining operations. Aiming to deliver real transformation in addition to efficiency gains, the framework comes with specific offerings that map AI adoption to key functions. These include safety, performance, exploration, and workforce readiness.

It is time for mining leaders to take decisive action and embed AI across people, assets, and decision making. Those who lead such transformation will define the next era of the industry, reshaping the entire mine-to-market value chain.

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