Exploration Geophysics (1992), **23**, 465–466

Future trends in Exploration Geophysics

Dr. D. O. Zimmerman
Executive General Manager-Mineral Resources
MIM Holdings Limited
GPO Box 1042
Brisbane, QLD 4001

Modern exploration relies on the integration of geology, geochemistry and geophysics to locate economically viable mineral deposits, water, oil and gas reserves. Exploration geophysics relies on detecting physical property differences within the shallow Earth to distinguish rock-type variations, structure, and the contrast between that unique rock — the ore body — and the host rock. These physical properties include density, magnetic susceptibility, conductivity, chargeability, velocity and reflectivity. The discovery of additional useful physical properties, and thus new geophysical methods, seems unlikely. The future of the continued advancement of geophysics is considered to be in the innovative use of the existing methods. Most of these have been in use since early this century and include the potential field methods of gravity and magnetics, electrical methods (resistivity, induced polarisation, self potential, electromagnetics), seismic and radiometrics.

In the recent past in Australia, geochemistry tended to be the main mineral exploration tool for the 60s through the 80s, except in uranium and more recently in diamond exploration. Geophysics was misused and poorly understood in the 60s and 70s, and its proper application improved markedly in the 80s. This was due to the inevitable progression of mineral exploration into areas of thicker cover and physically more inhospitable. Improved data quality and the side benefits reaped from private regional airborne surveys for diamonds showed the benefits of such surveys. These extensive reconnaissance-style surveys, particularly using environmentally friendly airborne platforms, will become more widespread as target-generating tools, and ground-based geophysical surveys will become the main targeting method for mineral drilling in areas of thicker cover.

The increasing sophistication and evolution of both ground and airborne contemporary geophysical techniques will be discussed. Advances foreshadowed will include better computer-based instrumentation that will allow detection of very small, significant signals, increased data-gathering speed and data storage, and easily interpretable output data.

Examples will include commercially viable airborne gravity and other airborne and downhole techniques. These improvements are not anticipated to increase survey costs greatly beyond the rate of inflation. If the gradual decrease in the costs of airborne magnetic and airborne electromagnetic surveys are used as a guide, then costs could actually decline in the future.

Management will need to dedicate more powerful personal computers and workstations for the exploration geophysicists to undertake adequately the increasingly more complicated tasks of interpreting larger data sets so as to remain competitive. Data storage hardware and good presentation equipment will also be required. Resources will need to be dedicated to develop fast, user-friendly software for interpretation. A good goal within five to ten years would be to get electromagnetic data and its interpretation to the same level of familiarity amongst mineral explorationists as is airborne magnetic data today. The increasing use of geophysics will require most explorationists to become fluent in geophysics. This will necessitate some changes in earth-science curricula within our teaching institutions. A new breed of mineral explorationists will emerge with equal competency in geology and in the practical application of geophysics, as we find now in petroleum.

Geophysics is most effective in petroleum search when results are integrated with high-quality geological and geochemical data to produce a robust holistic interpretation of the source-seal-reservoir relationship as determined by sequence stratigraphic techniques.

Rapid developments in petroleum geophysics since the mid-1970s have been a response to the increasing importance of cost-effective exploration and development of small, subtle and certainly more complex hydrocarbon traps.

These developments have mainly concentrated on the seismic technique and have relied extensively on constantly improving computer technology. Large volumes of high-resolution, accurately positioned seismic data can now be acquired, processed and interpreted relatively quickly and cheaply, enabling the extensive use of 3D seismic as an exploration tool.

The boundaries between the fields of acquisition, processing and interpretation are becoming less distinct, with advances in "real time" processing in the field, and interactive processing and interpretation on work stations. Advances in satellite communication have recently enabled the office-based explorationist to interpret on a work station, preliminary processed seismic data, within minutes of the data being acquired in the field, thereby optimising data quality and line locations.

There will also be an increase in the use of well-seismic techniques for the exploration, development and production of existing and future petroleum fields. Techniques such as

cross-hole tomography, have recently demonstrated the potential to produce very high resolution and virtually noise-free seismic scans between wells. This could prove particularly useful in development geophysics, and in areas where conventional surface seismic techniques are almost useless, as in the highlands of Papua New Guinea.

The increasing application of geophysics in mineral exploration will reflect in an acute shortage of geophysicists in middle management, where more staff trained in geophysics will control large-scale projects. As in the petroleum industry, we will see geophysicists heading up companies and being appointed to the boards of major mining companies. However, to achieve this broadening of career paths and opportunities, there will need to be a major attitude change in today's senior geophysicists. A purely scientific mentality will not be adequate to achieve the role changes successfully. There will need to be the motivation to drive and lead exploration by efficient management, using geophysics as an effective tool within the exploration armoury. Those geophysicists with management ambitions will need to seek out opportunities to get management training, such as the MBA, to broaden their base and increase their employability. To my mind, there should always be room for the technical manager who concentrates on management, as well as for the very senior and widely experienced technical person who concentrates on advancing the science. We have still to recognise the need to reward these people equally.