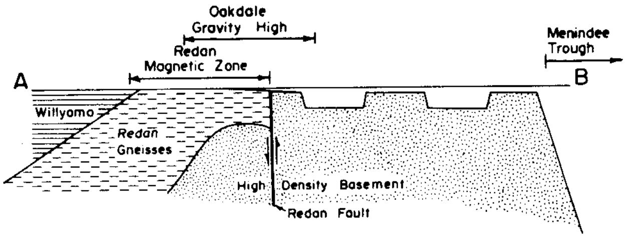

FIG. 2A INTERPRETATION OF GRAVITY HIGHS AS OLDER BASEMENT

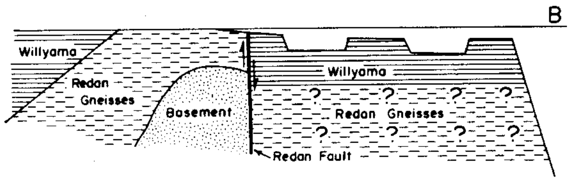

FIG. 2B INTERPRETATION OF GRAVITY HIGHS AS WILLYAMA COMPLEX

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, viz. a rock specimen, secondly a signal resulting from the leakage flux from one toroid to the other, and thirdly a common mode signal from distributed system imperfections. In the absence of specific countermeasures the latter two signals are in fact nulled by a deliberate unbalance of the bridge during the pre-measurement "zeroing" of the bridge.

(ii) Thermal stability has been improved by careful selection of the core material, though some temperature coefficient still exists. The effect of a high amplitude transient magnetic shock may in some circumstances result in the retention of a low level, slowly decaying, remanent magnetization. Facilities have therefore been provided in the electronic module for the convenient demagnetization of the cores.

(iii) Level monitoring circuits have been provided to warn of the existence of overload, which will cause erroneous measurements. Previous practice has been to monitor the detector waveform with a CRO. This is judged inconvenient and uneconomic.

(iv) Rationalization of the phase control circuits to provide the ability to read both the real and imaginary components of the unbalance voltage by simple switching.

(c) The Signal Processing Module. In general, the electronics area makes use of recent developments in solid state technology to simplify construction and enhance the performance. As stated in the previous two sections, at a number of points the internal design of the signal processing module requires special attention or involves innovations new to this type of equipment. Three points in particular will be noted in this summary:

(i) A precision input stage with high common mode rejection is used for the signal pre-amplifier. A standard (triple amplifier) differential instrumentation amplifier configuration is employed with additional reactive trimming to maximise the common mode rejection ratio at 211 Hz.

(ii) The deliberate selection of a low operating frequency greatly aggravates the problem of man-made noise. On the more sensitive ranges, power mains interference will cause gross overload unless the signal is processed by a filter before further amplification. An eighth-order, elliptical, state-variable, active filter, with maximally flat pass band and zero phase shift at centre frequency, is located in the signal path following the pre-amplifier.

(iii) The overload indicator monitors selected points at which overload can occur without the symptoms being obvious to the operator. Voltage comparators are used as bipolar limit detectors, their outputs being logically summed to control a LED indicator.

The bridge described above provides a significant improvement in accuracy and operational facilities compared to the designs which have been in use for some years. A number of additional improvements are under consideration and may be implemented during further development.

MAGNETIC AND GRAVITY INTERPRETATION ON THE STUART SHELF SOUTH AUSTRALIA

C.G. Anderson

South Aust. Dept. Mines & Energy (08 – 272 5711)

The Stuart Shelf region is a stable platform of Carpentarian or older crystalline basement which is overlain by flat lying Adelaidean and Cambrian sediments. It extends eastward from the exposed crystalline Gawler Block area to the mobile "Torrens Hinge" zone. The Olympic Dam copper-uranium deposit occurs near the eastern margin of the region in a zone of high magnetic relief which covers much of ANDAMOOKA. The deposit was discovered by reconnaissance drilling of coincident gravity and magnetic highs by Western Mining Corporation Ltd. in 1975. The mineralisation occurs beneath approximately 350 metres of Adelaidean sediments and therefore is an excellent example of the type of concealed ore body which will become a more frequent exploration target in the next decade.

Regional gravity and magnetic data in the area are widely spaced and variable in quality. Interpretation of the magnetic data indicates that the Olympic Dam deposit occurs in an upfaulted basement block, with fault movement controlled by northeast and northwest-trending fractures. Quantitative modelling indicates that the interpreted fault immediately north of the deposit may contribute directly to the magnetic anomaly observed at Olympic Dam. The northwest trend which is prominent in the regional magnetic data is attributed to dolerite dykes which are eroded feeders to the lower Adelaidean Beda Volcanics. Detailed aeromagnetic surveys from Billakalina and Pernatty Lagoon improve the resolution of these anomalies in areas where they are not as evident in the regional data. The north westerly trend is