

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

Dr. Simon Richards (previously Geophys Manager at Citigold), Adrok, srichards@adrokgroup.com
Mr. Gordon Stove, Adrok – gstove@adrokgroup.com

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ADR (Atomic Dielectric Resonance) TECHNIQUE



BACKGROUND

In September of 2013, Adrok was contracted by Citigold Ltd, an Australian, public listed gold mining company, to carry out a test of their Atomic Dielectric Resonance geophysical technique on the Charters Towers narrow vein gold deposit. At the time the experiment took place, Citigold was undertaking a test of multiple geophysical techniques in order to attempt to better "image" mineralisation in both near mine areas as well as target new areas where drilling was to commence soon after the geophysical survey results were delivered.

The following document contains an outline of the results from the trial using Atomic Dielectric Resonance (ADR).

The characteristics of the target deposit are important. The key aspects of the Charters Towers deposit are outlined in detail within this document in order to provide the reader with a full account of the details of the test conditions. In addition, a detailed description of associated diamond drill holes, ADR geophysical scan locations and known or unknown sub-surface geology and mineralogy are provided in order to disclose all the information pertaining to the test.

The test of the ADR method was intended to determine whether the technique could be effectively used to pinpoint areas of high-grade gold and sulfide mineralization from the surface and prior to drilling.

The ADR technique is designed to provide additional information about the sub-surface geology prior to committing high-risk and costly drill holes. The technique does not replace drilling, rather, it will allow more precise drilling to be completed by helping narrow down the location of target sulfides.

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



NOT ALL DEPOSITS ARE THE SAME

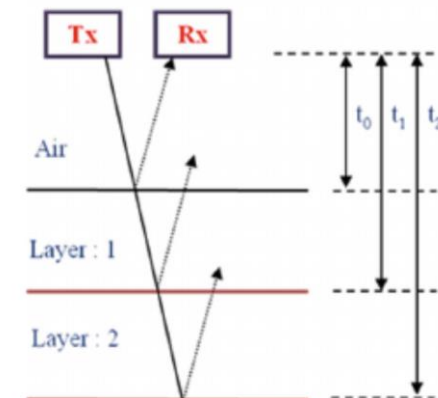
Geologists and geophysicists are aware that not all deposits are the same. Different deposits will respond to ADR differently, however, working together, Adrok and client Citigold found that the nature of the narrow vein sulfides resulted in a strong returned energy signal. Further information is outlined in detail in the following document, but a quick comparison can be made with other geophysics techniques where the reflection, and associated characteristics of an electromagnetic pulse is measured.

Ground Penetrating Radar (1-1000MHz) uses similar frequencies to the ADR tool used at Charters Towers (1-70MHz). There are, however, some fundamental differences in the technology in the transmitter and antenna but many of the physical principals for GPR are the same as those for ADR. ADR typically does NOT measure the thickness of sulfide layers at Charters Towers, simply the depth of the reflected energy (see Relative Energy (E% Log) results graphs in following document). The strong reflection coming from metal sulfides and not from any other discrepancies in the relatively homogeneous host granite.

"GPR *for example* consists of an antenna that produces short duration electromagnetic pulses that penetrate...materials. The radar pulses are reflected at interfaces where the dielectric constants of material layers change. The reflected amplitude depends on the change in dielectric constant, while the arrival time of a reflected wave at a detector also depends on the depth at which the discontinuity is encountered. Layer material's dielectric property is used for pulse velocity and thickness calculation. "

Exert taken from:

https://www.researchgate.net/publication/318152161_Ground_Penetrating_Radar_for_Measuring_Thickness_of_an_Unbound_Layer_of_a_Pavement



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Citigold Corporation Limited
ACN 060 397 177 ABN 30 060 397 177
PO Box 10 Charters Towers QLD 4820
Telephone: 07 4787 8300
Email: mine@citigold.com

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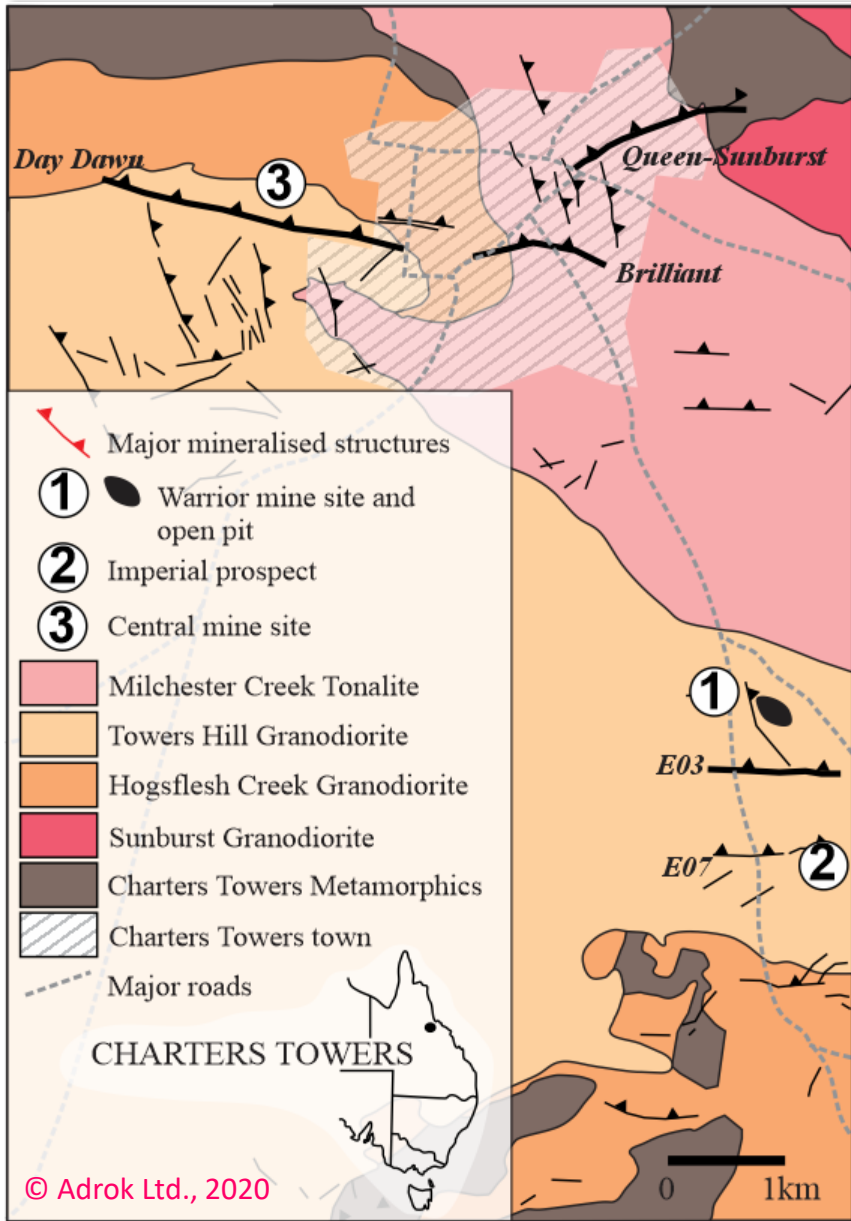
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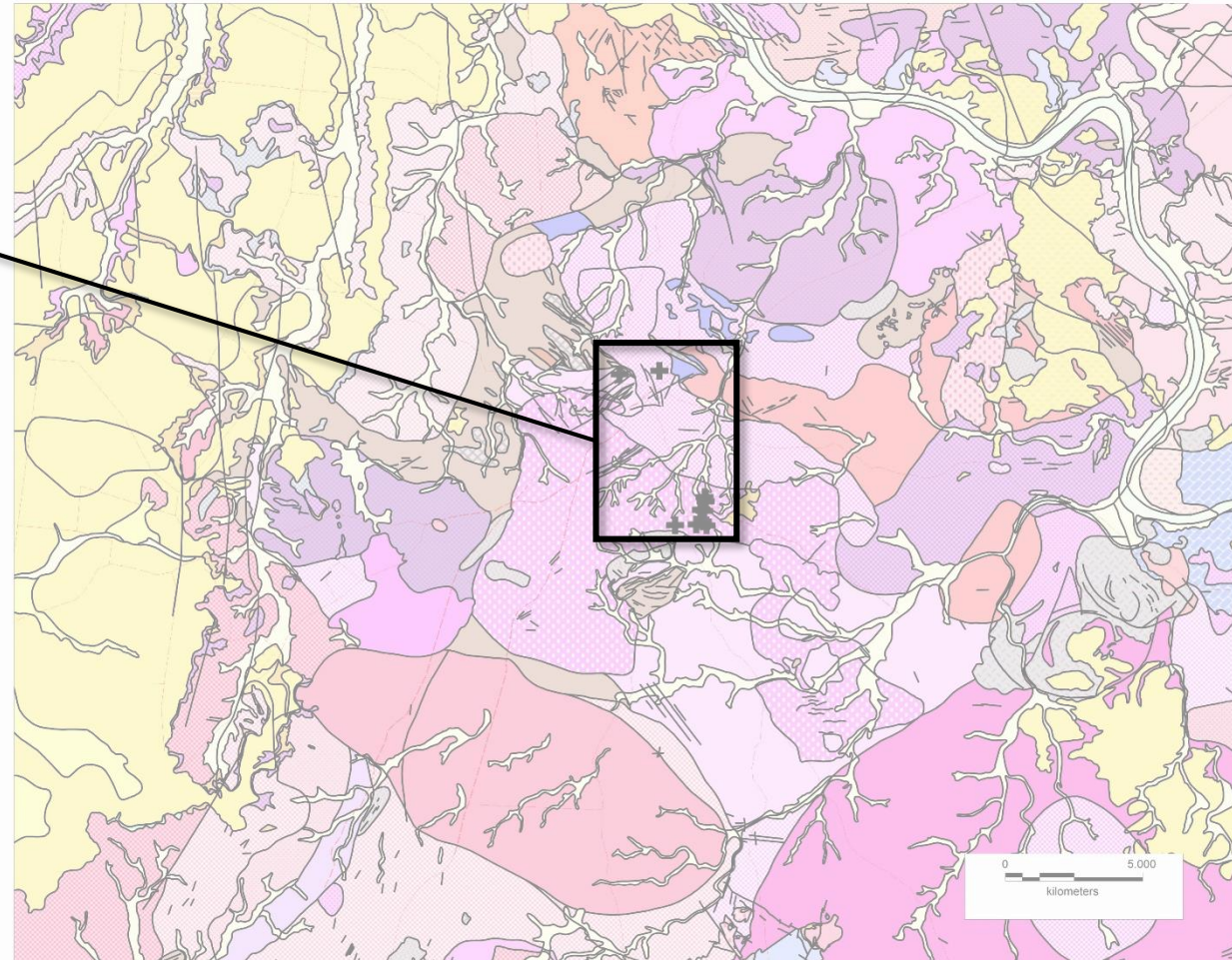
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GRANITE-DOMINATED GEOLOGY OF THE CHARTERS TOWERS AREA

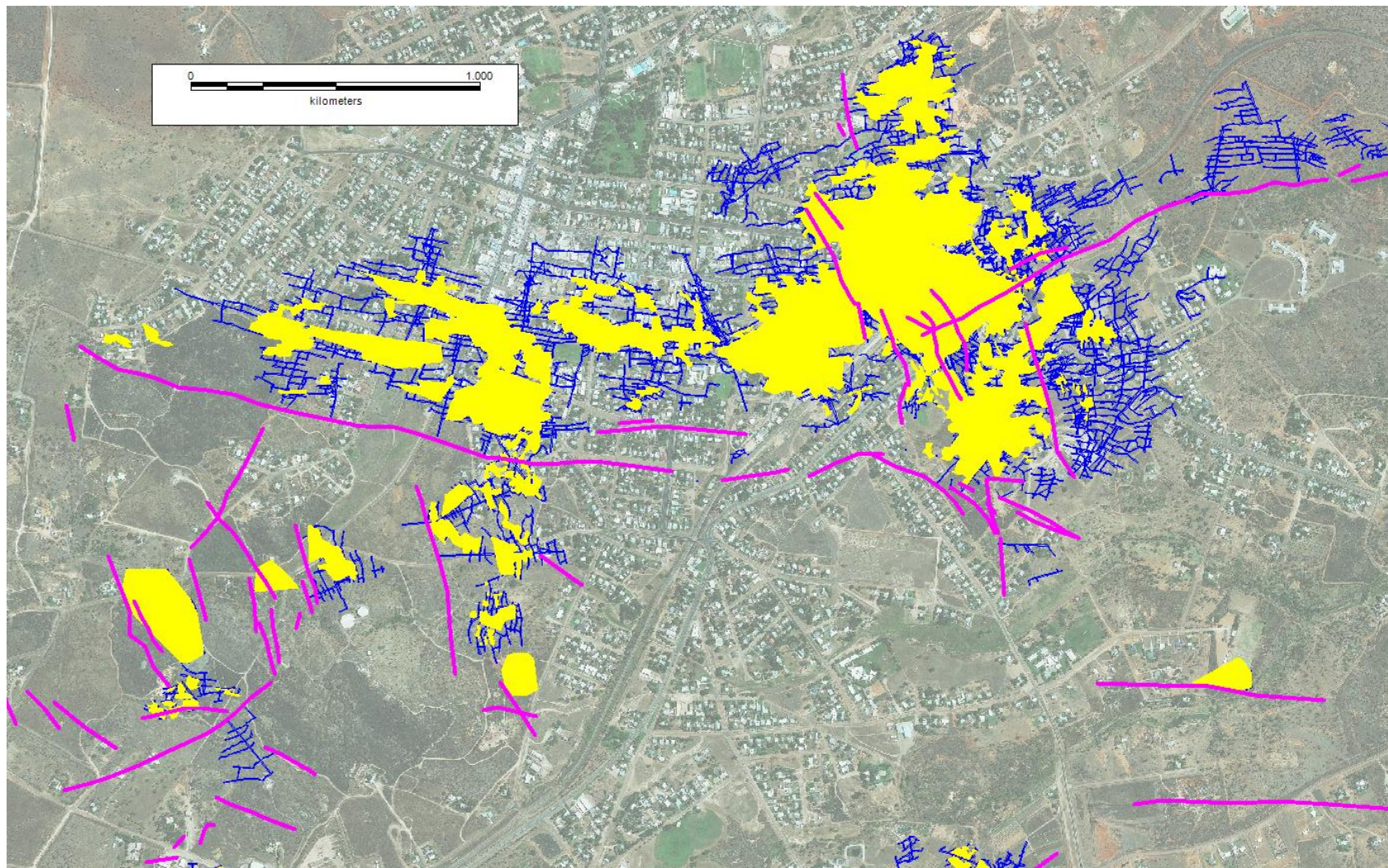


- Over 6.6 million ounces of Gold from the Charters Towers field
- Mineralisation is narrow-vein style with sulfides in fractures within granitic host rocks
- The granites within the region are relatively homogeneous but containing felsic and mafic dykes, fractures and un-mineralised faults



“PODDY” (NOT NUGGETY!) STYLE MINERALISATION

Narrow vein massive sulfide + gold mineralisation hosted by N-dipping and NE-dipping fractures

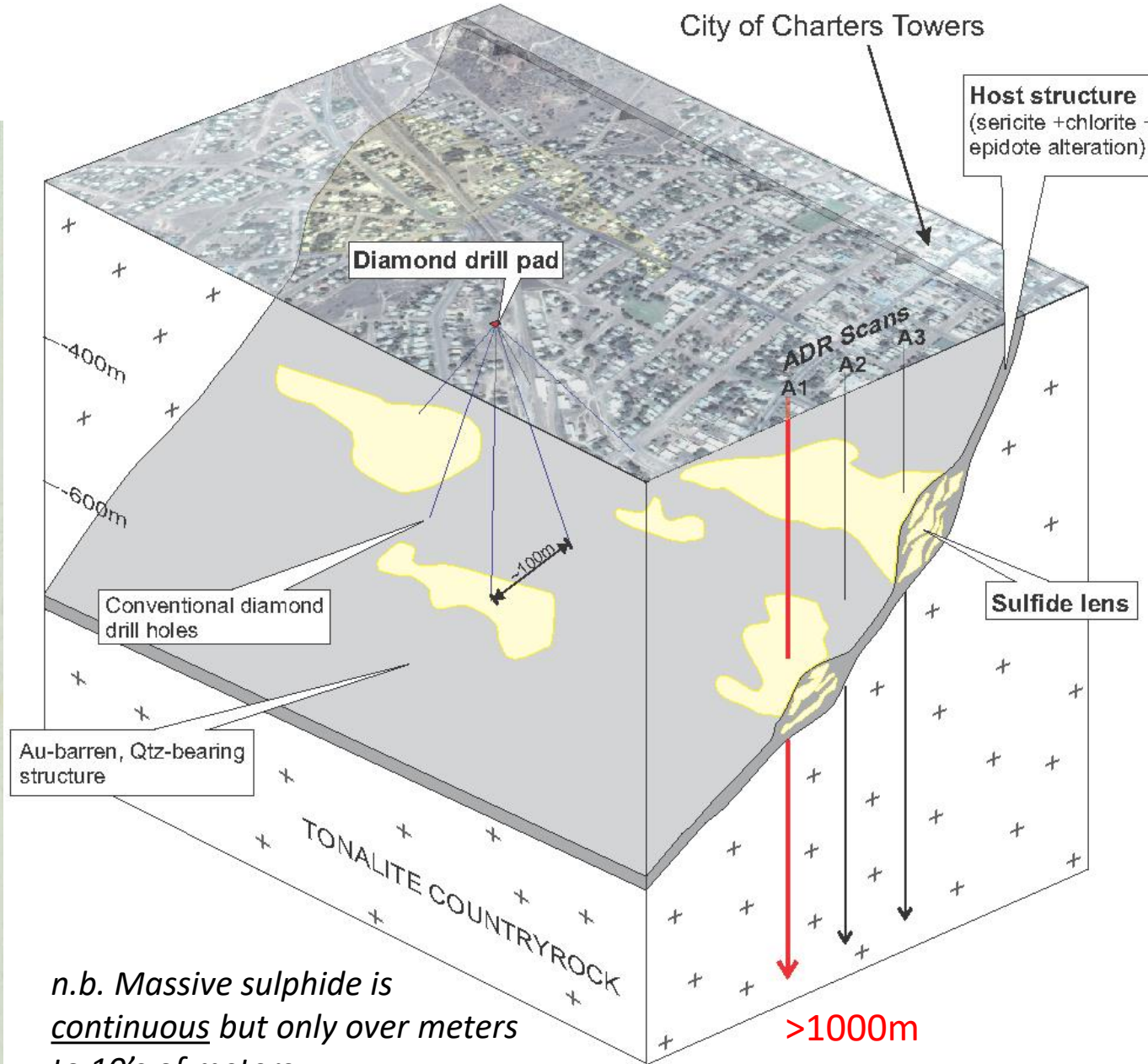


- Surface expression of fractures
- Historical development (drives, underlies etc)
- Stopes (not all high grade)

Charters Towers is a narrow vein, high grade gold deposit. The area shaded in yellow shows all the area that, based on a compilation of historical reports was mined out. While some stoped (mined) areas are not shown, many of the remaining areas (blue lines) are where mines were extended into low or no-gold producing areas. This part of Charters Towers produced over 6 million ounces of Gold over approximately 20 years before mining mostly ceased by 1914. Mining and gold discoveries were maintained by continuing underground shafts and drives until a new pod of mineralisation was found. This was unsustainable. A new method of targeting gold was and still is needed.

SCHEMATIC DIAGRAM SHOWING "PODDY" STYLE OF MINERALISATION

Homogeneous tonalite host rocks



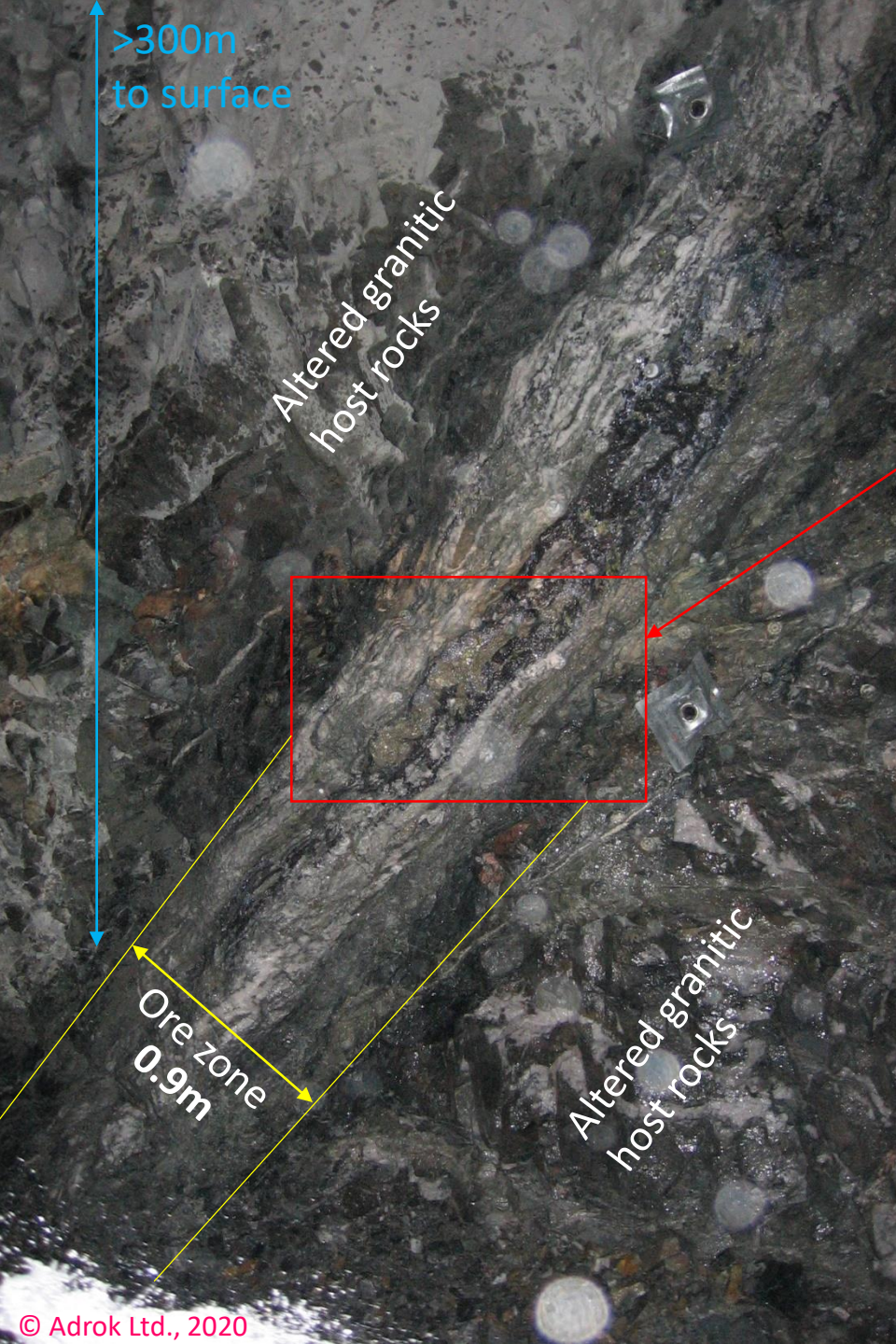
n.b. Massive sulphide is continuous but only over meters to 10's of meters

© Adrok Ltd., 2020

Massive sulfide + gold.
N.b. sharp boundary with host rocks.

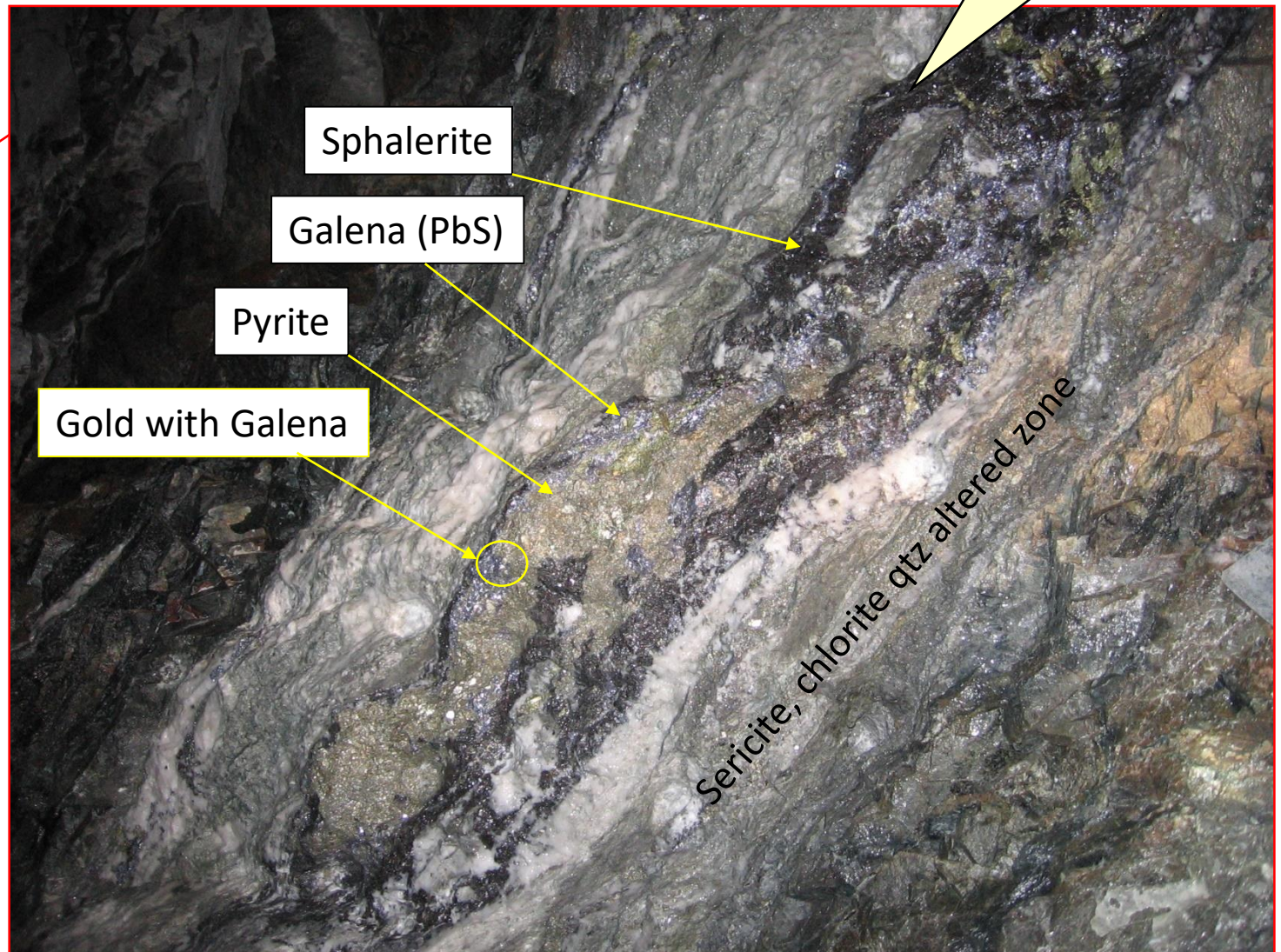


CHARTERS TOWERS ORE ZONES



Photos of the ore-zone Underground showing ne narrow-vein but massive sulfide nature of the mineralisation

Sharp (reflective) boundary between sulfides and siliceous host-rocks.

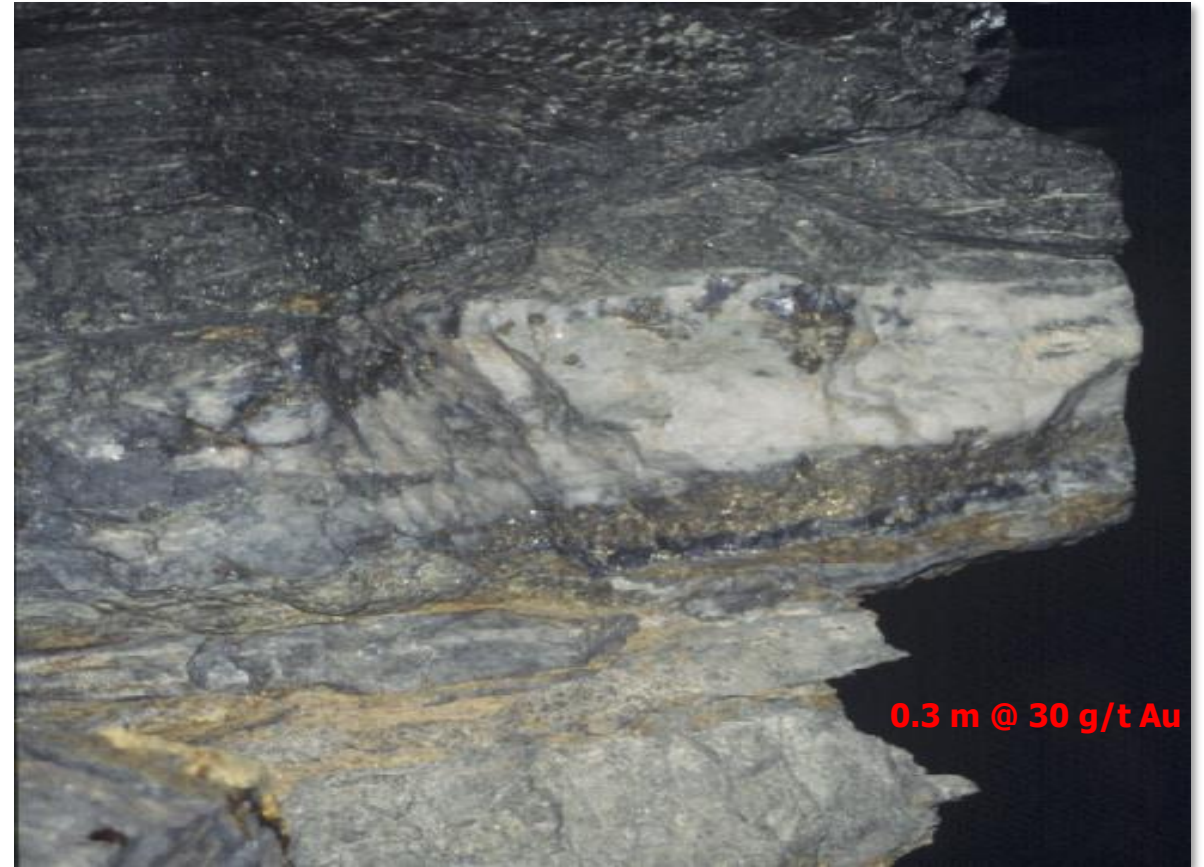


UNPREDICTABLE DISTRIBUTION OF SULFIDES – A PROBLEM FOR DRILLING

“Within-pod” grade distribution - variability in gold grade at the meter-scale. The nature of grade distribution makes traditional drilling and intercepts unreliable, regardless of drill hole spacing! Can be overcome using faster and cost-effective geophysics to pinpoint high potential regions.

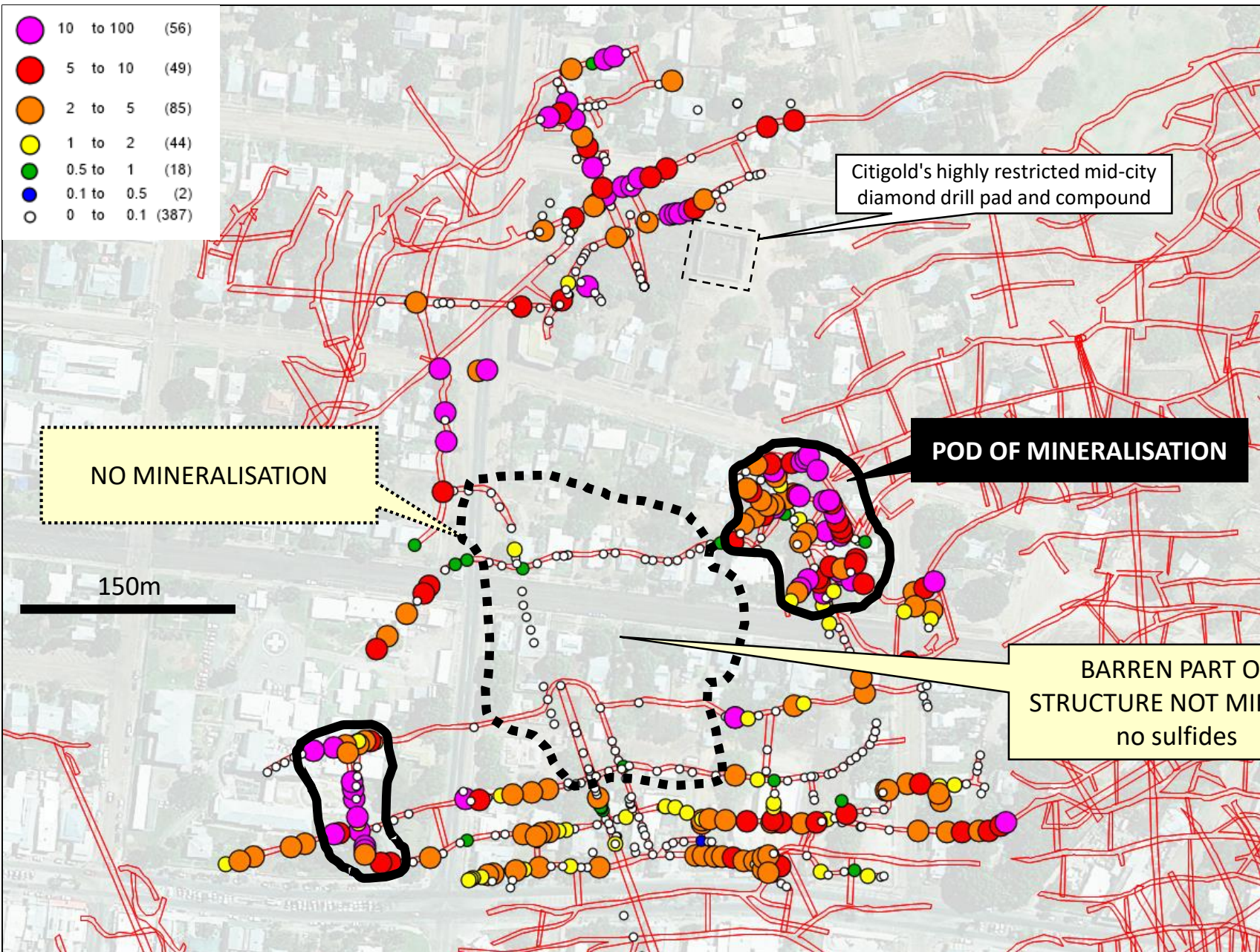


Charters Towers auriferous reef, C15 (CV2) stopes:
Low grade section.



Charters Towers auriferous reef, C15 (CV2) stopes

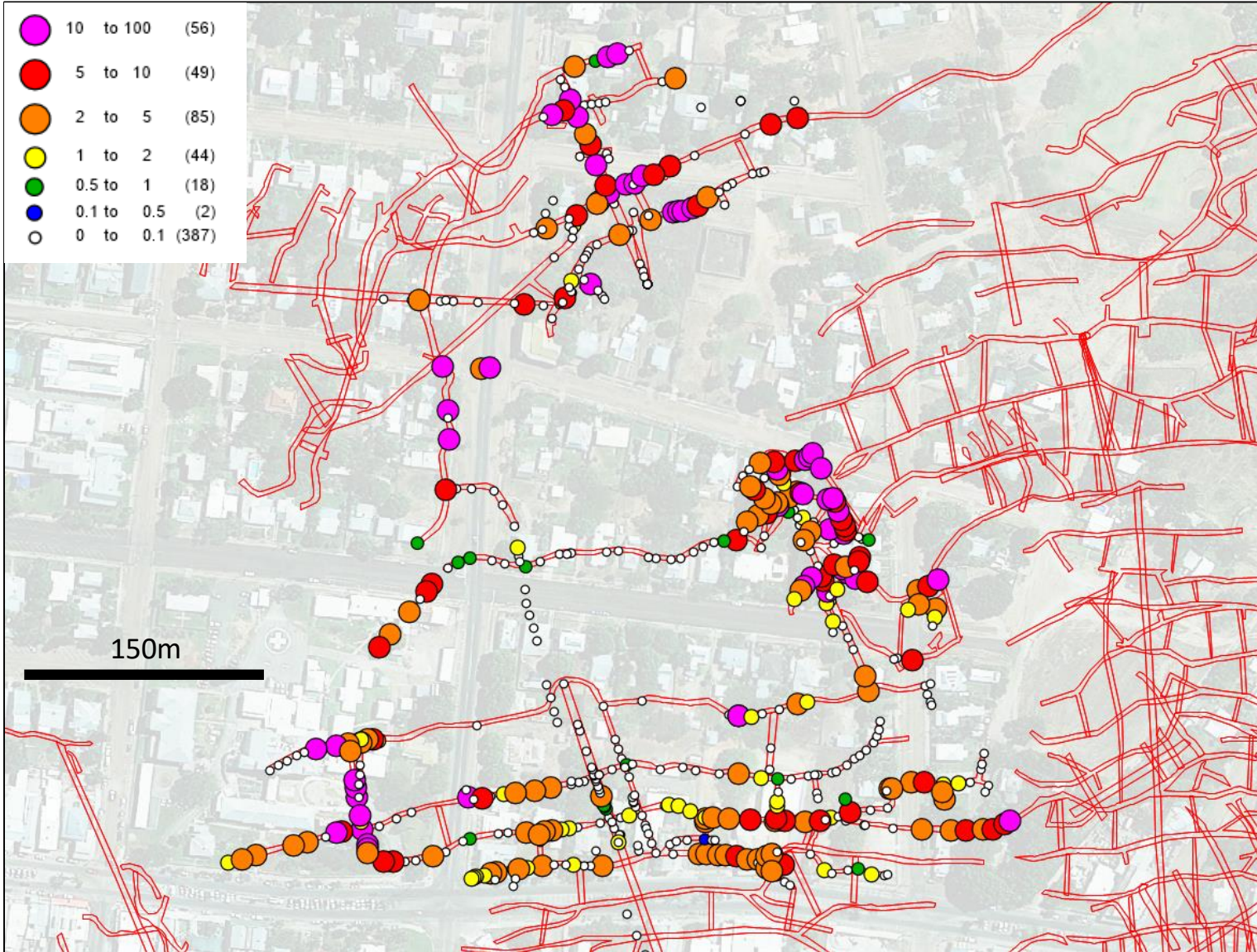
THE PROBLEM WITH DEFINING THE LOCATION OF "PODS" OF MINERALISATION



This is a map of underground workings (red lines) directly beneath the town of Charters Towers. The outline of the historical workings (here lie between 600-800m vertically beneath the surface) is overlain on the satellite photo of the region. The small, highly restricted drilling compound is labeled for reference)

Citigold's aim was to use ADR to pinpoint (from the surface and in the middle of a major country town), where the pods of sulfides were. This example shows just how variable the distribution of sulfides is, drilling, especially in the middle of a small town, is difficult, costly and most importantly, unreliable.

THE PROBLEM WITH DEFINING THE LOCATION OF "PODS" OF MINERALISATION



- Extremely irregular distribution of gold grades

- High grade “pods” are typically <100m in longest dimension.

- Grade variable on the meter-scale

- Overall grade of the Charters Towers gold field is ~27g/t Au (average from drilling) to 32.3 g/t Au (average from historical production).

Even at 25m spacing, DRILLING IS UNRELIABLE, EXPENSIVE, INACCURATE and TIME CONSUMING.

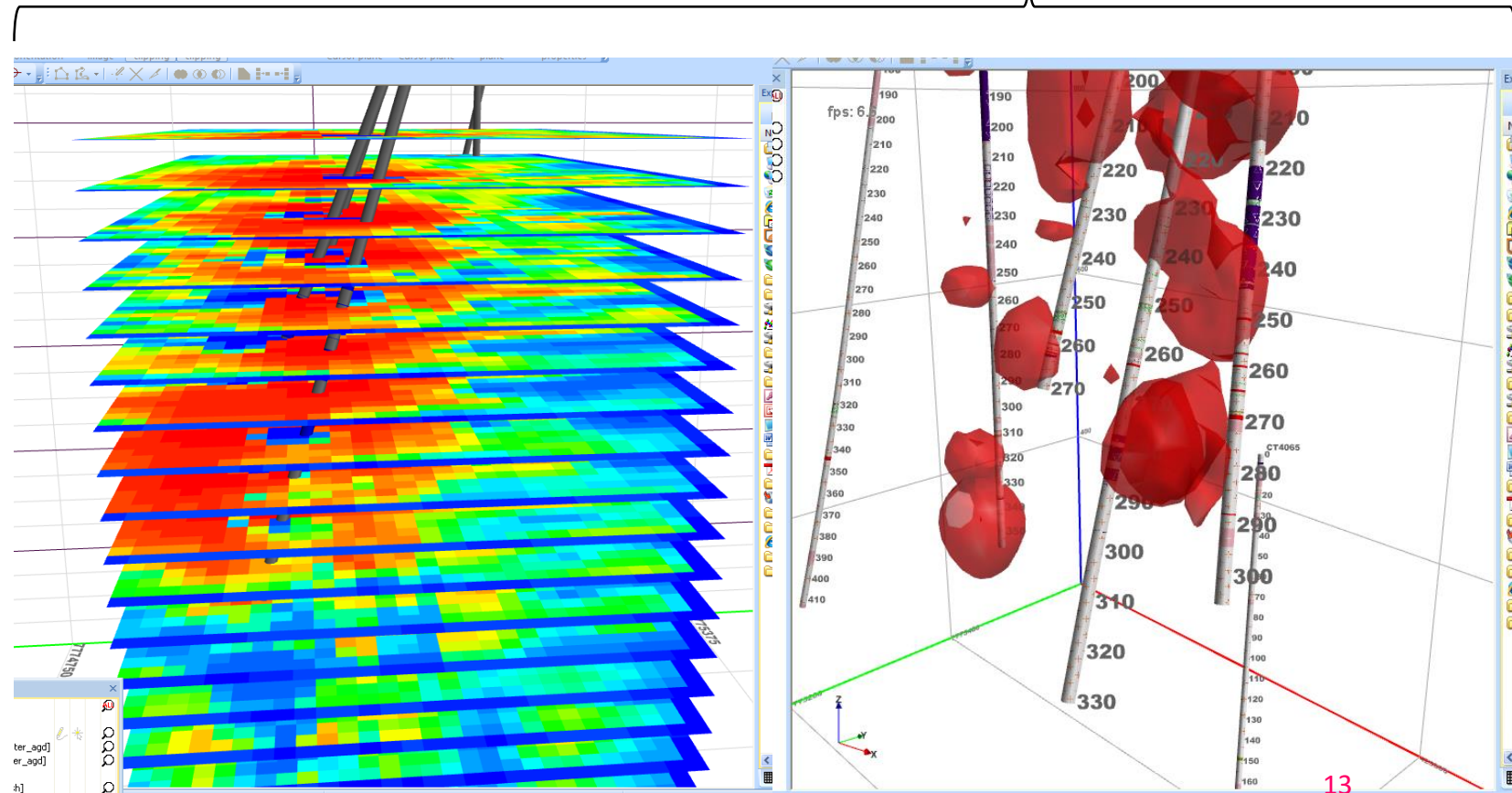
GEOPHYSICAL TECHNIQUES TRIALED BY CITIGOLD AT CHARTERS TOWERS

- Borehole radar
 - Surface magnetics
 - Surface magnetics, radiometrics & gravity processing
 - Borehole induction, mag and gamma
 - DHIP
 - Sfc TEM, borehole TEM, DCIP
 - Sfc TEM, DCIP
 - Sfc TEM
 - Regional MT and Deep Seismic
- Geoscience Australia
(government funded)

- = Requires drilling
- = Surface method

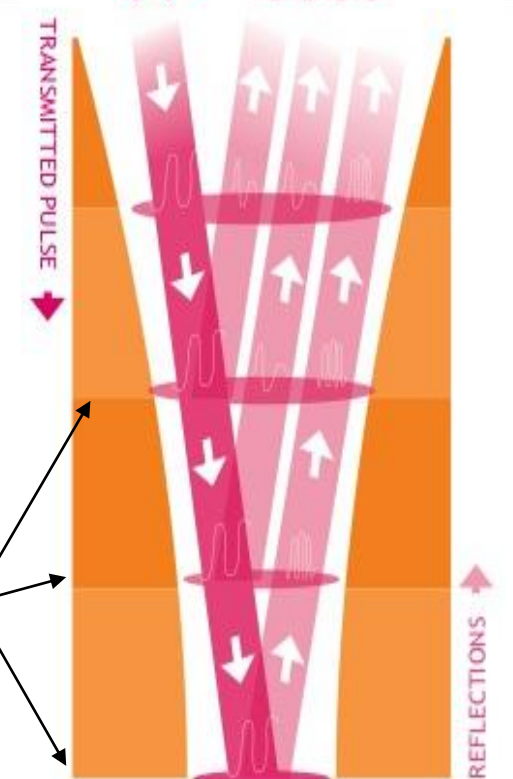
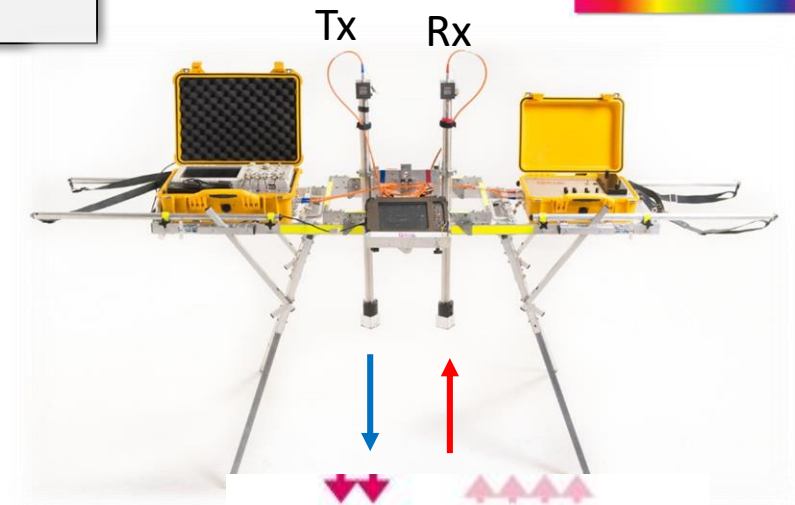
e.g. DHIP results

REQUIRES DRILLING & result = 52% anti-correlation between predicted zones of mineralisation and mineralisation present in diamond drill holes. This means, more likely to hit mineralisation if drilled off anomalies! Regardless, ~50% confidence is not enough to justify drilling.



ATOMIC DIELECTRIC RESONANCE (ADR)

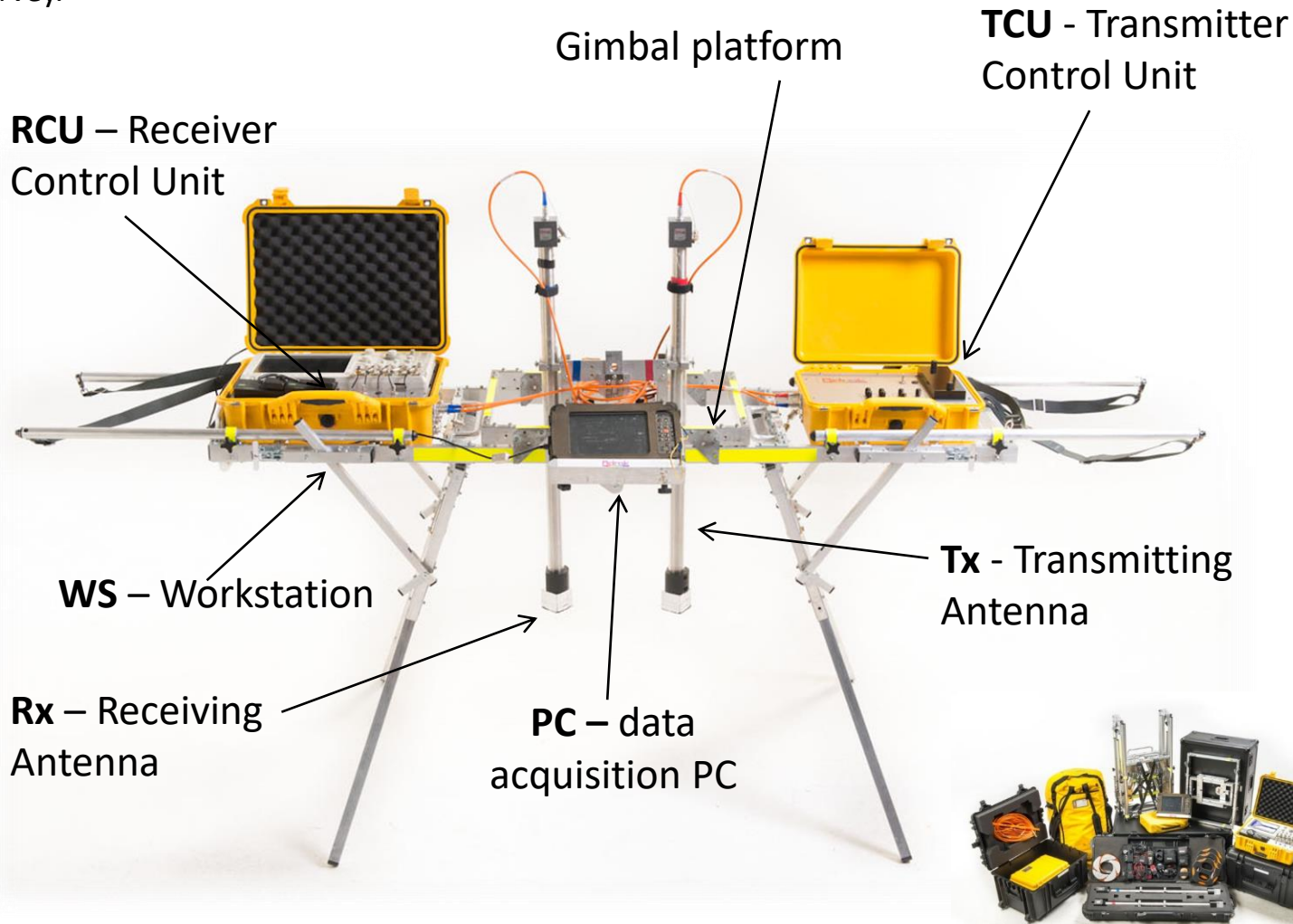
- Transmit pulsed broadband of radio waves and microwaves between 100kHz to 1GHz
- For large depth mining exploration typically transmit between 1MHz to 70MHz (similar to GPR).
- ADR sends broadband pulses into the ground and detects the modulated reflections returned from the subsurface structures.
- Reflections returned from changes in Dielectric Permittivity/Dielectric Constant of materials at depth. Recall, Charters Towers has layers of massive sulfide (fault-hosted) within a very homogeneous granite.



Sharp changes in layer DC such as a layer of massive sulfides.
Certain highly reflective layers should respond with strong reflection of energy (strength of return frequency signal)

PORTABLE AND LOW IMPACT

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.



Lab testing of samples from site



ANIMATION OF A PULSE TRAVELING THROUGH LOW DC ROCKS AND REFLECTING OFF HIGH DC WATERBODY

Dielectric Constant (DC) profile (bottom graph)

Peak in dielectric at 350m down represents a water body

Electric field animated in top graph

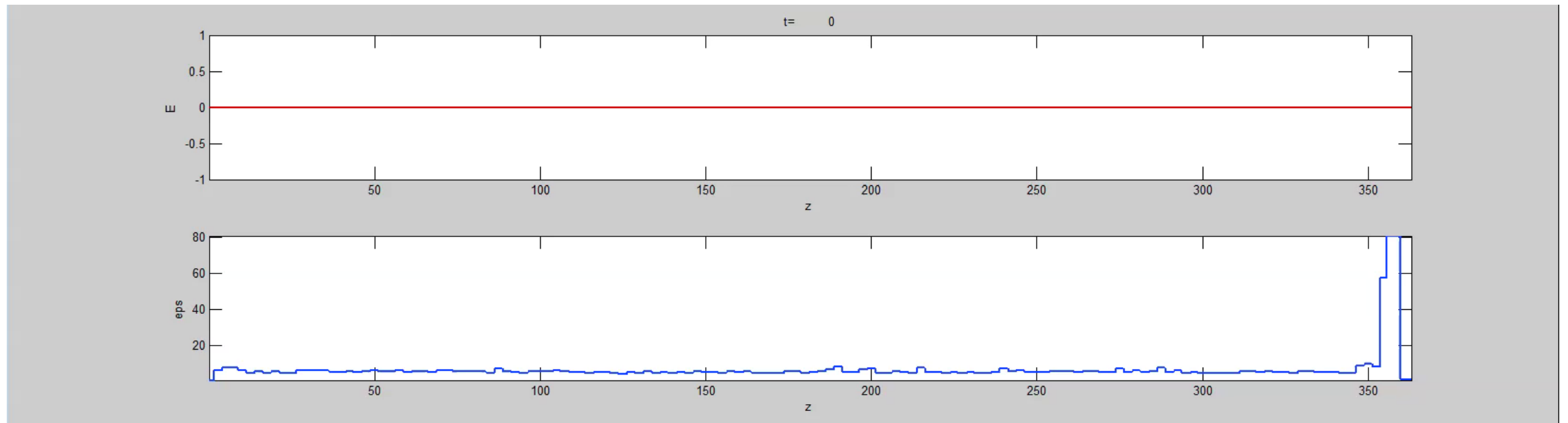
We observe pulse traveling down (left to right)

Small irregularities in DC cause backscatter

Big reflection at jump in DC propagates back to surface

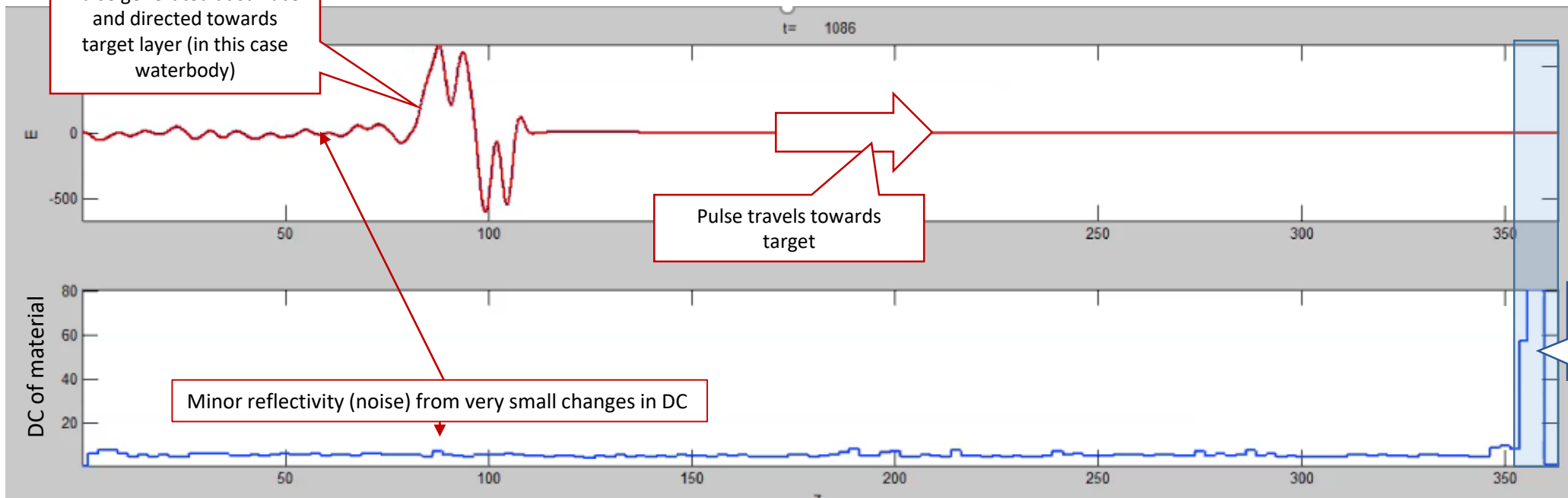
Lab measured DC of Charters Towers Rocks (CSIRO)

- **Granite av; 3 samples = 7.99 @ 1Mhz**
- **Pyrite ore; 1 sample = 73.63 @ 1Mhz**

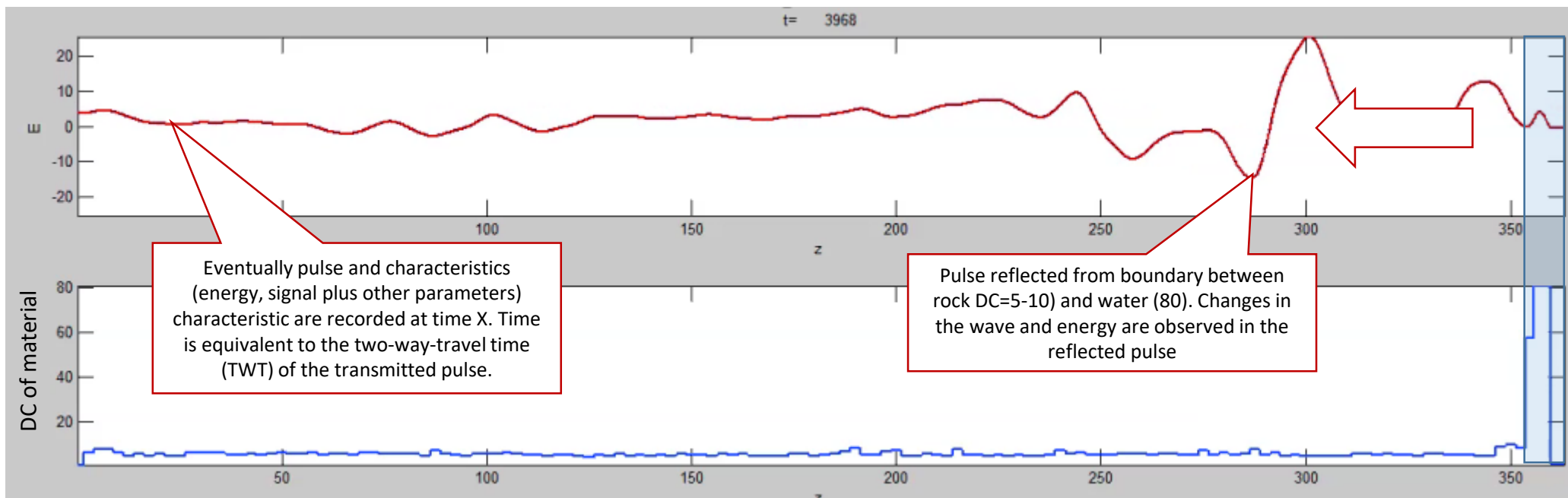


ANNOTATED SCREENSHOTS CAPTURED FROM ANIMATION

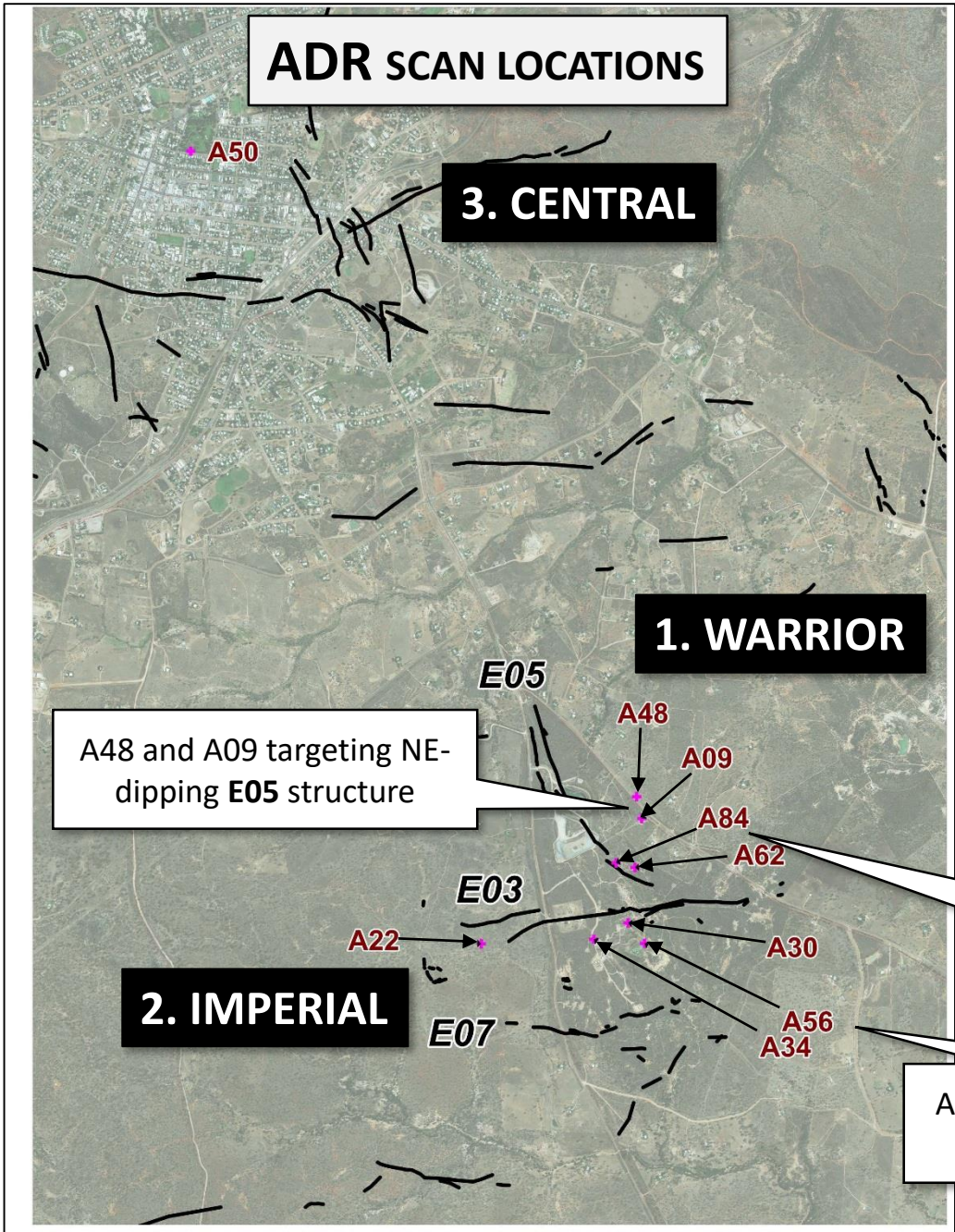
Transmission (time capture = 1086)



Reflection (time capture = 3968)



RESULTS



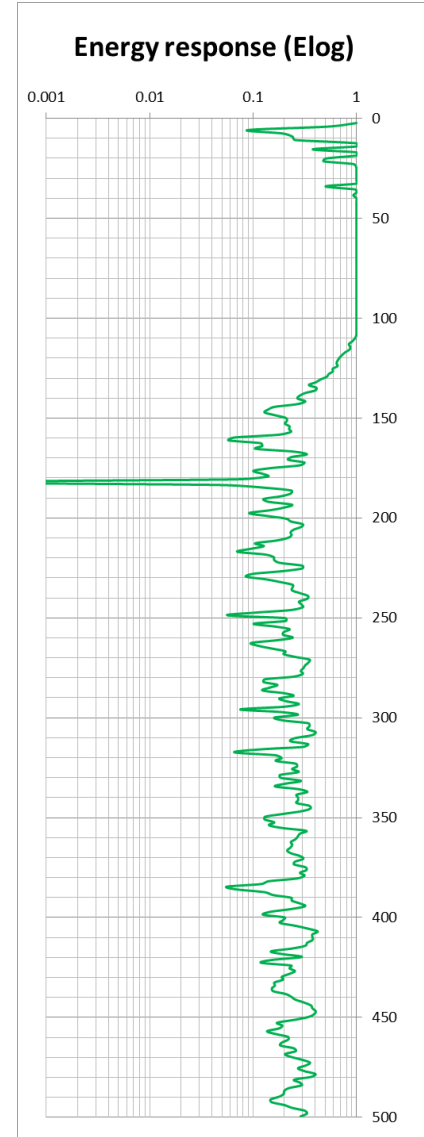
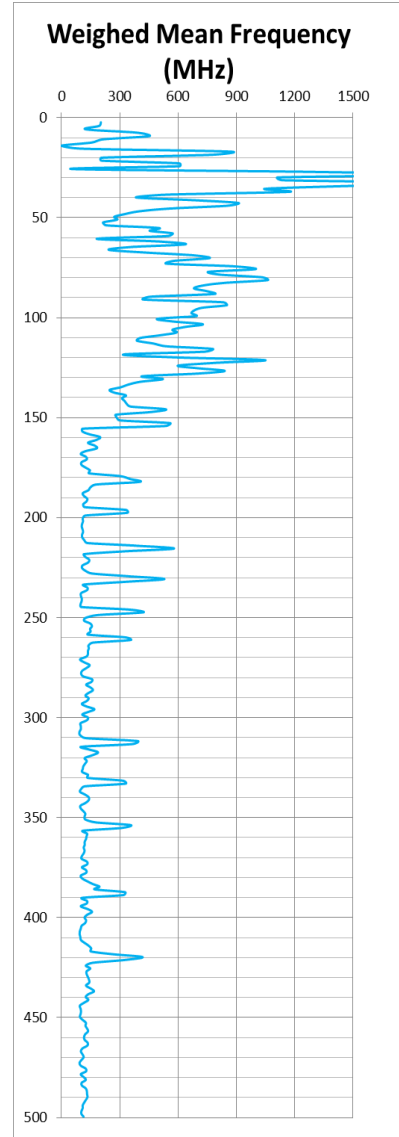
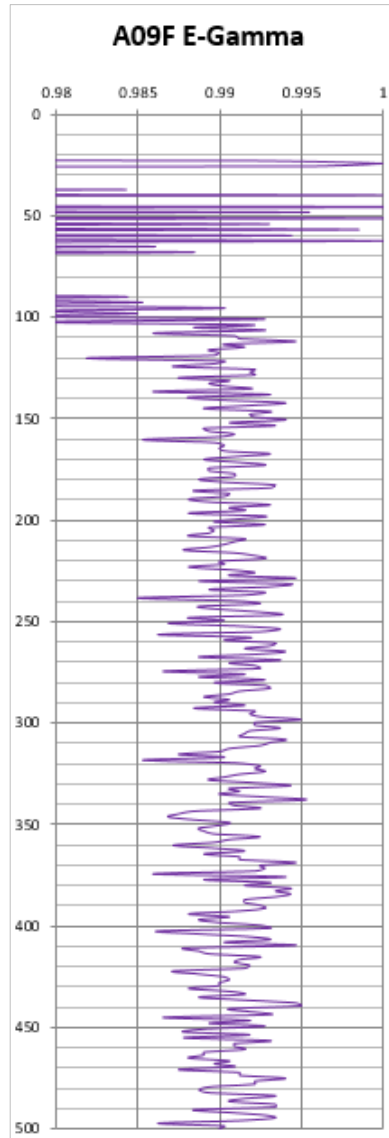
As this was a fully commercial test of the ADR technology by Citigold, only one drill core was provided to Adrok for training purposes. This allowed Adrok to establish settings and the background conditions of the survey which, for example, differs significantly from an oil-focused survey.

No further information regarding the location of sulfides was given to Adrok. Furthermore, several scans were carried (e.g. A56) out where even Citigold geologists had no knowledge of any sulfide mineralisation and where drilling was to commence AFTER the survey had been completed.

Finally, it should be explained that the target structures, while appearing superficially simple on basic maps, are complex at the tens of meters scale.

ADR RESULTS – HOW THE RESULTS ARE PRESENTED AND INTERPRETED

An example of some of the charts provided to Citigold by Adrok at the end of the processing



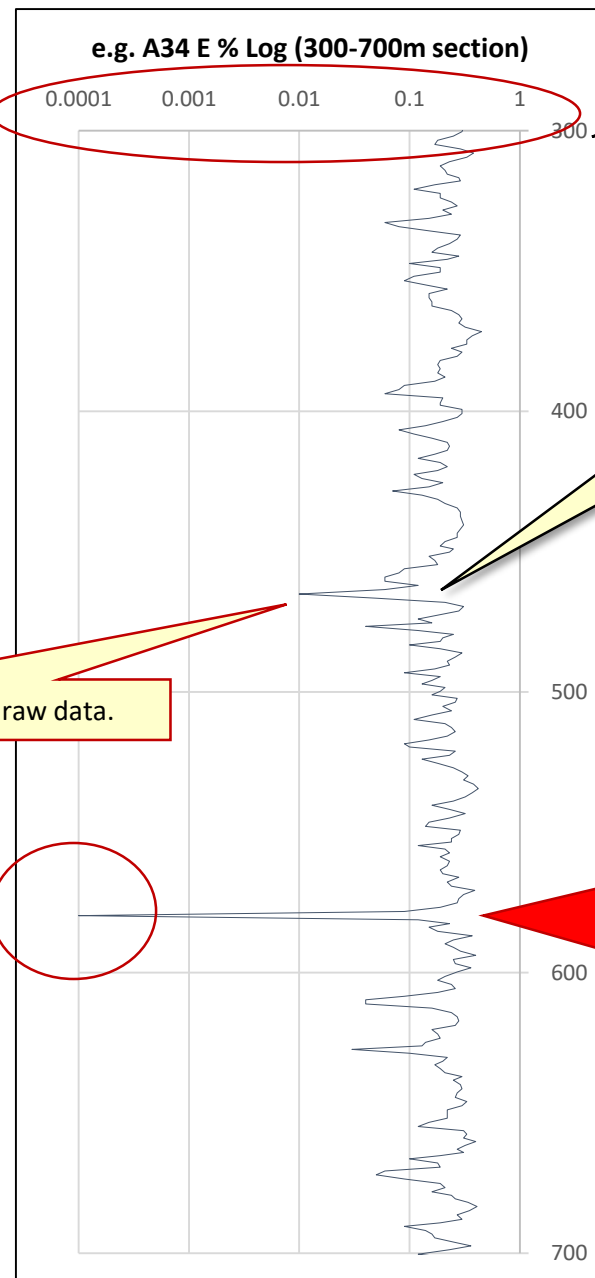
After examining the results presented by Adrok, it was determined that, as predicted by the physics, the interface between granite (DC= \sim 8) and the layer of massive sulfides (e.g, pyrite DC= $>$ 75), produced a strong reflection in the measured returned energy. Accordingly, the most useful result was the relative energy chart of which an annotated example is presented on the following page for scan A34.

Some features of the data need to be noted in order to understand the data as its presented over the page.

HOW TO READ A RELATIVE ENERGY CHART (E % Log) and what it means for sulfide potential

The X-axis plots RELATIVE ENERGY as a percentage and on a LOGARITHMIC SCALE. Accordingly, because the values are relative and scaled, the lowest value(s) will equal 0 and the highest value(s) equal to 1. HOWEVER, a value of 0 cannot be plotted on a log scale! To overcome this problem but retain the log scale, the lowest value of the series (which has been corrected to equal 0 in the processing), is assigned a value of 0.0001.

A LOW VALUE is equivalent to proportionally more energy (stronger returned/reflected signal) recorded at the receiver for that contact/boundary/change in DC.



Depth in meters below surface

At Charters Towers, 0.01 considered "anomalous and significant"

This is the second lowest value in the raw data.

In the raw data, this value will be the lowest returned energy. The "trough" is indicating a strong contrast in DC at this location/depth.

The host granite at Charters Towers is homogeneous so the major changes in DC are likely to be at the boundary with massive sulfides.

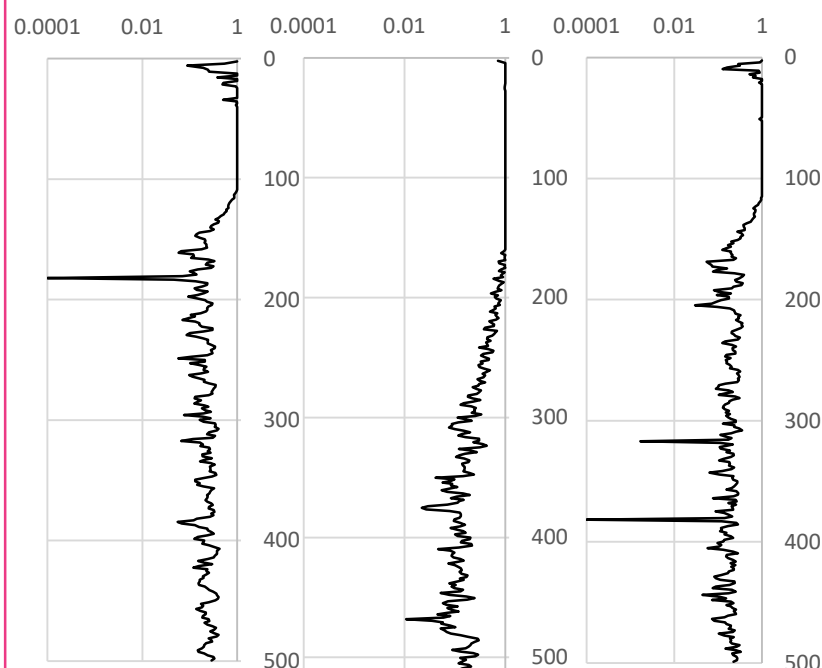
This response DOES NOT measure the thickness of the layer, simply the contact where there is a contrast between two layers with contrasting DC!

1. WARRIOR AREA – RESULTS SUMMARY

A09 ELOG

A48 ELOG

A84 ELOG



Training scan

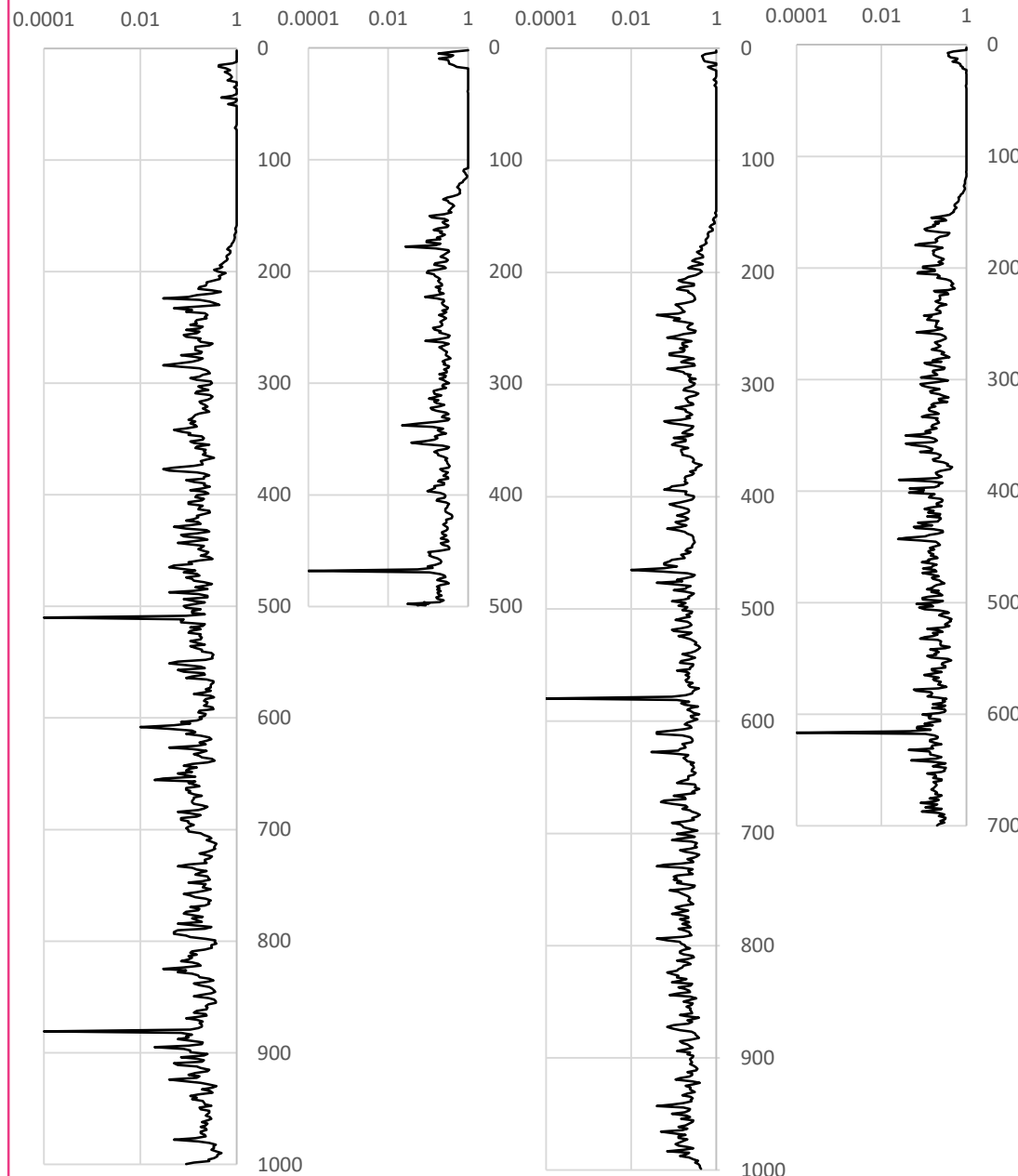
2. IMPERIAL AREA – RESULTS SUMMARY

A30 ELOG

A56 ELOG

A34 ELOG

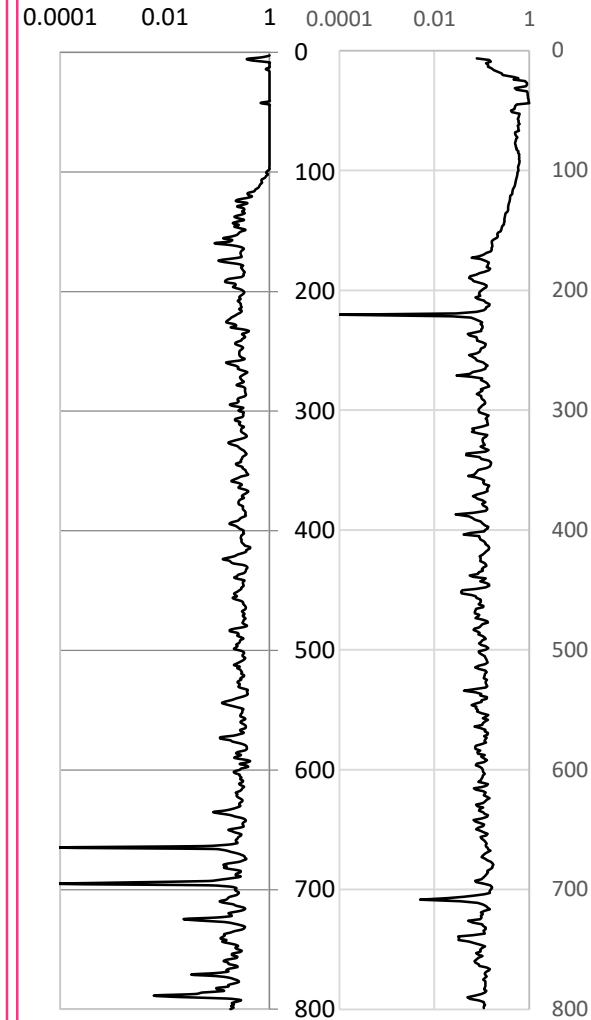
A22 ELOG



3. CENTRAL AREA – RESULTS SUMMARY

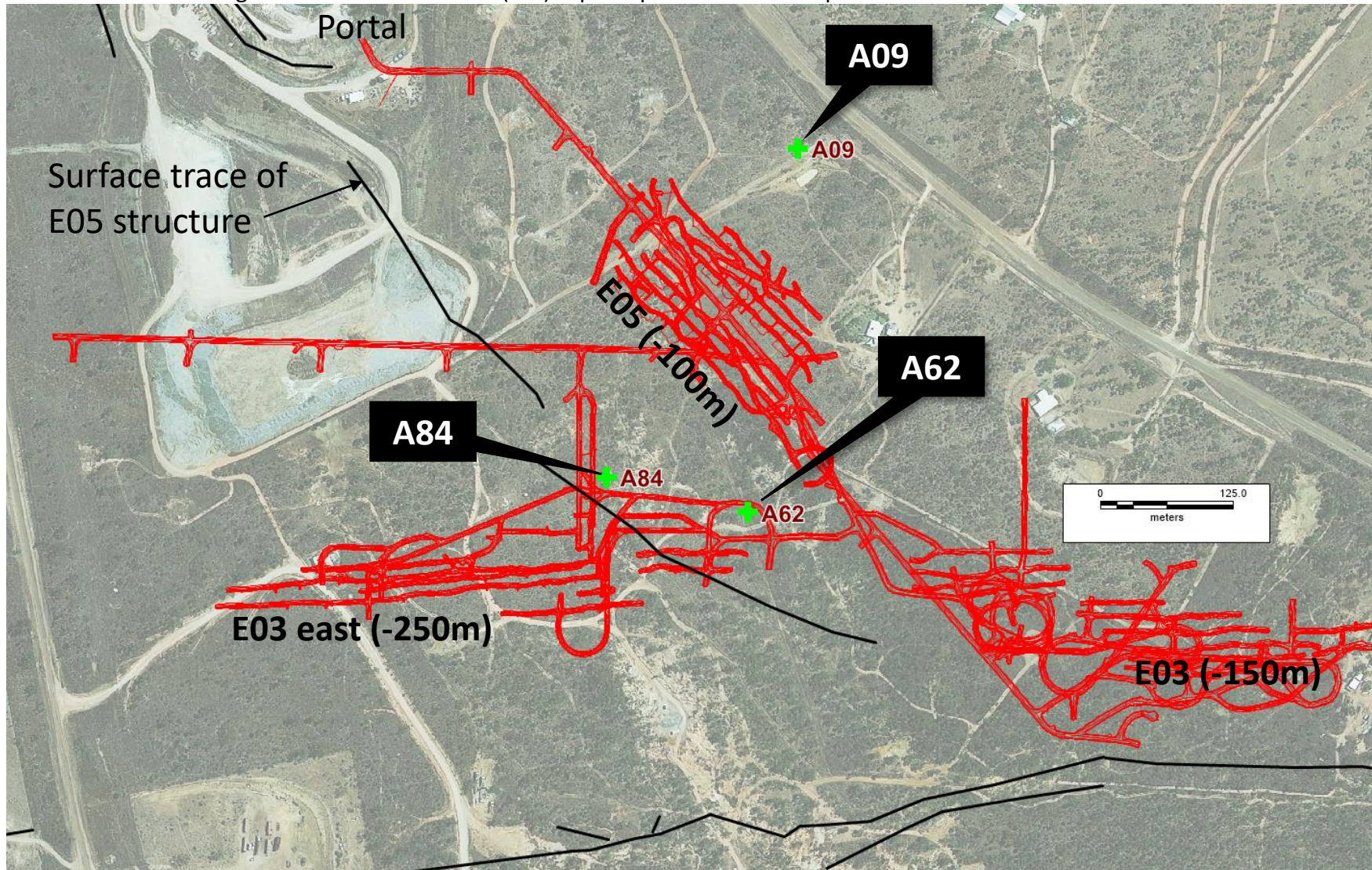
A63 Elog

A50 ELOG



1. ADR scans competed in the “WARRIOR” area

Plan view of the underground mine at WARRIOR (red) superimposed on satellite photo



- Extensive drilling around mine.
- Sulfides remaining in pillars and unstopped areas of the mine – exact location known to Citigold only.

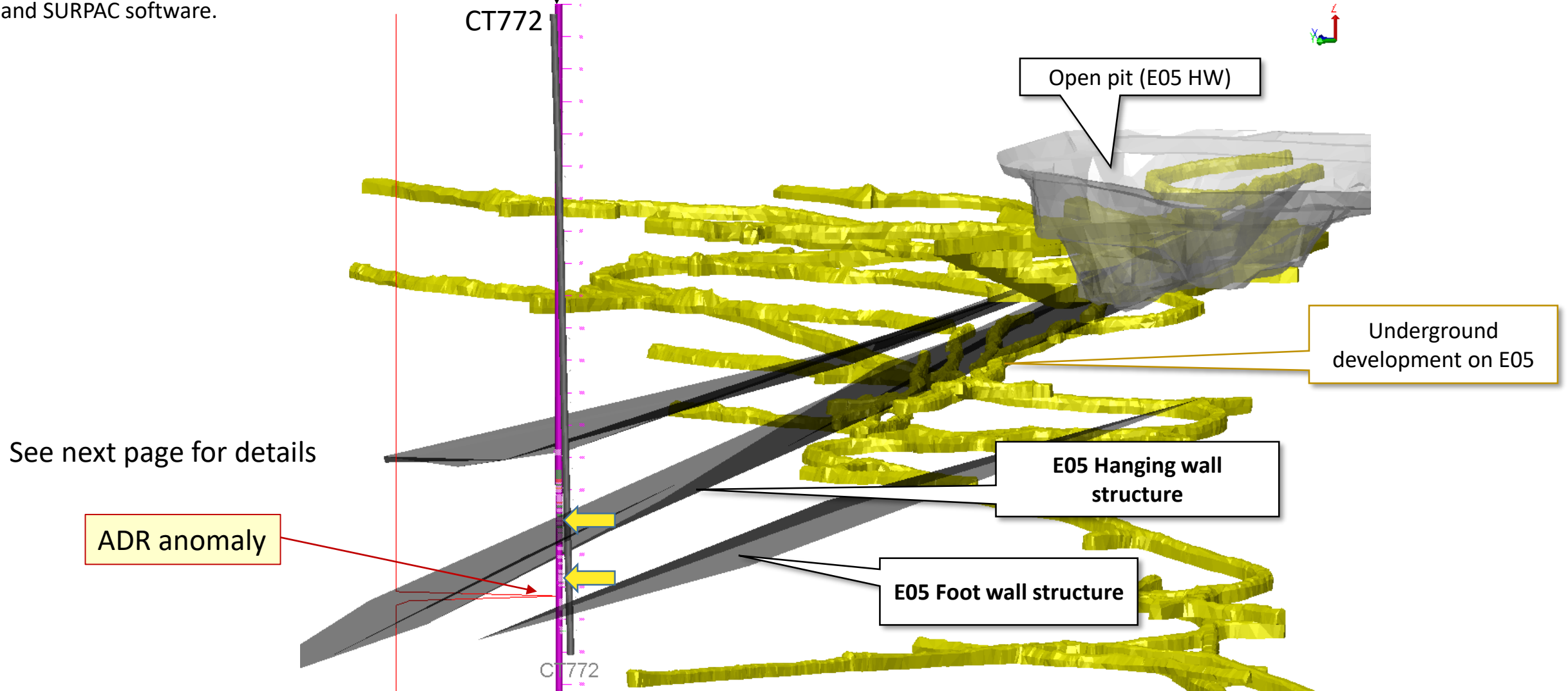
A09 – test/training scan targeting E05.

A84 and A62 – Scan targeting areas of known sulfides (A84) and inferred sulfides (A62) on the N-dipping E03 structure.

View looking to the SE*

*All 3D Mine models generated using 3DMine and SURPAC software.

A09 SCAN (purple) (collar – oblique view from 3D model without surface terrain so it appears above ground level)



See next page for details

ADR anomaly

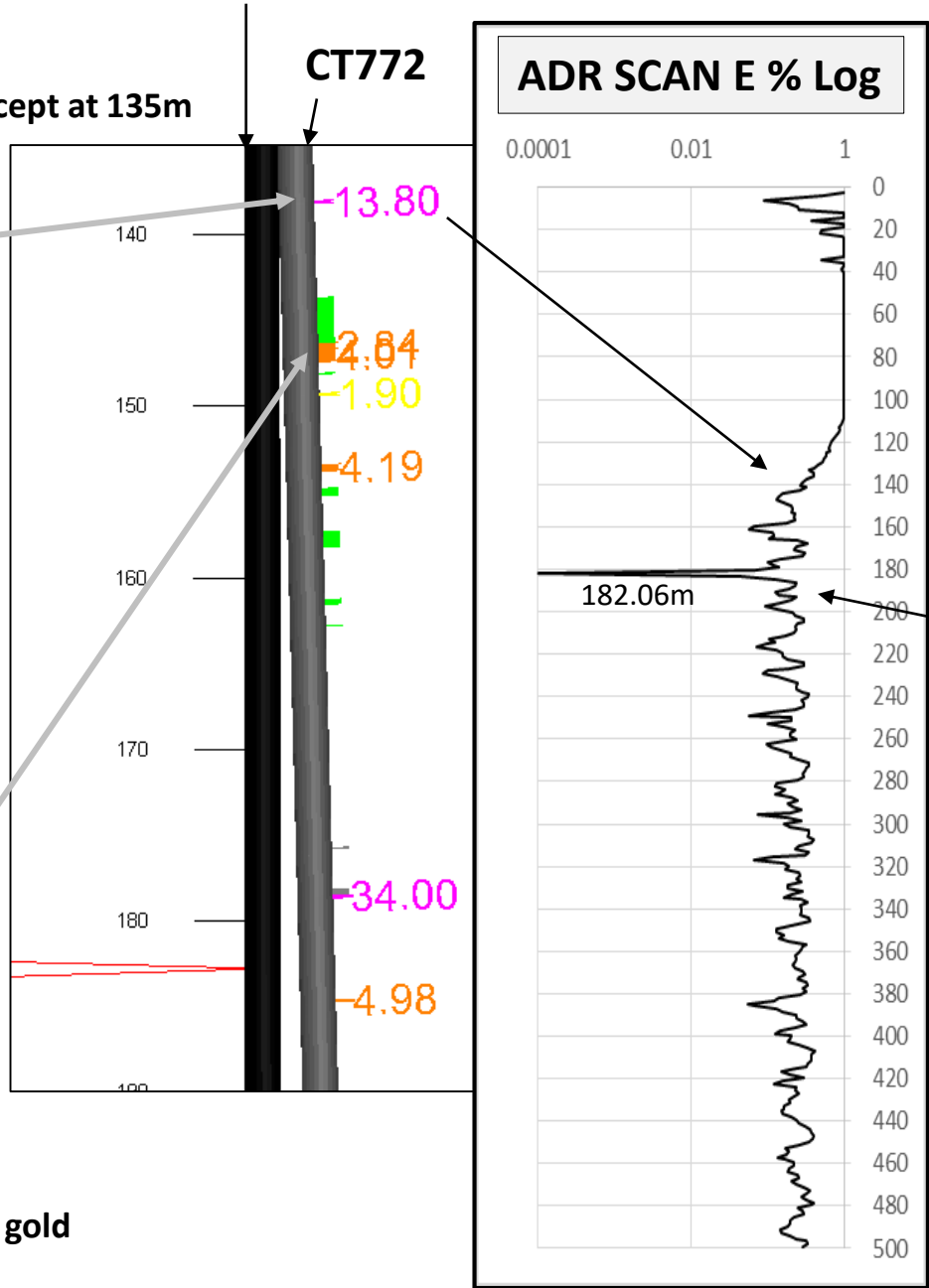
ADR A09

A09 Scan

CT772

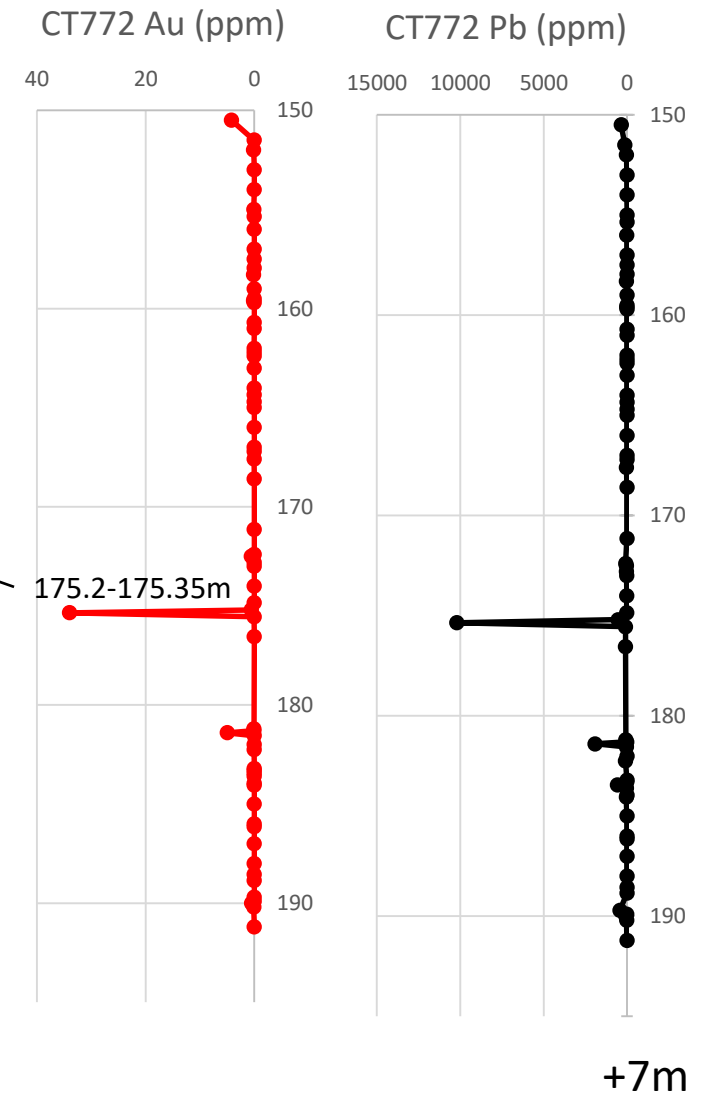
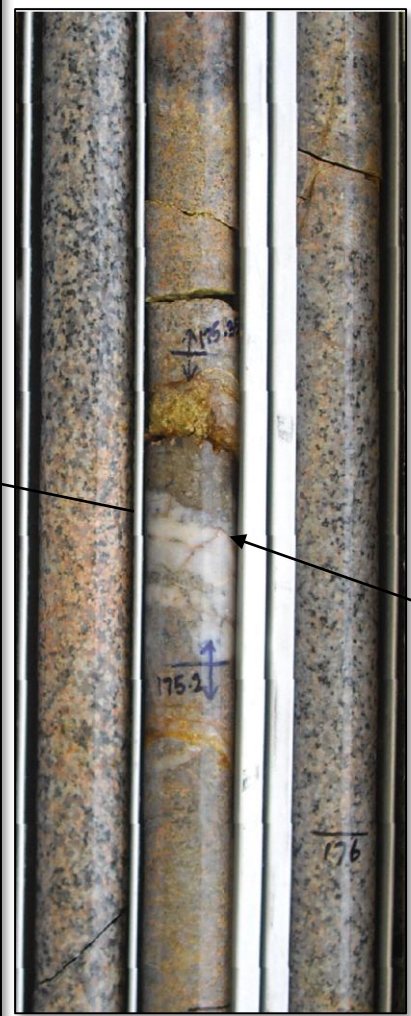
3. E05 intercept in drill core
High lead and gold

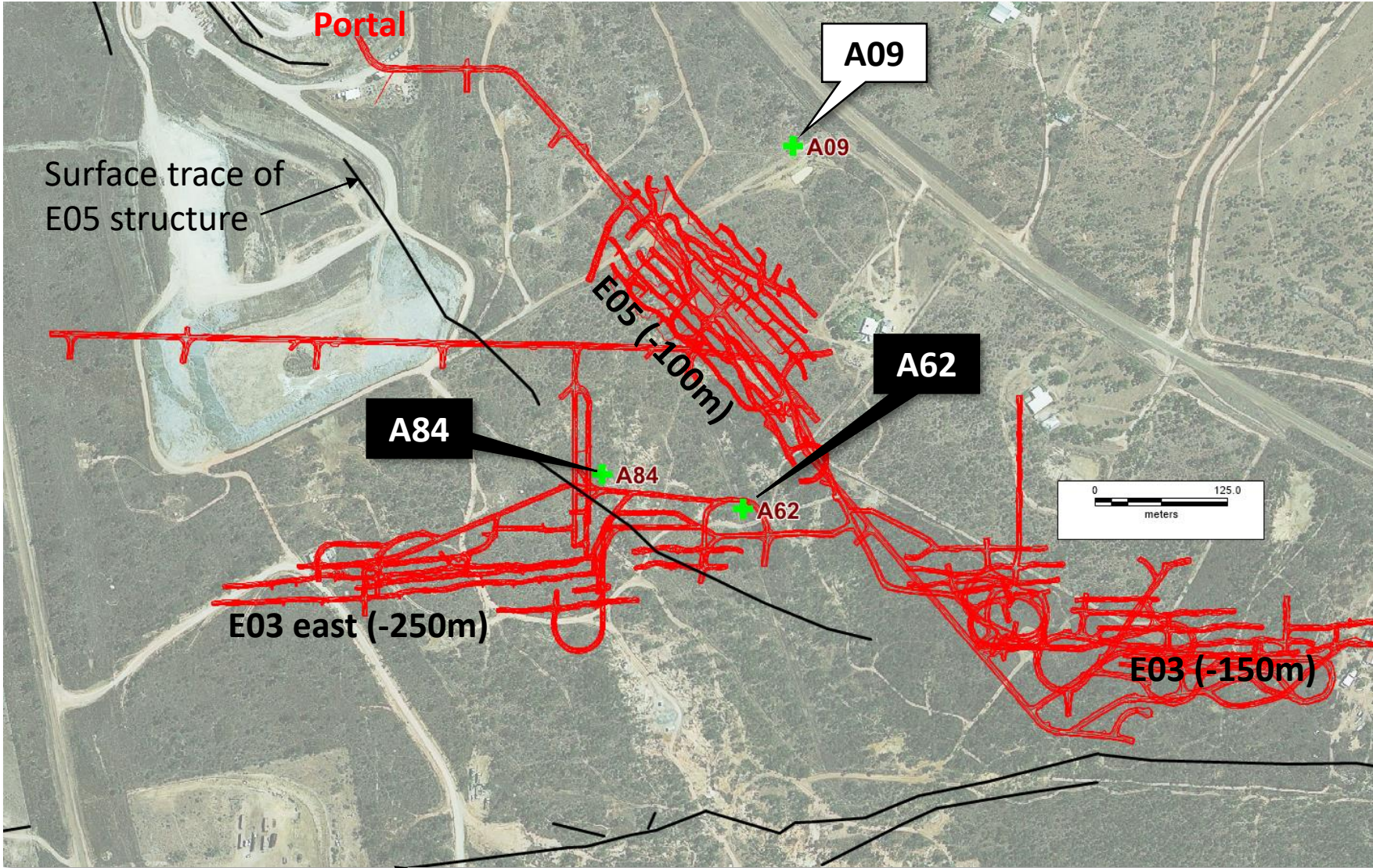
1. Small Intercept at 135m



2. Intercept at 145m
No sulfides, Low-grade gold

Assay results





Surface trace of E05 structure

Surface trace of E03 structure

Scans A84 and A62 were carried out in areas where drilling had identified sulfides (A84) or where mining had not removed known sulfides for under ground support. Both of these scenarios were an ideal test for the ADR as the precise location of the remaining ore was only known to Citigold geologists and were not disclosed to Adrok. Furthermore, the sulfides were confirmed to be mine-grade and therefore also an ideal type of target material.

Wireframe model of underground level drives and access drives. E-W trending drive are lode-parallel with increasing depth (deeper) towards the north. Greyscale semi-transparent air photo overlaid for spatial reference.

Drill hole CT3067
0.9m @ 20.4 g/t Au
0.8m @ 13.7 g/t Au

CT3067 lode parallel drill hole -500

A84
0.9m @ 20.4 g/t Au
0.8m @ 13.7 g/t Au

A62

7775250°N

425750°E

E03 RL 676

710

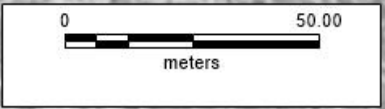
725

E03 RL 727

E03 RL 767

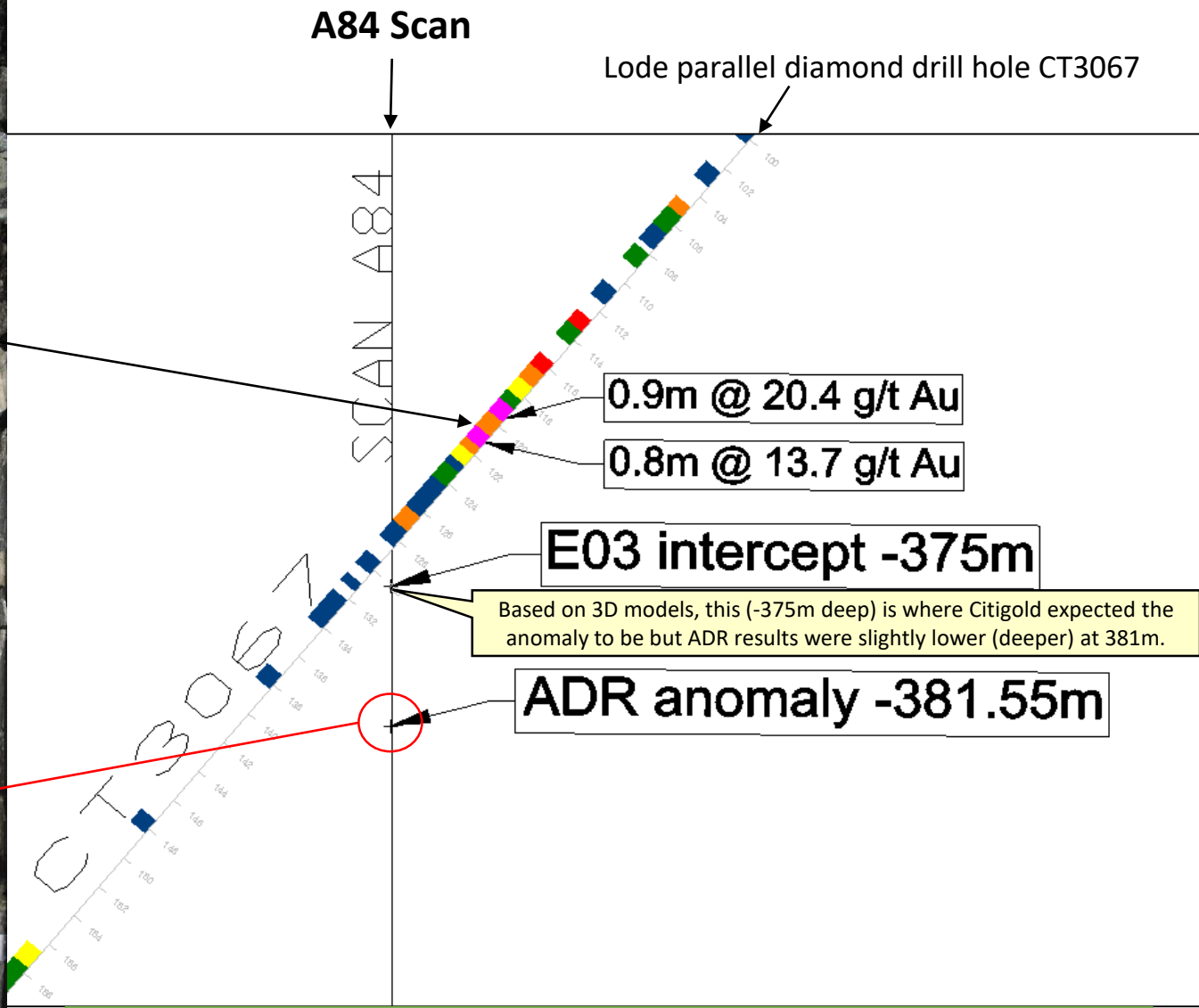
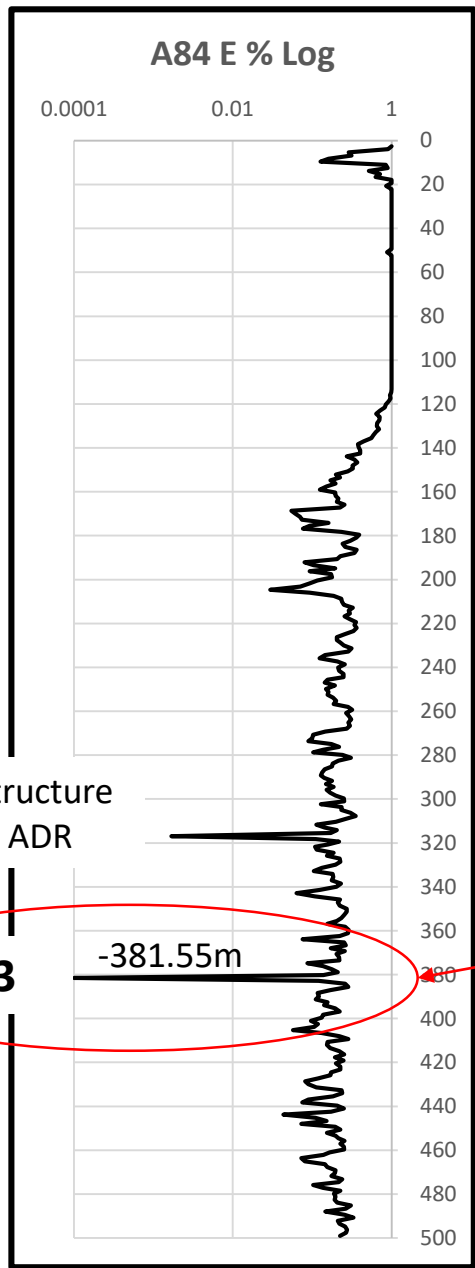
E05 surface trace

Surface RL 968m



This is a lode-parallel drill hole (CT3067) (plunging ~45 degrees down-dip) drilled from underground (red circle represents collar). The structure dips to the north and the drill hole follows the dip to the north.

CT3067



Screenshot from Surpac 3D Mine model - Cross-section (looking east) from the area where part of C3067 intercepts ADR scan A84 at around 370m depth

ADR A84

Warrior pit

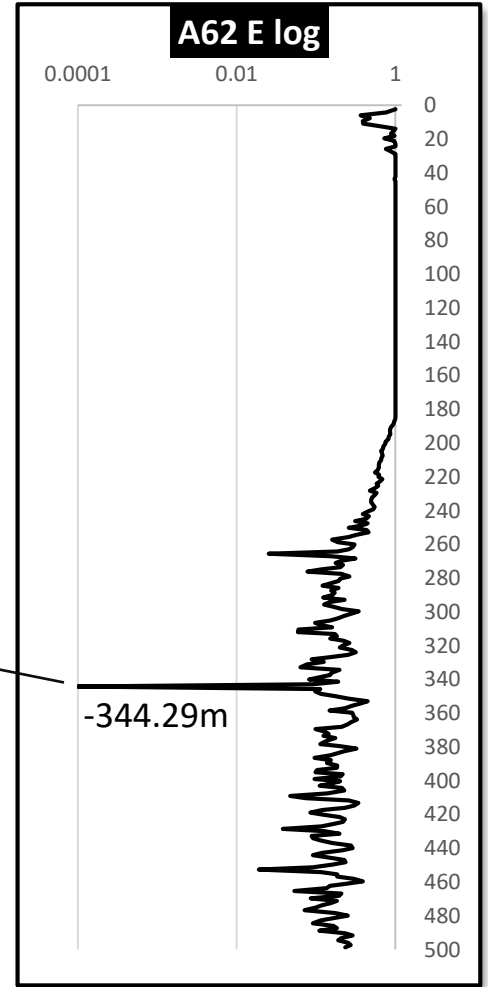
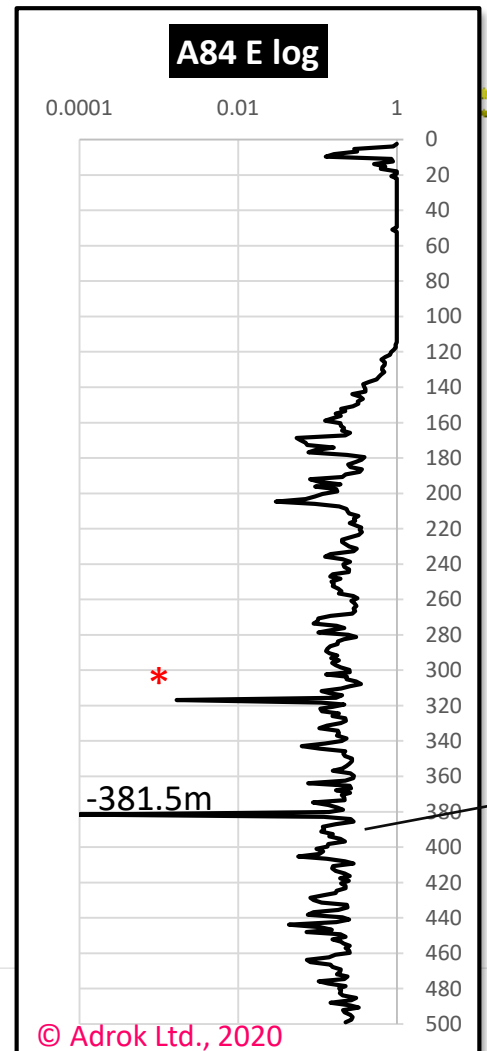


E05 underground workings (NE-dipping)

E03 underground mine workings (N-dipping)

Interpreted E03 structure

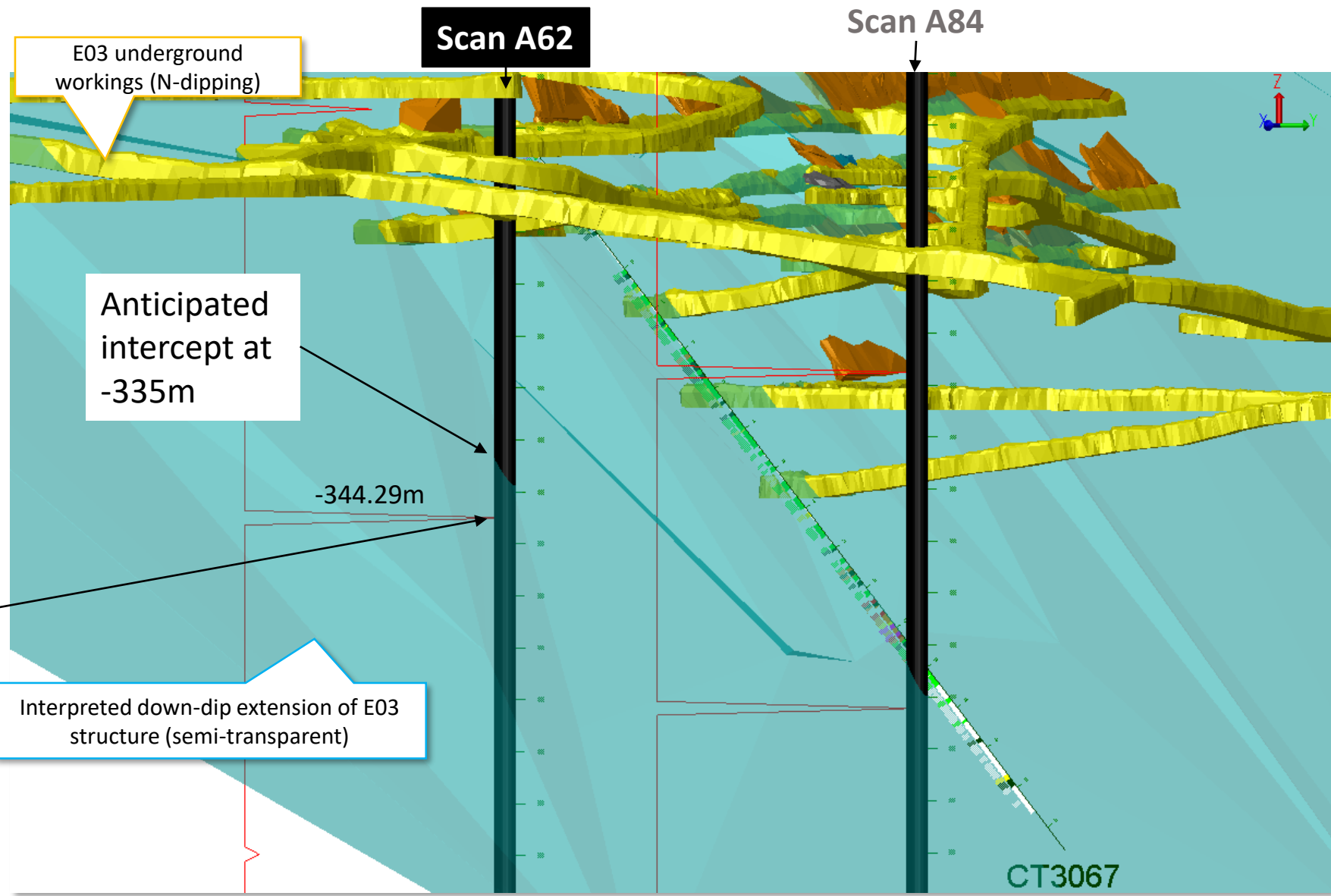
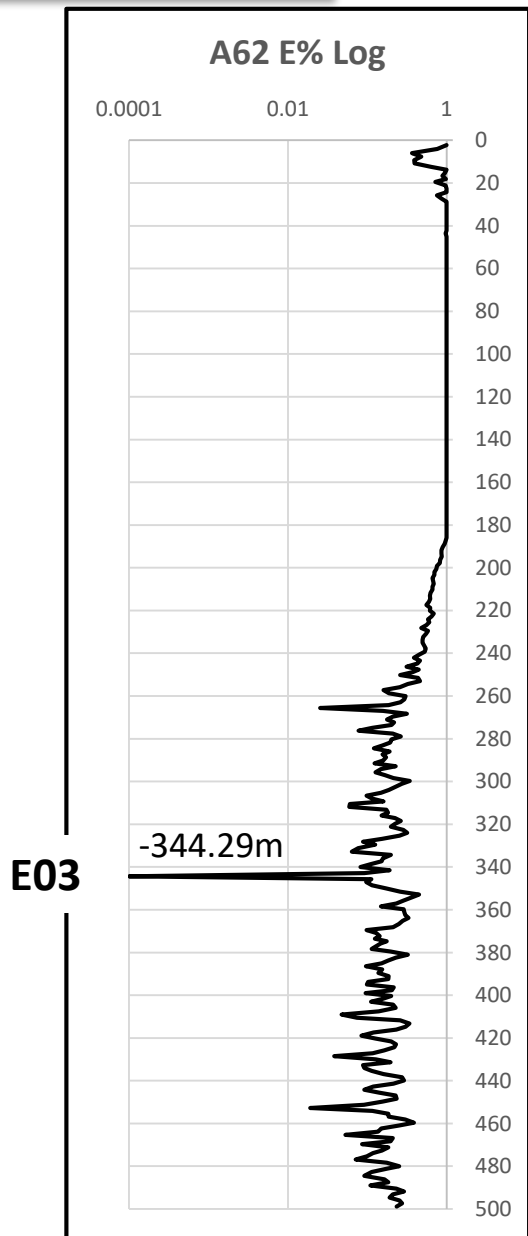
Screen capture from 3D mine model. View looking east along E03 structure (blue sfc labeled). The two scans, which were aimed at sulfides on the E03 structure are shown (black lines). The red lines parallel to the scans are the anomalous E % Log measurements. The depth where the peaks in the red lines touch the vertical scan trace are the depth at which the anomaly occurs.



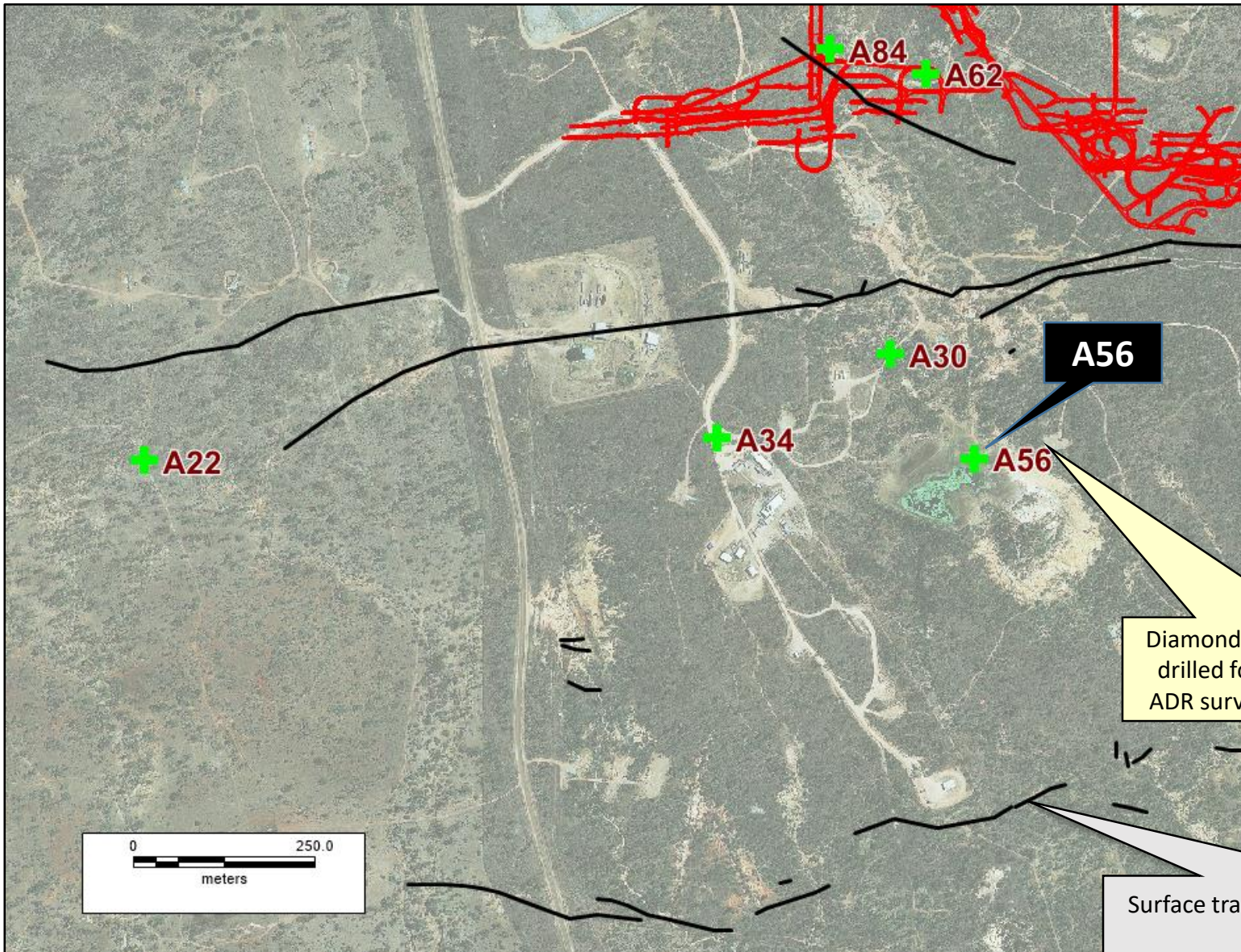
* Anomaly = unmined structure identified by ADR

ADR A62

Screen capture from Surpac 3D Mine model. View looking horizontally and to the SW across the face of the n-dipping E03 structure (blue transparent surface). Scans are shown in black. Underground mine workings in yellow and stoped (mined ore) shown in orange. CT3067 is lode-parallel diamond drill hole discussed on previous page.



2. ADR scans completed in the “IMPERIAL” area



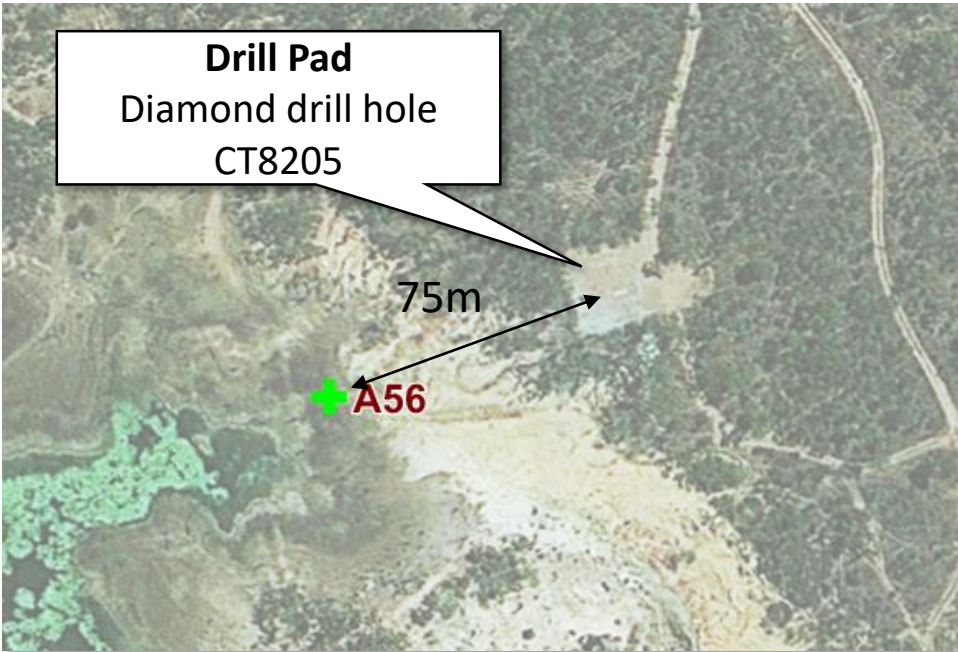
At the time the ADR geophysical survey was being carried out, Citigold had begun a drilling campaign to extend its known resources (near mine and new structures). Part of this drilling program involved several drill holes aimed at defining mineralisation on the N-dipping E07 structure. The area had some previous drilling, but the drilling was so sparse that little was known about the geometry of the structure and the distribution of gold, if any was present.

Once the results from Adrok were returned, A56 showed a strong anomaly that was interpreted to be sulfides. CT8205 was drilled in order to test whether the anomaly in the ADR scan could indicate the presence of sulfides in an area where very little was known about the structure. The depth of the structure was also not known as structural models were not well constrained.

Diamond drill hole CT8205 was to be drilled following completion of the ADR survey depending upon results.

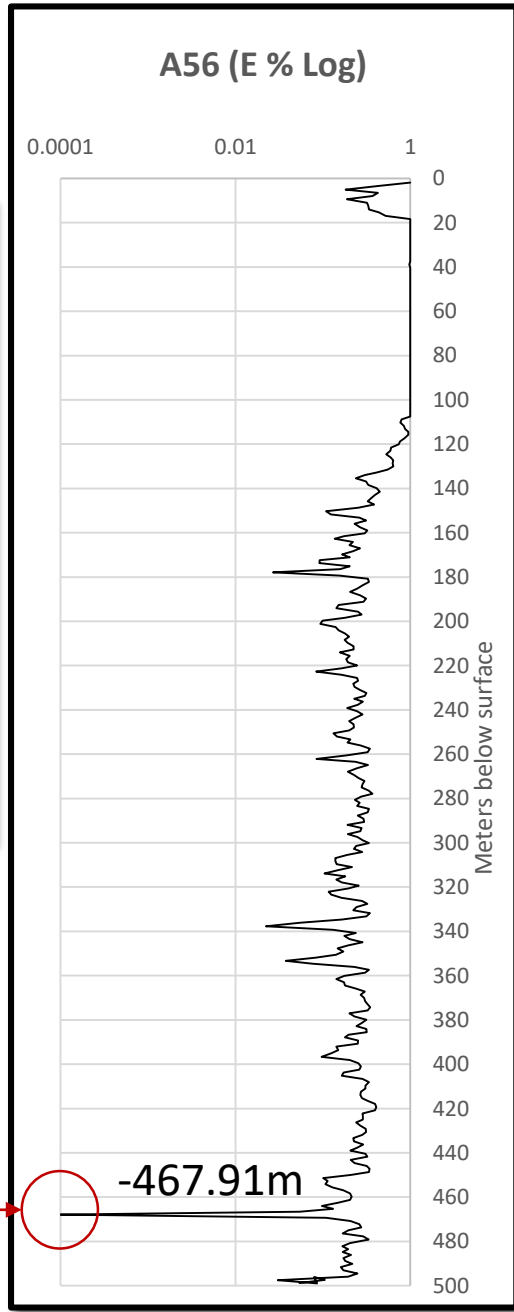
Surface trace of the N-dipping E07 structure where it can be identified

ADR A56

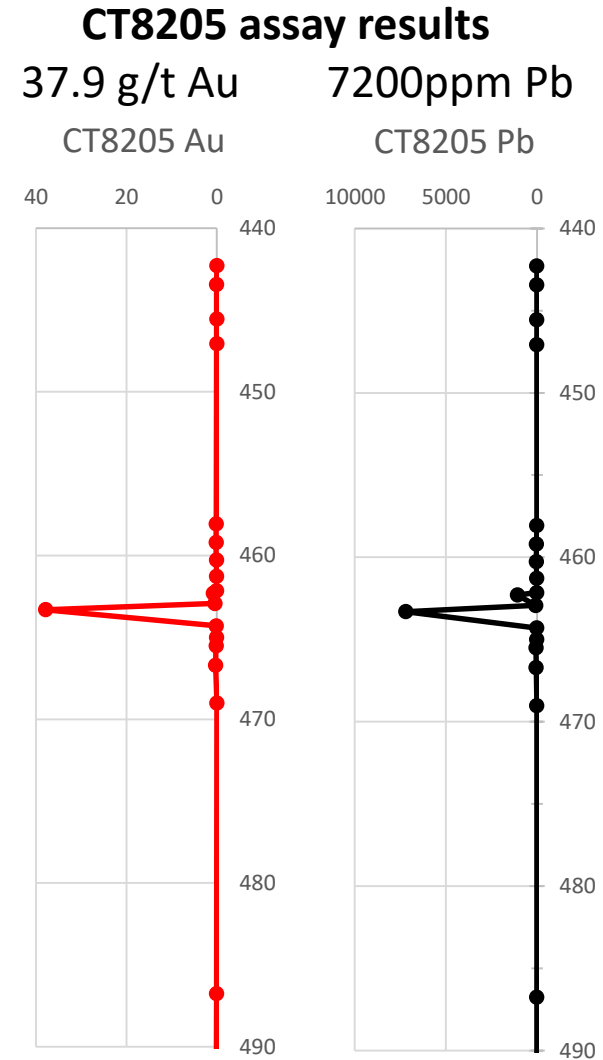


- Scan completed prior to drilling CT8205
- Single target identified at -467.91m
- Drilling confirmed target at -463m down hole

The lowest value in the scan (0) was assigned a value of 0.0001 as per methods described above. The anomaly at 467.91m in the ADR was indicative of a strongly reflective layer at depth below the collar at the surface. Based on the results from the Warrior area, Citigold was confident that this could be sulfides within the same homogeneous granite. Diamond drill hole CT8205 was drilled and confirmed the presence of high-grade gold and galena (PbS). An intercept of 37.9 g/t Au was returned from later assays



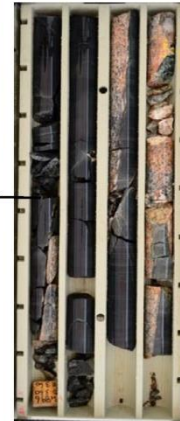
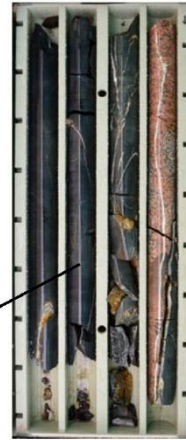
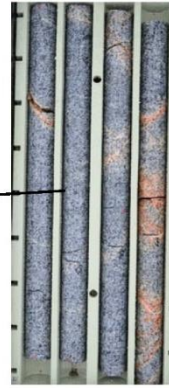
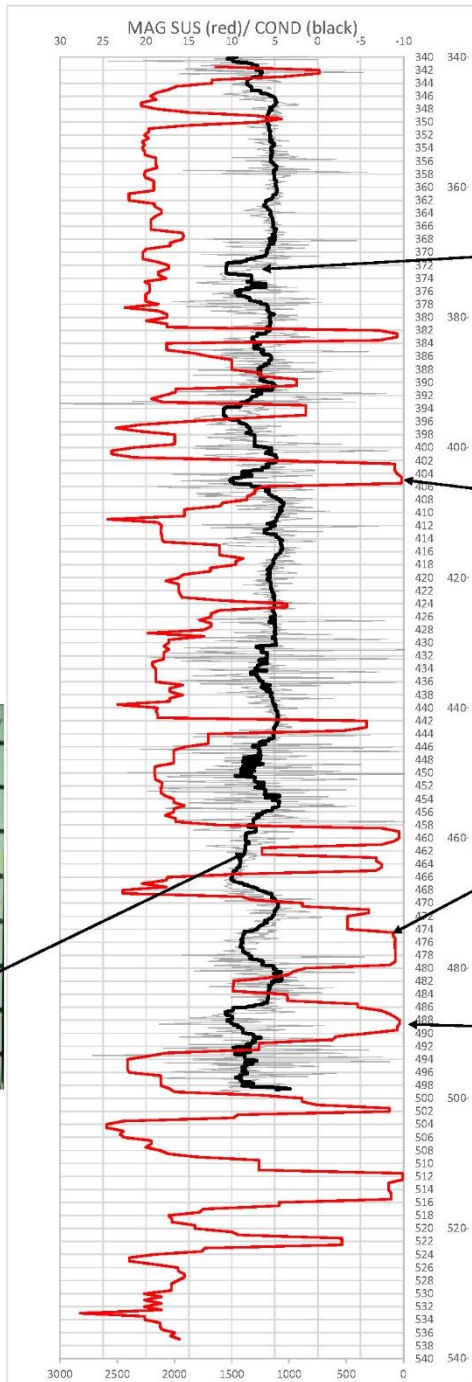
~40cm thick intercept at -463m



DH CONDUCTIVITY CT8205 – E07

Magnetic susceptibility
 Conductivity

Sulfides and Au

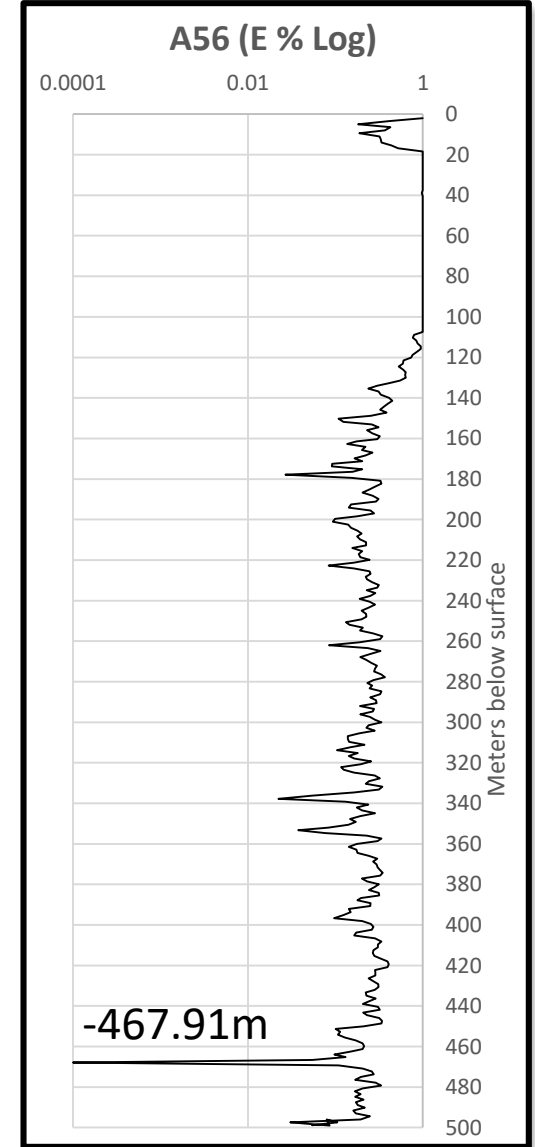


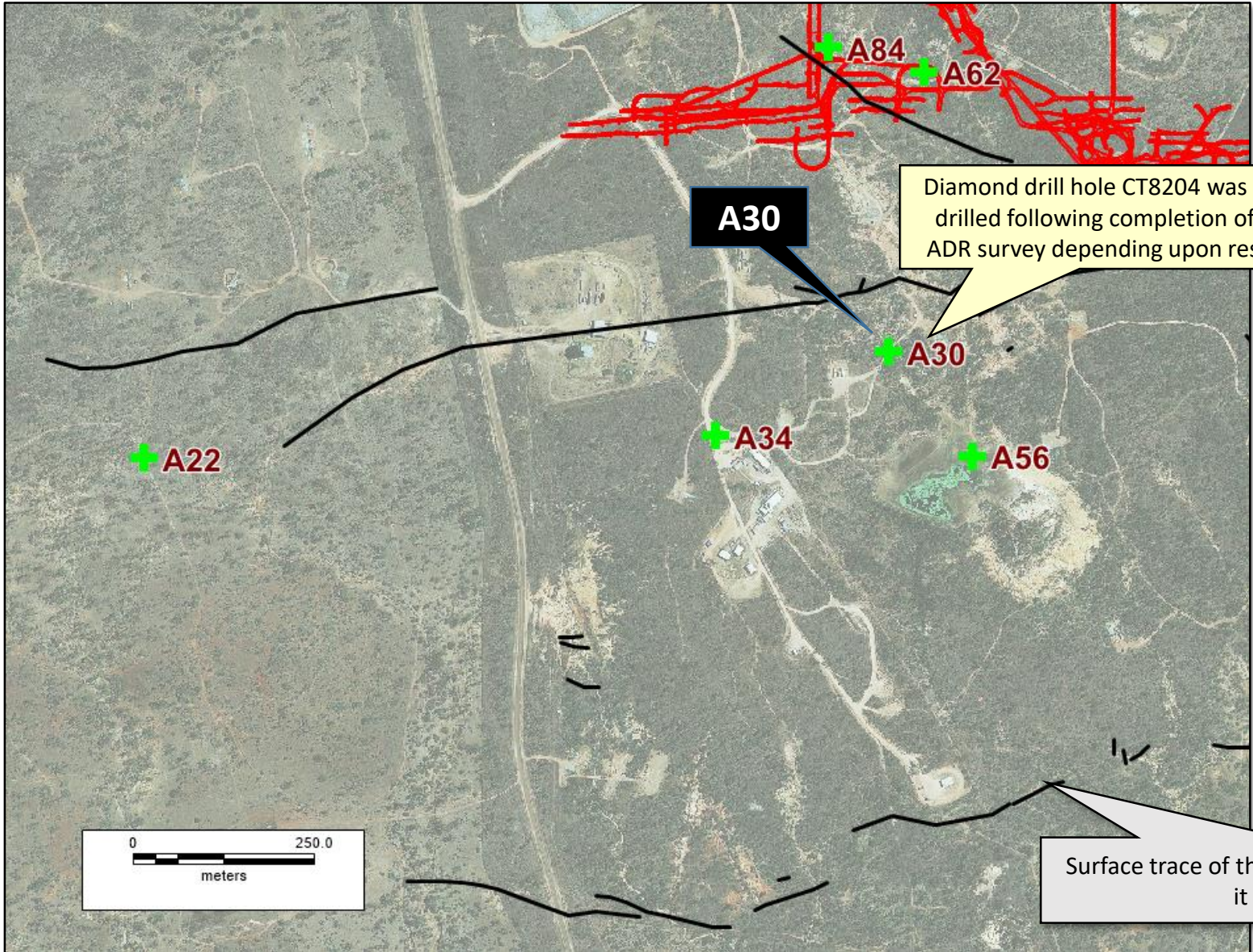
CT8205 was lined with PVC and subsequent DH geophysics (mag and conductivity) were completed. Neither Mag sus nor conductivity could identify the sulfides.

CT8205 DH Conductivity and Magnetic susceptibility

Data collected using a Mount Sopris 2PIA-100/2PIA-1000 and Matrix winch. Scanned twice at 5cm intervals.

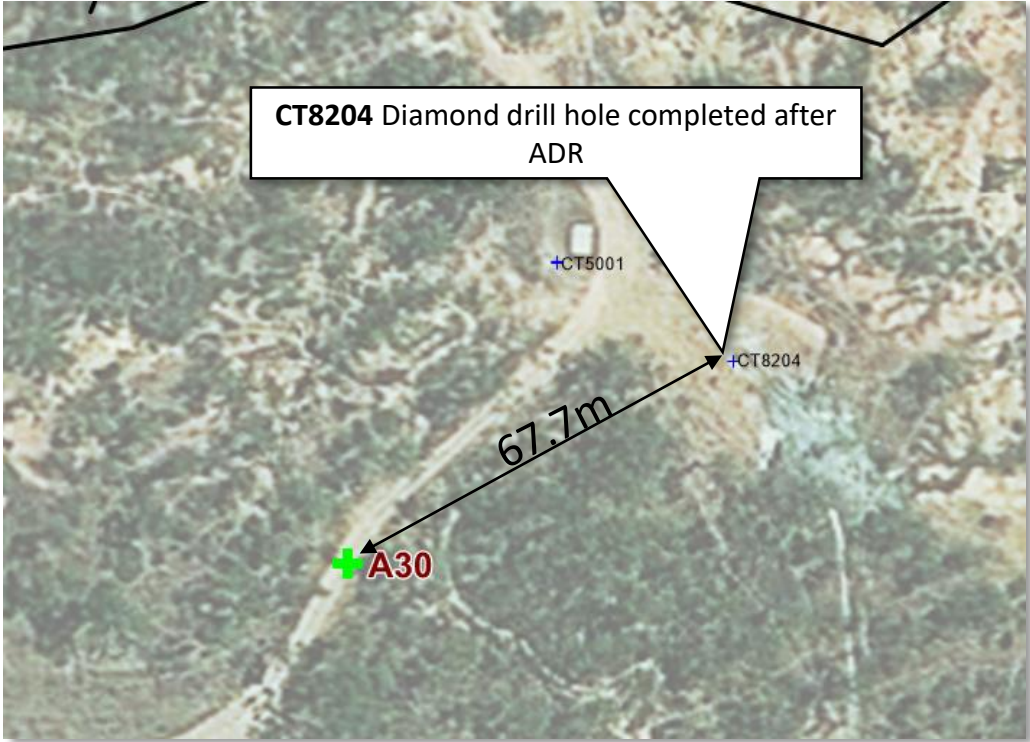
Mag lows and conductivity anomalies identify variations in rock type, in particular, mafic dykes.





Similarly to CT8205, CT8204 was drilled as part of Citigold's resource expansion exercise. Also similarly to CT8205 and A56 discussed previously, the E07 structure here was very poorly known until drilling CT8204 had been completed. Drilling confirmed the presence of two approximately parallel structures dipping to the north and separated by approximately 100m. The upper structure has a shallower dip than the lower structure so with increasing depth, the distance between the two increases.

ADR A30 – E07

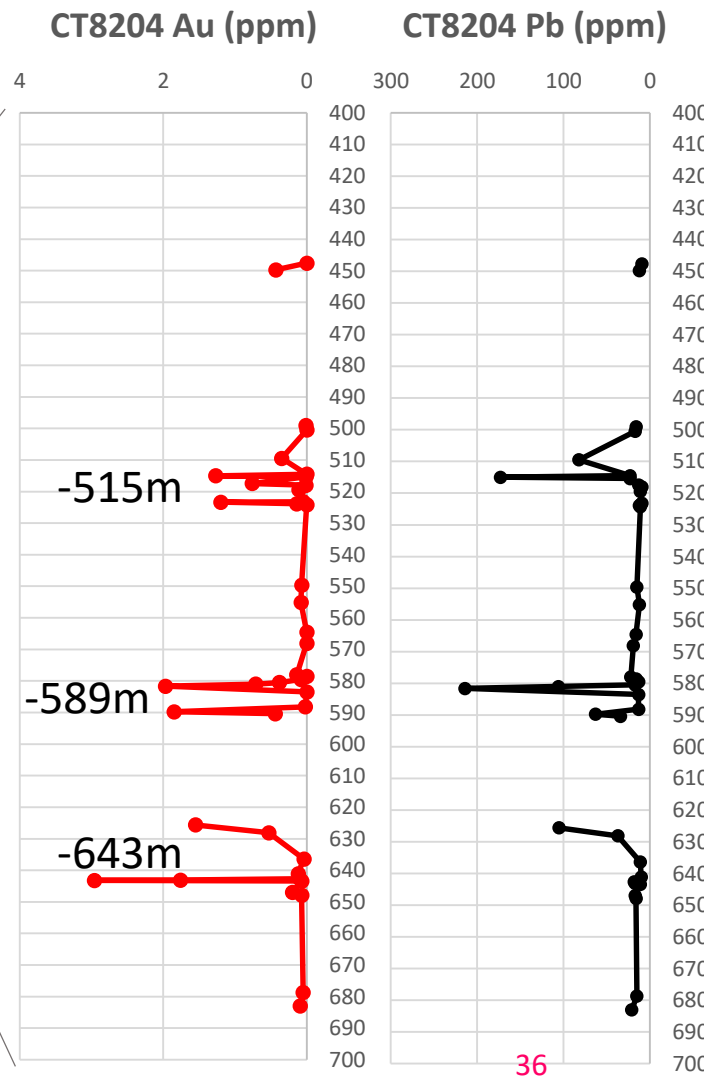
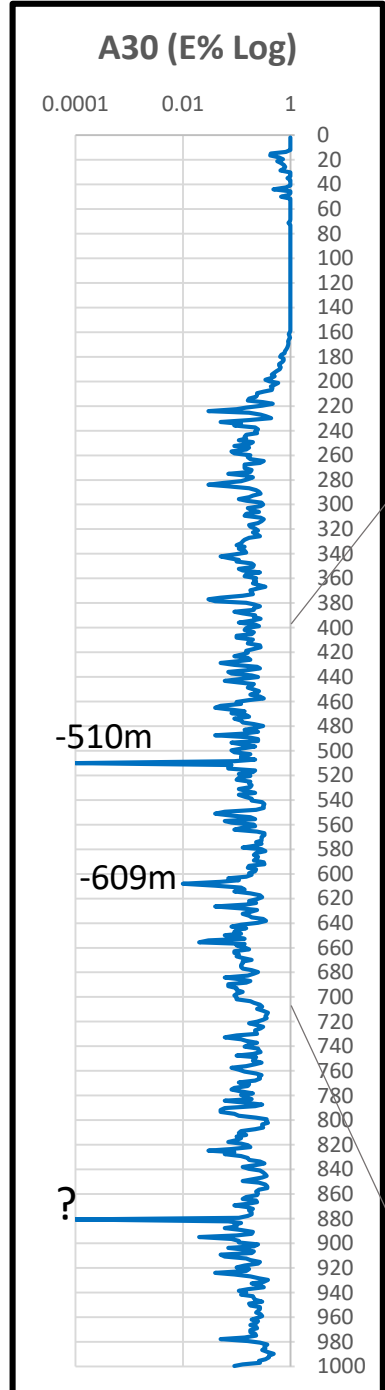
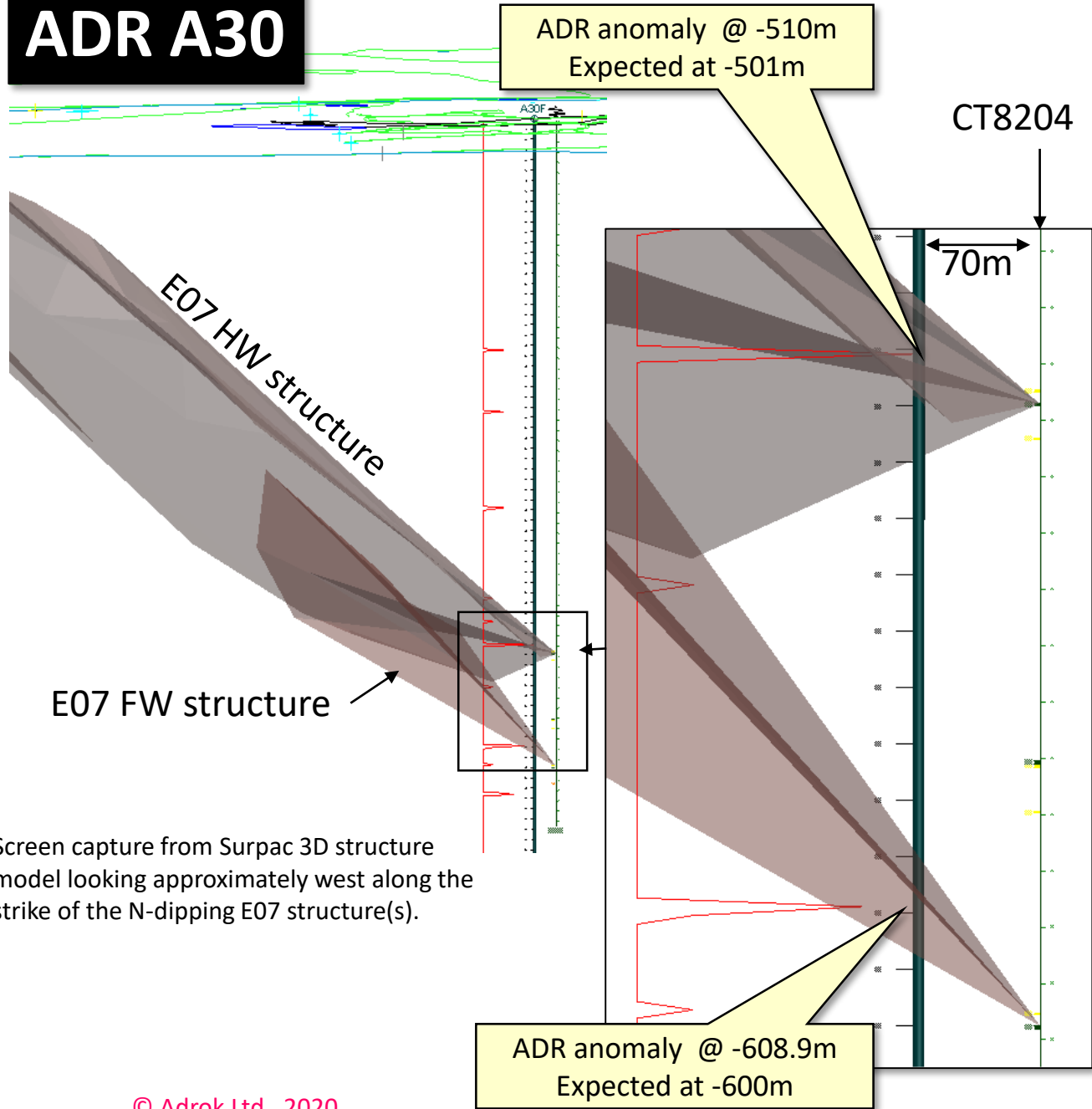


Diamond drilling intercepted two structures:

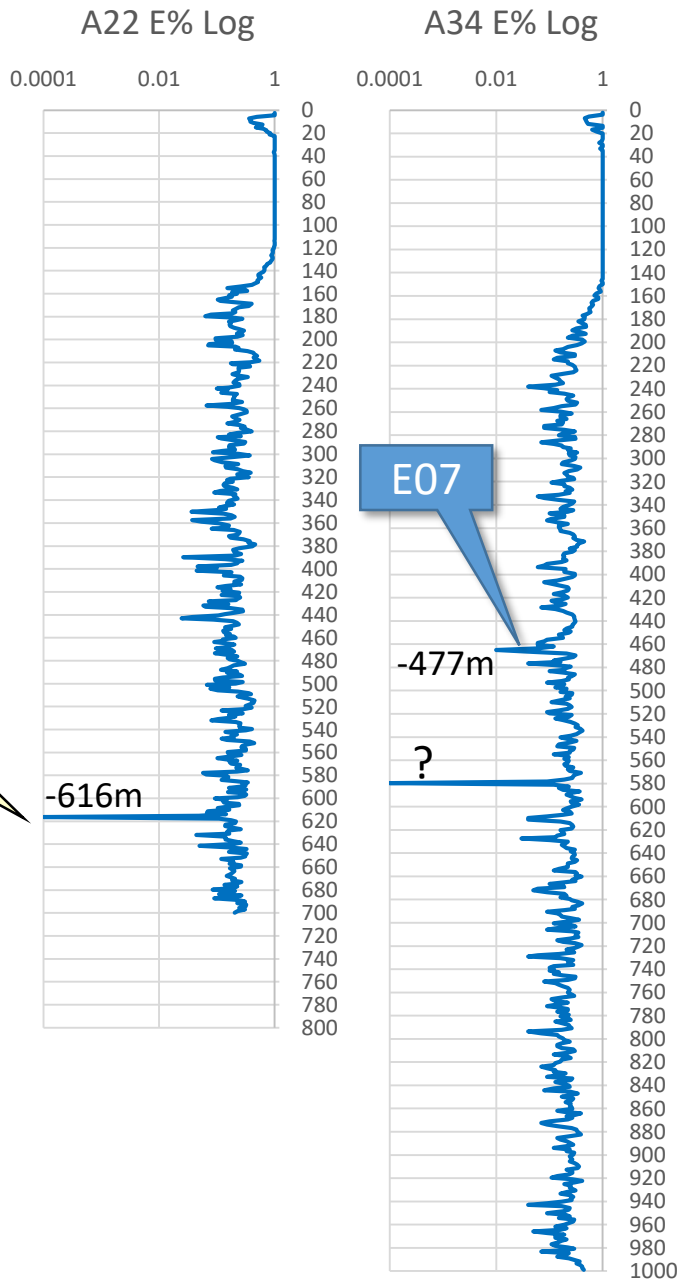
- E07 Hanging wall (-514.27m)
- New E07 Footwall (-589.5m)



ADR A30

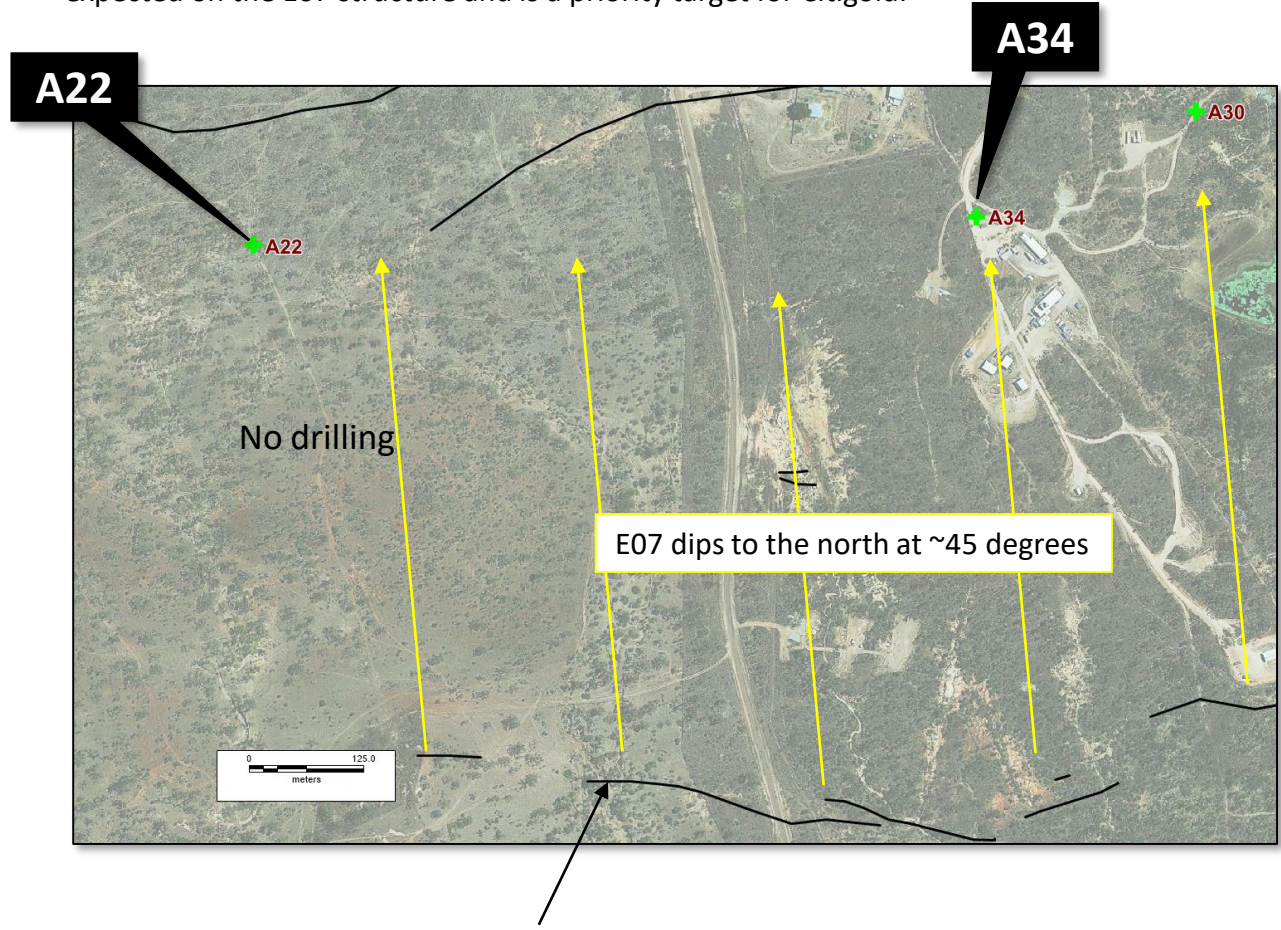


ADR A34
ADR A22
E07



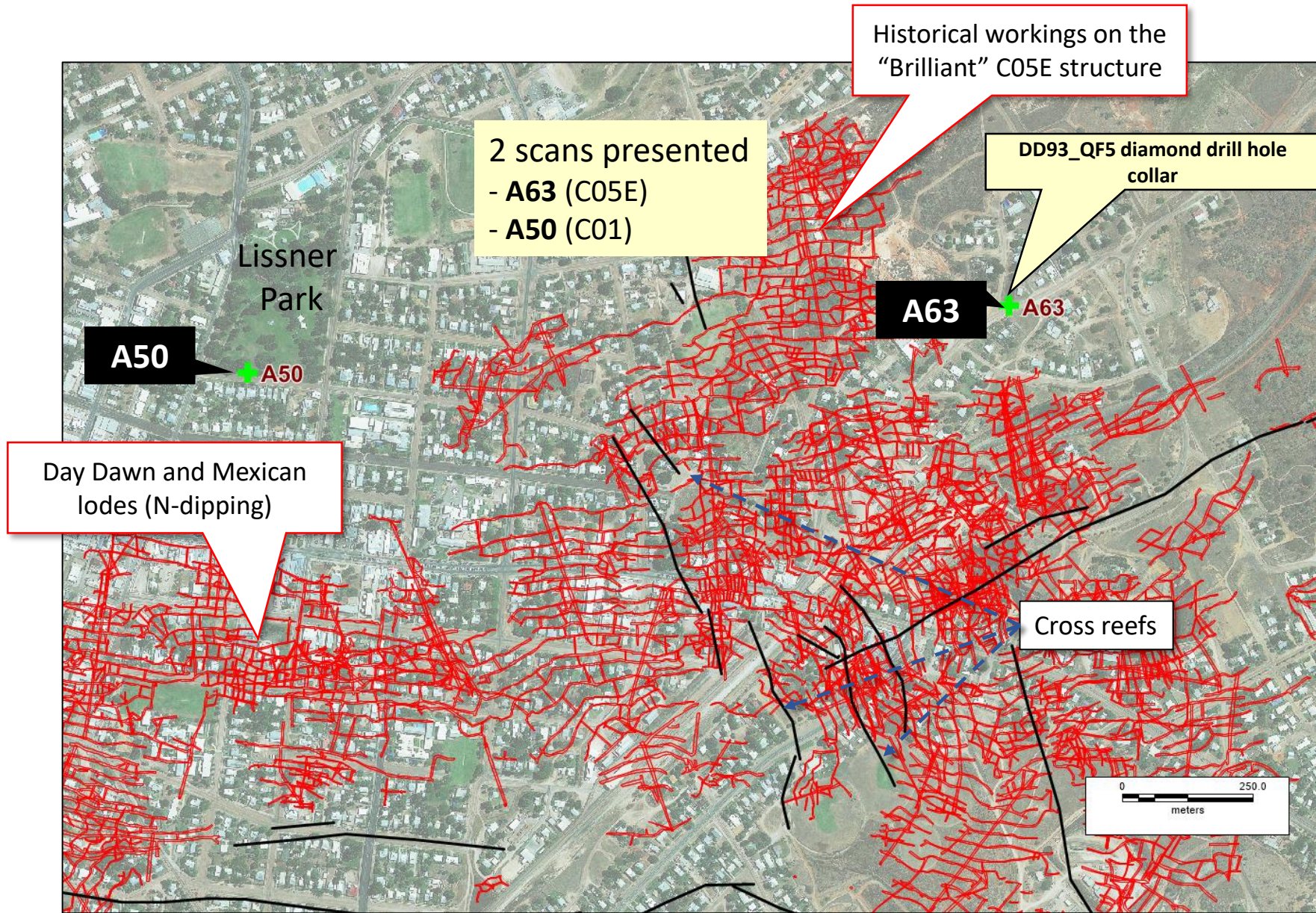
Potential sulfide mineralisation well-beyond the limits of drilling

Scan A22 lies to the west and approximately along strike of the E07 structure. No further drilling could be carried out, therefore the anomaly in A22 could not be tested. However, it is plausible, because the structures in Charters Towers are laterally continuous, that the strong reflection indicated by the trough in relative energy graph at 616m that sulfides are present on the E07 structure. This anomaly indicates sulfides might extend much further than expected on the E07 structure and is a priority target for Citigold.



N-dipping E07 structure
 Poorly constrained geometry of E07 due to lack of drilling

3. ADR scans completed in the "CENTRAL" area

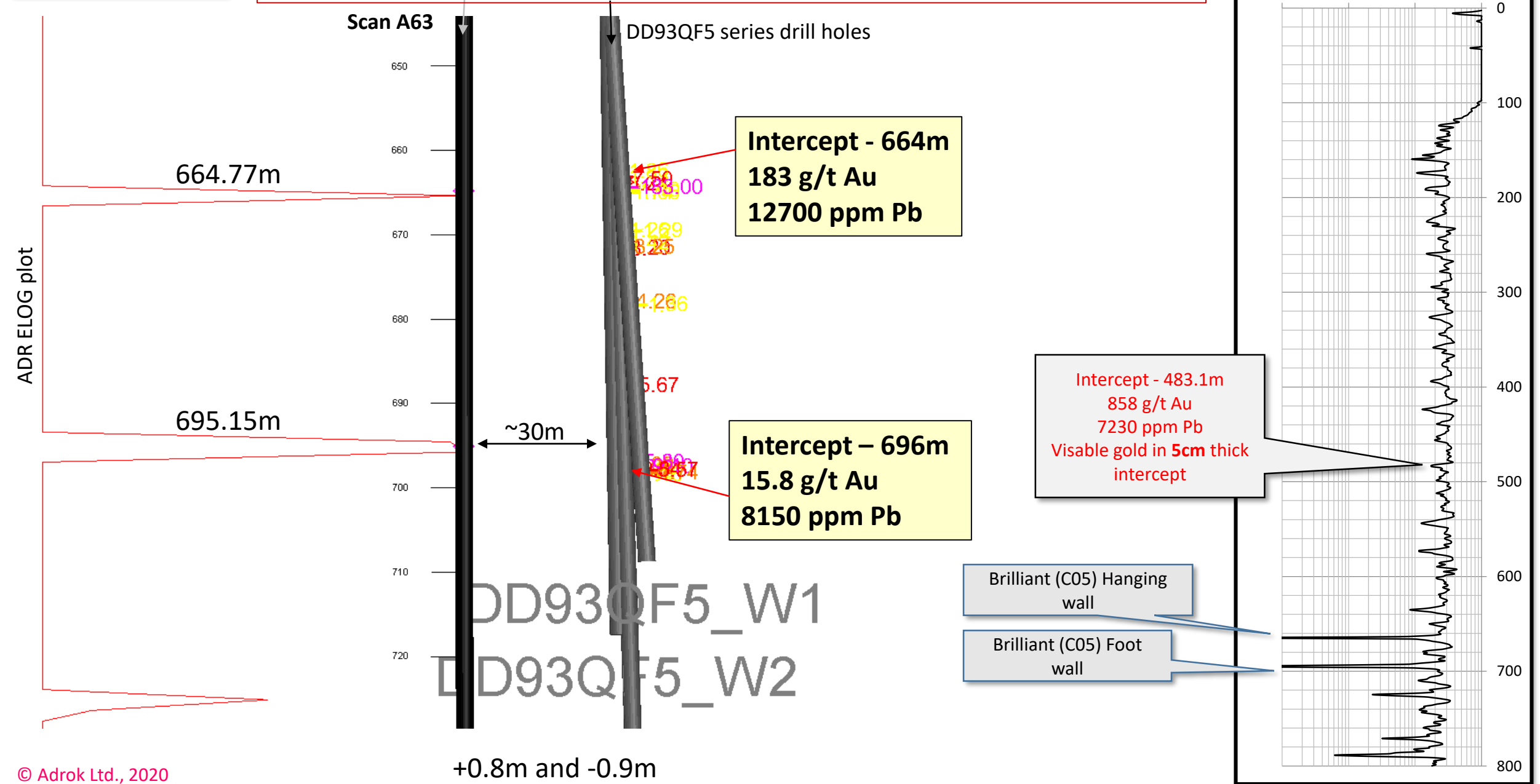


The "Central" area of Charters Towers is well-known globally because this part of the field produced over 6 Moz of Gold since ca. 1890. The area is still highly prospective BUT there is extreme difficulty in defining resources and reserves here because of the lack of area to undertake drilling. Drilling can be completed but it has to be extremely well-planned and constrained so that it only targets the BEST POSSIBLE AREAS. Historically resource drilling has been limited to "drill and see" philosophy. The pods of sulfides described throughout are too unpredictable to be able to confidently vector drilling to high grade targets. In addition, most geophysics techniques won't operate in the middle of a city owing to significant land access limitations and anthropogenic sources of EM radiation or false responses from historical underground infrastructure.

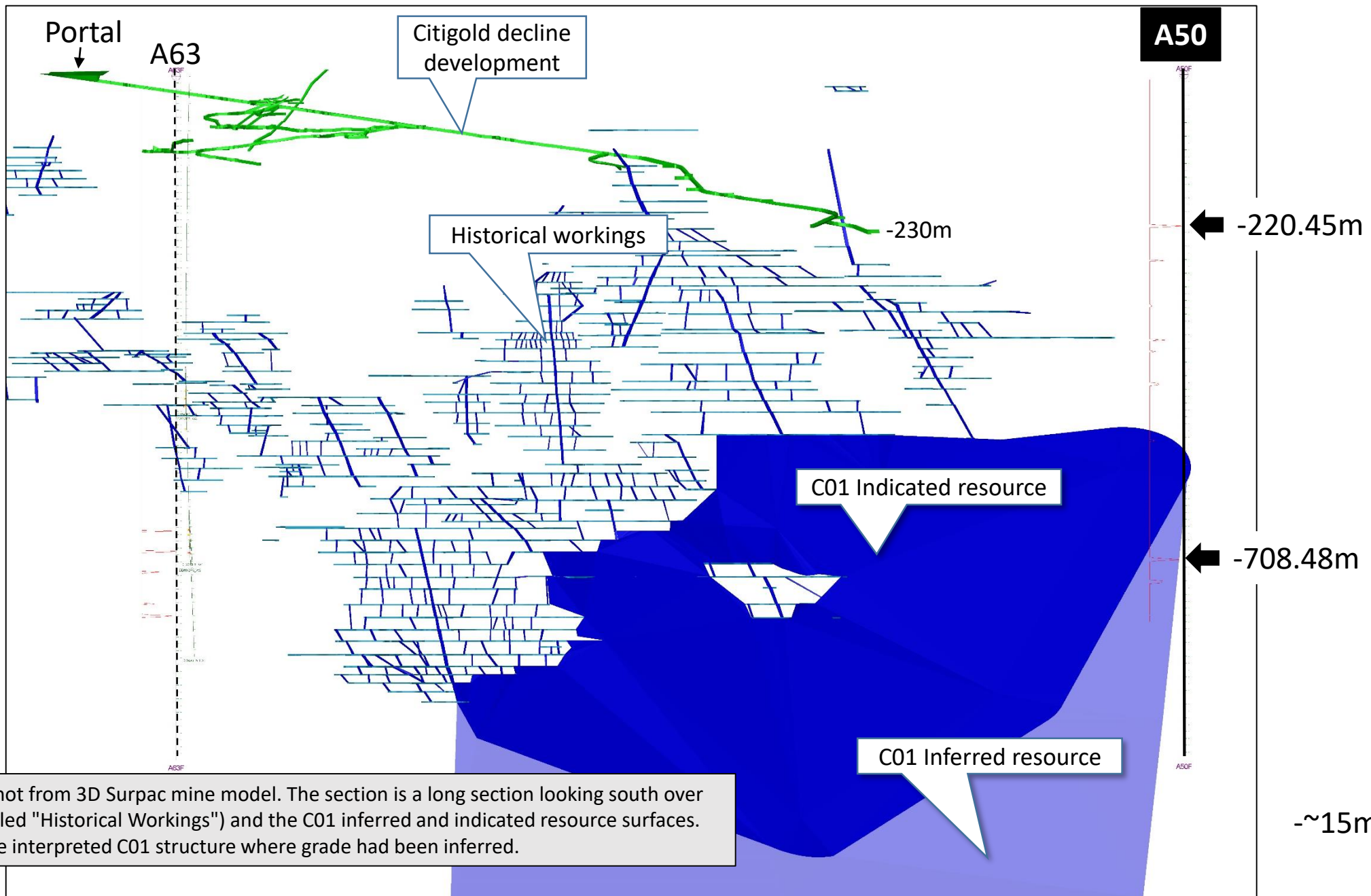
One of the reasons for trialling ADR here is 1) due to the known existence of sulfides at >500m depth and 2) to test the equipment in difficult-to-access areas. One scan took place in the central park in town, Lissner Park.

ADR A63

Screen capture from Surpac 3D Mine model between ~635m and 730m depth showing just the drill hole trace (DD93_QF5) and ADR Scan 63 trace. Intercept grades are labeled. The two lowest values in ADR E% Log plot correspond with high grade lead and gold values in drill core.

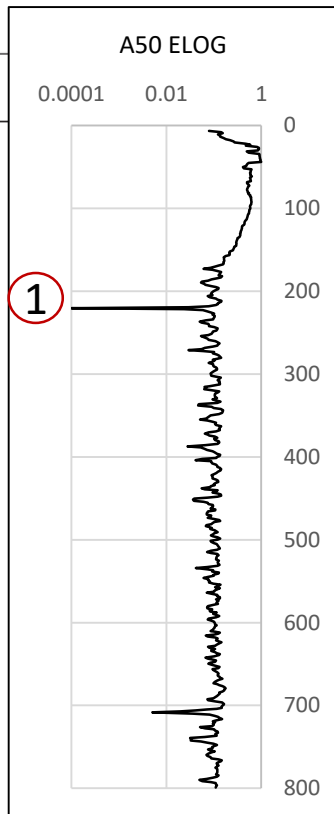
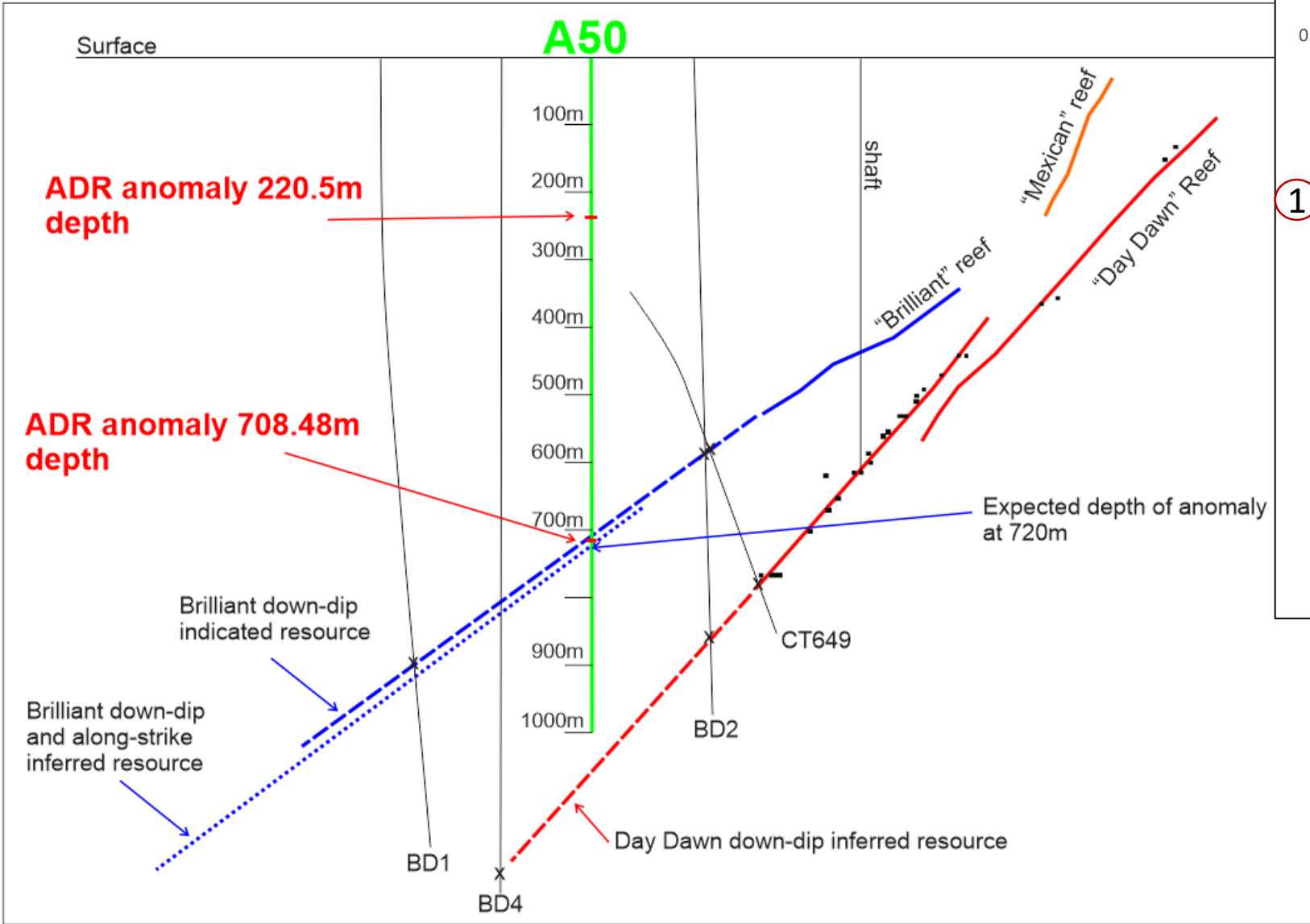


ADR A50



Background image is a screenshot from 3D Surpac mine model. The section is a long section looking south over the Brilliant E05 structure (labeled "Historical Workings") and the C01 inferred and indicated resource surfaces. A50 scan aimed to intercept the interpreted C01 structure where grade had been inferred.

Image is an annotated screen capture from 3D Surpac mine model. Cross section view looking approximately East across the N-dipping Brilliant and Day Dawn structures.



The ADR results show an anomaly in the E% Log chart at 220.5m and a second anomaly at 708.48. The anomalies are similar to those from the Warrior and imperial areas and indicate a reflective layer within homogeneous granites.

Scan A50 (vertical green trace) intercepts the brilliant reef at an expected depth of 720m which is approximately 12m deeper than the anomaly depth.

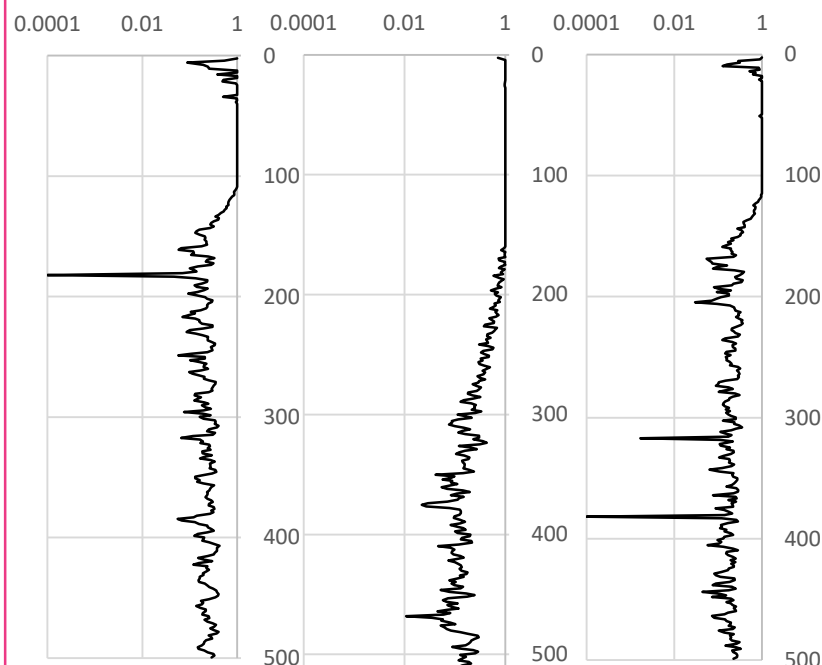
① The anomaly at ~220.5m has been un-drilled as it lies beneath the city central park reserve, Lissner Park.

1. WARRIOR AREA – RESULTS SUMMARY

A09 ELOG

A48 ELOG

A84 ELOG



Training scan

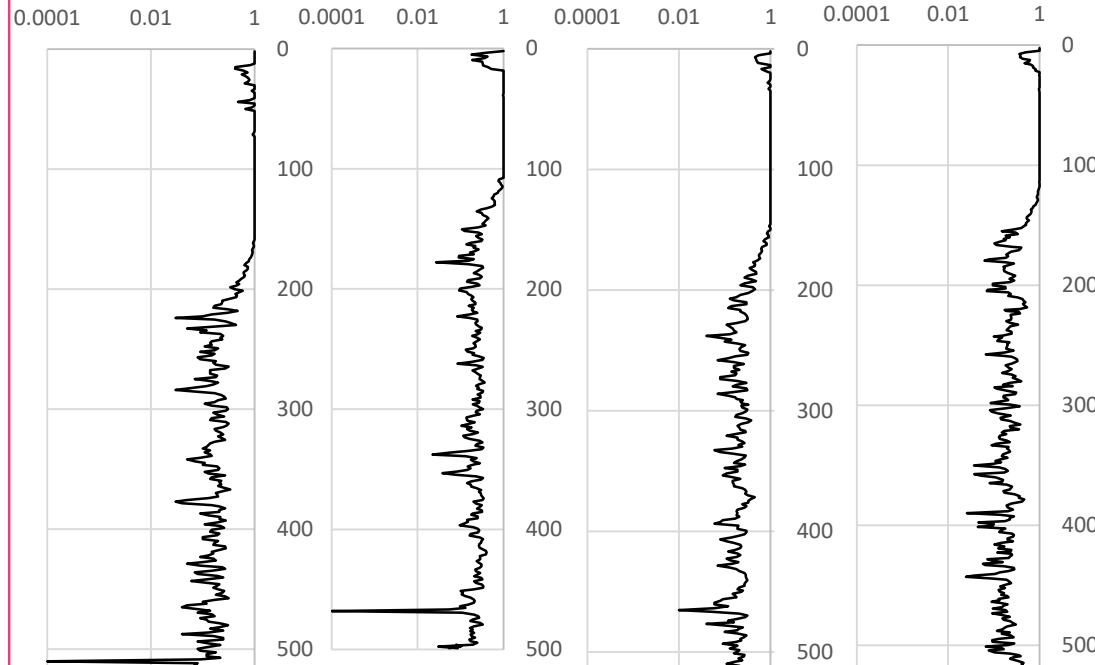
2. IMPERIAL AREA – RESULTS SUMMARY

A30 ELOG

A56 ELOG

A34 ELOG

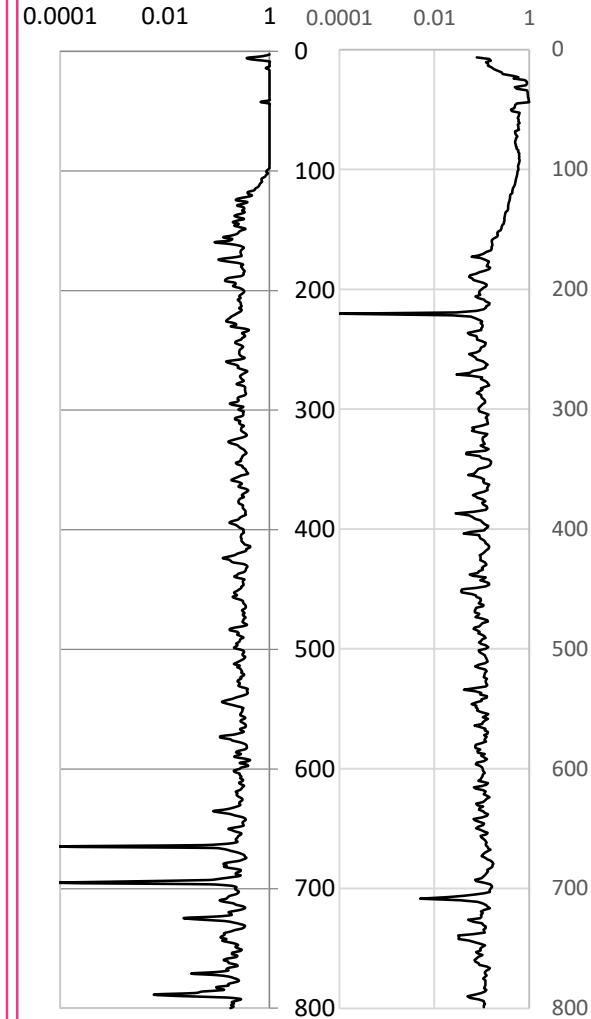
A22 ELOG



3. CENTRAL AREA – RESULTS SUMMARY

A63 Elog

A50 ELOG



CONCLUSIONS

Charters Towers type narrow vein gold is a relatively unique style of mineralisation and one that, due to both geological and environmental conditions, requires a different approach to exploration and resource definition.

Traditional geophysical techniques are not suitable and have been unsuccessful due to:

- 1) the small size of gold-bearing lenses (meters to tens of meters scale),
 - 2) the presence of a town over the primary target area,
 - 3) the depth of mineralisation (>400m),
 - 4) other masking factors including dykes, altered faults.
- According to the results from a trial carried out by Citigold in Charters Towers, the ADR technique appears to have successfully identified sulfides on target structures in three separate locations.
 - **Averaging 8 scans per day with >80 scans completed in 2 weeks – equivalent to 80,000m of drilling (~2300 days (>6 years) of continuous drilling with one diamond rig). Only those processed by Adrok are presented here. Many scans, while collected in the field, were not processed by Citigold.**
 - **Testing** of the geophysics by drilling has **confirmed** the presence of gold and sulfides indicated by ADR. It was concluded at the end of the trial that the returned relative energy (presented as E % Log) gave the best indication of sulfides. The response is interpreted to be the results of a reflection from the sharp contrast in DC at the boundary between massive sulfides and the host granite.
 - No false anomalies were recorded such that, in every case tested, the significant anomaly in energy corresponded with sulfides and in the scans there are no anomalous energy responses in the remainder of the scan.
 - Simple geology and markedly different dielectric properties between the host granite and Galena (Pb)-bearing sulfides may be key to the success.

