RFG 2018

A 3D subsurface model of the Erzgebirge (Germany, Czech Republic) for 3D mineral potential mapping of Sn-W deposits with Artificial Neural Networks (ANN)

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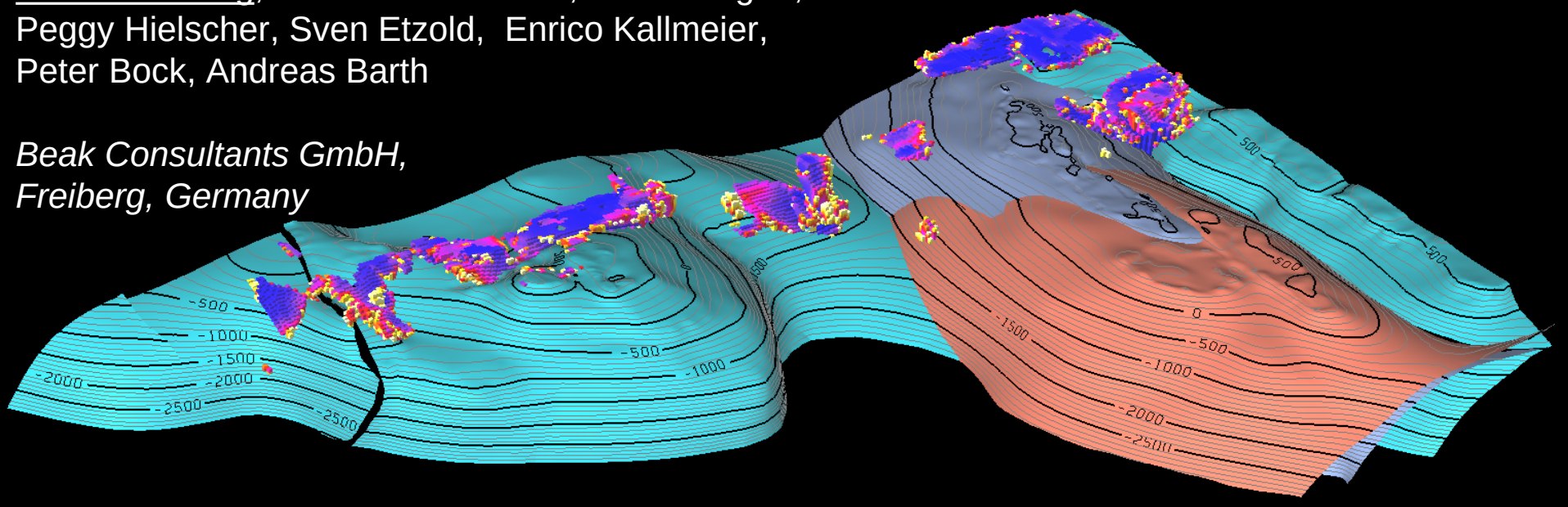
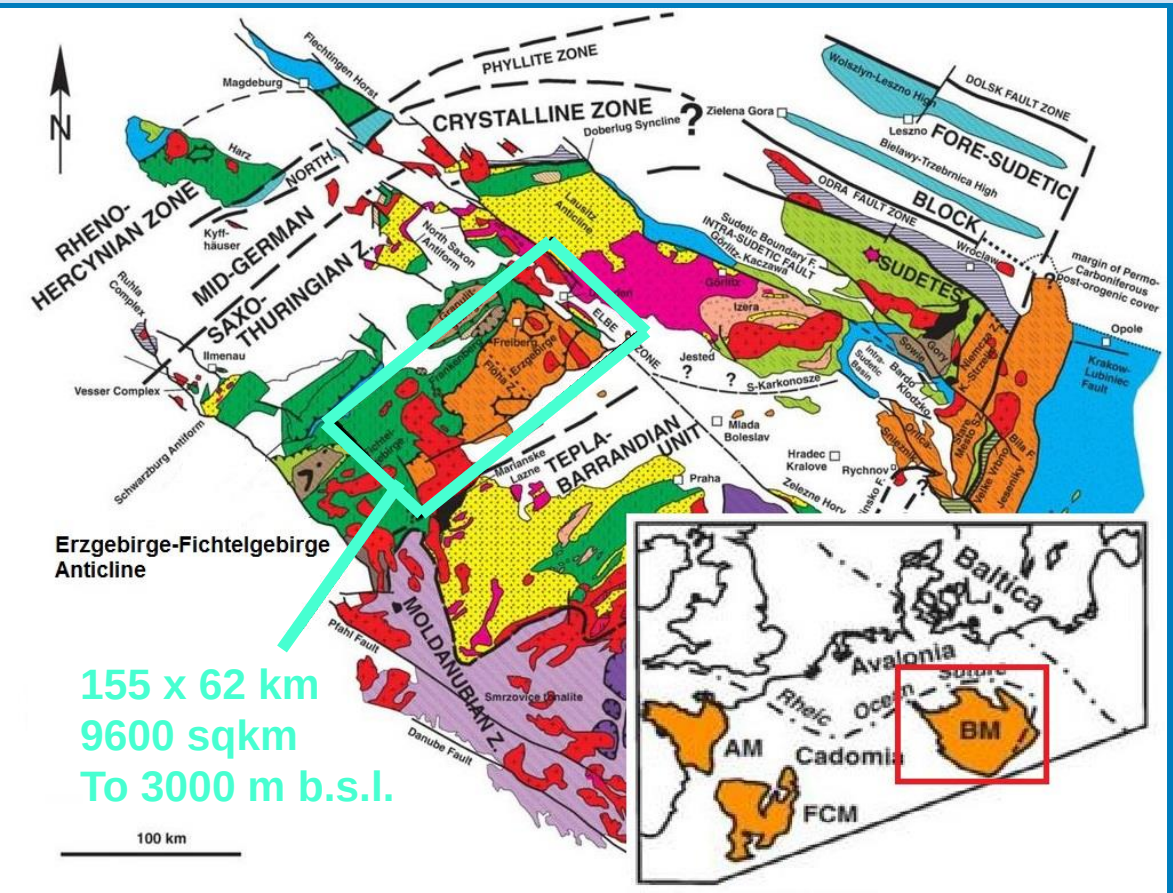


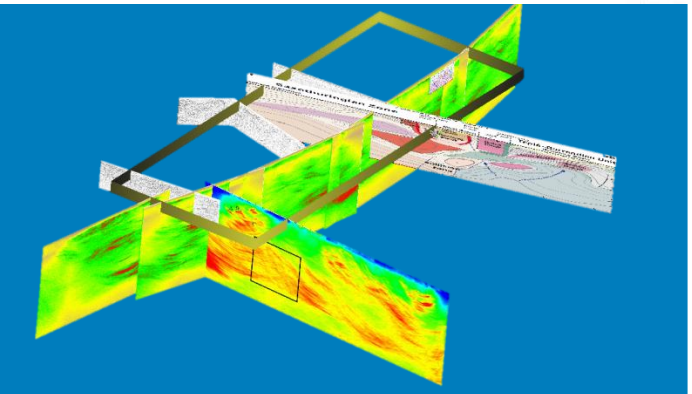
June 20th, 2018

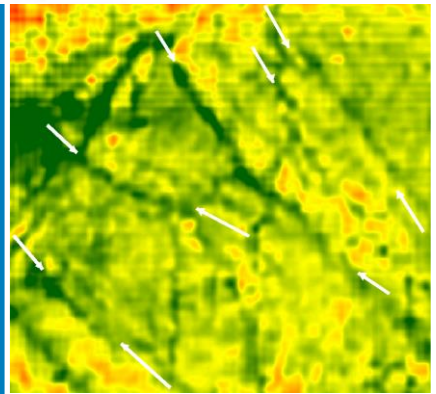
Constructing the 3D model

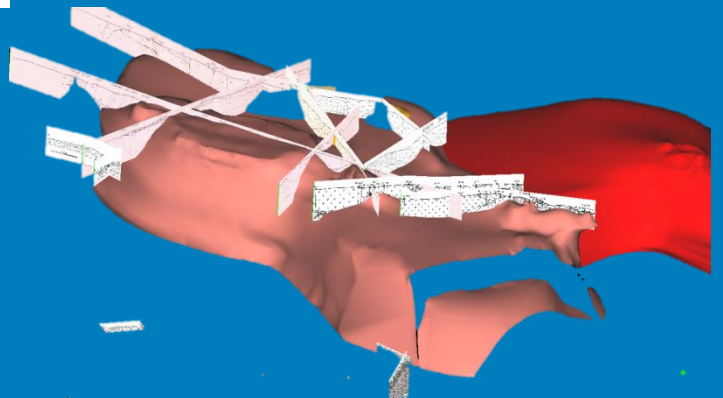


- Based on crustal-scale tectonic 3D model by Freiberg University

- 278 maps (geologic, tectonic, isoline and mining maps)
- 312 profile sections (incl. seismic profiles)
- c. 6700 wells (20 to 1700 m depth)
- Gravity, airborne magnetic and gammaspectroscopy legacy data



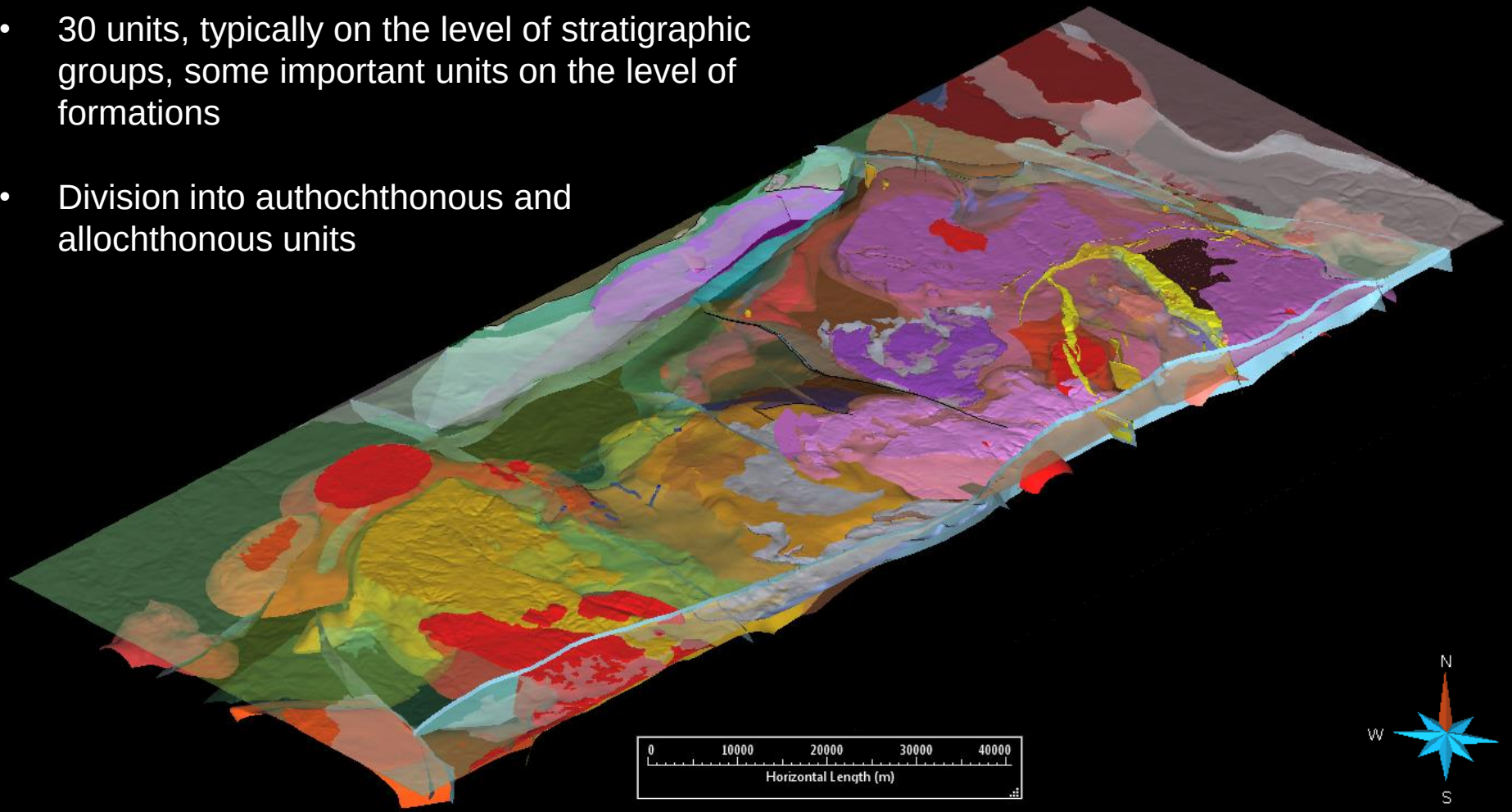




Constructing the 3D model

Cover units (sediments and metamorphics)

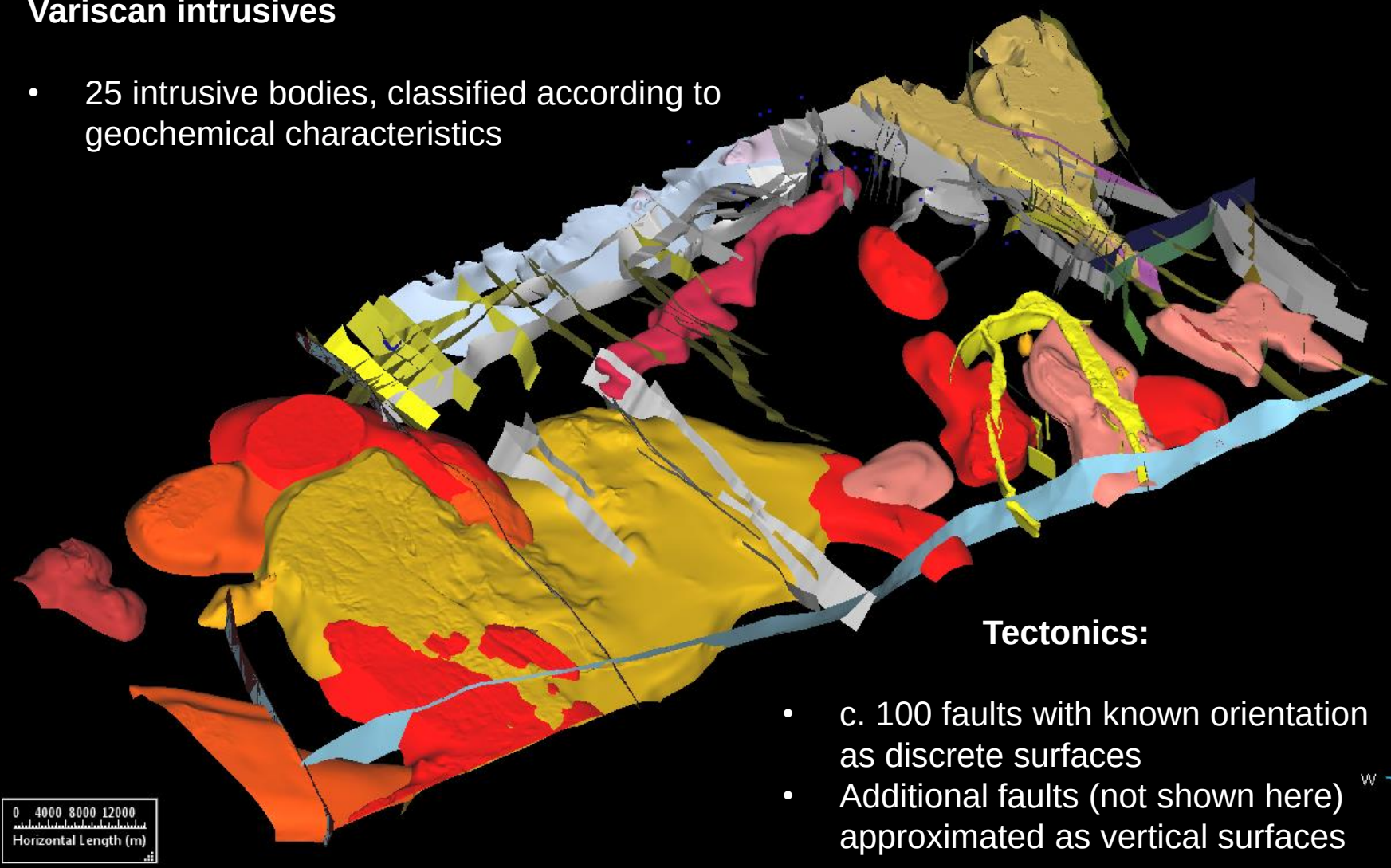
- 30 units, typically on the level of stratigraphic groups, some important units on the level of formations
- Division into authochthonous and allochthonous units



Constructing the 3D model

Variscan intrusives

- 25 intrusive bodies, classified according to geochemical characteristics



Tectonics:

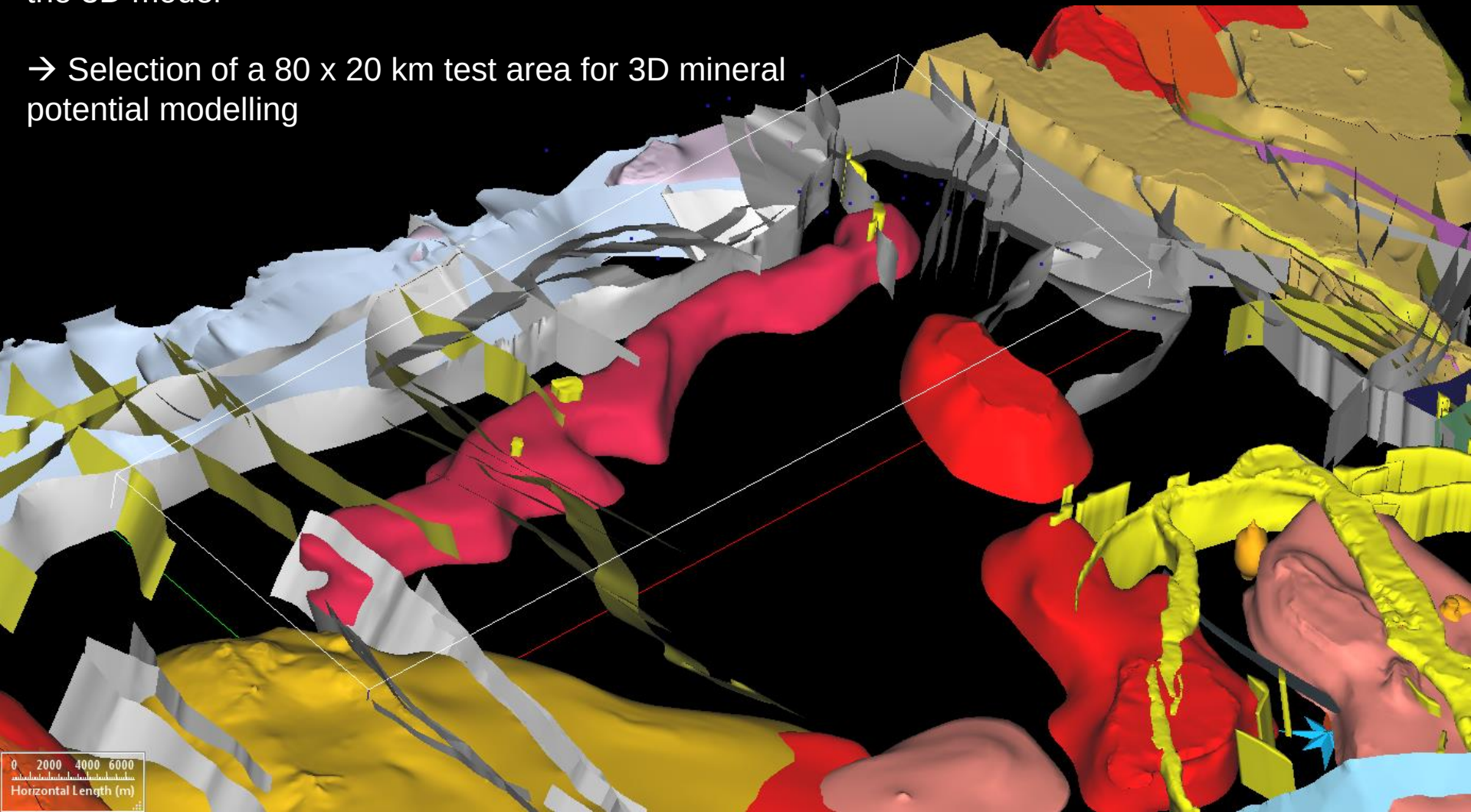
- c. 100 faults with known orientation as discrete surfaces
- Additional faults (not shown here) approximated as vertical surfaces

Constructing the 3D model

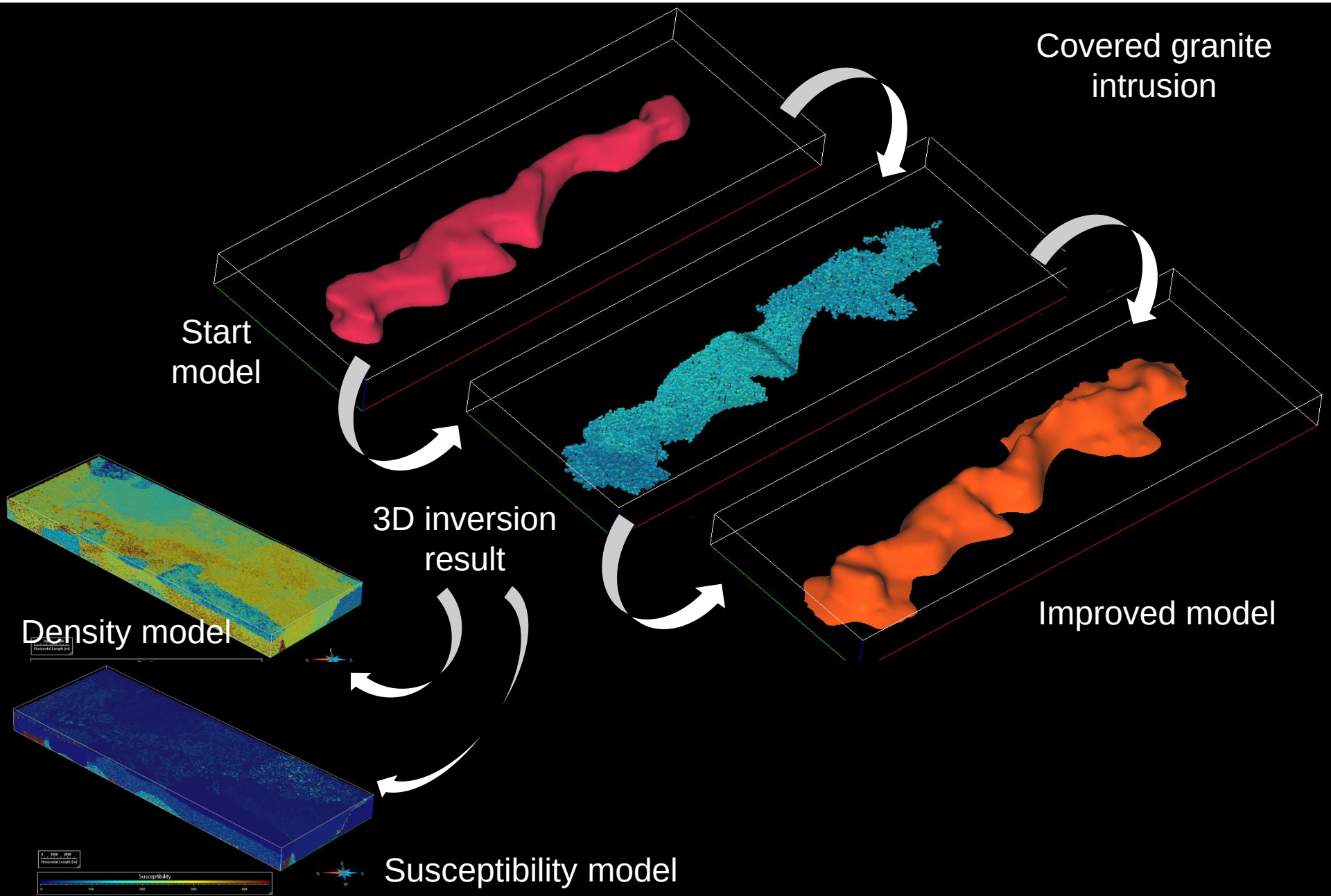
Covered intrusions

3D inversion of gravity amd magnetic data to improve the 3D model

→ Selection of a 80 x 20 km test area for 3D mineral potential modelling

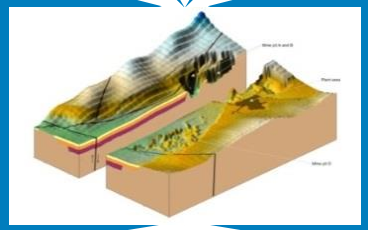


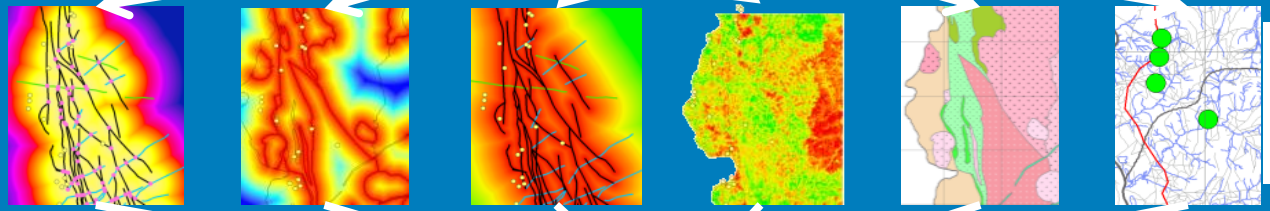
Constructing the 3D model



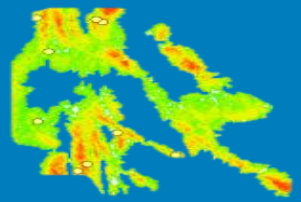
Mineral potential modelling with ANN

Workflow





advangeo®
Prediction Software



Raw data

Data preparation

3D modelling, processing of geophysics, geochemistry…

Model Input Data

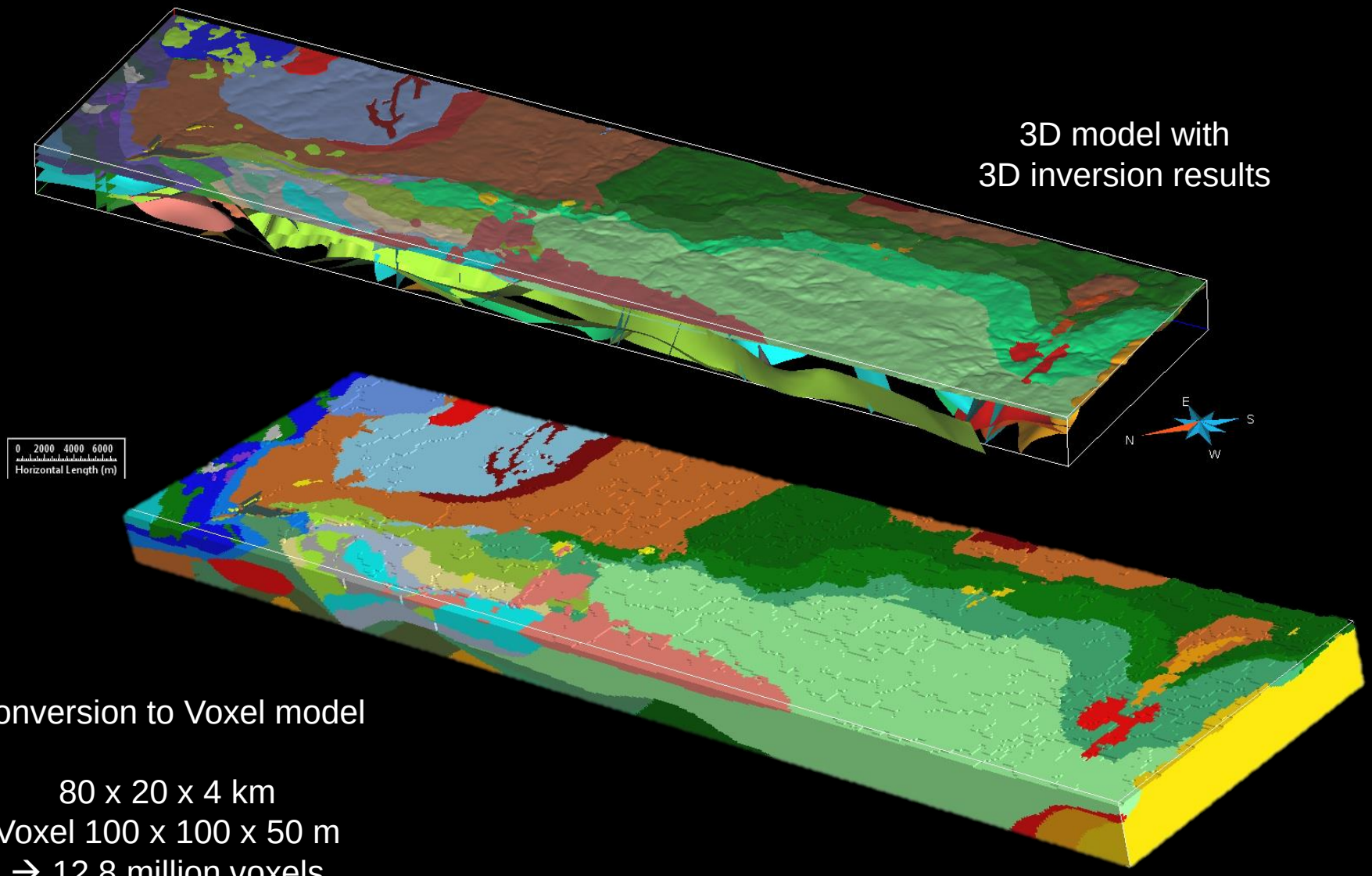
Training data (e.g. known deposits)

Training and application of artificial neural network

Mineral potential model
Favourability 0 … 1

Mineral potential modelling with ANN

Preparation of 3D model for ANN



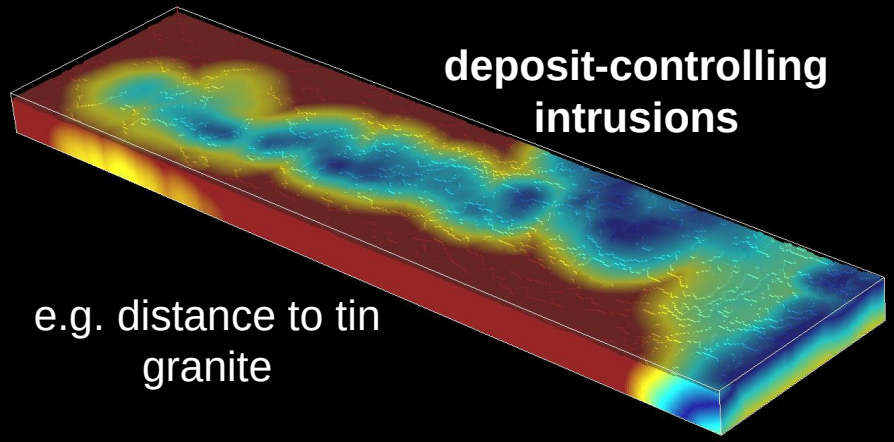
Conversion to Voxel model

80 x 20 x 4 km
Voxel 100 x 100 x 50 m
→ 12.8 million voxels

Mineral potential modelling with ANN

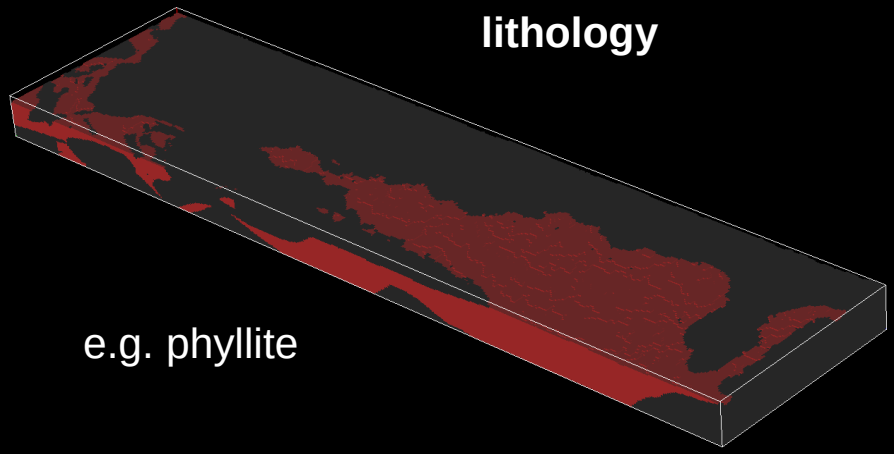
Examples of model input data for 3D mineral potetial modelling

deposit-controlling intrusions



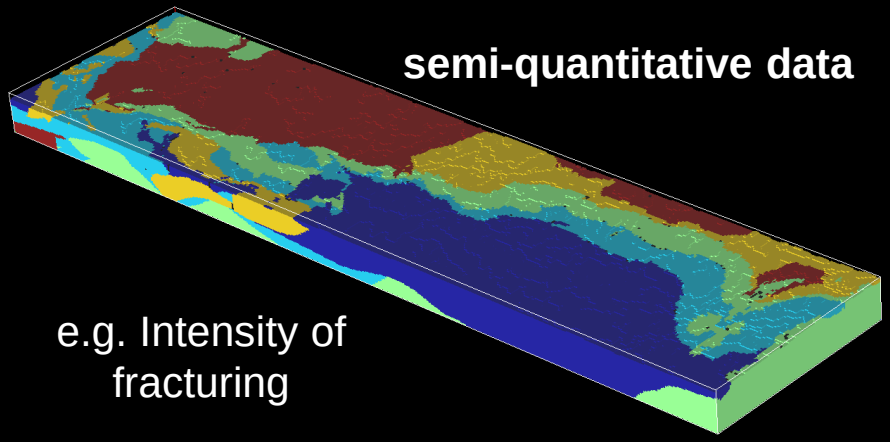
e.g. distance to tin granite

lithology



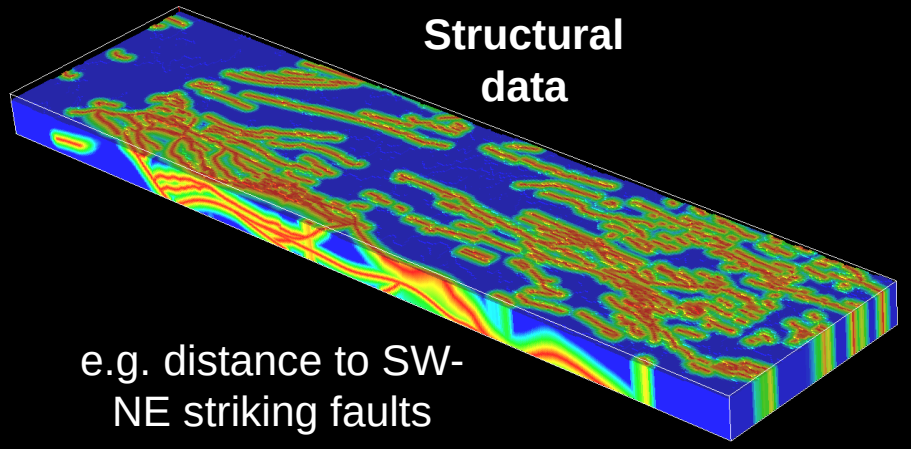
e.g. phyllite

semi-quantitative data



e.g. Intensity of fracturing

Structural data



e.g. distance to SW-NE striking faults

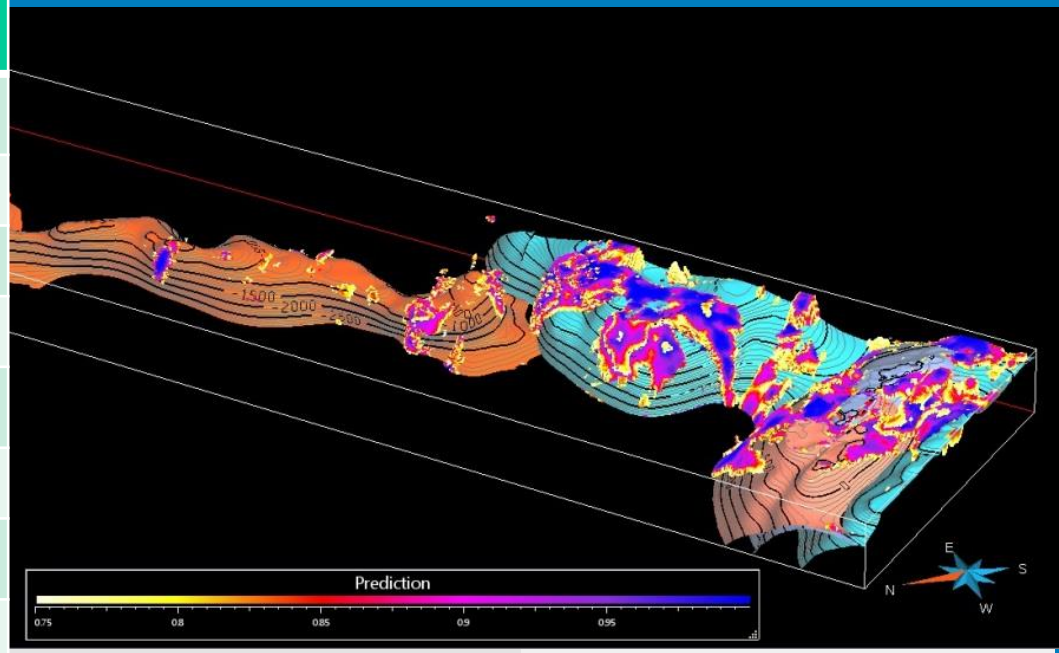
Also: density model, susceptibility model, stratigraphy, geochemistry, derivatives of geophysical data …

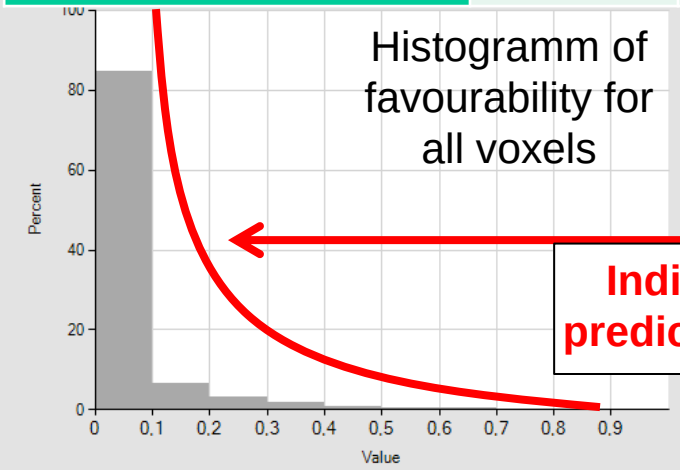
Mineral potential modelling with ANN

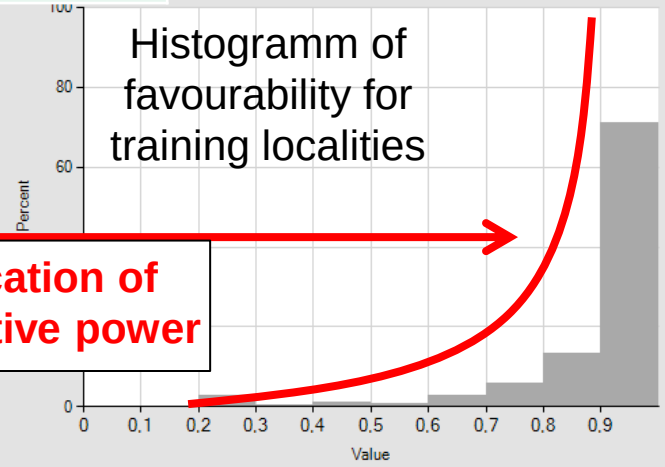
Weights of model input data

Model Input Data (MID)	Connection Weights	Garsons´ Algorithm
Distance to granite type Eibenstock	107,14	5,14
Extent of granite	-590,37	3,25
Aeromagnetics DeltaT Slope	-1922,43	3,24
Distance to very large faults	-498,07	3,17
Distance to Geological Units – Thum Group	-433,56	2,44
Gravimetry Gradient	-741,45	2,13
Distance to faults of high sinuosity	-324,36	2,07
…	…	…

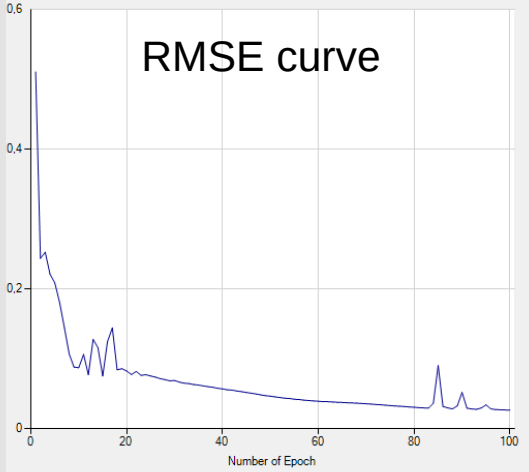
Mineral potential model for vein-hosted tin





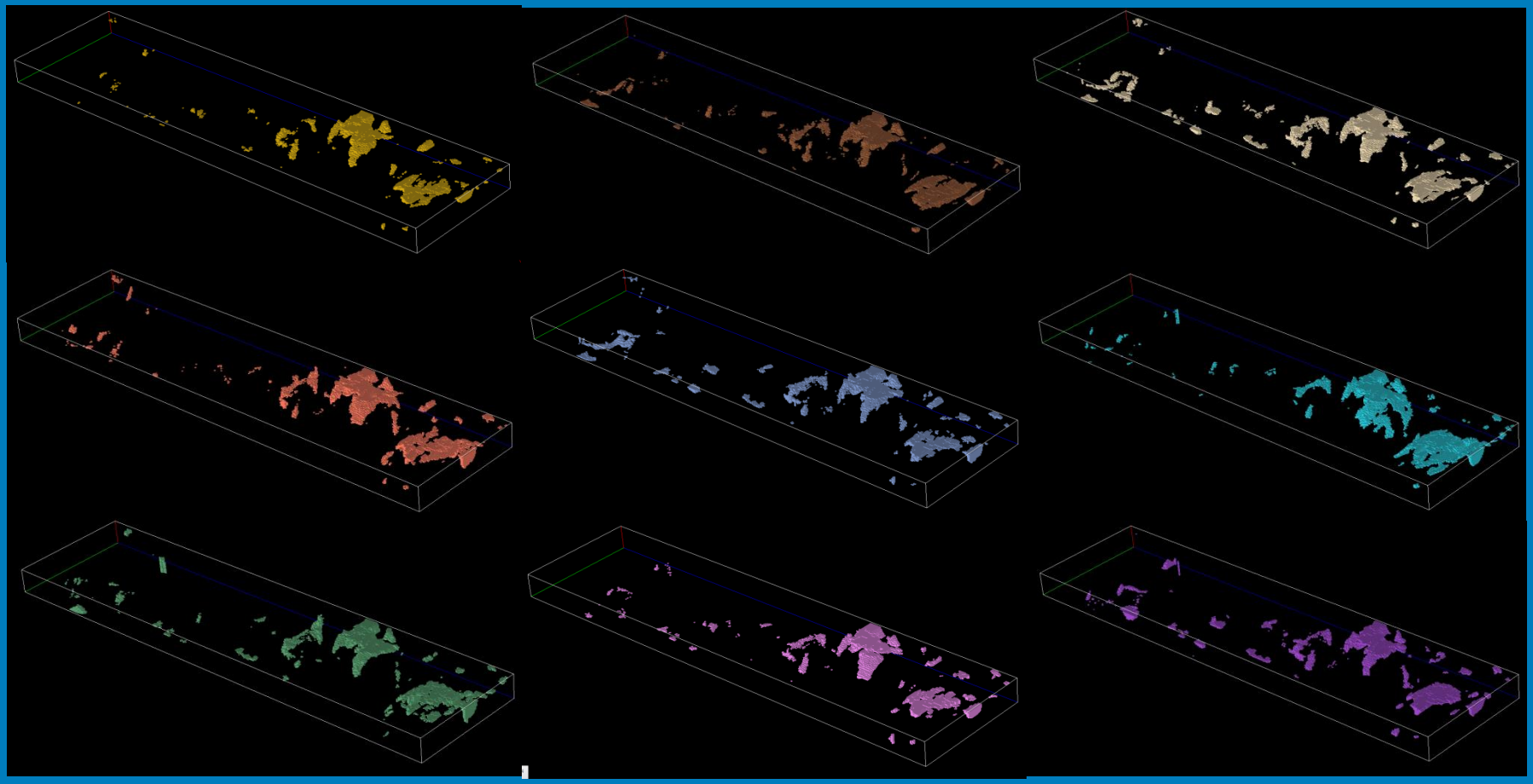


Indication of predictive power



Reproducibility and variance

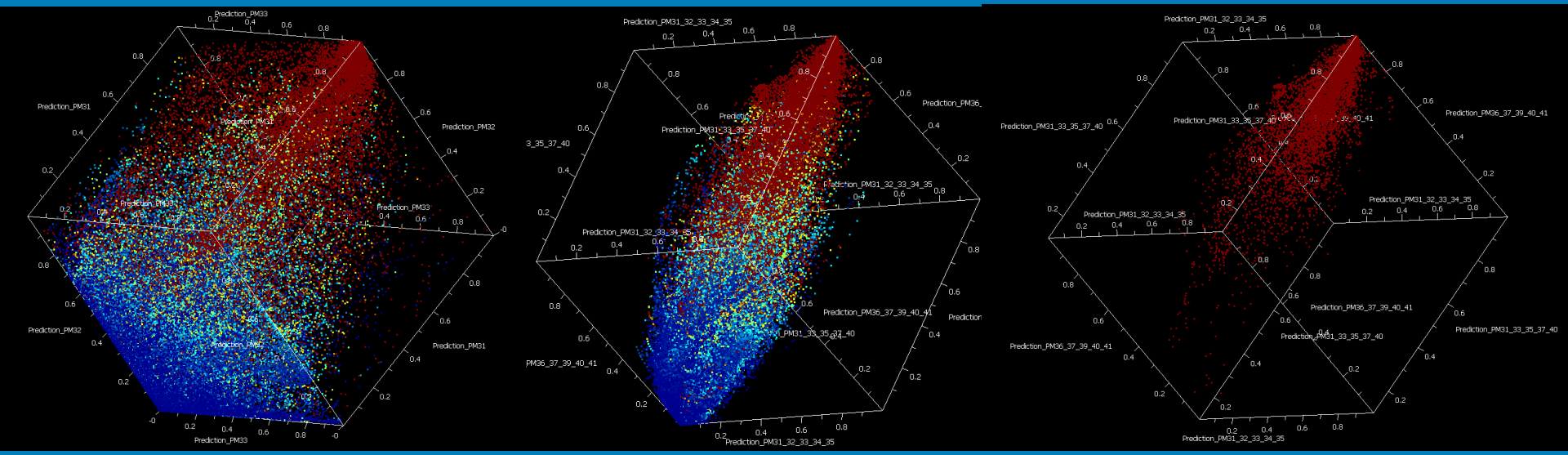
9 copies of the same model, showing voxels with favourability >0.75



→ Some „core volumes“ have high potetial in every model, „peripheral volumes“ have high potential in some models, less potential in others

Reproducibility and variance

Cube plot of favourabilites from three copies of the same model



All voxels

Only „core volumes“

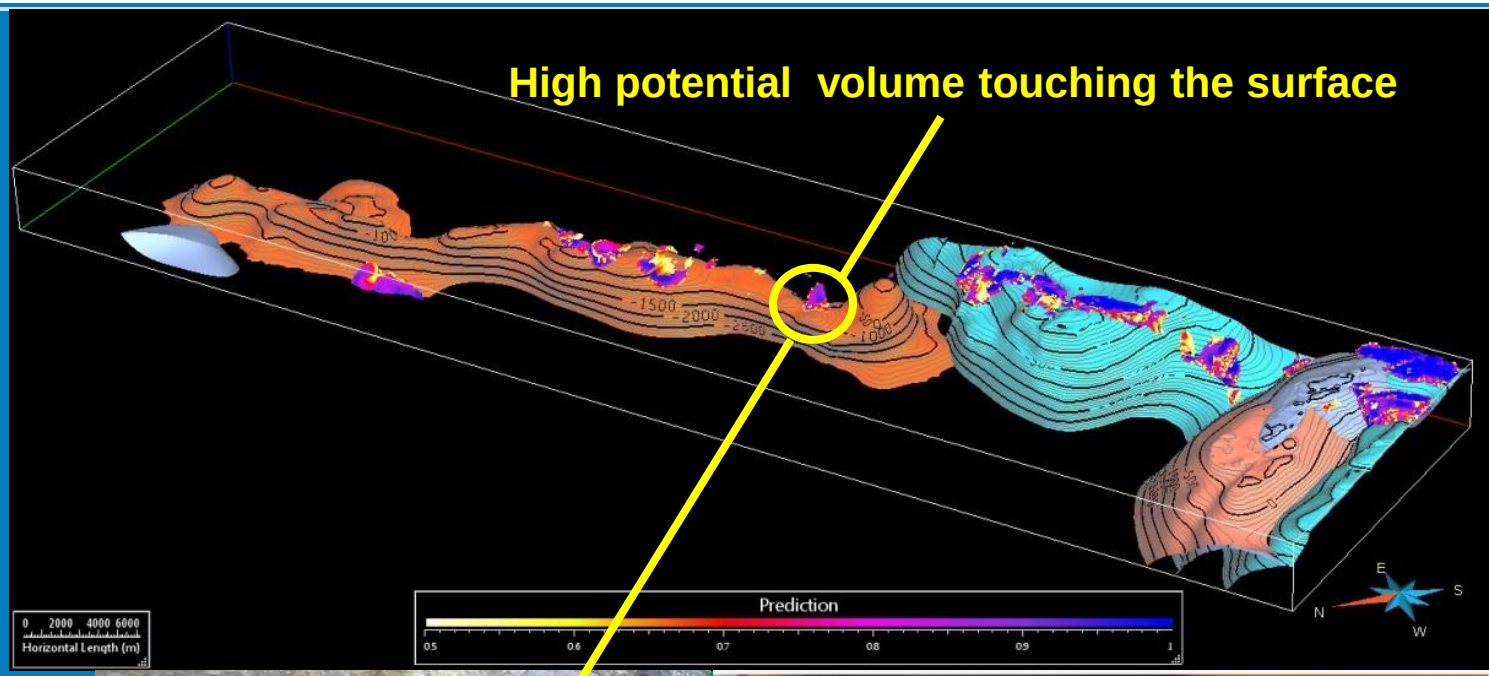
Only „core volumes“, only favourability >0.75

- „core volumes“ have high reproducibility
- „peripheral volumes“ are concentrated in parts of the 3D model that are less constrained by input data

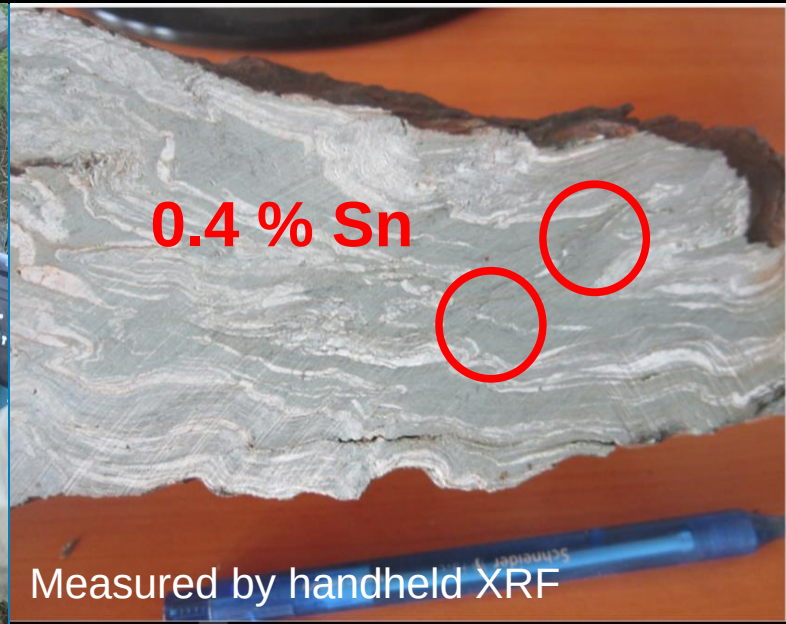
→ Variance of favourability over repeated model runs can be used to assess prediction uncertainties

Exploration Targeting / Field verification

Selection of near-surface high potential volumes for field reconnaisance



Chloritized micaschist with finely disseminated cassiterite at the Amtsberg locality



Conclusions: 3D Mineral potential modelling with ANN

- 3D predictive modelling results in volumes of interest and their depth below surface

  → **exploration targeting** greatly improved compared to 2D predictive maps

- **Model uncertainty** (2D and 3D) can be evaluated by repeated training of the artificial neural network and analysis of variability

  → exploration targets can be ranked for model uncertainty

- Requires enough information to construct 3D model and training data

  → best suited for **brownfields exploration**

beak CONSULTANTS

advangeo® Prediction Software

www.beak.de/advangeo/

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Bundesministerium für Wirtschaft und Energie

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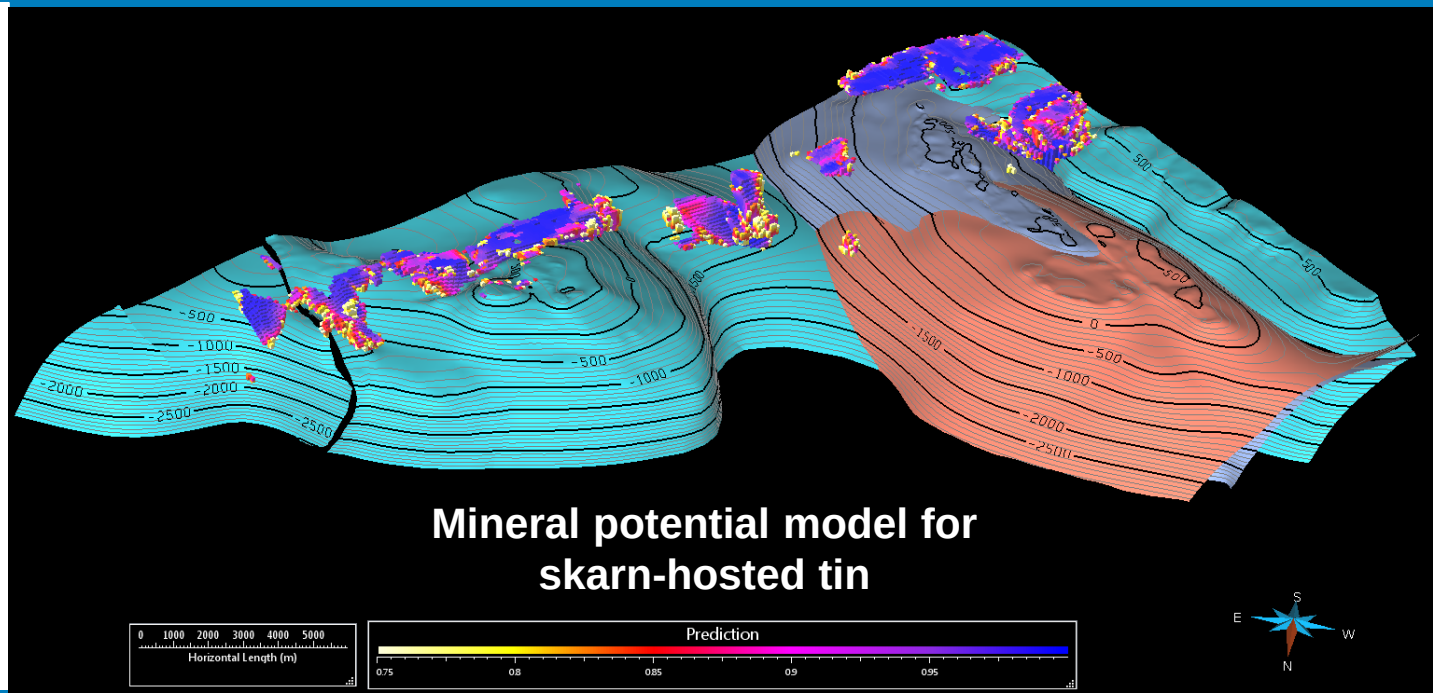

Mineral potential model for skarn-hosted tin