THE GEOLOGICAL SOCIETY OF AMERICA®

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CONNECTS ONLINE

Adrok®

HELPING REDUCE THE RISK AND COST OF EXPLORATION UNDER COVER:

INTRODUCING NEW CASE STUDY RESULTS FROM THE ONGOING DEVELOPMENT OF A SULFIDE TARGETING TOOL

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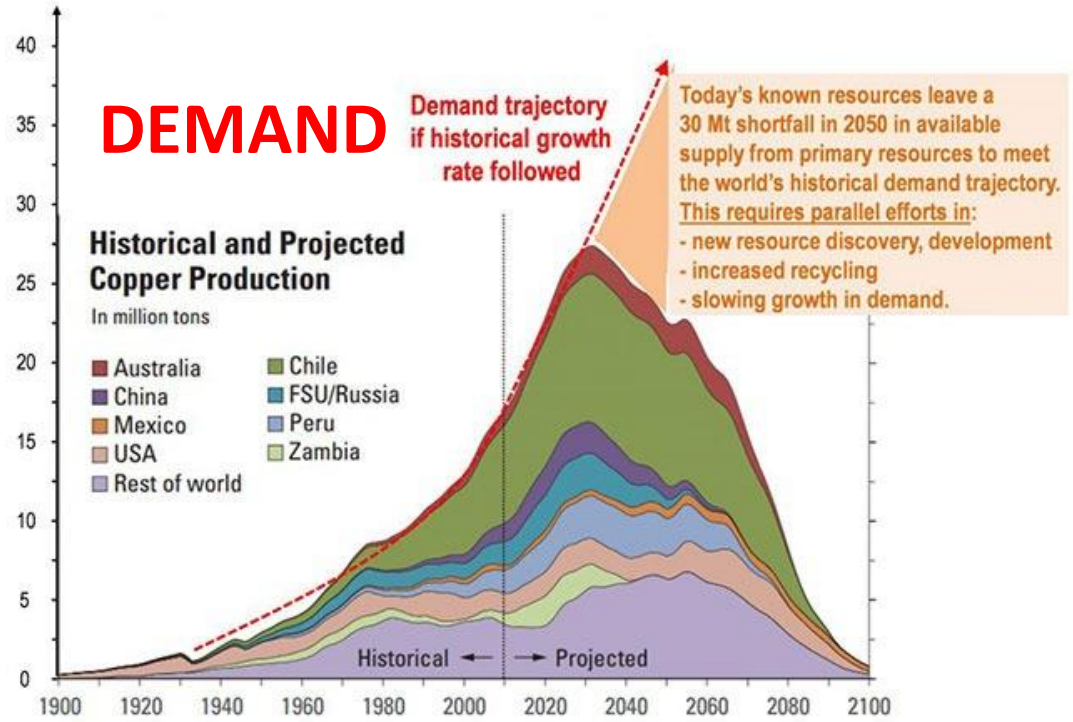
www.adrokgroup.com

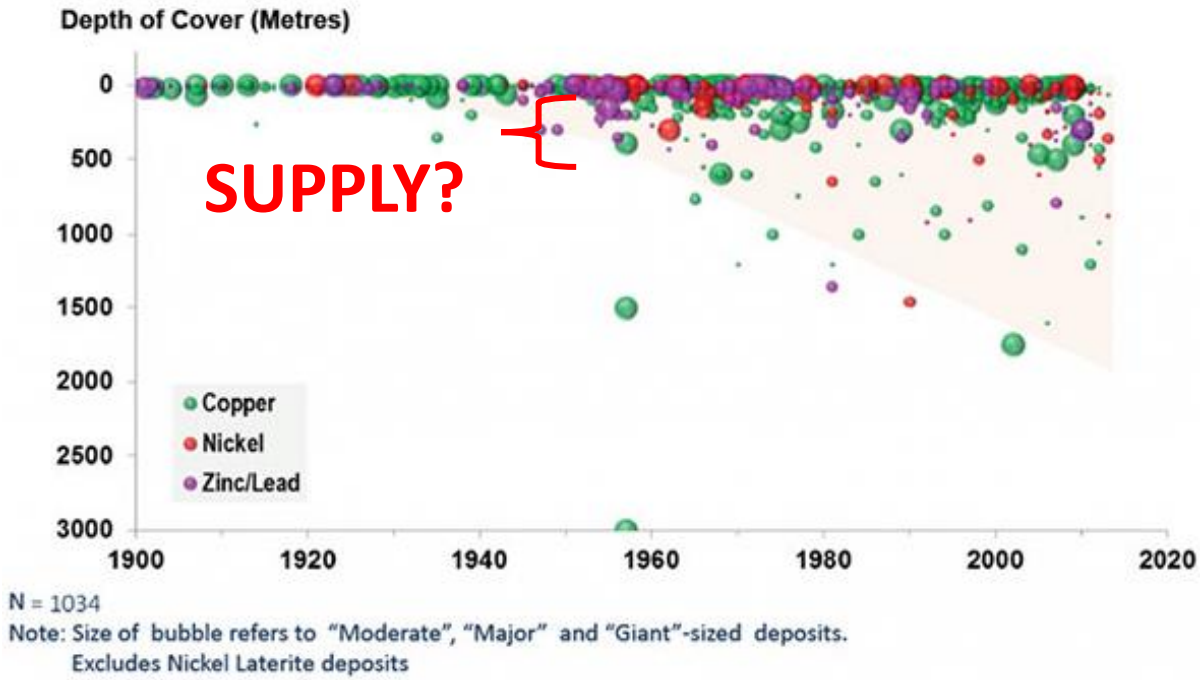
WHY TARGET MINERALS UNDERCOVER?

Motivated by:

1) Collaboration with mineral exploration companies who need better exploration techniques to decrease the risk associated with exploration under cover.

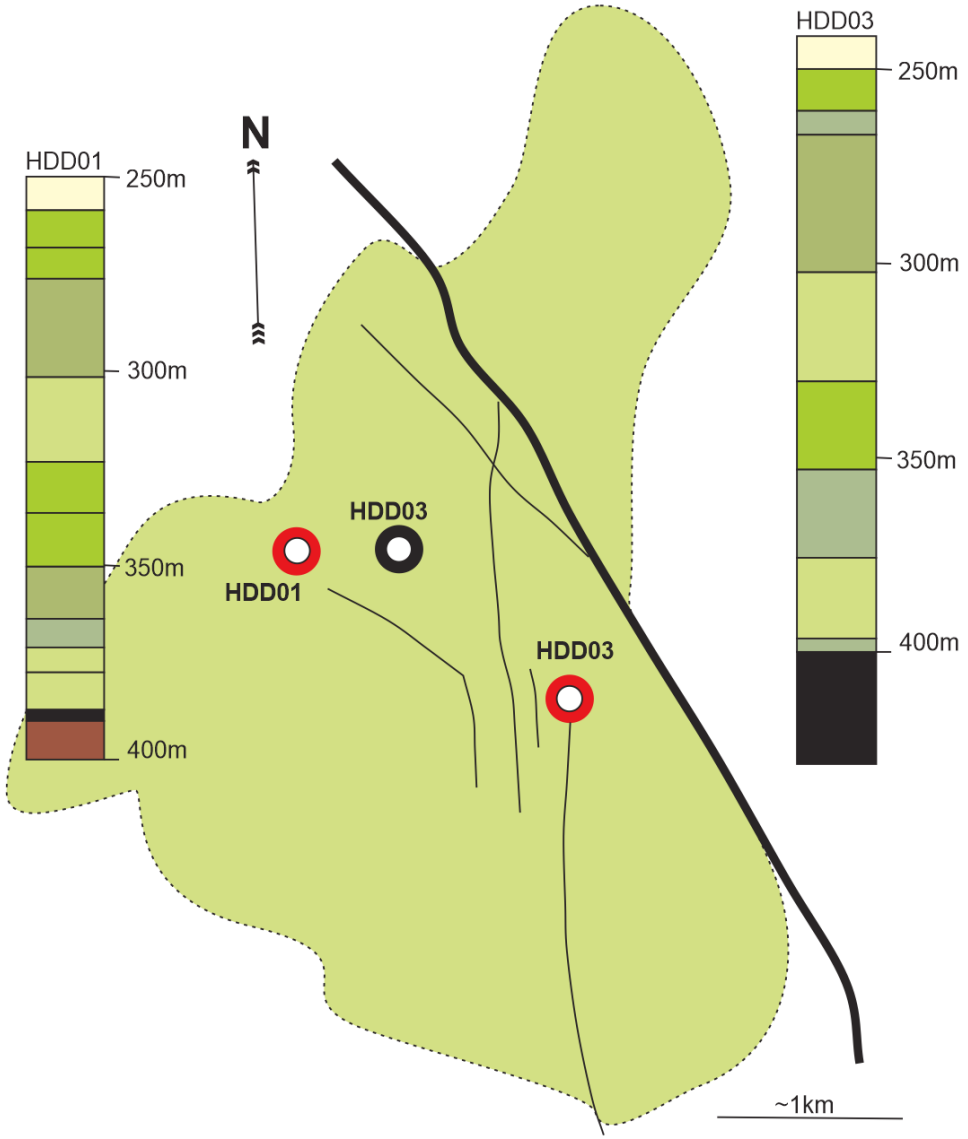
2) The demand for new Tier 1 discoveries in the new "window of opportunity" between 200-800m under cover.





Figures from - Edmund Nickless: Resourcing Future Generations: A global effort to meet the world's future needs head-on, European Geologist Journal 42

Exploration under cover can be difficult

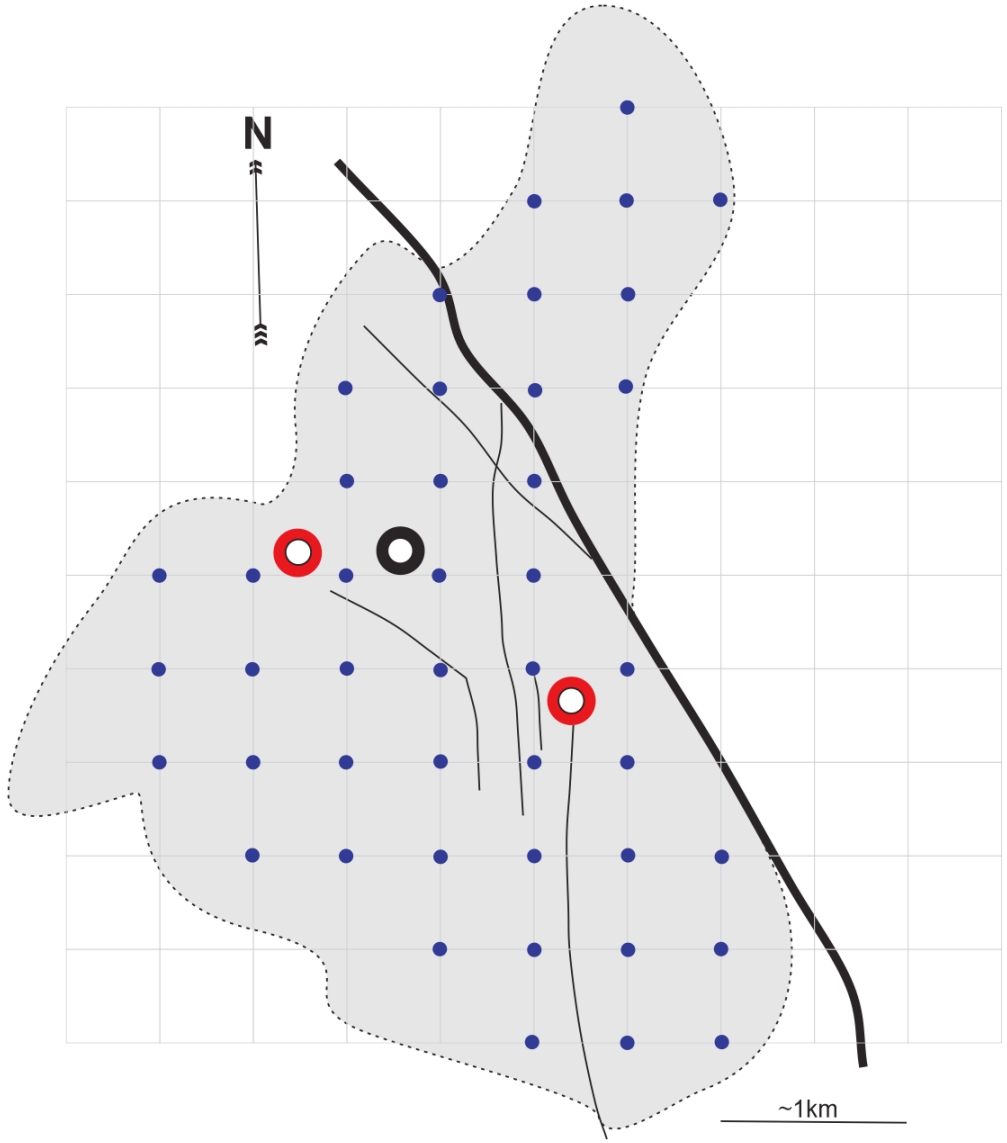


Sulfides present in drilling

Barren drill hole

Where to drill next?

Exploration under cover can be difficult



Sulfides present in drilling

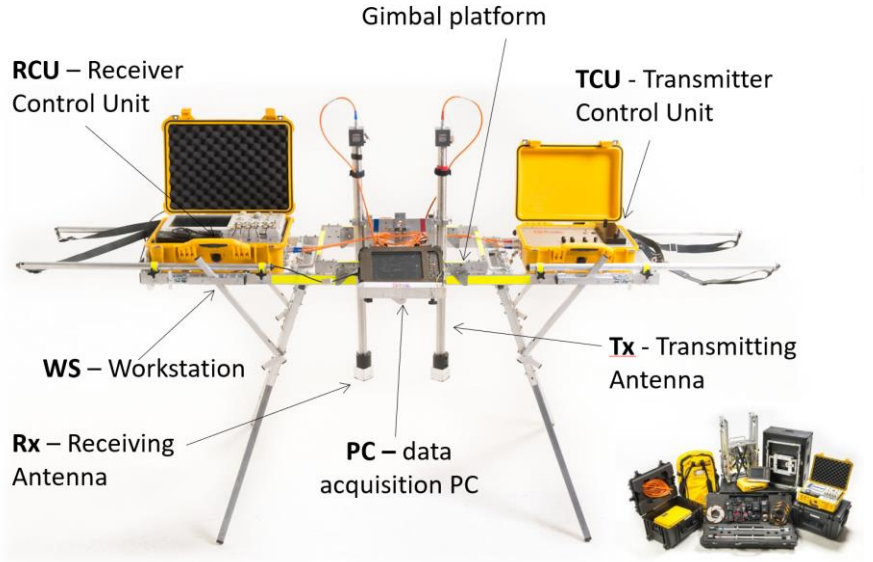
Barren drill hole

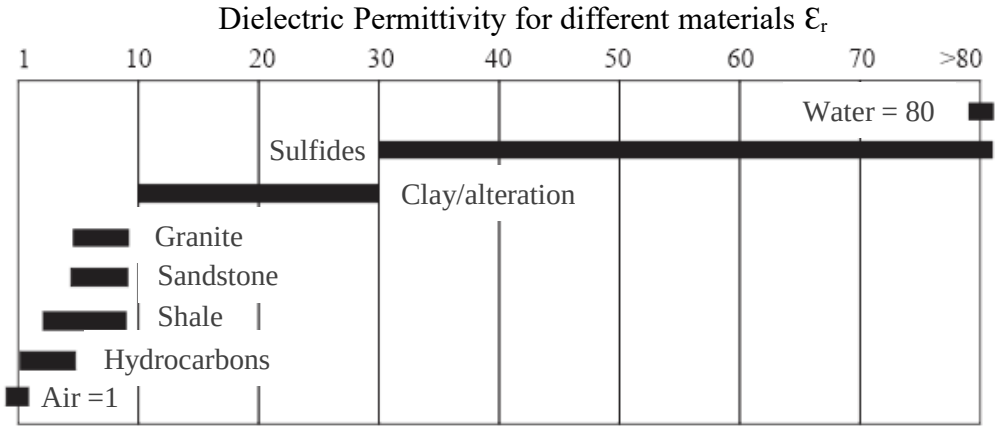
Where to drill next?

Grid v's targeted drilling

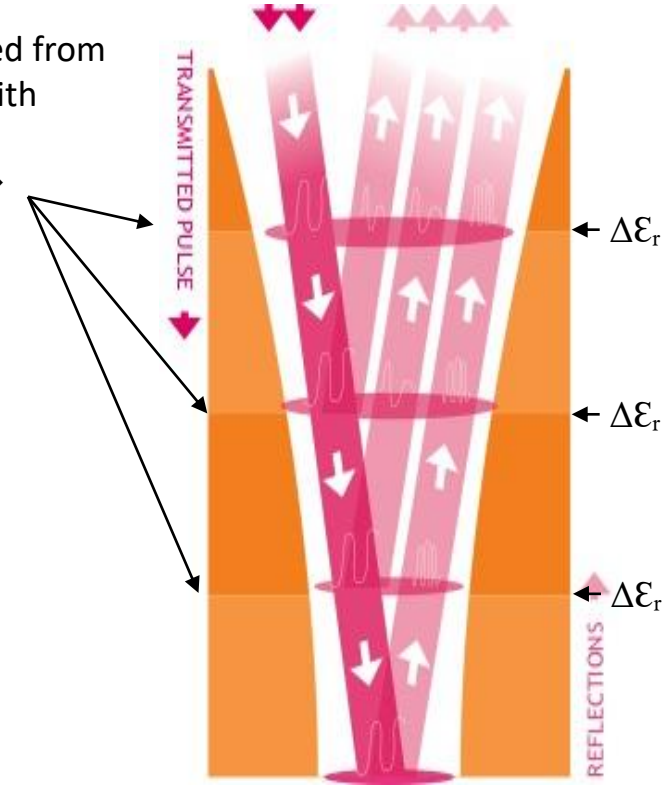
The ATOMIC DIELECTRIC RESONANCE (ADR) Technique

- Transmit pulsed broadband of radio waves and microwaves between 1-70MHz for mineral exploration applications
- ADR sends broadband pulses into the ground and detects the modulated reflections returned from the sub-surface structures.
- Reflections returned from changes in Dielectric Permittivity (ε_r)/Dielectric Constant (DC) of materials at depth.
- The entire field setup is extremely small and can fit in the back of a regular 4WD field vehicle. The antennas can be directed down, up, horizontally or in any direction required. No site clearing, no heavy machinery and no special permits are required. The only impact is walking the equipment in 50-100m transects depending on the survey.





Signal reflected from boundaries with high $\Delta\varepsilon_r$ e.g. granite → sulfides



Sulfides as targets?

Naval et al.,2018

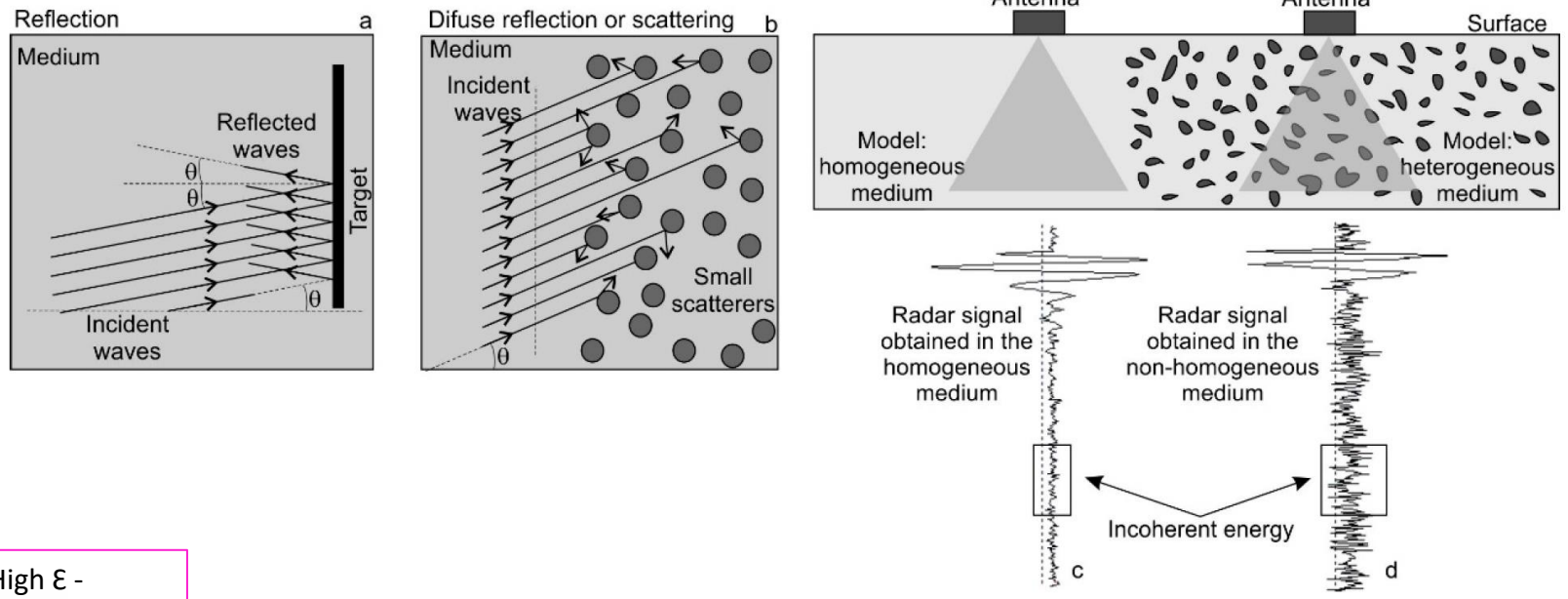
remote sensing 2018

MDPI

Article

GPR Clutter Amplitude Processing to Detect Shallow Geological Targets

Victor Salinas Naval [1], Sonia Santos-Assunçao [2] and Vega Pérez-Gracia [3,*]



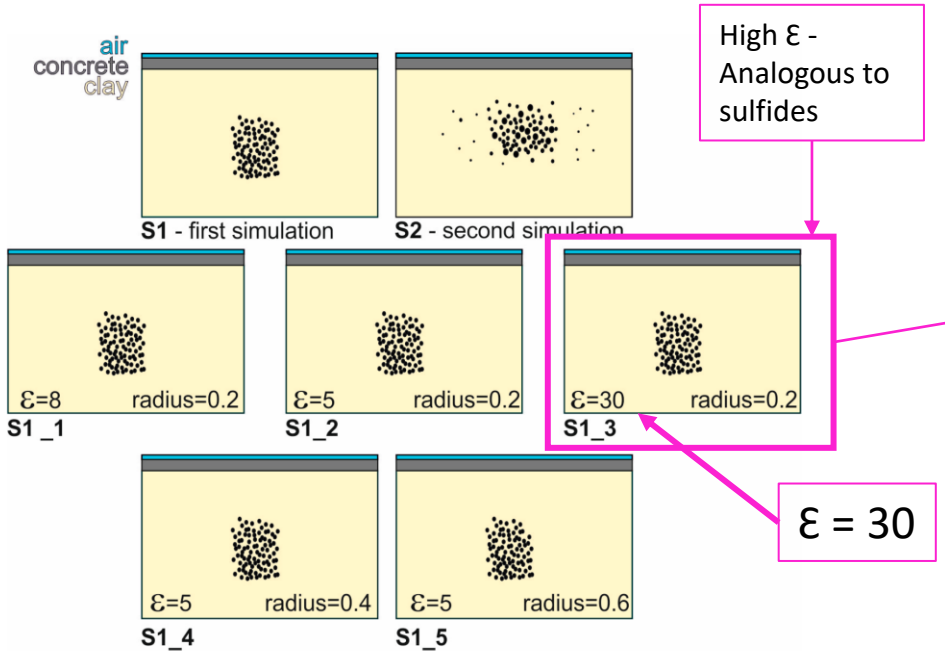


Figure 7. The two simulations (S1 and S2) based on different particles distribution. S1_1, S1_2, S1_3, S1_4 and S1_5 represent the five sub-cases considered in the first simulation (S1).

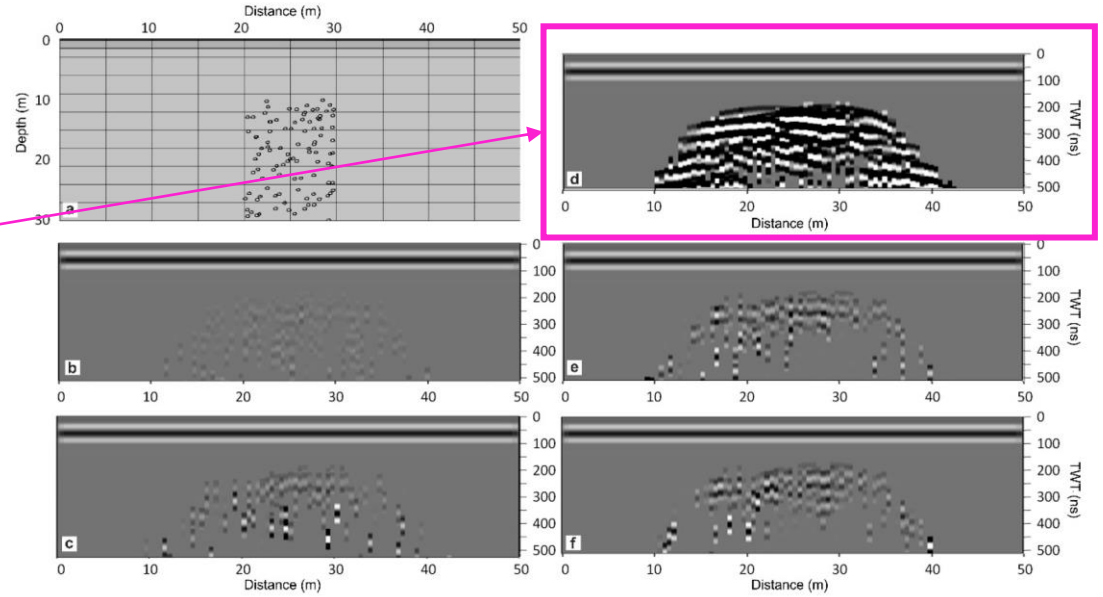


Figure 8. Three layered model with the position of the 100 scatterers (**a**) and synthetic traces for: case S1_1 (**b**); case S1_2 (**c**); case S1_3 (**d**); case S1_4 (**e**) and, case S1_5 (**f**).

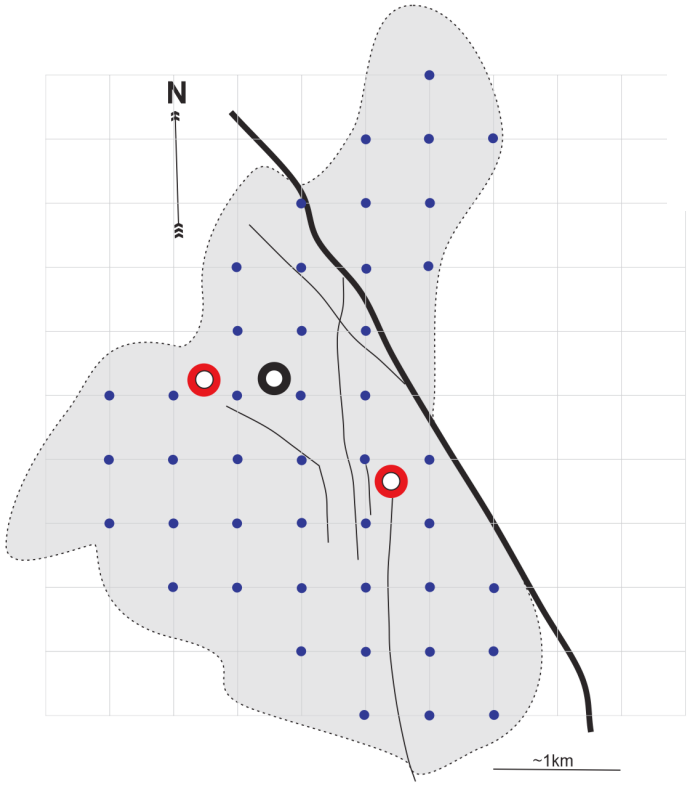
Disseminated sulfide targeting

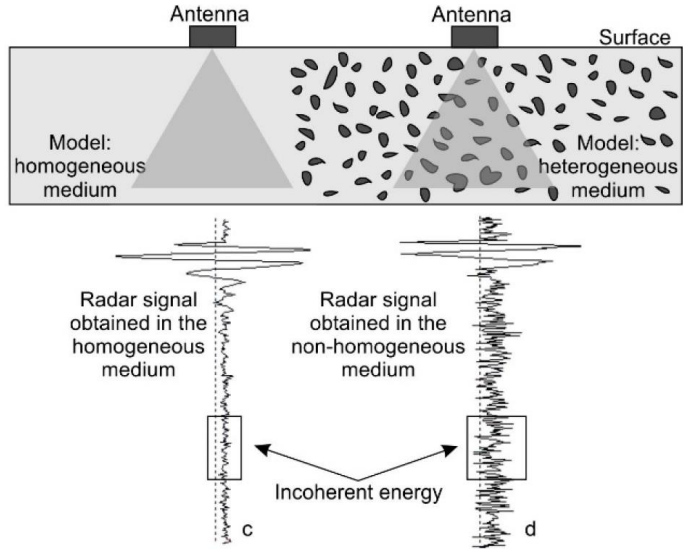
1. Do sulfides have a unique geophysical fingerprint that helps distinguish them from country rock?

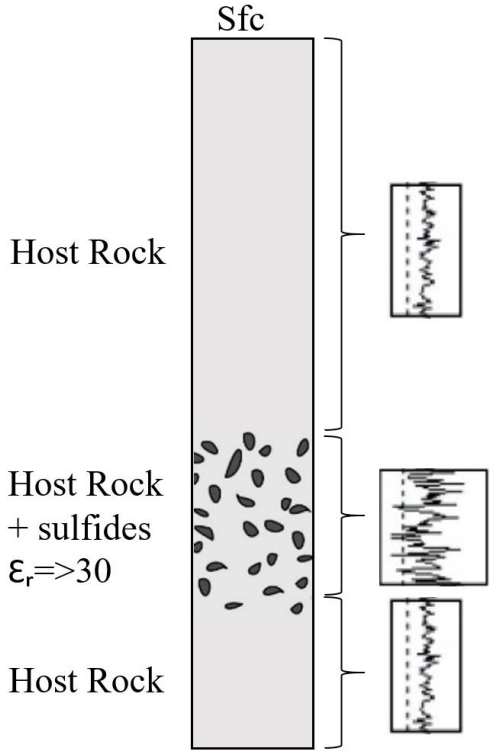
2. Can we help constrain the target area and target depth prior to drilling?

3. Can we provide a sulfide probability map to better inform drill planning?

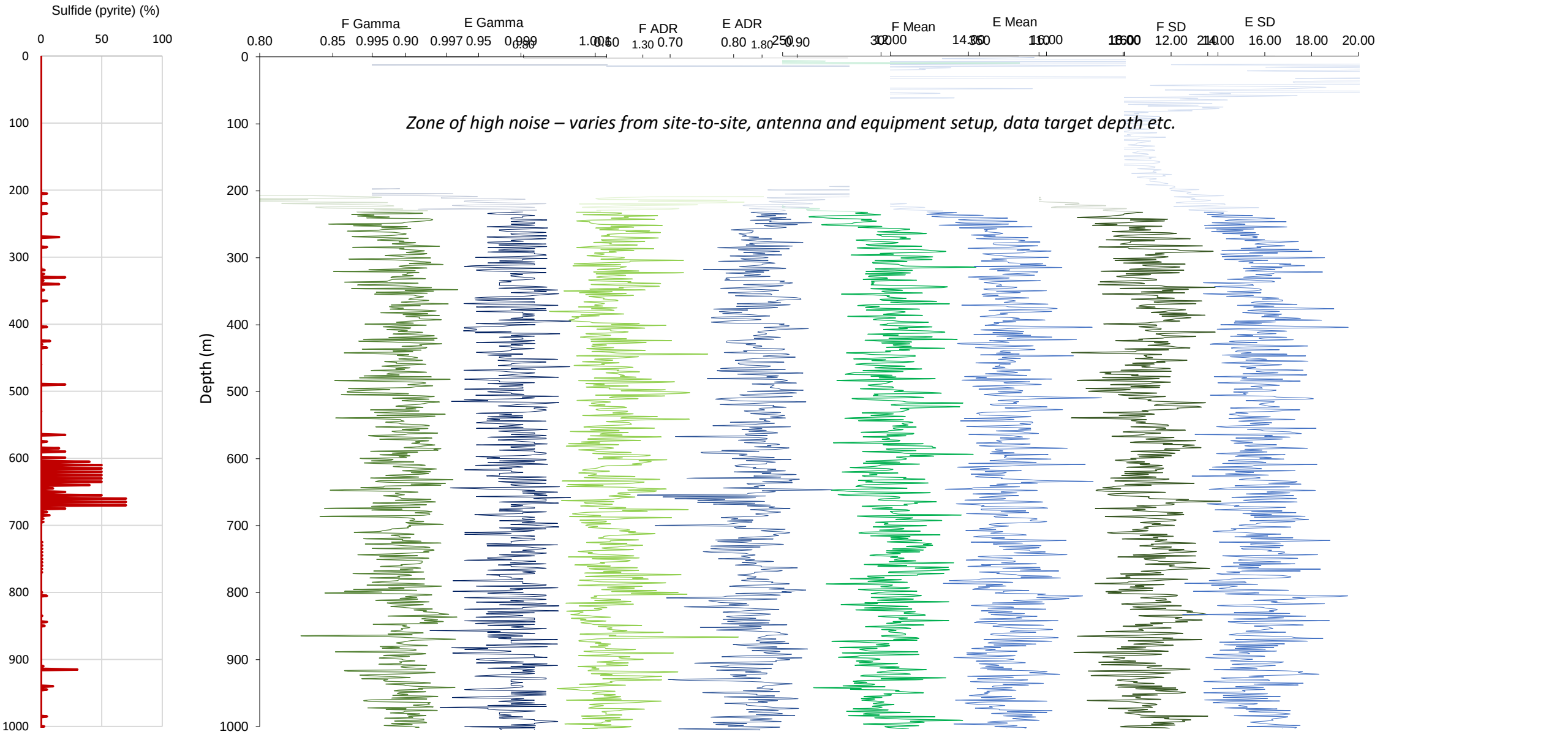
4. Can we help develop a technique that will enable mineral explorers to drill under cover with much greater confidence?





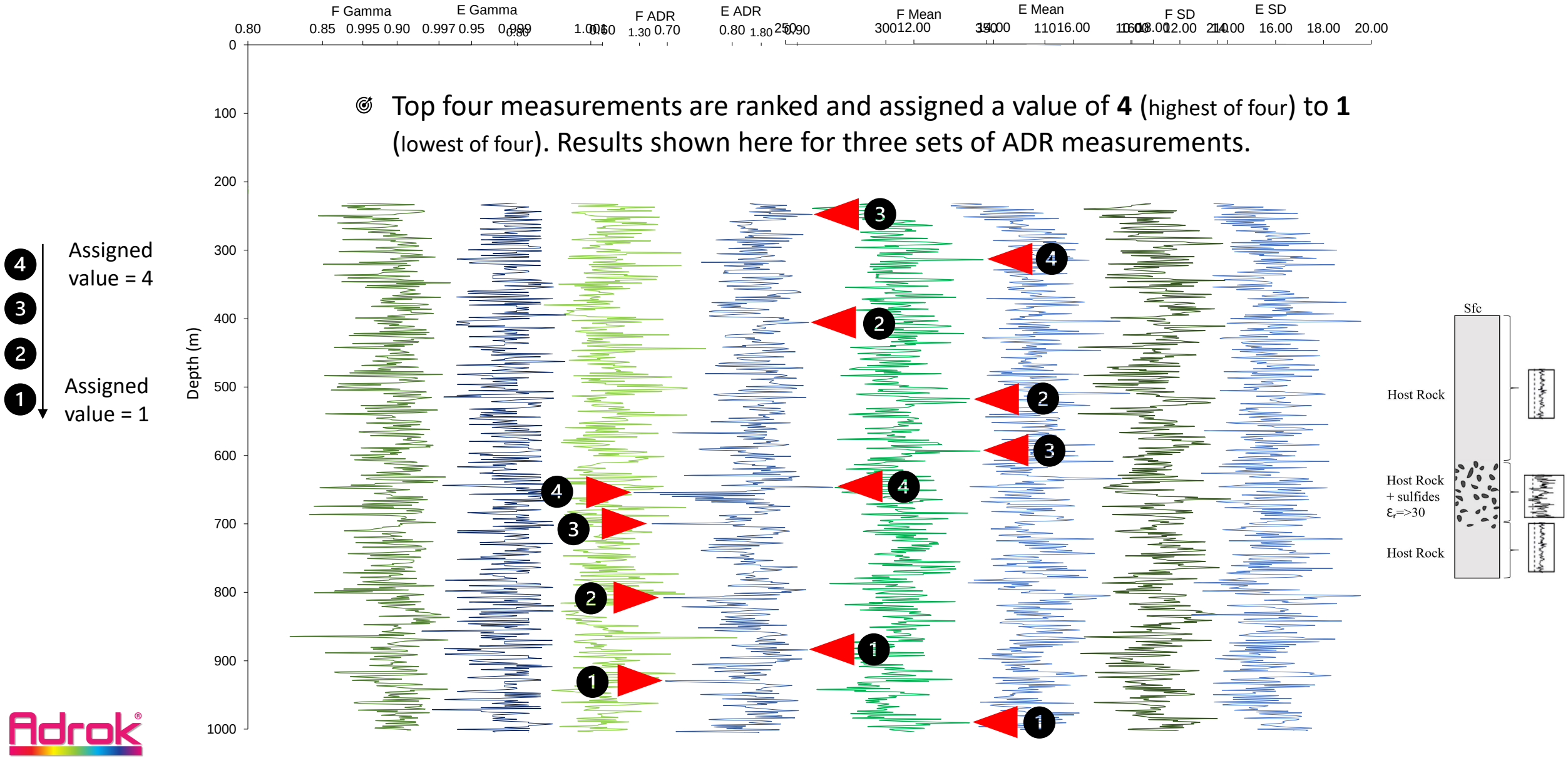


Results - Adrok records and then delivers multiple sets of Energy (E-) and Frequency (F-) results from a single scan



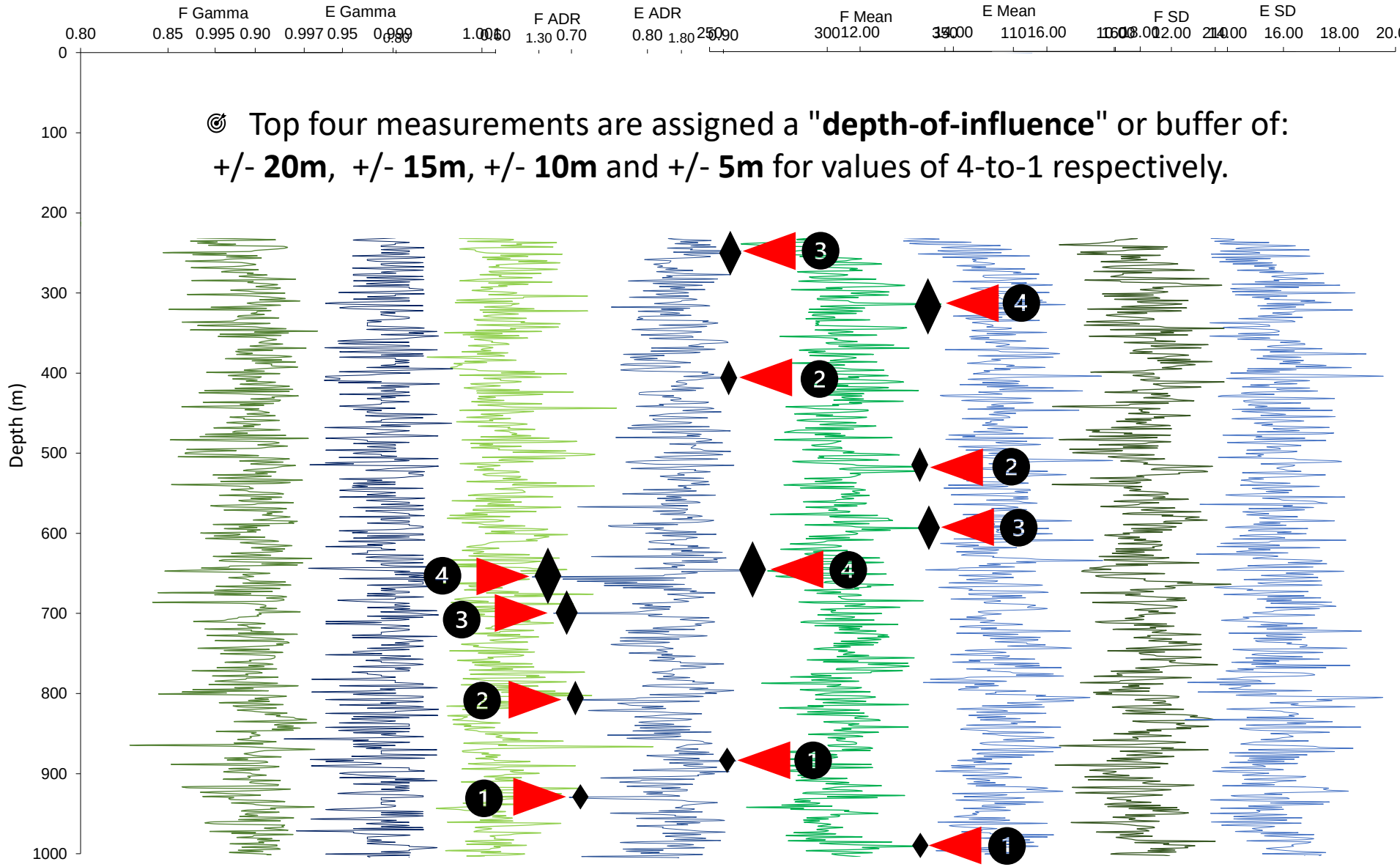
Weighted sulfide correlation criteria (WSCC) - Extracting the sulfide indicators

- Top four measurements are ranked and assigned a value of **4** (highest of four) to **1** (lowest of four). Results shown here for three sets of ADR measurements.



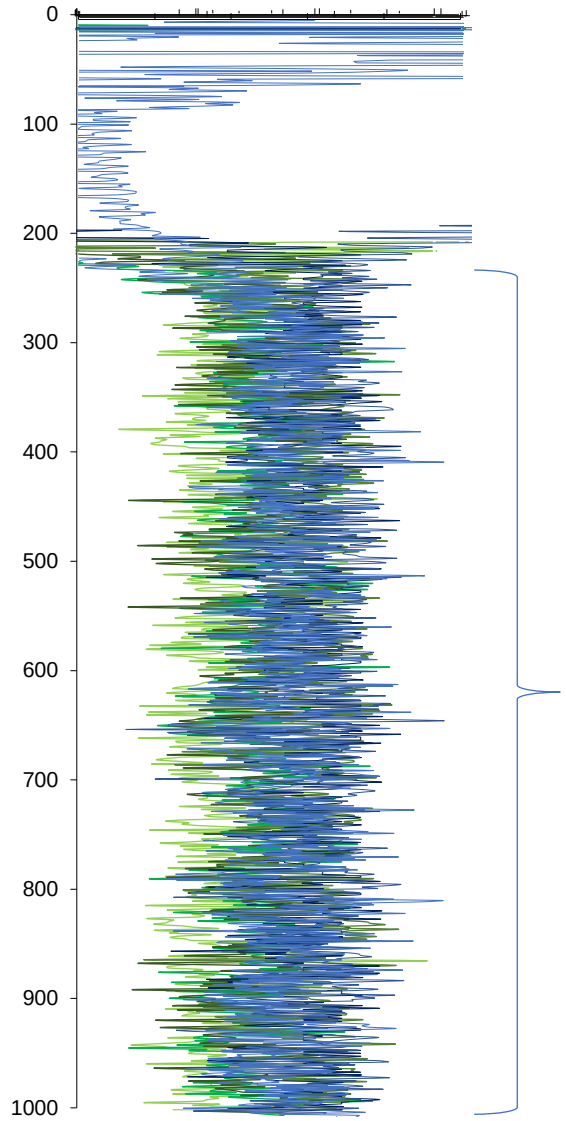
Weighted sulfide correlation criteria (WSCC) - Extracting the sulfide indicators

- +/- 20m
- +/- 15m
- +/- 10m
- +/- 5m



Top four measurements are assigned a "**depth-of-influence**" or buffer of:
+/- **20m**, +/- **15m**, +/- **10m** and +/- **5m** for values of 4-to-1 respectively.

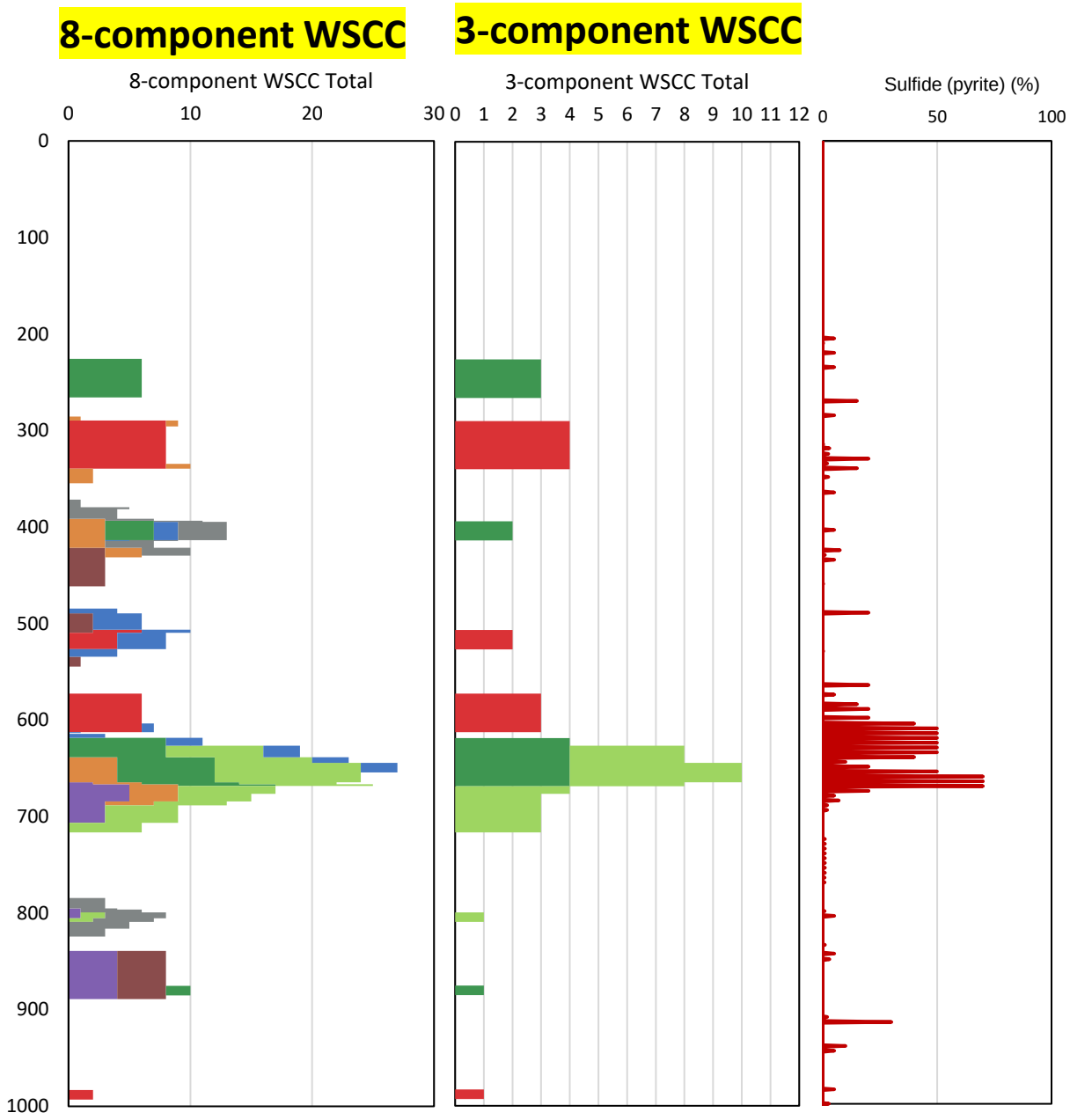
A simple, repeatable and client-friendly method



Two different sets of results are used to delineate:

8-component and
3-component WSCC results presented to the right.

Results are stacked to provide a graphical representation of the greatest number of matching criteria for sulfides



A simple, repeatable and client-friendly method

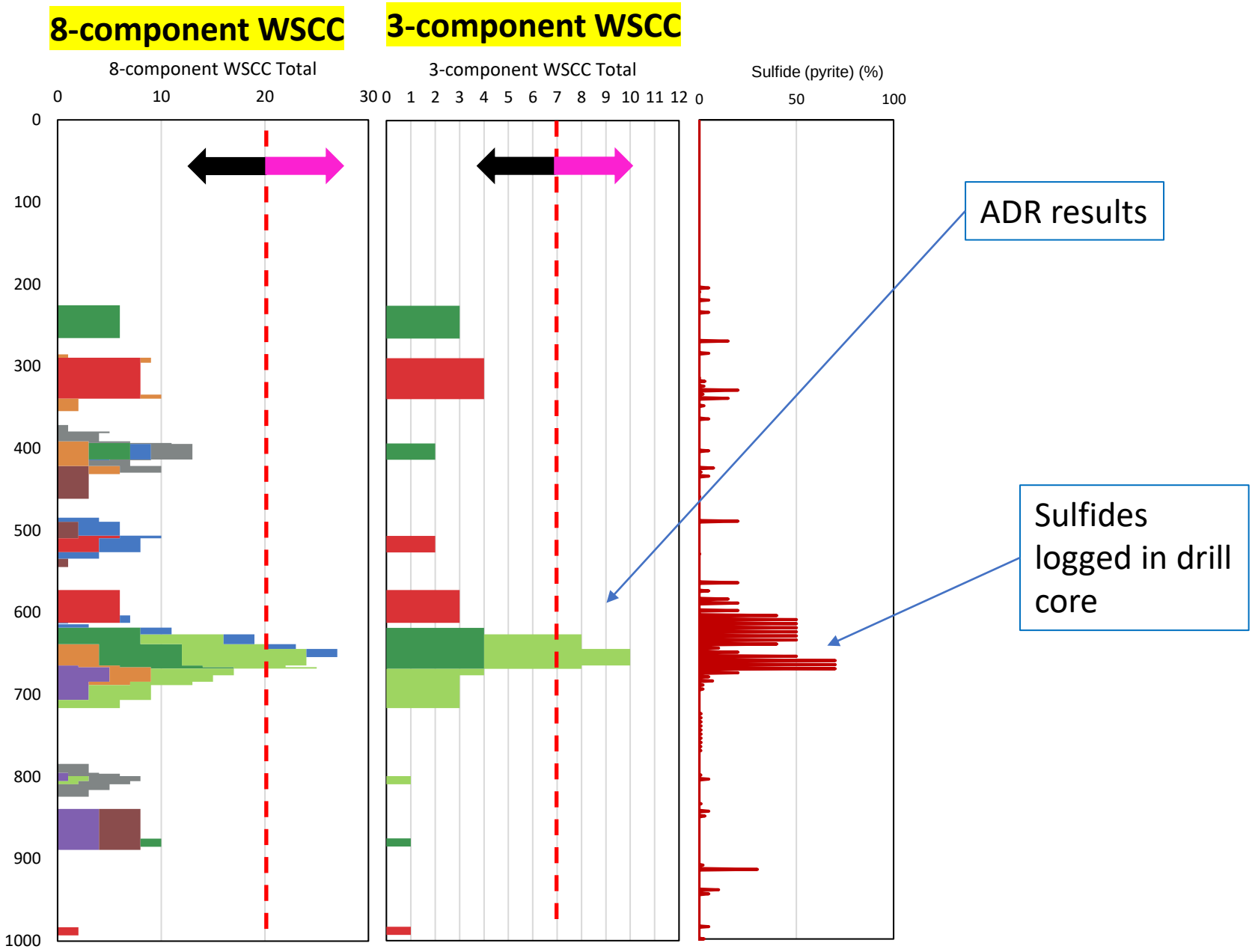
Preliminary WSCC target values

So far Adrok are using minimum WSCC values of 20 and 7 to define areas of high sulfide

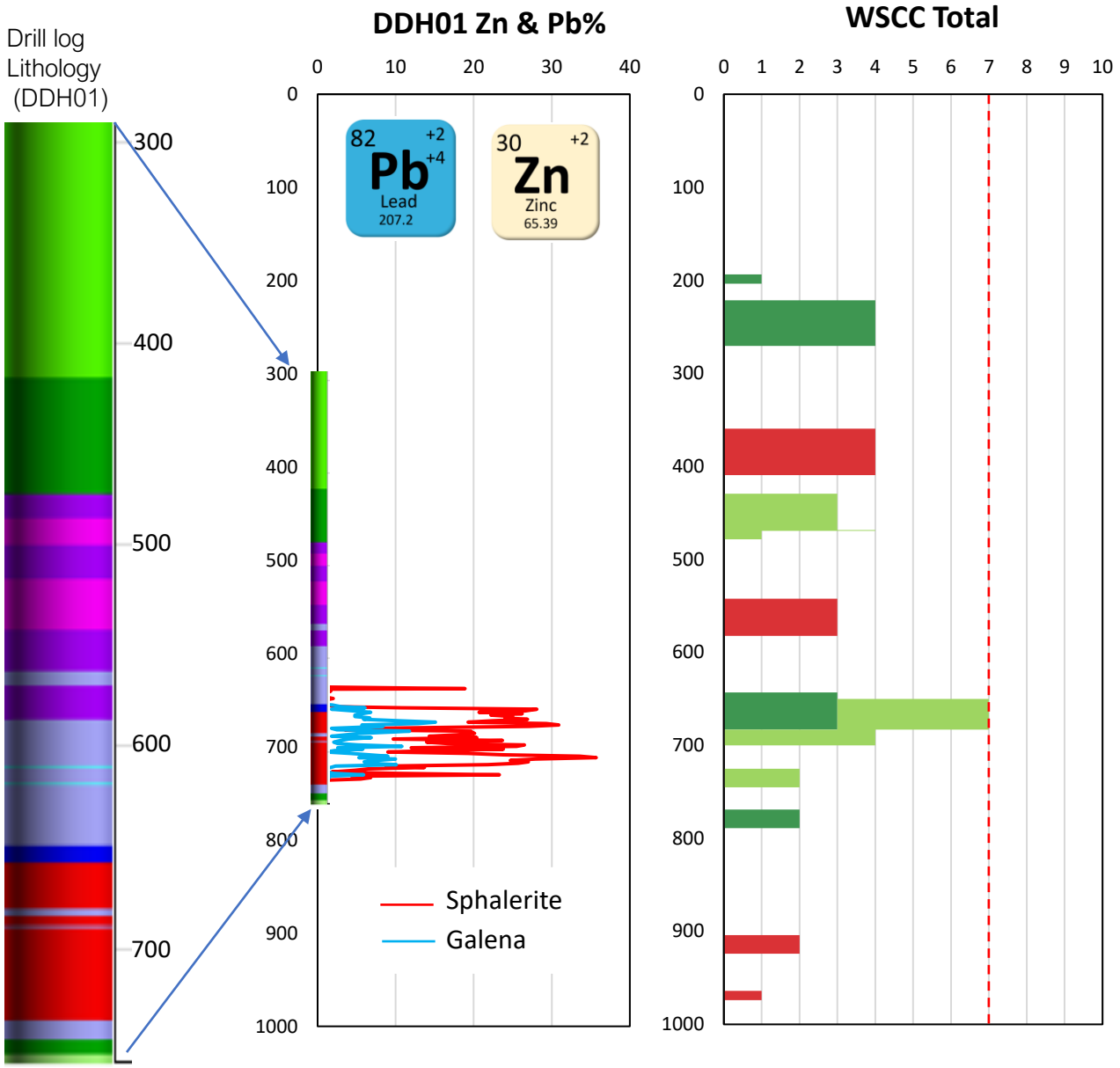
Higher confidence of sulfides

>20 or >7

Lower confidence of sulfides



Field case studies applying the WSCC criteria



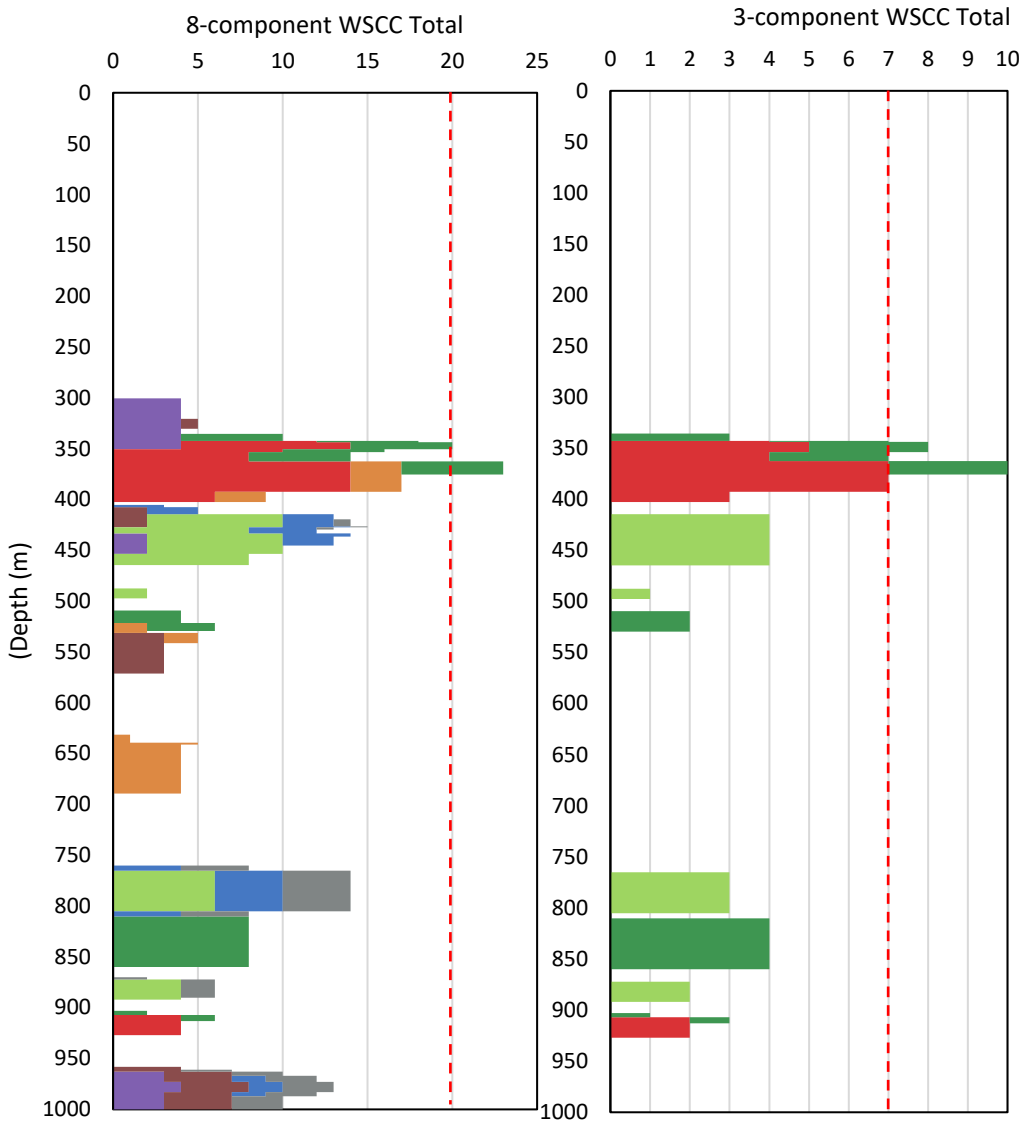
CASE STUDY 1 - Pb-Zn

~100m thick disseminated sulfides

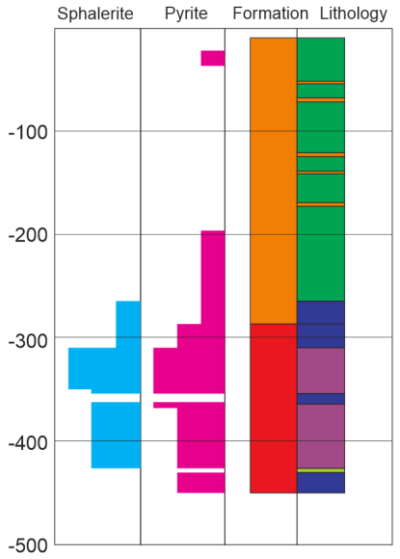
Adrok's 3-component sulfide targeting criteria was suitable for discriminating the location of sulfides at ~690m below the surface. Based on these results the highest potential for sulfides was between 650m and 700m.

CASE STUDY 2 - Zn

8-component and 3-component weighted sulfide correlation criteria results



Client drill results

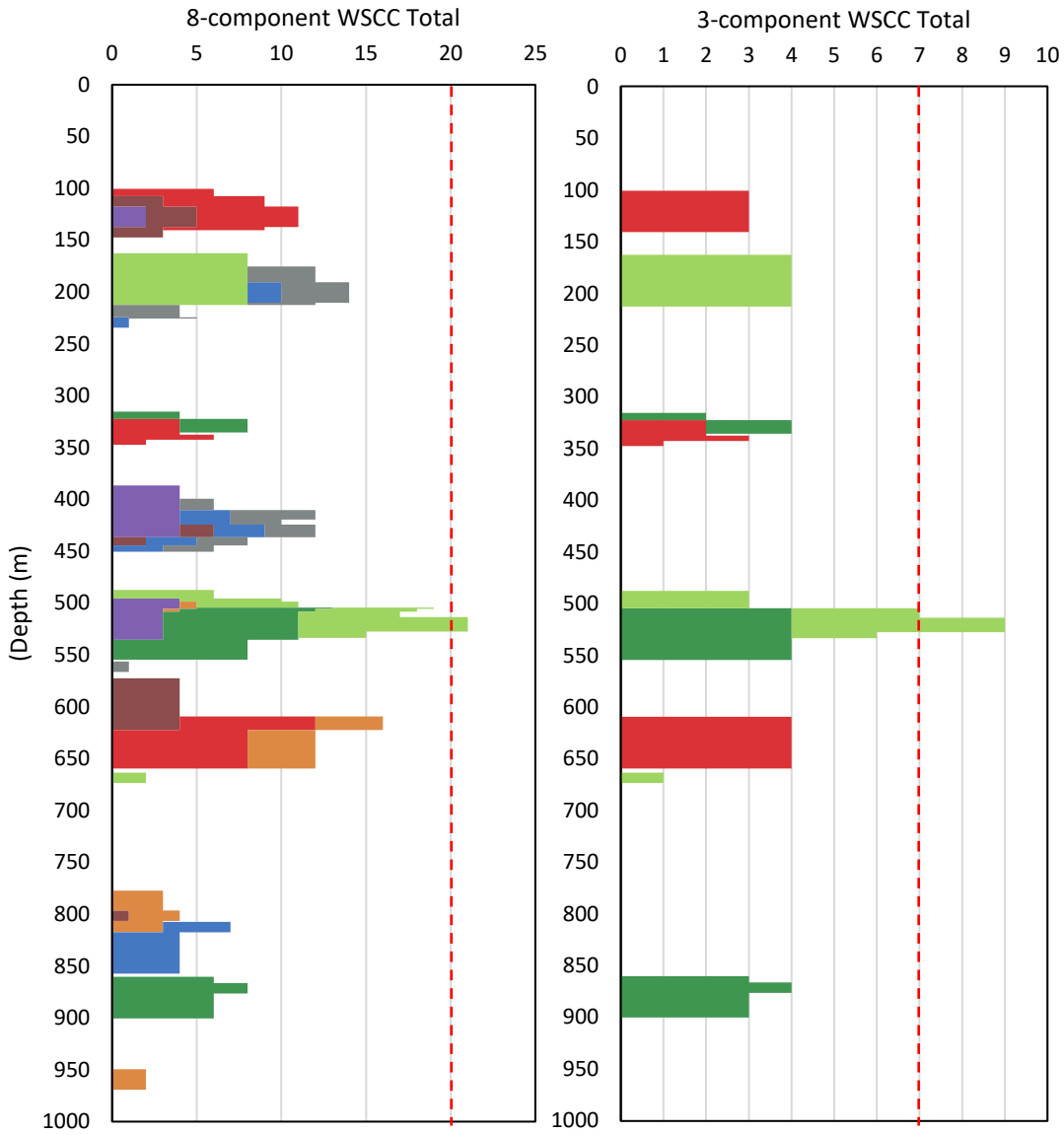


Sphalerite ((Zn,Fe)S) and Pyrite (FeS) were logged from drill core.

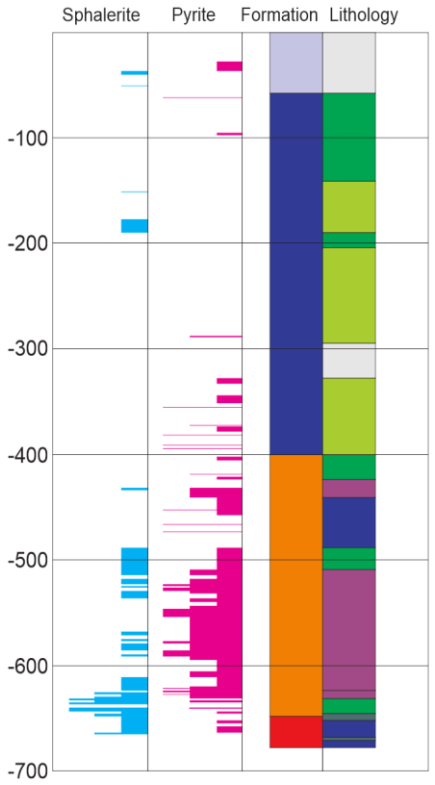
Both the 8- and 3-component sulfide targeting criteria correlates well with the location of sulfides at ~350m below the surface.

CASE STUDY 3 - Zn

8-component and 3-component weighted sulfide correlation criteria results



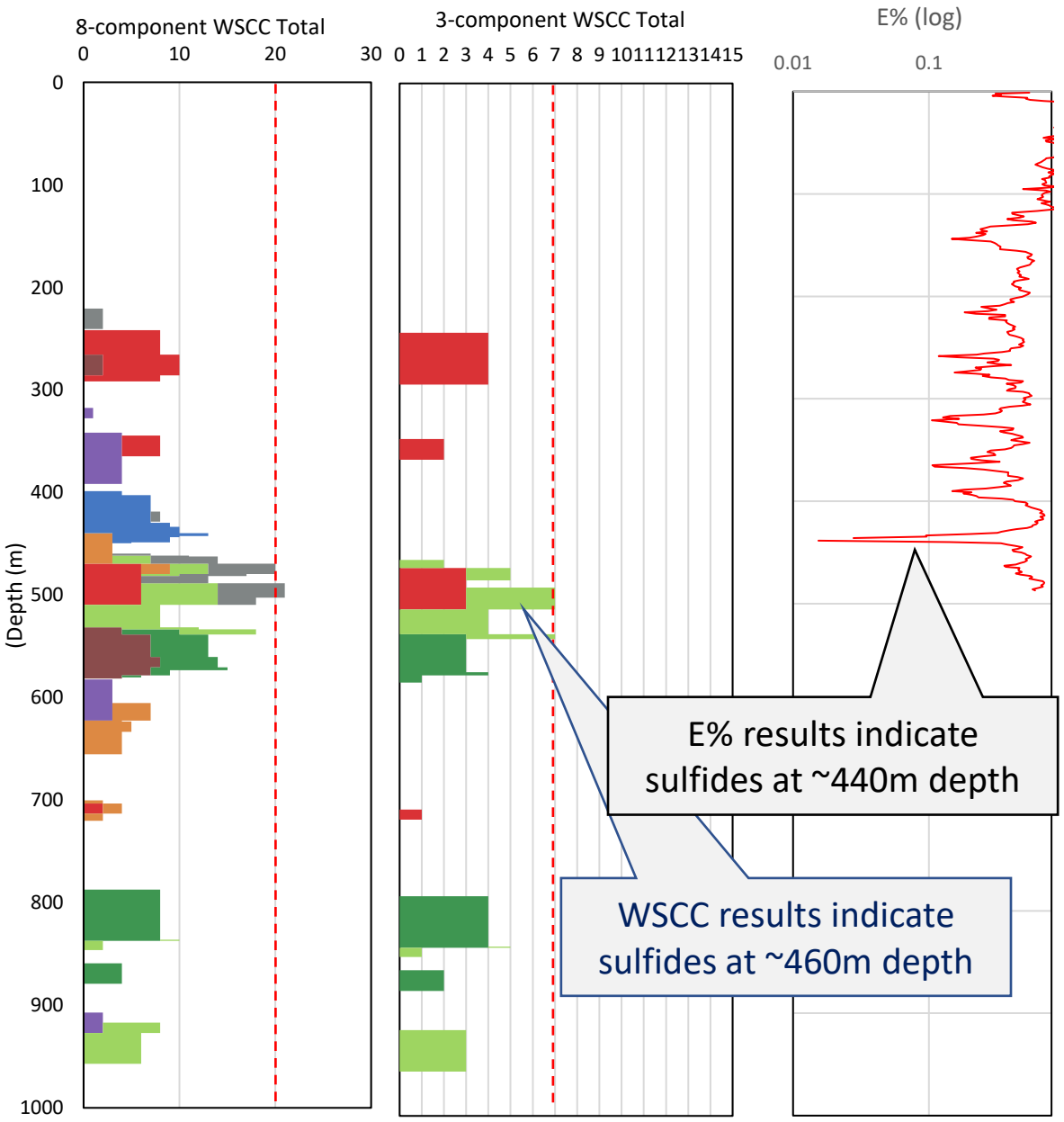
Client drill results

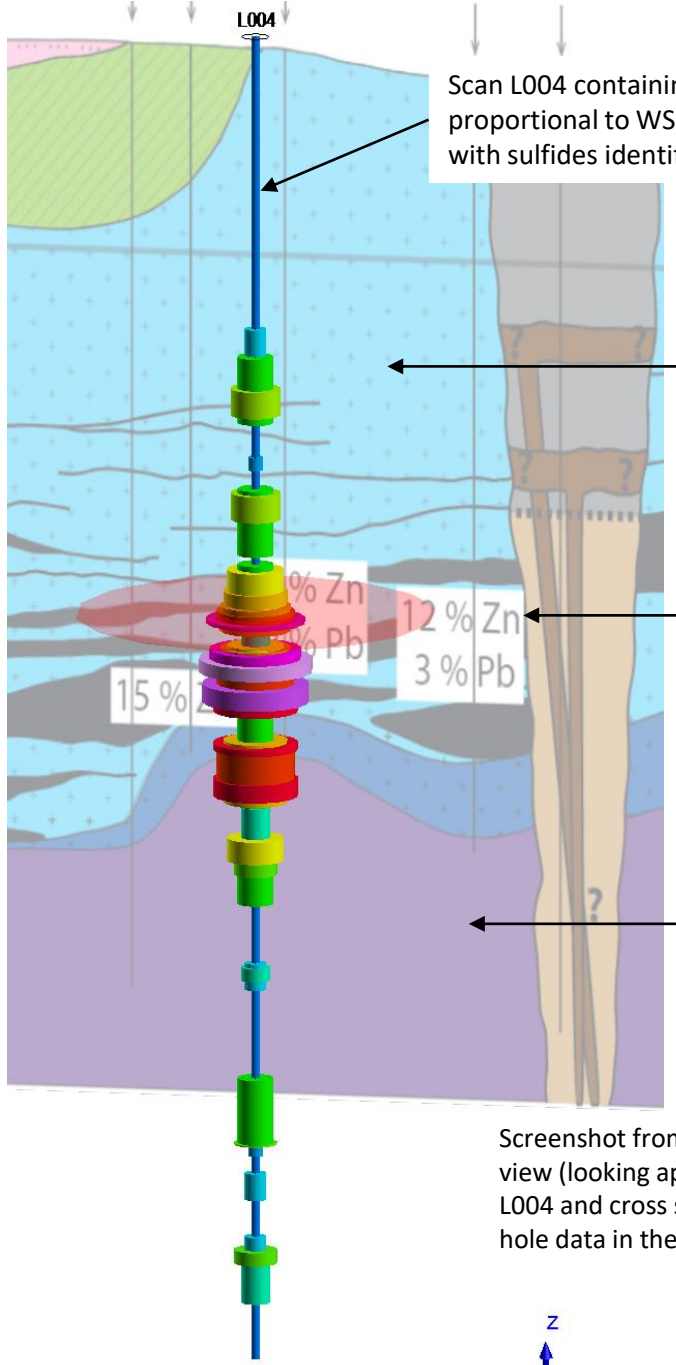


Sphalerite ((Zn,Fe)S) and Pyrite (FeS) were logged from drill core.

Both the 8- and 3-component sulfide targeting criteria correlates well with the top of the sulfide zone at ~500-550m below the surface.

CASE STUDY 4 – Pb-Zn





Scan L004 containing WSCC results (diameter proportional to WSCC value). High WSCC corresponds with sulfides identified in drilling at ~450m.

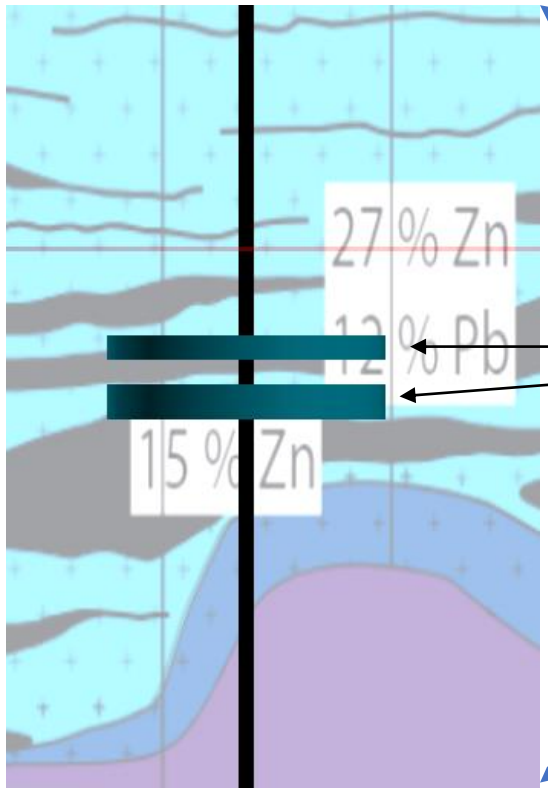
Waulsortian limestone

Pb + Zn Sulfide-bearing breccias identified in drill holes ~450m depth

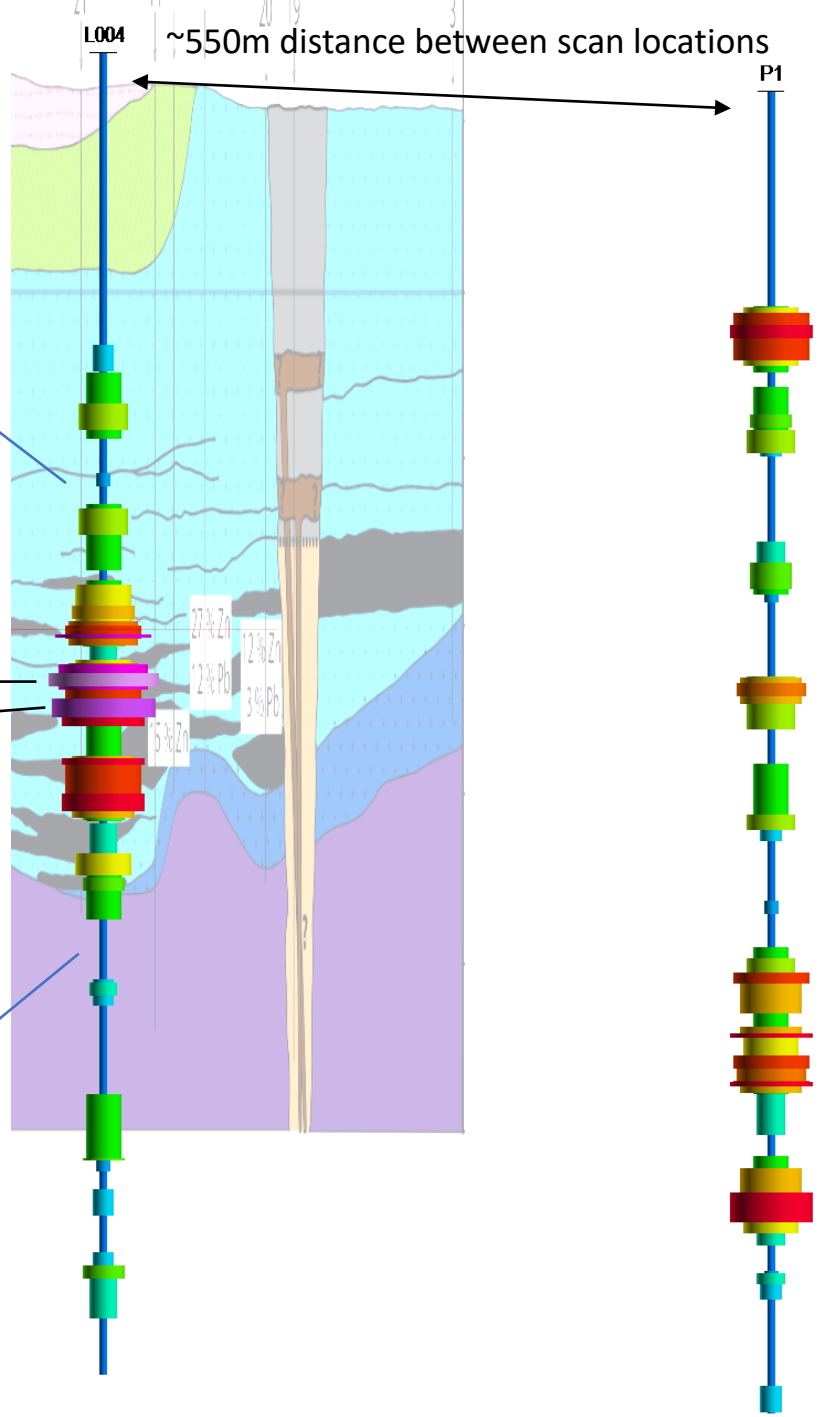
Lower Argillaceous Bioclastic Limestone Formation

Screenshot from 3D model showing a side-view (looking approximately west) across scan L004 and cross section interpreted from drill hole data in the region.

Section of scan L004 showing only values above 20 in the 8-component WSCC



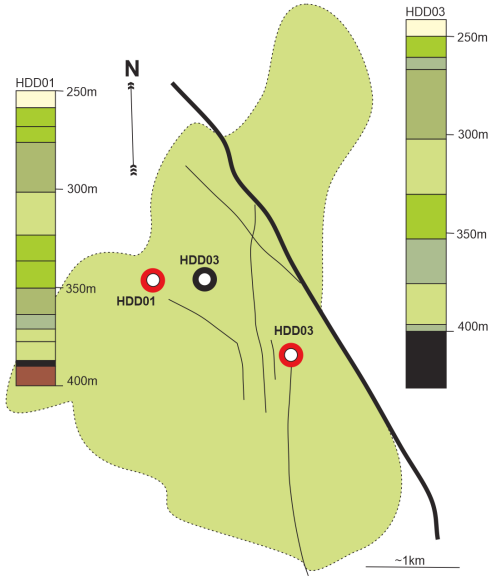
Looking west

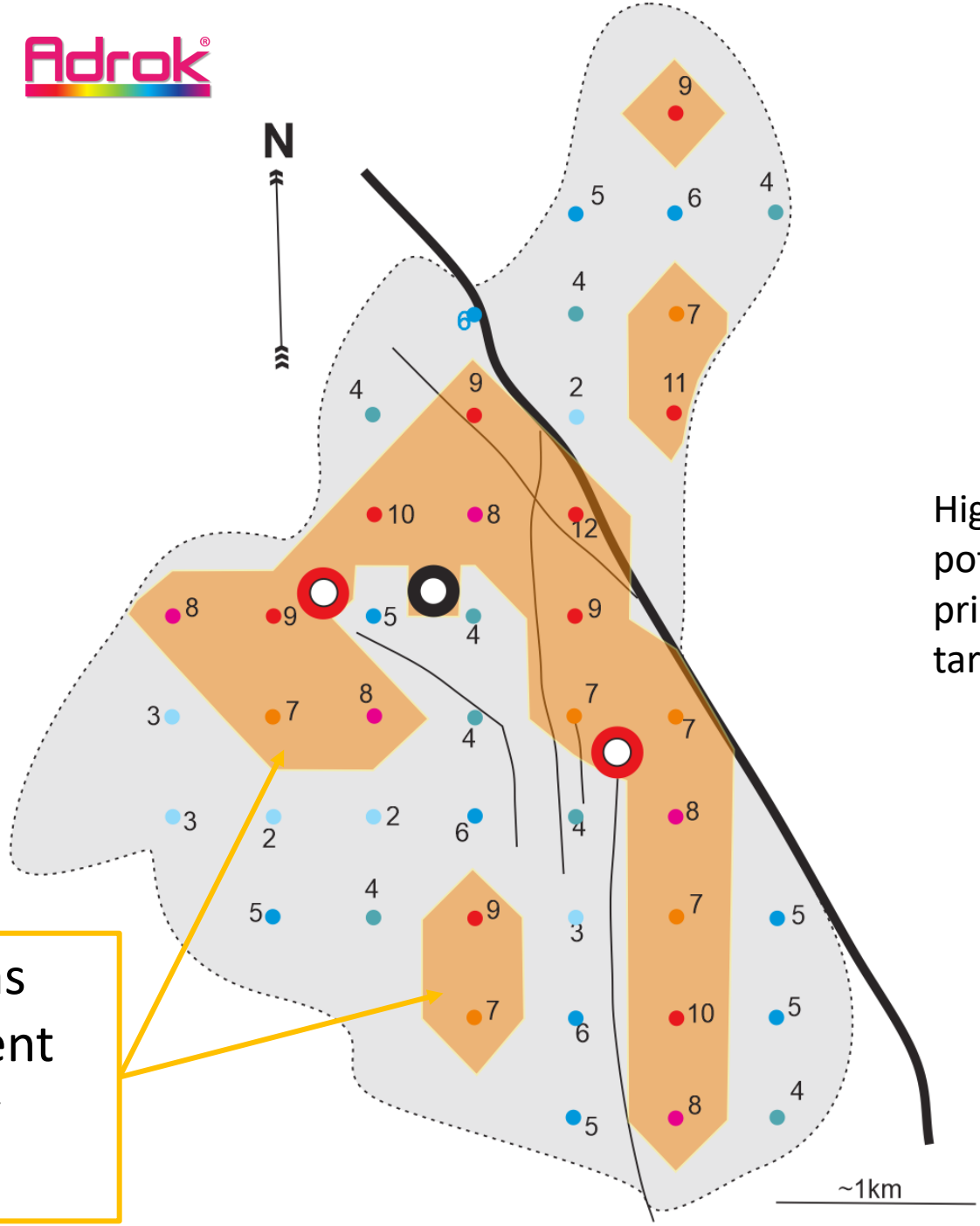


Some scans present with no significant indicators of sulfides

Nearby scan has no WSCC values above 20 in the 8-component WSCC results suggesting a lack of sulfides in this area but there are no drill holes in this area to confirm results.

Generation of a sulfide target map using WSCC results





High sulfide potential – priority drill targets

12
11
10
9
8
7
6
5
4
3
2

Low sulfide potential

Sulfide bearing areas based on 3-Compnent WSCC results below 400m

43 sites total

20 sulfide targets

23 low priority targets

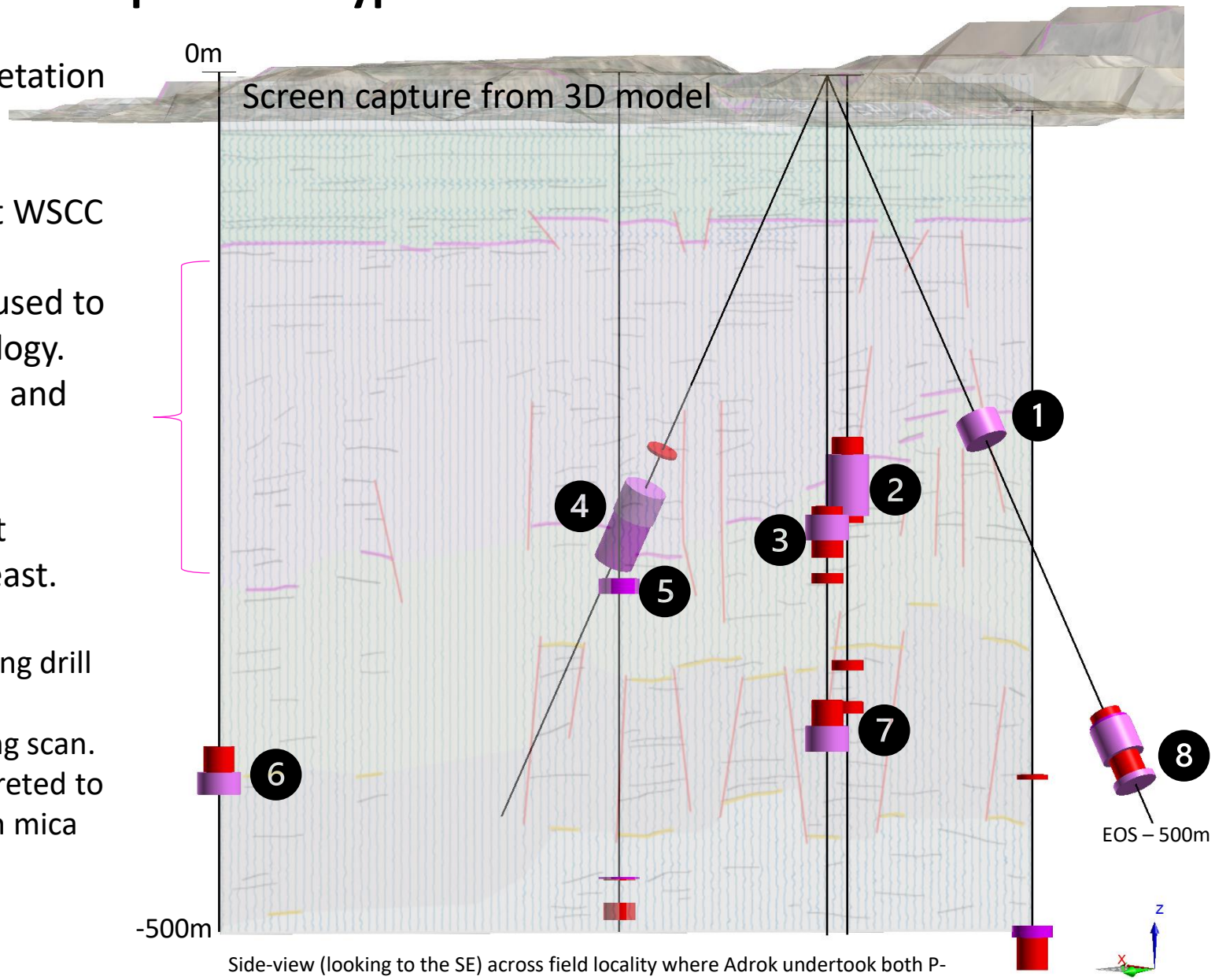
Building models with multiple scans types and scans in different orientations

P-scan showing results for E-mean and interpretation of lithological boundaries and faults

- WSCC results >7 are shown for 3-compnent WSCC results.
- Multiple scans (STARE and P-SCANS) ca be used to build up an "image" of the sub-surface geology. WSCC results are overlain on P-Scan results and indicate that here, sulfides are found predominantly within the greywacke unit.
- Sulfide targets increase in depth to the east suggesting the greywacke also dips to the east.

#1 – corresponds with sulfides in single, west-plunging drill hole.
#2-5 sulfides in vertical STARE scans and in E-plunging scan.
#6-8 sulfides identified below any drilling but interpreted to be within a lower greywacke unit below semi-barren mica schists and quartz schists.

Note - repeatability in #2 & 3 and #4 & 5.



Side-view (looking to the SE) across field locality where Adrok undertook both P-SCAN (profile) and STARE scans at different orientations. STARE scan plunging to the right (above points 1 & 8) is parallel to drill hole 60→ 275.

SUMMARY

Adrok have been working with the mineral exploration industry to develop the technology, data processing and interpretation technique to help reduce the risk of mineral exploration drilling, particularly under deep cover where targets are genuinely blind.

- The data acquisition technique utilises a conditioned pulsed radar pulse at low frequency (1-70MHz) to measure rock properties up to and sometimes over 1000m deep below the surface.

- Adrok have, for over more than ten years, been collecting the same data from a wide variety of mineral deposit types (SEDEX, VMS, Porphyry, Orogenic) and have been able to bring together all of these results to explore the possibility of extracting the "**sulfide fingerprint**" from the background noise/signal of the host rocks.

- The aim of this most recent project was to develop a method of **targeting high grade, disseminated sulfides, prior to drilling** which in-turn will help provide explorers with a higher level of confidence when placing the first discovery hole or when extending existing mineral resources.

- Adrok used a multi-project, iterative processing and stringent evaluation method to extract two initial sets of criteria that have been tested across multiple projects with a high level of confidence.

- The method, which Adrok has termed "**Weighted Sulfide Correlation Criteria**" (WSCC), uses a combination of up to four high and/or low values from either 8- or 3-datasets collected in the field (i.e. 32 or 12 total criteria respectively). These are termed 8-Compnent WSCC and 3-Component WSCC.

- The WSCC method can be carried out on legacy data, therefore Adrok have been able to internally blind test the technique on historical datasets where drilling assay or sulfide% values had been provided by clients.