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EPILOGUE to the Engineering Geophysics Workshop

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Introduction

Participants in our first engineering geophysics workshop were rewarded with presented papers of high quality and containing a significant amount of valuable case study material which was obtained with a variety of geophysical methods. There is little doubt that the wider audience will benefit from the publication of these edited proceedings.

The workshop was characterised by enthusiastic discussions throughout and followed by a rather foreshortened final discussion session which dealt with perceptions gained by the participants as to current engineering geophysical practice, state-of-the-art of the various methods and their limitations, and on perceived needs and future directions.

In order to provide a summary of these discussions, we have relied on memory, rough notes provided by some of the participants, and informed editing. We hope that any omissions or errors which are contained in the following will be forgiven by participants.

There were two quotes which set the tone of the final discussion and which are worth repeating.

The first of these, attributed to David Stapledon was:

". . . Contractors and Engineers are infinitely inventive in the manner in which they use geophysical interpretations . . .",

highlighting the need for engineering geophysicists to improve their communication skills.

The second, attributed to Graham Granger was:

". . . seismic is always trying to tell you something, but what? . . ."

emphasising that, although the seismic method was probably the most widely discussed during the workshop, there was still much to be done to improve seismic interpretation, particularly interpretation in engineering terms.

Most participants could recall instances when geophysical interpretations failed to agree with other information from a site. It was less clear whether this was due to a failure of the geophysical method in the particular conditions or to inadequate practice.

The principal points raised during the workshop are summarised below,

1. The severe and often unrealistic expenditure constraints which are imposed on engineering geophysical surveys frequently means that geophysical data are not re-interpreted in the light of additional geological information, unless legal action is pending.

2. There is considerable variation in engineering geophysical practice owing to a shortage of specialist engineering geophysicists. This frequently means that clients may not receive the best geophysical advice. The common practice of relegating geophysical data acquisition and interpretation to inexperienced personnel should be condemned. At very least, geophysical surveys should be planned and interpretations reviewed by experienced engineering geophysical consultants.

3. Present reporting standards are inadequate. Engineering geophysical reports should contain:

   a. a clear statement of the engineering problem, a description of the geophysical methods and their use, notes on field conditions, quality and adequacy of the geophysical data, processing methods and parameters, accuracy of interpretation and conclusions in engineering terms related to the problem,

   b. interpreted geophysical sections should be at natural scale; vertical exaggeration should be avoided. Scales of diagrams should be related to the accuracy of the data, and the detail required for the problem, rather than the page size,

   c. copies of raw data should either be included with the geophysical report or archived to be made available on request. This is particularly important as the final design of engineering works and their location often changes following the geophysical survey.

4. Improved and specific geophysical interpretative aids are required for engineering-scale problems.

5. Further research is needed in relation to specific engineering problems in geophysics, such as the influence of vertical defects on measured parameters.

Assessment of Geophysical Methods

The perceptions and state-of-the-art of various geophysical methods in their applications to engineering problems are summarised below:

Gravity and Microgravity

- no microgravity meter (e.g. La Coste D model) is permanently in Australia
- survey costs are expensive and interpretation is indefinite
- unlikely to become routine in engineering investigations

Magnetics

- highly developed for specific applications
- continuous reading (e.g. caesium vapour) magnetometer has considerable potential for engineering investigations as a mapping tool.
- feedback needed following completed excavations

Ground-Probing Radar

- undergoing rapid development and improvement
- currently restricted to less than 5 m penetration in other than dry rocks
- needs more exposure to local sites so that method can be evaluated
- will find routine use when penetration can be guaranteed to 20–30 m in all conditions

Seismic Refraction

- plays a prominent role in engineering geophysics but is still probably underutilised
- current field practice is often inadequate, and more channels and more traverses per site are needed
- Reciprocal interpretation method in widespread use, GRM not yet accepted and may not be suitable for most engineering problems
- more use should be made of microcomputer processing and numerical methods to check interpretations and correlations with engineering properties
- further work needs to be done on non-destructive, preferably non-explosive, seismic sources for use in urban areas

High Resolution Seismic Reflection

- not widely used although there is substantial interest in the method
- seems to work best in areas where radar works worst, i.e. where fine-grained and saturated sediments occur at the surface
- needs to be evaluated in a wider variety of Australian conditions
- costs need to be comparable with refraction for the method to be applied
- some improvement in field instrumentation is required and most engineering seismographs in common use are not adequate
- probably has site-specific application in relatively uniform conditions where depths of interest are greater than 30 m
- worthy of continued development in engineering geophysics

Downhole and Crosshole Seismic

- not widely used although there is substantial interest in these methods
- has potential for both target definition and engineering property specifications using both P and S waves
- surface and downhole instrumentation needs improvement and wider availability
- interpretative procedures need to be developed
- requires testing in a wider variety of local conditions

Electromagnetics

- available equipment is much too expensive and not really suitable for engineering investigations
- very early time transient electromagnetic (TEM) and more portable equipment needs to be developed
- very few suitable interpretative aids are available
- has considerable potential as a rapid mapping tool in engineering site investigation

Electrical Methods

- resistivity methods appear to lack resolution on an engineering scale using conventional electrode arrays (i.e. Wenner and Schlumberger) and are seen as a gravel location and groundwater tool rather than an engineering tool
- more innovation in fieldwork and interpretation is needed if resistivity methods are to find increased application in engineering investigation
- the induced polarisation (IP) method, has some potential in locating clays; however, more research and testing is needed to establish relationships between IP and engineering properties
- IP equipment is too expensive and interpretative aids for engineering applications are limited
- downhole and crosshole resistivity and IP could be useful, particularly if they can be used with similar seismic methods

Logging

- not yet used on a routine basis, but has considerable potential
- current electrical, sonic and nuclear logging equipment is too expensive and not adapted to engineering problems
- both soil and rock geophysical loggers need to be developed for dry and fluid filled holes
- current loggers lack resolution, which should be less than 5–10 cm for engineering applications
- limited aids are available for quantitative interpretation in soils and weathered material
- more research work is required to correlate log responses with engineering properties

Conclusions

The first engineering geophysics workshop was a considerable success, and it is hoped that future workshops will continue to attract attention and greater participation from civil and mining engineers. There is considerable scope to develop specialist workshops on specific engineering problems and applications. It is hoped that both the ASEG and the Geomechanics Society will continue active co-operation, which can only result in the improvement and advancement of engineering geophysical practice and improved employment opportunities for geophysicists, be they engineering geophysicists or geophysical engineers.

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