HYDROGEOPHYSICAL REPORT 84/7

TIMBER CREEK RESISTIVITY SURVEY

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Report No: 89/84D

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1. INTRODUCTION

A small resistivity survey was conducted in late October, 1984 at Timber Creek - a small community on the Victoria River. This work was completed by geophysical staff of the Water Division, NT Department of Transport and Works and represented the initial phase of a larger groundwater investigation in the area.

Total field time for the survey was three days. During this period one geophysicist and two field assistants completed the following operations:

1. Three Schlumberger vertical electrical soundings involving a total of 63 observations of apparent resistivity, and

2. Approximately 7 km of pole dipole resistivity profiling necessitating some 140 measurements of apparent resistivity.
2. GEOLOGY OF THE AREA

The rocks in the neighbourhood of Timber Creek comprise interbedded shales, mudstones and various carbonate lithologies of the carpentarian Timber Creek Formation. These are overlain by hard resistant sandstones of the Jasper Creek Sandstone.

The above flat lying lithologies have been deeply eroded by Timber Creek immediately upstream of its confluence with the Victoria River. The resulting land form is a steep sided, flat lying canyon-like feature, 1 to 3 km wide in the area of interest.
3. SURVEY AIMS

Previous water boring in the immediate vicinity of Timber Creek has resulted in variable yields from in excess of 20 L/s to nil - a surprising circumstance in view of the very shallow dips and consequent expected uniformity of geological conditions over the area.

The above observation tends to indicate that other controls are involved in the localization of groundwater in the area. Moreover, the shallow depths at which water has typically been struck suggests that erosion and weathering processes figure amongst these other controls. The possibility also exists that structural elements within the Timber Creek Formation may also produce significant secondary porosity suitable for the accumulation of groundwaters.

Accordingly, the aim of the present survey was to delineate zones of higher groundwater potential within the Timber Creek Formation. For the reasons outlined above this was best achieved by electrical surveying aimed at:

1. mapping the thickness of alluvium and/or weathering, and
2. monitoring the resistivity of the bedrock units.
4. INSTRUMENTATION AND TECHNIQUES

The resistivity instrumentation employed on the present survey is described in detail elsewhere. (See Hydrogeophysical Report 80/2). Basically it comprised:

1. A 250 watt d.c. transmitter capable of outputting up to 2 amps at voltage levels adjustable up to 1200 volts, and
2. A d.c. receiver (FLUKE 8062A) with an ultimate resolution of 10 microvolts and provision for offsetting d.c. noise voltages.

Resistivity soundings completed at Timber Creek employed the conventional Schlumberger array. Half current spacing were expanded to a maximum of 200 metres.

Resistivity profiles were conducted with the pole dipole electrode configuration employing:

1. a potential dipole of 50 metres,
2. a current pole to potential dipole spacing of 50 metres, and
3. a remote electrode spaced a minimum of 600 metres from the active electrodes.

The presence of the remote electrode was neglected in the formation of the apparent resistivities.
5. SOUNDING RESULTS

Several Schlumberger vertical electric soundings were initially conducted over the area as a reconnaissance exercise. These were all located along the Victoria Highway at the following locations:

S/1 - 1.5 km north of store
S/2 - 7 km south of store
S/3 - 4 km south of store.

In all cases the soundings were expanded to an AB/2 of 200 metres at an azimuth paralleling the adjacent highway.

The three soundings are illustrated in appendix A. Also shown here are the interpreted earth models presented as the most probable parameter sets of the causative earths.

The interpretations are the result of an unconstrained least squares inversion technique. The resulting solution earth models therefore represent a best fit (in a least squares sense) minimum layered (three layers in the present instance) solution of the field data. Also available from the present interpretation scheme (although not presented in this report) are interval estimates of the solution parameters compatible with a 68% parameter confidence level and a relative accuracy of the field data taken in this instance to be 5%.

Soundings S/1 and S/2 show well defined ultimate layer resistivities of 260-270 ohm-metres (i.e. for the unweathered Timber Creek Formation). The significantly higher figure indicated by the geographically intermediate sounding S/3 (601 ohm-metres) is surprising in view of the expected uniformity of geological conditions throughout the area.

This situation probably derives from the writer's choice of segment migration in the present instance (i.e. the migration of the shallower, generally more susceptible segment to agree with its larger spacing counterpart). More appropriate in the present case would be to migrate the final segment. Allowing this, the following model parameters would then be appropriate to the interpretation of S/3.

<table>
<thead>
<tr>
<th>Layer</th>
<th>Resistivity</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.37</td>
<td>3.5</td>
</tr>
<tr>
<td>2</td>
<td>29.8</td>
<td>13.14</td>
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<tr>
<td>3</td>
<td>344</td>
<td></td>
</tr>
</tbody>
</table>

The ultimate layer resistivity of 344 ohm-metres is in general agreement with the results of S/1 and S/2.
Shallow layers representing weathered Timber Creek Formation and alluvium, elluvium etc show predictably variable thicknesses and resistivities. Of some significance is the relatively shallow depth of weathering indicated by all soundings i.e. a maximum of 16 metres.
6. PROFILING RESULTS

Based on soundings completed throughout the area the pole dipole profiling configuration described in section 4 was chosen in order to achieve the ends outlined in section 3.

Profiles were completed along the traverses indicated in map 1. Results are shown plotted at a logarithmic ordinate scale in sheet 1.

Lines 2, 1, 3 west and 5 west were completed across the valley to the west of the Victoria Highway.

Background apparent resistivities on these lines increase northwards from somewhat less than 100 ohm-metres on lines 3 west and 5 west to in excess of 200 ohm-metres on northern-most line 2. This could reflect an increase in thickness and/or conductivity of the shallower layers to the south. Alternatively, it could reflect intrabedrock effects. More specifically, any flat lying resistive unit within the Timber Creek Formation will tend to be shallower downstream (northwards) due to the change in terrain heights. As a result apparent resistivities measured with the present array can be expected to increase in this direction.

A major feature appearing on all of these lines is a zone of significantly lower than background resistivity located as follows:

<table>
<thead>
<tr>
<th>Line</th>
<th>Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>line 2</td>
<td>550 W to 850 W</td>
</tr>
<tr>
<td>line 1</td>
<td>550 W to 1050 W</td>
</tr>
<tr>
<td>line 3 west</td>
<td>250 W to 550 W</td>
</tr>
<tr>
<td>line 5 west</td>
<td>west of 300 W</td>
</tr>
</tbody>
</table>

The causation of these features is not clear. The fact that the conductive zones on lines 2, 1 and 3 west lie on strike argues in favour of some rectilinear causative feature - probably structural. However, it should be mentioned that this theory is somewhat confounded by the position of the conductive indication on line 5 west - some 500 metres west of the line of strike mentioned above.

In the writer's opinion it is hard to explain the nature of the conductive indications in terms of stratigraphy (facies changes etc). Likewise an origin linked with an erosional effect of Timber Creek seems equally remote.

Irrespective of its origin, the geophysical data indicates a probably continuous conductive zone extending over a strike length of in excess of 3 km and up to 500 metres wide. Indications suggest that its resistivity is somewhat less than 20 ohm-metres over much of its length - although possibly higher on line 1.

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It should be mentioned that the low resistivity of the conductive feature significantly decreases its potential from a groundwater point of view. Resistivities of less than 20 ohm-metres tend to indicate the presence of surface conduction effects due to clays etc and a consequent loss of permeability. In this respect the anomaly displays its greatest potential on line 1 where it shows a diminished response (i.e. higher apparent resistivities) and its maximum width (i.e. some 500 metres).

Lines 3 east and 5 east cross the valley east of the Victoria Highway. They show little variation of any obvious significance. A small conductive anomaly of questionable origin is located on line 3 east between 1100 east and 1400 east. The increase in apparent resistivity eastwards on line 5 east probably derives from an increase in thickness of talus type elluvial material towards the valley walls at this location.

Line 4 traverses the valley longitudinally. Broad zones of low apparent resistivities located south of 500 N and between 1400 N and 1850 N probably indicate an increase in thickness and/or conductivity of surficial materials at these locations (probably due to the influence of the creek paralleling the cause of the traverse some little distance to the west).
APPENDIX A: SCHLUMBERGER VERTICAL ELECTRIC SOUNDINGS AND INTERPRETATIONS
SCHLUMBERGER ELECTRICAL SOUNDING

AREA: TIMBER CREEK

DESIGNATION: S/1

MODEL PARAMETERS:

<table>
<thead>
<tr>
<th>LAYER</th>
<th>RESISTIVITY (OHM-METRES)</th>
<th>THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
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<td>2</td>
<td>254.27</td>
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<td>4</td>
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</table>

FIELD DATA....
MODEL CURVE....
SCHLUMBERGER ELECTRICAL SOUNding

area: timber creek

designation: S/2

model parameters:

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<th>resistivity</th>
<th>thickness</th>
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</thead>
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<td>1.38</td>
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<tr>
<td>2</td>
<td>30.91</td>
<td>6.92</td>
</tr>
<tr>
<td>3</td>
<td>271.77</td>
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</tbody>
</table>
SCHLUMBERGER ELECTRICAL SOUNDOING

AREA: TIMBER CREEK

DESIGNATION: S/3

MODEL PARAMETERS ->

<table>
<thead>
<tr>
<th>LAYER</th>
<th>RESISTIVITY (ΩM-M)</th>
<th>THICKNESS (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16.36</td>
<td>3.5</td>
</tr>
<tr>
<td>2</td>
<td>52.2</td>
<td>13.14</td>
</tr>
<tr>
<td>3</td>
<td>601.62</td>
<td></td>
</tr>
</tbody>
</table>

FIELD DATA,...
MODEL CURVE,...