THE SOIL AND GROUNDWATER TECHNOLOGY ASSOCIATION

SAGTA REPORT 8 - REMOTE SENSING

Introduction

Non-intrusive investigative techniques have the potential to provide rapid, cost-effective information but suffer from a perceived lack of credibility.

SAGTA's Workshop on 24th September 1998 aimed to:

- present industry's view and past experiences;
- learn of research and development in the field;
- revisit geophysical techniques, including their potential and limitations; and
- to allow service providers to outline what services are available.

The emphasis was on:

- perceived and real concerns;
- what has been undertaken to address such issues; and
- new areas of research.

Summary of Workshop

The following issues currently appear to be preventing problem holders from making greater use of geophysics:

- techniques may have been oversold in the past resulting in a lack of confidence in, and understanding of, the form of the end product and limitations of data interpretation. Methods are regarded as expensive when the desired outcome is not forthcoming or appear not to be very robust;
- statistical uncertainty. Statistical methods are not being applied rigorously to existing procedures as many more samples are needed for robustness. Uncertainty exists for geophysics, as it does for more traditional remedial tests, where the full limitations of conventional sampling to ICRCL standards are not appreciated.

What could SAGTA Members do to use or promote the use of geophysics?

- *integration* - endeavour not to view geophysics as a stand alone technique, but as part of an integrated package incorporating borehole and trial pit results with various geophysical techniques to inform the site conceptual model. It could also be viewed as a screening tool with the aim of reducing the need for invasive sampling;
- *protocols* - generate or contribute to a guideline document on keypoints/failures of given techniques. This could be built on the protocols produced by the French for this area of activity. However, at first sight these were considered rather rigid, but they do include interaction with other specialists prior to the survey design. Guidelines may limit the use of unreasonable claims and sub-standard operatives. Guidelines could for example recommend doing a trial, or using geophysics as a high quality monitoring system with electrodes placed permanently in the ground and successive surveys carried out over time in conjunction with hydrogeological surveys;

- *verification* - encourage the comparison of geophysical data with what is actually found on site, seldom done or if so published to date;

communication - Members could publish experience and examples e.g. 'An Evaluation of Remote Sensing Measures'. Case study successes, failures and validation exercises could be attached or linked to SAGTA's website;

- *greater liaison*-between research councils/bodies and SAGTA to make clear to researchers what industry requires. Relevant strategic research plans could be sent to SAGTA (among others) for consultation.

Summary of Further Discussions on Potential Contributions from SAGTA to Remote Sensing Issues:

- encourage incorporation of geophysics trials for CLAIRE research community sites, among other techniques;
- strengthen and develop the link between industry and researchers;
- support the generation of background information on what happens to materials following contamination;
- compile a document listing problems in the industry;
- testing or promoting different techniques for different ground conditions.

Summary of the Workshop

Specific methodologies under consideration at the Workshop were:

- *ground penetrating radar* (GPR) - radio waves emitted from an antenna enter the ground where changes in electrical impedance generate reflection picked up by the same antenna;
- *electromagnetic induction* (EM) - can define shallow plumes of conductive contaminants in groundwater, magnetic anomalies and voids. Data is similar to that obtained using the resistivity method below;
- *resistivity* - measures electrical resistivity of soil rock and groundwater, providing information on layering, depths of subsurface geological horizons, site stratigraphy, later changes and contaminant plumes in groundwater, and requires more time than EM;
- *seismic refraction* - measures density, thickness and depth of geological layers and groundwater surface using acoustic waves;
- *metal detection* - sensitive to changes in electrical conductivity caused by magnetic sources;
- *magnetometry* - detects changes in the earth's magnetic field created by buried ferromagnetic objects, e.g. an underground storage tank (UST) would produce an anomaly.

Presentations

a) Overview

Industry's goals include: reliable delineation with minimum disruption; reliable data sets; and safety.

b) Research and Development Initiatives:

- airborne remote sensing capability to asses landfill sites, farming practice, monitoring, compliance, soil erosion as a pathway indicator, and stressed vegetation possibly indicating contamination which could impact groundwater;
- geochemical baseline surveys of the environment from solid and water samples, measuring total concentration rather than speciation;
- satellite and airborne sources with available imagery including stereo, airborne laser scanner to model surface runoff, thermal imagery, 3-D visualisation, elevation data, LIDAR (laser induced direction and range) for terrain mapping, SAR (synthetic aperture radar) interferometry to monitor subsidence and flooding, CASI (compact airborne spectrographic imager) for pollution detection, hyperspectral data to detect leachate, IRS-1D and aerial photography;
- research into the 'Rescan 3D'. While the data are valid, software intepretation need development;
- electrical tomography, where electrodes are inserted into the ground at regular intervals (distance between determines depth) and measuring the resistance between them.

c) Service Providers' Viewpoint:

- industry could endeavour to make more clear to researchers what it wants;

- users should: request calibration against a standard to demonstrate that the technique works; archive original data for comparison and verification; request that topography be included on interpretation of results and recommend that the same person does the survey and the interpretation;
- problems for service providers include: survey repeatability is difficult, even with GPS which does not work in dips and bogs; a substantial amount of geophysics is not 'intrinsically safe' and does not comply with other legislation; equipment calibration is not effective near concrete or cars; British operators do not have access to a code of practice as the French do; and case histories may be published in obscure journals;
- needs include: background information on what happens to material when contaminated, requirement for an independent adviser for quality assurance (as employed by the oil industry); and support for Expanded Site Capitalisation (ESC), a standard, more holistic and integrated approach;
- use multidisciplinary geophysical methods during site investigation, for analysis and presentation, with emphasis on validation and data integration.

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