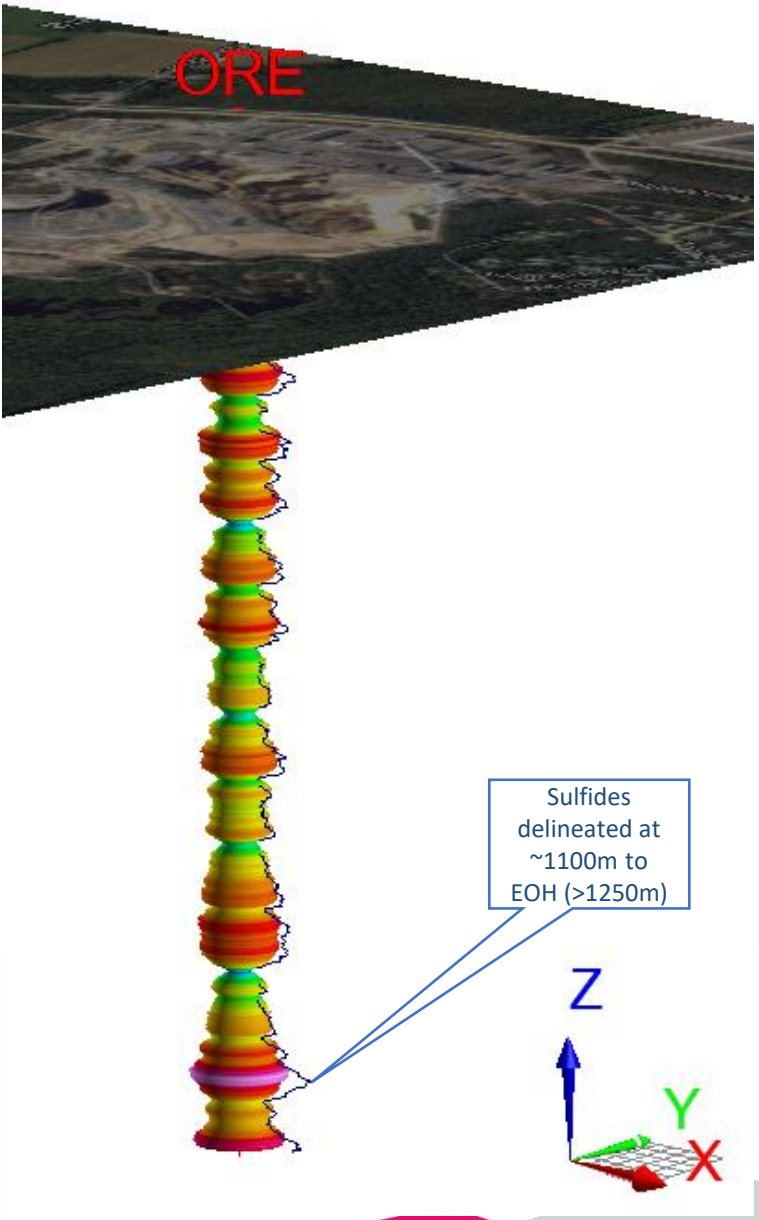


PYHASALMI MINE

SULFIDE DISCRIMINATION

Processing of scan "H3 ORE" as a test of Adrok's *new* sulfide discrimination criteria

Results and interpretations are presented for the scan number "H3 ORE" carried out at the Pyhasalmi Mine. The processing was carried out in order to provide a geographically independent, internal check of new sulfide targeting results developed by Adrok for other sulfide-project sites around the world. The extremely successful result opens up an opportunity to be able to scan for sulfides at depth with more confidence that ever before.

Adrok recently embarked on an initiative to review scan results from every sulfide targeting project from around the world. The aim was to determine whether base metal sulfides can be distinguished from the vast array of host-rock types.

The hypotheses: Sulfides should exhibit a unique "fingerprint" across the different results obtained via an ADR scan. Once determined, this unique fingerprint should be recognised at other sites, regardless of the host rock.

The following are results obtained after processing of scan H3 ORE collected in 2017 at the First Quantum Minerals' PYHASALMI MINE in Finland. Adrok were exploring old projects were scans had not been processed in order to test its new sulfide discrimination criteria. It was found that scan H3 ORE had not been processed and, owing to the name, may have intercepted sulfides. Accordingly, Adrok processed the data, interpreted the zone of sulfides using the criteria discussed in more detail below.

BACKGROUND

Prior to processing the H3 ORE scan, Adrok had settled on a set of specific criteria for the identification of sulfides. The criteria were based on results from many scans processed from Australia, Alaska and Scotland to name just a few.

Critically, this work differs from the targeting of narrow vein style sulfides that proved successful at the Charters Towers Gold mine and other sites. Here, the focus is on medium- to high- concentrations of sulfides in broader disseminated style targets (e.g. VHMS, SEDEX). The result represents just one result of ongoing work in refining the technique and interpretation methods*, however, we present the results of the H3 ORE scan as a test of the criteria as the result was a resounding success.*

We anticipate that the result obtained here will provide a platform to support future trials in similar styles of mineralisation. Adrok is always testing and developing, however, we are confident that, based on the overwhelming success gained from this initiative a sulfide-specific detection method will be developed in the very near future. With further development, Adrok forecasts that the methodologies will be suitable for Greenfields-type mineral targeting which is particularly useful for areas under cover.

Like all geophysics techniques, ADR is under continued development. It is a technique that s still in relative infancy, however, with an ever-increasing number of case studies, patterns relating to sulfides are emerging. Unlike targeting the narrow vein sulfides where a reflection from the boundary is recorded (not thickness of the sulfide layer as some third parties have incorrectly suggested), here Adrok is focused on delineating the response in the different datasets collected in the field. The selection of sulfide response criteria similar to a weights of evidence method whereby the highest number of responses at a given depth have been found to correspond with the presence of sulfides.

	Project	Target result	Concept
Quantitative	**PYHASALMI MINE** (provided in previous report)	Use High-Low analysis of harmonic data to delineate changes in rock types and rock type (including sulfide) fingerprinting.	The "DNA" of Adrok's technique and technology. Data-based and constrained by quantitative workflow.
Qualitative	This project **PYHASALMI MINE** Initially developed for other sites in Alaska and Australia, tested here for Phyasalmi mine.	Define selected criteria from harmonic data to delineate just the sulfide component of all project areas ignoring host rock type.	The "RNA" of Adrok's technique and technology. Iterative process leading to sulfide delineation criteria (results presented here). Strong emphasis on integrating geology and facets of ore zone mineralogy into interpretations.

Final result

Formulation of a unified technique and process for sulfide delineation without the need for training scans. Independent sulfide fingerprinting.

Final stages of quantifying the technique using internal lithometrics. In development

CONCLUSIONS

- Adrok have completed a trial of a new sulfide detection method using criteria in the ADR scans that are selective of sulfides independent on the host rock type. Work is continuing to refine the technique with a particular emphasis on quantifying the interpretation of, in particular, the Energy and Frequency results.

- Adrok delineated the criteria initially using other project results which involved iteratively fine-tuned the criteria for extracting the sulfide fingerprint. Adrok are excited to announce that we have settled on a preliminary list of key criteria that, across multiple sites in multiple countries and a multitude of different host rock types, correlates well with the sulfide zone in each demonstratable case.

- Only one scan "H3 ORE" was processed as part of this trial as Adrok wanted to check its criteria in an area with known sulfides.

- Applying the sulfide discrimination criteria, only one main site of sulfides was determined from 1125m below surface to EOH (end of scan) at 1250m.

- In order to determine whether this was an accurate result, Adrok found some publicly available plans of the PYHASALMI MINE and compared the results with these. It was determined that, even though the cross sections are not absolutely precise, the min zone corresponded well with the predicted depth at over 1125m.

- Adrok have not yet applied the specific frequency processing which has been used at other sites to further constrain the min zone as it was not required. Adrok are confident that the results from the harmonic E- and F- data alone are sufficient to target mineralisation in this setting.

- **Adrok recognise that some additional scans and testing of results in a mineralised project are is required** to continue to refine the methodology, however, the results presented here are extremely successful and show promise for the Adrok technology to become a site-independent sulfide detection tool in the very near future.

SURVEY DETAILS

- **Location X- Y-** (see table)
- **Survey acquisition date:** 08/08/2017
- **Data processing date:** 06/05/2020
- **Survey depth max:** 1250m
- **Data produced from processing:**
  - Dielectric Permittivity
  - Energy Log and Weighted Mean Frequency
  - Energy and Frequency Harmonics
  - 1-5MHz and 5-10MHz Frequency Correlation

BHID	N	E	Z	DIP	AZIMUTH	FINAL DEPTH (m)
H3 ORE	7058999	-452419	136	-90	360	1250

GLOSSARY

Term	Definition
ADR	Atomic Dielectric Resonance.
Correlation Method	Stacks a large number of traces from a series of stare scans and applies mathematical filtering to give a baseline over which the signal can be described as being of high quality. The signal returns are analyzed to show distinct changes in lithology for the area under investigation.
Dielectric Constant (DC)	The index of the rate of transmission of our ADR radio-wave lased beam through a medium relative to the transmission rate of the beam through air. This is also sometimes called the transmissivity index, where air has a dielectric constant of 1. For a medium such as limestone the dielectric constant (ϵr) is typically 9.
E-Log (Energy log)	During a stationary scan ("Stare" scan) the ADR transmitter and receiver antennas are positioned at known grid co-ordinates and aimed downward. The energy log ("E-log") indicator is produced by dividing the Stare scan image data in time windows. Windowing is carried out in equal time intervals or the time axis is migrated to depth after our WARR tracking of dielectric and windowing is performed equal spatial intervals. The data windows are subsequently analyzed and/or enhanced utilizing a suite of signal and image processing techniques such as Fourier analysis, wavelet decomposition, and image enhancement algorithms using RADAMATIC, Adrok's proprietary data analysis software. Amongst other indicators, this analysis produces the E-Logs which represent estimated energy values as a function of depth and were found to be excellent indicators. In this paper they are plotted on a logarithmic scale.
P-Scan	Profile Scan of the subsurface with fixed focus Antenna spacings at ground level. Both Transmitting and Receiving Antennas are moved simultaneously in parallel along the length of the scan line. This produces an image of the subsurface (from ground level) based on the two-way travel time of Adrok ADR Scanner's beams from Transmitter (Tx) to Receiver (Rx) Antenna. The WARR data converts the P-Scan time-stamps into depths in metres.
Stare	A stationary scan where data collected with both antennae pointing the ground.
WARR	Wide Angle Reflection and Refraction scan to triangulate subsurface depths from the surface ground level. The Transmitting Antenna is moved at ground level along the scan line, away from the stationary Receiving Antenna which is fixed to the start of the scan line. Collected by ADR Scanner at ground level (that produces depth calculations).
Weighted Mean Frequency	The frequency and energy values are combined to produce a Weighted Mean Frequency for each measured depth interval. WMF is a product of the sum of the frequencies, times the energy, divided by the total energy over all frequencies. Therefore, frequency values with a high weight contribute more to the WMF than frequency values with a low weight.

PURPOSE

To demonstrate significant improvements in Adrok's sulphide exploration capabilities by trialling new sulfide discrimination results and methodology.

GOALS

To prove that Adrok can accurately locate sulphide mineralisation regardless of the host rock type.

OBJECTIVES

Demonstrate the usefulness of the ADR technique for targeting sulfides in order to speed up and reduce cost of exploration drilling

How are we measuring success?

- Do the ADR targets correspond to the documented zone of mineralisation?
- Are the results useful for other sulfide-exploration/targeting projects?
- Internally - Can Adrok reliably identify sulphide mineralisation regardless of host rock across multiple project sites?
- Externally – Develop a targeting technique that advances mineral exploration with confidence and supported by real-world case study results.

PROJECT BACKGROUND

The current project follows on from the previous results, however, the results presented address a very different, but somewhat more complex issue, that of being able to pinpoint sulfides (undefined) in an ADR scan regardless of the site location and host rock composition and using the correlation criteria already developed for other sites.

How did Adrok arrive at a set of criteria? In theory, many scans collected over a variety of rock and containing a variety of sulfide abundances should have at least one, if not more, geophysical responses in common relating the presence of sulfides. The host rocks can be considered as "noise". After the processing of many scans, Adrok have been able to virtually see past this noise and extract the components that are responding to the sulfides only. Accordingly, the research and analysis was carried out with the goal of determining what characterises in a scan can be used to help confirm the presence of sulfides.

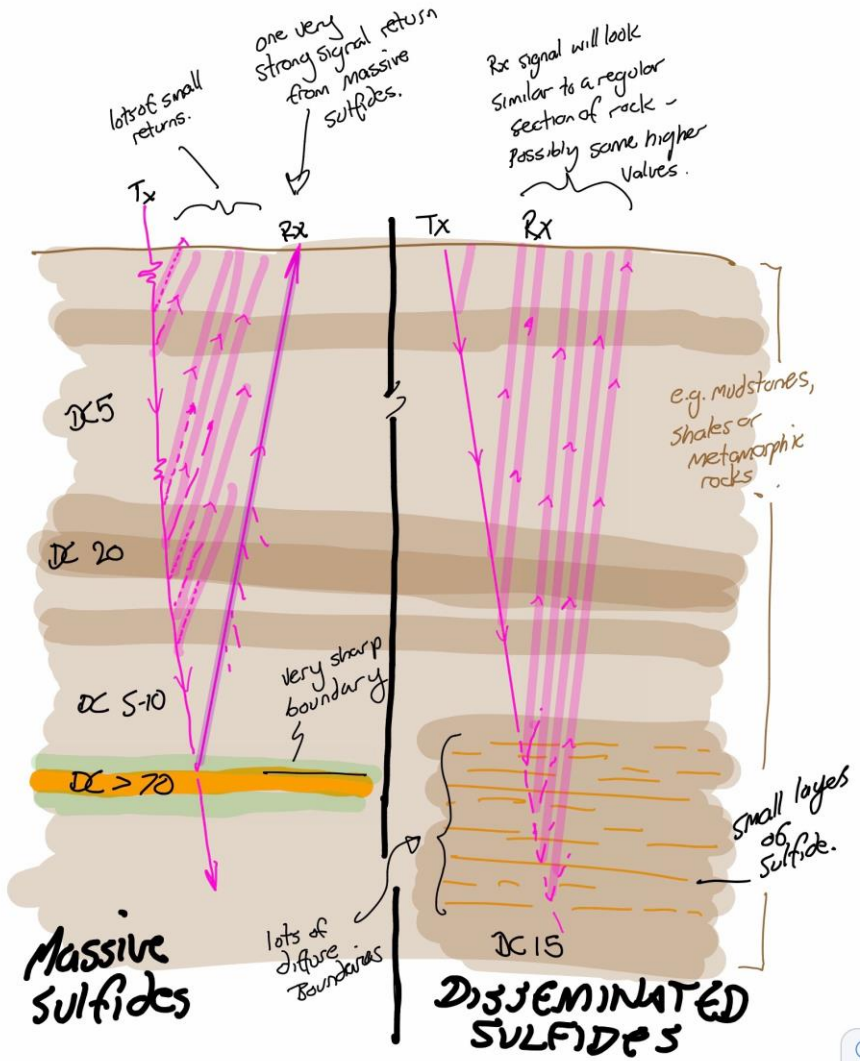
The following research also differs from some previous successful projects by Adrok targeting narrow vein gold and sulfide deposits. For cases exhibiting narrow vein sulfides, the response appears to be universal across projects whereby a strong reflection (low value) in Energy % Log typically indicates a strong return signal off the generally sharp contact between the host rocks (meta-sediments or granites for example) and the sulfides (such as galena, sphalerite, pyrite or chalcopyrite). In narrow vein deposits, the sulfides tend to be only m's thick but occur as massive sulfides.

The technique used here is a slightly different in that the target is high-grade disseminated sulfides such as might be found in VHMS-, Porphyry- or SEDEX-type deposits. Sulfide content (e.g. pyrite, chalcopyrite, sphalerite, galena) might reach high abundance (up to 80%) but typically the sulfide abundance is around 50% and grades (for the scans we had available) at or just below mine grade for copper, lead and zinc for example.

Regardless of the grade, a high abundance of sulfides should be detectable using ADR. Using results from parallel diamond drill holes from around the world, Adrok have been able to come up with a set of criteria that consistently provides target areas based on a qualitative Weights of Evidence (WofE) type analysis.

Narrow vein v's Disseminated sulfides

Two very different targets, two very different approaches



PROCESSING

How do the current processing and analysis techniques differ from the previous processing and results presented in 2018?

Previous processing was focussed on delineating rock types (including possible sulfides) and stratigraphic boundaries between major rock type groups. During the previous data collection and processing campaign, sulfide-bearing zones were treated as a lithology and therefore included in full-scan processing and fingerprinting. The aim for both sites (H1-PUR and H2-162) was, therefore, to extract the geophysical fingerprint of the different rock units using a training scan and then, using the training scan results, follow the signature of the particular rock types between the different scans. The anticipated result from this processing is to generate a geophysically defined lithostratigraphy. The results from this processing could not be corroborated as the scan was some 700m away from the drill hole. This work can be accessed at https://adrokgroup.com/case-studies/together-we-rock-vol-4/07-finland/finland-1.html

The aim of this project differs in that the emphasis has been placed on extracting the geophysical response of just the sulfide component regardless of the number or types of rocks in which they are contained.

At this point in time, Adrok have not yet applied evaluation metrics to the individual and collective datasets, instead, each positive response are given equal value. For the scan "H3 ORE" no specific frequency processing was carried out as it was found based on the positive results, that it wasn't necessary. This can be completed at a later stage if required by FQM.

Adrok are confident that, based on the results from across many projects from around the world, that the processing and practical-based targeting criteria devised are a significant advance in geophysical targeting for sulfides.

SELECTION CRITERIA (HARMONIC DATA) OVERVIEW

Adrok resolves a multitude of results for both Energy and Frequency. The sulfide selection uses a similar process as the well-documented Weights of Evidence method. Weights of evidence (WOE) is an approach familiar to geoscientists based on Bayes rule for combining data to predict occurrence of events. The effect of this condition is the decrease of a multitude of landslide-related variables on a map to “a pattern of a few discrete states” (Bonham-Carter 1994). An example is provided below. Adrok have defined the criteria it uses as positive evidence, therefore, the highest number of correlations across multiple results defines the zone with the highest WofE for sulfides. Instead of bitmaps, Adrok uses point-depth data obtained from its ADR scan.

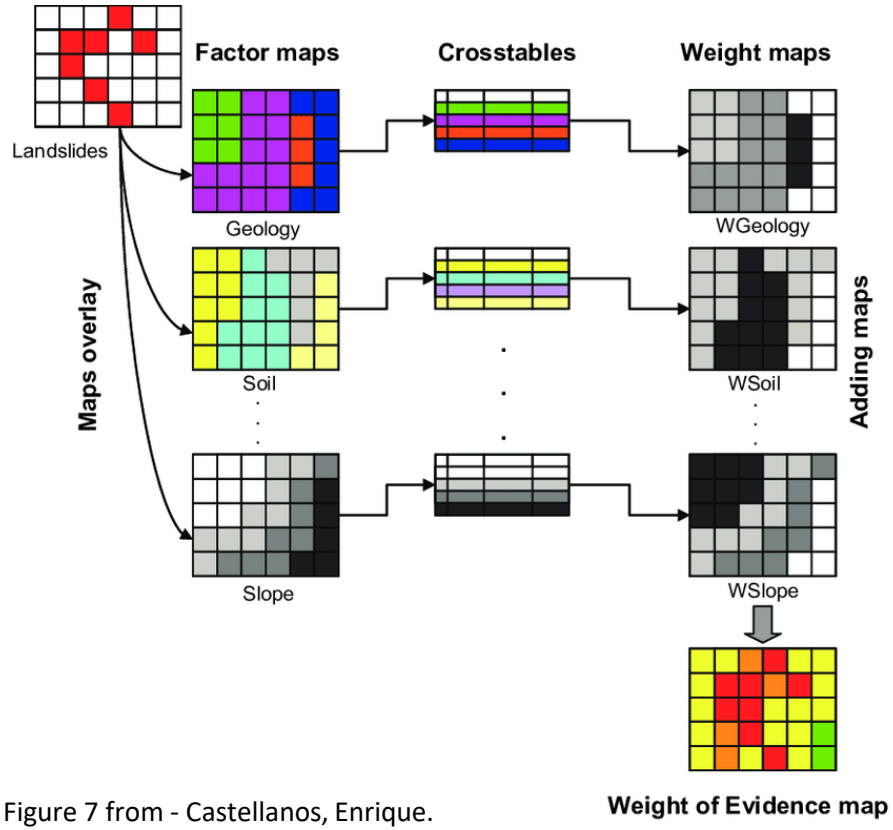


Figure 7 from - Castellanos, Enrique. (2008). CH 05 Provincial landslide risk assessment.

CORRELATION CRITERIA SUMMARY

F-Charts

Low F-Gamma
High F-ADR
High F-SD
(high F-Mean)

E-Charts

High E-Mean
Low E-Log
High E-SD
E-ADR (high &/or Low)

F-Corr charts

Peak in 5-10 MHz + no peak in 1-5MHz (intensity of peak corresponding to % sulfides

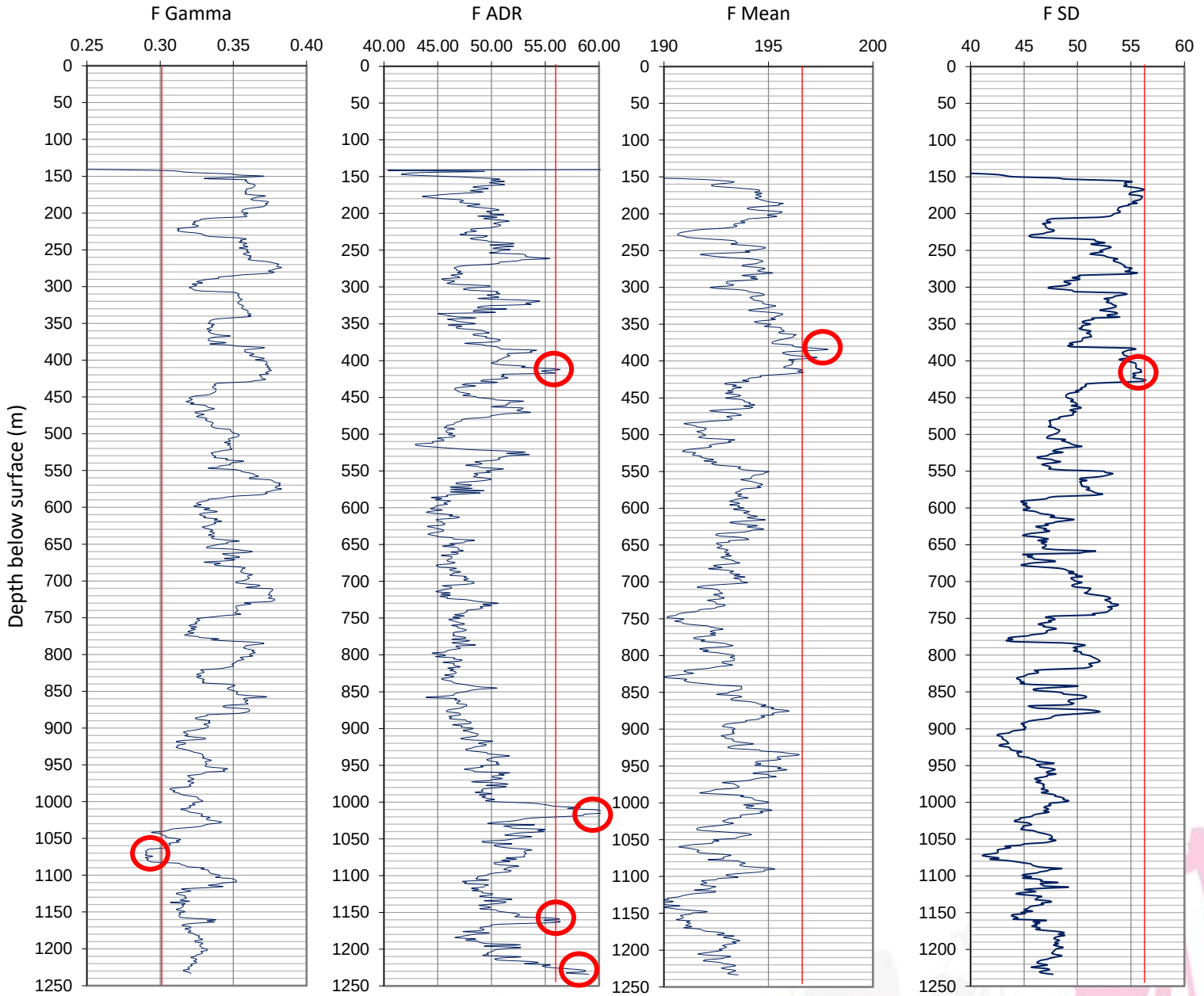
DC (Dielectrics)

Change from high variability from SD to low variability.

CURRENT CRITERIA – correlation criteria (Adrok's WofE criteria) were determined using other scan results where sulfides were present (i.e. training). The list (shown right) is a "running final" and requires further testing at other sites but so far is proving extremely successful.

Site "H3 ORE" was selected by Adrok as a test site for these criteria.

Adrok are currently working on quantifying values for each criteria which will allow an even more definitive response to be gained.



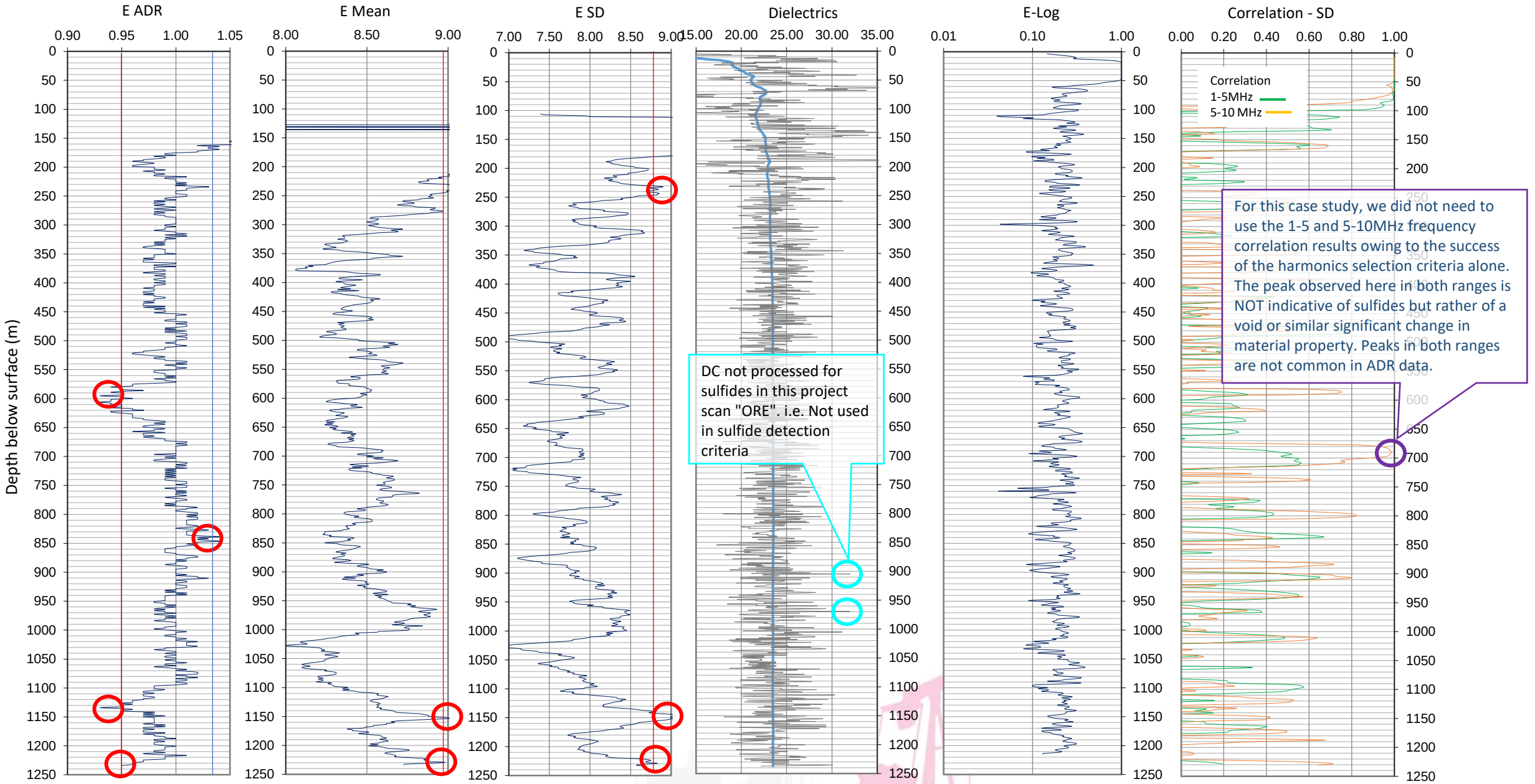
NEW RESULTS FROM PROCESSING SCAN "H3 ORE" Sulfide-only targeting

The following results (2-pages with 10 charts) are Adrok's standard processing datasets. Peaks and troughs in each correspond with different material responses to the pulse frequency(s) used. E- and F-results are processing harmonics while DC, E%'-log and 1-5 and 5-10 MHz Frequency correlation charts provide additional information that, for this case study, was not included owing to the successful targeting using harmonics alone. A set of high and low values are selected based on the criteria outlined above. The results presented here are processed using deep settings meaning that the data was processed concentrating on depths below 200-250m. A summary is provided at the end.

○ = target anomalies based on previously defined sulfide targeting criteria. The selected targets are based on a set of conditions defined for other sulfide-bearing and non sulfide-bearing projects as described above.

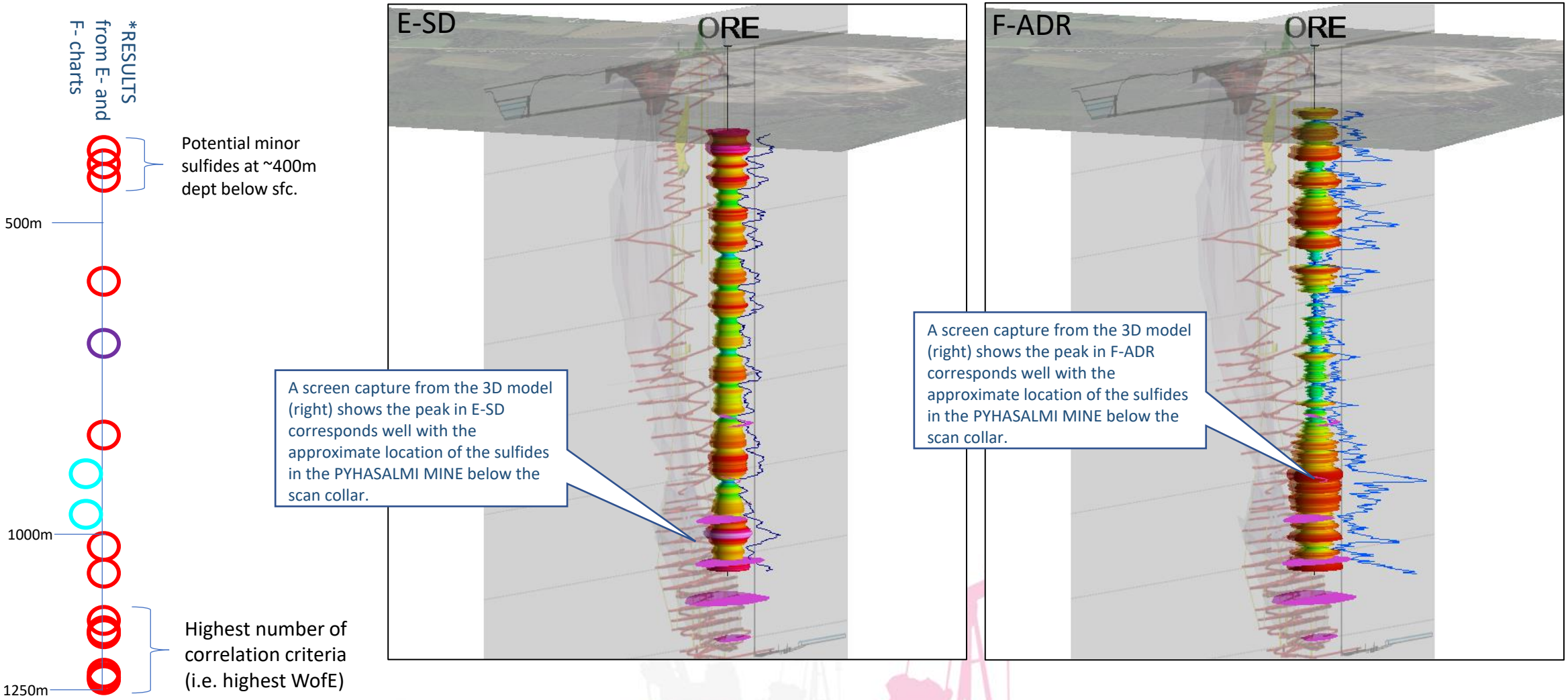
| = max and min cutoff values.

RESULTS - SCAN "H3 ORE" (interpreted)



RESULTS

The compilation or "list" of positive criteria* to the left shows a simple, graphical representation of the number of positive hits based on previous experience and the selection criteria defined for other sulfide projects. Scan H3 ORE was processed by Adrok to simply test the criteria internally, however, the positive results are reassuring that the criteria are working.



SUMMARY

- Adrok has carried out a test of its selected criteria for the delineation of sulfides at the PYHASALMI MINE using scan number H3 ORE. Adrok processed and interpreted the data and have found that the results were extremely successful. Accordingly, Adrok has pulled together this brief summary of the results in order to present some recent progress with the technique.

- If exploring for deep sulfides, Adrok is confident that the criteria used here, and at several other sites around the world where the criteria were developed, can help delineate potential targets at depth. Also based on a compilation of results, the depth of exploration is best suited between 200m and 1200m depending on the host rock types.

- The technique developed here is specifically aimed at avoiding the necessity for a trial scan so, while useful for examining the background "noise", a parallel training drill hole may not be required.

- The portability, speed and significantly reduced cost when compared with exploratory drilling means that the process presented here is a viable option for other exploration sites.

- We hope that the results are exciting and encouraging enough to explore some genuine opportunities for sulfide targeting in the future.

End