Dr G. Colin Stove BSc (Hons) PhD HFBAC HFRSGS

Chairman and Science Director, Adrok Ltd

Dr Stove has had 57 years' experience in geospatial mapping, automated photogrammetry and remote sensing and geological mapping and stratigraphic analysis. In 1981, he mapped the government-published first "Peat Resource Map and Terrain Categories of Lewis and North Harris" at 1:100,000 scale for which 80% of this mapping came from Landsat remote sensing and automated photogrammetry, hence cost saving, For this achievement he was awarded Honorary Fellowship of the Biographical Academy of the Commonwealth. He held government posts, strong in research and instrumentation, at the Macaulay Institute of Soil Research as HSO, SSO and PSO. In 1982 he was appointed Principal Investigator for ESA on SAR580 and AGRISPINE projects. In 1999 he co-founded Radar World Ltd and patented his invention of ADR (Atomic Dielectric Resonance) becoming the company's Chairman and Science Director.

Dr Stove is in his 20th year as Chairman and Science Director of Radar World, now re-branded as Adrok Ltd, with several application companies. The first full ADR Patent was awarded in 2005 (America), now some 45 international patents and new family of 5 linked patents. The company has extensive experience in oil, gas and mineral exploration world-wide using ADR, now fully operational, with contracts now completed in five continents.

As a scientist, inventor and entrepreneur Dr Stove has contributed enormously to the academic commercial and social life of Scotland over many years. He was recently appointed an Honorary Fellow of the Royal Scottish Geographical Society. His publications include 30 refereed scientific papers, many conference proceedings, and four Adrok books. Currently, with his expertise in remote sensing, material typecasting and material identification, he serves as a scientific referee for the *International Journal of Remote Sensing*.

1. Union Bridge, Revelation of Scottish anchorages by Atomic Dielectric Resonance

Colin Stove

Adrok was formed in Scotland in December 1997 and started trading from September 1999 after the first scientific invention patent was filed. The company has now developed a commercially viable subsurface exploration and appraisal tool for natural resources called Atomic Dielectric Resonance (ADR). The system has two unique capabilities (1) deep penetration with high vertical resolution, (2) classification of materials (spectrometric mapping) using the Science of Spectroscopy with Mathematical Fourier Analysis in TIME, SPACE and FREQUENCY domains.

An Adrok team led by Michael Robinson (Chief Technical Officer, Adrok), including myself (Science Director, Adrok), Prof R A Paxton (Hon Professor, Heriot Watt) and Hugh Halcrow (Senior Engineer, Adrok) was mobilised on 17th May 2018 at 9am from Edinburgh and arrived on site at 10.30am with ADR Survey Equipment. The site survey and ADR Tests commenced at 1100am. Routine data collection started at 1130am. Two longitudinal scans (downstream and upstream) were first collected in line with the visible chain sections for best chance to image the chain anchor plates through the sub-surface stratigraphic material.

Following the longitudinal scans, two lateral scans were carried out crossing the road from the downstream to the upstream side,

Fig. 1 *[L]. Surveying line Intersections from OS benchmark location on downstream chain support wall. [M] ADR bistatic stare scan at lateral line chainage 12.5m, immediately above downstream 1820 anchor plate. View showing red Tx transmitting telescope on left of the ADR stretcher platform and the Rx receiving telescope 1 m to the right for deep focusing. [R] View of this Stare scan looking down the downstream longitudinal line with Tx sensor closest*

Fig. 2 *[L] Start of moving lateral Scan at 12.5m [M] Mid-road scan position [R] End of scan at upstream chain plate intersection position*

joining the longitudinals at chainages most likely to illuminate and image the 1820 and 1903 anchors. After test scans to illuminate and find the location of the plates the intersecting lateral chainages were: 1903 Anchor at CH 6.8m and 1820 Anchor Plate at CH12.5m.

To image the anchor plates at the best viewing angle, a special ADR Sweeping Strategy was designed and employed to image the angled plate returns at right angles in a bistatic manner, using a stationary Rx Sensor at depression angles identified from the Longitudinal and Lateral targets identified. The Rx sensor was mounted looking through the Eyepiece aperture (with eyepiece lens removed) of a special Newtonian reflector telescope mount with mirror spacings at the same wavelength as Rx for standing wave oscillations (SWO) and imaging spectrometry.

The Planimetric orientation [Fig. 4] was calculated to provide optimum focusing convergence between the two bistatic sensors at the known depth of the 1903 plate which was used for training the sensors in order to obtain the best possible chance of imaging the 1820 anchor plate at its unknown depth.

Fig. 3

[L] Location of Rx receiver mounted onto the Newtonian reflector telescope which is pointed directly at the 1903 downstream anchor plate at right angles to the plate.

[R] Location of Tx bistatic ADR Sensor mounted on an astronomical motorized base tripod sweeping the 1903 plate from a depression angle (DA) of -51 to -42 degrees pointing from CH2.75 to CH3.0m along sweep line continuing to a DA of -16 degrees at chainage 4.75m

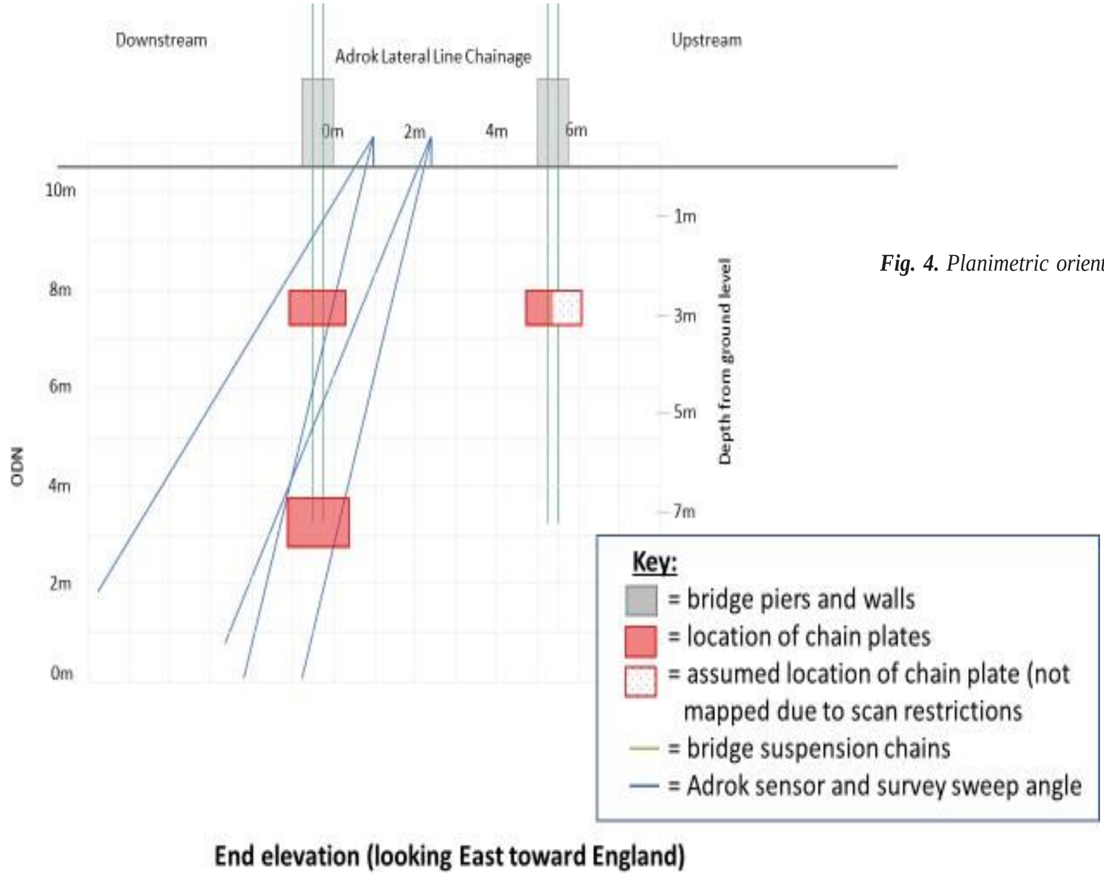
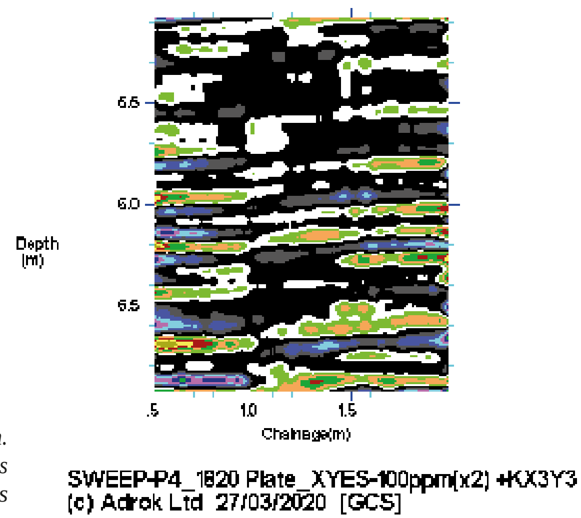


Fig. 4. *Planimetric orientation*



Fig, 5. *Equal scaled plot section of 1820 Anchor Plate from P4 sweep scan. By triangulation the time return image has been rectified to equal spatial scales in X and Y at a resolution of 100 pixels per metre on both axes*

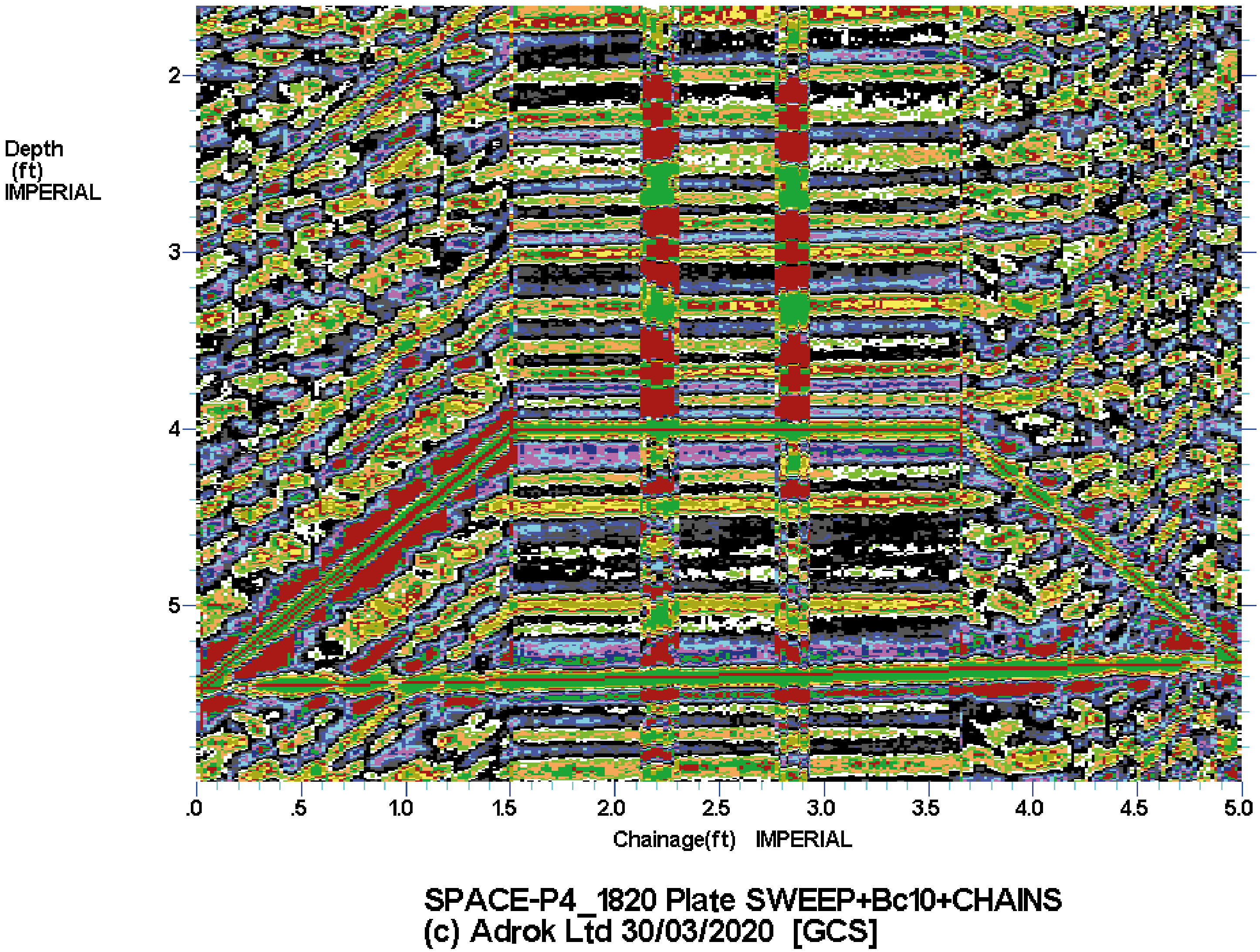


Fig. 6. *Final frequency filtered image showing the angular faces of the plate in coloured patterns and the interpreted chain centres as red crosses but with two vertical polarisation patterns along the long axis of the plate in line with the chain centres caused by the polarisation orientation of the ADR sensor dipoles and the doppler shifts of the lines of chains through the ground. Infinitely small chain resonance movements through the ground at the atomic level may be causing this effect.*

Further spectral filtering reveals the angular surfaces of this plate and the plate boundaries, indicating that the plate is close to 6ft in height (1.83m) Image reveals a depth of (6.9-5.2)m =1.7m, bearing in mind that the Receiver may not be looking down at the plate at exactly 90 degrees. Green interference patterns and scattering can be seen from the suspension chain intersections with the plate The angular reflectance patterns of this filtered image clearly correlate with Professor Paxton's **notional model of a 2-ton iron ballast plate** [Page 18].

The 10 frequency bands below were sequentially selected by Adrok's SENUTAXA frequency program and used in Adrok's RADAMATIC image processing program to automatically filter the ADR radar image to produce the final colour image of the plate from 4 carrier waves and 10 spectral lines from the fundamental harmonic frequency (H1 = 126.968MHz which is a Radio Wave Frequency) to the 55th Harmonic (SL6 or H55 = 6983.226MHz which is a microwave frequency) The selection process took about 100 hours to carefully correlate and sequence the materials identified but the final colour plot took microseconds to complete.

The correlated frequency bands used to band cut and produce the above coloured filtered image were the following sequential frequency bands in MHz:

B1 126.968 – 1650.581 (Carrier Wave [CW1]; Harmonic numbers [H1-H13])

B2 1904.516 – 2158.452 (Carrier Wave [CW2]); Harmonic numbers [H15-H17])

B3 2412.387 – 3047.226 (Carrier Wave [CW3]); Harmonic numbers [H19-H24])

B4 3428.129 – 3428.129 (Spectral Line [SL1] for Fe3O4-Cast Iron); Harmonic number [H27])

B5 3809.034 – 4316.903 (Carrier Wave [CW4]); Harmonic Numbers [Harmonic numbers [H30-H34])

B6 5078.710 – 5078.710 (Spectral Line [SL2] for Fe3O4-Cast Iron); Harmonic number [H40])

B7 5332.645 – 5332.645 (Spectral Line [SL3] for Fe3O4-Cast Iron); Harmonic number [H42])

B8 5840.516-5840.516 (Spectral Line [SL4] for Fe3O4-Cast Iron); Harmonic number [H46])

B9 6221.419 -6221.419 (Spectral Line [SL5] for Cast Iron); Harmonic number [H49])

B10 6983.226 – 6983.226 (Spectral Line [SL6] for Cast Iron; Harmonic number [H55])

This Final GCS Interpreted Image of the 1820 Plate [Fig. 6] is a revised interpretation of my original calculations which placed the base of the plate at 7.5m in vertical depth. This revised depth is based on more accurate dielectric constants produced from the spectrometric and spectroscopy analysis which places the bottom of the plate at 6.9m from the surface at chainage 12.5m on the downstream longitudinal line. This final interpretation also suggests slight water movements around the chain/plate intersections.

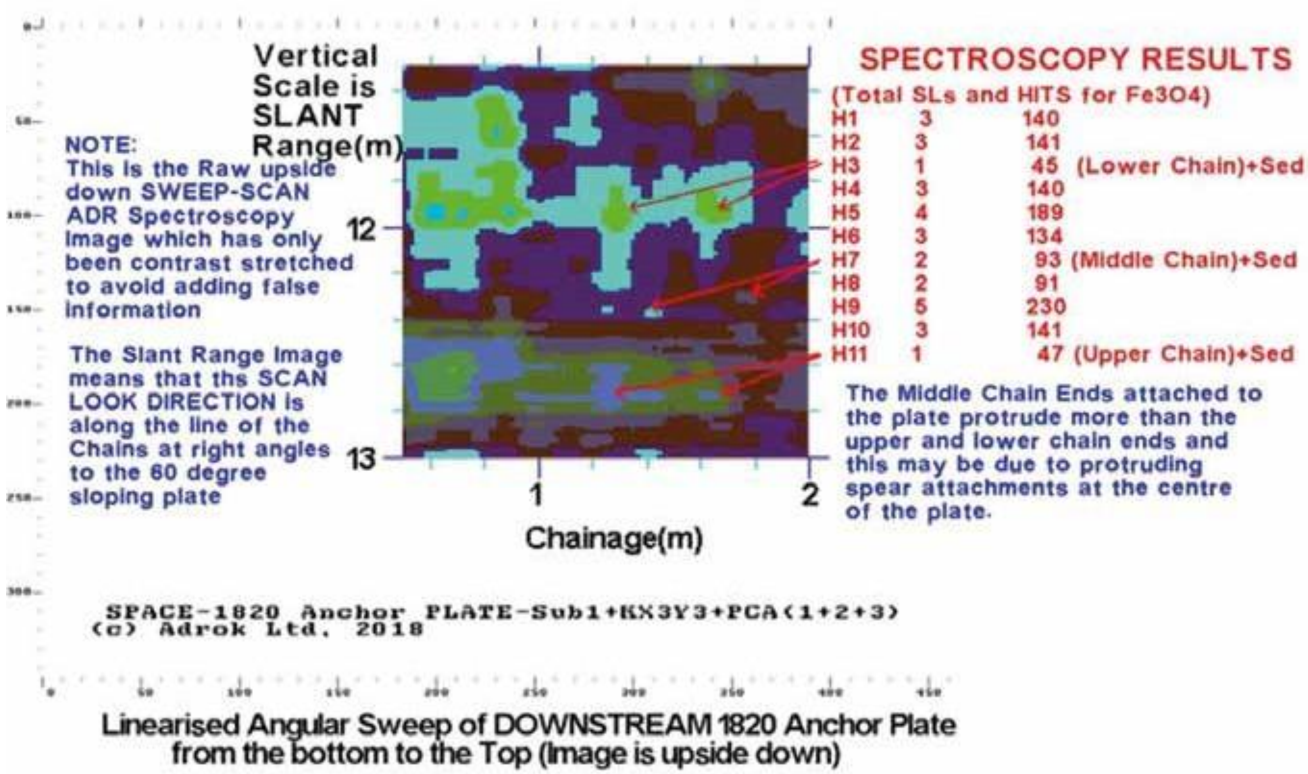


Fig. 7. *Spectroscopy results*

In conclusion, I would state that the spectroscopy results [Fig. 7] demonstrate that the ADR sensors have clearly recognised iron oxide spectra (Fe3O4) by hundreds of hits over 145 sections of the bottom 2ft of this plate. The brevity of this report prevents further results being stated but I am sure that the results reveal the existence of a large cast iron anchor which may not be completely covered by sediments. Tidal channels of water have also been identified and some of the gravels used in the original burial of this plate may now be washed out, which explains the well-known doppler shifts of water at the chain/plate interfaces.