Gravity and magnetics for mineral exploration in the 2020s

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Aeromagnetic surveying is a crucial tool for mineral exploration, particularly in covered terrains that are so prevalent in Australia. The technology and methodology were substantially in place 70 years ago following developments in submarine detection in world war 2. There have been incremental advances with development of new magnetometers but only one revolutionary change with the advent of GPS navigation in the early 1990s. It was only after the introduction of differential GPS that high resolution surveys became feasible. Advances in data visualisation and computation have overwhelmed advances in instrumentation and are happening at an ever-accelerating pace. The 2020s are touted as the era for 'big data' and machine learning, with machine learning perhaps more likely to steal the show in gaining more from magnetic field data. Magnetic tensor gradiometry should also play a growing role through the 2020s.

Gravity meters have changed marginally over the last 70 years, but there was the revolutionary development in the late 1990s of airborne gravity gradiometry (coincidentally also arising from submarine warfare – in this case from the need for a submarine to move around the sea floor in stealth mode). AGG can be acquired together with aeromagnetics but it has had limited impact because at present few of these expensive surveys are flown. AGG has been an exciting field of instrument development, but sadly over the last few years three instruments in different companies and based on quite different methodologies have all failed at the commercial hurdle of high development costs and the technical challenge of achieving final break-through noise reductions. However, there are completely different advances in physics including MEMS and atomic interferometry which may provide the gravimeters of the late 2020s.

What we should look forward to in the 2020s are not just instrument-driven advances, but improved capabilities to recover more geological information from gravity and magnetic data. In large part this needs to come from strengthened understanding of the linkage between measured and simulated rock physics and gravity and magnetic fields. We have yet to realise the advantages of incorporating advanced petrophysical data into inversion studies or of better integrating potential fields and other methodologies. Most importantly to take gravity and magnetics beyond pretty image generation and push-button subsurface models we require improvements in geophysicists. Not long-ago Australia was a nursery for potential field geophysicists to work in mineral exploration around the world, but at present geophysics undergraduate courses are closing or at threat of closing, with few students coming into geophysics with strong mathematical and physics backgrounds. This threat to Australia's future in mineral exploration needs to be attended to.