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ANNUAL REPORT FOR EL6938 (OFFICER HILL)

FOR THE PERIOD FROM 24 MAY 1995 TO 23 MAY 1996

1:250,000 Sheet Reference: The Granites SF52-3
1:100,000 Sheet Reference: Inningarra 4856

DAC Archibald, May 1996

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IMAGED

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APPENDICES

Appendix 1: Consultant's Mineralogical Report No.6992 (Drill Core, Officer Hill Prospect)
Appendix 2: Consultant's Mineralogical Report No.6851 (RAB Chips, Hyatt Prospect)
Appendix 3: Profiled Results of Hyatt Ground Magnetic Survey
Appendix 4*: Database Report with geochemical and lithological data, subdivided as follows:
  • Officer Hill RAB Drilling
  • Officer Hill RC Drilling
  • Officer Hill Diamond Drilling
  • Hyatt Rock Chip Sampling
  • Hyatt Lag Sampling
  • Hyatt RAB Drilling

*Appendix 4 presented as a separate volume.

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<td>5</td>
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<td>6</td>
<td>Hyatt Prospect Lag Sample Locations</td>
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SUMMARY

This report describes the exploration activity within the two non-contiguous blocks which have comprised EL 6938 (Officer Hill) during the twelve month period to May 1996.

Work undertaken at the Officer Hill prospect in Area One (for location see Figure 1) included:
- drilling 228 RAB holes (ORB1295 to 1520) drilled for a total of 7275 metres
- drilling 10 RC holes (ORC074 to 083) drilled for a total of 600 metres
- drilling 2 diamond holes (OHD001 and 002) drilled for a total of 381 metres, including precollars
- petrological study of 40 samples collected from the diamond drillholes
- incorporation of results from the above exploration into the existing Officer Hill database and assessment of results.

Gold mineralisation encountered in RAB drilling was further investigated by the RC and diamond drilling programmes.

Work undertaken at the Hyatt prospect in Area Two (for location see Figure 1) included:
- collection of 23 composite rock chip samples
- collection of 43 lag samples
- 45.5 km of ground magnetics traverses
- Drilling 59 RAB holes (HRB186 to 199 and HRB241 to 285) drilled for a total of 1755 metres
- petrological study of 27 samples
- incorporation of results from the above exploration into the existing Hyatt database and assessment of results.

The RAB drilling programme tested an anomaly defined by the groundmagnetic survey and encountered weak gold mineralisation.
1. INTRODUCTION

The Officer Hill area has attracted interest from several exploration companies in recent years. Enterprise Exploration were active in 1961; between 1968 and 1971 Peko Wallsend tested magnetic anomalies identified by an airborne BMR survey and Otter Exploration NL undertook a uranium search in 1978. North Flinders Mines Ltd began exploration in 1987, initially holding the ground as EL 2368 and later as EL 6938. Results have been sufficiently encouraging to underpin a substantial exploration programme.

The pattern of successive relinquishments has left the licence divided into two separate areas. The western area is centred on the original Officer Hill prospect whilst the other in the east includes the Hyatt prospect.

2. TENEMENT DETAILS

EL 6938 was due to expire on 23 May 1996. However promising exploration results at the two core prospects have led the Company to apply for an extension of tenure under Section 29A of the Act, with the 21 blocks retained to May 1996 being reduced to 12 for the following year.

<table>
<thead>
<tr>
<th>Title</th>
<th>Name</th>
<th>Blocks</th>
<th>Grant Date</th>
<th>Expiry Date</th>
<th>Extension Sought</th>
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<td>Officer Hill</td>
<td>21</td>
<td>24/5/90</td>
<td>23/5/96</td>
<td>23/5/98</td>
</tr>
</tbody>
</table>

3. LOCATION AND ACCESS

Situated within the 1:250 000 map sheet SF52-3, the Officer Hill tenement lies approximately 80km west-southwest of The Granites Gold Mine (Figures 1&2). Access from The Granites Gold Mine is via Dead Bullock Soak, the Tanami Downs Homestead, and thence a station track south.

4. REGIONAL GEOLOGY

The area is underlain by a sequence of Mt Charles and Killi Killi Beds with associated doleritic sills. A granite intrusion is evident to the south, while in the north, Antrim Plateau Basalt obscures Proterozoic lithologies which include Muriel Sandstone.
5. PREVIOUS EXPLORATION

5.1 Officer Hill Prospect

In 1961 Enterprise Exploration reported anomalous Cu and Zn assays in the region of Officer Hill (Otter, 1978).

From 1968 to 1971 Peko Wallsend undertook limited testing of magnetic anomalies located by the 1962 BMR airborne survey at Officer Hill (prospect known as Pioneer 20). Thirty-one auger holes plus some surface sampling returned no significant gold or base metal results (Mayer, 1985).

During 1978, Otter Exploration NL commenced exploration at Officer Hill. The programme was designed to test for uranium mineralisation of the Killili Killili Hills style at Inningarra Range and to test for Yeelinrie type mineralisation associated with the large claypan to the east, following up on anomalies identified by the regional BMR airborne radiometric survey. A helicopter-borne spectrometer was used to carry out a survey over the area to be investigated. Six anomalies were investigated by confirmatory ground scintillometry and rock chip sampling of small pits exposed by explosives. In addition, gridding and a ground magnetic survey were conducted over Officer Hill and "NCO Hill", to the northwest. It was concluded that the radiometric anomalies were sourced within granite, iron-rich Mt Charles Beds and laterite concentrations. The peak uranium assay was 65ppm.

Otter were also interested in further testing of the base metal anomaly reported by Enterprise Exploration. Anomalous values of 3000ppm Cu, 7000ppm Pb, 1% Zn, and 1500ppm As were returned from both Officer Hill and NCO Hill.

North Flinders Mines exploration began in 1987 with rock chip sampling and drilling at the Officer Hill Ridge. Gold assays at or below the detection limit (0.02ppm) provided little encouragement. However, a visible gold occurrence within quartz-pyrite-tourmaline +/- rutile veins to the north of the ridge prompted further work. Vacuum drilling in this area provided geochemical coverage targeting fine grained sediments coincident with a 2000 nT magnetic anomaly. Several anomalous (>0.1ppm) Au results were obtained, but the coverage was incomplete owing to unsuccessful bedrock penetration. Rotary air blast (RAB) drilling was substituted to overcome the limitations of the vacuum drilling programme, though it detected only sporadic gold values of >0.1ppm. The RAB drilling only covered the limb areas of the major east - west trending fold structure evident in the area. Selective reverse circulation (RC) drilling confirmed the erratic nature and patchy distribution of gold mineralisation, which showed a marked lack of continuity from hole to hole, along section and also from one drill traverse to another (spaced 100m apart). A peak result of 6m @ 4.24 ppm Au was returned.

The subsequent phase of RC drilling did not indicate any obvious lithological association with the gold. Since 1990, exploration has continued, with the ultimate objective of understanding the style of mineralisation at Officer Hill and progressively extending the RAB drilling coverage towards the fold closure mentioned above. This drill coverage was greatly extended during the 1994 field season.

Exploration activity in early 1995 consisted of an investigation of Officer Hill South, prior to relinquishment. This work included rock chip sampling and lag sampling.
5.2 Hyatt Prospect

North Flinders Mines Ltd initial interest in the Hyatt region was prompted by the identification of a curvilinear magnetic anomaly, interpreted as an extension of the Madam Pele magnetic anomaly, known to be associated with Mt Charles Beds. Two ground magnetics traverses (Officer Hill T16 and T17) over a coincident uranium/thorium anomaly, were followed up with vertical auger drilling which intersected bedrock. Anomalous arsenic results from 60ppm to 140ppm were reported, though without gold. Traverse 16 was later reinvestigated as the Hyatt West anomaly.

A grid was placed over the western end of Hyatt during 1989, with 69 rotary air blast (RAB) and 2 reverse circulation (RC) holes drilled, in order to define the magnetic body causing the anomaly. Unfortunately, all holes failed to reach bedrock, due to clays swelling behind the drill head, sealing off air, and therefore sample return. No anomalous geochemistry was returned.

During 1991, three aircore holes were drilled to test the magnetic feature at the far east of the original grid, where the grid abuts the salt lake system. Bedrock was intersected at depths varying between 18 and 52m in all three holes, with intersections of laminated metapelite of the Killi Killi Beds, metabasalt/dolerite, and granite. This relatively shallow cover encouraged further drilling of the prospect at other locations. The grid was subsequently extended to the east.

The western portion of the grid (approximately half the total area) was relinquished in 1993. During 1994 a ground magnetic survey of the prospect was carried out.

6. WORK UNDERTAKEN IN REPORTING PERIOD TO 23 MAY 1996

TABLE 2: Work Undertaken on EL 6938

<table>
<thead>
<tr>
<th>Prospect</th>
<th>Rock Chip</th>
<th>Lag</th>
<th>G. Mag</th>
<th>RAB Drilling</th>
<th>RC Drilling</th>
<th>Diamond Drilling</th>
<th>Petrology</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>samples</td>
<td>ampl</td>
<td>line km</td>
<td>holes</td>
<td>m</td>
<td>holes</td>
<td>m</td>
</tr>
<tr>
<td>Officer Hill</td>
<td></td>
<td></td>
<td></td>
<td>226</td>
<td>7275</td>
<td>10</td>
<td>600</td>
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<td>Hyatt</td>
<td>23</td>
<td>43</td>
<td>45.5</td>
<td>59</td>
<td>1755</td>
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</tr>
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</table>

6.1 Officer Hill Prospect

6.1.1 RAB Drilling

226 RAB holes (ORB1295 to 1520) were drilled for a total of 7275 metres to test prospective Killi Killi and Mt Charles lithologies where earlier drilling had encountered anomalous gold values in the vicinity of a major regional fold closure. The drill holes were situated on 7 north - south traverses and generally spaced 15 metres apart (or 25 metres apart if drilling in areas of overburden deeper than 20 metres). Successfully drilled holes were located on traverses 82400E, 82500E, 82800E, 83400E, 83550E, 83600E and83650E (see Figure 3). All holes were inclined at 60° to grid north to achieve maximum geochemical coverage of the bedrock. Thick unconsolidated cover caused drilling difficulties which led the abandonment of many holes.

All samples were riffle split and composited into three metre samples on site and dispatched to Analabs in Adelaide for gold analysis (Method 334 - 30g, aqua regia digestion, with carbon rod finish) and arsenic (Method 115 - perchloric acid digestion/hydride generation with atomic absorption finish).

Completed drillholes were capped in the approved manner.
6.1.2 RC Drilling

10 RC holes (ORC704 to 083) were drilled for a total of 600 metres to test selected zones of gold mineralisation identified by the earlier RAB drilling on traverses 82700E, 82800E, and 83000E (see Figure 4). All holes were 60 metres deep. The target zones were assumed to be vertical or south dipping so that all RC holes were angled 60° to grid north.

Samples were double riffle split and composited over one metre intervals on site, and dispatched for analysis for gold by Analabs in Adelaide for gold analysis (Method 334 - 30g, aqua regia digestion, with carbon rod finish) and arsenic (Method 115 - perchloric acid digestion/hydride generation with atomic absorption finish).

Completed drillholes were capped in the approved manner.

6.1.3 Diamond Drilling

2 diamond holes (CHD001 and 002) were drilled for a total of 381 metres, including precollars, with a combined precollar metreage of 120.2m (see Figure 4 for locations).

CHD001 was drilled at 82698E, 9678N on the local grid with a declination of 59.5° towards bearing 358°Mag. It was targeted on vein mineralisation in lower Mt Charles Beds where a RAB hole had previously intersected 9m @ 0.77g/t Au. As it failed to penetrate suitably veined or altered lithologies, it was abandoned 20 metres short of its designed depth. The hole was precollared to 72.2m, with cuttings generally collected over one metre intervals and samples dispatched to Analabs for gold analysis (Method 329 - aqua regia digestion, AAS finish). The least prospective drill core was scan sampled over three metre intervals. However most of the core was split and sampled continuously between half metre breaks elsewhere. Samples were dispatched to Analabs for gold analysis (Method 329 - aqua regia digestion, AAS finish).

CHD002 was drilled at 83555E, 8533N on the local grid with a declination of 40° towards bearing 64°Mag. It was targeted on stratabound gold mineralisation in the uppermost Mt Charles Beds where a RAB hole had previously intersected 12m @ 0.95g/t Au. The hole was precollared to 48m, with cuttings generally collected over one metre intervals and samples dispatched to Analabs for gold analysis (Method 329 - aqua regia digestion, AAS finish). The least prospective drill core was scan sampled over three metre intervals. However most of the core was split and sampled continuously between half metre breaks elsewhere. Samples were dispatched to Analabs for multielement analysis by methods listed below.

### TABLE 3: Analytical Techniques and Detection Limits for Analabs

<table>
<thead>
<tr>
<th>Analabs Method</th>
<th>Element [detection limit]</th>
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</thead>
<tbody>
<tr>
<td>GG329 AAS (Aqua Regia Digestion - AAS finish)</td>
<td>Au [1 ppb]</td>
</tr>
<tr>
<td>GA115 (Atomic Absorption Spectrometry)</td>
<td>As [5ppm]</td>
</tr>
<tr>
<td></td>
<td>Cu, Co, Pb, Zn, Ni [0.5ppm];</td>
</tr>
<tr>
<td></td>
<td>Mg [1ppm],</td>
</tr>
<tr>
<td></td>
<td>Ag [0.1ppm]</td>
</tr>
<tr>
<td>GS201 ICPMS,</td>
<td>Sb, W, Bi [0.1ppm]</td>
</tr>
<tr>
<td>Induced Coupled Plasma Mass Spectrometry</td>
<td>Sn [0.5ppm]</td>
</tr>
<tr>
<td></td>
<td>U [50ppb]</td>
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</table>

Annual Report For EL 6938 (Officer Hill), For the Period from 24 May 1995 to 23 May 1996.
4 samples were collected from OHDH001 and 36 samples from OHDH002 for petrological description (see Mineralogical Report No. 6992 in Appendix 1).

Completed drillholes were capped in the approved manner.

6.2 Hyatt Prospect

6.2.1 Composite Rock Chip Sampling

23 composite rock chip samples of vein quartz and chert were collected from around small areas of subcrop in the southwest and far east of the previously gridded area (Sample Nos 658740 - 658759, 658792, and 658844 - 658845). Sample positions were located using the Global Positioning System (GPS). All rock chip sample sites were marked with an aluminium tag displaying the sample number, and wrapped, face down, around a fragment of the rock sampled, with flagging tape. The samples consisted of 10-15 chips with a combined weight of 1.0 - 1.5kg. All samples were considered to be float rather than obvious outcrop.

Samples were submitted to Analabs for analysis for gold and a range of other indicator elements. Details of the analyses appear in Table 4 below and locations are shown on Figure 5.

**TABLE 4 : Analytical Techniques and Detection Limits for Analabs**

<table>
<thead>
<tr>
<th>Analabs Method</th>
<th>Element (detection limit)</th>
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<tr>
<td>GG334 AAS (Aqua Regia Carbon Rod Atomic Absorption Spectrometry)</td>
<td>Au [1 ppb]</td>
</tr>
<tr>
<td>GA115* (Atomic Absorption Spectrometry)</td>
<td>As [5ppm]</td>
</tr>
<tr>
<td></td>
<td>Cu, Co, Pb, Zn, Ni [0.5ppm]; Mo [1ppm], Ag [0.1ppm]</td>
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</table>

* Sample Nos 658844 - 658845 were only analysed for arsenic by this method.

6.2.2 Lag Sampling

43 lag samples were collected at 25 m intervals along grid traverses 102500E, 103000E and 103500E (Sample Nos 793801 - 793843). These were submitted to Genalysis Laboratory Services for multi-element analyses using a variety of techniques. Details of the analyses appear in Table 5 below and locations are shown on Figure 6).
TABLE 5: Analytical Techniques and Detection Limits for Genalysis Laboratory Services

<table>
<thead>
<tr>
<th>Genalysis Method</th>
<th>Element (detection limit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/ETA (Type B Graphite Furnace Atomic Absorption Spectrometry)</td>
<td>Au [1 ppb]</td>
</tr>
<tr>
<td>A/MS (Digestion/Induced Coupled Plasma Mass Spectrometry)</td>
<td>As [2ppm]</td>
</tr>
<tr>
<td></td>
<td>Sn [1ppm]</td>
</tr>
<tr>
<td></td>
<td>Sb [0.2ppm]</td>
</tr>
<tr>
<td></td>
<td>Mo BI [0.5ppm]</td>
</tr>
<tr>
<td></td>
<td>W U [0.1ppm]</td>
</tr>
<tr>
<td></td>
<td>sn</td>
</tr>
<tr>
<td>A/AAS (Type A Atomic Absorption Spectrometry)</td>
<td>Ni Pb [2ppm]</td>
</tr>
<tr>
<td></td>
<td>Fe [0.1%]</td>
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<tr>
<td>B/AAS (Type B Atomic Absorption Spectrometry)</td>
<td>Ag [0.1ppm]</td>
</tr>
<tr>
<td></td>
<td>Cu Co Zn [1ppm]</td>
</tr>
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6.2.3 Ground Magnetic Survey

A ground magnetic survey totalling approximately 45.5 km was conducted at the eastern end of the Hyatt grid. This work was designed to trace the trend of the faulted boundary between Mt Charles and Killi Killi Beds as airborne data indicated that it was marked by a sharp magnetic gradient and the zone was believed to be prospective. Magnetic data was collected using a G856 Proton Precession magnetometer. Data was collected at 10 metre intervals along traverses 100 metres apart. Diurnal variations were recorded at a base station during the survey using a second G856 instrument. On completion of the survey, the data was adjusted for diurnal variations using MAGPAC computer software.

No modelling of the data was undertaken as the contact between the two lithologies was immediately obvious from plotted profiles. The data was used to plan the ensuing RAB drilling programme across the contact zone.

Figure 7 displays the coverage of the ground magnetic survey during the reporting period. Profiled results for individual traverses are presented in Appendix 3.

6.2.4 RAB Drilling

59 RAB holes (HRB186 to 199 and HRB241 to 285) were drilled for a total of 1755 metres. Targeted areas had been identified by the ground magnetics programme as possible faulted contact zones between Mt Charles and Killi Killi Beds though Antrim Plateau Basalt, with a thickness which could be in excess of 60m, hindered the investigation of the underlying lithologies.

Drillhole spacing on each traverse was generally 15 metres over the interpreted contact and 200 metres elsewhere. Samples were collected as three metre composites near the contact, though this interval increased away from the zone. Locations of drillholes are shown on Figure 8.

All samples were assayed for gold by Analabs (Method 334 - 30g, aqua regia digestion, with carbon rod finish) and arsenic by Analabs (Method 115 - perchloric acid digestion/hydride generation with atomic absorption finish).

27 samples of drill cuttings were retained for petrological examination (see Mineralogical Report No. 6851 in Appendix 2).

Completed drillholes were capped in the approved manner.
EL 6938
Officer Hill
Area 2

EL 2367
Schist Hills

North Flinders Mines
HYATT
RAB HOLE LOCATIONS

North Flinders Mines Limited

Officer Hill
May 1996
Scale 1:10,000
Fig. 8
7. RESULTS

7.1 Officer Hill Prospect

7.1.1 RAB Drilling

The RAB drilling programme completed during the reporting period targeted two types of mineralisation:

- stratabound gold mineralisation within upper Mt Charles lithologies
- quartz vein type mineralisation within lower Mt Charles lithologies.

The RAB drilling during the reporting period returned some significant gold assays, particularly on traverse 82 800E (see Table 6). The pattern of mineralised intersections appeared to be related to the targeted lithologies though it did not exactly relate to the interpreted fold structure. A small RC drilling program was then undertaken to further test the mineralisation within the fold zone.

TABLE 6: RAB Drilling Results (Au>0.1ppm), 1995/96 Programme

<table>
<thead>
<tr>
<th>Drillhole</th>
<th>East (Local)</th>
<th>North (Local)</th>
<th>Downhole depth (m)</th>
<th>decl</th>
<th>Intersection Downhole Au (ppm)</th>
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<td>ORB1295</td>
<td>83600</td>
<td>8580</td>
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<tr>
<td>ORB1296</td>
<td>83600</td>
<td>8570</td>
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<td>-90</td>
<td>3m @ 0.26</td>
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<td>49-55</td>
<td>-90</td>
<td>6m @ 0.54</td>
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<td>6m @ 0.26</td>
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7.1.2 RC Drilling

The 10 hole RC drilling programme undertaken to further test the quartz vein type mineralisation hosted by lower Mt Charles Beds within the fold zone verified the results of the earlier RAB drilling. Better grade mineralisation is confined to discreet, relatively narrow, intersections. Table 7 summarises intersections greater than 1g/t Au over one metre.

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<th>Hole</th>
<th>East (local)</th>
<th>North (local)</th>
<th>Downhole Depth (m)</th>
<th>Decl</th>
<th>Intersection Downhole Au (ppm)</th>
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7.1.3 Diamond Drilling

The first diamond drillhole (OHDDH001) intersected a large proportion of meta-dolerite rather than veined/altered lower Mt Charles Beds as anticipated. The best mineralisation encountered was 1.0m @ 0.22 g/t Au from a depth of 59m.

The second diamond drillhole (OHDDH002) traversed the targeted lithologies, intersecting upper Mt Charles Beds with quartz vein material making up to 50% of the core locally. Veins also contain sercite, chlorite, carbonate, gypsum, sulphides (arsenopyrite, pyrite and chalcopyrite) and magnetite. The best mineralisation encountered was 0.5m @ a calculated grade of 6.29 g/t Au from a depth of 157.5m. There is an association of gold with arsenopyrite.

<table>
<thead>
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<th>Drillhole No.</th>
<th>East (local)</th>
<th>North (local)</th>
<th>Downhole Depth (m)</th>
<th>Decl</th>
<th>Intersection Downhole Au (ppm)</th>
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<td>8533</td>
<td>157.5-158.0</td>
<td>-60°</td>
<td>0.5m @ 6.29</td>
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</table>

Annual Report For EL 6938 (Officer Hill), For the Period from 24 May 1995 to 23 May 1996.
7.2 Hyatt Prospect

7.2.1 Composite Rock Chip Sampling

Gold values to 0.07 g/t Au were recorded from rock chip samples though these contained less than 15 ppm arsenic.

7.2.2 Lag Sampling

Inspection of the multielement analytical results indicates that the samples show little variation or anomalism.

7.2.3 Ground Magnetic Survey

The ground magnetic survey results were profiled (see Appendix 3). A very obvious peak marked the faulted contact of the Killi Killi and Mt Charles Beds and helped with the siting of the RAB drilling programme.

7.2.4 RAB Drilling

The RAB drilling programme beneath this covered area confirmed the position of the contact between the Killi Killi Beds and the Mt Charles Beds. Much of the metasedimentary lithology occupying the Mt Charles Beds position was now occupied by doleritic intrusives. A major granite body lay south of the main zone drilled.

Gold mineralisation was encountered at or close to the contact targeted by this phase of exploration. Best intersections are shown below in Table 9

<table>
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<tr>
<th>Drillhole No</th>
<th>Grid East</th>
<th>Grid North</th>
<th>Downhole Interval</th>
<th>Declination</th>
<th>Downhole Intersection</th>
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8. EXPENDITURE INCURRED FOR THE PERIOD TO MAY 1995

EL 6938 - OFFICER HILL

EXPENDITURE TO FEBRUARY 1996

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<tr>
<td>Geophysicist 28 days @ $400/day</td>
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<td><strong>Sub Total</strong></td>
<td><strong>$ 469,796</strong></td>
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Field Base Support Costs                                    | 93,959 |
Administration and Technical Support                        | 112,751|
**TOTAL**                                                  | **$ 676,506** |

Covenanted expenditure for the period was set at $100,000.

9. PROPOSED WORK

9.1 Exploration

- Further RAB drilling of identified gold mineralised zones at the Officer Hill prospect
- Further RC drilling of selected traverses across the mineralised zones at Officer Hill
- Pegging extensions to the exploration grid and undertaking additional geophysical interpretation.

9.2 Expenditure

Exploration expenditure on EL 6938 is anticipated to exceed $100,000 for the twelve month period to May 1996.
10. REFERENCES


APPENDIX 1

Consultant's Mineralogical Report No.6992 (Drill Core, Officer Hill Prospect)
MINERALOGICAL REPORT NO. 6992
by A.C. Purvis, PhD

November 15, 1995

TO: Dr Deng Qi
North Flinders Mines Ltd
24 Greenhill Rd
WAYVILLE SA 5034

COPY TO: Mr Duncan Archibald
North Flinders Mines Ltd
24 Greenhill Rd
WAYVILLE SA 5034

YOUR REFERENCE: Order No. 24438

MATERIAL & IDENTIFICATION: Officer Hills Drill Core
OHDH1 (4 samples) and OHDH2 (36 samples)

WORK REQUESTED: Thin section preparation, petrographic
description and report, with comments as specified.

SAMPLES & SECTIONS: Returned to you with this report.

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**Table 1**: Visually Estimated Mineralogies (Vol. %) of samples in OHDH-1 and OHDH-2 to 129.9m

[Note: Stilp = stilpnomelane, Amph. = Amphibole, C/aceous = Carbonaceous matter]
FIGURE 2: Graphical representation of visually estimated mineralogies from Tables 1 and 2.
INDIVIDUAL DESCRIPTIONS

OHDH-1

OHDH-1, 95.45 m

Mesobanded and microbanded quartz-sericite-chlorite slates with boudinaged quartz veins parallel to the schistosity, also microshears parallel to the schistosity; minor pyrite disseminated and in quartz veins.

This sample is a laminated slate with folded mesobands from 3 to 20 mm in thickness, and a schistosity which is typically at about 20-30° to the layering. The layers are composed of microbands of sericitic to chloritic slate, with different proportions of the microbands in each of the mesobands, some being largely sericitic, others with chloritic slates more abundant than sericitic slates. Quartz comprises up to 30% of the sericitic bands but is apparently absent from the more chloritic mesobands.

Many of the chloritic laminations have small augen (~0.2 mm diameter) of partly chloritised biotite and of largely clay-altered plagioclase. Very small lenses of leucoxene parallel to the schistosity may have replaced schistose ilmenite, and some of the biotite has lenses of alkali felspar parallel to the cleavage.

Boudinaged quartz veins occur parallel to the schistosity with minor pyrite, and there are laminated quartz-sericite-chlorite-rich shear zones, also parallel to the schistosity, with a lamination similar to that defining the bedding laminations, but of tectonic origin. These zones are quite evident in the core segment and are up to 5 mm wide.
OHDH-1, 98.15 m

Quartz-chlorite-carbonate-plagioclase-leucoxene schist with a spaced schistosity and carbonate veins parallel to or at a low angle to the schistosity, with pyrite or limonite after pyrite.

A spaced schistosity with a spacing of about 0.5 mm is seen in this sample, with lamellae of schistose chlorite alternating with lamellae rich in relatively coarse granular quartz (0.1 to 0.4 mm grainsize) plus unoriented chlorite flakes and minor carbonate. There is schistose leucoxene, possibly after ilmenite in the chloritic lamellae, and there are rare grains of plagioclase in the quartz-rich lamellae. Minor altered biotite is seen throughout the chloritic lamellae, and it is possible that the chlorite was formed from biotite.

Veins of carbonate occur parallel to or at a low angle to the schistosity, and locally contain very minor fresh sulphide (pyrite) or limonite after pyrite.

This sample may have been of volcanic origin as a lava, tuff or dyke.
OHDH-1, 103.3 m  

Quartz-felspar-chlorite schist (felspar-rich) with folded layers rich in chlorite and leucoxene (?heavy mineral laminations); early quartz-rich veins, locally with adularia, pyrite and iron-free sphalerite, also with carbonate, sericite and pyrite; later adularia to carbonate-rich veins.

This sample is largely a quartz-felspar-chlorite schist with a quartzofelspathic micromosaic which seems to be in most areas rich in plagioclase. However the plagioclase is most evident where it has been weakly to totally altered to sericite. In some areas there is disseminated green tourmaline, usually elongate parallel to the schistosity. Thin bedding laminations richer in chlorite and leucoxene than the rest of the rock are folded and are generally at about 30° to the schistosity. It seems possible that these are heavy mineral laminations. Also present are diffuse lenses to 2 mm long which are rich in quartz and sericite and may be disrupted early veins.

There are some veins parallel to the schistosity with quartz dominant over minor chlorite sericite and carbonate, also minor pyrite and colourless, apparently iron-free sphalerite. Boudinaged but weakly cross cutting veins occur with quartz, adularia, muscovite and tourmaline, as well as minor pyrite, which may be of similar age to folded recrystallised quartz-rich veins with relatively abundant pyrite as well as some muscovite and chlorite, passing into quartz-chlorite veins with pyrite. The age relationship between these two vein types is not clear, however.

Later adularia to carbonate-rich veins are seen to be cross cutting relative to the earlier veins, however. These later veins are up to 4 mm wide, and in the wider areas have cores of carbonate and rims of adularia.
OHDH-1, 126.55 m  

Altered hornblende diorite with metamorphic actinolite, chlorite, carbonate and albite, also minor late magmatic quartz to granophyre.

Olive-green hornblende is common in this sample (~35%) as prisms to 2 mm long, which may be of primary magmatic origin, passing out into pale green rims of probably metamorphic actinolite. There is also abundant plagioclase, altered to albite ± sericite ± chlorite, passing into areas of largely decussate chlorite, usually with minor to abundant carbonate. Some lenses of schistose chlorite are also evident, with a uniform schistosity throughout the sample. Minor interstitial late magmatic quartz occurs passing into areas of granophyre. Primary magnetite is rare, and there is only very minor sphene.

The original lithology was probably a hornblende diorite.
OHDH-2

OHDH-2, 87.95 m  Quartz-biotite schist derived from a poorly sorted matrix supported fine to medium grained sandstone, with some chlorite and sericite.

This is a schistose poorly sorted matrix supported metasandstone with single crystal quartz grains 0.1 to 0.5 mm in size (fine to medium grained sandstone) in a matrix of quartz-biotite schist with some chlorite and sericite. Limonite and leucoxene are abundant and there are possible intraclasts to 2 mm long of possibly carbonaceous metasiltstone. There are some limonite lined fractures at a high angle to the schistosity and it is possible that some of the disseminated limonite is after pyrite.

OHDH-2, 102.34 m  Metamorphosed fine grained matrix-rich quartz sandstone with a quartz-chlorite schist matrix (with chlorite after biotite) and boudinaged layer-parallel quartz veins with clouded plagioclase and chlorite.

This is also a poorly sorted matrix supported metasandstone but has single crystal quartz grains no larger than 0.25 mm, indicating a fine grained sandstone as the protolith. Also the matrix, which was a quartz-biotite schist, has had all of the biotite replaced by chlorite + limonite + leucoxene. The sediment is also more strongly banded than that in the previous sample, with biotite-rich bands at 0.5 to 2 mm intervals.

There are some layer-parallel quartz veins which have been boudinaged and have minor clay-clouded albite as well as some chloritised biotite. The widest of these veins is from 0.2 to 2.5 mm wide. The narrower veins of this type, usually about 0.5 mm wide, have more abundant chloritised biotite than the wider vein referred to above.
OHDH-2, 111.6 m  Layered quartz-chlorite schist with altered apparently phenocrystal biotite. Apparently a sheared and metamorphosed lamprophyre (?minette), as at Dead Bullock Soak.

This is essentially a laminated quartz-chlorite schist with a spaced schistosity on a scale of 0.2 to 0.5 mm with chloritic lamellae alternating with quartz-rich lamellae. However there are chlorite-(clay-limonite-leucoxene) aggregates which are apparently pseudomorphs after coarse biotite as flakes from 0.5 to 1.5 mm long, locally with an outline reminiscent of biotite in lamprophyres (previously called ‘glimmerites’ as the first samples examined appeared to be free of felspar) in the Dead Bullock Soak area. There is only rare apatite in this sample, however.

There are abundant layer-parallel boudinaged quartz veins as lenses to 10 x 1.5 mm, and some grains of quartz which may represent xenocrysts, surrounded by a quartz-chlorite altered reaction rim.

This is interpreted as a sheared altered lamprophyre (possibly a minette) as in the Dead Bullock Soak area, with boudinaged layer-parallel quartz veins.
OHDH-02, 116.95 m  Quartz-rich quartz-chlorite schist derived from a very fine to fine grained sandstone, with a boudinaged quartz vein containing limonite after sulphides passing into micaceous hematite.

This is again a quartz-rich very fine to fine grained sandstone with disseminated, poorly sorted quartz grains to 0.2 mm in grainsize in a well-foliated matrix of fine schistose chlorite within which there is some leucoxene. It seems possible that at least some of the chlorite is after biotite, with some leucoxene derived from titanium in the former biotite.

There are rare narrow layer-parallel veins with quartz and/or carbonate, and a large boudinaged vein occurs to 15 mm wide, largely composed of coarse granular, weakly deformed quartz plus some recrystallised new grains. There are large irregular lenses of limonite or hematite, apparently after sulphides, but rather unusually fringed by areas of very fine micaceous hematite, with many flakes thin enough to show a cherry-red colour in thin section.

OHDH-2, 128.54 m  Chloritised quartz-biotite schist derived from a matrix-rich metasandstone with filaments of limonite, possibly after pyrite parallel to the schistosity.

This sample sees a return to metasandstone with abundant single crystal quartz grains to 0.15 mm in size in a chloritised quartz-biotite schist matrix, indicating a very fine grained sandstone as the protolith. As in previously described metasandstones, there is a spaced schistosity with a spacing of about 0.2 to 0.4 mm, but in this sample there are filaments of limonite, possibly after pyrite, parallel to the schistosity.
OHDH-2, 133.7 m Chloritised quartz-biotite schist as domains separated by pyrite-quartz-rich slip zones, with intrafolial folds within each domain parallel to the main trend of the sulphide-rich areas. Minor disseminated pyrite after pyrrhotite, very minor covellite, chalcocite and rare chalcopyrite. Probable meta-argillite.

This sample has sulphides along zones of slip as in some samples from Titania described in Pontifex Mineralogical Report No. 6993 (15/11/95). The host rock is a quartz-sericite schist, much richer in sericite than in quartz, with intrafolial folds confined to blocks outlined by the sulphide-rich zones. Most of the metasedimentary domains are microbanded with quartz-rich against sericite-rich lamellae about 0.1 to 0.2 mm thick, folded into tight folds with an axial plane roughly parallel to the sulphide-rich areas, with a layer-parallel schistosity.

The sulphide-rich zones are up to 4 mm wide and composed of largely granular to porous to colloform low-temperature pyrite after pyrrhotite plus granular to recrystallised quartz. Some pyrite after pyrrhotite is also disseminated as ragged patches within the folded metasediment areas. There are also rare euhedral crystals of arsenopyrite which would have overprinted the original pyrrhotite.

Also present in areas of disseminated sulphide are lenses of covellite and/or chalcocite, rarely together with apparently residual chalcopyrite. Some of the chalcopyrite patches enclose fine pyrite.
OHDH-2, 134.1 m  Chloritised biotite schist, locally very rich in apatite, with quartz veins containing abundant arsenopyrite and porous pyrite after pyrrhotite; possibly in part derived from apatite-rich lamprophyre or argillite with a chemical phosphate component.

There are abundant quartz-rich veins in this sample, but the host rock is a chloritised biotite schist, which in some areas is rich in leucoxene and dispersed very fine radioactive grains, but in other areas also has up to 4% disseminated granular apatite. Lenses rich in probable vermiculite after biotite occur in the apatite-free zones.

The veins, which are up to 7 mm wide include some with coarse highly strained old grains and some with more abundant recrystallised new grains, as well as abundant sulphide, with, on the whole, granular to well crystallised arsenopyrite to 2 mm in grain size, more abundant than largely porous low-temperature pyrite after pyrrhotite. Again the arsenopyrite would have been later than the original pyrrhotite.

The original lithology is not clear, although the apatite-rich domains may represent former lamprophyric material which is less fractionated, and hence more apatite-rich than that at 111.8 m. Alternatively, an argillite with a chemically derived phosphate component is also possible.
OHDH-2, 136.7 m  Fine quartz-biotite-chlorite schist with layer-parallel and cross cutting quartz veins, locally with clays; metamorphosed sandy siltstone with finer siltstone intraclasts.

This is again a fine metasediment with a heterogeneous matrix, composed essentially of fine quartz-biotite schist, but has chlorite in lenses, layers and irregular patches, with the chlorite apparently derived from schistose biotite. It has abundant single crystal quartz grains to 0.1 mm in grainsize, indicating a very fine sandy siltstone.

Angular patches to 5 mm long, richer in biotite and chlorite than the rest of the rock, and also poor in, to free of, sand-sized quartz grains, may be metasiltstone intraclasts. Accessory leucoxene and fine rutile occur with the rutile parallel to the schistosity, but the leucoxene is after small granules about 0.05 mm in diameter.

There is a variety of layer-parallel to cross cutting deformed early quartz stringers/veins. Layer-parallel veins have been boudinaged and generally have some biotite and chlorite, whereas some of the cross cutting veinlets are diffuse, with quartz-rich areas and areas richer in chlorite and biotite. The cross cutting veins may also be folded and have some segments to 10 mm wide, measured parallel to the schistosity. Later pytgmatically folded quartz stringers occur at a high angle to the schistosity, with some segments containing olive-green clays. These have been in some areas offset by late movements parallel to the schistosity.
OHDH-2, 140.55 m  Layered quartz-chlorite schist, with chlorite ± clays after biotite (including possible relict phenocrysts as in a lamprophyre), also limonite apparently after carbonate. Virtually identical to the sample from 111.6 m, and interpreted as an altered, metamorphosed lamprophyre.

This sample is virtually identical to that at 111.6 m characterised by altered residual biotite flakes to 4 mm long, which may have been phenocrysts in an evolved lamprophyre, in a relatively coarsely recrystallised quartz-chlorite schist with the chlorite, locally together with some possible vermiculite or smectites, apparently after biotite.

A strong spaced schistosity is present, with altered originally biotite-rich lamellae alternating with quartz-rich lamellae. There is abundant limonite, more probably after carbonate than after sulphides or magnetite. Accessory disseminated granular apatite is evident, but the low abundance of apatite is more consistent with an evolved, rather than a primitive (apatite-rich) lamprophyre.

OHDH-2, 146.4 m  Vein quartz with rare carbonate, also a fracture filled by fluorite with rare limonite after pyrite.

This whole sample consists of essentially massive, coarse vein quartz, with some grains over 30 mm in maximum dimension. There are some later fracture-filling veins cutting the rock, some of which contain quartz and carbonate. The largest of these is about 1 mm wide and has been filled by fluorite as a grain with the cleavage uniformly oriented across the thin section i.e. at least 25 mm long. A small patch of limonite after pyrite occurs within the fluorite vein.
OHDH-2, 150 m
Brecciated and disrupted fine quartz-chlorite schist, derived from sandy siltstone. Some layer-parallel quartz veins and a network of veins partly rimmed by quartz and filled by coarse fluorite, between disrupted fragments.

This sample is a fractured to fragmented to sheared metamorphosed sandy siltstone with sparsely disseminated single crystal quartz grains to 0.4 mm in size in a quartz-chlorite-(sericite-biotite) schist representing a metasiltstone. The schist is laminated parallel to the schistosity with laminations about 0.1 mm thick, and has abundant disseminated leucoxene.

The orientation of the schistosity varies between roughly centimetre-scale blocks. Some of these contain internal layer-parallel quartz veins, and the blocks have been separated along zones of veining with some marginal fine granular quartz. The centres of the veins are partly empty in the thin section, but in the hand-specimen can be seen to be occupied by large grains of fluorite which, as in the previous sample, have a uniform orientation of cleavage planes over a large area. Relatively minor fluorite occurs in the veins in the thin section however.
OHDH-2, 153.55 m, Irregularly banded carbonate-talc-chlorite-(quartz) schist with granular to porous low-temperature pyrite ± marcasite, minor chalcopyrite, rare sphalerite and galena. Possible altered, metamorphosed ultramafic or possible meta-impure dolomite. [The sulphide mineralogy is more consistent with a meta, impure dolomite.]

Irregular bands from 1 to 10 mm thick are evident in this sample, with off-white bands of clouded carbonate visible in both the hand-specimen and thin section. These are commonly irregular with some offshoots which extend for up to 10 mm at a high angle to the overall orientation of the layering. More regular layers of chlorite schist and talc schist ± quartz occur in between the carbonate-rich layers and lenses, with talc more abundant than chlorite.

Because of the abundance of sulphide in this sample, the offcut was polished. This reveals lenses of granular low-temperature pyrite ± marcasite occurring as bands and vein-like masses, commonly with some porous low-temperature pyrite. There are also large diffuse areas with abundant small grains of chalcopyrite and some rare patches with chalcopyrite and/or sphalerite, locally accompanied by galena.

This rock may be interpreted to represent an ultramafic igneous protolith, or possibly a meta-impure dolomite.
Probable breccia of vein quartz with a matrix of pyrite-galena-sphalerite-chalcopyrite-carbonate-chlorite including foliated chlorite locally passing into late quartz veins.

Fragments of vein quartz with both coarse grains and apparently recrystallised new grains occur in this sample to 20 mm in maximum dimension form about 60% of this sample. These have a matrix of sulphide with minor quartz, carbonate and variously colourless to deep green (Mg to Fe-rich) chlorite.

The sulphide is largely pyrite, apparently after pyrrhotite, with small inclusions of marcasite, also some chalcopyrite, against which the pyrite is commonly euhedral. There are also some large areas of galena in areas adjacent to the pyrite, and in these areas there are also disseminated iron-rich to iron-poor sphalerite, and minor chalcopyrite. The chlorite is commonly schistose and passes into narrower veins of fine grained quartz which cut across some of the apparent fragments.

Very fine quartz-sericite-biotite-chlorite schist derived from a sandy siltstone. Several layer-parallel quartz veinlets containing sericite and clays.

Disseminated single crystal quartz grains from 0.1 to 0.25 mm in diameter in this sample (fine to medium sand) occur in a laminated metasiltstone with quartz as grains largely smaller than 0.05 mm, and a spaced schistosity defined by sericite, altered biotite and chlorite. Leucoxene is common and there is some disseminated fresh opaque oxide, both as small grains elongate parallel to the schistosity.

There are layer-parallel quartz veinlets with minor sericite and greenish clays, including a single 1.5 mm-wide vein which separates into three subparallel veins in a 2 mm-wide zone. Rarer quartz veinlets are at about 20° to the schistosity.
OHHD-2, 157.6 m

Lamellae of chlorite schist, occurring individually or in small packets in vein quartz with carbonate and patchy coarse aggregates of arsenopyrite, overprinted on pyrite after pyrrhotite.

There is a band about 8 mm thick in this sample with laminae of chlorite schist alternating with lamellae of recrystallised quartz, possibly representing recrystallised layer-parallel quartz veins. This band is set between larger layer-parallel quartz veins rich in sulphides, with rare lamellae and lenses of chloritic schist, also irregular patches of carbonate enclosing disseminated fine felted-prismatic quartz.

The main sulphide is quite coarse granular to prismatic arsenopyrite to 8 mm grainsize, locally overprinted on granular pyrite after pyrrhotite. There is about 35% by volume arsenopyrite in the area of this polished thin section.

[Note that the relationships of arsenopyrite to the secondary pyrite after pyrrhotite have been seen by this author from elsewhere in the Tanami Inlier; refer particularly to Pontifex Report 6989, discussing sulphide paragenesis at Anomaly-2 area.]
OHDH-2, 163.6 m

Laminated very fine quartz-chlorite schist with minor leucoxene, sericite and carbonate, in contact with a large partly recrystallised layer-parallel quartz veins, also smaller layer-parallel quartz veins and cross cutting carbonate veins.

The host rock in this sample is a laminated very fine quartz-chlorite schist intercepted as a chloritised metasiltstone. It has disseminated a fine leucoxene parallel to the schistosity, also small unoriented flakes of sericite, small patches of decussate fine sericite and grains of carbonate, with the fine sericite possibly after small felspar grains.

The schist is in contact with a recrystallised quartz vein with some lensoidal remnants of large highly strained old grains set in a matrix of recrystallised new grains. The highly strained old grains have a strong quartz fabric in which the quartz c-axes are at a high angle to the vein walls, and to the schistosity in the host rock, whereas the recrystallised new grains do not have a clear or obvious fabric. Smaller boudinaged veins of recrystallised quartz to 2 mm wide also occur within the host rock. Late cross cutting carbonate veins occur at a high angle to the fabric of the host rock + layer-parallel quartz veins. There is no sulphide in this sample.
OHDH-2, 166.6 m  Banded sericite to quartz-rich slates with streaky layer-parallel veins of quartz and of pyrite-quartz, disrupted apparently due to movement along the pyrite-rich veins, which commonly have chlorite to pyrite-rich extensions.

Sericite to quartz-rich fine-grained metasediments dominate this sample with complex deformation apparently related to movement on layer-parallel sulphide-rich laminations or veins, which would have had a low viscosity during deformation. The predominantly slaty lithology has been crumpled, contorted and kinked, with intrafolial folds in the more sericite-rich layers and kinks generally in more quartz-rich layers. Disruption along chlorite to sulphide-rich offshoots of the sulphide-rich lamellae or veins is also evident.

There are some layer-parallel disrupted streaky quartz veins as well as the sulphide-rich veins which generally carry minor to abundant quartz as well as some small patches of clays and abundant sulphide. The sulphide is granular to cubic pyrite, with euhedral faces against the vein quartz, and with lamellae of clays parallel to the pyrite veins, enclosed within the pyrite.
OHDD-2, 168.9 m  
Banded quartz-muscovite-biotite schist, probably meta-argillite. Incorporates complex folds having an axial plane at a high angle to the core axis, also boudinaged early quartz veins with sulphides. Later quartz-pyrite-clay-filled veinlets and fractures. Sulphide is very fine, probably low-temperature pyrite.

This host rock to complex structures and minor stringers of very fine sulphide is a layered very fine quartz-muscovite-biotite schist. It includes biotite-rich laminations, which at one end of the thin section are planar, with a layer-parallel schistosity, but at the other end are folded about the same foliation which is in this area an axial plane schistosity. More diffuse layering on a millimetre to centimetre scale, with biotite to sericite to quartz-rich layering, also varying from planar to folded, occurs between the thin discrete very biotite-rich lamellae referred to above. The original lithology was apparently an argillite.

The bedding and schistosity are also disrupted by small and large boudins of vein quartz. The largest lens of vein quartz (~20 x 10 mm) which has been totally recrystallised, has screens of fine schist and lenses of pyrite within it. Irregular lenses of fine sulphide and clays occur in the smaller boudins, with some fine sulphide in the necked-in areas between the boudins. There are also later cross cutting stringers and fractures with fine, probably low-temperature pyrite ± quartz ± fine clays.
OHDH-2, 174 m

Fine to medium quartz-chlorite albite-carbonate-(sericite-leucoxene) schist apparently derived from a quartzofelspathic fine grained sandstone. Rare layer-parallel quartz stringers and cross cutting carbonate veinlets.

This seems to have been a quartzofelspathic sandstone with largely albitised to sericite-altered plagioclase grains to 0.25 mm in size, plus recrystallised quartz lenses which may represent former detrital quartz grains of similar size, and common carbonate. These three minerals, singly or in combination, occur as small augen around which a spaced chlorite-dominated schistosity seems to flow. The chlorite occurs as lamellae to about 0.25 mm in thickness, with minor leucoxene and small radioactive grains made evident by their pleochroic haloes. Very minor possible sericite occurs, largely with the carbonate.

There are rare boudinaged layer-parallel quartz stringers and also rare cross cutting carbonate stringers with some disruption apparently due to late slip along the schistosity.
OHDH-2, 175.5 m  
Very fine quartz-chlorite-sericite schist derived from a bedded (?silty) argillite with some possible heavy mineral laminations. Includes boudins of vein quartz + sulphide, minor stringers of quartz, pyrite and adularia.

Relict bedding laminations 5-10 mm thick are common in this sample, which is a very fine layered quartz-chlorite-sericite schist. There are narrow laminations rich in leucoxene-altered apparently detrital opaque oxide grains, suggesting that these are heavy mineral laminations. Some of the layers are rich in disseminated pyrite. A large boudin of vein quartz (as in the sample from 168.9 m) consists of recrystallised quartz plus lenses of sulphide. Narrow layer-parallel quartz stringers are present as well as later stringers of apparently low-temperature pyrite, and narrow veinlets of adularia.

OHDH-2, 180.4 m  
Altered fine laminated quartz-biotite schist with limonitised carbonate, also boudins of vein quartz + limonite after carbonate. Meta-lamprophyre (minette?)

This fine schist is interpreted as a sheared metamorphosed and altered lamprophyre as at 111.6, 134.1 and 140.35 m above in this hole. It is a well-laminated quartz-clay-limonite schist, including limonite after carbonate as in the previous samples of lamprophyre, but in this sample with some residual carbonate.

The characteristic apparently residual biotite phenocrysts are smaller than in the previous samples but there is more abundant disseminated apatite, suggesting a less evolved lamprophyric genesis. There are rather rare small boudins of vein quartz with limonite after carbonate.
OHDH-2, 186.1 m  Laminated fine quartz-chlorite-carbonate-leucoxene schist with layer-parallel quartz-carbonate veins and some apparently residual biotite. Apparently a metasiltstone which has suffered carbonate-chlorite alteration.

This is a very finely laminated quartz-chlorite schist with about 20% quartz and disseminated lenses and lamellae rich in carbonate. The laminations are generally 0.05 to 0.2 mm thick, but there are also some layer-parallel quartz-carbonate veins some of which have been boudinaged and are up to 1 mm wide. Fine leucoxene is commonly disseminated along foliations, and in some areas there is some apparently residual schistose fine biotite.

It seems most likely that the original lithology was a siltstone or fine sandy siltstone, which has been chloritised after having been converted to a quartz-biotite schist. The carbonate may have formed during the chloritisation.

OHDH-2, 186.25 m  Vein quartz with shreds of schistose chlorite and patches and veins of pyrite-marcasite + arsenopyrite + carbonate.

Fragmented, deformed and largely recrystallised vein quartz dominates this sample, with some shreds of schistose deep green chlorite. Abundant irregular areas of sulphide, locally pass into areas of granular, largely limonite-stained carbonate. This sample is broadly similar to that at 154.6 m, but with a less varied sulphide assemblage.

The sulphide is largely pyrite + minor marcasite apparently after pyrrhotite, with some rare euhedral arsenopyrite crystals to 0.5 mm long which would have postdated the original pyrrhotite (the same as at 154.6 m).
OHDH-2, 188.45 m  Very fine chlorite schist with some quartz-rich bands, folded about the schistosity. Also lenses of quartz + carbonate, veins variously rich in carbonate and pyrite ± chlorite, and areas infiltrated by carbonate along the schistosity. Wide, largely recrystallised quartz veins with pyrite and, locally, rare sphalerite.

The host rock in this sample is essentially a chlorite schist with some thin quartz-rich bands which have been folded about the schistosity and are, in different parts of the folds, at about 20 to 60° to the schistosity. The schistosity is locally contorted adjacent to lenses of quartz, some of which have cores of granular carbonate. There are also veins varying from carbonate to sulphide-rich, locally with lenses of chlorite, and there are areas within which carbonate has infiltrated along the schistosity in planar zones to 2 mm wide.

Largely layer-parallel quartz veins occur from 7 mm to over 20 mm wide. These have been boudinaged and are largely composed of fine recrystallised to highly deformed quartz, with some irregular zones of coarser quartz which may correspond to highly strained old grains. Lenses of sulphide occur locally in the quartz veins. The main sulphide appears to be pyrite, with some porous zones as seen in low angle incident light, but the larger vein also has traces of pale, relatively iron-poor sphalerite.

OHDH-2, 192.9 m  Albite-chlorite-carbonate-leucoxene-altered probable basalt, with carbonate-(albite-quartz) filled vesicles.

Unoriented albitised plagioclase laths to 0.4 mm long are abundant in this sample in a matrix of foliated chlorite with minor carbonate and some very fine leucoxene. Some of the chlorite occurs as lenses to 1.5 mm long of obscure origin, which may be parts of anastomosing partly disrupted microshears. There are rare possible vesicles to 2 mm long with carbonate, minor albite and rare quartz.

The original lithology was apparently a basalt in terms of grainsize and texture, albeit possibly intrusive.
OHDD-2, 201.4 m

Banded quartz-chlorite-magnetite-stilpnomelane schist representing a shaly BIF. Microfaulting along sulphide-carbonate-quartz veins and some irregular veins and masses of sulphide. Cleavage/schistosity almost at right angles to primary layering.

Folded mesobands and microbands of a millimetre to centimetre scale characterise this sample. Wider bands are mostly rich in fine cherty quartz or in schistose chlorite with an axial plane schistosity relative to the folds in the rock (about 30 mm in wavelength). Thinner bands are rich in magnetite, commonly with some chlorite and/or stilpnomelane (brown ferristilpnomelane is present in this drill-hole rather than green ferrostilpnomelane). The stilpnomelane is partly parallel to the schistosity but partly in small fan-like bundles similar to garbenschiefer bundles of tremolite-actinolite or hornblende. The folded layering has been offset along planar veins with sulphides carbonate and quartz. Numerous planar to irregular veins rich in pyrite after pyrrhotite mostly cut across the layering, more or less along axial plane directions.

Irregular micro protruberances of this sulphide occurs locally along the layering adjacent to the crosscutting veins.
OHDH-2, 199.0 m Quartz-chlorite-magnetite-stilpnomelane schist with BIF affinities, passing into chert with ultrafine magnetite and some carbonate, also basically BIF. Recrystallised quartz vein with scattered carbonate, and lenses of coarse quartz rimmed by coarse sulphide-carbonate aggregates.

There are three zones in this sample. One is a microlaminated quartz-chlorite-magnetite-stilpnomelane schist with microlaminations folded into broad folds about an axial plane schistosity defined by the chlorite and some of the relatively minor stilpnomelane. This zone seems to be of banded iron formation affinities and has some magnetite microbands as well as quartz-rich microbands, alternating with “shaly” chlorite-stilpnomelane microbands.

The second is also banded but has abundant fine cherty quartz plus ultrafine possible magnetite and some disseminated microcrystalline carbonate. This also has been folded but has no suitable minerals to define any schistosity. The contact between these zones seems to be of tectonic character, separating two folds of similar character in different lithologies.

The third zone is a large quartz vein largely composed of very finely recrystallised quartz with some areas also rich in carbonate, and large lenses of coarse quartz (?highly strained old grains) rimmed by coarse sulphide-carbonate aggregates.
OHDD-2, 203.8 m  Complexly micro-folded, well-banded chloritic to sericitic, carbonaceous to non-carbonaceous slate, with boudinaged quartz veins and fine fractures variably rich in fine pyrite and in quartz.

This sample is dramatically micro-folded, well-laminated slate. Layering on a millimetre to centimetre scale is folded into complex flow-folds with a layer-parallel schistosity. It has bands which are alternately poor and rich in finely divided carbonaceous matter, as well as schistose chlorite and/or sericite, and apparently some quartz.

A large boudin dominated by recrystallised vein quartz (25 x 10 mm), encloses minor fine sulphides (essentially all granular to porous pyrite) + chlorite and carbonate. Fractures containing similar sulphide occurs along slip planes with some displacement of the folded layers, and there are irregular quartz to sulphide-rich anastomosing veinlets.
OHDF-2, 210.5 m

BIF, typically with fine magnetite, cherty quartz, stilpnomelane, cummingtonite and rare iron-rich chlorite. Planar layering, and a layer-parallel schistosity.

Mesobands and microbands are well-developed in this sample with magnetite mesobands and microbands alternating with cherty to shaly bands variously rich in fine cherty quartz ± cryptocrystalline to microcrystalline magnetite, also very thin needles of cummingtonite, or, in some layers fine schistose ferrostilpnomelane which may have been altered to clays. The mesobands are typically 5 to 10 mm thick, with microbands to 1 mm thick.

Microbands of stilpnomelane commonly alternate with cherty microbands in generally magnetite-poor mesobands, and there is commonly minor stilpnomelane (± rare iron-rich chlorite) in the magnetite mesobands.

The banding in this sample is primarily planar but there is also a layer-parallel schistosity. Rare fine pyrite after pyrrhotite is disseminated.
OHDH-2, 214.9 m

Rather complexly folded and disrupted chlorite-cummingtonite-(magnetite) to quartz-chlorite-cummingtonite-magnetite rock including some magnetite microbands. Sulphide-(clay-carbonate-quartz) veins permeate disruptions and include apparently low-temperature pyrite.

This sample shows variations in composition and texture from a banded quartz-free chlorite-cummingtonite fine schist, with some thin lenses and laminations rich in fine recrystallised magnetite, into a magnetite-free schist with iron-rich chlorite and lamellae rich in poorly oriented cummingtonite (partly altered to clays). Some lenses of magnetite return as this schist passes into a banded rock with chlorite-cummingtonite laminae and quartz-rich microlaminations, plus abundant disseminated magnetite.

Much of the layering may be of a tectonic origin as there are widely spaced magnetite microbands, which may represent bedding laminations, with the schistosity and banding referred to above at about 30-40° to these layers. The orientation of these possible bedding laminations varies between blocks of schist which appear to have been offset along sulphide-rich veins as in previous shaly banded iron formation samples.

Some of these bands, which are up to 3 mm wide contain abundant brown clays, as well as some quartz and some possibly low temperature carbonate. The sulphide seems to be largely low-temperature pyrite as far as this can be identified in low angle incident light.
OHDH-2, 217.5 m  Fine albite-chlorite-quartz-carbonate-(biotite-leucoxene) schist with plagioclase as laths about 0.5 mm long, also accessory apatite, suggesting a fine quartz micro-dolerite as a possible protolith (or a plagioclase crystal tuff?).

Poorly oriented plagioclase laths about 0.5 mm long form up to 60% of this sample, and occur with generally minor carbonate as small ‘augen’, in quartz-chlorite schist, with a schistosity which flows around the augen. Some leucoxene carbonate and rare biotite occur within the schistose foliae which are otherwise dominated by chlorite with only very minor quartz.

The plagioclase shows alteration to albite with minor sericite, chlorite and carbonate, and some of the grains have been pulled apart and veined by carbonate or by chlorite + quartz. Accessory apatite is seen, partly as inclusions in the plagioclase and also partly in quartz, which may suggest that the original lithology was a fine-grained quartz dolerite. However it may also be interpreted as a possible plagioclase crystal tuff.

OHDH-2, 221.0 m  Sheared metamorphosed lamprophyre (minette). Manifest as relict phenocrysts of biotite in a fine quartz-biotite-sericite schist matrix carbonate, disseminated and in diffuse veins, also minor lenses of secondary quartz.

The presence of abundant (relict) phenocrysts of pale magnesian biotite to 2 mm long, indicates that this sample is a sheared and metamorphosed lamprophyre (minette) as described for several samples above in this hole. These occur in a matrix of very fine quartz-biotite-sericite schist, locally with some chlorite and with zones of a second crenulation cleavage at about 40° to the main schistosity. Minor carbonate is disseminated throughout (without the limonite seen in the carbonate in previously described lamprophyres), and there is accessory apatite as micro-prisms which are commonly clouded, a feature seen in lamprophyres elsewhere. Some of the carbonate occurs as diffuse veins at a high angle to the schistosity, and there are rare lenses of quartz, possibly vesicles.
OHDH-2, 227.1 m

Structurally complex, microfaulted, disrupted and mineralised rock. Bands variously rich in fine chlorite, carbonate, quartz and in ultratine magnetite, indicating BIF affinity, but possibly including disrupted veins. Also discrete veins with various proportions of quartz, carbonate and sulphide, locally along microfaults. Sulphide veins with pyrite after pyrrhotite, disseminated lenses of chalcopyrite and chloritic shears with fine-grained arsenopyrite.

This sample has been disrupted along numerous microfaults, commonly cutting across areas which appear to be BIF-related metasediments, and areas of finely recrystallised quartz which may represent either vein quartz or recrystallised chert. One band of fine chlorite schist contains fresh to possibly altered fine decussate biotite, disseminated and in microbands. Another more cherty area has ultratine magnetite disseminated or as small flecks apparently confined to the cores of individual recrystallised quartz grains. A band of carbonate occurs adjacent to the chlorite-biotite schist, with millimetre-scale bands containing disseminated pyrite or fine schistose chlorite.

A large area of fine carbonate occurs with folded to microfaulted chlorite schist along one side, also some disseminated schistose chlorite as well as fine granular to prismatic quartz and sulphides. It is again not clear whether this is a vein or a layer of metasediment. However there are some narrow veins which contain various proportions of quartz, carbonate and sulphides, usually in different veins or different parts of the same vein. The widest of these is about 1.5 mm wide, with quartz, carbonate and sulphides together in complex aggregates. Some of the veins are along microfaults which have broken the rock up into various generally centimetre-scale domains.

The more vein-like sulphide occurrences are composed of granular to porous pyrite after pyrrhotite, but the more disseminated aggregates of sulphide are mostly composed of chalcopyrite. There are also some narrow chloritic shears which contain fine-grained arsenopyrite, but this is not seen in contact with the other sulphides, so that its relative age is not clear.
OHDH-2, 228.05 m  
Sequence of irregular lenses, layers and shreds of chlorite, varying to quartz-rich schists (including cherts/veins), plus large lenses and/or veins of sulphides plus chlorite ± carbonate, and late carbonate veins. 
Sulphides: irregular quite coarse and some microfractured pyrite > fine crystalline arsenopyrite. Lesser pyrrhotite altered to secondary pyrite, also accessory chalcopryite. Later possibly arsenic-bearing pyrite.

There are millimetre to centimetre scale layers, lenses and shreds of quartz-chlorite schist to pure chlorite schist in this sample, as well as areas of microcrystalline quartz which may represent chert or recrystallised vein quartz and incorporates minor extremely fine chlorite. Irregular masses and veins of sulphide, usually enclosing minor chlorite ± carbonate, and areas of granular quartz clearly representing veins, are abundant. Late-stage carbonate veins to 0.5 mm wide cut across layer veins. Much of the sulphide is banded, but apparently in roughly layer-parallel veins, rather than necessarily being in-situ/sygenetic, for example.

Total sulphide forms about 50% of this sample, pyrite (most of which is possibly after pyrrhotite) and arsenopyrite occur in approximately subequal abundance; there is minor (5-7%) microporous secondary pyrite after pyrrhotite, and lesser chalcopyrite (2%).

The granular pyrite occurs in very irregular anhedral grains commonly crowded with fine to coarse inclusions of quartz, and irregularly aggregated to form the layer veins described. Also this pyrite is commonly microfractured, locally disrupted and rarely possibly remobilised to form short discordant veinlets.

The arsenopyrite mostly occurs as small (<0.1mm) euhedral crystals, in variably loose to compact irregular aggregates, generally in lenses to 4 mm wide alternating with pyrite-rich lenses and shreds of schist. The usual textural relationship is seen with euhedral arsenopyrite cutting across granular-anhedral pyrite and apparently postdating either the pyrite or former pyrrhotite which this pyrite may have replaced. Trace inclusions of fresh pyrrhotite (<0.1mm) occur in pyrite, together with slightly larger grains of microporous secondary pyrite representing lower temperature replacement of pyrrhotite, which may have remained as kernels
after the replacement by granular pyrrhotite. Such patches are indeed common in this type of granular pyrite throughout the Tanami Inlier.

There are rare veins of weakly anisotropic, possibly later pyrite which sit across the arsenopyrite. This generation of pyrite may be independent of any former pyrrhotite and may have some arsenic in solid solution.

Sparse (<1%), very small (<0.1mm) grains of chalcopyrite occur in some of the more granular pyrite and a single short veinlet of chalcopyrite is cut across by primary pyrite, (enclosing altered pyrrhotite).
OHDH-2, 233.2 m  
Banded cummingtonite-chlorite-magnetite schist with narrow cross cutting carbonate veins.

This is a microbanded schist with thin bedding laminations having different proportions of schistose iron-rich chlorite, decussate cummingtonite as thin prisms to 0.5 mm long, and disseminated fine granular magnetite. Some of the bands are largely cummingtonite with possibly only 15-20% chlorite, whereas other bands are predominantly schistose chlorite. Bands with over 10% magnetite are rare, however. There are narrow cross cutting carbonate veins.

OHDH-2, 243.9 m  
Contact between folded largely carbonaceous sericitic slate and sparsely biotite porphyritic lamprophyre (minette) metamorphosed to a predominantly fine quartz-sericite-chlorite-biotite schist. Numerous chlorite-sulphide to carbonate-sulphide veinlets.

Part of this sample is a slate with thick carbonaceous layers (to 10 mm thick) and thin layers (to 1 mm thick) free of carbonaceous matter composed of schistose sericite with a layer-parallel schistosity. The layering has been folded into disharmonic folds, some of which have an axial plane crenulation cleavage. Small lenses of quartz and sericite occur locally in the carbonaceous layers.

A carbonate vein with some sulphide separates this lithology from a sparsely biotite-porphyritic lamprophyre with small glomeroporphyritic aggregates of biotite to 2 mm diameter. The contact is parallel to the axial planes of the folds in the slate. The biotite phenocrysts in this sample retain igneous zoning and are set in a quartz-sericite-chlorite-biotite schist. Much of the biotite seems to represent small flakes of igneous origin, and there is accessory apatite.

Irregular chlorite-sulphide to carbonate-sulphide veins occur in both the metasediment and the lamprophyre.
APPENDIX 2

Consultant’s Mineralogical Report No.6851 (RAB Chips, Hyatt Prospect)
MINERALOGICAL REPORT NO. 6851
by A.C. Purvis, PhD

May 18, 1995

TO:
North Flinders Mines Ltd
PO Box 3694
ALICE SPRINGS NT 0870
Attention: S. Hogan

COPY TO:
Mr Duncan Archibald
North Flinders Mines Ltd
24 Greenhill Rd
WAYVILLE SA 5034

YOUR REFERENCE:
Order No. 25260

MATERIAL:
22 Chip Samples
6 Rock and Core samples

IDENTIFICATION:
HYATT
HRB075 to HRB173 (21 chips)

WORK REQUESTED:
Thin section preparation, petrographic description and report, with comments as specified.

SAMPLES & SECTIONS:
Returned to you with this report.

PONTIFEX & ASSOCIATES PTY. LTD.
INTRODUCTION

This report discusses twenty-eight samples from the Hyatt area in the Tanami Inlier in the Northern Territory, including twenty-five samples of drill-chips and end-of-hole cores, as well as three outcrop samples, listed as follows:

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The samples fall regionally into two groups (as far as can be understood from the labelling, since some samples have AMG co-ordinates, others have local Hyatt-Grid co-ordinates, but the relationship between these is not known to the writer).

A letter from Stephen Hogan dated 30/3/95 which accompanied the samples, provides brief field identifications and comments on the geological setting, suggestions of a thermal aureole. The petrology is summarised below, according to the two co-ordinate groupings, and addressing the questions raised in your covering letter.
INDIVIDUAL DESCRIPTIONS

HRB-071, 22-28m (512094) 94500E, 19220N
Weathered amphibole schist with magnetite, quartz and possible ilmenite, possibly of mafic igneous origin (with hornblende) or siliceous high-iron formation (with cummingtonite).

Field Note: (None, sample not listed)

There is a strong schistosity in this sample, which has been altered to clays, with some (~1%) disseminated fine metamorphic quartz, and some (1-2%) disseminated crystals of magnetite to 0.2 mm diameter. Very fine opaque oxide is disseminated (2-3%), but it is not clear whether this is magnetite or ilmenite. Most of the rock seems to have been composed of well-aligned crystals of possible amphibole to 1 mm long, together with some aligned at an angle to the main schistosity.

Some of the magnetite in this sample is apparently in narrow quartz veins, which cut across the schistosity.
HRB-072, 23m (512099) 94500E, 18660N

Weathered apparently massive biotite granodiorite with some "fresh" alkali felspar and ragged granular quartz.

Field Note: granite: metamorphic texture? relation to Madam Pele granite?

This weathered granite has suffered the usual degree of detexturing seen in similar granites throughout the Tanami Inlier, with expanded biotite as well as totally kaolinised plagioclase. There seems to have been about 25% quartz as ragged granular aggregates as well as about 15-20% coarse granular alkali felspar (to 6 mm grainsize). As in most weathered granites this has no microcline twinning or exsolution, which is unusual for alkali felspar in a granite. The amount of biotite in the original rock is not clear, but there is no evidence of former hornblende, indicating a biotite-only granitoid. The amount of alkali felspar suggests a granodiorite rather than an adamellite or tonalite, however.
HRB-075, 57-60m (689504) 97000E, 19950N:

Massive grain-supported lithic-arkosic coarse-grained sandstone, also massive adamellite, foliated granodiorite, muscovite and quartz-rich schists (metasediments), possibly lithic clasts from a conglomerate; all possibly Gardiner Sandstone.

Field Note:  f.g. micaceous sandstone + granite + quartz - is it the Gardiner sandstone?

There are several lithologies in this sample, including massive to foliated granitoids, schistose metasediments and apparently unmetamorphosed sandstone, plus some limonite cemented apparent colluvium. The lithologies are as follows:

Foliated granitoid is represented by a single chip, with plagioclase more abundant than alkali felspar, and minor chloritised schistose biotite. There seems to be a gneissic layering in this chip with some very elongate quartz grains (to 3 x 0.5 mm). The size of the chip is small compared to its grainsize, but suggests a former granodiorite gneiss.

Massive granitoid is also represented by a single chip, with lobate quartz grains to 3 mm in diameter enclosing smaller grains of plagioclase and relatively abundant alkali felspar (perthitic microcline). Minor fresh to chloritised apparently iron-rich biotite is present. The composition suggests an adamellite with 30-35% quartz, 40% alkali felspar, 25-30% plagioclase and 2% biotite. Much of the plagioclase is clouded by clays and limonite, but the alkali felspar is largely fresh.

A single chip of crenulated quartz-muscovite-biotite schist occurs but has been cut parallel to the first schistosity, with bands of micas parallel to S₂ running across the chip. There is apparently 20% quartz and 5% biotite in this chip, which is predominantly muscovite. Similar schists are seen in other samples in this batch. The other metasediment chip is quartz-rich and fine-grained with abundant opaque oxide (magnetite ± ilmenite) and with abundant sericite, some of which may be after possible porphyroblasts (?andalusite).

Apparently unmetamorphosed sandstone in this sample is grain-supported and has single crystal quartz grains as well as polycrystalline recrystallised or vein quartz, muscovite, biotite,
alkali felspar and plagioclase. This sandstone seems to be similar to the Gardiner Sandstone as described in previous reports. It has a grain size of 0.3 to 1 mm (medium to coarse sandstone).

Some soil is also present.
HRB-076, 46-49m (689507) 97000E, 19850N

Metadolerite and very coarse lithic-arkosic sandstone with a sparse carbonate cement, possibly Gardiner Sandstone.

Field Note: Fine grained dolerite? + micaceous quartz-lithic sandstone - is it the Gardiner Sandstone? Identify 'dolerite.'

Some of the chips in this sample are metadolerites with uralitic hornblende after clinopyroxene grains about 1 mm in size, as well as limonite-leucoxene-altered opaque oxide grains about 0.3 mm long and abundant recrystallised plagioclase (+ hornblende).

The other chips are poorly sorted but grain-supported lithic-arkosic sandstones with some grains of apparently low-temperature hydrothermal cherty to sparry quartz, including some which contain or consist of chalcedony. The main component is single crystal quartz grains, but alkali felspar, clay-clouded plagioclase, biotite, muscovite and rare garnet are also present, as well as composite quartz-muscovite grains. The maximum grainsize is about 1.5 mm, indicating a very coarse-grained sandstone. There is a sparse cement of clear to clouded carbonate, and a single patch of limonite which may be after pyrite.
HRB 082, 28-31m (698558) 584561E, 7710328N

Very small, altered chips from clay to quartz-rich, rarely with chlorite, plagioclase and leucoxene (altered dolerite or quartz microdiorite), also vein quartz and some limonite possibly after pyrite.

Field Note: Strongly weathered dolerite + quartz veins: mineral identification (include sulphides) - both host rock and quartz veins.

The chips in this sample are very small and quite weathered, with no fresh sulphide. Some have quartz, chlorite, largely sericitised plagioclase and some leucoxene, whereas others seem to have been quartz-sericite schists, clay-rich altered schistose rock with little or no quartz, or quartz-rich chips with the quartz partly in veins. Some of the limonite in some of the chips may be after limonite, but no definite metadolerite can be identified.
HRB-104, 21-34m (689584) Weathered massive probable biotite-quartz syenite to syenogranite with some altered plagioclase.
98500E, 20200N

Field Note: Coarse-grained pink granite. Is this the same as Madam Pele Granite texturally/compositionally? is it the same as HRB 222, 169, 072 and sample 210937

This granitoid is apparently quartz-poor with possibly 10-15% coarse granular quartz, and is dominated by alkali felspar, some of which is microcline, but much of which is the optically featureless alkali felspar seen commonly in weathered granitoids in the Tanami Inlier. There was apparently some plagioclase (15%) and biotite (?~5%) both altered to clays, and the grainsize was apparently from 1 to 4 mm. There is a trace of leucoxene after small opaque oxide grains.
HRB-110, 54-57m
(689593)
98500E, 20750N
Grain supported coarse lithic-arkosic sandstones (Gardiner Sandstone) with some carbonate, and matrix (quartz-biotite-muscovite schist) supported weakly felspathic matrix supported sandstones (؟Madigan Beds, felspathic facies)

Field Note: Matrix supported greywacke? Is this a greywacke (Madigan Beds)?

Most of the chips in this sample are grain-supported micaceous-lithic-arkosic sandstones, with grains to 1 mm in size, largely single crystal quartz grains, but also abundant alkali felspar (mostly microcline) muscovite, biotite, some plagioclase, also sericitic to quartz-(carbonate)-rich lithic fragments, plus composite quartz-muscovite grains, in a sparse clay to carbonate-rich matrix. These seem to be typical Gardiner Sandstone. Finer-grained varieties of this sandstone have abundant micas (biotite + muscovite) defining an apparently layer-parallel foliation, due to compaction rather than metamorphism.

However there are some matrix-rich sandstones with single crystal quartz grains to 0.5 mm long and some plagioclase, but no microcline, in which the quartz-biotite-muscovite aggregate forming the matrix seems to be a schist, with a metamorphic texture. These may represent the felspathic, quartz-biotite-(muscovite)-schist hosted facies of the Madigan Beds. These also have rare tourmaline, which is not seen in the probable Gardiner Sandstone chips.
HRB-121, 60-63m (689604)  
98500E, 20750N  

Micaeous-arkosic grain-supported medium-grained sandstones (unmetamorphosed), probably Gardiner Sandstone, with rare possible pyrite.

Field Note: Greywacke? Mineralogy and identification.

These chips represent a relatively uniform, very micaeous grain-supported medium-grained sandstone with abundant detrital biotite and muscovite defining a layer-parallel foliation (bedding foliation), as well as quartz, alkali felspar, clay-altered plagioclase, fresh to leucoxene-altered opaque oxide grains and rare possible pyrite. The maximum grainsize is about 0.3 mm, apart from some muscovite flakes to 2 mm long. There is only very minor carbonate
HRB-126, 48-51m
(689609)
89500E, 22950N

Fine to medium bedded micaceous to quartz-rich, weakly felspathic, carbonate-(glauconite) bearing sandstones, coarser micaceous-arkosic sandstones and fine carbonate rocks, possibly all from the Gardiner Sandstone.

Field Note: Greywacke? Mineralogy and identification.

Most of the chips in this sample are fine to medium-grained sandstones, with bedding on a scale of a few millimetres. The adjacent beds are alternately rich and poor in detrital micas, both biotite and muscovite being present, and there is a layer-parallel foliation. These sandstones are grain supported but are not as felspathic as the coarser-grained equivalents described above. However they tend to have minor (3-10%) disseminated carbonate, with more carbonate in the more micaceous layers. Rare tourmaline occurs, and there are rare small patches of glauconite, as well as fresh to leucoxene-altered opaque oxide grains.

There are some chips of coarse grain-supported sandstone, with single crystal quartz grains to 0.8 mm long as well as microcline, plagioclase, biotite, muscovite, cherty recrystallised quartz-rich lithic grains and minor carbonate. In contrast there are some chips of microsparry carbonate, with minor quartz and fresh to altered micas as well as disseminated fine possible magnetite. It is not clear whether these are part of the Gardiner Sandstone sequence or of supergene origin.
HRB 164: 57-60m  Weathered quartz-biotite-(felspar) schists, some possibly
(732250)  with porphyroblasts, some with magnetite; possible
102500E, 20800N  Blake Beds metasediments (not dolerite).

Field Note: Foliated dolerite: classification; overprinting metamorphism structure,
foliation?

These chips are relatively coarse schists but are metasediments, not dolerites as suggested in
your notes. Some of the chips are simple quartz-biotite schists, with the biotite altered to
clays and leucoxene, whereas others have only 5-15% altered schistose biotite in a
heterogeneous clay-rich matrix. The clays seem to be kaolin and possible illite, with the illite
in bands or lenses, some of which may represent former porphyroblasts but were up to
10 x 2 mm. Some of the chips have minor (4-5%) magnetite and may represent Blake Beds
and there is usually about 20-35% fine recrystallised quartz.
HRB-165, 57-60m (732265) 102500E, 20750N
Foliated amphibolite plus leucocratic weathered possible amphibolites with plagioclase phenocryst and/or disseminated magnetite ± oxidised possible pyrite.

Field Note: Foliated dolerite, as above.

One of these chips is a foliated amphibolite with some slightly larger grains of weakly sericitised plagioclase (to 0.5 mm long) as well as abundant finer recrystallised plagioclase and hornblende, typically 0.1 to 0.3 mm in size. There is about 3% quartz as well as some disseminated opaque oxide (3-4%) and apatite (<1%).

One of the other chips is a weathered much more leucocratic amphibolite, with possibly only 20-25% hornblende, largely altered to clays (?smectite), although there is a band with about 50% clays after amphibole. Plagioclase occurs partly as phenocrysts to 2 mm long and is much more abundant in the recrystallised groundmass than in the more mafic chip. There are also some vein-like lenses of quartz, some of which contain plagioclase laths. This chip has rare probable magnetite grains to about 0.8 mm in diameter as well as 3% disseminated fine opaque oxide. Late-stage cross-cutting veins occur altered to clays and limonite, with a colloform texture.

A third chip is layered on a scale of a few millimetres, and is largely composed of different proportions of plagioclase and clays, possibly after amphibole. There is typically 35-55% plagioclase in the different layers, and there are more abundant disseminated magnetite grains than there are in the previously described chip. Moreover it is possible that some of the limonite in his chips may be after pyrite grains with poikilitic overgrowths.
HRB-169, 15-18m (732293) 102500E, 20500N

Weathered massive biotite-poor granitoid, possibly a tonalite, with no deformation.

Field Note: Pink granite: mineralogy, texture, relationship to Madam Pele Granites

The granite in this sample has lobate to angular aggregates of coarse quartz (to 5 mm grainsize) and totally clay-altered felspar (kaolin-?illite), probably all plagioclase. There is also sericite-leucoxene-altered biotite as relatively small flakes (~1 mm long), which appear to have escaped the expansion and detexturing seen in most weathered granitoids in the Tanami Inlier. There was perhaps 3-4% biotite and about 20-25% quartz, and there is no foliation. An original tonalite is suggested as alkali felspar typically persists into granitoids even more weathered than this sample.
HRB-173, 21-24m Carbonaceous to sericitic to siliceous slates with low-
(732337) temperature hydrothermal vein quartz and largely
colloform limonite: no dolerite, no greywacke.
103500E, 20900N

Field Note: Dolerite + greywacke: classification, mineralogy, metamorphism.

Some of these chips are carbonaceous slates to cherts, brecciated and veined by quartz on a
fine scale, whereas others are quartz-sericite schists passing into areas of vein quartz to a few
millimetres in width. These quartz-sericite schists appear to represent siliceous or silicified
argillites, without carbonaceous matter. There are also chips of heterogeneous vein quartz
with lenses or fragments of sericite schist and stylolitic veins rich in limonite. The quartz
varies from cherty and fine felted prisms to coarser granular to prismatic quartz and appears to
be of low-temperature hydrothermal origin. Patches of colloform limonite (?± manganese
oxides) are common in some of the veins and up to 5 mm long.
HRB-175, 21-24m
(732352)
103500E, 20550N

Fine schistose amphibolite apparently derived from basalt (not necessarily extrusive, however)

Field Note: Foliated dolerite, as above.

These chips represent a schistose fine-grained amphibolite with a grainsize of 0.05 to 0.2 mm, and about 55% hornblende. The opaque oxide grains are very small and of low abundance (<<1%). There are rare possible plagioclase phenocrysts to 1 mm long, and rare lenses rich in plagioclase, with minor quartz, to 4 mm wide, parallel to the schistosity.
HRB-215, 4-7m Quartz-sericite-(biotite-?ilmenite-?magnetite)-schist
(689669)
103000E, 20775N

Field Note: Foliated quartz-sericite-biotite schist: Madigan Beds?

These chips are contorted fine-grained quartz-sericite schists with quartz grains about 0.2 mm in size, but this is entirely of metamorphic origin. Fine sericite is abundant and in some areas appears to have replaced porphyroblasts such as andalusite. There are also abundant (~7%) fine opaque oxide grains, most of which are elongate and therefore probably ilmenite, but some probable magnetite is also present. Altered possible biotite is present but is less abundant than the sericite (~7-10%).

Lenses of vein quartz occur to 1 mm wide, parallel to the schistosity.
HRB-216 Quartz-epidote-sericite-magnetite metasediments with vein quartz, possibly altered Blake Beds.

Field Note: (None, not listed)

These chips are fine quartz micromosaic rocks with 5-20% intergranular epidote in most areas but with sericite is others. Minor (1-2%) magnetite is disseminated, as grains to 0.1 mm in size, and there are areas of vein quartz, locally with patches of epidote.
HRB-219, 58-61m (689690) Crenulated quartz-sericite schists possibly metasandstone (very fine grained), unlikely to be Madigan Beds.

103000E, 20925N

Field Note: Foliated crenulated sericite-biotite-quartz schist or phyllite: Madigan?

These chips are well-laminated, locally strongly crenulated quartz-sericite schists with quartz-rich lamellae which have a micromosaic texture, but may represent metamorphosed well-sorted, even grained fine to very fine-grained sandstone. The sericitic bands may represent argillites but may have formed by pressure solution from sandstone.

The crenulations vary from open asymmetrical crenulations on fold-limbs to tight symmetrical crenulations in fold hinges, with the compositional layering parallel to the crenulation cleavage.
HRB-220, 58-61m
(689710)
103000E, 20975N

Tremolite-phlogopite rock and variolitic amphibolite, plus quartz-biotite schist (?carbonaceous) and quartz-muscovite schist derived from a bimodal rock (sandstone or acid volcanic), unlike typical Madigan Beds.

Field Note: Sericite-biotite-quartz schist + dolerite: identification, dolerite intrusion's affect on schist?

Some of the chips in this sample appear to represent mafic to possibly ultramafic rocks. These include decussate chips composed essentially of tremolite and minor altered phlogopite (?metapyroxenite) as well as amphibolites with apparently primary variolitic textures. These may represent a layered or zoned mafic-ultramafic body. The amphibolite has minor chlorite and the plagioclase has been totally altered to sericite, and there are patches of apparently low-temperature hydrothermal adularia.

One of the metasediments is an apparently carbonaceous fine quartz-biotite schist which is similar to Davidson Beds. The rest are quartz-sericite schists with scattered large single crystal quartz grains to 0.8 mm long, in a recrystallised matrix. These schists also have some limonite, partly as boxworks apparently after sulphide. However, apart from rare apatite, these schists are distinctly lacking in heavy minerals compared with typical Madigan Beds, which always have either tourmaline or zircon or both (mostly tourmaline). It is indeed possible that this schist represents a sheared altered quartz-porphyritic acid volcanic rock or dyke.
HRB-223, 10-13m (689735) 103000E, 21075N

Greywacke, typical Madigan Beds with detrital muscovite and rare tourmaline.

Field Note: Greywacke/granite: identification

These chips are typical Madigan Beds with poorly sorted single crystal quartz grains to 1 mm long, as well as detrital muscovite, in a fine, weakly metamorphosed quartz-sericite-limonite matrix. There are some polycrystalline quartz grains, but tourmaline is rare and fine-grained. This sample is quite different from the quartz-sericite schist in the previous sample, however. The abundance of limonite makes reconstruction of the matrix mineralogy difficult.
HRB-230, 12-15m (689749) 103000E, 20575N

Biotite adamellite with quartz-biotite schists locally flooded by (?manganese) oxides, and apparently porphyritic micromonzodiorite.

Field Note: Dark grey dolerite + pale pink granite: contact metamorphism of dolerite? classification of both rock types; textures and fabrics?

Some of the chips in this sample are inequigranular granitoids as indicated in your notes, and some appear to represent variously quartz to biotite-rich schists, typically with large areas flooded by opaque oxide, possibly manganese oxide (?± limonite) but there are no doleritic chips in this sample.

The granite has a mineralogy appropriate for a massive adamellite, with minor biotite altered to clays, and a grainsize of 0.5 to 4 mm. The plagioclase has been totally altered but the alkali felspar is fresh. The quartz occurs as ragged grains but there is no foliation evident in the granite.

The schists appear to represent siltstones to very fine sandstones and have been in some instances cut parallel to the schistosity.

A single chip dominated by totally clay-altered plagioclase, with 15% alkali felspar, 5% quartz and 3% altered biotite is present, with a grainsize of about 0.4 to 2 mm. There are suggestions of plagioclase phenocrysts in this chip, which may represent a quartz micromonzodiorite.
HRB-234, 37-40m (689782) 104000E, 20750N

Schistose amphibolite with quartz-rich to quartzofelspathic veins and segregations, and quartz-sericite-biotite-magnetite schists, possibly Blake Beds; late veins of epidote-prehnite (amphibolite) or adularia to sericite-chlorite (sediments).


There are two lithologies on this sample, each represented within a separate thin section. One of the thin sections has a well-foliated amphibolite, which has only rare opaque oxide and no sulphide, whereas the other has metasediments rich in finely disseminated magnetite, as in Blake Beds, but apparently no sulphides.

The amphibolite (Section B) has abundant schistose hornblende to 0.5 mm long, but is poor in disseminated plagioclase (30-35%). However there are abundant layer-parallel quartz veins and quartzofelspathic segregations, including quartz-plagioclase lenses to 3 mm wide with minor coarse sphene and apatite. Oxides adjacent to some of these veins are rimmed by sphene and it seems likely that the only opaque oxide in this lithology is ilmenite. Veins of prehnite + epidote occur cutting across the schistosity.

The metasediments (Section A) are banded on a scale of 0.5 to 3 mm, with various proportions of quartz, sericite (possibly partly after plagioclase), altered biotite and 5-10% finely disseminated magnetite. Patches of apparently leucoxene-like material are also abundant but are quite irregular and diffuse. Veins of adularia and chlorite-sericite veins occur in these metasediments.
HRB-235, 34-37m (89796) 104000E, 20700N

Schistose amphibolite with abundant probable ilmenite, passing into an area with layer-parallel plagioclase-rich veins or segregations and disseminated finely recrystallised sphene; some quartz, sericite, epidote and limonite after pyrite in the veins.

Field Note: Foliated + sheared dolerite with quartz veining: hornfelsed? Mineralogical, textural history? Vein mineralogy and deformation?

This is a very similar amphibolite to that in HRB-234, with more abundant oxides (2%) in areas of the rock without layer-parallel veins, but with <1% oxide in areas with layer-parallel veins. There is possibly only 30% plagioclase especially in the oxide-rich areas, which are dominated by hornblende needles to 0.5 mm long. The oxide is apparently ilmenite and in the areas with veins is replaced by lamellae of very fine granular sphene (2-3%), locally with cores of probable ilmenite.

The veins or segregations are lensoidal and up to 4 mm wide. They are mostly plagioclase, with some diffuse coarser sericitised areas and abundant clear finely recrystallised areas. Some schistose hornblende is present, but quartz is rare except in the narrower veins. Some of the more heavily sericitised areas have minor epidote and limonite, possibly after pyrite.
HRB-237, 9-12m Fine grained leucogranite and quartz-epidote altered
(698801) probable metasediment, plus vein quartz.
104000E, 20500N

Field Note: Pink granite + massive dolerite + smoky to clear quartz -contact: classification,
mineralisation, texture? Mineralogical/deformational history?

There are several chips of leucocratic, inequigranular granitoid in this sample, with grains from
0.2 to 1.5 mm in size. There is about 35% quartz, 45% microcline, 20% plagioclase and very
minor muscovite, indicating a (syeno)granite transitional to adamellite. Traces of leucoxene
and oxidised possible magnetite occur in the granite.

There is also a chip of quartz-epidote rock as in one of the previous samples, with a grainsize
of about 0.1 mm but with about 60% epidote and very minor altered biotite, as well as some
limonite apparently after poikilitic grains of possible pyrite. This is probably a metamorphosed
altered sediment, possibly a former siltstone.

A chip of vein quartz is also present, composed of ragged quartz grains to 10 mm long.
HRB-241 (689806) 104000E, 21000N
Sericite-(quartz) schist and quartz-muscovite schists derived from claystone to sandstone, locally with minor tourmaline; some possibility of being Madigan Beds, but not definite.

Field Note: Foliated sericite, muscovite schist

One of the chips in this sample is essentially a sericite schist with 3% disseminated fine metamorphic quartz and rare lenses partly altered to fine decussate illite or sericite. The others have subequal amounts of fine schistose muscovite and quartz, but with some areas having up to 65% quartz and a grain size of about 0.1 mm. There is locally minor tourmaline in these schists, to 0.1 mm grainsize, and some limonitised flakes which may have been biotite. In one of the chips there are scattered quartz grains to 0.75 mm in size in a finer matrix.
210932 Weathered kaolin-limonite-quartz-leucoxene aggregate
584513E, 7710406N possibly derived from an amphibolite, with quartz veins.

Field Note: Foliated dolerite: texture, mineralogy, deformation related to metamorphism?
Contact metamorphism? (related to granite emplacement?).

Kaolin, limonite, quartz and perhaps some illite occur in this thoroughly weathered rock.
There is sufficient fine leucoxene (3%) to suggest a former mafic composition, but the amount
of very fine metamorphic quartz, though difficult to estimate, seems to be too high (at about
15%) for a normal amphibolite. Some quartz is also present in veins, some parallel to the
schistosity and boudinaged, with lenses to 1 mm wide, some very narrow and cross-cutting,
but much is disseminated, as grains 10 - 100 μm in diameter.
210934  Recrystallised probable vein quartz with a strong fabric
584439E, 7710358N and later colloform patches of opal, possible manganese
oxides and pyrite ± marcasite.

Field Note: Recrystallised quartz/chert? with Mn oxide staining: identification/
classification, mineralogy (dark minerals).

Much of this sample is composed of elongate recrystallised relatively small quartz grains with
a quartz fabric such that the c-axes are parallel to the elongation of the grains. Minor
components include black grains which are possibly manganese oxide, but would need a
polished thin section or polished offcut for identification. These are commonly rimmed by
what appears to be microcrystalline possible pyrite or marcasite, and similar loops and whorls
of possible pyrite or marcasite, locally altered to limonite, are common throughout. There are
also rare patches of colloform opal.
210937  Weathered biotite adamellite gneiss with minor sphene
584760E, 7710062N and magnetite.

Field Note:  Foliated granite:  texture, mineralogy, relationship to Madam Pele Granite?

This sample is composed of clays, limonite and about 30-35% residual quartz. It was a
foliated granite or granitic gneiss with a grainsize of 0.5 to 5 mm. Textures in the clays
suggest that there were two types of felspar, in subequal amounts, as well as some 5% biotite
and accessory coarse sphene (now leucoxene). Minor magnetite (<1%) is also present.

One of the felspars is altered to relatively coarse decussate kaolin (= illite), whereas the other
is altered to dense fine clays flooded by limonite. The altered biotite has lamellar limonite-
leucoxene intergrowths.
APPENDIX 3

Profiled Results of Hyatt Ground Magnetic Survey
HYATT LINE: 103200 East 18-8-95
Ground Magnetics - hyt132.slk
HYATT LINE: 103400 East 16-8-95
Ground Magnetics - hyt134.slk
HYATT LINE: 103800 East 16-8-95
Ground Magnetics - hyt138.slk

TMI nT

Metres (North)