Gold Potential Mapping in South-West Ghana Using Advangeo® Prediction Software: Database, Approach, Results, Benefits

How to find new exploration targets in an old mining area?

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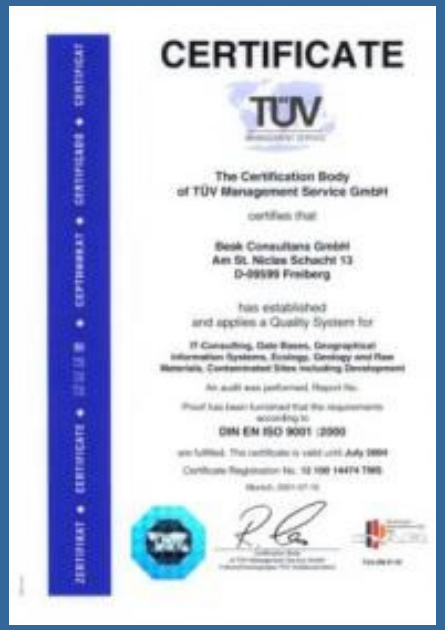
Agenda

- Gold in South-West Ghana
- Database
- Predictive Mapping Technology
- Results
- Application
- Conclusion

Beak Consultants GmbH

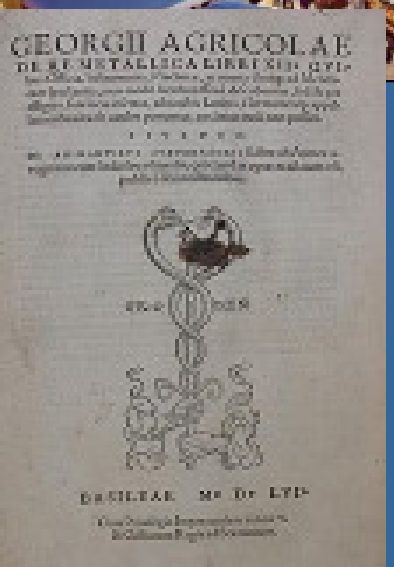
- Fields of business
  - Geology, exploration, environment
  - GIS and cartography
  - Tailor-made software
- ISO 9001:2000 certificate
- 19 years of company experience
- Roots are the
  - East German Geological Survey
  - Canadian Beak Consultants International
- Active in Ghana since 2005:
  - Databases and GIS
  - Mineral exploration targeting
  - Data processing



Geological Survey Department of Ghana

- Principle geoscientific governmental body of Ghana
- Hosts the national geoscientific data.
- Cooperation GSD – Beak Consultants since 2005

Mining University Freiberg



Helmholtz-Institut Freiberg für Ressourcentechnologie

HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

BERGAKADEMIE FREIBERG TECHNISCHE UNIVERSITÄT

- founded in 1765
- the most attractive University with bias in Mining and Geology
- > 1000 Students in Mining and Geosciences
- Cooperating with Beak Consultants since 15 years

Ghana Geological Survey

advangeo

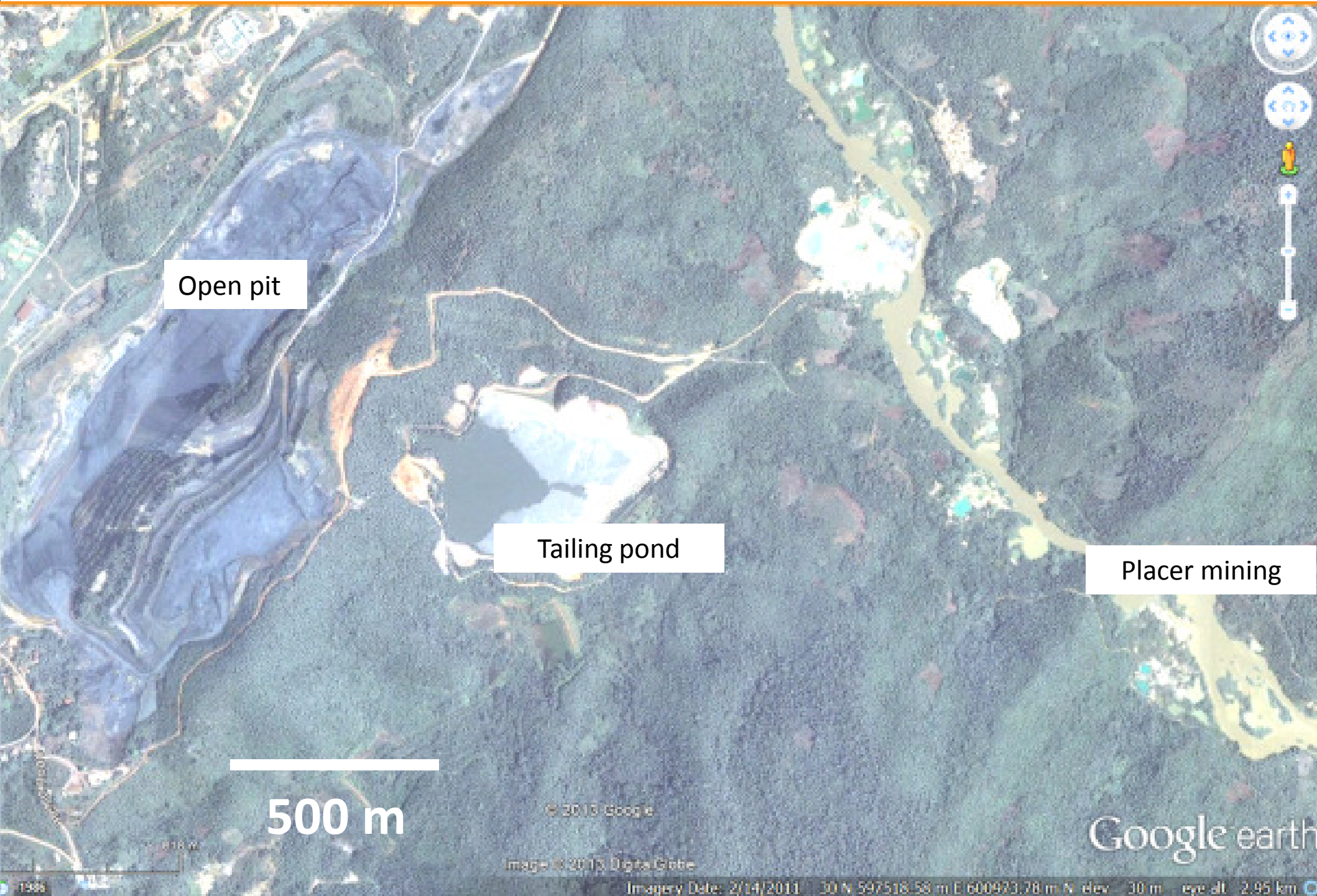
beak CONSULTANTS

Gold in South-West Ghana

- Prime product of Ghana for thousands of years
- Annual production reaches 134 t (2012)
- Income for millions of people

- Destroys landscapes
- Consumes land
- Competes with other land use
- Creates conflicts

Gold Mining at Prestea



Small Scale Gold Mining at Dunkwa

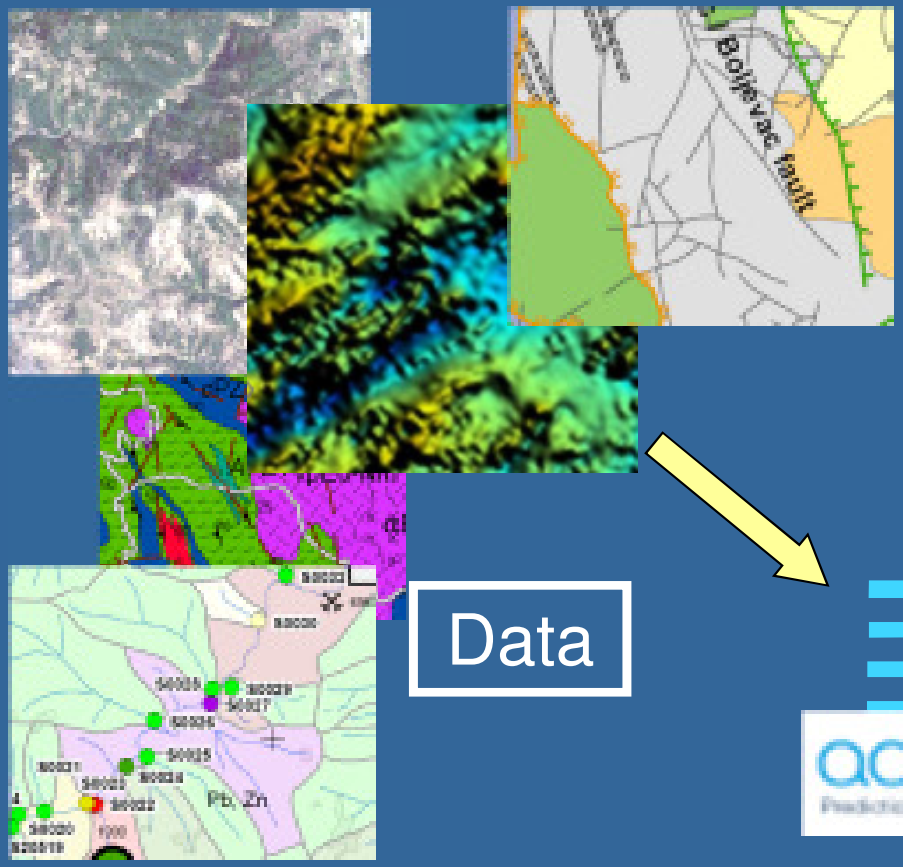
If we knew where the Gold is, we could....

- Safe exploration funds
- Attract more investment
- Guide the industry and ASM
- Foresee and manage land use conflicts
- Protect resources & environment
- Improve infrastructure planning
- do many more important things ...

Approaches of Predictive Mapping

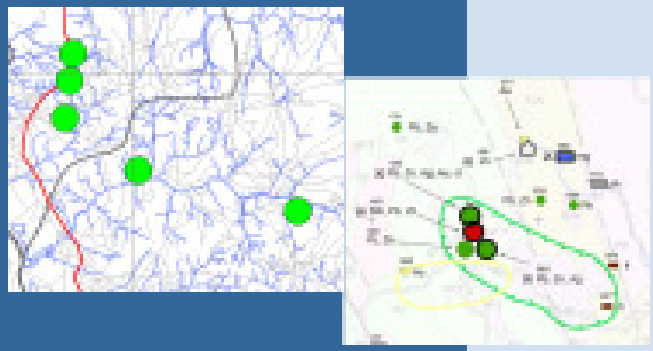
- Data driven:
  - neural networks
  - logistic regression
- Knowledge driven:
  - fuzzy logic
  - weights of evidence
  - simple summarizing of relevant information

Using artificial neural networks

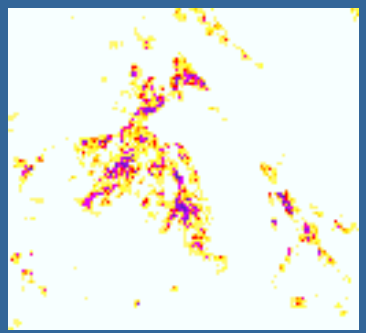


Data

Locations



advangeo®
Predictive Software



Validation

The predictive maps:

- probabilities
- grades
- resources ...

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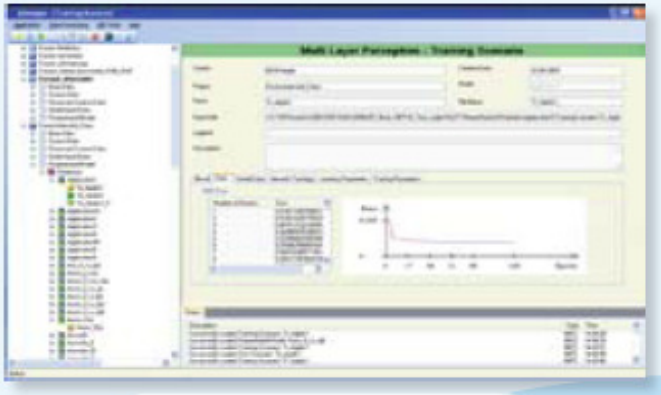
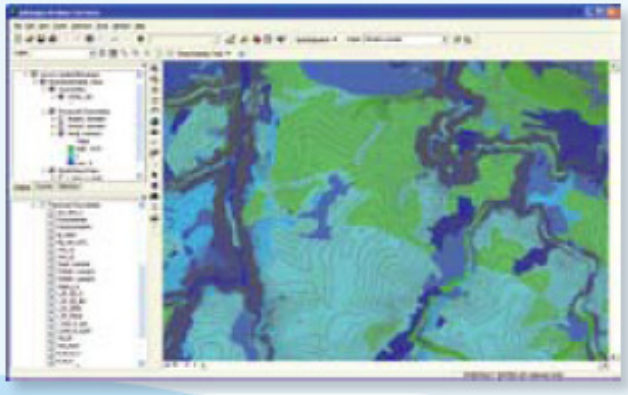
Advangeo Software Structure



Data and Model Explorer



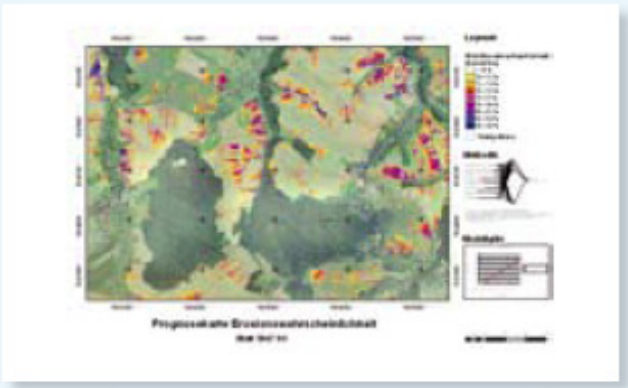
GIS Extension

Metadata

Referenced Data Resources

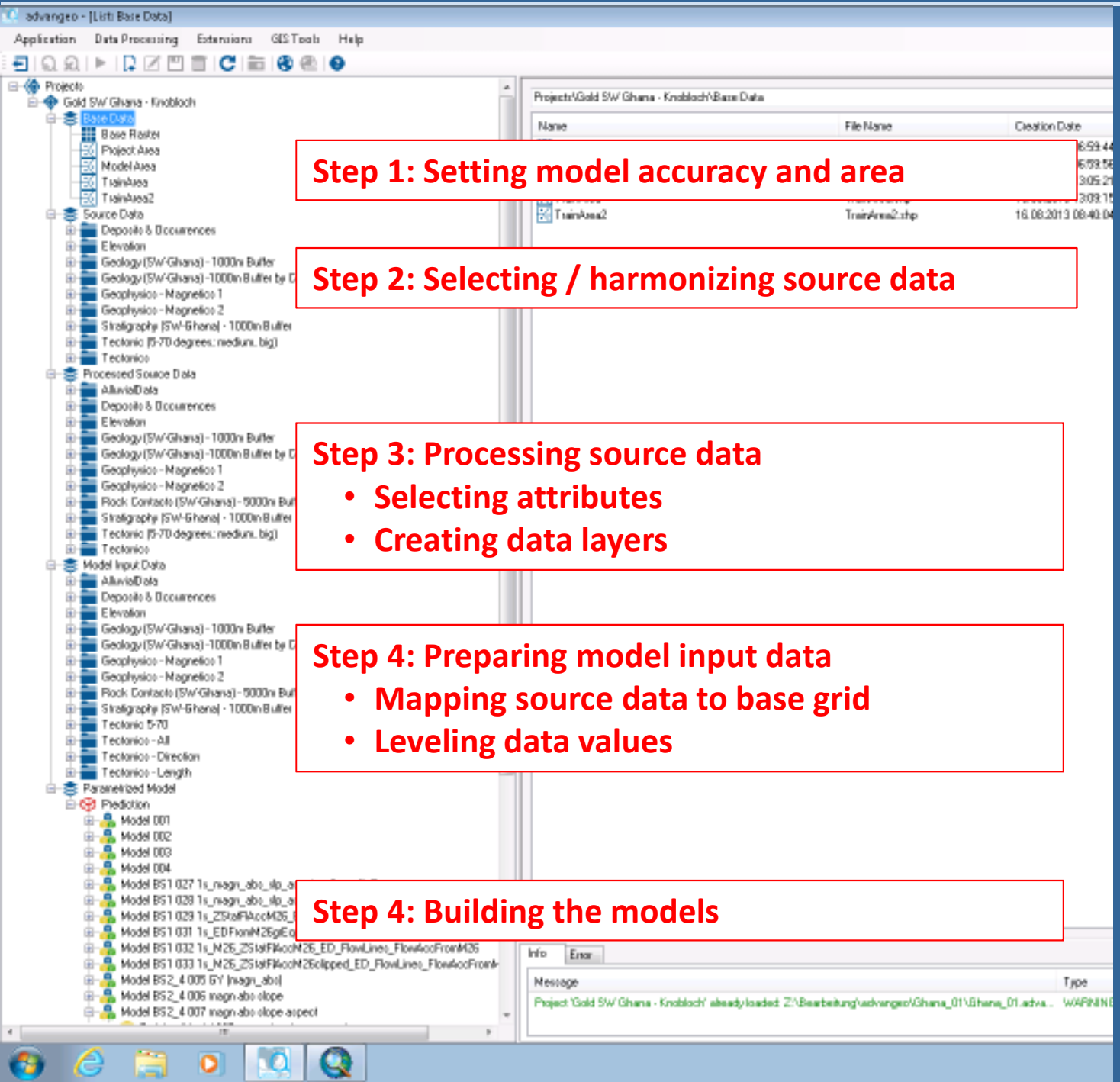
Spatial Data

advangeo's components



Prediction Presentation

How to build a predictive model with advangeo ?



Step 1: Setting model accuracy and area

Step 2: Selecting / harmonizing source data

Step 3: Processing source data

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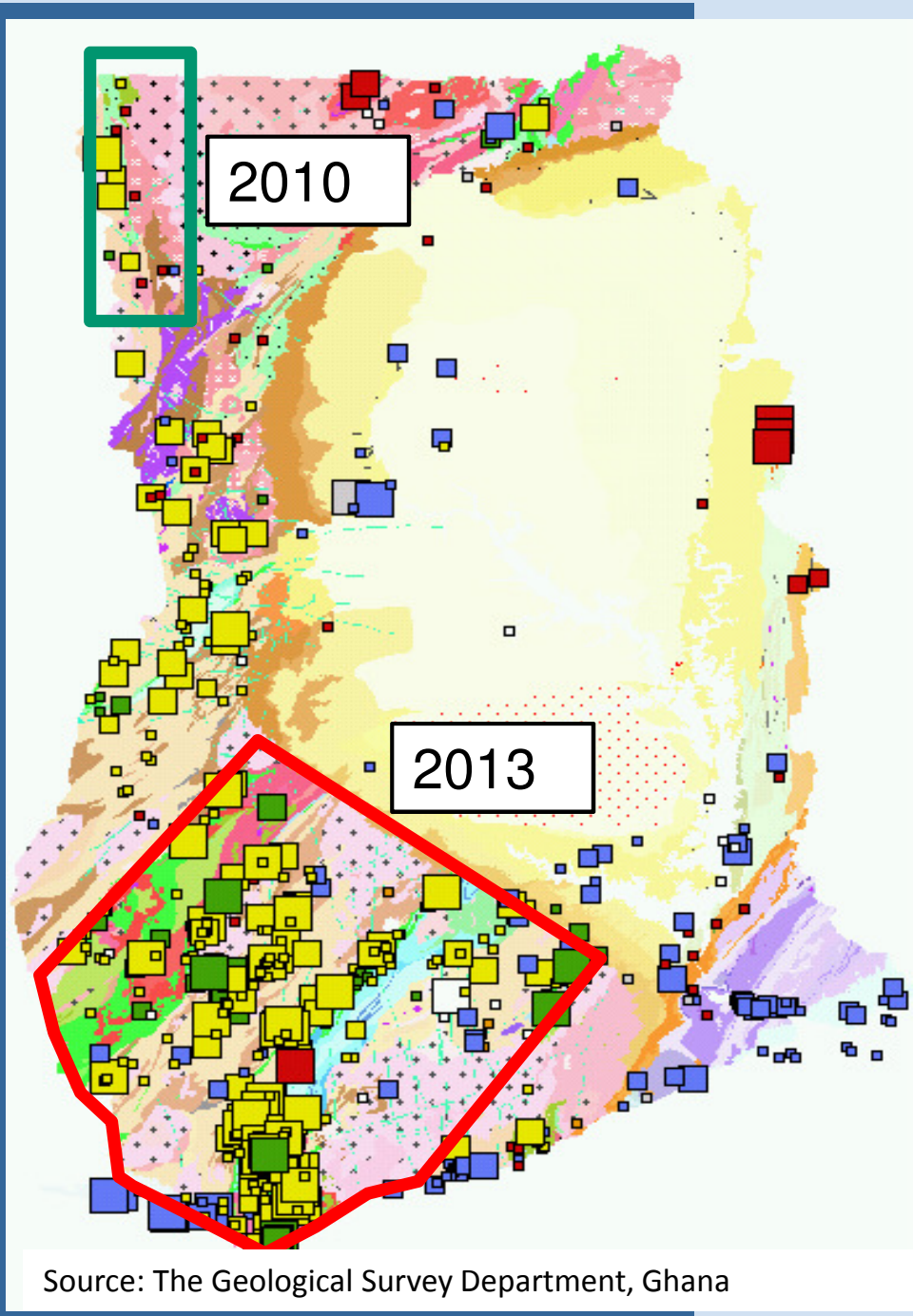
Step 4: Building the models

The project area

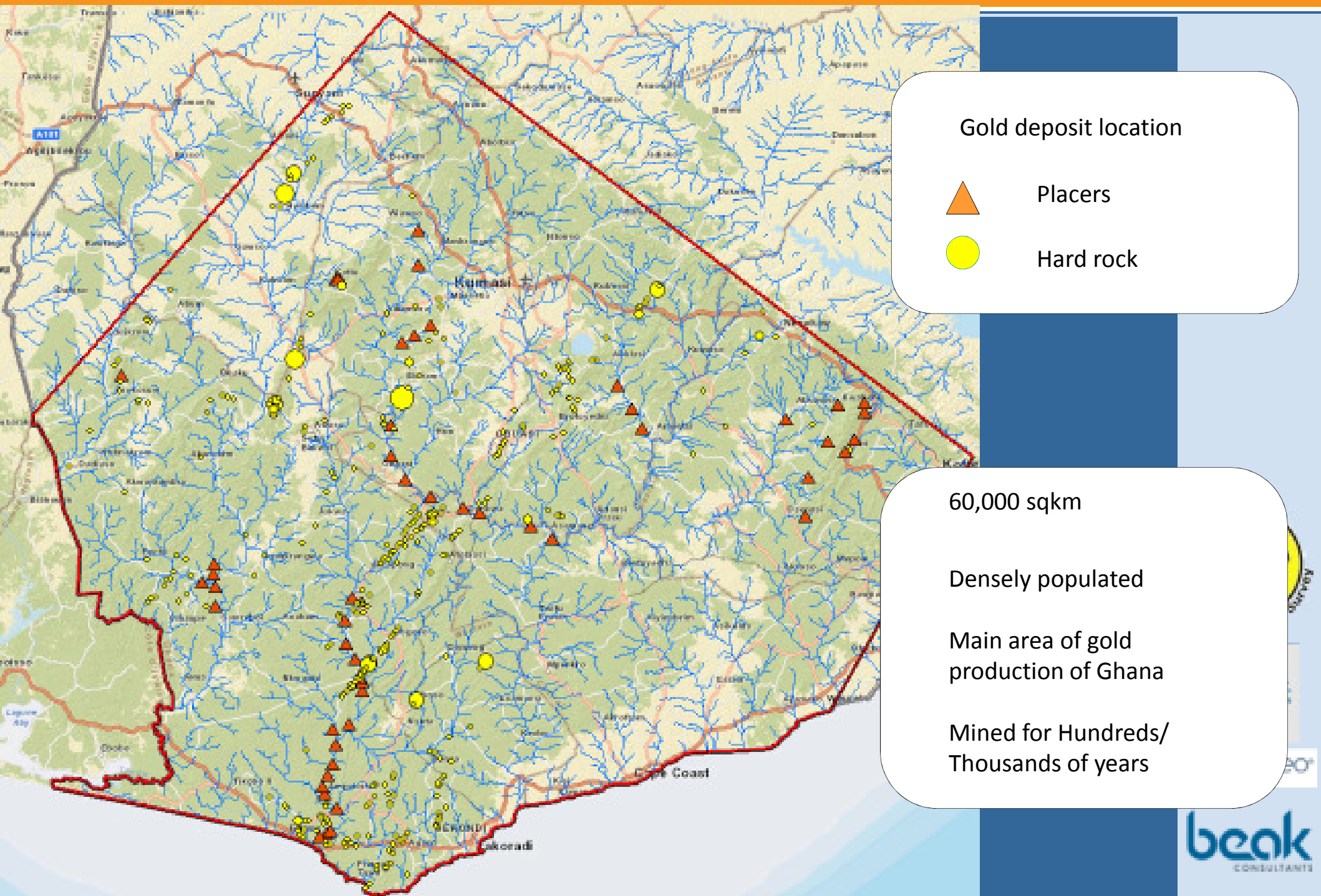
Find new exploration targets in well known mining areas

- Reasonable size
- Acceptable data coverage
- Big economic importance
- Many stakeholders involved
- Base raster: 100m
- > 400 known occurrences



Source: The Geological Survey Department, Ghana

The project area



Gold deposit location

Placers

Hard rock

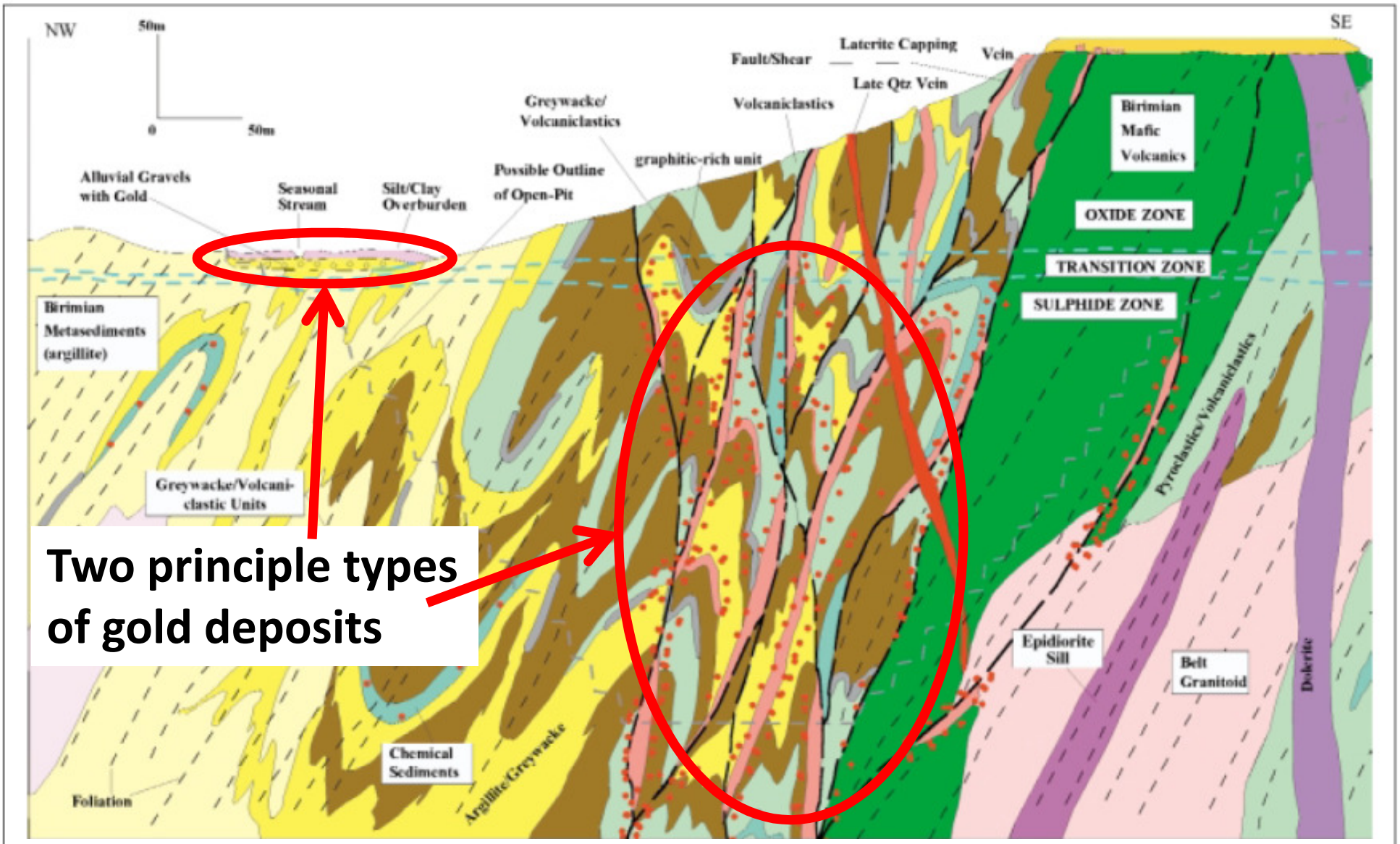
60,000 sqkm

Densely populated

Main area of gold production of Ghana

Mined for Hundreds/ Thousands of years

Metallogeny of hard rock & placer Gold in Ghana



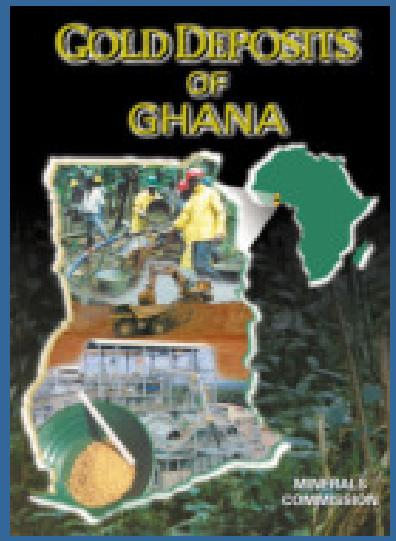
Source: Gold deposits of Ghana, Minerals Commission, Ghana, ROBERT J. GRIFFIS, KWASI BARNING, FRANCIS L. AGEZO, FRED K. AKOSAH, 2002

The metallogenic controlling factors

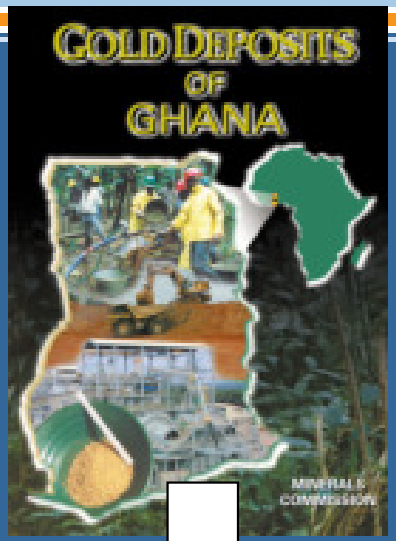
- Hard rock gold
  - Lithologies
  - Tectonic structures
  - Ages
- Placers
  - Distance from source
  - Power of source
  - Stream system properties

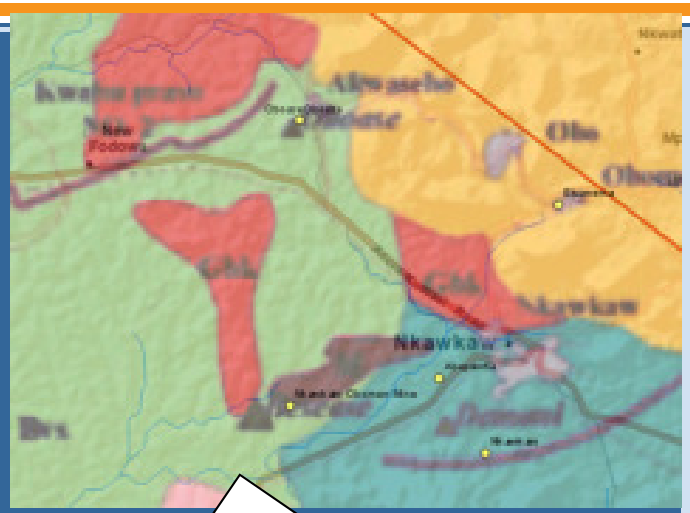
The Gold occurrence data

- Geodatabase Ghana, created during the MSSP 2005 – 2009:
  - Geological maps
  - Tectonic maps
  - Geophysical data
  - Mineral occurrence data
- Additional information:
  - published literature



Harmonizing Gold occurrence data



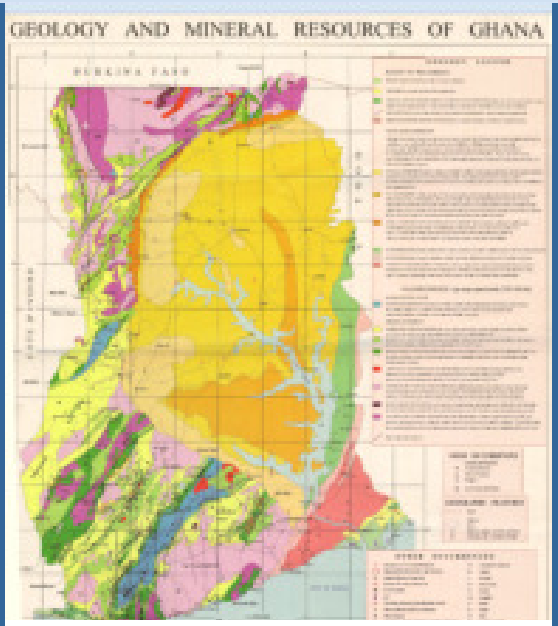


The project database

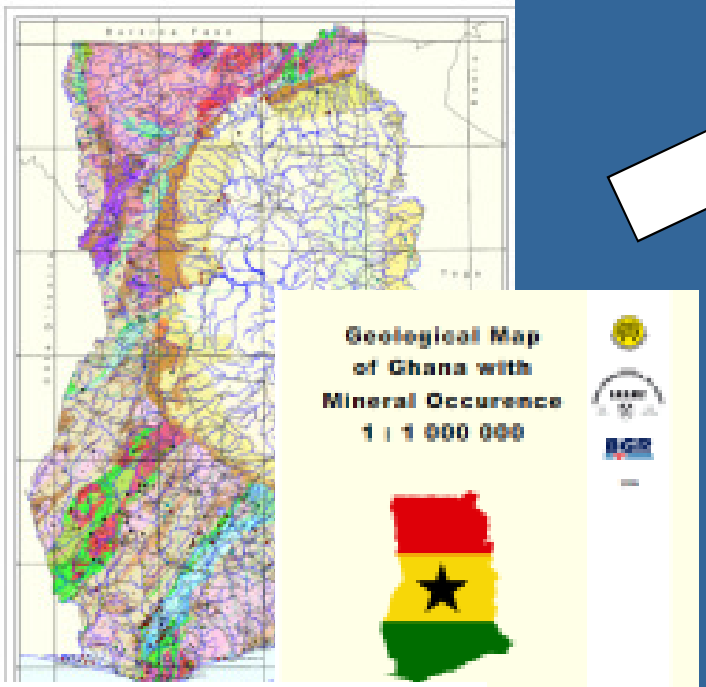
- Exact location
- Genetic type
- Host rocks
- Ressources
- Size
- Producer

- **340 vein/ stockwork deposits/ occurrences**
- **40 placers**
- **30 unclear (excluded)**

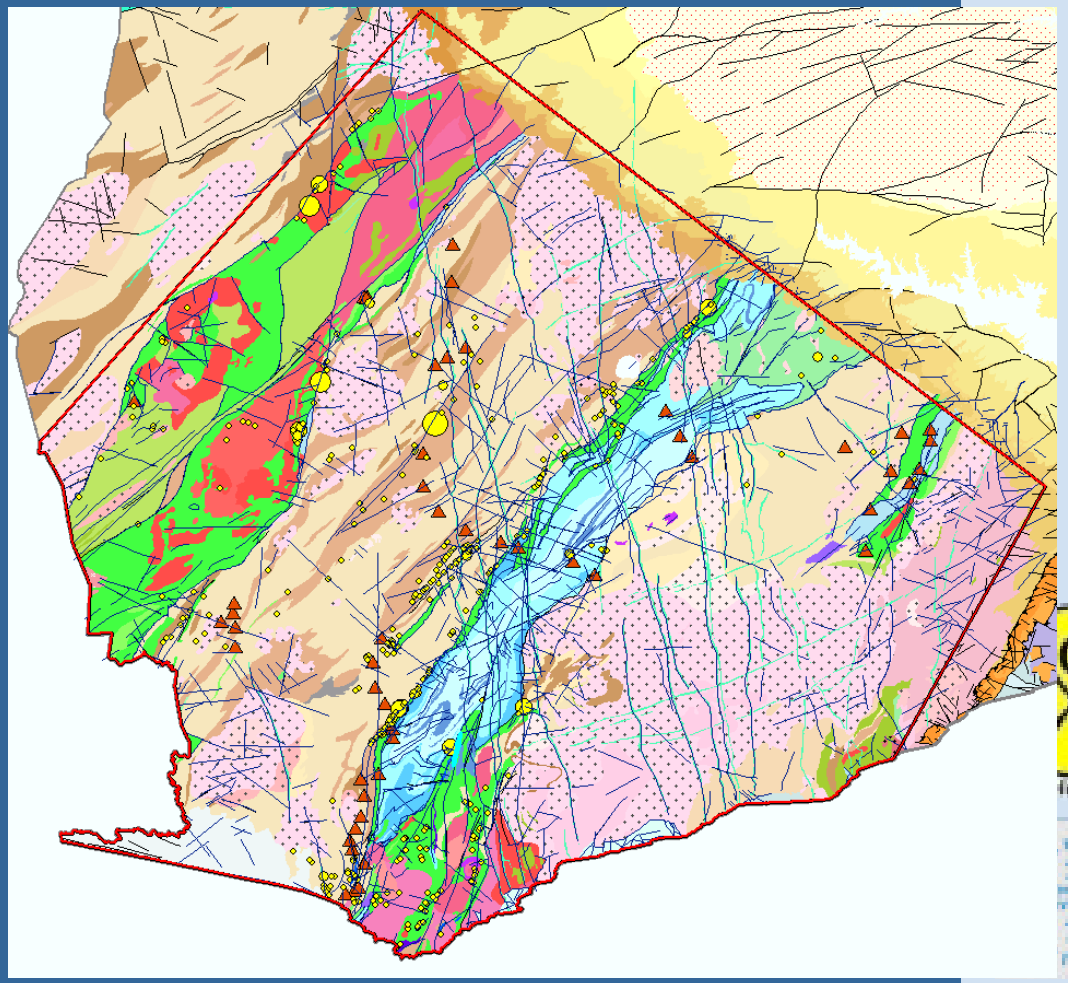
Harmonizing geological & tectonic data



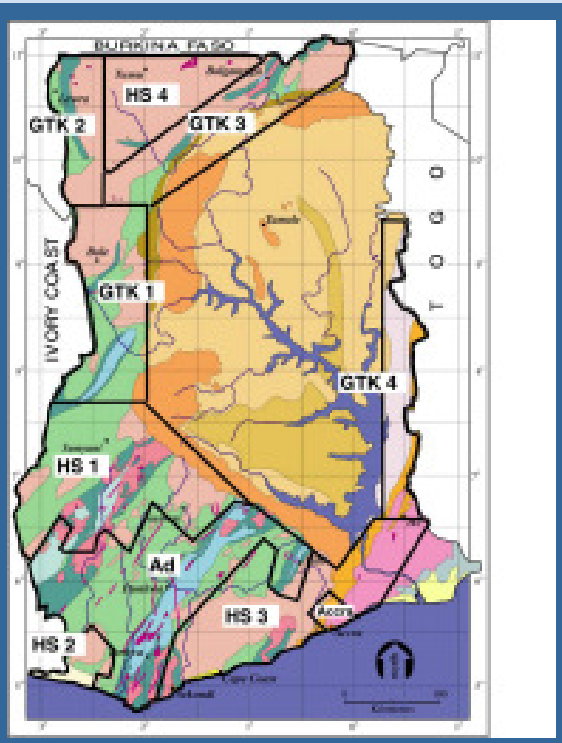
Minerals Commission, Griffis Consulting, 2002

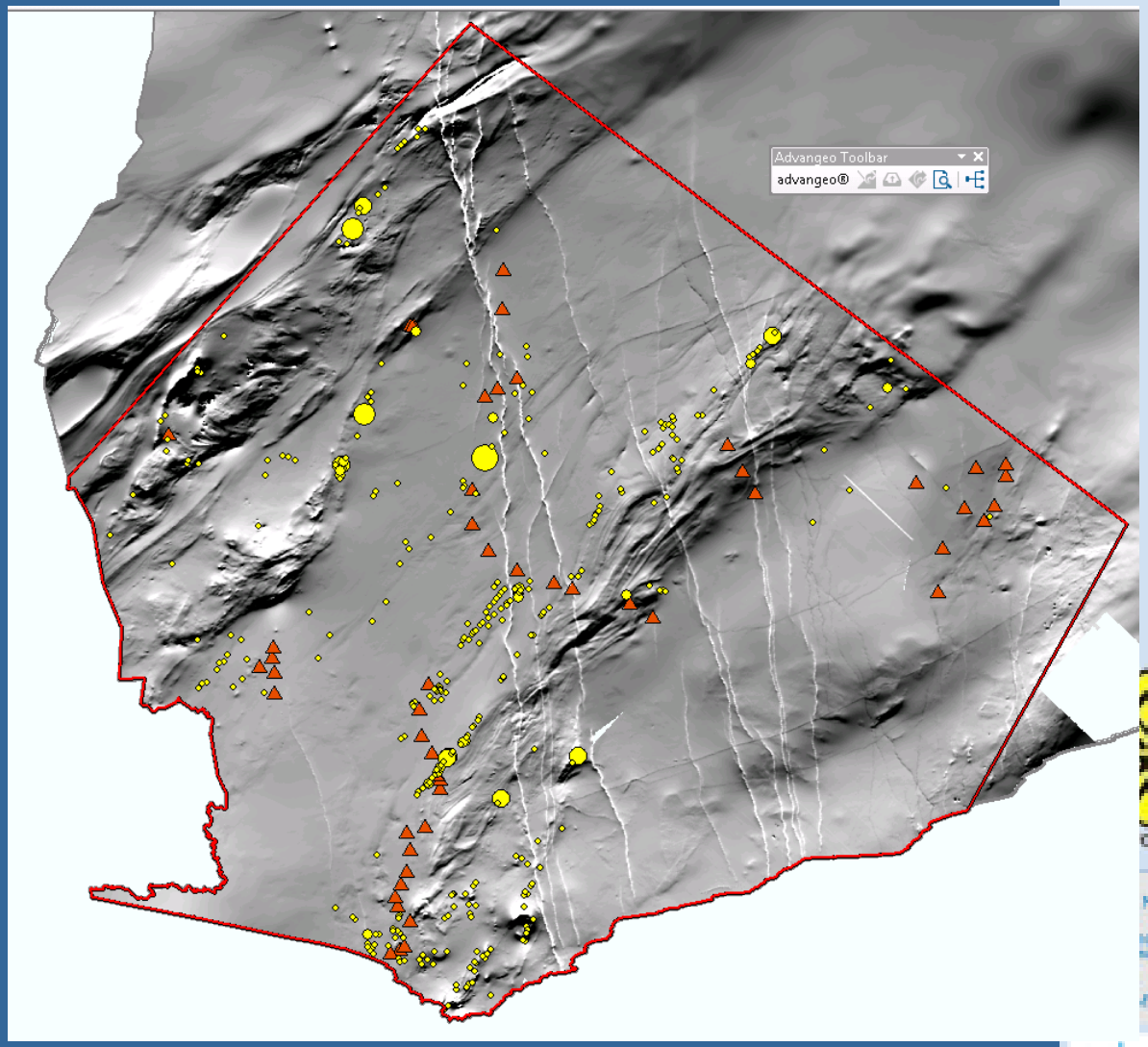


GSD, BGR, 2012



Processing / harmonizing geophysical data





PROCESSING AND INTERPRETATION OF AIRBORNE GEOPHYSICAL DATA

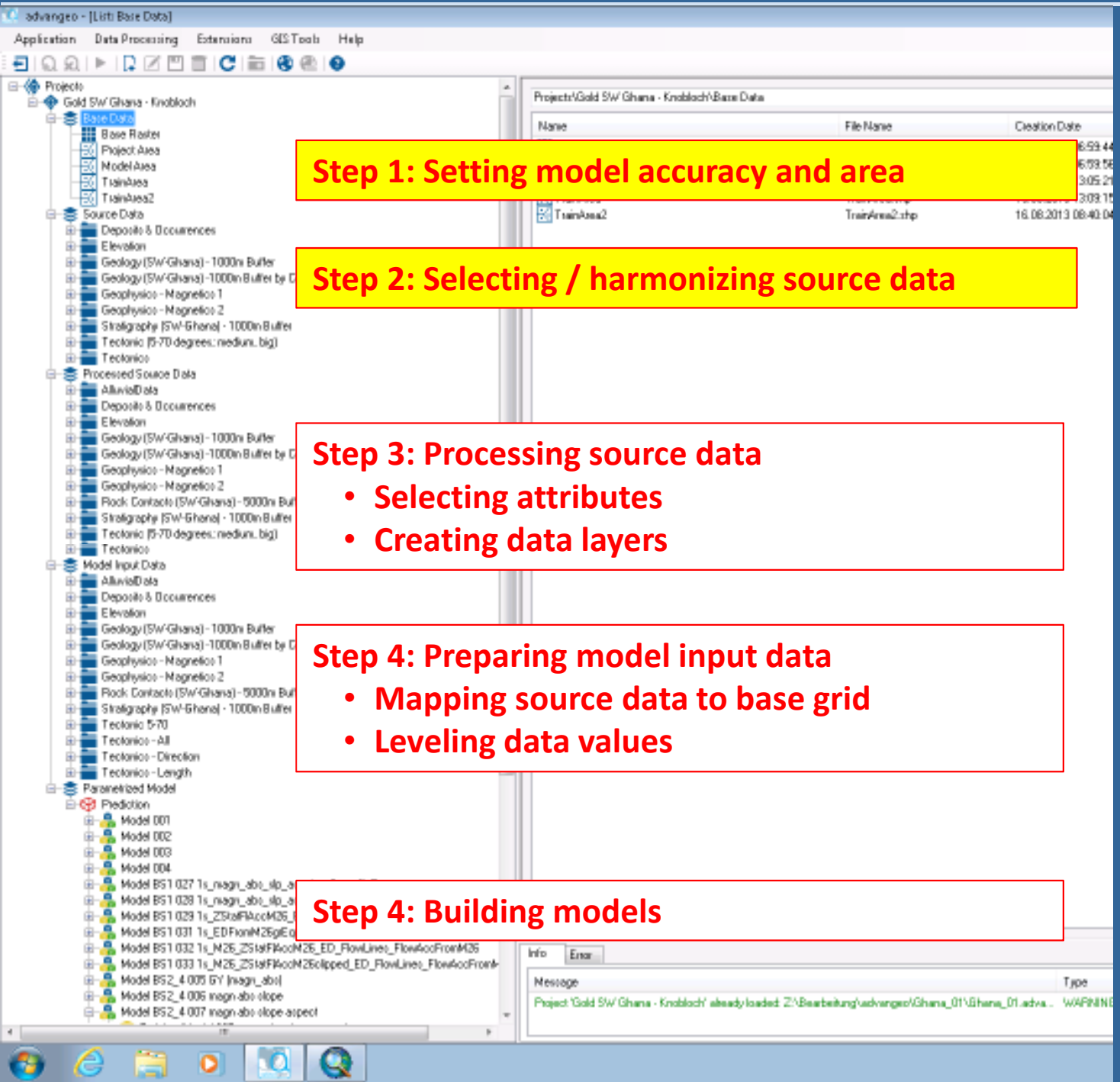
AIRBORNE SURVEY 1999-2000

Philip Yaw Oduro Amoako
Samuel Kwabla Amedofu
Thomas Akamaluk

Geological Survey Department of Ghana

February 2004

Source data preparation finalized



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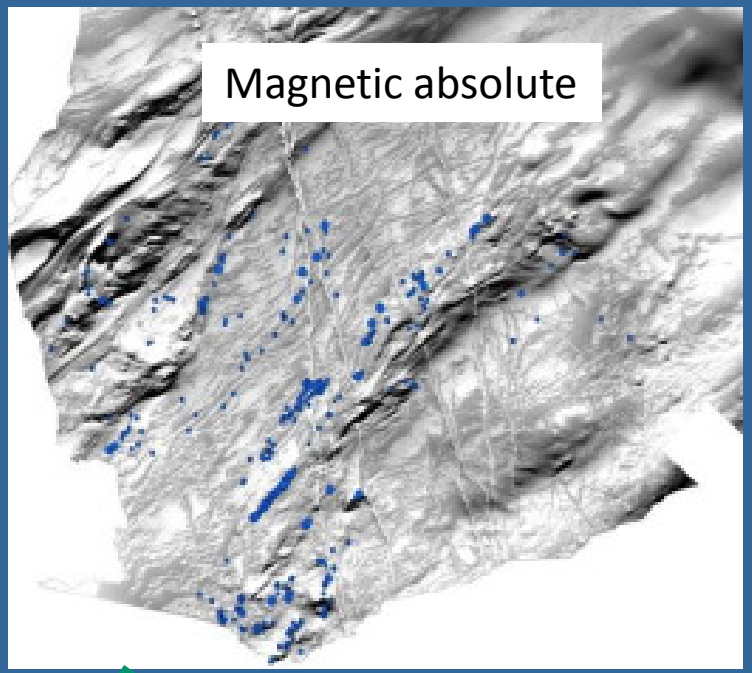
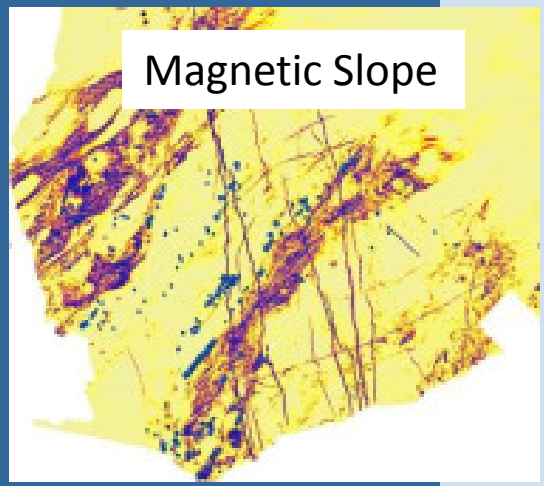
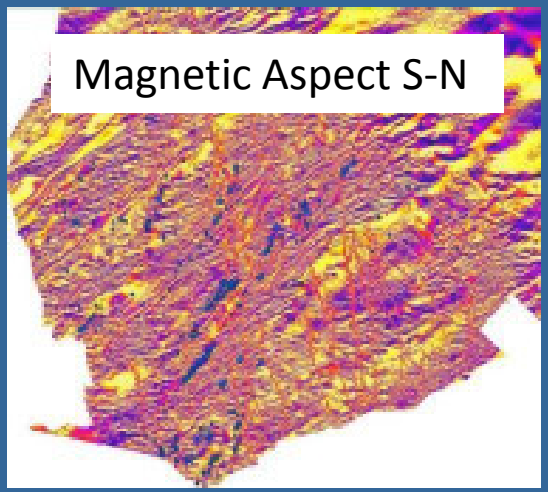
Accuracy:
1.50:000 - 1: 1,000,000

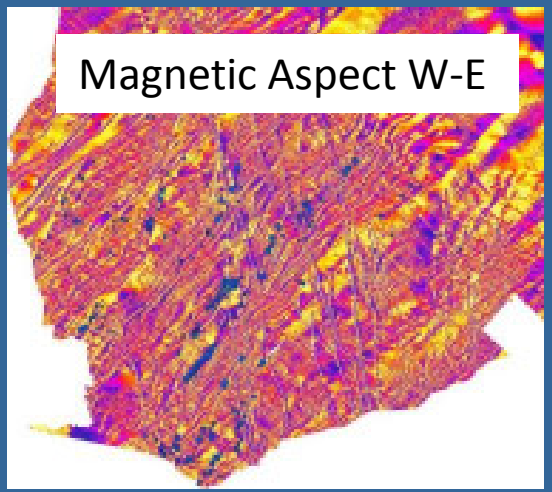
Actuality:
2000 - 2008

Processing magnetic data: the derivatives



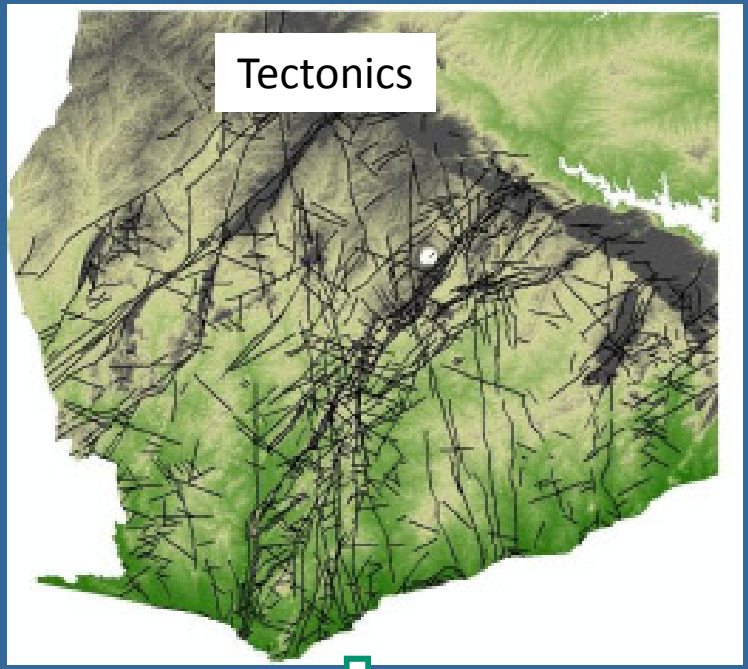




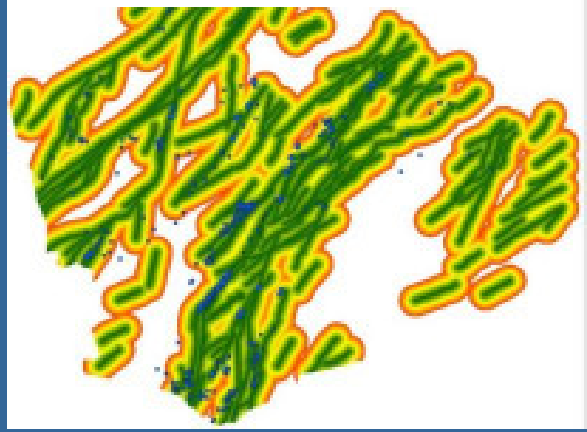


Processing tectonic data: by direction

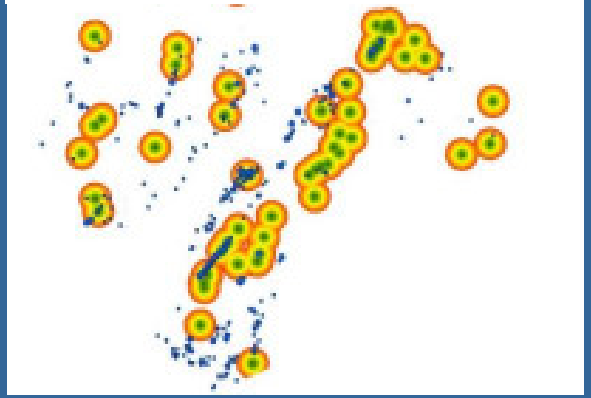
What structures are controlling Au mineralisations ?



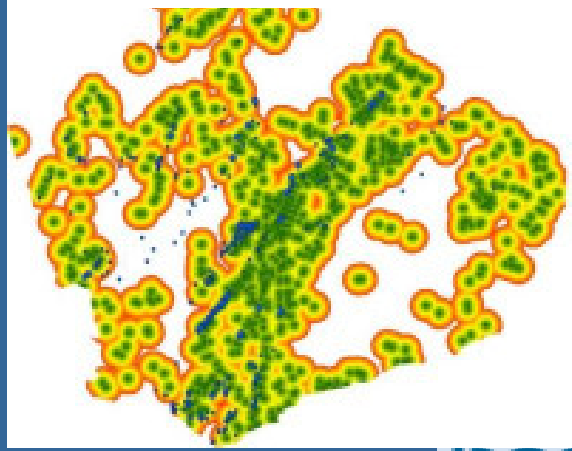
Faults: direction 0-70°



Junctions of Faults: direction 0-70°

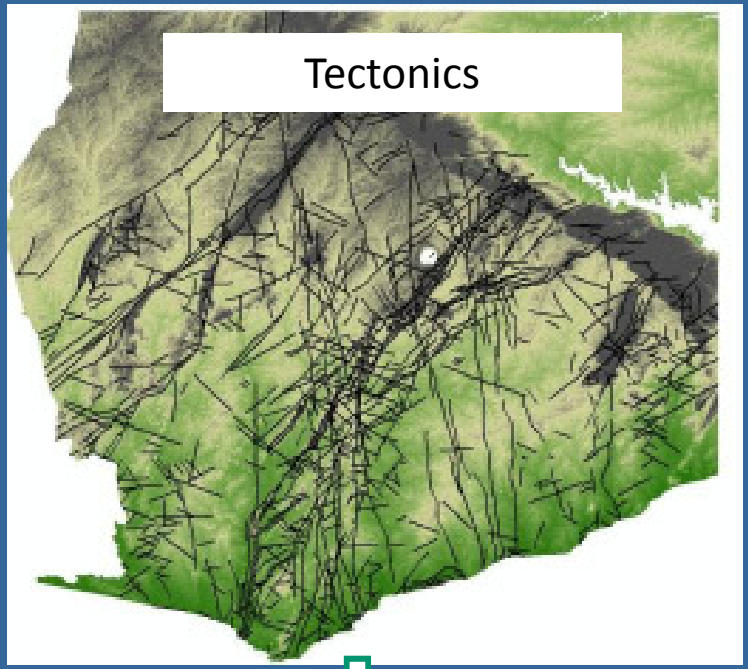


Junctions of all Faults

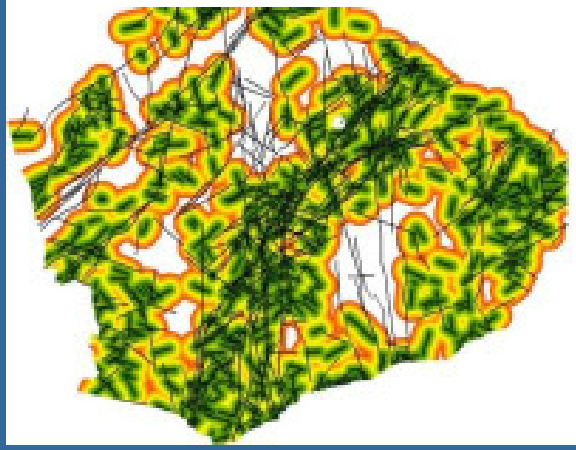


Processing tectonic data: by size

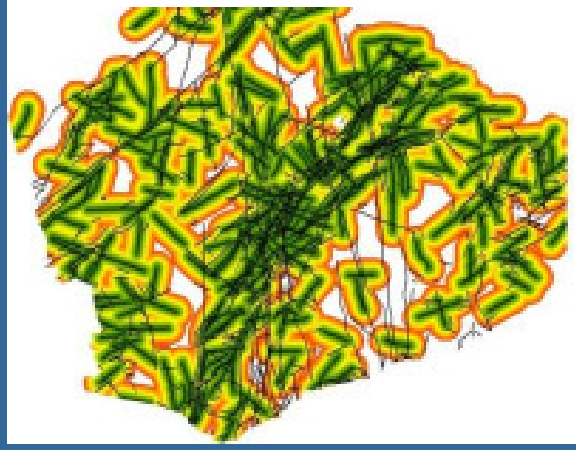
What structures are controlling Au mineralisations ?



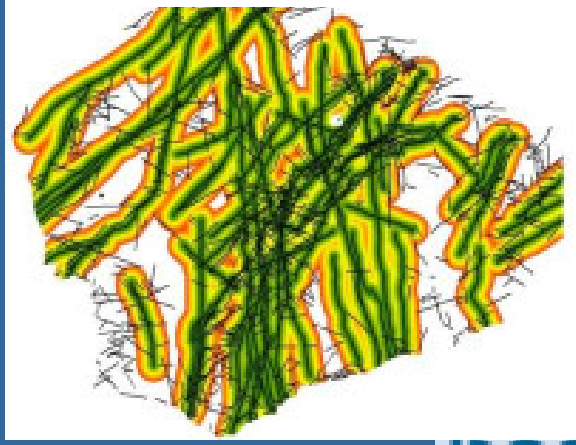
Faults (small < 14km)



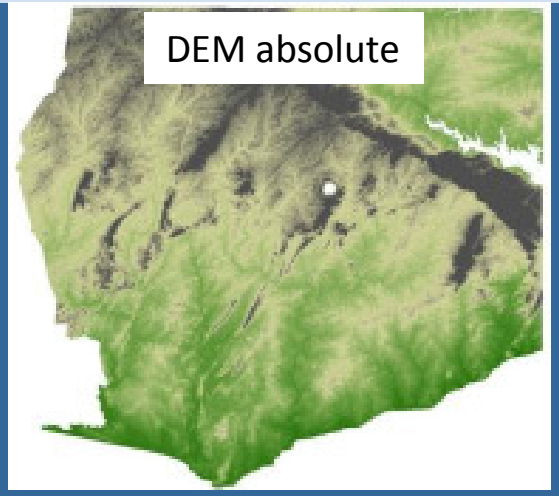
Faults (medium 14-36 km)

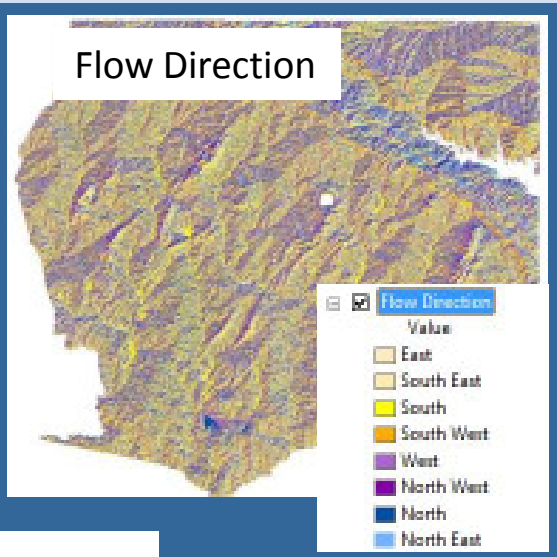


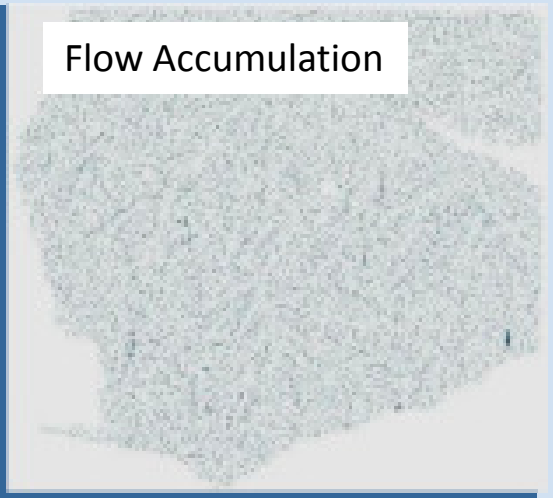
Faults (big > 36km)



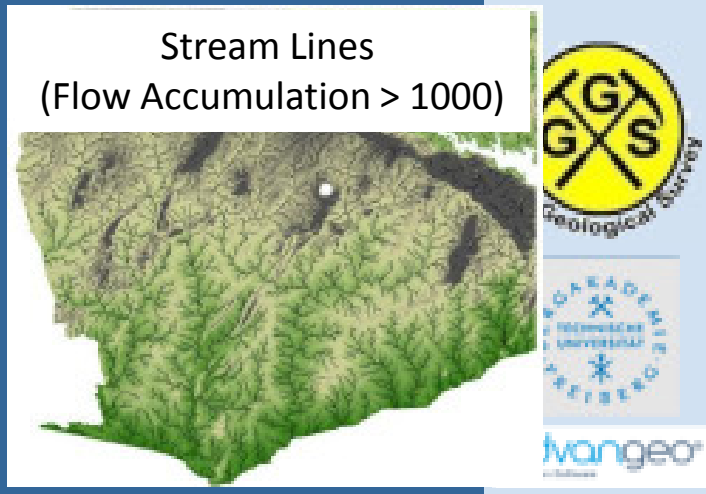
Processing elevation model data

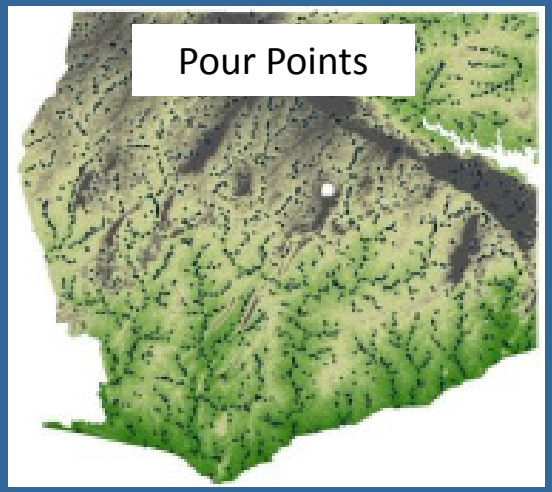


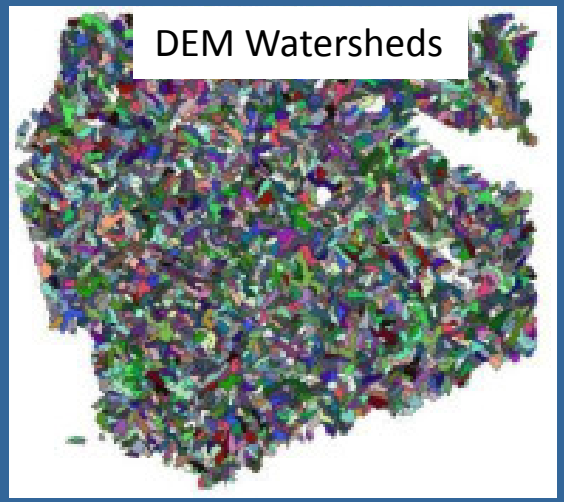




What DTM features are controlling placers ?

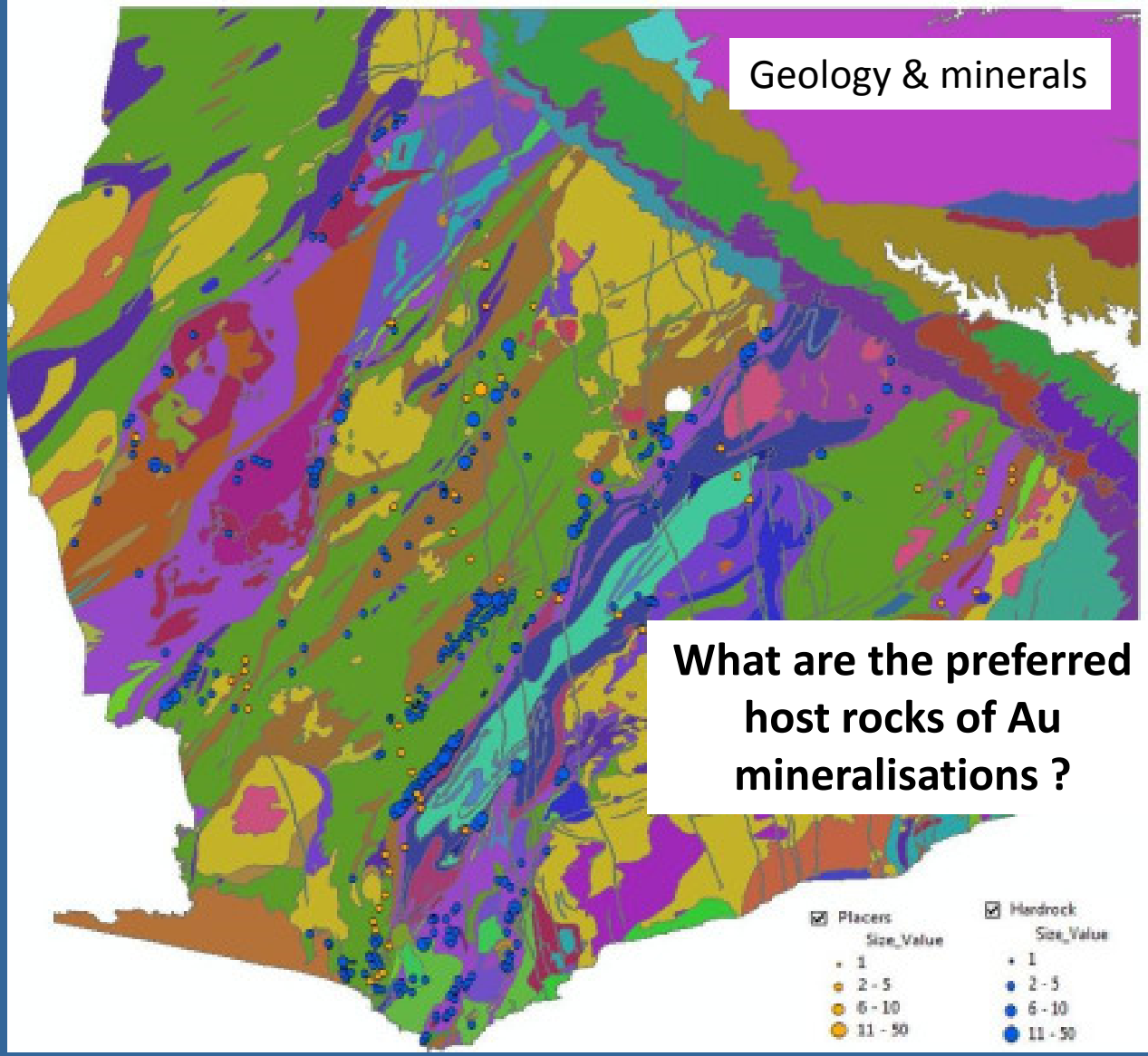


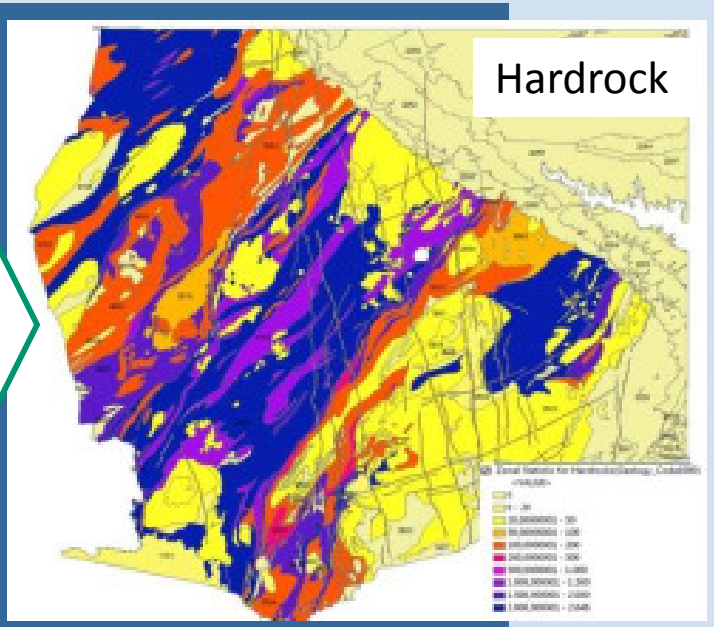


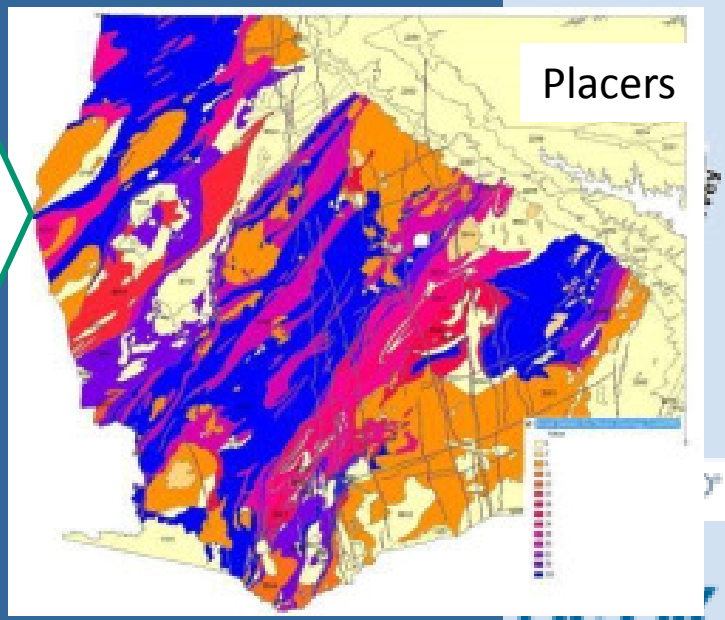


Processing geological data

What are the preferred rock units ?







Model input data finalized

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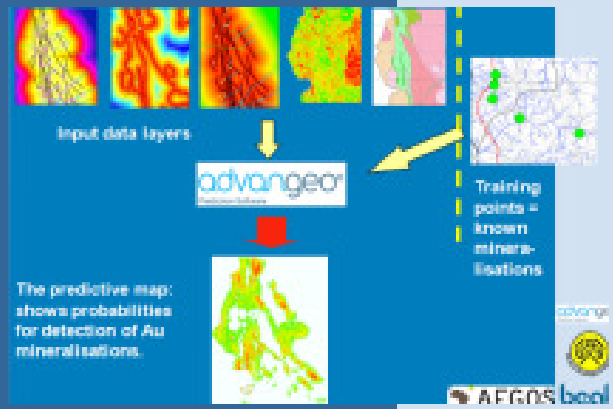
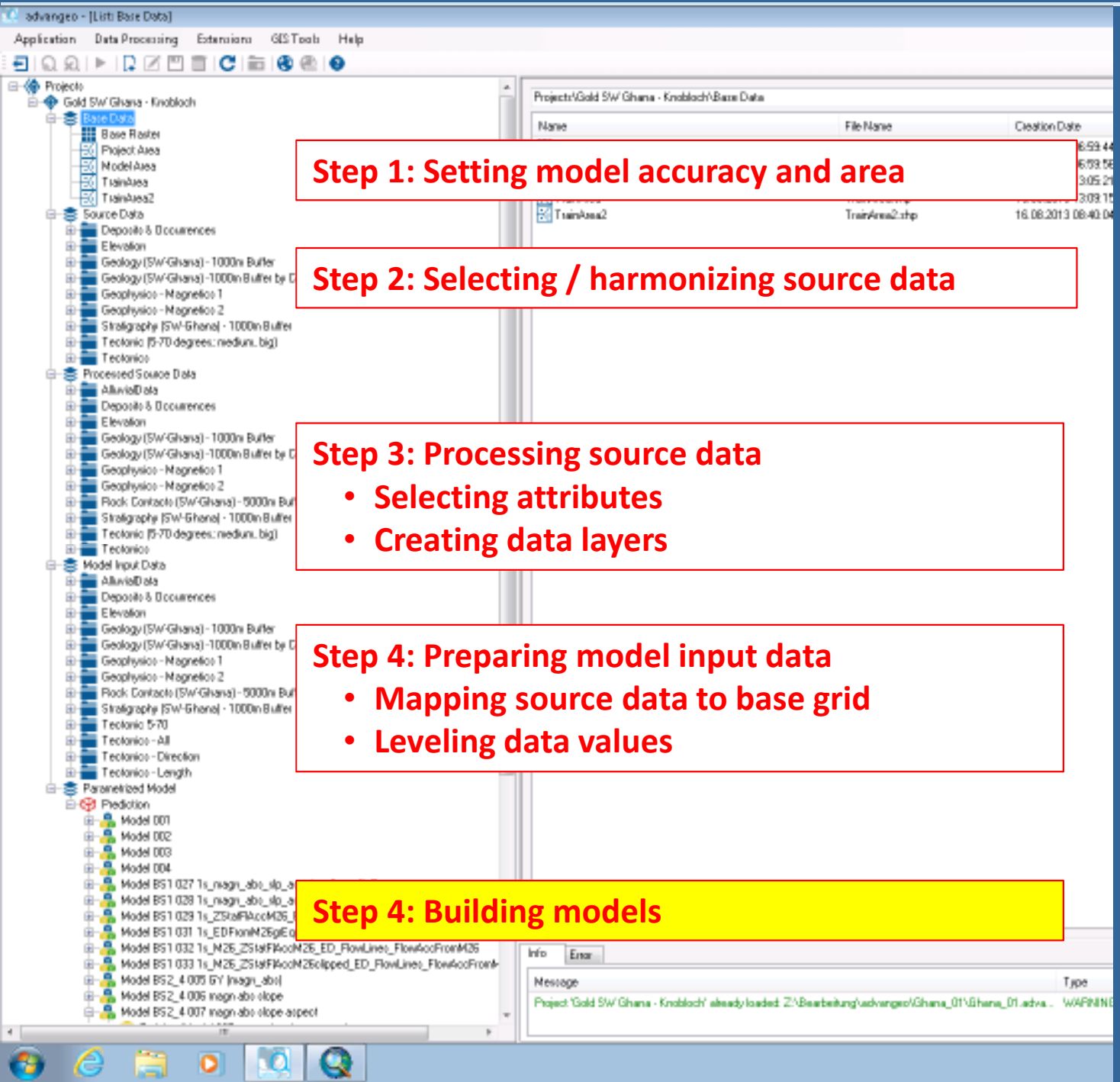


Building the model – hard rock Gold



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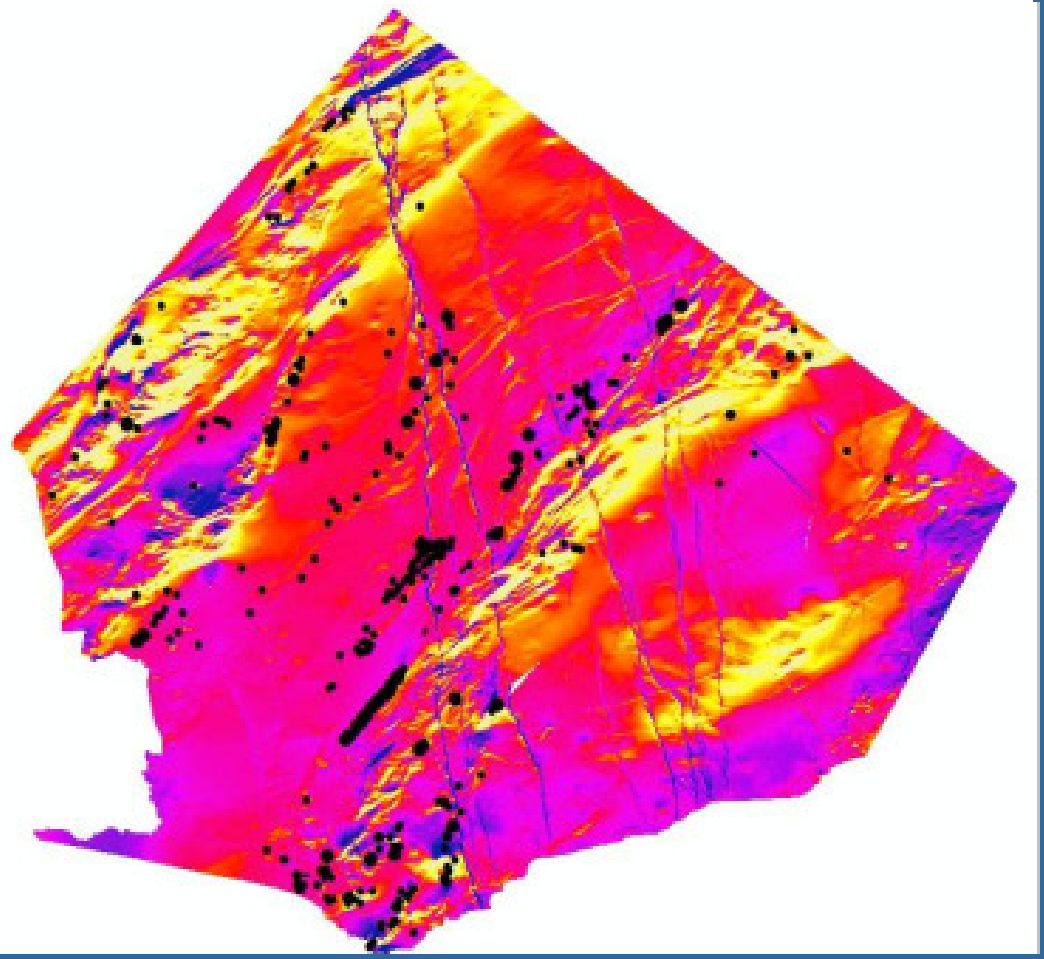
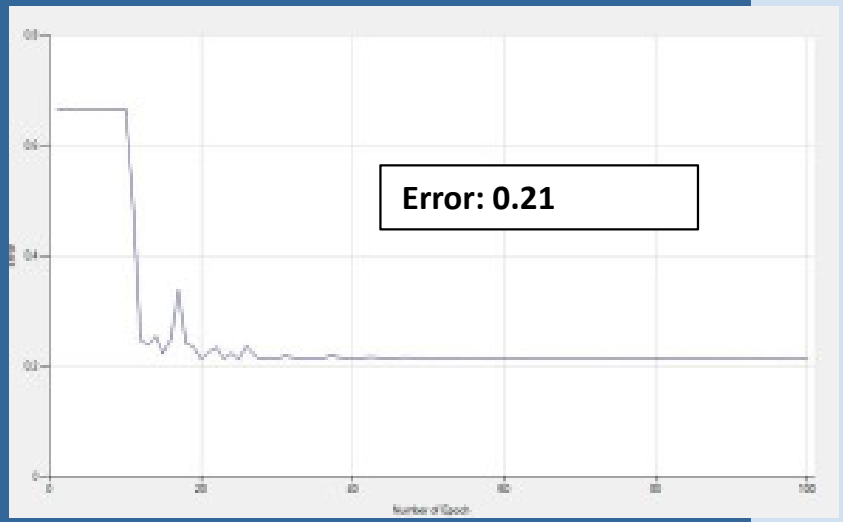
Qualitative models - Is there Gold? Y/N

Magnetics, absolute value

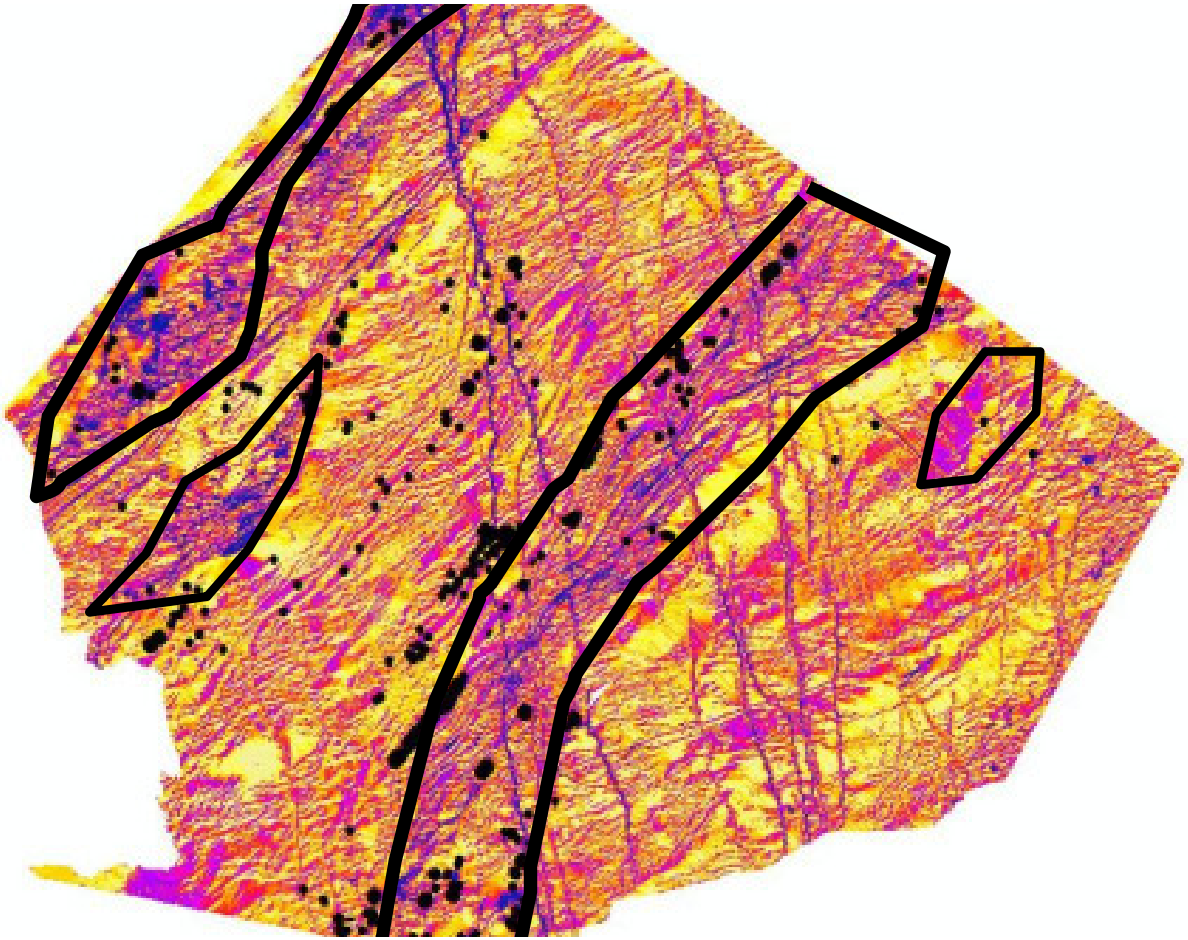


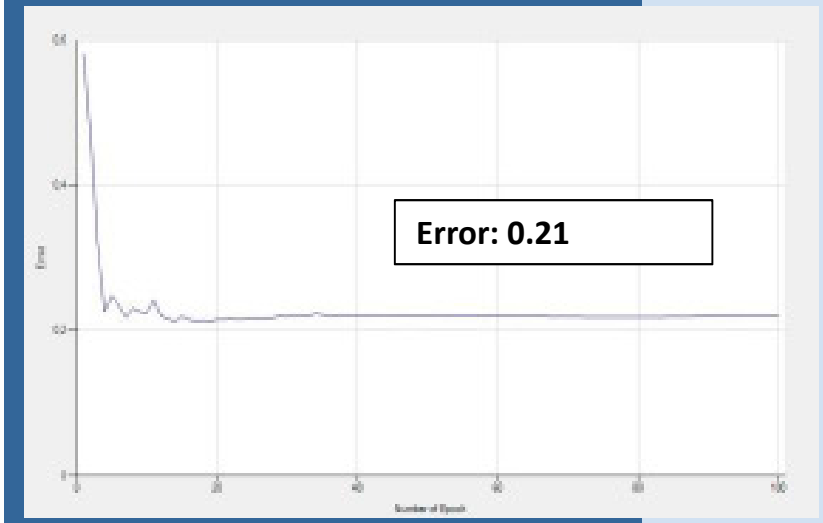


- nearly all Au Occurrences are located in high potential zones,
- the prospective zones are big: >> 50 % of the total area
- the error is big: >0.2

Magnetics, all derivatives

Magnetics, slope, aspect

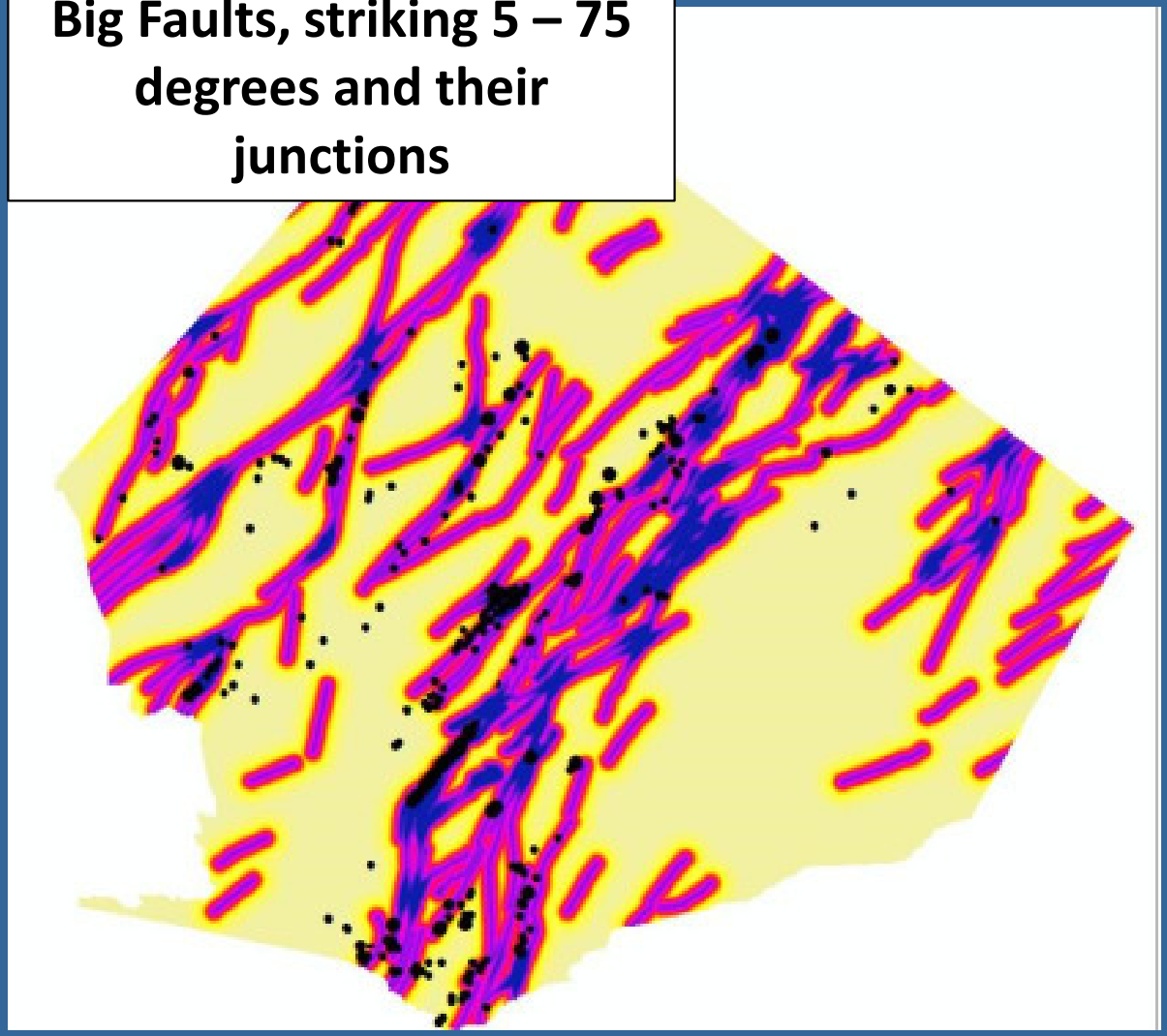


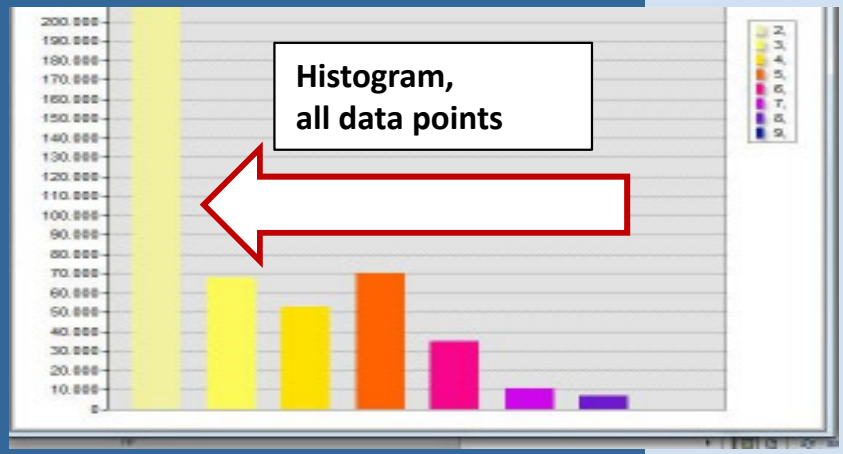


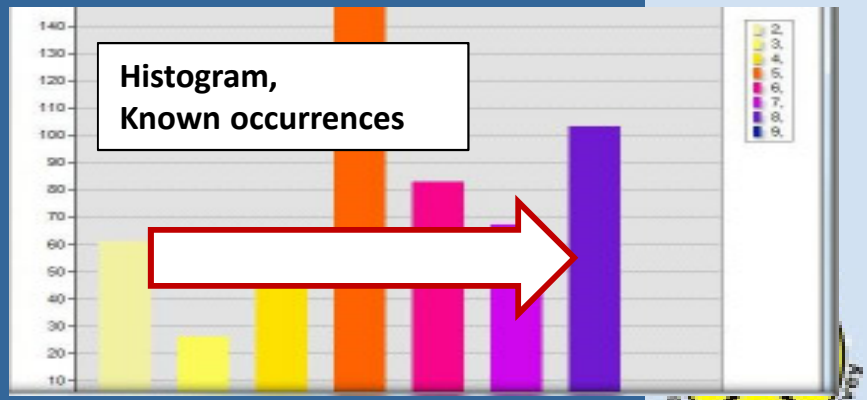
- there are some patterns of relationship ,
- the prospective zones are still big: > 50 % of the total area
- the prospective zones are spread over the entire area
- some target zones are exposing
- the error is still too big: >0.2

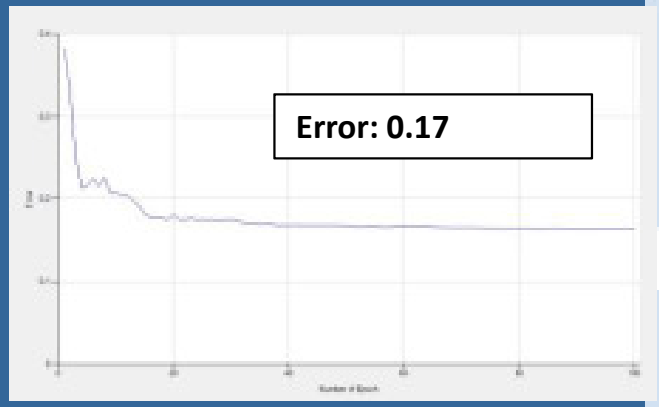
Tectonics I

Big Faults, striking 5 – 75 degrees and their junctions



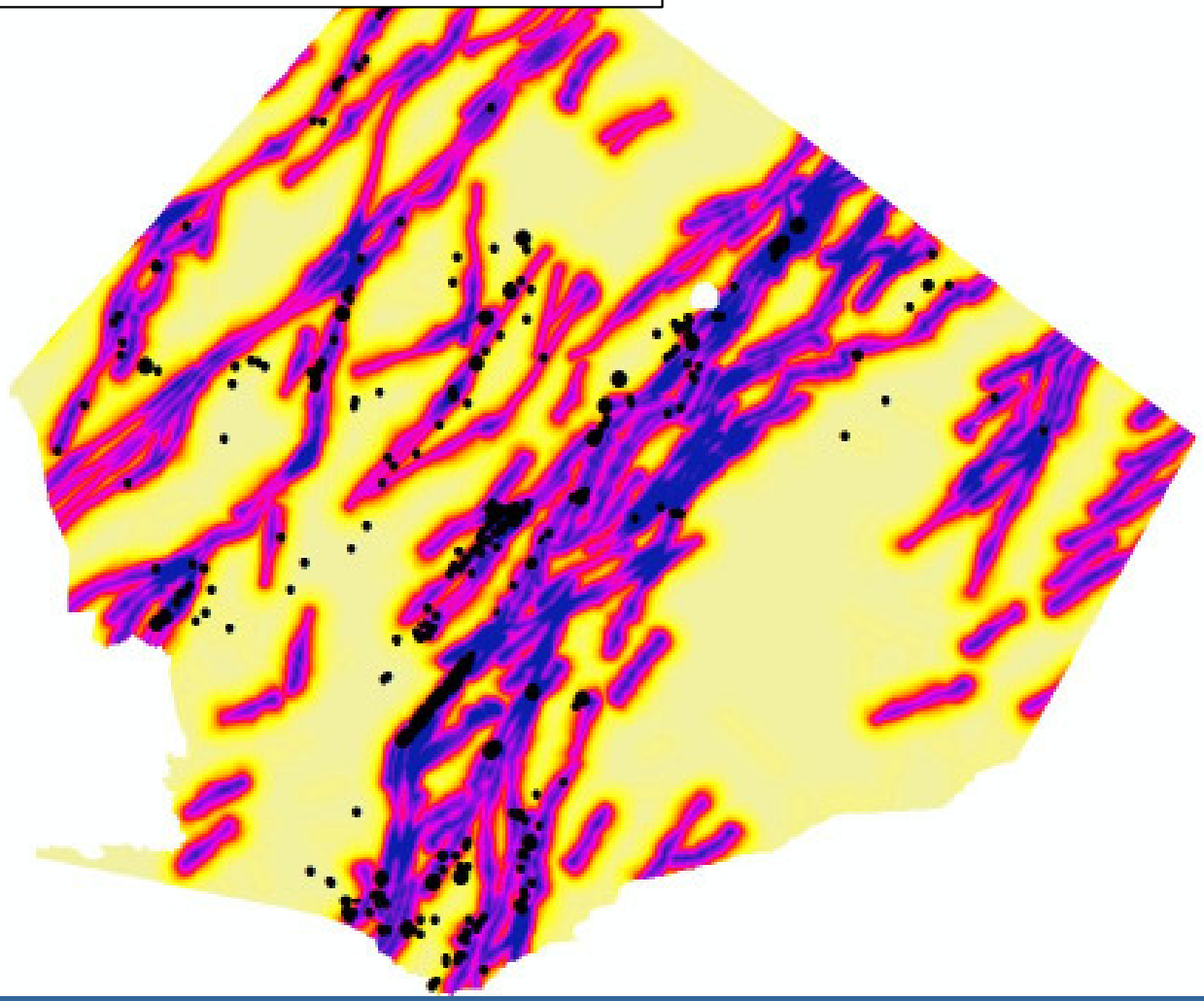


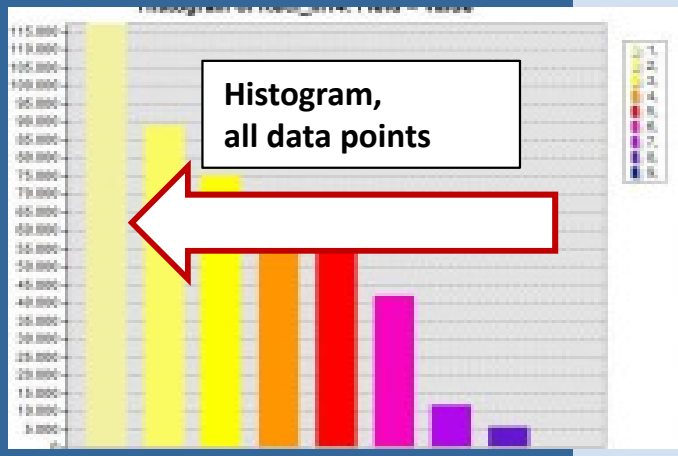


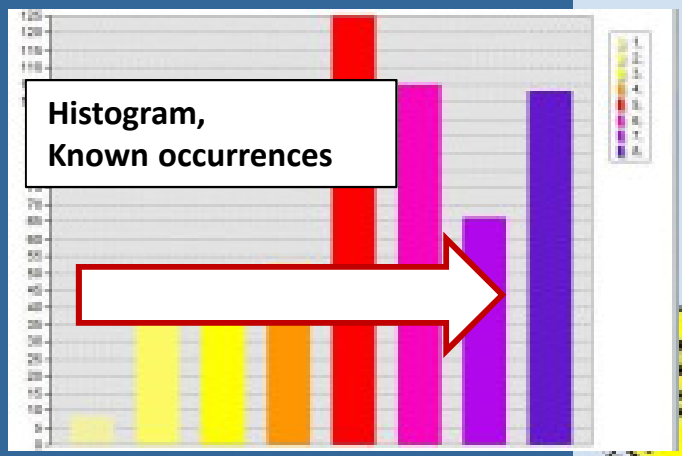


Tectonics II

Big Faults, striking 5 – 75 degrees and their junctions, any small faults

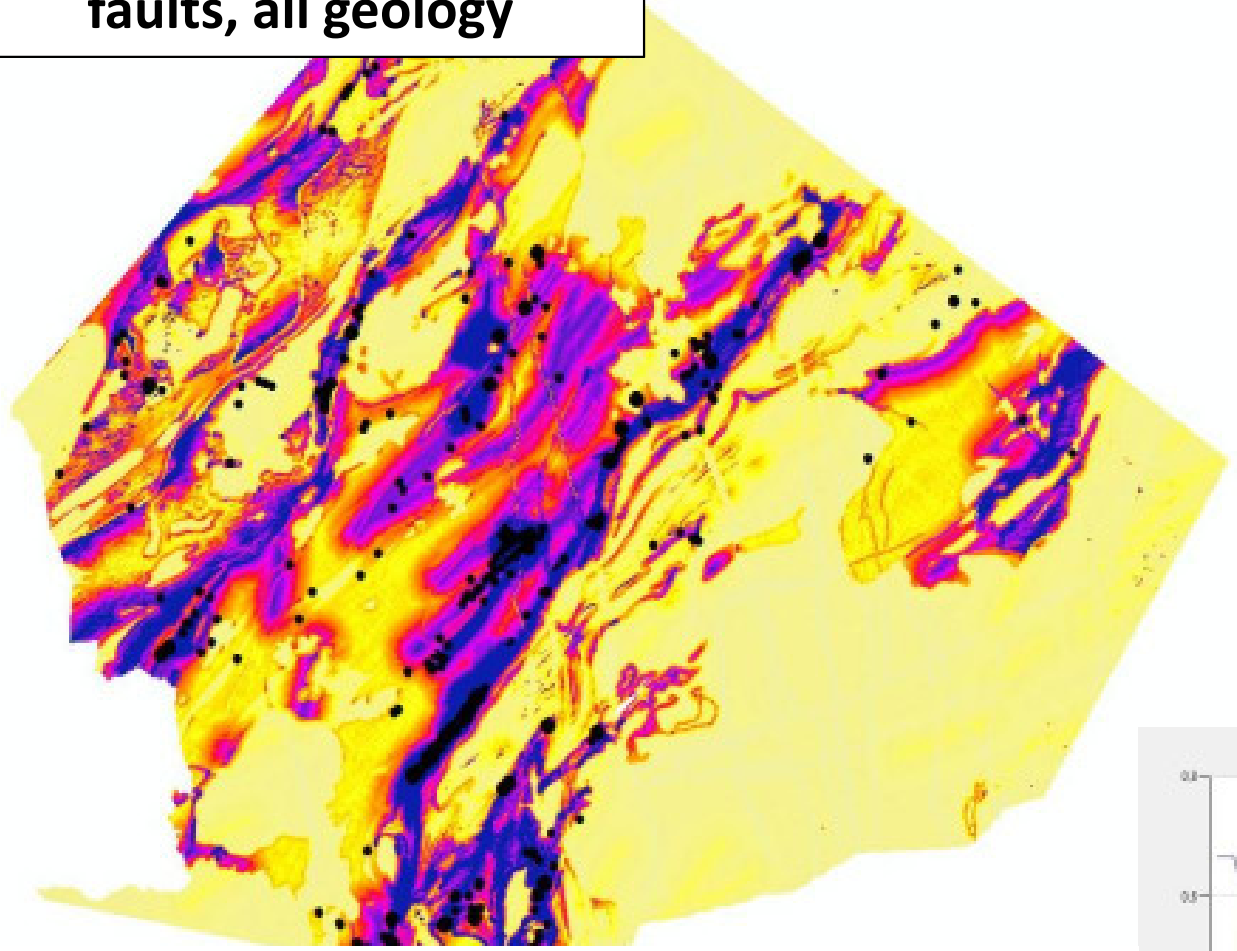


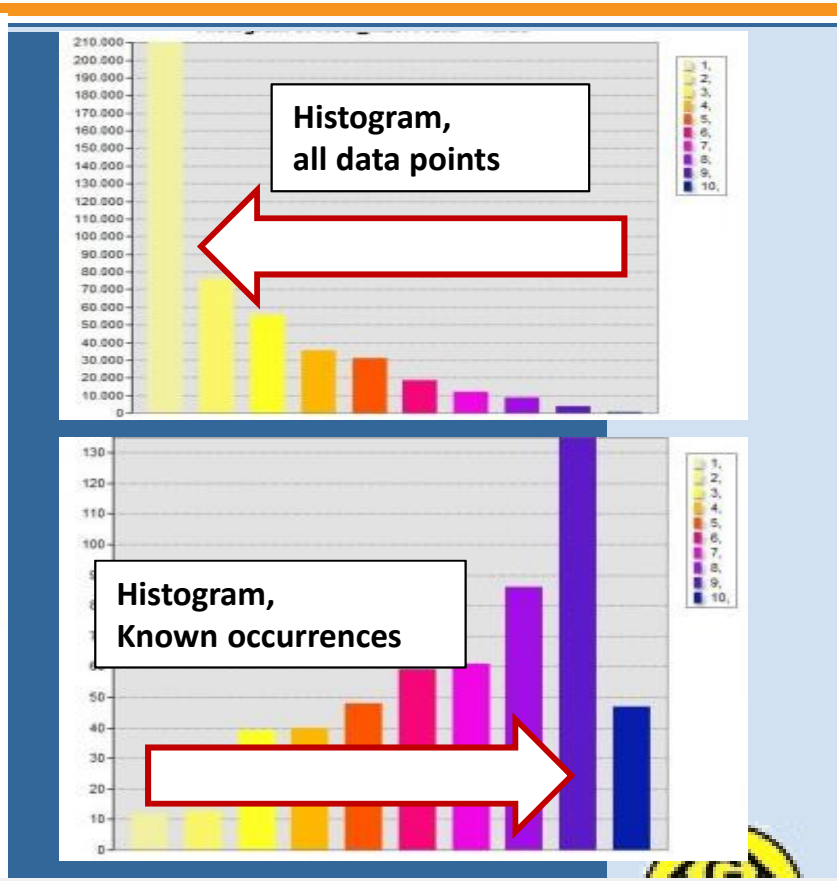


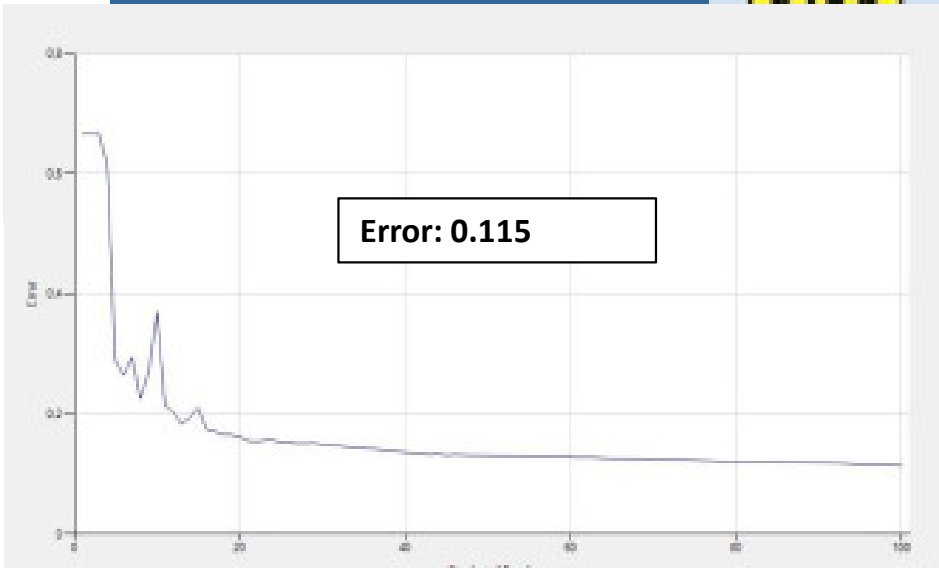


All data

Big Faults, striking 5 – 75° degrees and their junctions, any small faults, all geology

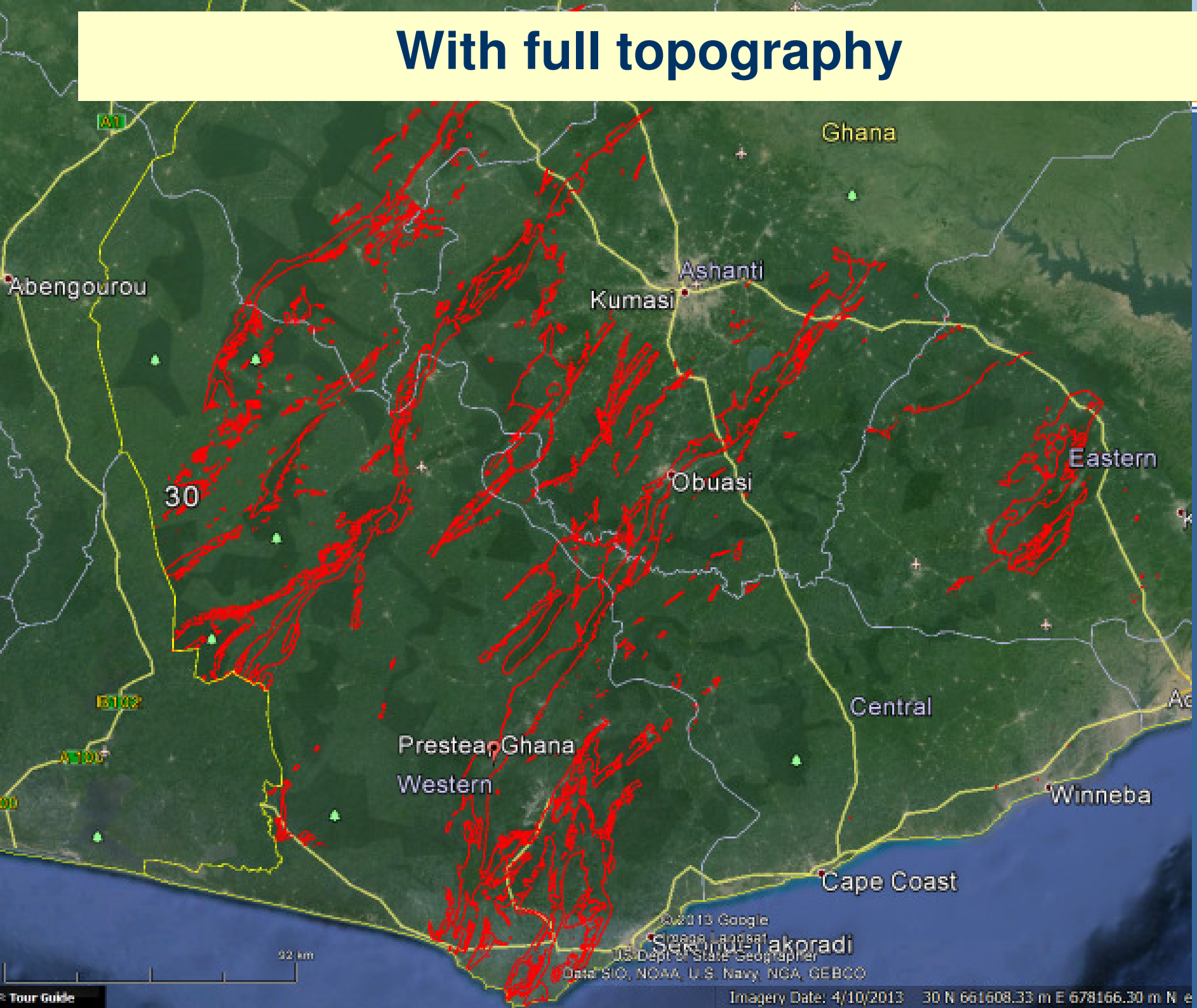






- very clear spatial pattern
- the prospective zones are small
- the prospective zones are focused
- most of known occurrences are located in high potential areas
- the error is low: approx. 0.15

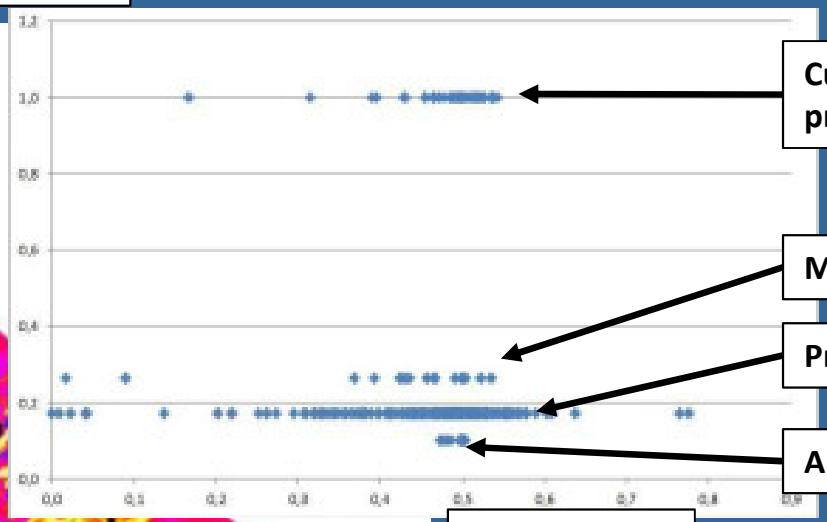
With full topography



Quantitative models: How big is a potential target?

Reality

Magnetics, absolute value



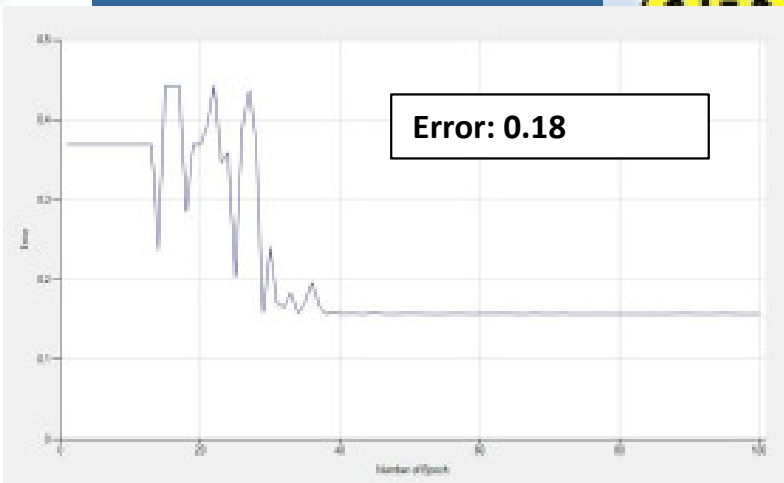
Current/ past producer

Major prospects

Prospects

Anomalies

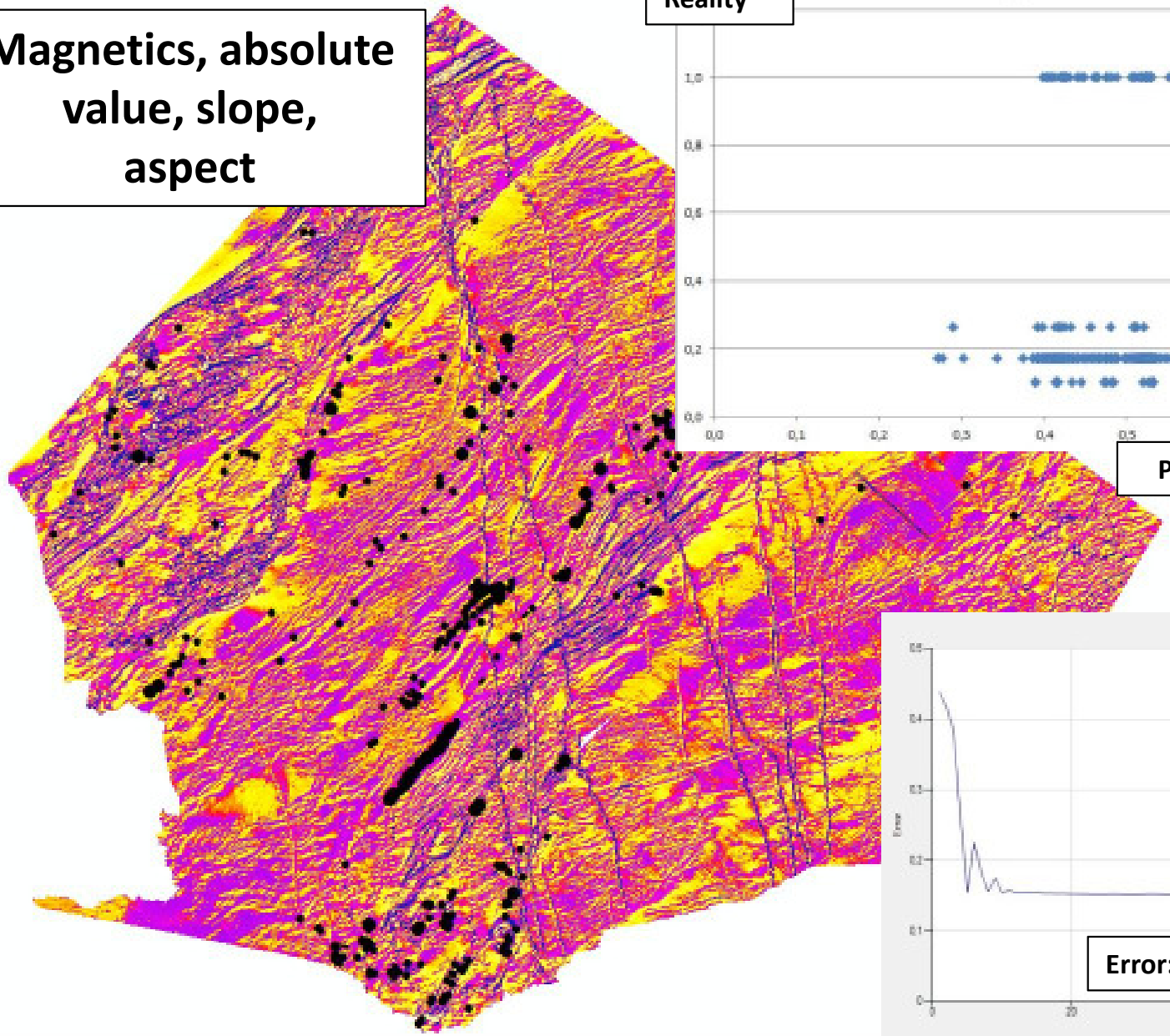
Prediction



Error: 0.18

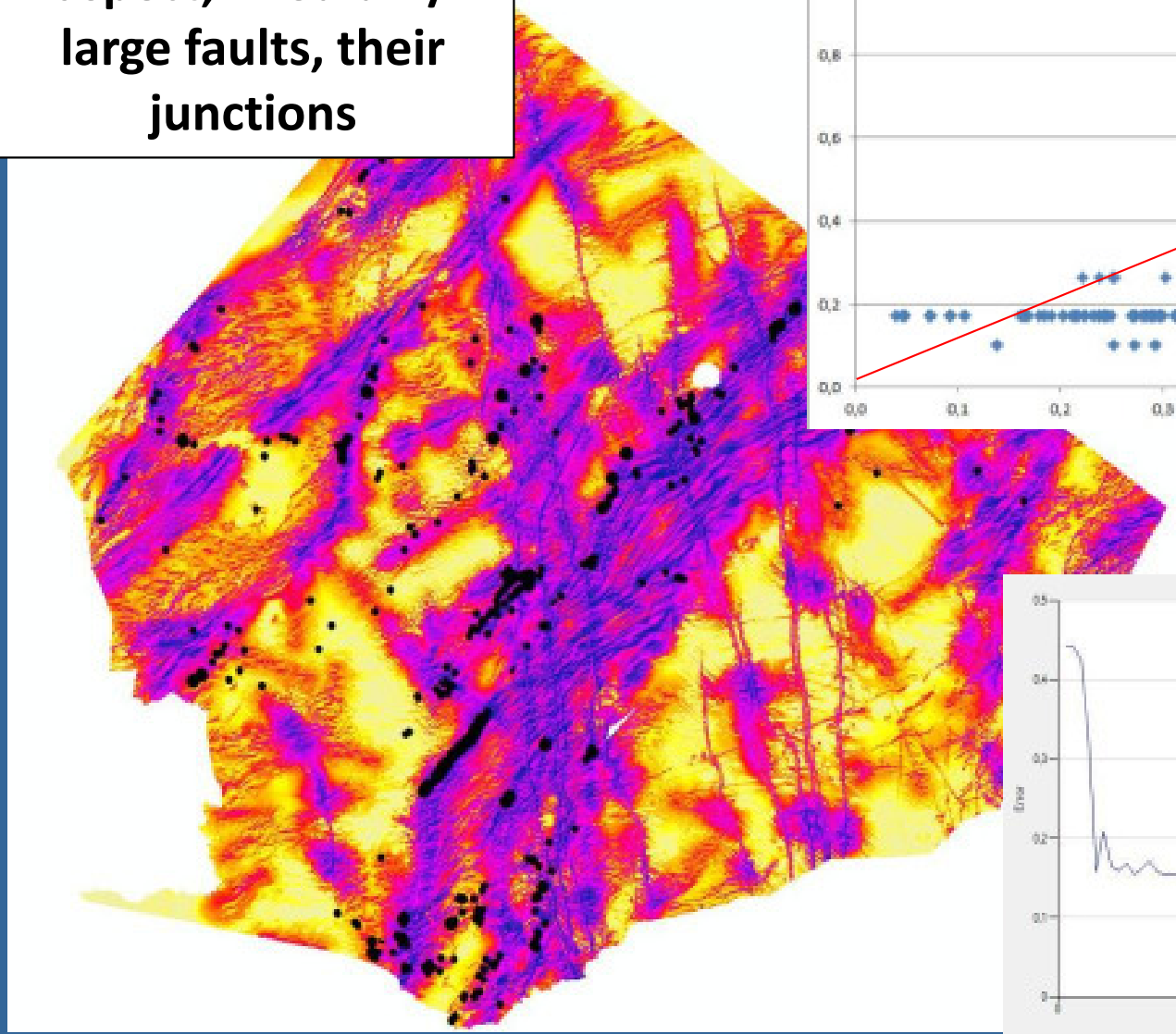
Quantitative models: How big is a potential target?

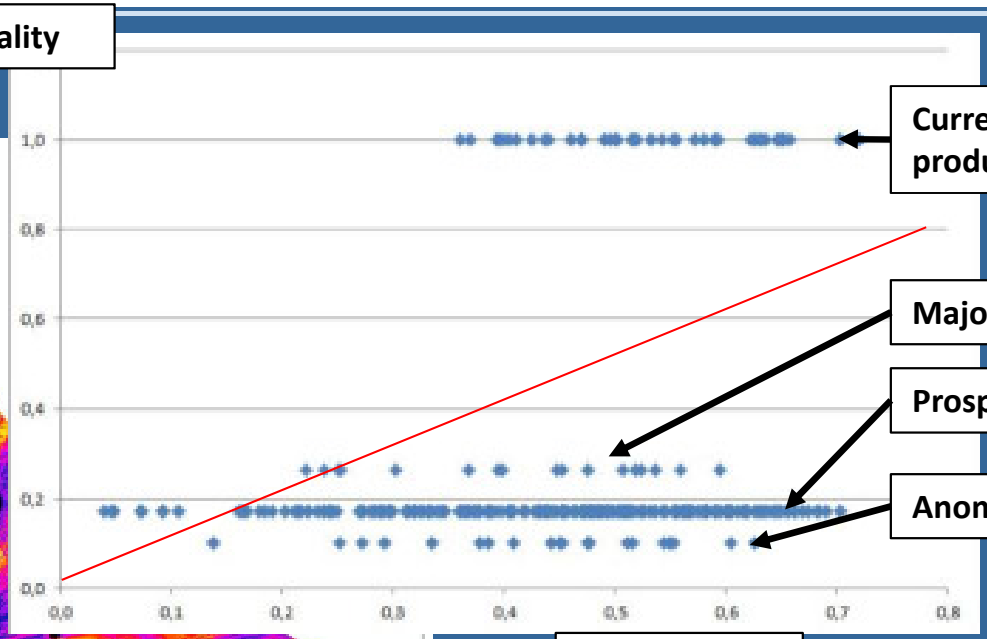
Magnetics, absolute value, slope, aspect

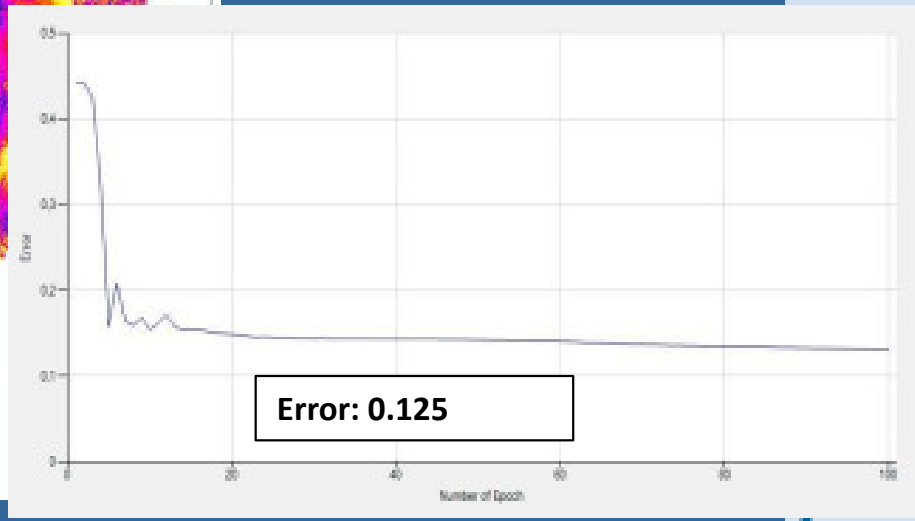


Quantitative models: How big is a potential target?

Magnetics, absolute value, slope, aspect, medium/ large faults, their junctions

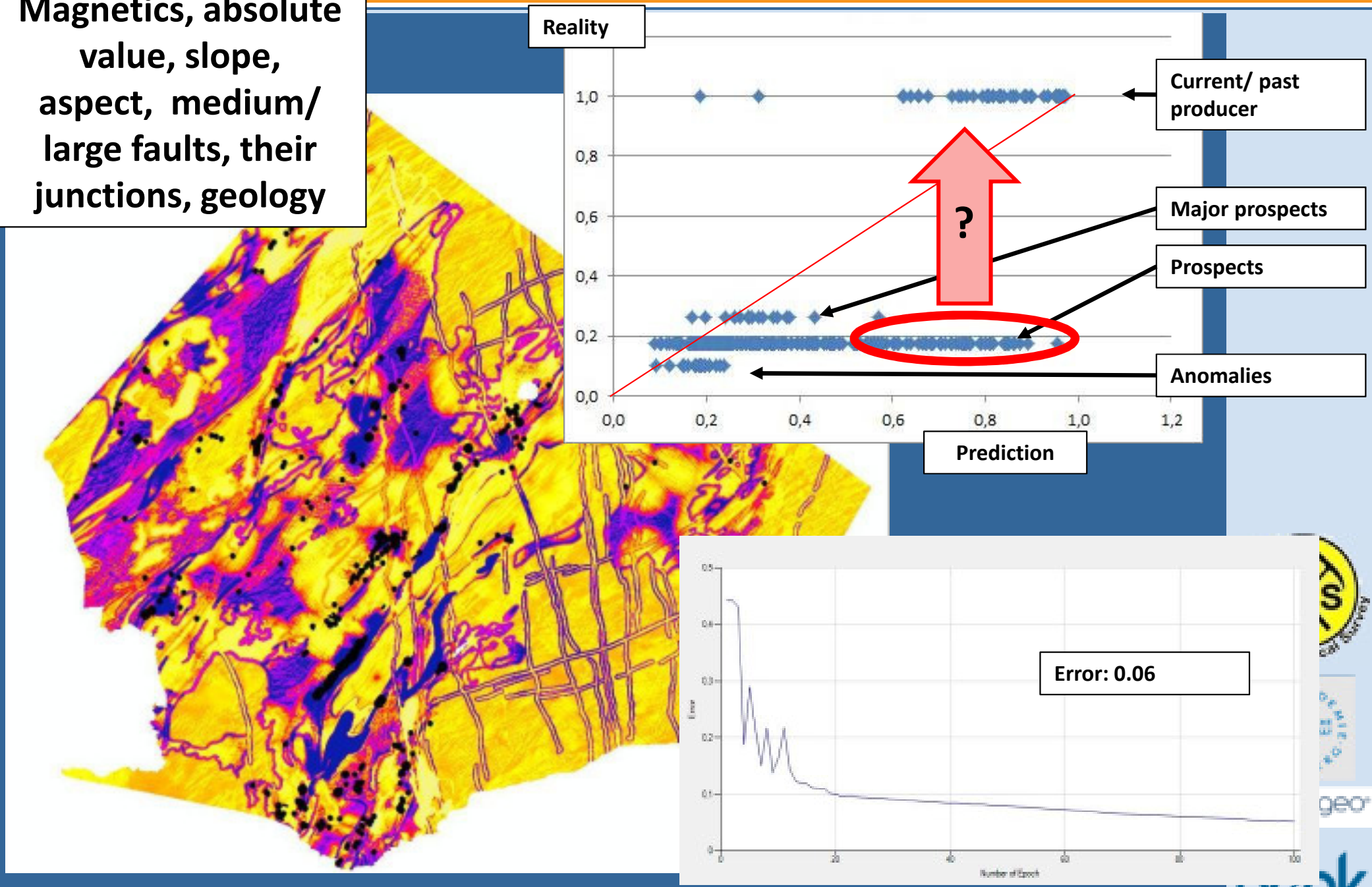




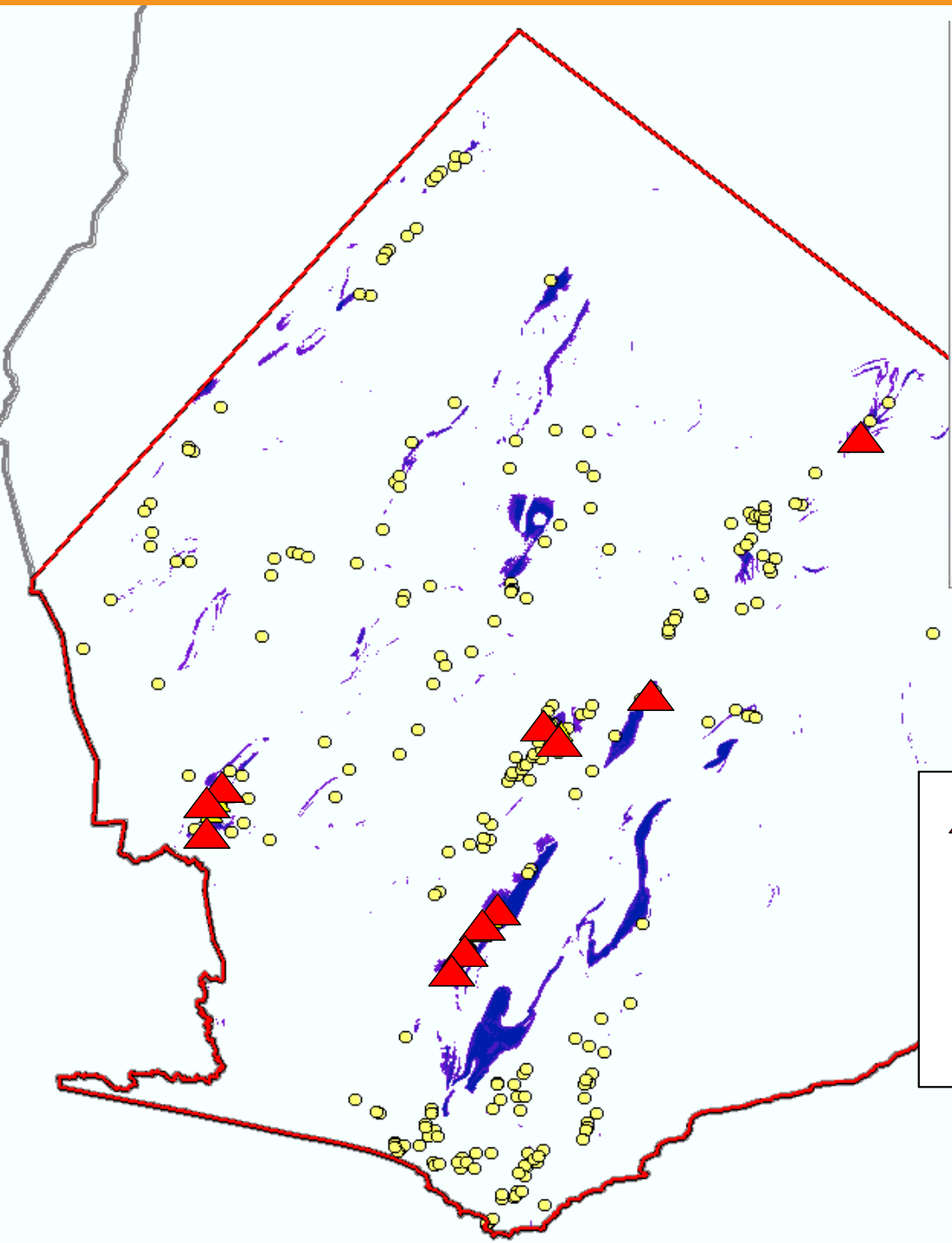


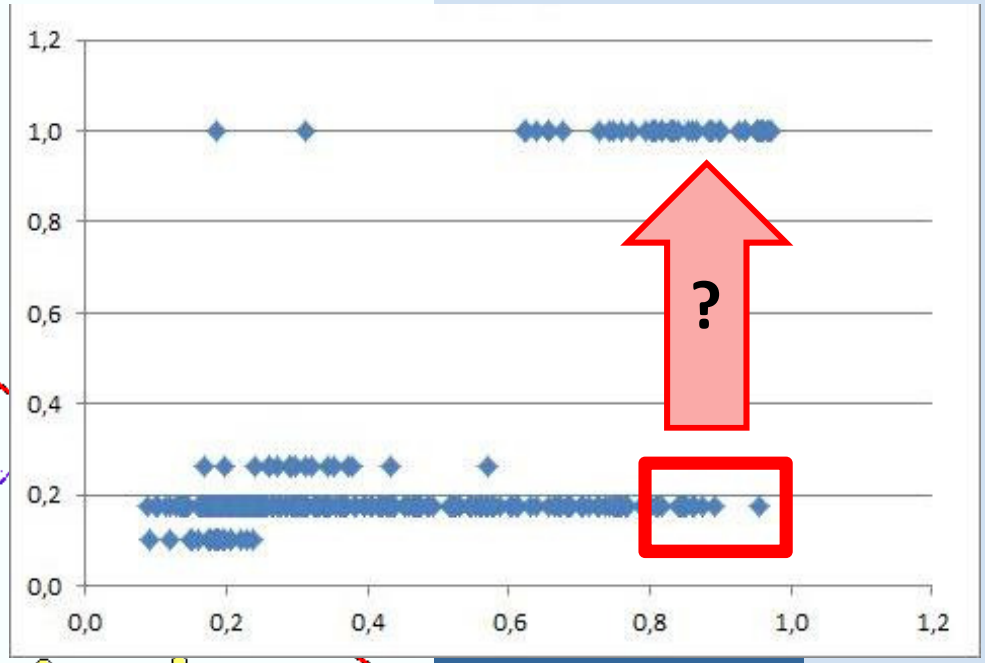
Quantitative models: How big is a potential target?

Magnetics, absolute value, slope, aspect, medium/ large faults, their junctions, geology



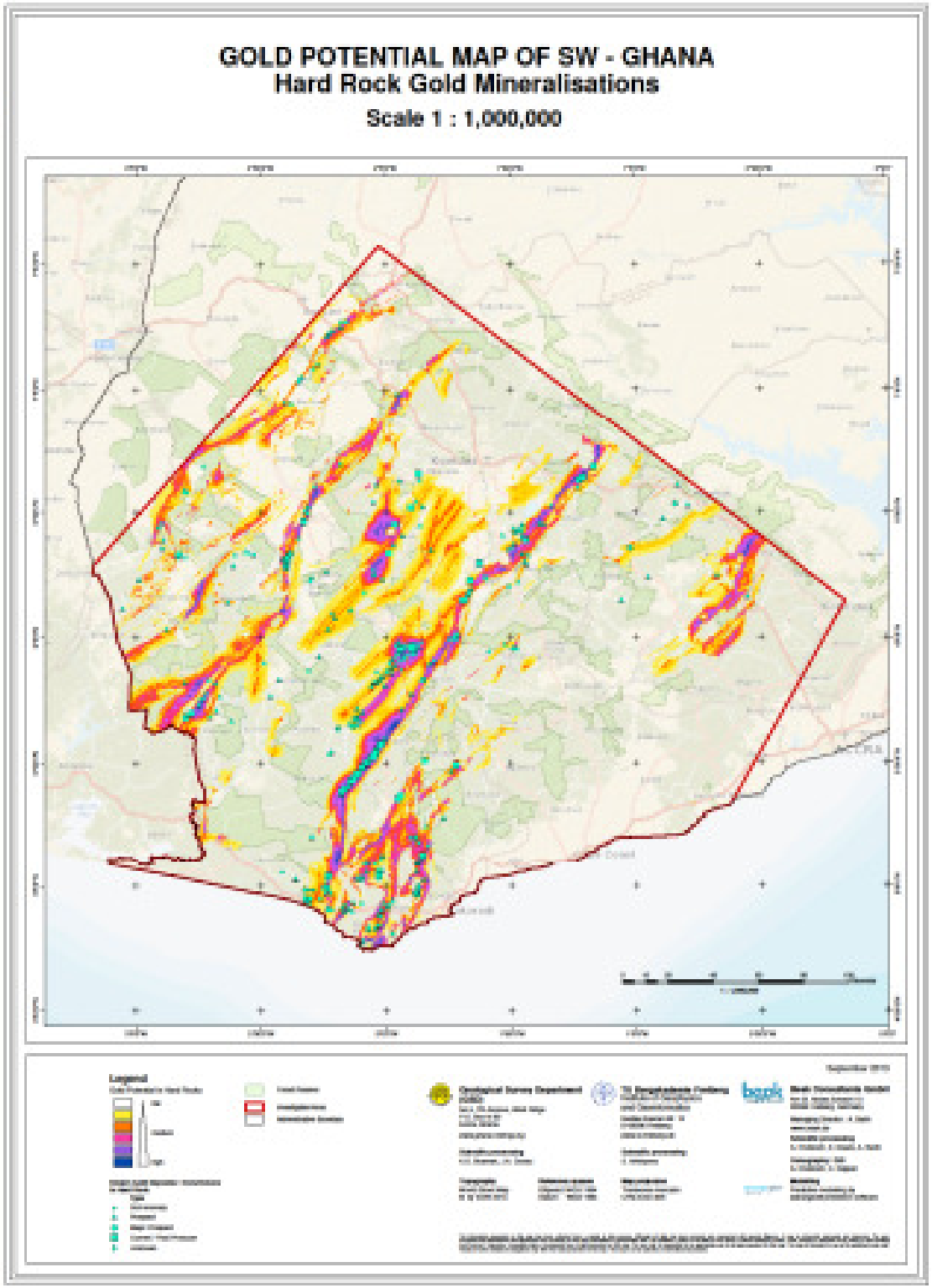
Where are the most prospective targets ?





▲ **Prospects located in areas with a potential of > 0.8**

● **All other prospects**



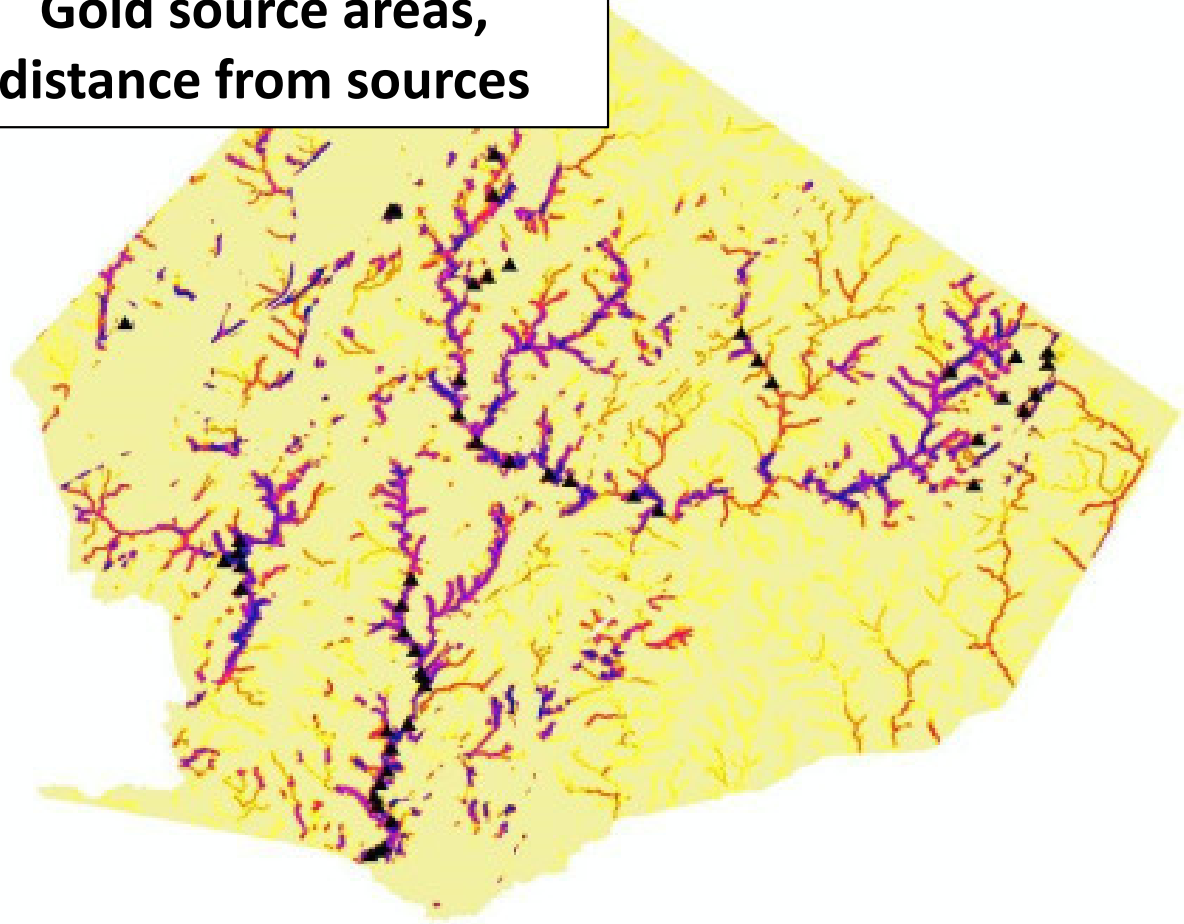
The product and its application

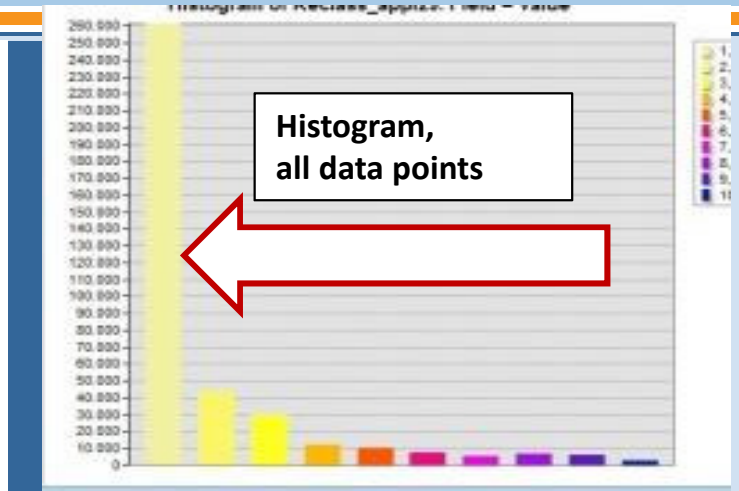
Mineral Potential Map – hard rocks

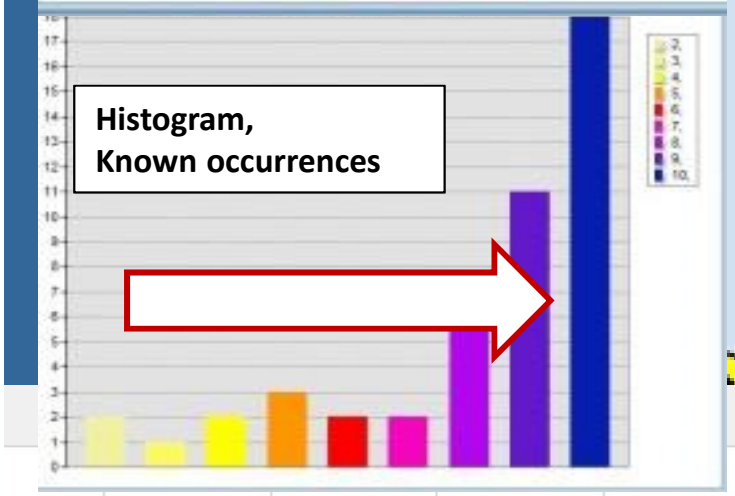
- Easy to read
- Sufficient accurate
- Represents existing knowledge
- Upgradable
- Usable for national/ regional planning activities
- Base for governance maps, to:
  - Protect resources
  - Guide big investment
  - Guide small scale mining
  - Analyze conflicts
  - Plan long term land use

Placers are different....

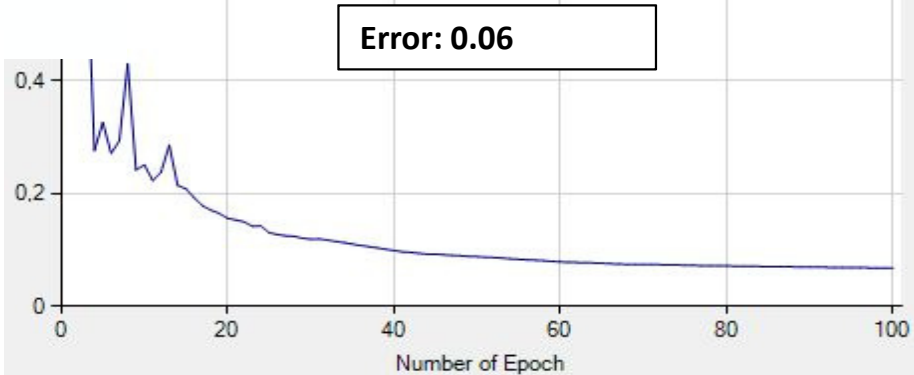
Streams and their catchment areas, Gold source areas, distance from sources



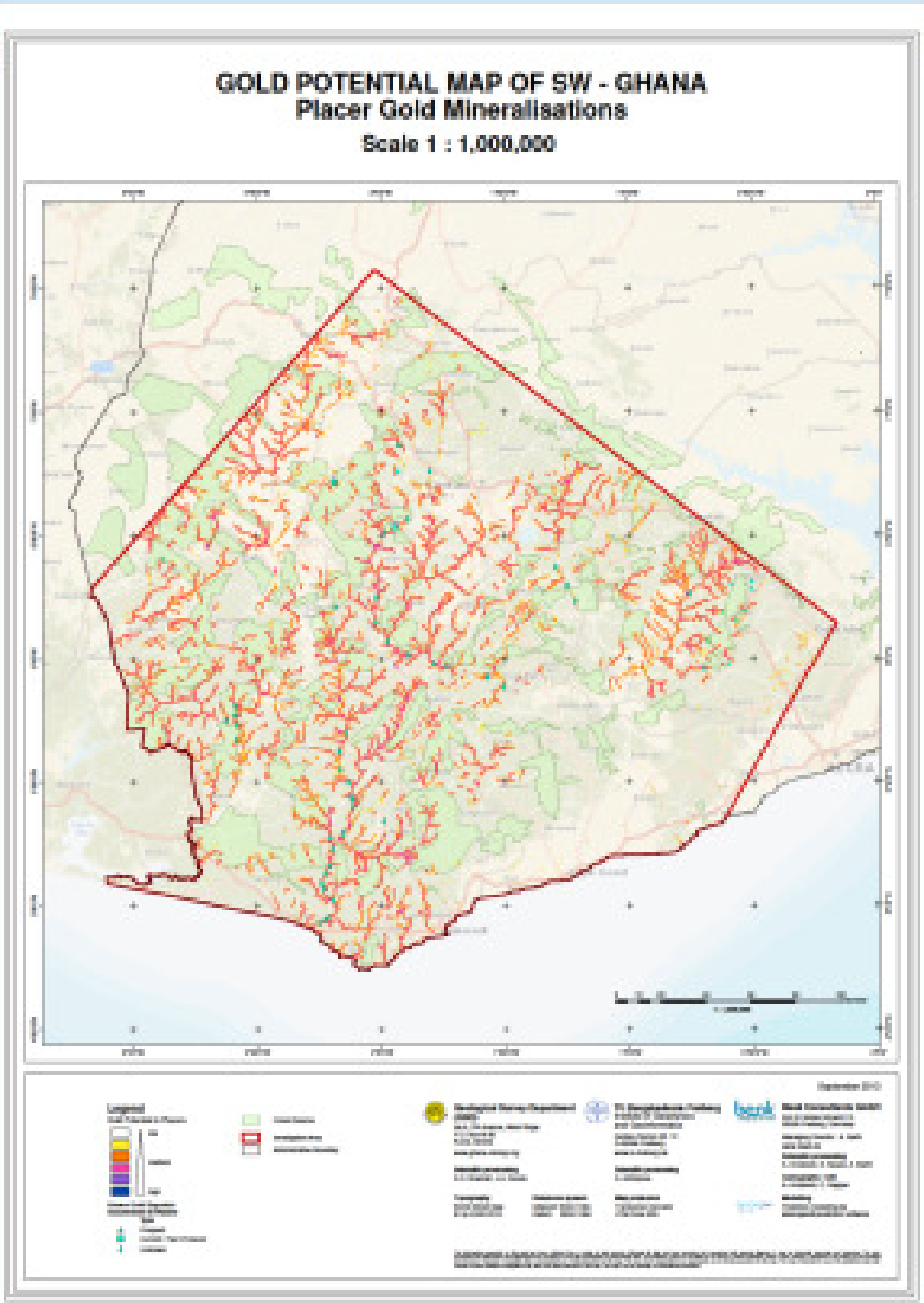




- very clear spatial pattern
- the prospective zones are small
- the prospective zones are focused
- most of known occurrences are located in high potential areas
- the error is very low: approx. 0.06



The product and its application



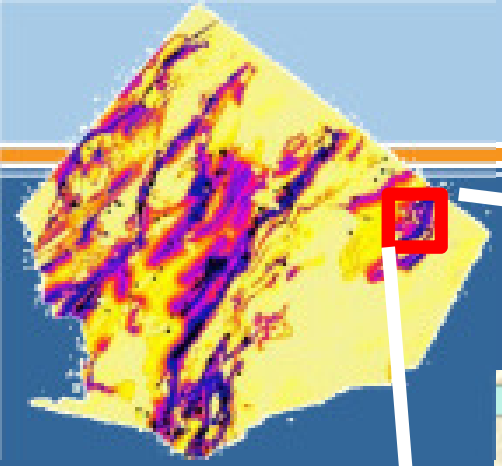
Mineral Potential Map-placers

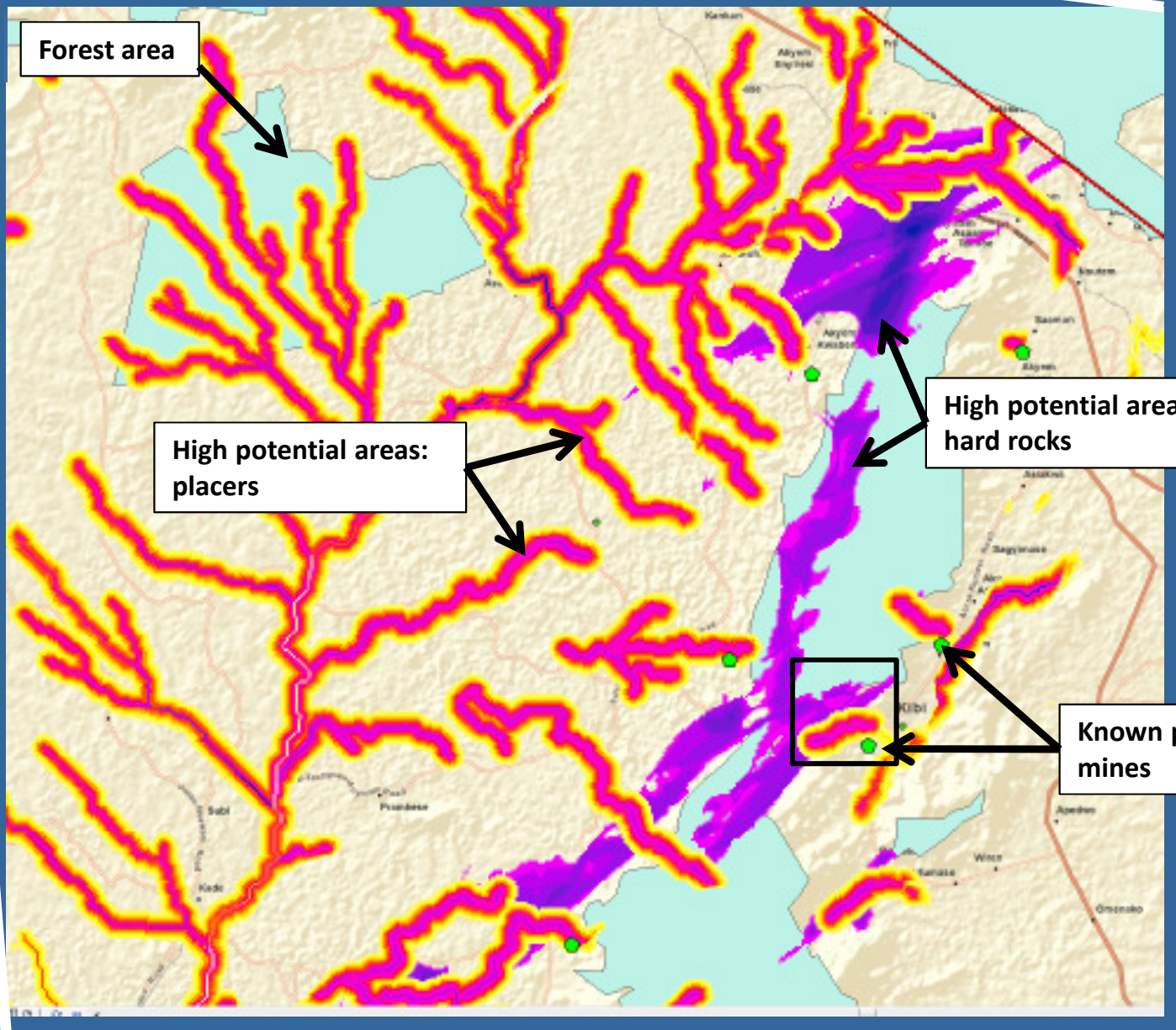
- Easy to read
- Sufficient accurate
- Represents existing knowledge
- Upgradable
- Usable for national/ regional planning activities
- Base for governance maps, to:
  - Protect resources
  - Guide small scale mining
  - Analyze conflicts
  - Plan long term land use

How good are the maps ???

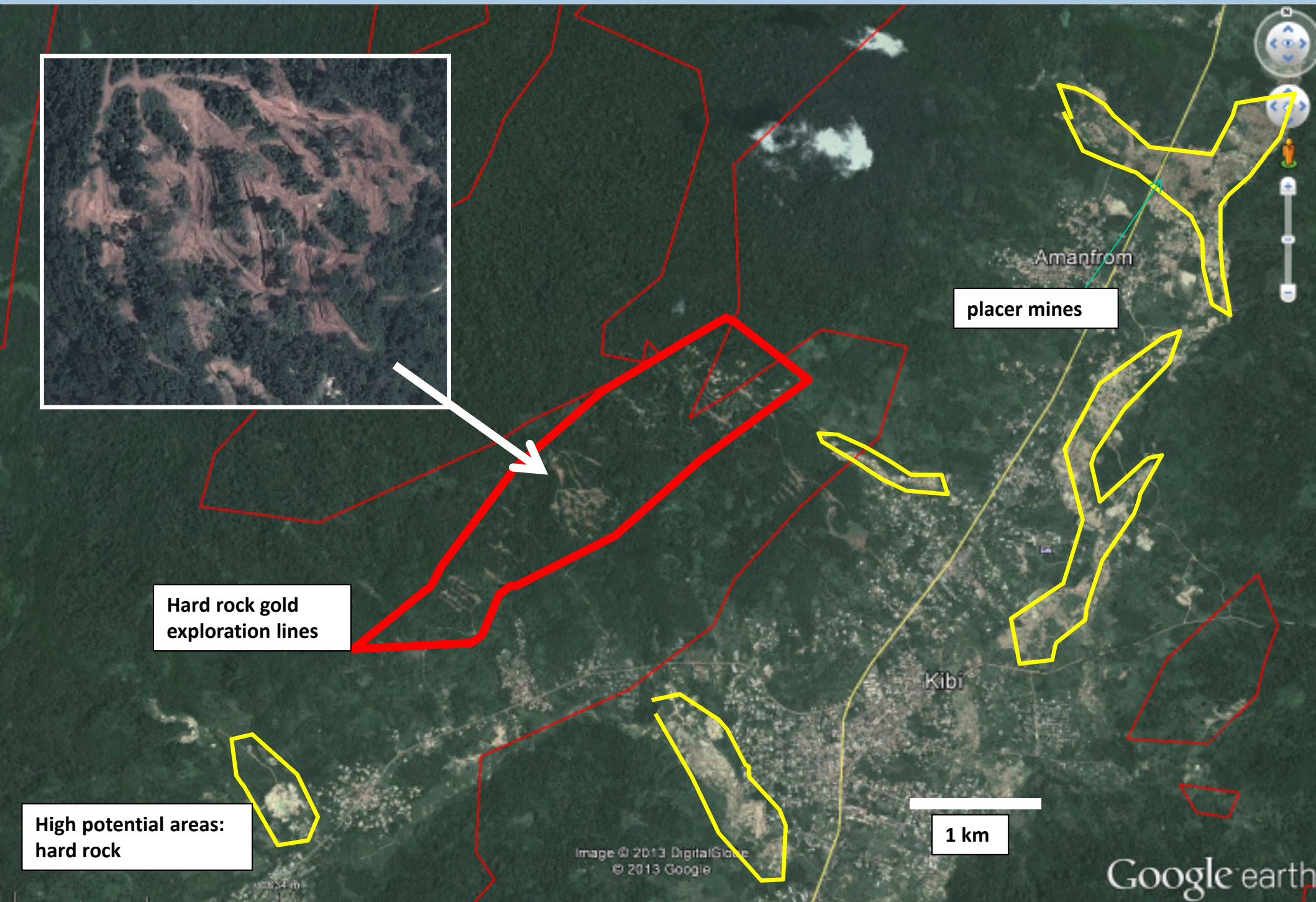
- As good as the input data is !
  - Locations and types of Au occurrences (used for training)
  - Location of ore controlling faults, lithologies,.....
  - Knowledge of geology
  - Geochemistry has not been used so far
- Neural network picks up the relationships, but wrong data will led to wrong conclusions

Details of Kibi prospects





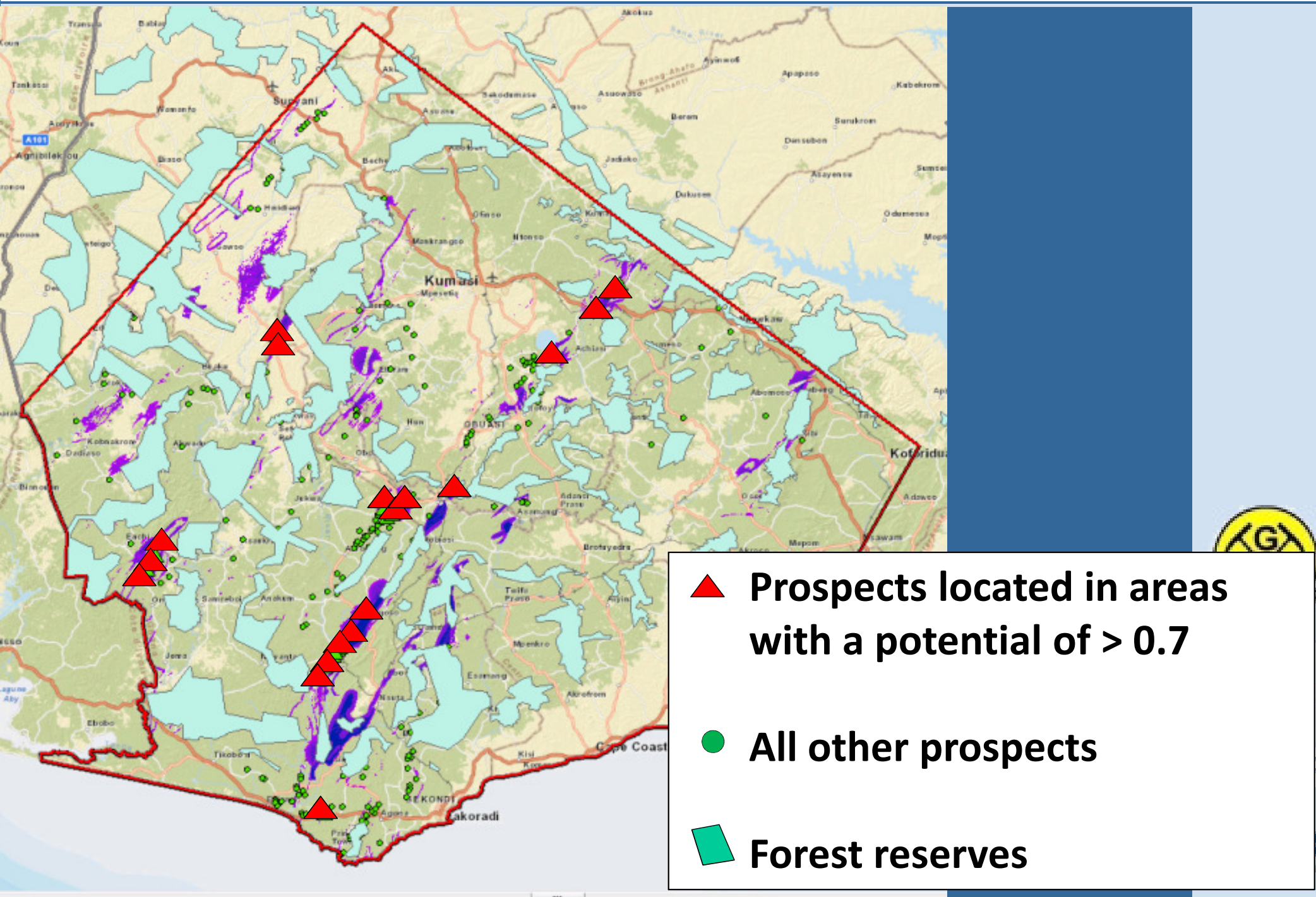
Details of Kibi area



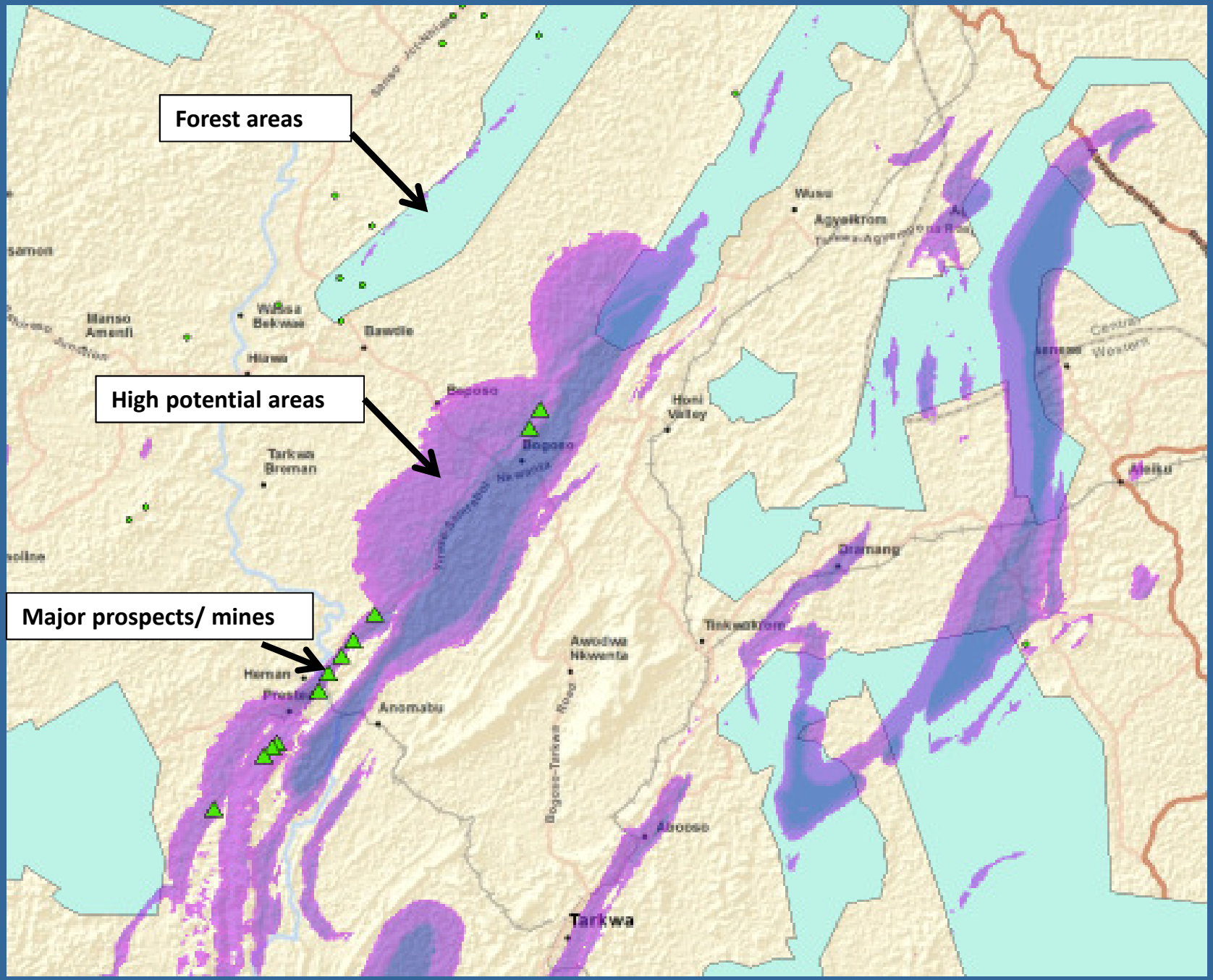
How predictive maps can be used

- Protect resources !!!
  - No further blocking by roads, settlements, water dams,....
  - Keep resources available for the future
- Guide exploration activities
  - Support exploration targeting
  - Support small scale mining
- Integrate mining into social and economic development
- Minimize conflicts
  - With agriculture
  - Nature conservation....

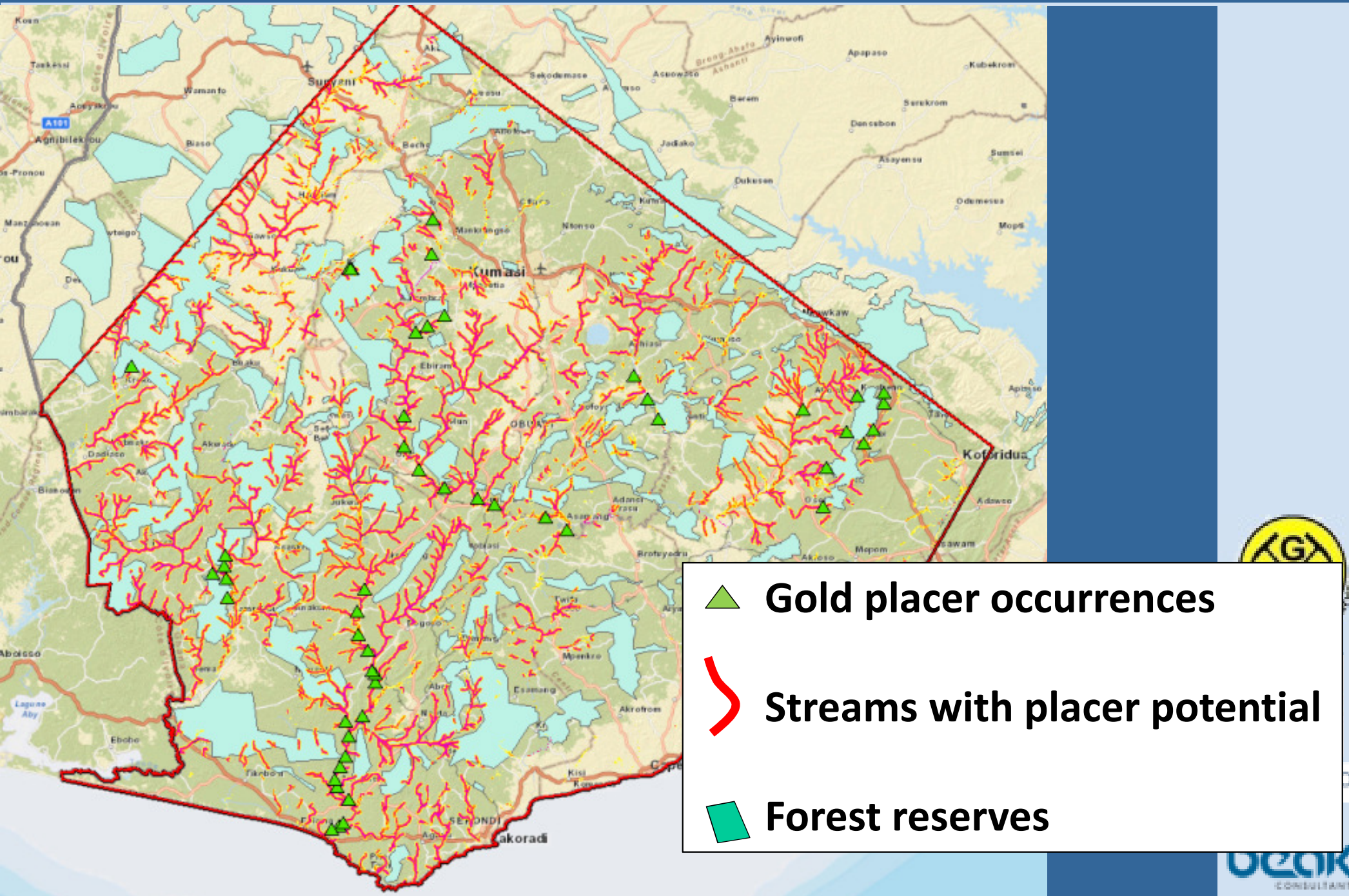
What kind of restrictions appear ?



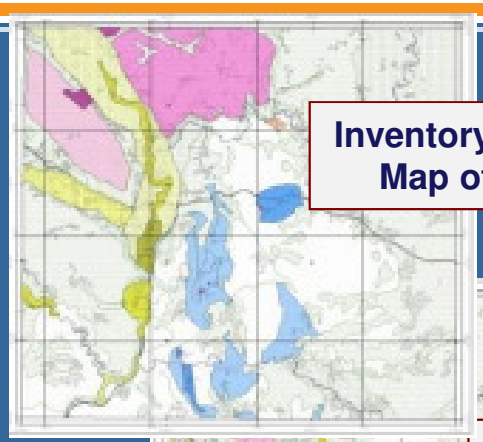
Detailed map of conflicts



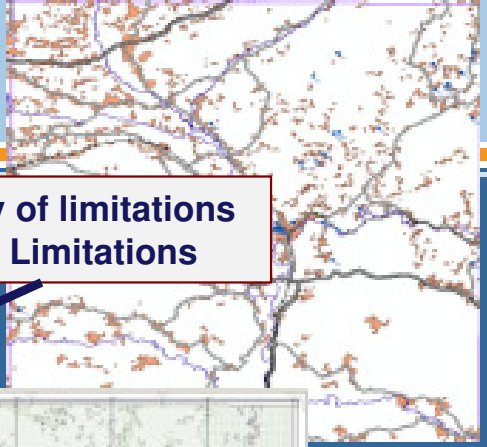
Conflicts with placers



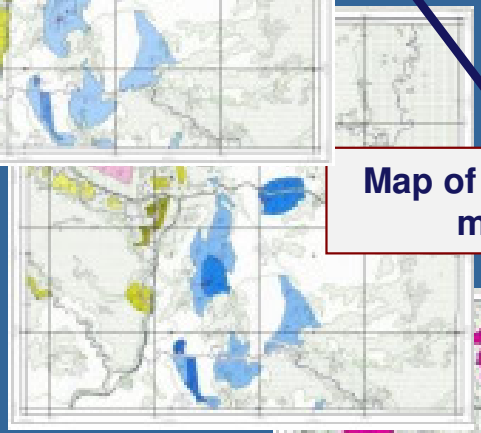
Land use conflict analysis



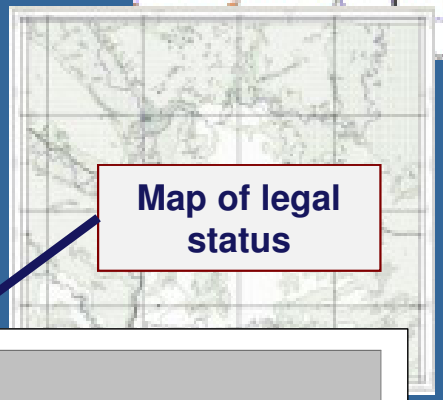
Inventory of minerals
Map of Minerals



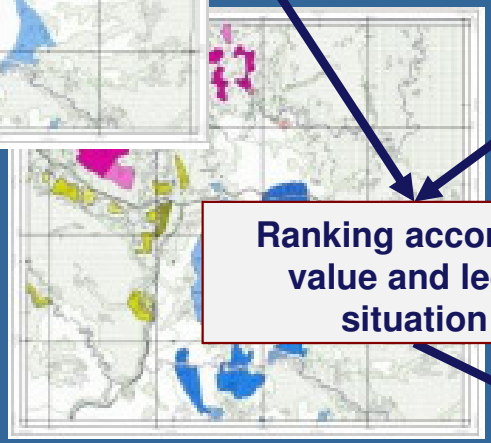
Inventory of limitations
Map of Limitations



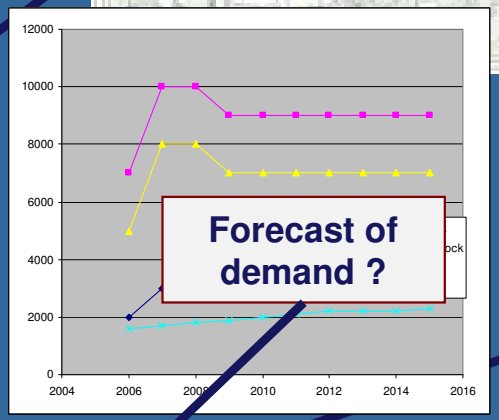
Map of non-blocked minerals



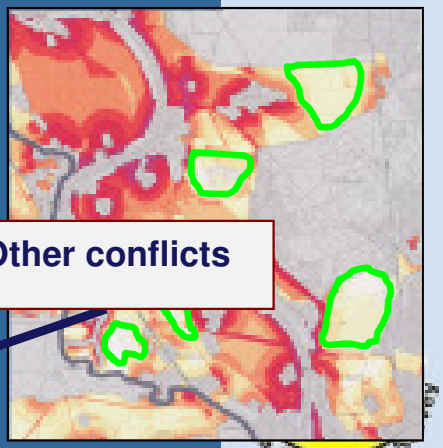
Map of legal status



Ranking according value and legal situation

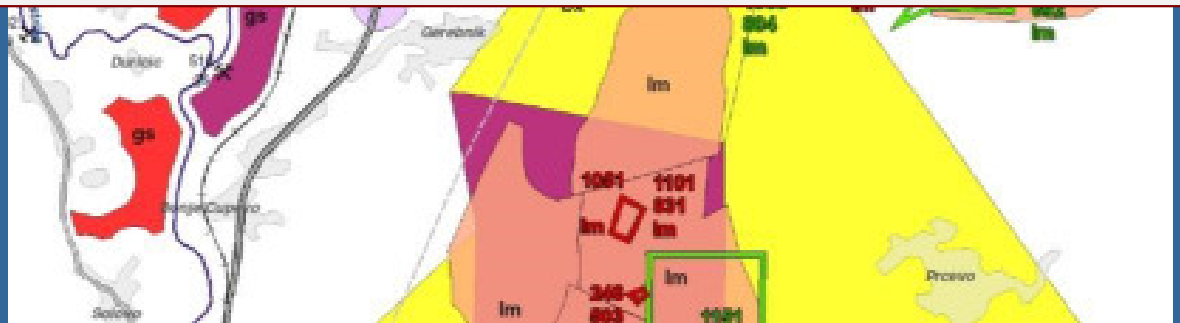


Forecast of demand ?

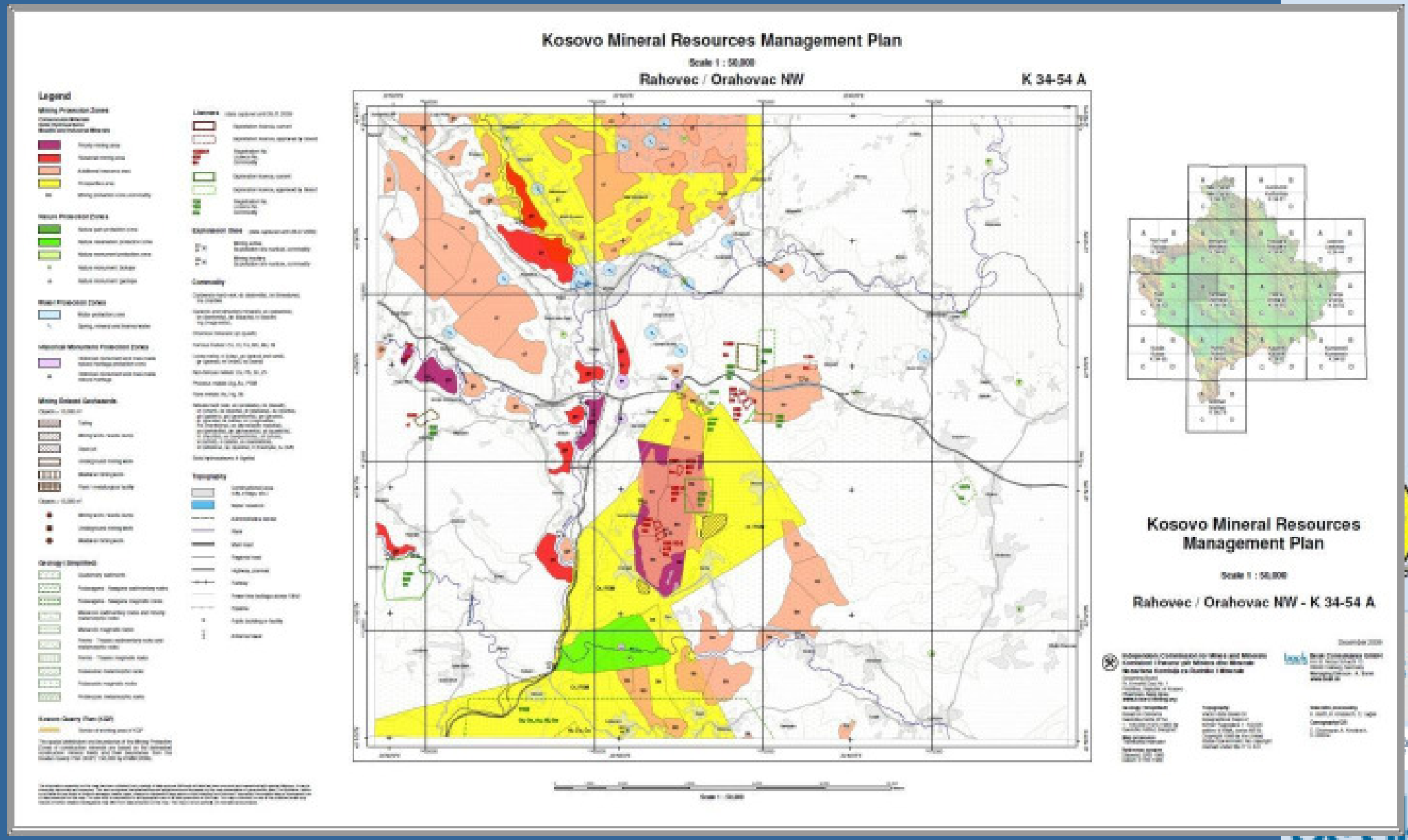


Other conflicts

Conclusions & recommendations = the mineral resources management plan

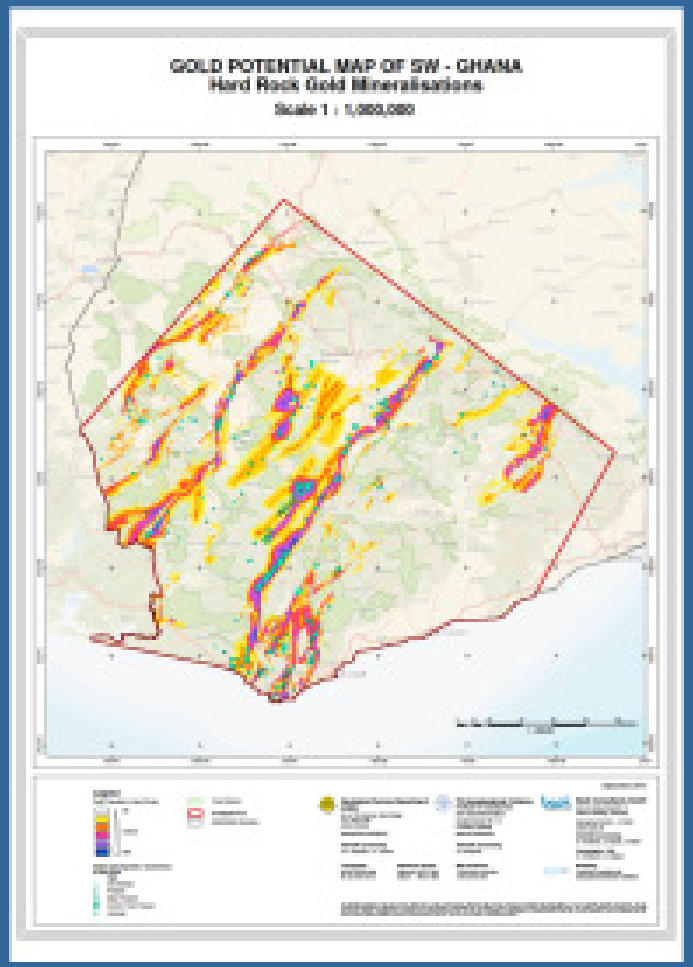


The Plan Document



Conclusions

- Gold predictive maps support:
  - informed decision making
  - investment attraction
  - Small scale mining
- Gold predictive maps safe:
  - Exploration funds
  - Use of land
- Gold predictive maps help:
  - Create mineral resource management plans
  - Develop infrastructure



Thank you for your attention

More information at

Our booth and our web site

www.beak.de

The predictive maps are available at our web site.

We wish to thank our clients, partners and supporters for the excellent co-operation.