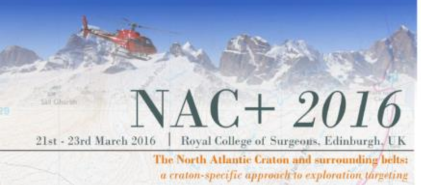


Dragging Exploration into the Quantum Age:

using Atomic Dielectric Resonance technology to classify sites in the North Atlantic Craton

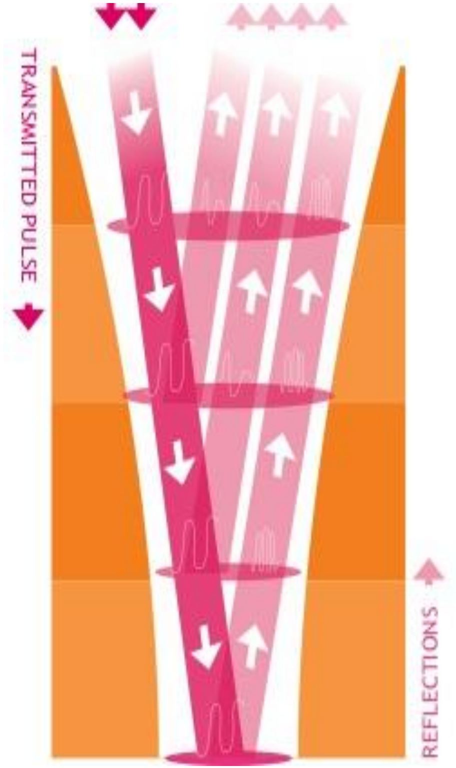
Gordon D.C. Stove
CEO & Co-founder

Agenda

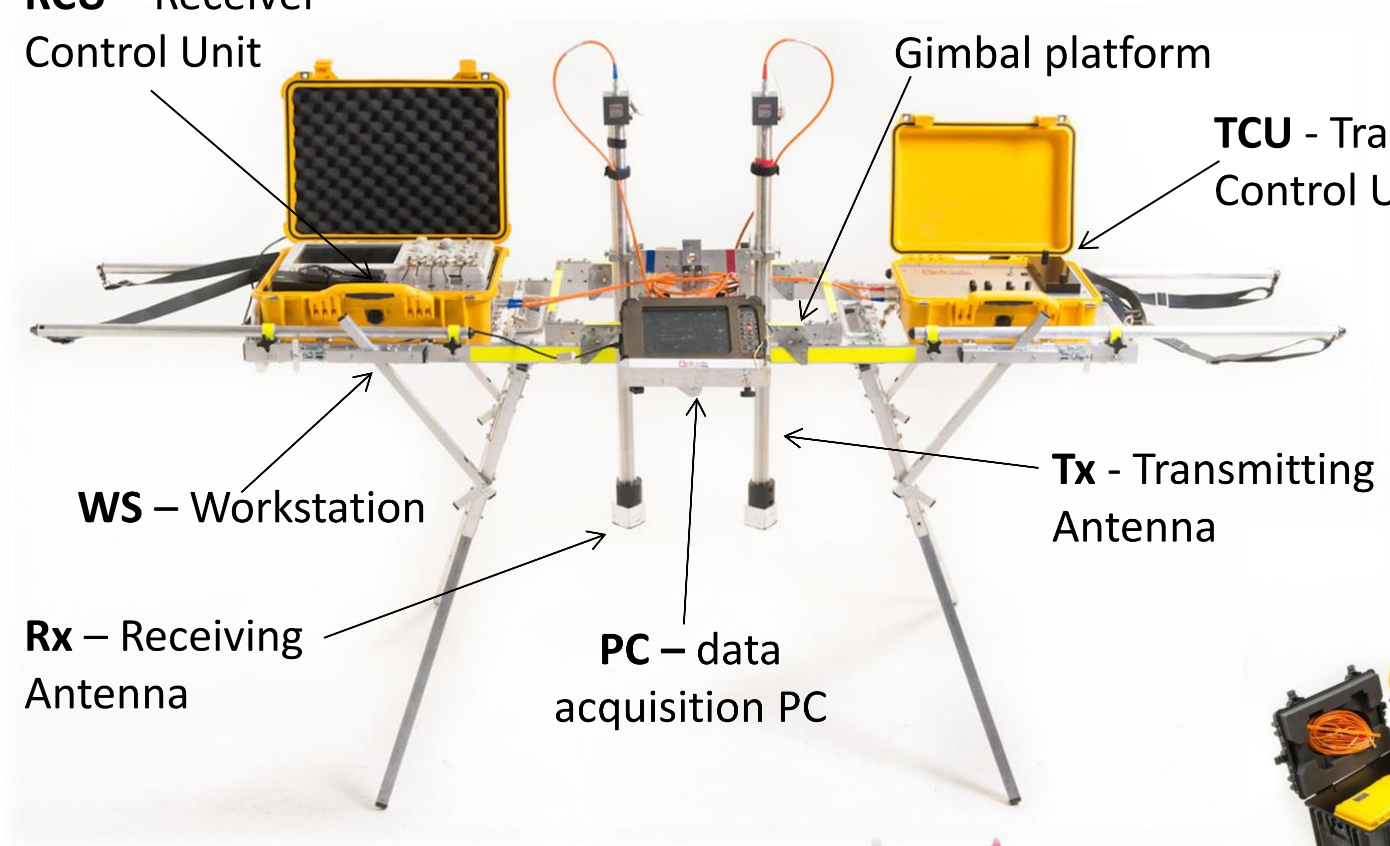
- What is Atomic Dielectric Resonance (ADR)
- How does it work
- Case Studies:
    1. Canada – nickel exploration
    2. Ireland – zinc & lead
    3. N.Ireland – PGM
    4. Australia & Canada – Gold exploration
    5. Scotland – Cononish gold deposit

Atomic Dielectric Resonance (ADR)

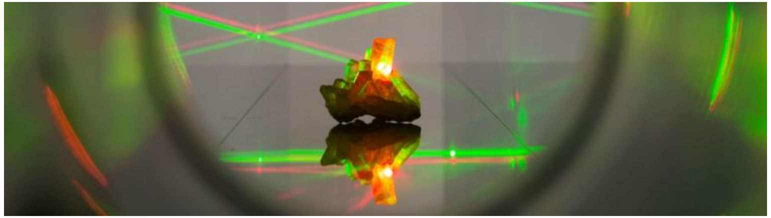
- RAdio Detection And Ranging in visually opaque materials
- Transmit pulsed broadband of radiowaves and microwaves
- Depending on depth of investigation transmit between 100kHz to 1GHz
- For large depth mining exploration typically transmit between 1MHz to 100MHz
- ADR sends broadband pulses into the ground and detects the modulated reflections returned from the subsurface structures
- ADR measures dielectric permittivity of material
- ADR also uses spectral content of the returns to help classify materials (energy, frequency, phase)



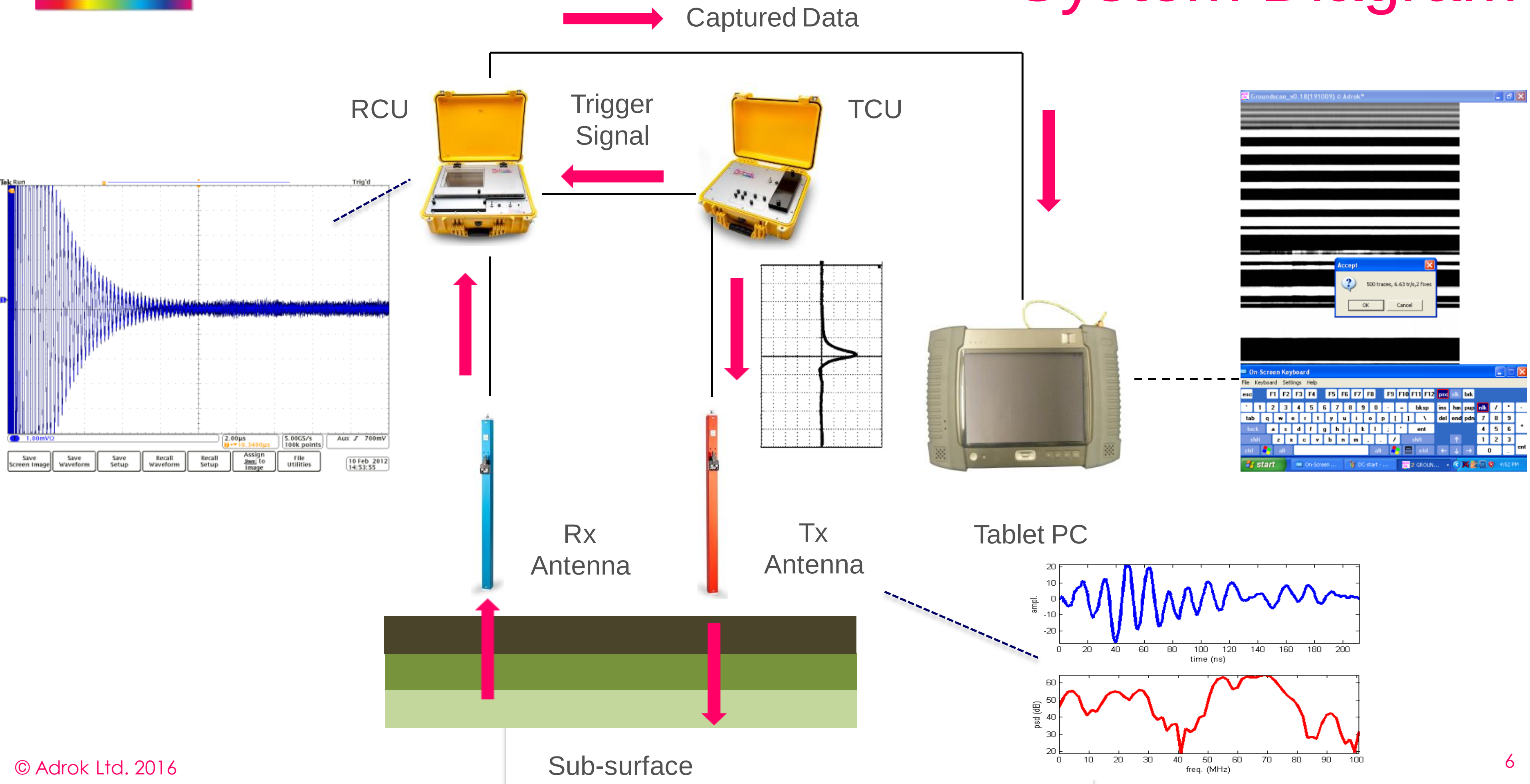
Field ADR Scanner



Laboratory ADR Core Scanner



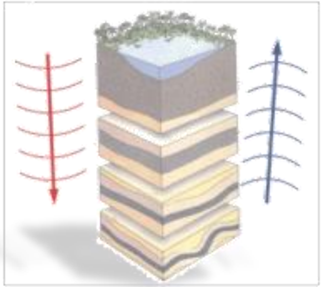
System Diagram



Specifications

ADR Setting	Typical Range
Tx frequency maximum	12.5MHz-10GHz
Tx frequency minimum	100kHz-1GHz
Time Range	2ns to 250,000ns
Number of pixels per trace	40 to 4000
Pulse Repetition Frequency (PRF)	10-100kHz
Pulse Width	0.1ns to 10ns
Power supply	4 off 24Vdc Li-Ion batteries
Power consumption	150W for ADR equipment *plus* 100W for tablet PC
Power transmission	< 5 miliwatts (mW)

1 **Pre-survey field modelling**

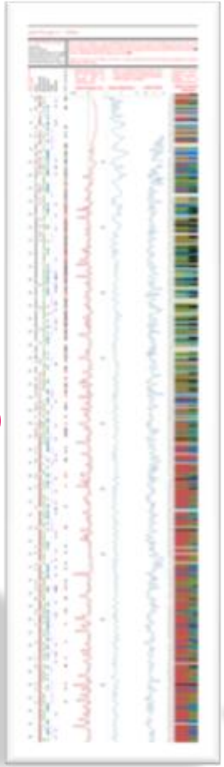


2 **Training for geological signatures**

On-site Survey Data Acquisition

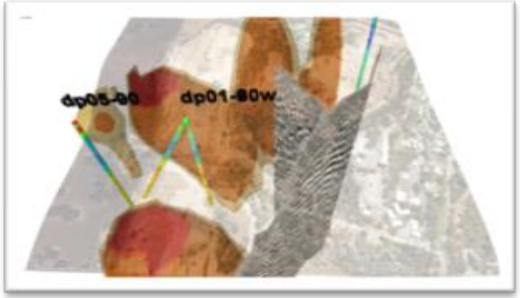
3

4 **Data Processing & Interpretation**



5 **Analysis & results Delivery**

6 **Integration to other data sets**



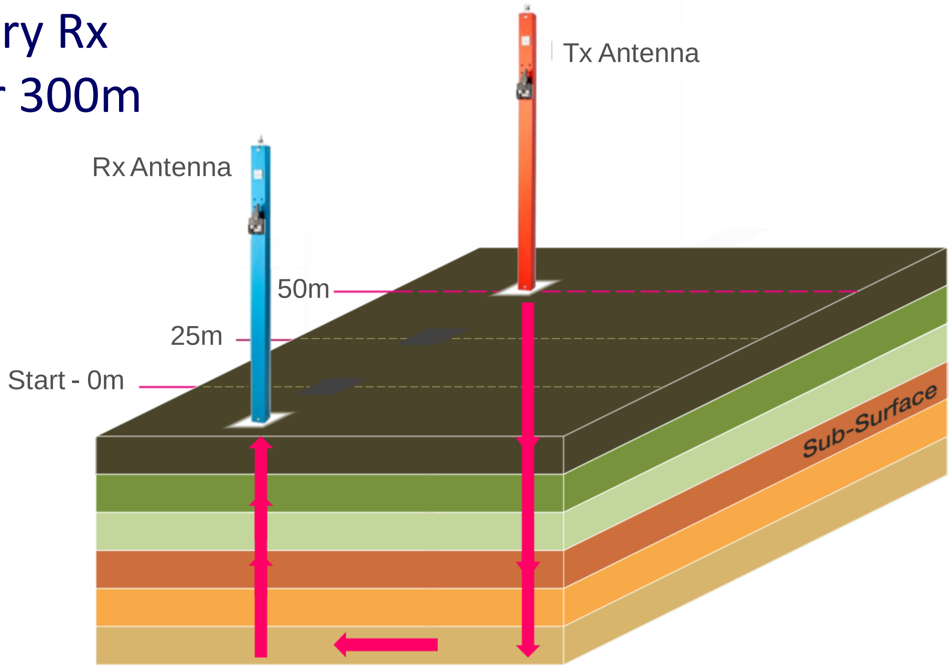
WE COMBINE EFFICIENT TECHNOLOGY WITH CUSTOMER SERVICE

THE BRITISH ASSESSMENT BUREAU ISO9001 UKAS Certification No. 188208

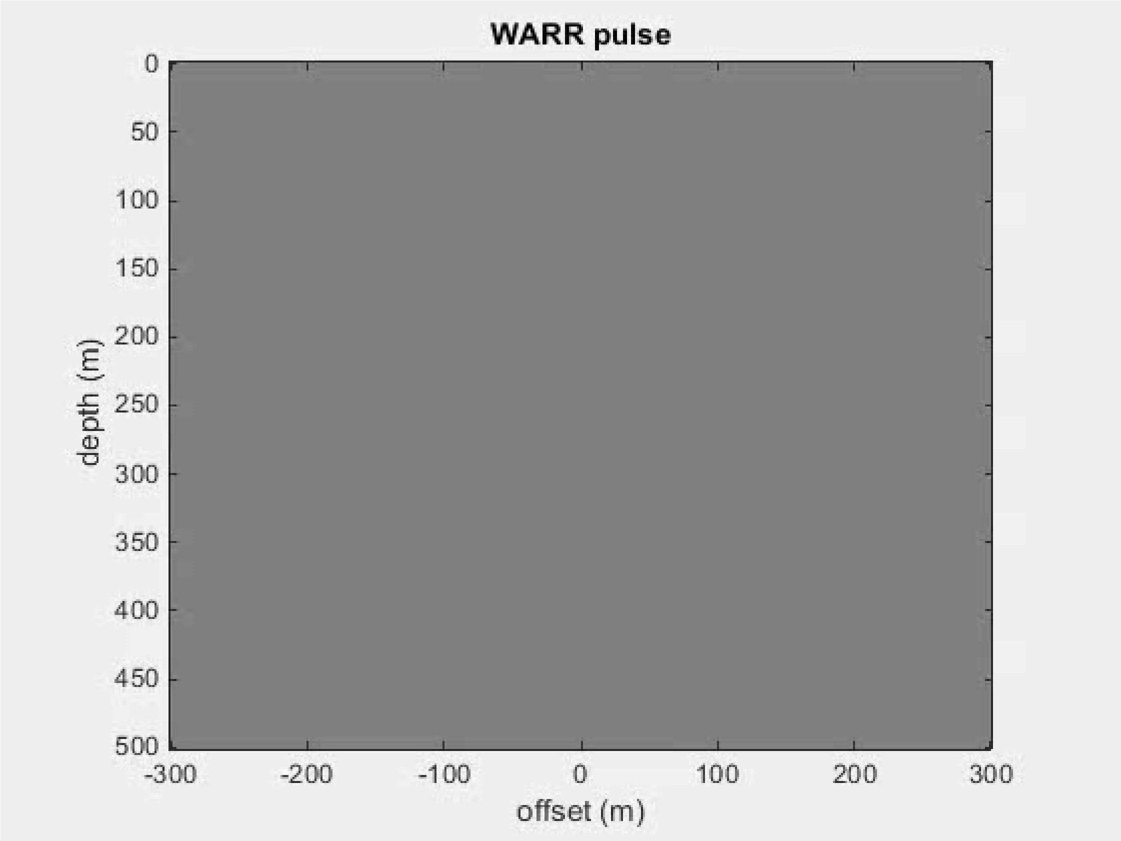
Adrok aims to provide useful subsurface measurements to help de-risk drilling programmes...
Thus enhancing recovery of hydrocarbons, minerals & water!

Types of ADR Scanning in Field (1) "WARR"

- Wide Angled Reflection & Refraction
- Triangulation for conversion of time into depth
- Tx antenna moves away from stationary Rx
- Tx moves continuously to say 100m or 300m
- Rx stays at start of scan line at 0m

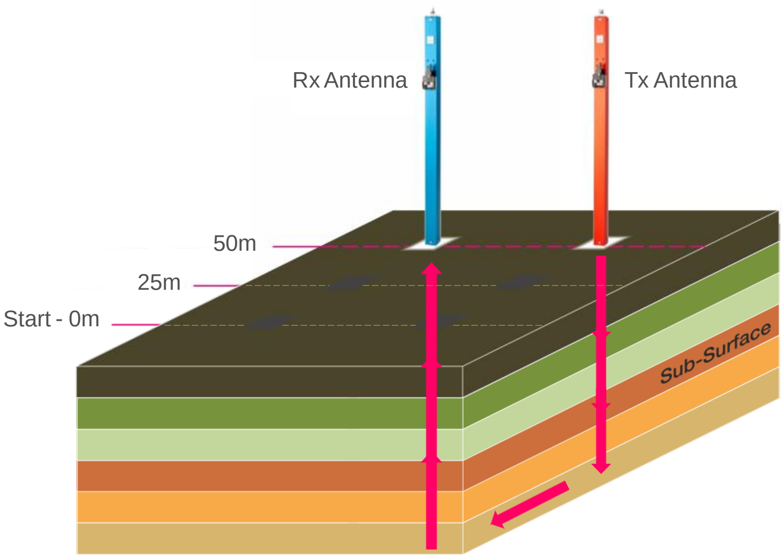


WARR beam forming



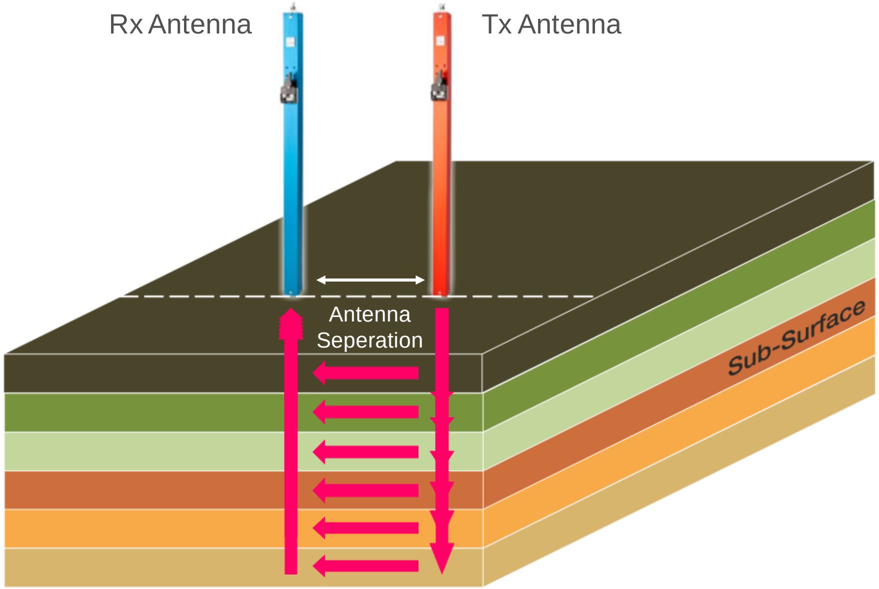
- Line of transmitters in WARR creates beam (Synthetic Aperture Radar, SAR)
- Note in animation pulse wavelet stays coherent

Types of ADR Scanning in Field (2) "P-Scan"



- Profile Scan (2-d cross-section)
- Continuous scanning on the move over short scan line distance (e.g., 50m)
- Tx & Rx antennas at fixed separation distance (e.g. 0.3m)
- Typically, 1 pulsed Tx ping every 5cm, repeatedly over entire length of scan line

Types of ADR Scanning in Field (3) “STARE”



- Tx & Rx antennas at fixed separation (e.g., 0.3m) and whole system stationary
- Active (Tx on) and Passive (Tx off) stares gathered to quantify noise levels
- Stack traces to enhance signal to noise ratio
- Up to 100,000 traces used in current stack

Forward Model

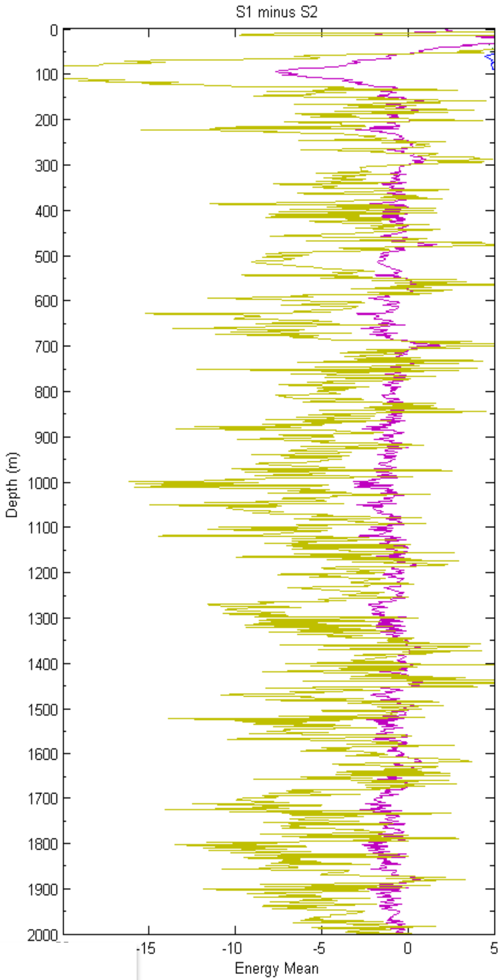
- Maxwell equations coupled to ground model
- Ground model: permittivity, conductivity and polarization (*P*)
  - E electric field, σ conductivity, τ Debye relaxation time, ε_r dielectric
- Resulting system of partial differential equations:

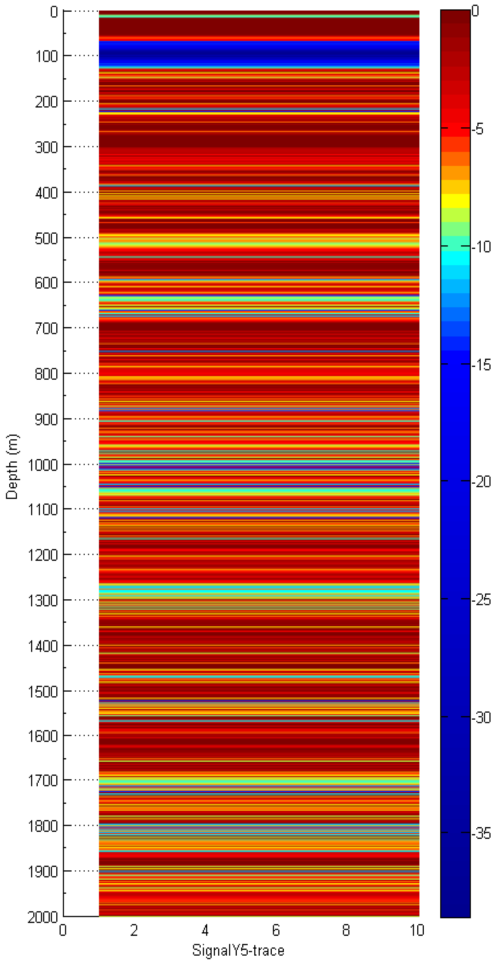
$$\epsilon_0 \frac{\partial^2 E(t,x)}{\partial t^2} + \sigma(x) \frac{\partial E(t,x)}{\partial t} + \frac{\partial^2 P(t,x)}{\partial t^2} - \frac{1}{\mu_0} \frac{\partial^2 E(t,x)}{\partial x^2} = 0, \qquad (1)$$

$$\tau(x) \frac{\partial P(t,x)}{\partial t} + P(t,x) = \epsilon_0(\epsilon_r(x) - 1))E(t,x). \qquad (2)$$

Toolbox of ADR measurements

Energy

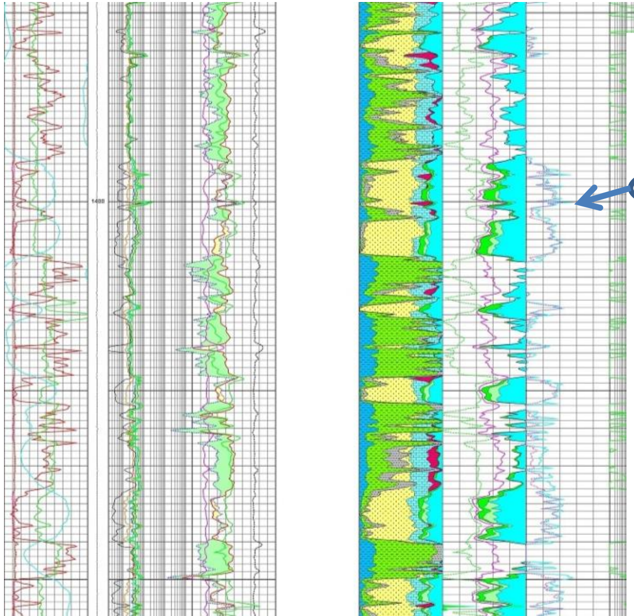


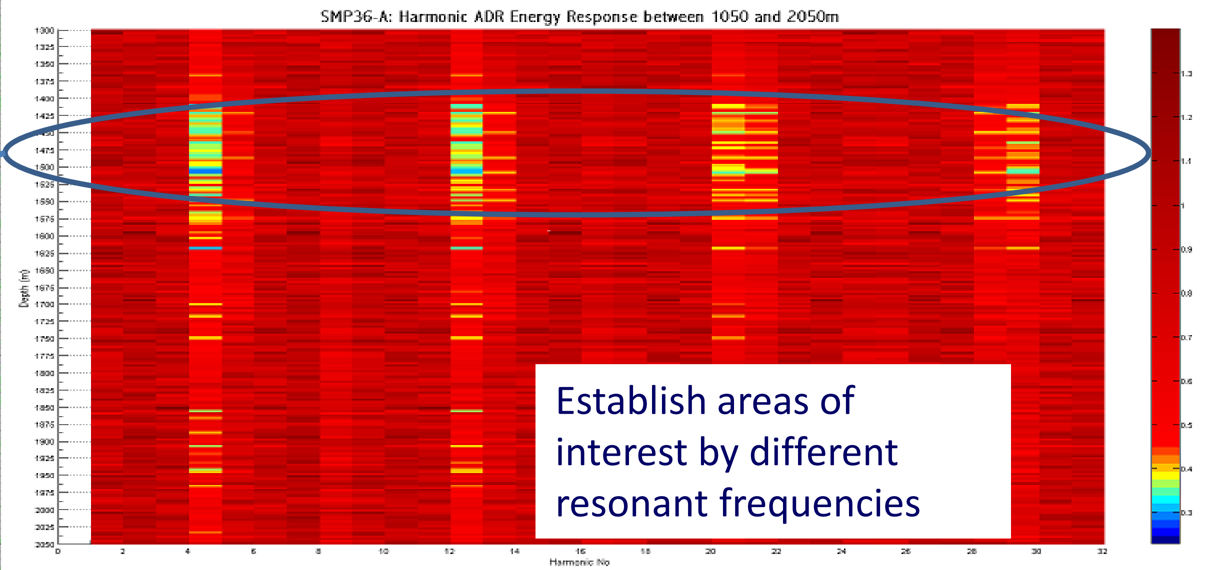


Frequency harmonics

Time (ns)	Frequency																															
	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	H20	H21	H22	H23	H24	H25	H26	H27	H28	H29	H30	H31	H32
51	100	59.2	22.9	77.4	89.5	71.5	31.9	8.1	20.1	28.1	30.3	27.7	13.9	11.2	4.9	10.3	15	6.8	1.6	2.5	1.4	1.7	1.4	4.1	3	3	3.1	1.2	0.7	0.4	0.8	0.8
102	100	52.1	22	25.5	21.8	14.3	8.4	10.6	14	14.5	12	8.3	6.6	6	5.3	3.7	1.4	1.2	2.2	2.2	1.8	1.3	1.5	1.8	1.3	0.6	0.3	0.6	0.7	0.5	0.3	0.6
153	100	46.2	34.9	29.2	26.5	22.3	15	7.5	3.4	3.8	6.4	8.9	9.6	8.4	6.3	4.7	3.8	3.5	3.3	2.8	2	1.3	1.3	1.5	1.6	1.6	1.4	1.2	0.9	0.8	0.8	0.9
204	100	13.4	20.4	16.2	21.3	13.9	7.8	18.9	11.8	4	7.4	2.1	7.1	5.7	6.3	6.5	4.6	5.2	3	3.2	2.9	3.2	4.3	3.5	3.5	2.5	1.6	1.6	1.3	2	1.5	1.7
255	11.4	34.2	52	91.4	100	22	51.1	22.9	21.8	15.1	6	21.7	17	11.1	24	24	15.2	2	2.8	8.1	5.8	3.5	8.9	21.3	8.9	6.4	9.4	9.5	4.6	1.9	2.1	3.1
306	100	53.6	30	36.3	59.3	40.7	34.4	29.7	27.3	15.5	8.4	14.1	25.9	29.7	24.4	16	23.8	18.2	5	12.2	16.6	13.9	11.6	13.5	16.2	9.6	3.9	6.9	5.9	3.8	7.7	8.7
357	100	71.5	36.1	22	21.1	20.4	9.6	14.5	13.5	9.1	8	11.9	7	6.4	7.7	6.9	4.6	5.1	5.3	3.8	4	3.9	4.5	2.9	3.9	4.1	3.6	3.1	4	3.5	2.6	3.3
408	100	92.5	63.2	37.4	6.4	30.3	29.8	19.1	6.3	12.7	15.9	12.6	10.1	4.7	8.9	12.3	10.2	3.8	5.3	9.7	7.4	4.9	3.6	4.9	6.7	5.7	3.8	2.7	5.6	5.6	3.9	2.3
459	64.2	100	93.3	81.2	72.4	53.1	29.6	18.3	8.9	8.7	13.3	23.4	27.7	21.8	17.4	14.2	10.4	7.4	5.4	10.4	11.7	11.2	11.6	10.8	9.4	7.2	5.3	5.3	5.2	6.4	7.4	7.3

Create image of harmonic energies

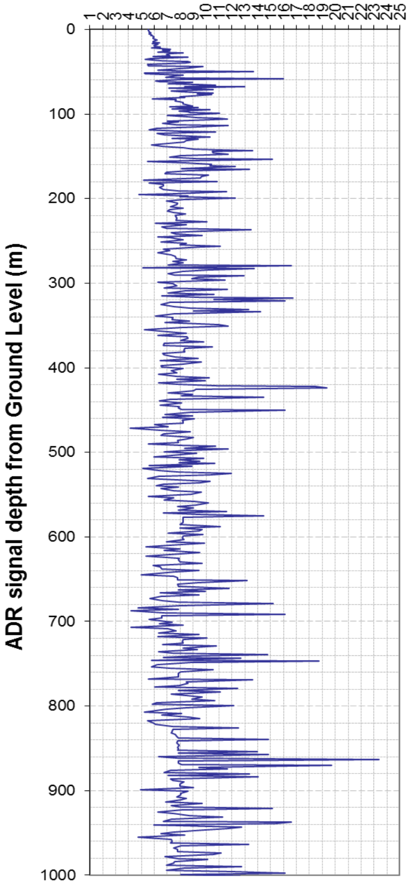


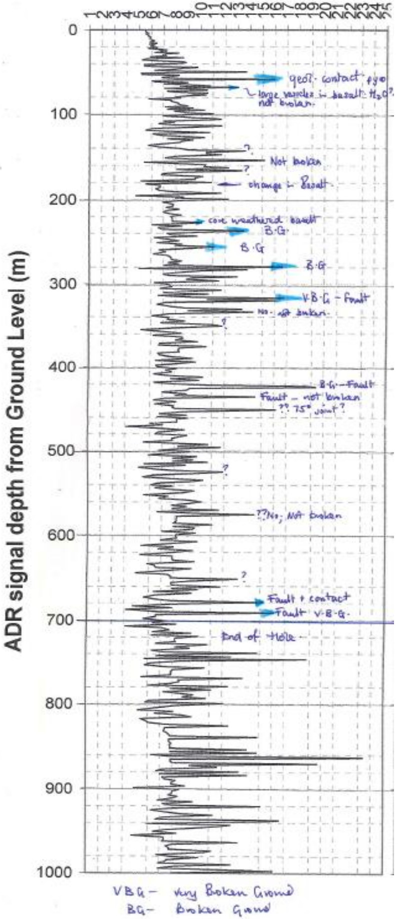


Establish areas of interest by different resonant frequencies

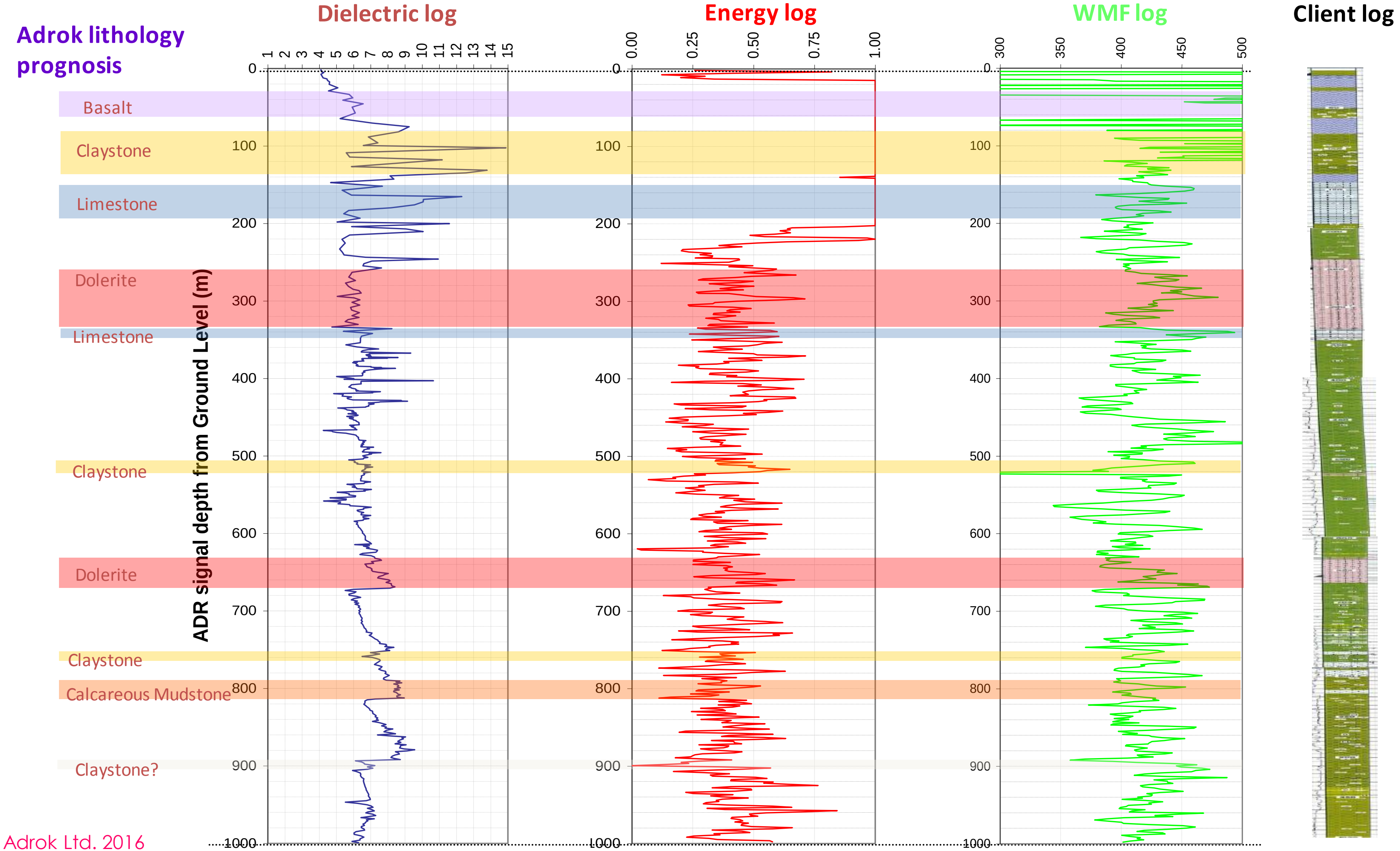
Toolbox of ADR measurements

Dielectrics





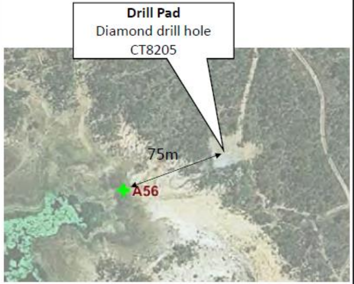
- Dielectric survey log
- In this example, from Northern Ireland, high dielectrics verified by client from core inspection to be broken ground, very broken ground or faulting (caused by moisture)


Adrok lithology prognosis
Dielectric log
Energy log
WMF log
Client log
ADR signal depth from Ground Level (m)
Basalt
Claystone
Limestone
Dolerite
Limestone
Claystone
Dolerite
Claystone
Calcareous Mudstone
Claystone?
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
0.00 0.25 0.50 0.75 1.00
300 350 400 450 500
0 100 200 300 400 500 600 700 800 900 1000

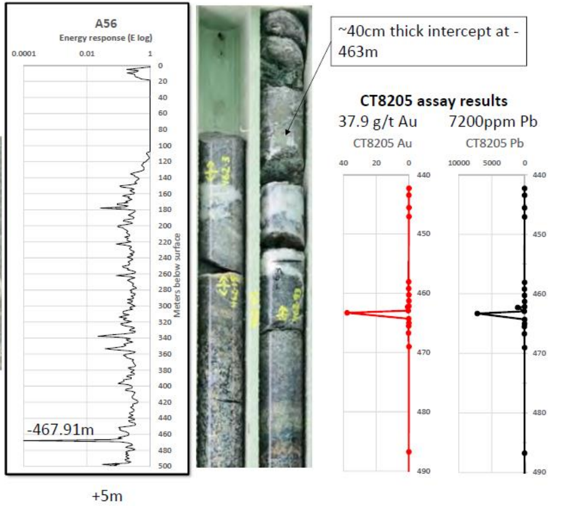
GOLD AND SULFIDE TARGETING USING ADROKS ADR (Atomic Dielectric Resonance) TECHNIQUE

Dr. Simon Richards, Citigold Corporation – srichards@citigold.com
Mr. Gordon Stove, ADROK – gstove@adrokgroup.com

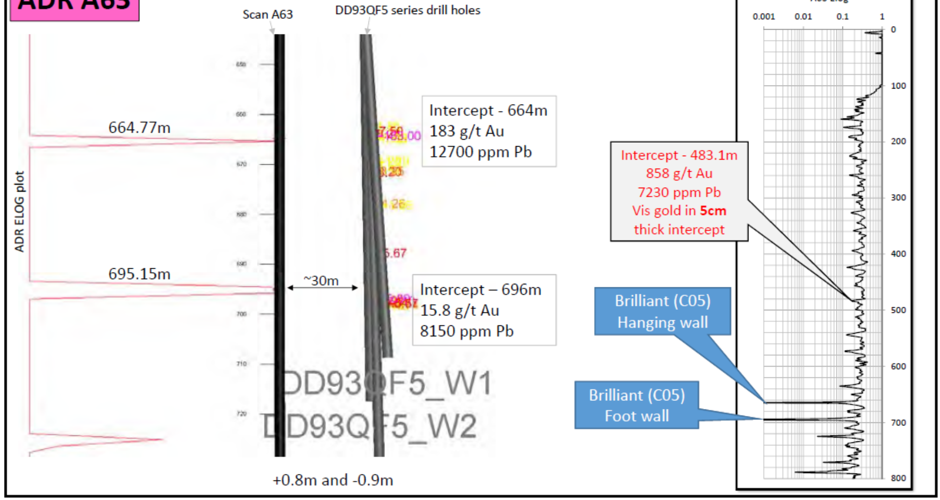
ADR A56



- Scan completed prior to drilling CT8205
- Single target identified at -467.91m
- Drilling confirmed target at -463m down hole



ADR A63



Case Study

Nickel exploration under thick permafrost layers in sub-arctic Canada

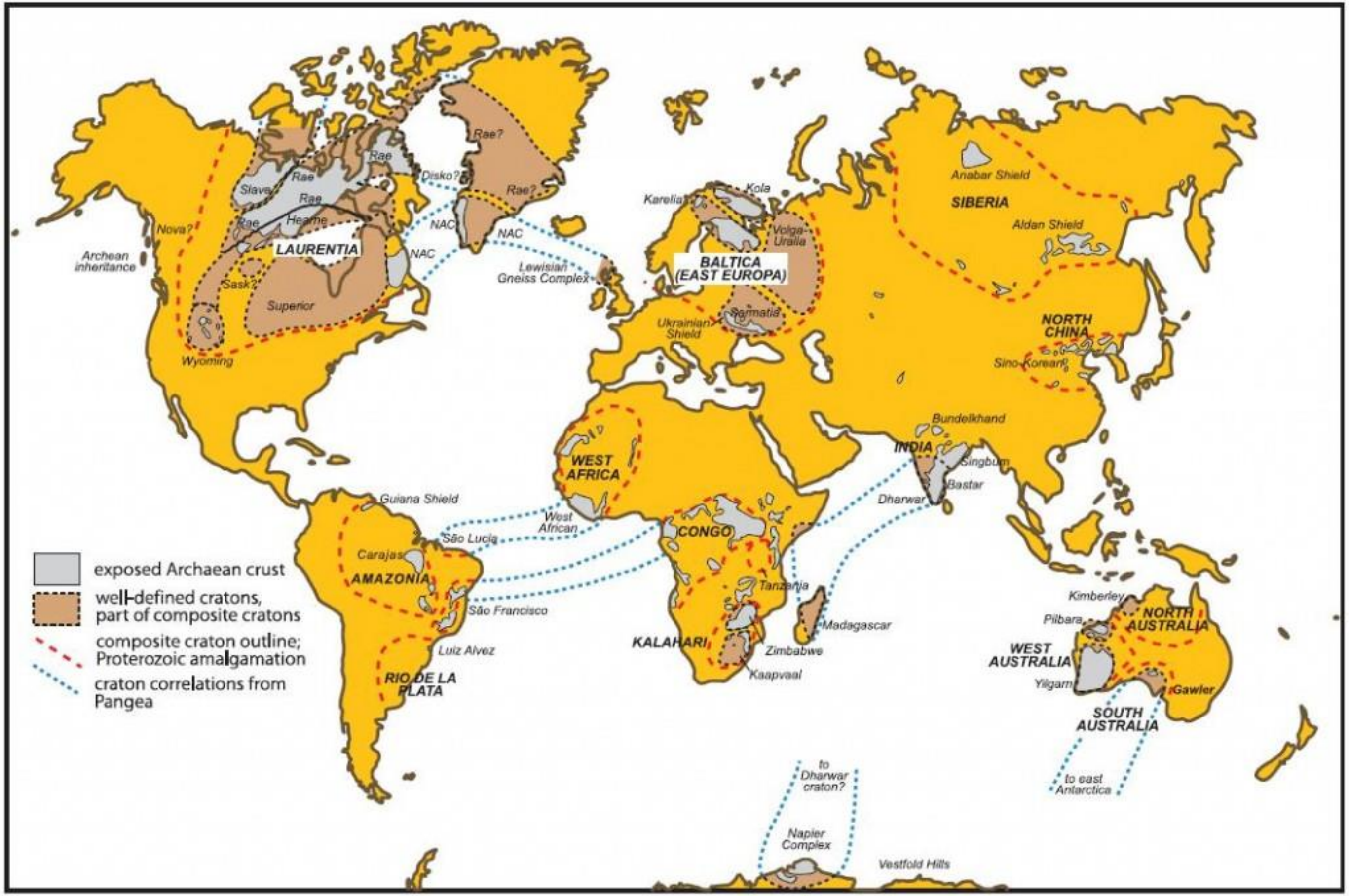
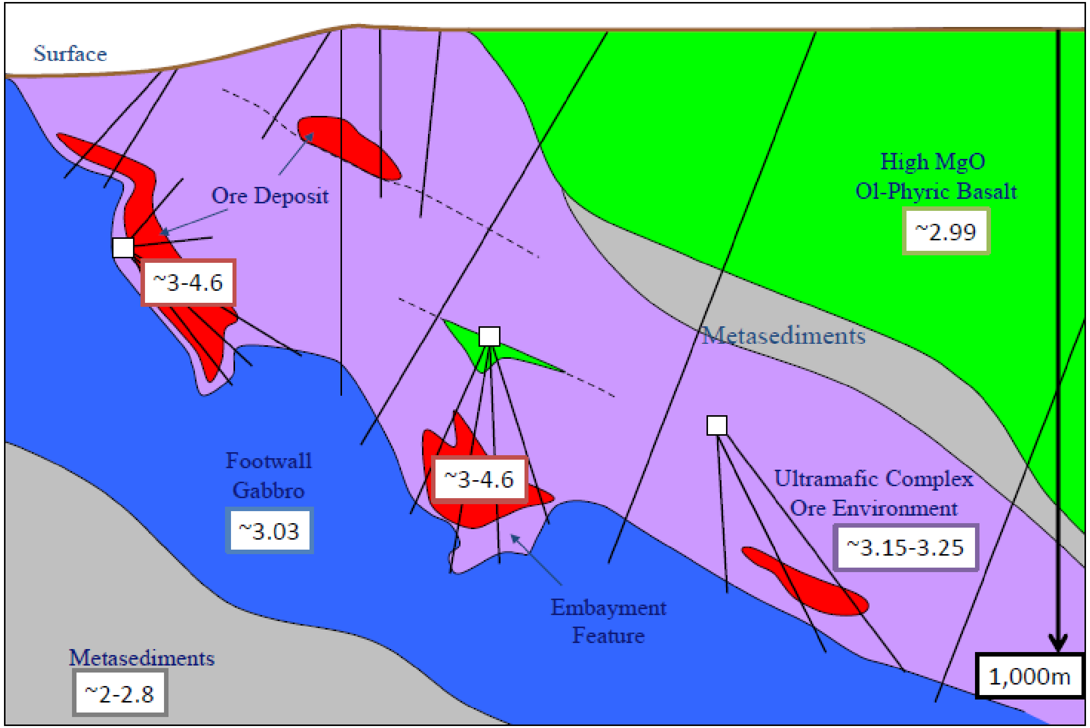


Fig. 1. Global distribution of the cratons (regions of crust >2.5 Ga old) modified after Bleeker (2003). Regional outcrops of Archaean crustal rocks are indicated in grey (those beneath Greenland are extrapolated under the ice cap) and other definable fragments of composite cratons in brown (from Bleeker 2003). The approximate outline of units that are relatively well defined as whole, composite cratons is shown by black dotted lines. Red dashed lines show the estimated extent of cratonic regions amalgamated from Archaean blocks during the Proterozoic. Blue dotted lines extended across oceanic areas show links between cratonic fragments that are thought to have once formed single cratonic blocks. NAC, North Atlantic Craton.

Project Aims & Exploration Challenges



(1) Find NiS pods encased within volcanic mafic ultra-mafic rocks to 1000m below ground level through shielding conductors.

(2) Comparison of V-bore data against core hole & other data.

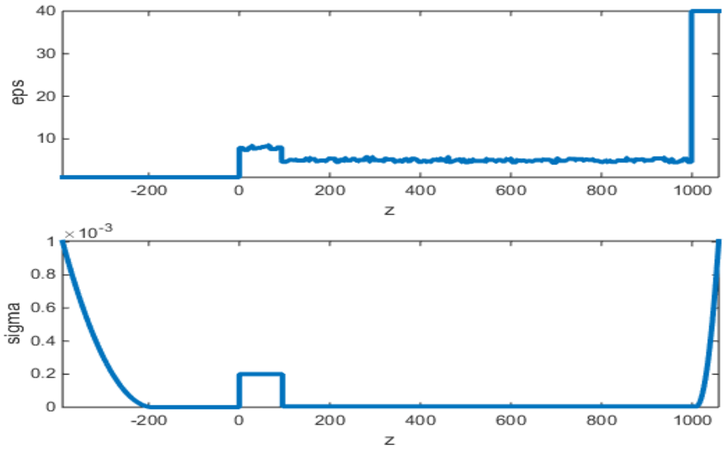
- Existing core holes with core.
- Undisclosed core holes (blind)

(3) Stepping out from the 'test' locations to map the exploration areas of specific interest (prospects)

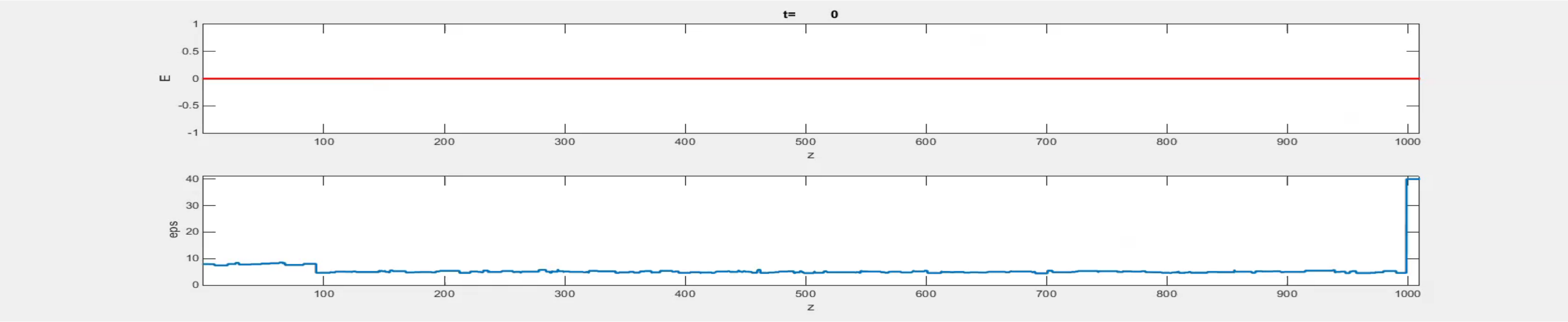
Methodology (1) – Forward modeling

- Model:
  - Unfrozen layer of 100m (Resistivity R=5KΩm, Dielectric permittivity ε=8)
  - Permafrost until 1000m (R=200KΩm, ε=5)
  - Liquid water at 1000m (R=1Ωm, ε=40)
  - Stochastic model for irregularities superimposed

    Permafrost values from: Electrical Resistivity Study of Permafrost on Ridnitšohkka Fell in Northwest Lapland, Finland. Heikki Vanhala, Petri Lintinen and Antti Ojala, Geophysica (2009), 45(1–2), 103–118
- STARE scan with 10X500 traces stacked
  - Show animation of wave in ground
  - Data analysis shows reflector
- WARR scan
  - 200m wide
  - 40 separations at 10*500 traces each
  - Analysis with dielectric spectrum method



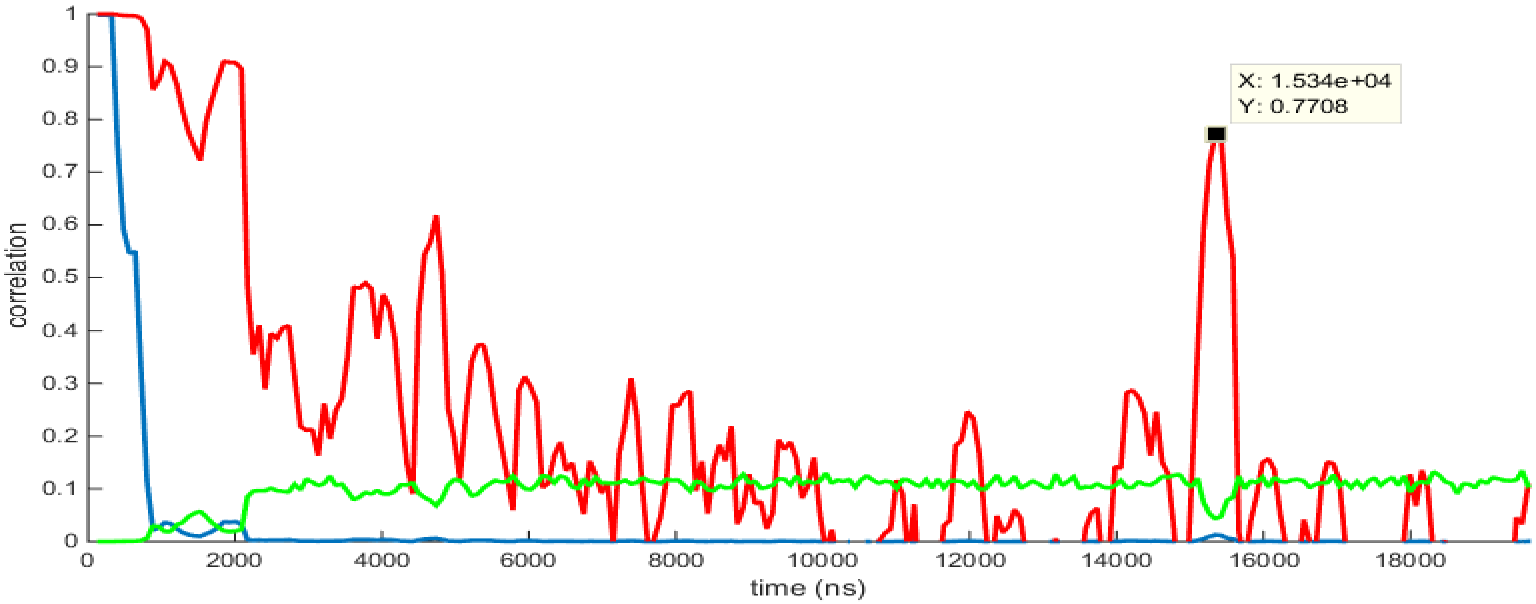
Animation



Top: Electric field from top (left) to bottom
Below: Dielectric profile

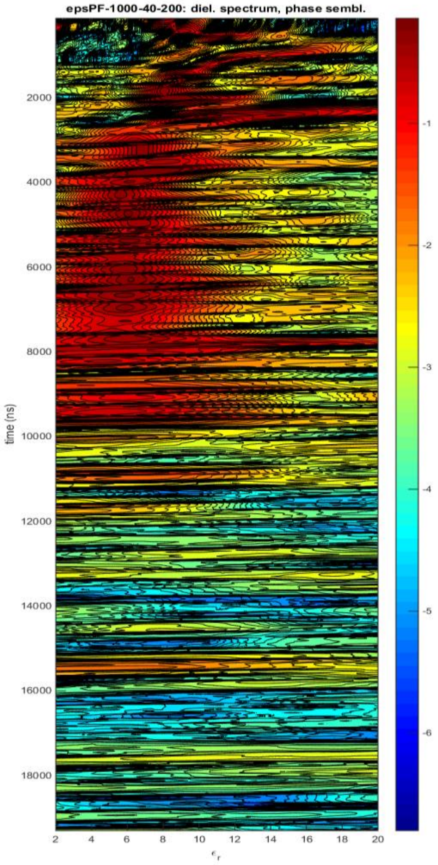
Pulse clearly comes back to surface.

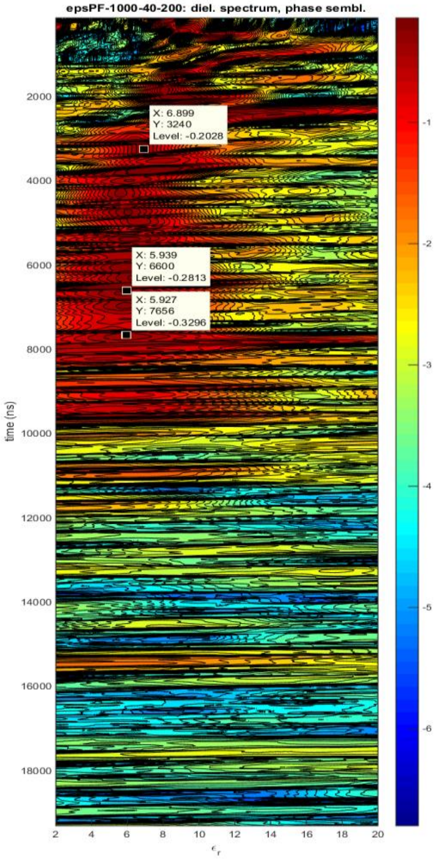
Model STARE



Reflection seen at t=15340ns

Model WARR



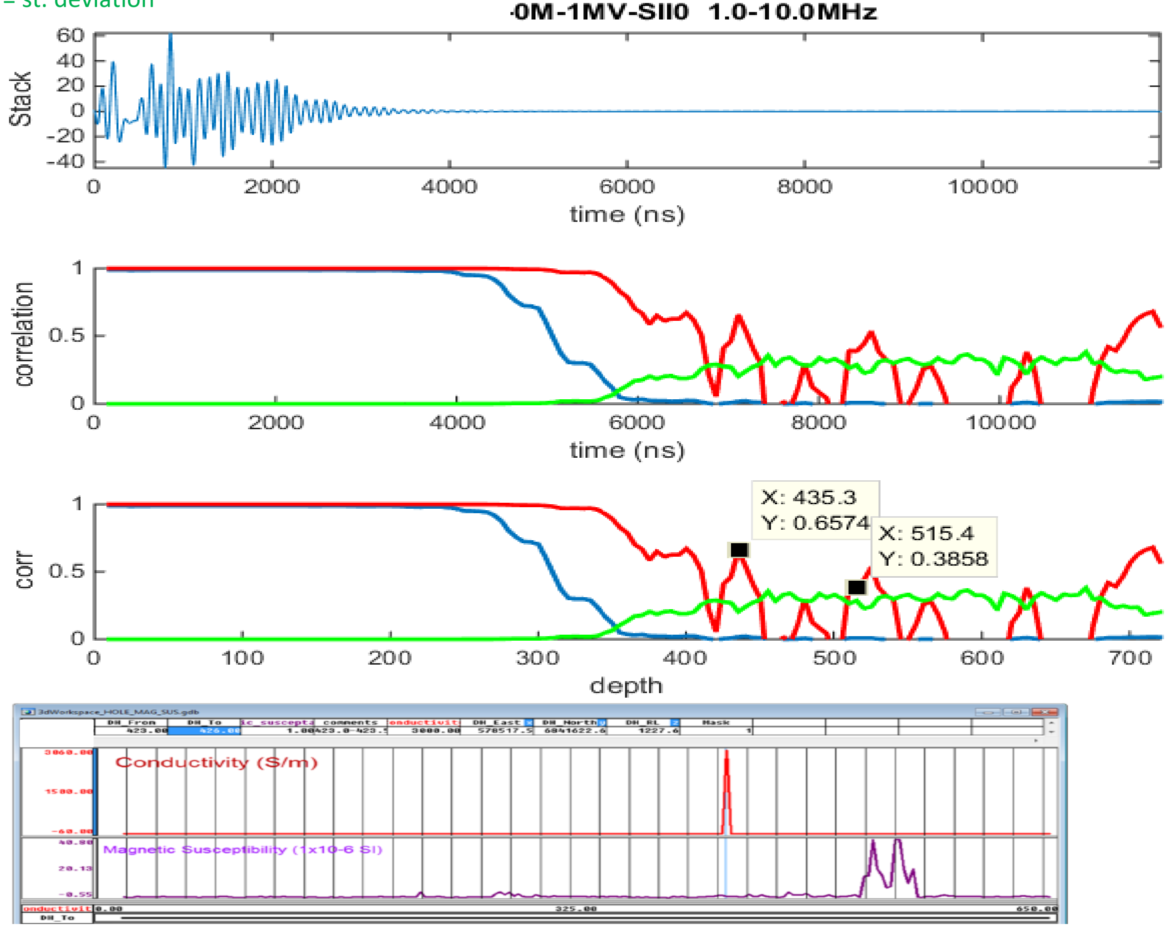


Dielectric can be estimated until about 75000ns at 5.9. Reflection from STARE localized at depth 3e8/sqrt(5.9)*15340e-9/2 = 947m.

5% error.

Methodology (2) – Existing Core Holes
Training hole 1

Blue = mean correlation
Red = mean correlation denoised
Green = st. deviation



Correlation peaks seem to correspond to:

- conductive shield at 430m
- weak mineralization 516-542m (shown by the peak in magnetic susceptibility)

Pulse appears to propagate through the conductive layer.

Correlation Key:

Blue = mean correlation

Red = mean correlation denoised

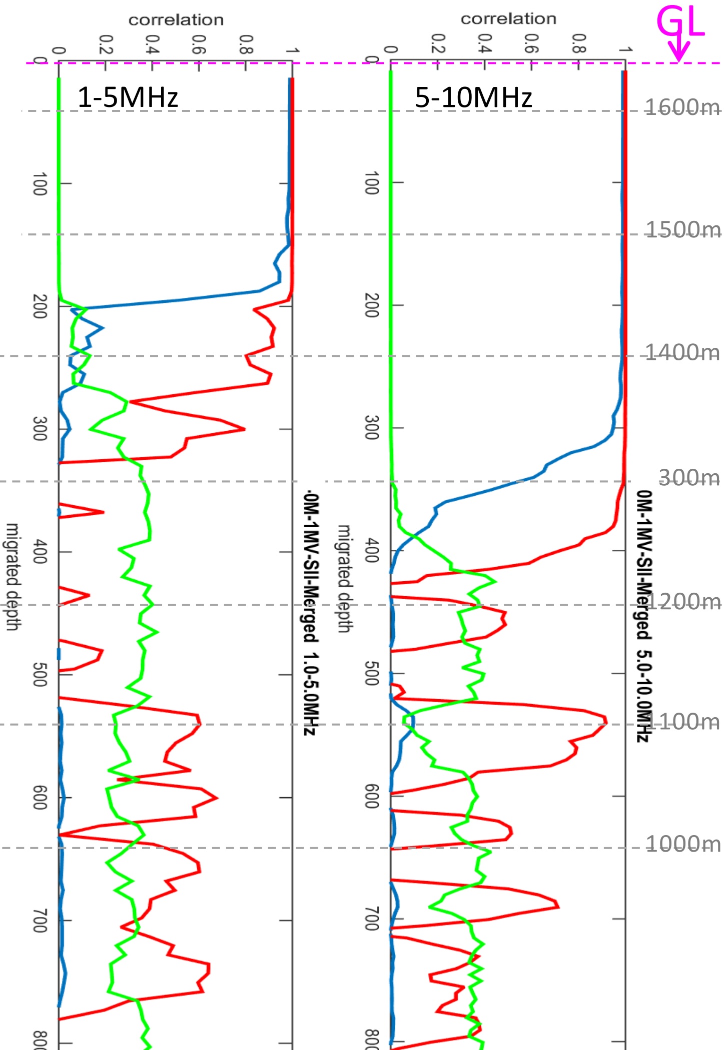
Green = st. deviation

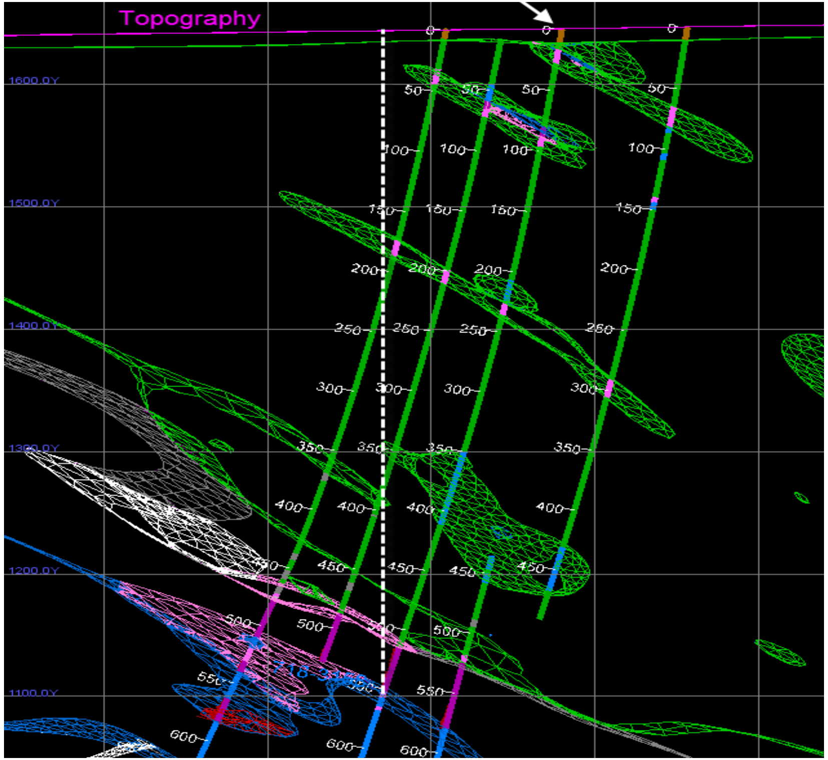
training data:

spike in conductivity, 430m

weak mineralization, 516-542m.

anomaly in magnetic susceptibility, 525m and 545m





Training hole 1 Correlation method

Correlation Key:

Blue = mean correlation

Red = mean correlation denoised

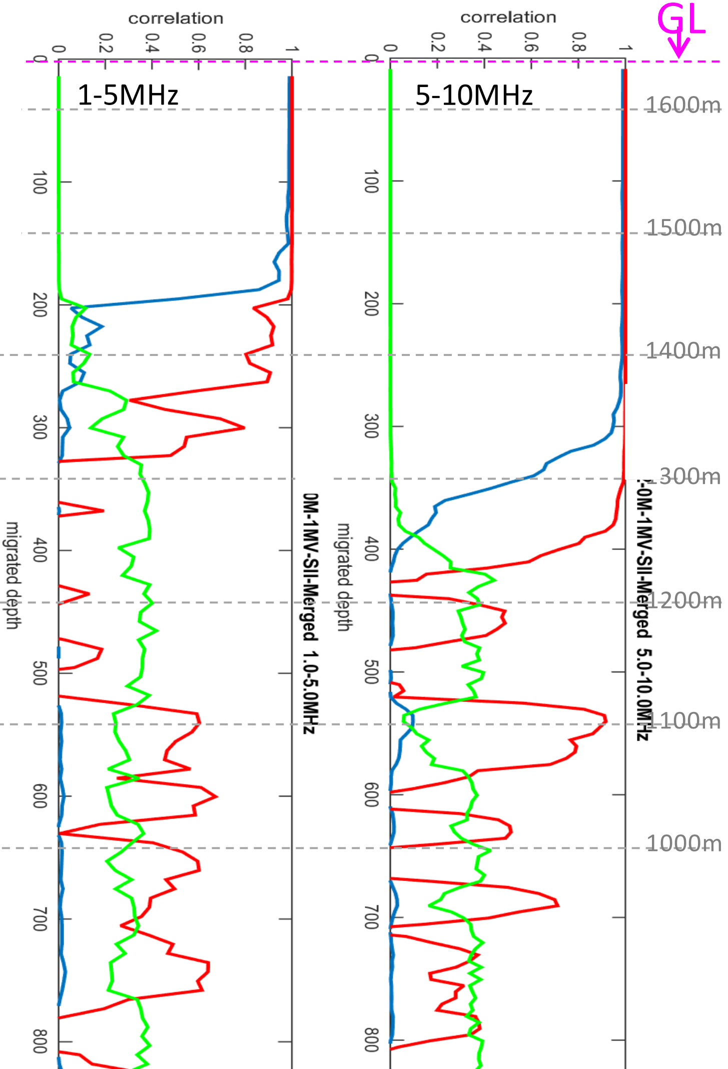
Green = st. deviation

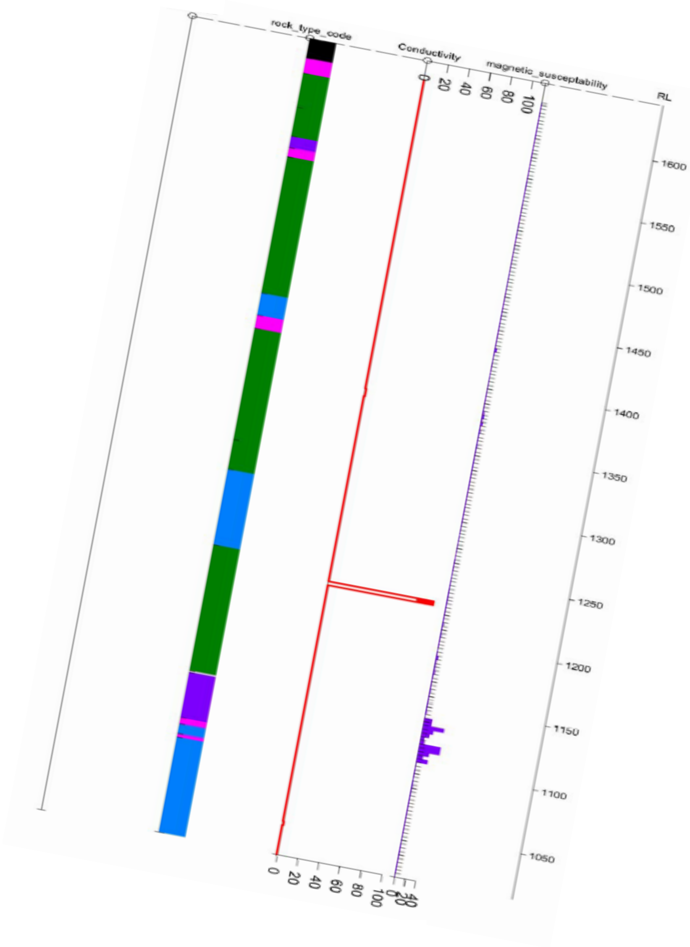
training data:

spike in conductivity, 430m

weak mineralization, 516-542m.

anomaly in magnetic susceptibility, 525m and 545m





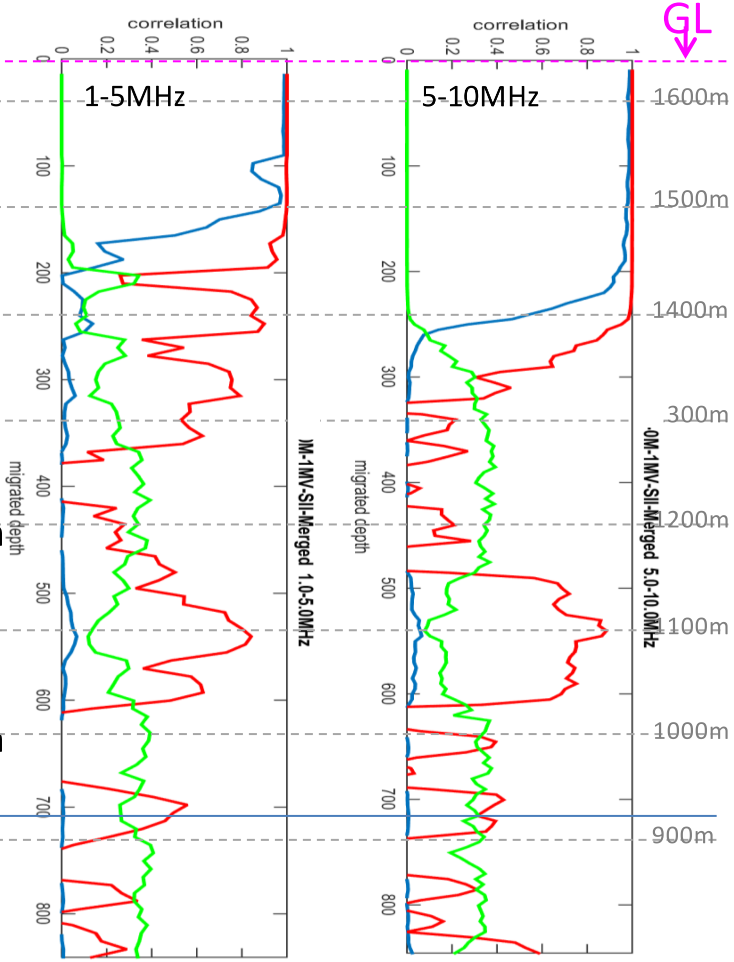
Training Hole 1

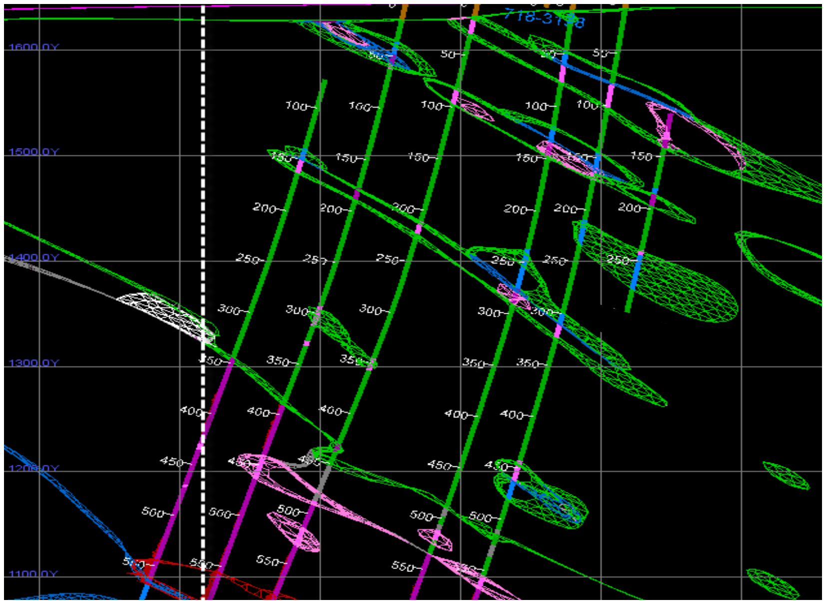
Correlation Key:
Blue = mean correlation
Red = mean correlation denoised
Green = st. deviation

training data:
weak mineralization 400-440m,

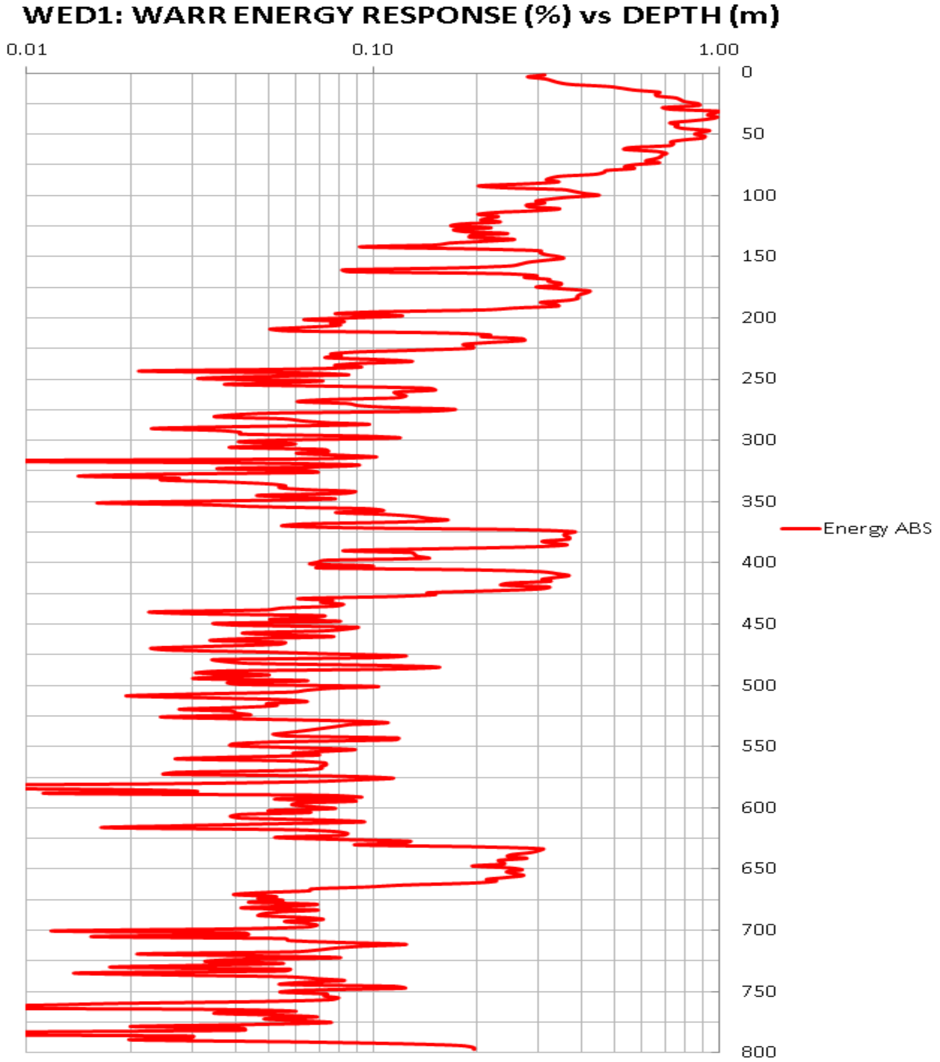
strong mineralization 533-593m,

spike in conductivity 610m.





Training hole 2 Correlation method



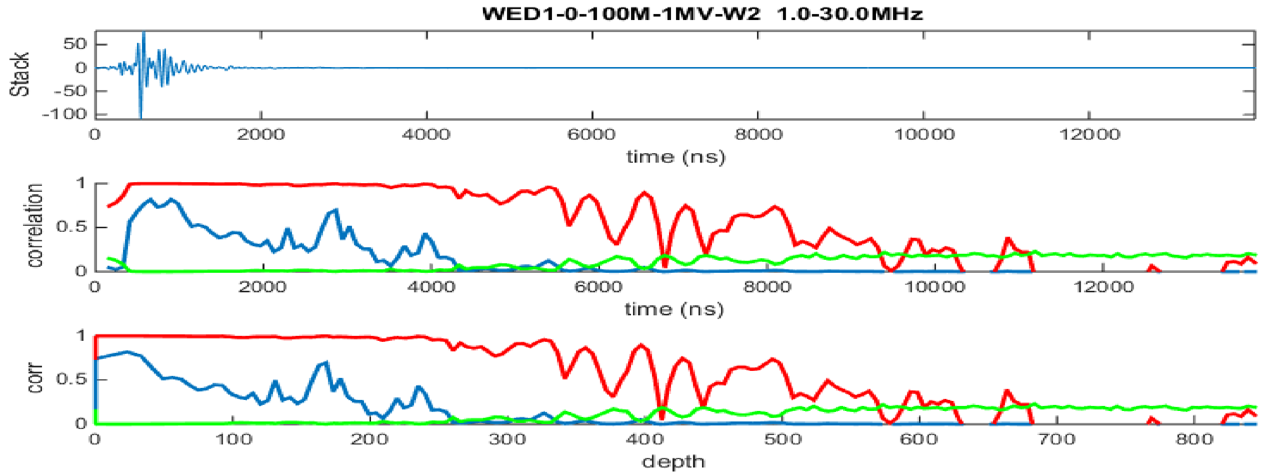
(3) Undisclosed holes – Spectral Analyses, Correlation, Dielectric spectrum

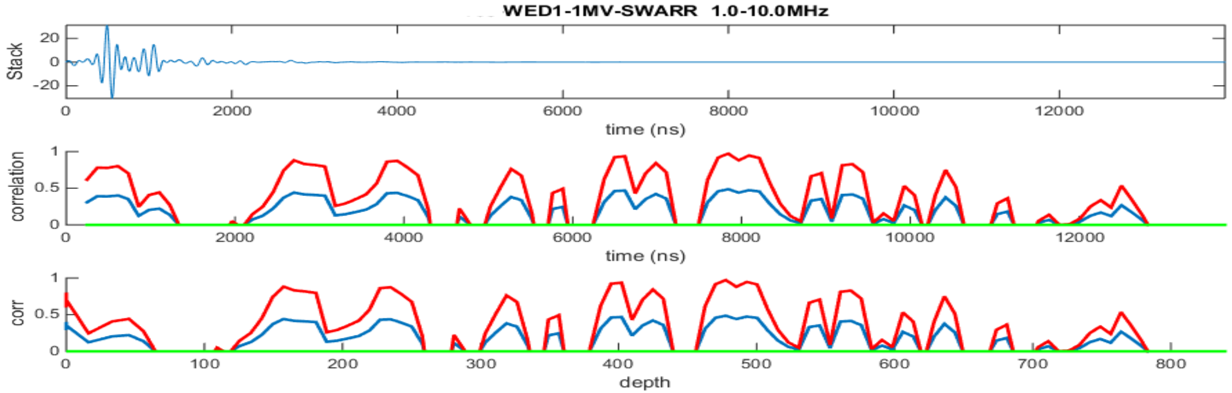
Blind Test WED1 Energy Log example

- two clear reflectors around 400m
- deeper reflector at 650m

- These are confirmed from correlation analysis of W2 and the SWARR (which is assembled by stacking all 21 STARES and collecting in a denoised STARE-WARR.

30



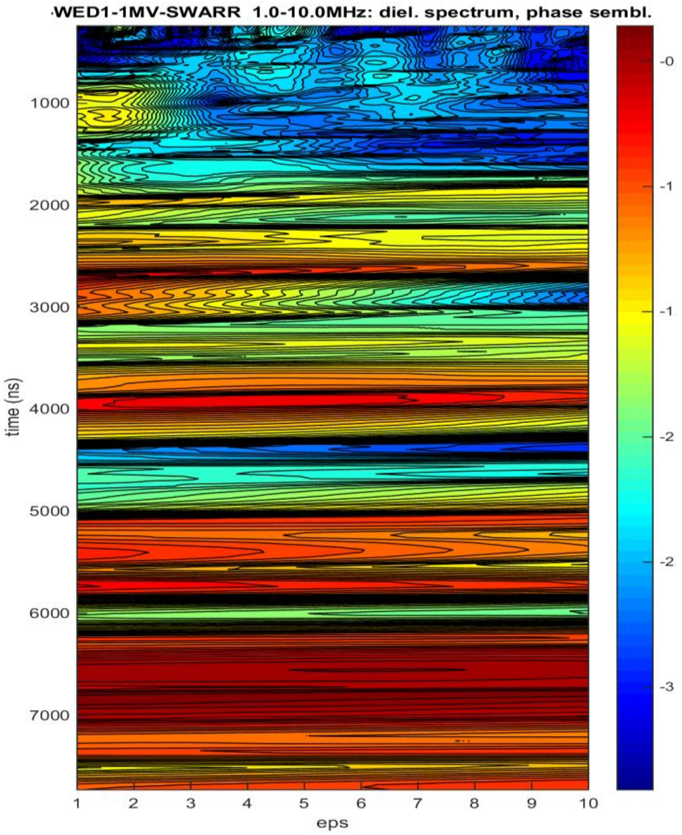


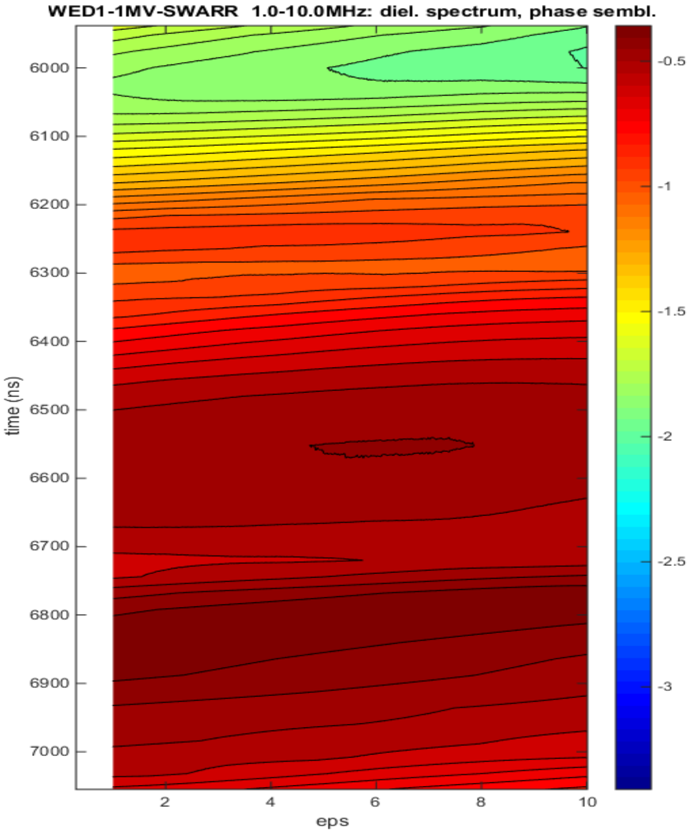
- Correlation analysis also shows other peaks, some of which correlate with weaker peaks in E-log.
- The double peak around 400m seems the most prominent feature
- The 620-650m peak is also but seems to be less clear.

WED1 dielectric spectrum

- To place reflectors at depth we have to know the pulse propagation velocity, which is determined by the relative permittivity or dielectric constant.
- This is obtained from what is essentially a triangulation, based on a function of transmitter/receiver separation.
- Detailed velocity analysis is accurately performed during processing stage
- quick estimate can be obtained with an appropriately modified version (dielectric spectrum method) of the semblance based velocity spectrum method, commonly used in seismic data analysis.

WED1 dielectric spectrum: Stare WARR

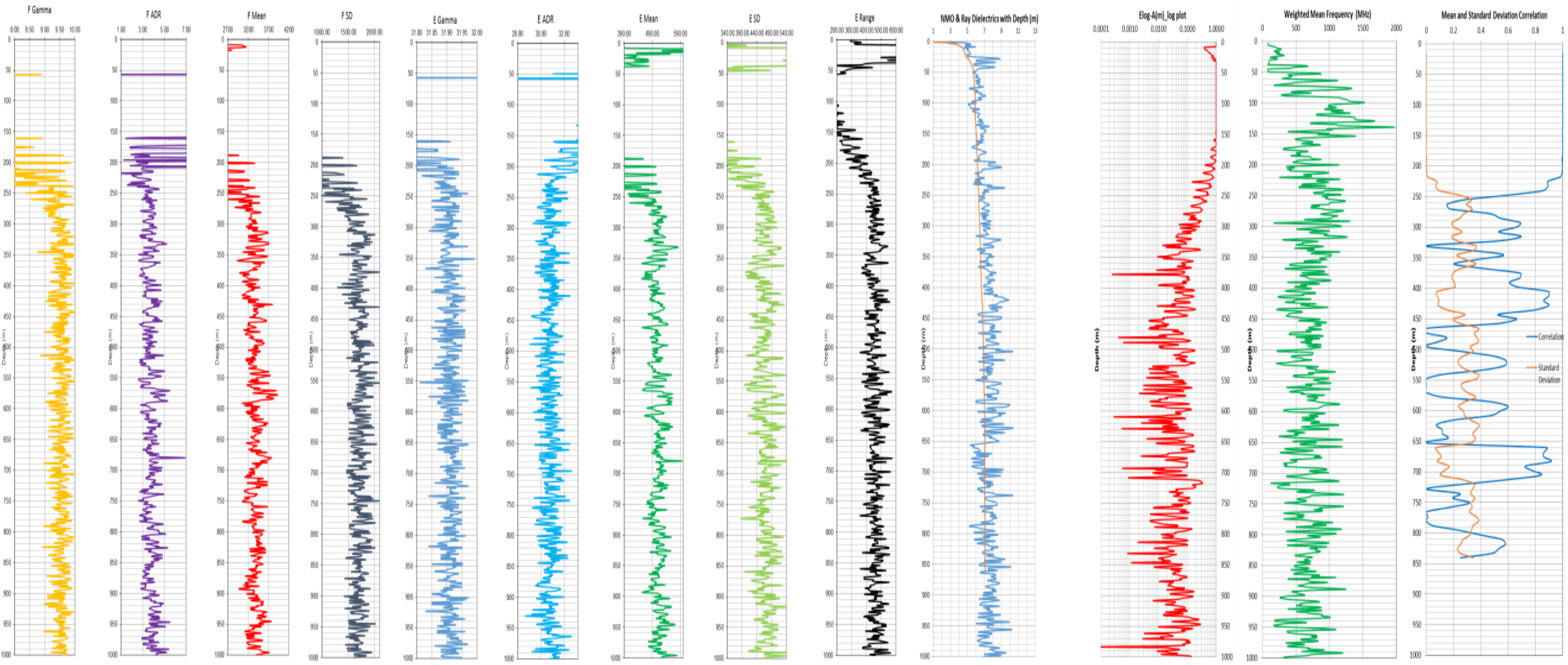




Dielectric constant readings are obtained from visually identifying peaks in the (time, eps) false color plot, which correspond to previously identified reflectors.

In this case the double reflection peak around 6500ns (400m) shows a peak at eps=6, which is the expected value for permafrost.

Total harmonics, dielectric constant, energy and weighted mean frequency data for Prospect (Thurs1)



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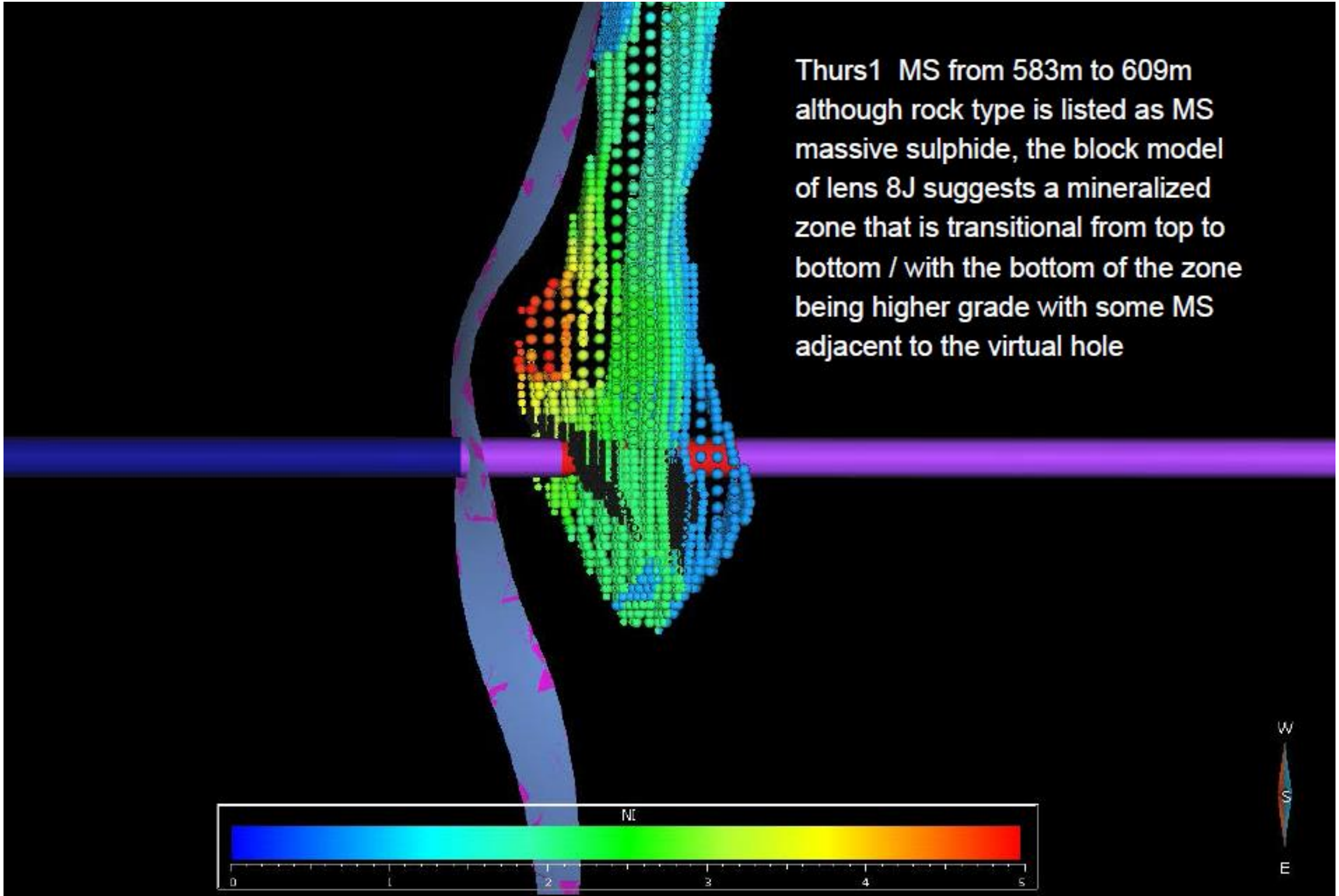
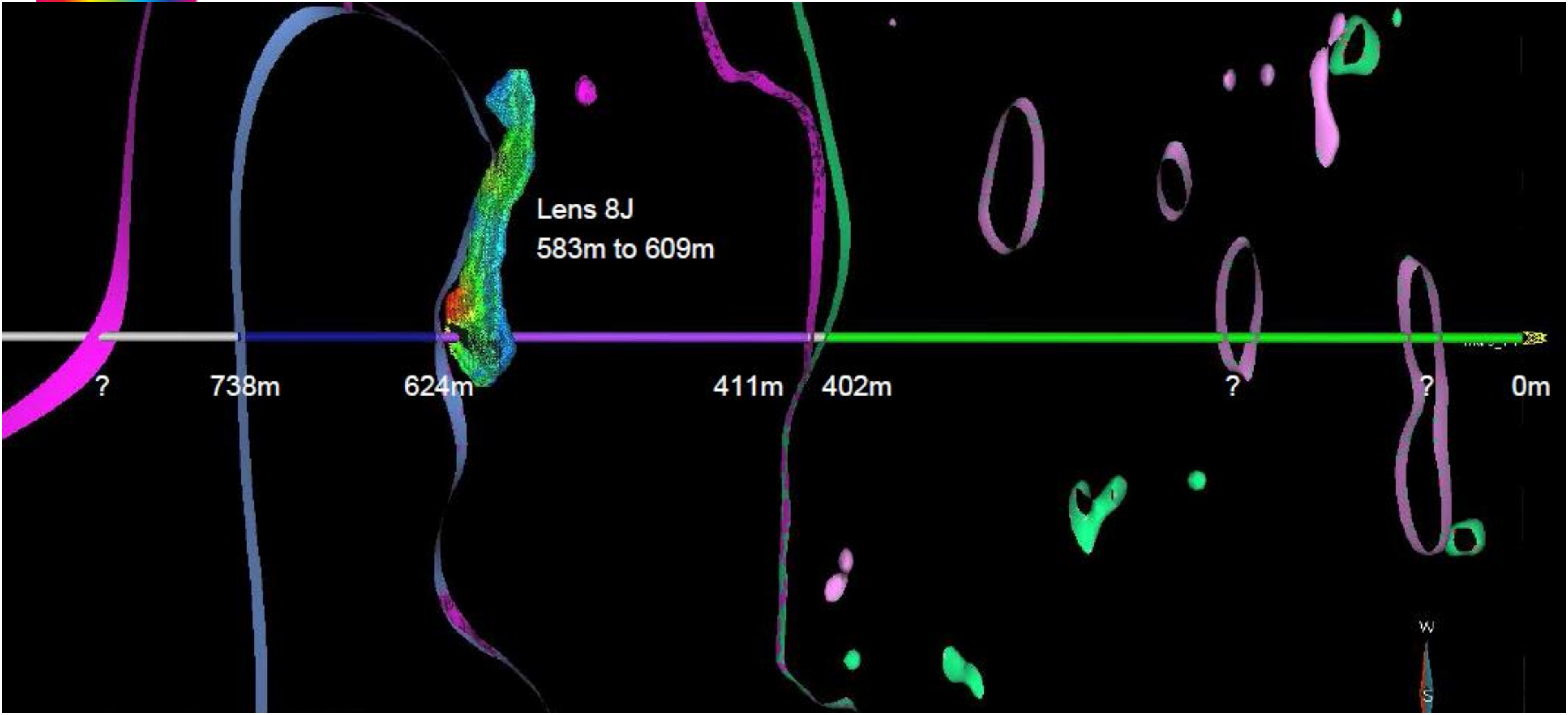
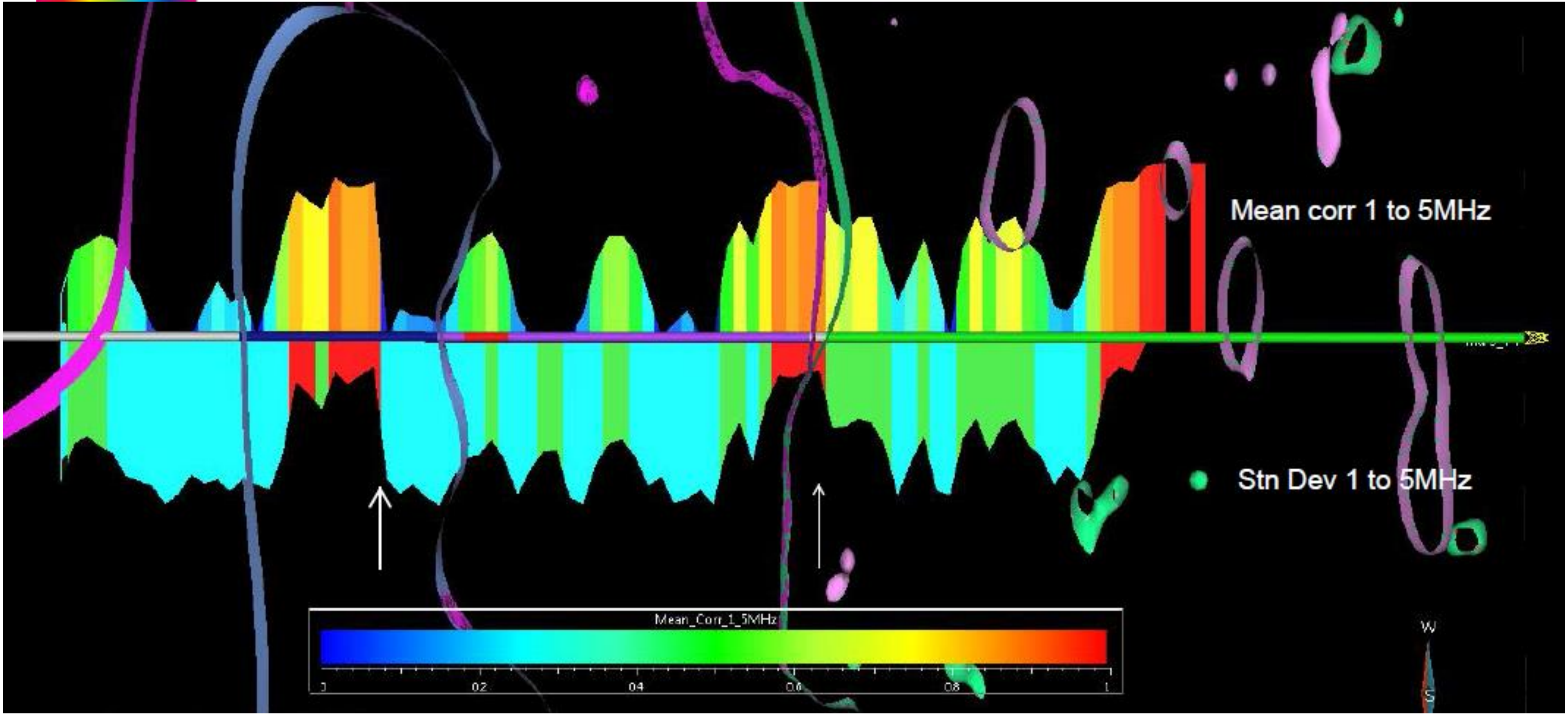
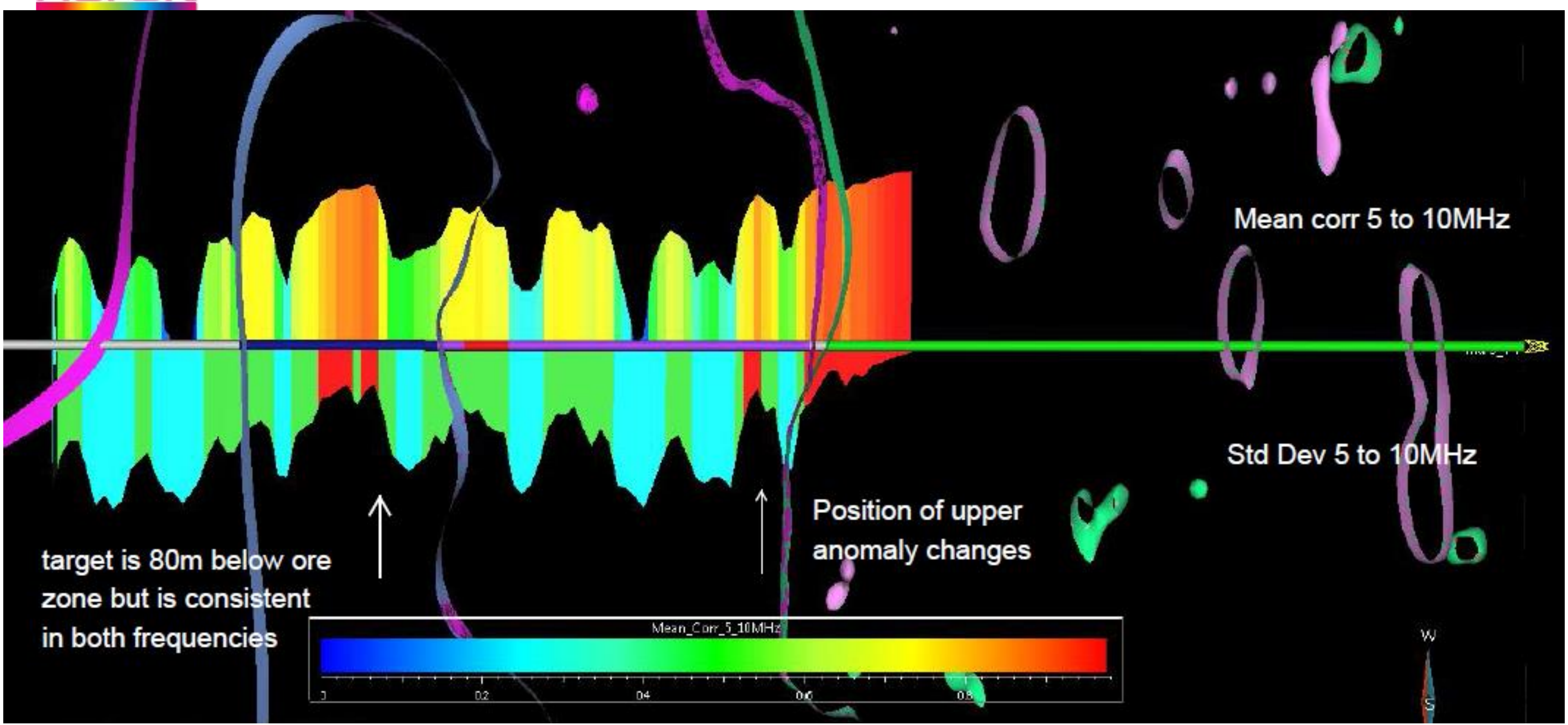

Thurs1 MS from 583m to 609m although rock type is listed as MS massive sulphide, the block model of lens 8J suggests a mineralized zone that is transitional from top to bottom / with the bottom of the zone being higher grade with some MS adjacent to the virtual hole
W
S
E

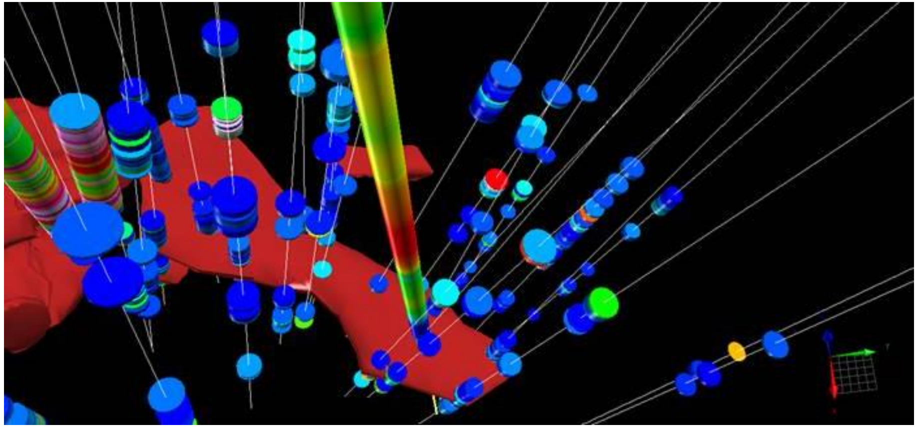

Lens 8J
583m to 609m
?
738m
624m
411m
402m
?
?
0m
W
S


Mean corr 1 to 5MHz
Stn Dev 1 to 5MHz
Mean_Corr_1_5MHz
0.2
0.4
0.6
0.8
1
W
S

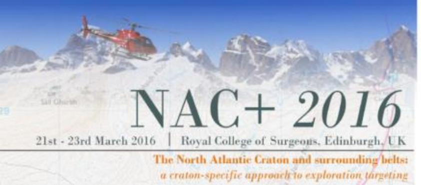

Mean corr 5 to 10MHz
Std Dev 5 to 10MHz
Position of upper anomaly changes
target is 80m below ore zone but is consistent in both frequencies
Mean_Corr_5_10MHz
0.2
0.4
0.6
0.8
W
S

Client feedback

- The two frequency bands for the 1-5MHz and 5-10MHz correlation and standard deviation profiles match up well.
- I have attached a Geoscience Analyst workspace along with some screen captures from Gocad showing the geology in comparison with the Adrok data. The target in this case was a deep lens of mineralization in the virtual borehole from 717m to 773m. This corresponds with the anomaly seen at the end of the profile from a depth of 722m to 771m. I find the correlation between this anomaly and the mineralized zone to be very encouraging.
- The correlation anomaly near the centre of the profile (from 550m to 607m) is interesting. It lies in a location that is untested by drilling and is on a horizon that is mineralized in adjacent boreholes. We are currently looking at the BHEM response in this area to further vector targeting.
- The upper anomaly is drill tested and appears to be a known geological contact.



Client's integrated ADR virtual borehole results against known drilled results



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CEO & Co-founder