INVESTIGATION OF THE
SOUTH ALLIGATOR GROUP
COSMO HOWLEY AREA

REPORT 7/1989

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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
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<tr>
<td>mm</td>
<td>millimetre</td>
</tr>
<tr>
<td>m</td>
<td>metre</td>
</tr>
<tr>
<td>km</td>
<td>Kilometre</td>
</tr>
<tr>
<td>kL</td>
<td>Kilolitre (1000 Litres)</td>
</tr>
<tr>
<td>L/s</td>
<td>Litre per second (by airlift)</td>
</tr>
<tr>
<td>SWL</td>
<td>Standing Water Level</td>
</tr>
<tr>
<td>agl</td>
<td>Above Ground Level</td>
</tr>
<tr>
<td>bgl</td>
<td>Below Ground Level</td>
</tr>
<tr>
<td>RN</td>
<td>Registered Number of the bore</td>
</tr>
<tr>
<td>E.O.H.</td>
<td>End of hole</td>
</tr>
<tr>
<td>C.W.</td>
<td>Completely Weathered</td>
</tr>
<tr>
<td>H.W.</td>
<td>Highly Weathered</td>
</tr>
<tr>
<td>M.W.</td>
<td>Moderately Weathered</td>
</tr>
<tr>
<td>S.W.</td>
<td>Slightly Weathered</td>
</tr>
<tr>
<td>AMG</td>
<td>Australian Map Grid</td>
</tr>
<tr>
<td>TMG</td>
<td>Transverse Mercator Grid (Clarke)</td>
</tr>
<tr>
<td>OC</td>
<td>Degrees Celcius</td>
</tr>
<tr>
<td>pH</td>
<td>Index of acidity or alkalinity</td>
</tr>
<tr>
<td>SC</td>
<td>Specific Conductivity</td>
</tr>
<tr>
<td>TDS</td>
<td>Total Dissolved Solids</td>
</tr>
<tr>
<td>u/cm</td>
<td>Microsiemens per centimetre</td>
</tr>
<tr>
<td>mg/L</td>
<td>milligram per litre</td>
</tr>
<tr>
<td>Ohm-m</td>
<td>Ohm-metre</td>
</tr>
<tr>
<td>NHMRC</td>
<td>National Health and Medical Research Council</td>
</tr>
<tr>
<td>AWRC</td>
<td>Australian Water Resources Council</td>
</tr>
<tr>
<td>BMR</td>
<td>Bureau of Mineral Resources</td>
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</table>
1. **INTRODUCTION**

An investigation program was undertaken as a part of the Project - "Groundwater Resources Evaluation of the Pine Creek Mining Region, N.T." culminating in a hydrogeological map of the area (Ref. 1). The objective of this investigation program was to evaluate the effectiveness of electrical traversing methods in identifying high yielding bore sites in the sediments of the South Alligator Group. These sediments are considered to be most promising aquifers within this project area.

The area for investigation drilling was selected in the sediments of South Alligator Group in the vicinity of Cosmo Howley Gold Mine (see Figure 1). This area was chosen because of the large number of water bores that had been drilled in the area and its accessibility.

Seven (7) investigation bores were drilled during the period from 16th to 27th June 1989. Interpretation of SPOT (System Probatoire d'Observation de la Terre) Imagery (see figure 2) was taken into consideration to assess hydrogeology of the area. Final depth of each bore was decided during the drilling depending upon hydrogeological condition encountered at the time. Geological logs of these investigation bores are provided in Appendix - A.

2. **RESULTS AND DISCUSSIONS**

In the project area, the sediments of the South Alligator Group are generally considered to have higher groundwater potential than those of other groups. Therefore, geophysical traverses were planned to traverse these sediments (see Figures 3 and 4).

Drilling targets were principally selected on the results of the electrical resistivity survey. Resistivity anomalies thought to be promising were selected as targets for drilling after correlating with existing hydrogeological data.

These resistivity anomalies are discussed in the following paragraphs relating to individual formations in which they are situated (also see Ref. 3).
Figure 1: Location Map
Figure 2: Satellite Image of the area
Figure 3: Surface Resistivity Profiles for South Alligator Group
Figure 4: Surface Resistivity Profiles for South Alligator Group
Koolpin Formation

Two very low resistivity values (about 1 Ohm-m) were found in the Koolpin Formation at 2650 W and 3280 W on the geophysical profile Line A (Figure 3A). Bore RN 26174 was drilled at peg 3280 W in preference to peg 2650 W, because of the easy access for the drilling rig. However, both anomalies appeared to be similar and thought to be associated with doleritic intrusion into black graphitic shale of the Koolpin Formation.

Bore RN26174 intersected Silicified Iron Formation (S.I.F.) and graphitic shale of the Koolpin Formation. No aquifer was struck in this bore.

The results indicated that a very low resistivity value may not be sufficient to justify drilling for water. The very low resistivity value on this site was due to high contents of graphite and iron in the shale.

Geological structures, therefore, should be taken into account before selecting drilling sites in the Koolpin Formation.

Gerowie Tuff Formation

Bore site 2 RN 26175 was located in the Gerowie Tuff Formation on the geophysical line A at 2200 W (Figure 3A), where the resistive value was around 150 Ohm-m. This value was considered to be very low, i.e. anomalous, for the Gerowie Tuff Formation. This bore was sited about 300m west of an existing production bore RN 26248.

This bore RN 26175 intersected interbedded (tuffaceous?) cherty shale and cherty siltstone with numerous brecciated vein quartz stringers and pyrites. A minor aquifer was struck with a yield of 0.5 L/s.

Geophysical signatures in the Gerowie Tuff have been noted to be characterised by very uneven values (noisy) and this is due to non-homogeneous sediments i.e. interbedded cherty shale and cherty siltstone with numerous brecciated vein quartz. Hence, a very low resistivity value in Gerowie Tuff may indicate a higher shale content and hence lower yields.
Mount Bonnie Formation

Bore sites 3, 5, 6 and 7 were located in the Mount Bonnie Formation of the South Alligator Group.

Resistivity value at site 3 was about 90 Ohm-m, which may be considered as a low value (anomalous) for these sediments. Therefore, the bore site 3 (RN 26173) was located on this anomaly, which was about 150m east of an existing production bore RN 26245. As expected black carbonaceous shale was intersected along with phyllite and most of the rocks were sheared and fractured. A yield of 10.0 L/s was intersected.

Site 5 was selected on the basis of both the geological structure and the low resistive value (around 150 Ohm-m), which was higher (less anomalous) than that of at site 3, but still considered to be anomalous. It was located about 300m south of an existing production bore (RN 26247) (Figure 3B). Bore RN 26177 at Site 5 intersected a yield of 10 L/s in black carbonaceous shale and phyllite which was highly sheared and fractured.

Bore RN 26179 at Site 6 was selected in order to investigate the possibility of aquifers in high resistive value (500 m) within the Mount Bonnie Formation. Fractured black carbonaceous shale was expected in this bore similar to Site 5. Bore RN 26179 intersected similar lithology to RN 26177 at site 5, but no aquifer was struck. Rocks were hard, occasionally with fractured green phyllite, black carbonaceous, siliceous micaceous shale - but not sheared.

Bore RN 26178 at Site 7 was located 300m north of an existing production bore RN 26247, where the resistive value was slightly higher than 250 Ohm-m and was expected to intersect black carbonaceous shale, very similar to the site 6 bore RN 26179. Bore RN 26178 intersected green phyllite, black carbonaceous, siliceous, micaceous shale that was hard and often fractured but 'not sheared'. An aquifer was struck with a yield of 2.5 L/s. This bore was very similar to bore RN 26179 at Site 6.

Resistivity signatures in the Mount Bonnie Formation have been noted as smooth due to generally homogeneous materials in it. It appears that resistivity values below 250m may be useful target for drilling, where possibly sheared rocks may exist.
Intrusive Rocks

Bore Site 4 was located on a very low resistivity value and the profile shows resistivities less than 1 Ohm-m (see the resistivity profile Fig. 4D). The low resistivities were thought to be due to a fault and/or contact. Bore RN 26176 intersected dolerite and amphibolite with high iron contents (mainly haematite). An aquifer was intersected in the weathered rock with a yield of 1.6 L/s.

High iron contents (mainly haematite) up to a depth of 12.0m appeared to be the cause of the anomalous resistivity value at this site.

3. WATER QUALITY

Groundwater in this area generally may not be potable due to mainly arsenic contents which often are above the limits set by AWRC/NHMRC.

4. CONCLUSIONS

Koolpin Formation

Resistivity values in the Koolpin Formation appear to be variable and generally higher than 50 Ohm-m, very low resistivity values (<10 Ohm-m) were also found and appeared to be caused by graphite and iron content.

It may be concluded, therefore, that a very low resistivity value may not be sufficient in itself to justify drilling for water. Both the geological structure and lithology have to be taken into consideration before selecting drilling sites for water.

Gerowie Tuff Formation

In the Gerowie Tuff Formation, a variable resistivity signature may be expected due to non-homogeneous materials and resistivity values were generally found to be above 200 Ohm-m. It is thought that lower resistivity values (<150 Ohm-m) which may be due to fractures and/or abrupt change in lithology may be useful drilling targets for water. Geological structures and lithology both should be taken into consideration.
Mount Bonnie Formation:

Generally resistivity values in the Mount Bonnie Formation may be expected to be consistent.

Resistivity values below 250 Ohm-m on Traverse Line B (Figure 3B) indicated that rocks are highly sheared and fractured within this zone in which bores RN 26247 and RN 26177 are located.

Bore RN 26179 and RN 26178 are situated in the area where resistivity values are above 250 Ohm-m and drilling showed that this zone is not sheared.

Therefore, it may be concluded that aquifer development is greatest in the zone where resistivity value is less than 250 Ohm-m.

Intrusive Rocks:

Usually, resistivity values in intrusives would be expected to be high. Low values in this area were thought to be due to very high content of iron at shallow depth and particularly in weathered zone.

5. REFERENCES


2. Geology Map - 1:100 000, Batchelor-Hayes Creek Region, NT Sheet 5208, B.M.R., 1985.

GEOLOGICAL LOG

RN 26173 (Site 3)
(Geophysical Line A, Peg 370E)

0.0 - 5.5m Red brown top soil, clay, gravel - ferruginous siltstone & banded quartzite, some black carbonaceous shale - Seepage @ 5.5m

5.5 - 7.5m Olive green phyllite, red brown siltstone, banded quartzite - C.W.

7.5 - 44.0m Black carbonaceous shale with disseminated pyrite on fractured surfaces & slicken side surfaces.
Possibly Fault Zone
Aquifer @16.0m - 0.5 L/s
Water Sample Bottle No. RO95
Temp 31°C; pH 7.8; SC 258

At 19.6m water supply increased to - 0.8 L/s
Water Sample Bottle No. R0143
Temp 31°C; pH 8.12; SC 261

Quartz Vein with geodes from 29m-30m
Flow Test @30.0m - 3.6 L/s
Water Sample Bottle No. 1087
Temp 32°C; pH 8.12; SC 252

From 31.8m - H.W. to S.W.
Flow Test at 37.9m - 4.5 L/s
possibly developing above aquifers as there is no more fractures. Quartz-vein with pyrites in fractures from 39.0m-40.8m & @43.0m.
Flow Test @42.8m - 10.0 L/s
Temp. 30°C; pH 7.7; SC 250

E.O.H. 44.0m
SWL 13.0m bgl on 17-6-1989 Backfilled

MV2:SB
<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 1.9m</td>
<td>Red brown lateritic clay</td>
</tr>
<tr>
<td>1.9 - 2.4m</td>
<td>Greenish-grey clay, H.W. to 2.4m</td>
</tr>
<tr>
<td>2.4 - 7.7m</td>
<td>M.W., interbedded black shale, red-brown granular siliceous (?) thin ferruginous chert bands (S.I.F.) Siliceous Iron Formation, fractured.</td>
</tr>
<tr>
<td>7.7 - 13.0m</td>
<td>As above &amp; limonite, yellow, H.W.</td>
</tr>
<tr>
<td>13.0 - 14.6m</td>
<td>Green &amp; red interbedded S.I.F.</td>
</tr>
<tr>
<td>14.6 - 47.1m</td>
<td>Black graphitic shale, highly sheared with numerous disseminated pyrites, arsenopyrites (?) at 36.3m in a band of siliceous iron.</td>
</tr>
<tr>
<td>47.1 - 48.1m</td>
<td>Greenish-grey silicified shale (S.I.F.) interbedded with red-brown ferruginous band similar to rocks between 2.4m to 14.6m.</td>
</tr>
<tr>
<td>52.0 - 56.2m</td>
<td>Red-brown and greenish-grey shale with pyrite, some graphitic shale, interbedded, S.W. to Fresh, hard drilling. No aquifer struck in this bore.</td>
</tr>
</tbody>
</table>

E.O.H. 56.2m

SWL 50.5m bgl on 18.6.1989 Backfilled
GEOLOGICAL LOG

RN 26175 (Site 2)
(Geophysical Line A, Peg 2200W,
Commenced 17.6.1989 Completed 17.6.1989

0.0 - 1.9m Rubbles of quartz, micaceous siltstone, ferruginous chert, brown-grey

1.0 - 5.0m Grey micaceous siltstone, phyllite, micaceous shale H.W. to M.W.

5.0 - 50.1m Dark grey interbedded cherty shale (Siliceous & Tuffaceous Shale) with pyrites and ferruginous and cherty siltstone, M.W. to S.W., vein quartz with pyrites in fractures @17.2m
  Flow Test 0.3 L/s @17.2m
  Temp. 32°C; pH 8.12; SC 442
  Water Sample Bottle No. A577

Fractures from 29.8m to 30m, brecciated quartz-vein stringers with pyrites, arsenopyrite (?) continuing again from 39m to 41m, calcareous materials on fractured surfaces. It is fractured all the way from 5m to 50.1m.
  Flow Test - 0.5 L/s @ 50.1m
  Temp. 29.8°C; pH 8.38; SC 429
  Water Sample Bottle No. A533

E.O.H. 50.1m Backfilled
GEOLOGICAL LOG

RN 26176 (Site 4)
(Geophysical Line D, Peg 280W)

0 - 5.8m Red haematitic clay, Top soil
5.8 - 7.0m Limonitic clay
7.0 - 9.0m Red haematitic & limonitic clay
12.0 - 27.2m Bright red haematitic clay, cemented haematitic materials - highly brecciated, Fault Zone (?), H.W. to S.W.
   SEEPAGE from fractures from 19m to 21m 0.2 L/s
   Water Sample Bottle No. AW6
   Temp. 27°C; pH 4.78; SC 200
   Aquifer in fractures from 26.6m to 27.2m;
   possibly developing top aquifer.
   Flow Test - 1.63 L/s @30m
   Temp. 28°C; pH 7.07; SC 267
   Water Sample Bottle No. D368

27.2 - 31.8m Fresh and hard, dark green
Dolerite/Amphibolite

E.O.H. 31.8m

SWL 10.7m bg1 on 21.6.1989 Backfilled.
GEOLOGICAL LOG
RN 26177 (Site 5)
(Geophysical Line B, Peg 1600W)

0.0 - 1.0m Red-brown clay, gravel of phyllite, C.W.
1.0 - 2.7m Green phyllite, C.W.
2.7 - 6.0m Red-brown ferruginous phyllite, C.W.
6.0 - 11.7m Red-brown ferruginous phyllite to green highly micaceous phyllite, C.W.
11.7 - 11.9m Quartz-vein with pyrite
11.9 - 28.0m Micaceous & siliceous black shale, pyrite content increased, very faint schistosity can be seen, highly sheared.
  Seepage @ 34.9m - 0.1 L/s
  Water Sample Bottle No. P66
  Temp. 26°C; pH 8.1; SC 239
Quartz vein with pyrite, pyrrohtite (?) in fractures from 40m to 42.9m and @45.6m
Flow Test @45.6m - 0/8 L/s
58.0 - 60.0m Quartz vein
60.0 - 64.0m Micaceous & siliceous black shale with pyrite, M.W.
  Aquifers in fractures from 58m to 60m
  Flow Test @60m - 2.2 L/s
  Water Sample Bottle No. P23
  Temp 28°C; pH 7.7; SC 195
More fractures from 60m to 62.3m
Flow Test @62.3m - 3.0 L/s
Water Sample Bottle No. P70
Temp. 29°C; pH 7.9; SC 195
64.0 - 65.0m Red-brown haematitic, siliceous & micaceous shale, highly sheared, Aquifer from 64m to 65m
Flow Test @65.0m - 10.0 L/s
Water Sample Bottle No. P64
Temp. 29°C; pH 7.9; SC 195
65.0 - 65.2m Micaceous & siliceous black shale with pyrite, M.W. to S.W., highly sheared.
65.2 - 66.0m Red-brown haematitic, siliceous & micaceous shale, S.W., highly sheared
66.0 - 66.5m Micaceous & siliceous black shale with pyrite, S.W. to fresh, highly sheared.

E.O.H., 66.5m

SWL 24.9m bgl on 22.6.1989 Backfilled
<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 1.9m</td>
<td>Red-brown clay, gravel of phyllite, C.W.</td>
</tr>
<tr>
<td>1.9 - 12.0m</td>
<td>Green micaceous phyllite, C.W.</td>
</tr>
<tr>
<td>12.0 - 13.5m</td>
<td>Cherty &amp; highly ferruginous shale &amp; quartz vein with pyrite, fault zone</td>
</tr>
<tr>
<td>13.5 - 25.2m</td>
<td>Dark grey micaceous &amp; siliceous shale with pyrite, H.W. to M.W. Quartz vein in fractures @ 15.6m, 21m &amp; 22m some vitreous dark brown, some water worn.</td>
</tr>
<tr>
<td>25.2 - 27.3m</td>
<td>Fractured chert &amp; vein quartz (Tuffaceous chert?)</td>
</tr>
<tr>
<td></td>
<td>Seepage - Flow Test @25.2m - 0.2 L/s</td>
</tr>
<tr>
<td></td>
<td>Water Sample Bottle No. P43</td>
</tr>
<tr>
<td></td>
<td>Temp. 25°C; pH 7.4; SC 213</td>
</tr>
<tr>
<td>27.3 - 28.0m</td>
<td>Dark grey micaceous &amp; siliceous shale with pyrite, M.W. to S.W.</td>
</tr>
<tr>
<td>28.0 - 29.7m</td>
<td>Red-brown chert &amp; vein quartz (Tuffaceous chert?) some haematitic band, M.W. to S.W.</td>
</tr>
<tr>
<td>29.7 - 39.0m</td>
<td>Dark grey to black micaceous &amp; siliceous shale with pyrite, S.W. to Fresh, Fractures @36.9m</td>
</tr>
<tr>
<td>39.0 - 40.0m</td>
<td>Fractured vein quartz &amp; chert,</td>
</tr>
<tr>
<td></td>
<td>Flow Test @ 39.0m - 1.3 L/s</td>
</tr>
<tr>
<td></td>
<td>Water Sample Bottle No. P58</td>
</tr>
<tr>
<td></td>
<td>Temp. 28°C; pH 7.69; SC 254</td>
</tr>
<tr>
<td>40.0 - 45.1m</td>
<td>Black micaceous &amp; siliceous shale with pyrite, Fresh,</td>
</tr>
<tr>
<td>45.1 - 45.6m</td>
<td>Fractured vein quartz &amp; chert, possibly some more water.</td>
</tr>
<tr>
<td>45.6 - 52.7m</td>
<td>Black micaceous &amp; siliceous shale with pyrite, Fresh,</td>
</tr>
<tr>
<td></td>
<td>Flow Test @52.7m - 2.5 L/s</td>
</tr>
<tr>
<td></td>
<td>Water Sample Bottle No. P85</td>
</tr>
<tr>
<td></td>
<td>Temp. 28°C; pH 7.77; SC 270</td>
</tr>
</tbody>
</table>

E.O.H. 52.7m

SWL 17.9m bgl on 26.6.1989 Backfilled.
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**GEOLOGICAL LOG**  
**RN 26179** (Site 6)  
(Geophysical Line B, Peg 1200N)  
Commenced 24.6.1989 Completed 27.6.1989

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 1.0m</td>
<td>Red-brown clay, gravel of phyllite, C.W.</td>
</tr>
<tr>
<td>1.0 - 3.2m</td>
<td>Brown ferruginous phyllite, C.W. to 2.4m</td>
</tr>
<tr>
<td>3.2 - 4.0m</td>
<td>Black micaceous &amp; siliceous shale with pyrite, C.W.</td>
</tr>
<tr>
<td>4.0 - 5.2m</td>
<td>Green phyllite, C.W.</td>
</tr>
<tr>
<td>5.2 - 7.4m</td>
<td>Black micaceous &amp; siliceous shale with pyrite, C.W.</td>
</tr>
<tr>
<td>7.4 - 8.0m</td>
<td>Green phyllite, C.W., some red-brown phyllite</td>
</tr>
<tr>
<td>8.0 - 9.0m</td>
<td>Limonitic yellow clay, highly fractured phyllite C.W.</td>
</tr>
<tr>
<td>9.0 - 11.0m</td>
<td>Green phyllite, C.W.</td>
</tr>
<tr>
<td>11.0 - 12.0m</td>
<td>Limonitic yellow clay - phyllite C.W.</td>
</tr>
<tr>
<td>12.0 - 13.5m</td>
<td>Black cherty micaceous shale with pyrite, C.W., some quartz vein with pyrite, highly fractured</td>
</tr>
<tr>
<td>13.5 - 15.6m</td>
<td>Quartz vein, chert, C.W.</td>
</tr>
<tr>
<td>15.6 - 18.1m</td>
<td>Black cherty micaceous shale with pyrite, C.W.</td>
</tr>
<tr>
<td>18.1 - 18.2m</td>
<td>Fractured, highly cherty (Siliceous Tuffaceous Shale?)</td>
</tr>
<tr>
<td>18.2 - 77.1m</td>
<td>M.W. to S.W., hard black cherty micaceous shale with pyrite, thin bands of quartz vein from 19.1m, Fractured from 24.0m to 24.1m</td>
</tr>
</tbody>
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E.O.H. 77.1m  
Dry Bore, caved-in up to 13.0m bgl Backfilled