CONGRATULATIONS ADROK

Semi-finalist in the Water Council's

TECH CHALLENGE

To find out more visit the Water Council's website at www.thewatercouncil.com

Adrok Ltd.
49-1 West Bowling Green Street
Edinburgh, EH6 5NX, SCOTLAND, U.K.

The Water Council
1.703.727.8781 I 247 W. Freshwater Way #500 I Milwaukee, WI 53204 USA
thewatercouncil.com

©Adrok Ltd., 2020

Unfortunately, Adrok didn't win the Water Councils Tech Challenge, however, the Adrok team would like to congratulate the winner.

This was a great learning experience for the team in an area of growing importance as the planet responds to significant climate challenges.

Adrok isn't slowing down. The team is continuing to develop a low- to no-impact, surface-based and precise sub-surface water detection tool. This is a more environmentally friendly way to explore for the worlds most critical resource.

Feedback from the judges was extremely positive with two of the three key points highlighted by them presented below:

1) "Presentation should have gone into more detail on what the results were for detection of compounds and their detection levels - and why this is better than competing technology."

2) "Focus on finding water supplies, not quality sensing or remediation."

Adrok is happy to say that we can address both these points with confidence and the team is now focussed on fine-tuning the WATER DETECTION capacity of the technology and, once complete, the second phase of development will focus on delineating the difference in the geophysical response presented by different compounds and/or contaminants.

©Adrok Ltd., 2020

Here is a slightly modified version of the team's presentation to the Water Council

ADVANCING WATER EXPLORATION FOR THE FUTURE

New technologies for identifying deep aquifers

Adrok®

©Adrok Ltd., 2020

ADROKs AIM

Adrok is developing a low- to no-impact, surface-based geophysical method for;

1) **detecting/exploring for aquifers (including stacked aquifers) and,**
2) **monitoring change in aquifers over time**

Adrok is at TRL 6 and is anticipating elevating this to TRL8-9 using a well-defined and proven internal business model, workflow and highly experienced team.

©Adrok Ltd., 2020

A well-recognised GLOBAL problem

Water is becoming **increasingly scarce** due to

1) Increasing population
2) Increasing global temperatures
3) Increased re-distribution of water through international trade
4) Increased land clearing
5) Increase in farming
6) …..

Q? How can we maintain water access and delivery in an environmentally sustainable way?

Solution X

Build more dams in order to maintain water security and reliability.

WATER STORAGE INFRASTRUCTURE

The International Resources Panel of the UN states that - ***"governments have tended to invest heavily in largely inefficient solutions" :*** *mega-projects like dams, canals, aqueducts pipelines and water reservoirs, which are generally neither environmentally sustainable nor economically viable.*

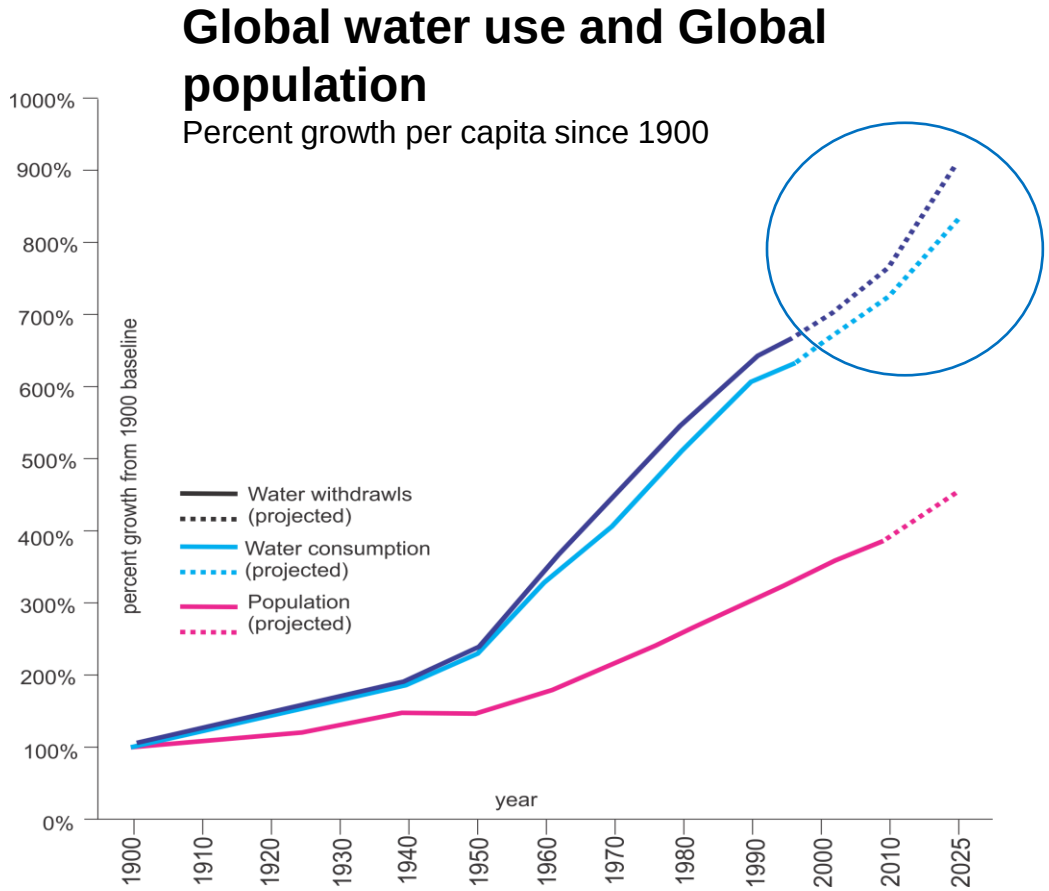
Adrok – contributing to an environmentally sustainable solution

Use <u>new technologies</u> to help map aquifers and monitor sub-surface dams and aquifer recharge.
Retaining reservoirs underground avoids the excessive amounts of loss through evaporation.

However, "***we need the technology to accurately map aquifers and to monitor aquifer health over time***" without having to carry out drilling which is both environmentally and financially expensive.

©Adrok Ltd., 2020

SMARTER WAY TO EXPLORE AND MONITOR SUBSURFACE WATER FOR A SUSTAINABLE FUTURE



Water use has been growing globally at more than twice the rate of population increase in the last century, and an increasing number of regions are reaching the limit at which water services can be sustainably delivered, especially in arid regions*. Demand is expected to outstrip supply by 40% in 2030, if current trends continue.

*Source: UN (United Nations) WATER
https://www.unwater.org/water-facts/scarcity/

©Adrok Ltd., 2020

Adrok offers SMARTER WAY TO EXPLORE AND MONITOR SUBSURFACE WATER FOR A SUSTAINABLE FUTURE

How can Adrok's technology help communities and the environment?

Water Exploration

Adrok's pulsed EM provides a non-invasive, quick and accurate way of detecting one or multiple aquifers at depths of up to 1000m below the surface

Water Monitoring

Adrok's technology can help monitor the health of an aquifer by taking measurements over time to build a trend of increasing or decreasing water content

Removing the necessity for excessive drilling

Adrok's technology can be used instead for exploratory drilling which often returns "dry holes" at significant financial and environmental cost.

©Adrok Ltd., 2020

ADROK IS ON THE CUSP OF DELIVERING NEW TECHNOLOGY TO THE GROUNDWATER SECTOR:

R&D FOR ACCURACY AND PRECISION

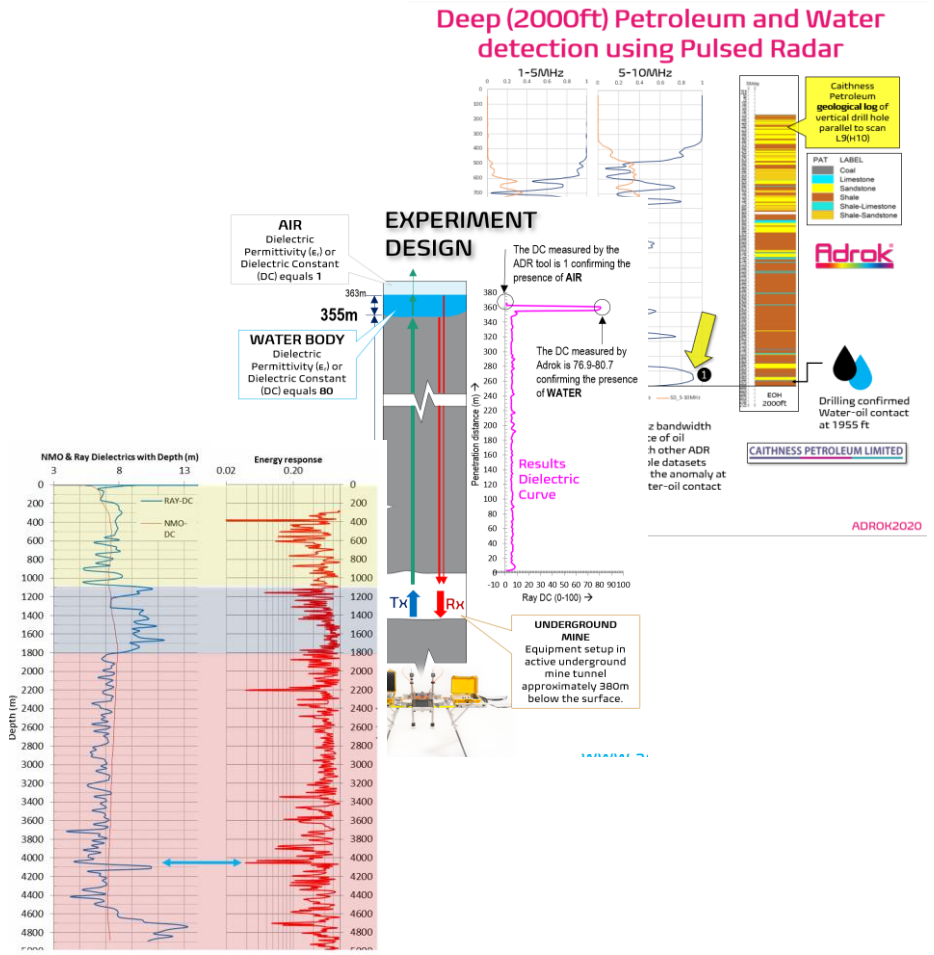
Adrok will utilise the **Tech Challenge** award to carry out targeted R&D specific to targeting sub-surface water detection.

One-step-ahead

Adrok will build on a foundation of success.

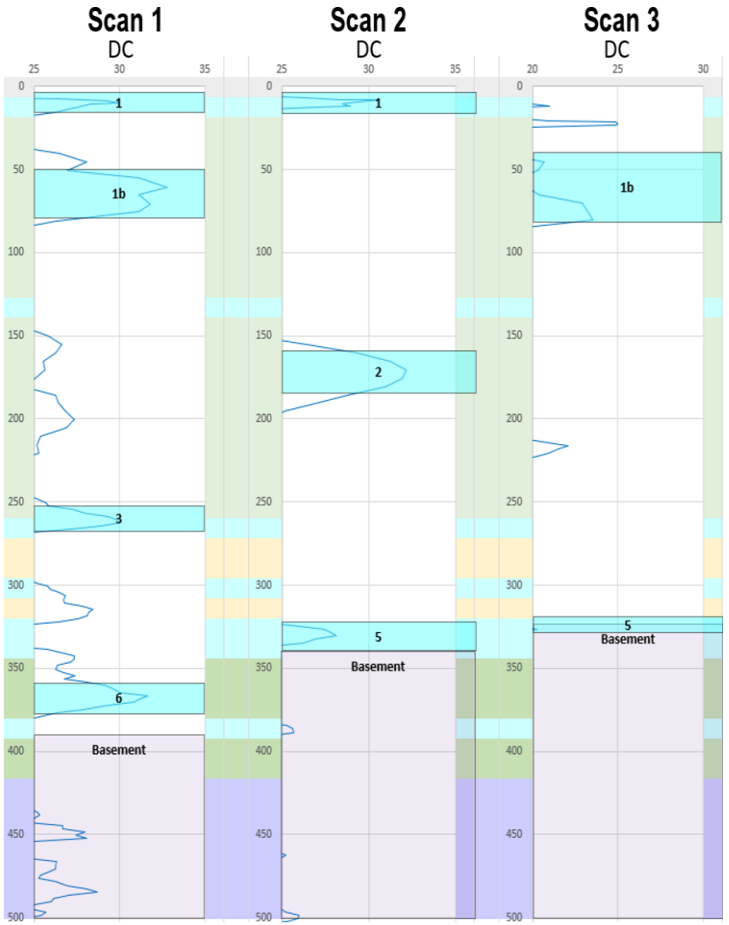
Adrok has carried out a number of field-based studies that have demonstrated the potential of the technology to detect water.

None of these surveys have, however, been specifically targeting water. Adrok has a well-defined scientific methodology it uses to test new developments. Adrok will utilise over 15 years of research, development and industry contracts to develop a water-specific targeting tool.



©Adrok Ltd., 2020

ADROK's Technology adds significant resolution and value to existing datasets



Adrok aquifer mapping using measured high DC while targeting sulfides below basement

1) Adrok measures the dielectrics of materials at depth. Water has a dielectric of 80 whereas rocks tend to have dielectrics of less than 15. Adrok uses this natural value of water to help delineate aquifers at depth.
2) Adrok's technology can help detect multiple aquifers thereby providing much greater resolution than existing technologies.
3) Adrok can provide accurate depth(s) of the aquifer(s) beneath the surface without drilling.
4) Aquifer mapping can provide more detail on the irregularity and/or continuity/discontinuity of certain aquifers *(see example left)*.
5) Adrok can provide linear (like drill holes) or planar scans (2D profile scans similar to seismic reflection).
6) Adrok is a pre-drilling targeting technology with the ability to provide communities with the confidence of the depth and potential amount of water in each aquifer*

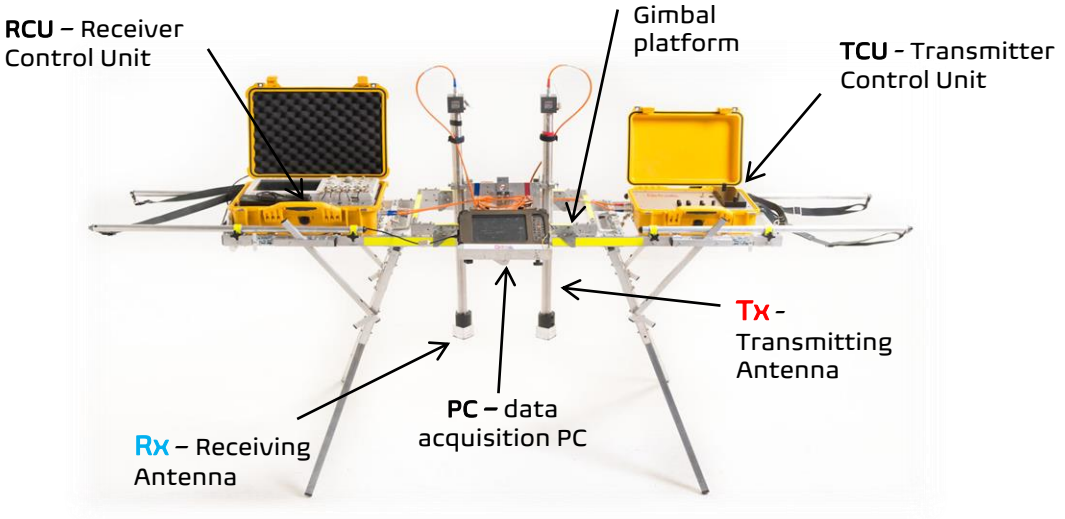
* The dielectric value is proportional to the amount of water present within a rock. Sandstones and shales for example have a maximum dielectric of 15, therefore, by increasing the volume of water in pore spaces, the dielectric value will also increase proportionally. A sandstone with ~50% pore space containing fresh water will have a DC of ~50-60.

©Adrok Ltd., 2020

THE SCIENCE

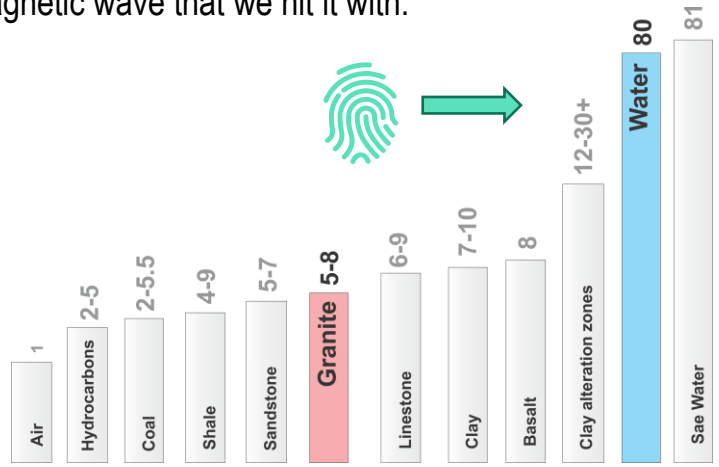
How does the scanner do what other sensors/techniques can't?

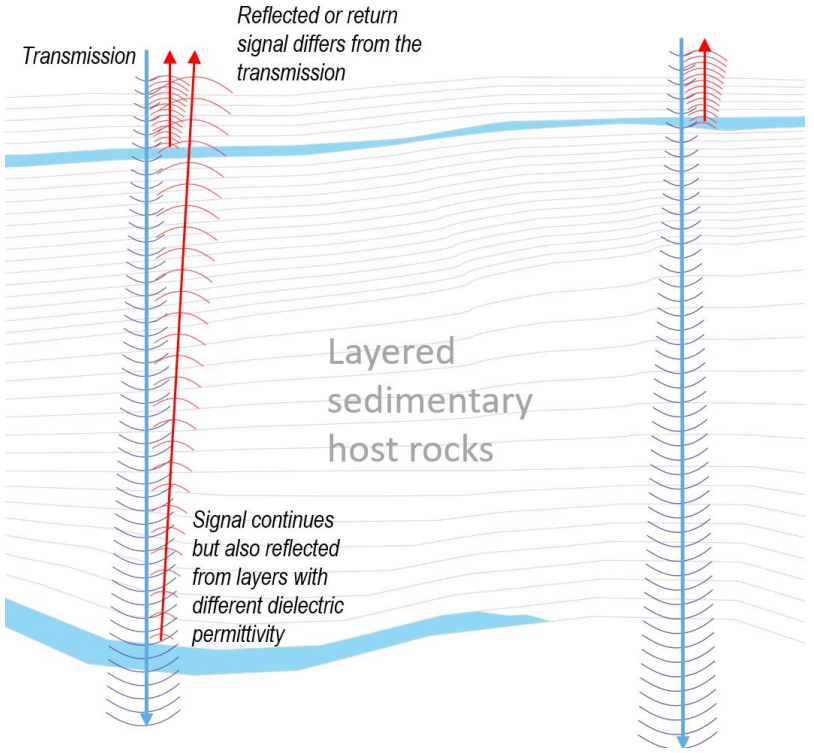
ADR stand for 'Atomic Dielectric Resonance' and is the key to how the scanner works. We measure 'dielectric resonance', which is the unique way materials resonate when hit by electromagnetic waves.



Dielectric Permittivity

The Adrok scanner transmits and then receives back, narrow pulsed beams of micro- and radio-waves. When these waves cross a boundary between material types, an 'echo' is reflected back to the scanner. But the 'echo' that is received is different to the one that was sent out. It has a slightly different resonance because each material has its own Dielectric Permittivity or 'resistance' to the electromagnetic wave that we hit it with.





©Adrok Ltd., 2020

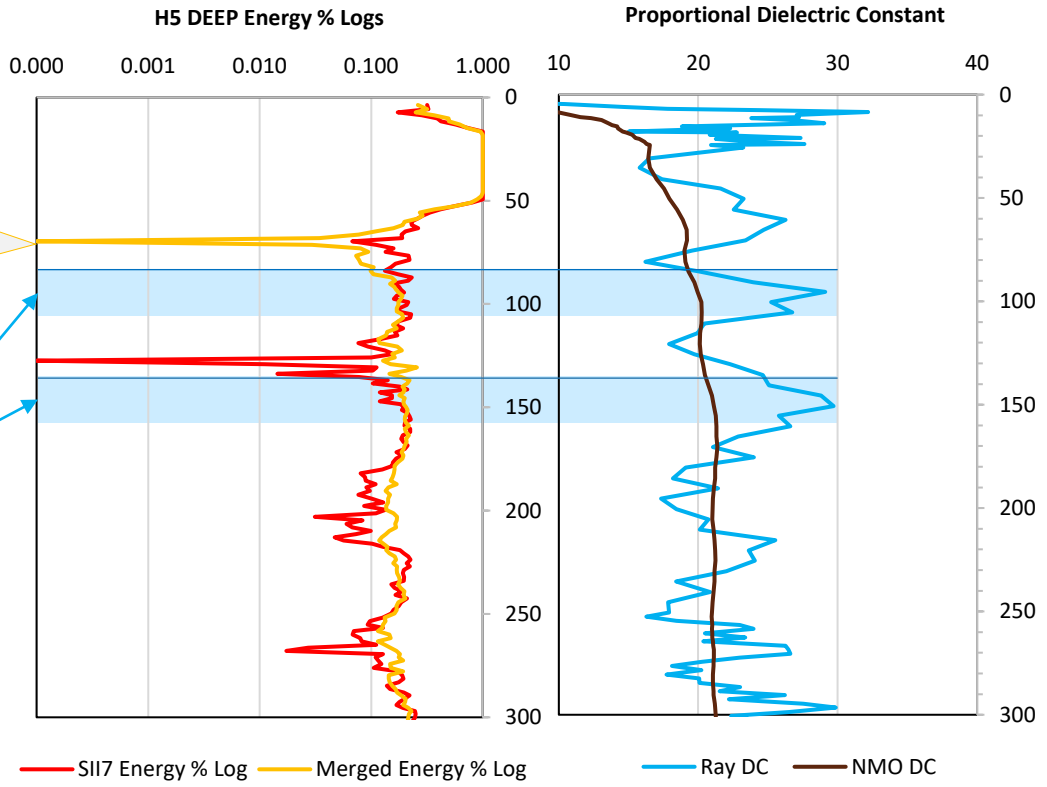
"On Earth, values greater than **15** are seldom associated with dry materials. RES data collected in Antarctica and Greenland show that a **permittivity larger than 15 is indicative of the presence of liquid water below polar deposits.**" (https://science.sciencemag.org/content/361/6401/490)

Water was defined on Mars using the principals of:

1) Signal power, which Adrok refer to as Energy and presented as E%Log (see example below) which in turn is an inverse of the relative reflected energy from layers within the Earth's crust and
2) The variation in permittivity between different materials which are air, water and rock.

Higher E% is representative of higher reflectivity at boundary between materials with different permittivities e.g. rock-water interface

AQUIFERS



An example from an Adrok survey where water-saturated sediments are inferred at around 100 and 150m depth where the peaks in Site Proportional Dielectric Constant (permittivity)correspond with (low values) in energy which indicate a "reflective" boundary between materials.

©Adrok Ltd., 2020
(c) Adrok Ltd., 2020

WATER TARGETING

Principals of water targeting are the same on Earth as they are on Mars

Higher power (dB) is representative of higher reflectivity at boundary between materials with different permittivities

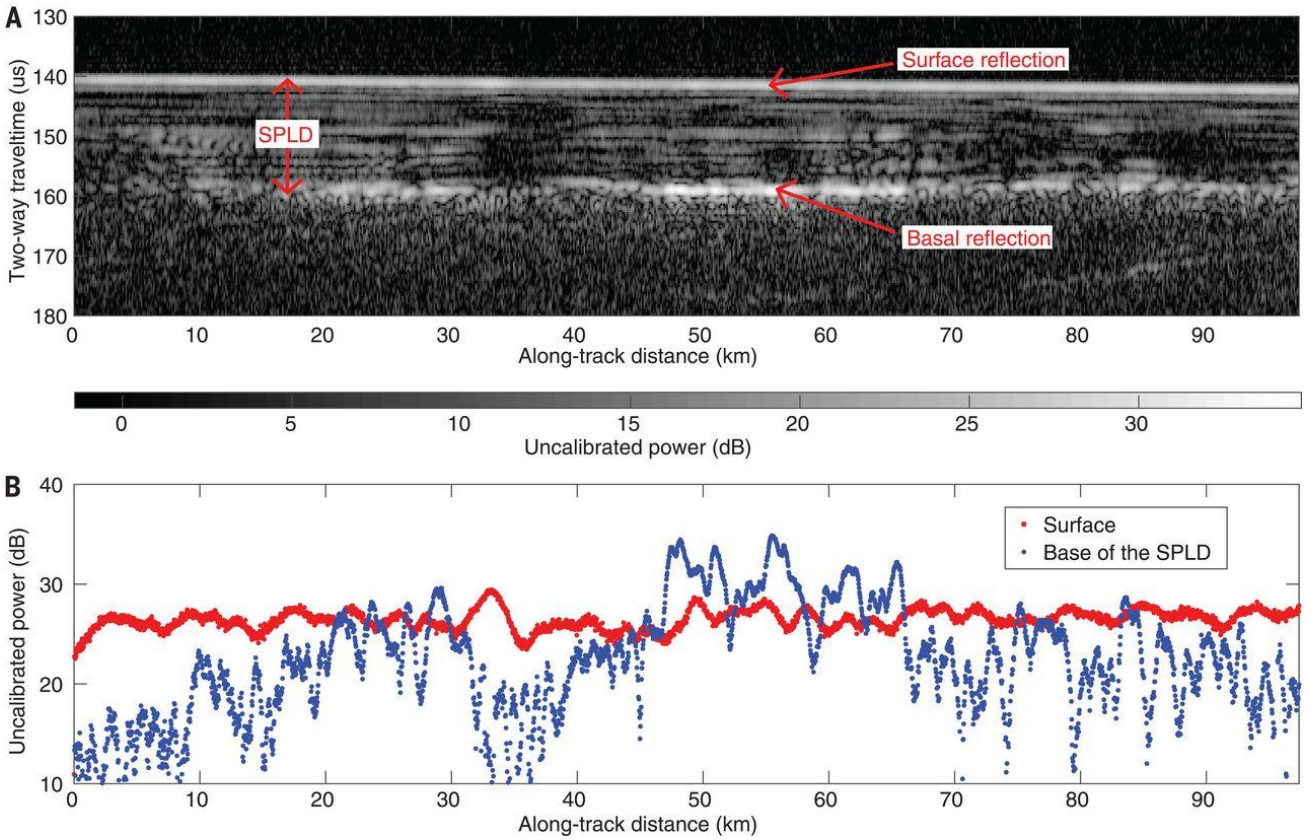


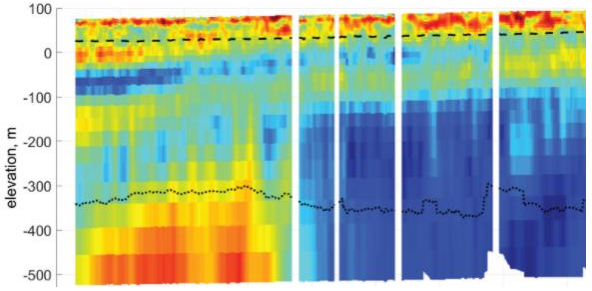
Fig. 2 from https://science.sciencemag.org/content/361/6401/490 **overleaf - Radar data collected by MARSIS.**(A) Radargram for MARSIS orbit 10737, whose ground track is shown in Fig. 1B (refer to original paper). A radargram is a bi-dimensional color-coded section made of a sequence of echoes in which the horizontal axis is the distance along the ground track of the spacecraft, the vertical axis represents the two-way travel time of the echo (from a reference altitude of 25 km above the reference datum), and brightness is a function of echo power. The continuous bright line in the topmost part of the radargram is the echo from the surface interface, whereas the bottom reflector at about 160 μs corresponds to the SPLD/basal material interface. Strong basal reflections can be seen at some locations, where the basal interface is also planar and parallel to the surface. (B) Plot of surface and basal echo power for the radargram in (A). Red dots, surface echo power; blue dots, subsurface echo power. The horizontal scale is along-track distance, as in (A), and the vertical scale is uncalibrated power in decibels. The basal echo between 45 and 65 km along-track is stronger than the surface echo even after attenuation within the SPLD.

©Adrok Ltd., 2020
(c) Adrok Ltd., 2020

From detection to monitoring

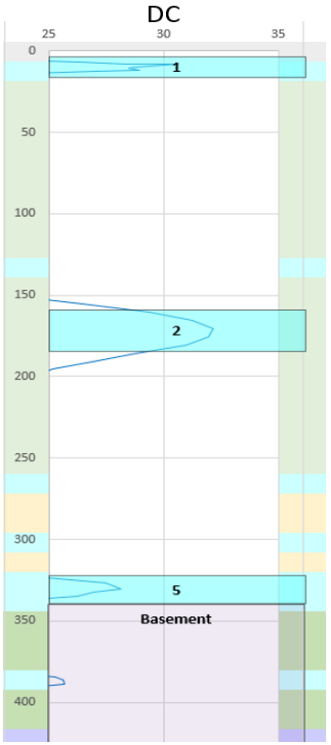
Collecting the same data, at the same location over a prolonged period of time can be used to monitor changes in the aquifer health. This can be achieved without the need for additional boreholes.

1 REGIONAL GEOPHYSICS AND TARGETING METHODS



Adrok adds value *throughout the exploration and monitoring lifecycle*

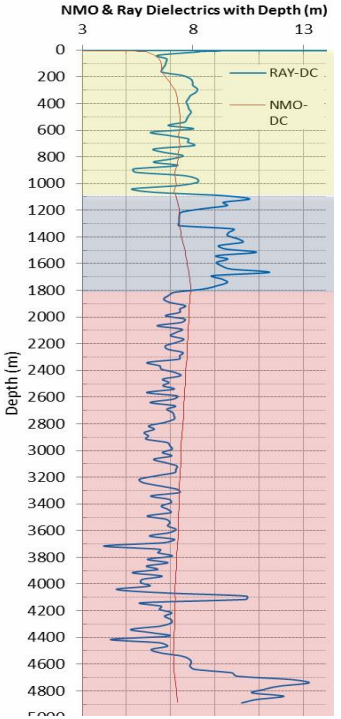
2 ADROKS DETAILED AQUIFER MAPPING



3 SUCCESSFUL AQUIFER DRILLING

Adrok adds value *throughout the exploration and monitoring lifecycle*

4 AQUIFER MONITORING

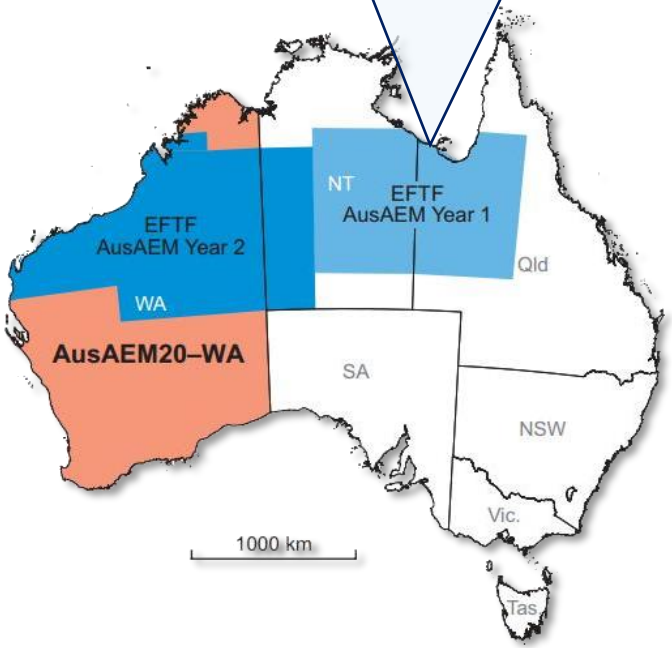


©Adrok Ltd., 2020

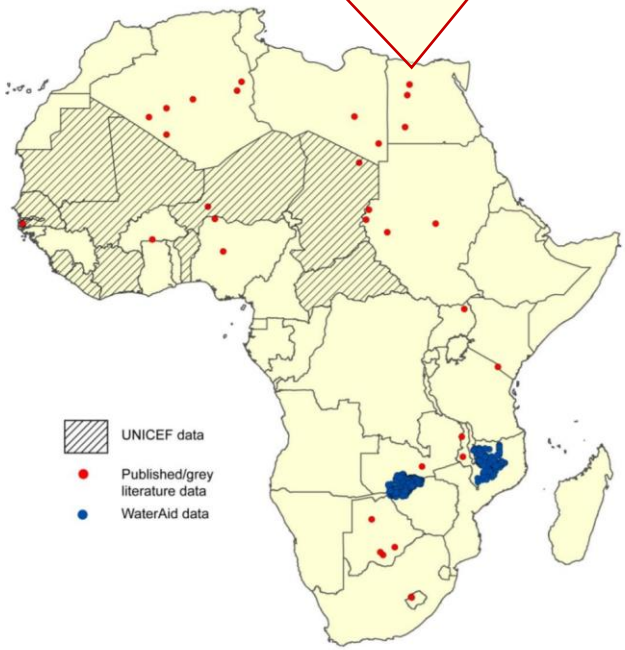
IDENTIFY + MANAGE

Some **examples** of where geophysics, specifically ADR can assist in either targeting aquifer delineation or can contribute to the equally important management of aquifers and groundwater

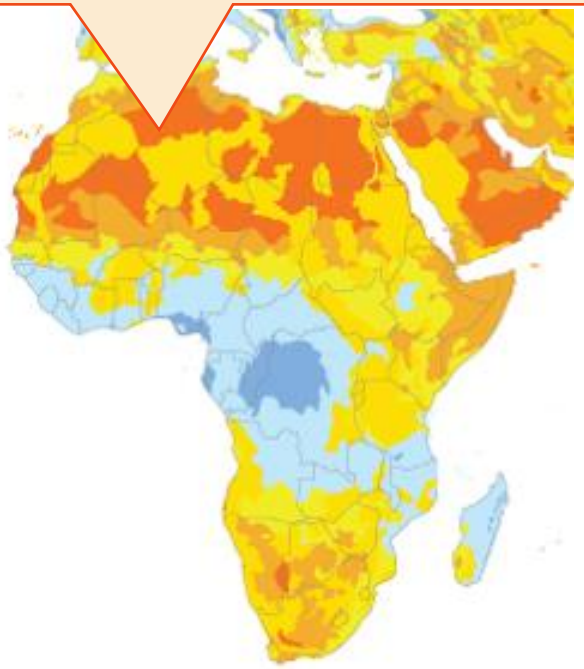
Adrok can add value to regional geophysical surveys by working together with government bodies &/or organisations to develop the pulsed radar technology to explore for aquifers.



PROVIDE ADDTITIONAL DATAPOINTS
Adrok can add value to the current almost complete lack of reliable groundwater data in northern Africa for example.



GROUND TRUTH data collected via remote sensing. Satellite-based models showing aquifer drainage require on-the-ground testing. Drilling numerous boreholes is an unreliable, costly and environmentally degrading means of testing.



©Adrok Ltd., 2020

THE BENEFITS OF ADROK'S ADR VIRTUAL BOREHOLE TECHNOLOGY

- No special environmental permits (non-destructive digital technology).
- Easy landholder negotiations as there is no impact.
- Almost no impact with no surface disruption, just footprints.
- Pre-drill confirmation - can help identify depth to multiple water tables to >1000m.
- Av. 4 scans per day to >1000m meaning it saves time. Scans take hours, not weeks.
- No road clearing and no pad (drill site) clearing.
- Only one 4WD, helicopter or other transport required to site therefore limiting risk of introducing weeds.
- Decreased risk of LTI's because its non-mechanical, quick and simple.
- Very cost effective, especially to depths over >300 meters where it is up to 90% less than the cost of drilling.
- No pollution and no diesel required (small carbon footprint)
- No additional resources such as water or diesel required at site.
- Not disruptive to native flora and fauna, to crops or livestock.

©Adrok Ltd., 2020

Taking it to the next level

Adrok has demonstrated a capacity to detect aquifers, but most case study results are for projects not specifically targeting water. Accordingly, Adrok want to fully commercialize the existing technology

Adrok's current TRL is **Level 6**

In order to increase the TRL to level 7-8 or higher, Adrok needs to carry out several calibration scans in areas where aquifers are well documented and where aquifers also represent a current or potential source of water for the future and where aquifer management is a key consideration.

Adrok aims to achieve the three following stages as an outcome of the WaterCouncil award

1) Final technology development (*correction of algorithms using field-trials*)
2) Technology application field testing in public domain (*test against known boreholes*)
3) Pre-production system finalisation
4) Current technology commercialization (TRL 9)

TRL		
	9	Commercialized
	8	Pre-production
	7	Field Test
	6	Prototype
	5	Bench / Lab Testing
	4	Detailed Design
	3	Preliminary Design
	2	Conceptual Design
	1	Basic Concept

©Adrok Ltd., 2020
(c) Adrok Ltd., 2020

A team with a proven track record for successful technology development

Adrok have been operating for over 15 years.
Adrok have been successfully working with major companies to resolve unique problems that other technology companies have been unable to achieve.

Adrok have an established team with a track record of working together to achieve industry-changing outcomes.

Dr G Colin Stove FBAC PhD BSc
Founder & Chairman

Gordon Stove BSc
Co-founder & CEO

Michael Robinson MEng
Chief Technology Officer (CTO)

Dr Kees van den Doel PhD, MSc
Chief Scientific Officer (CSO)

Dr Simon Richards BSc PhD
Chief Geologist

- Over 230 projects completed
- Over 30 technical conferences presented
- More than 10 technical publications
- 4 families of patents in many different countries
- Operating successfully in many countries around the world
- Developed technology for many industries/applications including oil reservoir monitoring, minerals and metal detection, rock type mapping, geothermal gradient mapping.

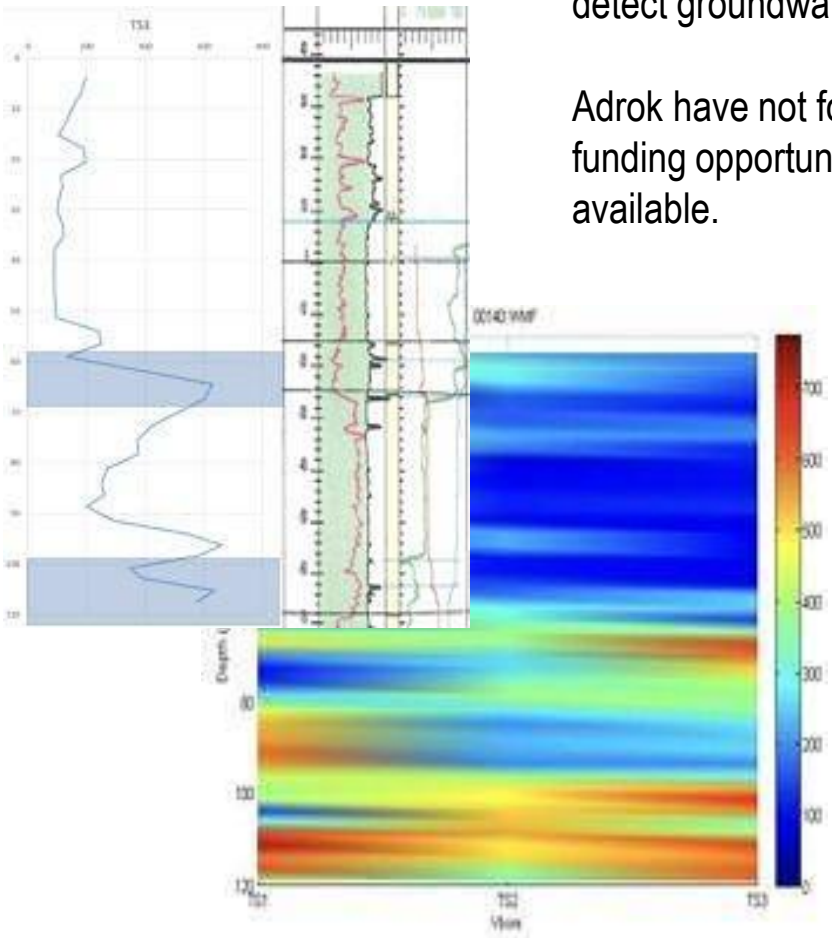
©Adrok Ltd., 2020

An established presence in geophysical imaging

Adrok has been undertaking surveys and technology since its inception in 1999.

The **first water-targeted survey** was carried out for Scottish Water in 2012. The survey was one of the first to demonstrate that the technology had the capacity to detect groundwater.

Adrok have not focused on the water-detecting aspect of the technology as the funding opportunities to undertake the final stages of development have not been available.



With recent impacts of climate change, the recognition of a method to be able to detect and monitor aquifers has only recently come to the fore.

Adrok has the technology and an opportunity to fill a void in aquifer detection and monitoring and therefore an opportunity to focus efforts on developing the technology for water industry.

©Adrok Ltd., 2020

An established and proven business model

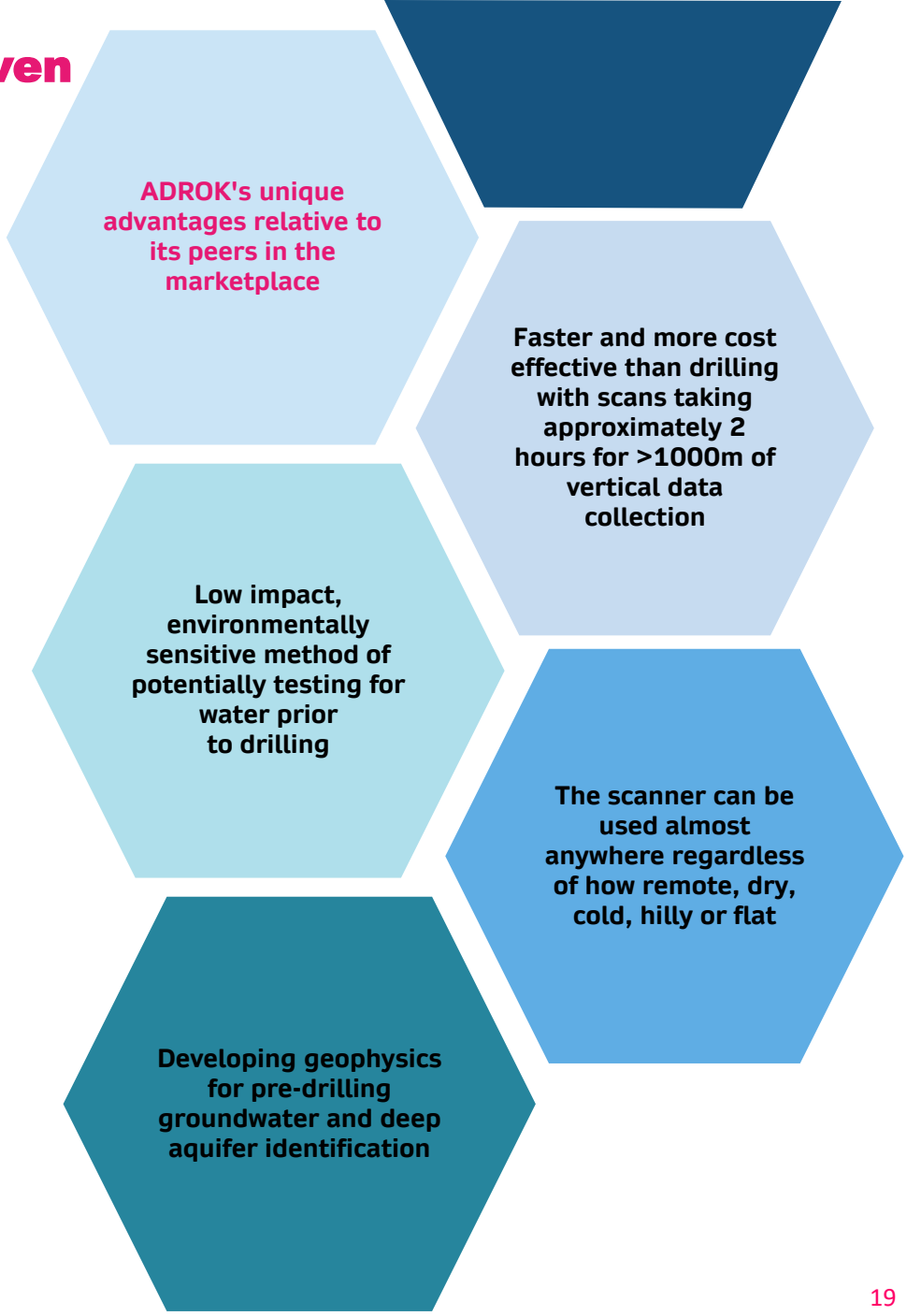
Adrok is a technology development company and a service provider.

On completion of the commercialization of the aquifer detection and monitoring aspect of the technology, Adrok will operate using the same, established business model and workflows as for the oil monitoring or mineral exploitation industry.

Stages to a working commercial service

1. **Identify** *(identify outstanding global problem)*
2. **Modify** *(modify existing technology to suit purpose. A recent example is the development of a metal-sulfide targeting tool)*
3. **Test/trial** *(trial developments in real scenarios)*
4. **Iterative correction** *(modify ←→ test/trial)* until commercial standard is met

   Test/trial will be carried out at locations where there are known boreholes with multiple, well-defined aquifers.
5. **Standardize workflow**
6. **Patent** (United States Patent Application No 15/117,289)
7. **Commercialize**



©Adrok Ltd., 2020

Desired Tech Competition Outcomes

Joint R&D and commercialization

Adrok seeks collaboration to finalize the processing for water-specific targets and to roll-out commercial survey services and/or products.

Water Monitoring

Adrok could help the install permanent monitoring stations at various locations around the planet and assist with remote monitoring of impurities and water levels.

Survey Services

Adrok could directly perform field survey services to help identify and monitor subsurface aquifers at various locations around the world, particularly where traditional methods are too costly or unfeasible.

©Adrok Ltd., 2020

To get involved with this green tech revolution and to help advance water exploration contact the team at Adrok.

INNOVATION FOR A CHANGING WORLD

CONTACT US

WEB: ADROKGROUP.COM

ADDRESS: 49-1 West Bowling Green Street
Edinburgh, EH6 5NX
Scotland

PHONE: +44 (0) 131 555 6662

EMAIL: gstove@adrokgroup.com *or*
srichards@adrokgroup.com

©Adrok Ltd., 2020