Minerals geophysics

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Mineral geophysics – a grumble, some good news, and GiGi

I started writing this contribution on my early morning flight at the start of a three week work stint on site. The exploration industry may have turned a corner; commodity prices are on the rise and geophysical contractors are reporting increased activity. Despite this somewhat rosier outlook, I felt a bit disgruntled. The pre-dawn departure time aside, one source of my discontent was the apparent widespread lack of knowledge of, and public indifference to, the science behind the technology that has had, and continues to have, an enormous impact on our everyday lives.

The contribution of the resource industry is, at best, grudgingly acknowledged in some quarters, yet it is vital to our well-being. Many aspects of the way our industry uses science are brilliant, but they are not well publicised. Is it a lack of interest and awareness, for which our industry must take some of the blame, or wilful ignorance? This is a theme I'd like to develop in future issues, and I'd welcome your thoughts. Perhaps the situation is not as bleak as it seems to me.

The particular aspect of scientific endeavour that I will touch on in this issue is how cross-pollination of ideas and experience from other sciences, and from other branches within the geosciences, has benefitted mineral geophysics. There has been a reverse flow of ideas too. I won't include any of the numerous and ingenious adaptions of the principles of physics and mathematical techniques to mineral geophysics, but focus on a few practical examples.

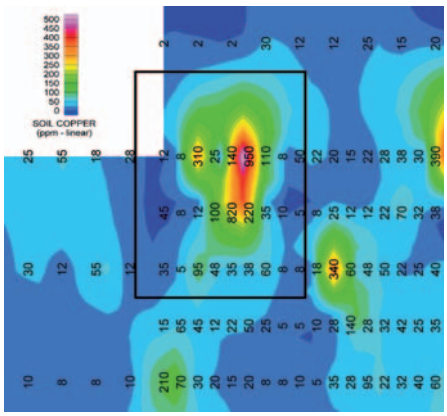
The oil exploration industry developed down-hole logging, some tools being quite specific to industry needs, others more general in nature. The use of nuclear physics to measure density (through gamma ray absorption) and porosity (through neutron capture by hydrogen) has always struck me as being particularly ingenious. Inspired by the oil industry usage, mineral geophysics now utilises borehole-logging to measure a wide range of physical properties of interest. And, arguably, our use of boreholes to position energy sources and/or geophysical sensors for 3D bore-hole based surveys surpasses current practice in the oil industry.

Refraction seismics has a history of usage in engineering and mineral exploration, but reflection seismics, once the exclusive domain of the oil exploration industry, is increasingly being trialled in hard rock exploration. Geological environments encountered in mineral exploration can be dramatically different to those in oil and gas; particularly in terms of the dominance of steeply-dipping disruptive structures and irregular rock boundaries over well-defined, near-horizontal reflectors. Modern 3D seismic survey design and processing is looking to address this.

In environmental, engineering and archaeological geophysics computer controlled systems using one multi-electrode array for both transmitting and receiving are now used to efficiently conduct detailed electrical surveys. Adaptions would be needed to cope with higher power outputs used in mineral exploration, and there is a need for non-polarisable electrodes for IP measurements, but the technique could address the under-sampling that plagues many conventional mineral exploration IP-resistivity surveys. And who knows, the ability to record readings from a myriad of non-conventional arrays may give us further insights into inversion processes.

Finally, in keeping with the cross-pollination theme, I thought I'd help out our geochemical brethren with a geophysical contribution. I've named it GiGi* and I reckon it will revolutionise geochemical data presentation. GiGi inputs geochemical survey data into 3D magnetic inversion software, uses 10 000 (ppm to percentage) as the inducing field and, hey presto, generates a block model of metal grade – a veritable virtual orebody. I used published government geochemical data in my trial (see results below) to give the procedure more gravitas. Exact processing details must, of course, remain confidential, and I haven't actually got around to testing the concept against drilling, but never mind, it looks glossy on paper.

I leave you to decide whether this analysis might be taking geophysical processing just a little bit too far out of context!



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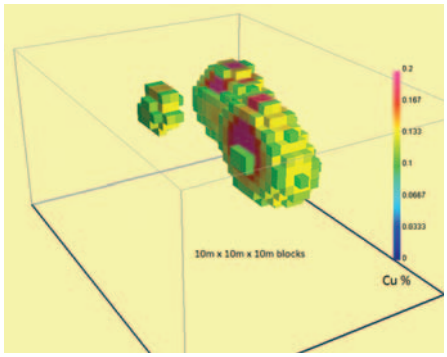

into this!

*Geophysically inspired Geochemical inversion.