A PROBABLE EXTENSION TO THE WILLYAMA BLOCK IN N.S.W.

D. J. Isles

Dept. of Economic Geology, University of Adelaide (08-233 4333)

Gravity and magnetic surveys south and southeast of Broken Hill reveal an area of around 2000km^2 where Willyama Complex or older rocks lie at relatively shallow depths beneath Cainozoic cover. The area lies immediately southeast of the Redan fault which is commonly considered to be the major boundary between the Willyama Complex and the Murray Basin in N.S.W.

The Redan Fault

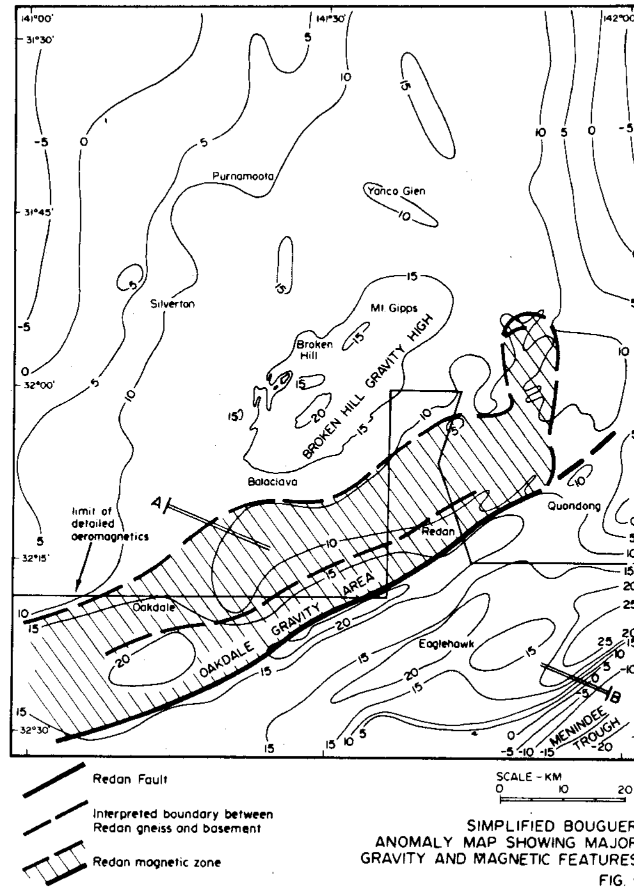
The Redan fault is defined by a prominent step type magnetic anomaly of more than 1000nT which persists for over 60km and coincides approximately with the termination of Willyama outcrop. Modelling of both airborne and ground magnetic profiles across the Redan fault consistently yields a steeply dipping contact with depth extent of around 4000 metres. The magnetic material on the north side of this contact is attributed to the outcropping Redan Gneisses; a magnetite rich rock group interpreted by geologists to occupy the lowest part of the Willyama stratigraphy and possibly to represent an older basement to the complex. On the southeast side of the fault only Cainozoic cover rocks are seen at the surface. If the Redan fault is treated as an abrupt contact between the Redan Gneisses and the much lower density Murray Basin sediments, a substantial decrease in gravity values would be expected southeast of the fault. In fact, gravity values increase considerably southeast of the Redan fault over most, but not all, of its strike length.

The Redan fault then appears as a contact between the highly magnetic Redan Gneisses extending to a depth of 4km and an unseen, higher density and non-magnetic formation to the southeast.

The Redan Magnetic Zone

The characteristic strong magnetic anomalies produced by the Redan Gneisses extend along a 20km wide belt north of the Redan fault. The greater part of this magnetic zone coincides with an extensive gravity depression implying that the adjacent Willyama rocks to the north are generally more dense than the Redan Gneisses. Toward the south, however, gravity values within the zone increase quite rapidly. This gravity change coincides with an abrupt decrease in the magnetic intensity level. The variability of the magnetic pattern and the relative amplitudes of individual anomaly peaks remain the same suggesting that the nature of the shallowest magnetic rocks does not change. No apparent differences have been observed in the outcropping lithologies from the two 'subdivisions' of magnetic zone which might cause major density or susceptibility changes. South of Oakdale, within the Redan magnetic zone, a completely non magnetic area is found which coincides with the peak of the Oakdale gravity high.

These gravity and magnetic relationships strongly suggest the existence of a high density non magnetic formation underlying the Redan Gneisses.



SIMPLIFIED BOUGUER ANOMALY MAP SHOWING MAJOR GRAVITY AND MAGNETIC FEATURES

FIG. 1

The Area Southeast of the Redan Fault

Three prominent ENE trending gravity highs are observed between the Redan fault and the Menindee Trough 40km to the southeast. These broad linear gravity anomalies, separated by well defined troughs, rise more than 10 milligals above the average Bouguer Anomaly level of the outcropping Willyama Complex. Widely spaced, high level airborne magnetic traverses southeast of the Redan fault show an uneven distribution of magnetic anomalies similar to that observed within the Willyama Complex. There are broad areas where anomalies are absent, some small but very intense areas and some moderately magnetic areas. Anomalies are not confined to the gravity highs but the depths to magnetic sources are generally shallower in the higher gravity areas. Depths of less than 100 metres below ground level have been calculated on the gravity highs while depths of up to 700 metres have been determined in the low areas.

Gravity modelling using depths calculated from the magnetic data indicate that the lows are due to steep sided depressions containing material with a density of 0.4 to 0.5 g/cm^3 less than that of the enclosing rocks. Using density measurements from within the Willyama Complex as a guide, a lower density limit of about 2.4 g/cm^3 on the material within the depression can be inferred.

Models

Two possible models for the covered area can be deduced from the available data.

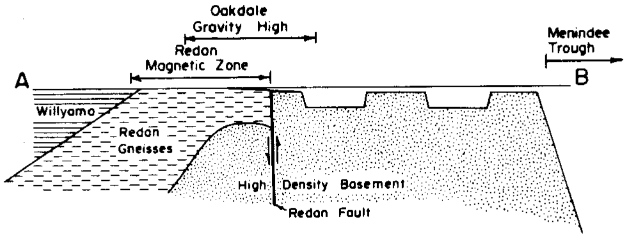


FIG. 2A INTERPRETATION OF GRAVITY HIGHS AS OLDER BASEMENT

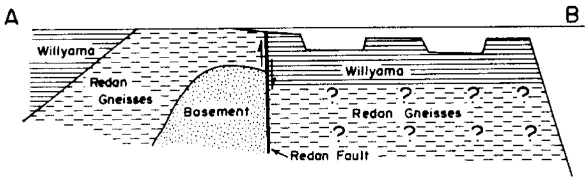


FIG. 2B INTERPRETATION OF GRAVITY HIGHS AS WILLYAMA COMPLEX

The simpler model equates the high density formations southeast of the Redan fault to the high density 'basement' interpreted to underlie the Redan Gneisses. The Redan fault then is seen as a normal fault upthrown to southeast (Fig. 2A). The shortcoming of this model is that it treats the variations in magnetic character as a feature of the basement, ignoring the observation that they are very similar to the style of magnetic variation seen in the main Willyama Complex.

A second model (Fig. 2B) equates the high gravity areas beyond the Redan fault to high density Willyama Complex of the type observed between Balaclava and Mt. Gipps. Although this model accounts for the observed magnetic anomaly variations it requires a vast area of dense Willyama Complex and also requires the Oakdale Gravity high to be divided into two different high density causative bodies.

There appears to be no simple compromise between the two models presented and alternative models involving intrusive bodies appear far less satisfactory. Better aeromagnetic coverage of this area is needed to provide a more conclusive interpretation.

The extension to the Willyama Block, then, is considered to consist of either an older basement or of a very dense variety of Willyama Complex similar to that associated with the regional gravity high around Broken Hill.

THE TRANSFORMER BRIDGE AND MAGNETIC SUSCEPTIBILITY MEASUREMENT

B.H. Ridley and H.E. Brown

CSIRO Division of Mineral Physics (02 – 888 1666)

The measurement of the magnetic susceptibility of rock specimens, at low fields, commonly employs instruments which measure the change in an inductive circuit when a sample is introduced into the magnetic flux path of the inductor. In many cases this takes the form of a transformer bridge. Some time ago the CSIRO Division of Mineral Physics recognised a need for such a bridge for use in research. Known existing designs appeared inadequate, and it was considered expedient to develop a new instrument with significantly improved performance.

For discussion, we will subdivide the design considerations into three sections:

(a) System Parameters. The most important system parameter is the operating frequency. Theoretical arguments indicate that the lowest feasible operating frequency should be used to reduce measurement errors in conductive samples to a minimum. However, reduction of the operating frequency also involves other factors, namely:

(i) The transducer sensitivity, as defined by the magnitude of the unbalance voltage generated by a given specimen. If other variables are held constant, then this voltage is a function of frequency from the simple relation
$e = {}^{d\Phi}/_{dt}$.

(ii) Man-made noise, which can be a serious problem, particularly on the most sensitive measurement ranges. From examination of the noise signal from a typical toroidal transformer the apparent desirability of using an operating frequency in the traditional range of 1 to 10 kHz is obvious.

(iii) The leakage flux from the toroidal transformers, which is an inverse function of frequency.

(iv) Noise from solid state devices, i.e. 1/f noise.

The choice of operating frequency must optimise the restrictions imposed by these factors, the economic cost of their suppression or avoidance, and the performance desired from the instrument. We have chosen a frequency of 211 hertz as the optimum for a general purpose instrument.

(b) Constructional and Operational Features. Earlier relevant papers on susceptibility measurement, and personal communications from various users, mention extreme sensitivity to mechanical shock and thermal disturbance. Our investigations have shown that these defects arise from a number of sources, some more amenable to treatment than others. Also a number of purely operational shortcomings were noted or became apparent during the construction of our first instrument.

Some of the measures which have been taken to reduce these factors include:

(i) operation of the transofmer secondaries in a truly differential mode combined with high common mode rejection in the signal pre-amplifier. Assuming perfect magnetic balance in the transformer cores, the signal to the electronic processing module will in practice consist of three components. Firstly, the signal resulting from the flux imbalance caused by the introduction of magnetic material,