Blue Waymark
راه‌نشان نیلی

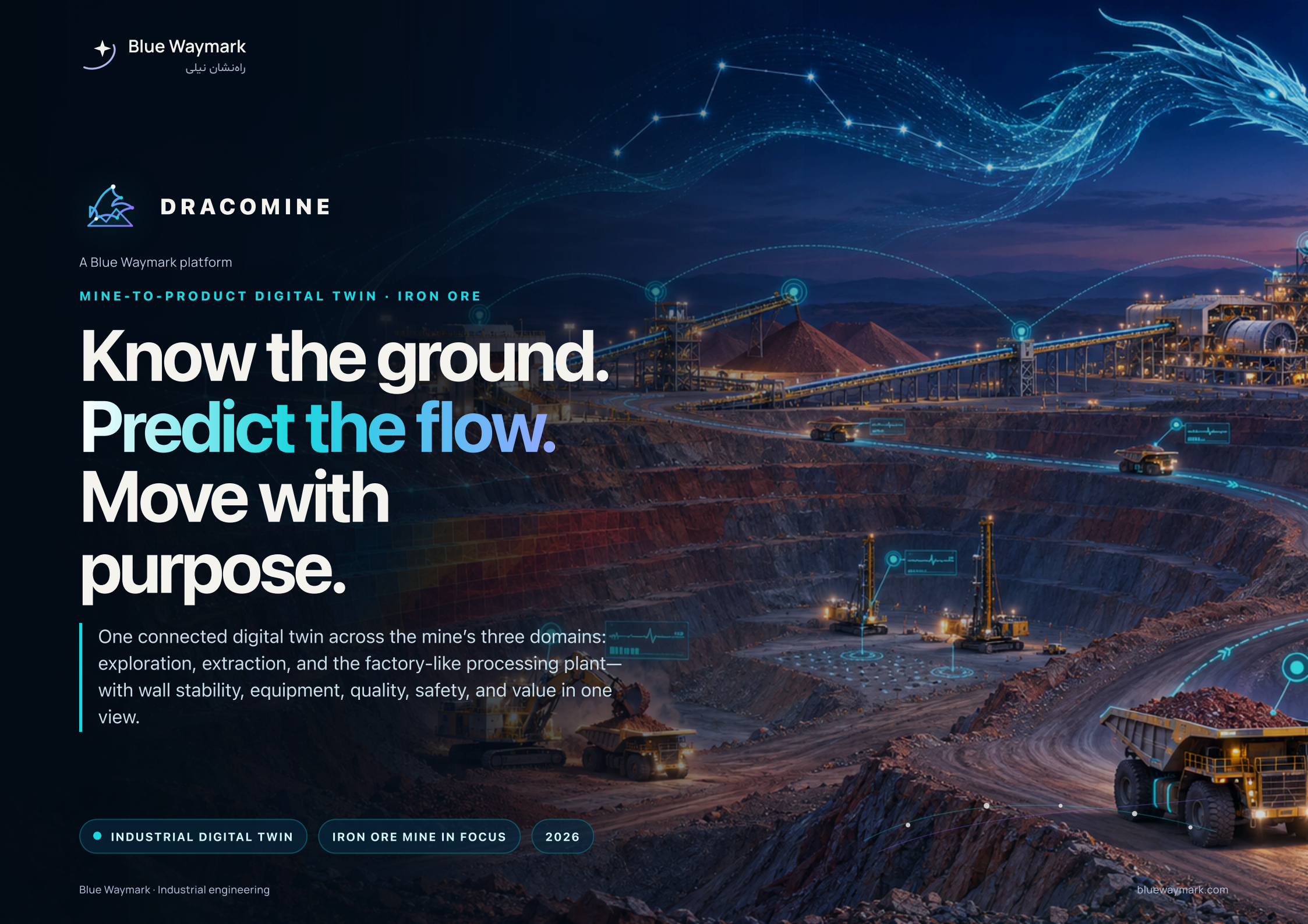
DRACOMINE

A Blue Waymark platform

MINE-TO-PRODUCT DIGITAL TWIN · IRON ORE

Know the ground. Predict the flow. Move with purpose.

One connected digital twin across the mine's three domains: exploration, extraction, and the factory-like processing plant—with wall stability, equipment, quality, safety, and value in one view.



INDUSTRIAL DIGITAL TWIN | IRON ORE MINE IN FOCUS | 2026

THE CHALLENGE

A mine is not a pit plus a fleet. It is a moving system of geology, time, and value.

Exploration changes what we know. Extraction changes the ground. Processing converts variable ore through a factory-like plant. DracoMine keeps all three synchronized with safety, equipment, quality, and value.

01

Plan–reality gap

Geological models, short-interval plans, dispatch, and actual field conditions can diverge within hours.

02

Material uncertainty

Ore and waste identity can be diluted, delayed, or lost between the face, truck, ROM pad, crusher, and stockpile.

03

Moving mine walls

Small slope displacements can accelerate. Ground-based radar and fixed sensors must detect rate and acceleration before instability becomes a landslide.

04

Three disconnected worlds

Exploration, extraction, and the processing plant often optimize locally—even though each changes the next stage's risk and performance.

THE COUPLED MINE REALITY

Explore → Extract safely → Process reliably → Quality + recovery + margin

THE OPPORTUNITY

One living mine. Pit-to-product foresight.

THE SOLUTION

From fragmented mine data to a shared operational truth.

DracoMine links the mine's three operational worlds—exploration, extraction, and processing—through a shared spatial, temporal, material, asset, and value context.

01 · EXPLORATION DOMAIN

Geophysics · drilling · assay

Ground surveys, exploration holes, core logs, samples, laboratory results, geology, and resource confidence.

02 · EXTRACTION DOMAIN

Plan · geotechnical · fleet

Pit design, drill/blast, dispatch, payload, roads, ground-based wall monitoring, weather, and events.

03 · PROCESSING DOMAIN

PLC · DCS · historian · LIMS

Crushing, screening, separation, dewatering, stockpiles, quality, water, energy, alarms, and maintenance.

04 · MINE TWIN CORE

Space + material + asset graph

Resource block → dig unit → truck load → plant feed → product, linked to equipment, sensors, and events.

05 · DECISION INTELLIGENCE

Predict · simulate · optimize

Resource confidence, wall movement, sequence, dispatch, blending, plant control, maintenance, and recovery.

06 · ROLE-BASED EXPERIENCE

Field to boardroom

Supervisor cockpit, planning studio, geotechnical view, maintenance workbench, and value dashboard.

Explore → extract → process → reconcile → learn

CLOSED LOOP · GROUND TO PRODUCT ↻ ACTUALS TO MODEL

Ground-based safety

Fixed radar, prisms/GNSS, extensometers, inclinometers, and piezometers continuously track wall behavior.

Factory-grade processing

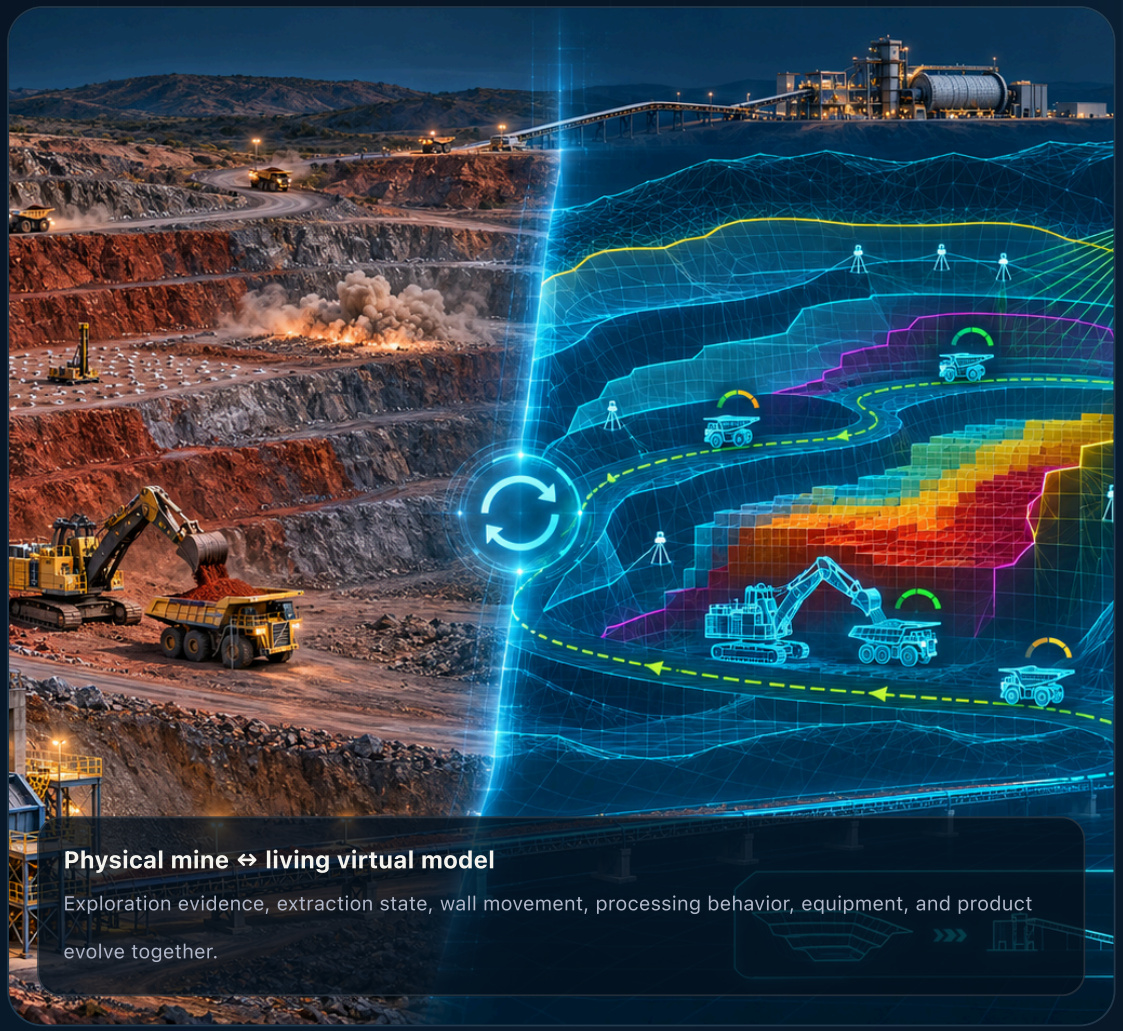
The processing plant is modeled like an industrial twin: equipment, control loops, mass balance, quality, and energy.

Value-chain ready

Connect resource knowledge to extraction, beneficiation, pelletizing, DRI, steelmaking, and customer quality.

THE LIVING MINE MODEL

Three connected domains. One safety and value context.



Physical mine ↔ living virtual model

Exploration evidence, extraction state, wall movement, processing behavior, equipment, and product evolve together.

Exploration twin

DISCOVER

Field mapping, geophysics, exploration drilling, core logging, assay, geology, resources, and confidence.

Drillholes | Core | Assay | Block model | Uncertainty

Extraction twin

EXECUTE

Pit design, drill/blast, wall stability, load/haul, roads, material custody, fleet, and shift plan.

Benches | Blast | Fleet | Dispatch | Ore / waste

Processing twin

TRANSFORM

A factory-like model of crushing, separation, dewatering, stockpiles, equipment, controls, quality, and recovery.

Plant | Mass balance | Quality | Recovery | Energy

Wall-stability twin

PROTECT

Continuous ground-based displacement, velocity, acceleration, pore pressure, alarm zones, and exposure.

Radar | Prisms / GNSS | Extensometers | Piezometers

HOW IT THINKS

A closed-loop engine for reconciliation, prediction, and action.

MINE INFERENCE

Reconcile + predict

Explains the current state across exploration, extraction, walls, fleet, material, and processing.

- Resource confidence
- Ore tracking
- Wall displacement
- Cycle forecast
- Plant recovery
- Uncertainty

DECISION INTELLIGENCE

Simulate + optimize

Tests sequence, exclusion zones, dispatch, blending, maintenance, and process choices before execution.

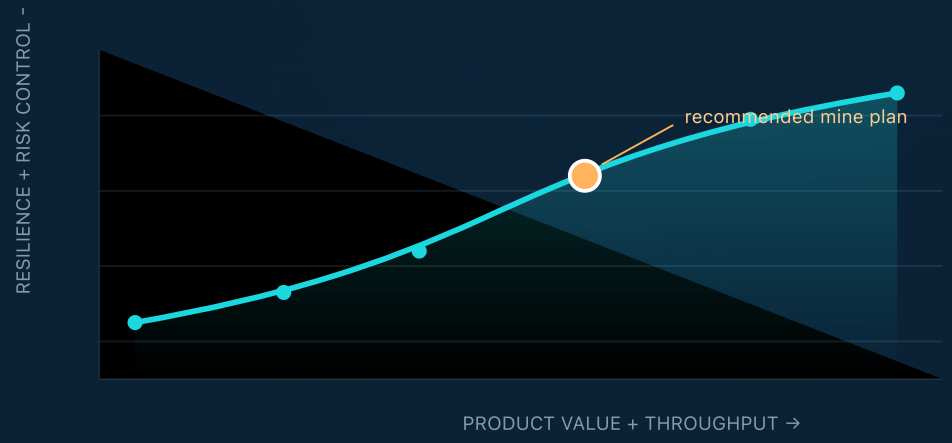
- Drill program
- Safe work zones
- Fleet dispatch
- Blend strategy
- Maintenance window
- Plant setpoints

```
maximize: product value + recovery + plan adherence
minimize: cost + delay + variability + energy + water + risk
subject to: safety ∧ slope ∧ fleet ∧ plant ∧ quality ∧
permit limits
```

Illustrative value frontier

Feasible · Recommended

Conceptual view — calibrated mine models will define the real decision frontier.



Wall safety first · What-if scenarios · Multi-objective trade-off · Uncertainty aware · Supervisor-in-the-loop · Outcome tracking

THE COMPLETE MINE LIFECYCLE

Explore. Extract. Process. One continuous digital thread.

The twin connects discovery and resource confidence to safe extraction, then carries material identity into a factory-like processing operation.

01 EXPLORATION	**Field mapping** Ground observations, structure, alteration, targets	**Ground geophysics** Magnetic, gravity, resistivity or seismic evidence	**Exploration drilling** Collar, trajectory, recovery, downhole records	**Core + assay** Logging, sampling, laboratory quality and chain of custody	**Resource model** CORE Domains, grade, tonnes, classification, uncertainty
02 EXTRACTION	**Pit design + sequence** Phases, benches, access, dig blocks, schedule	**Drill + blast** Pattern, energy, movement, fragmentation, release	**Wall monitoring** CORE Displacement, velocity, acceleration, pore pressure	**Load + haul** Ore/waste custody, payload, cycle, route, queue	**ROM control** Destination, stockpile, blend, crusher feed
03 PROCESSING	**Crush + screen** Feed size, rate, availability, recirculation	**Grind + classify** As applicable: liberation, density, power, size	**Separate + recover** CORE Concentration, mass pull, grade, recovery	**Dewater + stockpile** Moisture, water return, inventory, blend	**Quality + loadout** Fe, contaminants, product tonnes, dispatch

↻ Exploration updates the model; extraction actuals reconcile the plan; processing outcomes reveal ore behavior—and all three improve the next decision.

Slope radar
continuous wall-surface displacement

Prisms / GNSS
precise fixed-point movement

Extensometers
crack or internal deformation

Piezometers
pore-water pressure and trend

Wall-safety logic

The twin evaluates movement rate and acceleration—not only position—then links site-approved thresholds to alarms, exclusion zones, inspections, and evacuation actions.

ILLUSTRATIVE OPERATING SNAPSHOT · DEMO VALUES

Three domains. One decision cockpit.

A representative view combines exploration confidence, wall safety, extraction performance, and process-plant output. Values below demonstrate the design—they are not live mine data.

EXPLORATION CONFIDENCE
78%
classified resource in active horizon

MAX WALL MOVEMENT
2.3 mm/d
example alert band begins at 5.0

ORE MOVED
48.6 kt/d
target 50.0 · forecast 49.2

FLEET CYCLE TIME
34.8 min
load 3.1 · queue 4.6 · travel 27.1

PLANT THROUGHPUT
1,850 t/h
92.5% of illustrative target

PRODUCT QUALITY
67.1% Fe
illustrative recovery 82.4%

SCENARIO	QUESTION ANSWERED	PRIMARY MEASURES	STATE
New exploration result	How do new holes and assays change confidence and sequence?	Tonnes, grade, uncertainty	Explore
Wall acceleration	Is displacement accelerating toward a site alarm threshold?	mm/d, acceleration, exposure	Watch
Blast outcome	How will fragmentation affect dig rate and crusher feed?	P80, productivity, cost	Extract
Haul disruption	What dispatch response protects tonnes and safe access?	Cycles, queues, tonnes	Extract
Recovery drift	Which ore or plant condition is reducing recovery?	Feed, grade, recovery	Process
Outcome validation	Did the action deliver its predicted safety and value?	Error, confidence, benefit	Required

Illustrative demo only—do not use these values or the 5.0 mm/day example as an operating threshold. Live KPIs, alarm bands, escalation rules, and actions must come from the site's approved geotechnical, exploration, extraction, processing, safety, and control documents.

IMPLEMENTATION PATH

Start with one value stream. Scale to the life of mine.

Build the twin as three connected products—exploration, extraction, and processing—on one shared spatial, material, asset, wall-safety, and value foundation.

Explore	Extract	Process	One twin
resource knowledge + confidence	safe walls + field execution	factory-like plant + quality	shared safety and value context

PHASE 01 · EXPLORE

Model the ground

Connect mapping, geophysics, holes, core, assay, resources, confidence, and uncertainty.

PHASE 02 · EXTRACT

Protect + execute

Connect wall sensors, plan, drill/blast, fleet, material custody, maintenance, and shift control.

PHASE 03 · PROCESS

Twin the factory

Connect control loops, equipment, mass balance, quality, recovery, water, and energy.

PHASE 04 · INTEGRATE

Mine → value chain

Optimize all three domains together, then extend to pelletizing, DRI, and steel.

DracoMine

Draco—the dragon and constellation. Mine—the living digital ground where geology, material, machines, people, and decisions remain connected from first cut to final product.

MINE WITH FORESIGHT

Blue Insight Waymark
شرکت نیلی بینش راه‌نشان

bluewaymark.com

+98 21 8887 5397