Agile Geoscience
The 21st Century Playbook for Mineral Discovery

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Agile Geoscience

The global energy transition depends on discovery, but critical minerals are now found deeper and in increasingly complex geology. Traditional exploration models were designed for a different era, with decades-long timelines, slow data movement, and siloed teams.

Agile Geoscience offers a modern alternative. It reimagines mineral exploration as a continuous learning system, fast, adaptive, and integrated, where every dataset strengthens the next decision. It blends the rigour of geoscience with the pace of AI and digital science, enabling explorers to discover faster, de-risk capital, and achieve a more sustainable footprint.

We are now in a new era

Land + Luck	›	Geophysics + Consultants	›	Big Data + Fragmentation	›	Integration + Intelligence
1970s		1990s		2010s		Today

Agile methodologies have already reshaped how complex industries operate. In software development, aerospace engineering, and advanced manufacturing, agile principles have replaced rigid planning with continuous iteration, transparent collaboration, and rapid learning cycles. These approaches have proven that speed and adaptability drive both innovation and reliability when managing uncertainty. Agile Geoscience builds on this same foundation, applying the proven strengths of agile thinking to the unique challenges of geoscience.

The case for transformation

Exploration under pressure

Discovery rates for critical minerals have halved in the last two decades, even as exploration budgets doubled.

Ore grades decline, targets lie deeper, and geological environments grow more structurally complex. The bottleneck is not a lack of data, it's a lack of actionable, integrated insights. Valuable signals remain stranded across disconnected systems and slow decision loops.

Latency	Valuable data takes months to reach decision-makers. If data takes months to become actionable insights, its decision-making value decays as the window to adapt closes.
Silos	Geophysics, geochemistry, and drilling frequently function as separate workflows, where differing methods and interpretations create inconsistency and increase uncertainty.
Rigidity	Exploration plans are fixed too early. Projects cannot pivot when new information emerges.

The analogy: from waterfall to agile

Before the 2000s, software projects followed a linear "waterfall" process, with long planning cycles, rigid requirements, and late learning.

Agile methodologies reversed this, promoting short iterations and continuous improvement. Mining now faces the same inflection point. Agile Geoscience applies these agile principles to the subsurface, replacing annual field campaigns with adaptive loops that sense, model, decide, and learn.

Increasing costs, diminishing returns

McKinsey's analysis in the oil and gas sector found that nearly 80% of exploration expenditure fails to yield an economic discovery. Their modelling also showed that improving information velocity, compressing a typical 12-month feedback loop to around three months, can lift discovery probability by up to 30% and cut the cost per tonne (or barrel) discovered by 25–40%.

While these figures originate from oil and gas, the parallels in mineral exploration are striking, and the gap is wider. Mining remains significantly behind oil and gas in adopting integrated digital workflows, real-time data feedback, and probabilistic modelling. With slower information cycles and higher geological uncertainty, the impact of faster learning loops in mining is likely even more pronounced. Agile Geoscience applies this same principle: accelerating the flow of subsurface insight to raise discovery confidence and lower the true cost of exploration.

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Agile Geoscience: A guiding philosophy and why it's needed

Modern exploration is evolving faster than its frameworks.

New sensing technologies, AI tools, and data systems are transforming how geoscientists work, but without a unifying philosophy these advances risk becoming fragmented, inconsistently adopted or poorly applied. Around the world, explorers are adopting faster, more integrated and adaptive ways of working, similar to how agile methods reshaped software and manufacturing.

Agile Geoscience does not introduce new practices, it defines what is already emerging across the industry and gives exploration teams a shared language for what to measure, what to value and how to prioritise. It provides the structure, the name and the blueprint to focus those efforts, centring around three core tenets.

Core tenets of Agile Geoscience

[1] Velocity

[2] Integration

[3] Adaptation

Velocity captures value

The faster knowledge moves, the greater the return on insight.

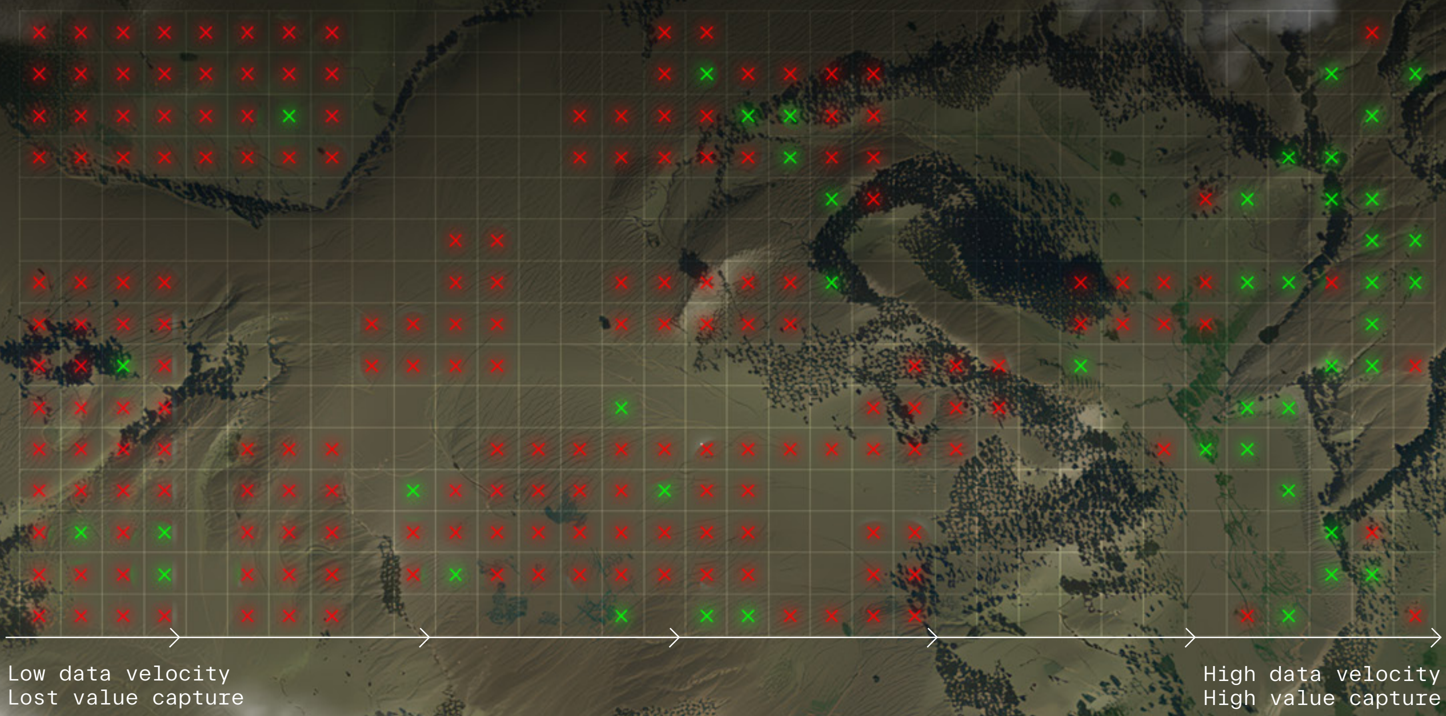
In exploration, time is capital. Investments are guided by data, but value is destroyed with every delay in transforming acquired data into integrated, actionable insights that enable decision makers to adapt. In Agile Geoscience, this concept is called data decay.

Traditional workflows, with long gaps in measurement, analysis and action, were designed for data velocities possible at the time. Today's advances reveal opportunity gaps in data latency, allowing explorers to adapt faster, capturing value for greater success and efficiency.

As data velocity rises, new behaviours naturally emerge. Real-time analysis, automated modelling, and continuous decision cycles become the norm rather than the exception. These are not prescribed processes but outcomes of a system designed for speed.

Real-time edge processing, cloud AI fusion, and satellite connectivity enable this continuous feedback loop, transforming exploration from a sequence of isolated campaigns into a living system of insight where the value of every measurement is captured, applied, and amplified in time to make a difference.

> Velocity is not about rushing; it is about eliminating latency. It measures how quickly information travels from the field to the decision-maker and how rapidly models evolve as new data streams in.



Integration builds confidence

Without it, every decision rests on a fragile, siloed foundation.

Confidence does not come from a single datapoint. It comes from combining multiple perspectives into one coherent picture, where seismic defines depth, magnetics trace structure, geochemistry signals alteration, and geology ties it all together. Each dataset tells part of the story, but only integration connects those fragments into knowledge you can trust.

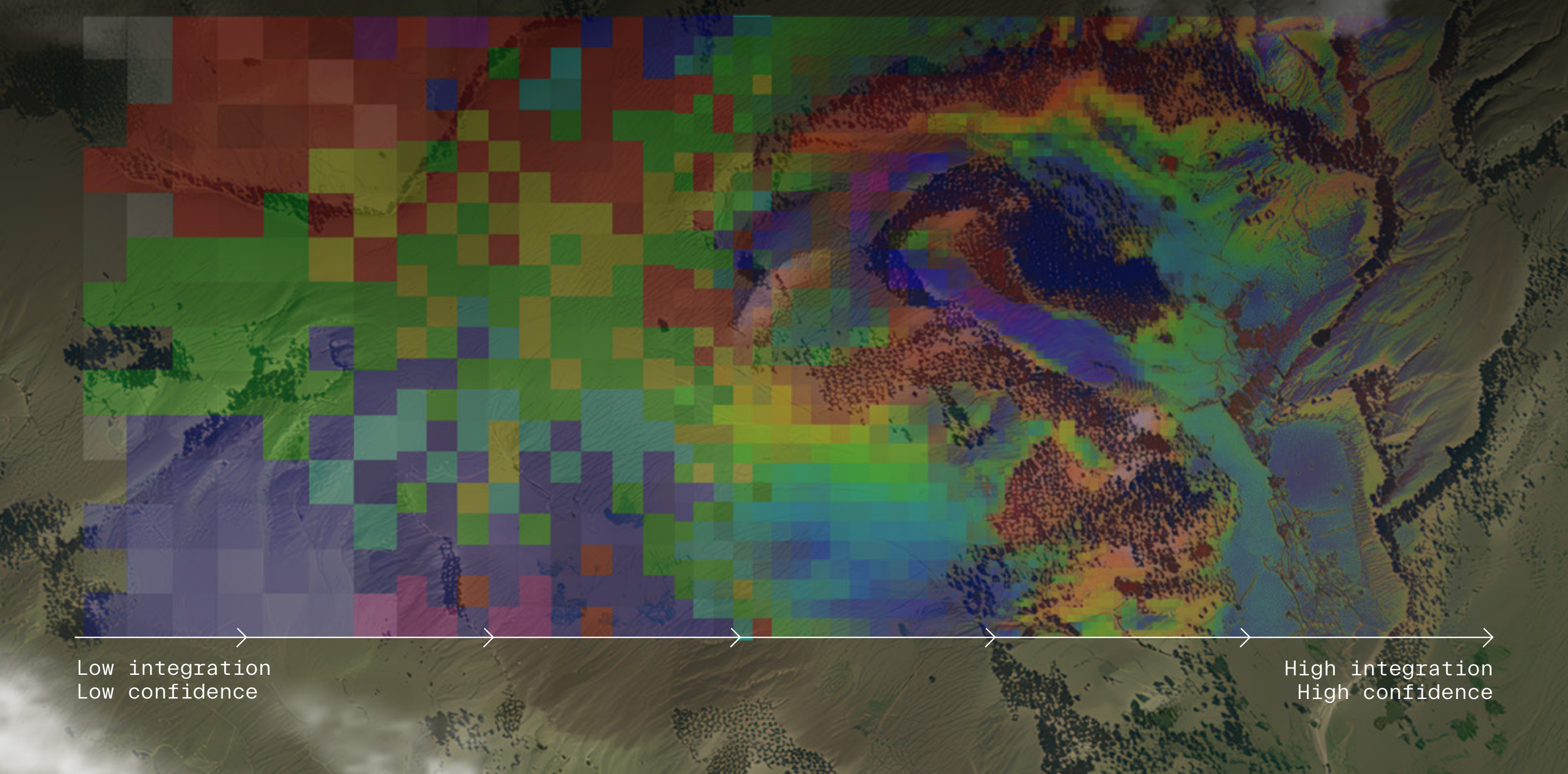
Siloed or narrow datasets produce fragile conclusions. Integrated geophysical, geochemical, geological, and operational data reduce uncertainty and build stronger, more defensible decisions. In the past, this was limited by human capacity, our workflows were solely dependent on human brains, analysing one layer at a time and stitching insights together after the fact.

Agile Geoscience encourages repeatable data preparation across datasets, adoption of open standards for data interpretation and workflows, and practices that ensure data is dependable and results are reproducible.

AI can also support this process by automating time-consuming tasks such as data cleaning, formatting, and reconciliation, allowing geologists and geophysicists to focus on interpretation and discovery. The outcome is a living, probabilistic model that strengthens with every dataset and amplifies expert capabilities.

Integration, through Agile Geoscience, transforms uncertainty into confidence, reduces wasted drilling, accelerates feasibility, and provides a transparent foundation for reporting, ESG assurance, and investment decisions.

> Integration, as intended within Agile Geoscience, changes this through multi-modal data fusion: aligning all inputs within a shared spatial and metadata framework so that cross-domain correlations can be detected, confidence quantified statistically, and models continuously updated as new information flows in.



Adaptation delivers success

Fail fast. Fail cheaply.
Build success into the system.

The subsurface rarely behaves as predicted. Success doesn't come from a static plan, it comes from the ability to course-correct continuously, using high-velocity, high-confidence data to steer decisions while they still matter.

Exploration is inherently uncertain and capital-intensive. Static approaches lead to overspending and missed opportunity. An adaptive operating system focuses time and capital where they have the greatest impact. This continuous learning cycle drives shorter decision loops, dynamic real location of resources, faster de-risking of exploration plays, and a culture that reframes failure as information that improves the next decision.

> Adaptation is the discipline of staying aligned to your goal as conditions change. It means updating models, re-ranking targets, and pivoting strategies as new evidence emerges. In Agile Geoscience, every drill hole, assay, and sensor reading flows back into the model in real-time, creating a living feedback loop that strengthens insight with each iteration.

Operational foundations

Multi-modal data fusion

Each sensing modality provides a fragment of truth. Agile Geoscience emphasises integration and data fusion to produce a single, coherent probabilistic view.

Standardisation	All datasets, geophysical, geochemical, and geological, are normalised into consistent coordinate systems and metadata schemas.
Machine Learning	AI models detect cross-domain correlations (for example, velocity anomalies aligned with alteration geochemistry) and assign weighted confidence scores.
Uncertainty Quantification	Rather than a single deterministic surface, models express probability envelopes. This approach aligns with modern reporting frameworks like **JORC** and **NI 43-101**, where confidence categories (Measured, Indicated, Inferred) map directly to statistical thresholds.
Continuous Learning	As new data streams in, models retrain, shifting confidence dynamically.

AI and edge computation

Traditional geophysical inversion requires centralised supercomputing.

Agile Geoscience, which champions real-time data velocities, leads to edge processing at the sensor level, compressing and filtering data before satellite uplink. Cloud-based AI orchestrates the fusion of multiple modalities, producing near-real-time confidence maps accessible through a web interface.

This architecture shortens the discovery feedback loop from quarters to weeks.

Governance and data integrity

Agile Geoscience embeds governance principles at the data layer:

- **Provenance:** Every dataset is timestamped and versioned
- **Lineage:** Transformation steps are recorded for auditability
- **Interoperability:** Open formats ensure integration with JORC/NI43-101 compliant resource modelling software

This ensures scientific credibility and simplifies external validation for feasibility studies and compliance audits.

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The Agile Geoscience workflow

[1]	**Hypothesis & alignment**	Projects begin with explicit hypotheses and uncertainty targets. Technical objectives align with corporate strategy and ESG commitments.
[2]	**Acquire**	Acquire historic and new data, such as geophysics from the ground, airborne or satellite, core data, geochemistry and other useful information.
[3]	**Prepare**	Standardise all inputs into a unified data architecture, including open standards and AI workflows.
[4]	**Integrate**	AI-automated and human-assisted processing fuses datasets into a living 3D model that evolves with every measurement. Geological interpretations become dynamic rather than static.
[5]	**Predict**	Targets are ranked by expected value, access cost, and confidence uplift. Machine learning identifies where the next invested dollar for data will deliver the most certainty.
[6]	**Adapt**	Each new survey, drill hole or assay becomes a new input which can inform decision making from the field to the boardroom.

Institutional Learning: Data Well

With repeatable, standardised data integration, insights feed into a growing repository, called the "Data Well". This is central to preventing data siloes and unusable data which doesn't then contribute toward future models. Along with capturing decisions, rationales and outcomes, it lives to become a compounded institutional memory that grows in value over time.

Cycle Speed

From the acquisition of new data, the goal is to move through this cycle as fast as possible, removing barriers which prevent the data from being transformed into actionable insights.

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End-to-End Mineral Exploration with Artificial Intelligence and Ambient Noise Tomography (arXiv, 2024).
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Case 1

Accelerated discovery for a Tier-1 gold producer

A major gold miner deployed ExoSphere sensors across structurally complex terrain. Integration of seismic and magnetic data revealed concealed shear zones controlling mineralisation. Within six weeks, the team re-prioritised targets, reducing drilling by 40% while increasing hit rates by 2.3×. Estimated cost savings: USD 4 million.

Case 2

Greenfields opportunity

At an early-stage project in Western Australia, passive seismic was combined with gravity and EM data. AI-driven fusion identified conductive anomalies linked to ultramafic host rocks. The program advanced from reconnaissance to drilling in one quarter, compressing a typical 12-month workflow.

Case 3

Near-mine optimisation

For a producing operation, integration of ExoSphere data with operational telemetry refined the orebody geometry. Resource conversion improved by 15%, directly influencing the next JORC update.

Case 4

Collaborative Exploration

Demonstrating the benefits of a shared Data Well, a consortium exploring copper-nickel across two continents used Agile Geoscience to unify datasets in a shared cloud workspace. With live confidence surfaces accessible to all partners, the JV reduced duplication, improved governance, and built a multi-party audit trail suitable for NI 43-101 disclosure.

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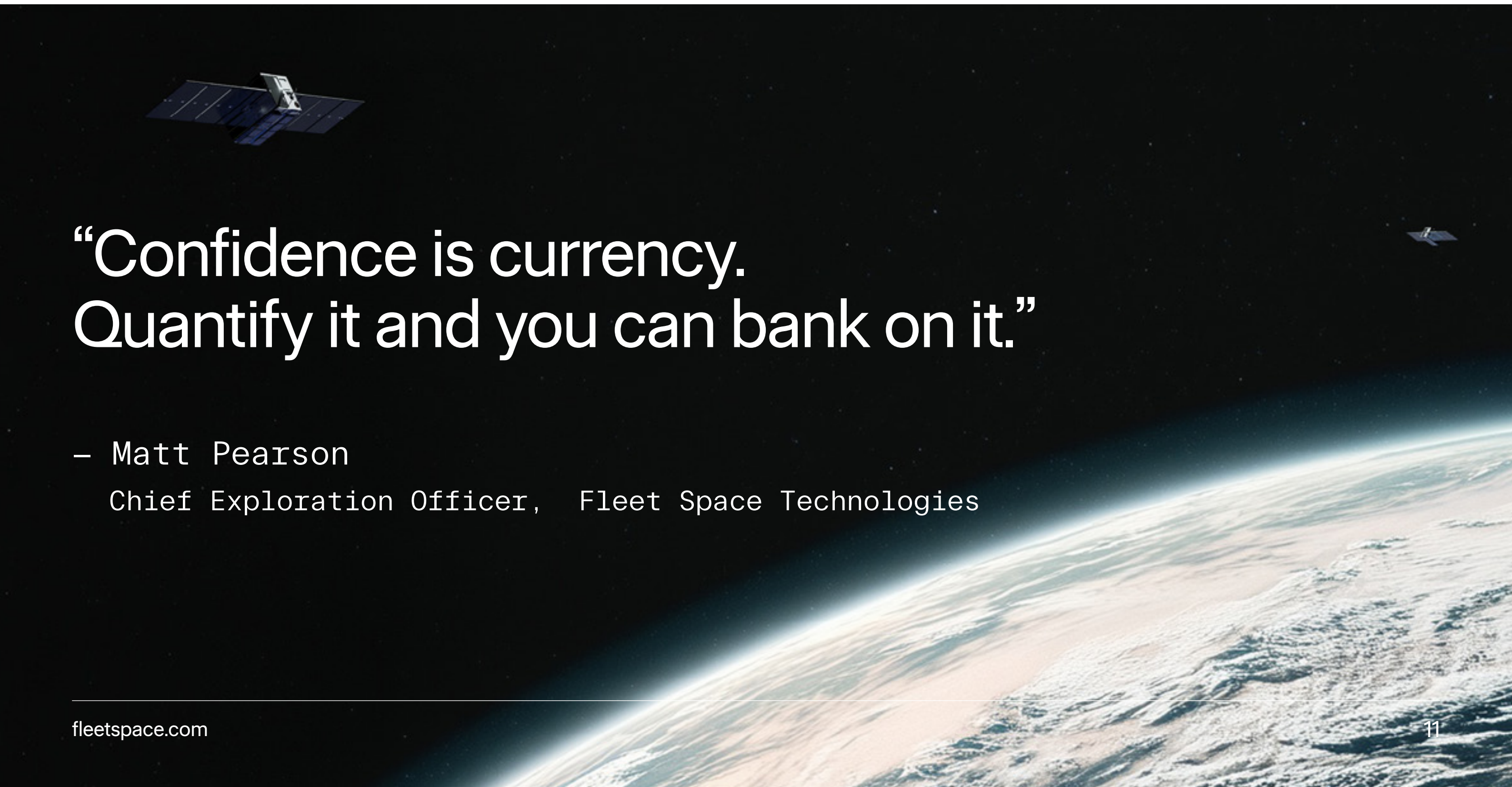

“Confidence is currency.
Quantify it and you can bank on it.”

– Matt Pearson
Chief Exploration Officer, Fleet Space Technologies

Quantifying return on insight

Traditional ROI measures cost per discovery. Agile Geoscience introduces Return on Insight (RoI^2), a metric describing how efficiently new data improves decision quality.

	Traditional	Agile Geoscience
Average Drill Holes to Discovery	100	50 - 60
Decision Latency	90 days	<30 days
Model Refresh Frequency	Seasonal / Annual	Continuous
Confidence in Top Target	~55%	>80%
ESG Footprint (Disturbance)	High	Low

Interpretation: Reducing decision latency and increasing confidence improves both commercial and environmental efficiency.

Each iteration compounds knowledge across the portfolio, forming what we call the Data Well, a growing repository of validated data, models, targets, and interpretations. Its value is clear in practice and manifests as:

- Higher confidence (consistent, integrated data)
- Rapid opportunity rankings (clarity on prospectivity)
- Higher probability of success across projects

The Data Well functions as an ever-evolving source of intelligence, improving capital efficiency and enterprise value by turning disparate data into reusable competitive advantage.

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S&P Global Market Intelligence (2023). Strategies for exploration success in critical minerals.
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Transforming your organisation

From Campaigns to Continuous Learning	Agile Geoscience replaces episodic exploration campaigns with continuous programs of sensing and refinement. Cross-disciplinary teams work in short cycles, integrating data science, geophysics, and geology.
Cultural Parallels	Like agile software teams, exploration squads operate as autonomous units with clear objectives, rapid feedback, and shared dashboards. Decision rights shift closer to the field, empowering experts where information is freshest.
Governance and Leadership	Executives monitor velocity (time from data acquisition to decision) and confidence uplift as new KPIs. These metrics complement traditional measures such as cost per metre and resource tonnage.

“To maximise value at the board and shareholder level, a company needs to have an efficient and competitive business practices.

Agile workflows are well understood by the space and software industries and the mineral industry stands to benefit from applying these principles. Whether greenfields exploration or mine expansion, geoscience workflows that consciously and deliberately embrace velocity, integration and adaptation, will, I believe, have a measurable effect on any relevant success metric.”

Anthony Reid
Head of Geology, Fleet Space Technologies

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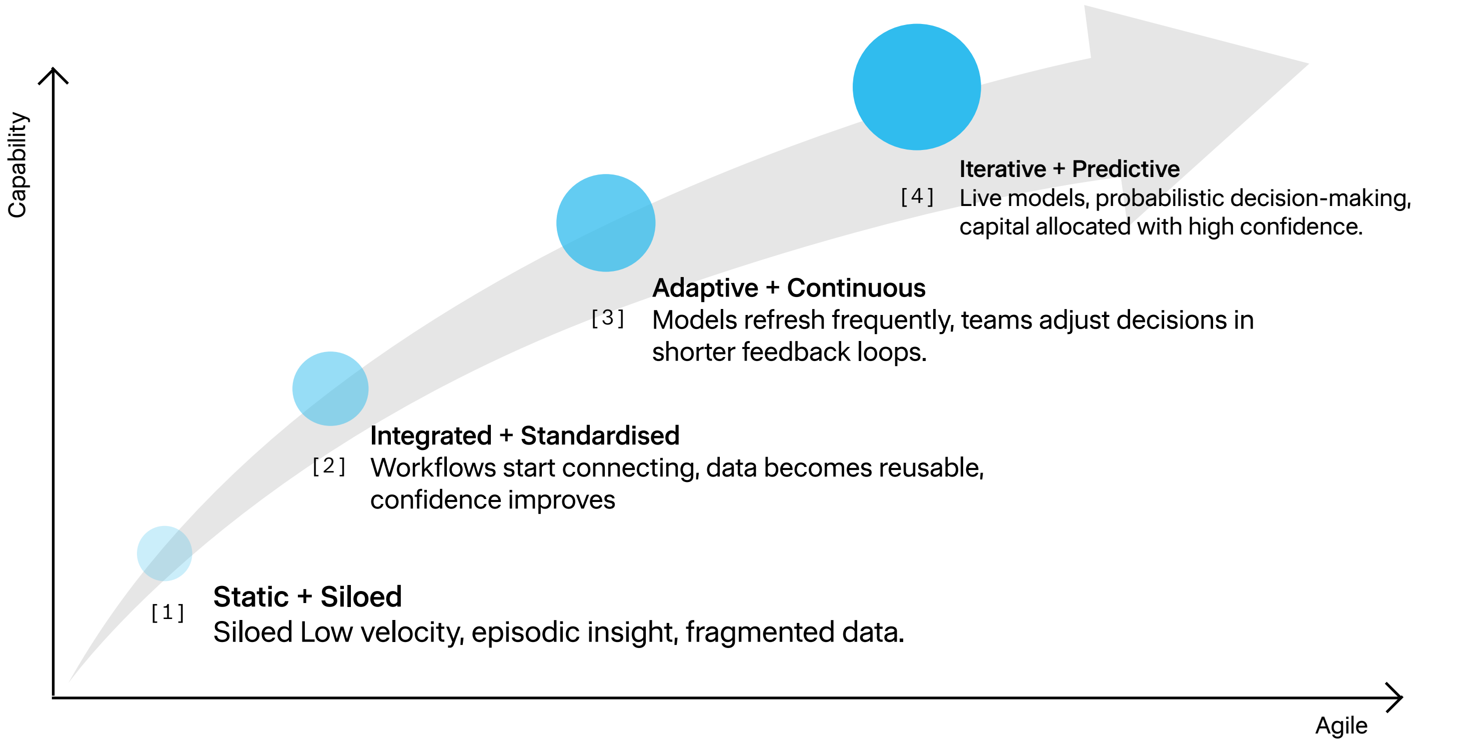
A roadmap to implementation

Organisational learning and change are often the hardest parts of modernising exploration.

Agile Geoscience defines clear, measurable focus areas that guide adoption through pilot projects and scaling for long-term institutional integration.

Phase 1	**Proof of Value** (4–8 weeks)	Pilot one project. Build a live model. Quantify time-to-decision and confidence uplift.
Phase 2	**Scale** (1–2 quarters)	Add modalities, standardise governance, train teams.
Phase 3	**Institutionalise** (2–4 quarters)	Embed Agile Geoscience into capital allocation cycles. Incorporate velocity and confidence metrics into executive dashboards.

Organisations that learn faster perform better



9 - Impact

Environmental and strategic impact

Precision reduces disturbance.

By targeting high-confidence zones, Agile Geoscience cuts unnecessary drilling, lowers emissions, and shortens field exposure. Standardised data lineage also strengthens ESG disclosure and stakeholder transparency.

At a strategic level, the same principles position companies for the future of exploration, one defined by space-enabled sensing, autonomous edge networks, and real-time planetary insight.

Sources

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10 - Conclusion

Conclusion

Agile Geoscience reframes exploration as a continuous system of learning and improvement.

It replaces static, linear workflows with adaptive cycles that integrate new data, refine models, and accelerate decision-making.

Grounded in scientific rigour and supported by advanced analytics, it provides a structured, measurable approach to reducing uncertainty and increasing exploration efficiency.

For decision-makers, Agile Geoscience represents a practical framework for achieving faster results, stronger confidence, and better use of capital and environmental resources. It enables teams to respond to new information in real-time and to turn data into value with greater precision.

Explore how your Agile Geoscience can work across your portfolio

Request a Discovery Impact Session

About Fleet Space Technologies

Fleet Space Technologies is redefining how the world discovers and develops critical minerals.

Fleet Space Technologies is revolutionizing data-driven mineral discovery, development, and management with its vertically integrated exploration platform, ExoSphere.

Unifying frontier technologies - satellites, rapid 3D multiphysics surveys, compute, and AI - into a single workflow for the global mining industry, ExoSphere's agile geoscience solutions and AI-enabled drill targeting is used to enhance ESG outcomes, success rates, and reduce costs at the most remote and complex projects worldwide.

For the breakthroughs enabled by ExoSphere, Fleet Space received Mining Magazine's Exploration Excellence Award and Innovation of the Year at the Mining Technology Excellence Awards 2025.

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