

From Data-Rich to Evidence-Driven: Benchmarking AI, Physics-Based Inversions and Geological Models as Porphyry Targeting Tools in Southeast Arizona

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Viridien has developed a predictive targeting framework through a multi-year regional project in Southeast Arizona, advancing prospectivity in under-cover terrains through integration of geology and high-resolution geophysics.

Phase 1 involved acquisition (across 55,000 km²) and merging of airborne magnetic, gravity and radiometric data, remote sensing alteration and geology data, and nearly one million digitized legacy records transformed into a geological database.

Phase 2 produced constrained and unconstrained inversion models resolving structural and lithological architecture beneath cover. Drillhole and geological map data constrained surface and subsurface density and magnetic parameters as inputs for regionally consistent gravity and magnetic inversions.

Phase 3 followed a staged unsupervised-to-supervised machine learning prospectivity workflow. Self-organizing maps (SOM) and isolation-forest outlier (ISO) maps initially clustered geophysical layers with lithological units at shallow, intermediate and deep intervals. SOM and ISO outputs can be used as standalone layers to QC and validate the refined products. The supervised stage applied gradient-boosted tree algorithms integrating geophysical layers with 24,877 soil, outcrop and mine samples to generate Cu-Mo prospectivity and porphyry-Cu threshold models.

An AI document analysis workflow comprising a vision-language model (VLM) and a large language model (LLM) was deployed to classify, identify and visualize Mineral Resource Estimate (MRE) outlines from public reports. The results supported the validation of a Laramide filter model constraining predictions to prospective lithologies (felsic plutonic rocks) associated with 80-45 Ma Laramide magmatism.

Inter-model correlation and high-probability predictions are observed across all approaches, especially beneath Quaternary cover. Models were cross-validated and spatially corroborated with known deposits, MRE outlines and independent stream-sediment analysis. This forms the basis for a wider regional review and development of a Regional Laramide Prospectivity Map, underpinned by a harmonized platform delivering curated data and prospectivity models, where iterative workflows are critical for evaluating diverse terrains and enabling smart exploration decisions.