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How Bernie Milton helped Hugh Rutter with the discovery of Olympic Dam

David Isles
disles@redgatevista.com.au

Introduction

The discovery of Olympic Dam in 1975 was a landmark event for mineral exploration worldwide. The WMC team that made it happen remains on an important pedestal in the annals of economic geology. Douglas Haynes' 2006 recollection of the events, and the various contributions of team members, are probably the most appropriate reading for those who were not in the exploration game at the time. Most of us who were in the game have our own personal 'twists' on the story. I was a very green postgraduate student at Adelaide University when the news broke. It felt like magic.

This note is not an attempt to re-write history. It seeks to reiterate the late Hugh Rutter's astute insights into the government data that lead to the discovery, and to highlight the role played by the South Australian Government – unquestionably through the efforts of the late Bernie Milton (Figure 1).

The importance of imagination

In recent trawling of the (soon to be scrapped) map cabinets at the Southern Geoscience Consultants office, I discovered a hand coloured, 'Andamooka' 1:250 000 scale TMI contour map, and it triggered a recollection of some Hugh Rutter wisdom. Soon after

Figure 1. *Bernie Milton on the road with the South Australian Geological Survey seismic field crew in the 1970s.*

Hugh invited me to join his team of geophysicists at BHP (early 1980) we were discussing issues around contouring of 'under-sampled' data and Hugh offered the example of the Andamooka gravity data. Figure 2 shows the 1971 published gravity map superimposed on that hand-coloured TMI contour map (published in 1965). These were the maps available at the time of WMC's interest in the Stuart Shelf – printed paper maps that cost a few dollars, uncoloured of course (young geophysicists spent Friday afternoons digesting their data by colouring it with their 'Derwents'). The red arrow came with the recently retrieved, archived copy of the gravity map. I think it points to the location of the discovery hole- a later, but important embellishment to the map!

Some critical observations on Figure 2 are that:

- Of the two extreme magnetic highs to the NE and SW of the 'Olympic Dam Anomaly', only the latter has an associated gravity high (this would later be defined as the 'Acropolis' mineralised system).
- The Olympic Dam magnetic anomaly is lower amplitude but appears more discrete. The gravity high associated with it appears as a more extensive linear feature and, based on the existing maps, it would be hard to argue for 'coincidence'.

Hugh Rutter's analysis of both magnetic and gravity 'line compilations' is well described in Haynes (2006). What is not described in Haynes' article is the 'focussed' or perhaps 'biased' way that Hugh re-contoured the gravity data. In Figure 3, I have highlighted and annotated the gravity station locations. Note the single, locally very anomalous station that is essentially coincident with the source of the aeromagnetic anomaly. The vagaries of barometric levelling coupled with the large station spacing, yielded the published map, contoured at 2 milligals and contoured in a firmly objective way (by the late Robin Gerdes). Hugh saw the single, highly anomalous gravity station as a likely indication of coincidence of sources and (as he described to me, verbally I hasten to add) proceeded to re-contour the gravity to give a 'circular' closure over the magnetic anomaly. Hugh's subjective but incisive re-contouring of the ~6 km grid of gravity stations highlighted the coincidence of gravity and magnetic anomalies at Olympic Dam. Without the re-contouring, the area looks decidedly less appealing, especially when compared to the larger area of very strong gravity and magnetic response to the SW. This then, I surmise, was the basis of Hugh's modelling leading to the statement: 'the anomaly at Olympic Dam possibly representing a fossil volcanic centre'.

Hugh also calculated a depth to the gravity source using a profile interpolated from his 'careful re-contouring' of the 6 km gravity stations. The preferred depth was 1150 m, with an alternative model shape at 850 m (Rutter and Esdale, 1985) and a recognition that the coarse station spacing would likely yield overestimates of the depth. The courage and intuition in Hugh's interpretation should not be underestimated, and it was totally in keeping with the courage of the WMC exploration team in vigorously pursuing conceptual targets at (even by today's standards) intimidating depths and 100s of kms from the nearest relevant bedrock exposures.

I have 're-enacted' Hugh's re-contouring of the SA Government gravity using the station locations from the original map and

Bouguer values interpolated from the most recent 'GADDS' data (using the original stations with their barometric heights was a bridge 'far too far'). Figures 4 and 5 show the near circular closure to which Hugh had alluded, and its 'coincidence' with the aeromagnetic anomaly. Note also the judiciously 'non-linear' colour schemes, another trick that 'us oldies' used when coloured pencils reigned and image processors were people in darkrooms with smelly chemicals!

I think these figures speak for themselves. The Olympic Dam anomaly stands out as 'coincident' in gravity and mag, quite localised and likely shallower than neighbouring features, hence its top priority for drilling. Readers are encouraged to source Haynes' account of the overall discovery story and the Rutter and Esdale paper for some further, key geophysical insights.

Perhaps the more important twist to the story relates to the SA Government's decision to cover the state with a ~6 km × 6 km gravity grid rather than the ~10 km × 10 km grid that was initiated by the BMR G&G (the Federal 'Bureau of Mineral Resources, Geology and Geophysics; precursor to AGSO and Geoscience Australia). I have not been successful in tracking down the origins of this decision, but my recollection is that the BMR had a funded program to cover the continent with approximately 10 km × 10 km stations. South Australia would have had to partially, if not wholly, fund the preferred tighter station spacing. The cost impost would have been substantial; 2.5–3 times more gravity stations. Figure 6 shows the 1976 gravity station distribution for Australia. The SA border is largely defined by the denser station coverage!

How did the decision to spend more on tighter gravity coverage affect the Olympic Dam discovery?

If SA had opted for the 'free' BMR coverage then Figure 7 shows that Hugh Rutter would have had very little to work with. I have created this image by forming a 0.1 minute (approx. 10 km) grid and interpolating Bouguer values from the same grid used for the 'Rutter re-enactment'. The Olympic Dam gravity anomaly is gone! The 0.1 minute grid is, I believe, very close to what the BMR crew would have planned for this area – there has been no need to 'tweak' the station positions to de-emphasise the Olympic Dam high. When viewed against the aeromagnetics, it is clear that not even Hugh could have made a case for drilling at OD!

I strongly submit that the SA Government's consistent and determined policy to gather 'its own' geophysical data coverage was an absolutely crucial factor in the discovery.

To whom should we attribute the credit? Clearly management was not only supportive of its geophysical department but was able to successfully draw funds from Treasury for this 'new-fangled' data gathering. My communications with 'old' SA Mines Department operatives, in particular Reg Nelson, Keith Johns and Chris Anderson, leave little doubt that Bernie Milton, who was the most senior geophysicist at the time, drove the decisions to gather higher quality data in locations that suited the State rather than going with the BMR's schedule. Bernie's management team, which included Keith Johns and Lee Parkin, also deserve credit for the State's push to promote exploration by gathering

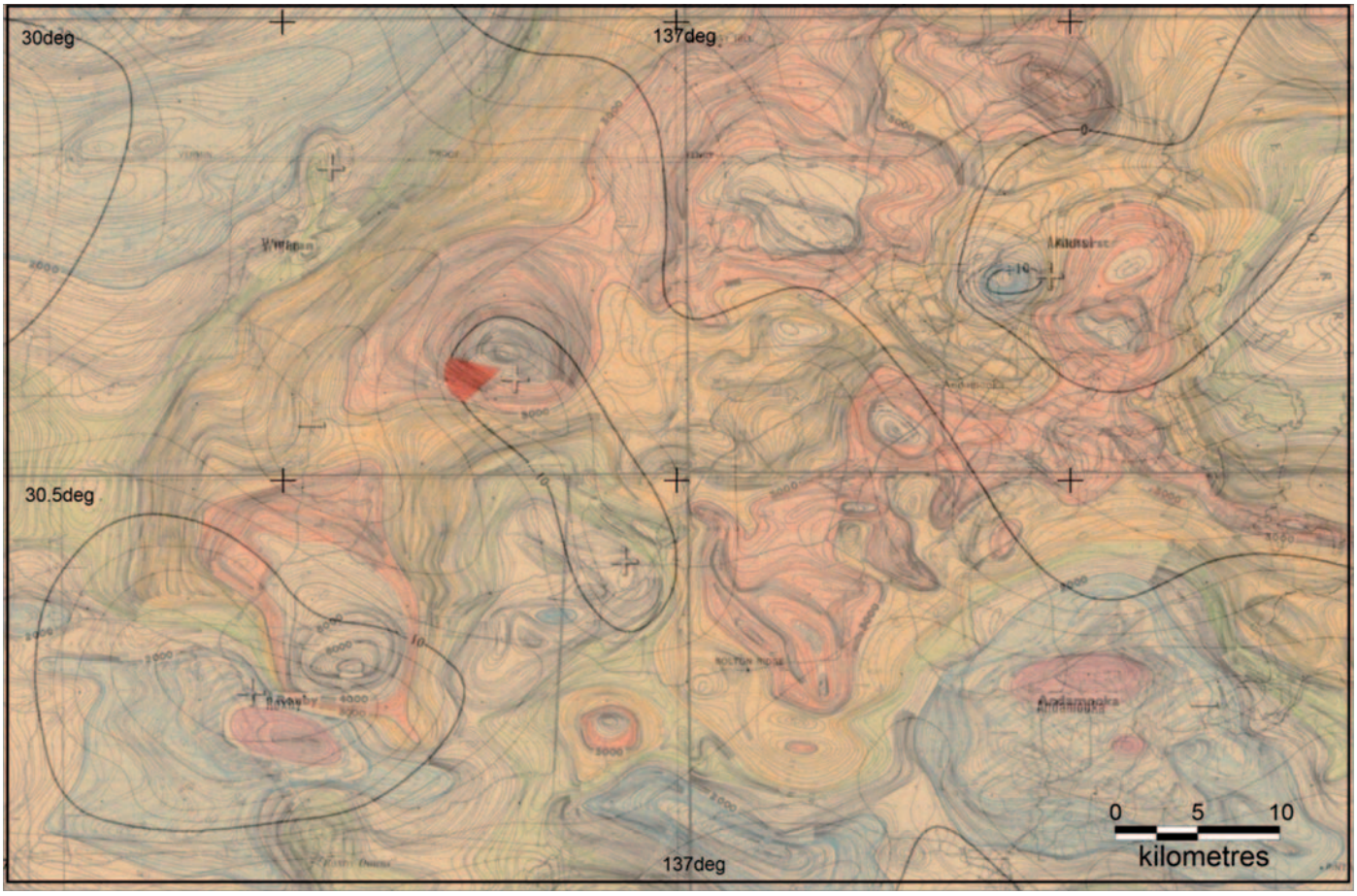


Figure 2. *1971 'Andamooka' SADME Bouguer gravity map superimposed on hand-coloured 1965 BMR/SADME aeromagnetic (TMI) contour map.*

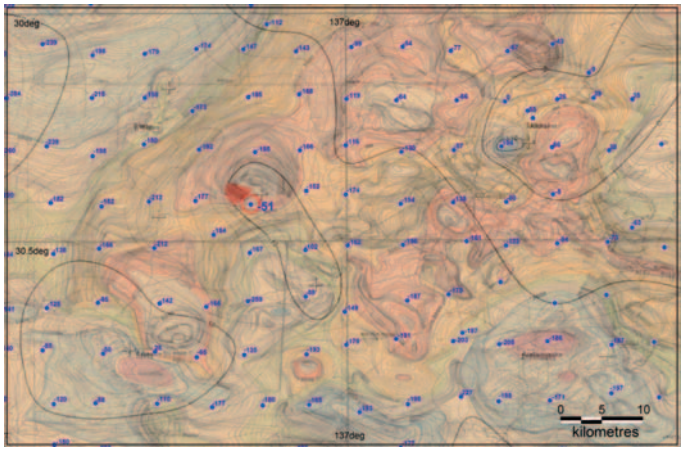


Figure 3. *Figure 2 with the addition of the original gravity station locations and 'modern' Bouguer gravity values.*

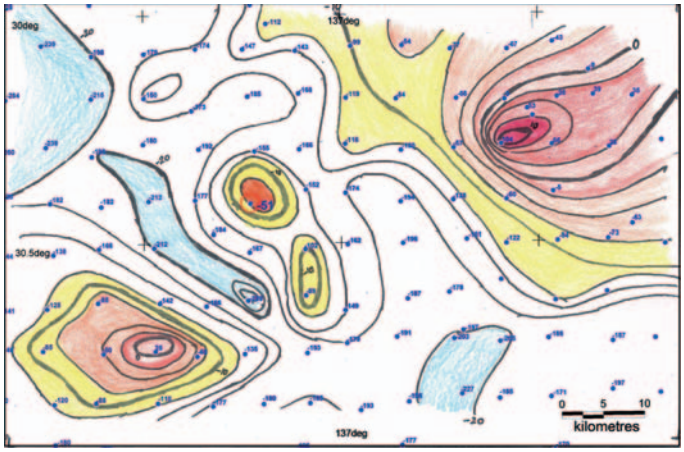


Figure 4. *Bouguer gravity values at the 1971 station location re-contoured by Dave Isles, guided by the aeromagnetic features using the 'Rutter method'.*

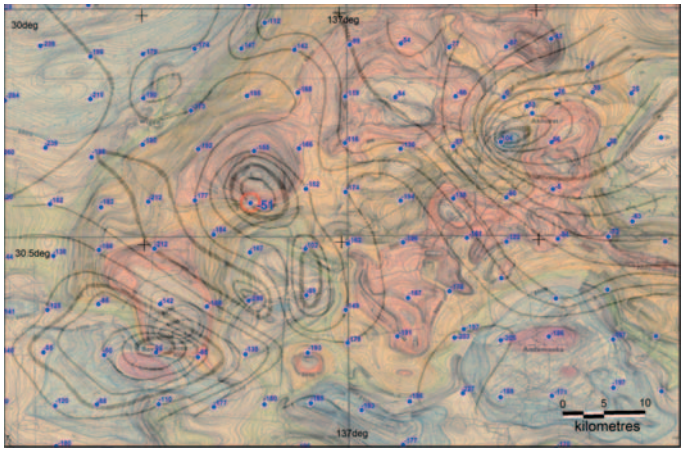


Figure 5. *Re-contoured Bouguer gravity superimposed on the aeromagnetics. Note the 'coincidence' of the Olympic Dam gravity and magnetic anomalies.*

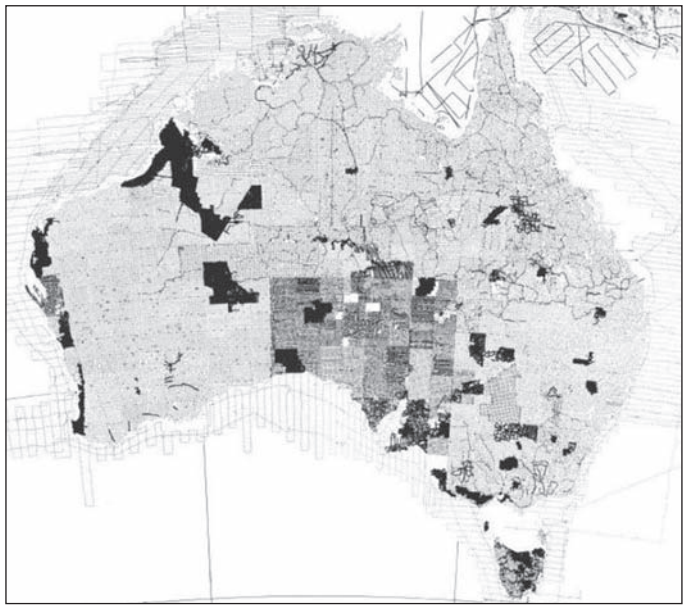
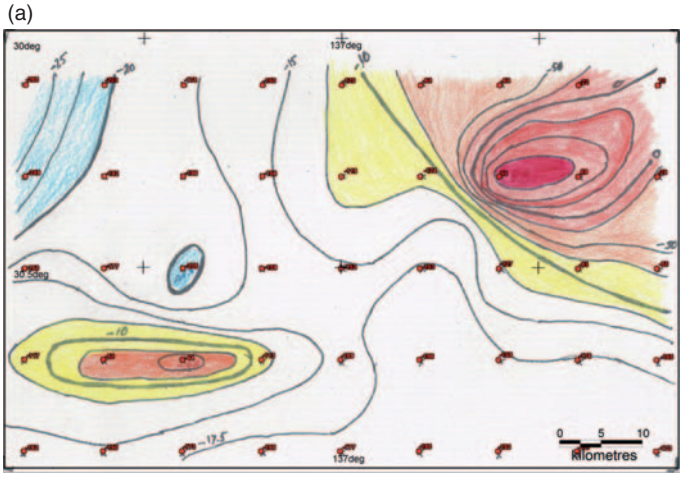


Figure 6. *1976 Australian (BMR) gravity station locations (taken from the first 'complete' Bouguer gravity map of Australia, Anfiloff et al., 1976).*

(a)



(b)

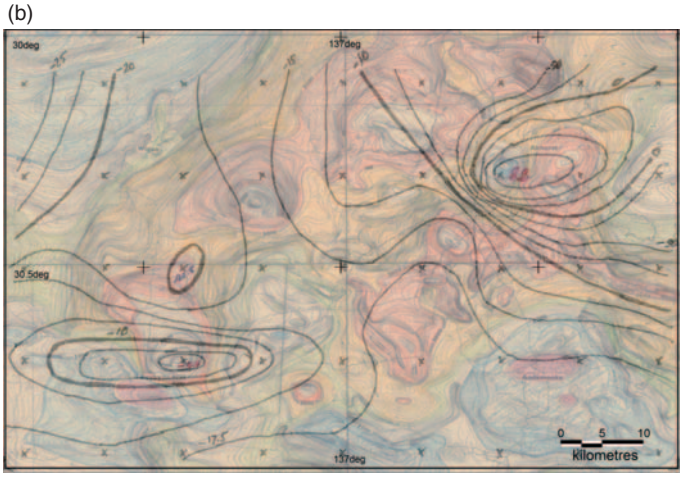


Figure 7. *(a) Simulation of 0.1 minute (~10 km) grid Bouguer gravity map. (b) 0.1 minute (~10 km) based Bouguer gravity map superimposed on a TMI contour map.*

pre-competitive geoscientific data and we should not overlook the forward thinking of Government and Treasury – the then Minister for Development and Mines was the Honourable Don Dunstan!

The book *Above and Below* (O'Neill, 1996) articulates the arm-wrestles between the BMR and the SA Geological Survey for 'mapping rights', highlighting the State Government's support in the 'Playford – Dickinson era' for pre-competitive data acquisition. Not only was Olympic Dam a consequence of this support, but also the oil and gas discoveries in the Cooper Basin. Bernie Milton also played a key role in those discoveries.

Conclusions

The Olympic Dam discovery was made possible by the availability of government gravity and magnetic data. South Australia's pro-active and independent approach to pre-competitive geophysical data collection was a significant drain on Treasury that rapidly reaped almost unimaginable reward, thanks of course, to the talent, determination and strong risk-taking culture of WMC – perhaps a lesson for the risk averse explorers and business analysts who dominate the exploration landscape today.

The easy option for SA would have been to go with BMR's program of ~10 km gravity grid. Bernie Milton, with the support of people like Keith Johns, had the 'fire in the belly', the vision and perhaps the impatience to go it alone and do it their way. The 6 km gravity grid and the fast tracking of aeromagnetic coverage on the Stuart Shelf resulted.

Hugh Rutter's analysis of the gravity should not be understated. If a pessimistic or totally objective or even lazy geophysicist had analysed the SA Government data, the Olympic Dam gravity and magnetic anomalies would have been much lower priority – and possibly never drilled.

The leading role of the Geological Survey of SA in the realm of acquiring and distributing precompetitive geoscientific data, now lauded around the 1990s South Australian Exploration Initiative and the decision to freely distribute data, actually had its beginnings in the 50s and 60s with stunning success. Today, despite the oscillations of the exploration cycle and mood-swings of Government support for Geological Surveys, we see that a visionary and perhaps risk-taking culture continues in South Australia. The SA Department of State Development recently announced the largest detailed airborne mag/rad survey ever flown in Australia – 1.8 million line km – designed to bring forward new world class copper discoveries.

From my personal perspective, a huge vote of thanks to both Hugh and Bernie for those early career lessons!

Acknowledgements

Phil Heath along with current and former SA Geological Survey colleagues; Peter Waring, David Love and Graham Pilkington, did the spade work to dig up the original 1971 SADME gravity map and provided insights into personnel involved with the 1960s/70s gravity program. Chris Anderson, who was hired by Bernie Milton soon after the discovery of OD to tie company gravity surveys on the Stuart Shelf into the National Gravity Network and has successfully continued his association with gravity in the region until very recently, contributed his perspective on that era. Reg Nelson, who worked under Bernie, contributed to the 'pre-OD' gravity and mapping programs and accompanied Bernie on seismic surveys at OD pre and post discovery, provided many insights into SA Geological Survey's exploration-driven culture which resulted in himself, as Chief Geophysicist and then Director of Mineral Development, being one of the main architects of the 1990s 'SAEI' and the subsequent 'PACE' initiatives. Finally and most importantly, thanks to Keith Johns who, as a regional mapping geologist on the Andamooka and Torrens '4 mile' sheets was on board BMR's DC-3 VH-MIN on 28 March 1962 when the aeromag survey tie-lines were flown, then as Bernie's 'boss' supported the independent approach to pre-competitive geophysical data gathering and later, as Director-General of Mines presided over Reg Nelson's successful endeavours to form the model for the SAEI. Keith has also written a book covering broad aspects of the discovery and development of Olympic Dam (Johns, 2010) and provided invaluable input to this article.

References

Anfiloff, W., Murray, A., Barlow, B. C., Denham, D., and Sandford, R., 1976, Compilation and production of the 1976 1:5 000 000 gravity map of Australia: *BMR Journal of Australian Geology and Geophysics*, **1**, 273–276.

Haynes, D.W., 2006, The Olympic Dam ore deposit discovery – a personal view, *SEG Newsletter*, **66**, pp 1, 8–15.

Johns, R. K., 2010, *A Mirage in the Desert?* O'Neill Historical Publishing, Adelaide.

O'Neill, B., 1996, *Above and Below – The South Australian Department of Mines and Energy 1944–1994.* Mines and Energy South Australia.

Rutter, H., and Esdale, D. J., 1985, The geophysics of the Olympic Dam discovery: *Exploration Geophysics*, **16**, 273–276.

Biography

Dave Isles's first job in geophysics (1971) was hand compiling airborne magnetic and radiometric data from the Narbalek region for Noranda Australia. He is a graduate of Melbourne (1975) and Adelaide (1983) Universities and has worked with BHP Minerals (1980–1987), World Geoscience (1987–1993) and a handful of junior explorer-miners (1993–2016). His involvement with aeromagnetics and gravity has been somewhat obsessive in that time – he has co-presented courses on these methods since 1978 and is co-author of the ASEG e-book on aeromagnetic interpretation. He is currently one of the 'senior' exploration consultants at Southern Geoscience and continues to provide short courses on aeromagnetics and gravity.