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Environmental geophysics

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Welcome readers to this issue's column on geophysics applied to the environment. I was very pleased when I got interest from readers on last issue's subject – equipment miniaturisation for use on UAVs. Andrew Foley, Group Chief Geophysicist at Gold Fields, wrote to me about work that his group is doing along these lines to collect high-resolution magnetics data over some of their ground, which is pretty challenging. Here is Andrew's story.

Ultra-high-resolution magnetic data acquisition over Lake Lefroy, WA

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Starting in 2012, Gold Fields designed and built a high-resolution dry lake-capable magnetic acquisition platform called SKIMPI (Sled Kart Instrument for Magnetic Prospectivity Imaging). The system was designed to rapidly acquire ultra-high-resolution magnetic data across the Lake Lefroy salt lake system, which covers approximately 40% of the St Ives tenement package (Figure 1).

High-resolution aeromagnetic data (40 to 50 m line spacing) already existed across the area and, in some cases, high-resolution ground magnetics (20 m and 40 m line spacing) was also available. However, it was felt that significant upgrades in our geological understanding, particularly with respect to structural mapping, could be achieved by acquiring ultra-detailed data, and so, a prototype lake platform and magnetometer system, SKIMPI, was built by Gold Fields and Technical Images Pty Ltd.

The SKIMPI system collects data at 25 Hz on 7.5 m spaced lines, and to date has completed acquisition across approximately 250 km^2 of Lake Lefroy. The system handled most conditions that the lake could dish up, from hardpan, glass smooth salt crust, through thick mud, to deep windblown water and waves. That said, inaccessible areas still exist, e.g. in particularly muddy inflow channels, drill-disturbed areas, and causeway 'dams'. In addition to this, the salt lake environment and style of driving required for straight-line data acquisition system was brutal on the towing vehicles,

Figure 1. *The SKIMPI system being towed across Lake Lefroy, WA.*

which ranged from Teryx, Max and Argo ATVs (in increasing terrain capability).

So, the logical next step was to go to the air, taking advantage of our experience miniaturising the system onto the SKIMPI platform, as well as the hard-, firm- and softwares that we had developed. The first phase of this project has now been completed with the development and deployment of the TRAMPE (Tethered Rotary Airborne Platform for Exploration) UAS (Unmanned Aerial System) system (Figure 2).

TRAMPE is a towed bird configuration flying at a Mean Terrain Clearance (MTC) of 5 m for the magnetometer, again sampled at 25 Hz at an average speed of 25 kph along 10 m spaced lines. Flight control is fully autonomous with pilot intervention only during take-off and landing; mostly as a precautionary procedure in order to face the bird into the wind on take-off and to protect the bird structure and sensor during landing. Broadcast differential GPS information is collected during acquisition. Final data processing utilises a post-processed DGPS workflow, along with standard, and specialised in-house potential-fields processing workflows.

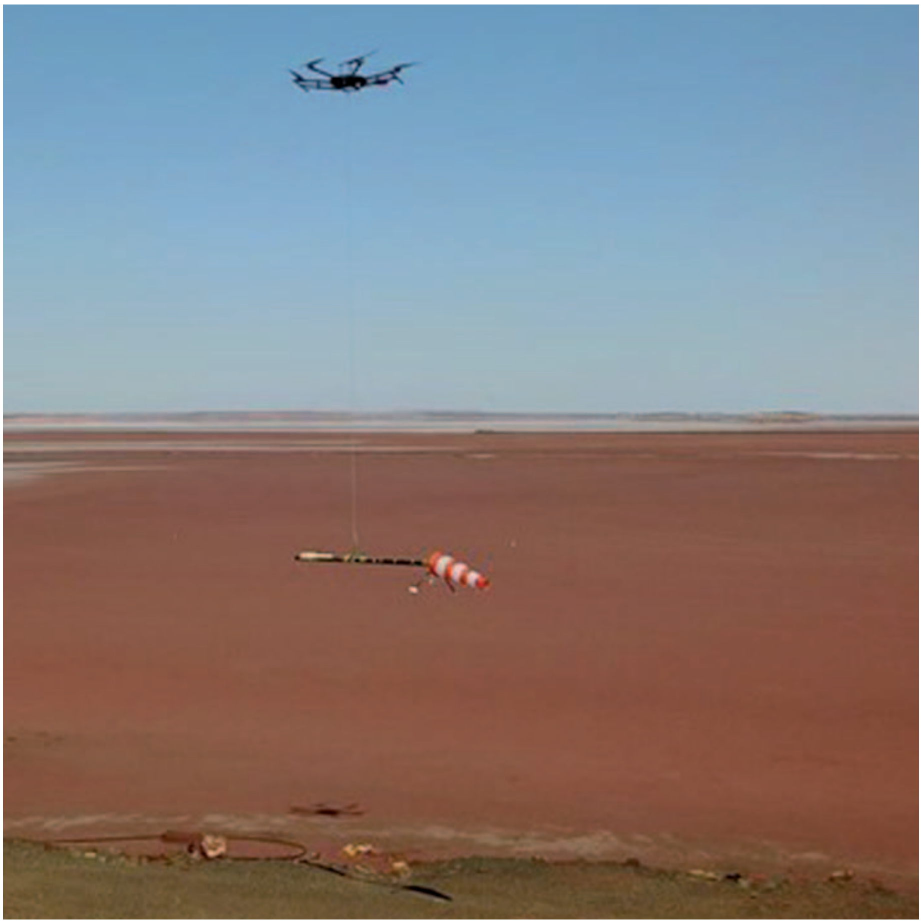

Figure 2. *The TRAMPE system in action.*

Unfortunately, due to the need to maximise data collection (and the fact that the two acquisition systems are so similar), a full comparison/overfly of SKIMPI and TRAMPE data sets has not yet been undertaken – apart from merging overlaps. An example of a merged data set is shown in Figure 3. The top image shows the UAV-based TRAMPE data only. This data set has been reduced to pole (RTP). The second image shows the

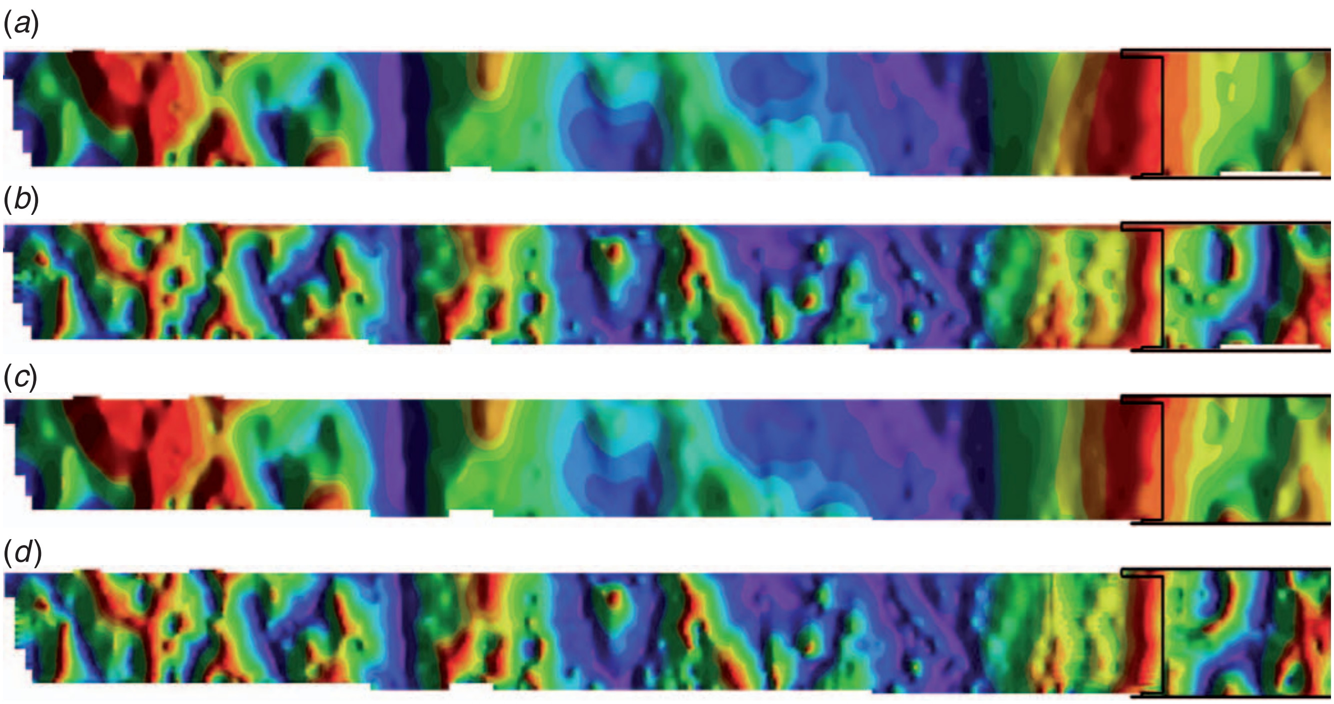

Figure 3. *Comparison of UAV-based TRAMPE data and ground-based SKIMPI data, highlighting the compatibility of the two data sets. (a) TRAMPE RTP data (overlap area with SKIMPI highlighted in black on right). (b) TRAMPE RTP data with TDR enhancement. (c) Merged SKIMPI and TRAMPE RTP data. (d) Merged SKIMPI and TRAMPE with TDR enhancement.*

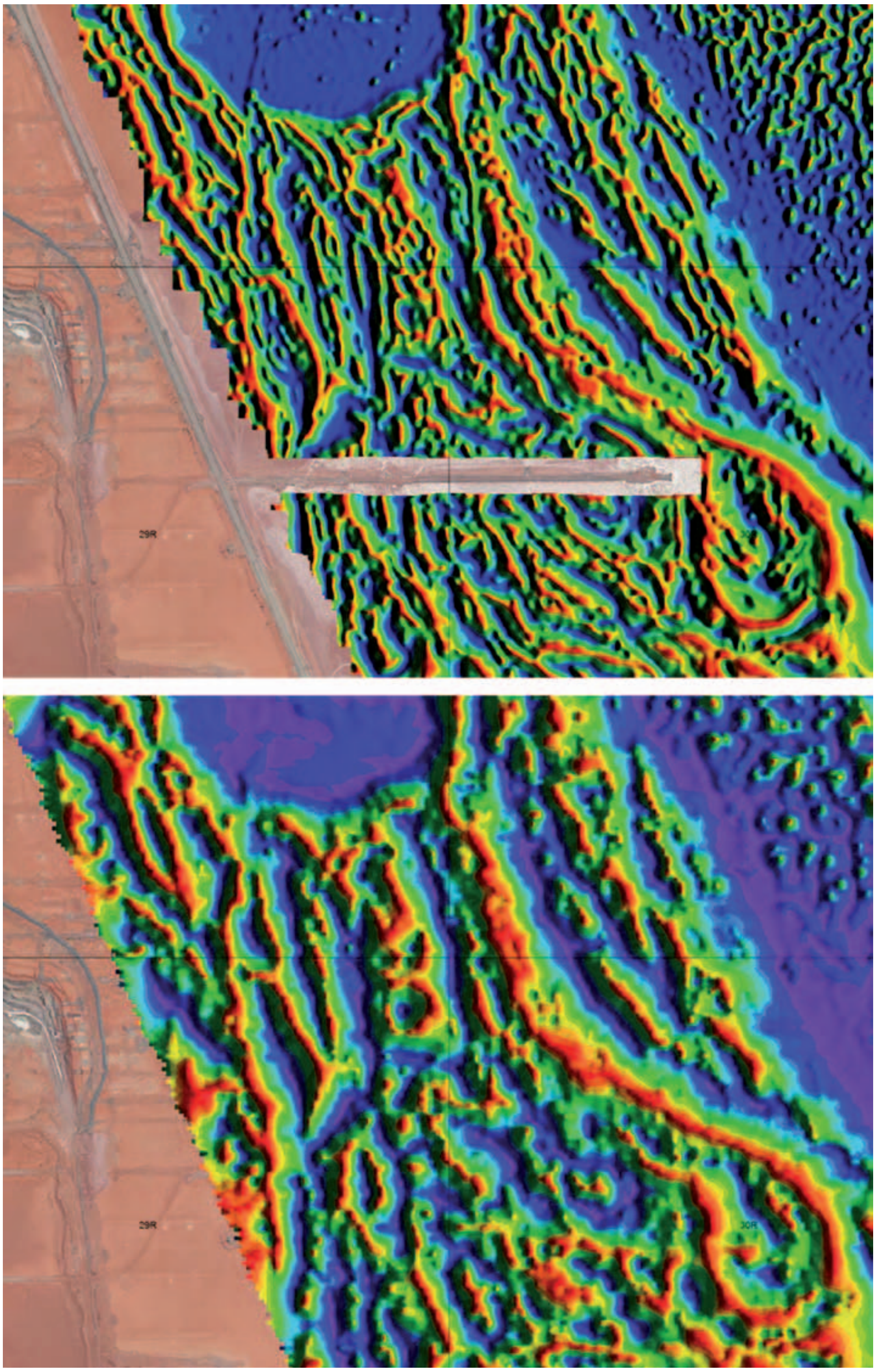

Figure 4. *Comparison of SKIMPI data (top) and high resolution ground mag data (bottom) collected at 20 m line spacing. Both data sets are RTP and then TDR filtered.*

same TRAMPE data, this time processed with additional tilt derivative filtering (TDR). The third image shows the merged SKIMPI and TRAMPE RTP data sets, and the bottom plot shows the merged data sets with TDR filtering. For all plots the overlap area is highlighted with the black polygon on the right side of the figure. Comparison of Figure 3*b* and 3*d* shows that the two data sets are very compatible.

To further illustrate the value of collecting high resolution data, whether ground-based SKIMPI data or UAV-based TRAMPE data, Figure 4 shows a comparison of SKIMPI data (top figure) and conventional high-resolution data (bottom figure – collected on foot).

With the deployment of TRAMPE Mk I now complete, further refinement of the system is underway. These include improvements with respect to the drape and avoidance systems, as well as the development of a stinger mounted magnetic sensor. All of which, if successful, will result in a lower flying height and closer line spacing!

Biography

Andrew Foley graduated in 1988 with an Honours degree in Geophysics and Exploration Geophysics. He joined Normandy Mining in 1991 through 2001, based in Adelaide, Perth and Townsville. In 2001 after the Newmont – Normandy – Franco Nevada merger, Andrew relocated with Newmont to Denver. In 2007 he joined Gold Fields International as Chief Geophysicist based in Denver, and remained through 2014, during which time he completed a Grad Dip in GIS and Data Modelling, 2012. After a major restructuring of the Exploration Group, Andrew relocated to Perth in 2014 as Group Chief Geophysicist.