THE GEORGINA BAISN: SIXTIES DATA; SEVENTIES INTERPRETATION; FOR EIGHTIES? DISCOVERIES?

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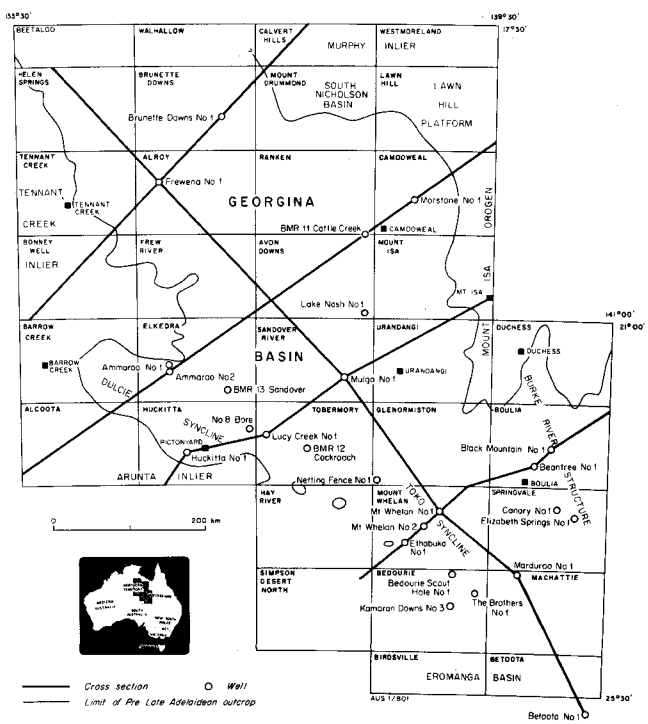
Exploration in the sixties has indicated that promising mineral potential of the Adelaidean to Cretaceous sediments of the Georgina Basin (see figure) lies in phosphates, and possibly lead-zinc deposits and hydrocarbons, within Cambrian and Ordovician sediments. Phosphorite has been mined from the thick accumulation of sediments in the Burke River Structural Belt, and found elsewhere; the hydrocarbon search has been most promising in the west in the Toko Syncline (Harrison, 1979). To help put future resource studies of this area on a broader base, a Bureau of Mineral Resources (BMR) multidisciplinary team undertook an overview interpretation of the geology and available regional geophysics in late 1978 to determine the structure and extent of the Georgina Basin and the upper crustal geology of the region. Principal finding, based on assumptions of rock physical properties, was that there may be 10 or more areas of thick preserved Adelaidean to Lower Cambrian sediments, and five of Palaeozoic sediments.

The present paper discusses the methods used in the interpretation of the old, largely non-digital, geophysical data available and in particular the application of computer modelling.

The figure shows the 23 deepest petroleum exploration and stratigraphic wells, of which 13 are 200-1000 m, 8 are 1000-2000 m, and 2 are 2000-3000 m deep; these bottomed in Precambrian granites, metamorphics, or Adelaidean to Palaeozoic sediments. Seismic surveys are concentrated in the Toko Syncline with others around Morestone 1, Mulga 1 and north of Betoota 1. Comprehensive gravity data, gathered mostly during 1957-63 on an 11000 m grid, are available in BMR's digital data bank. Total magnetic intensity data derived from BMR and subsidised surveys, flown mainly in the period 1962-67, are available in analogue form only and of these only BMR survey data are readily available.



The regional contour maps of Bouguer anomaly and total magnetic intensity were used to divide the basement beneath the Georgina Basin into regions which include the Mount Isa Orogen, the Tennant Creek Inlier, Arunta Inlier and part of the unknown basement beneath the Eromanga Basin, and to identify possible thick, non-magnetic sediment accumulations. The basement of the Georgina Basin was found to consist predominantly of metamorphic rocks and granites similar to the outcrop areas which fringe it. Existing depth to magnetic basement estimates, augmented by new estimates made in selected areas by computer inversion of 210 hand-digitised profiles over 128 linear anomalies, reduced from 20 to 10 the areas where the preserved sedimentary section exceeds 1000 m. Density models were constructed along six profiles drawn between key wells using two-dimensional computer modelling. The magnetic depth estimates and qualitative magnetic/gravity interpretation provided control on the basement surface as starting points for modelling. Modelling of the Bouguer anomaly profile over a secton across the Toko Syncline with good seismic reflection control to well ties, and measured rock densities from cores from most of the wells, provide the density control for rock units in the Georgina Basin. The specific gravities used in the modelling are shown below:

Rock units & lithology	Specific gravity	
	adopted	contrast
Mesozoic sediments (undifferentiated)	2.40	–0.40
Palaeozoic		
– carbonates	2.75	–0.05
– silicic rocks	2.60	–0.20
Adelaidean & ?Carpentarian sediments	2.65–2.70	–0.15 to –0.10
Precambrian		
– undifferentiated metasediments	2.80	0
– basic intrusives & extrusives	2.90–2.95	+0.10 to +0.15
– granites & acid volcanics	2.70	–0.10
Lower crust	3.00	+0.30

One of the most difficult problems encountered was the effective removal of a regional field from the Bouguer anomaly data. The method adopted was to vary the total crustal thickness in the models in order to reduce to zero the Bouguer anomaly in areas where density contrasts in the basement are probably zero. This method while not rigorously correct in ignoring probable isostatic effects was successful for the purposes of modelling.

References

HARRISON, P.L., 1979. Recent seismic studies upgrade the petroleum prospects of the Toko Syncline, Georgina Basin. *APEA Journal* 19, 30-42.

TUCKER, D.H., WYATT, B.W., DRUCE, E.C., HARRISON, P.L., & MATHUR, S.P. The upper crustal geology of the Georgina Basin (in prep.).

A GRAVITY SURVEY OF WOY WOY DISTRICT AND ITS LOCAL AND REGIONAL GEOLOGICAL SIGNIFICANCE

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A detailed gravity survey of the Woy Woy district, south of Gosford, New South Wales, was undertaken in order to determine the thickness of young, unconsolidated sediments overlying the Gosford Formation belonging to the Narrabeen Group of the Triassic. The district is situated within a valley which has a maximum width of 5 km, south of the Blackwall Mountain (Fig. 1). The valley is cut into the sandstone of the Gosford Formation by the Brisbane Water which occupies the valley almost entirely to the north. Near Woy Woy, the water channel bifurcates about St. Hubert's Island and further south it narrows down to a width of only 300 m near Bucher Bay (point D in Fig. 1). Near Ocean Beach at the southern boundary of the district, the channel widens again and joins up with the Broken Bay. The sides of the valley formed by the sandstone are generally steep and the valley floor in Woy Woy quite flat except for the intervention of the Blackwall Mountain, a monadnock over 115 m high.

Some 500 gravity stations were measured at a spacing of about 100 m, along most streets of the township and St. Hubert's Island and along roads in neighbouring districts (Fig. 1). An average station density of 12.5/km^2. Observations were made using a Worden Master gravimeter (No. 935). A local base station was established and connected to the BMR isogal station at Wahroonga. Station elevations were determined relative to bench marks using an automatic precision level with an accuracy of about 10 cm. Tidal and drift corrections were applied and observations reduced to Bouguer Anomalies using the 1978 International Gravity Formula. Topographical corrections were applied manually up to Hammer Zone F and thereafter to a radius of 20 km using a computer method. Overall accuracy of Bouguer anomaly for most stations is estimated at about 1 GU but for some stations close to steep topography it may be about 2 GU.

A steady eastward increase in anomalies from 338 GU in the west to 457 GU in the east is observed and shows the dominance of a regional gradient largely associated with the continental margin. A first degree trend surface analysis of the anomalies gives a trend of 16.4 GU/km along 107.5° with a correlation coefficient of 97.7%. Because the continental slope locally trends along 122° there is an obvious discrepancy between the two trends. An explanation of this discrepancy is proposed in the gravitational influence of the northward dip of the base of the Permian rocks in the region; this dip is indicated from the results of the seismic refraction studies of the Sydney Basin.

The residual anomalies, resulting from the removal of the first degree trend are shown in Fig. 1. They outline a broad low running north-south in the central part of the district. The values on the western flank rise to 9 to 11 GU and on the eastern flank in the vicinity of the Blackwall Mountain they approach similar magnitudes while along the trough they fall to – 6 to – 9 GU. A maximum drop of about 20 GU occurs along the low. Lows of smaller magnitude occur over St. Hubert's Island and further east in the vicinity of the Empire Bay. The locations and trends of these lows associate them quite firmly with the development of young sediments in these districts.

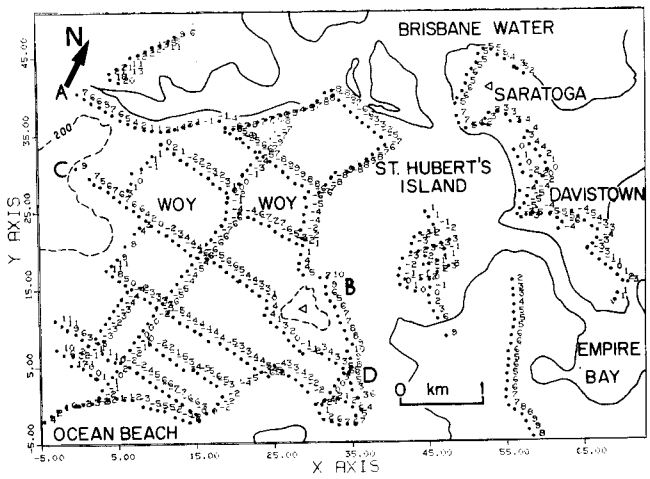

FIGURE 1

Location of gravity stations and residual anomalies (after the removal of first degree regional) in GU based on a computer plot. Continuous line shows land-water boundary (the line is not drawn on the eastern and southern boundaries of Woy Woy as stations follow these boundaries closely). Broken lines show 200 ft (61m) contours on the western scarp and on the Blackwall Mountain near point B.

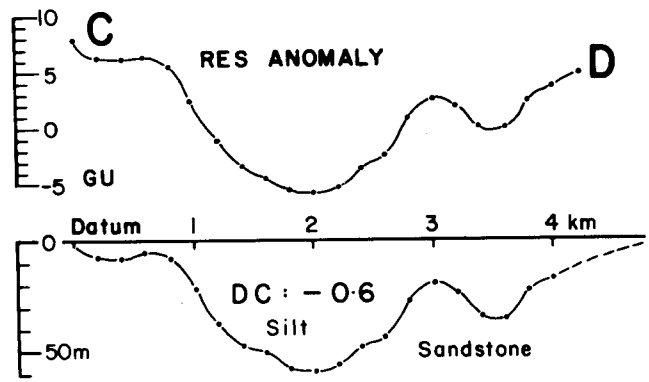

FIGURE 2

Smoothed residual anomalies along profile CD (see Fig. 1). Alternate points (1, 3, . . . 43) and a density contrast of –0.6 tonne m^{-3} were used in an iterative programme to obtain a distribution of young sediments. The RMS difference of the smoothed and calculated values was 0.06 GU.