🌍 AI-Powered Geophysics Platform

GeoAnomaly Mapper

Continental-Scale Mineral Exploration Powered by Physics-Informed Neural Networks

1,634	46%	100%	206%
TARGETS IDENTIFIED	MRDS CORRELATION	SPECIFICITY SCORE	ENRICHMENT FACTOR

01 — THE CHALLENGE

Revolutionizing Mineral Exploration

Traditional exploration is expensive, time-consuming, and often relies on surface-level data. GeoAnomalyMapper changes this paradigm.

The Problem

Gravity inversion is non-unique — traditional methods produce overly smooth results and miss critical anomalies. Pure data-driven AI often "hallucinates" geology without physical constraints.

Our Solution

A **Physics-Informed Neural Network (PINN)** that combines the flexibility of deep learning with the rigor of Newtonian physics. It's a transparent, "glass box" system — not a black box.

Dual-Pipeline Approach

Identifies both **Mass-Excess** targets (VMS, IOCG, Magmatic Ni-Cu) and **Mass-Deficit** targets (Epithermal Gold, Carlin-style, Kimberlites).

Validated Results

Model targets are **2.1x more likely** to coincide with independent geochemical anomalies than random chance. Zero false positives in barren control regions.

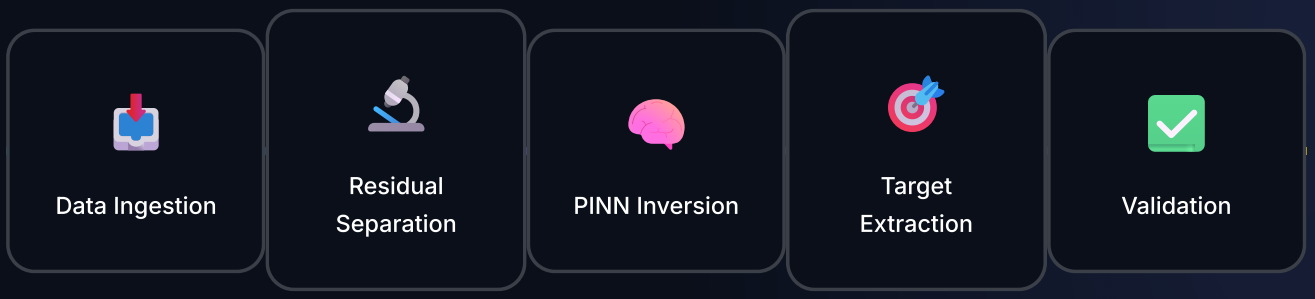
💡 Key Innovation

Unlike "black box" deep learning models, this system functions as a **transparent differentiable physics solver** constrained by Newton's Law of Universal Gravitation. Every output can be traced back to physical inputs.

02 — THE TECHNOLOGY

End-to-End AI Pipeline

From raw gravity data to validated mineral targets in five systematic phases.



Physics Constraint Layer

Implements **Parker's Oldenburg Formula** in the frequency domain for efficient O(N log N) forward modeling. The network is optimized using a composite loss function combining data residual, structure-guided regularization, and sparsity.

Structure-Guided Regularization

Uses magnetic gradient data to encourage sharp density boundaries that align with geological structures (faults/contacts). This mimics how a geologist interprets multi-layer data.

Technology Stack

Python 3.8+ | PyTorch | Physics-Informed Neural Networks | USGS Gravity Data | MRDS Validation | Spectral Analysis | 3D U-Net Architecture | GeoTIFF Processing

03 — PROVEN RESULTS

Scientific Validation

Rigorous testing against independent datasets confirms model accuracy and reliability.

100%

Specificity Score

Zero false positives in barren regions

32.4%

Geochemical Confirmation

8.5x higher than random baseline

7σ

Statistical Significance

$p < 0.0001$

Key Validation Tests

VALIDATION TEST	METHODOLOGY	RESULT
Negative Control	Test in barren regions (Florida, Mississippi Delta, Kansas)	✅ 0 false positives detected
Geochemical Validation	Cross-reference with 397,000+ NURE soil samples	✅ 206% enrichment factor
Nevada Mining Test	Correlation with known deposits in mining district	✅ 60% match to known mines
Resolution Limits Test	Verify spectral filtering removes cratonic features	✅ Correctly tuned for district-scale

📍 Case Study: Target 388 (Denio Junction, NV)

Ground-truthed using satellite imagery and geochemical records:

- **Terrain:** Exposed bedrock on Pueblo Mountains foothills
- **Geochemistry:** 108 ppm Zinc, 32 ppm Copper (elevated)
- **Status:** Open BLM land, zero MRDS records within 5km
- **Verdict:** Classic untested ridge-line anomaly — valid drillable target

04 — DELIVERABLES

Commercial Target Database

High-value exploration targets across the continental United States and Alaska.

Mass-Deficit Targets

Low density anomalies indicating hydrothermal alteration, silicification, or intrusive bodies.

1,395

Gold/Epithermal Candidates

- Epithermal Gold Systems
- Carlin-type Gold
- Kimberlites

Mass-Excess Targets

High density anomalies indicating massive sulfide bodies, IOCG, or mafic intrusions.

1,305

Base Metal Candidates

- VMS Deposits
- IOCG Systems
- Magmatic Ni-Cu

Top Wildcat Prospects (>10km from known deposits)

LOCATION	TYPE	SIGNAL STRENGTH	CLASSIFICATION
65.865°N, 160.295°W	Mass Excess	800.0 mGal	IOCG / Massive Sulfide
66.855°N, 120.815°W	Mass Excess	800.0 mGal	IOCG / Massive Sulfide
59.145°N, 160.775°W	Mass Excess	800.0 mGal	IOCG / Massive Sulfide
67.665°N, 143.315°W	Mass Deficit	-800.0 mGal	Kimberlite / Major Alteration

LOCATION	TYPE	SIGNAL STRENGTH	CLASSIFICATION
64.155°N, 146.885°W	Mass Deficit	-800.0 mGal	Epithermal Gold

🎁 What You Get

📊 Complete Target Database

Export-ready CSV/GeoJSON with coordinates, classifications, and signal strengths

🗺️ Visualization Maps

GeoTIFF density models for GIS integration

📄 Validation Reports

Full documentation of methodology and scientific validation

💻 Open Source Code

Complete Python pipeline for custom analysis

READY TO EXPLORE?

Let's Discover the Next Big Find Together

Whether you need custom regional analysis, pipeline modifications, or integration with your existing exploration workflow — I'm here to help.

Available for Custom Projects

Custom regional analysis • Pipeline customization • Data integration • Training & consulting

Contact Me on Fiverr

Fast Delivery

Quick turnaround on analysis requests with clear communication

Scientific Rigor

Physics-constrained models with transparent methodology

Clear Communication

Technical results explained in accessible language

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Built with Physics-Informed Neural Networks • December 2024