HYDROGEOPHYSICAL REPORT 85/1

PALMERSTON RESISTIVITY TRAVERSES

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INTRODUCTION

During the latter portion of December, 1984 a number of resistivity traverses were conducted in the Palmerston area by the Geophysical Section, Water Division, NT Department of Transport and Works. Subsequently, two additional traverses were completed in late February, 1985 and a further two in March of that year.

In a total of nine day's field work 11 individual traverses were completed involving approximately 21.2 km of pole dipole resistivity profiling at a station interval of 50 metres (ie. 433 apparent resistivity observations).

The present work extends the area investigated in the 1983 survey (reported in Hydrogeophysical Report 83/2) some distance mainly to the south to accommodate the planned expansion of Palmerston in this direction. Like the previous survey the present work comprised the initial phase of a groundwater investigation aimed at providing irrigation water for community ovals, parks and gardens etc.
2. GEOLOGY

The surface geology as indicated by recent mapping by the N T Geological Survey is shown in Map 1 at a scale of 1:25000. The relevant legend with lithology descriptions is presented in Figure 2.1.
3. SURVEY OBJECTIVES

The aim of the present survey was basically to elucidate the geology of the area. Particular objectives included:

1. determining accurate locations of lithological boundaries, and

2. outlining any structural elements (faults etc) which could possibly represent high permeability zones in the area.
4. INSTRUMENTATION AND TECHNIQUES

The d.c. resistivity system used on the present survey is documented in Hydrogeophysical Report 83/2.

The present survey employed exclusively a pole dipole electrode arrangement with the following specifications:

1. a potential dipole of 50 metres;
2. a potential dipole, current pole separation of 100 metres; and
3. a minimum remote electrode separation of 1000 metres.

This arrangement was used successfully during the 1983 survey.
5. RESULTS

The results of all apparent resistivity profiles are shown on Sheet 1. Traverse locations of the present survey (along with those of the 1983 survey) are shown plotted on Map 2.

For the purpose of discussing the results it is convenient to identify a number of apparent resistivity response types which may be identified in all profiling data acquired to date with the present pole dipole electrode configuration. These are:

1. high apparent resistivities in excess of 500 ohm-metres and typically about 1000 ohm-metres,
2. moderate apparent resistivities typically showing quite variable amplitudes in the range 100 to 500 ohm-metres,
3. low apparent resistivities in the range 10 to 100 ohm-metres, and
4. very low apparent resistivities of less than 10 ohm-metres.

Regions showing these response patterns have been delineated in Map 2 (based on all profiling operations to date). Also shown on this map are the location of two major conductive indications.
6. GEOLOGICAL CONSEQUENCES

NTGS mapping in the area (see Map 1) basically shows a north-north-west trending boundary between the Wildman Siltstone to the east and undifferentiated metasediments of the South Alligator Group to the west. Divisional drilling following the 1983 survey indicated that this boundary lies substantially to the west of its inferred position on Map 1. Moreover, it confirmed that in the vicinity of Marlow's Lagoon the type 1 apparent resistivities seen on the 1983 survey correlated with dolomite overlain by a variable cover of Cretaceous claystones and sandstones of the Bathurst Island Formation (Darwin Member). Additionally, type 2 apparent resistivities observed on the eastern sections of profiles 1, 2 and 3 (1983) were subsequently found to correlate with argillaceous metasediments (phyllitic siltstones etc) of the Wildman Siltstone.

The present work extended the coverage of the 1983 survey mainly to the south and east.

Map 2 shows a major north-west trending zone of type 1 response behaviour. It is largely truncated to the north of line 1 by the onset of substantially lower type 2 apparent resistivities. North of this discontinuity lines 16 and 19 encounter significantly narrower zones of type 1 apparent resistivities than those seen to the south on lines 1, 3, 11, 12 and 17. Moreover, the onset of the type 1 response behaviour is displaced to the east of its expected position based on the results of the southern lines.

Two alternative explanations are offered for the above behaviour. These are:

1. The geoelectrical discontinuity could result from faulting along a north-east trending plane laying parallel to and some few hundred metres to the north of line 1.

2. Alternatively, the effect could result from saltwater contamination of the groundwaters surrounding an unnamed saltwater inlet lying due west of Packard's Knob. In this case the eastern boundary of the South Alligator Group sediments between lines 1 and 11 would most likely extend some distance east of the indicated extent of type 1 apparent resistivities to the major north-south trending conductive indication. The indicated apparent resistivity gradient associated with this
A conductive anomaly would then reflect the transition from resistive carbonate sediments eastwards to the more conductive Wildman Siltstone.

While the interpretation of the above discontinuity is somewhat ambiguous the gradational onset of type 1 apparent resistivities eastwards on lines 6, 16 and 19 supports the latter explanation - as does the obvious parallel course of the limit of tidal flats and the onset (westwards) of progressively more conductive response types (2, 3 and 4 respectively).

The easterly extension of type 1 apparent resistivities from the major north-west trending zone (in the vicinity of line 11) requires some comment. It is suggested that in the majority of this area the high apparent resistivities do not necessarily derive from a resistive lithology at depth. Rather they are thought to reflect a substantial thickness of resistive cretaceous claystone cover which forms a residual plateau up to 25 metres high in this location. Indeed, Map 1 shows outcrops of Wildman Siltstone exposed at the base of this plateau.

The above explanation however does not account for the type 1 apparent resistivities observed east of 200 E on line 11 and between 2100 N and 3250 N on line 12 - substantially east of the extent of the cretaceous plateau. It is suggested that these apparent resistivities reflect a resistive proterozoic bedrock at this location - an observation that lends some support for the existence of the type of fold structure indicated in Map 1 (although differing substantially in the location of the lithological boundaries).

Southern line 17 shows strong type 1 apparent resistivities between 550 E and 1350 E. These are terminated eastwards by the abrupt onset of type 3 and 4 responses - clearly reflecting saline groundwater conditions associated with the lower reaches of Mitchell's Creek. Unfortunately the influence of this creek precludes the use of any resistivity lines south of line 17 to confirm the continued southern course of the resistive carbonate lithology or its deflection northwards as suggested by the NTGS mapping.
Type 2 apparent resistivities are present on all profiles in the eastern section of the survey area. It is recalled that this response has correlated previously with argillaceous Wildman Siltstone lithologies. As mentioned above this lithology also occurs at depth in the area of type 1 apparent resistivities between 200 E and 1000 W on line 11.

Type 2 responses occur elsewhere. In particular a substantial region of this response type exists to the west of the major belt of type 1 response behaviour discussed above. This may be the result of a lithology change westward to a more conductive argillaceous rock type. Alternatively (and more probably), it reflects the onset of saline groundwater conditions in this near coastal zone.

The type 2 response behaviour present at the extreme northern end of line 12 and on the majority of line 12 north probably indicates a conductive argillaceous unit within the Wildman Siltstone. The north west striking brecciated fault zone mapped due south east of 4300 N on line 12 (see Map 1) may account for this change in lithology.

Type 4 response behaviour is restricted to near coastal areas and is clearly the result of the extreme influence of saltwater on the groundwater regime.

A major conductive anomaly indicative of a thin steeply dipping conductor under shallow cover with a resistivity as low as somewhat less than 10 ohm-metres bisects the survey area from south to north. It is generally associated with an apparent resistivity gradient that divides type 1 response behaviour to the west from more conductive type 2 responses to the east. The causative feature is most probably a discreet shear whose conductivity has been enhanced by the development of substantial amounts of clay in the fault plane.

Another conductive indication of less intensity occurs further east in the areas of type 2 apparent resistivities on lines 1, 2 and 19. This feature appears to indicate faulting and brecciation within the Wildman Siltstone increasing in intensity to the north.