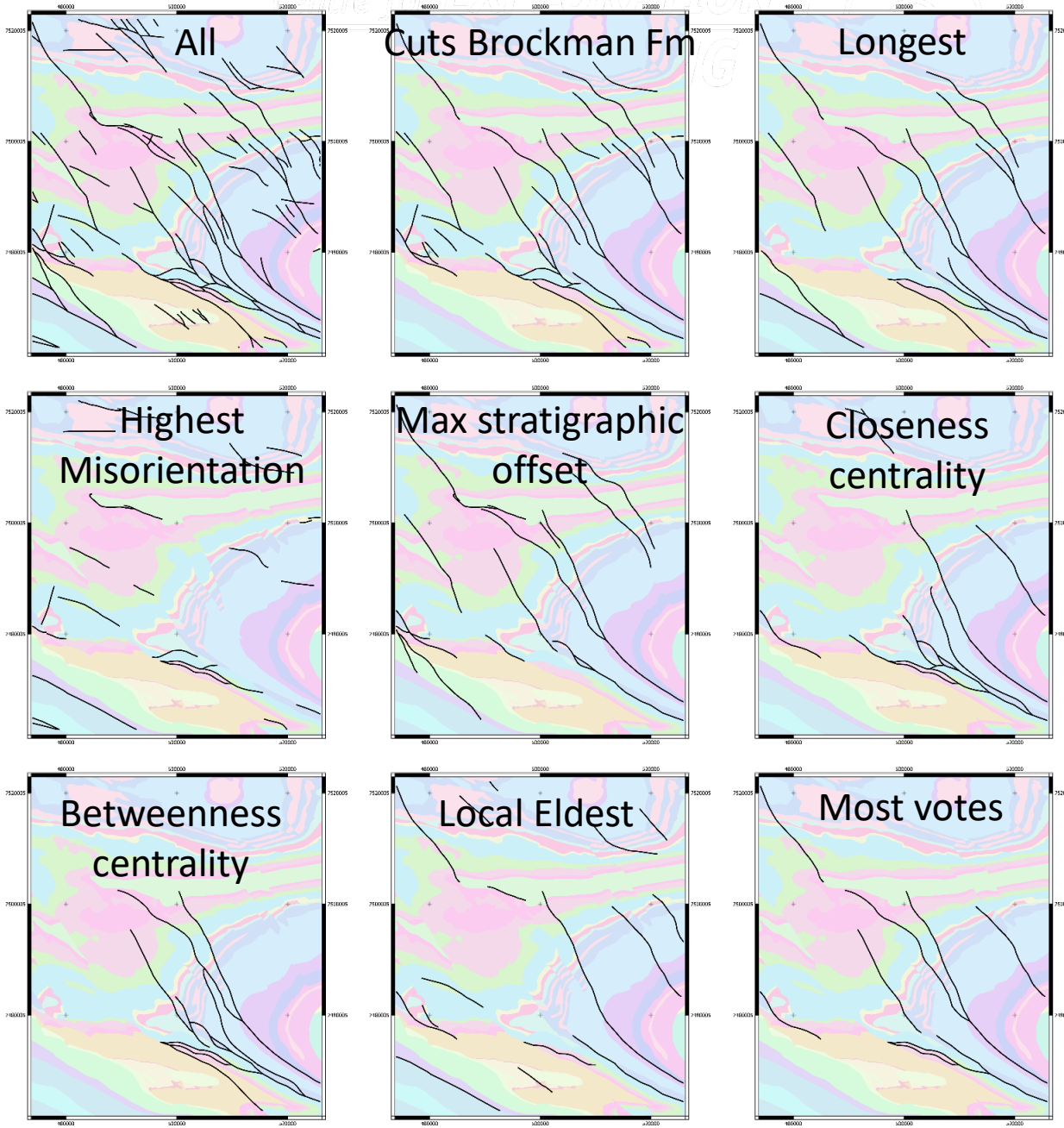
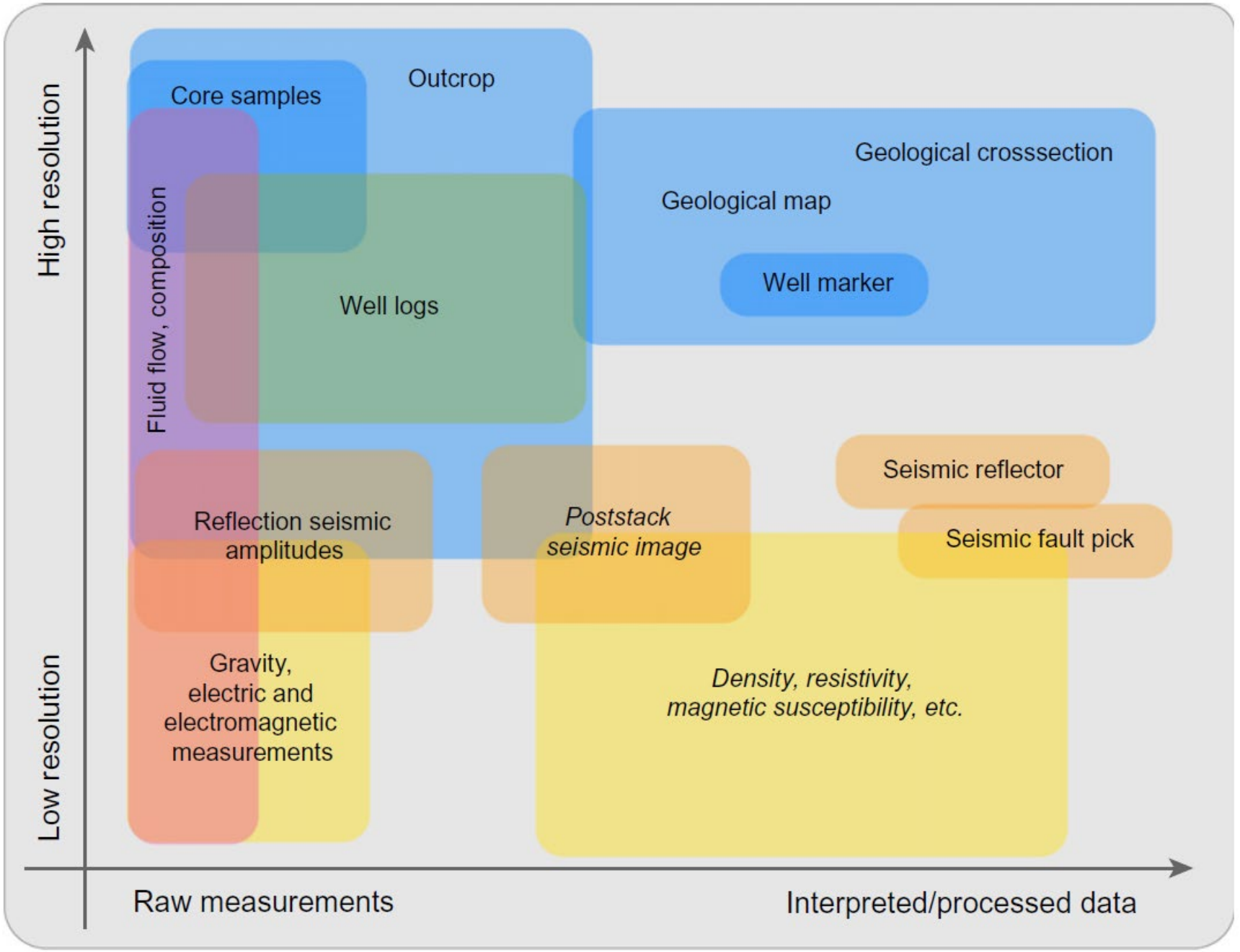
What data and conceptual constraints to use.

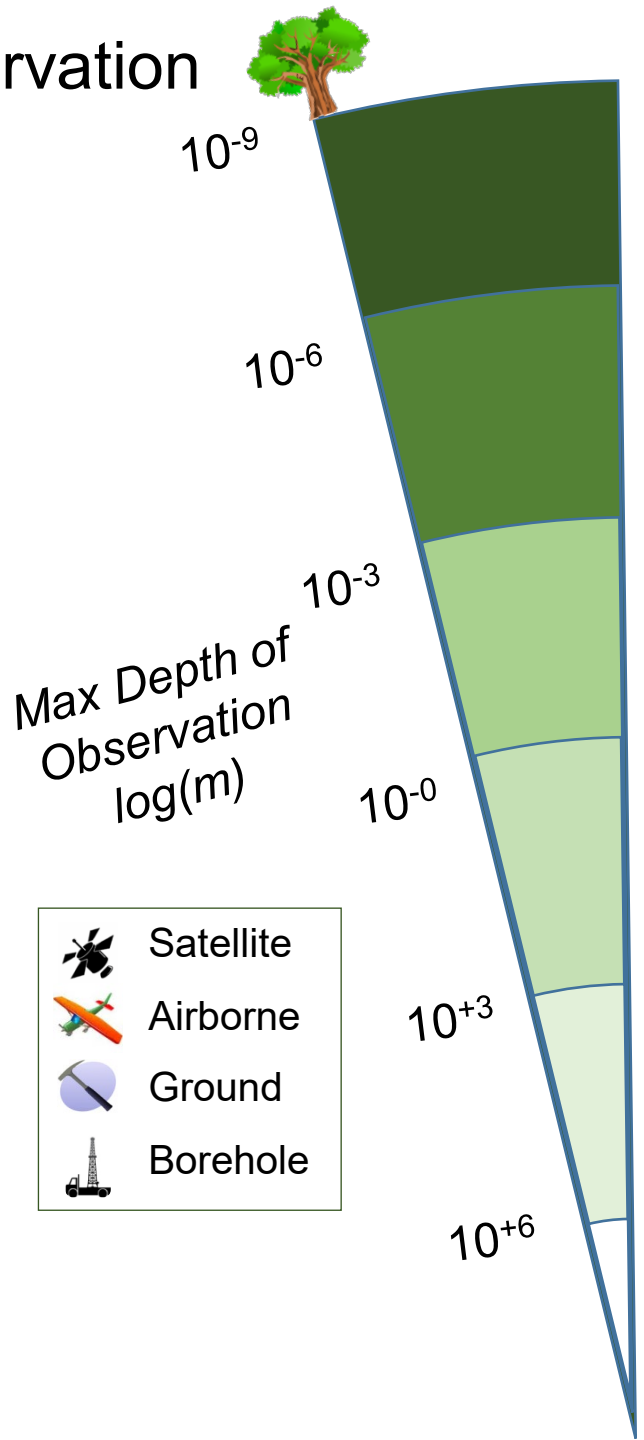


Typical Earth data used in geomodeling



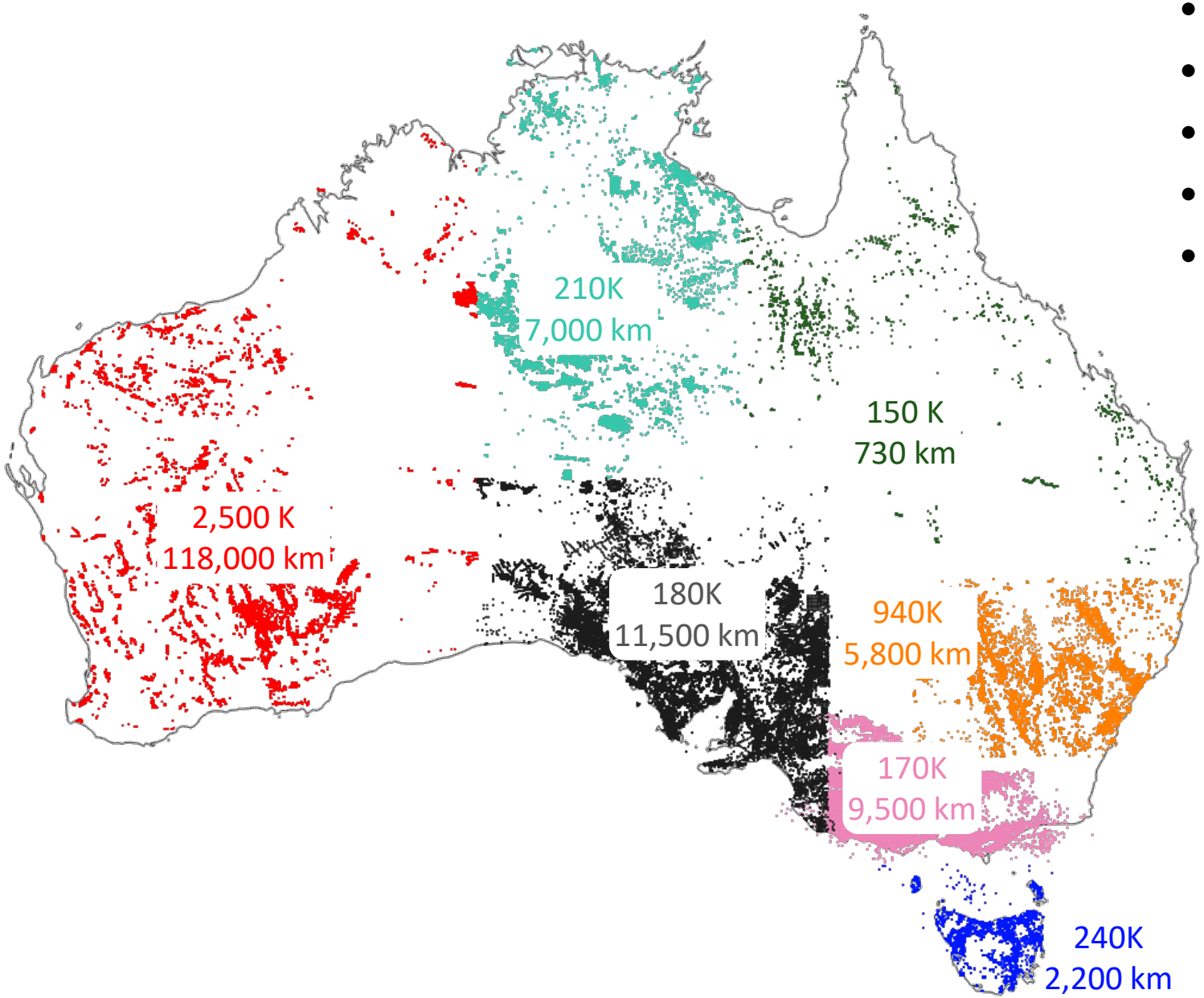
Wellmann & Caumon 2018

Depth of geo-observation



Observation	Platform	Property	Measurement
Topography	Borehole, Ground, Airborne, Satellite	Elevation	EM Radiation
Geology	Borehole, Ground	Lithology, structure	Geology 101
Spectral	Borehole, Ground, Airborne, Satellite	Soils, Mineralogy, vegetation	EM Radiation
Radar (SAR)	Borehole, Airborne, Satellite	Rugosity	EM Radiation
Radiometrics	Borehole, Ground, Airborne	U,K,Th	EM Radiation (gamma rays)
Radar (GPR)	Borehole, Ground	Electrical Properties	EM Radiation
Electromagnetics	Borehole, Ground, Airborne	Conductivity, Capacitance	Electrical, magnetic fields
Magnetics	Borehole, Ground, Airborne, Satellite	Susceptibility, Remanence	Magnetic field
Magnetotellurics	Ground	Impedance	Electrical, magnetic fields
Seismology	Borehole, Ground	Elasticity	Vibration
Gravity	Borehole, Ground, Airborne, Satellite	Density	Gravity

MinEx CRC

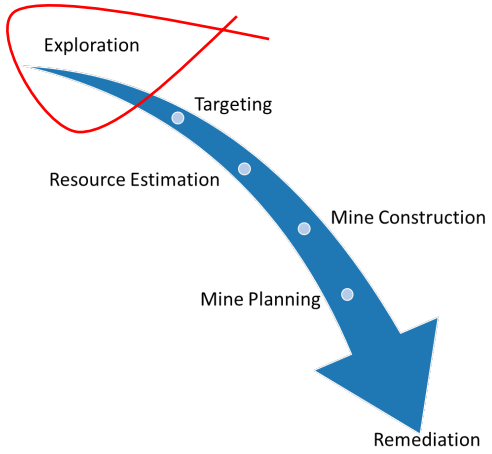


Australia's Legacy Drillhole Data

- 4.3M collars in geosurvey databases
- 150M metres of logging information
- >1 drillhole every 2 km^2
- 2% > 200m
- Average depth = 60m

Challenges:

- Need Stratigraphy for 3D modelling
- Parallel efforts to harmonise geochemical information
  - Need lithology for interpretation
  - ML needs lithology for labelling



Which faults to model?

Choice of data and features

What is the dip of *this* fault?

Feature values

Which interpolator should I use?

Modelling parameters

Which 3D models match my geological constraints?

3D Geological Models

Which models match my geophysical constraints?

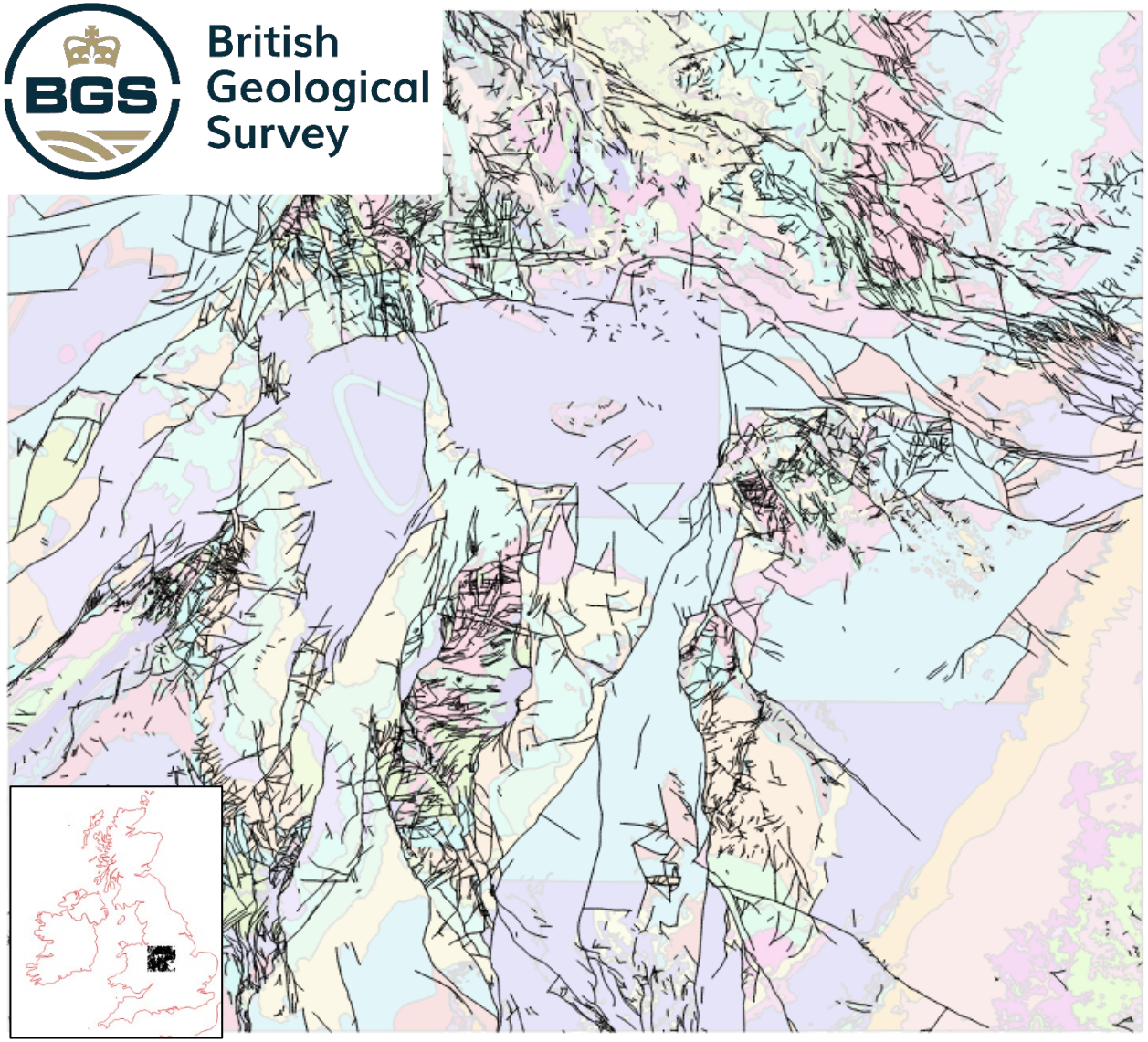
Geophysical Inversions

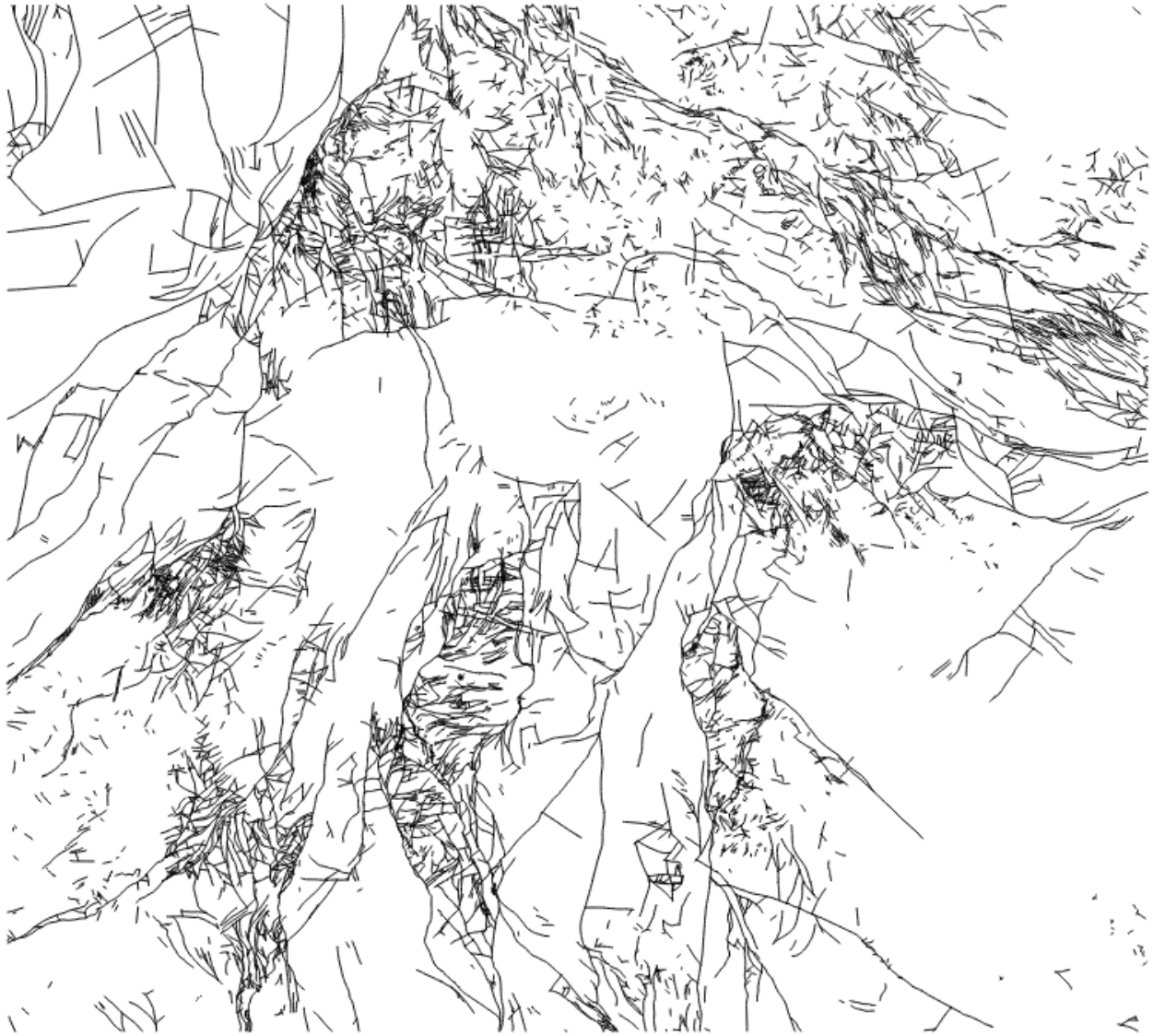
"The Uncertainty Chain"

Topology filters (e.g. faults that allow percolation in 3D)

Uncertainty analysis

British Geological Survey





Which faults to model?

Which faults to model?

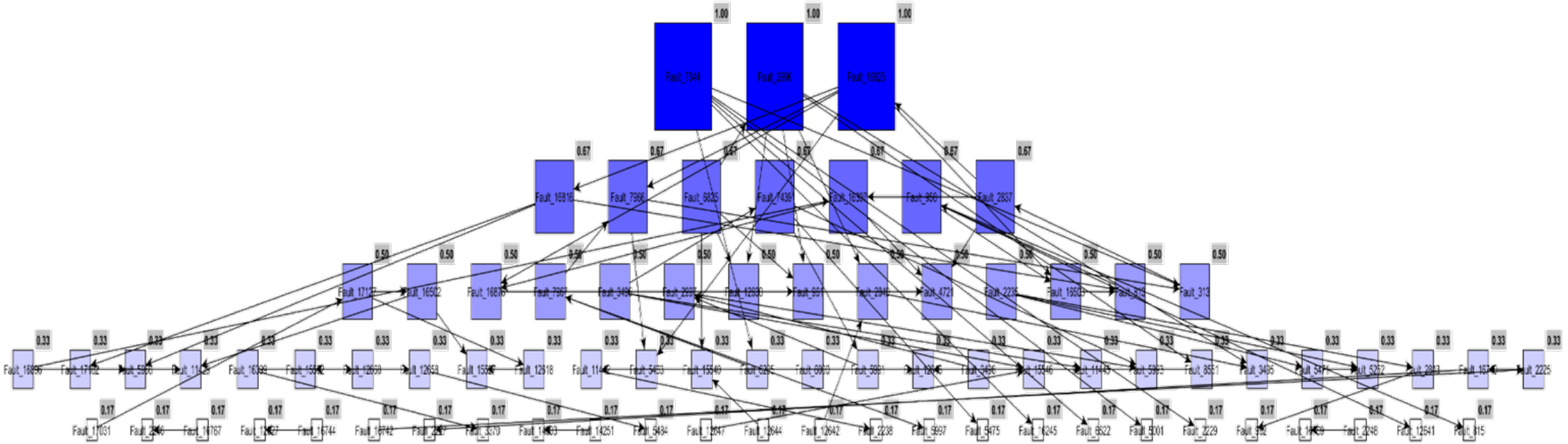
Question • Features to prioritise

1. **Hydrogeology-Fluid flow potential**
   - Long Length
   - Large Throw
   - Connected Topology
   - Local Wall Rock relationships

2. **Mineralisation potential**
   - Fluid Flow Potential
   - Spatial relationship to known mineralisation
   - Local Wall Rock relationships
   - High Fault Curvature
   - Large Misorientation
   - Relative Age

Fault/fault relationships

Automated Topology



Size ∝ centrality

Fault A truncates fault B
B is most “central”
A is “eldest”

Which Faults to Model?

1. Intersects formation of interest (Brockman Formation) [30]
2. Length [14]
3. Faults at high angle to mean fault orientation [28]
4. Maximum stratigraphic offset across fault [18]
5. Topologically central in terms of distance to all other faults [14]
6. Topologically central in terms of position on shortest path between all faults [11]
7. Oldest fault in local network [16]
8. Most selected by criteria above [9]

Fault accepted

Fault rejected

filter	Fault_10762	Fault_11445	Fault_1208	Fault_12628	Fault_12641	Fault_12645	Fault_12647	Fault_12660	Fault_1355	Fault_14251	Fault_14259	Fault_14303	Fault_14378	Fault_15280	Fault_15527	Fault_15546	Fault_15552	Fault_16438	Fault_16502	Fault_16503	Fault_16737	Fault_16739	Fault_16769	Fault_16816
strat	0	1	1	0	1	0	1	1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	1
len	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1
ori	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	1
offset	0	0	0	1	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	0	0	0	0
connected_edges	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	1
node_betweenness	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
eldest_in_tree	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
most_selected	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1

filter	Fault_16825	Fault_16896	Fault_17127	Fault_17182	Fault_2229	Fault_2235	Fault_2246	Fault_2248	Fault_2688	Fault_2689	Fault_2838	Fault_2843	Fault_2994	Fault_2995	Fault_313	Fault_317	Fault_318	Fault_3496_2	Fault_506	Fault_511	Fault_513	Fault_515	Fault_5252	Fault_5298	Fault_5469	Fault_5471	Fault_5990	Fault_5997	Fault_6189
strat	1	1	0	0	0	1	1	0	1	0	1	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0
len	1	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
ori	0	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	0	1	1	1	1	1	0	0
offset	1	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1
connected_edges	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
node_betweenness	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
eldest_in_tree	1	0	1	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0
most_selected	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

filter	Fault_6205	Fault_6521	Fault_6522	Fault_6534	Fault_6574	Fault_6807	Fault_7025	Fault_7099	Fault_7127	Fault_7222	Fault_7344	Fault_7389	Fault_7966	Fault_7967	Fault_813	Fault_815	Fault_824	Fault_826	Fault_828	Fault_8910	Fault_9174	Fault_958	Fault_962	Fault_965	Fault_966	Fault_967
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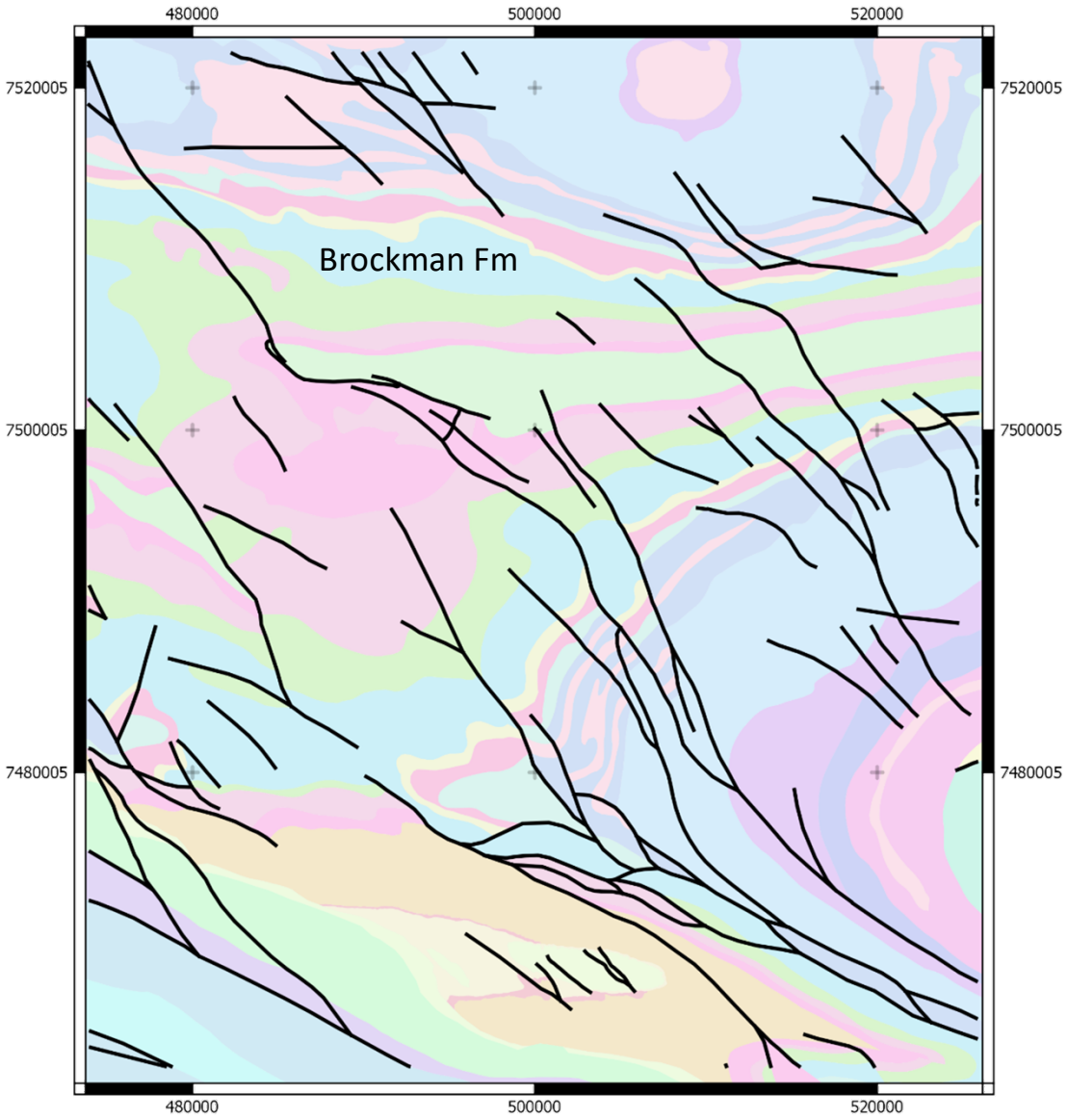
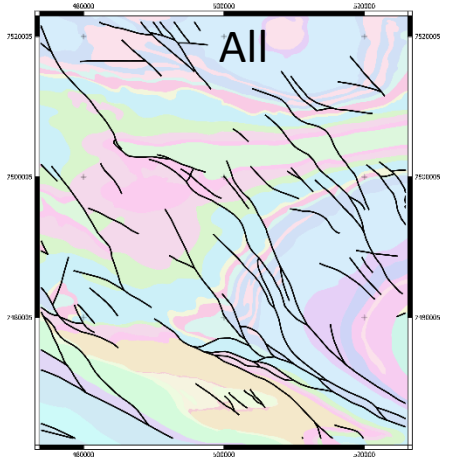
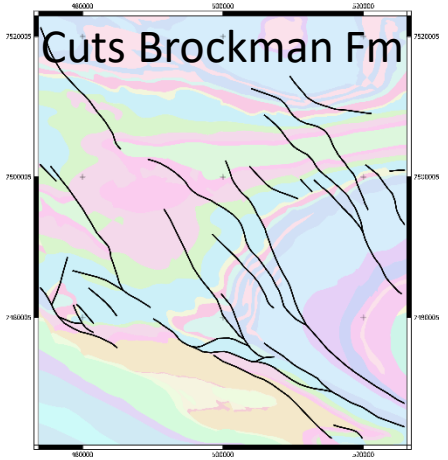
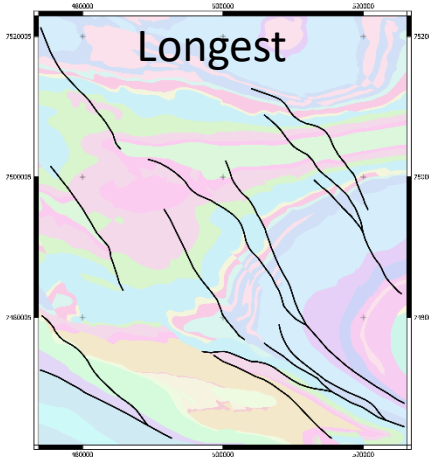
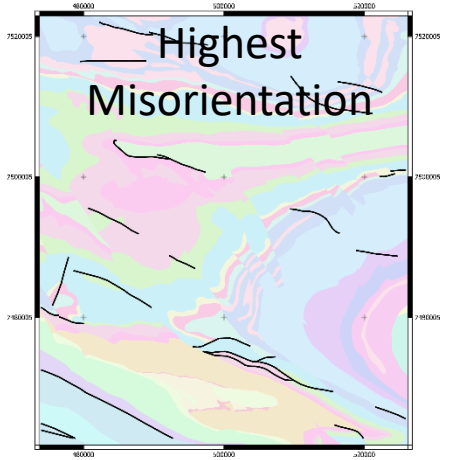


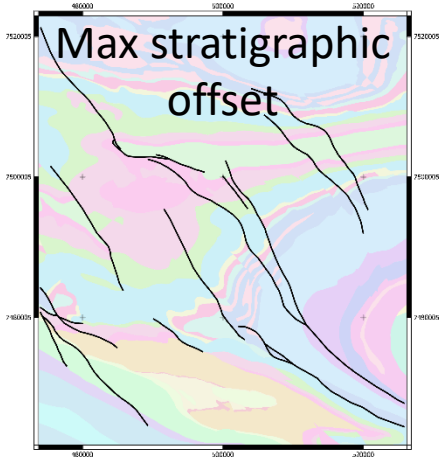
Which Faults to Model?

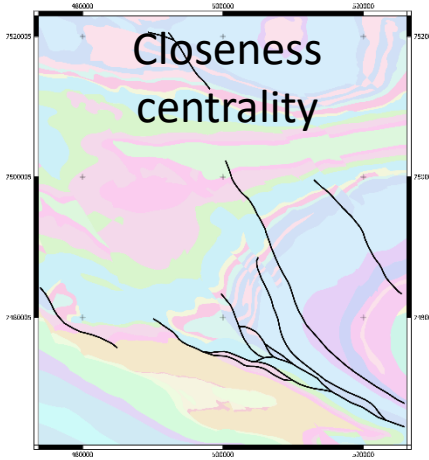


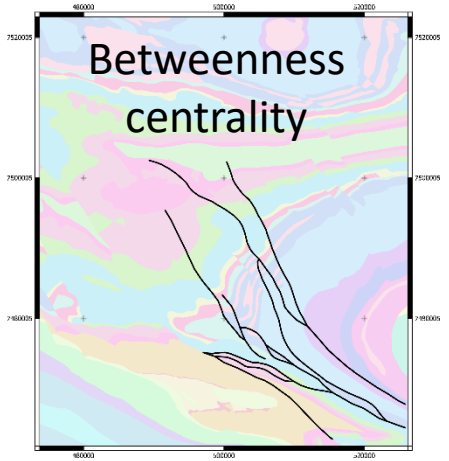


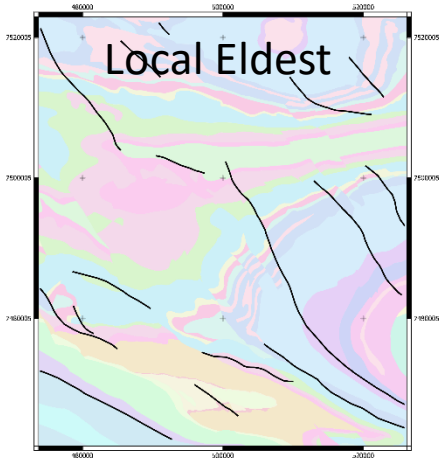


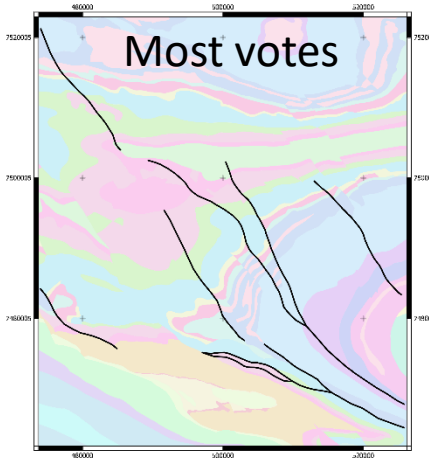


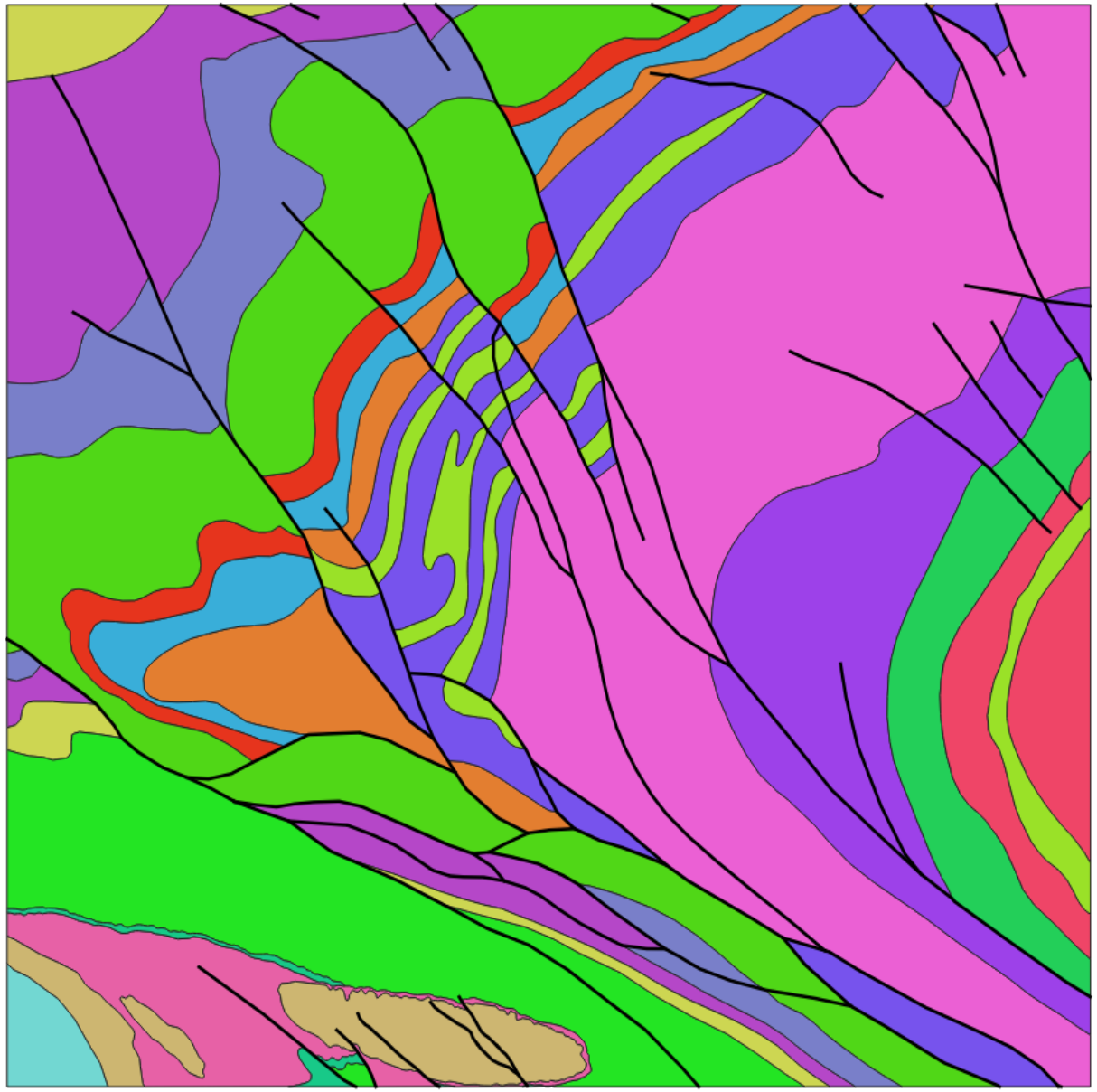


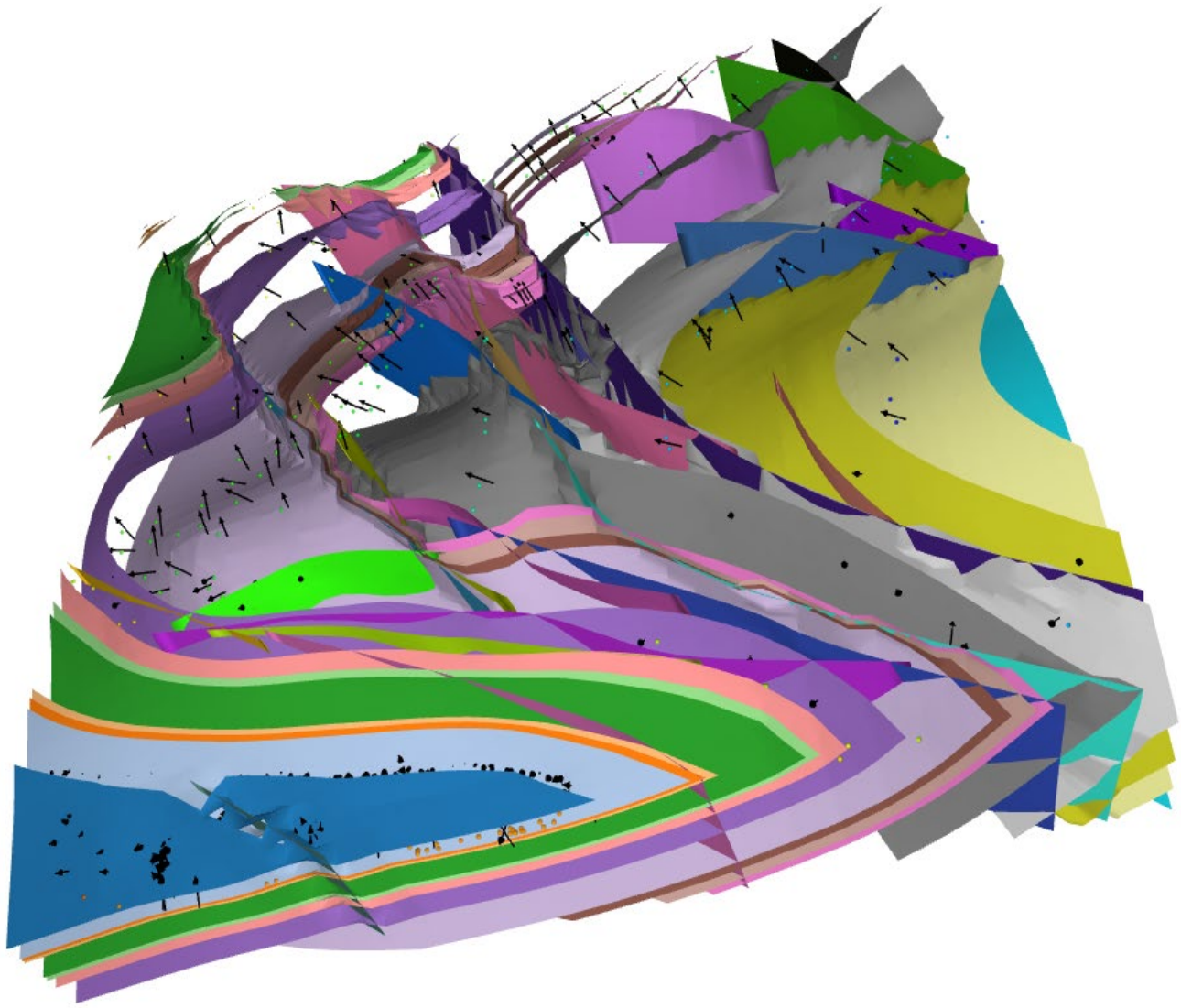








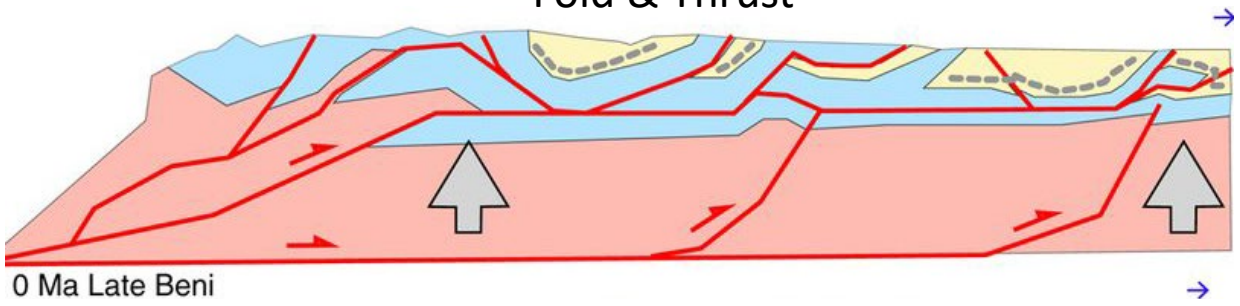




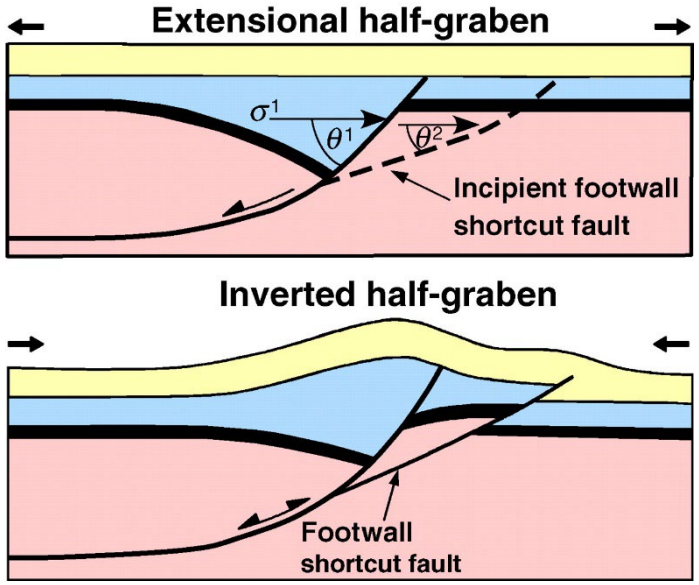
2D vs 3D connectivity of fault systems?

Conceptual Priors= Tectonic Context

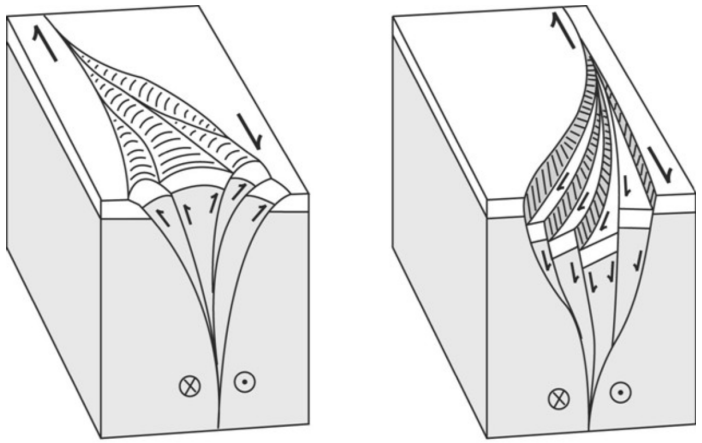
Fold & Thrust



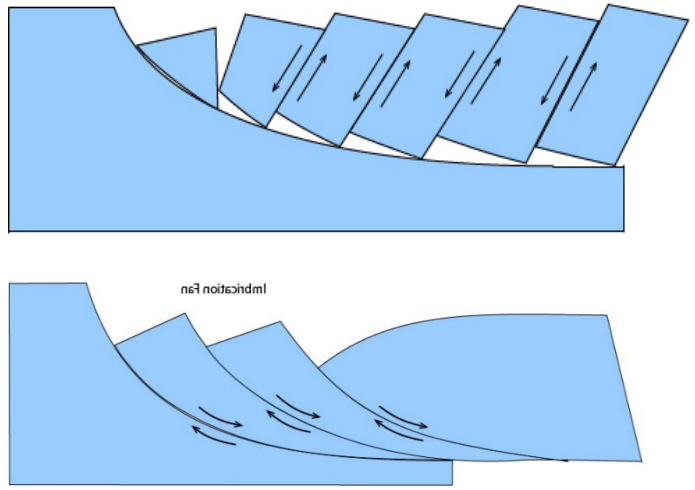
Extension & Inversion



Transcurrent

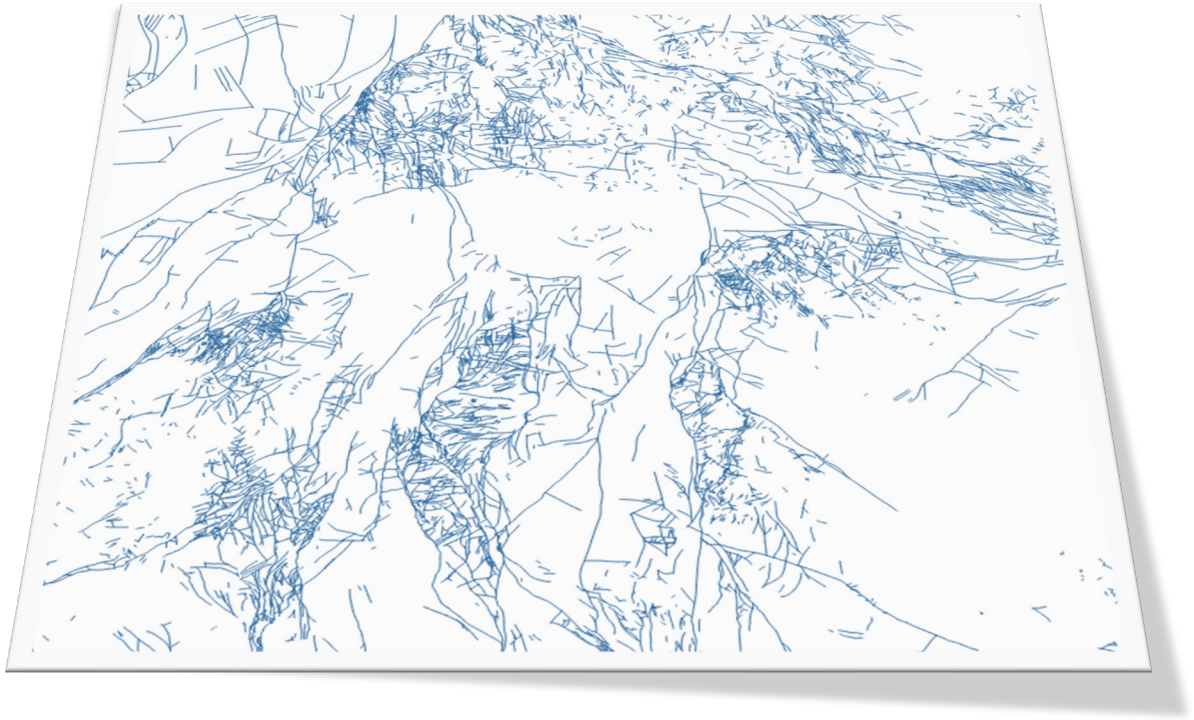


Extensional



Without limited geophysical constraints, the sub-surface geometry of faults is often ‘solved’ by applying a pre-conceived notion based on vertical, listric, flower or negative flower or fold & thrust geometries.

Conclusions



Which data to keep?

1. Accessible and Useable Data
2. Relevant data for your question
3. Data useful for constraining the model
4. Data relevant to scale of the model
5. Subset of data that retains most significant features
6. Be systematic: preferably automate the choices, or at least document them