An Artificial Intelligence-driven Approach to Mineral Exploration in Botswana

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BOTSWANA DIAMONDS PLC

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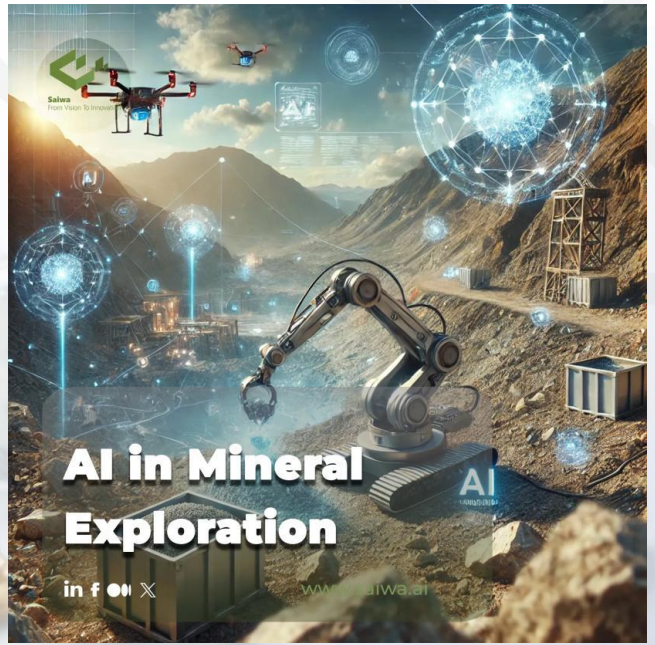
AGENDA

- Global demand: exploration crisis
- AI foundations: remote sensing, geophysics, data fusion
- Company landscape & case studies
- Cost/time benefits: juniors vs majors
- BOD strategy: dataset & AI-screened targets
- Polymetallic & kimberlite examples
- AI vs traditional methods: future of AI

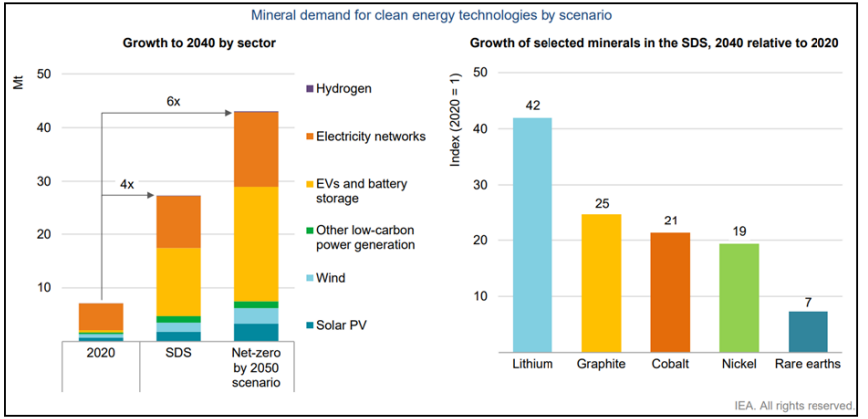


Saiwa, 2025

Global demand: exploration crisis

Global Demand for Critical Minerals

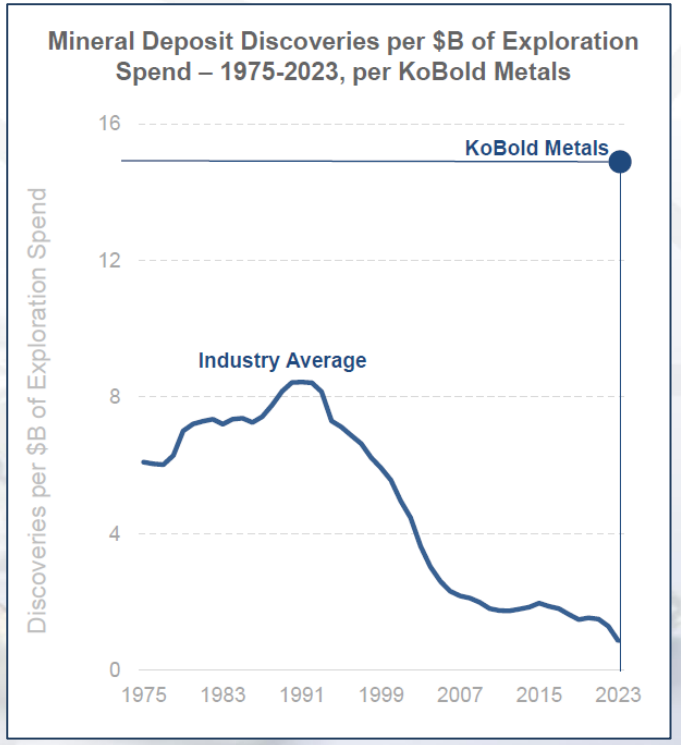
- The energy transition is **accelerating demand** for copper, lithium, cobalt, nickel, graphite and rare earths used in batteries, renewables and grid storage.
- Authoritative outlooks indicate lithium demand may rise **more than fivefold** by 2040, with nickel, cobalt and rare earths **at least doubling** over the same period.
- Botswana is **well placed geologically** with highly prospective Cu–Ni–Co and PGM terranes that complement its world-class diamond endowment.
- Absent discoveries, **supply gaps of ~30–40%** for key minerals such as copper and lithium are forecast by the mid-2030s, **sharpening the exploration imperative**.



Deloitte, 2024

Exploration Crisis: Rising Costs, Fewer Discoveries

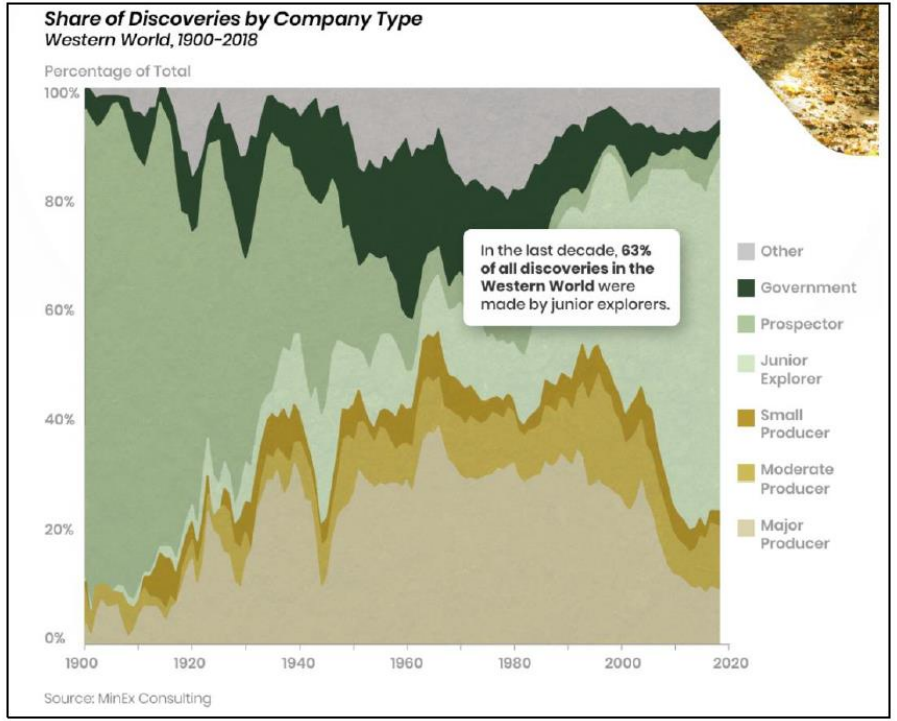
- Global **discovery rates have fallen significantly** since 2010 despite higher spend; greenfield success is commonly cited at ~0.02% (≈1 in 5,000 drillholes).
- Shallow, outcropping deposits are largely exhausted; **deeper targets under cover** require new geoscience and computational approaches.
- Escalating drill and logistics costs **erode ROI and suppress risk capital**, particularly for juniors, prolonging the 'orphan period' between campaigns.
- These structural headwinds motivate systematic, **data-driven targeting** to raise hit rates and compress cycles.



Bond, 2025

Juniors vs Majors in Discovery

- Historically, **>60% of commercial discoveries are credited to junior explorers** who specialise in high-risk front-end work.
- Majors increasingly replace reserves by **acquiring advanced projects** rather than leading greenfield search in frontier terrains.
- Tighter capital markets and higher failure rates **(>90% for juniors**) impede the venture pipeline that majors ultimately rely upon.
  - If the Junior is correctly **incubated**, the failure rate is **considerably lower**.
- AI-enabled prospectivity can **lower technical risk for juniors**, improving financing potential and partnership options.

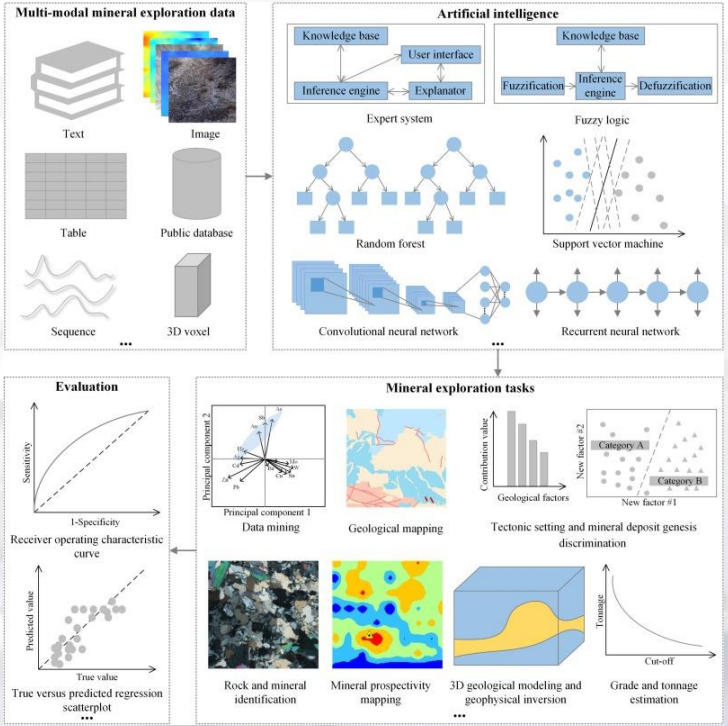


Visualcapitalist, 2024

AI foundations:
remote sensing, geophysics, data fusion

Artificial Intelligence in Mineral Exploration

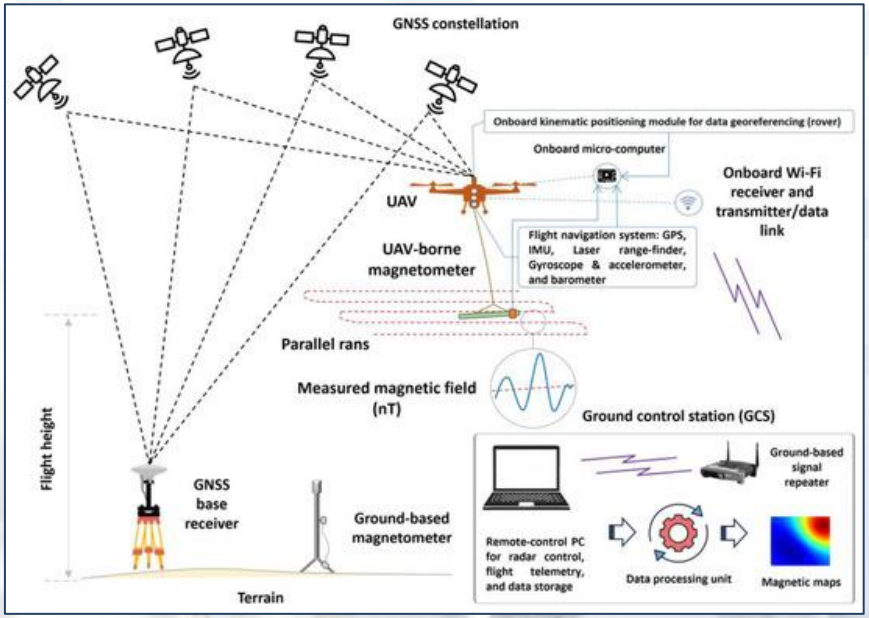
- AI **integrates geological, geochemical, geophysical and remote-sensing data** to reveal patterns that are difficult to detect with manual methods.
- Common techniques include supervised and unsupervised learning, ensemble models, anomaly detection and Bayesian decision frameworks.
- Outputs are **prospectivity maps and ranked target lists** with feature importance and uncertainty, enabling transparent ('glass-box') interpretation.
- Iterative re-training with new field data continuously **improves models and decision quality**.



Yang et al, 2024

Remote Sensing and Geophysical AI

- Multispectral/hyperspectral satellites and UAVs map alteration, structure and regolith; AI **automates pixel-to-mineral information extraction**.
- Machine Learning assisted inversion and clustering of gravity, magnetics, and EM **improve depth estimates and structure/host recognition under cover**.
- Joint inversion and data fusion reduce ambiguity by consistent geophysical application across **multiple datasets simultaneously**.
- These methods **rapidly screen large areas** to funnel scarce field budgets to the most prospective areas.



Javan et al, 2024

Data Fusion and Prospectivity Modelling

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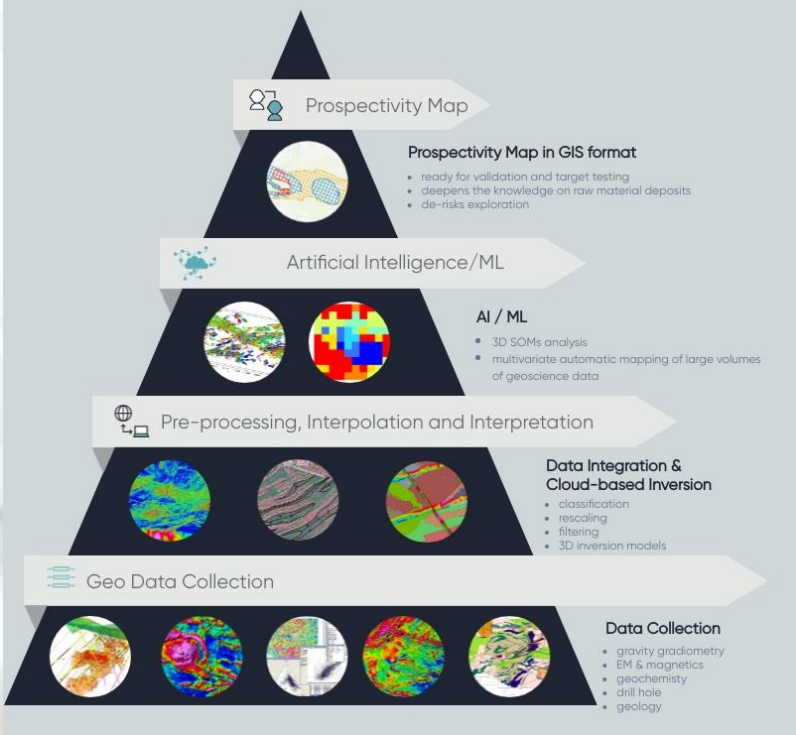
- Knowledge-driven rules (deposit models, expert features) are combined with data-driven learning to **compute pixel-level prospectivity**.
- Feature engineering captures **litho-structural context** (e.g., contacts, dilational jogs, dyke swarms, basin architecture) across scales.
- Ensembles (e.g., random forests, gradient boosting, deep nets) **output class probabilities with uncertainty for ranked targeting**.
- Model governance includes cross-validation, blind tests and sensitivity analysis to **avoid over-fitting and spurious correlations**.



Bell Geospace, 2024

Company landscape and case studies

Select Companies Applying AI

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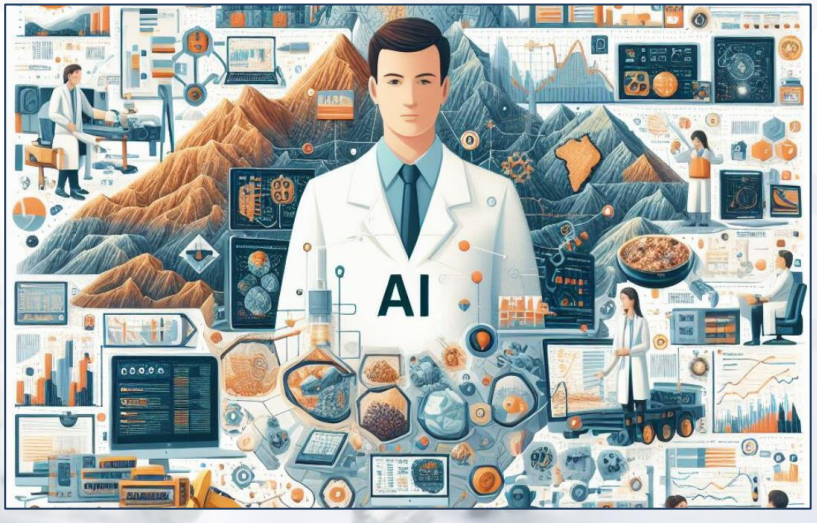
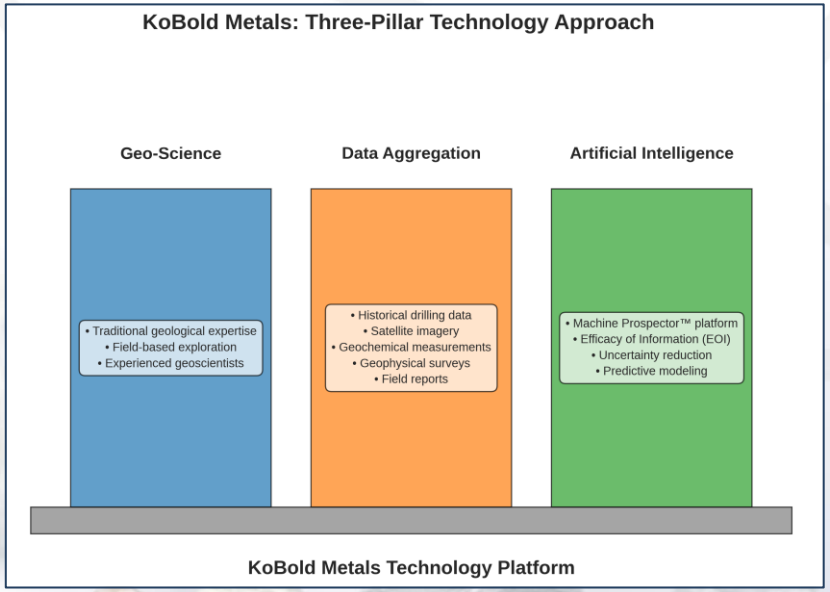
- *KoBold Metals* applies decision theoretical targeting ('Intelligent Prospector') to **accelerate discovery** of Cu–Ni–Co–Li deposits.
- *Earth AI* integrates in-house data science with nimble drilling capability, reporting **materially higher drill-hit ratios** than historical norms.
- *Planetary AI* (Xplore) couples knowledge models with Machine Learning for **transparent prospectivity at local-to-country scales**.
- Other players (e.g., GoldSpot, Mira) specialise in hyperspectral/geophysical Machine Learning and **integrated targeting** for clients.



Mining Doc, 2024

Case Study: KoBold Metals (Zambia Copper)

- Applied Machine Learning and decision analytics to legacy and new data, delineating the Mingomba orebody reported as **Zambia's most significant copper discovery in a century**.
- **Rapid drill confirmation** (~1 year) contrasts with typical multi-year campaigns in covered terranes.
- Portfolio scale and continuous model updates allow **fast redeployment** of learning across districts.
- Illustrates how algorithmic triage can **prioritise scarce drilling** for maximum information gain.
- Funded by Gates/Bezos with **$500M capital**.



KoBold, 2024

Case Study: Earth AI (Australia)

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- Reports **~75% drill-hole success** on AI-generated targets versus sub-1% historical norms for greenfields in similar terrains.
- Combines satellite analytics, geological Machine Learning and rapid drilling to close the loop between prediction and testing.
- **Cost reductions of up to ~80%** are cited through tighter drill focusing and fewer abandoned campaigns.
- Shows the value of owning both the data / Machine Learning pipeline and **fast execution capability**.

Earth AI unveils six new mineral prospects in Australia

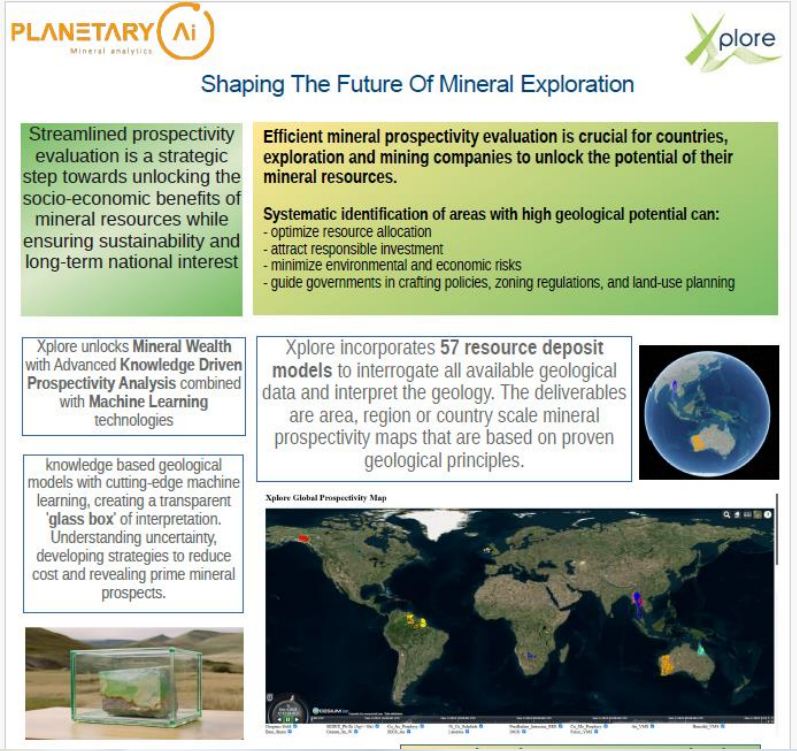
Staff Writer | March 26, 2025 | 9:07 am Exploration Australia Cobalt Copper Gold Silver Tungsten

Earth AI says it can move from detecting a prospect to drill-testing in just three to six months. (*Stock image generated with AI. By utaem2022 | Adobe Stock.*)

Mining.com, 2025

Planetary AI 'Xplore' (Botswana)

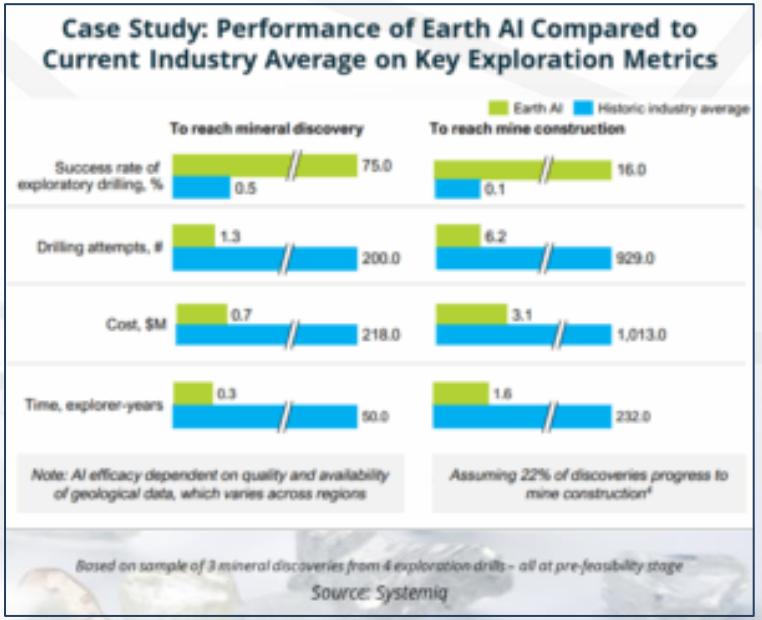
- Combines 57+ deposit models with Machine Learning to **compute prospectivity at multiple scales** ('glass-box' interpretability).
- Semantic methods capture geological context (e.g. proximity to structures, host lithologies, permissive facies).
- Delivers **ranked target maps with quantified uncertainty**, feature importance and recommended subsequent data acquisition to reduce risk, powered by Machine Learning for adaptive targeting and evidence-based prioritisation.
- Configured for governments and explorers; **supports area selection**, licensing and JV screening.



PlanetaryAI, 2025

AI Cost and Time Benefits

- AI narrows search space early, focusing drilling on high-probability targets and **lifting drill-hit ratios** from sub-1% to orders-of-magnitude higher in some reports.
- **Exploration cycles compress** (planning → test → learn) through automated data prep, rapid modelling and adaptive survey design (4x faster).
- Claims of up to **~80% reduction in discovery cost** reflect fewer false positives and better sequencing of work programs.
- At industry scale, modelling suggests **multi-hundred-billion dollar annual savings** by the mid-2030s if broadly adopted.



Differential Impact

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Juniors

- Juniors can leverage AI to **process large legacy datasets**, lifting target quality without adding fixed headcount.
- Higher-confidence targets **improve access to risk capital and strategic partners**, shortening the 'orphan period'.
- **Transparent, explainable outputs** support investment committees and JV negotiations.
- AI-ready data rooms become a **competitive asset** when farming out or transacting licences.

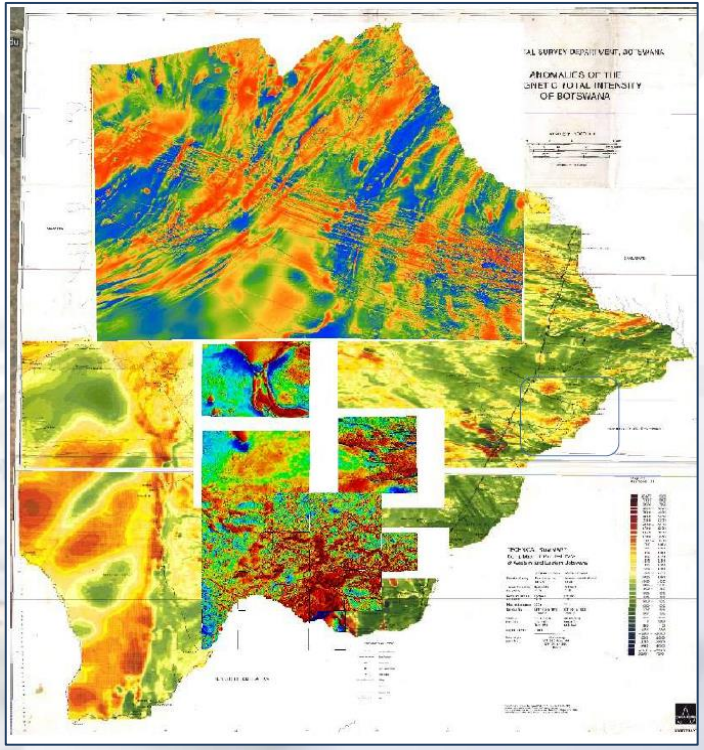
Majors

- Majors can apply AI at portfolio scale to rank districts, **optimise capital allocation** and integrate brownfields with greenfields.
- Standardised **data governance** and Machine Learning pipelines enable comparability across business units and countries.
- Decision analytics frameworks quantify trade-offs between resource replacement, optionality and **ESG constraints**.
- AI also improves brownfields targeting, extending mine life and **smoothing reserve replacement profiles**.

BOD strategy: dataset and AI-screened targets

Botswana Diamonds plc (BOD): Strategy Overview

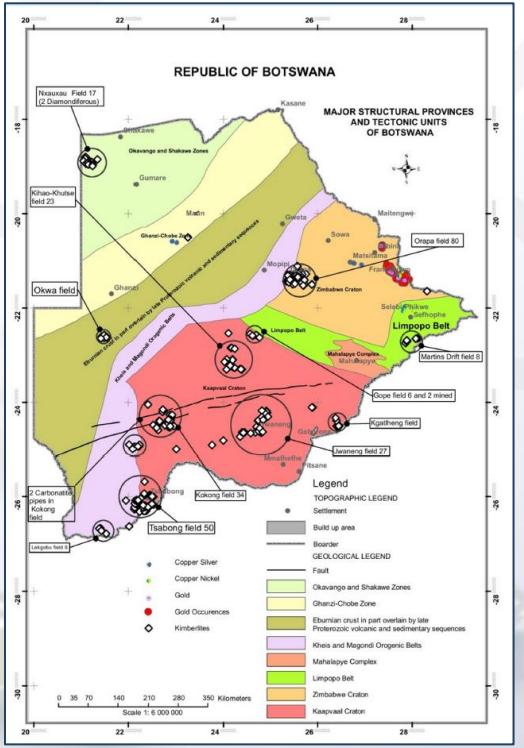
- BOD's strategy is to exploit a proprietary, comprehensive Botswana dataset **accumulated over ~20 years** and to apply AI for rapid prospectivity screening.
- Partnership with Planetary AI enables **country-scale analysis** before license applications, improving ground selection quality.
- Focus spans **polymetallics** (Cu-Ni-Co-Zn-Pb-Ag, PGEs) and diamonds, reflecting **Botswana's metallogenic diversity**.
- Objective is to **secure high-potential ground**, develop drill-ready targets and form value accretive JVs.



Botswana Geoscience Institute, 2024

BOD Legacy Dataset: Scale & Composition

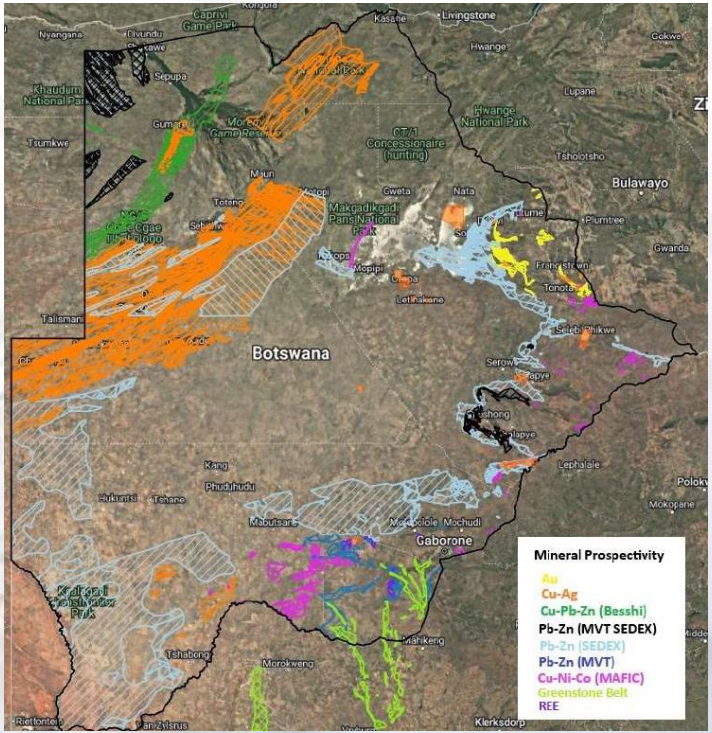
- **~225,000 km² of spatial coverage** and ~383 GB of data comprising:
  - ~375,000 line km airborne geophysics,
  - 606 ground geophysical surveys,
  - ~358,000 soil sample results and
  - ~32,000 drill logs.
- Datasets were **standardised**, georeferenced and fused for AI ingestion to ensure apples-to-apples comparisons across tiles.
- Coverage extends across Ngamiland, SE Botswana and other permissive belts, including **kimberlite fields and mafic-ultramafic terranes**.
- This scale permits consistent, **unbiased target ranking** from license to province.



Botswana Geoscience Institute, 2020

BOD License Applications: AI-Screened Results

- First AI pass generated applications over ~7,500 km²: **11 polymetallic and 3 kimberlite targets** meeting de-risking criteria.
- Selection emphasised permissive geology, multi-commodity potential and adjacency to **undercapitalised neighbours**.
- AI ranking guides phased ground acquisition and **JV approaches** to stitch contiguous trends where appropriate.
- Field programs **prioritise drill-ready targets** while acquiring missing datasets to lift model confidence.



BOD's Competitive Advantage

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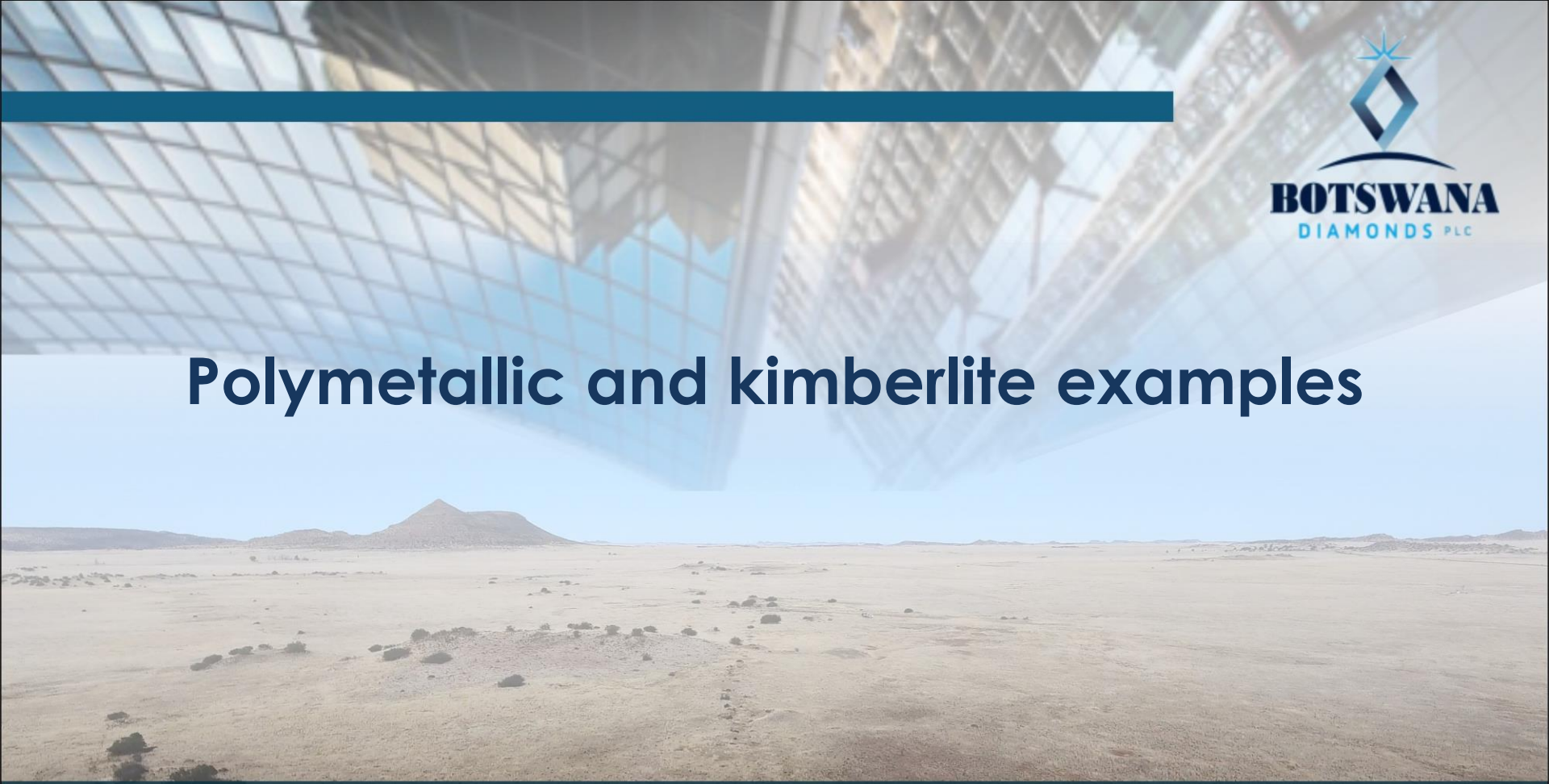
Five Pillar approach

- ***Data***. BOD already has an extensive database in Botswana and proposes to acquire more across Southern Africa.
- ***AI technology***. BOD also has access to this through an alliance with Planetary AI Xplore, which utilises a proprietary platform which unlocks mineral wealth with advanced knowledge-driven prospectivity analysis combined with machine learning technologies.
- ***Government relations***. The ability to apply for and receive Prospecting Licenses. BOD has a demonstrated track record in this regard in Southern Africa.
- ***Field and commercial skills***. Once a Prospecting License has been granted, the ability to conduct field and other technical work to achieve a rapid commercial conclusion. BOD has a proven track record in this area and runs a very tight, lean company.
- ***(Cash …)***

Polymetallic and kimberlite examples



BOD Polymetallic Targeting: Examples

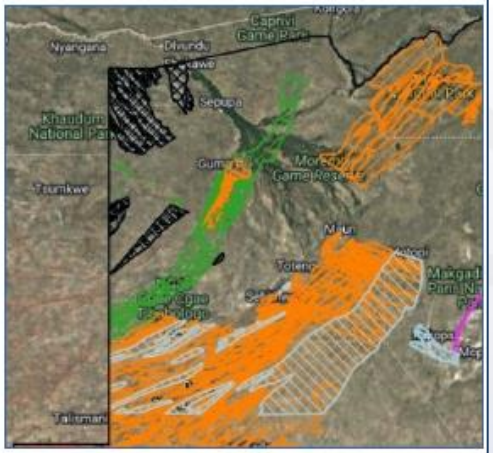
- Ngamiland terranes flagged as permissive for **Cu-Pb-Zn-Ag** with associated V-Co-Ge-Au-PGE signatures across **multiple deposit styles**.
- SE Botswana blocks prioritised for **Cu-Ni-Co** with ultramafic/mafic hosts and shear-related traps.
- Historic resources and showings (e.g., Zn-Pb-Ag) locally **validate the predictive patterns** highlighted by AI.
- Next steps: integrate new surface geochem/EM to tighten drill collars on **top-ranked anomalies**.

Ngamiland Copper, Zinc & Lead, Silver

Ngamiland terranes are permissive for Copper, Lead, Zinc, Silver + associated mineral potential (Vanadium, Cobalt, Germanium, gold & PGE's).
Minerals formed via 4 different deposit types enabling broad range of spatial occurrences and resource assemblages.

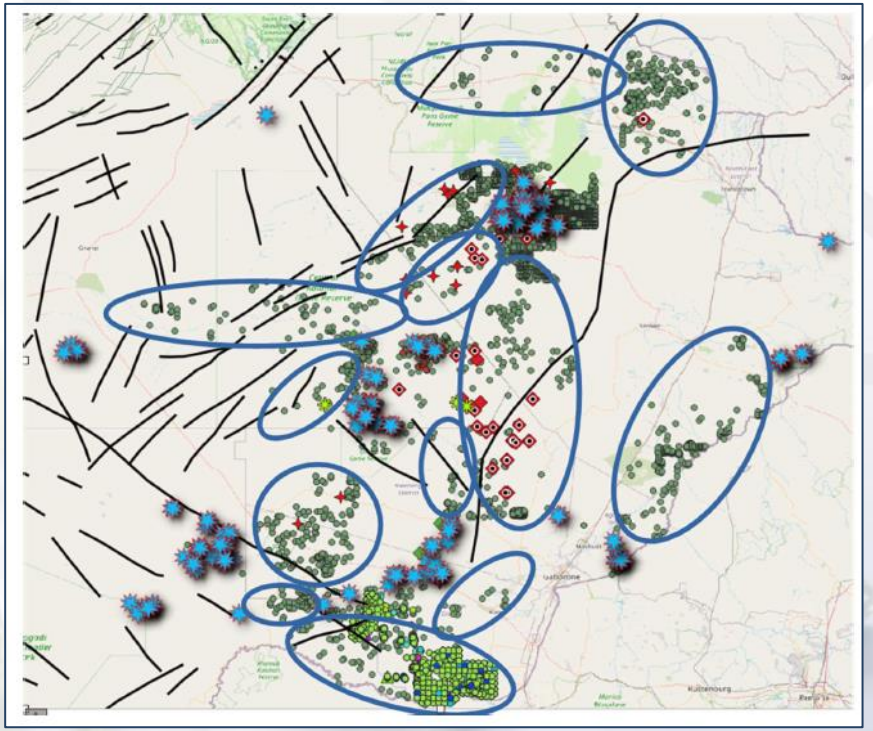
Historically less well explored part of Botswana but interest in the region is rapidly expanding with some promising results to data.

Region example:
Zinc/Lead/Silver/Germanium and Vanadium 2004 JORC compliant resources of 25 million tonnes @ 3% Zn/Pb together with 3.3 million ounces of Silver.



BOD Kimberlite Targeting: Examples

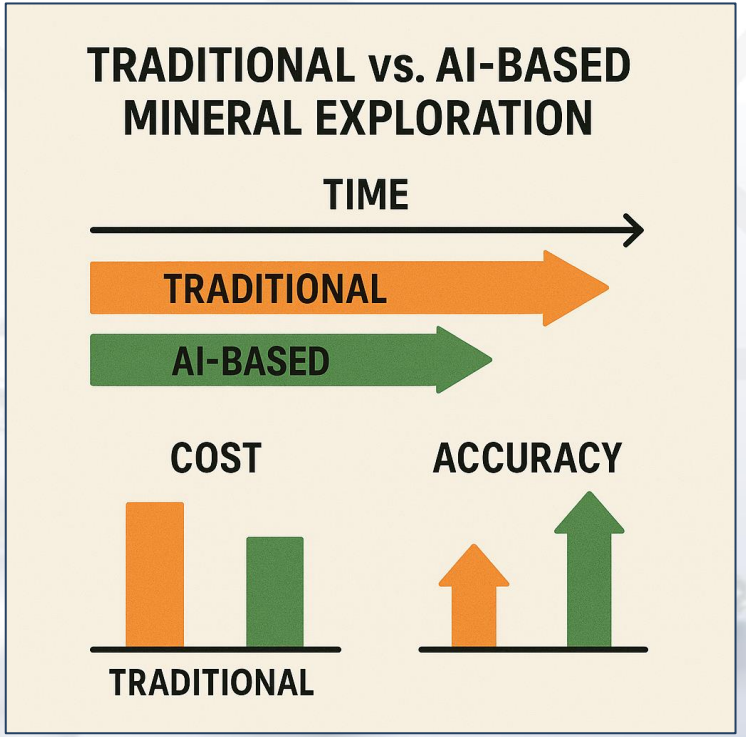
- Indicator mineral (KIM) differentiation isolates key garnet/spinel populations that **drive dispersion trends**.
- Geophysical context (gravity lows, moderate magnetics) is used to focus **under-cover kimberlite** searches.
- Clusters of KIMs far from known fields suggest undiscovered sources; cover thickness modelling informs **exploration technique**.
- Prospective clusters have been captured in **granted licenses** for follow-up ground geophysics and drill testing.



AI vs traditional methods: future of AI

AI vs Traditional Exploration

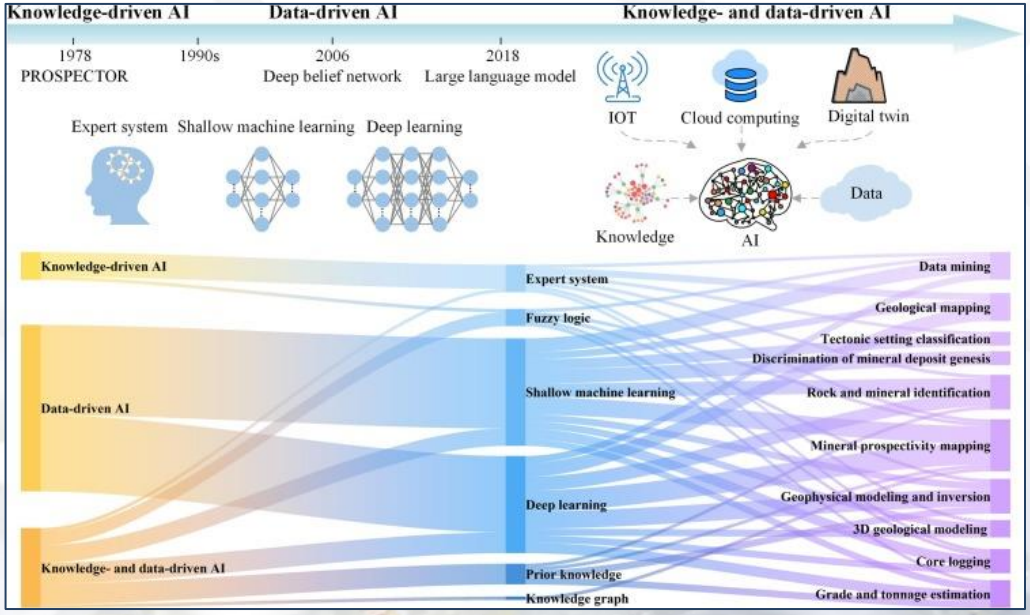
- *Traditional*: sequential, expert-led overlay mapping; **slow feedback** and limited hypothesis throughput.
- *AI-enabled*: parallel hypothesis generation, probabilistic ranking and adaptive survey design with **rapid feedback** loops.
- Explainability and uncertainty quantification support disciplined 'stage-gate' decisions and **budget defence**.
- Outcomes reported to date show **materially higher drill conversion and lower unit discovery cost**.



RASonly, 2025

Possible Future State (2030–2035)

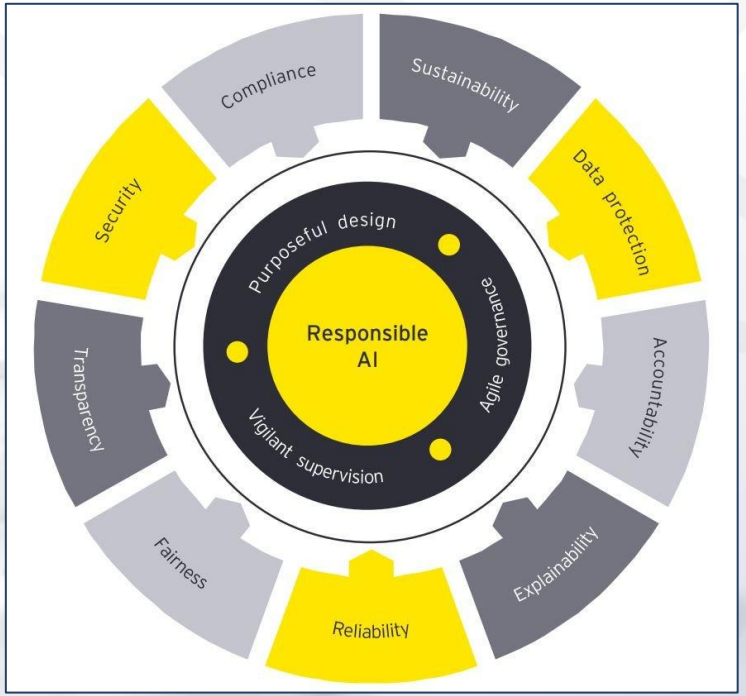
- Digital twins of districts/ore bodies that update with drilling, sensing and operational data to guide **real-time decisions**.
- Autonomous UAVs and robotic drills integrated with active learning to **test the highest potential holes first**.
- Next-generation sensors (quantum gravimetry, improved hyperspectral) **extend the depth of investigation beneath the cover**.
- Skillset shift: geologists operate as **domain-expert data scientists**, curating features and governing models.



Yang et al, 2024

Policy, Investment and ESG Context

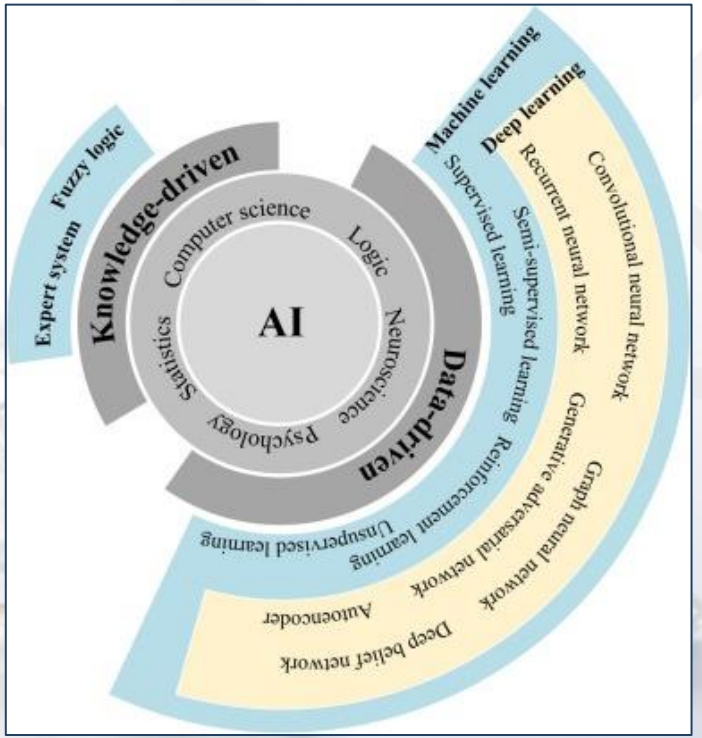
- Critical-minerals policies (US, EU and others) and strategic finance favour projects that **demonstrate efficient, low-impact and successful commercial discovery**.
- AI reduces **unnecessary disturbance** by focusing work on the highest-probability targets and documenting evidence trails.
- Transparent, auditable models **strengthen stakeholder engagement** and permit narratives.
- Botswana's **stable jurisdiction and data-rich history** are aligned with this investment thesis.



EY.com, 2024

Conclusions and Strategic Outlook

- AI is **reshaping exploration economics** by raising hit rates, compressing timelines and lowering unit costs across commodities and terrains.
- Botswana's geology, data depth and stability make it an **ideal proving ground** for AI-enabled exploration.
- For juniors, explainable AI **improves financing potential**; for majors, it enables portfolio-level optimisation and reserve replacement.
- Early adopters will **capture outsized benefits** as models, data assets and partnerships compound over time.



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Thank You

Questions & Discussion

Photo: Andreas Stelzer

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- Planetary AI. Xplore prospectivity platform overview and method notes.
- KoBold Metals case reports and industry coverage (e.g., Mining.com, Reuters).
- Earth AI technical briefs and public case studies (Australia).
- NASA Earth Observatory. Botswana diamond mines satellite imagery (contextual).
- Cleantech/industry analyses on AI in exploration and discovery efficiency.

About the Author

- James Campbell is Managing Director of Botswana Diamonds plc (a diamond development company active in Botswana, South Africa and Zimbabwe and listed on London AIM and the Botswana Stock Exchange). He has spent over forty years in the diamond industry in a variety of leadership roles both in major and junior companies.
- Previous roles include Non-Executive Director of Shefa Gems (where he is still Technical Advisor); Chief Executive Officer and President of Rockwell Diamonds Inc; Non-Executive Director of Stellar Diamonds plc; Vice President - New Business for Lucara Diamond Corp, Managing Director of African Diamonds plc; Executive Deputy Chairman of West African Diamonds plc and Director of Swala Resources plc and Bugeco sa.
- James also worked at De Beers for over twenty years; his roles included General Manager for Advanced Exploration and Resource Delivery and the Executive Chairman Nicky Oppenheimer's first Personal Assistant.
- James holds degrees in Mining and Exploration Geology from the Royal School of Mines (Imperial College, London University) and an MBA with distinction (and top student prize) from Durham University. He is a Fellow of the Geological Society of South Africa, Institute of Mining, Metallurgy and Materials, South African Institute of Mining and Metallurgy and Institute of Directors of South Africa. He is also a Chartered Engineer (UK), Chartered Scientist (UK) and a Professional Natural Scientist (RSA).
- James is also chairman and founding director of Common Purpose South Africa NPC (a not-for-profit organization that develops leaders who can cross boundaries and is synonymous with the terms '*cultural intelligence*' and '*leadership beyond authority*'). CPSA celebrated its twenty-fifth anniversary in 2025. He was also a director, trustee and chairman of the Joburg Ballet for almost fifteen years.

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