Mineral exploration targeting – A case study from Ghana

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Ghana Geological Survey

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Agenda

1. Ghana – mineral potential
2. Creation of Geo-database Ghana
3. Methodology of predictive mapping
4. Gold predictive mapping in NW Ghana
5. Conclusions

INTRO.

POPULATION GROWTH

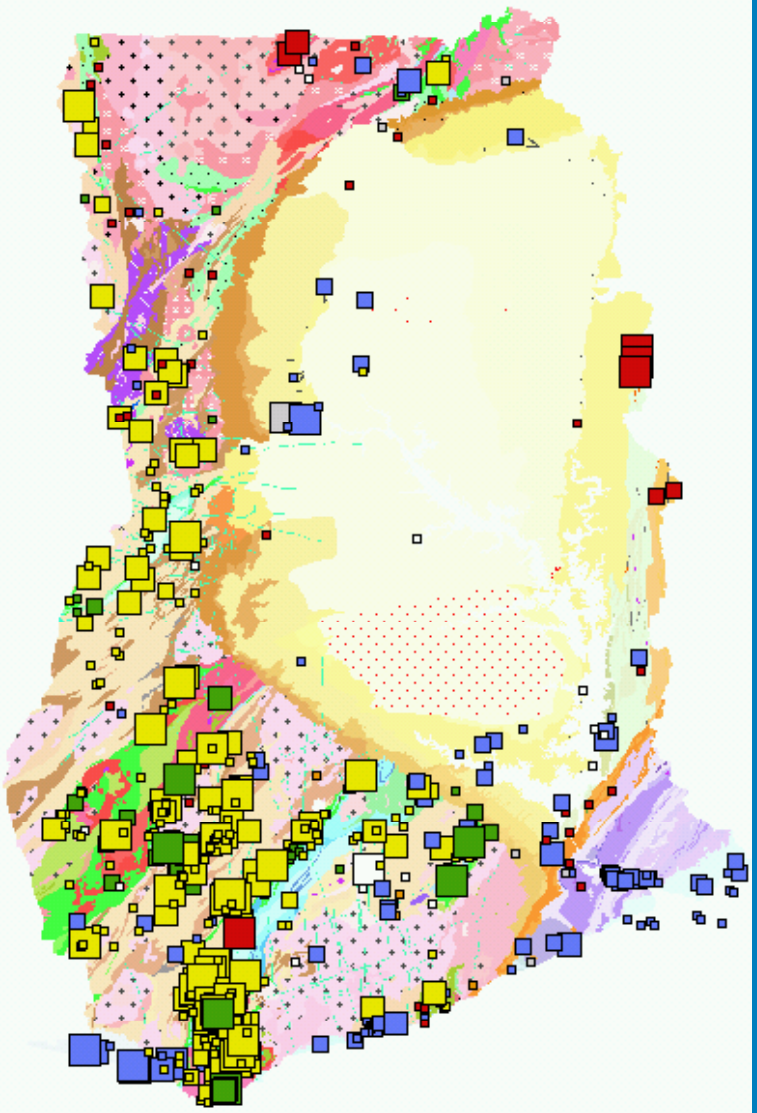
Demand for more land for:

Mining

Agriculture/forestry

Human settlement

Ghana – mineral potential



Source: Geological Survey Department of Ghana

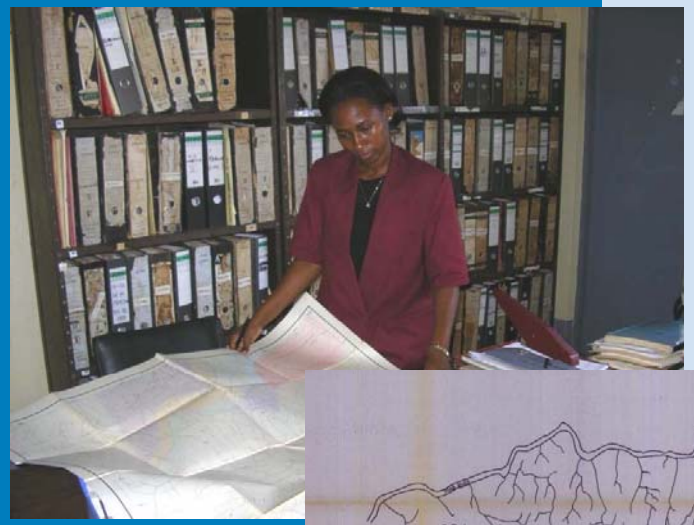
Main minerals are gold, manganese, diamonds, bauxite, iron.
Geological Survey has generated volumes of data on these minerals

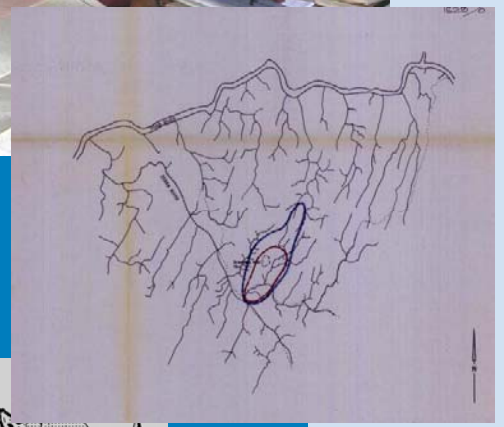
Private exploration and international projects have generated a large amount of geo-scientific data.

In 2003 – 2010 the EU funded MSSP has spend 35 Mio EU, mainly for data generation and related issues.

The usual situation….

- Data is not systematically stored
- Data is not really available
- Many (potential) users are not aware of the existing data





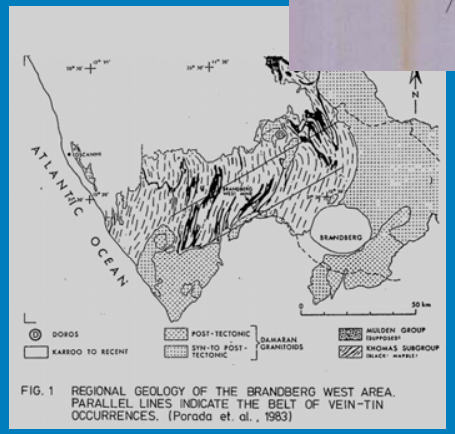


FIG. 1 REGIONAL GEOLOGY OF THE BRANDBERG WEST AREA. PARALLEL LINES INDICATE THE BELT OF VEIN-TIN OCCURRENCES. (Porada et. al., 1983)

The Geo-database Ghana was implemented in 2006-2007

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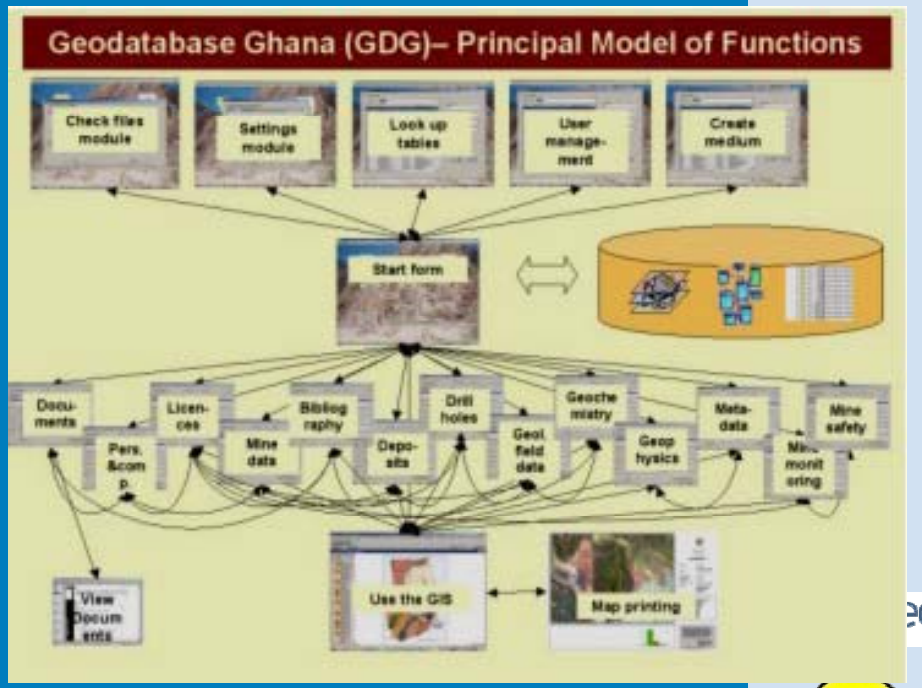
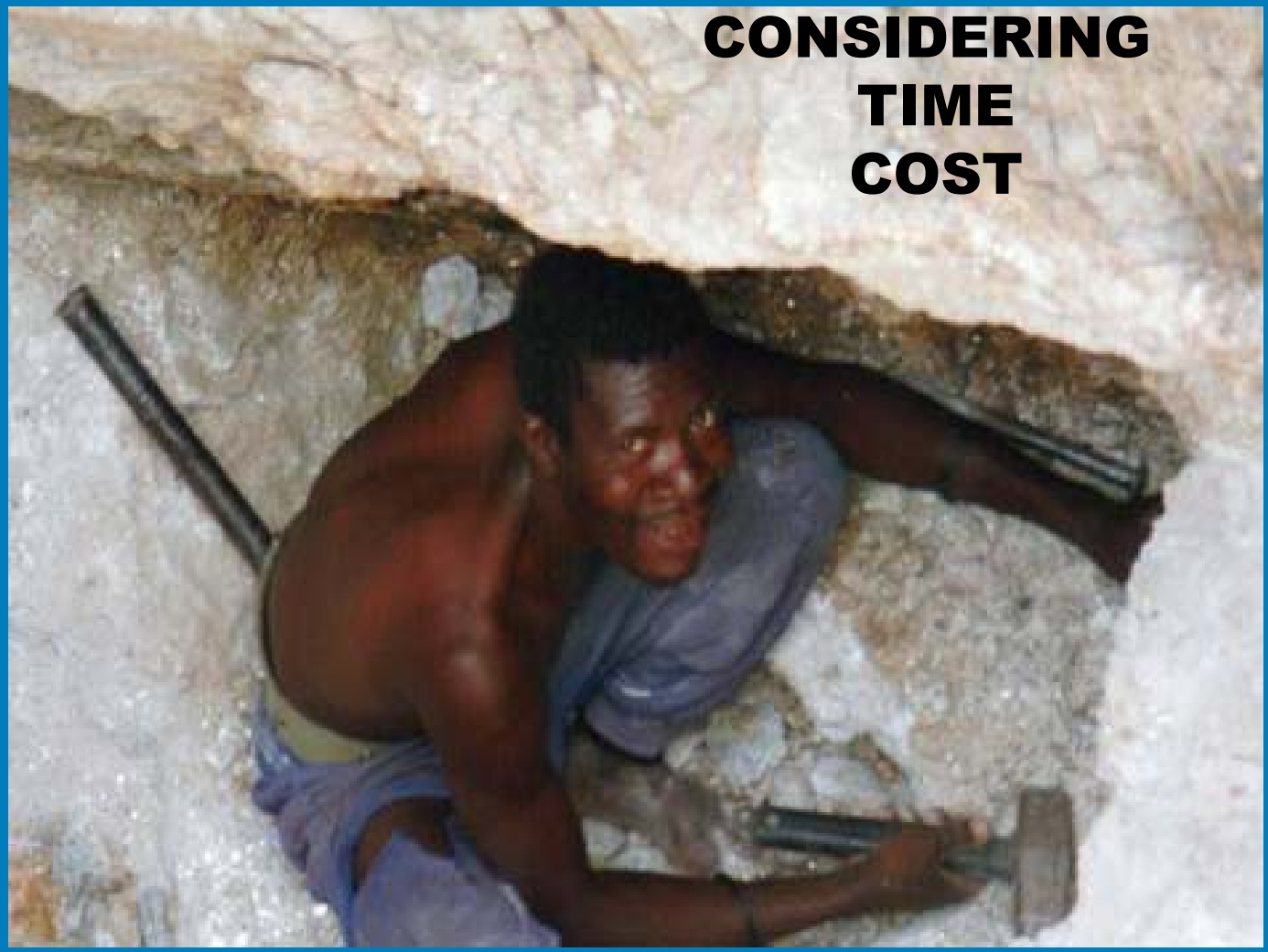
Geo-database Ghana

- Geodata
  - Deposits, mines, production data, bore holes, licenses, field data, geochemistry, geophysics, ...
- Metadata
  - Reports, maps
- Functions
  - Inquiries, export, import
  - Presentation, GIS, maps
- Complementing features
  - Base data

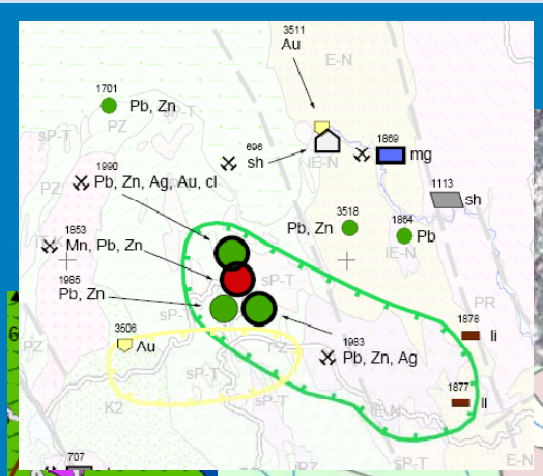


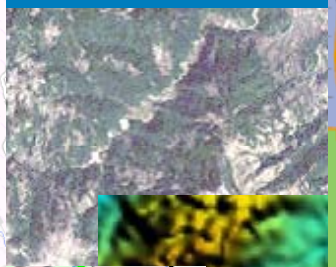
Exploration targeting

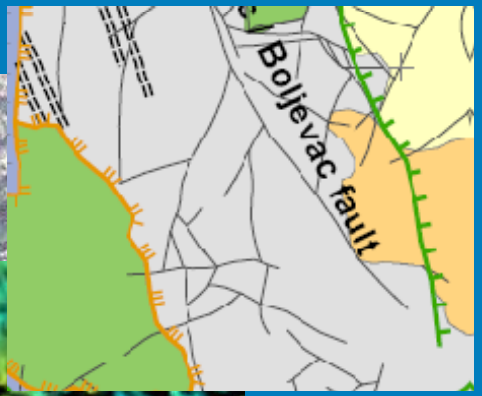
Identify sites with a high mineral potential

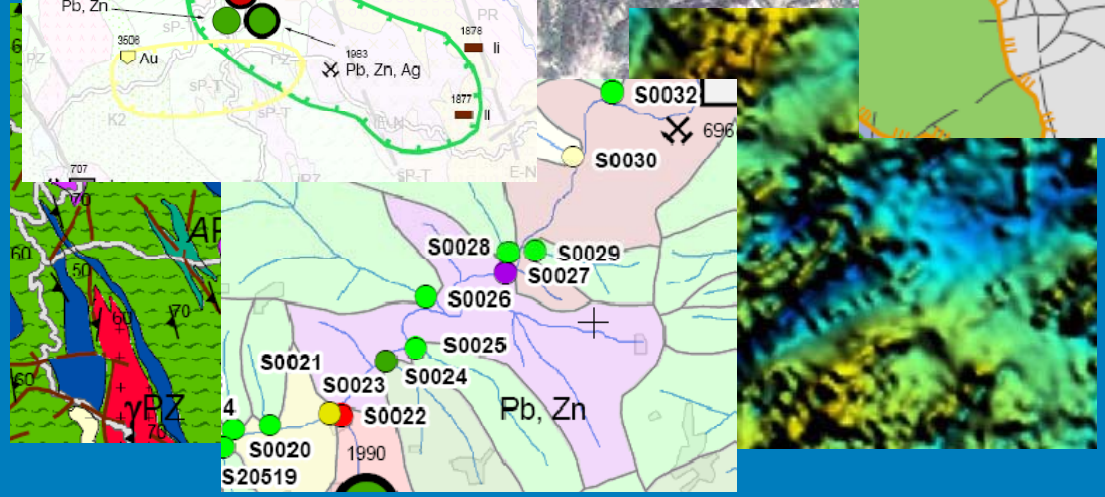


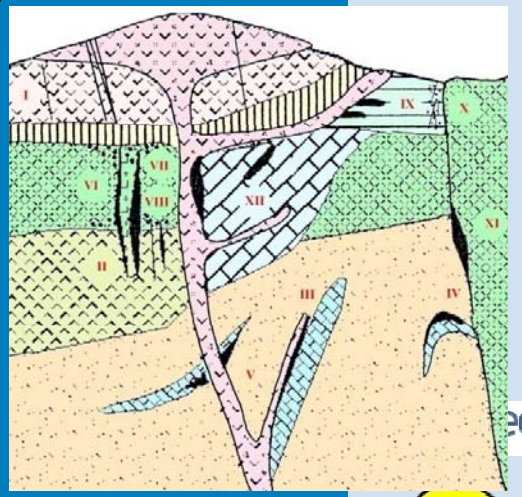
Data and Knowledge requirements for predictive mapping











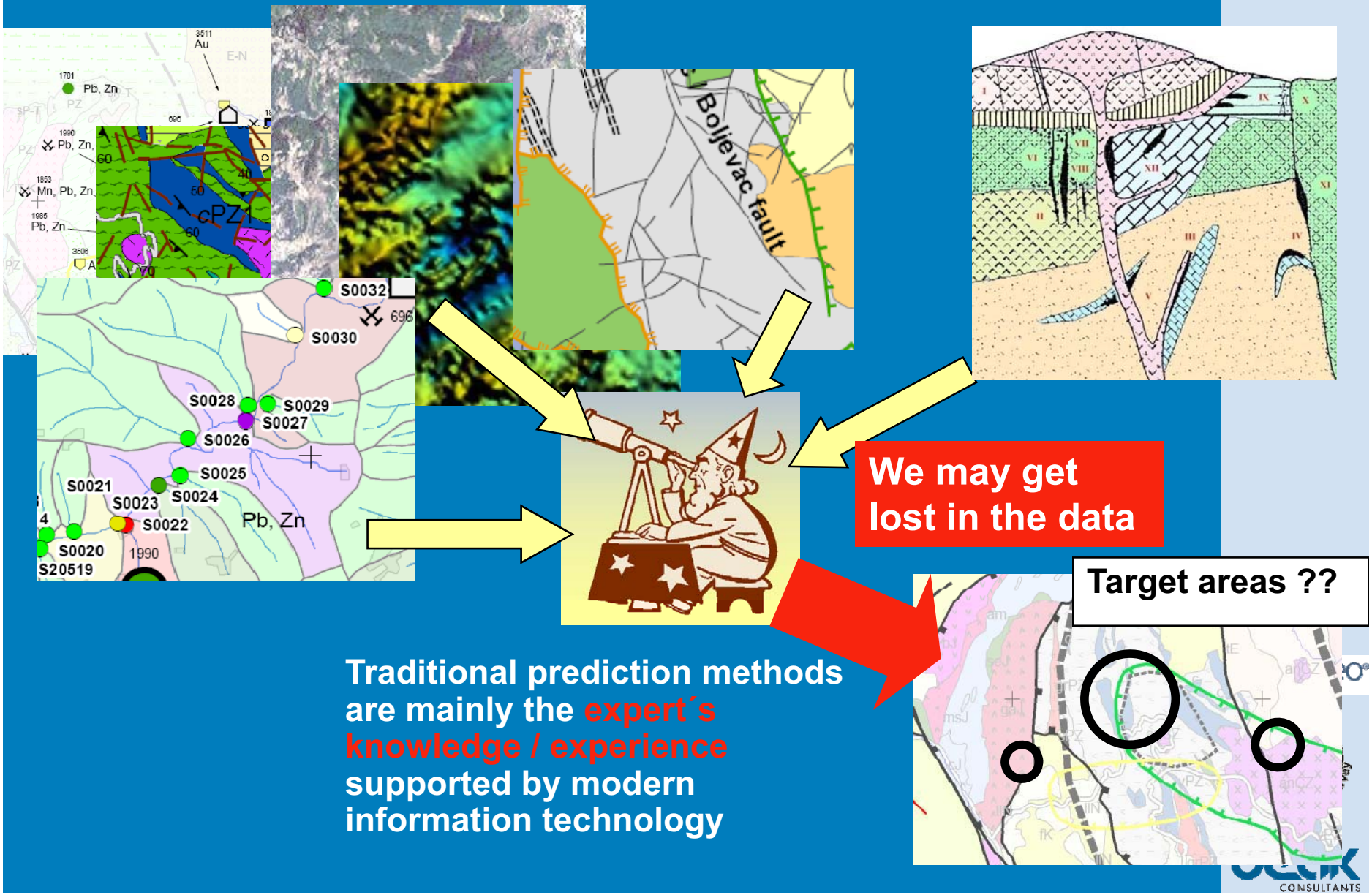
- Geology
- Minerals
- Geochemistry
- Geophysics
- Tectonics
- Geomorphology…

Data

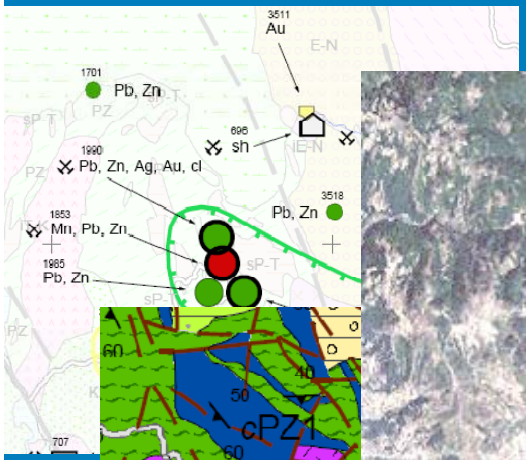
Knowledge

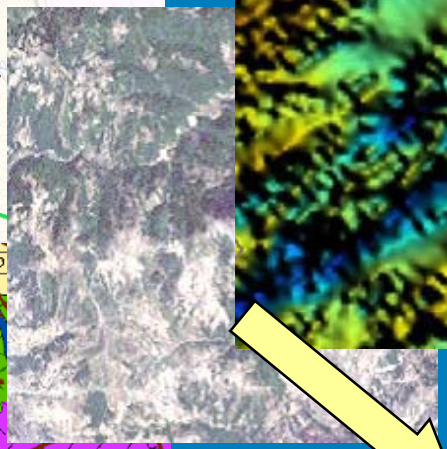
Metallogenetic models

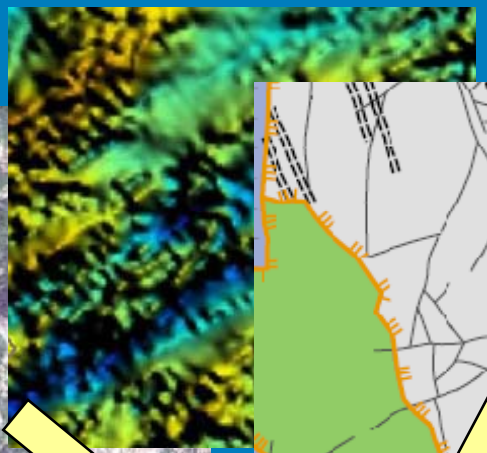
The traditional approach of predictive mapping

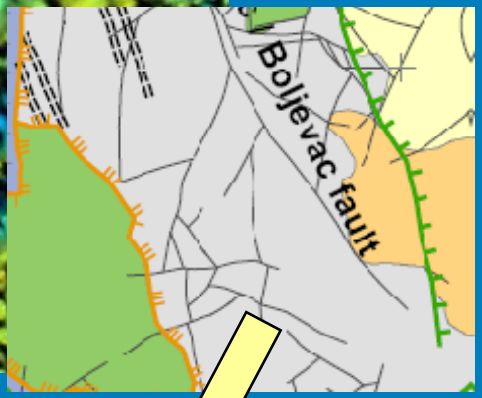


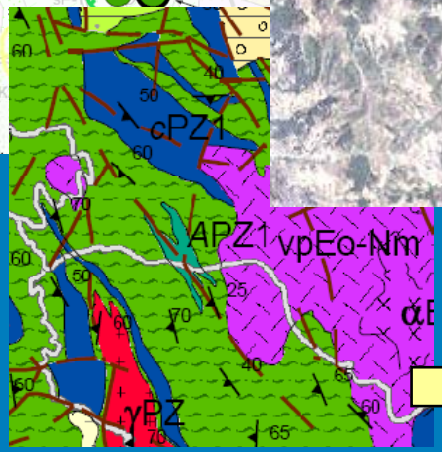
Using artificial neural networks

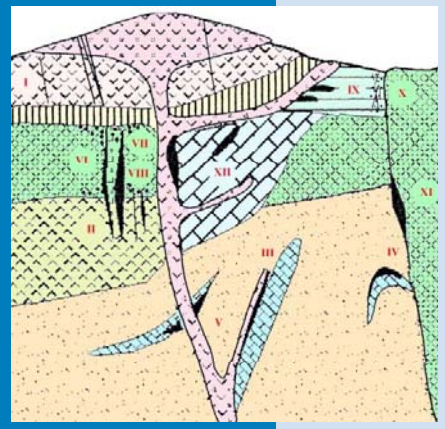


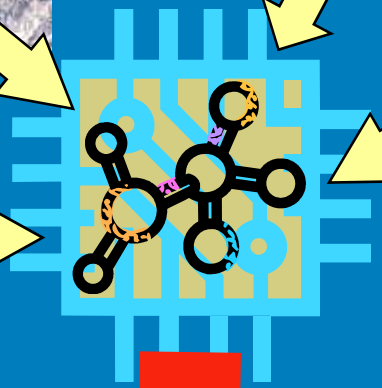


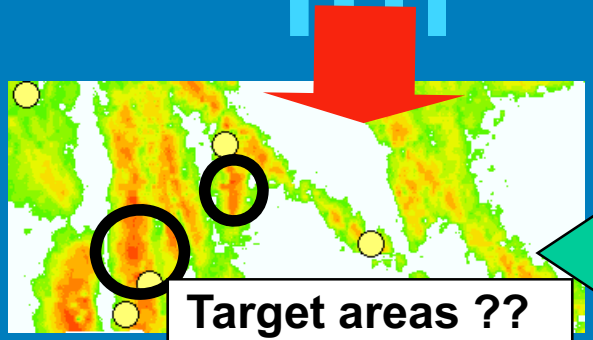












Target areas ??

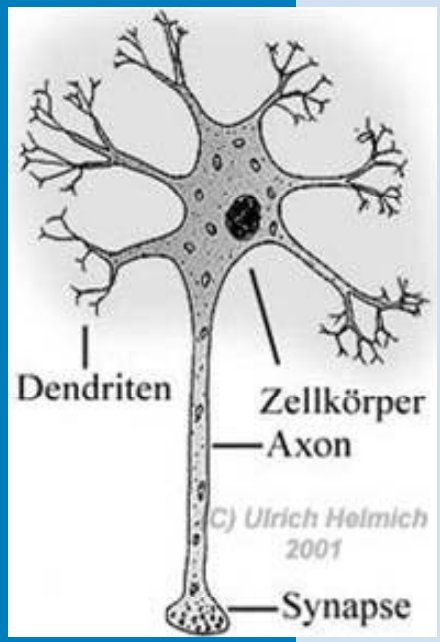
The artificial neuronal network “replaces” the expert’s empirical data analysis

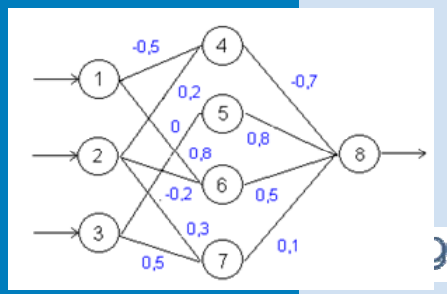
Is it correct ?
Can it be ?

Artificial neural network features

Model: natural neuron

- Simulation of biological processes by use of suitable mathematical operations
- ARTIFICIAL NEURAL NETWOKS is a statiscal analyzing method for
- complex as well as for non linear
- relationships
- They able to learn from given examples
- Work with huge amount of data
- No problem with noisy data
- Work with existing data
- Comparable quick
- Apply their knowledge in similar environment



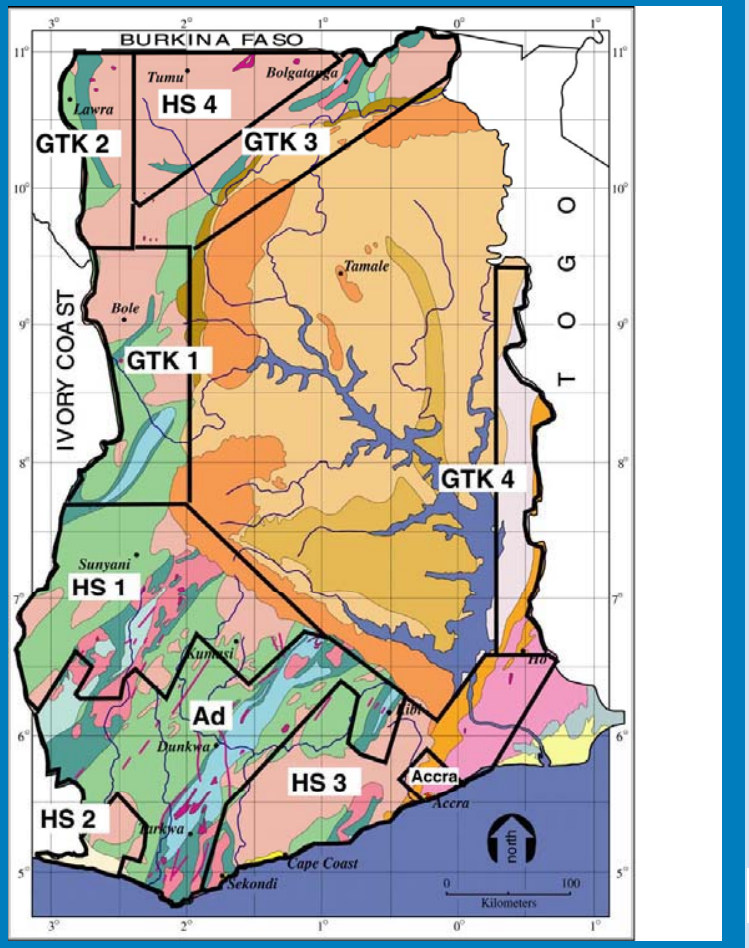


Available data and knowledge

- 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

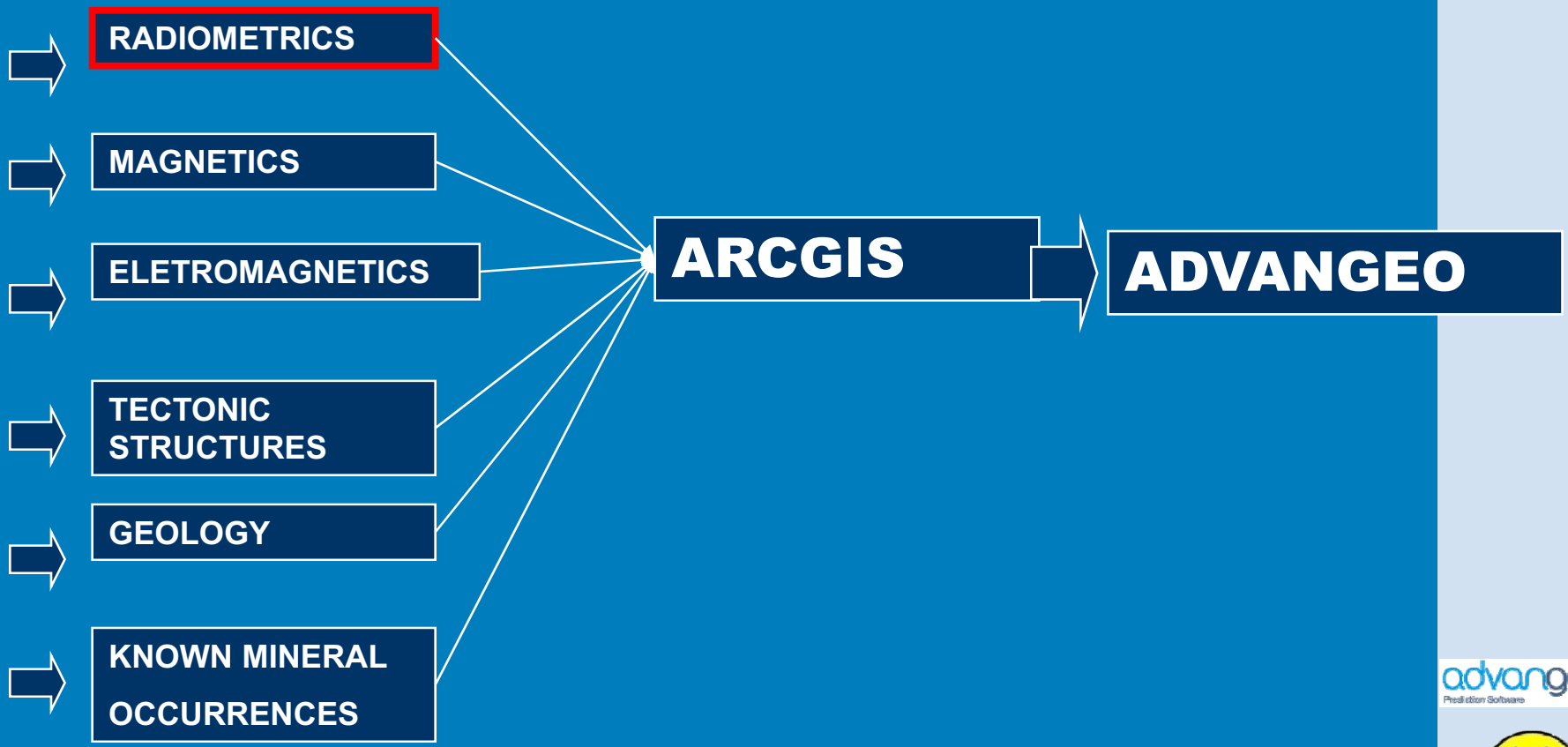
Airborne Geophysical Data

- Between 1996 and 1998, the World Bank/ Nordic Development Fund sponsored the Mining Sector Development and Environment Project.
- The EU funded MSSP has covered the Volta and Keta bassins



Source: Geological Survey Department of Ghana

MODEL DATASETS



Create predictive maps for Au - NW Ghana

- Au generates i income in Ghana more than any mineral
- 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 important input into the national development strategy

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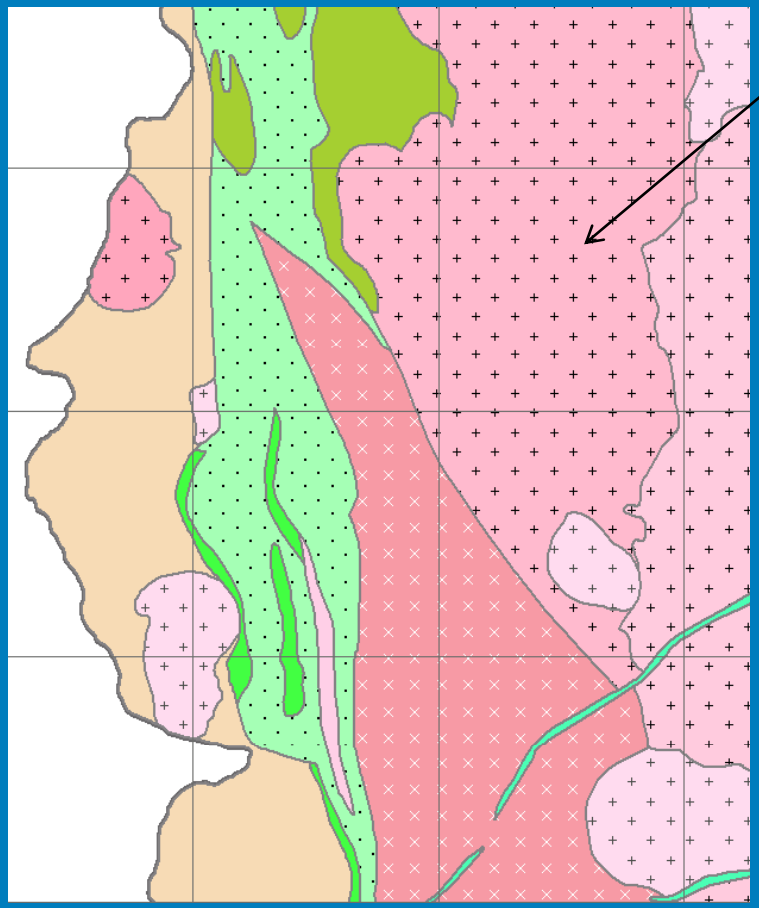
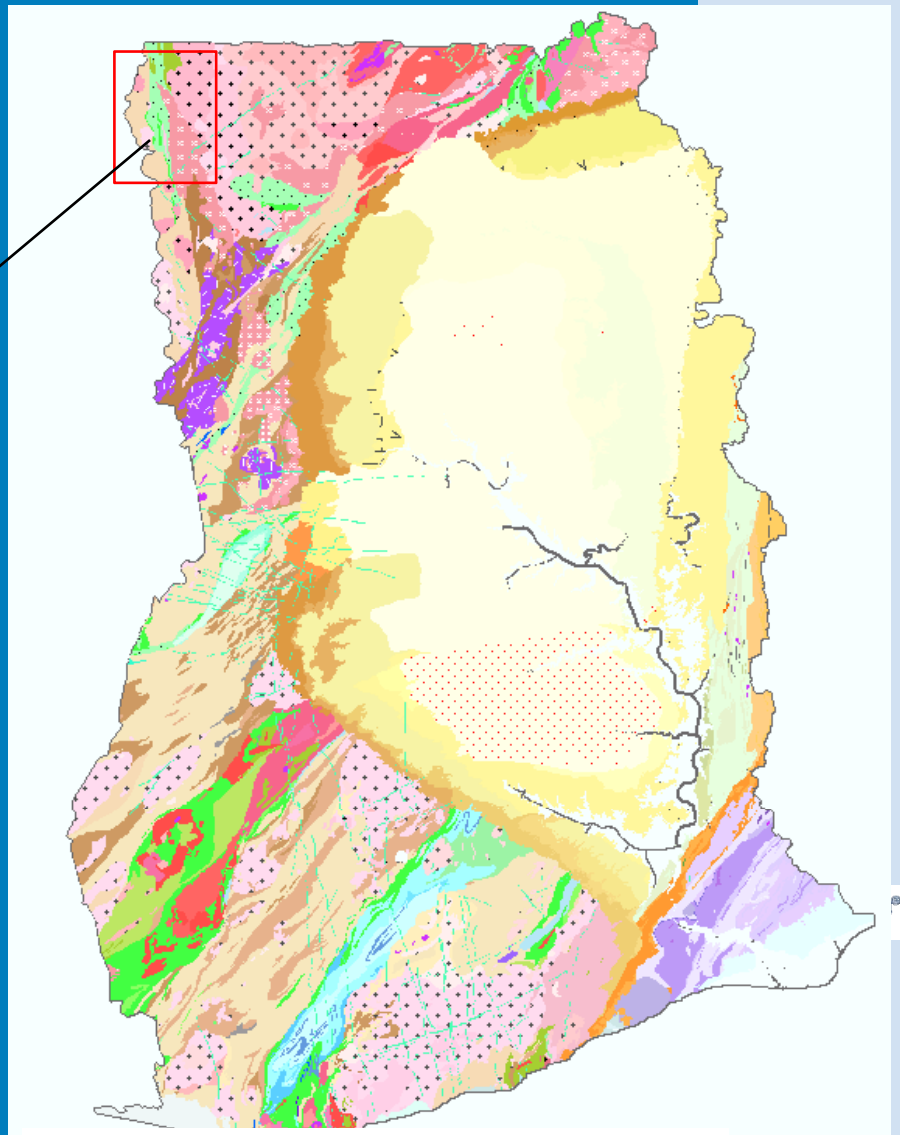
The geology

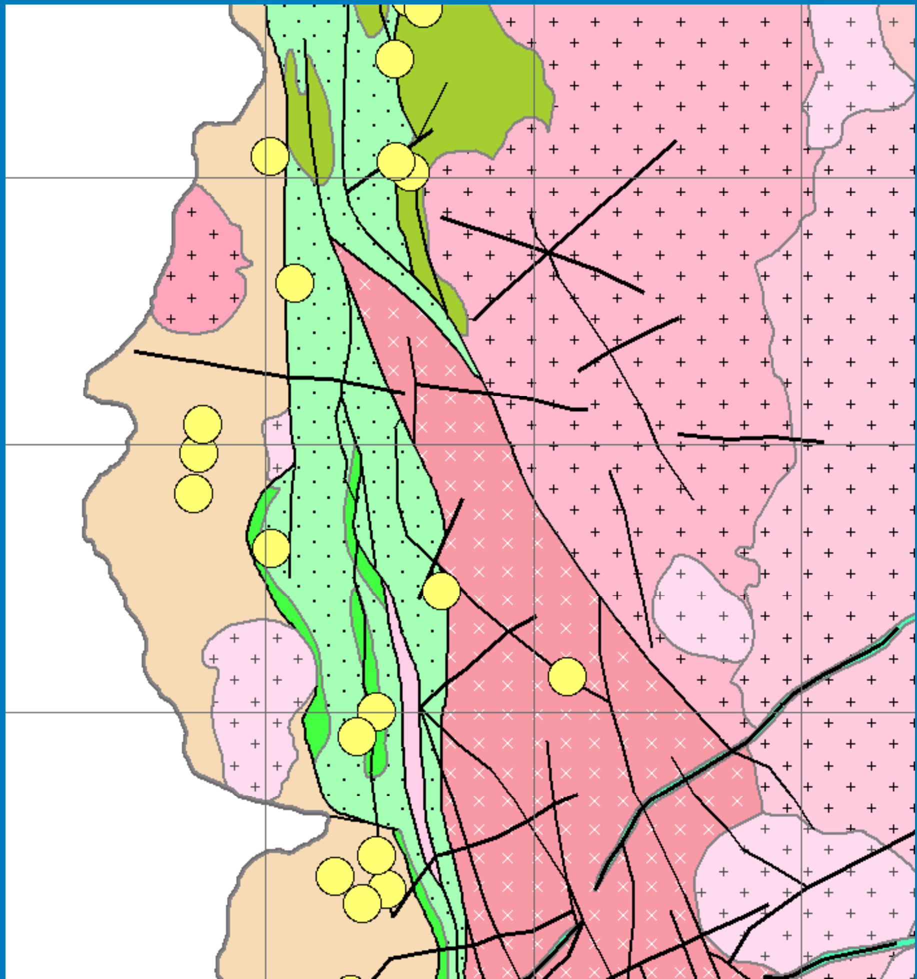
Source: Geodatabase Ghana; 1:1,000,000 scale geological maps



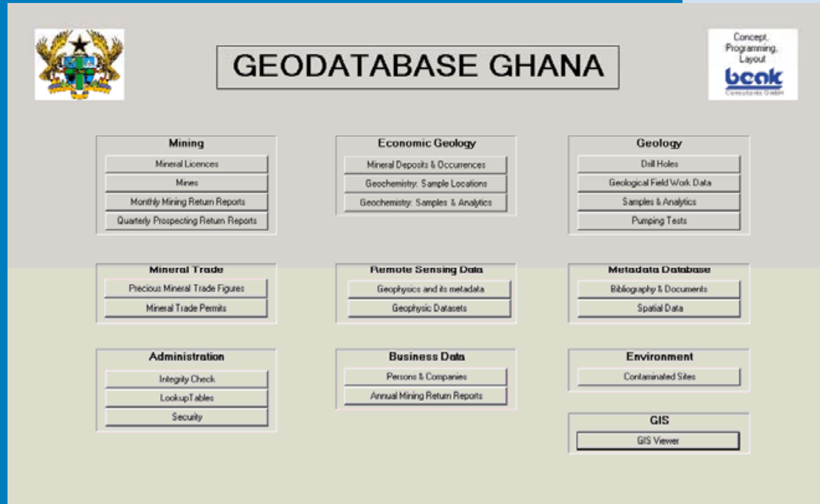


Source: Geological map of Ghana, 2010

Mineral occurrence locations

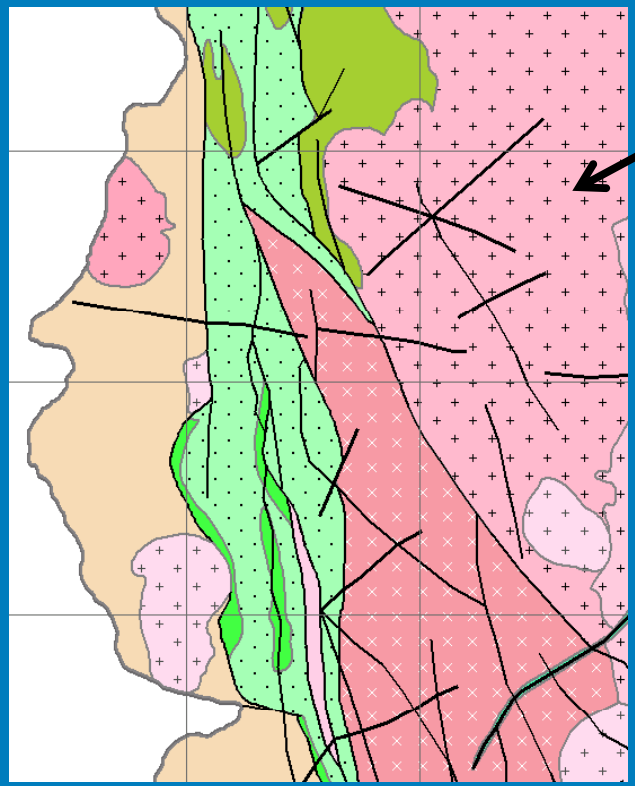


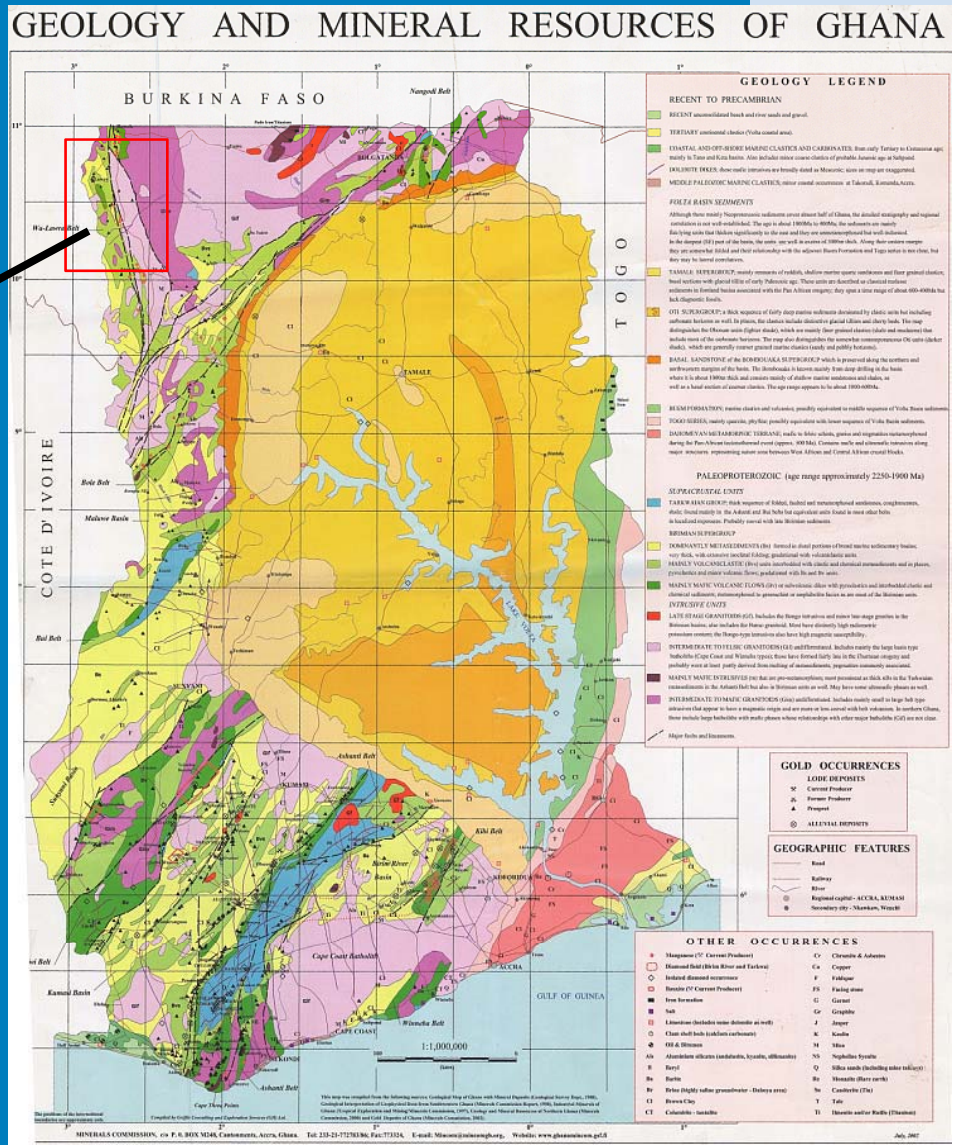
Source: Geodatabase Ghana



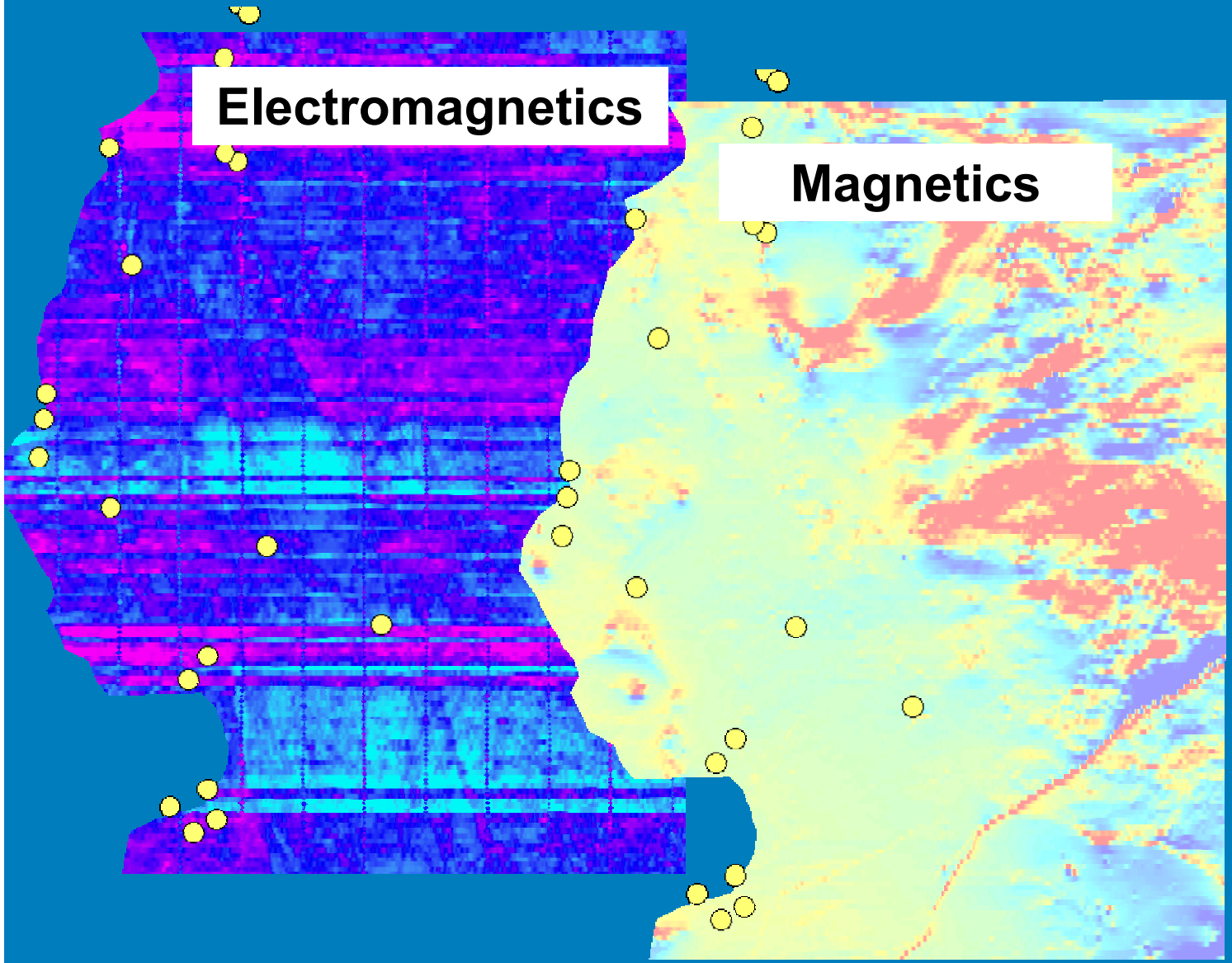
The tectonic structures

Source: Geodatabase Ghana;
Different geological maps





Magnetics & electromagnetics



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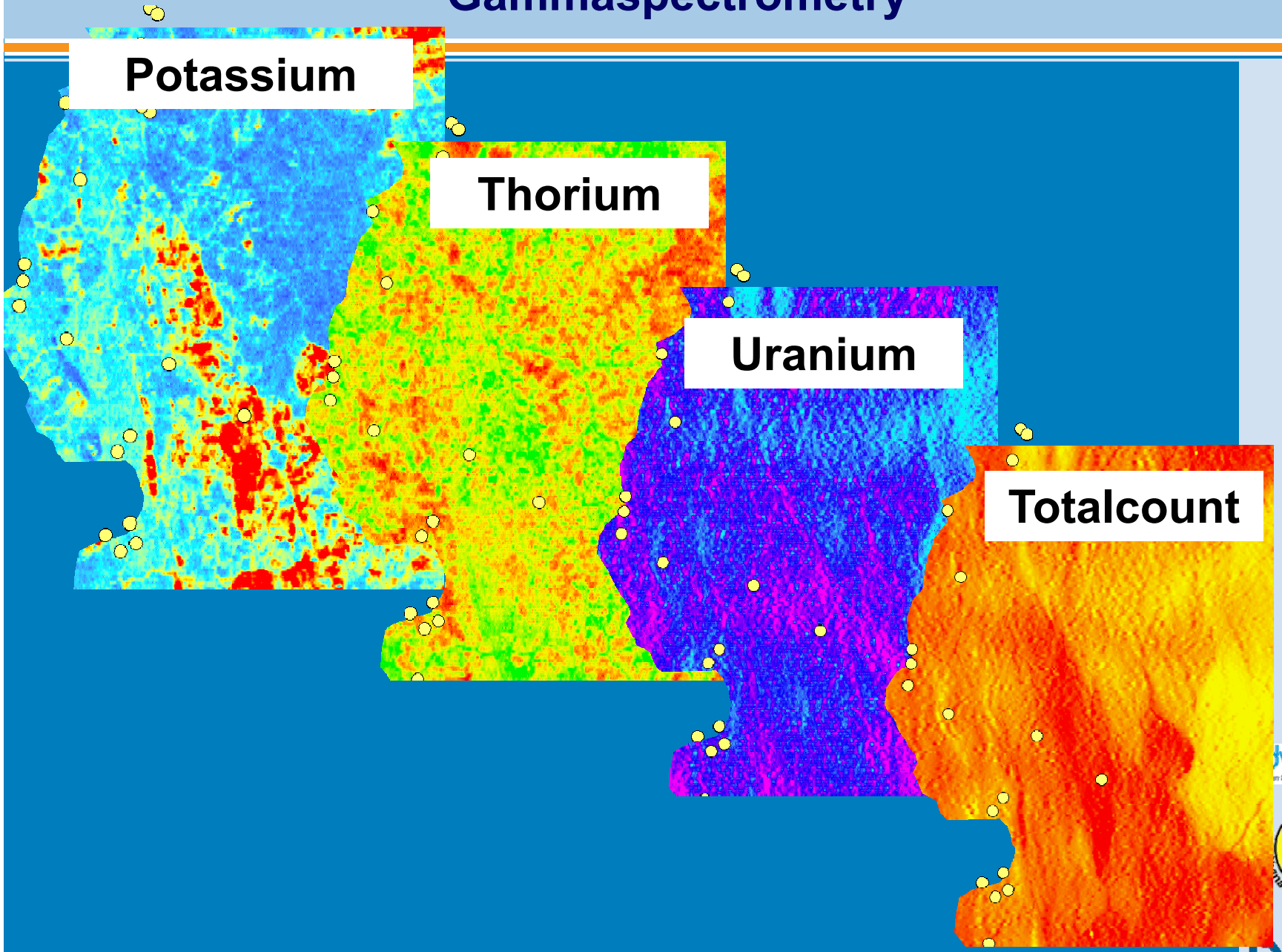
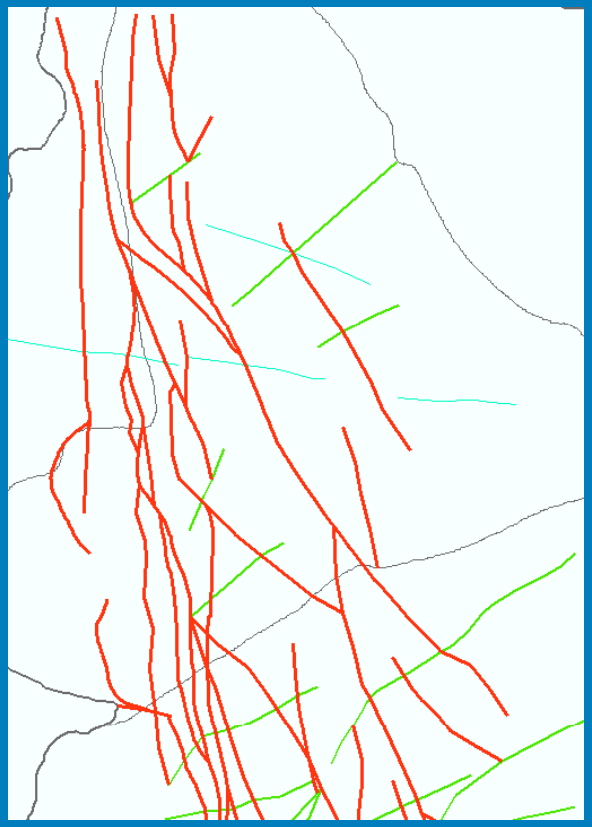
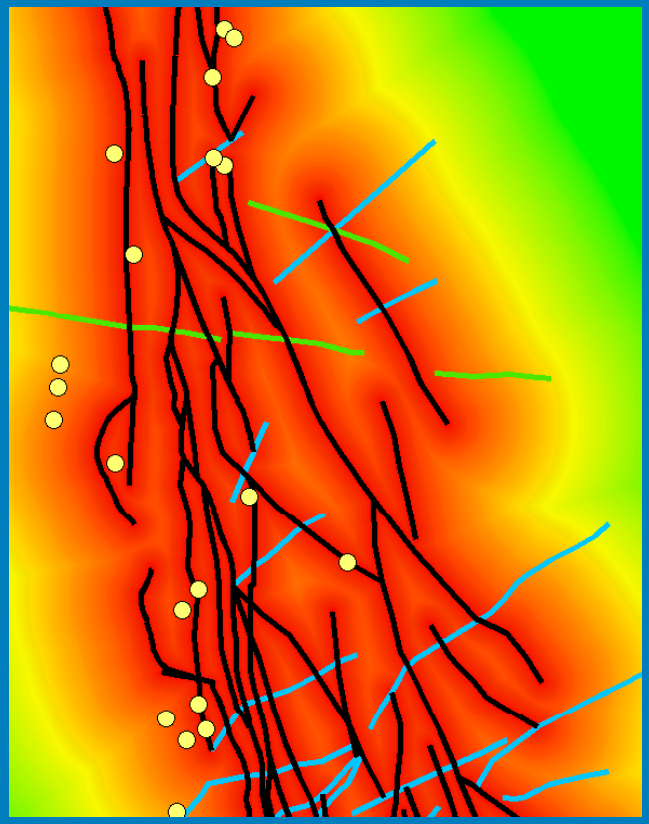
Gammaspectrometry



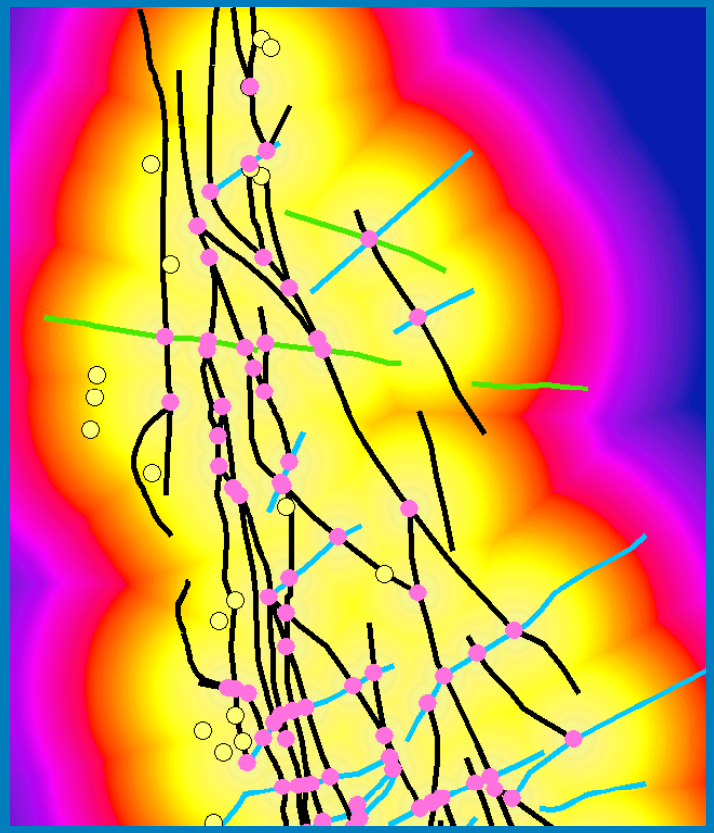
Processing of model input data: tectonics



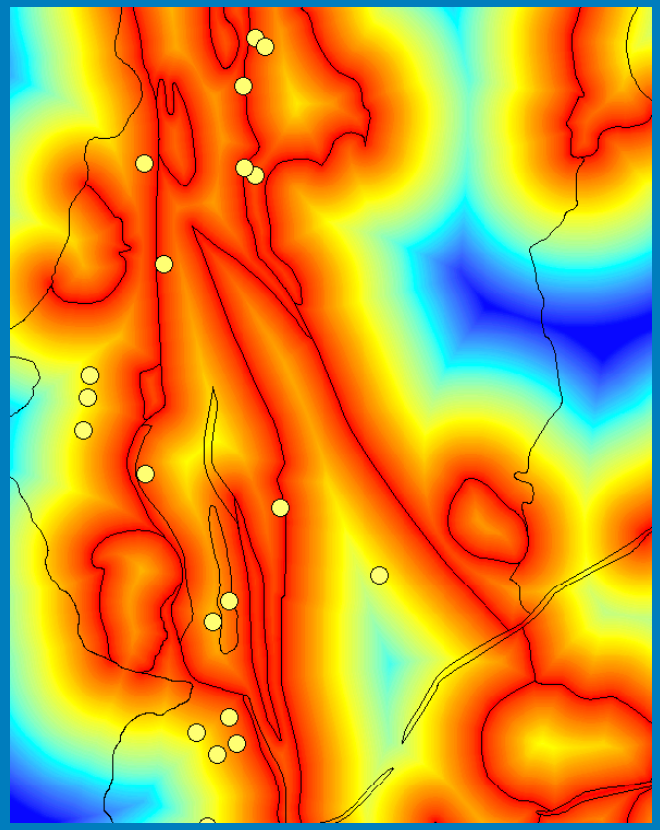


Creation of distance layers: how fare is a point away from a structure

More model input data



Intersections of tectonic structures



Important rock contacts

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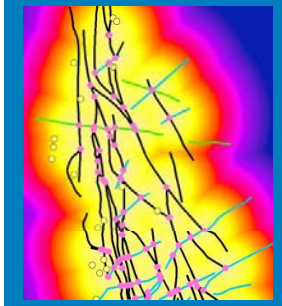
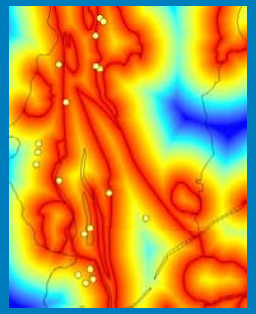
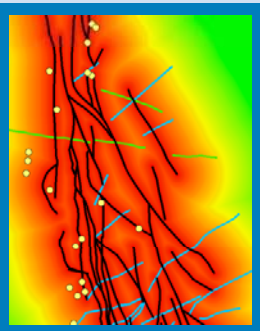
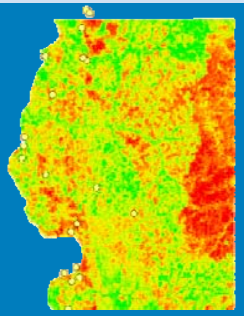
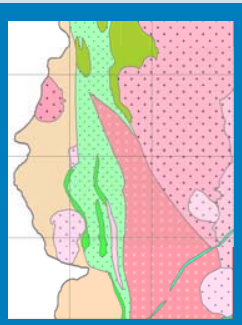
The artificial neural network modeling

Input data layers

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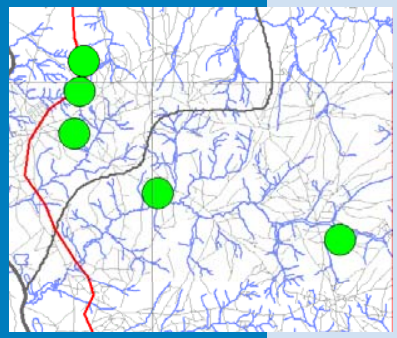

Training points = known minera-lisations

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

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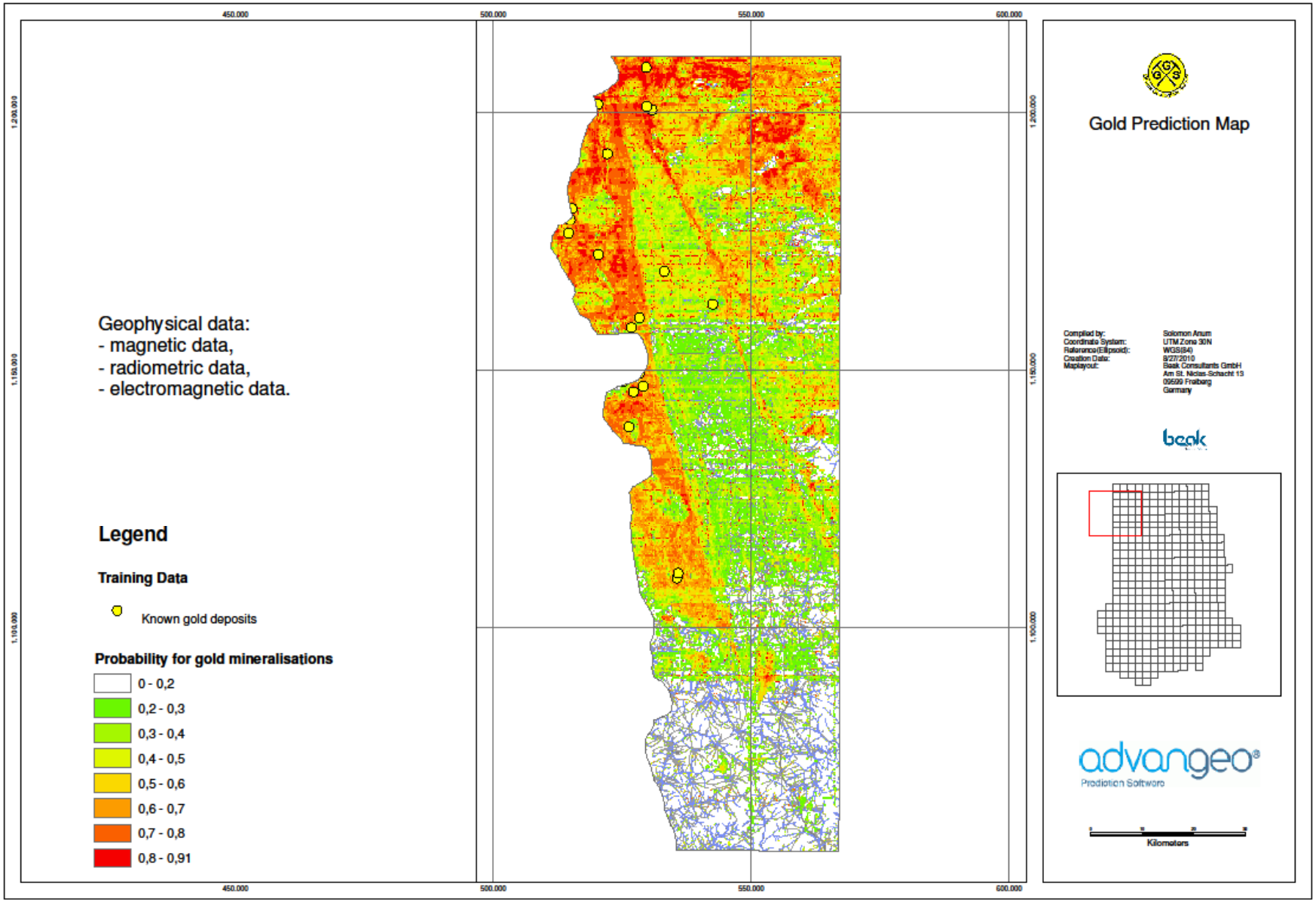
450.000
500.000
550.000
600.000
1.200.000
1.150.000
1.100.000
Geophysical data:
- magnetic data,
- radiometric data,
- electromagnetic data.
Legend
Training Data
Known gold deposits
Probability for gold mineralisations
0 - 0,2
0,2 - 0,3
0,3 - 0,4
0,4 - 0,5
0,5 - 0,6
0,6 - 0,7
0,7 - 0,8
0,8 - 0,91
Gold Prediction Map
Compiled by:
Coordinate System:
Reference(Ellipsoid):
Creation Date:
Maplayout:
Solomon Anum
UTM Zone 30N
WGS(84)
9/27/2010
Baak Consultants GmbH
Am St. Niclas-Schacht 13
09599 Freiberg
Germany
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Kilometers


450.000
500.000
550.000
600.000
1.200.000
1.150.000
1.100.000
Geophysical data:
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9/27/2010
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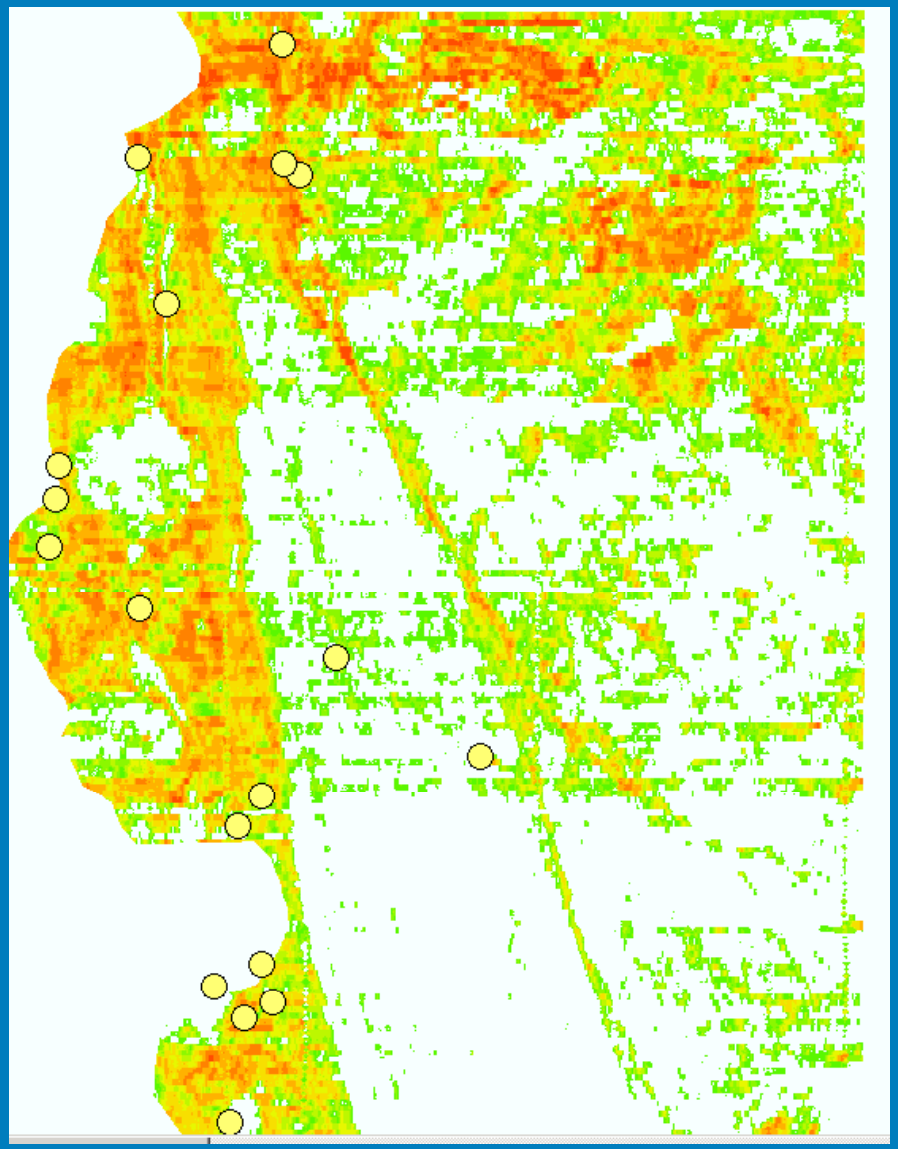
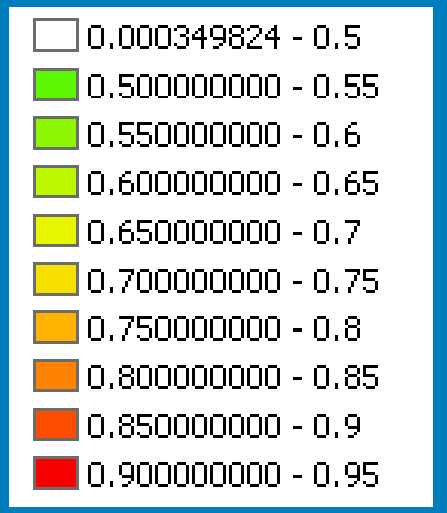
Model 3



U, Th, K, total, magnetics, elctromagnetics



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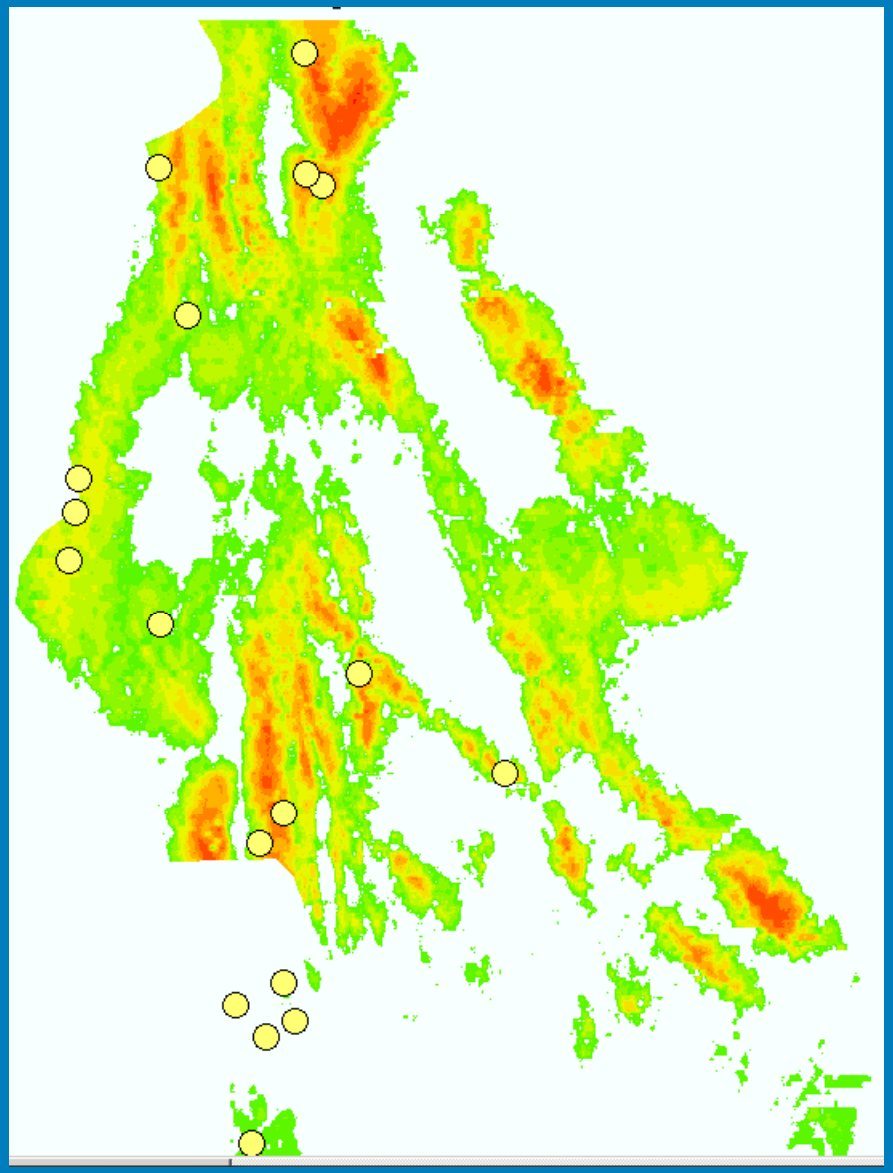
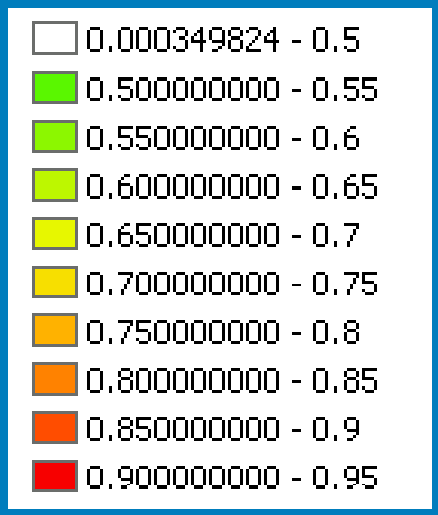
Model 4



U, Th, K, total, magnetics, structures



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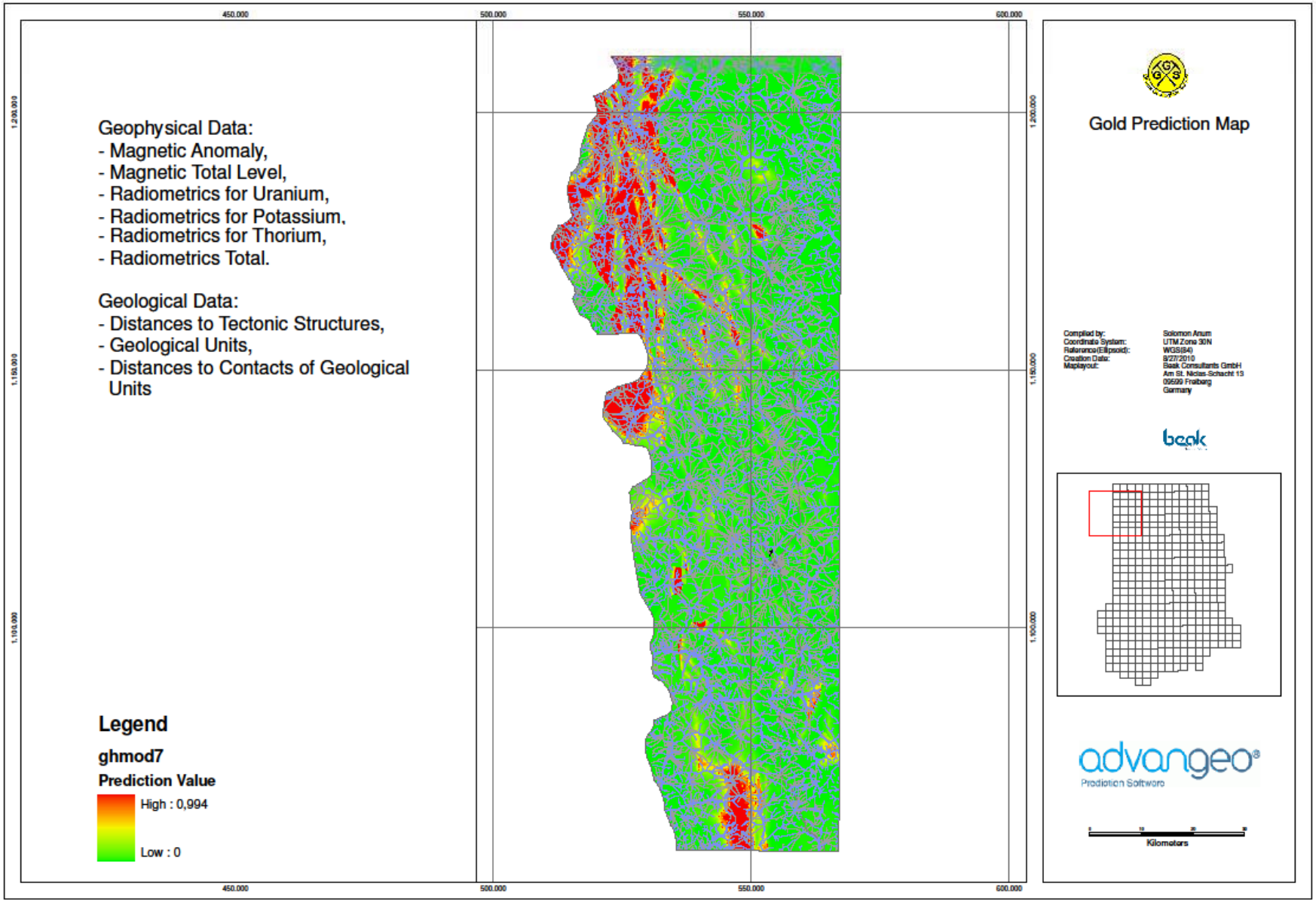
Geophysical Data:
- Magnetic Anomaly,
- Magnetic Total Level,
- Radiometrics for Uranium,
- Radiometrics for Potassium,
- Radiometrics for Thorium,
- Radiometrics Total.
Geological Data:
- Distances to Tectonic Structures,
- Geological Units,
- Distances to Contacts of Geological Units
Legend
ghmod7
Prediction Value
High : 0,994
Low : 0
450.000
500.000
550.000
600.000
1.200.000
1.150.000
1.100.000
Gold Prediction Map
Compiled by:
Coordinate System:
Reference(Ellipsoid):
Creation Date:
Maplayout:
Solomon Anum
UTM Zone 30N
WGS(84)
9/27/2010
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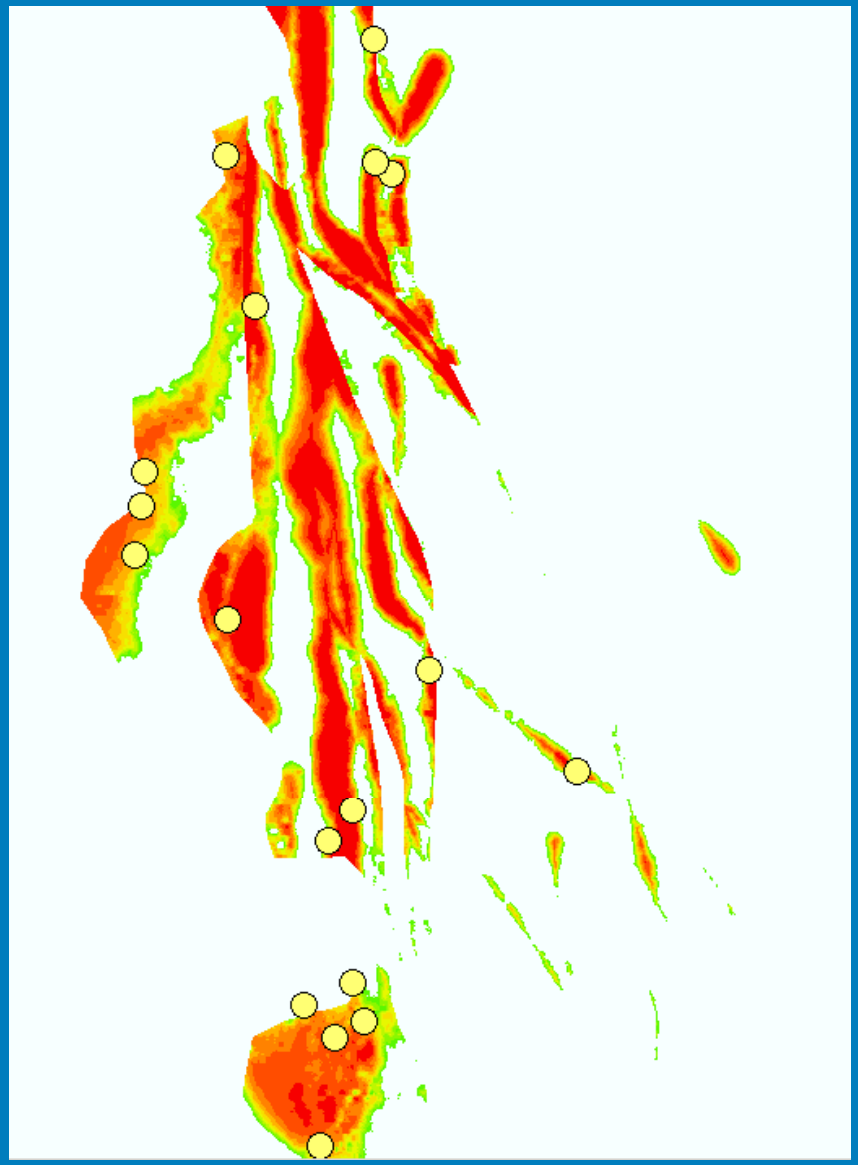
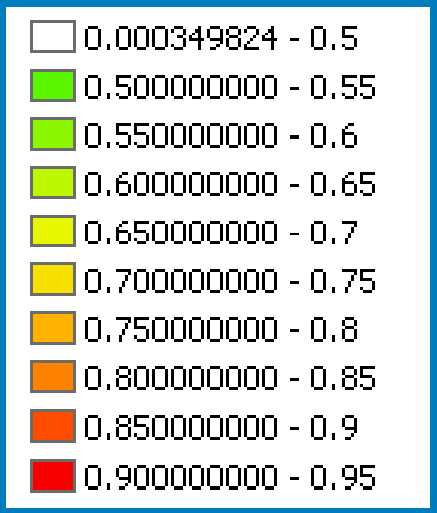
Kilometers

Model 5



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



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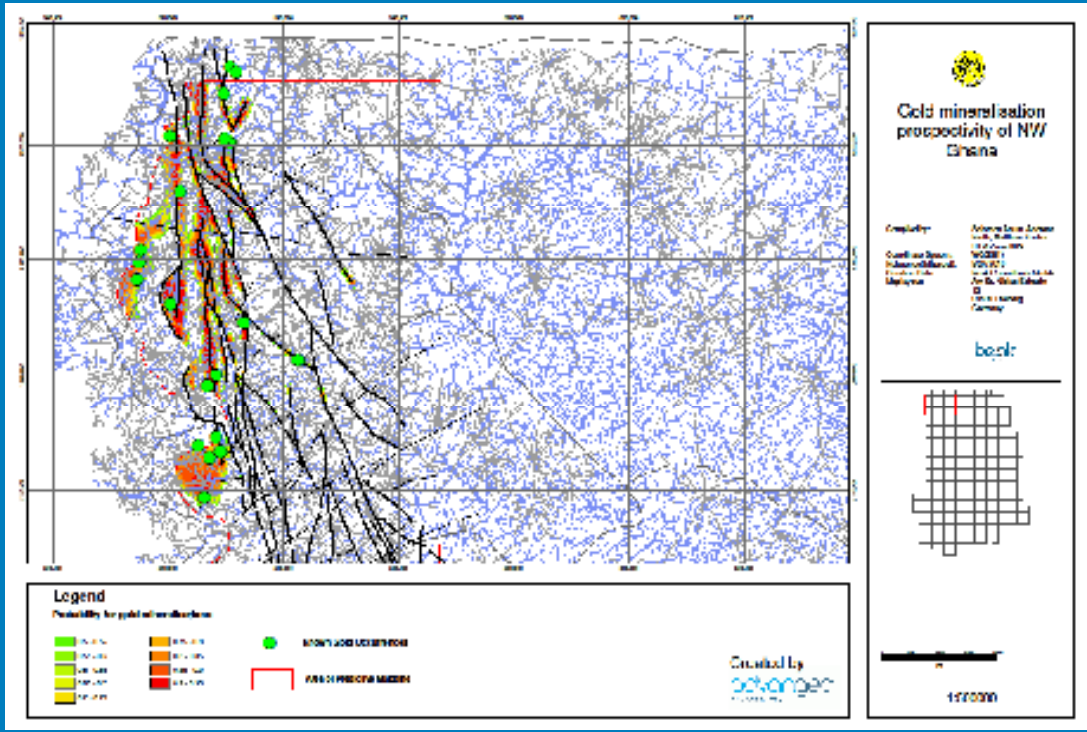
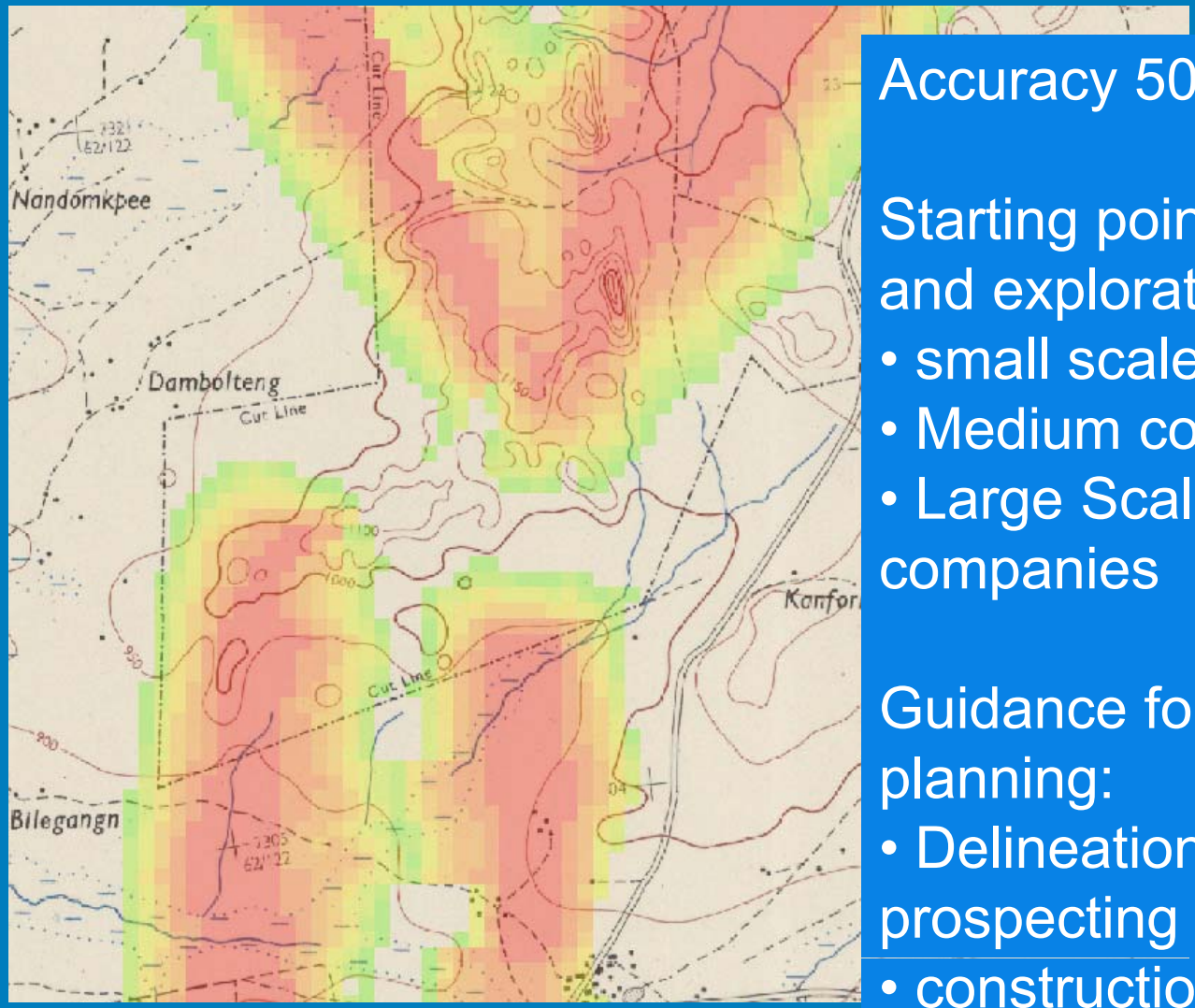
The regional predictive map



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

High resolution predictive maps 1:50,000



Accuracy 50 - 100 m

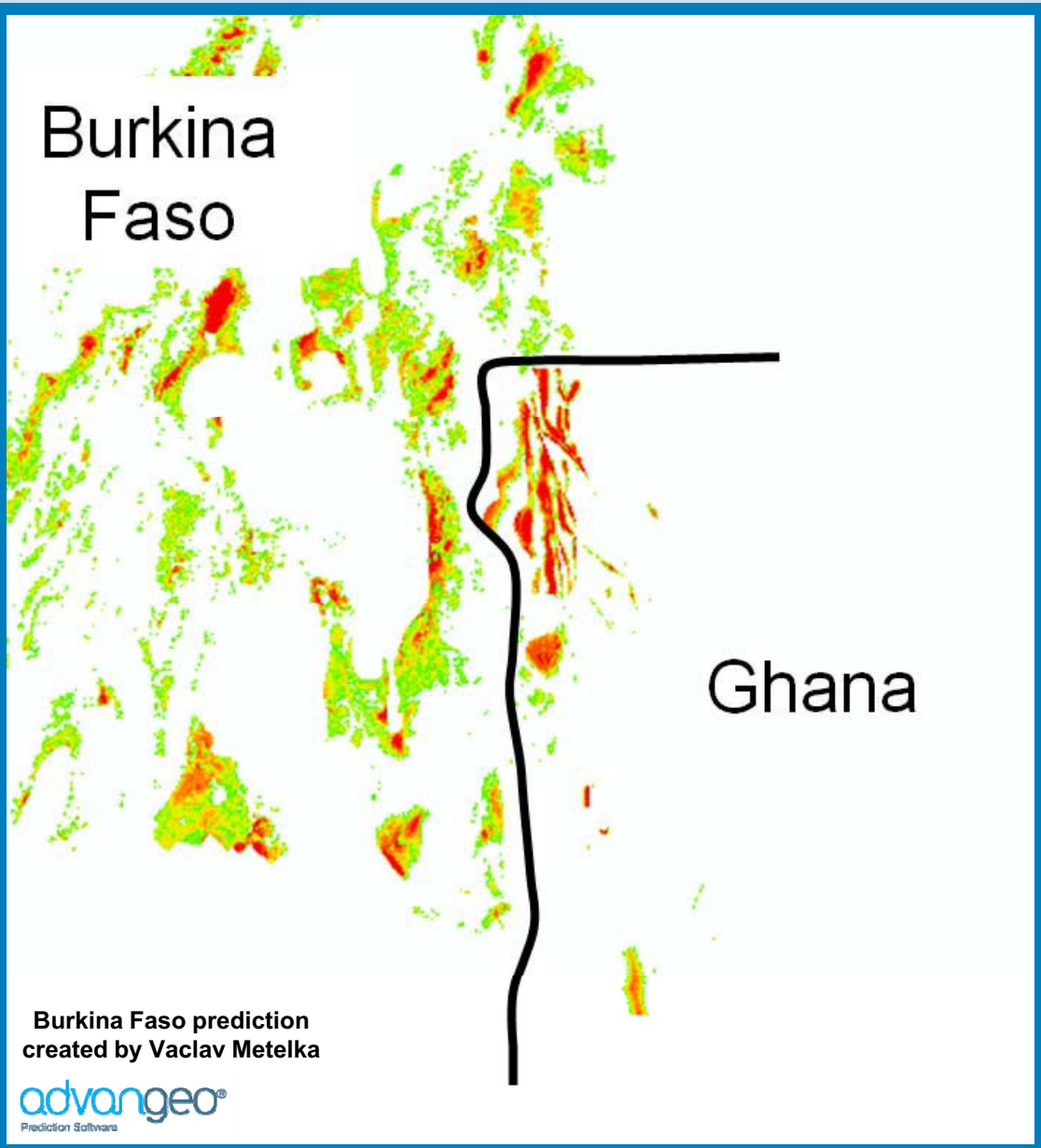
Starting point for prospecting and exploration activities for:

- small scale miners
- Medium companies
- Large Scale mining companies

Guidance for local land use planning:

- Delineation of preferred prospecting areas
- construction of roads and settlements….

Cross border application



Burkina Faso prediction created by Vaclav Metelka

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Benefits of predictive mapping

- State sector:
  - Guidance of mineral sector development, incl. small scale mining activities → contributes to employment programs
  - Guidance of the national development & land use planning

- Private sector:
  - Fast identification of exploration targets
  - Support of investment decision making processes
  - Support/ enhance exploration activities
  - Reduction of exploration risks

Conclusions

- Mineral prediction maps are important instruments:
  - To identify potentials
  - To attract and guide investment
  - To guide the national development
  - To improve the resource management at both local and national levels
- Artificial neural networks are an effective tool for the creation of prediction maps
- The fast knowledge based identification of exploration targets becomes possible

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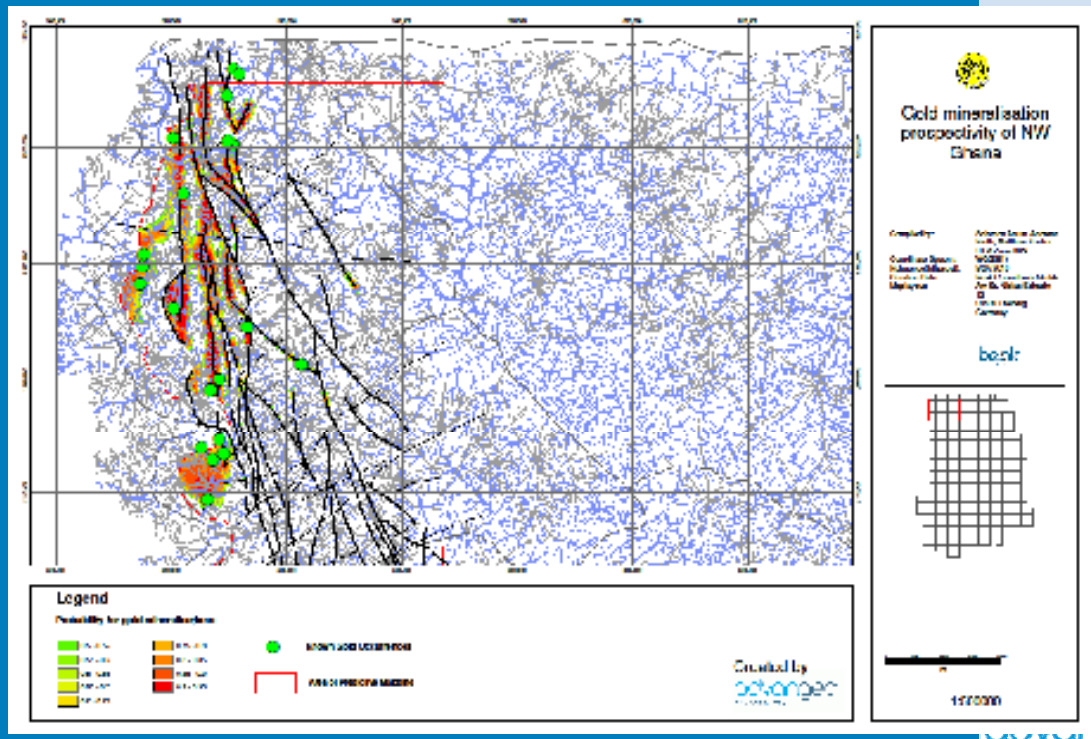
Thank you for your attention



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