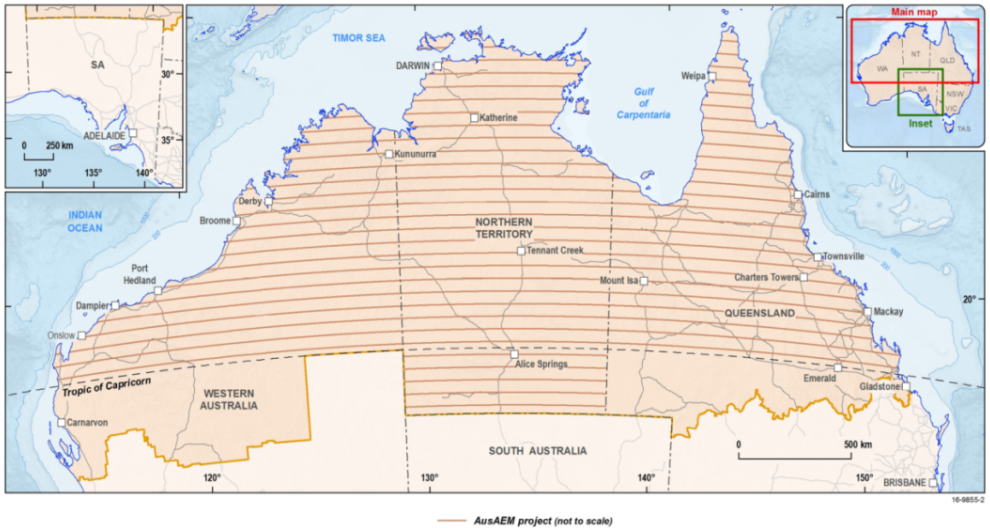
Exploring for the future AusAEM

4 year program acquisition starting NOW



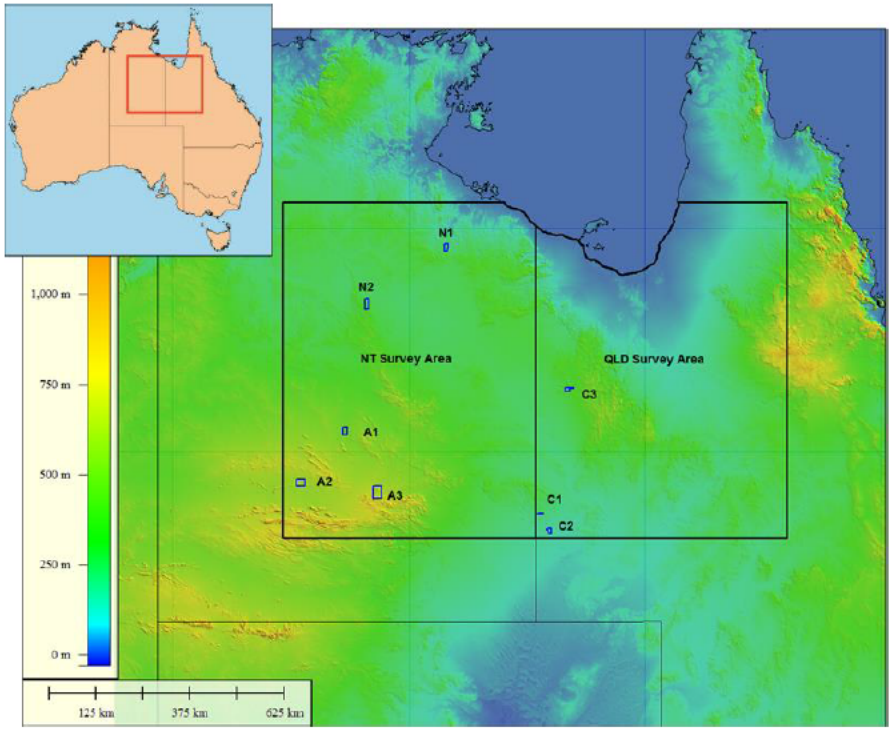


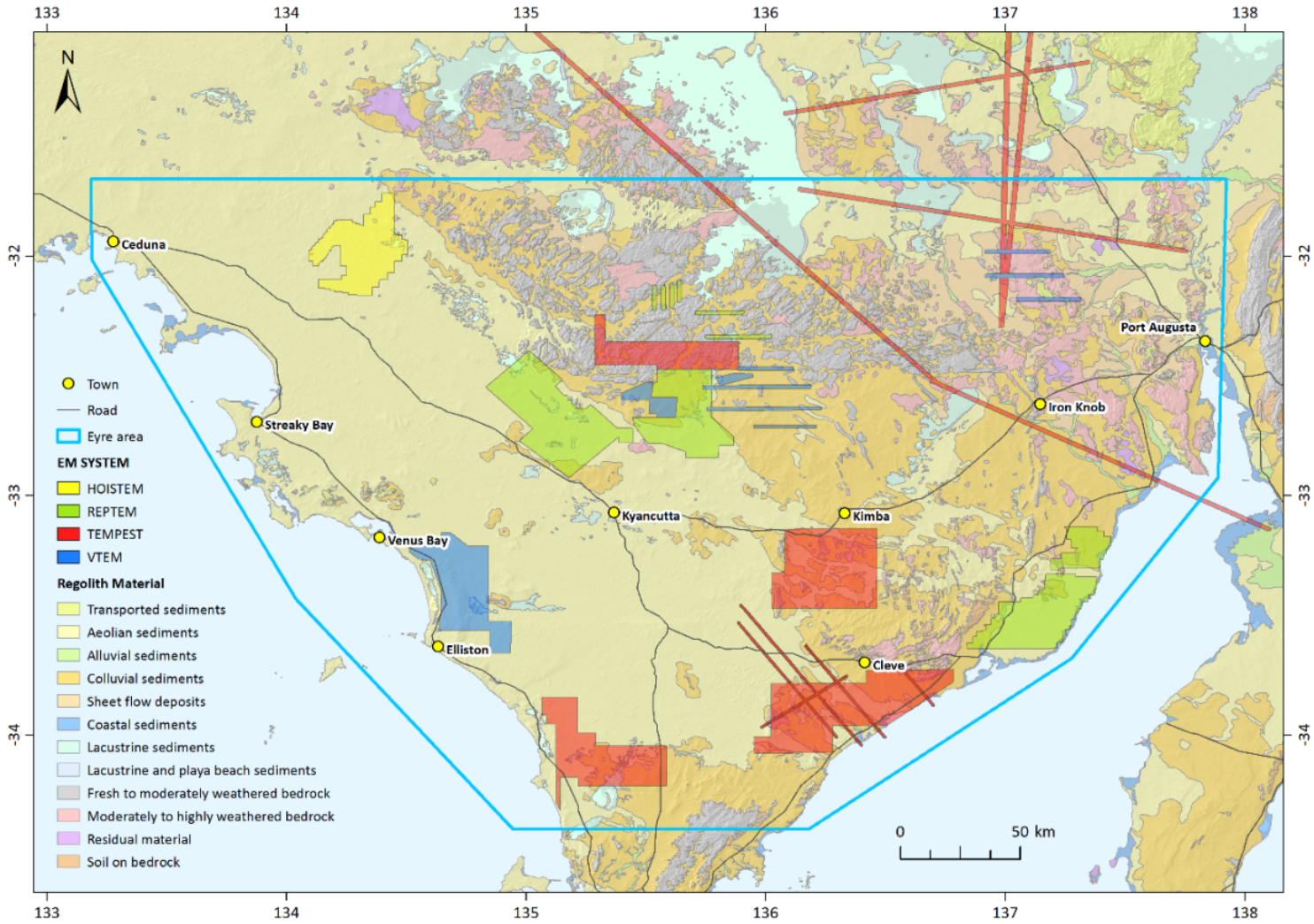
Figure 1 – Map showing the survey and infill area locations overlain on 30m SRTM image

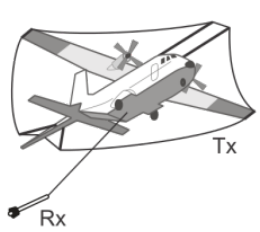
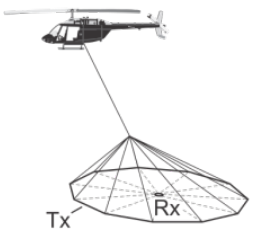
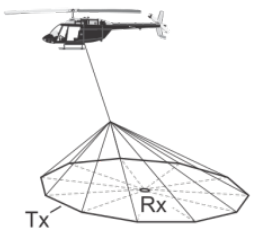
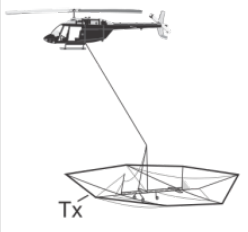
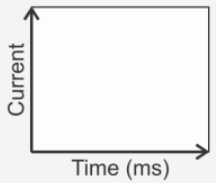
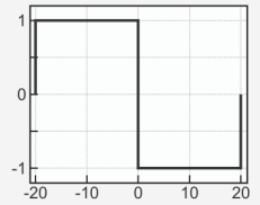
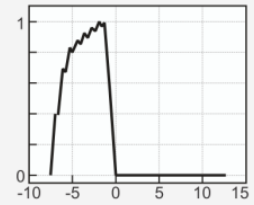
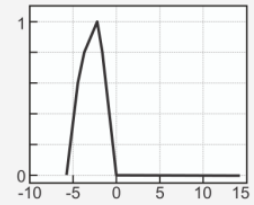
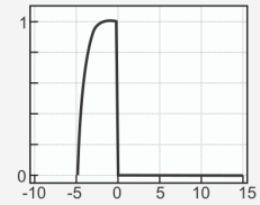
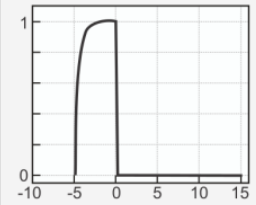
AusAEM Year

~ 65,000 km , an area of ~ 1million km^2

Yusen ley-Cooper

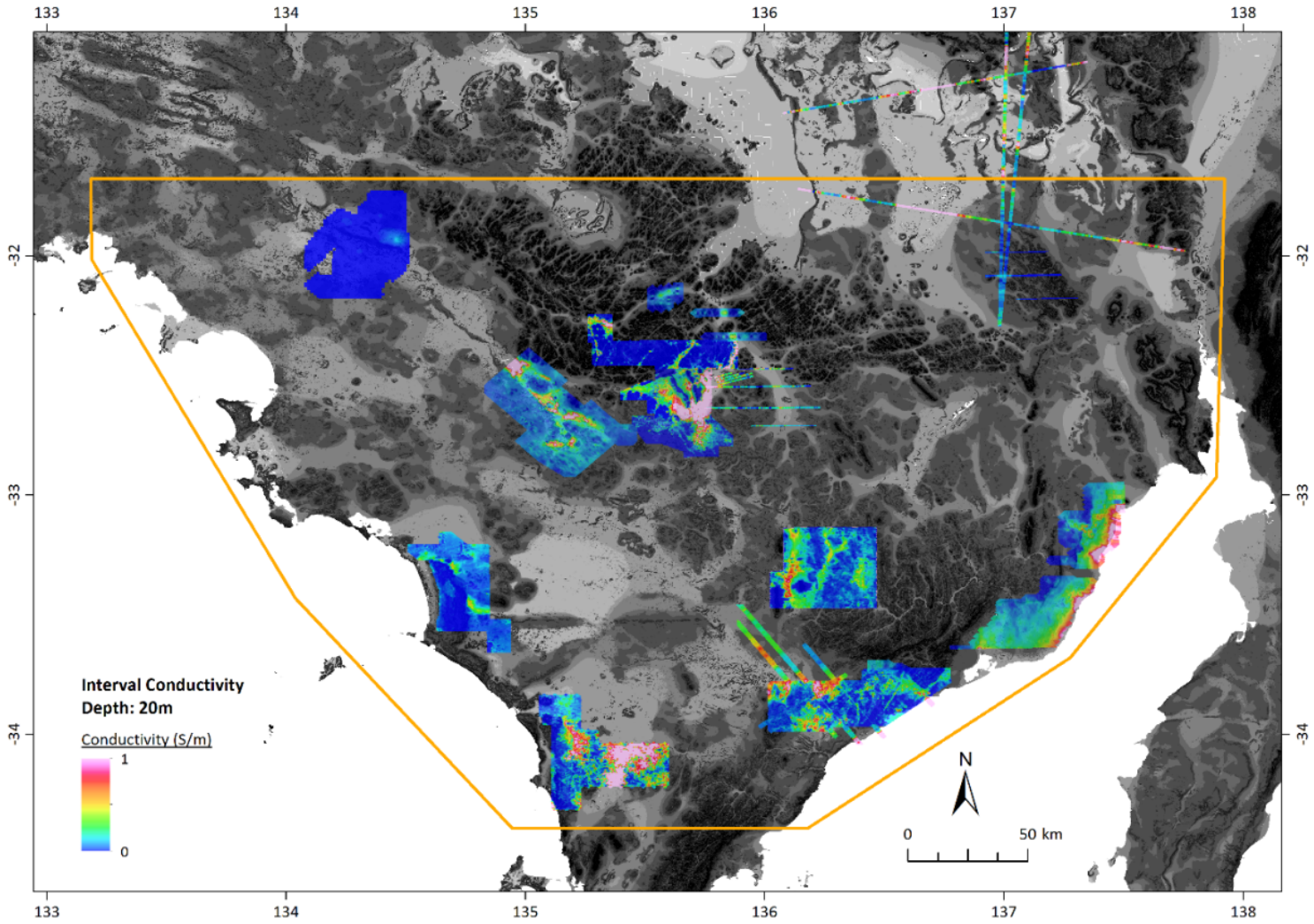
Reprocessing legacy AEM data in the North Eyre peninsula, South Australia



	TEMPEST	VTEM	VTEM MAX	HOISTEM	REPTEM
					
Survey Year flown	2000, 2006, 2007, 2008	2011	2014	2006	2010
Platform	Fixed wing	Helicopter	Helicopter	Helicopter	Helicopter
System geometrical configuration	Transmitter (Tx): Loop on aircraft	Concentric loop Tx/Rx	Concentric	Concentric	Concentric
	Receiver (Rx): Towed bird	Suspended weight	Suspended weight	Suspended weight	Suspended weight
Nominal heights Tx	Tx: 120 (m)	Tx: 49 (m)	Tx: 54 (m)	Tx: 30 (m)	Tx: 30 (m)
Rx	Rx: 65 (m)	Rx: 49 (m)	Rx: 54 (m)	Rx: 30 (m)	Rx: 30 (m)
Transmitter coil axis	Vertical	Vertical	Vertical	Vertical	Vertical
Tx loop area	186 (m^2)	531 (m^2)	962 (m^2)	300 (m^2)	375 (m^2)
Tx base frequency	25 (Hz)	25 (Hz)	25 (Hz)	25 (Hz)	25 (Hz)
Tx number of loop turns	1	4	4	1	1
Peak current	300 (A)	200 (A)	243 (A)	340 (A)	340 (A)
Peak moment	55,800 (Am^2)	424,740 (Am^2)	861,952 (Am^2)	108,800 (Am^2)	127,000 (Am^2)
Nominal waveform shape 	Quasi-Square 	Half Sine-Trapezoid 	Half Sine-Trapezoid 	Half Sine-Trapezoid 	Half Sine-Trapezoid 
Duty cycle	50%	37%	37%	25%	25%
Tx height measured	Measured	Not measured (derived from helicopter)	Derived from helicopter	Derived from helicopter	Derived from helicopter
Tx orientation	Measured (from aircraft)	Measured Indirectly (GPS)	GPS	Not measured	Not measured
Tx-Rx separations	Not measured Nominal horizontal 100 vertical 53 (m)	Not measured (flexible frame)	Not measured (flexible frame)	Not measured	Not measured
Receiver orientation	Not measured	Not measured	Not measured	Not measured	Not measured
Receiver coils	X, Z & (Y not delivered)	X & Z	X & Z	Z	Z
EM Sensor	dB/dt	dB/dt	dB/dt	dB/dt	dB/dt
# of receiver windows	15	35	45	21	22
EM channels start times (ms)	0.007 to 12.4 (ms)	0.078 to 8.6 (ms)	0.018 to 9.9 (ms)	0.066 to 10.7 (ms)	0.065 to 12.9 (ms) YLf001-14

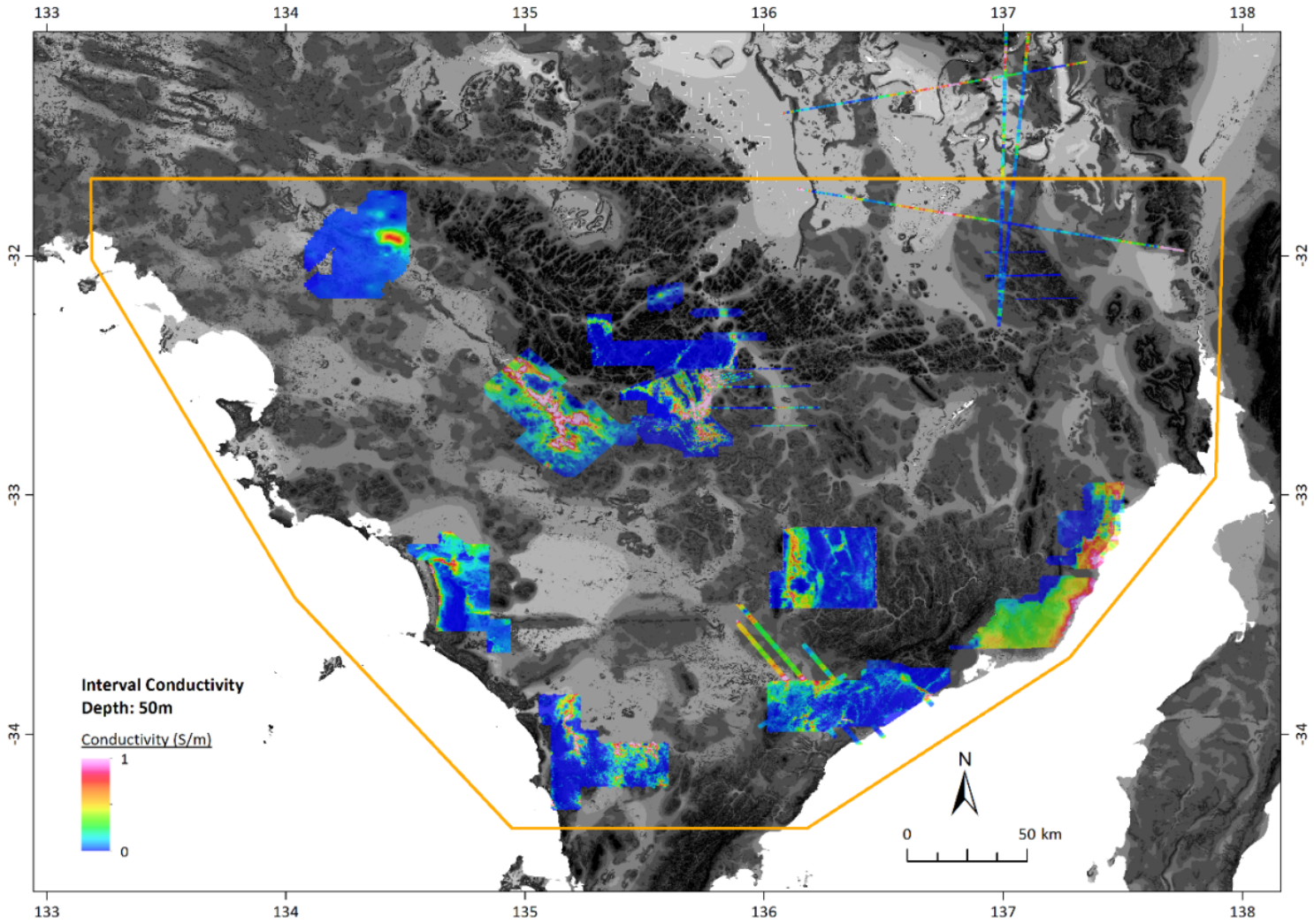
Map of inverted conductivity derived form 17 datasets and 5 different airborne EM systems

20m Depth



Map of inverted conductivity derived form 17 datasets and 5 different airborne EM systems

50m Depth



Timor-Leste– Hydrogeology

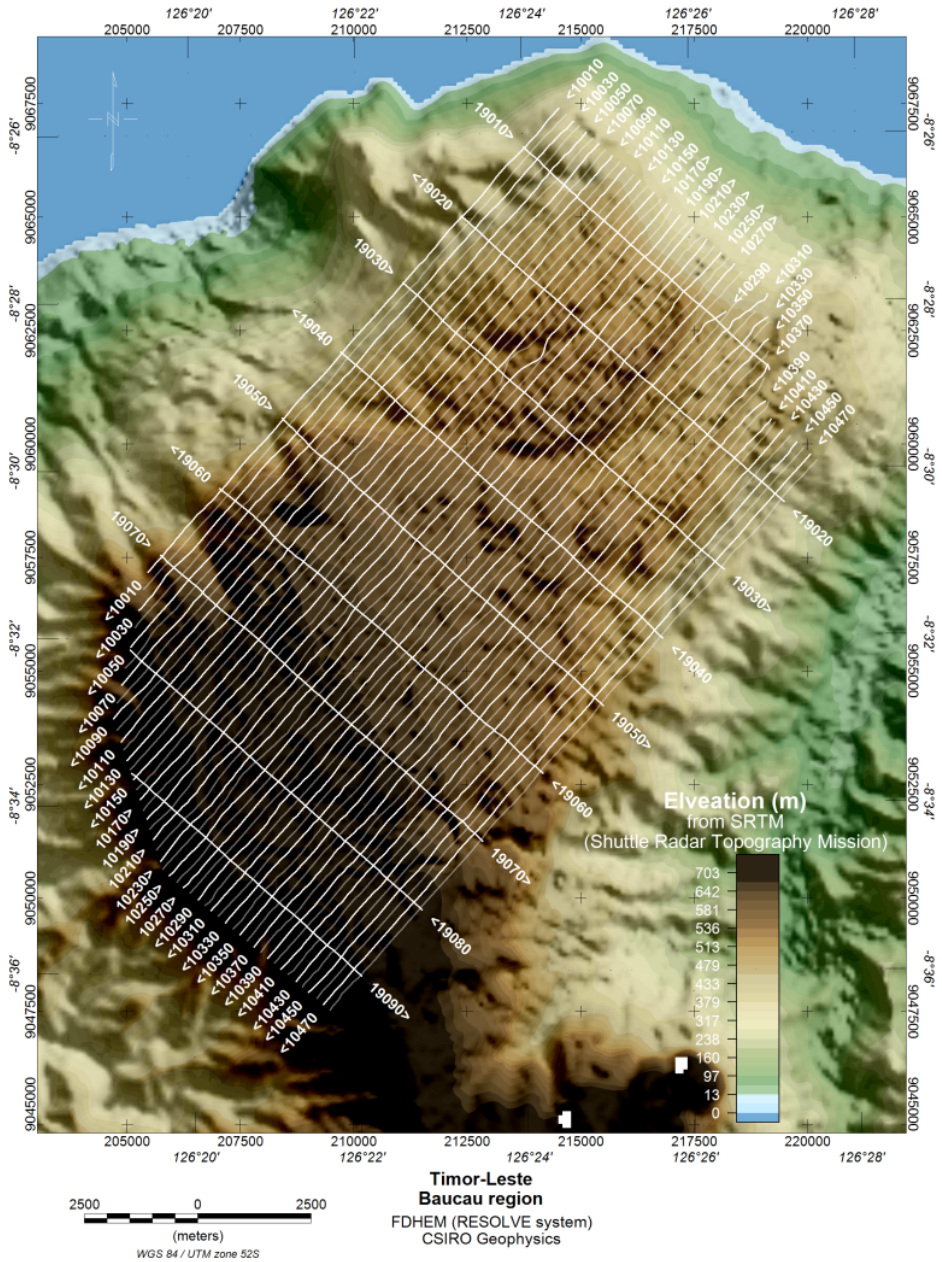
Question

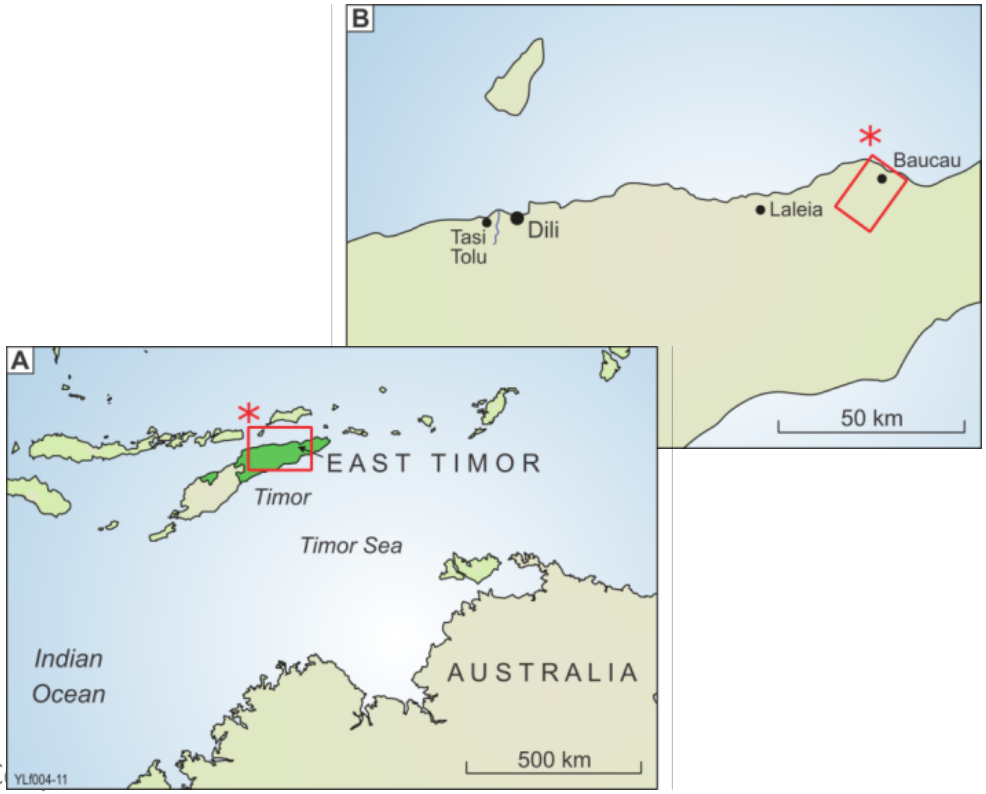
- Main water supply comes from springs in the centre of town
- Can we locate the base of limestone and locations of preferential flow paths?

AEM survey

Survey design

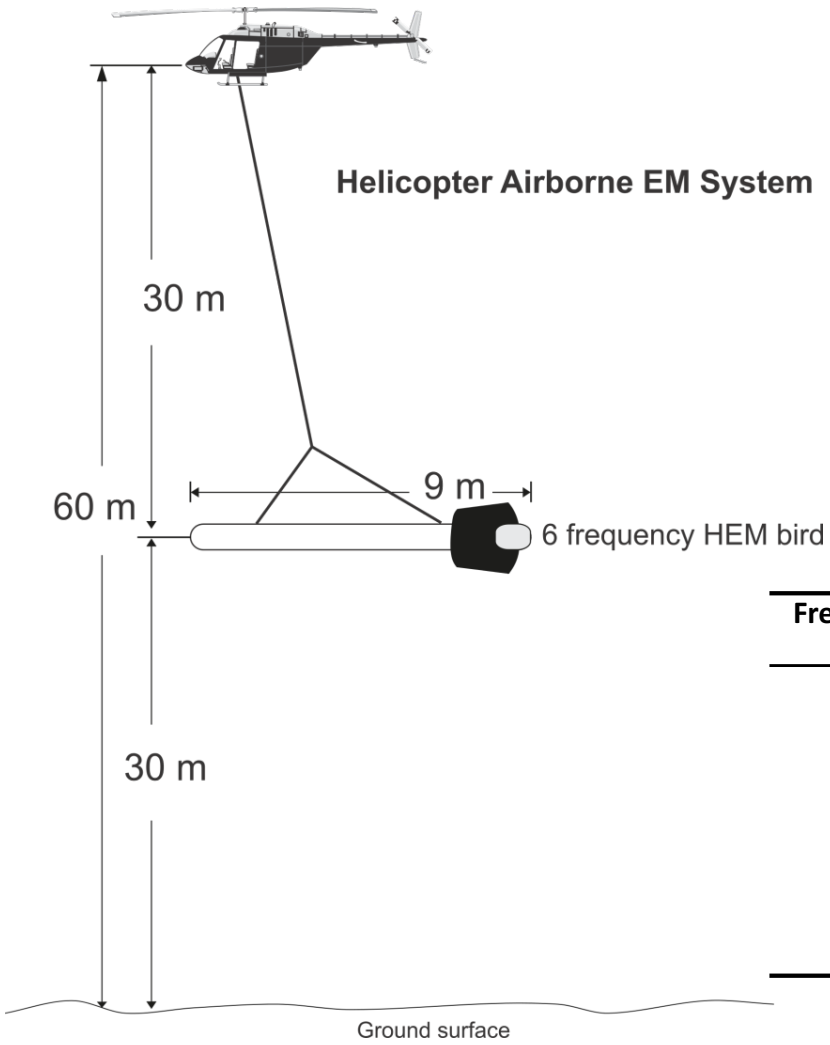
- Area: 170 km^2
- 49 lines of 200 m separation
- Inverted data to get a conductivity and depth model
- Typically well-described by 3-4 layers
- Topmost layer is interpreted to be the Baucau Limestone formation

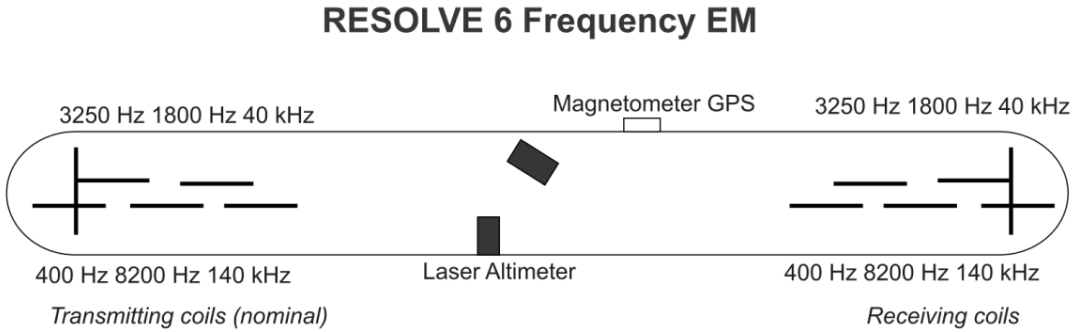




The FDEM system

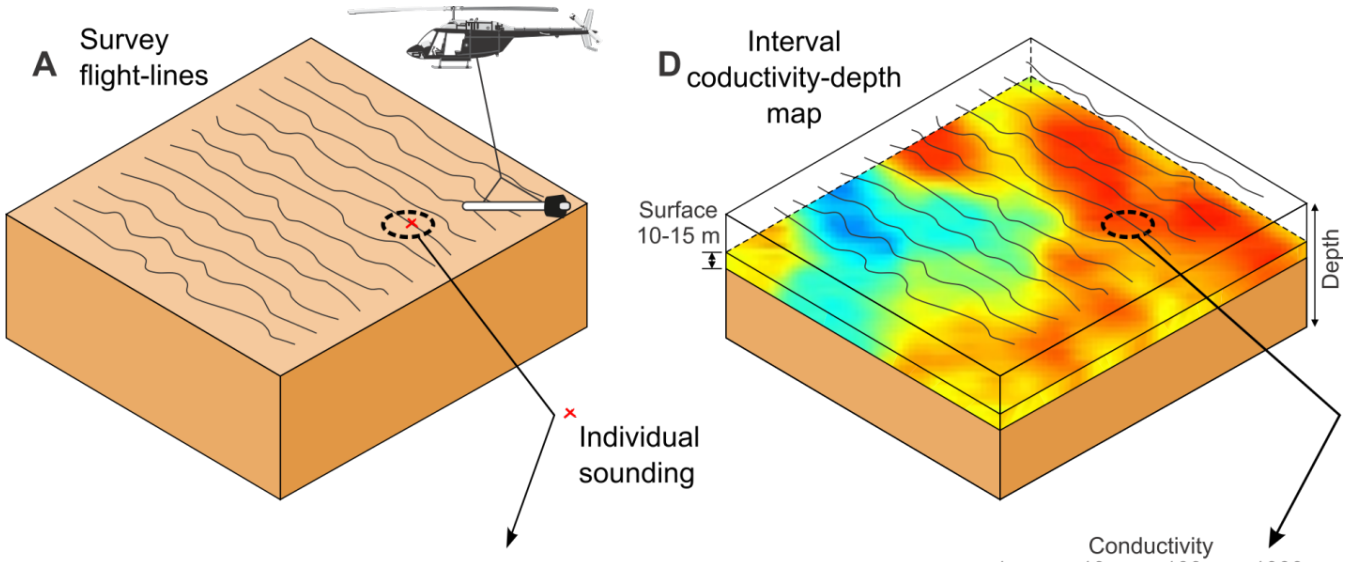
What Data?

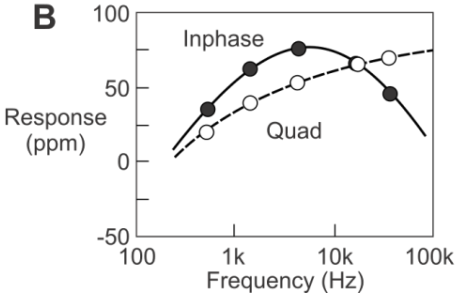




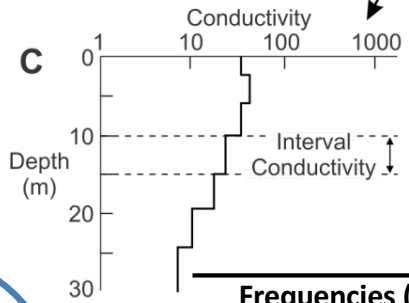
Frequencies (Hz)	Orientation	Diploe moment (Atm^2)	Coil separation (m)	Sensitivity (ppm)
380	Coplanar	310	7.93	0.12
1814	Coplanar	175	7.94	0.12
3250	Coaxial	211	9.06	0.12
8191	Coplanar	70	7.95	0.24
41k	Coplanar	35	7.93	0.60
132k	Coplanar	18	7.95	0.60

From acquisition to interpretation





Inversion



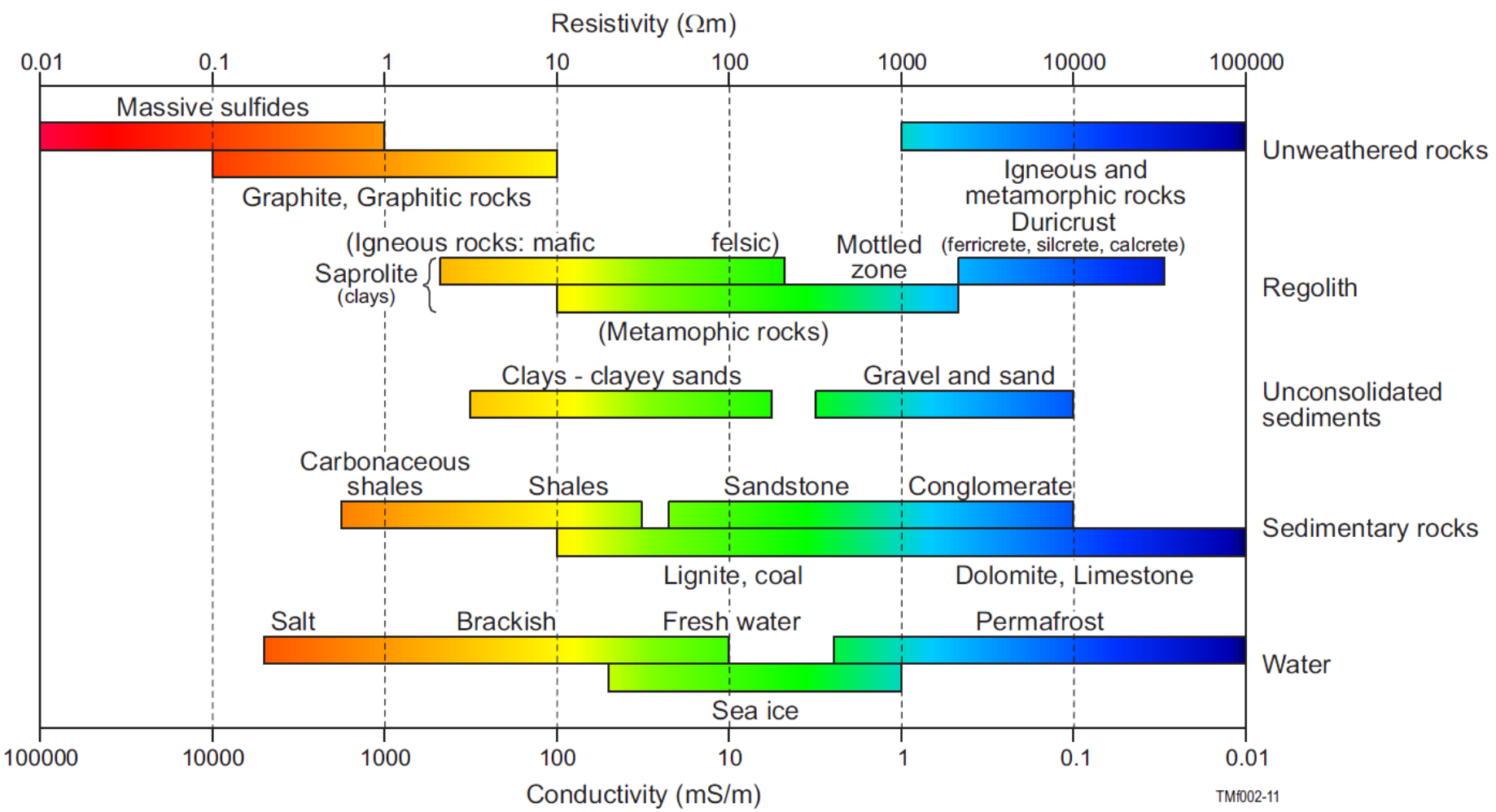
Processing

Frequencies (Hz)	Amplitude Scale	Phase shift (degrees)
380	1	0
1814	1	0
3250	1.09	0.1
8191	1.13	3.56
41k	1	0
132k	1	0

Re calibration
Ley-copper *etal.*, 2006 and 2007

Earth forming

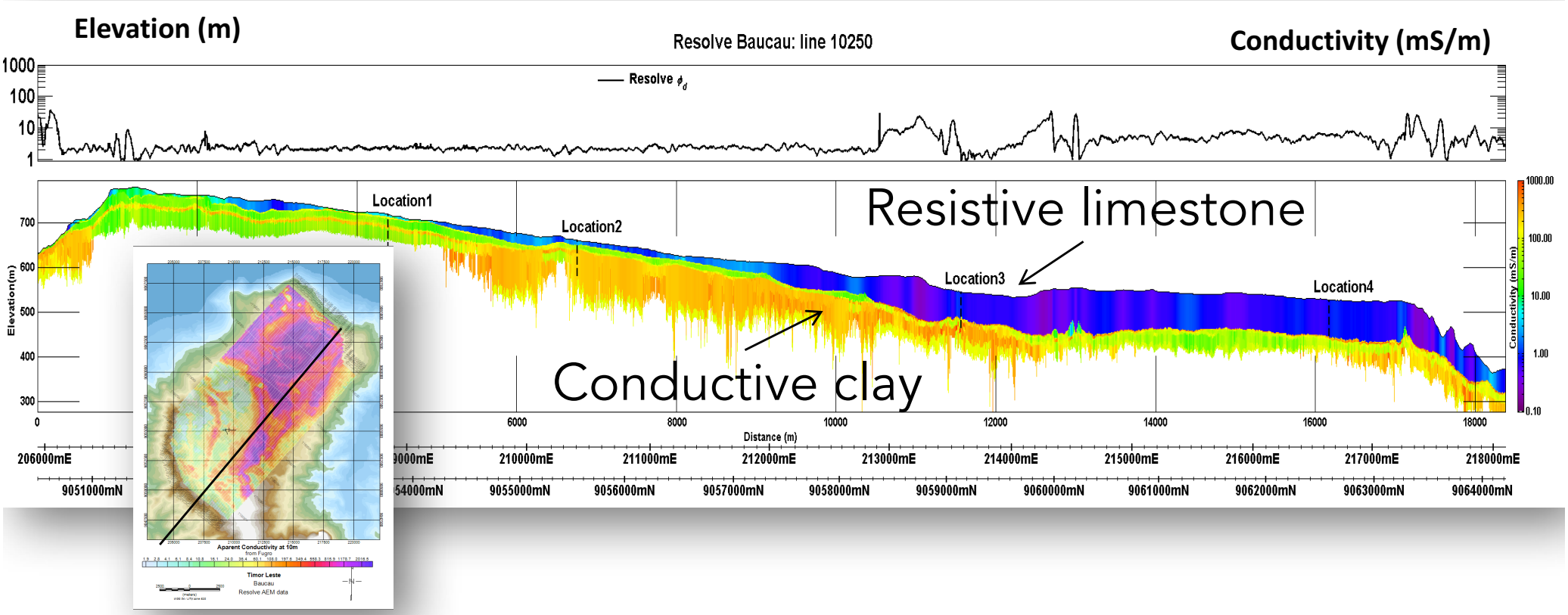
Properties



Preliminary geophysical inversions

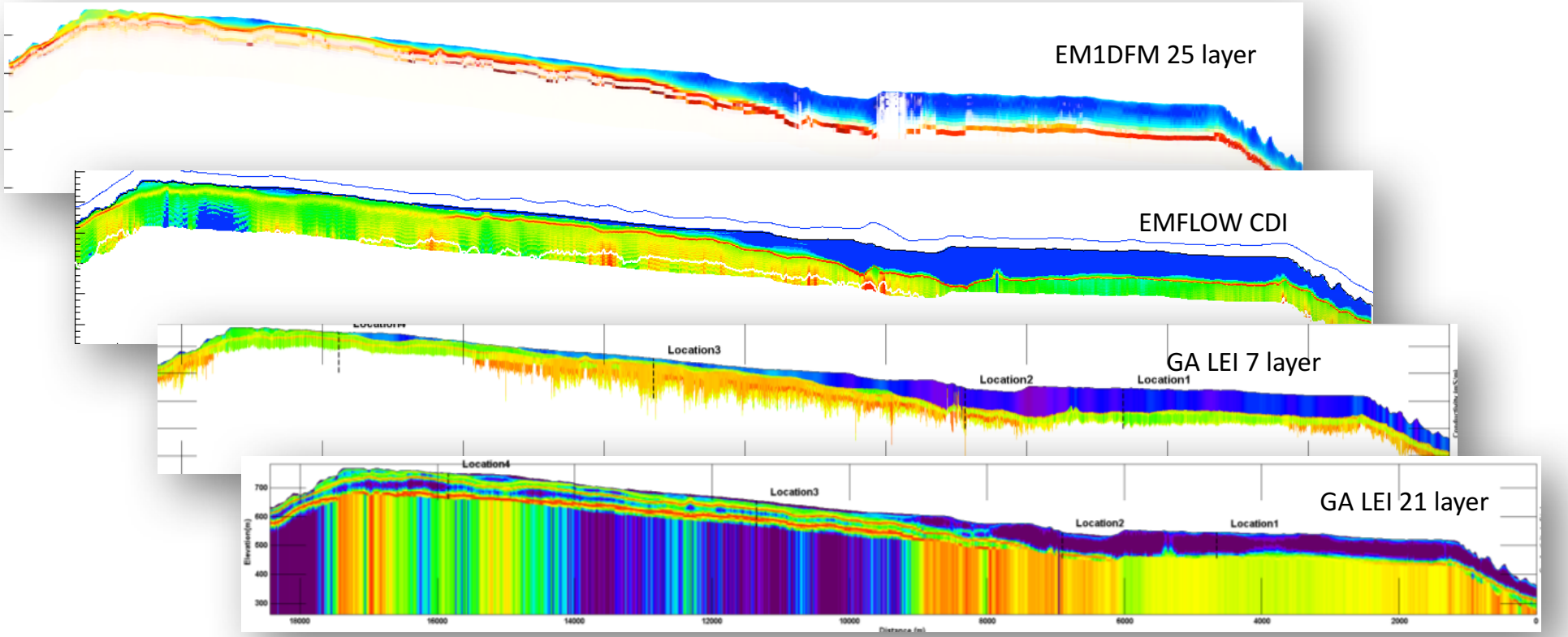
Processing

Deterministic inversion (Fdem_sbs) – L10240



Deterministic inversion challenges & McMC motivation

Processing



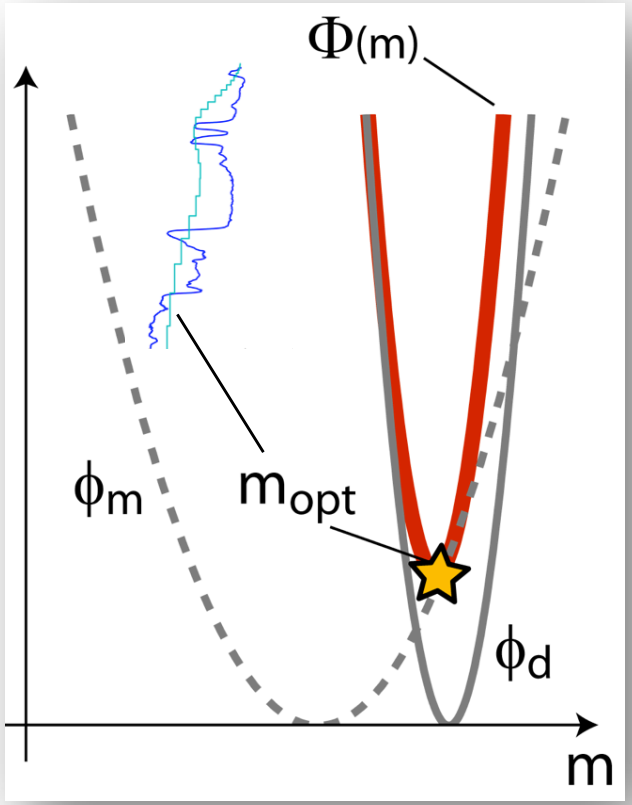
Different inversion choices produce different results

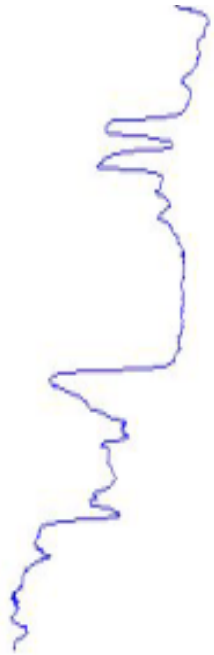
- Which is right?
- Difficult to find optimal inversion parameters for entire survey

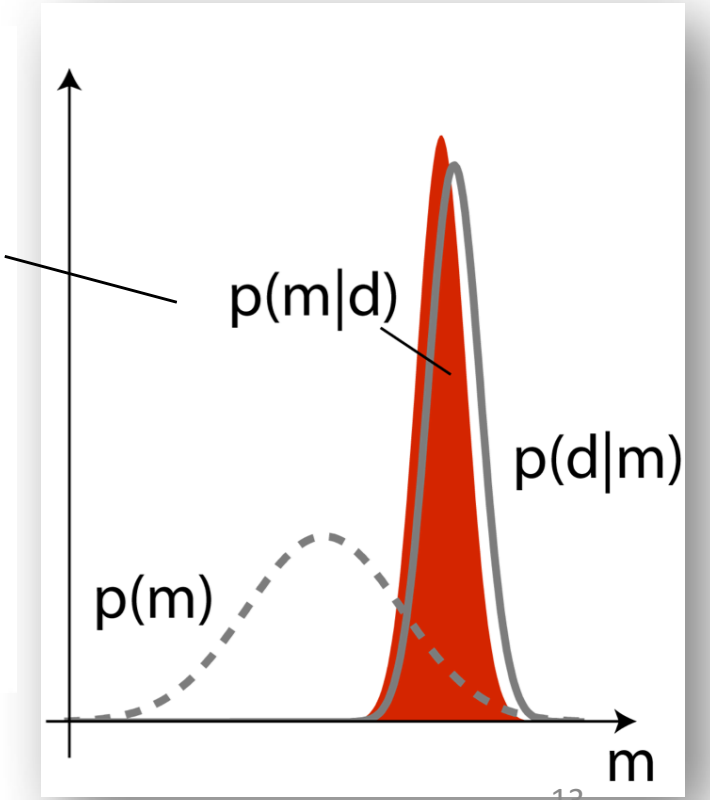
Optimization versus sampling

Find the single 'best' model consistent with data and model constraints (deterministic

Sample many plausible models consistent with data and prior information (Bayesian)

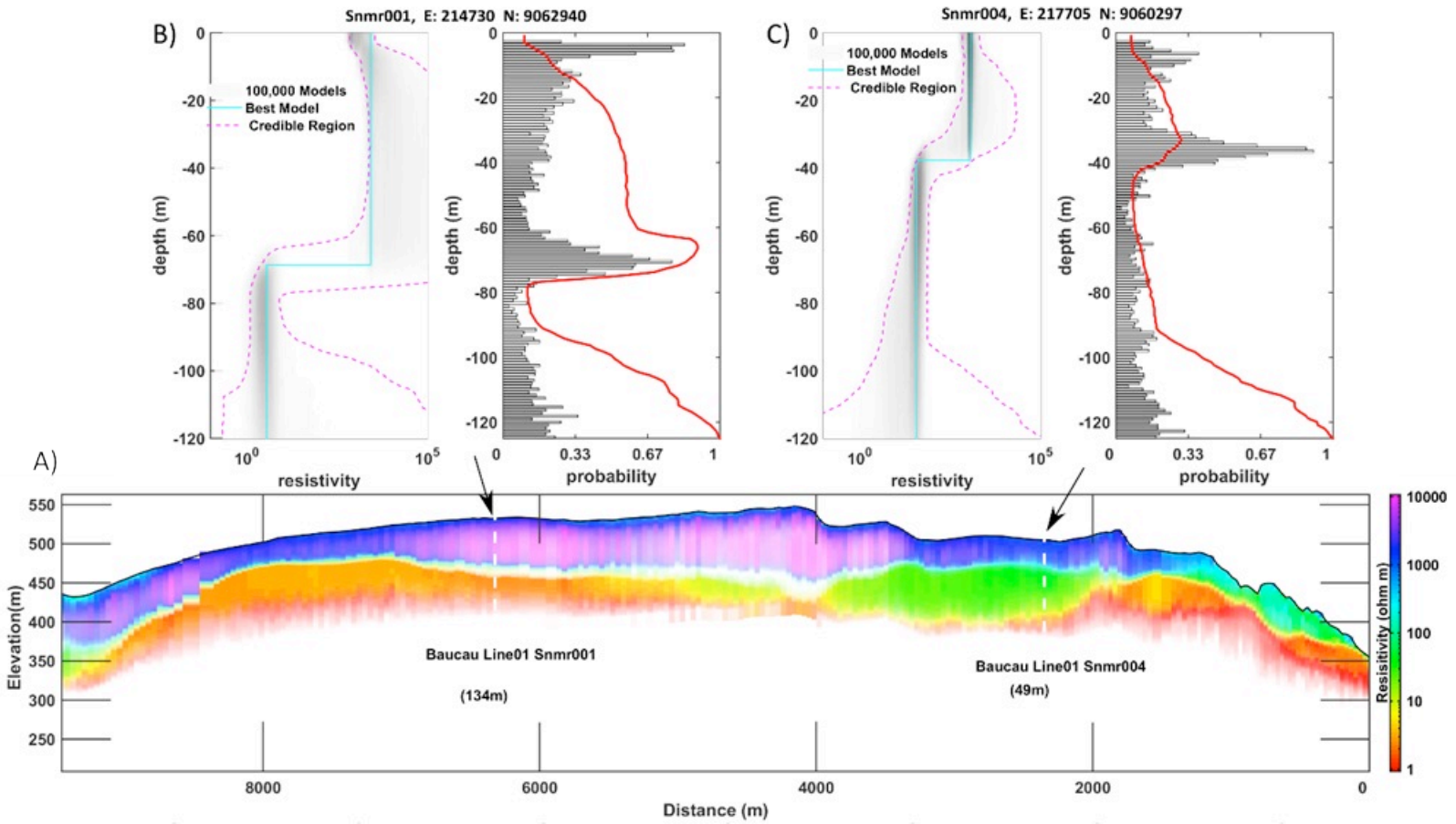






Baucau McMC results

Processing/interpretation



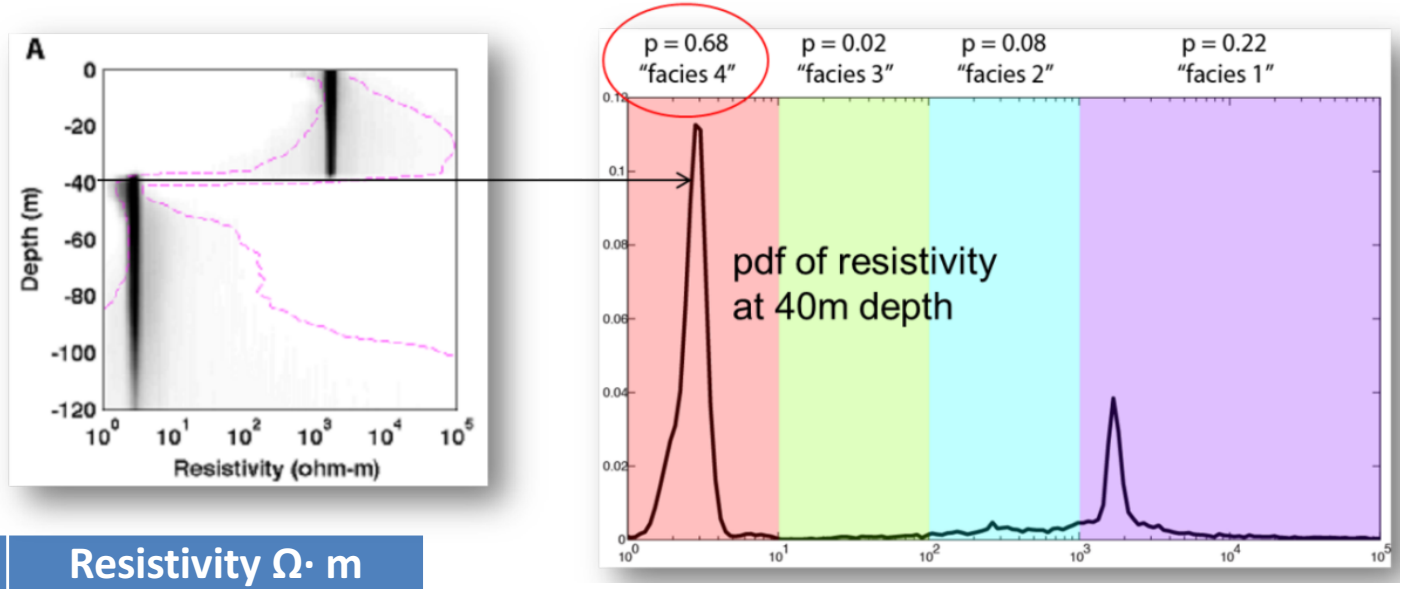
Stitched 'mean model' constructed from 100k sampled models at each location. With ~500 locations and 100k models/location, the content in this figure is built from 50Million models!

Analyses of layer-depth interface at two locations are shown in B) and C).

Conductivity cut-off values

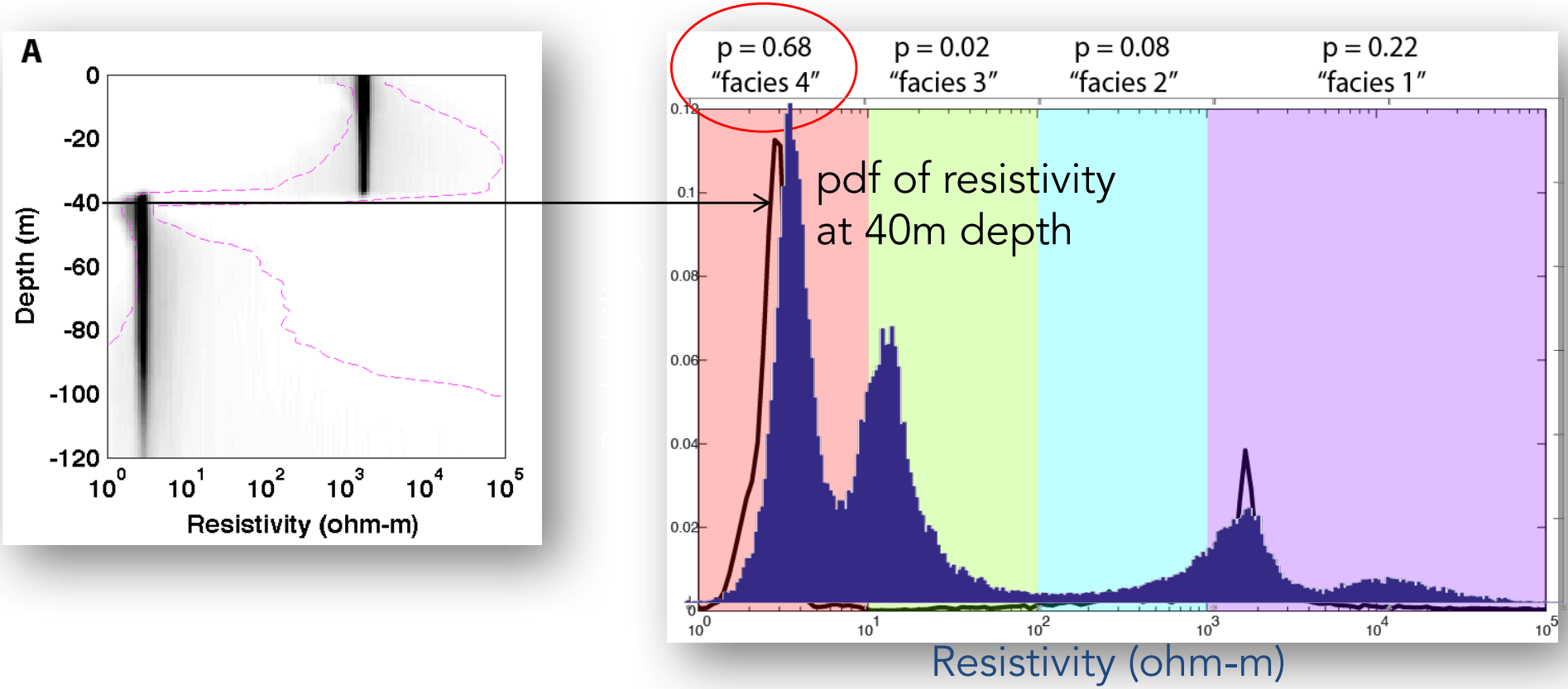
Processing/interpretation

The cut-off values we have the pre-determined for rock types in this case study range over three orders of magnitude and are listed in



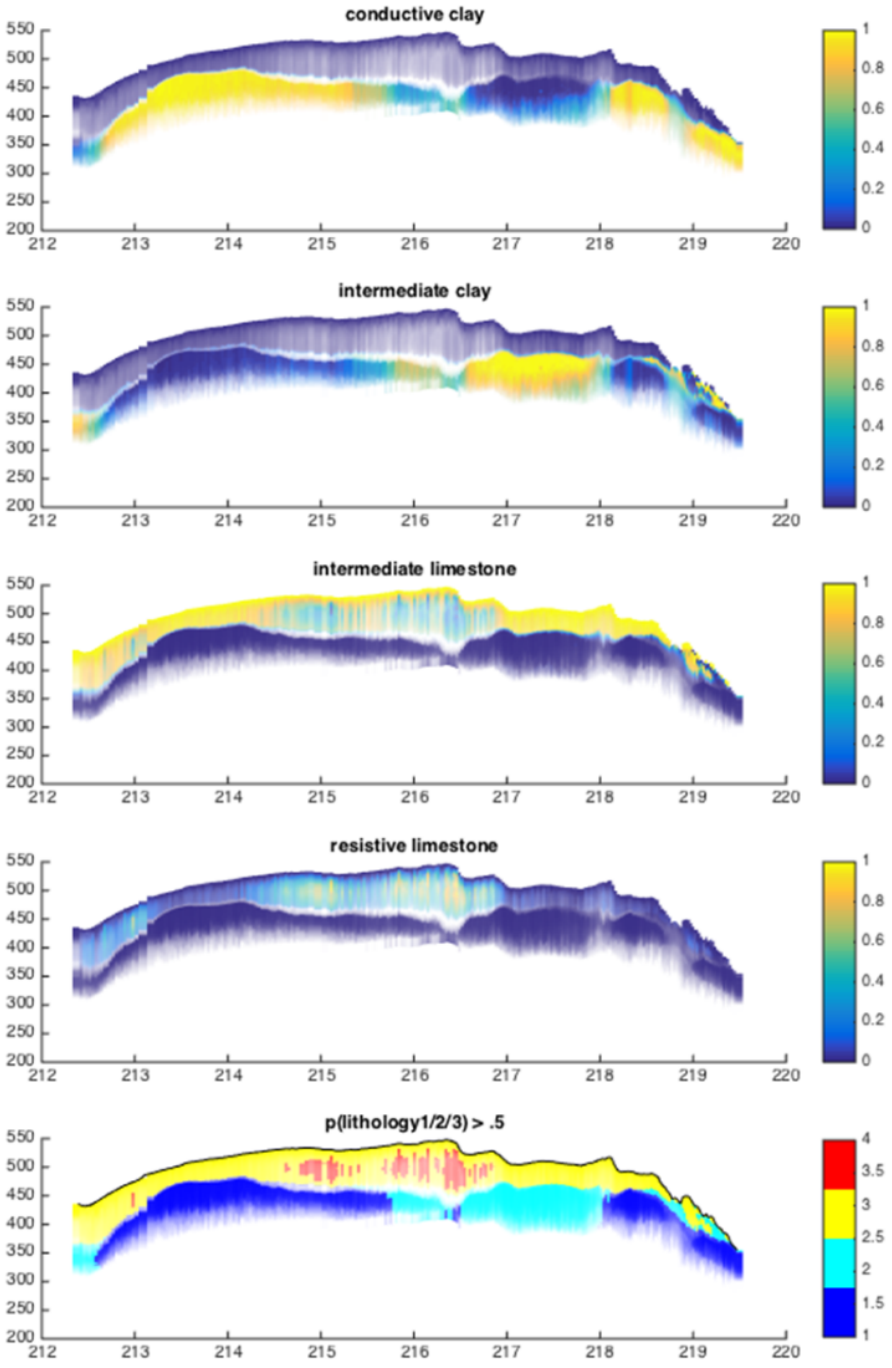
Lithology	Resistivity Ω· m
very resistive limestone	>1000
intermediate limestone	100-1000
intermediate clay	10-100
conductive clay	<10

Baucau AEM – from resistivity to 'lithology'



Processing/interpretation

Probability distribution of resistivity extracted from a depth of ~40 m, near the layer interface at this location. Overlay colours indicate uniform resistivity ranges use here to quantify different facies or lithologies.



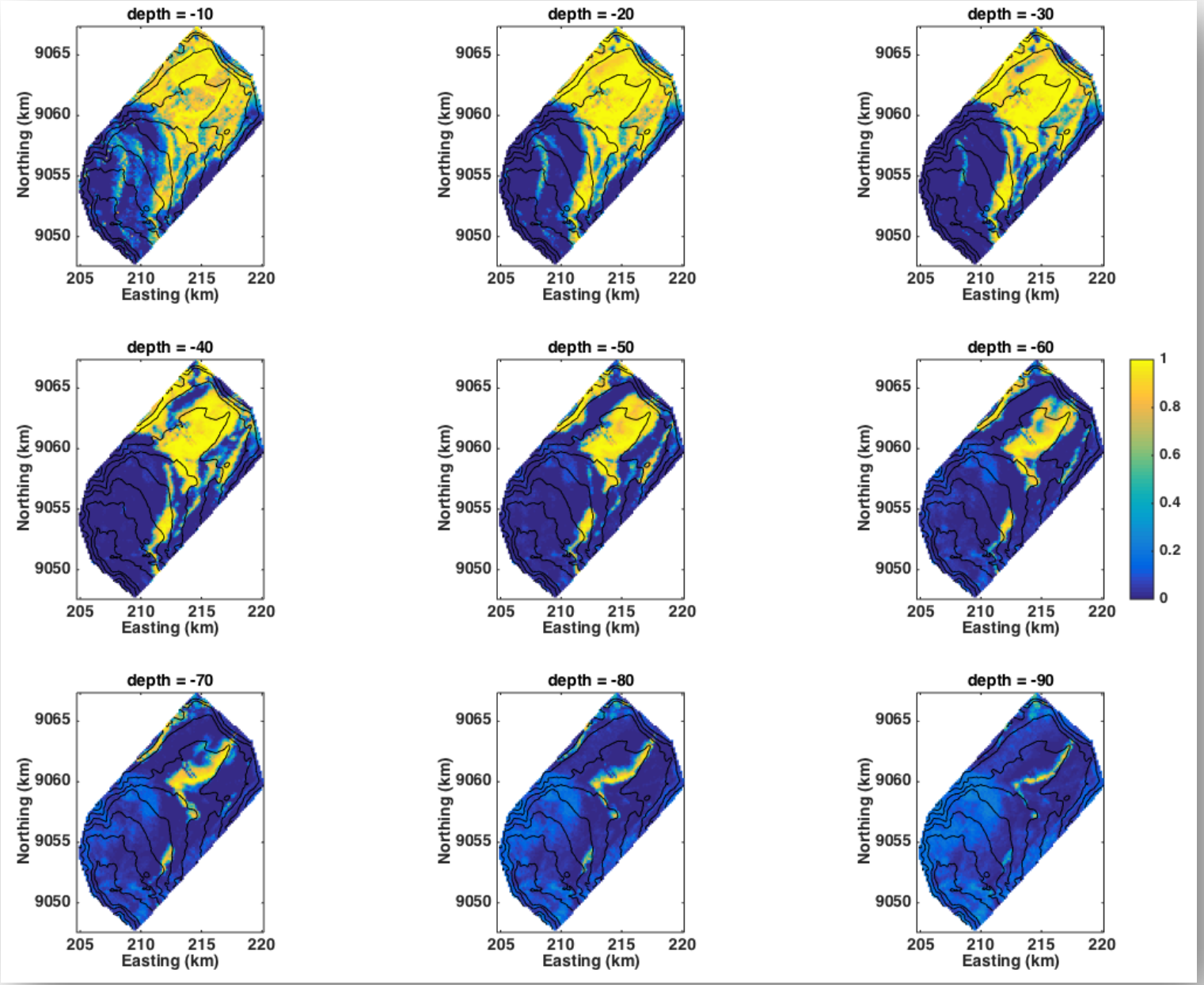
Probability cross-section within any given lithology.

Probabilities coloured using a range from 0-1

The bottom panel is an indicator (1-4) of which lithology is most probable at each location

Interpretation

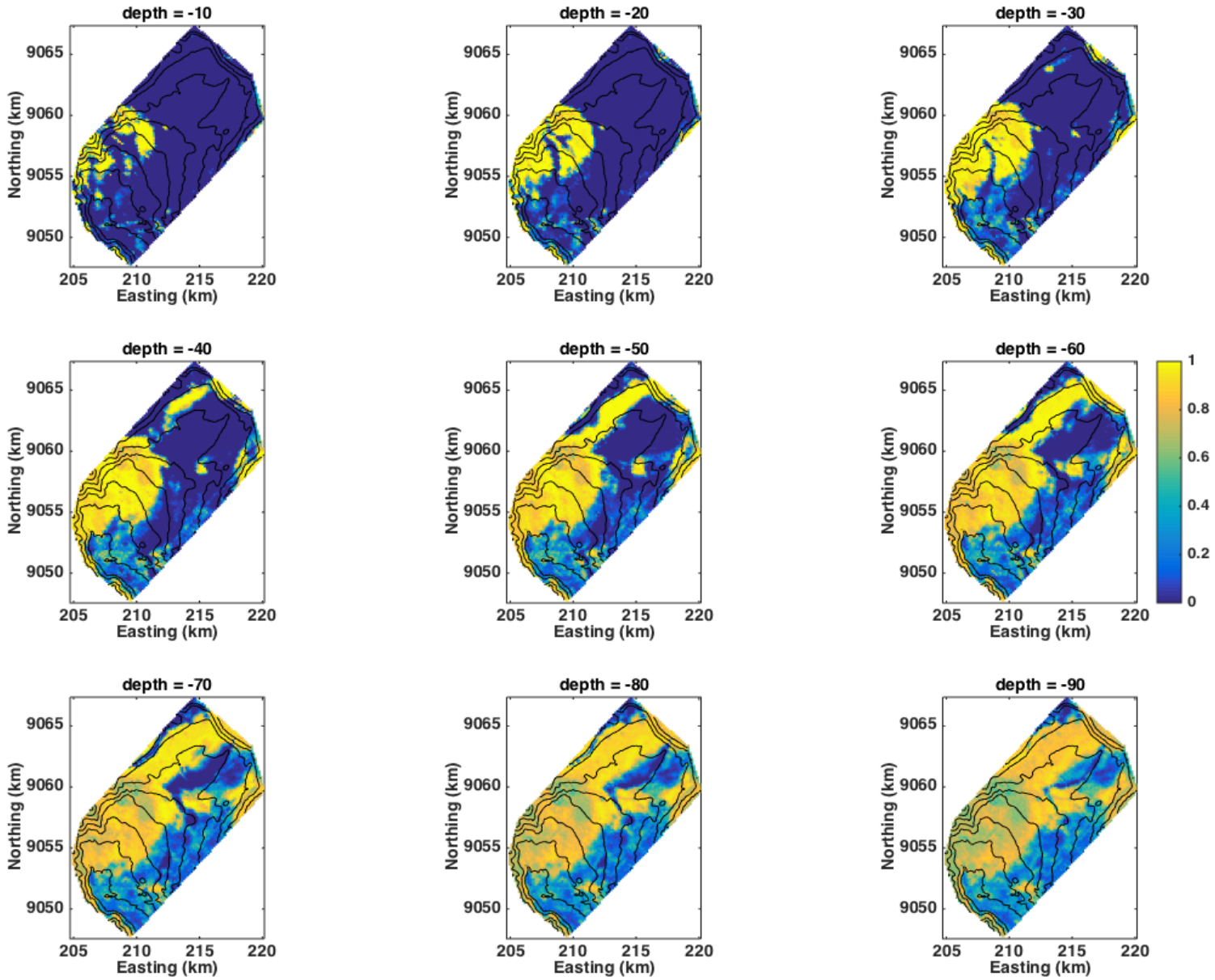
Probability of resistive limestone



AEM | Ley-Cooper et.al,

Interpretation

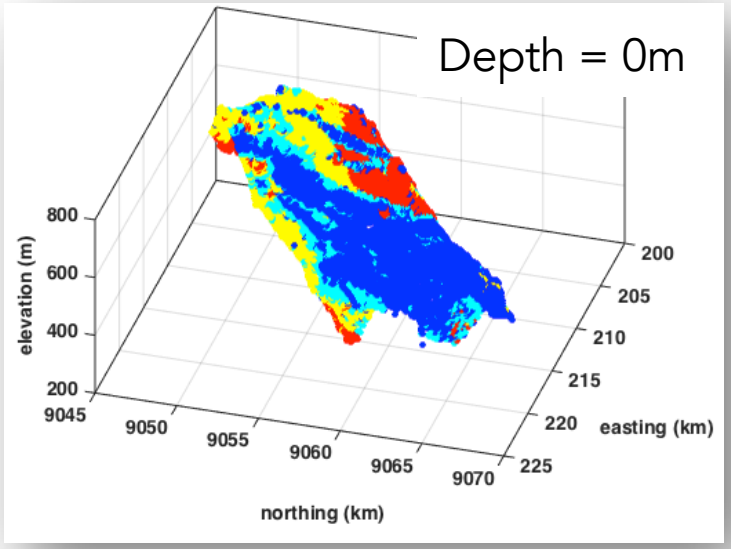
Probability of conductive clay

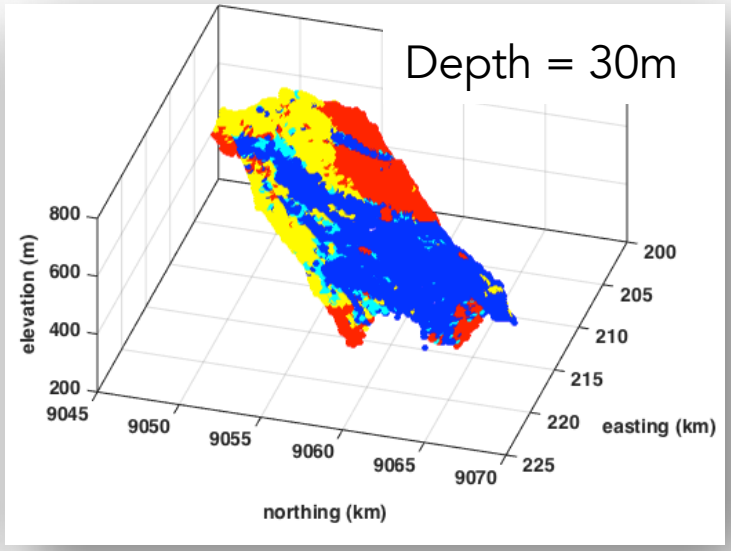


AEM | Ley-Cooper et.al,

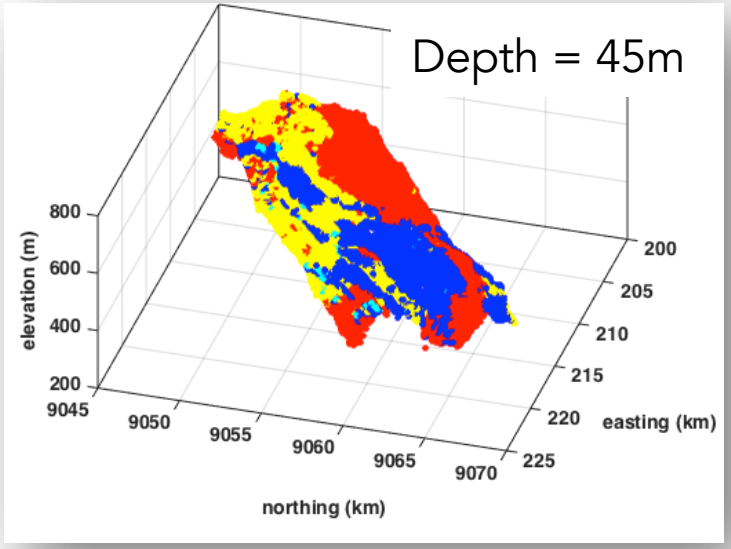
Interpretation

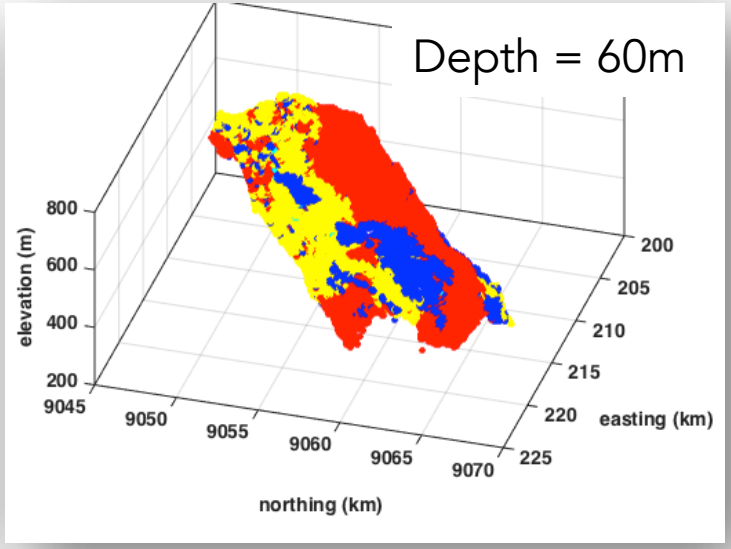
Mapping the ‘most probable’ lithology





Synthesis





Conductive clay

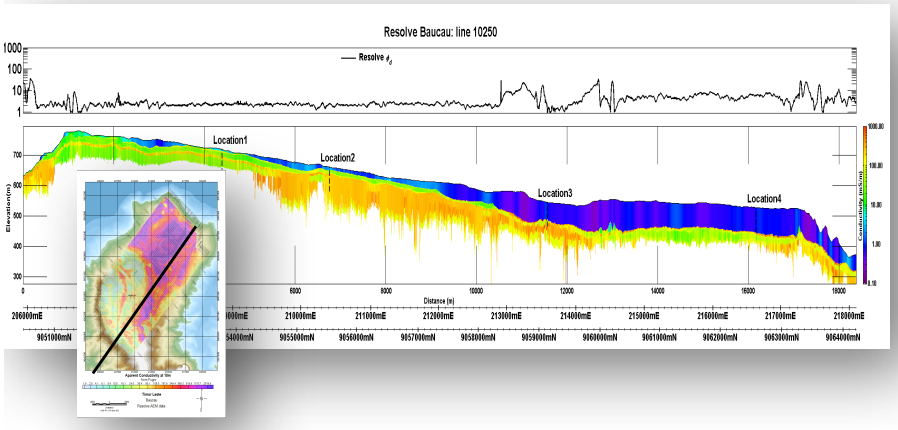
Intermediate clay

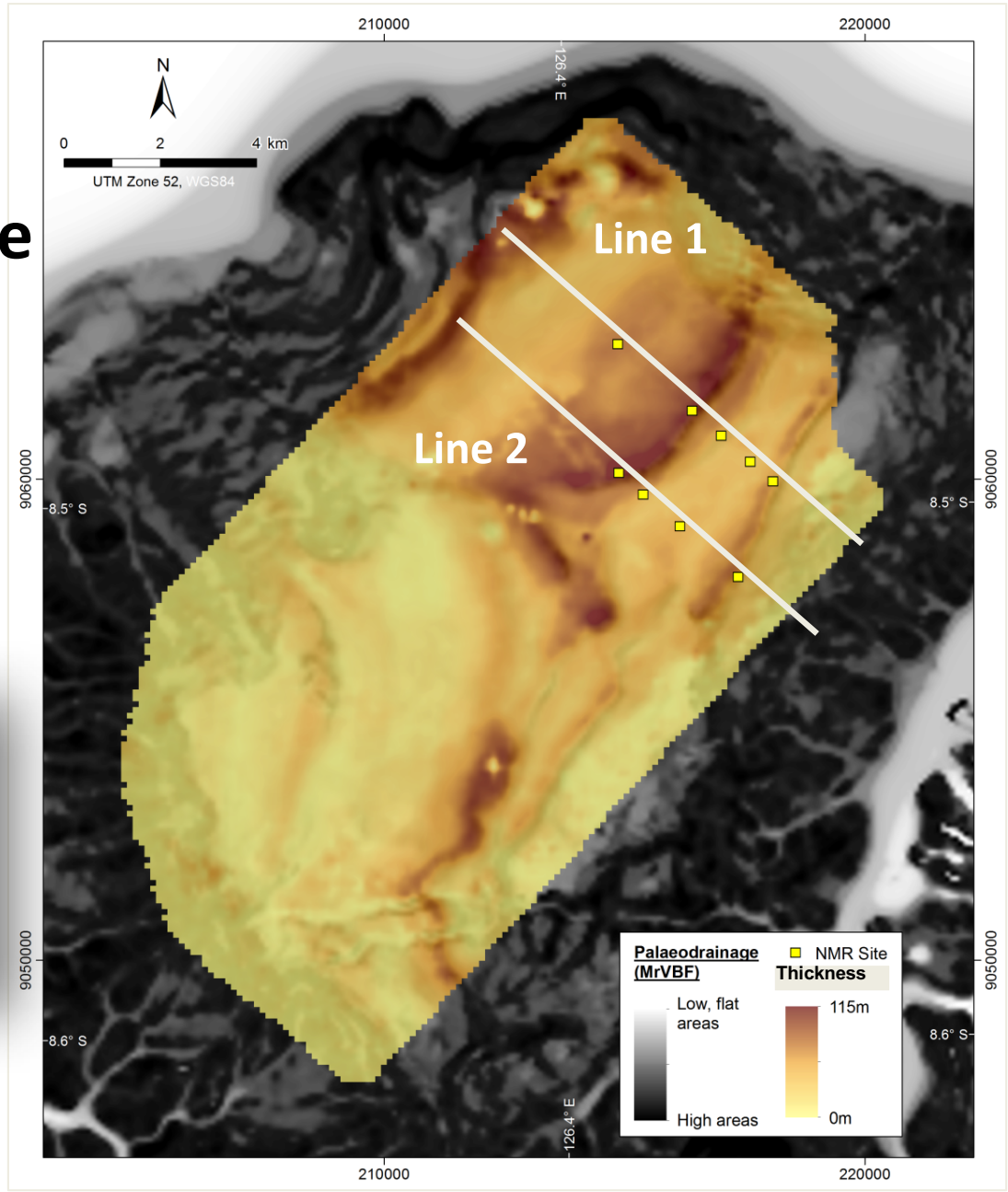
Intermediate limestone

Resistive limestone

AEM derived:

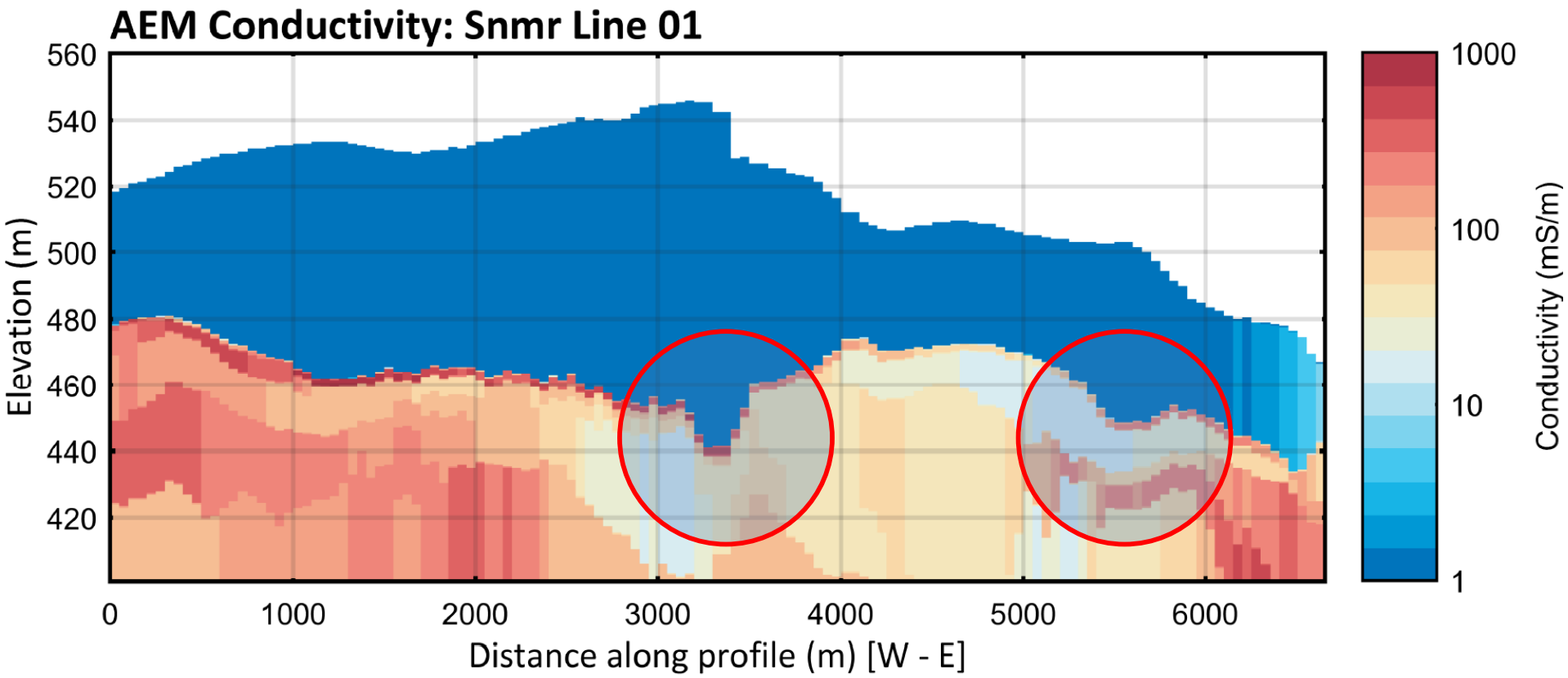
Thickness of the Limestone



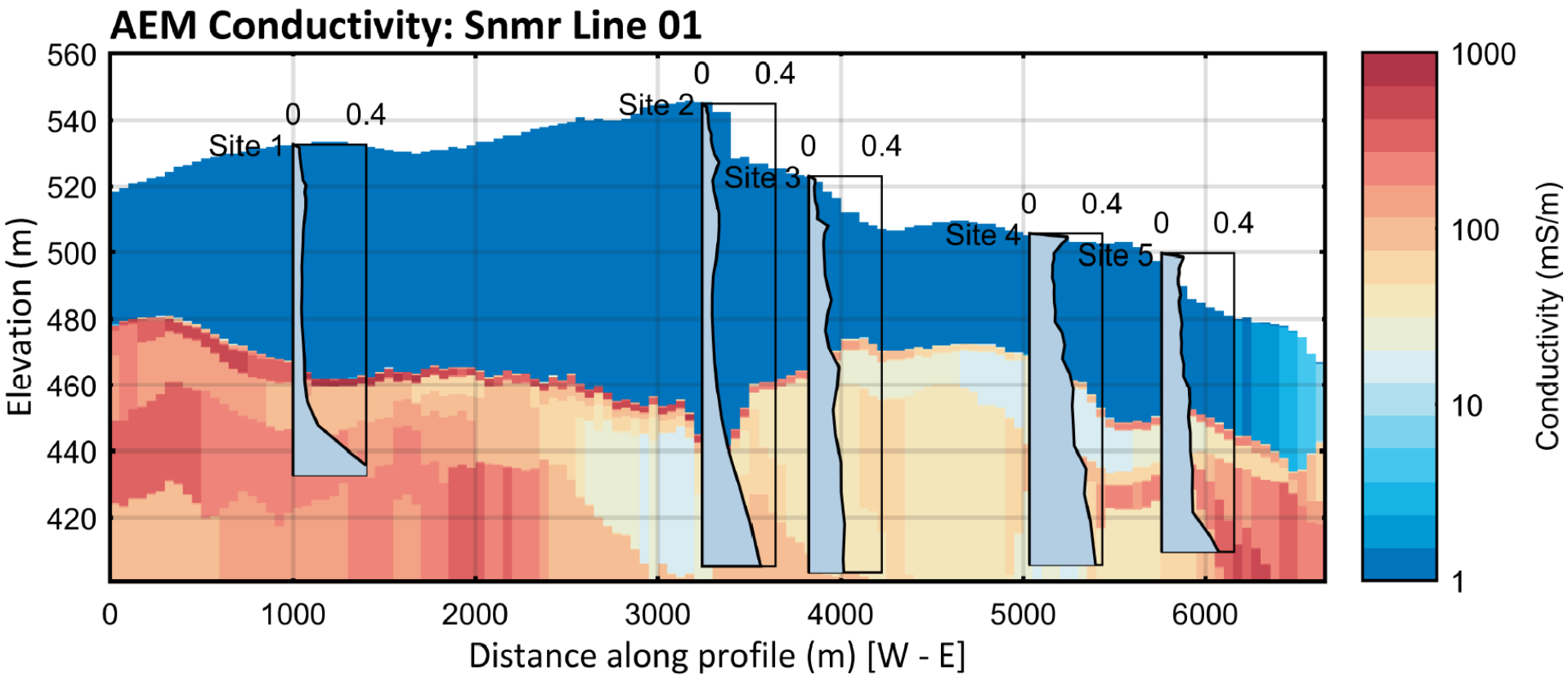


Results +survey planning + data collection

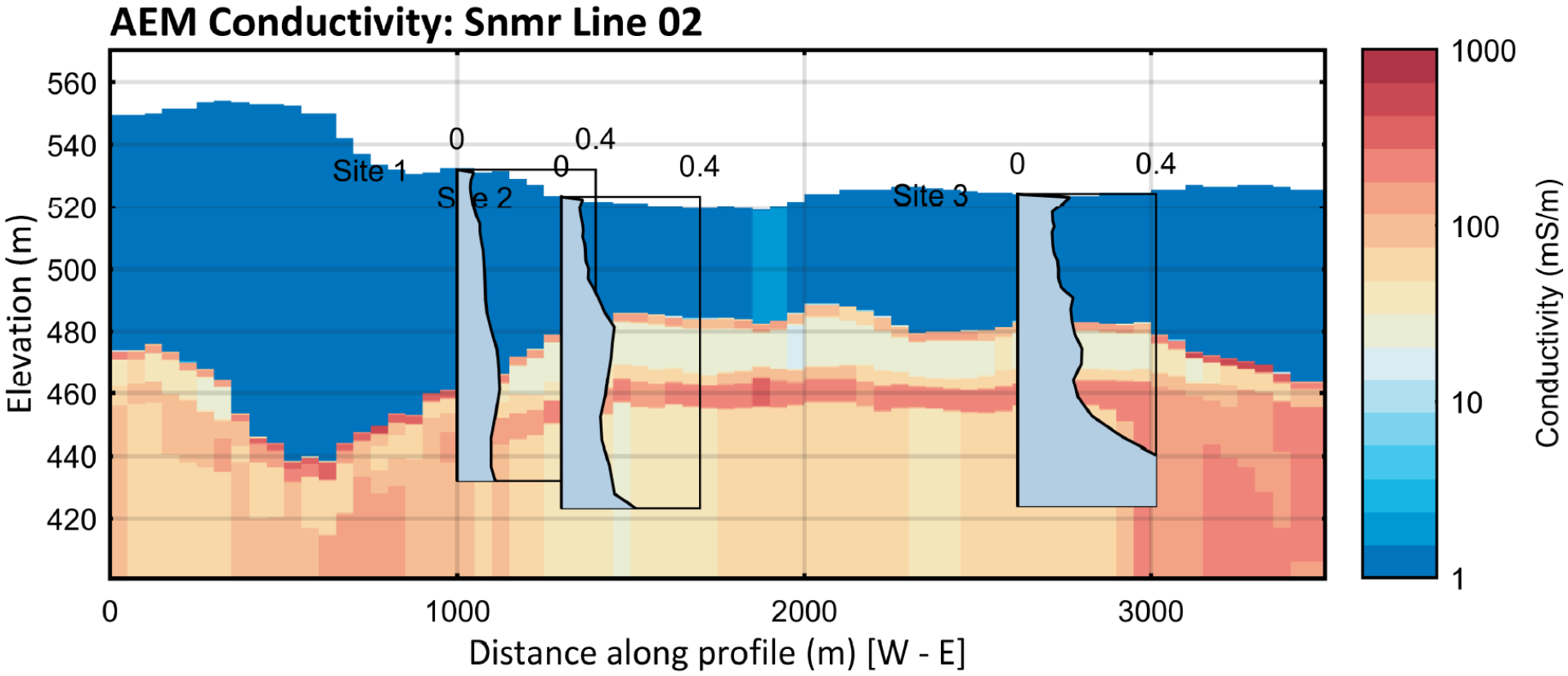
AEM Section line 1



AEM Section line 1



AEM Section line 2



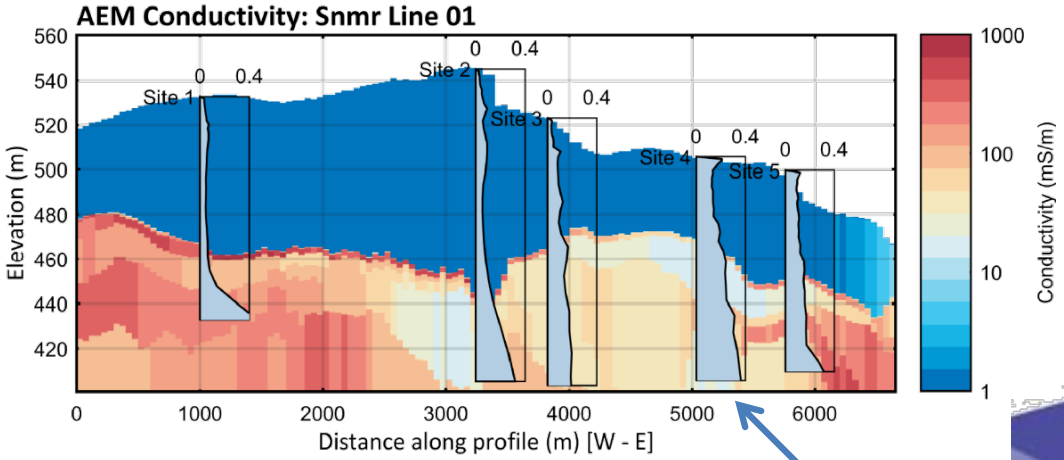
Summary

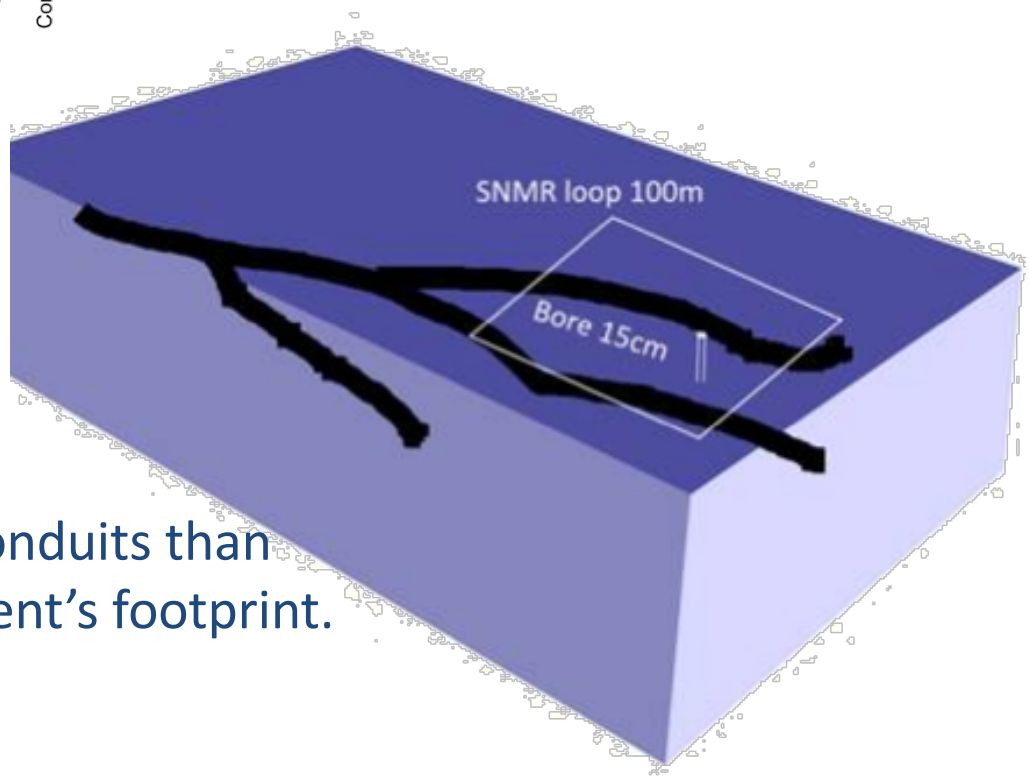
- *Reject* unrealistic models
- *Explore* the model characteristics consistent with measurements (not to focus on any one particular model)

Conclusion

- Mapped the bottom of the Baucau Limestone Formation with AEM survey
- Determined SNMR lines of soundings intersecting preferential flow paths
- Found groundwater at 10-30 % porosity
  - **But not where we expected it!**

Synthesis





The sNMR data indicates their is water

Water secluded in smaller more confined conduits than what we are not resolving with the instrument's footprint.

bulk measurement from an area ~10,000m^2 at
Drilling a 15cm bore into it.