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GEOTHERMAL 2023
REALISING THE AMBITION

Adrok

Using low carbon, low cost, low risk, high value-adding electromagnetic technology to help in the race to net zero

G. Stove, Adrok Ltd

The Challenge

Trying to quantify subsurface rock, minerals, gas, fluid, density and temperature conditions for the exploration & production of geothermal and natural resources is difficult because of the following reasons:

Subsurface fluids, porosity, permeability, minerals and temperature are very uncertain and difficult to read as they are dynamic and complex.

The easiest way to read it accurately is through drilling, which is very expensive & environmentally damaging.

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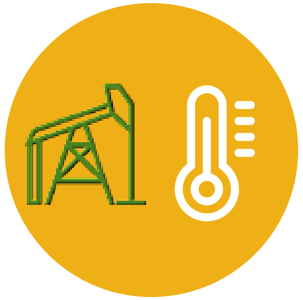
The Solution

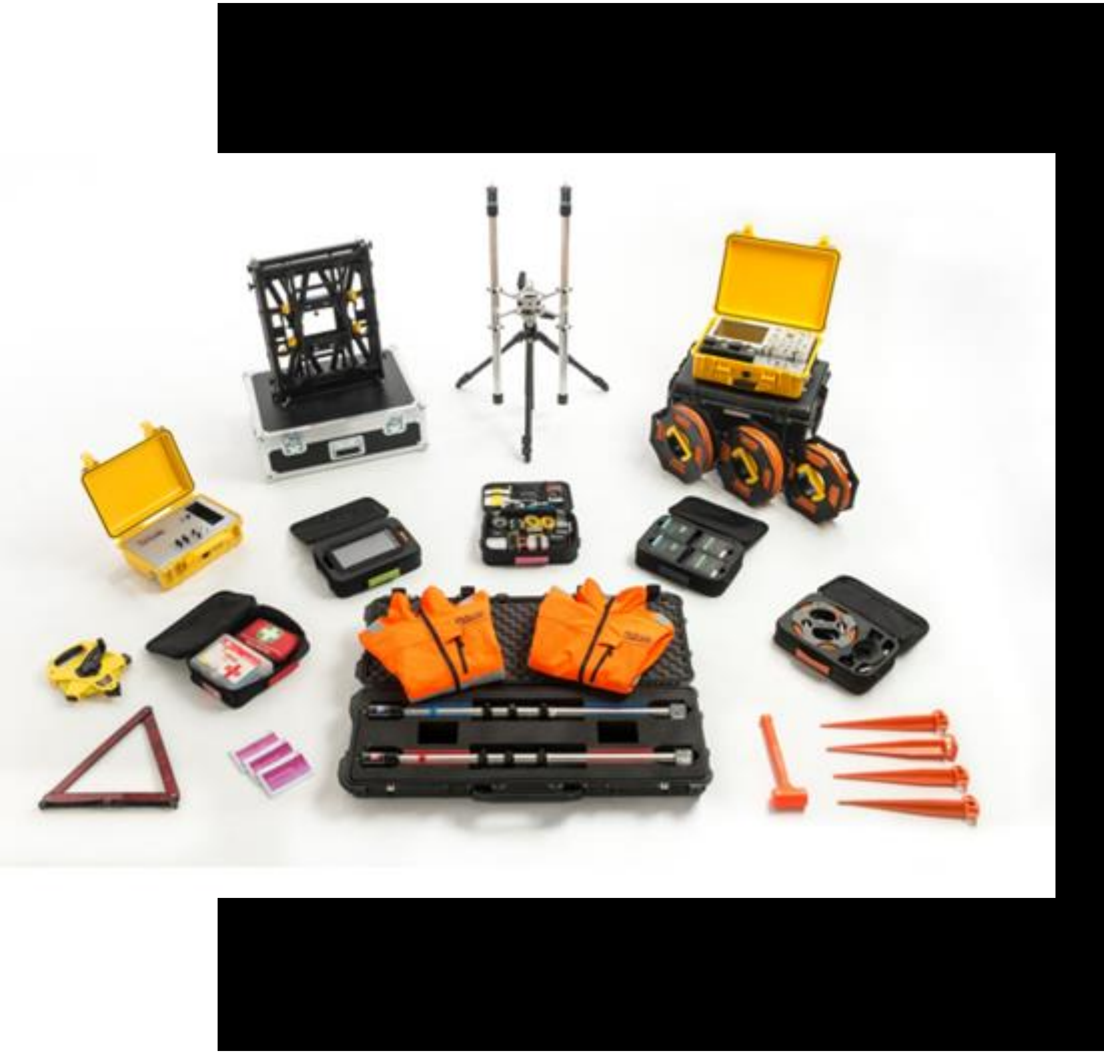
Atomic Dielectric Resonance (ADR)

Using pulsed electromagnetic ADR Technology, we can now determine the existence and location of subsurface natural resources, movements and fluids without the need for invasive drilling.



ADR allows the measurement of subsurface temperature, rock, minerals, fluid and gas conditions from the earth’s surface, non-destructively.

Our technology eliminates the need for drilling and therefore reduces the expense and risks associated with it.



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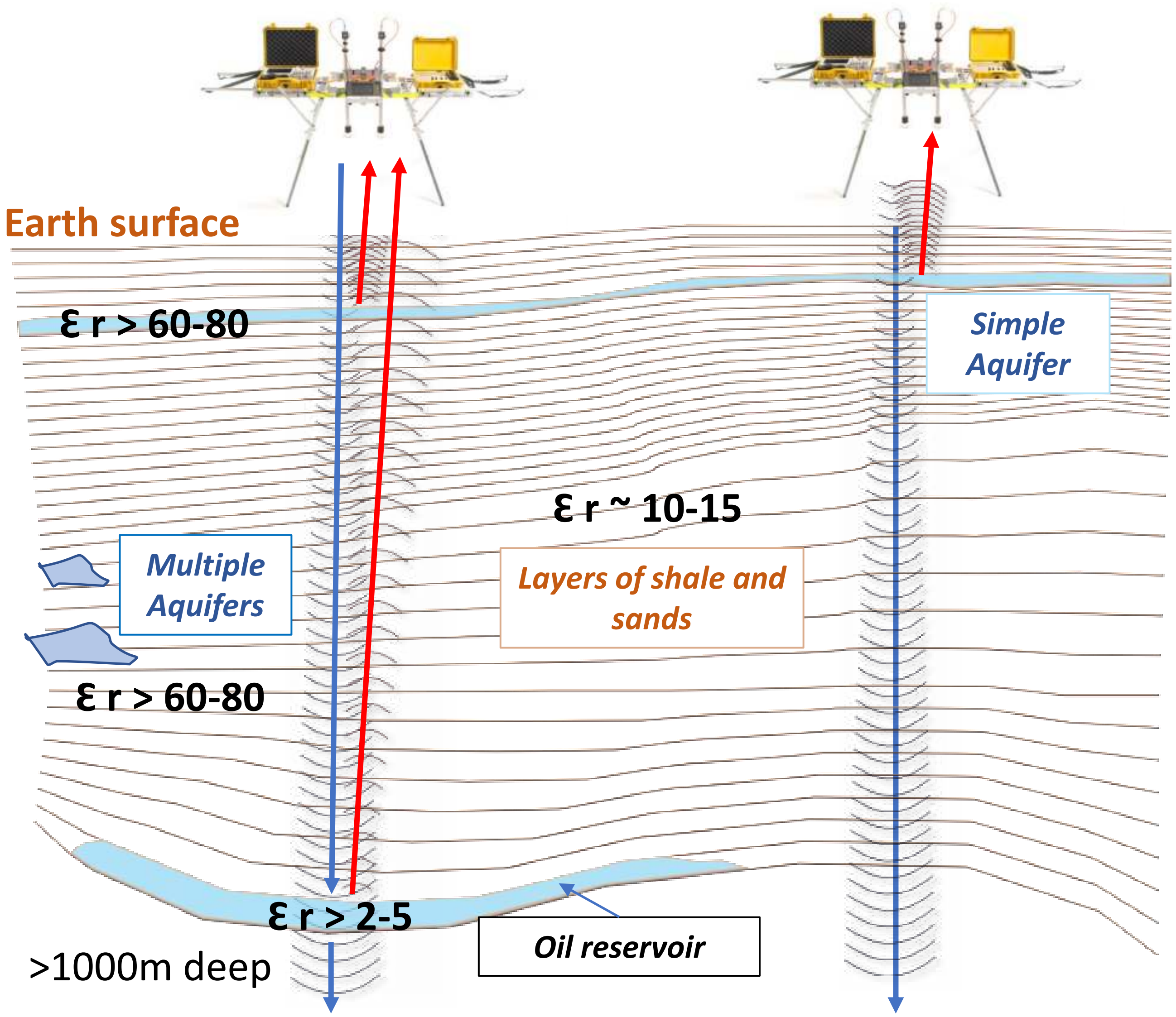
How the technology works



- Transmits broadband pulses of radio waves between **1 to 70 MHz** into the ground.
- Detects the modulated reflections returned from the subsurface structures.
- Measures dielectric permittivity (Ɛ r) and conductivity of material.
- Analyses spectral content of the returns to help classify materials (energy, frequency, phase).
- Time & frequency domain.
- Time ranges typically 20,000ns, 40,000ns & 100,000ns.
- High speed time domain sampling ~5GS/s
- Stack return signals for improved signal-to-noise 20,000, 100,000…..1million.

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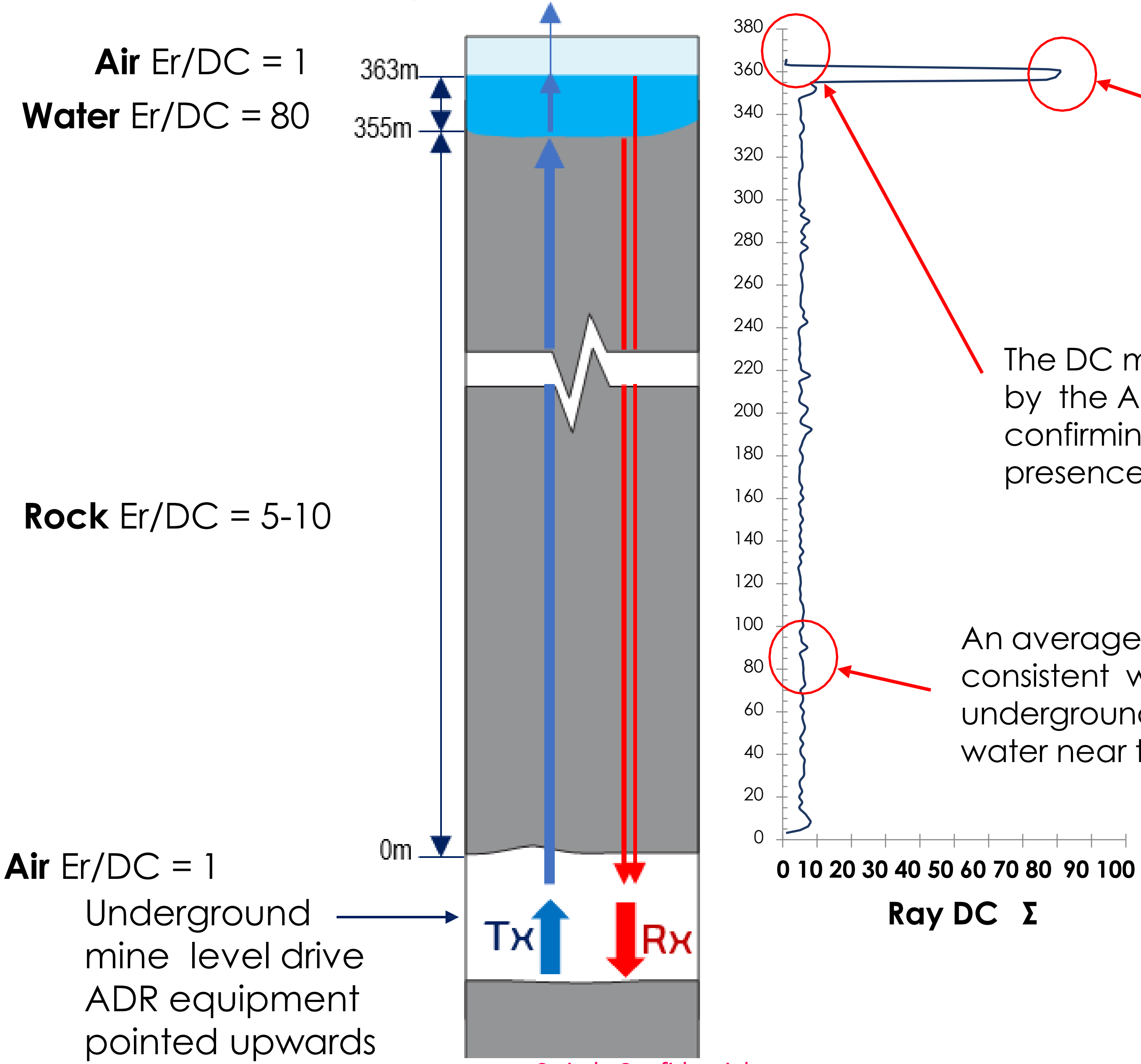
Propagation proven in underground mine



The DC measured by Adrok is 76.9-80.7 confirming the presence of **WATER**

The DC measured by the ADR tool is 1 confirming the presence of **AIR**

An average DC of around 7 is consistent with rock between the underground mine drive and the water near the surface

Reference
K. van den Doel, J.Jansen, M.Robinson, G. C. Stove, and G. D. C. Stove (2014) Ground penetrating abilities of broadband pulsed radar in the 1-70MHz range. SEG Technical Program Expanded Abstracts 2014: pp. 1770-1774. SEG Denver 2014 Annual Meeting. DOI

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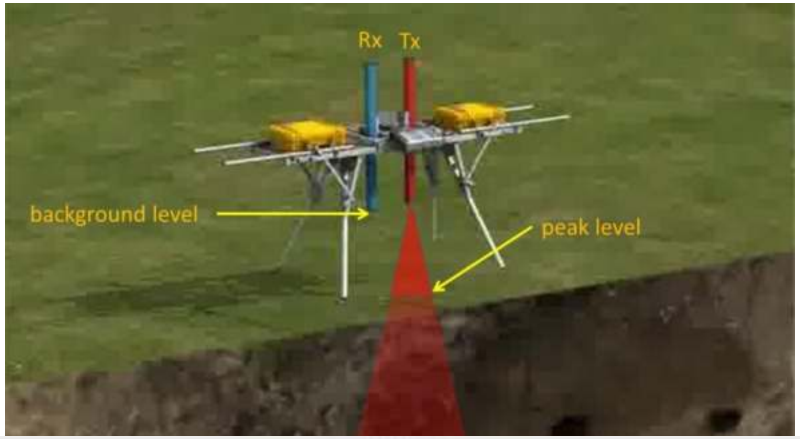
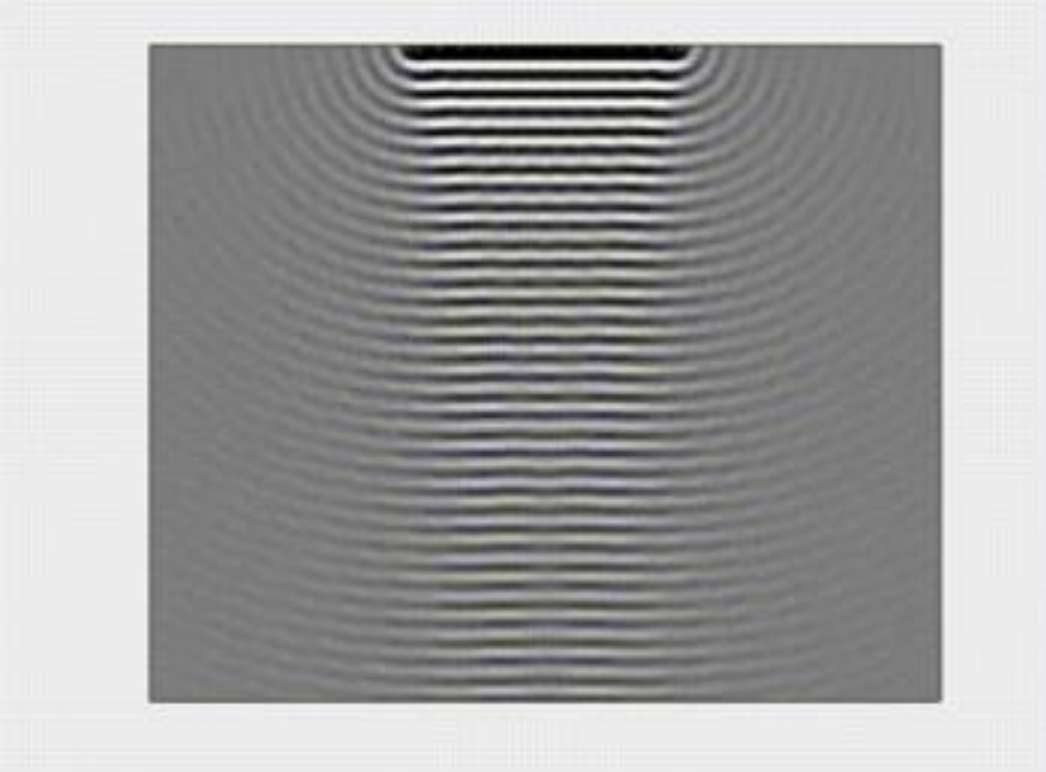
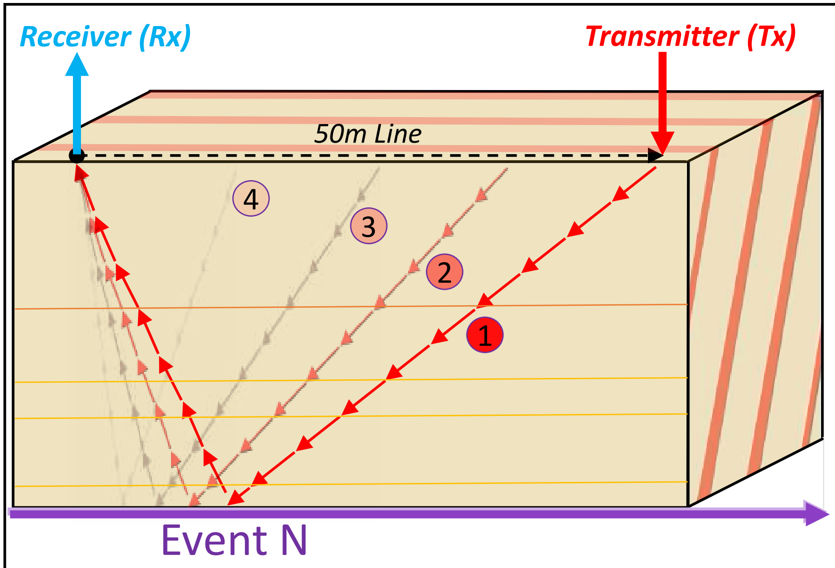
Wave propagation





- Line of transmitters in Wide Angled Reflection & Refraction (WARR) mode creates beam (Synthetic Aperture Radar, SAR based phased array); separating transmitter (Tx) from stationary receiver (Rx)
- For Stare scans Tx & Rx are stationary
- Profile Scans (P-Scans) move Tx & Rx along scan line to produce 2-D imagery

Depth conversion



Two way time from Tx at a given length of the line to Rx at 0 after event N reflection.

1 *TwT for Tx at 50m*
2 *TwT for Tx at 32.50m*
3 *TwT for Tx at 25m*
4 *TwT for Tx at 12.5m*

- WARR stands for Wide Angle Reflection and Refraction. These are 50m long lines that serve as Time-Depth calibration for our Stares, and are taken along the trend of the geology. An operator moves the Transmitter Antenna along a straight line and away from the Receiver Antenna, from, for example, 0m to 50m. Longer lines can be used to obtain deeper penetration.

- After that, and by analysing the Two Way Time (TwT) from common points, we can solve a depth-time equation. This is based on principles of Ray Tracing, solving the problem by repeatedly advancing idealized narrow beams called rays through the medium by discrete amounts. Simple problems can be analysed by propagating a few rays using simple mathematics.

Resolution:

- ✓ We are using a resolution in which we analyse the TWT every 0.5 to 2.5 metres.
- ✓ Rock layer resolution of approximately 30 to 40m.
- ✓ Vertical depth accuracy is approximately +/- 10m.
- ✓ Our analysis checks for the events every 3.3m along the line (that is 15 columns in X) and every 0.5m vertically (for a total of 400 lines in Y). The values acquired take into account the surrounding, averaging from the previous point.
- ✓ Therefore, every WARR is computed based on 6000 points.

Limitations:

- ➢ The manual process can involve intrinsic errors of around 2 to 5%.
- ➢ Strong changes in velocity can alter the depth-conversion significantly in unknown geological settings.
- ➢ Steeply dipping horizons challenge certain mathematical assumptions of the calculations, decreasing overall precision.
- ➢ Therefore, while the order of events will always be correct, the precise depth of the targets or boundaries may be metres away.

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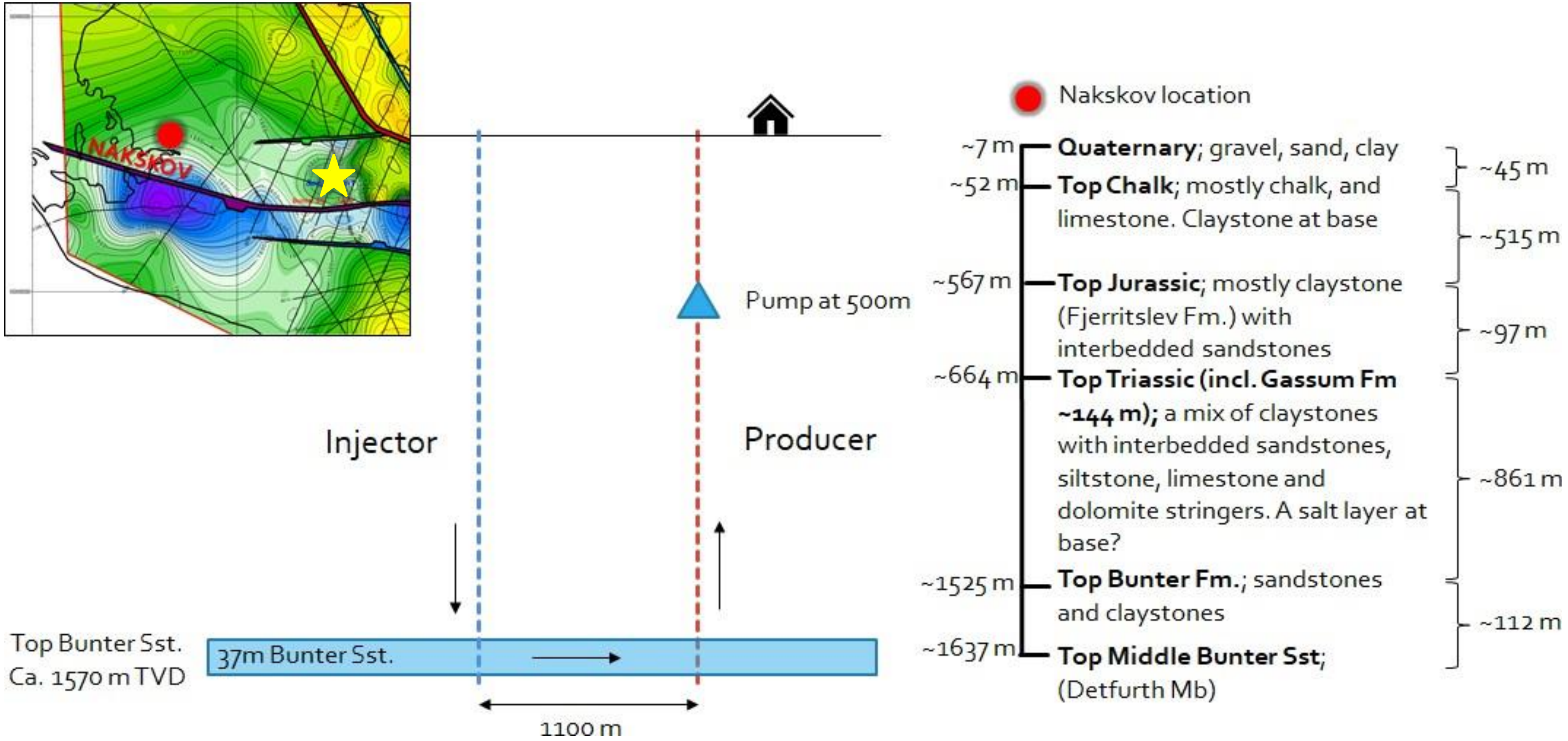
ADR Simulation Model input data



Rock layer	Dielectrics
Quaternary	5
Top Chalk	10
Top Jurassic	15
Top Triassic	8
Top Bunter Fm	4
Top Middle Bunter Sst	3

- Geological data provided for Denmark geothermal setting example.
- Transmit ADR wave packet from transmitter (Tx) and record reflections from receiver (Rx).
- Dielectrics of the materials (DC) as indicated in table are theoretical, based on Adrok's experience of similar rock types.
- Reflection from dielectric interfaces will arrive at time.
- 2*(10sqrt(5) + d*sqrt(Er)) * 1e9/3e8, with d the thickness of each layer.

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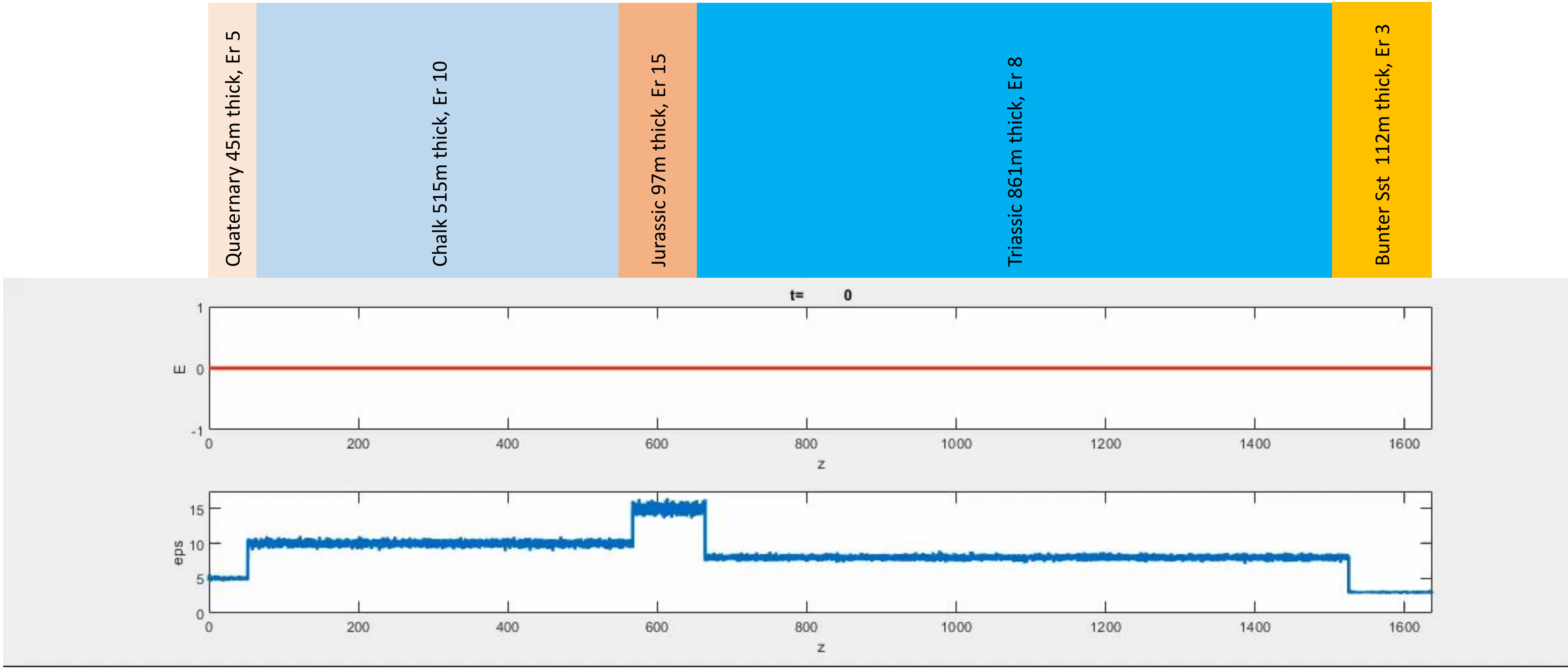
Finite Difference Time Domain (FDTD) simulation showing two-way-travel of ADR signal in rock layers



Overlain rock layers from ground level (0m) through the subsurface to depths of 1637m using input data from page 8.

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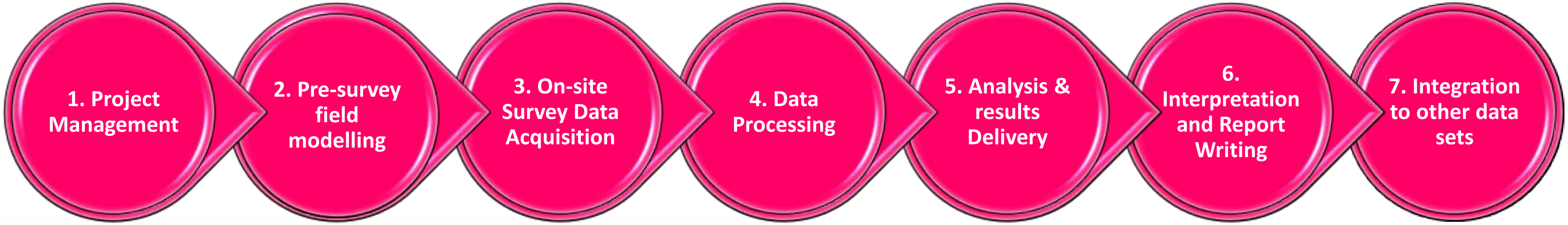
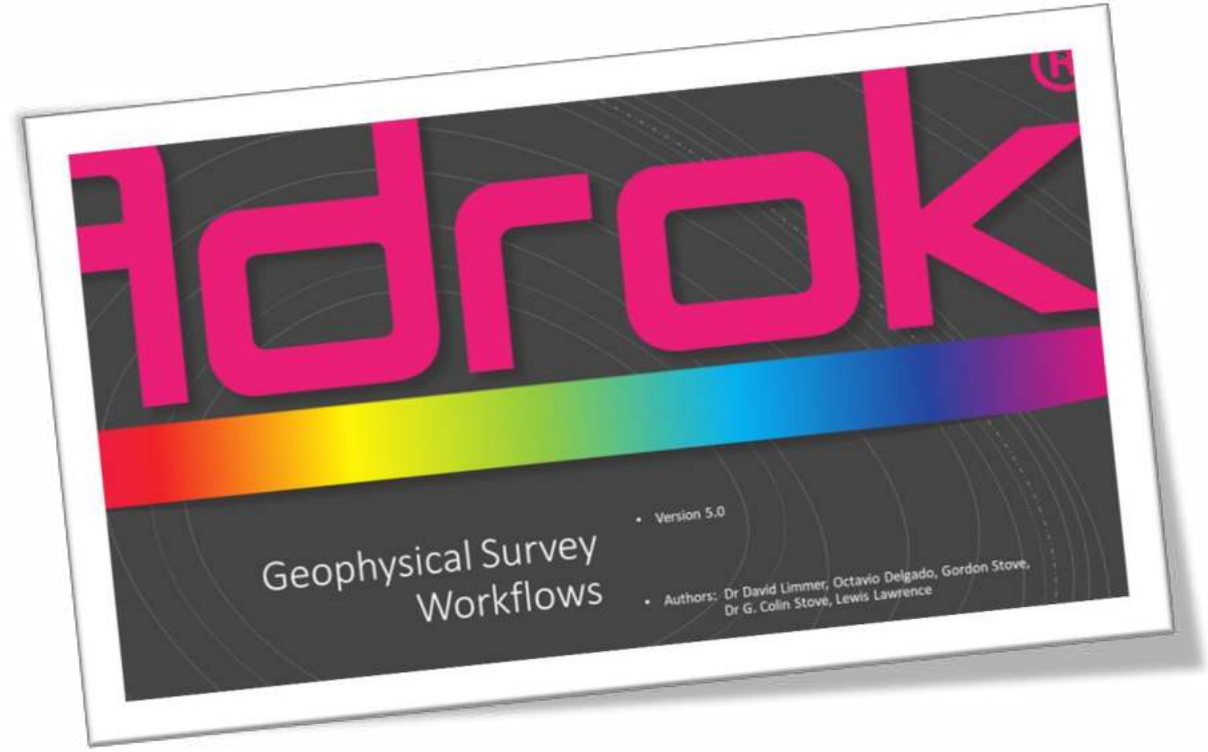
Stage-gated Workflows





- The Geophysical Survey Workflows describe which process will be performed in each stage of the project to ensure quality, repeatability and a successful completion.

THE BRITISH ASSESSMENT BUREAU ISO9001 Registration 188208

THE BRITISH ASSESSMENT BUREAU ISO27001 Registration 213059

INVESTORS IN PEOPLE™ We invest in people Gold

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At Adrok, we develop fast, cost-effective, environmentally safe and socially accepted technology to explore for natural resources. We power our equipment using compact, rechargeable batteries. The power we emit is less than 5milliwatts, meaning that our carbon footprint is exceptionally low, non-ionising and non-destructive.

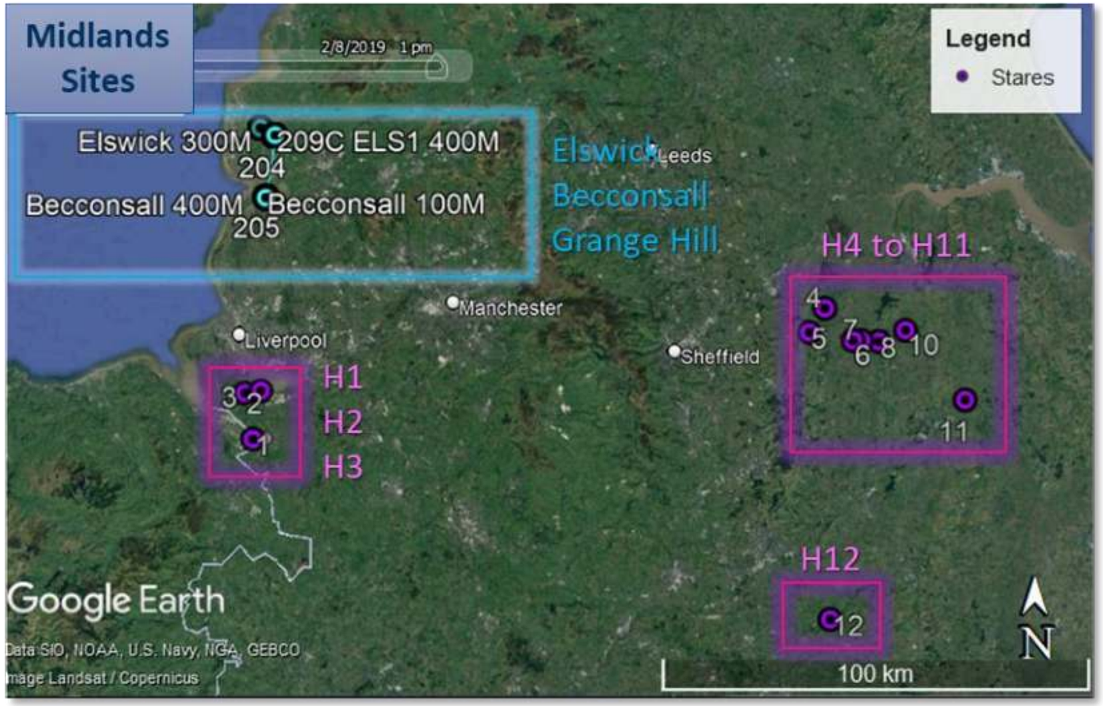
Our operations are environmentally harmless.

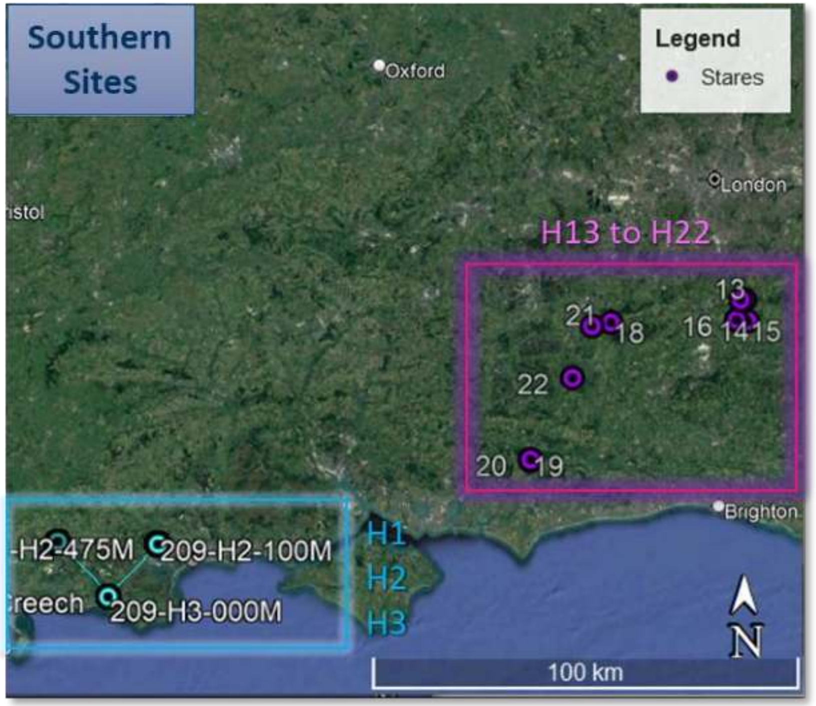
Case Studies: Repurposing onshore UK oil & gas wells

Case Studies: Onshore UK oil & gas wells

- Internal project for Adrok's development of geothermal tools.
- Reprocess 26 V-Bores from two separate Adrok projects:

    (1) collected in 2017 for Igas; and (2) collected in 2018 for Cuadrilla and Transgas.
- Project purpose: **to assess the geothermal potential at onshore O&G sites using our stare data.**
- Focus on showing the identified geothermal potential via the Energy Gamma toolsets, producing Visual E-Gamma graphs and a comparison with the temperature map of the UK at a depth of 1000m from Busby et al, 2011*.





* Busby J, Kingdon A, Williams J. The measured shallow temperature field in Britain. Q J Eng Geol Hydrogeol. 2011;44:373–87.

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Methods: Processing & Analysis

The flow diagrams below shows a synopsis of Adrok's processing methodology for this project.

Time-Depth Conversion

WARR Tracking

- WARR QAQC by analysing the range of frequencies and by identification of visual anomalies.
- Dielectric WARR tracking down to 200m at a 1m resolution, then AutoWARR to varying depths.

Phase Correction

- Completed based on the .DCO.
- Corrects the signal and produces a more accurate depth model after tracking.

Extraction of time-depth conversion

- Extraction of the time to depth conversion form the .xlsx file.

Virtual Borehole Processing

Stare Image Processing

- Stare QAQC by analysing the noise to signal ratio and by identification of visual anomalies.
- Merge of those stares with the best signal to noise ratio taken at a single location to boost signal strength.

Harmonics Processing

- Completed at 128 Pixels per step and 128 per window, with 8192 samples per window for temperature analysis.
- Produced Energy Gamma, across 32 Harmonics as a .prn in Radamatic.

Conversion to readable files

- Conversion from .prn Radamatic file to .csv excel file for further analysis.

Virtual Borehole Analysis

Data Analysis on the .csv

- E-Gamma = Energy-Gamma
- For temperature analysis, E-Gamma is processed with 8192 samples per window.
- E-Gamma values for the first 32 Harmonics of each horizon were averaged.
- Conversion of Time to Depth data using the .DCO file.

Temperature Impact Analysis

- E-Gamma values plotted against depth, for the full range from 0 to 1 and clipped ranges from 0.95 to 1 & 0.985 to 0.995.
- 10 point moving average graphs produced additionally for trend identification.
- Plotting the 20 most significant troughs of the log and stacking across nearby scans.

Methods: Averaged E-Gamma Analysis

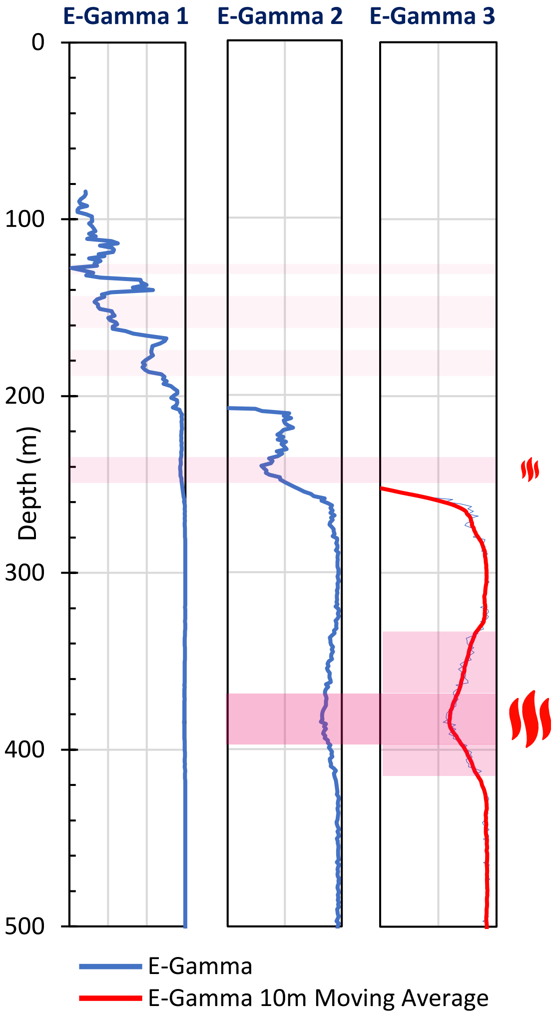
E-Gamma Moving Average Analysis

Pros

- V-Bore specific hotspots can be identified.
- Allows for thorough site by site analysis and comparisons.

Cons

- Visual analysis used if a baseline cannot be established from the training data.
- Cannot estimate temperatures, only identify zones that have high thermal impact.



For each virtual borehole three E-Gamma logs are displayed from left to right.

E-Gamma 1: Shows data within values of 0.25 to 1.

E-Gamma 2: Shows data within values of 0.95 to 1.

E-Gamma 3: Shows data within values of 0.985 to 0.995, also shows the 10m Moving Average in red.

This method of identifying E-Gamma troughs as temperature anomalies is good for targeting hot zones or aquifers, due to the high contrast in temperature with adjacent units. However, the method is not as effective at identifying geothermal gradients.

"Hot zones" are interpreted when the E-Gamma moving average falls below 0.99. This is where we interpret high temperature.

Confidence of ADR derived geothermal potential at scanned sites

High Confidence Mid Confidence Low Confidence

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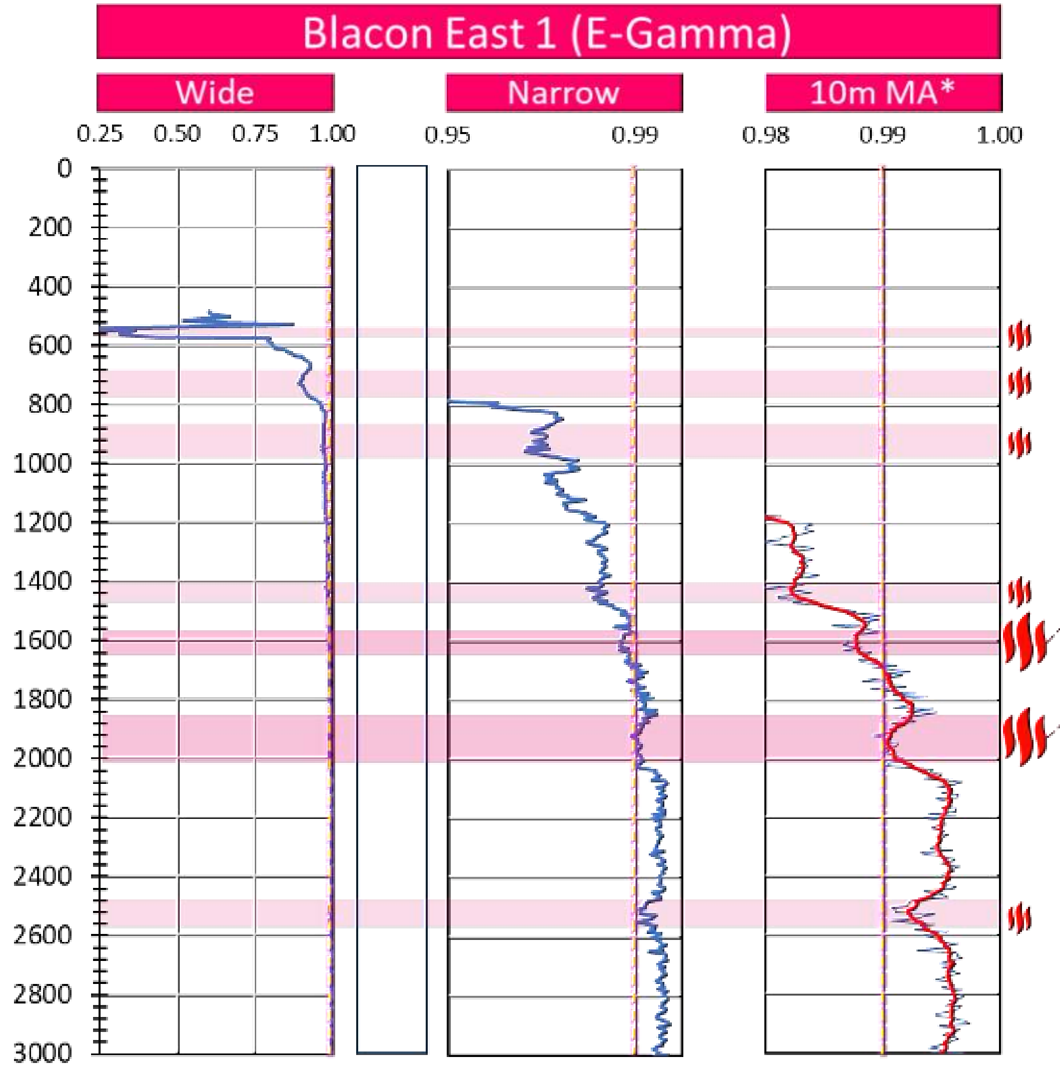
H1 – Blacon East 1:

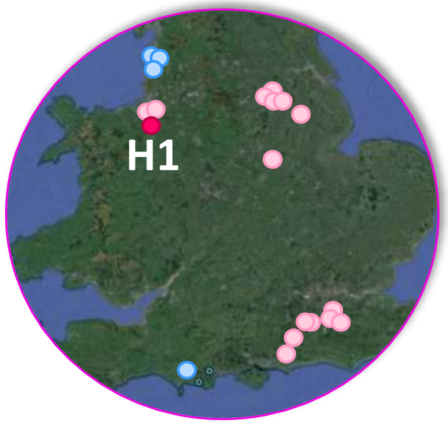
High Confidence Geothermal Site



High Confidence Geothermal Site

E-Gamma

E-Gamma 10 metres Moving Average*



The three graphs in the slide show the same dataset at increased levels of detail. As the signal travel deeper, we needs to look at smaller variations within.

Any areas with outstanding troughs may be indicative of locally increased temperature. We are most interested in the spots where the signal approaches 0.99 after passing it for the first time.

- **Major Targets:**
  - **Target 1:** The strongest thermal impact at the site. Thinner than the following one but more intense. Located at 1560-1640m.
  - **Target 2:** Wider but weaker target deeper down from the previous one. The trough seems more relevant, but does not consistently trespass the 0.99 baseline. Located at 1840-2010m.
- **Minor Targets:**
  Up to 5 minor targets are found in this site. The first three occur between 560 and 980m. The last occurrence is at 2480-2560m.
- **Trend Observations:**
  Overall, this site shows **strong indications of thermal impact**, with well defined troughs and peaks. Most of the Energy Gamma readings are above the baseline.

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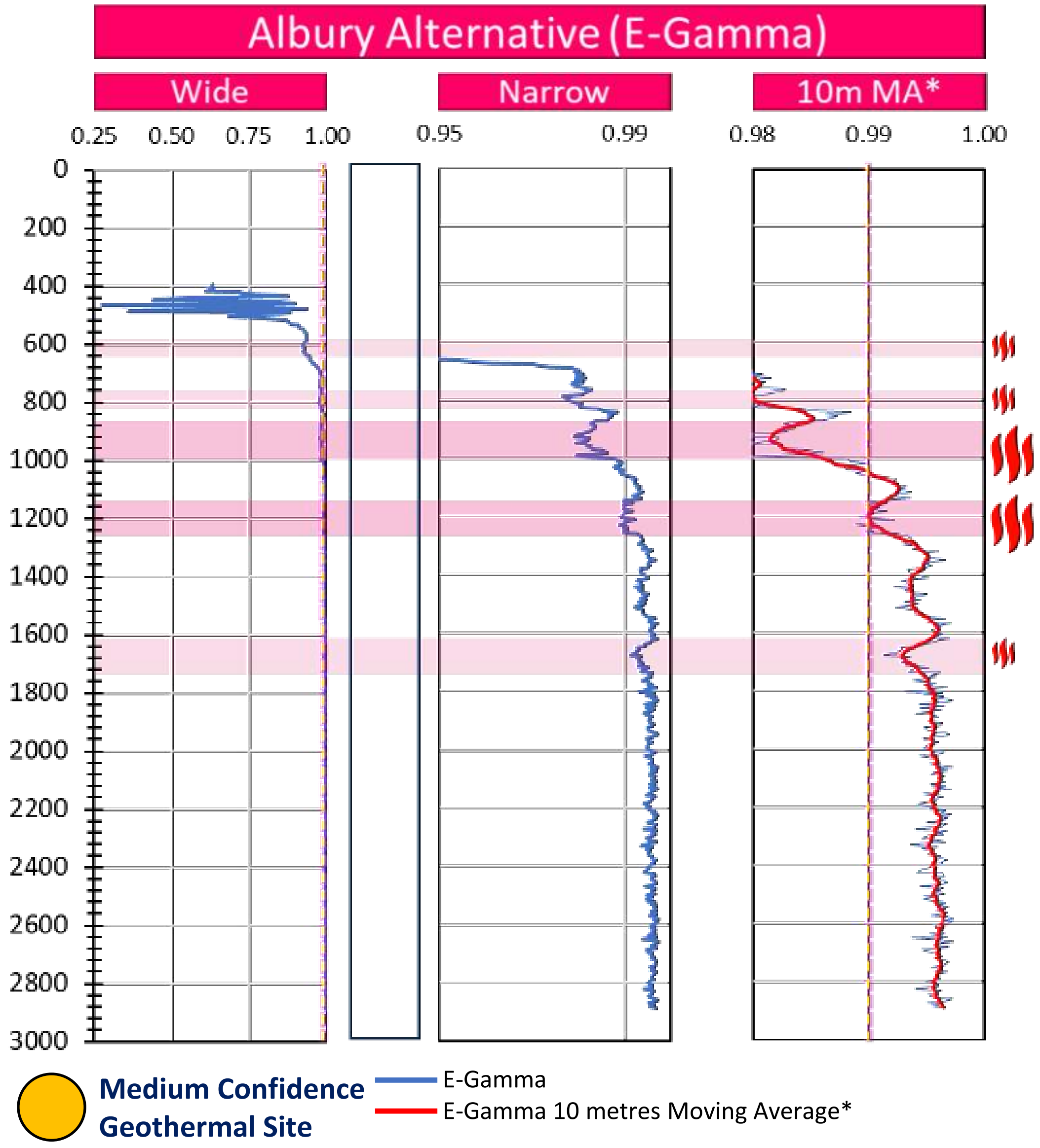
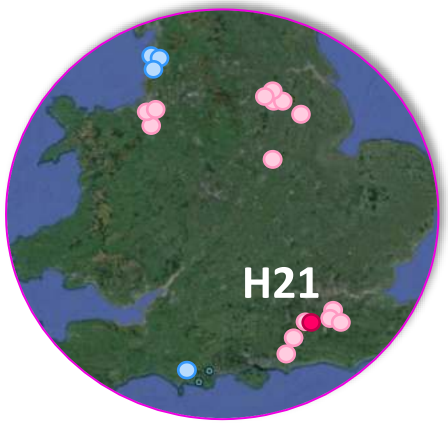
H21 – Albury Alternative:

Medium Confidence Geothermal Site



The three graphs in the slide show the same dataset at increased levels of detail. As the signal travel deeper, we needs to look at smaller variations within.

Any areas with outstanding troughs may be indicative of locally increased temperature. We are most interested in the spots where the signal approaches 0.99 after passing it for the first time.



- **Major Targets:**
  - **Target 1:** The strongest thermal impact at the site However, the moving average does not reach the 0.99 stabilization before the troughs, reducing the confidence on this target. Located at 880-1000m.
  - **Target 2:** Weaker target deeper down from the previous one. The trough seems more relevant, but does not consistently trespass the 0.99 baseline. Located at 1160-1250m.

- **Minor Targets:**
  Up to 2 minor targets are found in this site. The first two occur between 600 and 800m. The last occurrence is at 1600-1720m.

- **Trend Observations:** Overall, this site shows moderate indications of thermal impact, with well defined troughs and peaks.

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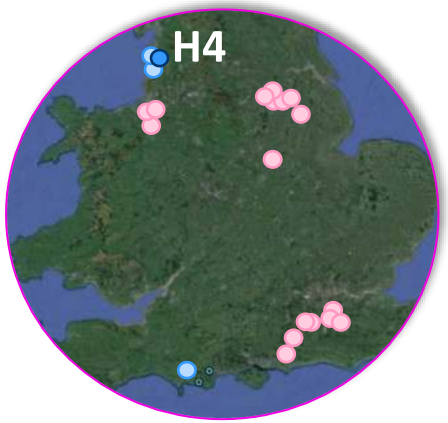
H4 @ 300M – Becconsall:

Low Confidence Geothermal Site

The three graphs in the slide show the same dataset at increased levels of detail. As the signal travel deeper, we needs to look at smaller variations within.

Any areas with outstanding troughs may be indicative of locally increased temperature. We are most interested in the spots where the signal approaches 0.99 after passing it for the first time.



- **No Major Targets:** This log does not show any major targets below the relevant baseline.
- **Minor Targets:**
  The single target appears before signal stabilisation and is weak, located at 520-600m.
- **Trend Observations:**
  There is only a single low-confidence minor target, this is not a prospective location.

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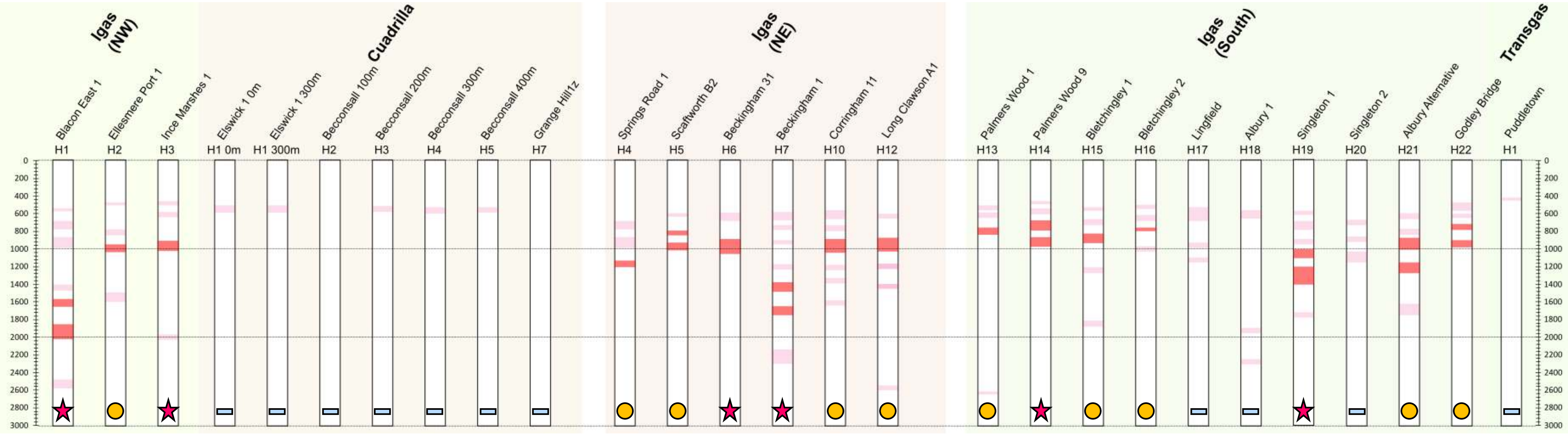
Discussion: Integration of results



- Integration of all the sites analysed with the data and model from Busby et al, 2011 and a comparison between the areas of high temperature at 1000m depth to the geothermal potential derived from ADR readings. This is presented with a vectorized version of the Watson et al, 2020* maps derived from the Busby et al 2011** models.

- The panel above summarizes the targets found at each site, with brighter red for targets that meet the baseline, and more transparent red for very low confidence targets. Each site also has a mark (star, circle or bar) that indicates the overall geothermal confidence level.

Confidence of ADR derived geothermal potential at scanned sites

- High Confidence
- Mid Confidence
- Low Confidence

*** Watson, Sean & Falcone, Gioia & Westaway, Rob. (2020). Repurposing Hydrocarbon Wells for Geothermal Use in the UK: The Onshore Fields with the Greatest Potential. Energies. 13. 3541. 10.3390/en13143541.**
**** Busby J, Kingdon A, Williams J. The measured shallow temperature field in Britain. Q J Eng Geol Hydrogeol. 2011;44:373–87.**

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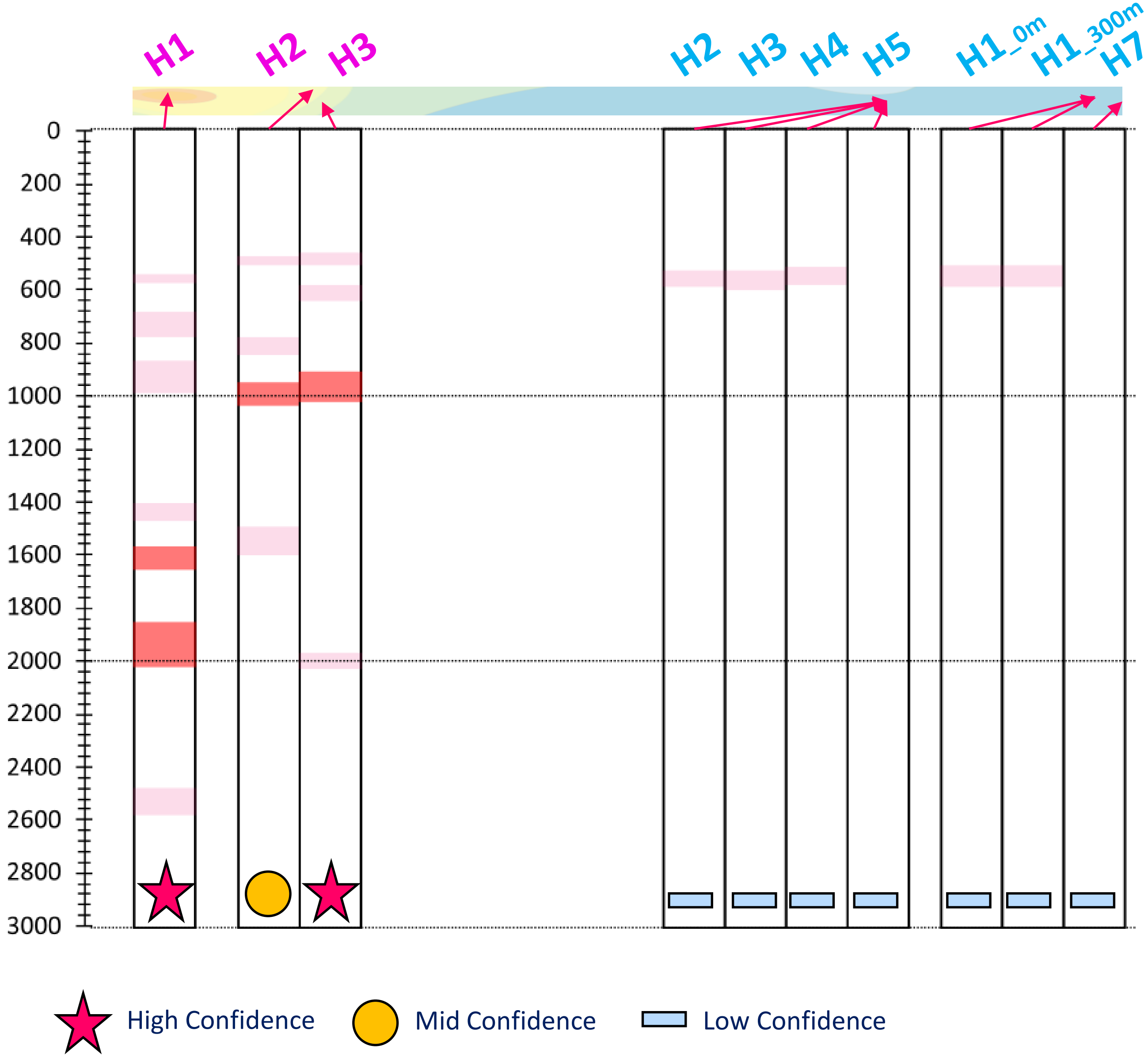
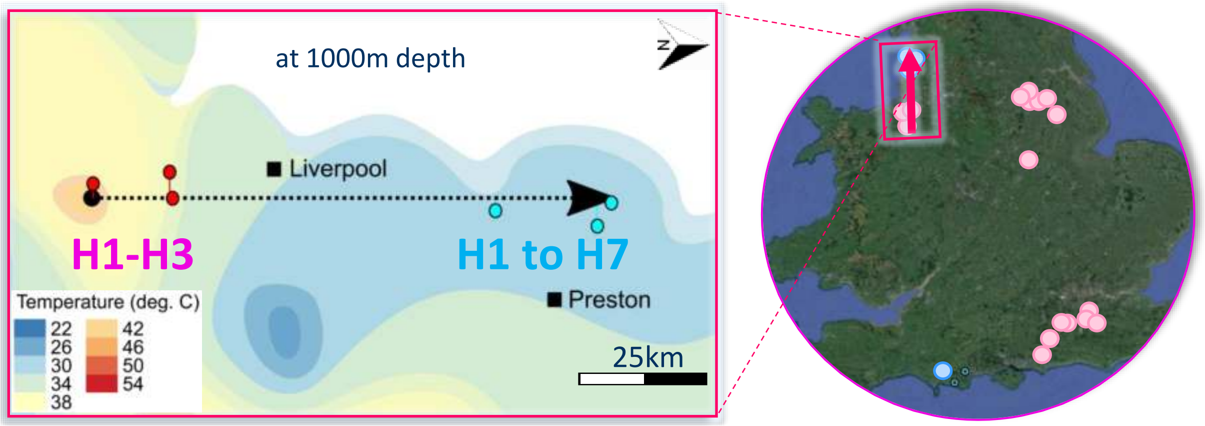
Discussion: North-West panel



- This is a panel cross-section in NW England, from the south of Liverpool to north of Preston. It shows how the Energy Gamma derived temperature prognosis changes northward in a trend that decreases in both intensity of the energy indicators, and confidence.
- The prognosis closely matches the validation provided by the Busby et al, 2011 geothermal maps as shown in the vectorized version of the Watson et al, 2020 maps.
- H1(project 1) is indeed the highest confidence and best position for geothermal potential in this area, both based on ADR prognosis and the map, while the blue sites (project 2) are located in a relatively colder area.



*Map vectorized from Watson et al, 2020

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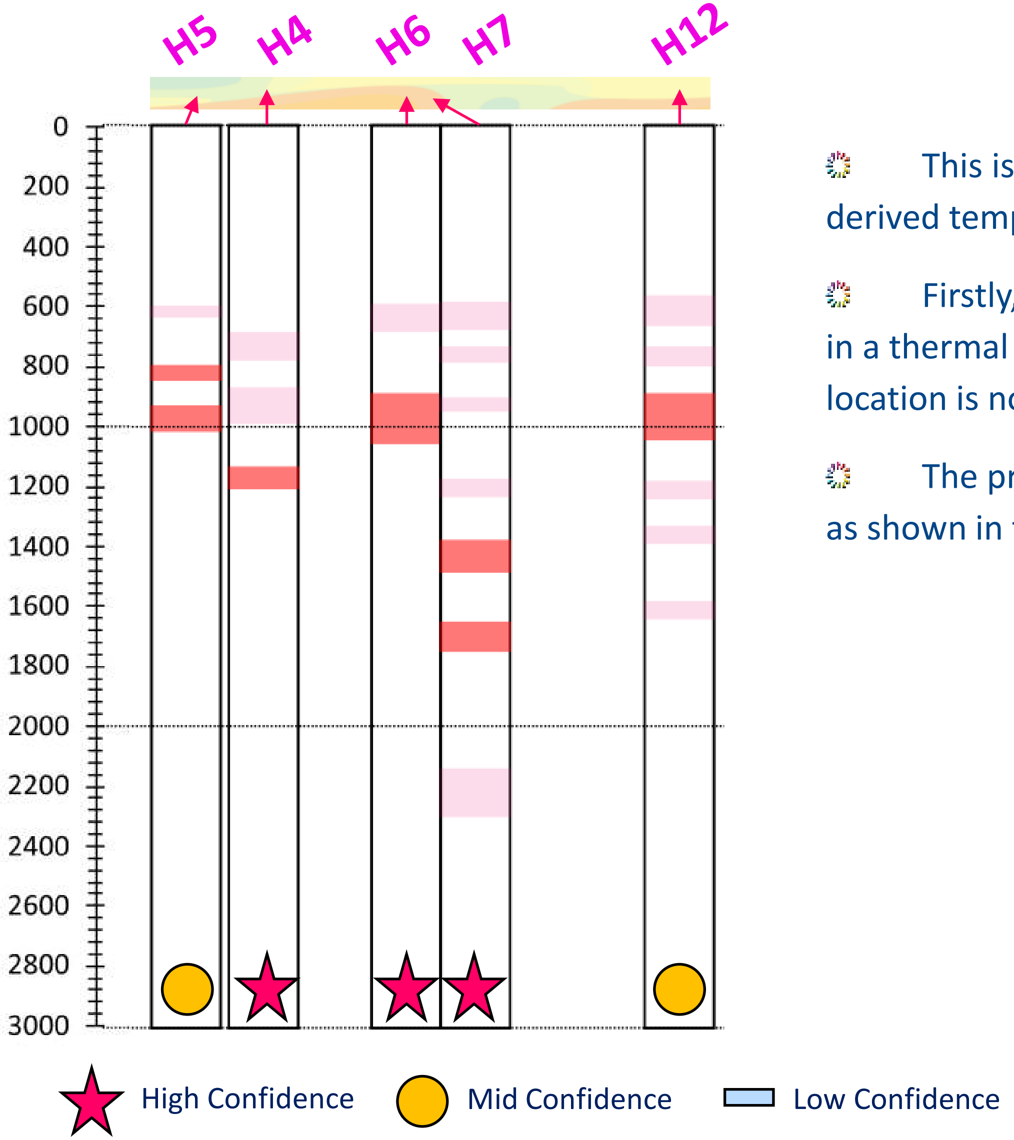
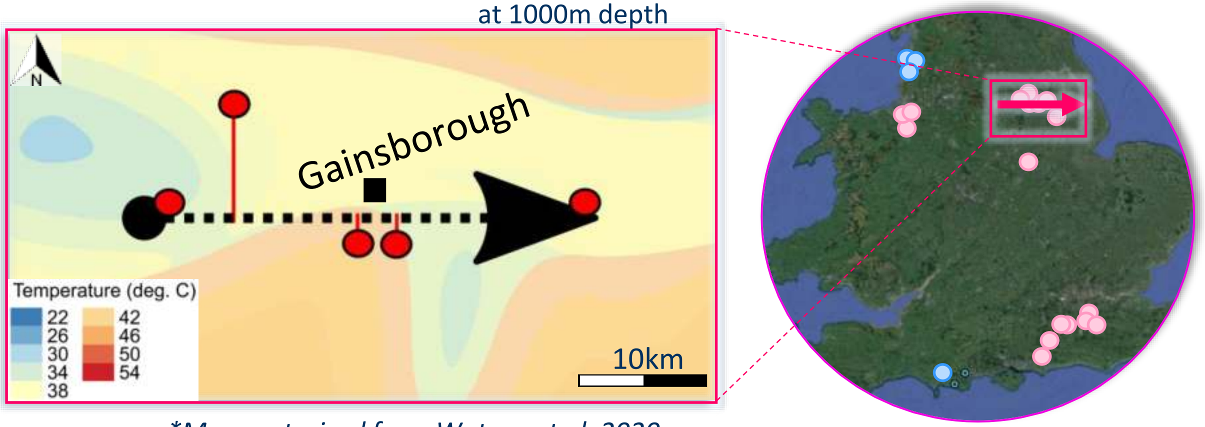
Discussion: North-East panel



- This is a panel cross-section in NE England, around Gainsborough. It shows how the Energy Gamma derived temperature prognosis changes eastwards.

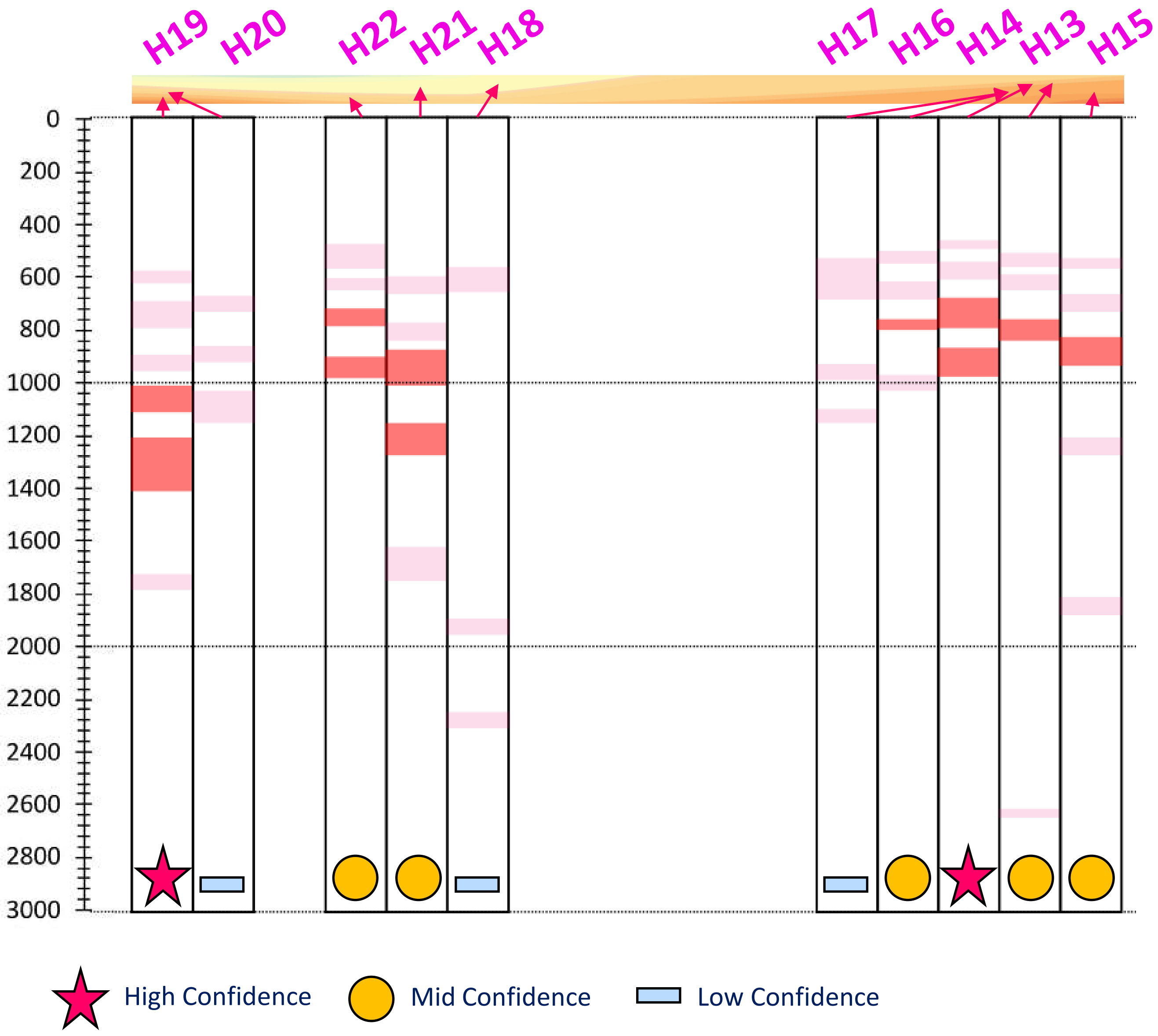
- Firstly, the ADR results show medium confidence, but then as it approaches Gainsborough, located in a thermal high, the confidence increases. On the easternmost site, the confidence reduces again. That location is not far away from a thermal low.

- The prognosis closely matches the validation provided by the Busby et al, 2011 geothermal maps, as shown in the vectorized version of the Watson et al, 2021 maps.

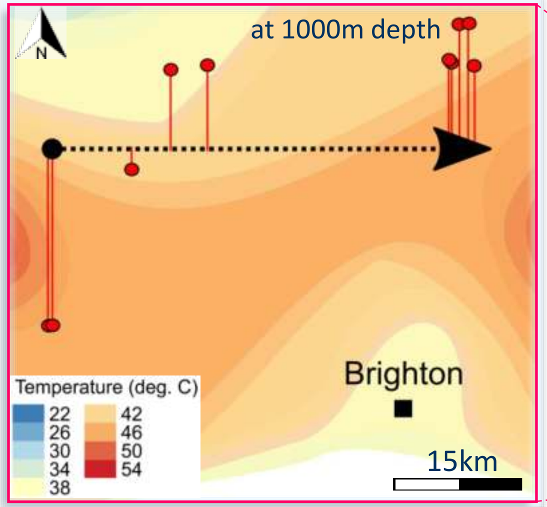


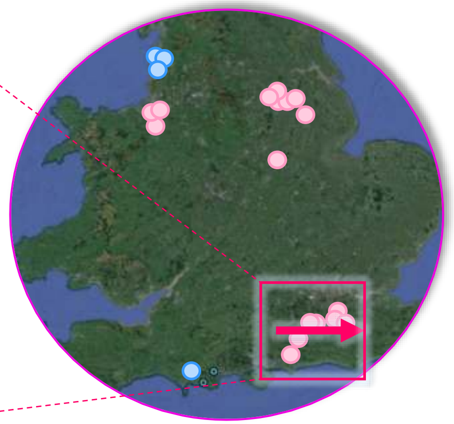
*Map vectorized from Watson et al, 2020

Discussion: South England panel



- This is a panel cross-section in SE England, north of Brighton. It shows how the Energy Gamma derived temperature prognosis changes eastwards.
- The location with highest confidence and greatest thermal prognosis is H19, and it's close to the thermal high in the model. H22 to H18 are closer to a northern thermal low, and have lower confidence in the ADR interpretation. For the western sites, as the sites approach a western thermal high, the confidence and thermal impact grow as well.
- The prognosis closely matches the validation provided by the Busby et al, 2011 geothermal maps, as shown in the vectorized version of the Watson et al, 2021 maps.





**Map vectorized from Watson et al, 2020*

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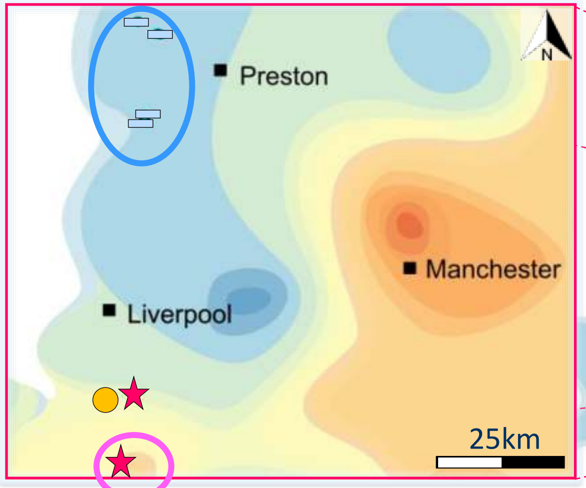
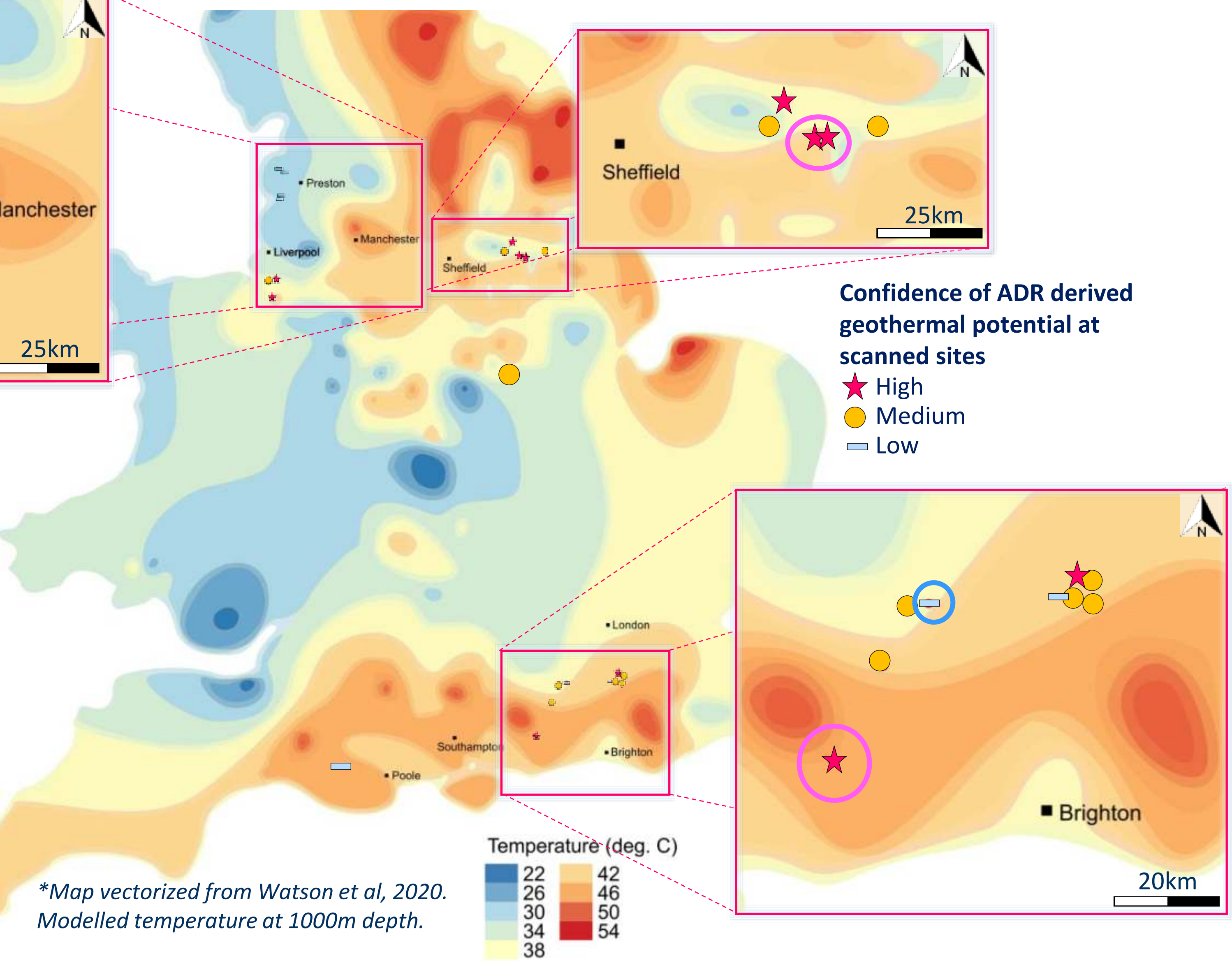
Strictly Confidential

Conclusions: ADR geothermal assessment

- Considering the ADR prognosis into a regional scale in context with the thermal model at 1000m depth (Watson et al, 2020), we can see strong correlation.



- Sites near the thermal highs are invariably of high confidence, while sites in blue low-thermal areas display much less confidence on the ADR prognosis. This provides examples of **true positives** (south of Liverpool, west of Sheffield and east of Brighton) as well as **true negatives** (around Preston and north of Brighton).



Map vectorized from Watson et al, 2020. Modelled temperature at 1000m depth.

The ADR thermal prognosis technique can be used as a regional geothermal exploration tool.

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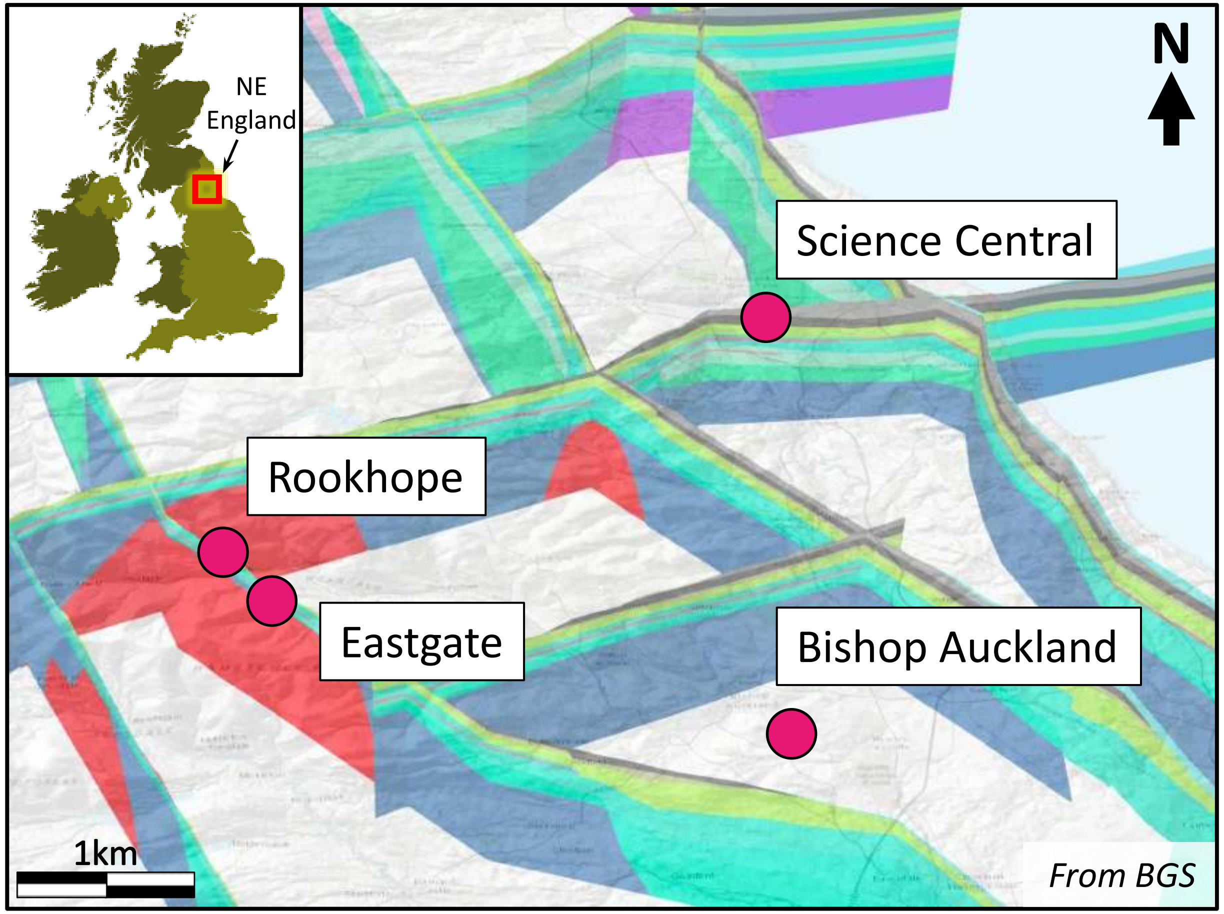
Case Studies: NE England

Case Studies: NE England

- There are two different geological settings within this NE England project that have a large impact on the geothermal scenarios that may be encountered.
- Science Central & Bishop Auckland are both situated within successions of Carboniferous Limestones and Sandstones. This means that the geothermal setting is likely to be a deep aquifer related to heat transfer from the many granite batholiths in NE England.
- Drilling at Science Central has confirmed a high geothermal gradient of 39°C/km (13°C/km higher than the UK average), with a potential reservoir in the Fell Sandstone at 1418m deep (Younger, 2016)*. Unfortunately, our Science Central V-Bores have an end depth of 1368m, so we cannot analyse the Fell Sandstone as a potential hot sedimentary aquifer.
- There has been no deep drilling at Bishop Auckland, therefore this is a blind sites. We can make assumptions on the geological settings based on the BGS geology maps.
- Rookhope & Eastgate are both situated directly above the Weardale Granite, which drilling has pinpointed at depths of 390m & 270m, respectively. The Weardale Granite is expected to be a strong source of heat in the area, with post-drilling logging at Eastgate showing temperature of 46.2°C at 995m (10-15°C higher than the UK average).
- Significant volumes of hot saline water was also encountered during drilling at Eastgate, particularly at 410m depth (PB Power, 2005)**.



Lithology Key:

Pennine Middle Coal Measures Formation	Unnamed igneous Intrusion	Dinantian Rocks
Pennine Lower Coal Measures Formation	Alston Formation	Ordovician Rocks
Stainmore Formation	Tyne Limestone Formation	Intrusive Igneous Rocks (Weardale Granite)

** Younger, P.L., et al., 2016. Geothermal exploration in the Fell Sandstone Formation (Mississippian) beneath the city centre of Newcastle upon Tyne, UK. Quarterly Journal of Engineering Geology and Hydrogeology, 49(4), pp.350-363.*

*** PB Power & University of Newcastle, 2005. Eastgate Geothermal Exploration Borehole, Final Report. British Geological Survey, NY93NW97.*

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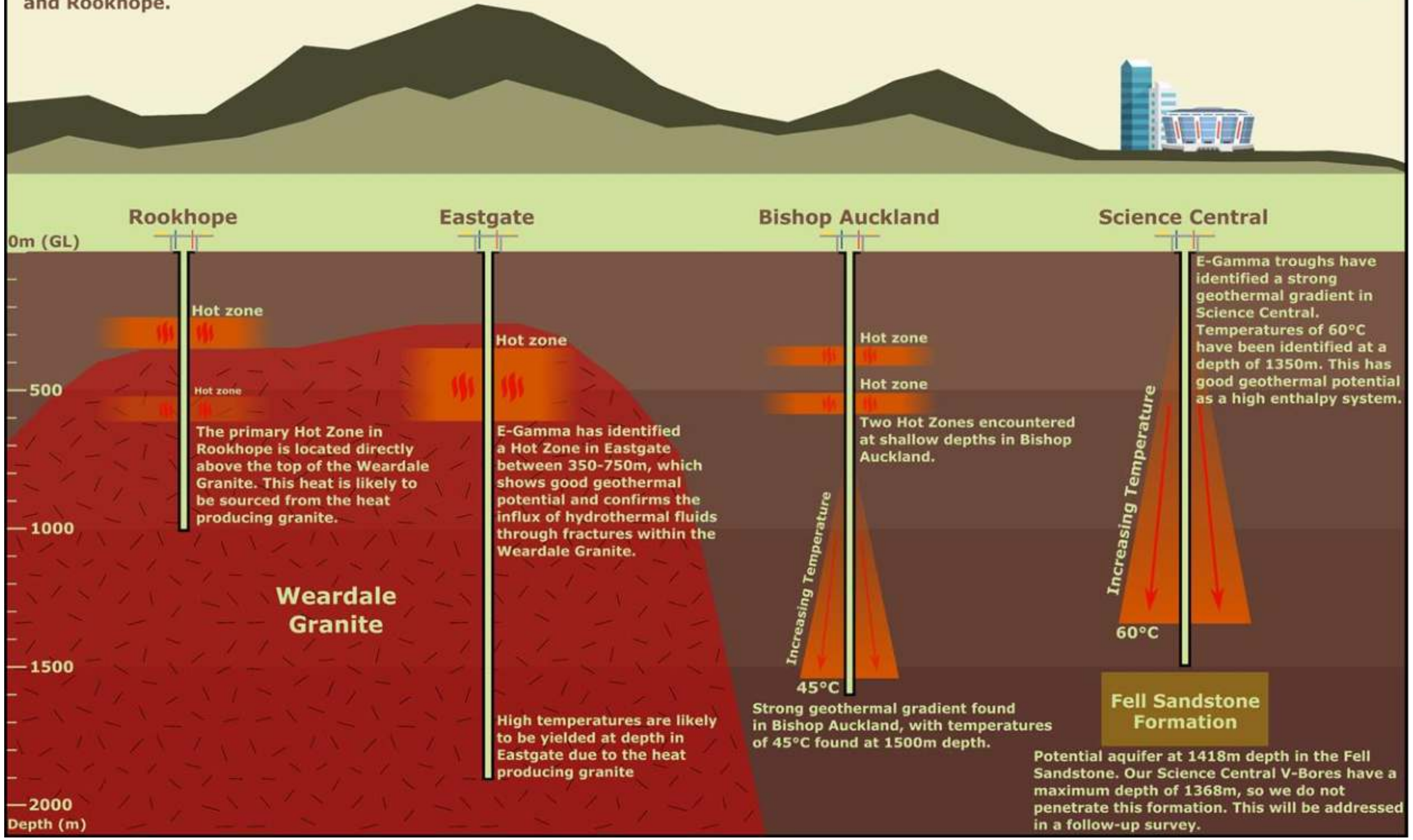
Case Studies: NE England

This project was undertaken by Adrok as a technology capability demonstration for onshore subsurface geothermal heat identification. The data was previously collected during April & November 2014. Adrok has reprocessed the data in July 2021 using the latest tools and workflows, with a focus on 4 geothermal sites across North-East England; Science Central, Bishop Auckland, Eastgate & Rookhope.

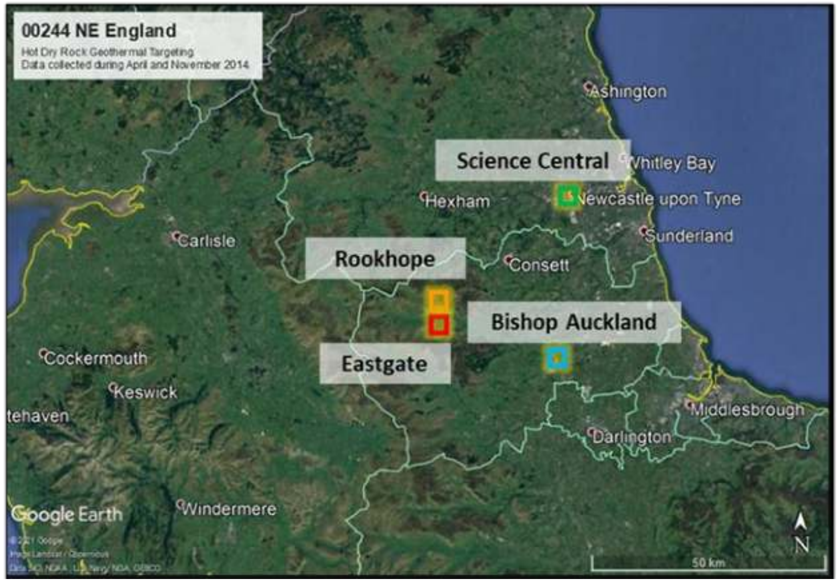
The primary goal is to use E-Gamma and Adrok's Temperature Neural Network to identify the high geothermal gradients and potential gothermal systems that are expected to be present across the four sites. A secondary goal will be to map the Weardale Granite in Eastgate and Rookhope.



The final conclusions are that **Science Central and Eastgate have the best Geothermal Potential**. Science Central has an enhanced geothermal gradient (60°C at 1350m) that may host a high enthalpy system. Eastgate hosts a hot hydrothermal zone at 350-750m within fractures in the Weardale Granite.

A future survey should have two main priorities:

- Repeatability studies at Science Central, Eastgate & Rookhope.
- Deeper V-Bores at Science Central, targeting the potential aquifer in the Fell Sandstone.



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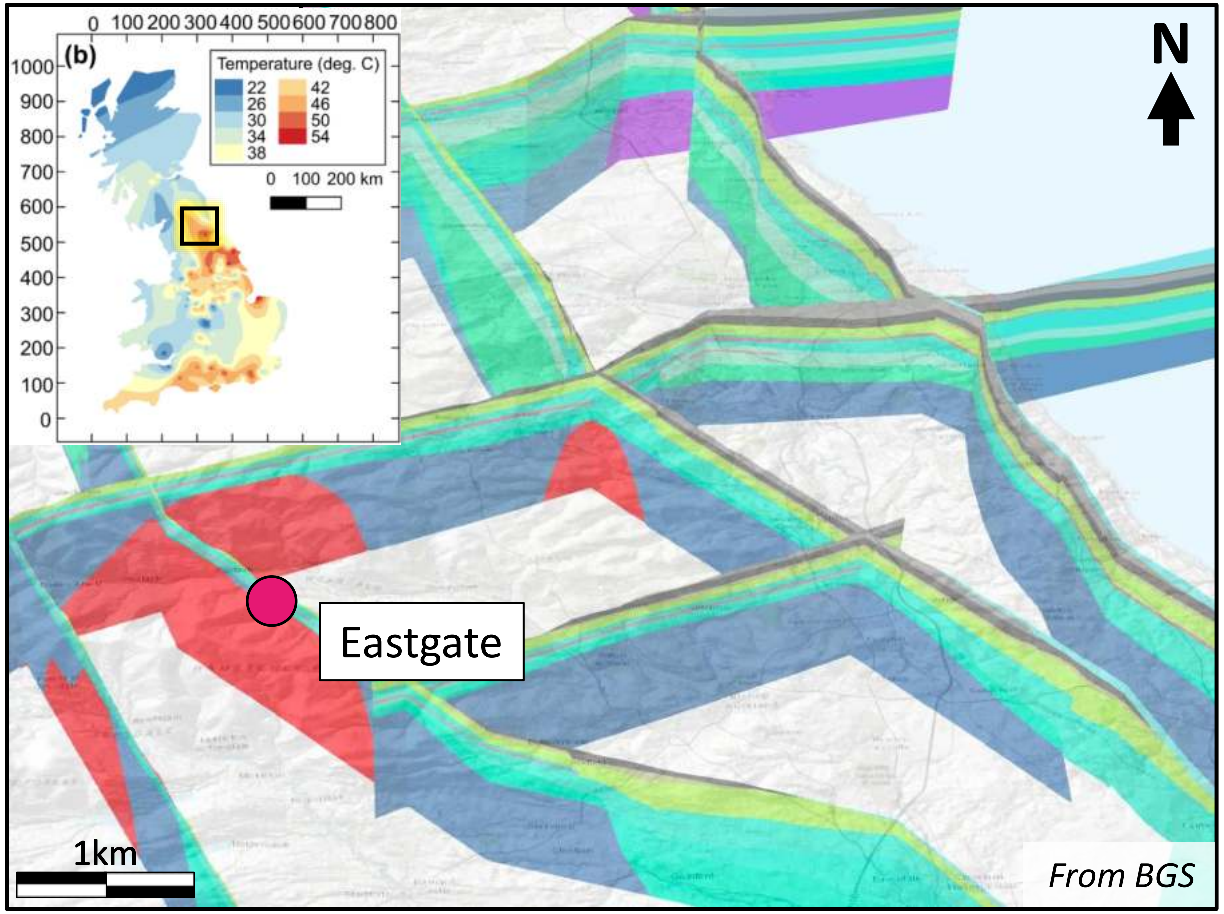
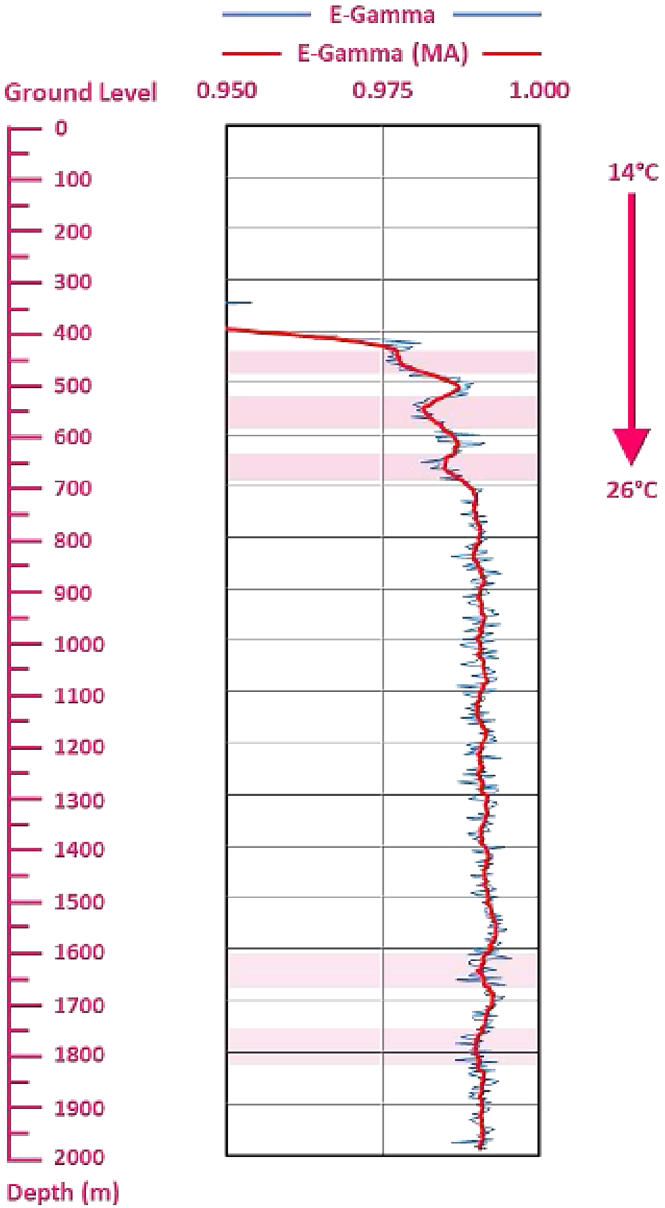
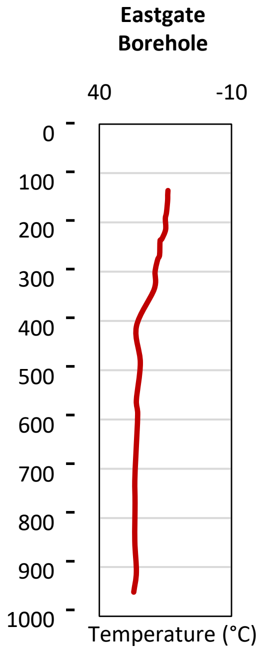
Validation: Eastgate E-Gamma Heat



Lithology Key

- Pennine Middle Coal Measures Formation
- Pennine Lower Coal Measures Formation
- Stainmore Formation
- Unnamed igneous Intrusion
- Alston Formation
- Tyne Limestone Formation
- Dinantian Rocks
- Ordovician Rocks
- Intrusive Igneous Rocks (Weardale Granite)





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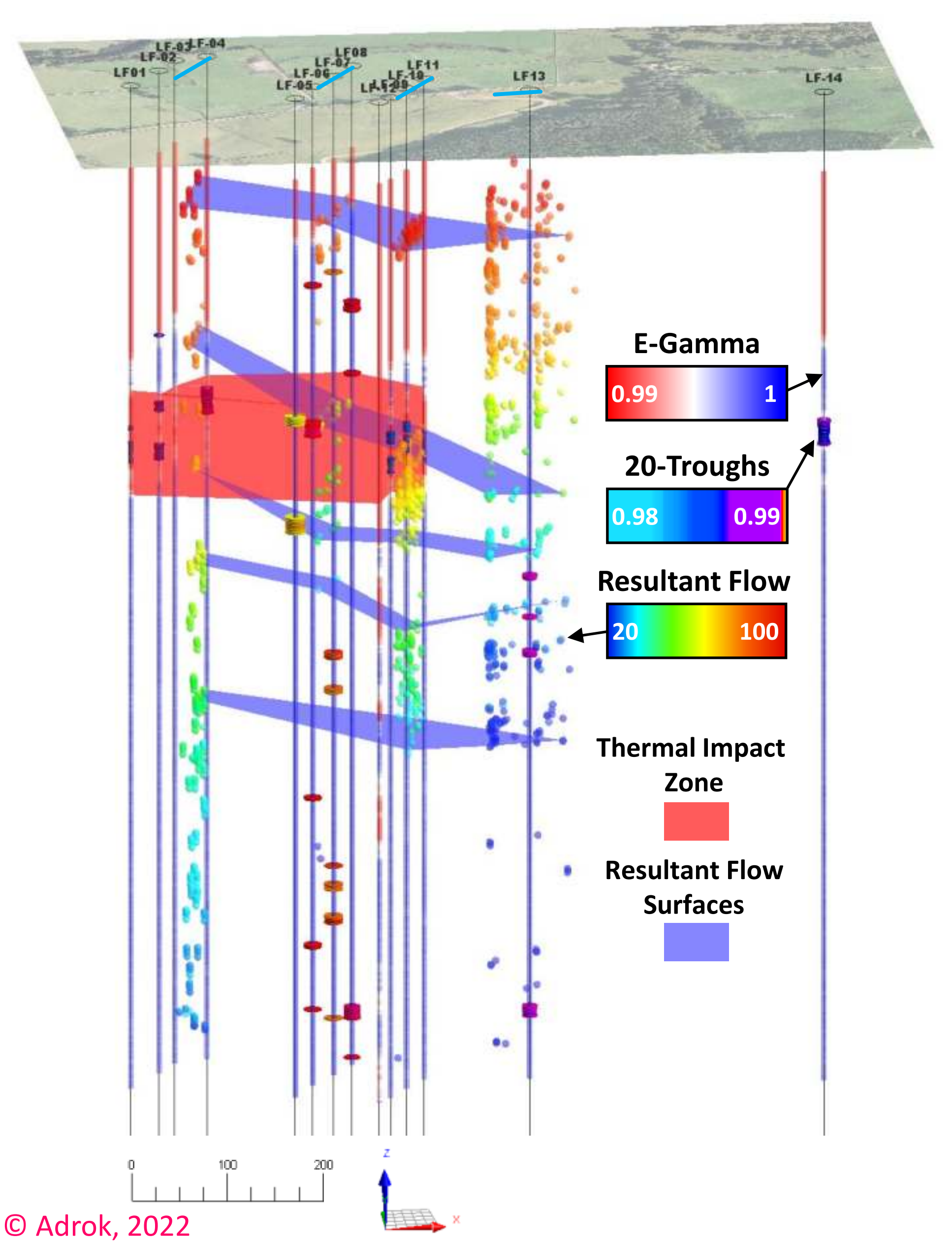
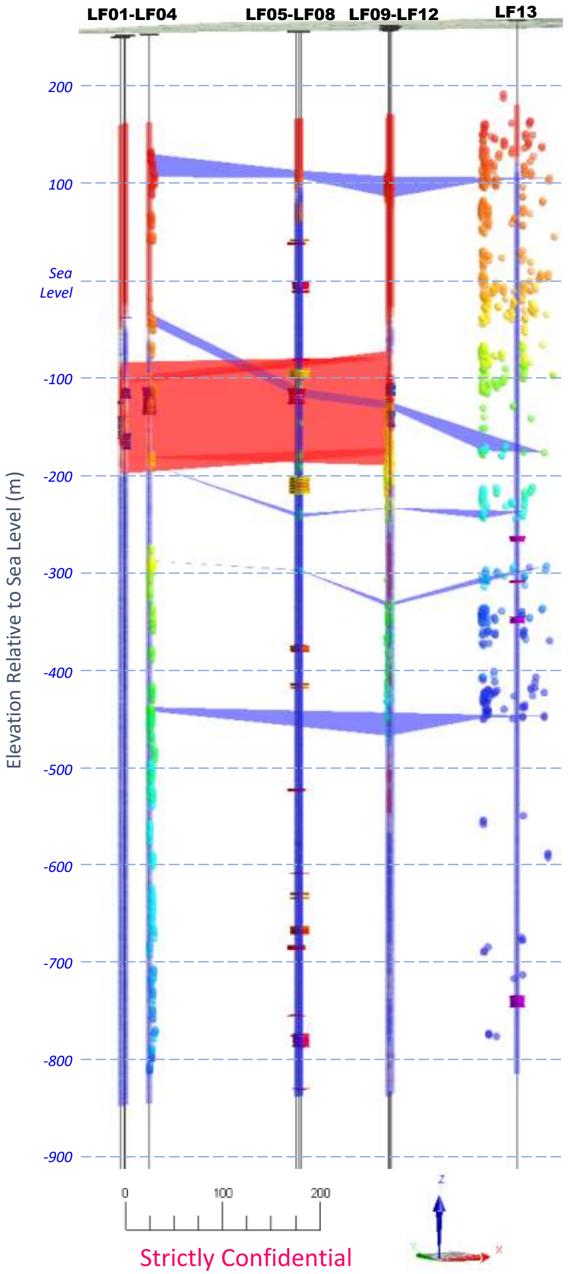
3D Surfaces: Heat & Flow Integration





- Integrating the thermal impact surfaces/block with the resultant flow surfaces gives an idea for the location of high heat flow, where there could be a presence of hot saline fluids.
- The primary regions of overlapping heat and flow from surfaces is located from 80-140m depth BSL, in sites LF-05 to LF-12.
- From these sites, the highest thermal impact zone is along the profile from LF-09-LF-12, which includes LF-10.
- **Overall, the 3D surfaces for thermal impact and resultant flow suggest high heat flow potential from 80-140m depth BSL in sites LF-09 to LF-12.**
- **We are able to create these 3D models and surfaces when we have a high data density**

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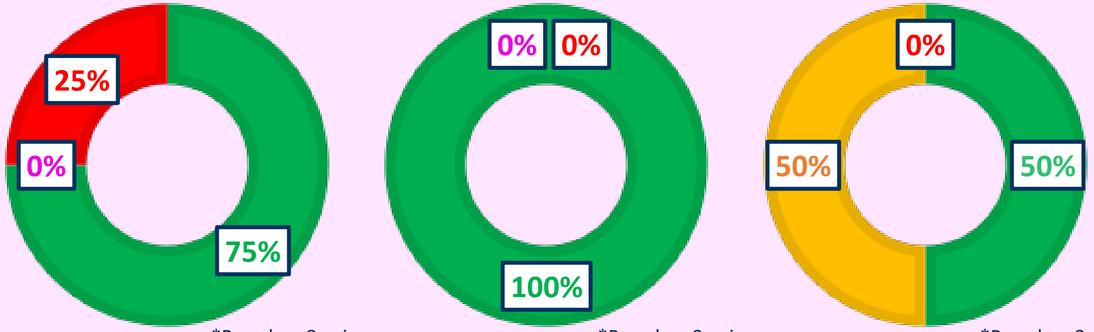
Repeatability: NE England, 2021 & 2022 scans

Individual E-Gamma	Averaged E-Gamma	E-Gamma Top 20 Troughs



*Based on 8 pairs *Based on 2 pairs *Based on 2 pairs

Key: Good Repeatability Moderate Repeatability Poor Repeatability

Data Collection
- V-Bore Location
- Equipment Used
- RCU Settings
- TCU Settings

WF3

WF4

Data Processing
- FFT Characteristics
- Processing Tools
- Processing Methods

Results Analysis
- E-Gamma Temperature Procedure
- E-Gamma Temperature Results
- Top 20 Troughs Analysis Procedure
- Top 20 Troughs Analysis Results

WF5

WF6

Reporting and Interpretations
- Interpretation Procedures
- Reporting Procedure
- Geothermal Potential Conclusions

Key:
- Good Repeatability
- Poor Repeatability

Controlled Variables	*Uncontrolled Variables*
➢ V-Bore location ➢ RCU & TCU Settings used ➢ Equipment used ➢ Field survey team ➢ Processing methods ➢ Data processing team	➢ Environmental Factors ➢ External noise (e.g. satellites)

ASSESSMENT

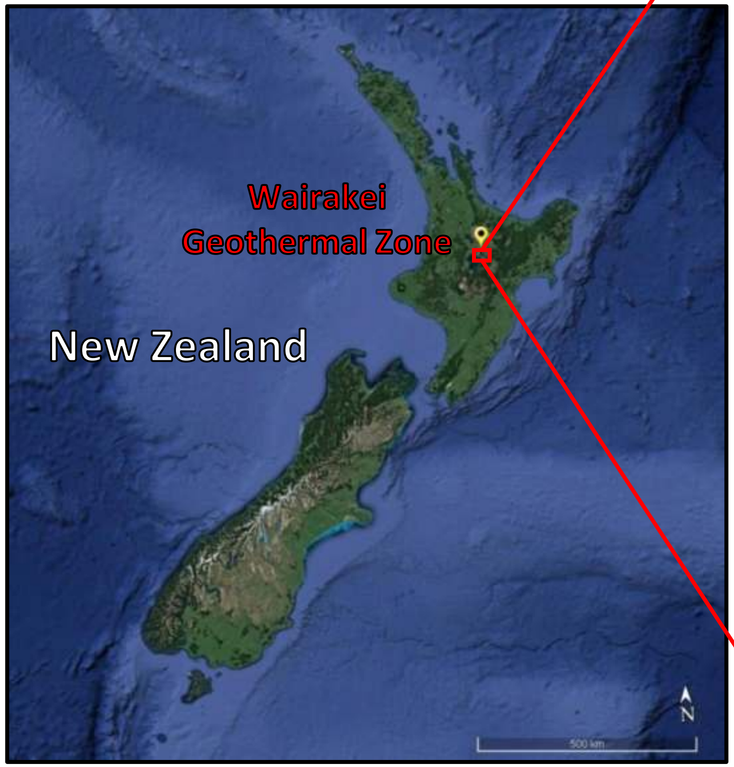
Overall, the repeatability between 2021 project results and the 2021-Repeat results is very good across multiple settings..

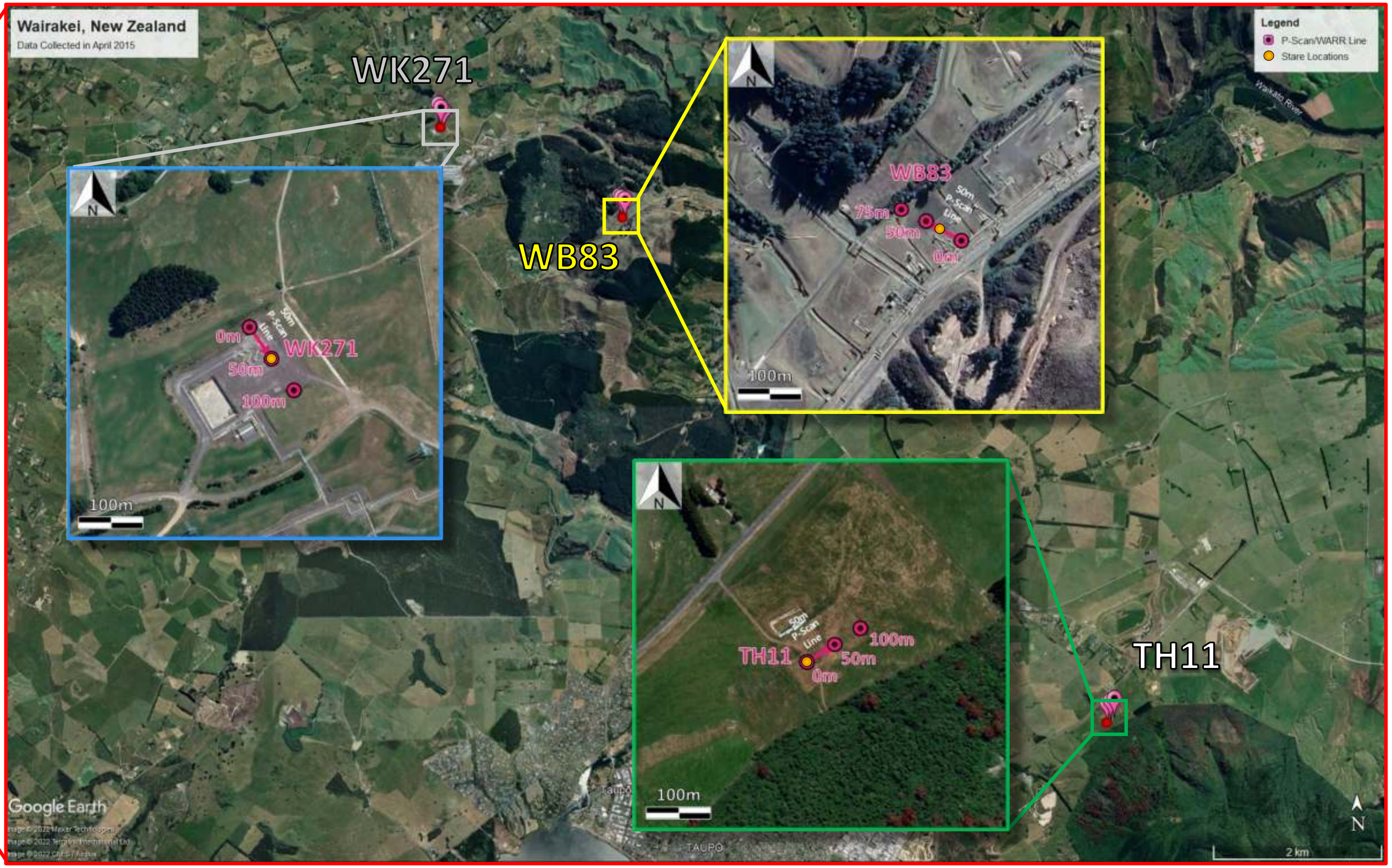
The vast majority of results have displayed good repeatability, with 75% of the individual E-Gamma results, 100% of the site averaged E-Gamma results and 50% of the Top 20 E-Gamma Trough results showing good repeatability. This leads to very good repeatability in the final geothermal interpretations.

Case Studies: New Zealand

Case Studies: New Zealand

The Wairakei Geothermal Field is a well established, producing geothermal zone that sits above the Taupo Volcanic Zone, that is known to have high geothermal potential, so we should expect ADR to be able to identify these geothermal zones. The data collection programme was completed successfully during May 2015.





Introduction: Geological Background

- The Wairakei-Tauhara field is an active zone of the Lau-Havre extensional back arc basin, formed by the subduction of the Pacific plate beneath the Australian plate.
- The field is underlain by a combination of NE-SW to ENE-SW striking faults (***Fig 1***) which, with the associated fracture networks, form important pathways for circulation of hydrothermal fluids.
- The primary reservoir unit is the Wairakei Ignimbrite (Wk) which formed 320-340ka (***Fig 2*** and ***Fig 3***). The Wairakei Ignimbrite is up to 50m thick, however, the lateral extent is not fully understood. The Wairakei Ignimbrite has good permeability near the Wairakei powerplant. This is overlain by the Waiora Formation (Wa), which is a sequence of volcaniclastics mixed with sandstones and mudstone (***Fig 2***). There are many Andesitic and Rhyolitic layers within the Waiora Formation.

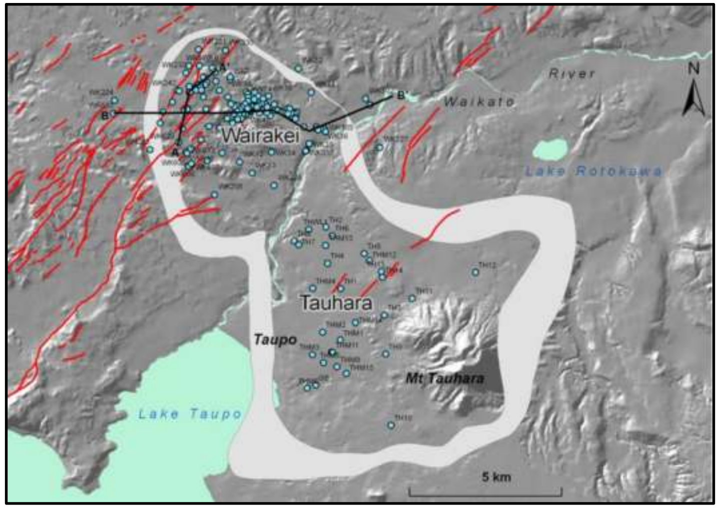
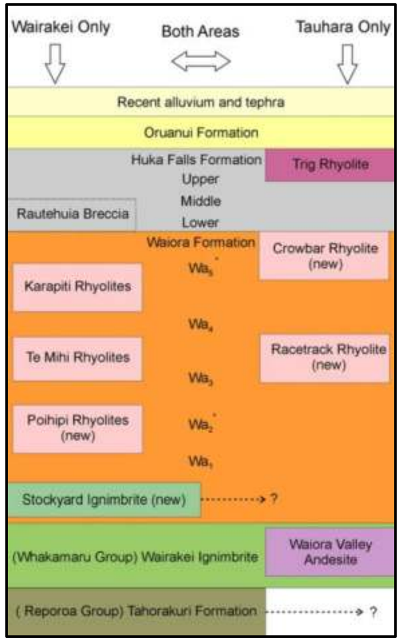


Figure 1: Digital Terrain Map of the Wairakei-Tauhara Field showing drill holes (circles) and faults (red). Rosenburg et al. 2009.



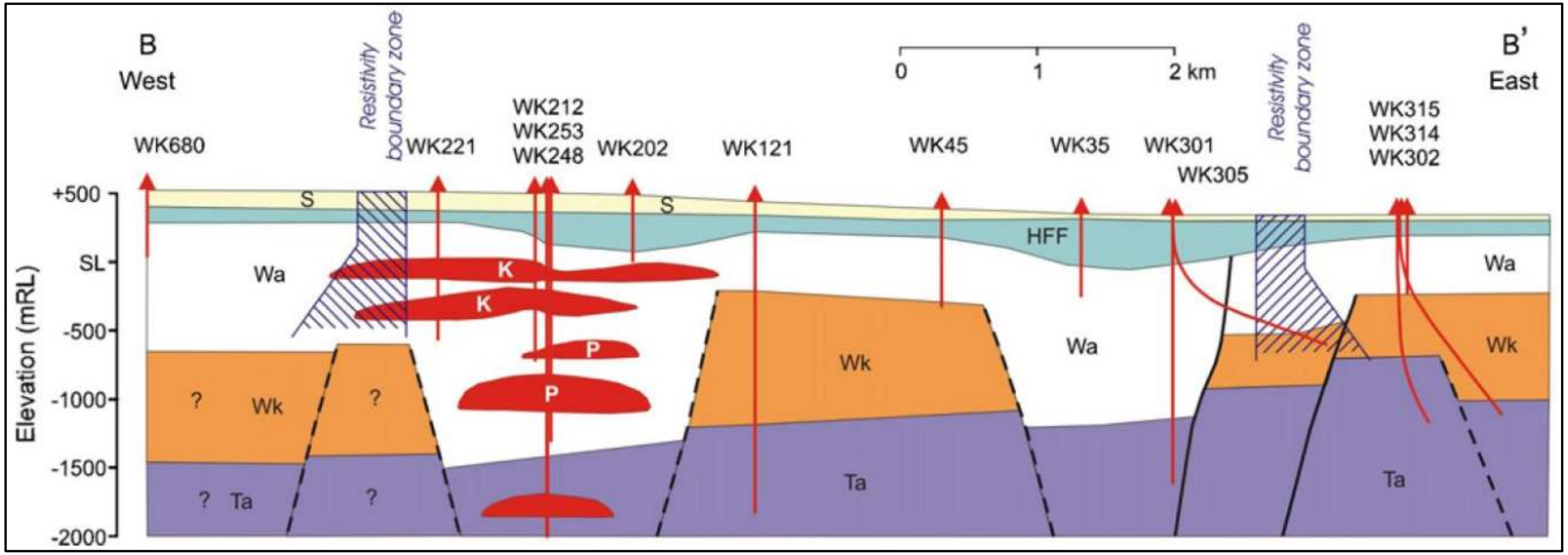
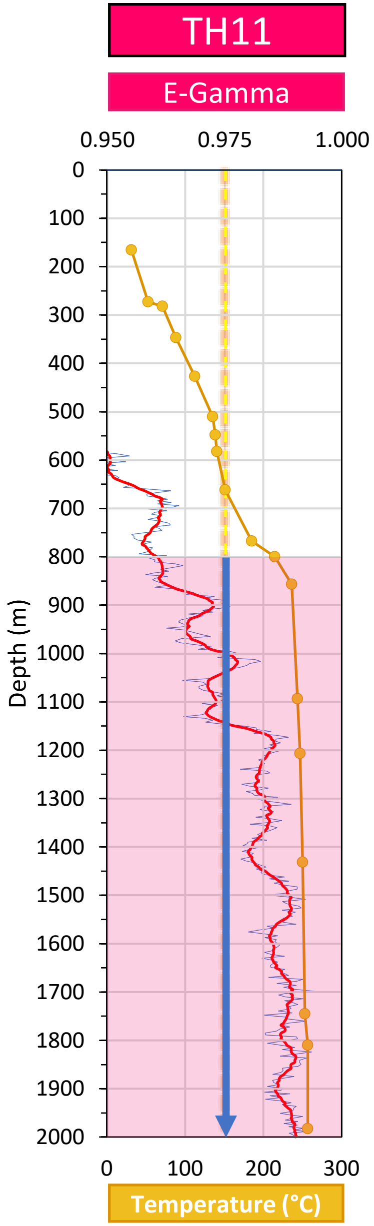


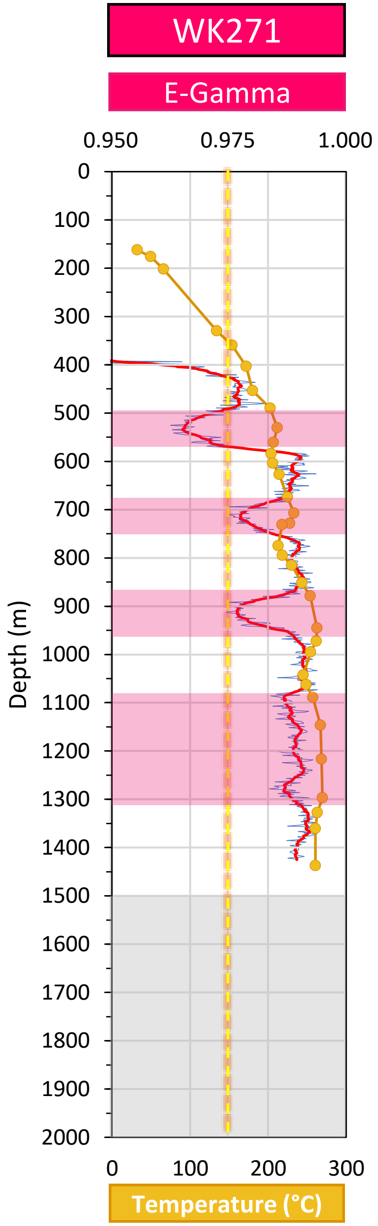
Figure 2: Major stratigraphic units in Wairakei. Rosenburg et al. 2009.

Figure 3: 2D interpretation of structural elements at Wairakei. Rosenburg et al. 2009.

Conclusions: New Zealand ADR Geothermal potential

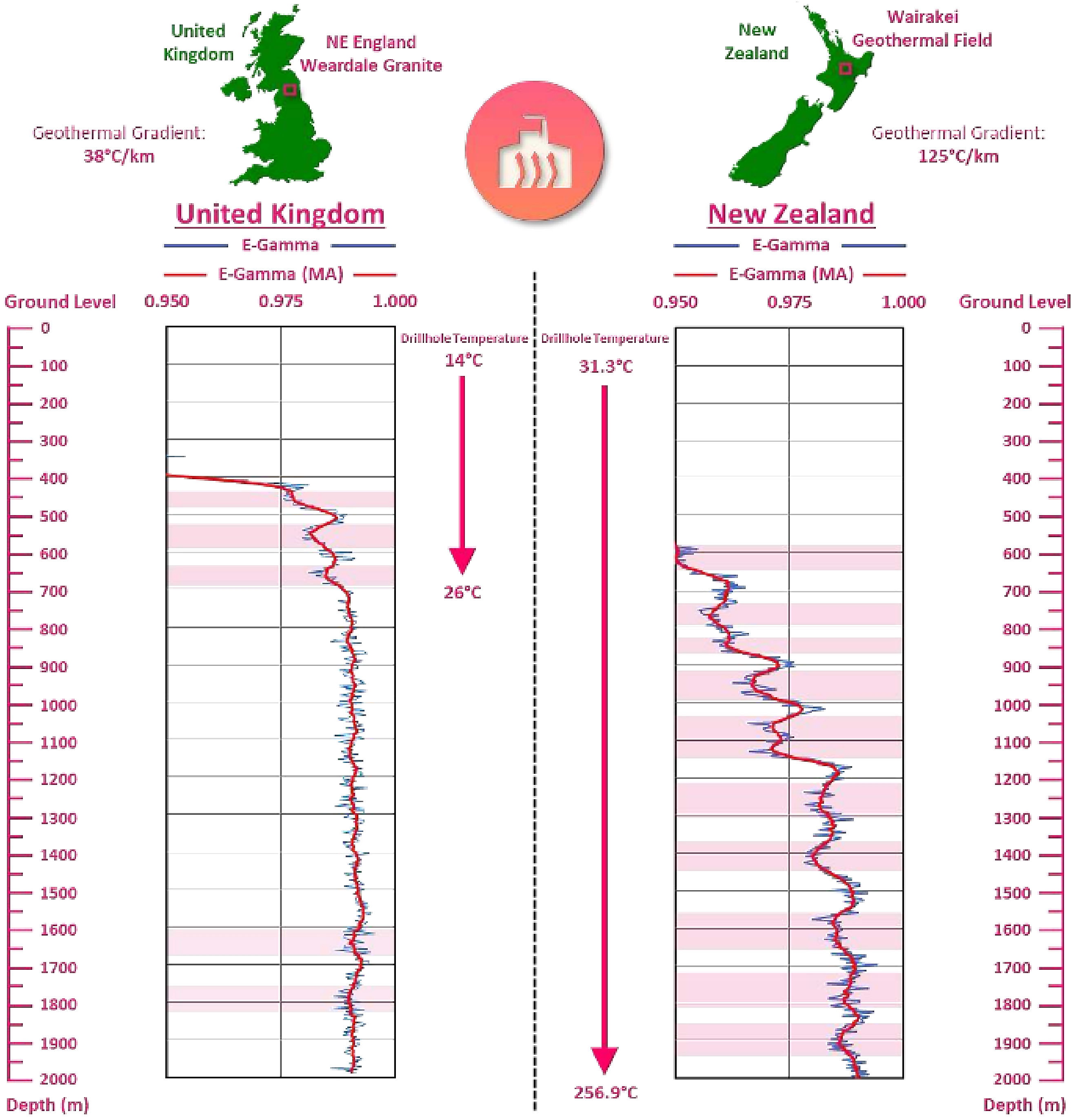


- Both TH11 and WK271 E-Gamma plots generate **high confidence thermal impact** to 2000m and 1450m, respectively.
- Onset of TH11 thermal impact zones coincides with a large step increase in the drill hole temperature to >200°C.
- All four thermal impact zones in WK271 correlate perfectly to increases/peaks in the drill hole temperature.
- **Overall, the high thermal impact in TH11 and WK271 are representative of the high geothermal potential in the Wairakei Geothermal Zone, with geothermal gradients up to 125°C/km.**



Comparison:

UK v New Zealand



- The differences in the ADR signal from UK to NZ reflects the different geothermal gradients of 38°C/km in NE England's Weardale Granite to 125°C/km in Taupo Volcanic Zone

Summary of geothermal applications

- Pulsed electromagnetic ADR waves can identify change in temperature using dielectrics, conductivity and energy reflections from return signals.
- Case Studies presented from onshore UK & New Zealand.
- The field measurements show encouraging potential for the technology to be applied as a pre-drilling tool in onshore geothermal plays around the world, given the ease of survey deployment and low environmental footprint.
- We acknowledge that this technique for geothermal exploration is still in its infancy and requires more work to explain the scientific relationships for full-scale commercialisation.
- Is this method picking up changes in temperature, or changes in water, or a mixture of both?
- We do not (and cannot) claim to fully understand why it works at this stage, but the case studies we have worked on have shown consistent matches to reality. Further research is needed for geothermal applications. We are currently seeking partners for collaboration.

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