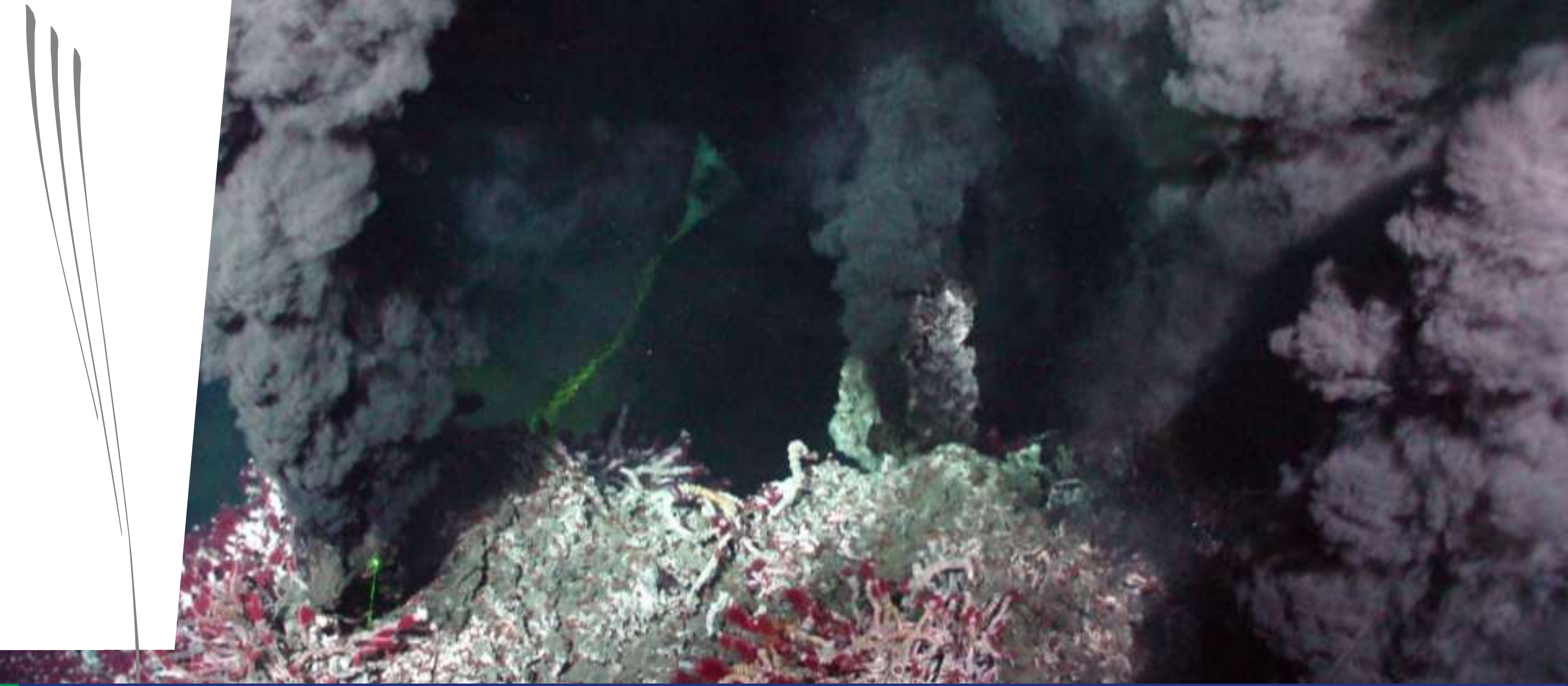

Prospectivity Modelling of Seafloor Massive Sulphide Deposits in the Kermadec Arc and Colville Ridge Regions, New Zealand

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- Kenex is a business development company focusing on spatial modelling to create new business opportunities.
- Spatial modelling is where we make the connection between data, information, processes, and the ideas of people, to deliver innovative knowledge-based business solutions.
- Adopting and driving the latest GIS technologies, Kenex have undertaken predictive modelling to identify prospective areas for potential mineral deposits, wildlife habitats, and geothermal & wind energy.

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Our Services

- Spatial data modelling including mineral prospectivity mapping, wind farm prospectivity mapping and habitat mapping
- Mineral Exploration and industry advice
- Mineral Exploration project management
- Tenement management
- Data management and acquisition
- GIS workshops and training
- Complete spatial business management
- Fund raising and business development

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Potential Applications for Spatial Modelling

- Prospecting for economic minerals (gold, copper, nickel, uranium etc)
- Assessing suitability of land for energy generation such as hydro, geothermal or wind power
- Assessing suitability of land for agricultural / horticultural use
- Environmental assessment
- Endangered species habitat models
- General land management

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Why undertake spatial modelling?

- Combine spatial data and knowledge
- Create predictive maps from digital data
- Non-bias view of data
- Take of advantage of digital data
- Save time and money

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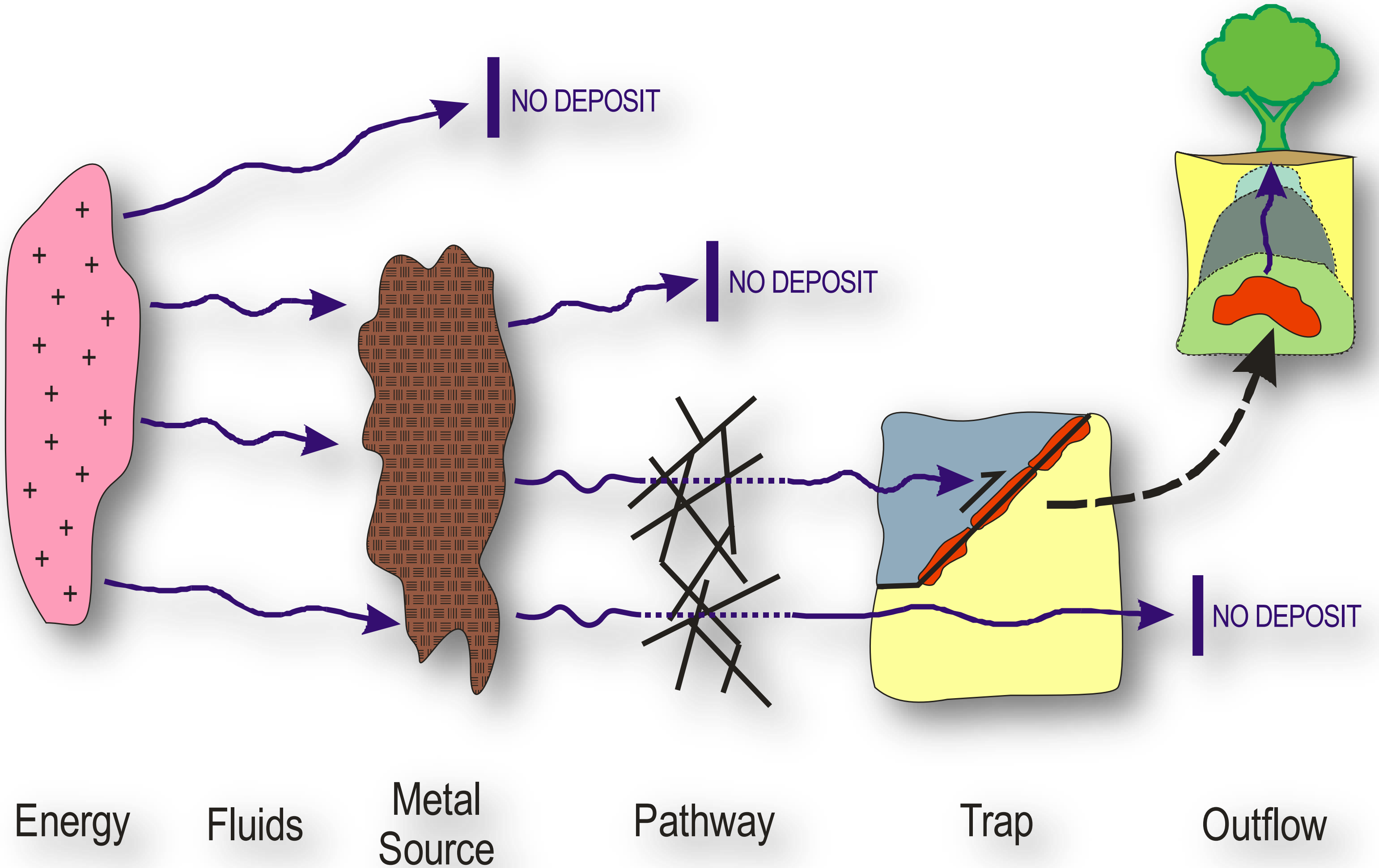
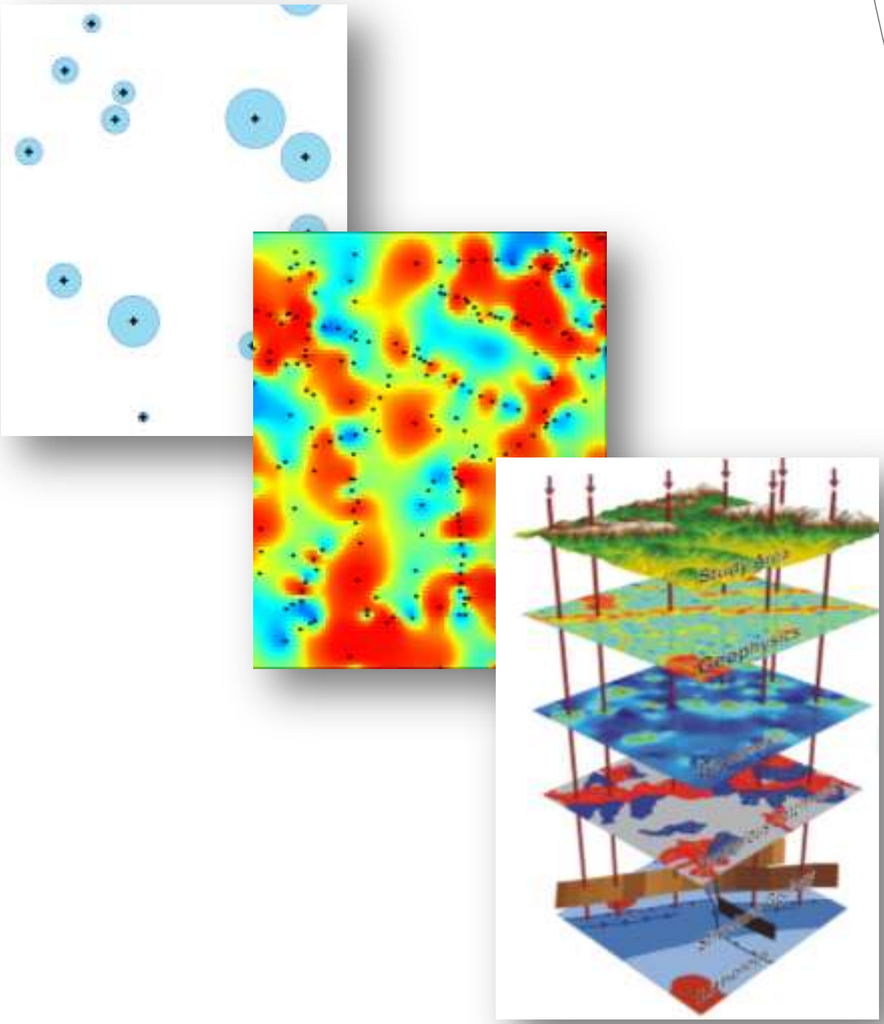
The Mineral System Concept



Types of Modelling

- Illustrated maps
- Single layer modelling
- Multi-variable models
  - Weights of evidence
  - Fuzzy logic
  - Neural networks



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Predictive Modelling

- Goal
  - To predict where there is a high probability of a mineral deposit
- Basic Method
  - Compile digital data into GIS & develop maps related to mineral system being modelled
  - Use training data to weight mapped data (weights of evidence)
  - Or, use expert defined values to weight important mapped data (fuzzy logic)
  - Combine evidential maps using weights of evidence or fuzzy logic to produce predictive map

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Weights of Evidence Modelling 1

- What is needed:
  - A study area (the extent of your search area in grid form)
  - Training data (points representing known occurrences or mines)
  - All available spatial digital data compiled into a GIS
  - Knowledge about the particular mineral system you are trying to model

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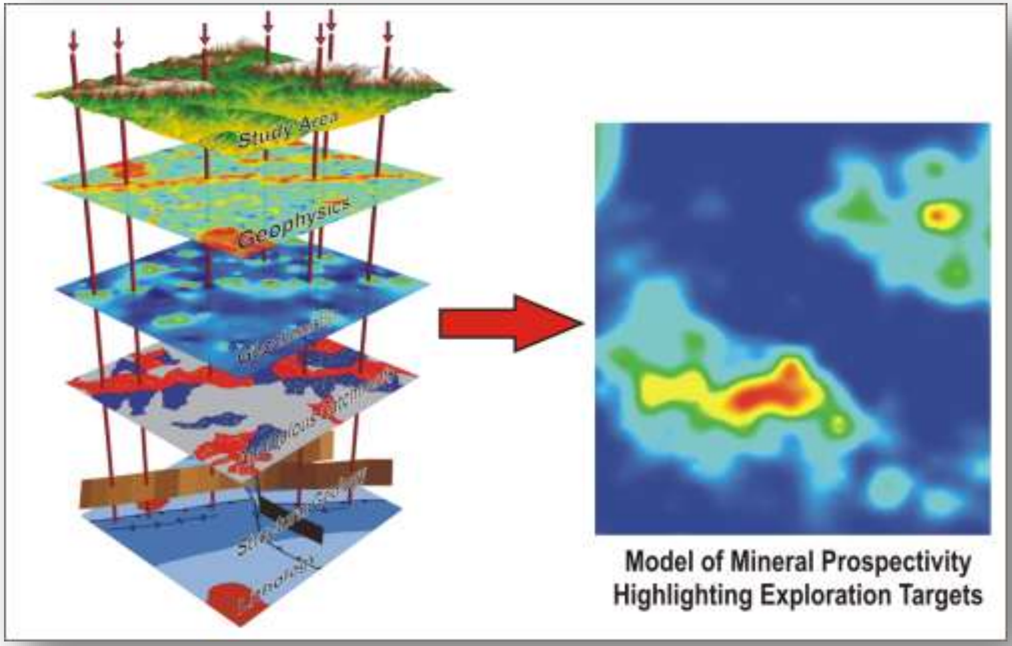
Weights of Evidence Modelling 2

- Basic Method:
  - Develop binary or multiclass predictive maps of data relevant to the mineralisation style being modelled
  - Use training data to test predictive maps for spatial correlation
  - Combine selective predictive maps together using weights of evidence operators to produce a map of probabilities (Prospectivity Map).



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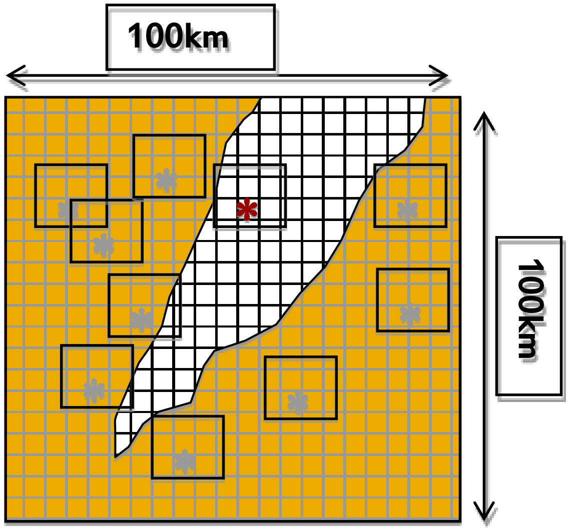

a = total study area (e.g. 10,000 km)
A = Unit Cell = 1 km^2 cell
N(D) = number of deposits
P(D) = prior probability
N(T) = total area of study region
N(B) = area of binary theme
N(B) = area of binary theme not present
N(T) = N(B) + N(B) (as long as no missing data)

When unit cell inf. small

$$W+ = \ln \frac{N(B \cap D)/N(D)}{N(B)/N(T)}$$

$$W+ = \ln \frac{P(B \mid D)}{P(B \mid \bar{D})}$$

$$W- = \ln \frac{P(\bar{B} \mid D)}{P(\bar{B} \mid \bar{D})}$$

$$W- = \ln \frac{N(\bar{B} \cap D)/N(D)}{N(\bar{B})/N(T)}$$

$$Ws+ = \frac{1}{N(B \cap D)} + \frac{1}{N(B)}$$

$$Ws- = \frac{1}{N(\bar{B} \cap D)} + \frac{1}{N(\bar{B})}$$

$$C = (W+) - (W-)$$

$$Cs = \sqrt{(Ws+) + (Ws-)}$$

$$StudC = C / Cs$$

From: Bonham-Carter, G.F. (1994)
“Geographic information systems for geoscientists”.

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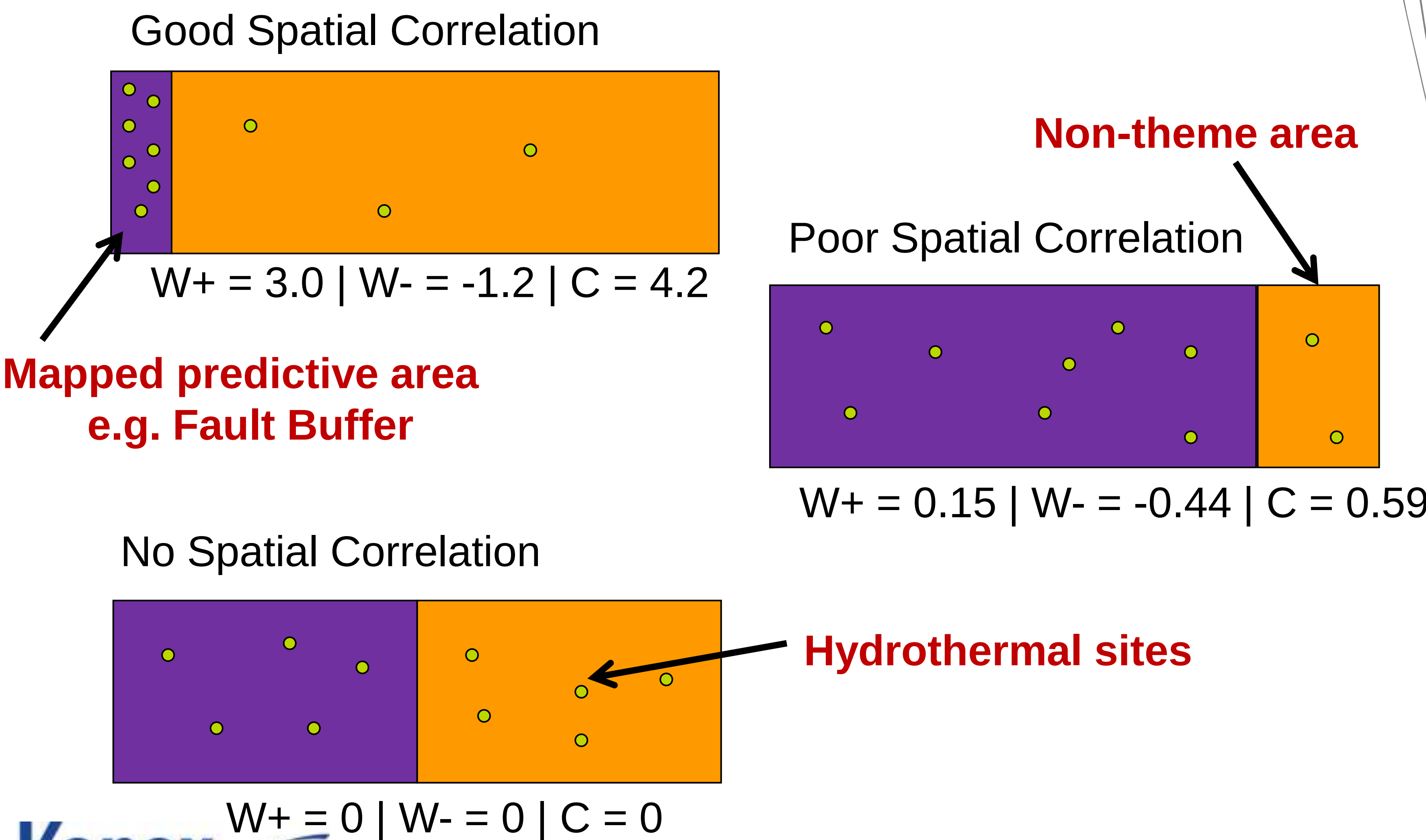
Correlation of Themes



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Important Spatial Indicators

$$W+ = \text{natural log} \frac{\text{Proportion of deposits on theme}}{\text{Proportion of total area occupied by theme}}$$

$$W- = \text{natural log} \frac{\text{Proportion of deposits not on theme}}{\text{Proportion of total area not occupied by theme}}$$

W+ > 0 indicates positive association with theme

W- < 0 indicates negative association with non-theme

C > 3.0 Strong correlation

C 1.0 – 3.0 Moderate correlation

C < 1.0 Weak to poor correlation

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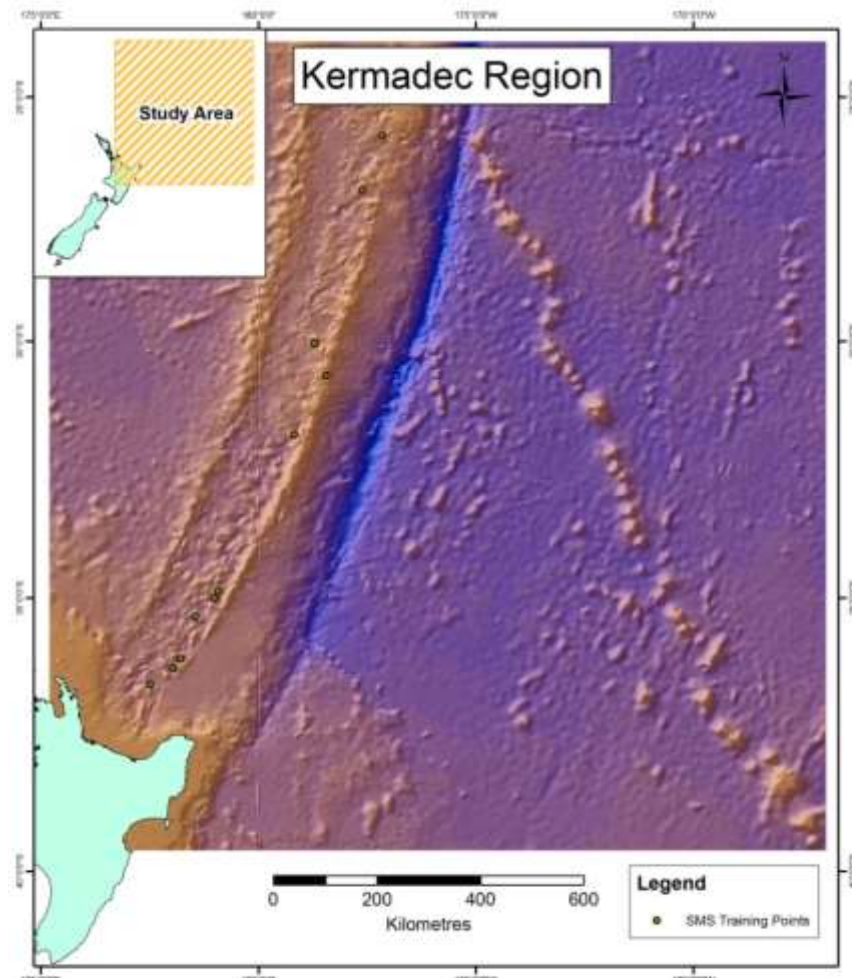
The Model Parameters

- Study area grid = 1000 m
- Hyrdothermal Training points = 13
- Unit Cell = 1 km²
- PP = 0.000006



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Layers Tested

- Total layers tested 97
  - Faults
  - Ridges
  - Volcanoes
  - Subduction zone
  - Intersections, Jogs, Bends & Splays
  - Bathymetry

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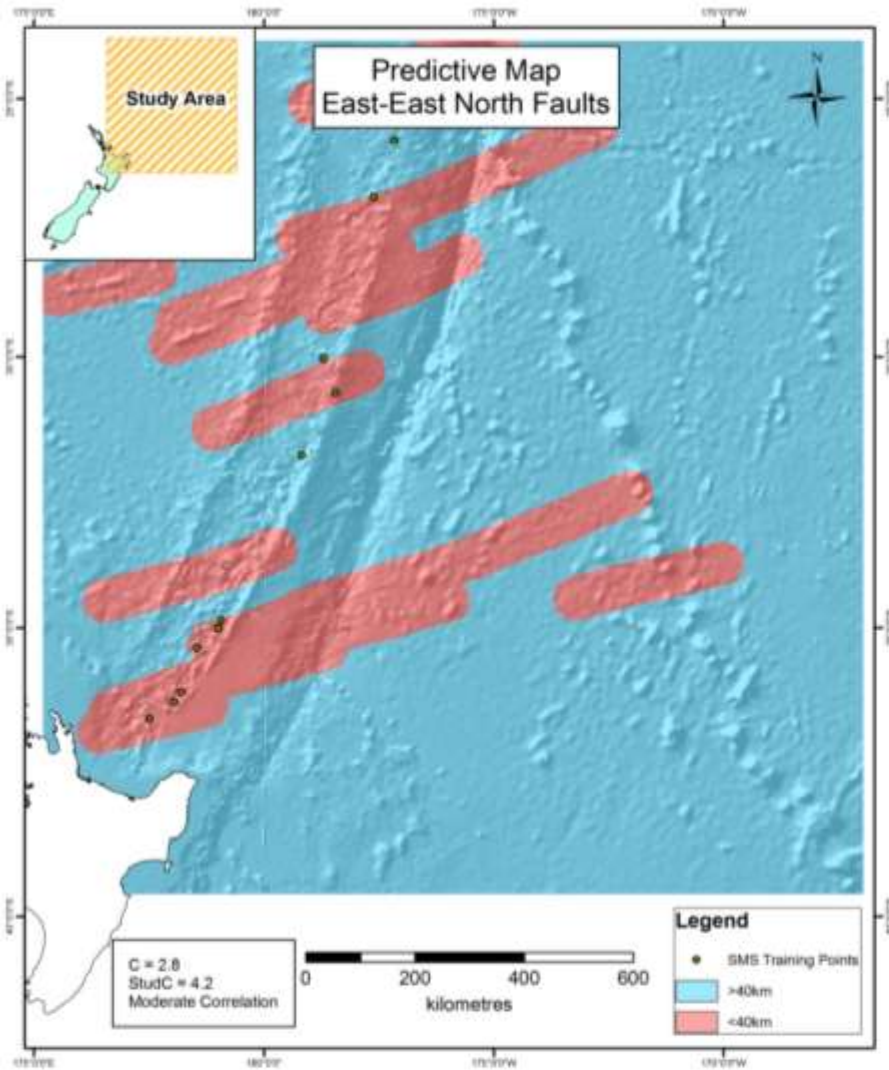
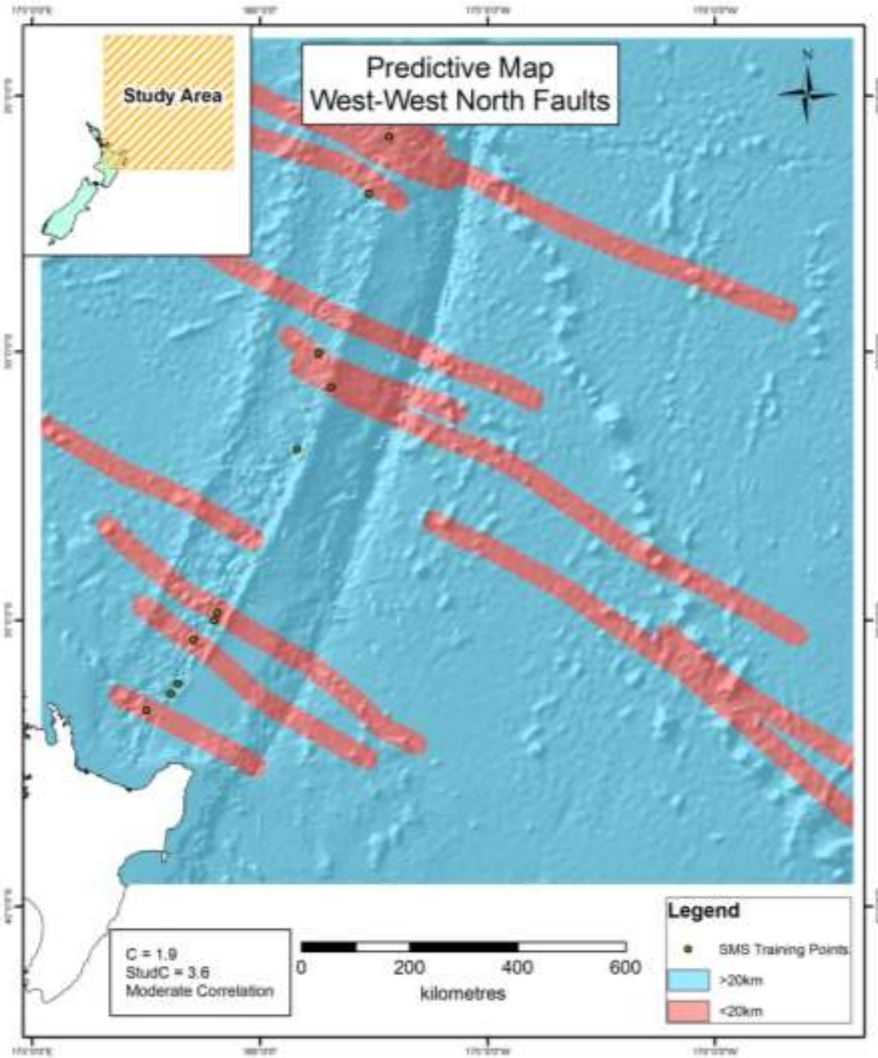
East North East Faults



West North West Faults



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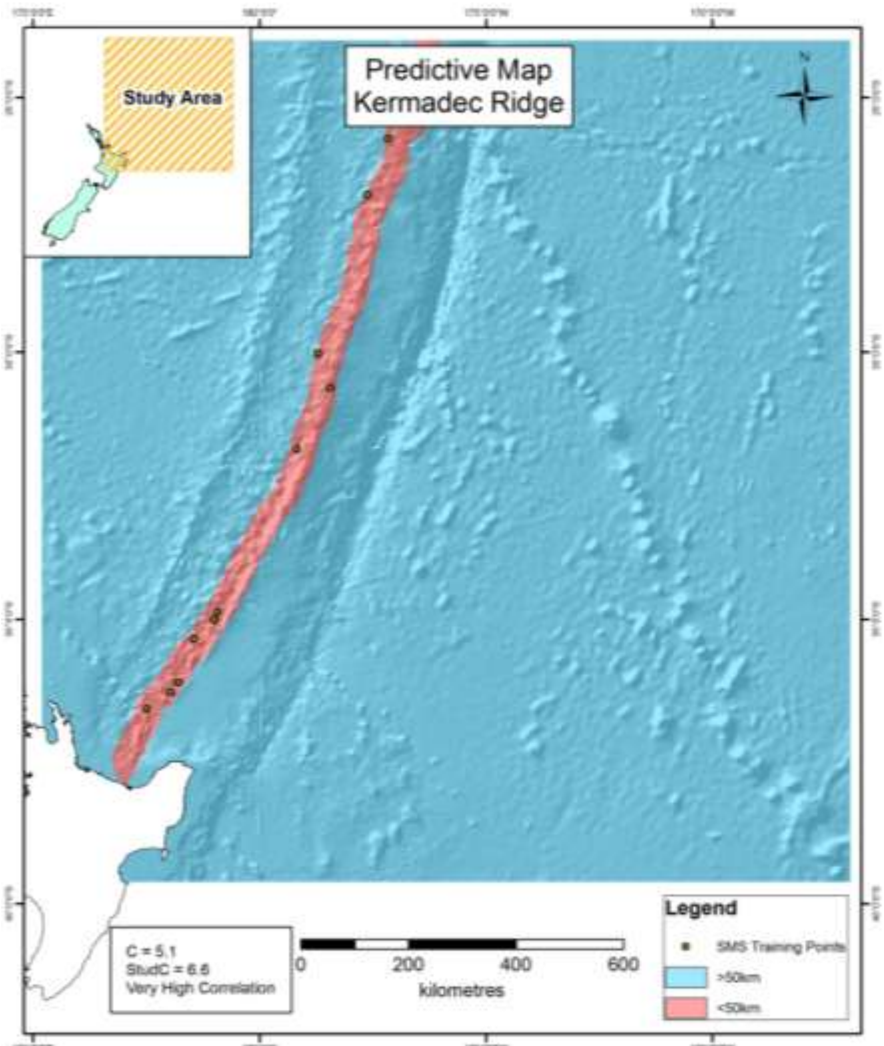
Kermadec Ridge



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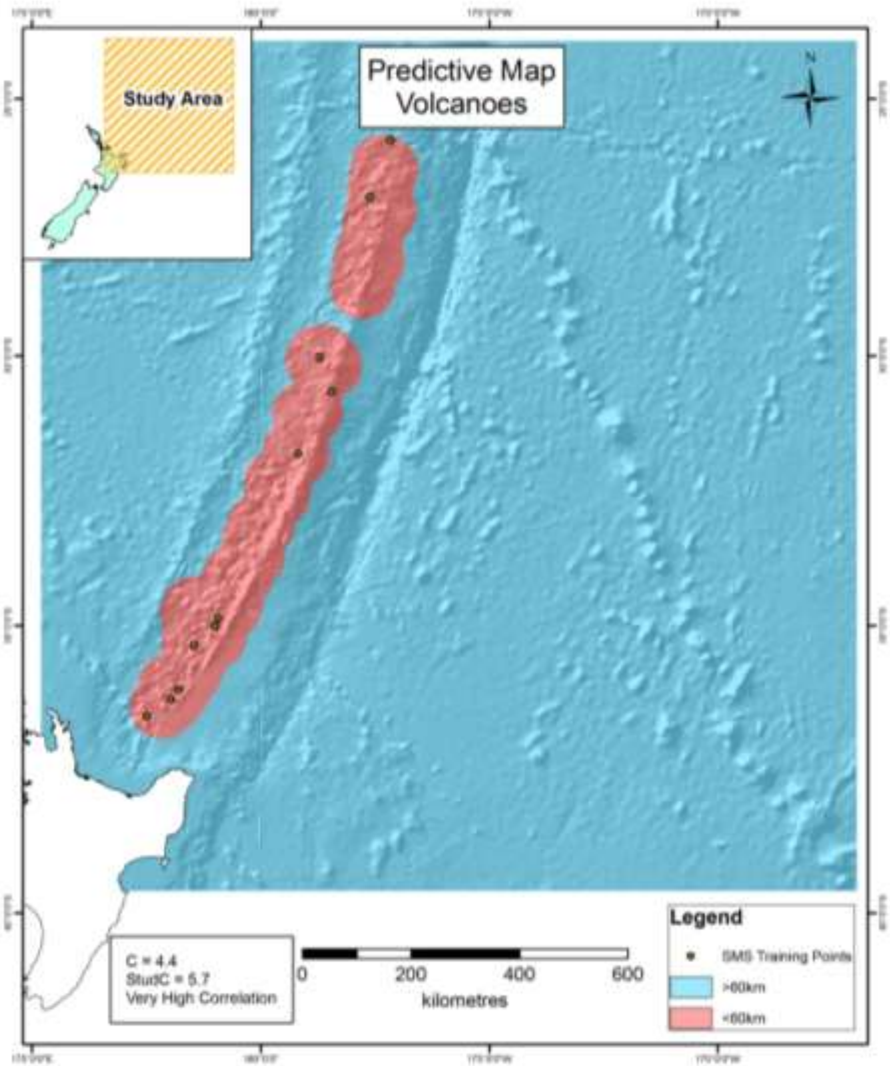
Volcanoes



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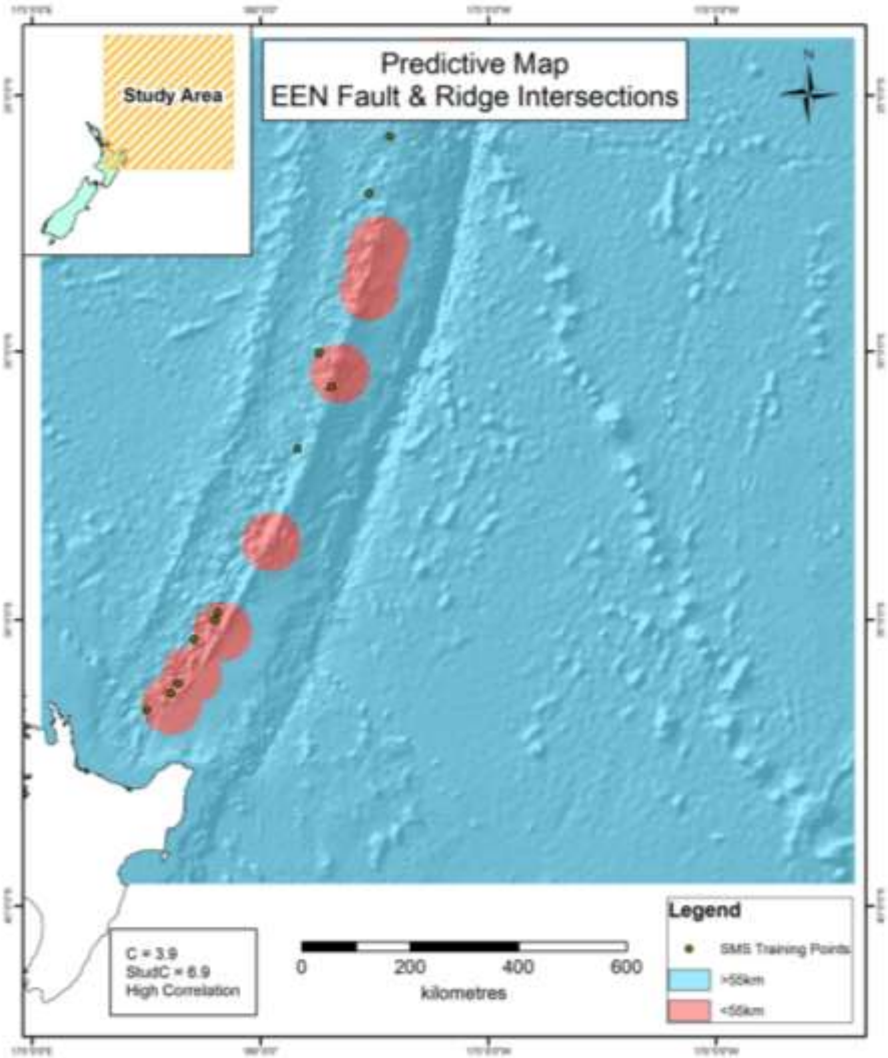
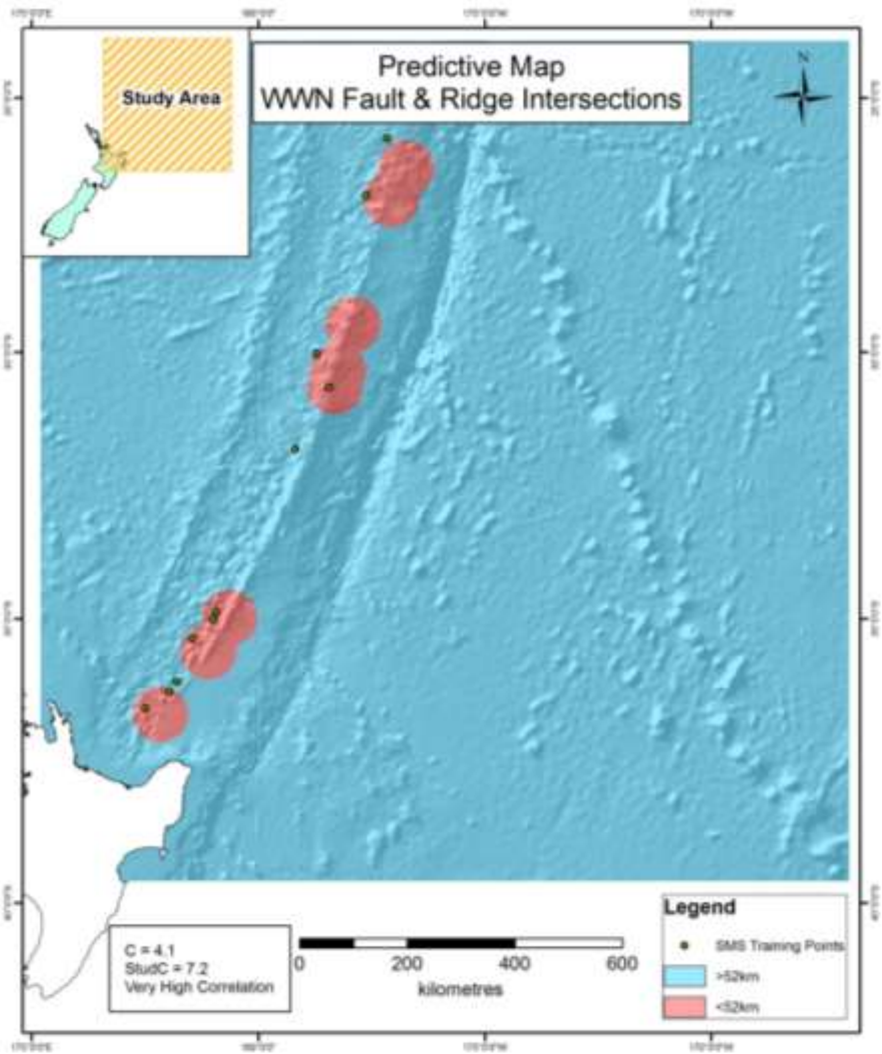
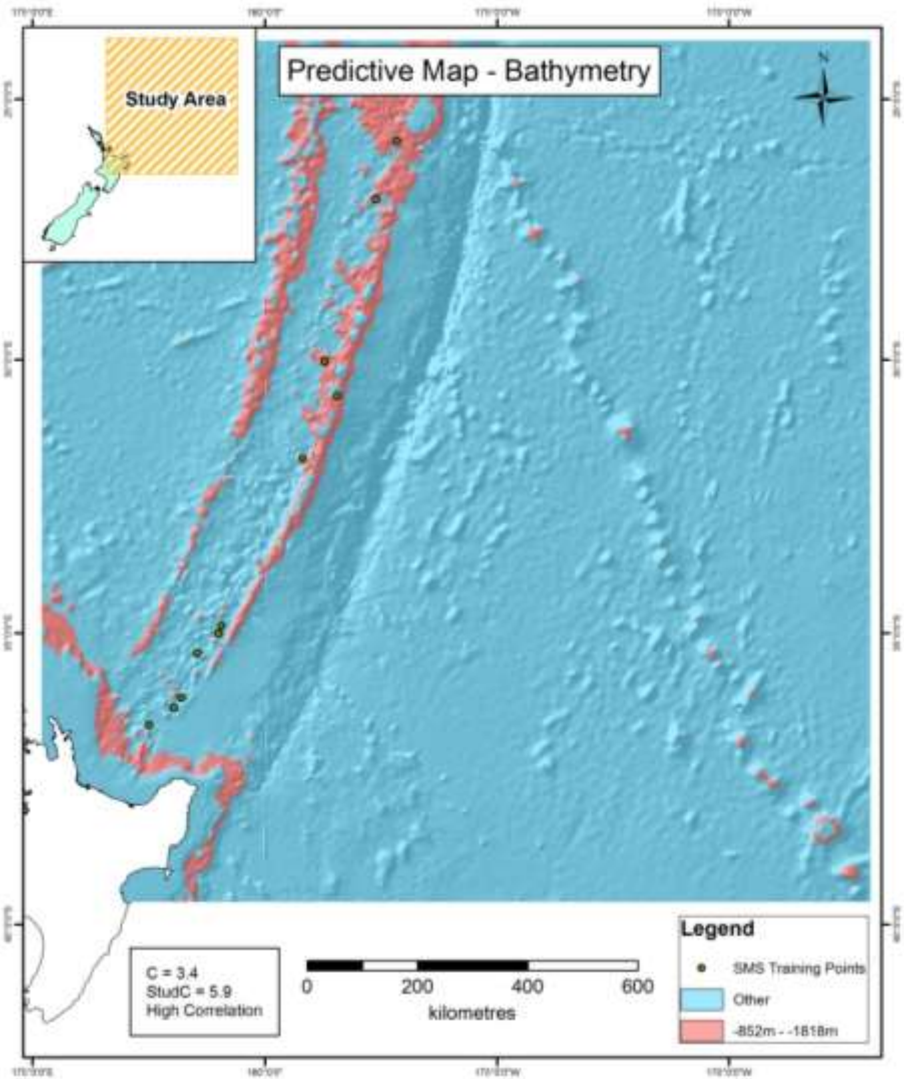
ENE Fault & Kermadec Ridge Intersections



WNW Fault & Kermadec Ridge Intersections



Bathymetry



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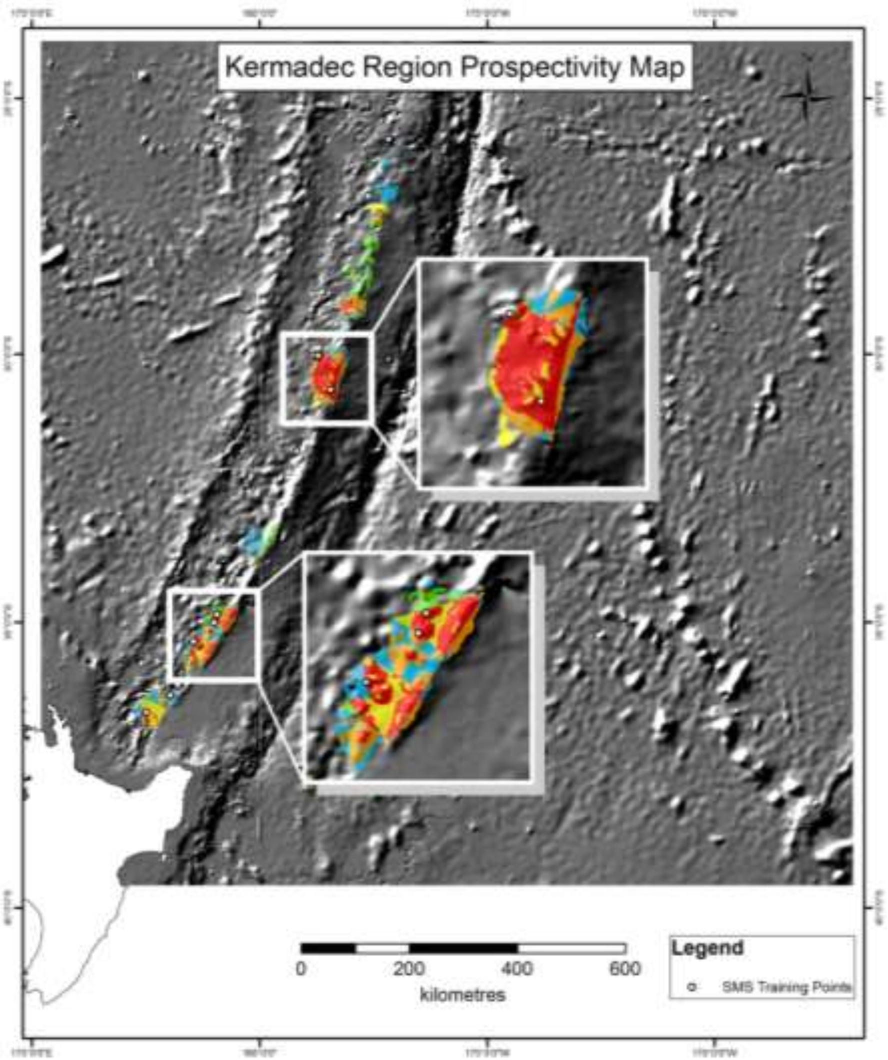
Prospectivity Map



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Conclusions

- Weights of evidence modelling has successfully identified areas with known hydrothermal sites in the Kermadec region
- Identified potential areas where SMS may be discovered
- Fuzzy Logic Modelling:
  - Kermadec Back-Arc
  - Colville Ridge

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Fuzzy Logic Spatial Modelling

- Combine exploration dataset using subjective judgement
- Method relies on expert opinion to derive weights to rank the mapped variables e.g. GNS
- Each map variable is weighted using fuzzy membership function (0 – low weighting, 1 – high weighting)
- Maps are combined using fuzzy operators to produce predictive map

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Thank You

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