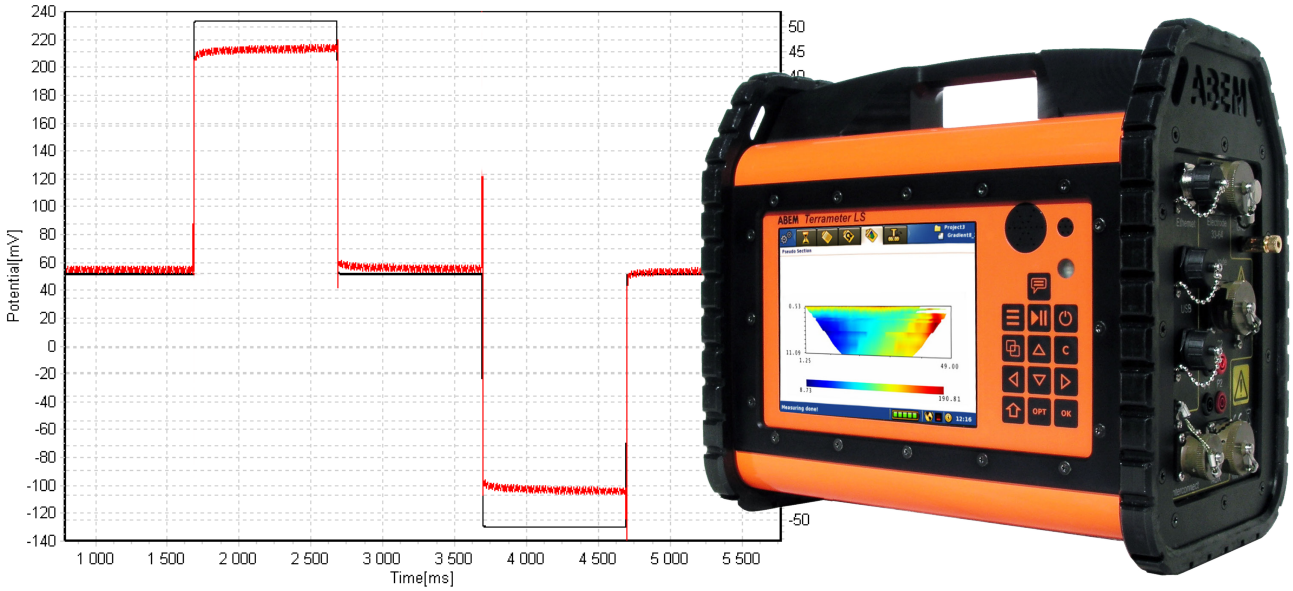
Terrameter LS

INDUCED POLARIZATION



Automatic System for Resistivity and IP Imaging

Terrameter LS is a world leading resistivity-IP instrument that offers high quality data. The instrument can be used for several applications and Induced Polarization is one of its many strong competences where its wide dynamic range provides superior results.

Many answers lie in chargeability

Variations in lithology do not always lead to significant contrasts in resistivity, for example in the case of disseminated ore minerals. In such cases the ground may contain many small conducting zones that are isolated from each other, thus imitating the characteristics of a capacitor. The presence of the conductors does not affect the resistivity measured by direct current, whereas the chargeability measured as Induced Polarization (IP) will reveal them. This chargeability varies for different materials and they can therefore be differentiated from each other by using IP measuring (e.g. Bertin and Loeb 1976; Sumner 1976).

Combined resistivity and IP imaging is also a powerful tool for mapping of waste deposits. There are often several issues that need to be known about existing waste deposits for environmental protection or land re-use purposes. There is often contamination of the ground as a result of contaminant leakage from the waste, which poses a threat to the groundwater.

Furthermore, IP surveys can be used for discriminating between different types of rock that may have similar resistivities but different chargeabilities, for example sandstone and limestone where a sandstone would generally be expected to have higher chargeability.

It has also been reported that leachate contamination from e.g. landfills and NAPL (non-aqueous phase liquid) contamination can give rise to IP anomalies, and this is an active research field.

World leading Resistivity/IP system - optional configuration tailored to fit your needs

Highest bandwidth on the market - providing highest resolution data

No need for Non-polarizable electrodes - less maintenance and cost, higher productivity

No analog input filters - leaves signal uncompromised

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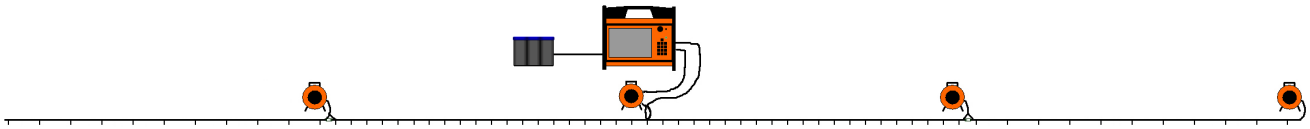
ABEM Terrameter LS system

Terrameter LS system incorporates both a powerful transmitter, high resolution receiver as well as a integrated electrode switching matrix. Together with an integrated computer and full colour screen it's a one single item solution configuration tailored to meet each individual clients requirements.

Terrameter LS utilizes a constant current transmitter that sends an almost perfect square current wave. This means that the instrument is less sensitive to noise disturbances. The instrument also incorporates galvanically isolated input channels where every input can measure totally independent of the others. Together with 24 bit input resolution the Terrameter LS has the highest bandwidth on the market.

IP-surveying is traditionally carried out using non-polarizable electrodes, but thanks to the large dynamic range, the Terrameter LS system performs excellent IP-measurements with common stainless steel electrodes (Dahlin, Leroux and Nissen 2002), thus increasing field effectiveness as well as eliminating the need of electrode maintenance.



Field setup

The Terrameter LS system standard setup is carried out by connecting the instrument to 4 interconnected cables with 21 electrode takeouts each. Stainless steel electrodes are connected to each takeout and the internal relay switch automatically addresses every electrode during data collecting.

Field effectiveness is kept at its maximum by using the Multiple Gradient protocol were all input channels can be used simultaneously for data sampling, with optimal resolution and depth penetration compared to traditional arrays such as Wenner, Schlumberger or Dipole-Dipole.

Using roll-along, the measuring profile is extended as far as desired and field measurement is interpreted using 2D or 3D inversion software such as Res2Dinv or Res3Dinv.

High resolution data sampling

During the IP-measurement, the Terrameter samples the voltage discharge with a sampling rate of 1 kHz with 24-bit resolution, catching the full IP curve including background electrode self potentials which is automatically compensated. In conjunction with the galvanically isolated input channels, Terrameter LS can measure with its finest input range of +/- 2.5 V.

This results in a high dynamic range ensuring excellent IP-measurements with common steel electrodes (Dahlin, Leroux and Nissen 2002), which saves time but also provides better ground contact.

Another benefit using the Terrameter LS is that the instrument has no analog low-pass input filters since this would greatly compromise the measured result.

Did you know?

With an ABEM 4x21 cable set, the cables are interconnected with an overlap, thus sharing an electrode position. This enables easy maintaining of electrode spacing since no control with measuring tape is required.

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Example of Resistivity-IP Survey for Gold Prospecting

The following example shows data from a combined resistivity-IP (induced polarisation) survey that was carried out using an ABEM Terrameter LS with the purpose to find gold. Gold bearing formations are often associated with metallic sulfide mineralization, which creates IP effects in the gold bearing zone. The gold itself will not contribute significantly to the IP effect, but by finding the sulfide mineralization the chances of finding gold is greatly enhanced (Hallof and Yamashita 1990).

The field survey was done using an 800 m long cable spread with 81 electrodes at a spacing of 10 m. Measurements were carried out along three more or less parallel lines.

The data were inverted using Res2dinv, resulting in model sections with maximum depth of the models around 150 metres. The good data quality resulted in mean residuals as low as 1-2 % for both resistivity and IP model. Figure 1 shows the inverted resistivity and IP sections for one of the lines. A number of high chargeability zones are evident, and one of the zones reaches shallow depths (around length co-ordinate 950 m) and would thus be an easy target for exploration drilling.

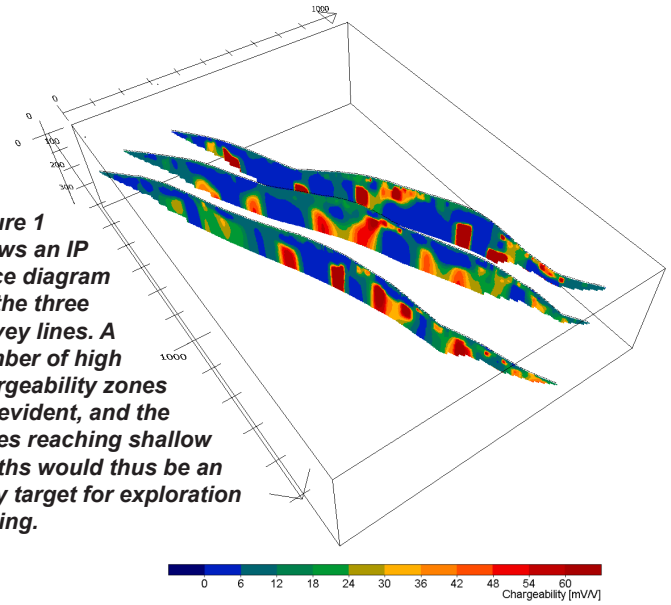


Figure 1 shows an IP fence diagram for the three survey lines. A number of high chargeability zones are evident, and the zones reaching shallow depths would thus be an easy target for exploration drilling.

Example of Waste Characterisation

A 3D resistivity and time-domain induced polarization survey using Terrameter LS was carried out over part of a Municipal Solid Waste (MSW) landfill, the Filborna landfill site, Helsingborg, Sweden. The objective was to assess the possibilities to map variations in material distribution in the landfill.

The 3D field survey was carried out using 300 m long layouts with 5 m electrode take-out spacing. A total of 11 lines 300-330 m long spaced 10 m were measured in one field week, resulting in 17680 resistivity-IP data points on a total of 3330 m of profile. Data were inverted with Res2dinv and Res3dinv using L1-norm (robust) inversion.

An example of preliminary results is shown in Figure 2. The volumes with high normalised chargeability are interpreted to consist of mixed waste or leakage contamination, whereas low chargeability volumes are interpreted as soil cover on top of the waste, soil barriers between waste cells and sedimentary rock below the waste respectively. Parts of the waste that are not covered by soil are clearly visible as high chargeability at the surface. High chargeability in the bottom part of the model is probably caused by precipitation in connection with contaminant migration.

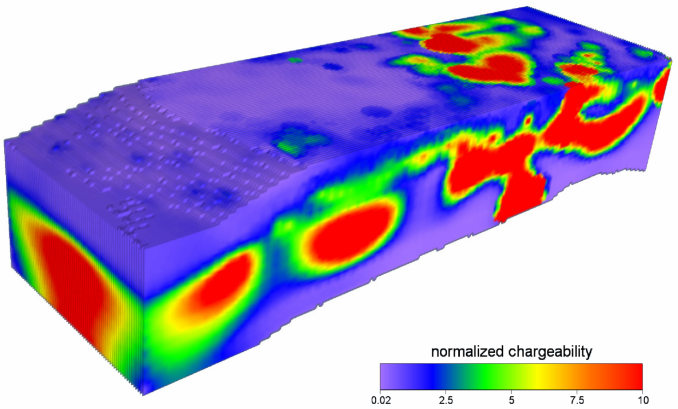


Figure 2 shows normalised IP model based on 3D inversion of data from Filborna waste deposit.

Full Waveform recording

Terrameter LS optionally records Full Waveform data, ensuring that the received measured signal is stored totally uncompromised. This means that it can be thoroughly analysed and supply the user with vital information.

Since Terrameter LS utilises constant current transmission, the measured voltage is a direct result of the ground response. It also reveals any form of disturbance, such as power-net noise, which can easily be averaged out.

Full waveform data also opens possibilities for developing advanced signal processing algorithms, which in real time or post processing might extract meaningful data from data sets that are otherwise too noise contaminated to be used in a meaningful way.

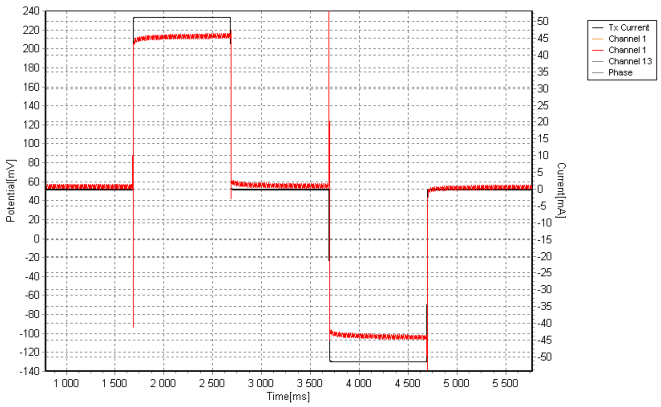
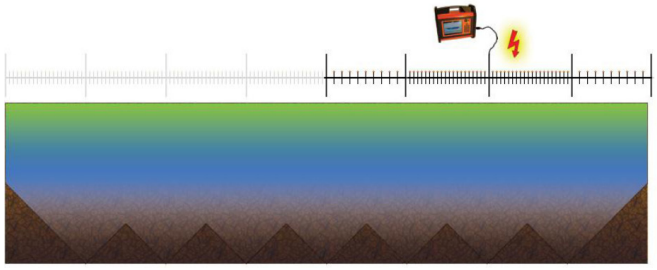


Figure 3 shows an example of a raw data sweep (Full Waveform) where black is transmitted current and red is received voltage.



Did you know?

The Multiple Gradient Array protocol utilizes all input channels in the instrument simultaneously. This means that a four channel Terrameter LS measures four data points where a Wenner or Schlumberger only measures one.

This provides more data in less time!

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ABEM has been in the geophysics business since 1923 which means valuable experience second to none. Through a network of distributors we offer local support in order to give our customers the best possible advantage.

For more information regarding our various system packages, please contact your local distributor or our sales department at sales@abem.se.

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References

Bertin, J. and Loeb, J. (1976) Experimental and Theoretical Aspects of Induced Polarization, Vol I and II, Gebrüder Borntraeger, Berlin-Stuttgart, 335p.

Dahlin T., Leroux V. and Nissen J. (2002) Measuring techniques in induced polarisation imaging, Journal of Applied Geophysics, 50, 3, 279-298.

Hallof, P.G. and Yamashita M. (1990) The use of the IP method to locate gold-bearing sulphide mineralization, in Induced Polarization - Applications and Case Histories, ed. Fink, J.B, Sternberg, B.K., McAlister, E.O., Weiduwilt, W.G., Ward, S.H., Investigations in Geophysics, vol 4, SEG, Houston, p 227-279.

Sumner, J.S. (1976) Principles of induced polarization for geophysical exploration, Developments in Economic Geology 5, Elsevier, Amsterdam, 277p.

Dahlin, T. Rosqvist H., Johansson S., Svensson M., (2012) Resistivity-IP characterisation and short term monitoring at Filborna waste deposit, Procs. 74th EAGE Conference, Copenhagen, 4-7 June 2012, EAGE, 4 p.

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