# GIS-Based Mineral Potential Modeling as a Strategic Planning Tool in British Columbia

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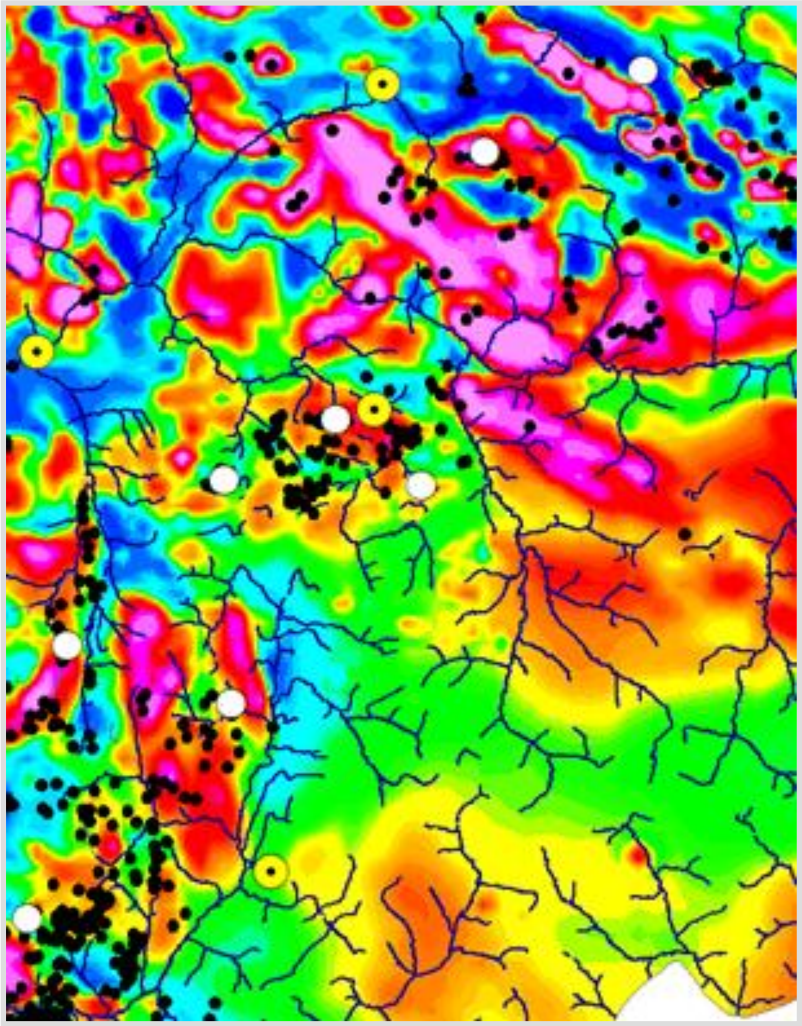
Creating opportunities in the spatial world

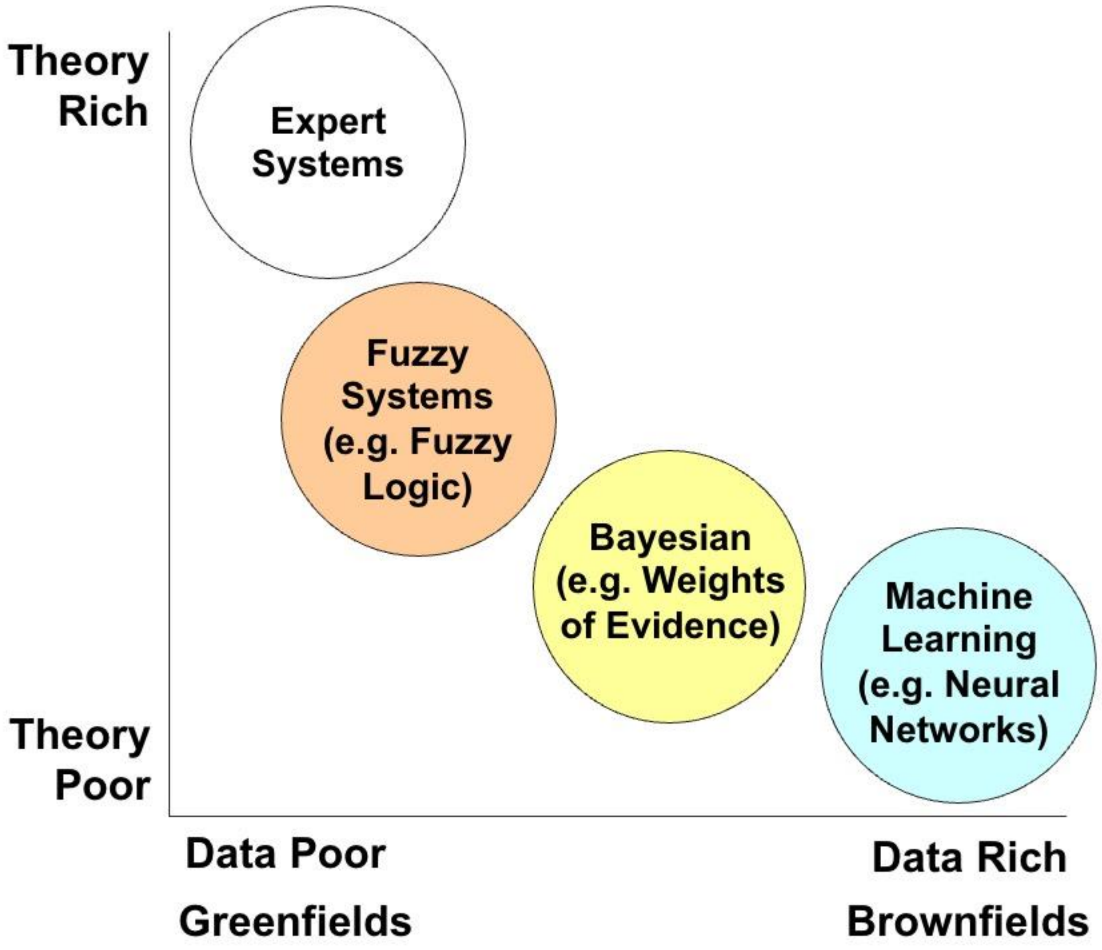
# Pilot Project Background

- **Method development, data evaluation and mineral potential models for land-use planning**
- **Three mineral system models were developed**
  - **Temporarily undisclosed area in British Columbia**
  - **Porphyry Cu-Au, Magmatic Ni, VMS**
- **Development included**
  - **Researching relevant mineral systems**
  - **Reviewing and compiling available data**
  - **Developing spatial data tables and selecting training data**
  - **Preparing predictive maps**
  - **Performing a spatial analysis to create weights and test correlations**
  - **Assessing if maps are geologically reasonable and statistically valid**
  - **Applying criteria to select final maps for each model**
  - **Reporting is ongoing**



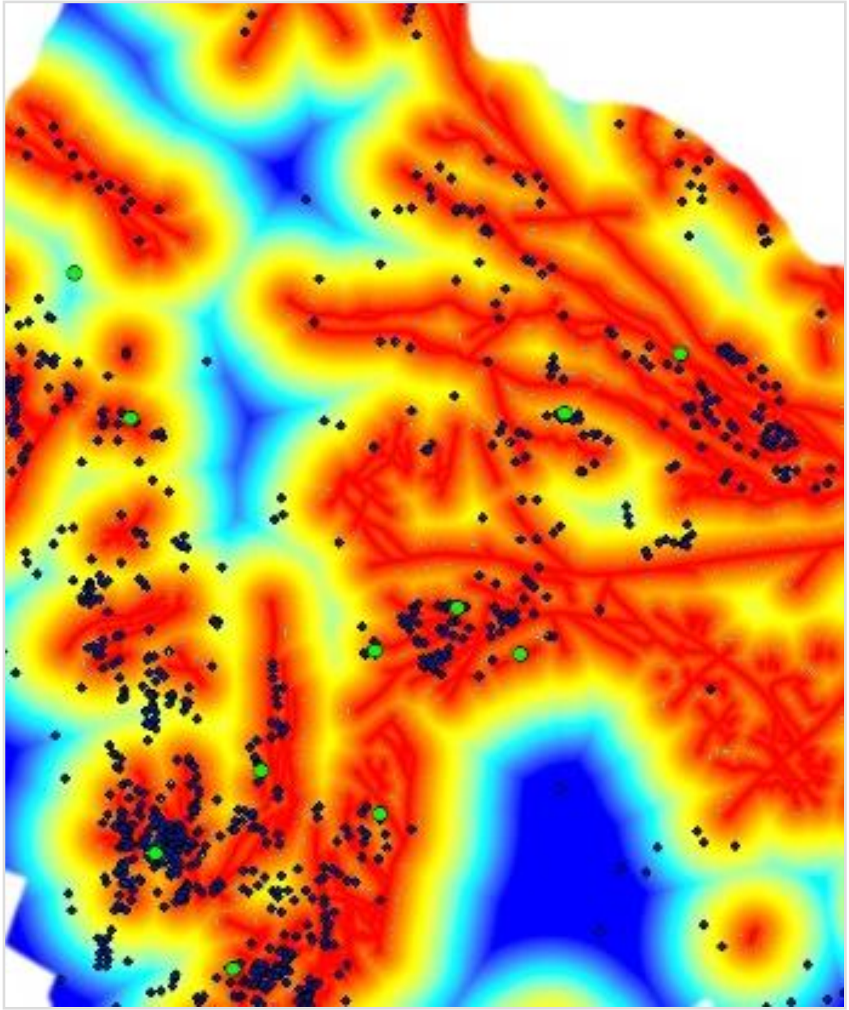
*Magnetics 1st vertical derivative map of somewhere in BC*

# Which Method is Appropriate?




- There is not necessarily a ‘best’ method
- The method chosen should depend on
  - How much data do you have?
  - How constrained is your mineral system model?
  - Do you have representative training data?
  - Is there good spatial coverage of data?
  - What software and human resources do you have available?
  - How much money are you willing to spend?
  - What questions do you want answered?

# Weights-of-Evidence Method



*Predictive map of some location in BC*

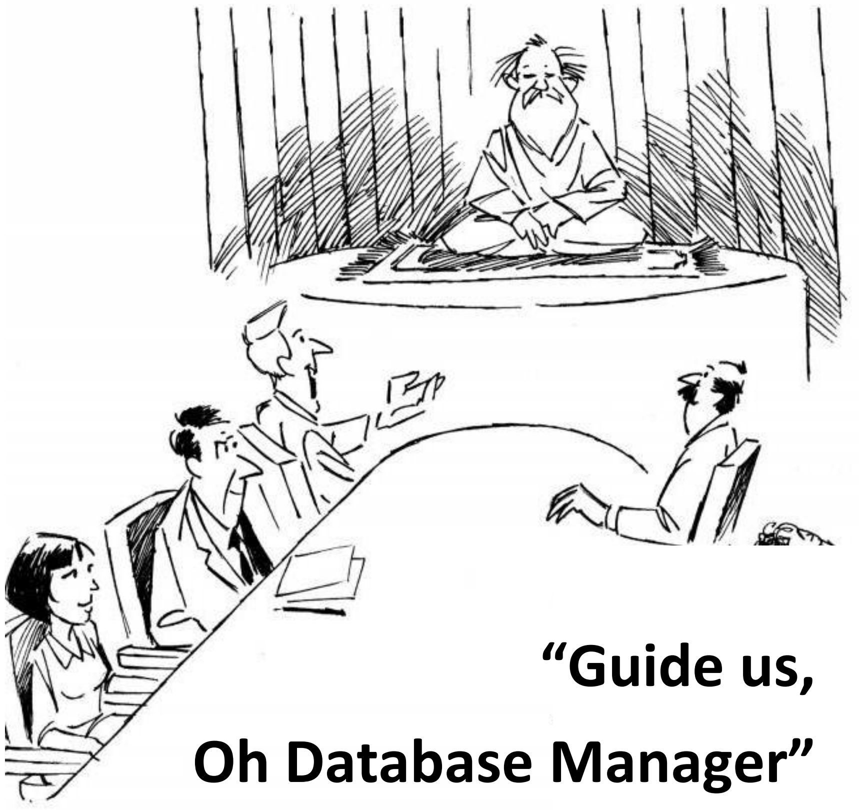
- **Weights-of-Evidence is a Bayesian statistical approach for combining data to predict the occurrence of events**
  - **In our case, the occurrence of a mineral deposit**
- **Calculated based on the presence or absence of map variables (e.g., fault intersections) and the occurrence of an event**
- **The *Prior Probability* for the occurrence of a mineral deposit is the probability of the existence of a mineral deposit based on no information**
- **The *Posterior Probability* is the probability of the existence of a mineral deposit based on new information**
- **The aim of the modeling is to improve upon the prior probability by integrating favorable evidence for mineralization and maximizing the posterior probability**

# Geoscientific Data Used in the Models

- Mineral occurrence data (MINFILE)
- Geology data (distribution and age of rock types)
- Fault data (attributed by age and type)
- Geophysical data (magnetics, gravity, radiometrics)
- Geochemical data (stream sediment, surface samples)

BCGS already has a significant digital repository of geoscientific data…

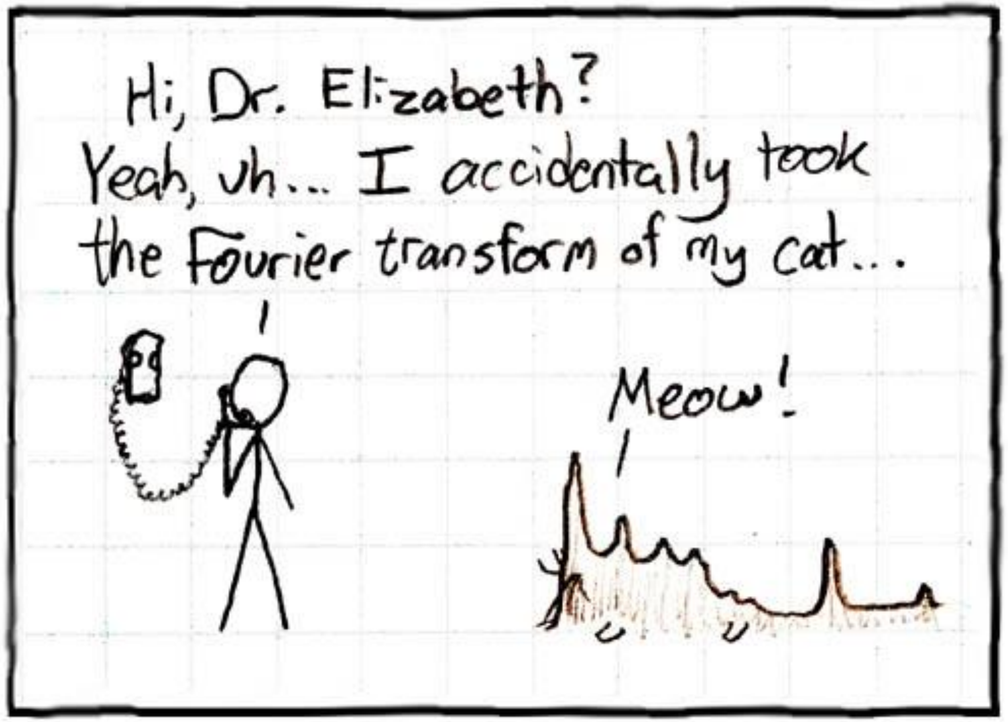
…but there is much more data available hidden in assessment reports



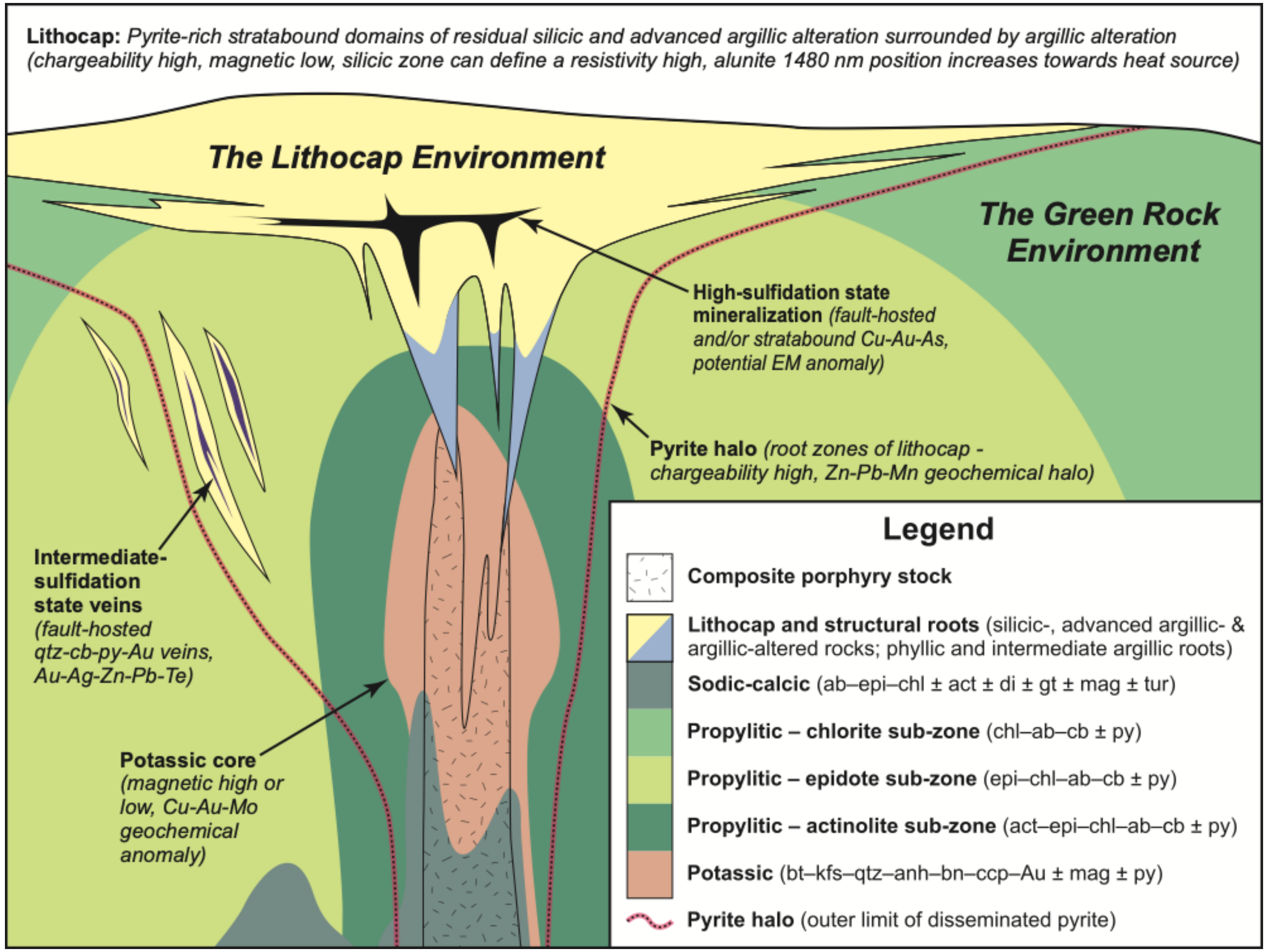
"Guide us,
Oh Database Manager"

# Data Compilation

- Do you have the right types of data and appropriate attributes?
  - e.g., if you have a porphyry Cu-Au mineral system, do you have a well attributed map of intrusive units or arc assemblage rocks?
- Many datasets require updating and upgrading
- New data may need to be acquired
  - Pull from assessment reports, literature, other
  - May require large digitization campaigns
- QA/QC will require a lot of time
  - Don't apply useful statistics to useless data



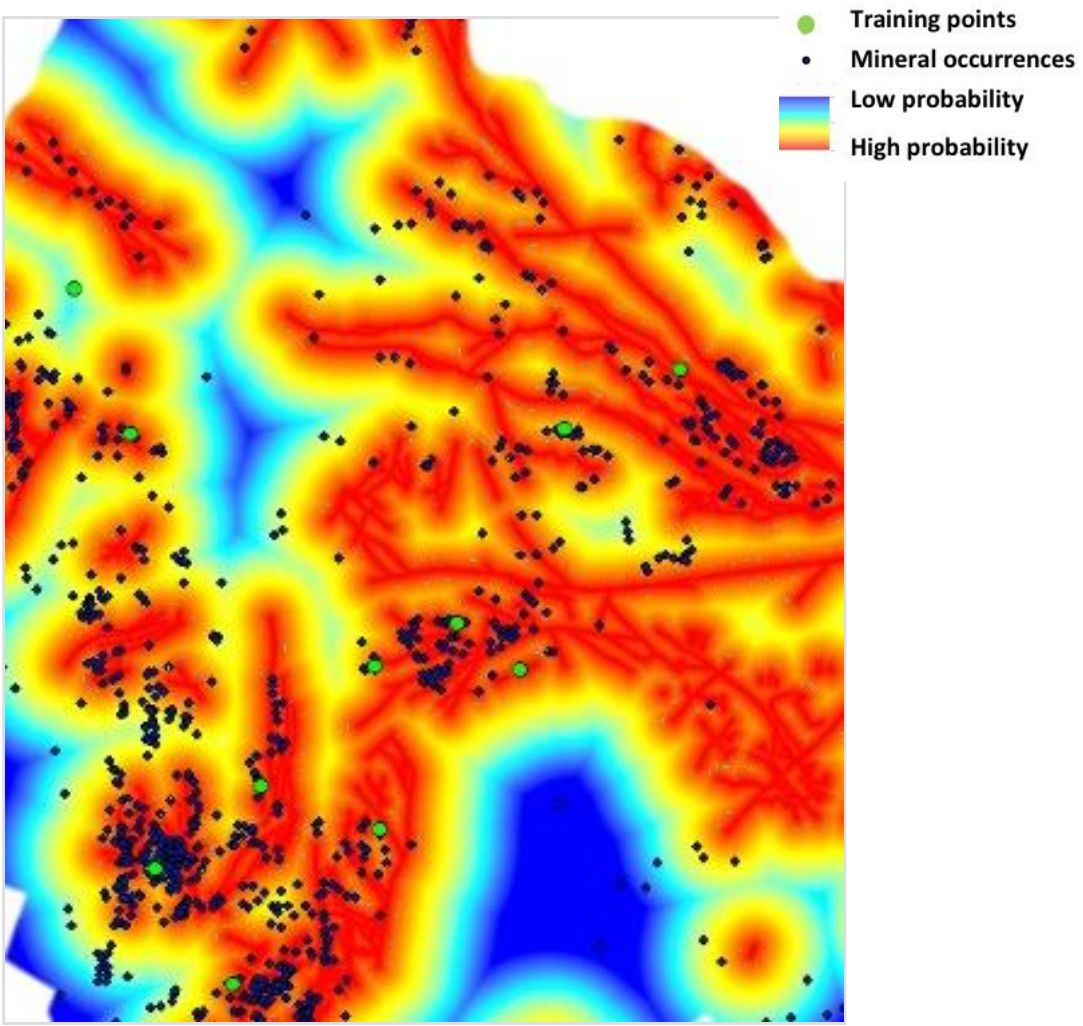
# Mineral Systems




*Porphyry-epithermal mineral system from Orovan and Hollings (2020)*

- Mineral systems are used to constrain the development of predictive maps in mineral potential models
- Mineral systems must have clearly defined and ascribed predictive variables that span source, transport, trap and deposition, e.g.,
  - fertility of nearby igneous intrusions
  - proximity of reactive horizons
  - intersection of faults
  - density of associated mineral occurrences

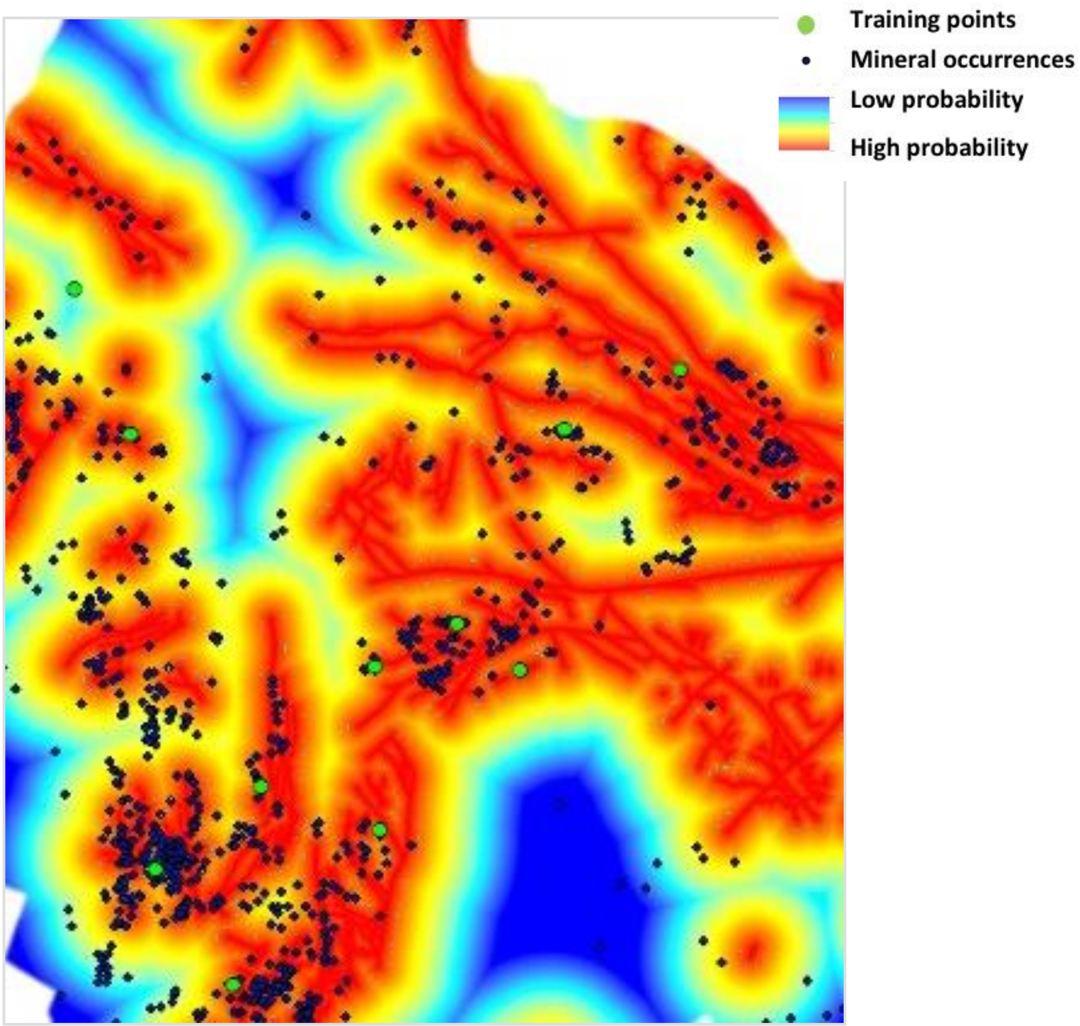
# Derivative and Predictive Modeling




*Predictive map of some location in BC*

- Mineral potential maps are constructed from a series of evidential layers (modeled predictive variables)
- Here is an example produced from publicly available BCGS fault traces
- This map is a model of the ‘distance to’ fault jogs
- Based on the mineral system information, faults jogs may be an important trap mechanism for mineralization
- This is one of many evidential layers that will be mathematically combined into a mineral potential map

# Map Selection




*Predictive map of some location in BC*

- All components of each mineral system must be represented
  - At least one source, transport, trap, and deposition map
- Each map must have significant spatial association with mineralization
  - Assessed from statistics and expert geological review
- Each map should have good regional coverage
- Must try to avoid duplication of predictive map patterns
  - Are you effectively mapping the same thing in two different maps?
  - This causes an issue with “conditional dependence” which is a statistical problem rather than a geological one

# Spatial Data Table

| Spatial Variable | System | Measure | Source Data | Technique |
|---|---|---|---|---|
| Gravity highs within mafic and ultramafic units | Trap | Association with high density host rocks | Gfd_X_bedrock_alb_poly and Canada 2km GRAV | Query mafic and ultramafic units from X geology, assign mean Bouguer gravity value to each polygon, reclassify each polygon based on the value into 10 classes using quantile method, query polygons in class 9-10 (high gravity), buffer and test for spatial association |
| Multiple intrusive phases | Trap | Evidence of complex conduits | Gfd_X_bedrock_alb_poly and Canada 200m MAG | Query mafic and ultramafic units from X geology, assign standard deviation of magnetic residual total field value to each polygon, reclassify each polygon based on the value into 10 classes using quantile method, query polygons in class 9-10 (high magnetic stddev>=72.720311), buffer and test for spatial association |
| Stream sediment Ni anomaly | Deposition | Anomalous geochemistry indicative of mineralisation | RGS Stream Sediments | Calculate anomalous Ni values using percentiles; buffer anomalies (class=2) and non-anomalies (class=1) separately to 4000m; test for spatial association |
| Stream sediment S anomaly | Deposition | Anomalous geochemistry indicative of mineralisation | RGS Stream Sediments | Calculate anomalous S values using percentiles; buffer anomalies (class=2) and non-anomalies (class=1) separately to 4000m; test for spatial association |

| Data Type | Predictive Map | Set Up | Variable ID | Area | Units | # TP | W+ | W+s | W- | W-s | C | Cs | StudC | Action |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polygon | d2gravmaf | WoE Method, Study Area = X_sa2, Unit Area = 1, Training Data = MagmaticNi_TP.shp, Missing Data = -99, PP = 0.000136, confidence = 2 | No valid statistics | | | | | | | | | | | |
| Polygon | d2magmaf | WoE Method, Study Area = tahltan_sa2, Unit Area = 1, Training Data = MagmaticNi_TP.shp, Missing Data = -99, PP = 0.000136, confidence = 2 | 1300 m | 8211.53 | 8211.53 | 11 | 2.2881 | 0.3017 | -1.782 | 0.7071 | 4.0701 | 0.7688 | 5.2942 | GOOD |
| Point | d2ni_sss | WoE Method, Study Area = X_sa2, Unit Area = 1, Training Data = MagmaticNi_TP.shp, Missing Data = -99, PP = 0.000136, confidence = 2 | Ni >= 153.825 ppm | 8768.78 | 8768.78 | 11 | 2.0212 | 0.3017 | -1.7529 | 0.7071 | 3.7741 | 0.7688 | 4.9092 | GOOD |
| Point | d2s_sss | WoE Method, Study Area = X_sa2, Unit Area = 1, Training Data = MagmaticNi_TP.shp, Missing Data = -99, PP = 0.000136, confidence = 2 | No valid statistics | | | | | | | | | | | |

# Mineral Potential Models

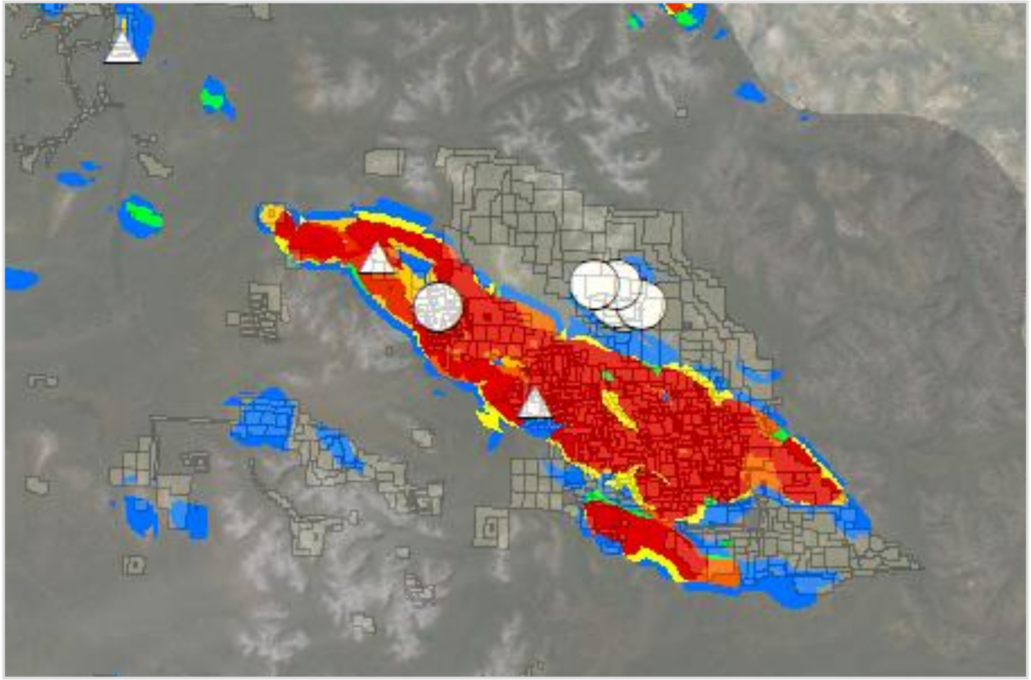
- **Mineral potential models show the relative probability to predict the occurrence of a mineral deposit based on the presence or absence of evidence**
  - **e.g., presence of a favorable host rock**

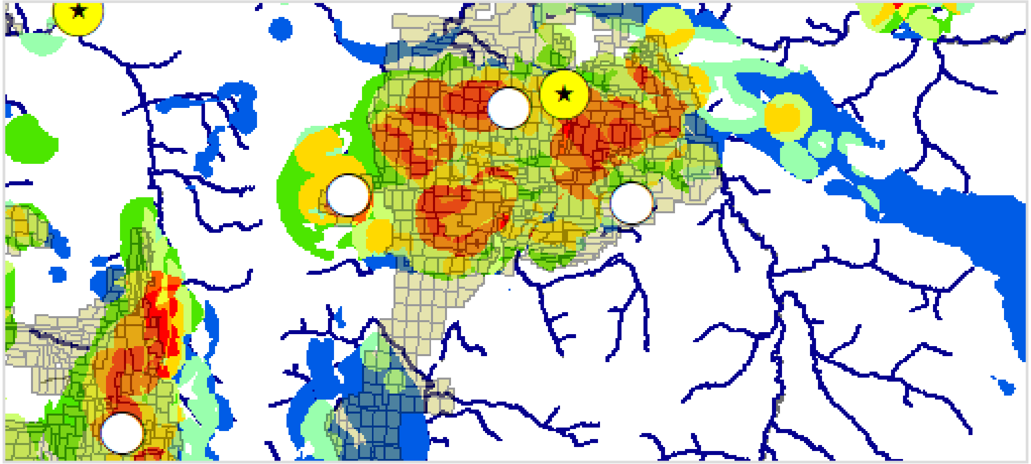
- **The color coding (red to blue) describes the relative probability for a particular mineral deposit to occur**
  - **Red indicates an area that is more favorable, whereas blue indicates an area that is only marginally favorable based on the data**

- **The color coding is not indicative of the size or economics of a potential mineral deposit and cannot be used to make valuations on any resource**

- **The model is not conclusive**
  - **Regions without color may indicate a paucity of data**
  - **Regions with color (even areas with red) do not mean a mineral deposit is necessarily located there, only that the data used in the modeling indicate that the area is relatively favorable for hosting an ore deposit**

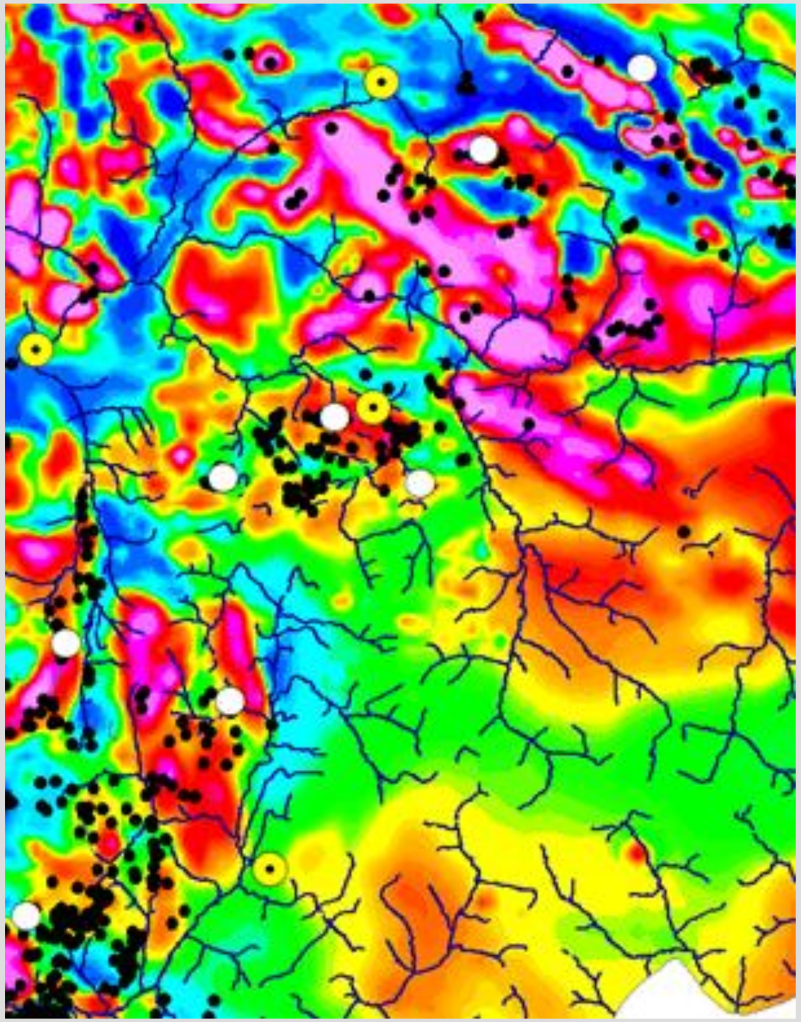
- **These two mineral potential models are an interim product, and future iterations will take into account additional datasets, which may have a minor impact on the results**





# In Summary

- Pilot study focused on method development
- Three mineral potential models were developed for land-use exercises
  - Temporarily undisclosed area in British Columbia
  - Porphyry Cu-Au, Magmatic Ni, VMS
- Weights-of-evidence approach was used
- Improved datasets and data evaluation shows excellent quality data
- A wide range of predictive maps were created, but not necessarily used in each modeling product
- Expanding into other areas in British Columbia
- Reports and publications will be available upcoming



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