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Prediction Software

Advangeo® - Exploration targeting by use of artificial neural networks: Background and experiences

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Daily questions …

Where is the deposit?

Where do forest pests occure?

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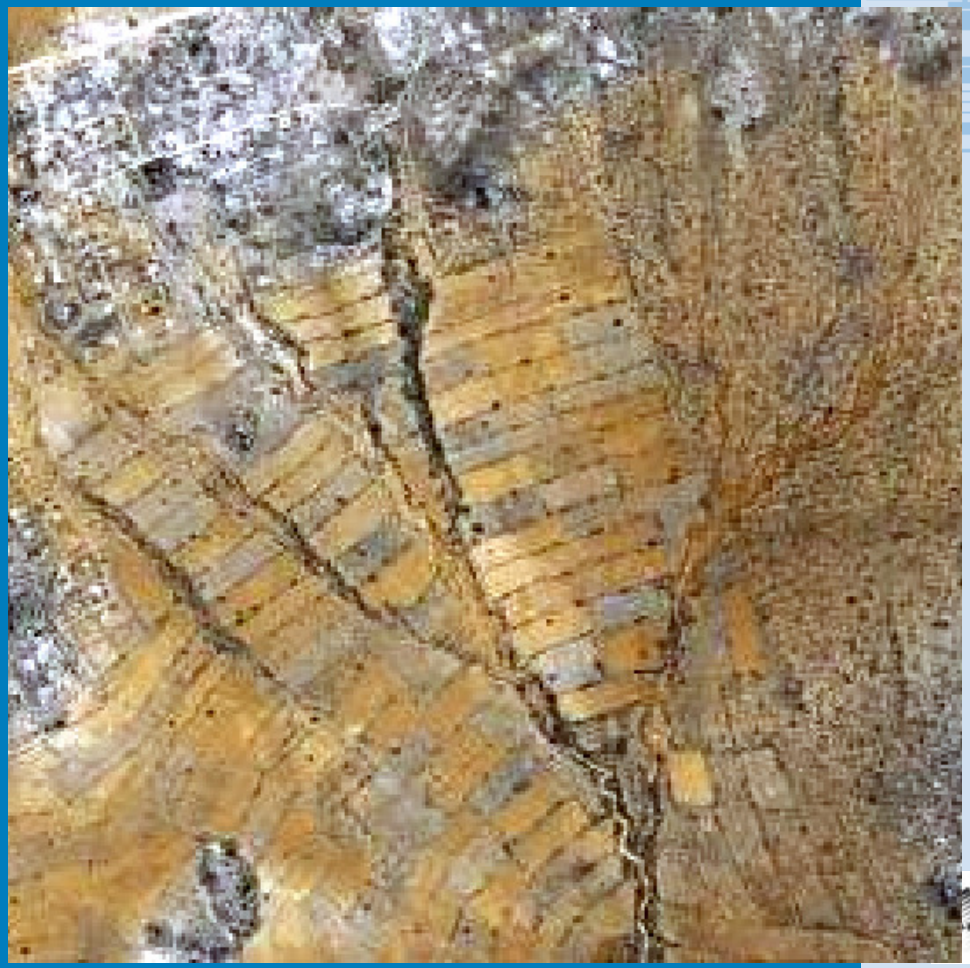
Daily questions …

Where occur slope slides ?

Where do erosion gullies form ?



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Daily questions …

Where burns the coal seam ?

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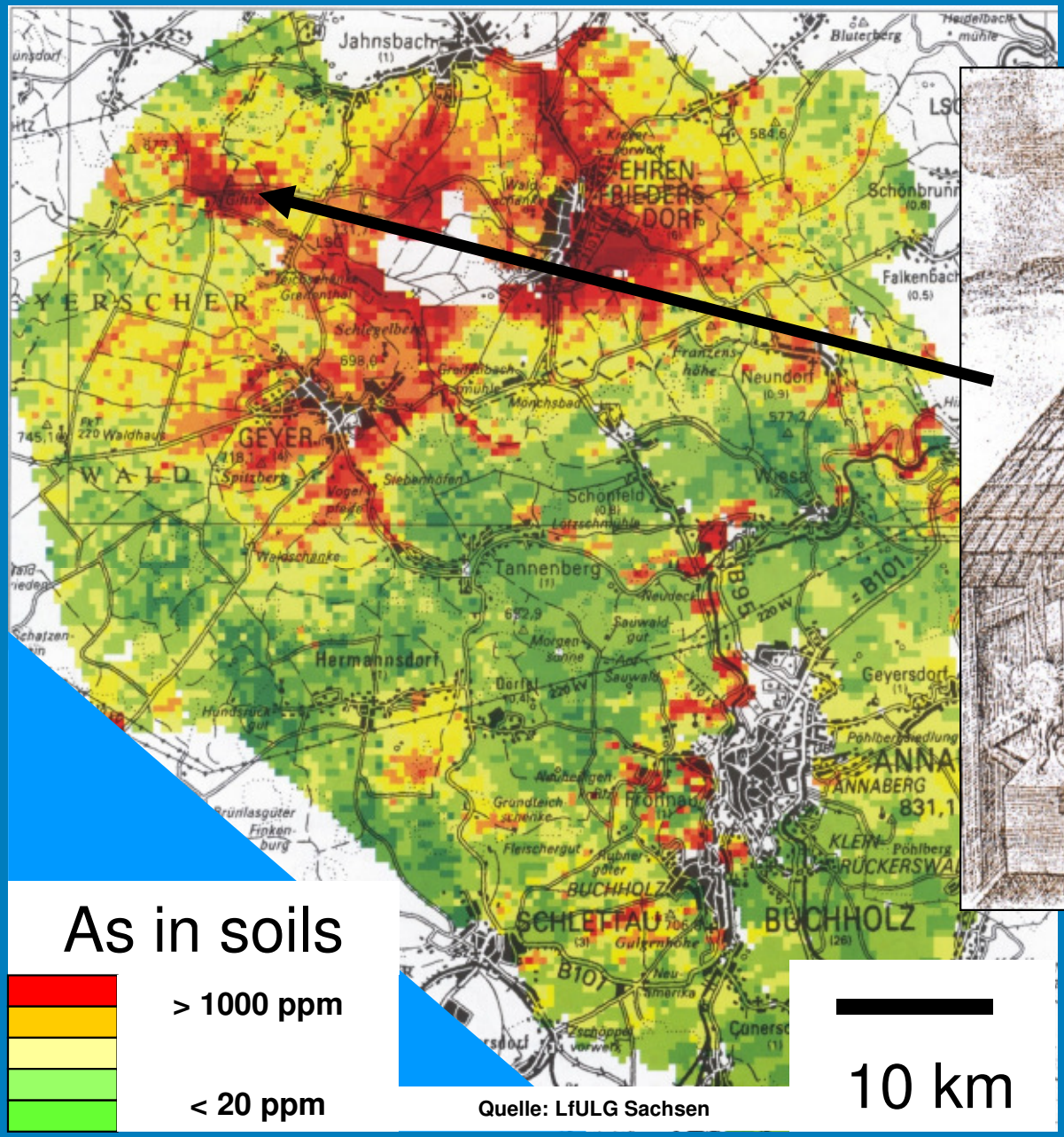
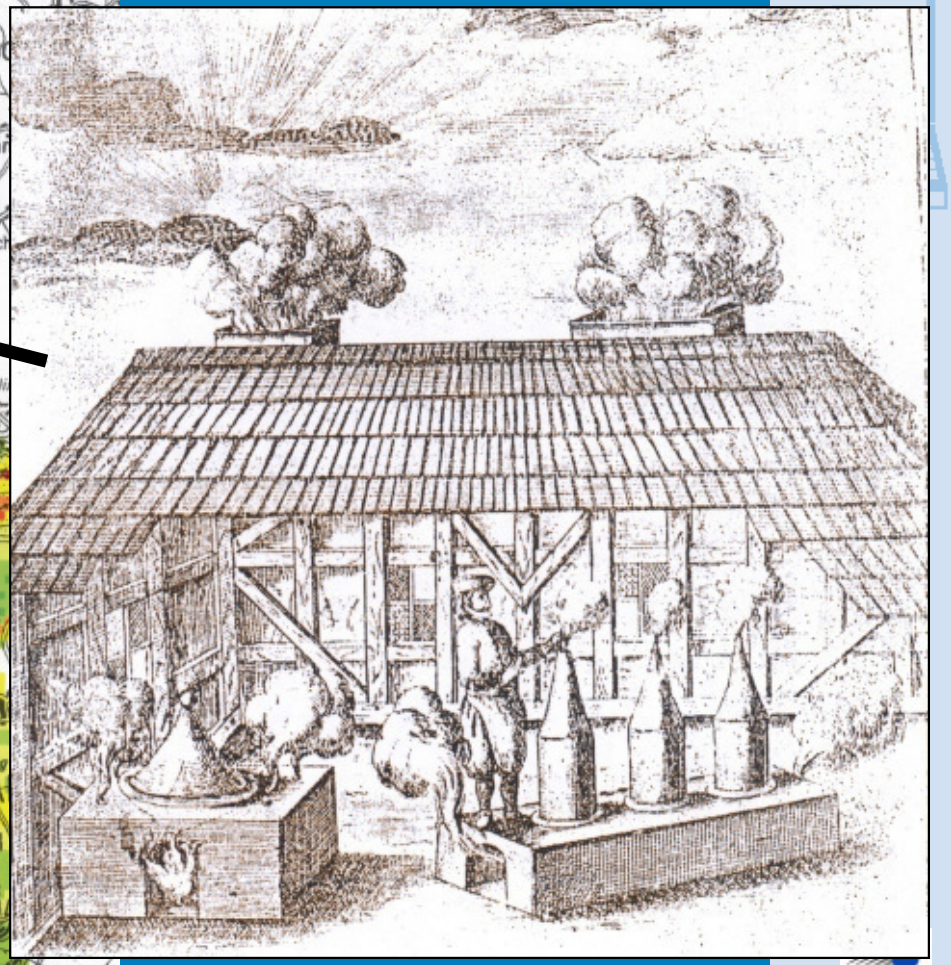
Daily questions …

Where are the contaminations ?





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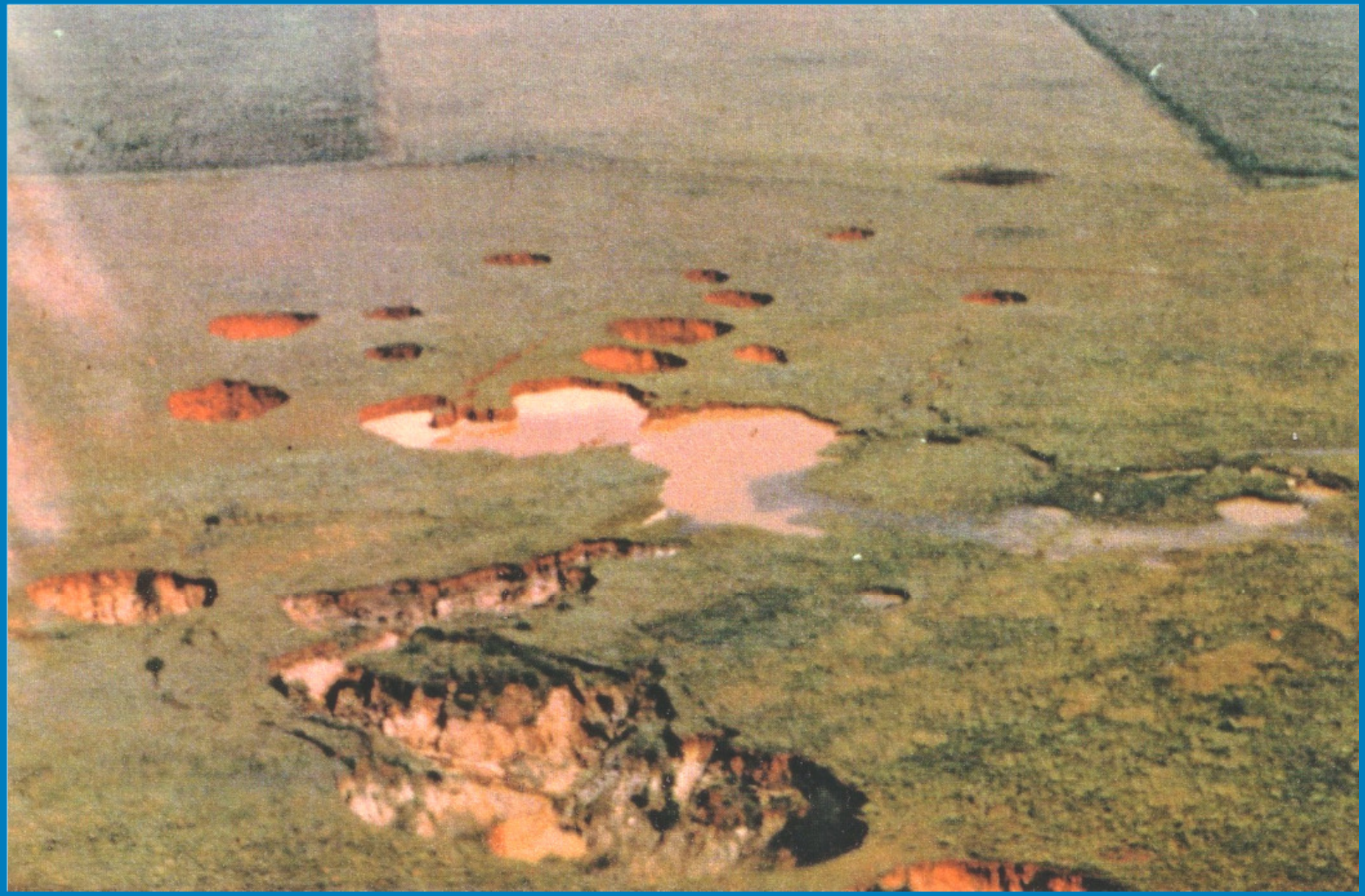
Daily questions …

Where will karst form ?



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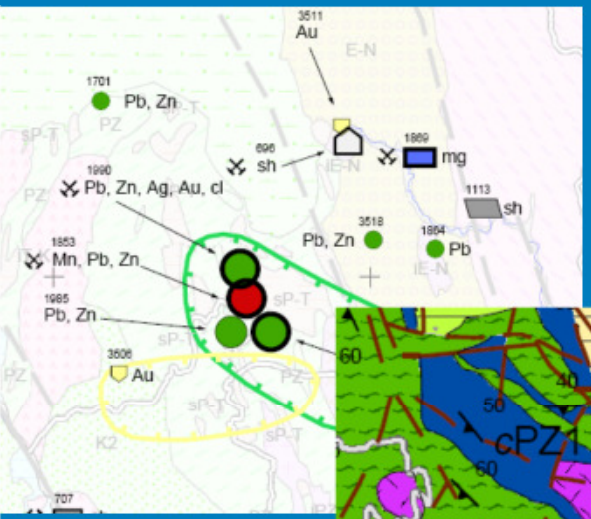
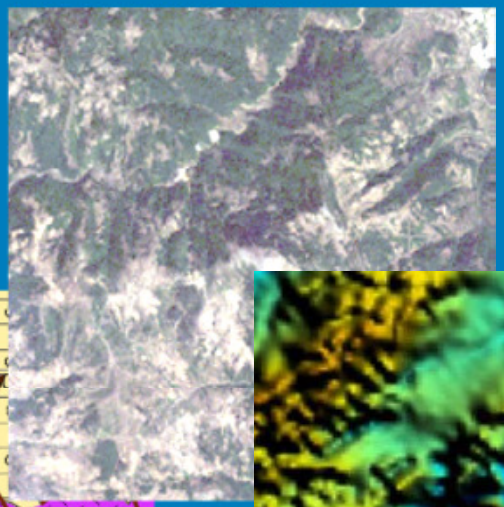
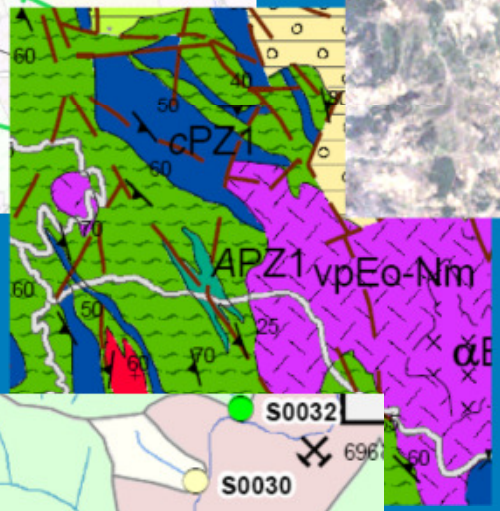
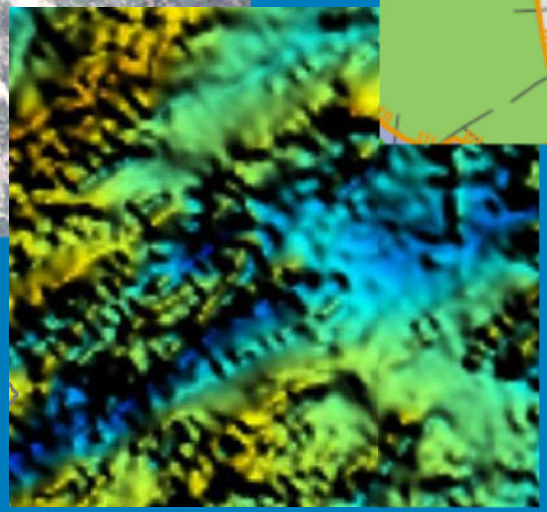
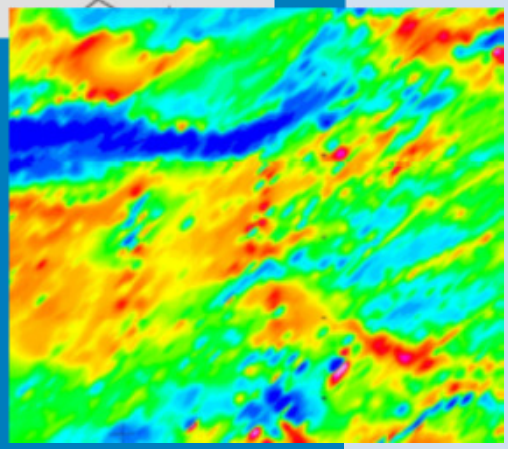
Data and knowledge: basis for prediction

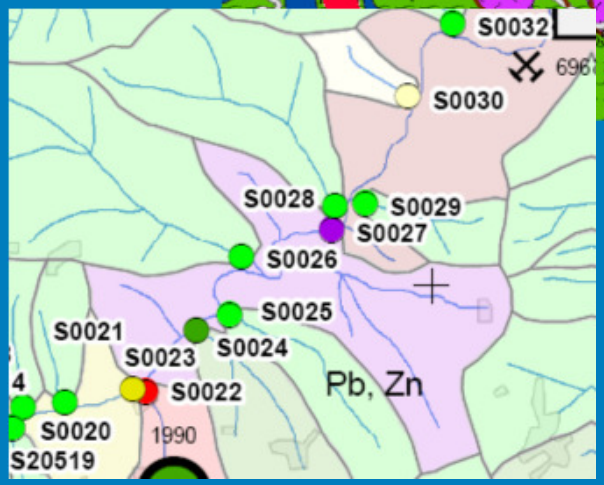












- Geology
- Raw materials
- Geochemistry
- Geophysics
- Tectonics
- Geomorphology
- DEM

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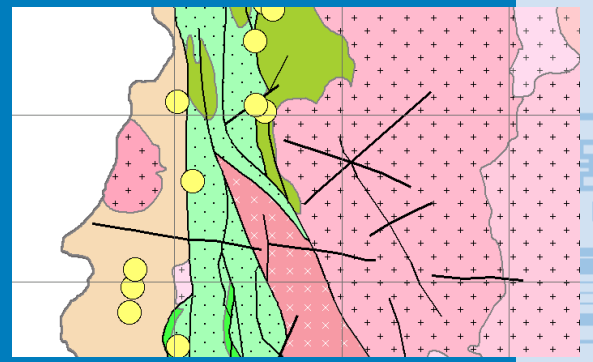
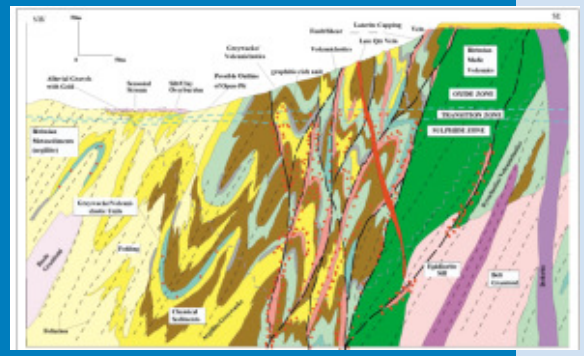
Steps for making a prediction map

Input data:
Geological map, deposits, geophysics,…

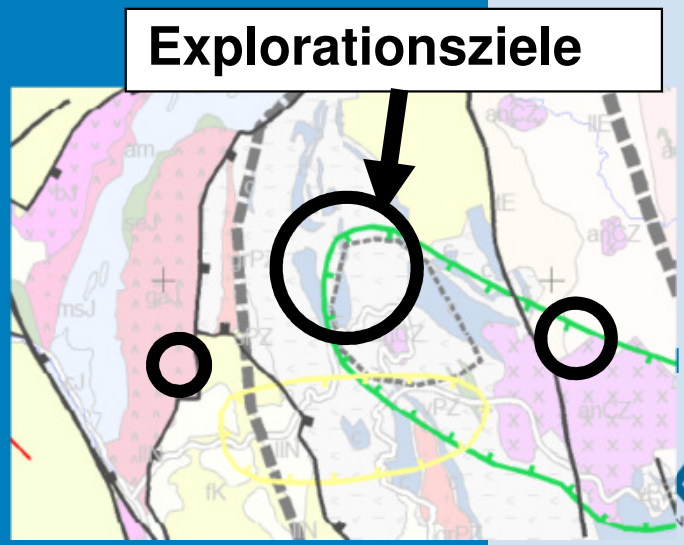


Our knowledge:
Known relations, Models



Possibilities of data analysation:
analytic or empiric / statistic solutions

Application of experience → Prediction map



Basic models and prediction methods

Empiric approach: Experience of Experts

- Commonly used
- Supported by statistical methods

Analytic approach: mathematical Modelling

- intense knowledge about processes
- Field observations, model calibration and application
- Time consuming, expensive
- In practice often not applicable
- Mostly only parts can be modelled
- constant boundary conditions

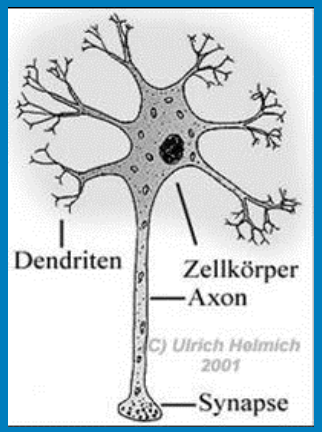
$$E = f(a,b,c,d,g,...)$$

Artificial Intelligens, self learning methods

→ **Artificial neural networks**:

Analysis of complex, non-linear relations

- Self learning, generalisation
- qualitative and quantitative analysis



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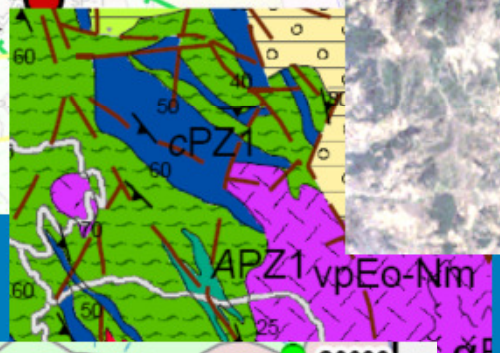
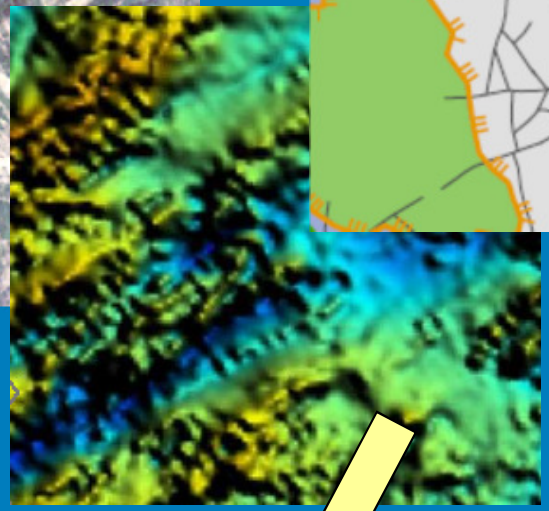
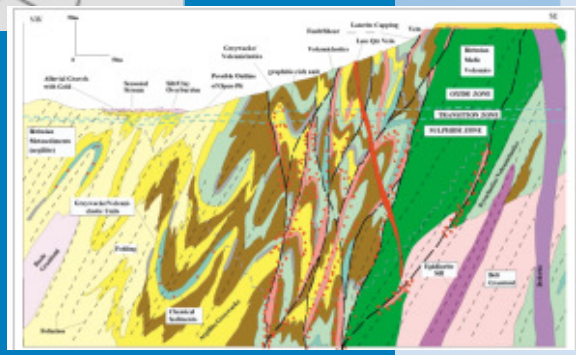
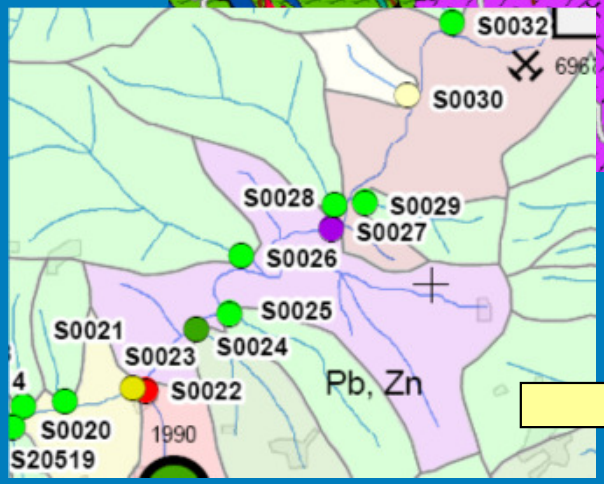
empiric approach



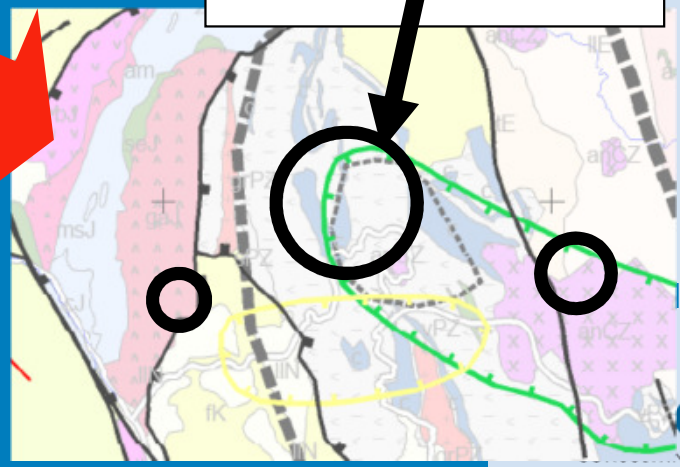


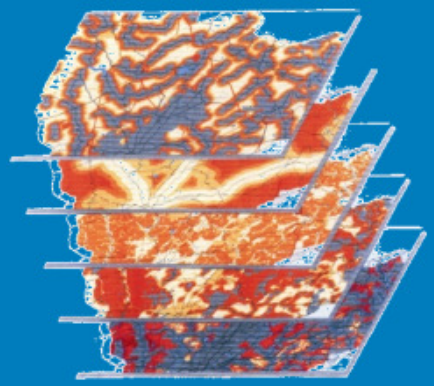




We may get lost in the data and knowledge

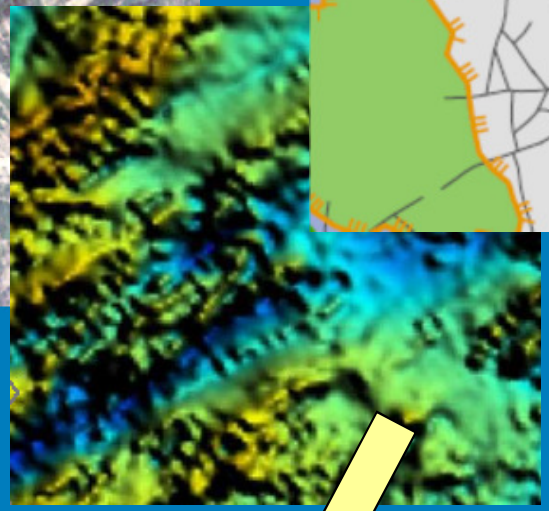
Target areas ??

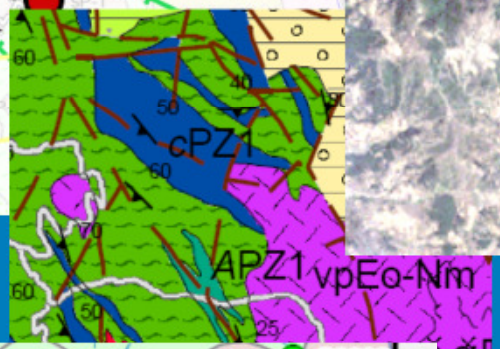


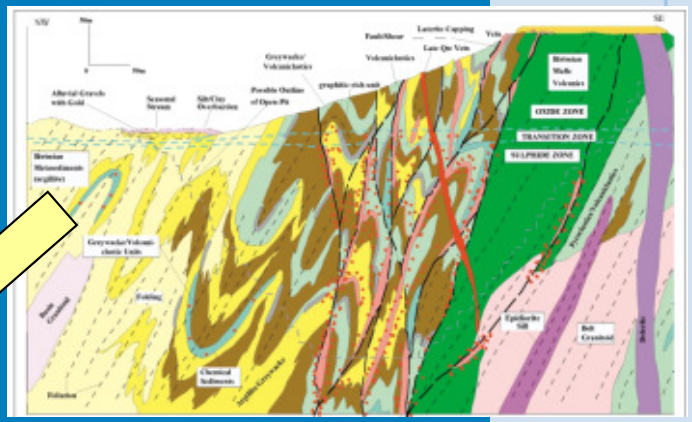


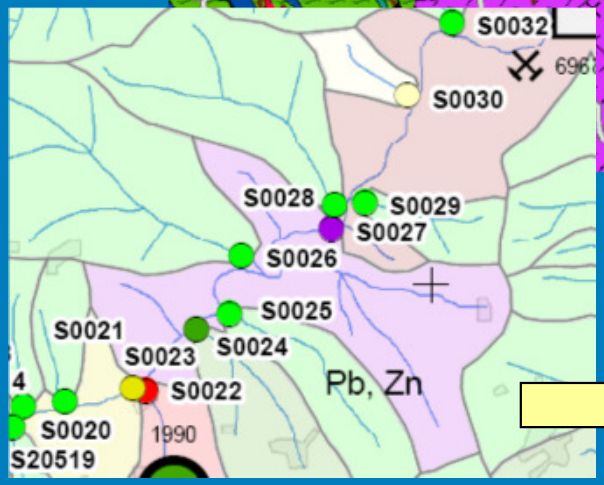
Remember your desk

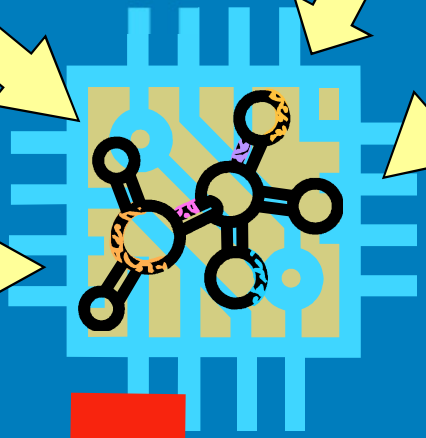
Application of artificial neural networks

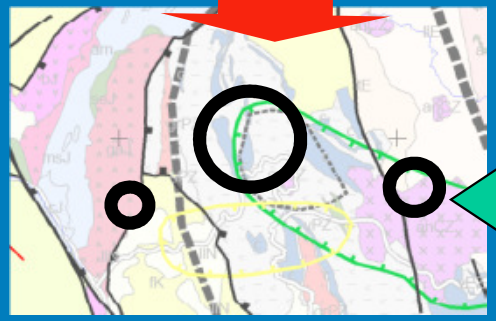






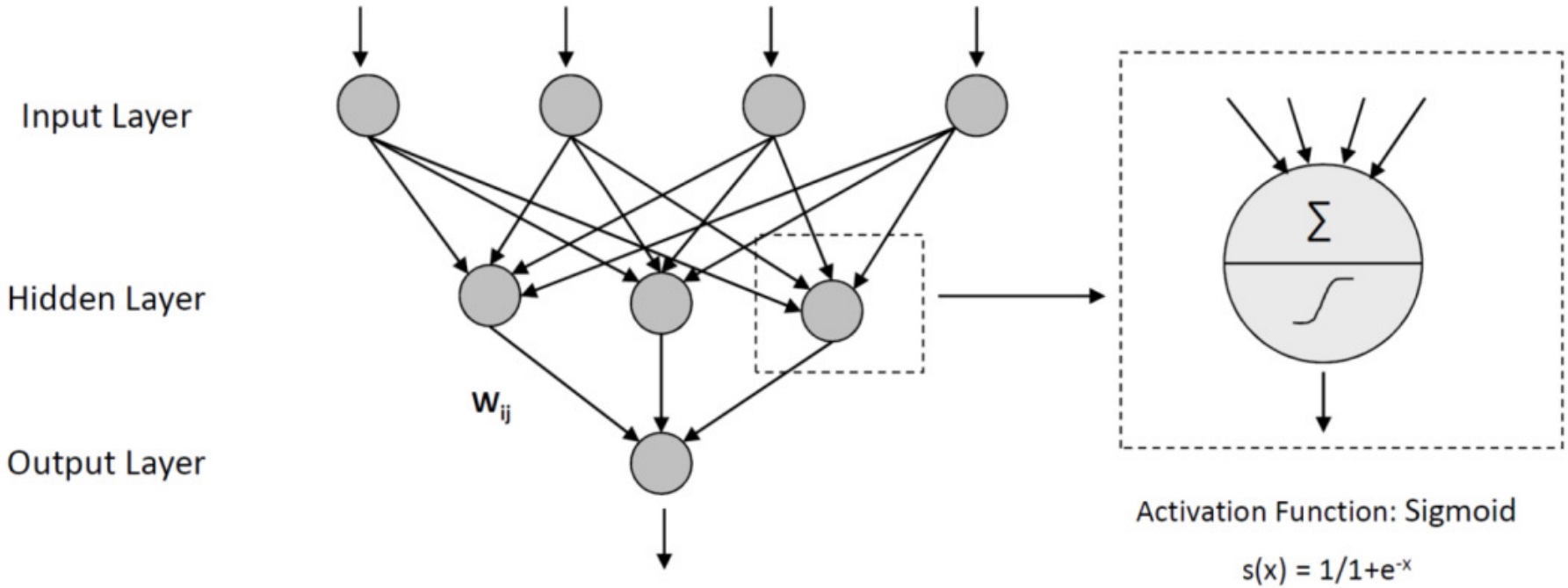






Plausibel ?

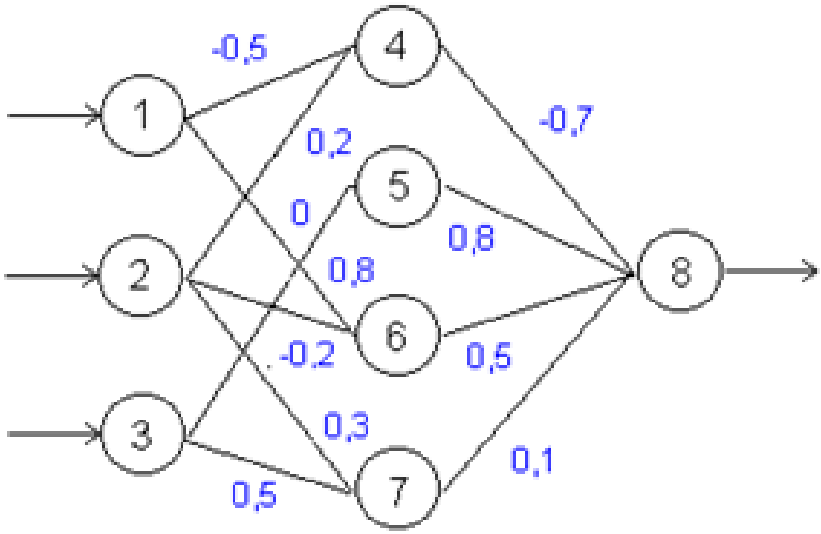
principle construction of artificial neural networks

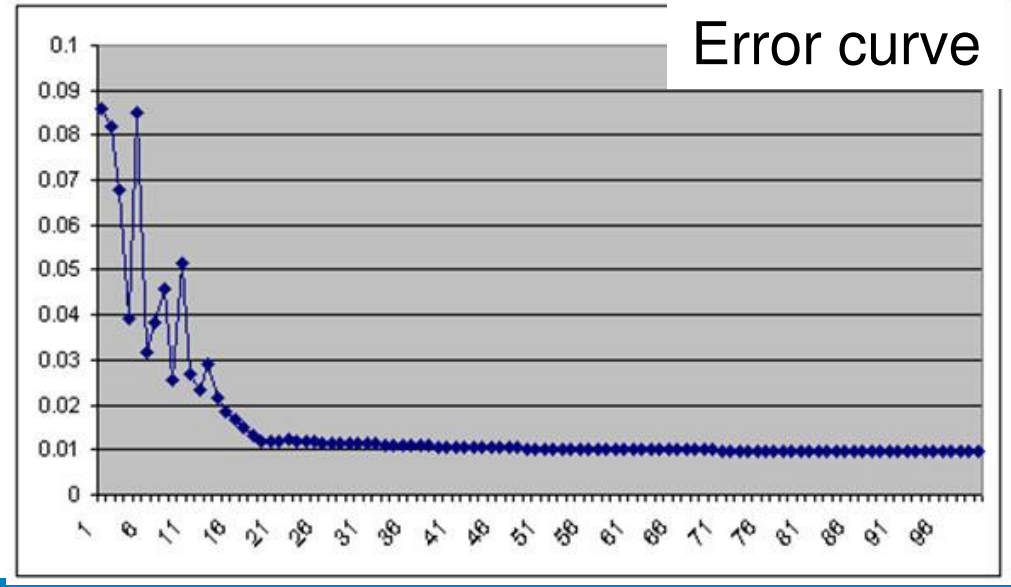


How does the network learns ?

→ Back-Propagation

- Iterative „learning“
- Modification of the weights
- Reduction of the error





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Software: advangeo

- Simple acces to the methods of artificial neural networks for the prediction of spatial data
- Dokumentation of the working steps
- Capturing and management of metadata
- tools for Datapreparation, -postprocessing and result mapping
- Integration in ESRI ArcGIS-Software

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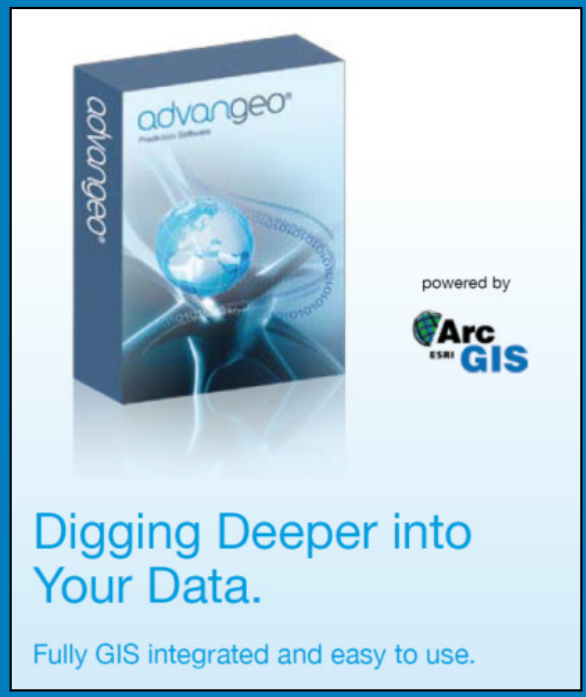

System requirements

- ✓Standard PC / Notebook
- ✓Windows XP
- ✓ESRI ArcMap 10.0 und Spatial Analyst 10.0

Project Workflow

❶ Problem Definition & Data Collection

❷ Data Pre-Processing & Preparation

❸ Network Training

❹ Model Validation

❺ Model Application

❻ Result Presentation

Example: prediction of Au deposits in Ghana

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The task: Create predictive maps for Au

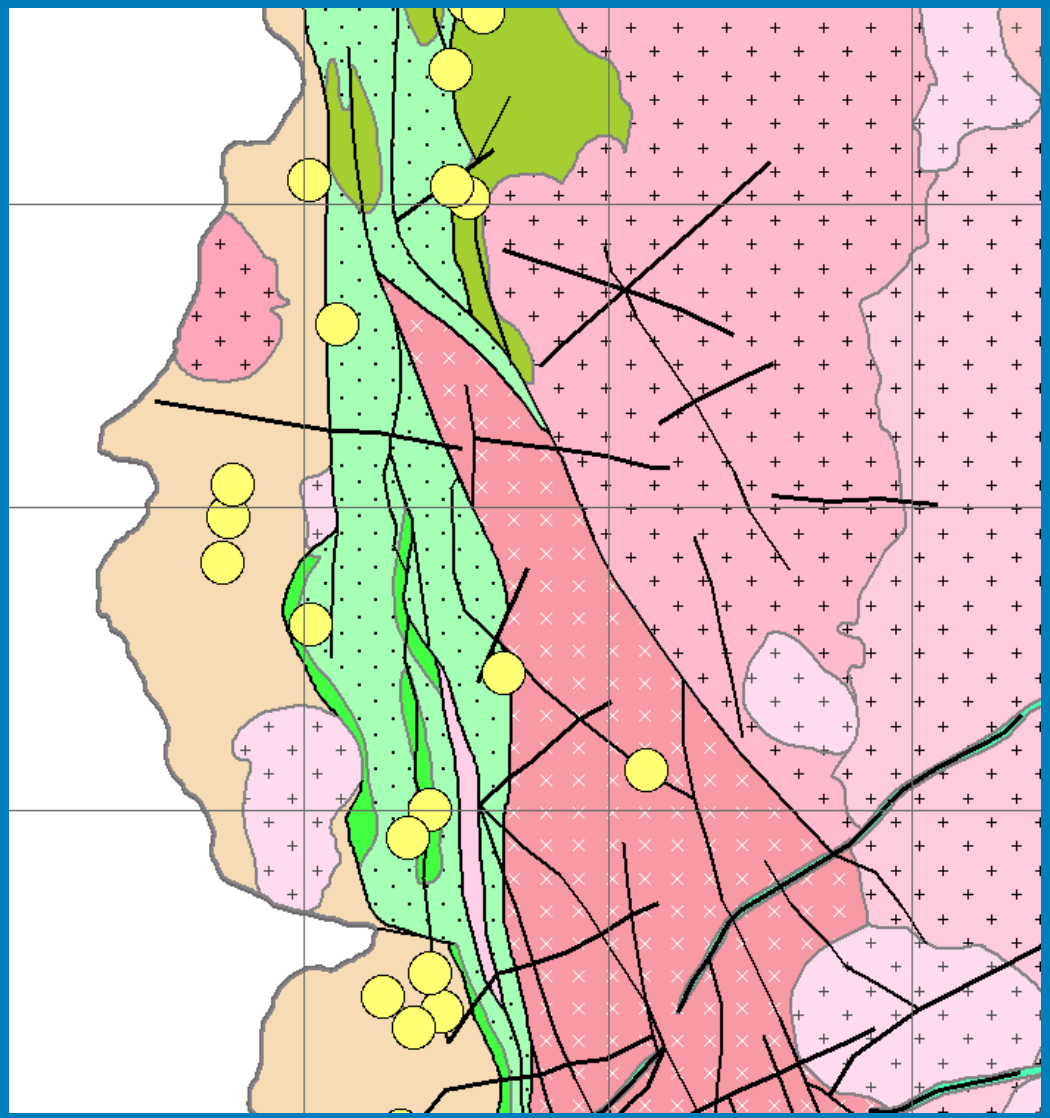
- Au generates important income in Ghana
- Au mining creates jobs and supports the local & national economy
- Au mining creates serious environmental damages
- Mineral resources must be included into the land use planning activities

Predictive maps can provide a serious input into the national development strategy

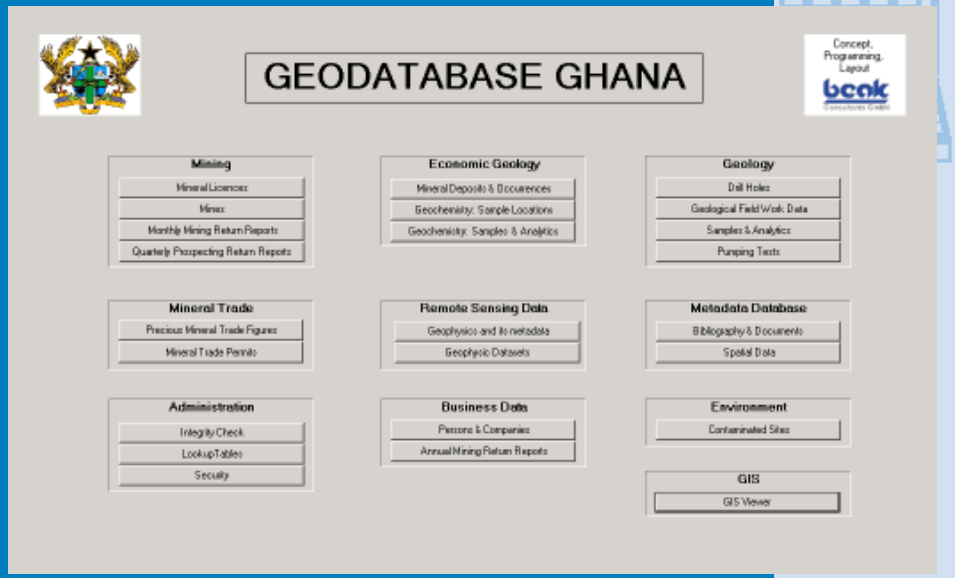
Available data and knowledge

- Airborne geophysics:
  - all country covered, but different resolution, equipment, …
- Geological maps:
  - 1:1,000,000 for the country (BGR-GSD Ghana, 2010)
  - 1:1,000,000 map (Minerals Commission of Ghana, 2002)
  - Other scales
- Geochemical data:
  - selected maps only, no systematic data in a suitable density
- Metallogenetic models of Au ore bodies

Mineral occurrence locations



Source: Geodatabase Ghana



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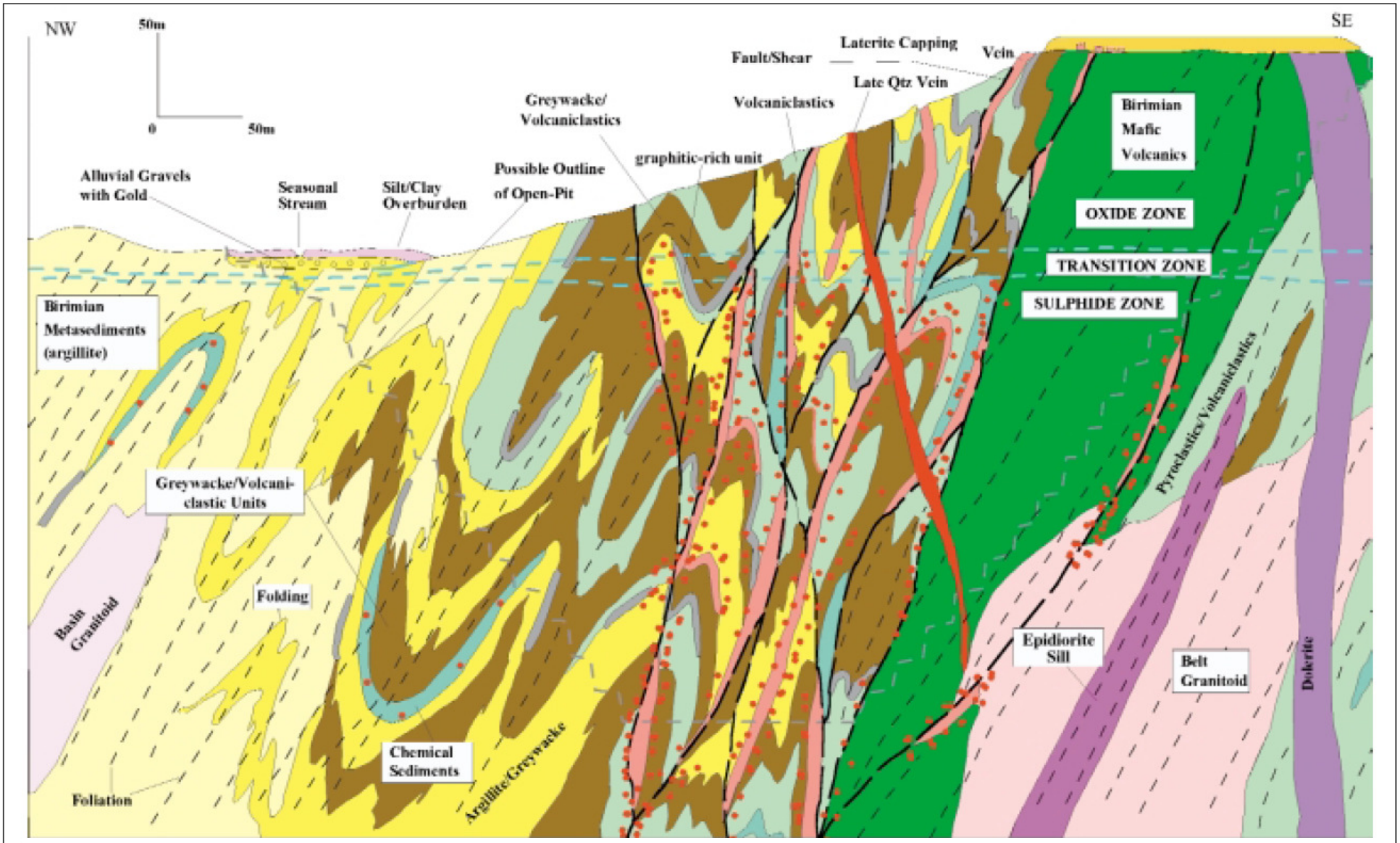
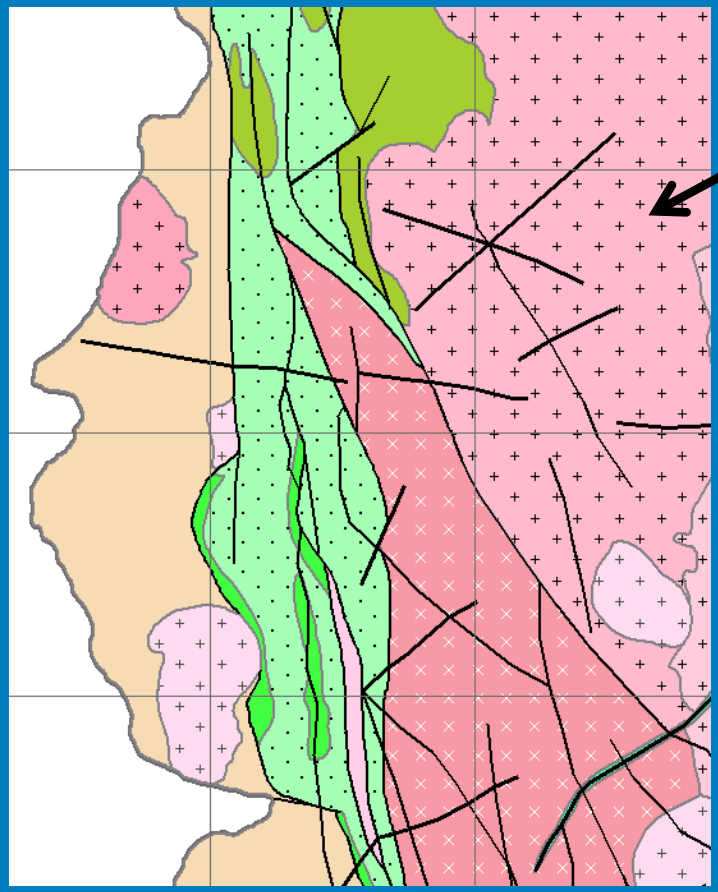
Existing knowledge: the mineral deposit model

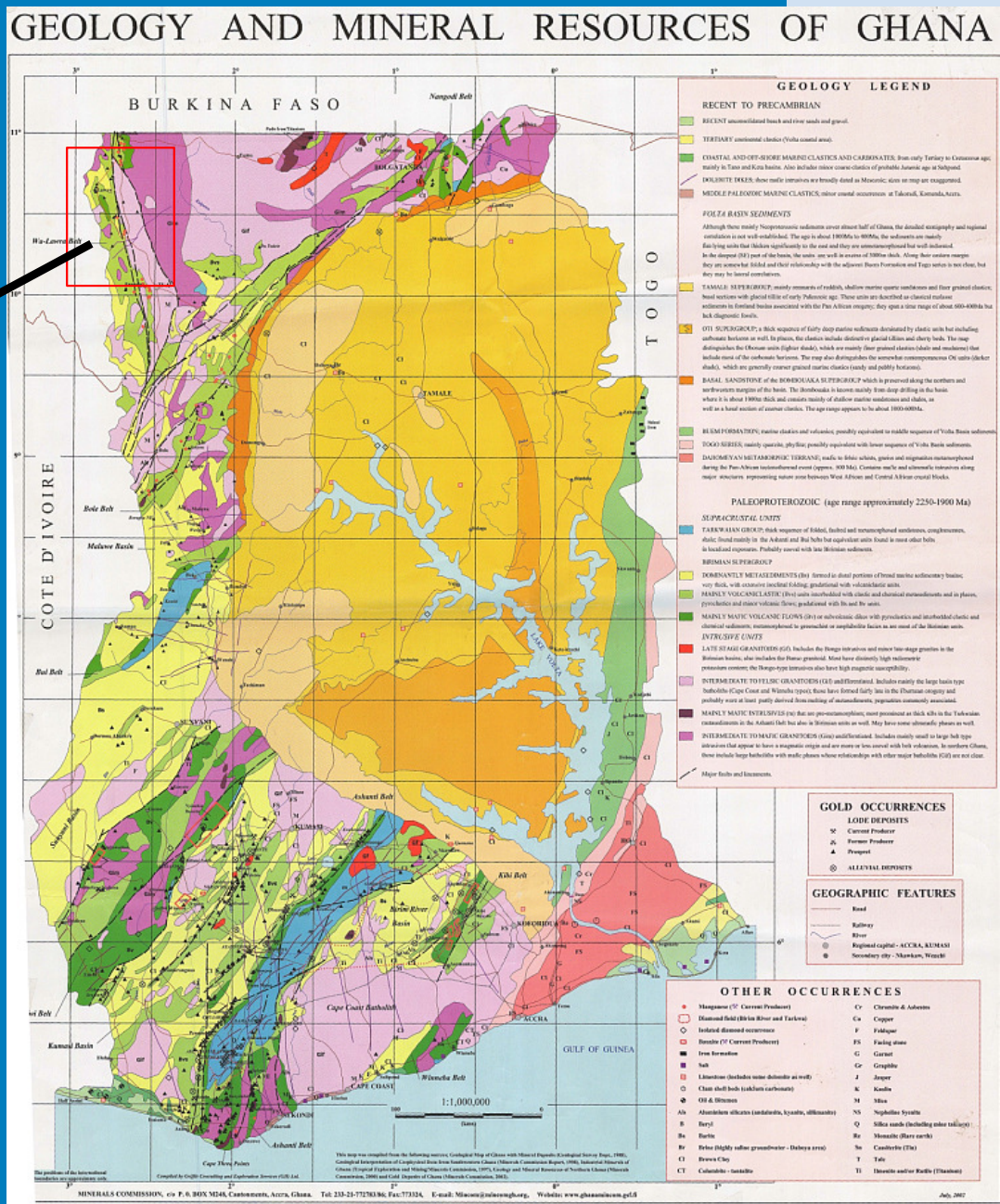


Source: Gold deposits of Ghana, Minerals Commission, Ghana, ROBERT J. GRIFFIS, KWASI BARNING, FRANCIS L. AGEZO, FRED K. AKOSAH, 2002

The tectonic structures

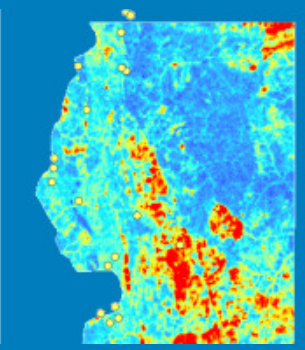
Source: Geodatabase Ghana;
Different geological maps

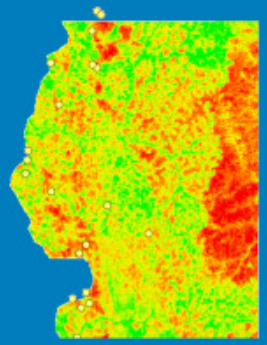


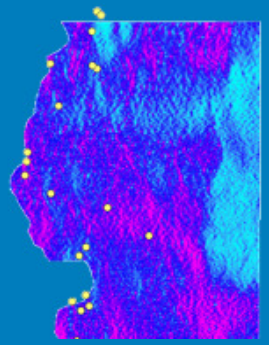


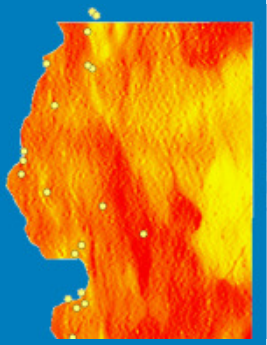
geophysics

Input Data:
Airborne Geophysical Survey - Radiometric

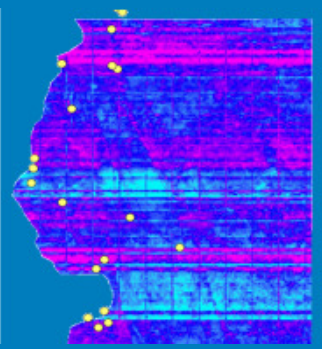

Potassium


Thorium

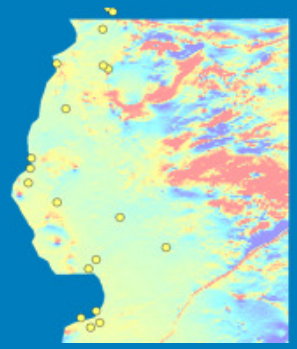

Uranium


Total

Input Data:
Airborne Geophysical Survey - Electromagnetic

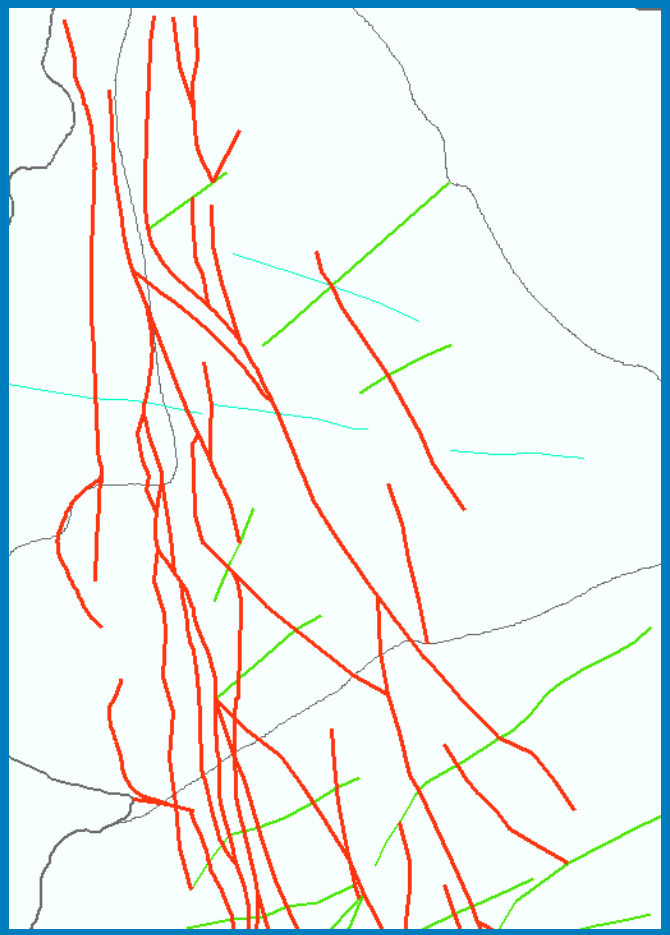


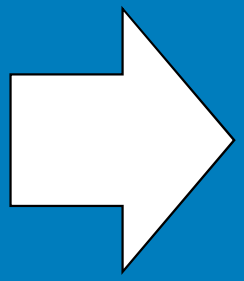
Input Data:
Airborne Geophysical Survey – Magnetic

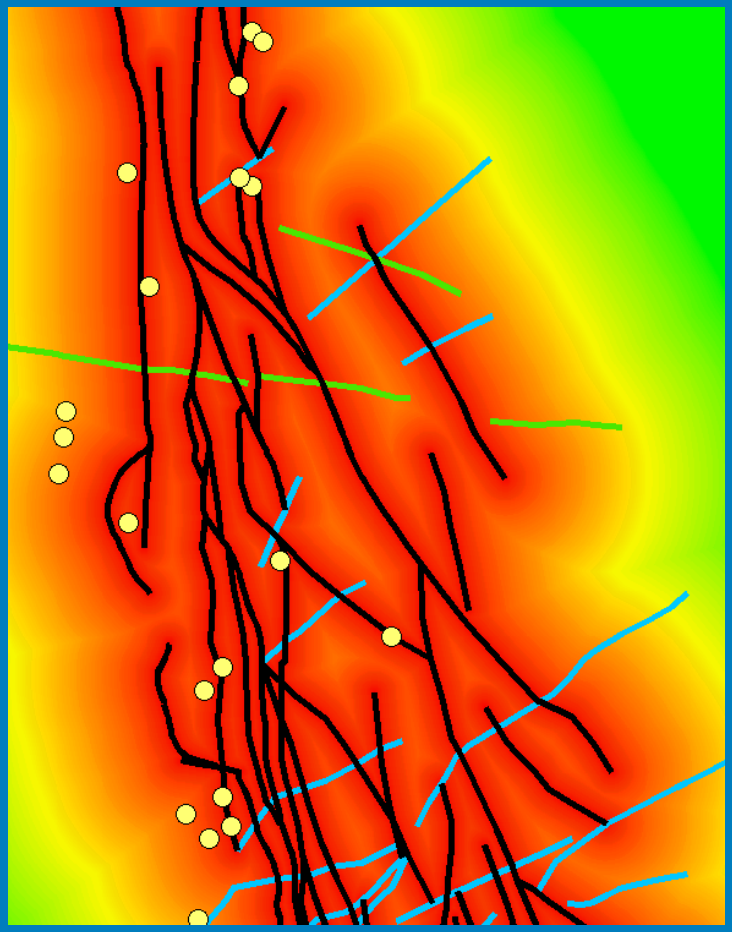


Source: Geological Survey Department of Ghana

Processing of model input data: tectonics

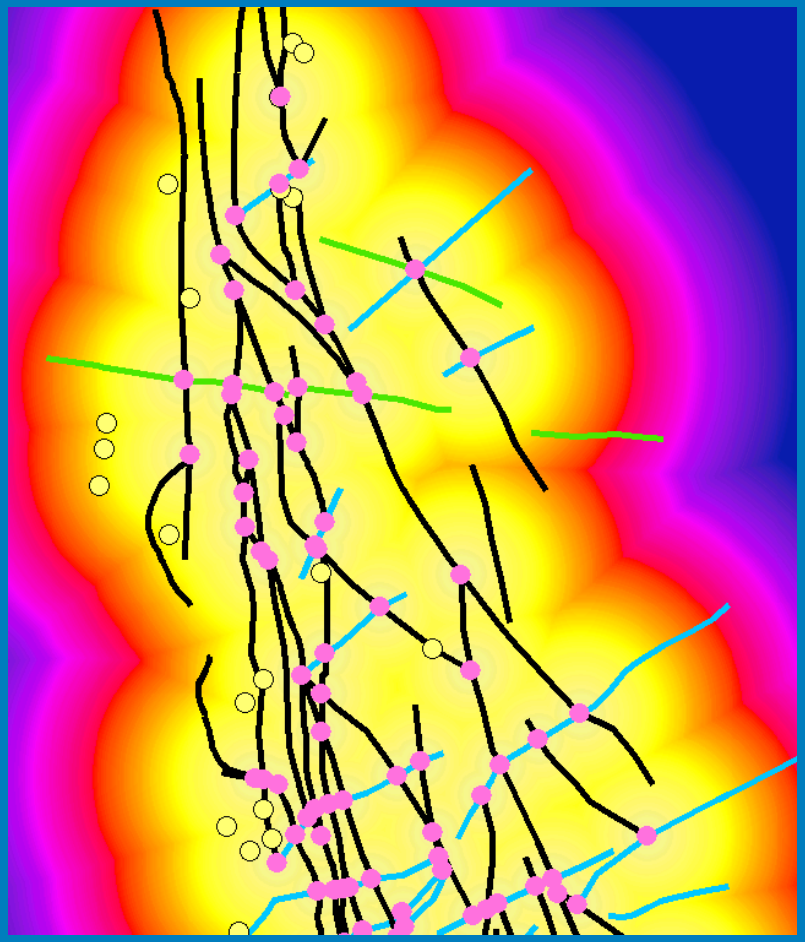




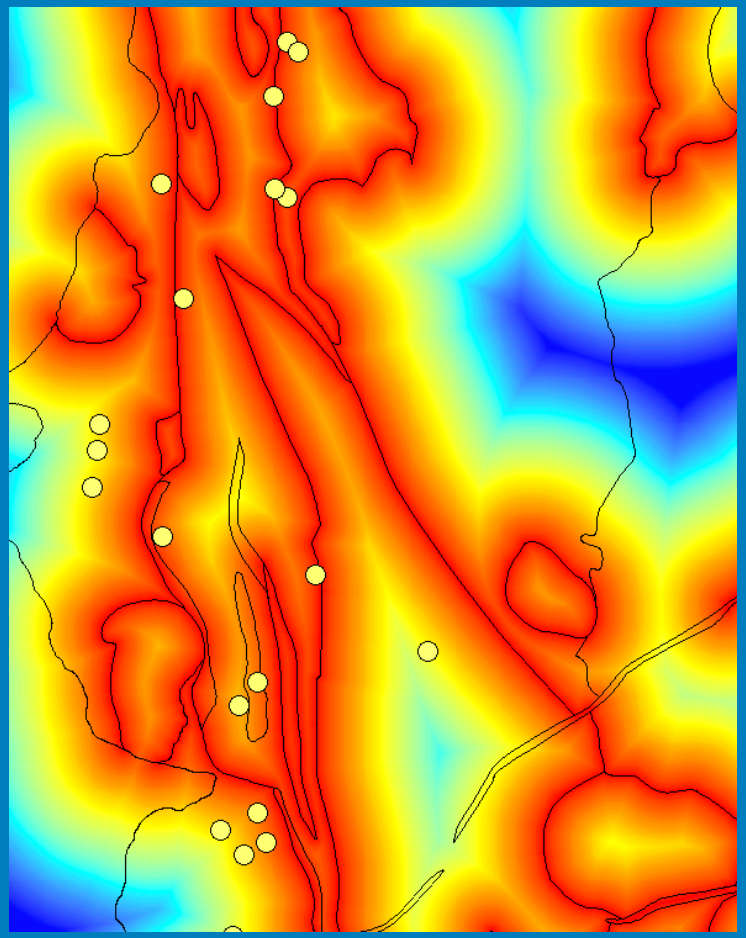


Creation of distance layers: how fare is a point away from a structure

More model input data

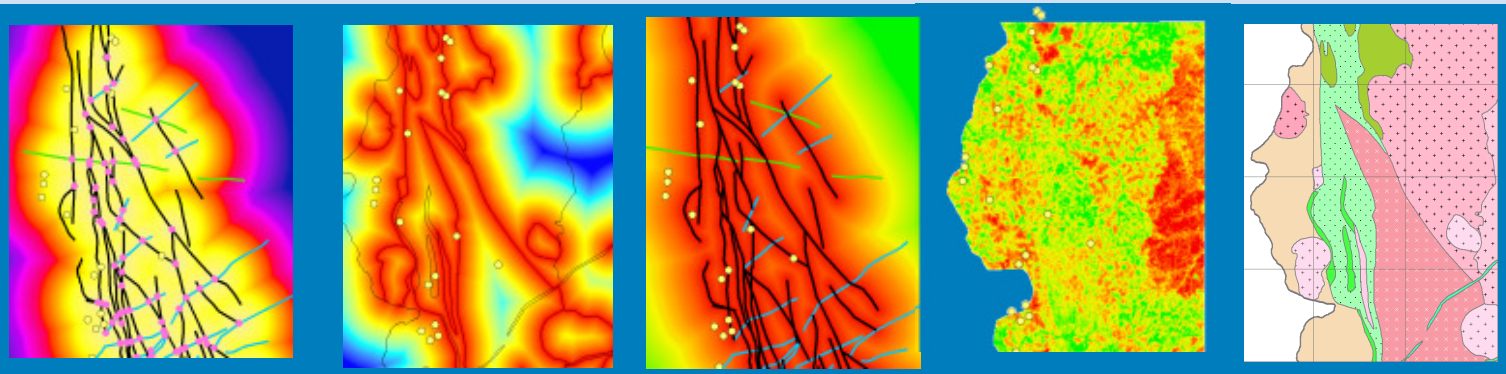


Intersections of tectonic structures

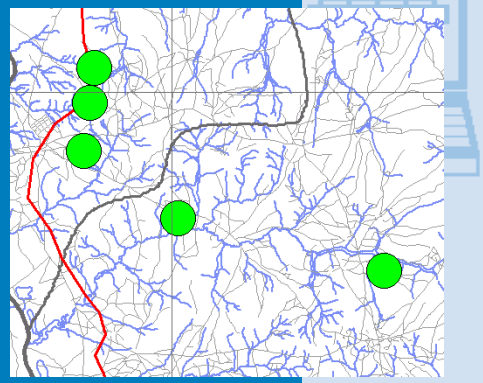


Important rock contacts

The artificial neural network modeling



Input data layers



Training points = known minera-lisations

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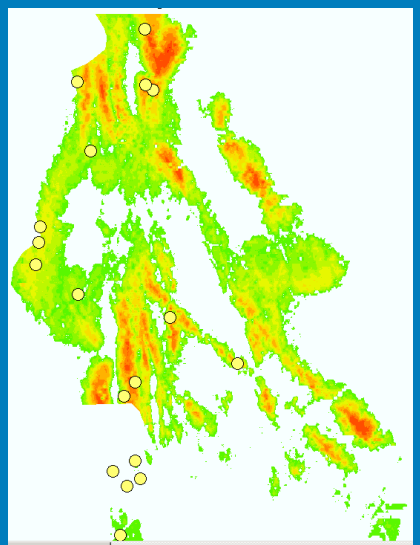

The predictive map: shows probabilities for detection of Au mineralisations.

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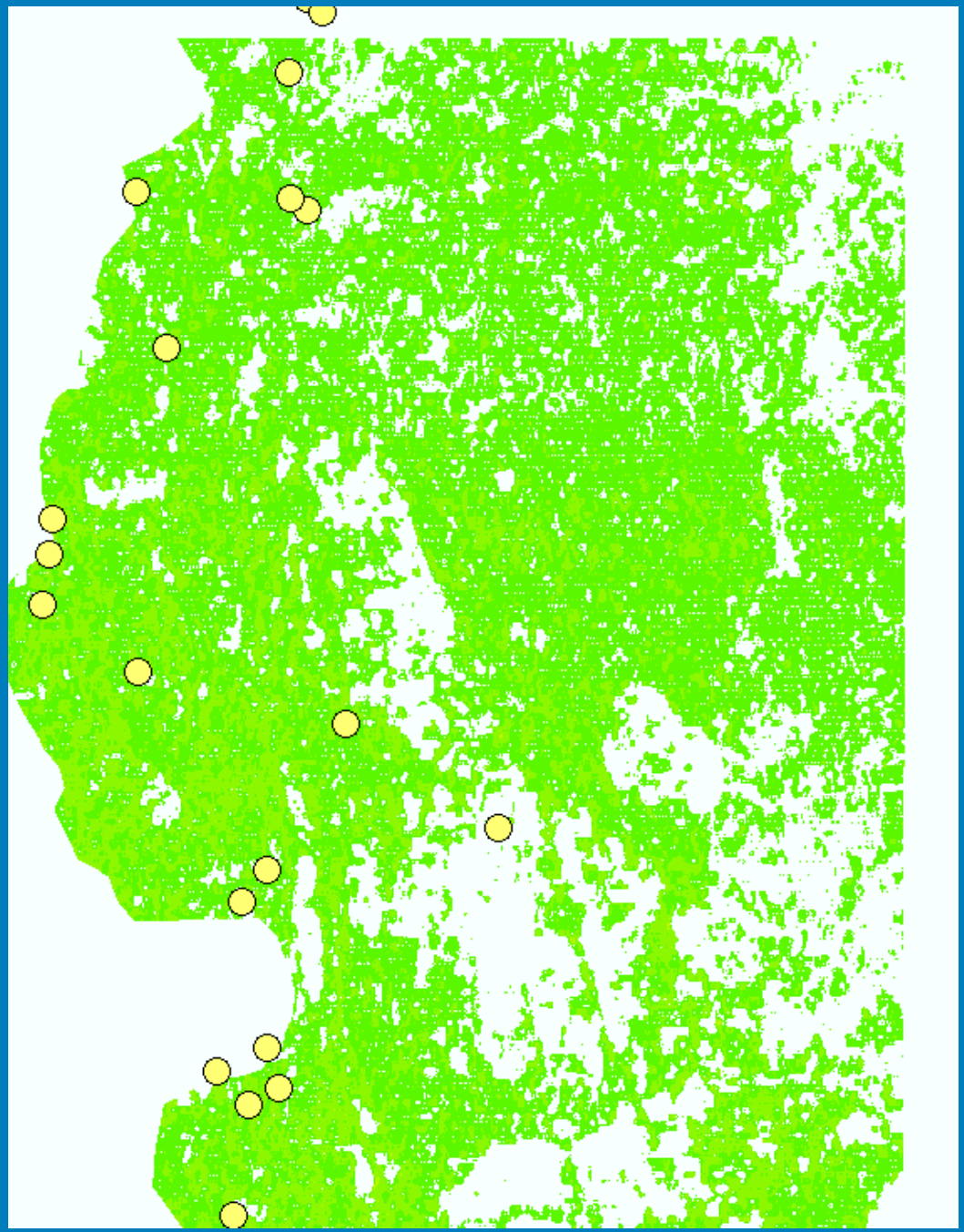
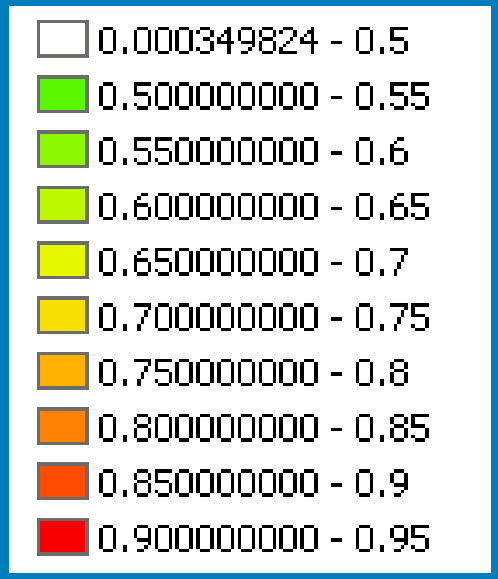
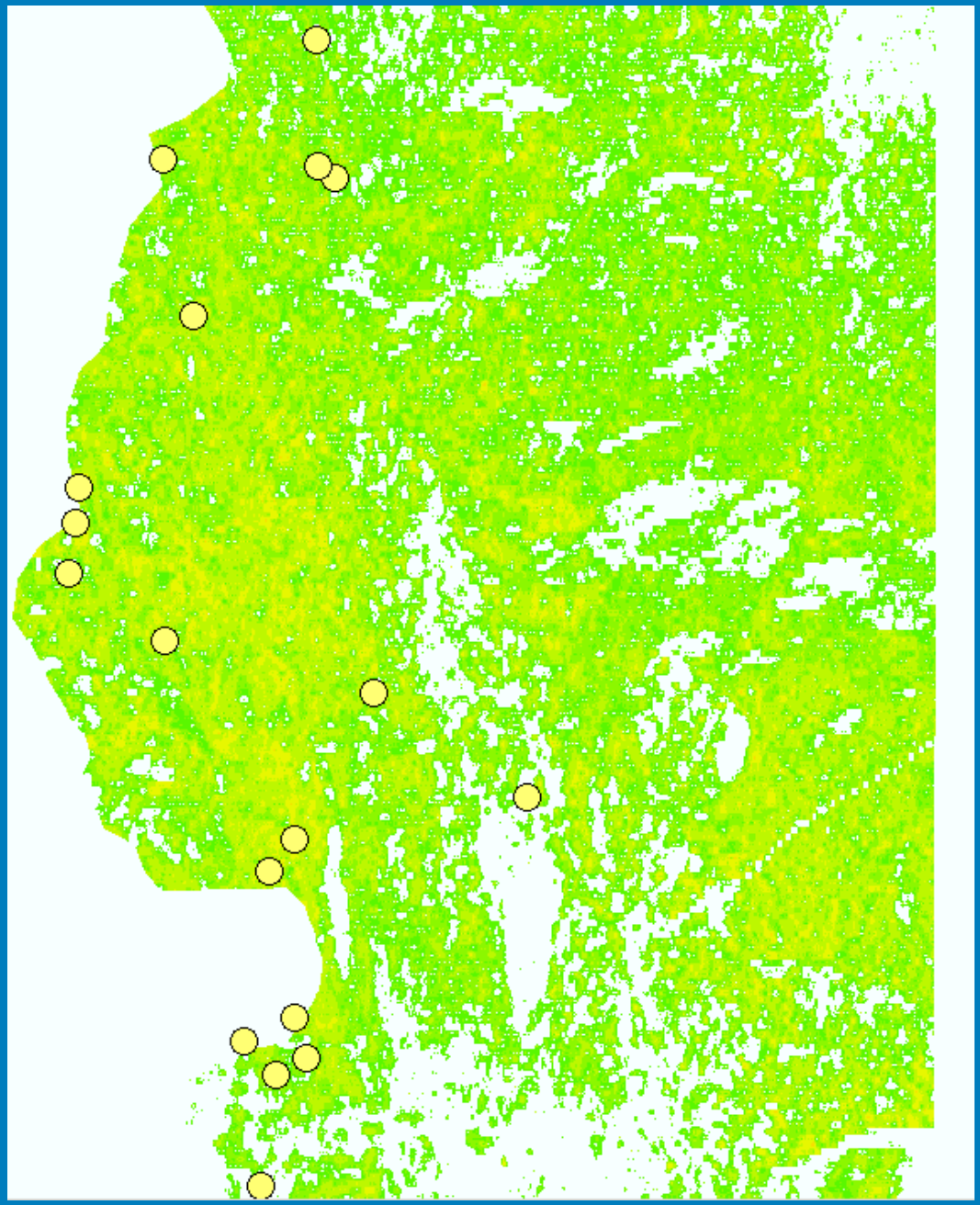
Model 1



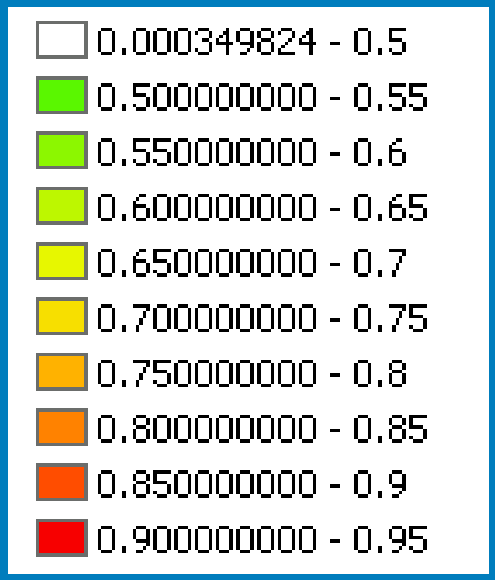
U, Th, K, total



Model 2



U, Th, K, total, magnetics



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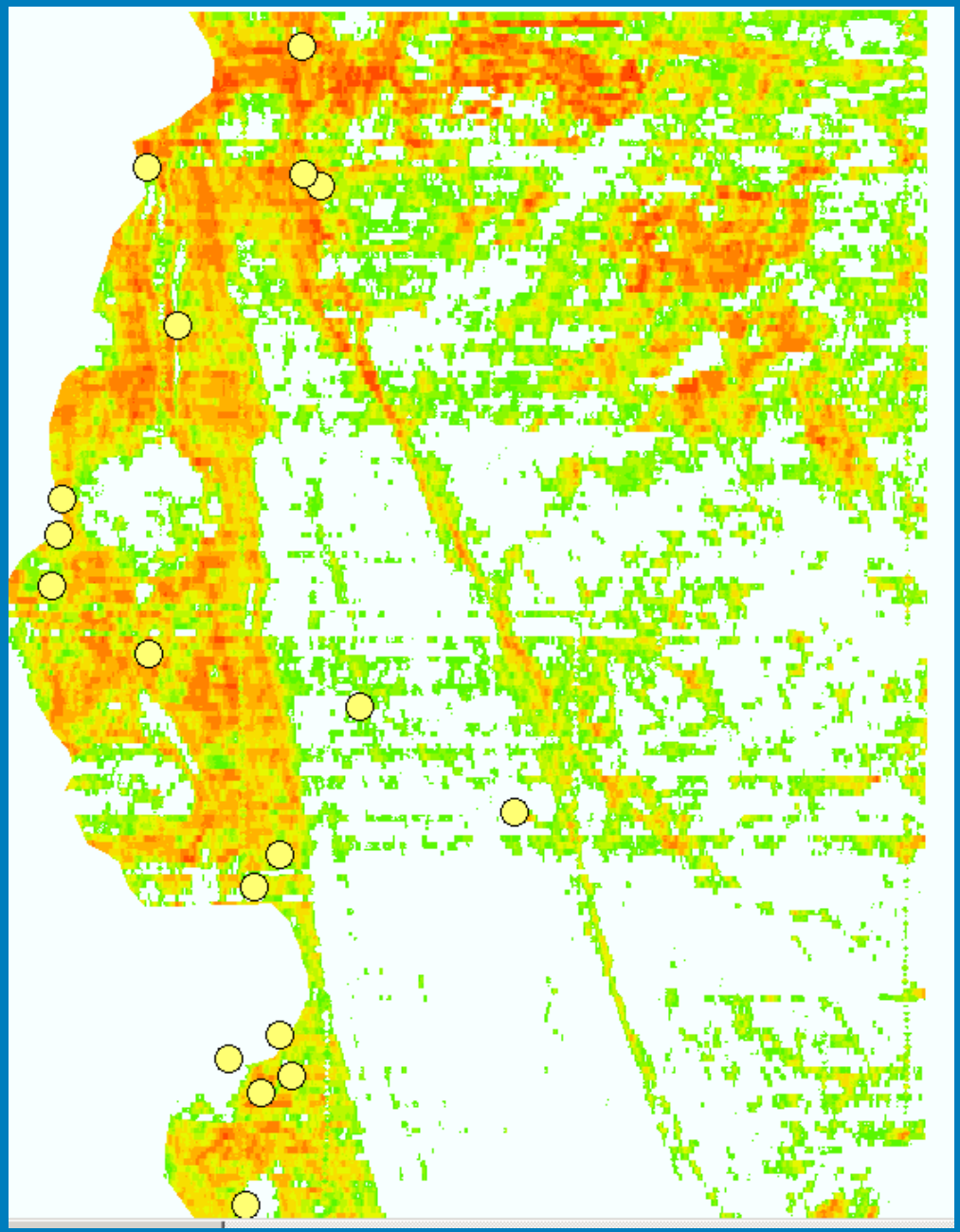
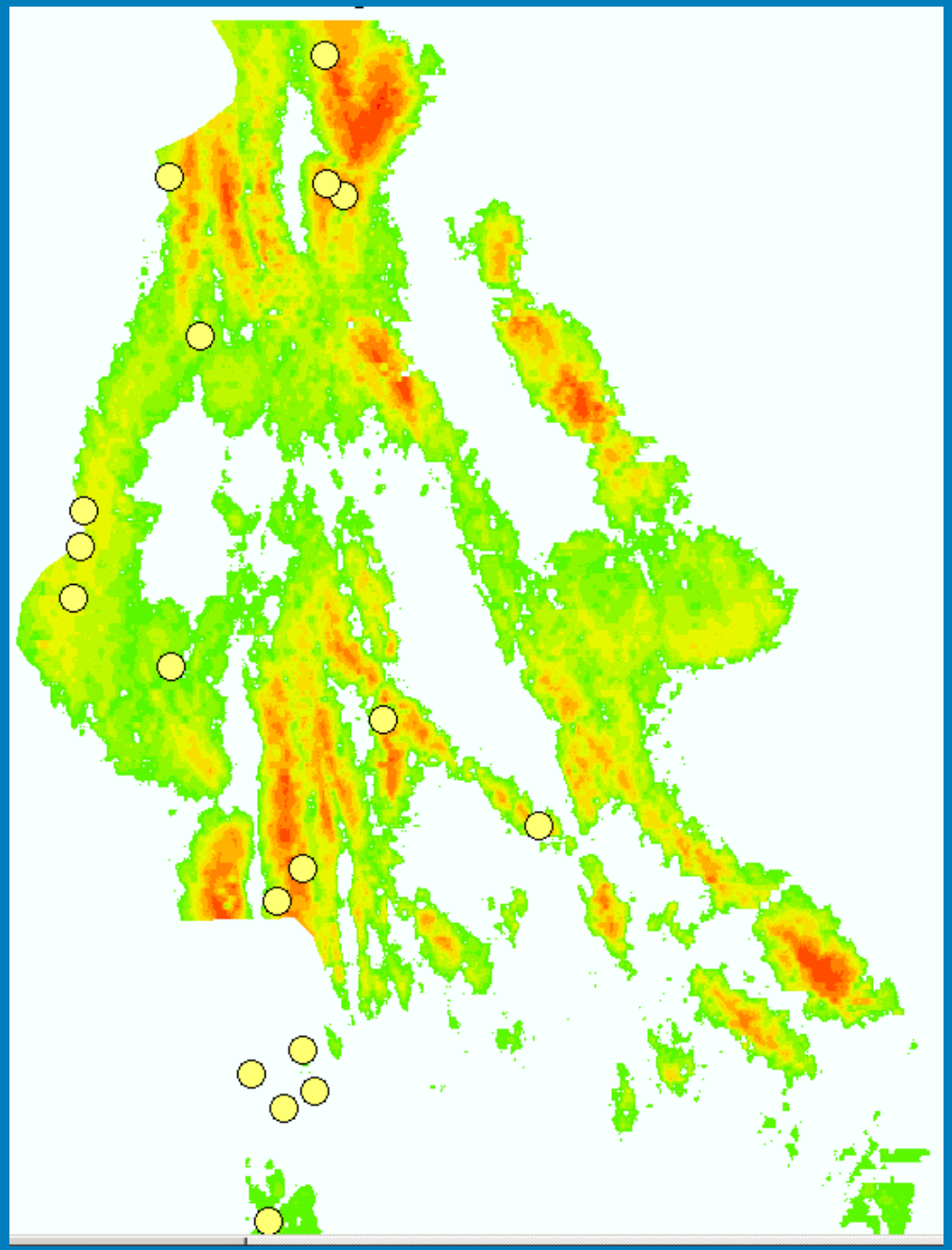
Model 3



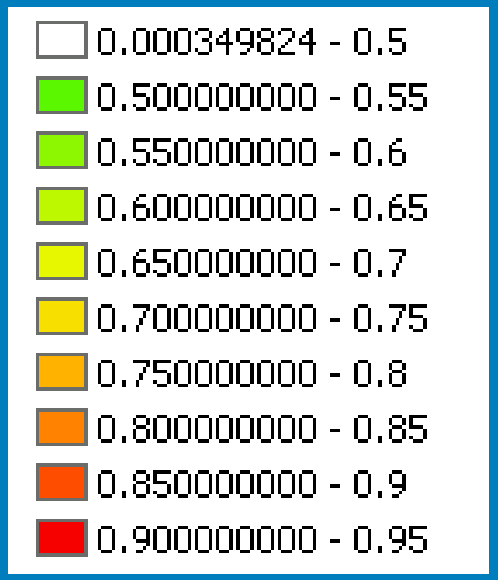
U, Th, K, total, magnetics, elctromagnetics

- 0.000349824 - 0.5
- 0.500000000 - 0.55
- 0.550000000 - 0.6
- 0.600000000 - 0.65
- 0.650000000 - 0.7
- 0.700000000 - 0.75
- 0.750000000 - 0.8
- 0.800000000 - 0.85
- 0.850000000 - 0.9
- 0.900000000 - 0.95

Model 4



U, Th, K, total, magnetics, structures



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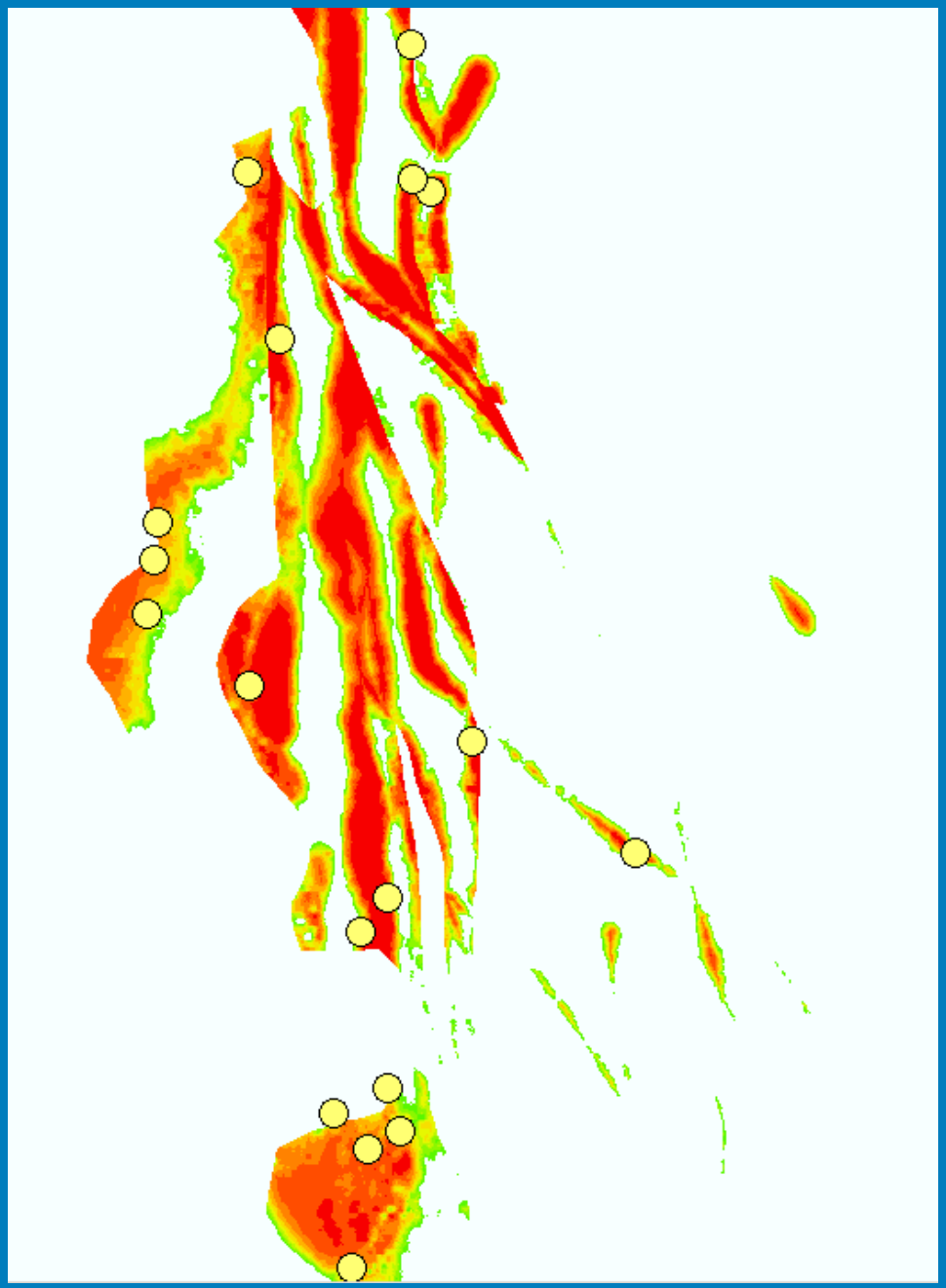
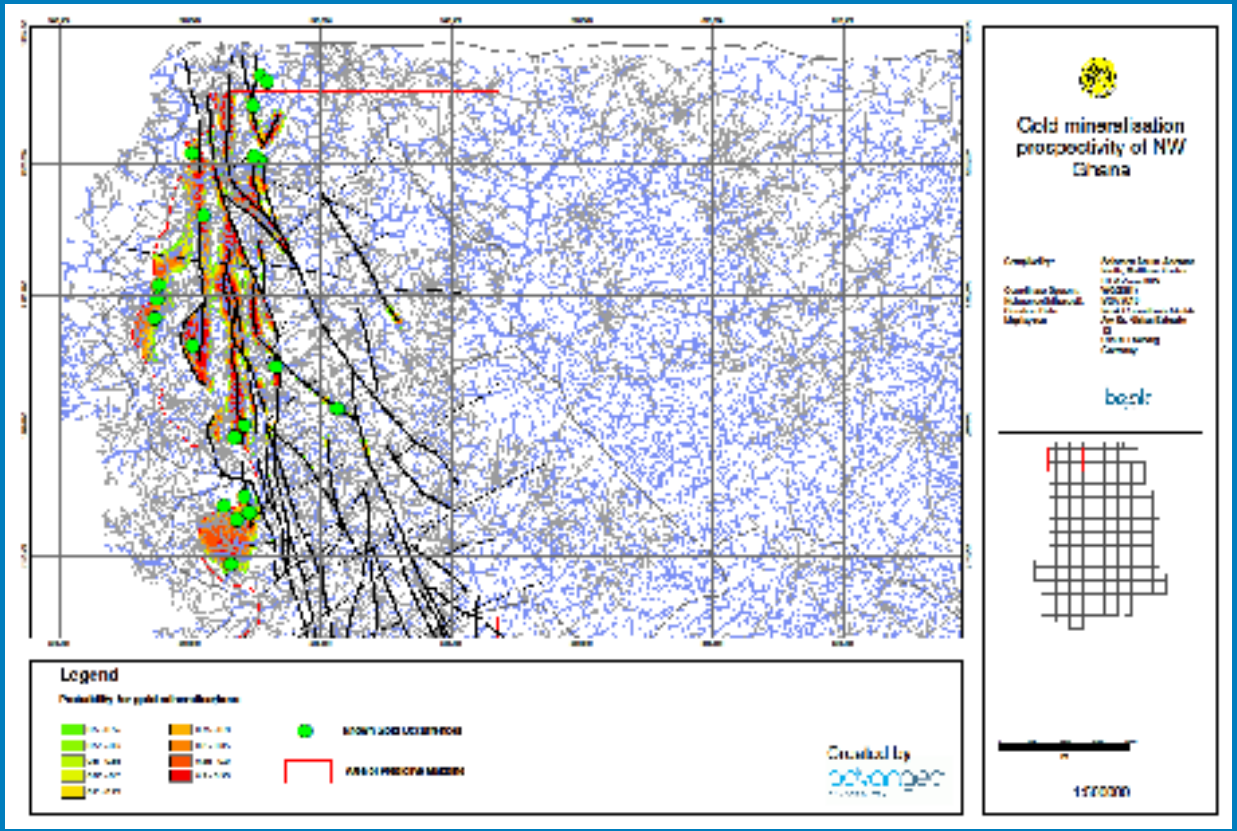
Model 5



U, Th, K, total, magnetics, structures, rocks, intersections, rock contacts

0.000349824 - 0.5
0.500000000 - 0.55
0.550000000 - 0.6
0.600000000 - 0.65
0.650000000 - 0.7
0.700000000 - 0.75
0.750000000 - 0.8
0.800000000 - 0.85
0.850000000 - 0.9
0.900000000 - 0.95

The regional predictive map



- easy to read
- suitable for long term national planning
- ensures better use of exploration funds
- attracts and guides investment

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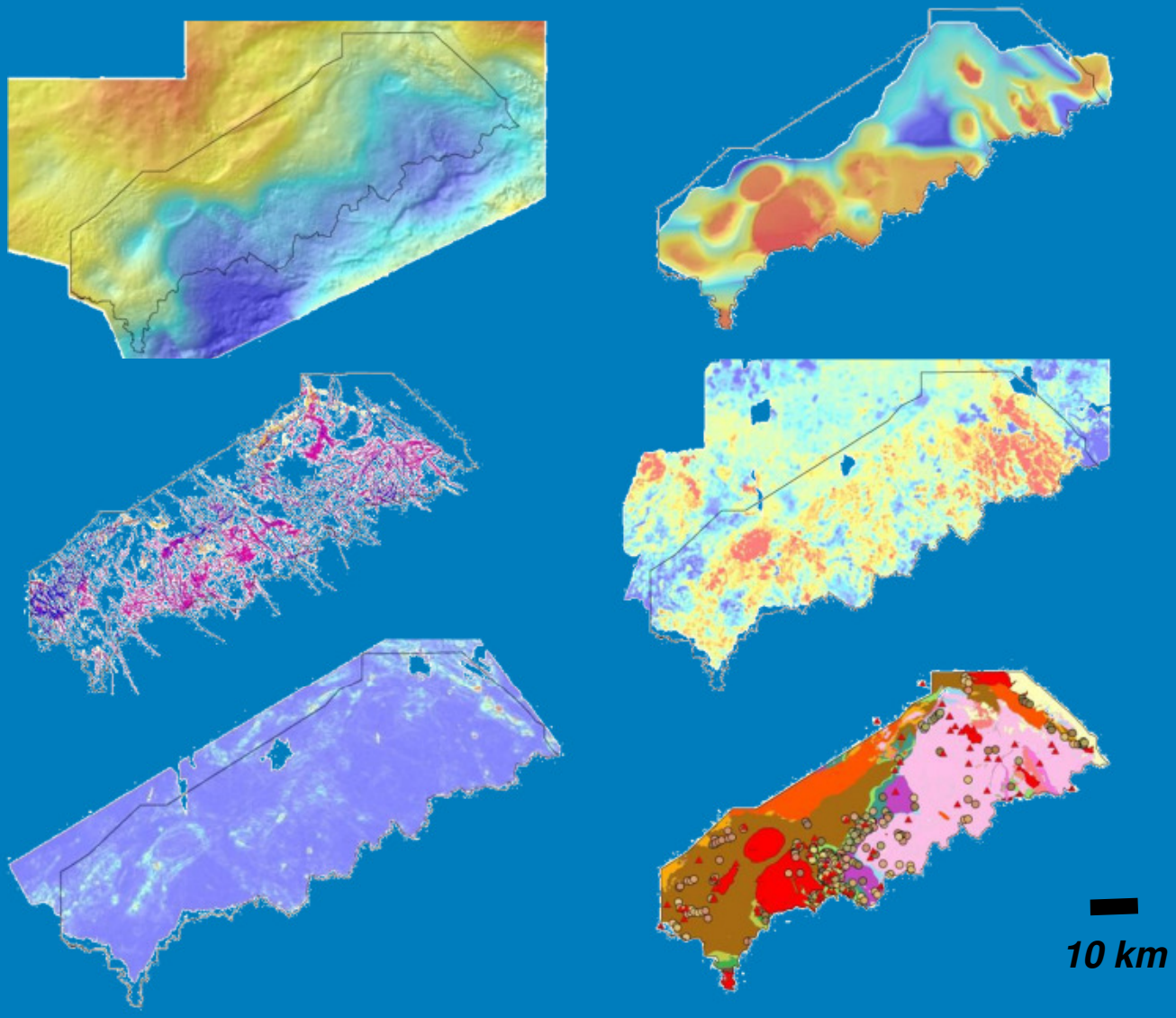
Further Case Studies - *Mineral Deposits*: Sn, W, Mo, Pb, Zn - Erzgebirge (Germany)

Input Data: DEM, Geology, Tectonics, Geochemistry, Geophysics



10 km

sachsen

Model Area:
Erzgebirge Mountains
Saxony / Germany

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Further Case Studies - *Mineral Deposits*: Sn, W, Mo, Pb, Zn - Erzgebirge (Germany)

Favorability Map for Tin Deposits in Skarns

Big skarn deposits Hämmerlein/ Tellerhäuser: 240 kt contained Sn
Joint Venture: Saxony Mines Ltd./ Beak Consultants

Recently re-discovered Sn skarns
Joint Venture: AVRUPA Minerals/ Beak Consultants

10 km

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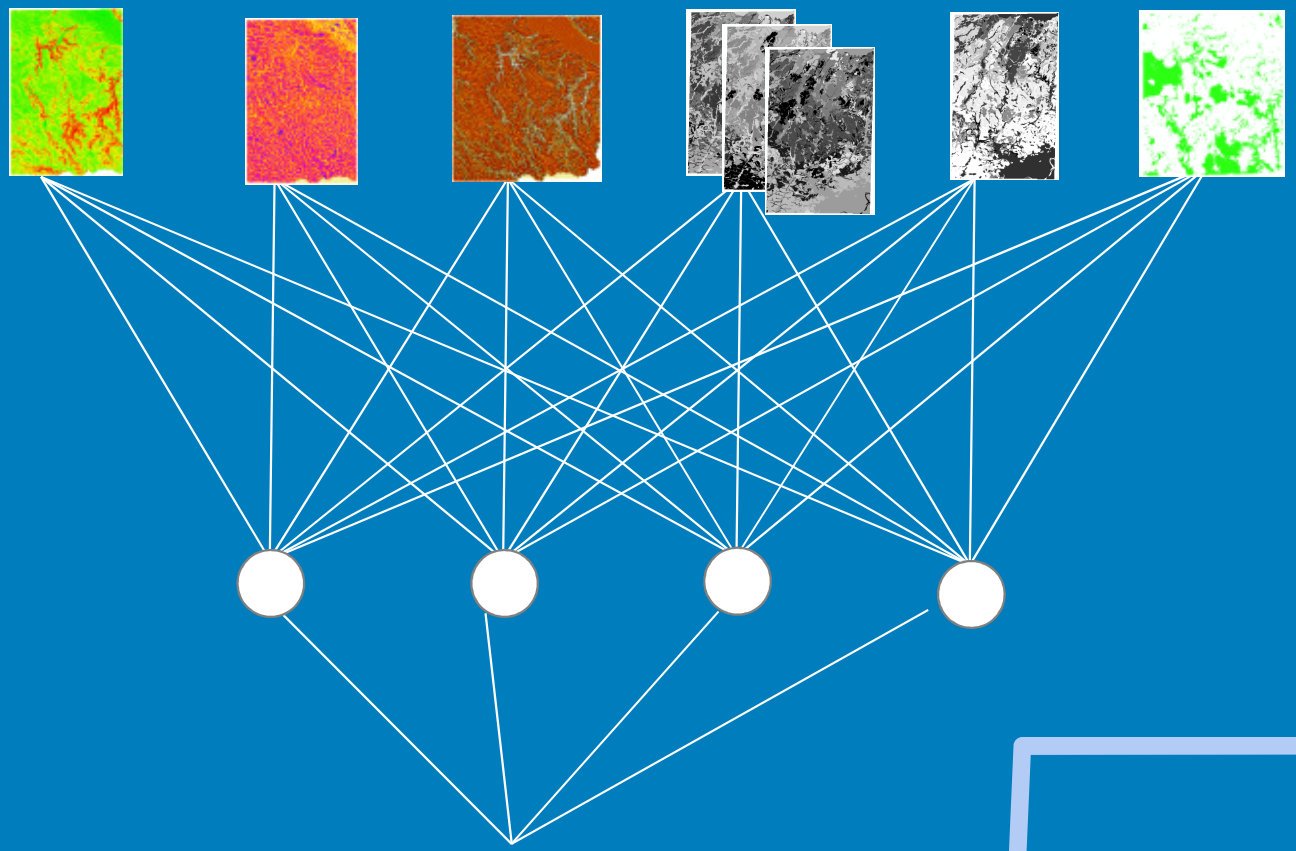
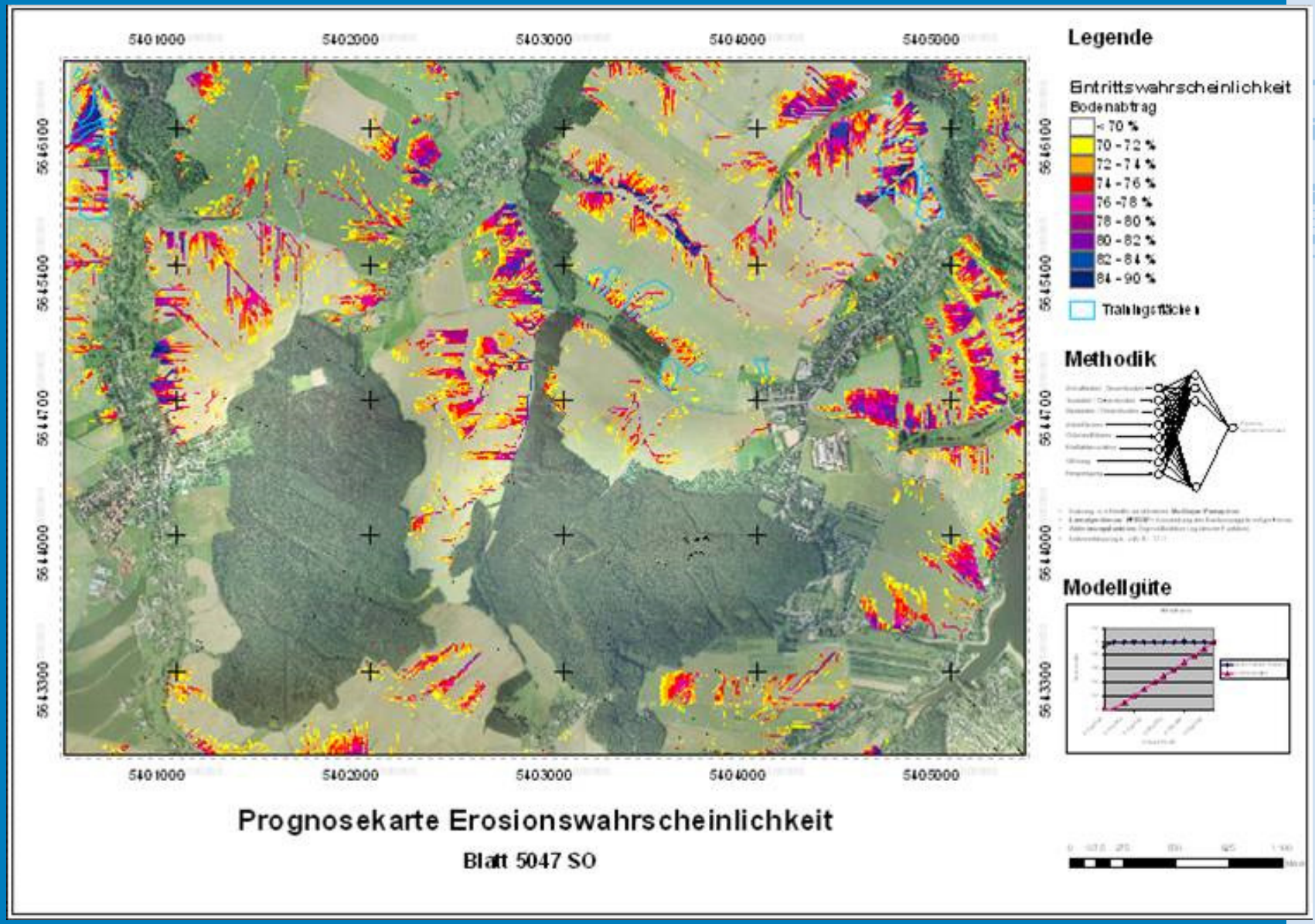
Application example: soil erosion



Application example: soil erosion



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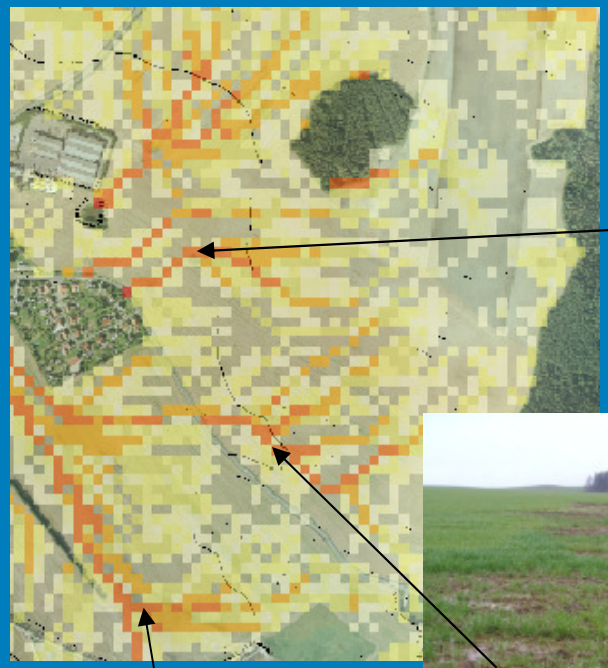
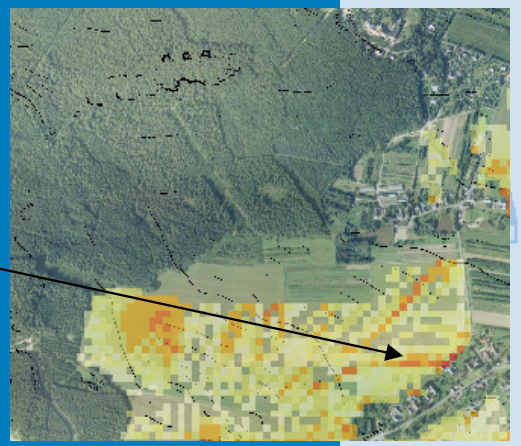
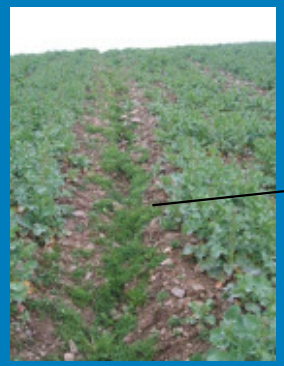
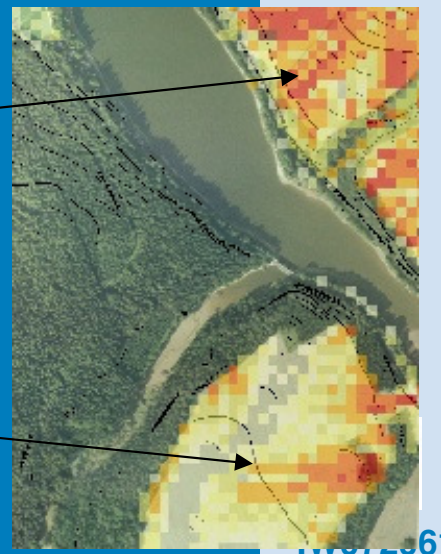
Application example: soil erosion

Validation of prediction in field





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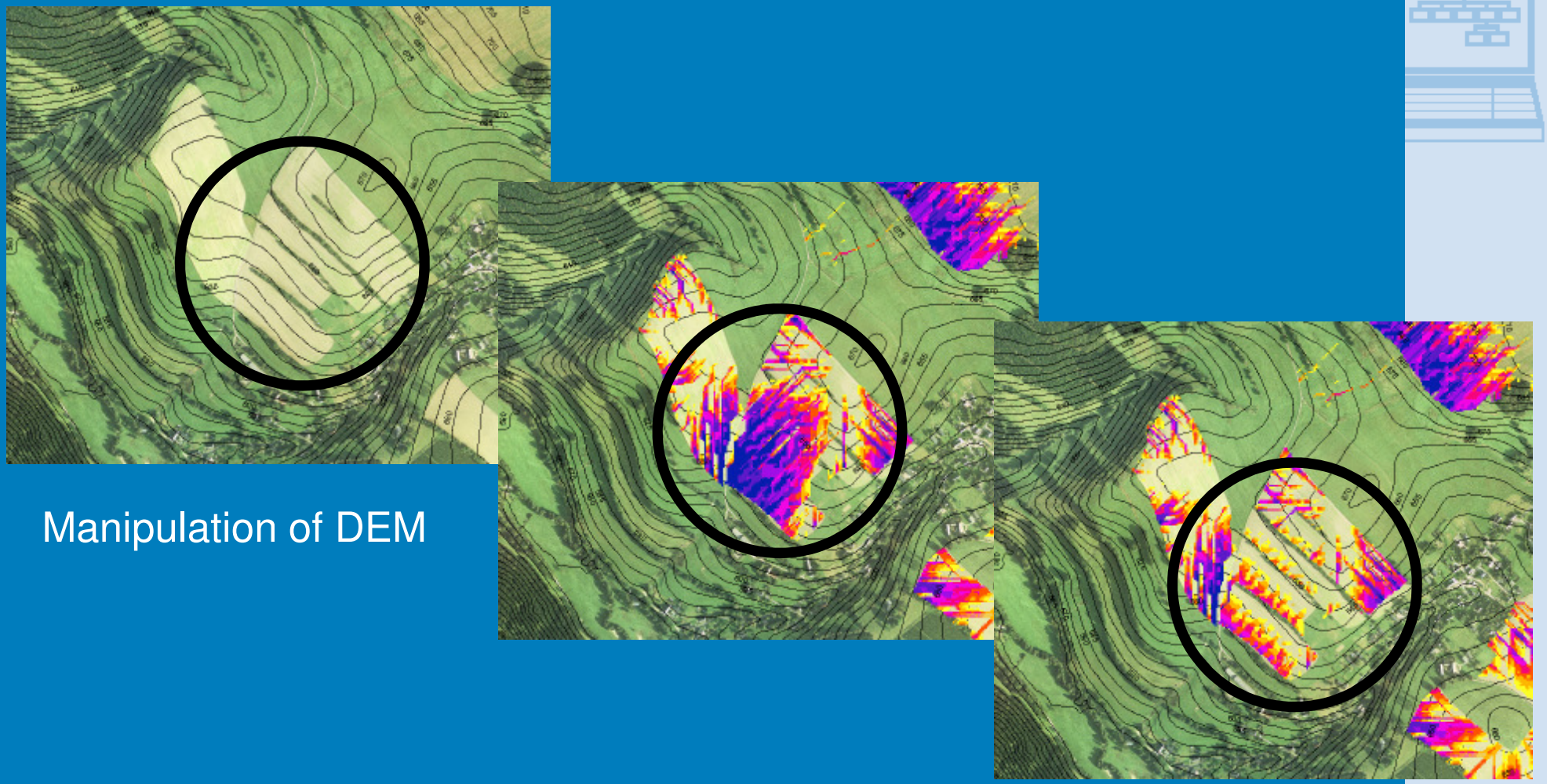
Application example: soil erosion

Optimizing of protective actions



Manipulation of DEM

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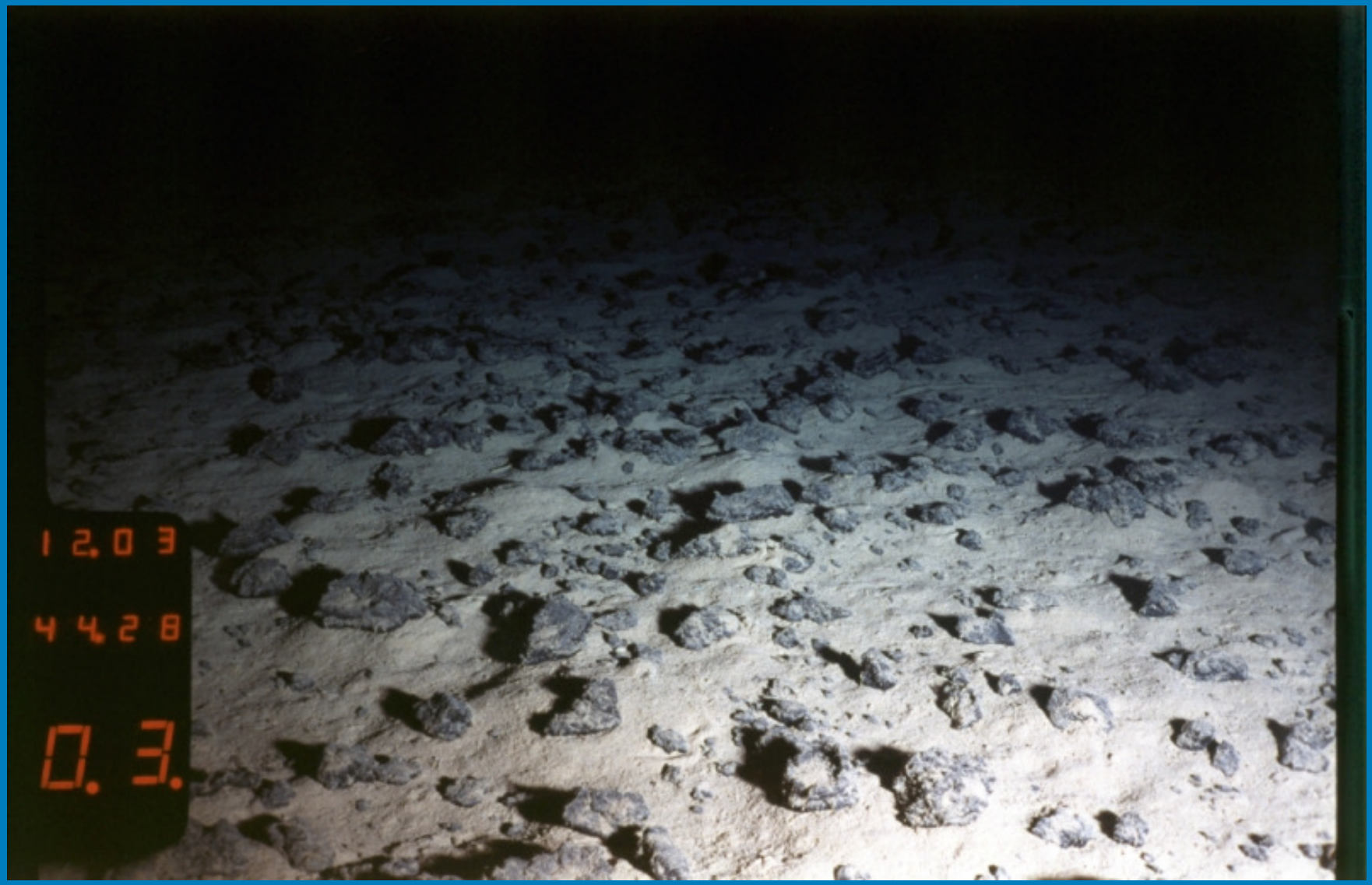
Prediction Mn – nodule distribution

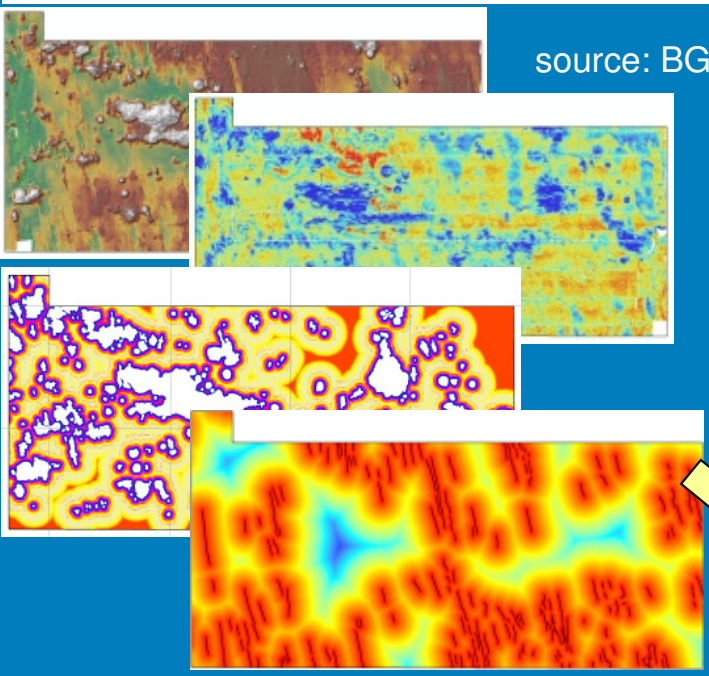


source: BGR

Vorgehensweise

inputparameter

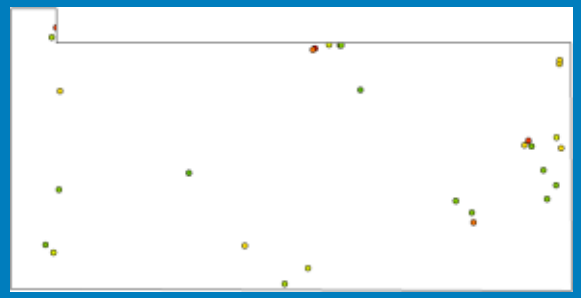
Bathymetry and its derivatives
Sonic backscatter
Structures



source: BGR

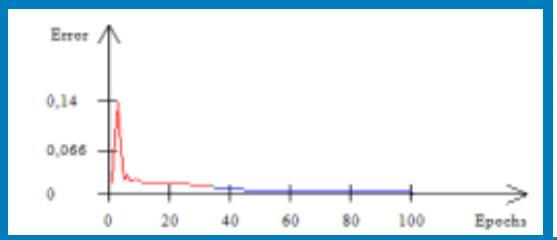
Training

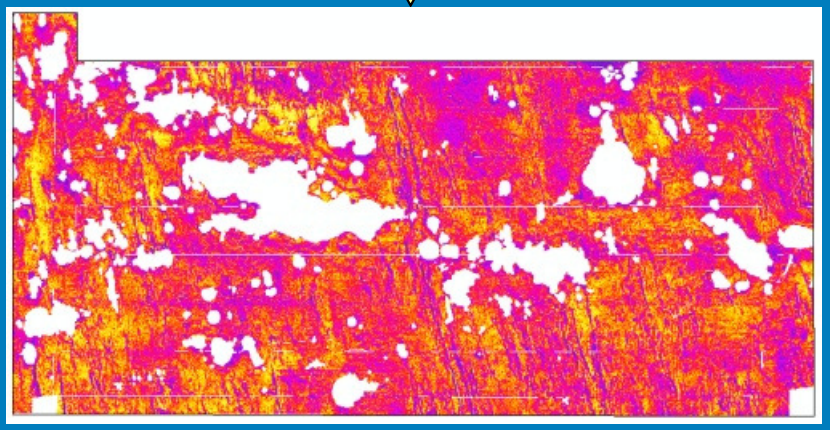
29 sample points



source: BGR

advangeo®
Prediction Software





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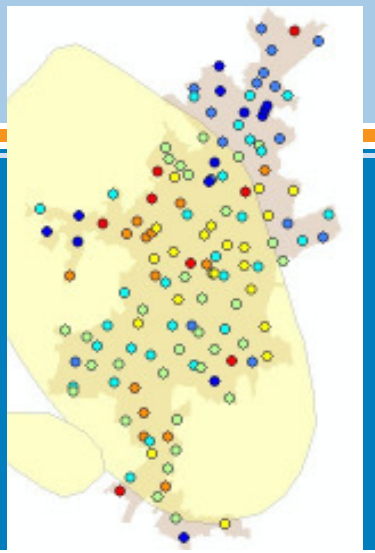
Prediction of As-content in upper soil (Annaberg)

Input parameter

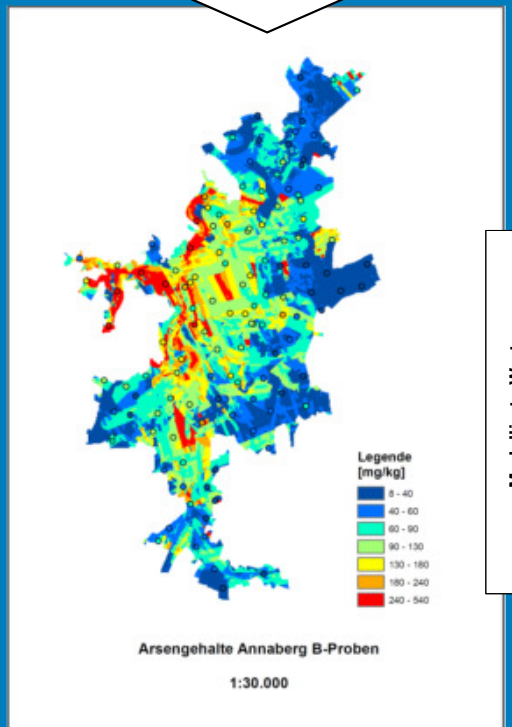
DEM, Geology: Lithology, age, structures, veins
Landuse, actual and former slag

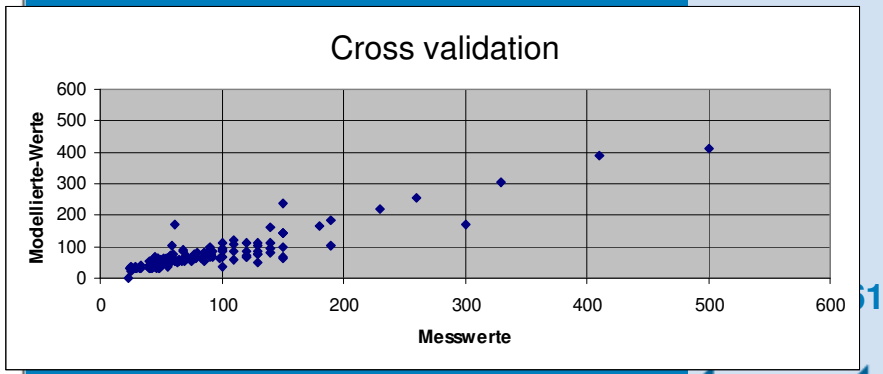
advangeo®
Prediction Software



Training

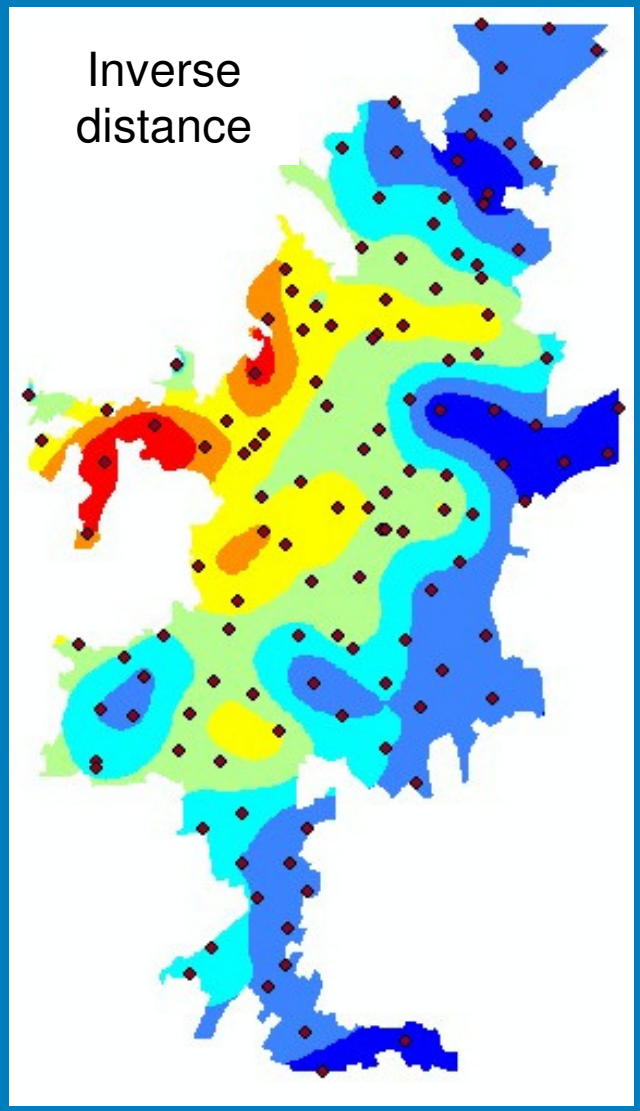
Known areas with known conten (130 samples)

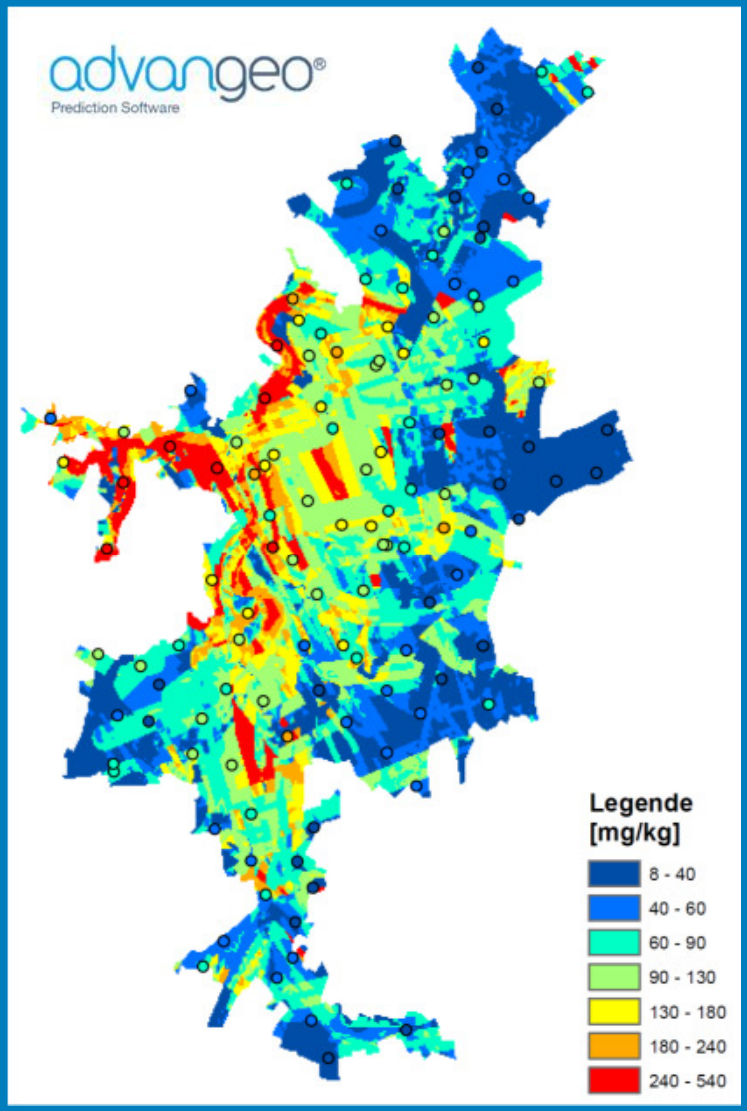




beak CONSULTANTS

Prediction of As-content in upper soil (Annaberg)





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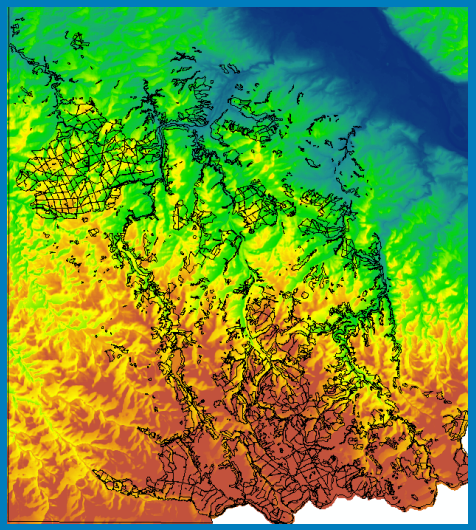
Exposure of spruce forests to spruce bark beetle

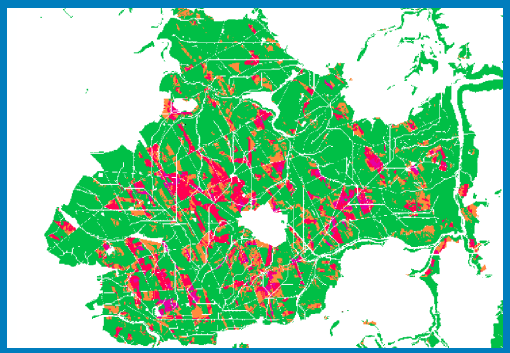
Input data:
DEM and derivatives,
Soil propperties,
Inventory data



STAATSBETRIEB SACHSENFORST | Freistaat SACHSEN

Sachsenforst

advangeo®
Prediction Software



Training:
Qualitative/
Quantitative pest
data

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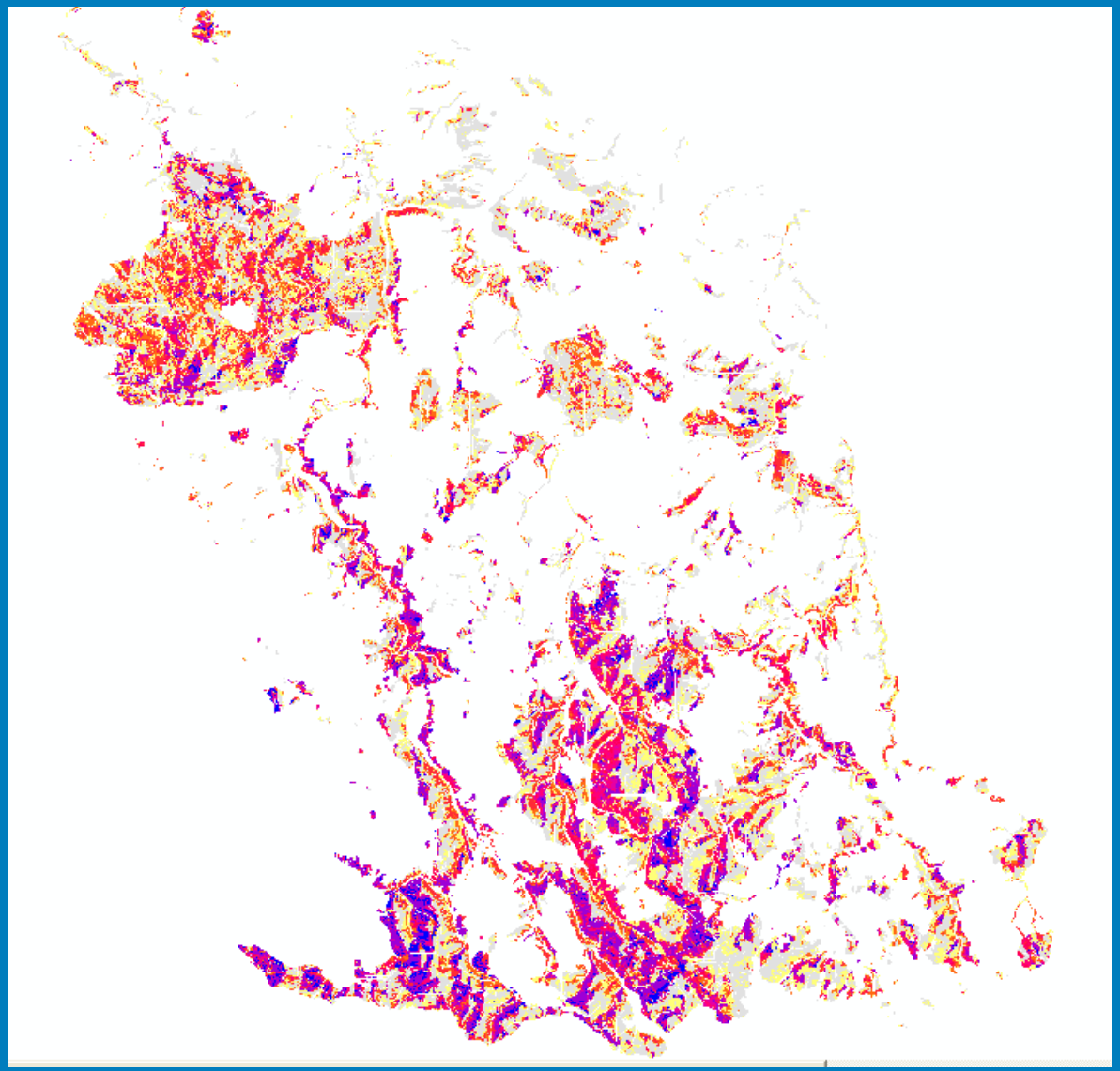
Exposure of spruce forests to spruce bark beetle



Extrapolation of results to other regions

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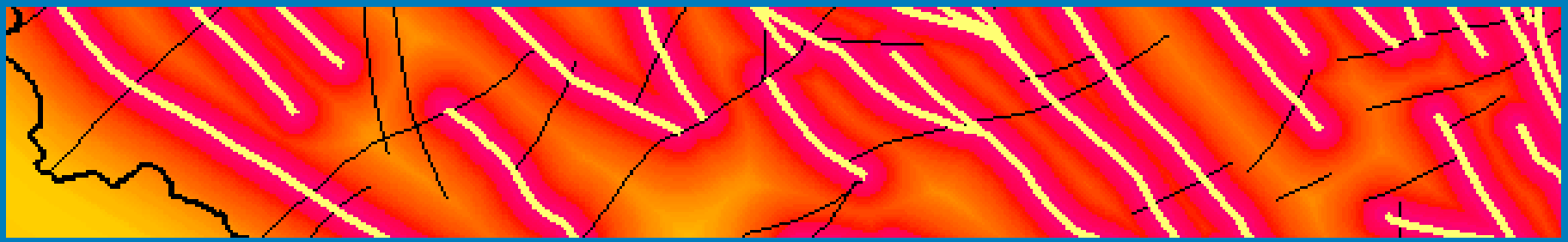
Summary

- Artificial neural networks are an excellent method for the analysis and interpretation of complex datasets
- Applicable in many branches of economy, science and technics
- Advangeo enables the usage of this method to a standard GIS-user in the known everyday environment



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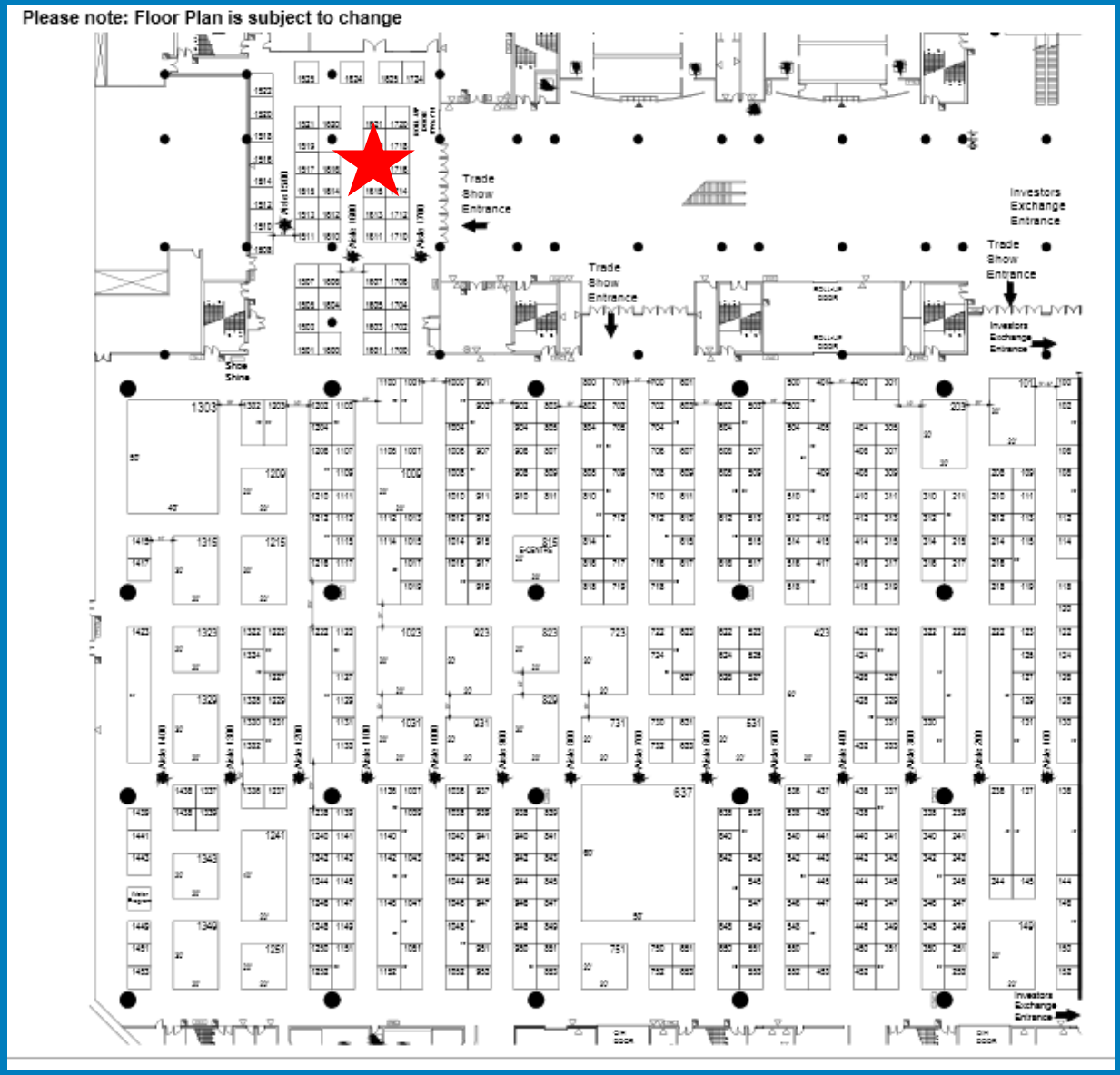
Booth 1617



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