Summary Report
1985 Exploration Programme
Coronation Hill Joint Venture

Text and Appendices 1, 3 and 4

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December 1985
SUMMARY

The objectives of the Coronation Hill Joint Venture (CHJV) in continuing exploration at the Coronation Hill prospect, and other prospects in the South Alligator River Valley, have been met.

This document reports on only the surface and underground mapping and sampling programme, and the drill-hole geological and geophysical logging, sampling and analysis results.

Exploration to date has significantly upgraded the prospect.
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1. **INTRODUCTION**

The 1985 exploration programme carried out by BHP as operators for the Coronation Hill Joint Venture (CHJV) was defined by resolutions passed at a meeting in Brisbane 9th July 1985. The programme was implemented in two phases, Phase I July to September and Phase II October to November. Detailed specifications for Phase I were planned at this meeting, however a decision was made to detail Phase II after assessment of Phase I results.

Detailed specifications for Phase II exploration were defined at a CHJV technical meeting, which included a progress report and on-site briefing, held at El Sherana Camp 10th September.

Work on site at Coronation Hill commenced 23rd July and was completed 10th November. Rain hindered work in the last two weeks. Personnel departed Darwin 16th November on the completion of relogging last year's drill-holes.

A base camp was maintained at the old El Sherana Camp for the duration of the programme. Drill-core, sample rejects, and CHJV equipment is now stored at BHP Exploration offices in Darwin.

1.1 Reporting

This report describes the complete work programme carried out, however reporting on results is confined to surface and underground mapping and sampling, and diamond-drill-hole geological and geophysical logging, and sampling for gold only.

Platinum and palladium results are not discussed as due to a problem of sampling at the laboratory, a full set of results is unavailable.
2. **WORK PROGRAMME**

2.1 **Phase I**

The CHJV resolved to carry out the following work and this work was completed:

Drill-core samples from previous drill-holes were tested to determine geophysical response, in particular I.P. characteristics.

The adit was re-opened, walls were cleaned down, and the adit was mapped.

Two angle holes were drilled on AMG west azimuth to 150m each, located on collar sites east of DDH6 and DDH8. Core was logged and samples were rushed for analysis results.

Drill-holes DDH5, 6, 7, & 8 were deepened in that sequence to 125m. Core was logged and samples were sent for analysis.

Reconnaissance of other prospects was undertaken to a limited extent this period, with the sampling of Scinto VI quarry only.

In addition, the following work was carried out:

The adit was sampled for gold only.

The open pit was mapped and sampled for gold only.

The immediate area of the drilling was mapped and sampled for gold only.

Drill-hole DDHSE1 previously drilled by United Uranium Pty Ltd was logged and sampled.
As a result of the technical meeting, it was resolved to carry out the following work programme which was subsequently implemented:

A grid, 1.0km x 0.75km, pegged and levelled at 40m intervals, was surveyed in on AMG azimuth (see Fig. 2). The grid covered the area of interest at Coronation Hill and was located within the area of granted leases and lease applications. Present and planned drill-hole collars were located. Steel pickets were used to mark selected grid pegs in the prospect area.

Six diamond drill-holes, of nominal length 150m, with 100m of additional discretionary length, for a total of 1000m, were approved. The drill-holes planned were on AMG west azimuth and were at 45° declination. The drill-hole collars were located on plans, from which the drill-hole collars were surveyed. Drilling of these holes commenced 18th September and was completed without delays on 30th October 1985.

Surface mapping was carried out concurrently with the drilling. Mapping of the prospect area was undertaken at 1:500 scale and was complementary to the limited surface mapping, mapping in the adit, and the open pit (see Plate 6). This previous work was presented on an uncontrolled base at the technical meeting.

Mapping of the remainder of the grid excluding the elevated area of capping sandstone, was undertaken at 1:1000.

Sampling of outcrop was carried out in combination with this mapping. Because of the paucity of outcrop it was not possible to sample on a 40m grid and sample density is low.

A ground magnetic survey at 10m stations was conducted over the grid. A radiometric survey involving 2.28 line km of readings at 20m stations was conducted concurrently. Two experimental VLF lines, one east-west (grid) and one north-south (grid) were run with stations at 20m.
Downhole geophysical logging was carried out on all diamond-drill-holes currently drilled in Phase I and Phase II. Gamma, self potential and single point resistance logs were generated.

Regional work in the South Alligator Valley was confined to sampling at Saddle Ridge open cut and at the Coronation Hill South-West Anomaly. Following a visit to the Palette area, maps, plans and sections of the mine, currently stored in Darwin, were assessed, and this data will be compiled separately. Prospecting and sampling of old exploration and mining sites at Sleisbeck, in the Katherine River Valley was also carried out.

3. GEOLOGY

3.1 Surface Geology and Mineralization

Current mapped surface geology is shown on plans at 1:500 scale over the prospect area (see Plates 1-5 inclusive).

Rock types considered most prospective for mineralization, based on drilling, surface sampling and underground sampling to date, include quartz feldspar porphyry, tuffaceous chloritic siltstone and diorite/basic intrusive. To a minor extent debris flow conglomerate appears to be prospective locally in sheared zones.

Surface mapping and sampling has indicated that prospective rock types for mineralization extend west to the base of the capping sandstone cliff, north to the outcrop of the major quartz reef at approximately 8496800 N, east to approximately 241200 E and south to approximately 8496280 N. Of these boundaries none is precise, the limiting factor being lack of outcrop in three directions, east, north and south and the hill to the west.

The boundary to the west, the contact between barren capping sandstone and potentially prospective rock units, is partially obscured by scree and in one area between 8496360N and 8496400N, a landslide, extending some 220m east from the base of the cliff, has been mapped.
These surface conditions limit the use of rock-chip geochemistry to establish the gold potential along the boundary. The closest surface rock-chip sampling is in the open cut, some 40m to the north-east of the sandstone cliff. Mapping indicates that the capping sandstone overlies purple pyroclastics and dips to the west at 30°-45°. The capping sandstone is interpreted as sandstone of the Kombolgie Formation and the contact is interpreted as an unconformity. One drill-hole, DDH3, has penetrated rocks beneath the capping sandstone at depth. The bottom 30m of DDH3 intersected clastic haematitic breccia (sandstone).

The sandstone hill is a formidable barrier to surface development westward, particularly if ore is discovered adjacent to or beneath the capping sandstone.

The northern boundary of gold mineralization appears to be the major quartz reef at approximately 8496800 N. This reef appears to be an infilling of a major extensional fault, the width of the quartz extending to a maximum of 20m. The eastern extent of the quartz reef in outcrop is the road at 241160E. Rock units prospective for gold mineralization have been mapped to the south of the quartz reef but have not been observed to the north. Outcrop, however, is absent for 120m north. The limited prospect rock-chip geochemistry indicates 0.241 and 0.490ppm Au values over 5m samples within 20m south of the quartz reef. Of five samples selected across the quartz reef, four samples were below 0.060ppm Au, however, one sample carried 0.201 (0.131)ppm Au. Absence of outcrop to the north of the quartz reef precluded rock-chip sampling in that area. The quartz reef is known to host uranium and gold mineralization below surface (pers com J. Fisher).

The eastern boundary of gold mineralization is approximately 241200 E. This limit has been established by two rock-chip samples, 0.060 (0.045)ppm Au at 8496640 N, 241190 E and 0.124 (0.143)ppm Au at 8496600 N, 241180 E. Minimal outcrop in the vicinity of this boundary has limited rock-chip sampling sites, and therefore the reliability of the boundary. Sample results in the regional programme to the east of the boundary were invariably less than the limit of detection (less than 0.005ppm Au) and will be presented in a later report.
The southern boundary of gold mineralization is extremely poorly defined by rock-chip sampling. The most southerly drilling intersecting good gold mineralization, is on transect 496500 N (DDH11 and 12). Although DDHSE1 was collared at 8496447.7N, the top 70m of the hole were essentially barren. Because of the limitation of sampling in the drilling area, and the paucity of outcrop outside this area, the location of rock-chip sampling nearest to the drilling is a group of samples, south of 8496330 N and east of 241200 E. These samples were less than 0.005 ppm Au.

It appears likely that a major geological discontinuity exists between these samples sites and the drilled prospect area. At present the southern limit of potential mineralization can be tentatively put at 8496 360N.

3.2 Drilling

3.2.1 Maps and Sections

The location of all drill-holes completed to date by United Uranium Pty Ltd, or the CHJV and its forerunner, are shown on Fig. 6.

East-west cross-sections (Plate 7 to 16 inclusive) show down-hole geology and gold intersections at a cut-off of +1ppm Au over a 2m interval.

Fig. 6 which shows surface and underground rock-chip sample gold results also shows the projection to the horizontal of drill-hole gold results. These projections are generalized gold mineralization zones only and are not intersections at the above cut-offs.
3.2.2 Logging and Sampling

The 1985 programme involved drilling eight angle holes and deepening four of the previous five vertical holes, for an aggregate of 1499.00m. These drill-holes were logged, sampled and analysed according to the 1984 conventions.

Drill-hole DDHSE1, drilled by United uranium in 1964, was also logged and sampled although major core losses were recorded.

Drill-holes DDH3, 4, 5, 6, 7 and 8 were briefly relogged at the end of the programme.

Summary drill-hole logs show geology and gold intersections at a cut-off of +1ppm Au over 2m intervals, and are attached as Appendix I.

Detailed drill-logs are attached separately as Appendix II. Analysis result sheets for some drill-holes do not have platinum, palladium or mercury results as these are unavailable from the laboratory at the time of writing this report.

3.2.3 Petrographic Descriptions

A number of samples from drill-core were sent for petrographic description to confirm rock units, mineralization and alteration logged. Thirteen samples were sent from DDHSE1 to provide detail petrography down-hole because whole core from this drill-hole was sent for analysis and only a limited number of core sections were retained for reference. The current petrographic descriptions are complementary to the previous year's data, and are attached as Appendix III.

3.2.4 Geophysical Logging

Geophysical down-hole logging was carried out on all drill-holes completed or extended in the 1985 programme.

A discussion of this logging is attached as Appendix IV and logs are included.
3.2.5 Drilling Results

Results of the recent drilling have increased the strike length, the width, and the depth of significant gold mineralization on the Coronation Hill prospect.

Gold results and geology are discussed section by section, commencing from the south.

Sections 8496460 N, 8496480 N and 8496500 N

See Plates 7, 8, and 9.

These three sections are dealt with together as DDHSEL, a 55° angle hole on azimuth 055° AMG and collared at 241 026.3E, 8496447.7 N has been projected on all three sections.

Drill-holes DDH11 and DDH12 were angle holes drilled nominally on AMG west azimuth and a declination of 45° on transect 8496 500N during the recent programme.

Down-hole gold intersections at +1ppm Au and 2m cut-off in DDHSEL are difficult to correlate with similar gold intersections in DDH11 and DDH12. Because of very high core loss in the narrow diameter (AX and BX?) core the results of this hole are suspected to be unreliable and to be a minimal indication of gold mineralization.

Results from DDH11 and DDH12 indicate a gold intersection of 50m width, with a near vertical trend, possibly dipping steeply to the west. The intersection of 3.80ppm Au in DDHSEL from 144.82m to 147.26m appears to be in isolation.

Down-hole geology is compatible between the three drill-holes.

The results from these holes gives confidence to stepping out south in the future drilling programme.
Two diamond drill-holes were sited on this transect. Both drill-holes drilled nominally west on AMG azimuth at a declination of 45°. Drill-hole DDH13 was drilled to 150.00m and DDH14 was drilled to 180.00m. Gold intersections at +1ppm Au + 2m cut-off extended over 90m in DDH13 and over 95m in DDH14. A zone of true width of 60m is indicated, and this near vertical zone possibly dips steeply to the west. An intersection of 1.05ppm Au from 10.00m to 12.00m in the top of DDH14 appears in isolation.

Correlation of geology between the two holes is not possible with the present data. The major hosts for mineralization in DDH13 are quartz feldspar porphyry and medium-grained intrusive, whereas in DDH14 the major host is diorite. The medium-grained intrusive may be a fine-grained, contact zone of the diorite. Gold mineralization appears to be localized in a zone which directly cuts across rock unit boundaries. The drill-holes cored only intrusive rocks.

Diamond drill-hole DDH5 drilled 80.00m vertically on this section in the 1984 programme, and was extended to 125.00m in 1985. Gold intersections of +1ppm Au at 2m cut-off occur from the collar of the drill-hole to 124.00m, thus establishing this depth as the minimum depth of the gold zone for this section. Drilling must test to beneath this depth in the future programme.

Gold intersections are hosted by both quartz feldspar porphyry and diorite, and the drill-hole cored only intrusive rocks.
Section 8496620 N

See Plate 12.

Those diamond drill-holes are projected onto this section. The bottom 43m of DDH3, an angle hole drilled from a collar at 241006.8 E and 8496699.5 N is projected at depth on this section. The drill-hole does not carry significant gold mineralization on this section.

Diamond drill-hole DDH6, a vertical hole, was drilled to 80.00m in the 1984 programme and was subsequently deepened to 125.00m in 1985. The drill-hole carries gold intersections over the length of the hole, and is the most spectacular drill-hole for gold mineralization, drilled to date on Coronation Hill prospect. Gold mineralization is hosted in tuffaceous chloritic siltstone and quartz feldspar porphyry.

Diamond drill-hole DDH9 drilled west on AMG azimuth 264.5° and at a declination of nominally 45°, to a depth of 159.50m. Gold intersections of +1ppm Au over 2m cut-off occurred over a 50m length down-hole, and one intersection of 1.31ppm Au occurred in isolation between 112.00m and 114.00m. Gold intersections at +1ppm Au and 2m cut-off are hosted in tuffaceous chloritic siltstones, diorite, and quartz feldspar porphyry.

The geometry of significant gold intersections in DDH6 and DDH9 can be interpreted as a sub-vertical zone of width approximately 40m. This gold zone can reasonably be expected to continue to a depth of +125m.

The gold zone cuts across rock unit boundaries indiscriminately.

Section 8496640 N

See Plate 13.

Two diamond drill holes DDH3 and DDH7 are projected onto this section.
The projected interval of DDH3 is approximately 105m to 147m and does not carry significant gold mineralisation on this section.

Diamond drill-hole DDH7 was drilled to 80.00m vertically in 1984, and was extended to 125.00m in the 1985 programme. Gold intersections of +1ppm Au and 2m cut-off are encountered from the drill-hole collar down-hole to 110.00m; thus these values do not extend the length of the hole. The geometry of the significant gold mineralization can not be interpreted from the section, but the potential westerly extent at depth is limited by the barren interval of DDH3.

Significant gold mineralization in DDH7 is hosted by tuffaceous chloritic siltstone and quartz feldspar porphyry.

Section 8496670 N

See Plate 14.

Three diamond drill-holes are located on this section, the projected interval of DDH3 from approximately 30m to 105m, DDH8 and DDH10.

The projected interval of DDH3 carries gold intersections of +1ppm Au at 2m cut-off from above the interval (30m) down to 100m. These intersections occur in quartz feldspar porphyry and tuffaceous chloritic siltstone.

Diamond drill-hole DDH8 was drilled to 80.00m vertically in the 1984 programme, and was extended in the 1985 programme to 125.00m. Gold intersections of +1ppm Au at 2m cut-off extend from 8m to 70m and are hosted by both tuffaceous chloritic siltstone and quartz feldspar porphyry.

Diamond drill-hole DDH10 drilled west on AMG azimuth 266.5°, at a declination of nominally 45° to a depth of 160.00m. Gold intersections of +1ppm Au at 2m cut-off extend from 30m to 142m down-hole, indicative of a possible true width of approximately 80m. Gold intersections are hosted mainly in tuffaceous chloritic siltstone and quartz feldspar porphyry, however the two deepest intersections, 118.00m to 122.00m at 1.32ppm Au, and 132.00m to 142.00m at 1.87ppm Au, occurred in debris flow conglomerate.
Geometry of gold intersections in drill-holes DDH8 and DDH10 appears to indicate the easterly margin of a body of significant gold mineralization, dipping steeply west. It is possible to interpret gold intersections in drill-hole DDH3 and DDH10 as the westerly margin of the body dipping similarly.

Gold intersections cut across rock boundaries generally.

Section 8496700 N

See Plate 15.

Two diamond drill-holes DDH3 and DDH4 are projected onto this section.

The projected interval of drill-hole DDH3 extends from the collar to approximately 30m down-hole. Gold intersections of +1ppm Au at 2m cut-off extend from 4.90m through to +30m on the adjacent southerly section. The gold intersections are hosted primarily in quartz feldspar porphyry and to a lesser extent in tuffaceous chloritic siltstone.

Diamond drill-hole DDH4 was drilled vertically to 80.00m in the 1984 programme, and because of lack of significant gold intersections at depth, was not extended in the 1985 programme. One gold intersection of +1ppm Au at 2m cut-off occurred down-hole, from 10.00m to 16.00m at 6.27ppm Au. This intersection was hosted by quartz feldspar porphyry and tuffaceous chloritic siltstone.

The fact that only the top of drill-hole DDH4 is mineralized would appear to put a limit of mineralization on this section to the east, however anomalous surface gold sampling exists in this direction. Previous wagon-drill-hole data indicates a body of gold mineralization extending from drill-hole DDH4 west through to the open pit.
Section 8496730 N

See Plate 16.

Two diamond drill-holes were sited on this transect. Both drill-holes drilled nominally west on AMG azimuth at a declination of 45°. Drill-hole DDH15 was drilled to 190.00m and DDH16 was drilled to 179.50m in what was thought to be prospective host rocks, matrix breccia (a breccia of altered quartz feldspar porphyry fragments in altered but varying matrix), and carbonaceous siltstone, shale and chert interpreted to be of the Koolpin Formation. Quartz feldspar porphyry is the major host rock on the prospect and the Koolpin Formation is the host rock for a mineralization at Rock-hole and the El Sherana mines.

The only significant intersection was 1.87ppm Au from 146.00m to 148.00m in DDH15.

Apart from the top 30m in each hole in which geology could be predicted from surface mapping, the down-hole geology was unexpected, none of the rock-types having local surface exposure. Despite surface sampling in the vicinity of the drill-collars providing results of up to approximately 0.5ppm Au over 5m samples, these values were not translated into near surface drill-hole values of +1ppm Au; the near surface drill-hole results being less than 0.03ppm Au.

The gold results in both DDH15 and DDH16 indicate a major discontinuity of gold mineralization between these holes and the next nearest successful drill-hole, DDH3.

Surface geology and sampling for gold, and also previous wagon drill-hole results, however, do indicate a block of +1ppm Au ground west of DDH4 through to the open pit.

In view of this situation additional drilling is warranted in the area.
4. CONCLUSIONS

The exploration programme carried out at Coronation Hill in the 1985 field season, achieved the objectives set down by the CHJV at the meeting on 9th July, 1985 and the subsequent technical meeting of 10th September 1985.

The results of the programme of work for 1985 have significantly upgraded the potential of Coronation Hill prospect.

Significant gold mineralization remains to be closed off to the south, and the eastern and western limit more closely defined. Surface gold values to the east of the presently drilled area remain to be tested. Two drill-holes appear to close-off mineralization to the north, however, down-hole results do not relate to surface gold values. Additional drilling is required to establish this possible boundary.

Drilling has yet to define the vertical extent of gold mineralization.

High gold intersections continue to carry anomalously high platinum and palladium in results received to date.
5. **ACKNOWLEDGEMENTS**

The following technical personnel, in addition to the writers, were associated with the project: I.C. Diemar, J. Palmer, D.G. Price, C.A. Towsey and D.G. Wood.
APPENDIX 1

Summary Drill-hole Logs
SUMMARY LOG - GEOLOGY

CH DDH SE1

metres

0-3.37  No core.  N.C.

3.37-9.00  Quartz feldspar porphyry (rhyolite)  QFP

9.00-12.10  Medium grained basic intrusive.  Di

12.10-15.55  Quartz feldspar porphyry (rhyolite).  QFP

15.55-18.00  Medium grained basic intrusive.  Di

18.00-150.61  Quartz feldspar porphyry (rhyolite).  QFP

E.O.H.

*intervals are metric conversions from feet.*

J.F. LECKIE
29.11.85
SUMMARY LOG - GEOLOGY

CH DDH3
metres

0-1.95 Site fill ✗
1.95-4.90 Tuffaceous chloritic siltstone TCS
4.90-21.30 Quartz feldspar porphyry QFP
21.30-37.00 Tuffaceous chloritic siltstone
37.00-40.20 Quartz feldspar porphyry
40.20-41.10 Tuffaceous chloritic siltstone
41.10-43.00 Quartz feldspar porphyry
43.00-43.80 Tuffaceous chloritic siltstone
43.80-46.90 Quartz feldspar porphyry
46.90-82.20 Tuffaceous chloritic siltstone
82.20-84.60 Breccia at tuffaceous chloritic siltstone and quartz feldspar porphyry ✗
84.60-90.55 Quartz feldspar porphyry
90.55-95.10 Tuffaceous chloritic siltstone
95.10-103.80 Quartz feldspar porphyry
103.80-105.75 Matrix breccia (quartz feldspar porphyry fragments) ✗
105.75-123.00 Debris flow conglomerate (?) ✗
123.00-140.75 Matrix breccia (Quartz feldspar porphyry fragments) ✗
140.75-153.00 Tuffaceous chloritic siltstone
153.00-157.90 Quartz feldspar porphyry
157.90-170.30 Tuffaceous chloritic siltstone
170.30-200.70 Sandstone SST

E.O.H.

A.A. DURBIN
3/12/85
SUMMARY LOG - GEOLOGY

CH DDH4
metres

0.20  Site fill
2.20-6.00  Tuffaceous chloritic siltstone
6.00-14.50  Quartz feldspar porphyry
14.50-61.00  Tuffaceous chloritic siltstone
61.00-69.60  Quartz feldspar porphyry
69.60-80.00  Tuffaceous chloritic siltstone

E.O.H.

A.A. DURBIN
3/12/85
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E.O.H.

A.A. DURBIN
3/12/85
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E.O.H.
SUMMARY LOG - GEOLOGY

CH DDH7
metres

0-2.40 Site fill
2.40-13.70 Quartz feldspar porphyry
13.70-14.60 Tuffaceous chloritic siltstone
14.60-15.70 Quartz feldspar porphyry
15.70-17.75 Tuffaceous chloritic siltstone
17.75-39.40 Quartz feldspar porphyry
39.40-52.25 Tuffaceous chloritic siltstone
52.25-53.35 Quartz feldspar porphyry
53.35-55.10 Tuffaceous chloritic siltstone
55.10-56.50 Quartz feldspar porphyry
56.50-58.40 Tuffaceous chloritic siltstone
58.40-60.10 Quartz feldspar porphyry
60.10-70.10 Tuffaceous chloritic siltstone
70.10-71.30 Quartz feldspar porphyry
71.30-73.80 Tuffaceous chloritic siltstone
73.80-75.10 Quartz feldspar porphyry
75.10-85.40 Tuffaceous chloritic siltstone
85.40-94.90 Quartz feldspar porphyry
94.90-97.85 Tuffaceous chloritic siltstone
97.85-99.50 Quartz feldspar porphyry
99.50-125.00 Tuffaceous chloritic siltstone

E.O.H.

A.A. DURBIN
3/12/85
SUMMARY LOG - GEOLOGY

CH DDH8
metres

0-2.60 Site fill
2.60-14.50 Tuffaceous chloritic siltstone
14.50-39.00 Quartz feldspar porphyry
39.00-48.00 Tuffaceous chloritic siltstone
48.00-69.50 Quartz feldspar porphyry
69.50-125.00 Tuffaceous chloritic siltstone

E.O.H.
SUMMARY LOG - GEOLOGY

CH DDH9 metres

0-2.40 Site fill
2.40-37.95 Tuffaceous chloritic siltstone
37.95-39.30 Quartz feldspar porphyry
39.30-41.65 Tuffaceous chloritic siltstone
41.65-46.20 Quartz feldspar porphyry
46.20-54.10 Tuffaceous chloritic siltstone
54.10-56.55 Medium grained basic intrusive
56.55-58.10 Basic volcanic BAS
58.10-63.60 Diorite
63.60-65.75 Quartz feldspar porphyry
65.75-69.70 Diorite
69.70-84.60 Quartz feldspar porphyry
84.60-88.75 Diorite
88.75-104.60 Quartz feldspar porphyry
104.60-112.60 Diorite
112.60-139.00 Quartz feldspar porphyry
139.00-148.90 Pale pyroclastic PT
148.90-150.00 Quartz feldspar porphyry
150.00-159.50 Pale pyroclastic PT

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A.A. DURBIN
3/12/85
CH DDH10
metres

0-1.50  Site fill
1.50-29.85  Tuffaceous chloritic siltstone
29.85-45.70  Quartz feldspar porphyry
45.70-54.00  Tuffaceous chloritic siltstone
54.00-60.60  Quartz feldspar porphyry
60.60-61.50  Tuffaceous chloritic siltstone
61.50-63.75  Quartz feldspar porphyry
63.75-118.30  Tuffaceous chloritic siltstone
118.30-122.70  Debris flow conglomerate X A
122.70-129.70  Quartz feldspar porphyry
129.70-142.50  Debris flow conglomerate X A
142.50-160.00  Quartz feldspar porphyry

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A.A. DURBIN  
3/12/85
SUMMARY LOG - GEOLOGY

CH DDH 11
metres

0-2.00 Site fill

2.00-150.00 Quartz feldspar porphyry

E.O.H.

A.A. DURBIN
29.11.85
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E.O.H.

A.A. DURBIN
29/11/85
SUMMARY LOG - GEOLOGY

CH DDH13
metres

0-2.10       Site fill
2.10-20.20   Quartz feldspar porphyry
20.20-21.60  Diorite
21.60-71.00  Quartz feldspar porphyry
71.00-71.50  Quartz feldspar porphyry/medium grained basic intrusive
71.50-74.85  Medium grained basic intrusive
74.85-81.00  Quartz feldspar porphyry
81.00-97.40  Medium grained basic intrusive
97.40-99.30  Quartz feldspar porphyry
99.30-109.50 Medium grained basic intrusive
109.50-150.00 Quartz feldspar porphyry

E.O.H.

A.A. DURBIN
29/11/85
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E.O.H.
SUMMARY LOG - GEOLOGY

CH DDH15 metres

0-3.30 Site fill
3.30-30.15 Medium grained basic intrusive
30.15-36.90 Quartz feldspar porphyry
36.90-50.60 Carbonaceous silstone - shale and chert CSH
50.60-52.05 Quartz feldspar porphyry
52.05-55.50 Tuffaceous chloritic siltstone TCS
55.50-63.10 Carbonaceous shale and chert CSH
63.10-64.00 Siltstone/carbonaceous shale/grey limestone (?) CL
64.00-65.95 Quartz feldspar porphyry
65.95-66.90 Acid lithic tuff AT
66.90-78.70 Matrix breccia. (Quartz feldspar porphyry XB fragments)
78.70-85.30 Conglomerate CGL
85.30-86.90 Acid lithic tuff (?) AT
86.90-96.60 Matrix breccia (Quartz feldspar porphyry fragments) XB
96.60-98.00 Conglomerate CGL
98.00-106.90 Matrix breccia (Quartz feldspar fragments) XB
106.90-108.80 Conglomerate CGL
108.80-130.10 Matrix breccia (Quartz feldspar porphyry fragments) XB
130.10-135.10  Carbonaceous shale and chert brecciated \textit{XCS}
135.10-141.70  Conglomerate \textit{CSL}
141.70-145.50  Carbonaceous shale and chert brecciated \textit{XCS}
145.50-147.7  Quartz feldspar porphyry \textit{QFP}
147.7-150.55  Carbonaceous shale and chert brecciated \textit{XCS}
150.55-158.50  Chlorite siltstone \textit{CSL}
158.50-179.65  Carbonaceous shale and chert brecciated \textit{XCS}
179.65-190.00  Sandstone \textit{SSH}

E.O.H.

A.A. DURBIN
29.11.85
SUMMARY LOG - GEOLOGY

CH DDH16 metres

0-2.50  Site fill
2.50-5.15 Quartz feldspar porphyry
5.15-28.20 Tuffaceous chloritic siltstone TCS
28.20-38.80 Carbonaceous siltstone CSH
38.80-42.50 Carbonaceous siltstone interbedded with white chert CSH bands
42.50-57.65 Microdiorite DI
57.65-60.80 Quartz feldspar porphyry/microdiorite •
60.80-74.65 Acid lithic tuff/microdiorite AT
74.65-93.90 Carbonaceous shale CSH
93.90-104.95 Matrix breccia (quartz feldspar porphyry) fragments XB
104.95-111.85 Basalt breccia XA
111.85-120.25 Conglomerate CGL
120.25-141.50 Tuffaceous chloritic siltstone brecciated XTC5
141.50-148.50 Conglomerate CGL
148.50-152.40 Quartz feldspar porphyry QFP
152.40-157.10 Volcanic breccia XV
157.10-167.00 Matrix breccia (quartz feldspar porphyry) fragments XB
167.00-179.50 Conglomerate CGL

E.O.H. J.F. Leckie
29.11.85
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<td>No values greater than 0.5 g/T gold.</td>
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</table>

J.F. Leckie
A.A. Durbin
12 December, 1985
APPENDIX 3

Petrographic Descriptions
The sample (MRL 17605) has been identified as extremely altered (sericitized) lithic crystal tuff (ignimbritic?).

X-ray diffraction of hand picked waxy greenish fracture coating material has confirmed dominant white mica, probably sericite rather than illite. Also according to XRD, the bulk sample comprises dominant quartz together with sub-dominant sericite.

Microscopic examination shows a relict pyroclastic or fragmental texture with abundant angular to subrounded (some corroded and embayed) strained quartz phenocrysts, together with strongly sericitized angular to subrounded lithic fragments all embedded in an alteration matrix of sericitic mica. The quartz phenocrysts range in grain size from 200-400 μm, where many show recrystallization to aggregate quartz. The relict sericitized fragments range in size from 400 μm to 5.2 mm, where some form stretched elongated patches, possibly representing original fiamme structures which means that this pyroclastic rock may have originally been an ignimbrite. However relict shard structures are absent probably due to extreme sericitization effects.

In reflected light the opaques comprise rutile/leucoxene, hematite and rare pyrite.

The presence of dominant sericite* suggests a phyllic alteration assemblage in this sample.

D.J. Gilbert
Senior Project Petrologist

cc: Mrs. L. Liggins, Library Camberwell, then Dr A. Goode.

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* Footnote: This white mica ranges in grain size from 10-30 μm; it is best described as sericite since true illite should show a typical clay grain size of 2 microns or less.
PETROLOGICAL REPORT ON TWELVE SAMPLES
FROM CORONATION HILL, N.T.

prepared for

BHP COMPANY LIMITED

Order No. : Q97089
Ref : F. Leckie

A. S. Joyce, B.Sc.(Hons), Ph.D.

GENERAL COMMENTS

1. Eleven of the samples are altered, finely porphyritic rhyolite and they can be categorized into two main groups on the basis of their textures.

2. Samples which comprise the largest group (59.45m, 108.23m, 112.50m, 128.0m, 135.70m, 147.50m and 149.50m) display small phenocrysts set in a homogeneous, allotriomorphic, fine groundmass. Some of them have distinct ovoid amygdales and it is considered very likely that all of the samples originated as rhyolitic lava. All have since been heavily to intensely altered and weakly mineralized with sulphide.

The largest and most obvious amygdales, filled mainly with light olive sericite, are seen in samples from 108.23m and 112.50m and they are absent or most poorly developed in the sample from 59.45m.

The most sericitized sample is at 128.0m and the most sulphide impregnated samples are at 112.50m, 128.0m and 147.50m.

3. The four samples which comprise the second group (12.80m, 36.50m, 95.50m and 131.0m) have more variable appearances with coarser recrystallization. Two are flow banded and mottled, another is mottled and the fourth displays micrographic recrystallization.

It is probable that all originated as finely porphyritic rhyolite similar or identical in composition to the main group of samples, but perhaps they are the tops or bottoms of flows.

Like the common style of rhyolite all feature heavy sericitization but three samples (12.80m, 95.50m and 131.0m) are also silicified. The upper two samples carry no sulphide but a weak, distinctive hematitic pigmentation. The deeper sample (95.50m) carries traces of pigmentation and rare grains of sulphide. The deepest sample (131.0m) carries about 0.5-1% sulphide and inconspicuous pigmentation.

4. It seems that the main group of samples shows a progressive colour change with increasing depth (from moderate orange pink to pale orange to yellowish grey) and that this is paralleled by an increase in sulphide abundance. Much of the sulphide seems to be pyrite with a dull lustre. The second group of banded/mottled/coarsened samples shows a similar change in colour with increasing depth and an even more distinct variation from no sulphide to rare sulphide to significant sulphide. A difference from the common rhyolite is the addition of silicification.

Thus, it may be fruitful to speculate that initial alteration involved heavy pervasive sericitization along with development of fine sulphide and that subsequently there was modification by oxygenated, siliceous fluids working downwards into the pile, destroying pyrite, producing hematitic pigmentation and some silicification.
The observation that the most profound silicification, distinct hematitic pigmentation and lack of sulphide is encountered in several of the banded/mottled/coarsened samples might be explained by greater permeability along flow-banded zones which may be flow tops or bottoms.

5. The twelfth sample (16.16m) is intensely argillized and chloritized, moderately sericitized and silicified diorite or dolerite. It is too altered to allow determination of whether it was intermediate or basic.
Sample Number: CH DDH SE 12.80m

Identification: Completely silicified and sericitized porphyritic, flow-banded rhyolite

Description:

The sample is a drill core specimen with mottled banding in moderate orange pink and light olive. The crude bands are about 2 to 5mm thick. There are inconspicuous small phenocrysts of very light grey quartz. A quartz vein several mm wide is present on one end of the core.

A cobaltinitrite staining test produced some diffuse staining by reaction with sericite.

In thin section the sample displays subhedral, smoothly corroded phenocrysts of quartz, about 0.3 to 2mm in size. There are also quite distinct smoothly corroded tabular phenocrysts which were feldspar, but are now cherty aggregates of fine quartz. The mottled, banded groundmass consists of anhedral, sutured quartz and very fine-grained sericite. The quartz shows mottled variations in grainsize from about 0.05 to 0.3mm and it is all very finely pigmented with hematite. There are also a few 0.03mm aggregates of earthy hematite which may have developed from disseminated sulphide, but if so the textural evidence is not clear. Leucoxene forms a few small tabular aggregates.

Concordant and discordant fissure veins (0.1 to several millimetre wide) carry strained quartz, some as coarse as 1.5mm.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3%</td>
<td>quartz phenocrysts</td>
</tr>
<tr>
<td>2-3%</td>
<td>quartz pseudomorphs of feldspar phenocrysts</td>
</tr>
<tr>
<td>50-60%</td>
<td>fine quartz, pigmented by very fine hematite</td>
</tr>
<tr>
<td>35-45%</td>
<td>fine sericite</td>
</tr>
<tr>
<td>0.2-0.3%</td>
<td>tiny aggregates of earthy hematite</td>
</tr>
<tr>
<td>rare</td>
<td>leucoxene</td>
</tr>
<tr>
<td>0.5-1%</td>
<td>vein quartz</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This sample is interpreted to represent coarsely flow banded porphyritic rhyolite lava which has undergone intense silicification and sericitization, resulting in the destruction of all feldspar. There are also some late quartz fissure veins.

Much of the sample has an orange pink colour, resembling feldspar, but the colour is attributable to very finely hematite-pigmented quartz; it seems likely that the colour developed during silicificatio rather than during more recent weathering. Tiny specks of coarser hematite are of uncertain origin; they might reflect disseminated sulphide oxidized during silicification, but there is no sound textural evidence.
Sample Number: CH DDH SE 16.16m

Identification: Intensely argillized and chloritized, moderately sericitized and silicified diorite or dolerite

Description:

The sample is a drill core specimen of fine to medium-grained, dark greenish grey, intensely altered rock.

A cobaltinitrite staining test produced some diffuse discolouration and revealed several possible grains of K-feldspar.

In thin section the sample is seen to be completely altered and primary textures are only poorly preserved: they seem to indicate a medium-grained, crystalline igneous rock with grainsizes mainly of about 1 to 3 mm. Grains which have prismatic shapes suggestive of pyroxene have been replaced by chlorite which is almost colourless in section, along with relatively coarse quartz in a few cases. Tabular grains of possible plagioclase have been replaced by relatively coarse (?)kaolinitic clay, accompanied in many cases by some sericite. There are a few anhedral cloudy grains, up to 0.5 mm, which seem to be primary orthoclase. Disseminated 0.2 to 0.4 mm grains of inferred ilmenite or titaniferous magnetite are plainly portrayed as lattice aggregates of leucoxenized sphene.

There are several thin replacement veins of quartz and (?)kaolinite.

An approximate mineralogical mode is:

<p>| | |</p>
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<thead>
<tr>
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<th></th>
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</thead>
<tbody>
<tr>
<td>50-60%</td>
<td>(?)kaolinitic clay</td>
</tr>
<tr>
<td>25-35%</td>
<td>chlorite, almost colourless in section</td>
</tr>
<tr>
<td>8-12%</td>
<td>sericite</td>
</tr>
<tr>
<td>2-3%</td>
<td>quartz</td>
</tr>
<tr>
<td>0.4-0.6%</td>
<td>leucoxene-sphene</td>
</tr>
<tr>
<td>0.3-0.5%</td>
<td>orthoclase</td>
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</table>

Comments and Interpretations:

This sample has been intensely hydrothermally altered to clay-chlorite-sericite-leucoxene but its remnant textures indicate that it was probably a medium-grained basic or intermediate rock, perhaps from a dyke or similarly small intrusion. It does not resemble lava, tuff or sediment.

There are no reliable features on which to decide between diorite and dolerite as possible precursors. Quartz has been introduced, but no primary quartz was recognised.
Sample Number : CH DDH SE 36.50m

Identification : Heavily sericitized, porphyritic, flow-banded rhyolite

Description :

The sample is a drill core sample of generally pale red to orange pink, fine-grained rock with finely mottled banding similar to that encountered in recrystallized, flow-banded rhyolite. The thickest band is about 5mm and most bands are less than 1mm and poorly delineated. There are inconspicuous small phenocrysts of quartz.

A staining test revealed that the rock is rich in fine K-feldspar.

In thin section the sample displays many subhedral, smoothly corroded phenocrysts of quartz, up to about 1mm in size. There are also subhedral phenocrysts of orthoclase, up to 2mm in size, heavily altered to sericite. The groundmass has subtle banding and mottled recrystallized and altered textures. It carries anhedral quartz, about 0.1 to 0.5mm in size, commonly with clear cores and rims outlined by earthy hematite or hematite-pigmented fine orthoclase. The quartz and feldspar are enveloped by a major network of very fine-grained sericite. Each "island" of quartz and/or orthoclase is thinly rimmed by earthy hematite.

An approximate mode is :

2-3% quartz phenocrysts
3-4% orthoclase phenocrysts heavily altered to sericite
30-35% groundmass quartz
30-35% groundmass orthoclase
25-30% groundmass sericite
0.3-0.4% very fine hematite pigment

Comments and Interpretations :

This sample is interpreted to represent finely flow-banded porphyritic rhyolite lava which has undergone heavy sericitization to destroy any plagioclase which may have existed along with some of the orthoclase. An earthy hematite pigment seems to have been generated during the sericitization. The rock does not seem to have been silicified. There is no indication that sulphides have existed in the rock.
Sample Number : CH DDH SE 59.45m

Identification : Porphyritic rhyolite with heavy sericitization and some hydrothermal carbonate, dumortierite (or tourmaline) and sulphide

Description :

The sample is a drill core specimen of moderate orange pink, fine grained rock with sparse small phenocrysts of quartz and yellowish grey altered feldspar.

A cobaltinitrite staining test revealed that the groundmass is dominantly K-feldspar and that traces of K-feldspar persist in the altered phenocrysts.

In thin section the sample displays a simple porphyritic texture. Subhedral, smoothly embayed quartz phenocrysts are about 0.2 to 2mm. Former feldspar phenocrysts have been pseudomorphed by sericite and carbonate: some have remnants of former orthoclase. Possible biotite phenocrysts are represented by thin tabular aggregates of sericite with incipiently oxidized fine sulphide. The groundmass consists of anhedral quartz and orthoclase, about 0.03 to 0.05mm in grain size, and minor sericite, probably after plagioclase.

Some fine sericite occurs in a subtle pattern of veinlets and small patches. In several sericite patches there are tiny radial aggregates (0.1 to 0.2mm) of colourless dumortierite (or possibly tourmaline).

An approximate mode is :

- 2-3% quartz phenocrysts
- 3-4% sericite-calcite pseudomorphs of feldspar phenocrysts, some with remnant orthoclase
- rare sericite-sulphide pseudomorphs of inferred biotite phenocrysts
- 30-40% groundmass quartz
- 45-55% groundmass orthoclase
- 8-12% groundmass sericite
- 2-3% sericite in veinlets and patches
- tr dumortierite in sericitic patches

Comments and Interpretations :

This rock is considered to have originated as porphyritic rhyolite. It was probably of extrusive origin. It has experienced hydrothermal alteration involving subtle veining by sericite, complete sericitization of inferred plagioclase and biotite and intense alteration of feldspar phenocrysts to sericite and calcite. Colourless dumortierite or tourmaline is a trace hydrothermal mineral and there are rare aggregates of fine sulphide in altered mica phenocrysts.
Sample Number :  CH DDH SE 95.50m
Identification :  Completely silicified and sericitized porphyritic rhyolite
Description :

The sample is a drill core specimen of fine-grained rock mottled in light olive and subordinate pinkish grey. There are inconspicuous small phenocrysts of very light grey quartz.

A cobaltinitrite staining test produced some diffuse discolouration but did not demonstrate any K-feldspar.

In thin section the sample displays smoothly corroded subhedral quartz phenocrysts, up to about 1mm, and coarsely cherty, silicified pseudomorphs of subhedral feldspar phenocrysts, up to about 2mm. The groundmass is a mottled and finely replacement-veined mass of quartz and very fine sericite. Most of the quartz has anhedral, sutured shapes, about 0.05 to 0.3mm in size; some grains (?primary) are clear, but most are faintly pigmented with hematite. The sericite is cloudy and forms a network of patches similar in size to the quartz.

Many thin (less than 0.2mm) fissure veins of clear quartz are present as late structures.

There are rare disseminated grains of subhedral and euhedral pyrite, about 0.1mm in size, enclosed in relatively clear (?primary) grains of quartz.

An approximate mode is:

- 2-3% quartz phenocrysts
- 2-3% quartz pseudomorphs of feldspar phenocrysts
- 45-50% groundmass quartz, some clear and most pigmented
- 40-45% groundmass sericite
- rare pyrite
- 0.3-0.5% fissure veins of quartz

Comments and Interpretations :

This sample does not display any obvious flow banding but has undergone a mottled style of recrystallization and intense silification and sericitization comparable to that displayed by the sample at 12.80m. There is little doubt that it was originally rhyolitic lava, but all feldspar has been destroyed. There is very weak hematitic pigmentation of the replacement quartz, but not of later fissure veinlets of quartz.

Rare grains of pyrite are present in clear quartz grains. They may have been protected by primary quartz during the oxidizing stage of the alteration which is inferred from the hematitic pigment accompanying silification of the groundmass.
Sample Number: CH DDH SE 108.23m

Identification: Porphyritic rhyolite with heavy sericitization, some carbonate and amygdales of sericite-quartz-dumortierite-sulphide

Description:

The sample is a drill core specimen of greyish orange, fine-grained rock with a moderate abundance of small, ovoid, light olive aggregates (resembling amygdales) and sparse small phenocrysts of light-grey quartz and yellowish grey, altered feldspar.

A staining test revealed that the groundmass is dominated by K-feldspar and that a few phenocrysts are potassic.

In thin section the sample displays a porphyritic, finely amygdaloidal texture. Subhedral smoothly corroded and embayed quartz phenocrysts are about 0.2 to 1.5mm in size. Inferred subhedral phenocrysts of feldspar have been pseudomorphed by carbonate and minor sericite: a few retain remnants of K-feldspar. The groundmass consists of anhedral quartz and orthoclase, about 0.03 to 0.05mm in grainsize, along with chlorite aggregates of similar size. Ovoid amygdales, about 0.5 to 3mm, are filled mainly with fine sericite but in some cases also carry quartz, tiny radial aggregates of colourless dumortierite (or possibly tourmaline) and sulphide.

Sulphide, about 0.05 to 0.4mm in size, is a very minor component of the rock, occurring in amygdales and in a few altered phenocrysts. Some resembles simple cubic grains of pyrite, but much of it is in tabular aggregates of fine grains.

An approximate mode is:

- 2-3% phenocrysts of quartz
- 3-4% calcite-sericite pseudomorphs of feldspar
- 40-50% groundmass quartz
- 8-12% groundmass orthoclase
- 3-4% groundmass sericite
- 0.2-0.3% sulphide within amygdales and a few altered phenocrysts

Comments and Interpretations:

This rock is considered to have originated as finely vesicular porphyritic rhyolite, probably lava. It is similar in primary textures and alteration style to the sample from 59.45m, except that it carries amygdales of sericite-quartz-dumortierite-sulphide instead of sericitic veining.
Sample Number: CH DDH SE 112.50m

Identification: Porphyritic rhyolite with heavy sericitization, minor carbonate, amygdales of sericite-quartz-dumortierite-pyrite and a cloud of disseminated fine pyrite

Description:

The sample is a drill core specimen of pale orange, fine-grained rock with numerous light olive ovoid spots (resembling amygdales smaller than 3mm) and sparse small phenocrysts of light grey quartz and yellowish grey altered feldspar. About 5cm of the core has a grey colour attributable to disseminated fine sulphide.

A staining test revealed that the groundmass is dominated by K-feldspar and that some phenocrysts are potassic.

In thin section the sample displays a porphyritic, finely amygdaloidal texture. Subhedral, smoothly corroded phenocrysts of quartz are about 0.3 to 2mm in size. Inferred feldspar phenocrysts have been replaced by sericite and subordinate carbonate; some have remnants of orthoclase. Rare biotite is inferred from aggregates of sphene and sericite. The groundmass is anhedral quartz and orthoclase, about 0.03 to 0.05mm in grainsize, with sericite after inferred plagioclase. Ovoid amygdales, about 0.5 to 3mm, are filled with fine sericite accompanied by very minor quartz, radial aggregates of colourless probable dumortierite, and subhedral pyrite. More abundant subhedral pyrite, about 0.03 to 0.1mm, occurs as a cloud of disseminated grains.

An approximate mode is:

2-3% phenocrysts of quartz
2-3% sericite-calcite pseudomorphs of feldspar
  phenocrysts, some with remnant orthoclase
  rare
  sericite-sphene after probable biotite
30-40% groundmass quartz
40-50% groundmass orthoclase
8-12% groundmass sericite
3-5% amygdales of sericite with minor quartz,
  dumortierite and pyrite
tr-4% disseminated pyrite

Comments and Interpretations:

This rock is considered to have originated as finely vesicular porphyritic rhyolite, probably lava. It was quite similar to the rock at 108.23m and experienced similar alteration involving complete sericitization of inferred plagioclase and biotite and intense sericite-carbonate alteration of orthoclase phenocrysts. Vesicles were filled by sericite with minor quartz, dumortierite and pyrite. It differs from the rock at 108.23m in carrying an inhomogeneously distributed cloud of disseminated fine pyrite.
Sample Number: CH DDH SE 128.0m

Identification: Intensely sericitized porphyritic rhyolite with disseminated tabular aggregates of fine sulphide

Description:

The sample is a drill core specimen of pale olive, fine-grained rock with very fine light olive specks and sparse small phenocrysts of very light grey quartz and yellowish grey altered feldspar.

A cobaltinitrite staining test produced a diffuse stain more consistent with reaction with potassic sericite than K-feldspar.

In thin section the sample displays a simple porphyritic texture with one possible, 3mm, irregular amygdale filled with fine sericite. Quartz forms smoothly corroded phenocrysts, about 0.3 to 1mm. Inferred feldspar phenocrysts have been entirely replaced by fine sericite. The groundmass consists of anhedral quartz grains, about 0.04 to 0.05m in grainsize, along with aggregates of sericite of similar size. There are rare grains of sphene.

A sulphide which seems to be pyrite occurs as small tabular aggregates (up to 0.3mm long) of fine grains (0.01 to 0.03mm).

An approximate mode is:

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<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3%</td>
<td>quartz phenocrysts</td>
</tr>
<tr>
<td>3-5%</td>
<td>sericite pseudomorphs of inferred feldspar</td>
</tr>
<tr>
<td>35-40%</td>
<td>groundmass quartz</td>
</tr>
<tr>
<td>50-60%</td>
<td>groundmass sericite</td>
</tr>
<tr>
<td>rare</td>
<td>sphene</td>
</tr>
<tr>
<td>rare</td>
<td>sericite amygdale</td>
</tr>
<tr>
<td>0.5-1%</td>
<td>sulphide, probably pyrite</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This rock is considered to have originated as a porphyritic rhyolite, quite similar to the sample from 59.45m and similar to the samples from 108.23m and 112.50m except for a scarcity of amygdales. Unlike those samples the rock has undergone sufficiently intense sericitization to destroy inferred groundmass K-feldspar as well as the plagioclase.

Fine sulphide in the sample occurs in tabular aggregates of fine grains. Perhaps it is pseudomorphing mica.
Sample Number: CH DDH SE 131.0m

Identification: Silicified, heavily sericitized, coarsely recrystallized porphyritic rhyolite with disseminated tabular aggregates of sulphide.

Description:

The sample is a drill core specimen of finely crystalline, greyish orange pink rock, many fine yellowish grey specks and some larger pale olive specks, up to about 1mm in size. There are sparse, small phenocrysts of quartz.

A staining test revealed that the rock is rich in K-feldspar.

In thin section the sample displays smoothly corroded phenocrysts and altered phenocrysts, up to about 2mm in size, set in a coarsely recrystallized, sutured and micrographic, sericitized groundmass, about 0.2 to 0.5mm in grainsize. The most obvious phenocrysts are quartz. Less obvious phenocrysts were feldspar, now crudely pseudomorphed by sericite-quartz-carbonate. Much of the groundmass is quartz, clouded with an ultra-fine (?)hematite pigment; some quartz is clear and may be of recrystallized primary origin, rather than replacement origin. Fine sericite forms aggregates comparable in size to the quartz grains and it also heavily clouds intergrown K-feldspar.

Minor fine, dull sulphide which resembles pyrite (about 0.01 to 0.02mm) occurs as tabular aggregates (up to about 0.5mm), perhaps after biotite.

An approximate mode is:

- 2-3% quartz phenocrysts
- 1-2% sericite-calcite-quartz pseudomorphs of feldspar phenocrysts
- 35-40% groundmass quartz
- 30-35% groundmass K-feldspar
- 20-30% groundmass sericite
- 0.5-1% sulphide

Comments and Interpretations:

This sample is interpreted to have originated as porphyritic rhyolite, quite possibly lava, but its groundmass has undergone significant coarsening and alteration to a sutured micrographic assemblage of quartz, K-feldspar and sericite. Former feldspar phenocrysts were replaced crudely by sericite-calcite-quartz and the groundmass looks as though it has undergone some pervasive silicification. Sulphide occurs as tabular aggregates of dull, fine grains, possibly after former mica.
Sample Number : CH DDH SE 135.70m
Identification : Porphyritic rhyolite with heavy sericitization, minor carbonate, amygdales of sericite-quartz-sulphide and a late vein of quartz-calcite

Description :

The sample is a drill core specimen of very pale orange, fine-grained rock with many very small light olive specks and sparse small phenocrysts of very light grey quartz and yellowish grey, altered feldspar. There is a subtle, quartz vein.

A staining test revealed that the groundmass is dominated by K-feldspar.

In thin section the sample displays a simple porphyritic texture with lenticular amygdales about 0.5 to 2mm long. Quartz forms smoothly corroded phenocrysts up to about 1mm in size. Inferred feldspar phenocrysts, up to 2mm, have been pseudomorphed by sericite, accompanied in most cases by calcite. Sphene-sericite aggregates suggest a few former grains of biotite. The groundmass consists of anhedral quartz and orthoclase, about 0.03 to 0.05mm, along with sericite. The small amygdales are filled with fine sericite, accompanied in some cases by quartz and a few grains of partly oxidized sulphide resembling pyrite. Only a few grains of sulphide occur in altered phenocrysts.

A fissure vein, about 0.5mm wide, carries quartz and calcite.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3%</td>
<td>quartz phenocrysts</td>
</tr>
<tr>
<td>3-4%</td>
<td>sericite-calcite pseudomorphs of inferred feldspar phenocrysts</td>
</tr>
<tr>
<td>rare</td>
<td>sericite-sphene after inferred biotite</td>
</tr>
<tr>
<td>30-40%</td>
<td>groundmass quartz</td>
</tr>
<tr>
<td>30-40%</td>
<td>groundmass orthoclase</td>
</tr>
<tr>
<td>20-30%</td>
<td>groundmass sericite</td>
</tr>
<tr>
<td>1-2%</td>
<td>amygdales of sericite with minor quartz and sulphide</td>
</tr>
<tr>
<td>0.1-0.2%</td>
<td>total sulphide content</td>
</tr>
<tr>
<td>0.2-0.3%</td>
<td>veins of quartz and calcite</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This rock is considered to have originated as a porphyritic, finely vesicular rhyolite, generally similar to the samples from 108.25m and 112.50m, but with smaller, flatter vesicles. It has since experienced heavy alteration to completely sericitized and mildly carbonated the feldspar phenocrysts, sericitized much of the groundmass feldspar, and filled the vesicles with sericite, minor quartz and traces of sulphide. A barren fissure vein of quartz-calcite marks a late event.
Sample Number : CH DDH SE 147.50m

Identification : Porphyritic rhyolite with heavy sericitization, minor carbonate, amygdales of sericite-quartz-dumortierite-sulphide and disseminated sulphide

Description :

The sample is a drill core specimen of yellowish grey, fine-grained rock with many light olive specks, up to about 1mm, and with sparse phenocrysts of very light grey quartz and yellowish grey altered feldspar.

A staining test revealed that the groundmass is dominated by K-feldspar.

In thin section the sample displays a porphyritic, finely amygdaoidal texture. Smoothly corroded quartz phenocrysts are about 0.3 to 2mm. Inferred feldspar phenocrysts have been pseudomorphed by carbonate and sericite. The groundmass consists of anhedral quartz and orthoclase, about 0.03 to 0.04mm, along with sericite and a few specks of sphene. Ovoid amygdales, generally less than 1.5mm are filled with fine sericite, accompanied in most cases by minor quartz and sulphide, and in a few cases by radial aggregates of probable colourless dumortierite. The sulphide resembles dull pyrite but occurs commonly as small tabular aggregates of very fine grains. Some similar aggregates are disseminated through the rock.

An approximate mode is :

2-3% quartz phenocrysts
2-3% calcite-sericite pseudomorphs of feldspar phenocrysts
30-40% groundmass quartz
35-45% groundmass orthoclase
12-18% groundmass sericite
tr sphene
3-4% amygdales of sericite with minor quartz and dumortierite
1-2% sulphide within amygdales and as disseminated tabular aggregates

Comments and Interpretations :

This rock is considered to have originated as finely vesicular porphyritic rhyolite, probably lava. It has experienced heavy hydrothermal alteration, involving carbonate-sericite replacement of feldspar phenocrysts, sericite replacement of all inferred plagioclase, mica and possibly of some groundmass K-feldspar. Amygdales filled with sericite-quartz-dumortierite-sulphide and additional sulphide formed disseminated small tabular aggregates.

The sample is very similar to those from 108.23m, 112.50m and 135.70m and quite similar to those from 59.45m and 128.0m, but carries a greater abundance of evenly disseminated sulphide.
Sample Number : CH DDH SE 149.50m

Identification : Porphyritic rhyolite with heavy sericitization, minor carbonate amygdales of sericite-quartz-dumortierite-sulphide and disseminated sulphide

Description :

The sample is a drill core specimen of yellowish grey, fine-grain-rock with small, irregular, light olive specks and sparse small phenocrysts of very light grey quartz and yellowish grey, altered feldspar.

A staining test revealed that the groundmass is dominated by K-feldspar.

In thin section the sample displays a porphyritic, finely amygdaloidal texture. Smoothly corroded quartz phenocrysts are about 0.3 to 2mm. Infured feldspar phenocrysts have been pseudomorphed by calcite and sericite and inferred biotite by coarser sericite with quartz and sphene. The groundmass consists of anhedral quartz and orthoclase, about 0.03 to 0.05mm in size, along with sericite. Some irregular aggregates of sericite with quartz and minor sulphide and radial aggregates of colourless probable dumortierite appear to be amygdales. There are also some inconspicuous autoxenolithic structures about 1 to 5mm in size, composed of finer-grained altered rhyolite.

Sulphide which resembles pyrite occurs as sparsely disseminated tabular aggregates (less than 0.5mm long) composed of fine subhedral and anhedral grains (about 0.01 to 0.02mm), both within the host rock and within some amygdales.

An approximate mode is :

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3%</td>
<td>quartz phenocrysts</td>
</tr>
<tr>
<td>3-4%</td>
<td>calcite-sericite pseudomorphs of inferred feldspar phenocrysts</td>
</tr>
<tr>
<td>0.1%</td>
<td>sericite-quartz-sphene pseudomorphs of inferred biotite phenocrysts</td>
</tr>
<tr>
<td>30-40%</td>
<td>groundmass quartz</td>
</tr>
<tr>
<td>30-40%</td>
<td>groundmass orthoclase</td>
</tr>
<tr>
<td>20-25%</td>
<td>groundmass sericite</td>
</tr>
<tr>
<td>1-2%</td>
<td>amygdales of sericite with minor quartz and dumortierite</td>
</tr>
<tr>
<td>0.5-0.8%</td>
<td>sulphides, disseminated and within amygdales</td>
</tr>
</tbody>
</table>

Comments and Interpretations :

This sample is considered to have originated as finely vesicular porphyritic rhyolite and to have experienced heavy hydrothermal alteration involving sericite, minor carbonate, quartz, dumortierite and disseminated sulphides. It is quite similar to the sample from 147.50m, but carries less sulphide, fewer and less regular amygdales, and a few autoxenoliths (probably generated by flow brecciation).
PETROLOGICAL REPORT ON EIGHT SAMPLES
FROM CORONATION HILL, N.T.

prepared for

BHP COMPANY LIMITED

Order No. : Q97115
Ref : P. Leckie

A. S. Joyce, B.Sc.(Hons), Ph.D.

GENERAL COMMENTS

1. Two samples (G 18 1129 and CH DDH9 68.80m) are considered to be similar types of medium-grained, non-porphryitic, micrographic quartz-rich diorite which have undergone intense hydrothermal alteration to sericite-chlorite-leucoxene and sphene. Only quartz survives as a primary mineral.

In view of the intensely altered nature of the rocks there is uncertainty about whether they may have carried K-feldspar as well as plagioclase and there is also uncertainty in estimating the abundance of precursor mafic silicates.

The sample G18 1156 or 1198 is regarded as a coarser grained, non-porphryitic, micrographic granodiorite which is probably closely related to, or a gradational variant of, the quartz-rich diorite. It is intensely altered in a similar fashion, with only quartz surviving as a primary mineral.

All three samples have textures of plutonic or hypabyssal intrusive style and show no volcanic or subvolcanic characteristics. They are also devoid of sulphides or remnant textures suggestive of sulphides.

2. The original nature of G18 1161 has been obscured by intense chloritization with some silicification and sericitization. It may have been a conglomerate or some other form of clastic rock, perhaps of intermediate or basic igneous derivation. It seems not to have carried sulphides, but it does carry hematitic pigmentation localized in an unusual fashion in silicified spots.

3. The remaining four samples are interpreted to have originated as rhyolite, probably lava.

Two are conspicuously hematized, one of them (G18 1148) being a pervasively hematitic, chloritized, intensely sericitized rhyolite with vuggy veins of hematite-chlorite-quartz and the other (G18 1170) being a hematite-cemented breccia of intensely silicified, formerly sericitized rhyolite. In both cases there is evidence to suggest that hematite was generated by hydrothermal activity which was associated with deposition of some fissure fillings of quartz.

The other two (CH DDH10 148.0m and 'Buff rhy tuff') are inconspicuously banded rhyolites with relatively coarse groundmass styles, analogous to those discussed as the "second group" in the petrological report of 28/8/85. Both are weakly pigmented, intensely altered rocks devoid of sulphides or sulphide textures.
Sample Number: G18 1129

Identification: Medium-grained, quartz-rich diorite or similar rock with intense alteration to sericite, chlorite, leucoxene and sphene

Description:

The sample is a lightly to moderately weathered, light olive grey hand specimen of altered, medium-grained igneous appearance. Old weathering surfaces are greyish red.

In thin section the sample is seen to be intensely hydrothermally altered and lightly stained by weathering, but primary igneous textures are well preserved and involve hypidiomorphic to micrographic textures. The rock was not porphyritic and primary grains were mainly about 0.5 to 1.5mm.

Primary quartz is prominent, mainly as equant micrographic grains with previously intergrown feldspar replaced by sericite. Much of the rock consists of aggregates of sericite with equant to crudely tabular form: such aggregates probably replaced feldspar. Many other tabular prismatic aggregates consist of sericite, minor chlorite and tiny grains of sphene: they may represent former pyroxene or amphibole. Inferred ilmenite grains, up to 0.5mm in size, are represented by translucent leucoxene. There is a narrow (0.2mm) ill-defined vein of quartz and sericite.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-70%</td>
<td>sericite aggregates after probable feldspar</td>
</tr>
<tr>
<td>20-25%</td>
<td>sericite-chlorite-sphene aggregates after</td>
</tr>
<tr>
<td></td>
<td>probable mafic silicates</td>
</tr>
<tr>
<td>10-15%</td>
<td>primary quartz</td>
</tr>
<tr>
<td>2-3%</td>
<td>leucoxene pseudomorphs of inferred ilmenite</td>
</tr>
<tr>
<td>0.4-0.5%</td>
<td>limonite stains</td>
</tr>
<tr>
<td>0.1-0.2%</td>
<td>vein of quartz and sericite</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This sample is considered to have originated as an intrusive intermediate rock, composed of feldspar, quartz, mafic silicates and ilmenite or titaniferous magnetite. It was probably quartz-diorite, but it is unknown whether it carried significant amounts of K-feldspar. The micrographic form of the quartz may suggest that some K-feldspar existed.

Intense hydrothermal alteration has converted all feldspar to sericite, all mafic silicates to sericite-chlorite-sphene and all opaque oxides to leucoxene. Primary quartz survives untouched.

The primary textures are of medium-grained intrusive style and bear no similarity to subvolcanic textures.
Sample Number : G18 1148

Identification : Hematized, chloritized, intensely sericitized porphyritic rhyolite with vuggy veins of hematite-chlorite-quartz

Description :

The sample is a hard, but apparently weathered hand specimen which displays many greenish black, altered phenocrysts (up to 2mm) and some light grey phenocrysts of quartz set in a greyish red, fine groundmass. There are some straight, vuggy fissure veins with distinctly toothy quartz. They are about 0.5 to 2mm wide.

In thin section the sample displays many smoothly corroded subhedral phenocrysts of quartz, up to about 1mm in size. There are also some tabular phenocrysts which may have been feldspar, now pseudomorphed by pale green chlorite with minor sericite. The groundmass is dominated by sutured grains of sericitic quartz, about 0.1 to 0.2mm in size, with associated aggregates of sericite of similar size, pale chlorite and evenly distributed, earthy hematite.

The vuggy fissure veins carry toothy anhedral and subhedral quartz: up to 1mm in grainsize. Some have linings of colloform and platy hematite giving way to chlorite, then a core of quartz. Bleached zones several millimetres wide jacket the veins.

An approximate mode is :

- 2-3% quartz phenocrysts
- 3-4% chloritized inferred feldspar phenocrysts
- 40-45% groundmass quartz
- 30-35% groundmass sericite
- 2-4% groundmass chlorite
- 6-8% disseminated hematite
- 4-6% vuggy veins of quartz with thin linings of hematite and chlorite

Comments and Interpretations :

This rock originated as porphyritic acid volcanic rock, probably rhyolite lava. It has experienced intense alteration to convert all feldspar and mafic components to sericite and chlorite. There is also a great deal of evenly disseminated hematite which has either been introduced or has developed by oxidation of some disseminated ferruginous mineral such as pyrite. Textural evidence is not good, but there are vague suggestions of former cubes, about 0.02 to 0.05mm in size.

Vuggy fissure veins of quartz seem to have developed after the hematite since they have aureoles largely leached by hematite and internal linings of colloform to platy hematite, followed by chlorite, followed by quartz. Such relationships seem to preclude recent weathering as an explanation of the hematite.
Sample Number: G18 1156 or 1198

Identification: Granodiorite or similar rock with intense alteration to sericite, chlorite, leucocene and sphene and with hematite pigmentation

Description:

The sample is a moderately soft, greyish red hand specimen of medium to coarse-grained, altered igneous appearance.

In thin section the sample is seen to be intensely hydrothermally altered and irregularly pigmented by earthy hematite, but primary igneous textures are well preserved and of hypidiomorphic to micrographic style. The rock was not porphyritic and primary grains were mainly about 1 to 4 mm.

Quartz is prominent as equant micrographic grains. Tabular and anhedral grains of inferred feldspar have been completely altered to fine sericite. Inferred tabular to prismatic mafic silicates have been replaced by coarser sericite with small inclusions of secondary sphene and a few remnants of apatite: aggregate shapes are inconclusive but biotite and other mafic silicates may have been precursors. Inconspicuous very pale chlorite occurs in some sericitized inferred mafic silicates but it also occurs in some micrographic intergrowths with quartz where it may represent former K-feldspar. Equant to tabular leucocene pseudomorphs of inferred ilmenite are prominent.

Earthy hematite is unevenly distributed as a pigment. All of the rock shows some pigmentation but ill-defined patches a few centimetres in size show heavy pigmentation, especially of leucocene and sericitized inferred mafics.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-50%</td>
<td>sericite aggregates after inferred feldspar</td>
</tr>
<tr>
<td>20-25%</td>
<td>sericite-chlorite-sphene aggregates after inferred mafic silicates</td>
</tr>
<tr>
<td>25-30%</td>
<td>primary quartz</td>
</tr>
<tr>
<td>2-3%</td>
<td>leucocene pseudomorphs of inferred ilmenite</td>
</tr>
<tr>
<td>1-3%</td>
<td>chlorite</td>
</tr>
<tr>
<td>1-3%</td>
<td>hematite pigment</td>
</tr>
<tr>
<td>tr</td>
<td>apatite</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This sample is considered to have originated as an intrusive granitoid rock, composed of feldspar, quartz, mafic silicates and ilmenite or titaniferous magnetite. It was probably granodiorite but it is unknown whether it carried significant amounts of K-feldspar.

Intense hydrothermal alteration has converted all feldspar to sericite (and minor chlorite), all mafic silicates to sericite and sphene (and minor chlorite) and all opaque oxides to leucocene. The origin of irregular hematite pigmentation is uncertain but it seems to post-date the main hydrothermal alteration and may relate to weathering.

This rock is coarser grained and more quartzose than G18 1129, but of generally similar appearance and probably closely related.
Sample Number: G18 1161

Identification: Silicified and lightly sericitized, intensely chloritized rock with hematitic pigmentation in silicified spots

Description:

The sample is a freshly broken hand specimen of dark greenish grey altered rock with light brown spots about 0.5 to 3mm in size. Texture revealed on sawn surfaces are suggestive of a pebbly or otherwise clastic rock.

In thin section the impression of a pebbly or clastic rock is reinforced but textural features have been greatly obscured by intense alteration. The brown spots occur within larger equant to ovoid lithic clasts, about 3 to 10mm in size, and there is a dark chloritic matrix between fairly densely packed clasts. The brown colour is attributable to earthy hematite pigment localized in finely silicified lightly sericitized, former tabular (?)phenocrysts or clasts. The groundmass or matrix constituting the rest of the enclosing lithic clasts consists of very pale green chlorite, secondary quartz and traces of sericite in aggregates vaguely suggesting former feldspar and mafic silicates perhaps 0.3 to 1mm in grainsize. There are also a few chlorite-sphene pseudomorphs of prismatic grains several millimetres in size and some sphene aggregates after possible ilmenite grains about 0.2mm in size. The dark matrix between the clasts is dominated by chlorite and fine secondary sphene.

An approximate mineralogical mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Mineral</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-90%</td>
<td>chlorite</td>
</tr>
<tr>
<td>8-12%</td>
<td>quartz</td>
</tr>
<tr>
<td>5-8%</td>
<td>sericite</td>
</tr>
<tr>
<td>0.3-0.5%</td>
<td>sphene</td>
</tr>
<tr>
<td>0.2-0.4%</td>
<td>hematite</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

The origin of this sample is obscure because it has undergone intense hydrothermal alteration and its primary textures have been blurred. The alteration involved intense chloritization along with some silicification and sericitization. There are no indications of any sulphide or sulphide textures. Hematitic pigmentation is localized in an unusual fashion in finely silicified (?)phenocrysts: it seems to be of hydrothermal origin rather than a product of weathering.

Prior to alteration the rock may have been a conglomerate or some other form of clastic rock composed of intermediate or basic igneous rock.
Sample Number: G18 1170

Identification: Hematite-cemented breccia of intensely silicified, formerly sericitized probable rhyolite

Description:

The sample is a freshly broken hand specimen of hard, greyish red, hematitic, fine-grained rock. A sawn surface reveals a pattern of disrupted finely siliceous rock densely cemented by hematite.

In thin section the sample is confirmed to be a breccia with angular clasts of intensely silicified rock, a fraction of a millimetre to tens of millimetres in size, cemented by hematite and some quartz.

The silicified clasts retain a few phenocrysts of quartz, up to about 1 mm in size, and a few sericitized pseudomorphs of feldspar phenocrysts, but otherwise they consist largely of cherty quartz, about 0.02 mm in grainsize. Most contain very little hematite, but several have hematite as equant grains or aggregates about 0.02 to 0.05 mm with vague suggestions of cubic form.

Much of the breccia is cemented by earthy to finely crystalline hematite, but locally there are thin plates up to about 0.5 mm in size. In a few cases there are examples of cement involving finely botryoidal hematite linings and a core of quartz with grainsizes up to 0.5 mm. There are also examples of toothy quartz giving way to hematite.

An approximate mode is:

88-92% clasts of intensely silicified, formerly sericitized porphyritic acid rock
8-12% hematite cement with minor quartz

Comments and Interpretations:

This sample is interpreted to have originated as porphyritic acid volcanic rock, probably rhyolite lava. It was sericitized, then intensely silicified, then brecciated by tensinal or expansive processes. It was then cemented by hematite under hydrothermal conditions, since the hematite both precedes and succeeds minor associated cavity fillings of quartz.

The silicified clasts carry little hematite, but locally there are some hematite aggregates with vague textural suggestions of precursor pyrite. However, most of the hematite in the breccia was probably transported hydrothermally to its present cementation sites.
Sample Number: CH DDH9 68.80m

Identification: Medium-grained, quartz-rich diorite or similar rock with intense alteration to sericite, chlorite, leucoxene and sphene

Description:

The sample is a drill core specimen of olive grey, altered, medium-grained rock of igneous appearance.

In thin section the sample is seen to be intensely hydrothermally altered, but primary igneous textures are well preserved and of hypidiomorphic to mildly micrographic style. The rock was not porphyritic and primary grain sizes were mainly about 0.5 to 1.5mm.

Primary quartz is prominent, mainly as equant to micrographic grains. Tabular and anhedral grains of inferred feldspar have been completely replaced by sericite. Inferred mafic silicates have been completely replaced by slightly coarser sericite with dustings of secondary sphene: some aggregates are suggestive of former biotite, others may have been amphibole or pyroxene. Minor, inconspicuous pale chlorite occurs replacing inferred micrographic feldspar (?formerly potassic) and some mafic silicates. Inferred ilmenite grains, up to 1mm, have been replaced by leucoxene. There are a few slender prisms of remnant apatite. There are traces of weak, very fine hematitic pigmentation.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-70%</td>
<td>sericite aggregates after inferred feldspar</td>
</tr>
<tr>
<td>15-20%</td>
<td>sericite-sphene aggregates after inferred mafic silicates</td>
</tr>
<tr>
<td>12-18%</td>
<td>primary quartz</td>
</tr>
<tr>
<td>2-3%</td>
<td>leucoxene pseudomorphs of inferred ilmenite</td>
</tr>
<tr>
<td>0.5-1%</td>
<td>chlorite</td>
</tr>
<tr>
<td>tr</td>
<td>hematite pigment</td>
</tr>
<tr>
<td>tr</td>
<td>apatite</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This sample is considered to have originated as an intrusive intermediate rock, composed of feldspar, quartz, mafic silicates and ilmenite or titaniferous magnetite. It was probably quartz diorite and almost granodiorite, but it is unknown whether it carried significant amounts of K-feldspar.

Intense hydrothermal alteration has converted all feldspar to sericite, all mafic silicates to sericite and sphene and all opaque oxides to leucoxene. There are small amounts of inconspicuous chlorite and traces of weak hematitic pigmentation, the latter of uncertain origin.

This rock is quite similar to G18 1129 and generally similar to, but finer and less quartzose than G18 1156 or 1198. It is of plutonic intrusive style, with no volcanic or subvolcanic textures.
Sample Number : CH DDH10 148.0m

Identification : Intensely sericitized, porphyritic, flow-banded rhyolite

Description :

The sample is a drill core specimen which displays a few small quartz phenocrysts and some dark greenish grey altered phenocrysts (up to 2mm) set in a speckled, fine to medium grained, generally greenish grey groundmass. A 10mm wide band of finer rock is visible.

In thin section the sample displays some small phenocrysts (1 to 2mm) of smoothly corroded subhedral quartz and sericitized, tabular inferred feldspar. Much of the groundmass consists of anhedral, sutured quartz grains, about 0.2 to 0.3mm in size, along with similar sized aggregates of sericite. Several poorly defined bands have finer groundmass grain sizes, of about 0.03 to 0.05mm.

Minor earthy hematite occurs in some of the sericite. There are no sulphides, nor sulphide textures. There are sparse small grains and aggregates of secondary sphene.

An approximate mode is:

2-3% quartz phenocrysts
3-4% sericite pseudomorphs of inferred feldspar phenocrysts
35-40% groundmass quartz
50-60% groundmass sericite
tr groundmass sphene
0.1-0.3% earthy hematite

Comments and Interpretations :

This rock is considered to have originated as porphyritic rhyolite with subtle flow banding. It has undergone intense sericitization and it has been faintly pigmented by very fine hematite. Neither sulphides nor remnant sulphide textures were recognised.

This sample is regarded as belonging to the second group of rhyolites as discussed in the petrological report of 28/8/85. That is, it is flow-banded and more coarsely crystalline, or recrystallized, than the common types.
Sample Number : Adit 'Buff rhy tuff' 2

Identification : Lightly limonite and hematite pigmented porphyritic rhyolite with intense silicificati chlo

Description :

The sample is a freshly broken but apparently weathered hand specimen which displays small phenocrysts of quartz and dark greenish grey altered tabular phenocrysts (up to 2mm) set in a vaguely banded, moderate reddish orange and greyish orange groundmass. A porous vein or veins of toothy quartz occupies about 5 to 15mm of one end of the sample.

In thin section the sample displays subhedral corroded phenocrysts of clear quartz, about 0.5 to 2mm in size, and smoothly corroded tabular phenocrysts of inferred feldspar, now pseudomorphed by chlorite-quartz-sericite. The groundmass is dominated by a sutured mosaic of quartz grains, about 0.2 to 0.4mm in size and clouded by a very fine limonitic and hematitic pigment. There are similarly sized, pigmented chloritized grains and aggregates of fine sericite. There are a few very fine fissure veinlets (0.03mm) of clear quartz.

The prominently veined end of the sample displays one thick fissur vein of quartz and several associated thinner veins or branches. The quartz is anhedral but somewhat toothy; grains range up to 4mm in size and are mildly deformed. A central vug is partly occupied by iron-stained clay.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Mineral/Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3%</td>
<td>quartz phenocrysts</td>
</tr>
<tr>
<td>0.5-1%</td>
<td>inferred feldspar phenocrysts replaced by chlorite-quartz-sericite</td>
</tr>
<tr>
<td>50-60%</td>
<td>groundmass quartz</td>
</tr>
<tr>
<td>12-18%</td>
<td>groundmass chlorite</td>
</tr>
<tr>
<td>25-30%</td>
<td>groundmass sericite</td>
</tr>
<tr>
<td>tr</td>
<td>groundmass sphene</td>
</tr>
<tr>
<td>0.2-0.3%</td>
<td>limonite and hematite pigment</td>
</tr>
<tr>
<td>10-15%</td>
<td>quartz veins</td>
</tr>
</tbody>
</table>

Comments and Interpretations :

It is considered most unlikely that this rock originated as tuff. There is a small possibility that it represents intrusive rhyolite, but it seems more likely that it was porphyritic rhyolite lava with subtle banding and that its groundmass has been coarsened by recrystallization before or during hydrothermal alteration. There are general textural similarities to the sample from CH SE 131.0m.

Intense alteration has involved silicification, sericitization and chloritization. There are also quartz fissure veins. There is pervasive minor pigmentation by fine limonite and hematite but no suggestion of any sulphides or their remnant textures.
PETROLOGICAL REPORT ON TWENTY-ONE SAMPLES
FROM CORONATION HILL, N.T.

prepared for

BHP COMPANY LIMITED

Field Order: 43975A
Ref: F. Leckie

Stan Joyce
A. S. Joyce, B.Sc.(Hons), Ph.D.

GENERAL COMMENTS

1. Twelve samples are considered to be closely related and to represent altered, intrusive microgranitoid rock (DDH12 at 12.75m; DDH13 at 20.60m, 28.15m, 82.90m, 89.30m, 91.20m and 93.40m; DDH14 at 72.35m, 79.80m, 109.20m, 113.00m and 151.15m).

Primary compositions seem to have been in the range from adamellite to potassic granodiorite, quartz-rich diorite and quartz-rich monzodiorite. Textures were non-porphyritic, micrographic and involved grainsizes mainly in the range from about 0.4 to 3mm.

Homogeneous alteration generally involved complete alteration of inferred plagioclase to sericite, K-feldspar to hematite pigmented quartz and sericite, mafic silicates to sericite and sphene, and ilmenite or titaniferous magnetite to cloudy sphene and possibly leucoxene.

The samples from DDH12 at 12.75m, DDH13 at 28.15m and DDH14 at 72.35m and 79.80m are the least altered, having preserved K-feldspar. All others are so intensely altered that all primary minerals except quartz and apatite have been destroyed. Chlorite occurs in the least altered samples.

Additional inhomogeneous alteration effects are displayed in six of the samples. In two cases (DDH14 at 113.00m and 151.15m) such additional alteration involves heavy pigmentation by hematite. In three cases (DDH13 at 20.60m, 28.15m and 93.40m) the additional alteration involves patchy pigmentation by a black mineral, probably a manganese oxide, introduced in fracture locations and within some altered grains, such as inferred K-feldspar. The sixth case (DDH13 at 89.3m) involves chlorite and quartz in fractured locations.

Two samples carry small enough quantities of quartz to be regarded as intermediate rock (DDH14 at 72.35m and 151.15m). Whether some of the other samples may have originally qualified as intermediate rock has been obscured by the probable development of secondary quartz as a replacement of inferred K-feldspar. Certainly some of the samples are distinctly acid adamellite.

On textural grounds and broad compositional similarity the altered microgranitoid rocks are considered to be closely related to samples previously examined from Coronation Hill and described as micrographic quartz-rich diorite (e.g. G18 1129 and DDH0 at 68.80m) and micrographic granodiorite (e.g. G18 1156 or 1198). There is compositional variety, but a common source magma is very likely.

2. Sulphide (pyrite) is present in only one of the altered granitoid samples (DDH13 at 93.4m), occurring as densely disseminated replacement grains in a fracture zone which also carries minor probable manganese oxide.
3. Eight of the remaining samples are derived from porphyritic rhyolite.

One sample (DDH13 at 26.6m) is a coarsely silicified, intensely sericitized rhyolite, thought to be analogous to the "second group" of rhyolites discussed in comments on 28/8/85.

All of the other samples are derived from simple porphyritic rhyolite with intense sericitization and variable degrees of hematite pigmentation and some with alteration effects related to fracturing.

Lightly pigmented unfractured types are represented by samples from DDH13 at 53.00m and from G18/1120. More heavily hematite pigmented types are represented by samples from DDH13 at 67.90m, 113.85m and 148.80m; the latter is homogeneously pigmented but the other two are depleted in hematite around tight fractures. The two samples from 119.00m and 127.3m are incipiently brecciated and brecciated, respectively: both are depleted in hematite and carry calcite, dumortierite and quartz as hydrothermal breccia fillings.

4. No sulphide was detected in the samples of rhyolitic derivation but the samples from 26.60m and 53.00m in DDH13 and sample G18/1120 carry some hematite in textures suggestive of former disseminated fine pyrite. Hematite in the other rhyolitic samples appears transported.

5. The sample from 98.00m in DDH10 is a hematite cemented breccia of tensional hydrothermal style. Its clasts are chloritized, finely silicified rock of unrecognised derivation, but probably not rhyolitic.

6. DDH13 does not seem to display a simple pattern of lithology or pigmentation. The shallow and four moderately deep samples are of altered, intrusive, microgranitoid type. Below and between them there are samples of altered, extrusive, rhyolitic style. Hematitic pigmentation occurs to a variable extent throughout the suite, with probably depletion in fractures or brecciated regimes. Hydrothermal fluids active in fractures were capable of crystallizing carbonate, quartz, dumortierite and to a lesser extent chlorite and sericite.

The most uniform style of alteration seems to have involved sericitization, hematite pigmentation and inconspicuous silicification. All or much of the silicification may be a product of differential enrichment of silica during destruction of feldspar. There is little textural evidence to suggest that it was introduced by hydrothermal fluids.
Sample Number : CH DDH10 98.0m

Identification : Hematite cemented breccia of finely chloritized and silicified rock of unknown origin

Description :

The sample is a drill core specimen of breccia which displays subangular, medium grey and light olive grey clasts of altered rock, about 1 to 20mm in size, set in a dusky red, finely hematitic matrix.

A staining test revealed no K-feldspar.

In thin section the clasts are seen to have textures vaguely suggestive of shearing and to consist of abundant fine, almost colourless chlorite and fine quartz, along with prominent streaks and aggregates of cloudy finely granular sphene. Parts of the clasts are replaced by anhedral grains of calcite up to 0.5mm in size. There is minor pigmentation by hematite and by a platy black mineral.

The clasts are cemented by earthy hematite, a platy black mineral calcite and minor quartz. The platy black mineral seems to be specular hematite, about 0.1mm in grain size. Streak is persistently red and a few grains are translucent red.

An approximate mode is :

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-95%</td>
<td>clasts composed of chlorite, fine quartz, calcite, sphene and traces of hematite</td>
</tr>
<tr>
<td>5-8%</td>
<td>earthy and specular hematite cement</td>
</tr>
<tr>
<td>1-2%</td>
<td>calcite cement</td>
</tr>
<tr>
<td>0.2-0.4%</td>
<td>quartz cement</td>
</tr>
</tbody>
</table>

Comments and Interpretations :

This sample is a tensional breccia of completely altered rock of uncertain origin. It seems unlikely that the clasts were derived from rhyolite because they contain too much secondary sphene. Perhaps they are derived from sheared intermediate rock or similarly titaniferous rock which has been completely chloritized and silicified.

The breccia has been cemented by earthy and finely specular hematite with minor calcite and traces of quartz.
Sample Number : CH DDH12 12.75m (?DDH12 or ?DDH13)

Identification : Micrographic micro-adamellite with heavy alteration to sericite and sphene and light pigmentation by hematite

Description :

The sample is a drill core specimen of heavily altered, medium-grained, crystalline rock. It displays mainly moderate orange pink feldspar and a light olive grey sericite. There are a few grains and patches of light grey quartz and many specks of yellowish grey sphene.

A cobaltinitrite staining test revealed that the feldspar is potassic.

In thin section the sample is seen to be intensely sericitized, but it has well preserved primary igneous textures of hypidiomorphic, micrographic, granitoid style with primary grainsizes mainly in the range from about 0.5 to 3mm.

Quartz is prominent, mainly as equant micrographic grains intergrown with K-feldspar. Most of the abundant K-feldspar is at least partly intergrown with quartz. Inferred subhedral, tabular grains of plagioclase have been pseudomorphed by sericite. Sericite with fine sphene pseudomorphs inferred mafic silicates of uncertain type. Inferred titaniferous opaques have been pseudomorphed by cloudy sphene (yellowish grey specks in hand specimen). A faint hematite pigment is confined to the K-reldspar.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Mineral</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-45%</td>
<td>sericite after plagioclase and minor mafic silicates</td>
</tr>
<tr>
<td>30-35%</td>
<td>orthoclase</td>
</tr>
<tr>
<td>20-25%</td>
<td>quartz</td>
</tr>
<tr>
<td>2-3%</td>
<td>sphene (mainly after ilmenite or titaniferous magnetite)</td>
</tr>
<tr>
<td>tr</td>
<td>hematite pigment</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This rock is considered to have originated as micrographic micro-adamellite, crystallized within a small or quenched intrusion.

Heavy hydrothermal alteration has converted all inferred plagioclase to sericite, all mafic silicates to sericite and sphene and all opaque oxides to sphene. Primary quartz and orthoclase persist unchanged except for faint hematite pigmentation developed in the orthoclase.
Sample Number : CH DDH13 20.60m

Identification : Micrographic micro-adamellite or potassic micro-granodiorite with heavy alteration to sericite and sphene, pervasive light pigmentation by hematite and local pigmentation by probable manganese oxide

Description :

The sample is a drill core specimen of intensely altered, medium-grained rock. Parts of the sample are light red and light olive grey with small prisms or tabular grains of darker olive grey; other parts are a more uniform light olive grey with 1 to 4mm splotches of dark grey.

A cobaltinitrite staining test revealed abundant K-feldspar in micrographic intergrowths.

In thin section the sample is seen to be intensely sericitized, but it has well preserved primary igneous textures of hypidiomorphic, micrographic, granitoid style with primary grainsizes mainly in the range from about 0.4 to 2mm.

Quartz forms a few simple anhedral grains and small aggregates, but occurs mainly as micrographic intergrowths with orthoclase. K-feldspar forms a few simple grains, but occurs mainly as intergrowths with quartz; it is distinctly pigmented with very fine hematite.

Within the reddish parts of the sample fine sericite pseudomorphs subhedral, tabular grains of inferred plagioclase and slightly coarser sericite with fine sphene pseudomorphs inferred mafic silicates of thick tabular or prismatic form. Within more uniformly olive regimes sericite has replaced not only inferred plagioclase and mafic silicates, but also some of the micrographic K-feldspar. Hematite pigmented quartz also seems to represent some former K-feldspar. Throughout both types of sericitized rock equant grains inferred titaniferous opaque oxide have been pseudomorphed by granular aggregates of cloudy fine sphene.

The inhomogeneously distributed dark grey splotches of alteration are seen to correspond with an earthy black pigment developed variously with and instead of the faint hematite pigment within micrographic grains of orthoclase. As far as can be determined on limited properties the black mineral is probably a manganese oxide.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-40%</td>
<td>sericite</td>
</tr>
<tr>
<td>30-35%</td>
<td>quartz</td>
</tr>
<tr>
<td>12-18%</td>
<td>orthoclase</td>
</tr>
<tr>
<td>2-3%</td>
<td>sphene</td>
</tr>
<tr>
<td>1-2%</td>
<td>opaque oxide, probably manganeseous</td>
</tr>
<tr>
<td>tr</td>
<td>apatite</td>
</tr>
<tr>
<td>tr</td>
<td>hematite pigment</td>
</tr>
</tbody>
</table>
Comments and Interpretations:

This rock is considered to have originated as micrographic micro-adamellite or potassic granodiorite. It is texturally quite similar to the sample from DDH13 (?DDH12) at 12.75m.

Heavy hydrothermal alteration has pervasively converted all inferred plagioclase and mafic silicates to sericite and titaniferous opaque oxides to sphene. Inhomogeneous alteration effects which were probably synchronous with sericitization involved faint hematite pigmentation of orthoclase, partial conversion of orthoclase to sericite and quartz and patchy pigmentation of orthoclase and altered orthoclase by probable manganese oxide.
Sample Number: CH DDH13 26.60m

Identification: Coarsely silicified, intensely sericitized, porphyritic rhyolite with coarse hematite pigment, probably derived from pyrite

Description:

The sample is a drill core specimen of greyish red, altered, fine-grained rock with inconspicuous small phenocrysts of light grey quartz and a dusky red, altered mineral.

A cobaltinitrite staining test revealed a moderate abundance of fine K-feldspar in small spherulitic structures.

In thin section the sample is seen to consist of smoothly corroded quartz phenocrysts and subhedral completely sericitized feldspar phenocrysts, about 0.3 to 2mm in size, set in a modified groundmass dominated by fine sericite and relatively coarse, sutured quartz, about 0.1 to 1mm in grainsize.

The quartz phenocrysts are clear grains, but the sutured groundmass quartz is faintly pigmented by ultra-fine hematite. Some of the quartz has microspherulitic textures with intergrown sericite and in some cases K-feldspar. Relatively coarse hematite pigment occurs in sericitized phenocrysts, crudely outlining spherulites and as disseminations. Some of the disseminated hematite, with and without accompanying pores, is suggestive of former cubic pyrite grains, less than about 0.1mm in grainsize.

An approximate mode is:

2-3% quartz phenocrysts
2-3% sericite pseudomorphs of inferred feldspar phenocrysts
50-55% groundmass quartz
30-35% groundmass sericite
5-10% groundmass K-feldspar
2-3% coarse hematite pigment and related pores

Comments and Interpretations:

This sample is interpreted to have originated as porphyritic rhyolite but it has undergone intense alteration and its groundmass textures have been greatly modified and coarsened.

Quartz phenocrysts remain unaltered and clear. Inferred feldspar phenocrysts have been pseudomorphed by sericite and coarsely pigmented by hematite. Groundmass quartz, probably supplemented by silicification, has been coarsened and faintly pigmented by ultra-fine hematite. Minor K-feldspar survives in some microspherulitic structures with quartz. All other feldspar has been converted to sericite. Coarse hematite pigment has been mobile in the rock and it seems likely to have been derived by oxidation of disseminated fine pyrite.

This sample is considered to be broadly analogous to the "second group" of rhyolites as described in comments on 28/8/85.
Sample Number: CH DDH13 28.15m

Identification: Micrographic microgranitoid rock with intense alteration to sericite, sphene, quartz and faint hematite pigment, and with local pigmentation by probable manganese oxide

Description:

The sample is a drill core specimen of moderate orange pink, altered fine to medium-grained rock with yellowish grey specks of leucoxene or sphene. A fine-grained dark grey mineral occurs as irregularly distributed small patches and within irregular zones of brecciation up to several millimetres wide.

A cobaltinitrite staining test produced some diffuse reaction but did not demonstrate the presence of any K-feldspar.

In thin section the sample is seen to be intensely altered, but plainly preserved primary textures are consistent with an hypidiomorphic, micrographic, granitoid rock with grainsizes commonly of about 0.4 to 3mm.

The main bulk of the rock displays clear grains of primary quartz sericitic grains of possibly partly primary and partly secondary micrographic quartz, completely sericitized anhedral and subhedral inferred feldspar, sericite-sphene aggregates after a few inferred mafic silicates, aggregates of cloudy sphene after inferred titaniferous opaques, and accessory acicular prisms of apatite. Very fine, faint hematite pigment occurs mainly in the sericitic quartz grains and in adjacent sericite. Some sericite forms vague veinlets.

The dark alteration noted in hand specimen is seen to correspond with earthy disseminated aggregates of an opaque oxide, probably manganiferous. Where it occurs as spots the alteration involves heavy pigmentation of anhedral aggregates of sericite and micrographic quartz, quite possibly representing altered K-feldspar. Some of the oxide also occurs around grain boundaries and along short fractures near such aggregates. A 3mm wide zone of tensional brecciation is also liberally impregnated with the earthy black oxide.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-55%</td>
<td>sericite</td>
</tr>
<tr>
<td>40-45%</td>
<td>quartz</td>
</tr>
<tr>
<td>2-3%</td>
<td>sphene</td>
</tr>
<tr>
<td>4-6%</td>
<td>opaque oxide, probably manganiferous</td>
</tr>
<tr>
<td>0.1-0.2%</td>
<td>apatite</td>
</tr>
<tr>
<td>tr</td>
<td>hematite pigment</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This rock is interpreted to have originated as a micrographic microgranitoid rock, probably of adamellite or granodiorite composition.

Intense hydrothermal alteration seems to have involved conversion of plagioclase to sericite, K-feldspar to quartz and sericite, mafic silicates to sericite and sphene, and ilmenite or titaniferous magnetite to sphene. Faint hematitic pigmentation accompanied the alteration. At about the same time or later a black pigment, probably a manganese oxide, was introduced into small zones of tensional brecciation and into quartz and sericite which was probably generated by alteration of K-feldspar.
Sample Number: CH. DDH13 53.00m

Identification: Moderate red porphyritic rhyolite with moderate sericitization and disseminated hematite after probable pyrite

Description:

The sample is a drill core specimen which displays small phenocrysts of light grey quartz and light olive altered phenocrysts set in a fine-grained, moderate red groundmass.

A cobaltinitrite staining test revealed that the groundmass is dominated by K-feldspar.

In thin section the sample displays a simple porphyritic texture. Subhedral, smoothly embayed phenocrysts of quartz are about 0.2 to 2 mm. Former tabular feldspar phenocrysts have been pseudomorphed by sericite and very minor chlorite. There are also several small aggregates of quartz and sericite which may represent amygdales. There is one thin pod or short vein of quartz with a sheal of colourless dumortierite. The groundmass consists of anhedral quartz and orthoclase, about 0.02 to 0.04 mm in grainsize, and minor sericite.

Specks of hematite, probably after pyrite about 0.01 to 0.02 mm in size, are disseminated through the groundmass. There are a few residual specks of pyrite. Ultra-fine hematite pigmentation pervades the groundmass K-feldspar.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3%</td>
<td>quartz phenocrysts</td>
</tr>
<tr>
<td>3-4%</td>
<td>sericite pseudomorphs of feldspar phenocrysts</td>
</tr>
<tr>
<td>30-40%</td>
<td>groundmass quartz</td>
</tr>
<tr>
<td>40-50%</td>
<td>groundmass K-feldspar (hematite pigmented)</td>
</tr>
<tr>
<td>10-15%</td>
<td>groundmass sericite</td>
</tr>
<tr>
<td>tr</td>
<td>sericite-quartz (?) amygdales</td>
</tr>
<tr>
<td>tr</td>
<td>quartz-dumontierite vein or pod</td>
</tr>
<tr>
<td>0.5-1%</td>
<td>disseminated hematite after probable pyrite</td>
</tr>
<tr>
<td>rare</td>
<td>disseminated pyrite</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This rock is considered to have originated as porphyritic rhyolite of probably extrusive origin.

Pervasive moderate hydrothermal alteration has converted all inferred plagioclase to sericite (and traces of chlorite), but K-feldspar survives. The rock also seems to have been impregnated with finely disseminated pyrite, subsequently largely converted to hematite. The presence of boron in the hydrothermal fluids is indicated by probable dumortierite in a quartz vein or pod.
Sample Number: CH DDH13 67.90m

Identification: Intensely sericitized, probably silicified porphyritic rhyolite with coarse hematite pigment which is depleted adjacent to tight fracture veinlets

Description:

The sample is a drill core specimen of greyish red purple, fine-grained rock bleached to a dusky yellow to pinkish colour for about 1 to 20mm from inconspicuous thin, quartzose veins. Small light grey quartz phenocrysts and dark greenish grey altered phenocrysts are disseminated through the rock.

A cobaltinitrite staining test gave some diffuse reaction, but revealed no definite K-feldspar.

In thin section the sample is seen to be altered but it displays simple porphyritic volcanic textures with phenocrysts about 0.3 to 2mm in size and an allotriomorphic groundmass with grainsizes of about 0.03 to 0.1mm.

Quartz phenocrysts are smoothly corroded, clear grains and groundmass grains are also clear. Tabular phenocrysts of inferred feldspar have been pseudomorphed by sericite and pale green chlorite. Anhedral groundmass feldspar has been replaced by sericite. A phenocryst of inferred biotite has been pseudomorphed by sericite and minor sphene.

The bulk of the sample is coarsely pigmented by hematite in a fashion which does not suggest local derivation from oxidizing sulphide. Within some mottles and within zones more than 10mm wide jacketing a tight fracture the hematite pigment is depleted. The fracture carries a thin coating of earthy hematite and a pod of colourless dumortierite, quartz and pale green chlorite.

An approximate mode of the bulk rock is:

- 2-3% quartz phenocrysts
- 2-3% sericite-chlorite pseudomorphs of inferred feldspar phenocrysts
- rare sericite-sphene pseudomorphs of inferred biotite phenocrysts
- 40-45% groundmass quartz
- 40-45% groundmass sericite
- 2-3% hematite pigment
- 0.1-0.2% veinlets of hematite, quartz, chlorite and dumortierite

Comments and Interpretations:

This sample is interpreted to have originated as porphyritic rhyolite, probably of extrusive origin.
Intense hydrothermal activity has produced sericite, minor chlorite and probably some secondary quartz. Relatively coarse hematite pigmentation developed at the same time or later, probably by introduction rather than by internal derivation. At a later stage hydrothermal activity associated with tight fractures seems to have stripped the hematite pigment from adjacent wall rock for up to tens of millimetres. Within the fractures small amounts of hematite, quartz, chlorite and dumortierite crystallized.
Sample Number: CH DDH13 82.90m

Identification: Micrographic microgranitoid rock with intense alteration to sericite, sphene and quartz and light pigmentation by hematite

Description:

The sample is a drill core specimen of intensely altered, medium-grained rock. Its colour is medium dark grey with tinges of greyish red and light olive grey.

A cobaltinitrite staining test produced some diffuse reaction but revealed no definite K-feldspar.

In thin section the sample is seen to be intensely sericitized, but there are plainly preserved igneous textures consistent with an hypidiomorphic, micrographic, granitoid rock with primary grainsizes mainly in the range from about 0.3 to 1.5mm.

Quartz is conspicuous as a few simple clear, anhedral grains and as hematite pigmented larger, finely micrographic intergrowths with sericite. No feldspar is preserved, but there are many tabular aggregates of fine sericite consistent with inferred plagioclase and other anhedral micrographic aggregates consistent with inferred K-feldspar. Probable mafic silicates are poorly displayed as aggregates of slightly coarser sericite with very minor fine secondary sphene and in some cases with primary inclusions of apatite. Equant anhedral to subhedral grains of former titaniferous opaque oxide are represented by aggregates of very cloudy sphene and leucoxene. Acicular prisms of apatite are disseminated through the rock.

A pigment of very fine hematite occurs with varying intensity throughout the sericite and much of the quartz. Traces of probable dumortierite occur as tiny sheafs of acicular grains (up to 0.2mm long) associated with small amounts of almost colourless chlorite and quartz in a 2mm pod and in a discontinuous, small replacement style vein.

An approximate mode is:

<table>
<thead>
<tr>
<th>%</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-65%</td>
<td>sericite</td>
</tr>
<tr>
<td>30-35%</td>
<td>quartz</td>
</tr>
<tr>
<td>3-4%</td>
<td>sphene and leucoxene</td>
</tr>
<tr>
<td>0.2-0.3%</td>
<td>apatite</td>
</tr>
<tr>
<td>tr</td>
<td>hematite pigment</td>
</tr>
<tr>
<td>tr</td>
<td>dumortierite with chlorite and quartz</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This rock has remnant textures quite comparable to those of the less altered potassic micrographic samples from DDH12 at 12.75m and DDH13 at 20.60m.

Intense hydrothermal alteration has converted all inferred plagioclase to sericite, mafic silicates to sericite-sphene and titaniferous opaques to sphene and leucoxene. Infurred K-feldspar within micrographic intergrowths seems to have been replaced by quartz and sericite. Mild hematite pigmentation pervades the rock and appears to have preceded the growth of secondary quartz.
Sample Number : CH DDH13 89.30m

Identification : Micrographic microgranitoid rock with intense alteration to sericite, sphene, quartz and hematite pigment, then fracturing and cementation by chlorite with quartz

Description :

The sample is a drill core specimen of greyish red, medium-grained intensely altered rock with specks of whitish sphene. Greenish black chlorite occurs in several fractures and patches of brecciation.

A cobaltinitrite staining test produced some diffuse reaction, but revealed no K-feldspar.

In thin section the sample is seen to be intensely sericitized, but there are plainly preserved igneous textures consistent with an hypidiomorphic, micrographic, granitoid rock with primary grainsizes commonly in the range from 0.5 to 3mm.

Quartz is prominent as large, anhedral, commonly finely micrographic grains, many clouded by sericite and faint hematite pigmentation. Inferrred feldspar, variously subhedral tabular and anhedral micrographic, has been completely replaced by fine sericite with hematite pigmentation. Inferrred mafic silicates are poorly displayed as aggregates of coarser sericite with minor sphene. Equant titaniferous opaque oxides have been replaced by aggregates of fine sphene, some arranged as lattices. Small acicular prisms of apatite are conspicuous as a primary accessory.

The sample displays local brecciation and several fractures densely cemented by fine-grained, bright green chlorite accompanied by minor opaques of unidentified type (probably an oxide) and quartz.

An approximate mode is :

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Mineral</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-50%</td>
<td>quartz</td>
</tr>
<tr>
<td>40-45%</td>
<td>sericite</td>
</tr>
<tr>
<td>3-4%</td>
<td>sphene</td>
</tr>
<tr>
<td>4-5%</td>
<td>chlorite, with traces of an opaque (?)oxide</td>
</tr>
<tr>
<td>0.2-0.3%</td>
<td>apatite</td>
</tr>
<tr>
<td>tr</td>
<td>hematite pigment</td>
</tr>
</tbody>
</table>

Comments and Interpretations :

This sample is an intensely altered micrographic microgranitoid rock comparable to that from DDH13 at 82.90m except that it has been mildly brecciated and healed by chlorite, quartz and an opaque mineral.

The original rock was probably adamellite or potassic granodiorite, judging by the prominent micrographic textures. Intense hydrothermal alteration has involved development of sericite from inferred plagioclase- sericite-sphene from mafic silicates, sphene from titaniferous opaques and quartz-sericite from inferred K-feldspar. Light pigmentation by hematite is pervasive, but concentrated to some extent with quartz after inferred feldspar. The chlorite-quartz fracture fillings post-date the pervasive alteration.
Sample Number: CH DDH13 91.20m

Identification: Micrographic microgranitoid rock with intense alteration to sericite, sphene, quartz and light hematite pigmentation

Description:

The sample is a drill core specimen of intensely altered, medium-grained, crystalline rock. It is dominantly moderate red, but with tabular and lath-shaped olive grey, altered grains and specks of yellowish grey leucoxene.

A cobaltinitrite staining test produced weak diffuse reaction but revealed no K-feldspar.

In thin section the sample is seen to be intensely sericitized, but there are plainly preserved textures consistent with an hypidiomorphic, micrographic, granitoid rock with primary grainsizes commonly in the range from 0.3 to 1.5mm.

There are some clear, small grains of quartz, but most quartz occurs as relatively large grains with finely micrographic textures and clouded by fine hematite pigment and sericite. Tabular to lath-shaped grains of inferred plagioclase are now composed of fine sericite with little hematite pigmentation. Former equant to subhedral grains of inferred titaniferous opaqueoxide have been pseudomorphed by fine sphene and leucoxene, some of it with lattice textures. Probable mafic silicates are poorly displayed as sericite aggregates with minor sphene and some hematite pigmentation. Fine apatite is an accessory mineral.

Probable dumortierite is present as colourless radial sheafs of very acicular crystals, up to 0.4mm long, in a 2mm pod.

An approximate mode is:

60-65% quartz
30-35% sericite
3-4% sphene
0.1-0.2% apatite
tr hematite pigment
rare dumortierite

Comments and Interpretations:

This rock is interpreted to have originated as a micrographic microgranitoid rock, probably of adamellite composition.

Intense hydrothermal alteration seems to have converted plagioclase entirely to sericite, mafic silicates to sericite and sphene, ilmenite or titaniferous magnetite to sphene and probable K-feldspar to hematite pigmented quartz and minor sericite. The presence of at least some boron in the hydrothermal fluids is suggested by a small pod of probable dumortierite. The same mineral is also present at 82.90m in DDH13.
Sample Number: CH DDH13 93.40m

Identification: Micrographic microgranitoid rock with intense alteration to sericite, sphene, quartz and faint hematite pigment, and with local pigmentation by probable manganese oxide and replacement by pyrite

Description:

The sample is a drill core specimen of moderate red, medium-grained, intensely altered rock with disseminated specks of yellowish grey leucoxene/sphene and a patchy distribution of dark grey alteration.

A cobaltinitritite staining test produced some diffuse reaction but revealed no K-feldspar.

In thin section the sample is seen to be intensely altered, but there are plainly preserved textures consistent with an hypidiomorphic micrographic, granitoid rock with primary grainsizes commonly in the range from 0.4 to 2mm.

The common style of mineralogy seen throughout the sample involves a few small primary grains of clear quartz, many larger, hematite-pigmented, sericitic, finely micrographic grains of quartz, finely sericitized anhedral and subhedral grains of inferred feldspar, finely granular, partly leucoxenized sphene pseudomorphs of inferred titaniferous opaques, and sericite-sphene aggregates after poorly displayed inferred mafic silicates. There are rare patches of bright green chlorite.

Earthy, probably manganiferous, opaque oxides occur with a patchy distribution as a pigment in some sericite aggregates, in some quartz and in some irregular short fractures.

A 2 to 5mm wide zone of mildly brecciated rock has been partly replaced by abundantly disseminated subhedral pyrite (about 0.02 to 0.2mm in grainsize) intergrown with tiny sheafs of colourless dumortierite. The pyrite is quite fresh. A few wisps of probable manganese oxide occur in the same fractured zone.

An approximate mode is:

45-50% quartz
40-45% sericite
3-4% sphene
1-2% opaque oxide, probably manganiferous
1-2% pyrite
tr dumortierite
rare chlorite

Comments and Interpretations:

The rock is interpreted to have originated as a micrographic microgranitoid rock, probably of adamellite or potassic granodiorite composition.
Intense, pervasive hydrothermal alteration seems to have converted all plagioclase to sericite, all mafic silicates to sericite and sphene, all titaniferous opaques to sphene, and all probable K-feldspar to hematite pigmented quartz and sericite. At about the same time or later a black pigment of probable manganese oxide was developed within small fractures and within a few altered mineral grains. Then or later a replacement zone of pyrite and traces of dumortierite developed in a narrow brecciated regime.
Identification: Intensely sericitized, probably silicified porphyritic rhyolite with coarse hematite pigment which is depleted around tight fractures with partly oxidized sideritic selvages.

Description:

The sample is a drill core specimen of dusky red purple, fine-grained rock with small, light grey quartz phenocrysts and pale olive altered phenocrysts. Several very thin whitish veins are jacketed by moderate red alteration selvedges, about 1 to 2mm wide, passing abruptly into pale olive alteration which extends a further 1 to 5mm.

A cobaltinitrite staining test produced some diffuse reaction, but revealed no K-feldspar.

In thin section the host rock is seen to be pigmented and altered rhyolitic rock with smoothly corroded and subhedral phenocrysts and altered phenocrysts, about 0.3 to 2mm in size, set in a mosaic groundmass of quartz, about 0.03 to 0.1mm grainsize, and aggregates of sercite. Quartz phenocrysts are clear. Inferred feldspar phenocryst have been pseudomorphed by aggregates of calcite with subordinate sercite and in some cases quartz; some pseudomorphs carry relatively coarse hematite pigment. Some groundmass quartz grains are clear, but many are sericitic. Relatively coarse hematite pigment pervades the matrix sercite.

The fractures with the prominent coloured selvedges are seen to contain narrow (maximum 0.5mm) fillings of sercite and carbonate. The initial filling seems to be fine sercite, but cut by later fillings of ankerite grading sharply to more abundant calcite. Moderate red selvedges extend for about 0.5 to 1mm into wall rock on each side of one fracture and asymmetrically about 0.1 and 2mm from another. The colour is attributable to partly hematized siderite occurring as anhedral grains replacing much of the sercite of the wall rock. The pale olive zones which extend further from the fractures and their moderate red selvedges correspond with wall rock which has been completely depleted in hematite pigment.

An approximate mode of the sample is:

- 2-3% quartz phenocrysts
- 3-4% calcite-sercite(-quartz) pseudomorphs of inferred feldspar phenocrysts
- 45-50% groundmass quartz
- 35-40% groundmass sercite
- 2-3% hematite pigment in host rock
- 0.2-0.3% sercite-ankerite-calcite in fractures
- 3-4% hematite pigmented siderite in selvedges beside fractures.

Comments and Interpretations:

This sample is considered to represent hematite pigmented, intensely sericitized and probably silicified rhyolite quite similar to the sample from DDH13 at 67.90m except that its feldspar phenocryst have been carbonated. The hematite pigment does not reveal any textural evidence of direct derivation from sulphide within the sample.
Tight fractures carry thin fillings of sericite cut by other fillings of ankerite grading abruptly to calcite. Symmetrical and asymmetrical moderate red alteration selvedges of partly oxidized fine siderite extend for up to several millimetres into adjacent wall rock. Bleached zones of hematite depletion extend a further 1 to 2mm from the reddish brown zones. These bleached zones are analogous to even broader bleached zones in the sample from DDH13 at 67.90m.

The deduced sequence of events involves firstly pervasive sericitization, probable silicification (perhaps by differential enrichment during sericitization, rather than by introduction of silica), development of carbonate in altered phenocrysts and relatively coarse pigmentation by hematite. Then hematite was leached from broad zones adjacent to tight fractures along which hydrothermal fluids were permeating and depositing sericite then carbonate. Probably during the leaching or subsequently the migrating fluids caused the development of siderite selvedges in the host rock. Perhaps carbonate moving out from the fractures reacted with iron moving into the fractures. The carbonate then partly oxidized.
Sample Number : CH DDH13 119.00m

Identification : Incipiently brecciated, intensely sericitized, porphyritic rhyolite with angular carbonated patches and with fracture fillings of quartz, calcite, dumortierite and sericite

Description :

The sample is a drill core specimen of altered rhyolite which displays angular patches of yellowish grey rock, about 2 to 12mm in size evenly distributed through light olive grey rock of otherwise similar appearance.

A cobaltinitrite staining test produced some diffuse stain, but revealed no K-feldspar.

In thin section the sample is seen to have remnant porphyritic rhyolitic textures, many short fracture fillings, pervasive sericitization and local development of carbonate.

Quartz forms corroded, subhedral phenocrysts about 0.3 to 2mm in size and inferred feldspar phenocrysts are now variously sericite or calcite with sericite. The groundmass carries abundant anhedral quartz, about 0.02 to 0.05mm in grainsize, associated with either aggregates of sericite or anhedral grains of calcite with minor sericite. The yellowish grey patches correspond with the carbonated regimes. Transitions between carbonated and sericitized regimes are fairly abrupt but generally of diffusion/replacement style, not clastic boundaries; there are exceptions in which filled fissures mark the boundaries. Hematite pigment is sparsely and inhomogeneously distributed.

There are many irregular short fissures (up to about 1mm wide and up to about 10mm long) filled by quartz, variable amounts of calcite and a few sheafs of dumortierite. One late fissure is filled by calcite and later sericite.

An approximate mode is :

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3%</td>
<td>quartz phenocrysts</td>
</tr>
<tr>
<td>3-4%</td>
<td>inferred feldspar phenocrysts altered to sericite or calcite-sericite</td>
</tr>
<tr>
<td>40-45%</td>
<td>groundmass quartz</td>
</tr>
<tr>
<td>35-40%</td>
<td>groundmass sericite</td>
</tr>
<tr>
<td>10-15%</td>
<td>groundmass calcite</td>
</tr>
<tr>
<td>4-5%</td>
<td>fracture fillings of quartz, minor calcite and traces of sericite and dumortierite</td>
</tr>
<tr>
<td>tr</td>
<td>hematite pigment</td>
</tr>
</tbody>
</table>

Comments and Interpretations :

This rock originated as porphyritic rhyolite.

Intense hydrothermal alteration involved pervasive sericitization and localized replacement by carbonate. Quartz seems enriched, but perhaps only by differential enrichment related to formation of the other alteration minerals. Incipient brecciation is recorded by discontinuous fractures filled with quartz, calcite and traces of sericite and dumortierite. The angular shapes of the patches of carbonate replacement seem likely to be related in some way to the existence of the fracturing but it is not clear whether the carbonate was emplaced because of the fractures or depleted by leaching into fractures. Certainly the carbonate patches tend to occur more commonly away from the fractures.
Sample Number : CH DDH13 127.35m

Identification : Breccia of intensely sericitized porphyritic rhyolite with fracture fillings of calcite-dumortierite-quartz and with a hematite pigmented remnant of probably earlier alteration

Description :

The sample is a drill core specimen of breccia which displays densely packed angular clasts of light olive grey, altered rhyolite, about 1 to 50mm in size, cemented by very light grey quartz and other minor minerals. A 60mm section of the core displays moderate red and less conspicuous dusky red pigmentation in patterns which are vaguely pumiceous in geometry. Smaller specks of pigment also occur elsewhere in the sample.

A cobaltinitrite staining test revealed no K-feldspar.

In thin section the light olive grey rock which constitutes the bulk of the sample is seen to correspond with intensely sericitized rhyolite with phenocrysts of quartz and sericitized inferred feldspar (about 0.3 to 1.5mm in size) set in a groundmass of anhedral quartz (about 0.02 to 0.05mm) and small aggregates of sericite.

The fracture fillings in the light olive grey regime are seen to consist of partial linings of calcite, then a few small sheafs of colourless dumortierite, then cores of quartz.

The red pigmented regimes are seen to have abrupt boundaries of diffusion/replacement style, superimposed on coarsely brecciated, altered rhyolite. The subordinate dusky red regimes display evenly disseminated minor hematite pigment in intensely sericitized rhyolite. The more conspicuous moderate red regimes have densely and relatively coarsely hematite pigmented, sericitized rhyolite with some pale green chlorite and minor carbonate. Fractures carry hematite, chlorite, sericite and minor calcite and quartz, in approximately that paragenetic sequence.

An approximate mode, estimated for the bulk sample, is:

- 2-3% phenocrysts of quartz
- 2-3% sericite pseudomorphs of inferred feldspar phenocrysts
- 40-45% groundmass quartz
- 45-50% groundmass sericite
- 0.1-0.2% groundmass chlorite (confined to red regimes)
- 0.3-0.5% groundmass hematite and minor remnant carbonate (confined to red regimes)
- 5-8% fracture fillings of calcite-dumortierite-quartz in light olive grey regimes and hematite-chlorite-sericite-calcite-quartz in red regimes

Comments and Interpretations :

This sample is interpreted to be a tensional breccia formed from intensely sericitized, probably silicified rhyolite. The bulk of the breccia is free of hematite and the densely packed, barely disturbed clasts are cemented by calcite-dumortierite-quartz.
Part of the breccia is heavily pigmented by hematite and it is thought that the pigmented regime is a remnant of earlier alteration involving hematite pigment developed in intensely sericitized, partly chloritized and carbonated rhyolite. The pigmented regime also differ in having fractures filled by hematite-chlorite-sericite-calcite and minor quartz. This assemblage may well have preceded the calcite-dumortierite-quartz assemblage of the non-pigmented (presumably leached) bulk of the sample.
Sample Number : CH DDH13 148.80m

Identification : Intensely sericitized, probably silicified porphyritic rhyolite with coarse hematite pigment delineating a fine mesh pattern of possible shattering

Description :

The sample is a drill core specimen of dusky red, altered, fine-grained rock with small light grey phenocrysts of quartz and other hematite pigmented, altered phenocrysts.

A cobaltinitrite staining test revealed no K-feldspar.

In thin section the sample is seen to be coarsely hematite pigmented and sericitized, but remnant textures are plainly consistent with smoothly corroded, subhedral phenocrysts, about 0.3 to 2mm in size set in a groundmass dominated by anhedral quartz grains about 0.03 to 0.1mm in size.

Quartz forms unstrained, clear phenocrysts. Inferred phenocrysts of feldspar consist of sericite pigmented by hematite. Groundmass quartz varies from clear to sericitic. Additional sericite occurs as aggregates similar in size to the quartz grains.

Relatively coarse hematite pigment pervades the rock but also shows a tendency to delineate a mesh pattern with cell sizes varying from about 0.05 to 0.5mm.

An approximate mode is:

- 2-3% quartz phenocrysts
- 3-4% sericite pseudomorphs of inferred feldspar phenocrysts
- 55-60% groundmass quartz
- 30-35% groundmass sericite
- 3-4% hematite pigment

Comments and Interpretations :

This rock is considered to have originated as porphyritic rhyolite.

Intense hydrothermal alteration has resulted in sericitization and probably silicification. At that stage or later there was pervasive pigmentation by relatively coarse hematite. There are no textural indications to suggest local derivation of the hematite within the sample. Much of it has been deposited in a fine mesh pattern which may suggest mild tensional shattering. If so, the shattering has not significantly disrupted the remnant rhyolitic textures. Perhaps the grains were loosened by mild heaving after sericitization.
Sample Number: CH DDH14 72.35m

Identification: Micrographic quartz-rich monzodiorite with heavy alteration to sericite, chlorite, leucoxene/sphene and with hematite pigmentation in K-feldspar

Description:

This is a drill core specimen of altered, medium to coarse-grained igneous rock which displays mainly moderate red and dark greenish grey minerals. Close inspection also reveals quartz and yellowish grey specks of sphene/leucoxene.

A cobaltinitrite staining test revealed that the red mineral is K-feldspar in micrographic intergrowths with quartz.

In thin section the sample is seen to be heavily altered, but it has well preserved primary textures of hypidiomorphic, micrographic, granitoid style with primary grainsizes mainly in the range from about 0.5 to 3mm.

Quartz is quite prominent as clear micrographic and anhedral grains. Orthoclase is present as distinctly hematite pigmented grains most of which are locked in micrographic intergrowths with quartz. A few are lightly carbonated and sericitized. Subhedral tabular grains and laths of inferred plagioclase have been completely pseudomorphed by sericite. Equant anhedral and subhedral opaque oxide grains have been heavily but incompletely replaced by leucoxene and sphene, commonly with lattice textures. Prismatic mafic silicates (probably pyroxene or amphibole) have been pseudomorphed by light green chlorite, variable amounts of sericite and traces of sphene. Small acicular prisms of apatite are present in trace amounts.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-55%</td>
<td>sericite pseudomorphs of inferred plagioclase</td>
</tr>
<tr>
<td>15-20%</td>
<td>orthoclase, some lightly carbonated and sericitized</td>
</tr>
<tr>
<td>10-15%</td>
<td>sericite-chlorite-sphene pseudomorphs of inferred mafic silicates</td>
</tr>
<tr>
<td>10-15%</td>
<td>quartz</td>
</tr>
<tr>
<td>2-3%</td>
<td>opaque oxides, heavily replaced by leucoxene and sphene</td>
</tr>
<tr>
<td>tr</td>
<td>apatite</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This sample is interpreted with confidence to have originated as an intrusive micrographic quartz monzodiorite.

It has experienced heavy hydrothermal alteration to convert all plagioclase to sericite, all mafic silicates to sericite-chlorite-sphene, opaque oxides largely to leucoxene and sphene and to redden and lightly alter orthoclase to calcite and sericite.
Sample Number: CH DDH14 79.80m

Identification: Micrographic micro-adamellite with heavy alteration to sericite and sphene/leucoxene and with hematite pigmentation of K-feldspar

Description:

The sample is a drill core specimen which displays medium-grained moderate red rock grading sharply into altered rock with moderate red and dark greenish grey minerals cut by a 3mm wide fissure vein of quartz and chlorite.

A cobaltinite staining test revealed very abundant K-feldspar present as micrographic grains.

In thin section the main part of the sample is seen to be heavily sericitized but it displays hypidiomorphic, micrographic, granitoid textures with primary grainsizes mainly in the range from about 0.3 to 3mm.

Quartz is prominent as clear micrographic grains and a few anhedral grains. Orthoclase is very abundant as micrographic grains and anhedral grains, all pigmented with fine hematite, most lightly sericitized and some partly altered to calcite. Former small tabular and lath shaped grains of inferred plagioclase have been completely sericitized. Inferred mafic silicates are represented by aggregates of coarser sericite with traces of fine sphene. Inferred equant to subhedral titaniferous opaques have been completely altered to aggregates of fine cloudy sphene and leucoxene, commonly in lattice patterns. There are a few apatite grains.

The greenish part of the sample is a sharply gradational variant in which fine-grained chlorite accompanies sericite and sphene in pseudomorphs of more obvious mafic silicates.

The fissure vein is of zoned style, with thin zones of alternating quartz and chlorite and a core of coarser grained, "toothy" quartz.

An approximate mode of the main part of the sample is:

- 40-45% orthoclase, pigmented by hematite and lightly sericitized
- 30-35% quartz
- 20-30% sericite after inferred plagioclase and minor mafic silicates
- 1-2% sphene and leucoxene
- tr calcite
- tr apatite

Comments and Interpretations:

The bulk of the sample is confidently identified as having originated as micrographic micro-adamellite, trending close to granite. Its textures are quite consistent with an intrusion and not at all like those of a lava. Heavy hydrothermal alteration has completely sericitized inferred plagioclase and minor mafic silicates, completely altered ilmenite or titaniferous magnetite to sphene and leucoxene, and reddened and lightly sericitized orthoclase.
The greenish variant on one end of the specimen is similar adamellite, but with prominent chloritic pseudomorphs of mafic silicates. In the absence of information on larger scale relationships within the core it is not clear whether the chloritic rock is a gradational variant of the red adamellite or a host to a dyke of the red adamellite.
Sample Number : CH DDH14 109.20m

Identification : Micrographic microgranitoid rock with intense alteration to sericite, quartz, sphene and hematite pigment

Description :

The sample is a drill core specimen of greyish red, altered, medium-grained, crystalline rock, finely speckled with yellowish grey sphene.

A staining test produced some diffuse reaction but revealed no K-feldspar.

In thin section the sample is seen to be intensely altered, but plainly preserved textures are consistent with an hypidiomorphic, micrographic, granitoid rock with grain sizes commonly in the range from about 0.3 to 2mm.

Quartz is displayed partly as clear anhedral to micrographic primary grains and partly as finely hematite pigmented micrographic to anhedral, sericitic grains and overgrowths on clear quartz. Much of the sample consists of sericite, some of it pseudomorphing tabular to lath shaped grains of inferred plagioclase, some of it coarser and intergrown with sphene after inferred mafic silicates, and the rest of it in anhedral masses and veinlets. Specks of relatively coarse (up to 0.02mm) hematite pigment occur in some of the sericite. Former equant to platy titaniferous opaque oxides have been pseudomorphed by finely granular sphene. There are small acicular grains of primary apatite and rare secondary aggregates of bright green chlorite.

An approximate mode is :

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Mineral</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-55%</td>
<td>sericite</td>
</tr>
<tr>
<td>40-45%</td>
<td>quartz</td>
</tr>
<tr>
<td>2-3%</td>
<td>sphene</td>
</tr>
<tr>
<td>0.1-0.2%</td>
<td>apatite</td>
</tr>
<tr>
<td>0.2-0.3%</td>
<td>hematite pigment</td>
</tr>
<tr>
<td>rare</td>
<td>chlorite</td>
</tr>
</tbody>
</table>

Comments and Interpretations :

This rock is considered to have originated as a micrographic microgranitoid rock, probably of adamellite or granodiorite composition.

Intense hydrothermal alteration seems to have converted all plagioclase to sericite, K-feldspar to hematite pigmented quartz and minor sericite, mafic silicates to sericite and sphene, and titaniferous opaques to sphene. Rare small aggregates of bright green chlorite also formed.
Sample Number : CH DDH14 113.00m

Identification : Heavily hematite pigmented, mildly fractured micrographic microgranitoid rock with intense alteration to sericite, sphene and hematite pigmented quartz

Description :

The sample is a drill core specimen of dusky red, medium-grained altered rock, finely speckled with yellowish grey leucoxene or sphene

A cobaltinitrile staining test produced a diffuse reaction but revealed no K-feldspar.

In thin section the sample is seen to be intensely altered and heavily pigmented but remnant textures are plainly consistent with an hypidiomorphic, micrographic, microgranitoid rock with grainsizes commonly in the range from about 0.5 to 2mm.

Quartz occurs partly as clear grains, generally micrographically intergrown with sericite, and partly as hematite pigmented grains, some with simple anhedral shapes and some as overgrowths on clear micrographic quartz. There are many tabular to lath-shaped aggregates of sericite after probable plagioclase. Additional sericite occurs as anhedral aggregates and as vague pseudomorphs with fine sphene after probable mafic silicates. Former equant to subhedral titaniferous opaques have been pseudomorphed by aggregates of very cloudy sphene. There are some small apatite grains.

Hematite pigment coarser than that within quartz grains pervades the sample and crudely delineates an irregular pattern of mild fracturing.

An approximate mode is :

60-65% sericite
25-30% quartz
3-4% sphene
3-4% hematite pigment
tr apatite

Comments and Interpretations :

This rock is considered to have originated as a micrographic microgranitoid rock, probably of adamellite or granodiorite composition.

Intense hydrothermal alteration seems to have involved alteration of all plagioclase to sericite, K-feldspar variously to sericite or to hematite pigmented quartz, mafic silicates to sericite and sphene, and ilmenite or titaniferous magnetite to cloudy sphene. Mild fracturing accompanied or succeeded the sericitic alteration and facilitated the development of a coarser style of pervasive hematite pigmentation than that seen in the inferred secondary quartz.
Sample Number : CH DDH14 151.15m

Identification : Heavily hematite pigmented, quartz-rich microdiorite or similar rock with intense alteration to sericite, sphene/leucoxene, green mica and probably quartz

Description :

The sample is a drill core specimen of dusky red, medium-grained, altered rock, finely speckled with yellowish grey leucoxene or sphene.

A cobaltinitriite staining test produced a diffuse reaction but revealed no K-feldspar.

In thin section the sample is seen to be intensely altered and heavily, inhomogeneously pigmented by hematite. Remnant primary textures are consistent with an hypidiomorphic, igneous rock with grainsizes mainly in the range from about 0.4 to 1.5mm.

In the least pigmented parts of the rock quartz occurs as anhedral clear grains and as anhedral, sericitic, very finely hematite pigmented grains. Tabular to prismatic grains of inferred plagioclase and mafic silicates are represented by aggregates of sericite and variable amounts of sericite, another mica pleochroic from colourless to green, and minor cloudy sphene; the distinction between inferred plagioclase and inferred mafic silicate grains has been blurred. There are a few remnants of brown biotite. Former equant opaque oxides have been pseudomorphed by cloudy sphene and leucoxene.

In gradational zones of denser pigmentation the altered titaniferous opaques have been densely hematized and additional, relatively coarse pigment has pervaded the rock. A single 0.3mm wide fissure vein with a lining of sericite and a core of quartz has been cut by hematized microfractures.

An approximate mode is :

60-70% sericite
10-15% quartz
8-12% green mica
5-7% sphene and leucoxene
4-6% hematite
0.1% apatite

Comments and Interpretations :

Remnant textures indicate that this rock originated as a medium-grained intrusive igneous rock. It was probably quartz diorite or some similar rock type. There are no satisfactory indications on which to conclude whether the rock carried K-feldspar prior to alteration.

Intense hydrothermal alteration has generated sericite, a fine green mica, sphene/leucoxene and probably some hematite pigmented quartz. The only primary minerals preserved are quartz, apatite and rare remnants of brown biotite. Heavy pigmentation by hematite appears to post-date the main alteration, since sphene/leucoxene aggregates are seen in various states of hematization and since some hematitic veinlets cross a fissure vein of sericite and quartz.
Sample Number : G18 1120

Identification : Slightly pigmented porphyritic rhyolite with intense sericitization and probably some silicification

Description : The sample is a hand specimen of greyish orange pink, fine-grained rock with small, grey quartz phenocrysts and olive grey, altered phenocrysts.

A cobaltinitrite staining test revealed no K-feldspar.

In thin section the sample displays a simple porphyritic texture, and vague suggestions of flow banding. Quartz forms smoothly corroded subhedral phenocrysts, about 0.3 to 2mm in size. Tabular phenocrysts of inferred feldspar have been pseudomorphed by sericite. Coarse sericite with traces of sphene suggests rare phenocrysts of former biotite. The groundmass consists of anhedral quartz grains, about 0.03 to 0.05mm in size, and aggregates of fine sericite. Much of the quartz is faintly pigmented by ultra-fine hematite.

A few cubic aggregates of hematite, about 0.1mm in size, suggest the former presence of pyrite.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3%</td>
<td>quartz phenocrysts</td>
</tr>
<tr>
<td>3-4%</td>
<td>sericite pseudomorphs of inferred feldspar phenocrysts</td>
</tr>
<tr>
<td>rare</td>
<td>sericite-sphene pseudomorphs of inferred biotite phenocrysts</td>
</tr>
<tr>
<td>40-45%</td>
<td>groundmass quartz</td>
</tr>
<tr>
<td>40-45%</td>
<td>groundmass sericite</td>
</tr>
<tr>
<td>tr</td>
<td>hematite after probable disseminated pyrite</td>
</tr>
</tbody>
</table>

Comments and Interpretations :

This sample is interpreted to have originated as porphyritic rhyolite, probably of extrusive origin.

It has experienced intense sericitization and probably some silicification to destroy all feldspar and mafic silicates. Probably a very few grains of fine pyrite were present prior to oxidation to hematite. The whole rock is slightly pigmented by hematite.
PETROLOGICAL REPORT ON TWELVE SAMPLES
FROM CORONATION HILL, N.T.

prepared for

BHP COMPANY LIMITED

Order No. : Q97260
Ref : F. Leckie

Stan Joyce
A. S. Joyce, B.Sc.(Hons), Ph.D.
1. Two samples (DDH15 at 66.50m and 85.60m) represent intensely altered, unwelded, acid vitric crystal tuff. One contains traces of pyrite.

If field relationships negate an interpretation that the samples are likely to represent a terrestrial ashflow, then an alternative possibility is that they represent the feeder system to an ashflow.

2. Four samples (DDH15 at the pad, at 22.0m and 22.4m and DDH16 at 45.5m) represent similar types of intensely altered porphyrytic microdiorite or quartz-bearing dolerite. They carry no sulphides. The three shallowest samples have minor hematitic pigmentation, possibly of weathering origin. The deepest sample has black selvedges of probable manganese oxide developed by hydrothermal processes adjacent to quartz-chlorite veinlets. The black mineral is probably analogous to that recorded previously in DDH13 at 20.60m, 28.15m and 93.4m.

3. The remaining six samples are breccias of diverse type.

The four breccias from DDH15 at 71.00m, 92.25m, 122.50m and 124.80m all involve angular clasts of altered rhyolite. The shallowest sample has a matrix of altered acid tuff and perhaps it is part of the feeder system to acid ashflows. The deepest sample also has suggestions of a tuffaceous matrix, heavily overprinted by fine silicification and abundant probable dumortierite, a boron mineral. The other two rhyolitic breccias have hydrothermal cements rather than a clastic matrix. Minor pyritic mineralization occurs in the three shallowest rhyolitic breccias.

The breccia from DDH16 at 109.55m consists of clasts of intensely altered porphyrytic basalt or fine dolerite cemented by calcite with some silica and hematite. It carries no sulphides.

The remaining breccia from a deep location (DDH15 at 150.30m) is a sedimentary style of breccia, composed of immature clasts of richly carbonaceous phyllite and fine quartzite or recrystallized chert.
Sample Number : CH DDH15 Pad

Identification : Porphyritic microdiorite or dolerite, intensely altered to sericite, chlorite and sphene

Description :

The sample consists of two hand specimens, one composed of moderate red highly weathered rock and the other of less weathered, weakly hematite pigmented olive grey rock with similar fine to medium-grained textures. The least weathered specimen was sectioned.

A staining test revealed no K-feldspar.

In thin section the sample is seen to be intensely hydrothermally altered. Moderately preserved primary textures are consistent with a porphyritic basic or intermediate igneous rock with many subhedral phenocrysts, about 1mm in size, set in an hypidiomorphic groundmass formerly rich in laths and prisms about 0.2mm long.

Some lath shaped phenocrysts and groundmass grains consist solely of sericite and were probably plagioclase. Many other prismatic grains consist of sericite and pale green chlorite and have features suggestive of former pyroxene. Many other grains have also been replaced by sericite and chlorite but their origins cannot be interpreted with confidence. Former titaniferous oxides, about 0.2mm in size have been pseudomorphed by aggregates of cloudy sphene. There are a few anhedral grains of quartz of apparently remnant primary origin.

Mild limonitic/hematitic staining pervades the rock.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Mineral</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-80%</td>
<td>sericite</td>
</tr>
<tr>
<td>20-25%</td>
<td>chlorite</td>
</tr>
<tr>
<td>1-3%</td>
<td>sphene</td>
</tr>
<tr>
<td>0.5-1%</td>
<td>quartz</td>
</tr>
<tr>
<td>0.2-0.3%</td>
<td>limonite/hematite staining</td>
</tr>
</tbody>
</table>

Comments and Interpretations :

This sample is interpreted to have originated as porphyritic pyroxene microdiorite or dolerite. It carried a small amount of quartz. Intense hydrothermal alteration has destroyed all primary minerals except quartz and produced sericite, chlorite and sphene. It has since been stained by incipient weathering.
Sample Number: CH DDH15 22.0m

Identification: Porphyritic microdiorite or dolerite, intensely altered to chlorite, sericite and sphene

Description:

The sample is a drill core specimen of fine to medium grained, greyish red rock with light olive speckles.

A staining test revealed no K-feldspar.

In thin section the sample is seen to be intensely hydrothermally altered. Moderately preserved primary textures are consistent with a porphyritic basic or intermediate igneous rock with many subhedral phenocrysts, about 1 to 2mm in size, set in an hypidiomorphic groundmass formerly rich in laths and prisms about 0.2mm long.

Many of the phenocrysts and groundmass prisms have shapes and alteration textures suggestive of former pyroxene, now altered to pale chlorite and in some cases partly to sericite. Some other tabular to lath-shaped grains resemble former plagioclase, now replaced by chlorite and sericite. Former groundmass grains of inferred titaniferous oxide have been pseudomorphed by aggregates of cloudy sphene. There are some groundmass grains of apparently primary quartz.

Mild hematitic pigmentation pervades the rock, especially outlining grain boundaries and fractures.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Mineral</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-75%</td>
<td>chlorite</td>
</tr>
<tr>
<td>20-25%</td>
<td>sericite</td>
</tr>
<tr>
<td>2-3%</td>
<td>quartz</td>
</tr>
<tr>
<td>2-3%</td>
<td>sphene</td>
</tr>
<tr>
<td>0.2-0.3%</td>
<td>hematite pigment</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This sample is interpreted to have originated as porphyritic pyroxene microdiorite or dolerite. Intense hydrothermal alteration has obliterated all primary minerals except the minor quartz. Certainly the rock seems to have been quite rich in pyroxene, but in the absence of satisfactory estimates of the original mafic index or of the original feldspar compositions, no discrimination can be attempted between microdiorite and quartz dolerite.

This sample probably represents the same rock unit as the sample from the pad at DDH15, but it carries more chlorite at the expense of sericite. Pervasive hematitic pigmentation may be a product of weathering.
Sample Number: CH DDH15 22.4m

Identification: Porphyritic microdiorite or dolerite, intensely altered to chlorite, sericite and sphene

Description:

The sample is a drill core specimen of dark greenish grey, fine to medium-grained rock with patches of moderate red alteration, some in narrow zones around irregular tight fractures.

A staining test revealed no K-feldspar.

In thin section the sample is seen to be intensely hydrothermally altered. Moderately preserved primary textures are consistent with a porphyritic basic or intermediate igneous rock with many subhedral phenocrysts, about 1 to 2mm in size, set in an hypidiomorphic groundmas formerly rich in laths and prisms about 0.2mm long.

Many of the phenocrysts have shapes and alteration textures suggestive of former pyroxene, now altered to chlorite, accompanied by sericite in some cases. The groundmass appears to have additional chloritised pyroxene and completely sericitized chloritized plagioclase. There are grains of apparently primary quartz and very cloudy sphene aggregates after inferred titaniferous oxide grains.

Mild hematitic pigmentation occurs throughout the rock, especially around grain boundaries and along microfractures. It is slightly more abundant near a tight fracture vein which carries goethite.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Mineral</th>
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<tbody>
<tr>
<td>65-70%</td>
<td>chlorite</td>
</tr>
<tr>
<td>25-30%</td>
<td>sericite</td>
</tr>
<tr>
<td>2-3%</td>
<td>quartz</td>
</tr>
<tr>
<td>2-3%</td>
<td>sphene</td>
</tr>
<tr>
<td>0.1-0.2%</td>
<td>hematite pigment and goethite veins</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This sample is interpreted to be intensely chloritized and sericitized porphyritic microdiorite or quartz dolerite, quite comparable to the sample from 22.0m in DDH15, but with less homogeneous and less obvious iron oxide pigmentation.

It seems quite likely that the variations in colour of the samples from the pad, 22.0m and 22.4m are attributable to varying degrees of recent weathering of the chloritic mineral assemblages.
Sample Number : CH DDH15 66.50m

Identification : Carbonated and intensely sericitized acid, unwelded, vitric crystal tuff

Description :

The sample is a pitted and disintegrating drill core specimen of coarsely tuffaceous rock which displays large quartz phenocrysts, yellowish green and moderate red altered lithic clasts, yellowish green sericitized vitric and mineral clasts and a moderate orange pink matrix.

A staining test revealed no K-feldspar.

In thin section the sample plainly displays acid tuffaceous textures. There are many smoothly corroded and some broken quartz phenocrysts, about 0.1 to 7mm in size. Many ragged clasts of pumiceous appearance, a fraction of a millimetre to at least 10mm in size, have been completely altered to sericite and some calcite. Tabular phenocrysts which were probably feldspar have been pseudomorphed by calcite and minor sericite and quartz. Lithic clasts include sericite-quartz schist (metapelite), silicified porphyritic rhyolite and sericitized, carbonated intermediate porphyry and carbonated quartz sandstone. The matrix has many unwelded vitroclastic textures but now consists of fine sericite and fine quartz (a few microns grain size). Very fine hematite and rutile are trace components of various clasts and the matrix.

An approximate mode is:

- 8-10% quartz phenocrysts
- 4-6% carbonated pseudomorphs of inferred feldspar phenocrysts
- 20-25% sericitized and carbonated pumiceous clasts
- 5-7% lithic clasts of various altered rock types
- 50-60% vitroclastic matrix of sericite and fine quartz

Comments and Interpretations :

This sample is considered to represent relatively coarse acid tuff of unwelded ashflow style. Deposition was probably terrestrial, otherwise the pumiceous clasts might be expected to have floated clear of the crystal and massive vitric components. If the field relationships do not favour the interpretation that the sample is part of an ashflow, then it must be part of a feeder system to an ashflow.

The rock has experienced intense alteration to a sericite-carbonat assemblage and there has been mild hematitic pigmentation. The disintegrating nature of the hand specimen suggests that the sericite may be a mixed layer illite-smectite or at least an illite rather than white mica.
Sample Number: CH DDH15 71.00m

Identification: Altered, faintly mineralized breccia of rhyolitic clasts in an acid tuffaceous matrix

Description:

The sample is a drill core specimen of breccia, displaying a disrupted framework of greyish olive, angular clasts of fine-grained rock, a fraction of a millimetre to about 35mm in size, set in a prominent matrix with a yellowish grey colour.

A staining test revealed no K-feldspar.

In thin section the angular clasts are seen to display simple porphyritic textures with sparse phenocrysts and altered phenocrysts, up to about 1mm in size, set in an altered, flow-banded groundmass of anhedral grains about 0.02mm in size. The most obvious phenocrysts are smoothly corroded quartz. Tabular phenocrysts of inferred feldspar have been replaced by sericite and grey green chlorite and prismatic mafic silicates have been replaced by sericite and (?)rutile. The groundmass consists of quartz, sericite, very fine (?)rutile and traces of calcite.

The matrix between the large clasts resembles altered, unwelded acid vitric crystal tuff. There are corroded and broken phenoclasts of quartz (ranging up to 1mm), sericitized and carbonated tabular clasts of inferred feldspar (up to 1mm), many ragged, sericitized and carbonated pumiceous clasts (up to 3mm) and a very finely siliceous (few microns), lightly sericitic vitroclastic matrix with many remnant textures of unwelded, small vitric shards.

There are traces of partly oxidized fine pyrite in the tuffaceous matrix. Veinlets of calcite cut the matrix and the clasts.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-50%</td>
<td>angular clasts of altered rhyolite</td>
</tr>
<tr>
<td>50-55%</td>
<td>acid tuffaceous matrix</td>
</tr>
<tr>
<td>1-2%</td>
<td>calcite veins</td>
</tr>
</tbody>
</table>

The altered rhyolite consists of about:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3%</td>
<td>quartz phenocrysts</td>
</tr>
<tr>
<td>1-2%</td>
<td>inferred feldspar phenocrysts, altered to sericite and chlorite</td>
</tr>
<tr>
<td>0.1-0.2%</td>
<td>inferred mafic phenocrysts, altered to sericite and (?)rutile</td>
</tr>
<tr>
<td>30-40%</td>
<td>groundmass quartz</td>
</tr>
<tr>
<td>55-65%</td>
<td>groundmass sericite</td>
</tr>
<tr>
<td>tr</td>
<td>groundmass rutile and carbonate</td>
</tr>
</tbody>
</table>

The tuffaceous matrix consists of about:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3%</td>
<td>quartz phenocrists</td>
</tr>
<tr>
<td>2-3%</td>
<td>phenocrysts altered to sericite and calcite</td>
</tr>
<tr>
<td>20-30%</td>
<td>pumiceous clasts, altered to sericite and carbonate</td>
</tr>
<tr>
<td>65-75%</td>
<td>vitroclastic matrix of quartz and sericite</td>
</tr>
<tr>
<td>0.1%</td>
<td>partly oxidized pyrite</td>
</tr>
</tbody>
</table>
Comments and Interpretations:

This sample is a breccia, composed of a disrupted framework of intensely sericitized, fine, porphyritic rhyolite and an altered acid tuffaceous matrix. The matrix is sericitized, carbonated and finely silicified and carries traces of partly oxidized pyrite.

This breccia seems likely to be part of an altered feeder system passing through a rhyolite lava flow to erupt acid ashflow tuff. An alternative, less likely, explanation is that it represents the base of an acid ashflow developed on top of rhyolite lava. The matrix is finer than, but similar to the tuff represented at 66.50m and 85.60m in DDH15.
Sample Number: CH DDH15 85.60m

Identification: Silicified, carbonated, chloritized and sericitized acid, unwelded vitric crystal tuff with minor disseminated clusters of pyrite

Description:

The sample is a drill core specimen which displays coarsely acid tuffaceous textures. Light grey phenocrysts of quartz and light olive grey and dark grey altered lithic pumiceous and mineral clasts are set in a medium light grey matrix with patches of greyish orange carbonate alteration.

A cobaltinitrite staining test produced a yellow stain in several sericitized clasts, but revealed no definite K-feldspar.

In thin section the sample displays plainly tuffaceous textures of unwelded acid ashflow style. There are many quartz phenocrysts, about 0.1 to several millimetres in size, variously smoothly corroded or broken. Tabular clasts which were probably feldspar (up to 7mm) have been replaced by mosaics of quartz, with remnants of sericite and calcite in some cases. Ragged pumiceous clasts, a fraction of a millimetre to at least 10mm in size have been replaced by sericite, calcite and inconspicuous grey green chlorite. Lithic clasts include sericite-rutile pseudomorphs of microdiorite, sericite schist and sericitized porphyritic rhyolite. The vitriclastic matrix has many remnant textures of unwelded vitric shards, but now consists of very fine quartz and subordinate sericite.

There are many inconspicuous veinlets of fine quartz and several wider veins (up to 2mm) of partly replacement and partly fissure filling style, containing quartz and calcite. Fine pyrite (0.005 to 0.1mm) occurs sparsely as clusters in some altered clasts.

An approximate mode is:

- 7-9% quartz phenocrysts
- 4-6% silicified pseudomorphs of inferred feldspar phenocrysts
- 20-25% sericitized, carbonated and chloritized pumiceous clasts
- 3-5% lithic clasts of various altered rock types
- 50-60% vitriclastic matrix, now quartz and sericite
- 1-2% veins of quartz and calcite
- 0.1-0.2% pyrite

Comments and Interpretations:

This sample is considered to represent relatively coarse acid tuff of unwelded ashflow style, probably the same unit as DDH15 at 66.50m. The intense alteration style is different in featuring silicification, chloritization and minor pyrite in addition to sericite and calcite development.
Sample Number : CH DDH15 92.25m

Identification : Breccia of heavily sericitized rhyolite clasts with chloritic and pyritic selvedges and cemented by sericite-chlorite-calcite-quartz

Description :

The sample is a drill core specimen of breccia, displaying angular clasts of altered rhyolite, a fraction of a millimetre to about 50mm in size, cemented by a small amount of white carbonate and other minerals. The clasts of inferred rhyolite are banded and finely mottled in greenish grey and greyish orange colours.

A cobaltinitrite staining test produced diffuse reaction with the clasts, but revealed no definite K-feldspar.

In thin section the clasts are seen to be heavily altered but primary textures involve phenocrysts up to 1mm in size set in an allotriomorphic groundmass, about 0.03mm in grainsize. The phenocrysts are quartz, finely sericitized feldspar and a few more coarsely sericitized mafic silicates set in a groundmass of quartz and sericite, chlorite and specks of (?)sphene and extremely fine hematite.

Within about 1 to 2mm of their margins the rhyolitic clasts are darkened by very fine grey green chlorite and disseminated specks of pyrite, about 0.02mm in grainsize.

Between the clasts there is a cement, dominated by calcite but with an apparent paragenetic sequence involving margins of sericite and chlorite passing in to calcite, then minor quartz. A few tiny grains of pyrite occur in the cement and mainly pre-date calcite.

An approximate mode is :

82-88% clasts of heavily sericitized, mildly chloritized and probably silicified rhyolite
0.1-0.3% pyrite in chloritized selvedges
12-18% cement of sericite-chlorite-calcite-quartz with traces of pyrite

Comments and Interpretations :

This sample is interpreted to be a hydrothermal breccia. Heavily sericitized and probably silicified rhyolite lava has been expansively brecciated then cemented by hydrothermal minerals involving a paragenetic sequence from sericite and chlorite (with traces of pyrite) to major calcite then minor quartz. Thin chloritic alteration selvedges developed adjacent to the cement and were impregnated with very fine pyrite.
Sample Number: CH DDH15 122.50m

Identification: Breccia of heavily sericitized, moderately silicified and carbonated rhyolite clasts with chloritic selvedges, cemented by fine silica-sericite-chlorite-quartz and veined by quartz and calcite

Description:

The sample is a drill core specimen of breccia, displaying angular clasts of moderate orange pink, altered rhyolite, a fraction of a millimetre to about 70mm in size, set in a prominent medium grey matrix.

A cobaltinitrite staining test produced a stain suggestive of abundant fine K-feldspar in the rhyolitic clasts.

In thin section the rock is seen to be heavily hydrothermally altered and recrystallized but breccia textures are plainly visible and porphyritic rhyolitic textures are moderately preserved in the clasts.

The least modified parts of the rhyolitic clasts display corroded phenocrysts of quartz, up to 1.5mm in size, and coarsely silicified tabular phenocrysts of inferred feldspar set in a groundmass of quartz and possible feldspar, about 0.03mm in grain size, along with sericite and sphene. More heavily modified regimes feature sutured, poikiloblastic mosaics of quartz, about 0.4mm in grain size, and similar mosaics of calcite. Margins of clasts are slightly chloritic.

Between the rhyolitic clasts there is a cement of very finely cherty quartz, grading locally into cavity fillings of sericite and chlorite passing into relatively coarse quartz (0.1 to 0.4mm grain size). There are some late, thin fissure veins of quartz and of calcite with minor quartz.

Rare tiny specks of pyrite occur in altered clasts and in the sericitic regime of the cement.

An approximate mode is:

70-80% clasts of heavily sericitized, moderately silicified and carbonated rhyolite
20-30% cement of fine silica-sericite-chlorite-quartz
1-2% veins of quartz and calcite
rare pyrite

Comments and Interpretations:

This sample is interpreted to be a hydrothermal breccia, similar to that at 92.25m in DDH15. Heavily sericitized, moderately silicified and carbonated rhyolite clasts are set in a hydrothermal cement or fine silica grading to sericite and chlorite then relatively coarse quartz. Fissure veins of quartz and of calcite with quartz may be further progressions. Chloritic alteration selvedges are inconspicuously developed in the clasts. Pyrite is rare.
Sample Number: CH DDH15 124.80m

Identification: Breccia of intensely sericitized and silicified rhyolitic clasts set in a probably tuffaceous matrix which now consists of very fine silica and abundant dumortierite.

Description:

The sample is a drill core specimen of breccia which displays angular clasts of altered rhyolitic rock, about 1 to 60mm in size, set in a medium grey matrix. The rhyolitic clasts are mainly greyish orange, but several have reddish cores or internal zones; one has a pale olive core enveloped by a reddish zone.

A cobaltinitrite staining test produced only diffuse reaction in the clasts.

In thin section the angular clasts are seen to consist of a few phenocrysts of quartz (less than 1mm) and of sericitized inferred feldspar set in a fine groundmass of quartz (0.02mm grainsize) and sericite; patches in the clasts are more coarsely silicified (sutured poikiloblastic grains 0.1 to 0.2mm). There is faint pigmentation.

The matrix between the clasts consists of very fine, chalcedonic quartz (less than about 0.005mm grainsize) with patches of fine sericit and with quite prominent rosettes and sheafs of a colourless mineral which is thought to be dumortierite. The dumortierite grains are acicular and less than about 0.05mm long. In places there are ghost textures which suggest that prior to fine silicification some of the matrix had vitric tuffaceous textures. A few clasts of quartz support the interpretation. There are also several cavity fillings of relatively coarse quartz (up to 1.5mm) with tiny radial aggregates of dumortierite.

An approximate mode is:

- 60-65% clasts of intensely sericitized and silicified rhyolite
- 20-30% fine matrix silica
- 8-10% matrix dumortierite
- 2-3% matrix sericite
- 0.1% matrix clasts of quartz
- 1-2% cavity fillings of quartz and dumortierite

Comments and Interpretations:

This sample is considered to be a breccia generated by expansive disruption of intensely sericitized and silicified rhyolite lava. A matrix of vitric tuffaceous style was probably introduced, but then intensely replaced by fine silica (probably chalcedonic) with abundant fine dumortierite. Quartz and dumortierite filled a few residual cavities.

Perhaps this breccia represents a somewhat style transitional between the cemented style of the samples from 92.25m and 122.50m in DDH15 and the mainly clastic style of the sample from 71.00m in DDH15, where a distinctly tuffaceous matrix fills the spaces between altered rhyolitic clasts. The abundant dumortierite is a distinctive feature.
Sample Number: CH DDH15 150.30m

Identification: Sedimentary breccia of carbonaceous phyllite and fine quartzite or recrystallized chert

Description:

The sample is a drill core specimen which consists of densely packed, angular and surrounded clasts, a fraction of a millimetre to about 10mm in size. The clasts are variously very dark grey or light grey.

A staining test revealed no K-feldspar.

In thin section the sample displays an epiclastic style of breccia texture, with densely packed angular and surrounded lithic clasts ranging from sand sizes at least as small as 0.1mm to pebble sizes as large as 10mm.

The light grey clasts resemble fine quartzite or recrystallized chert. The dark clasts are abundantly finely carbonaceous rocks with finely siliceous, phyllite textures. There is neither a distinct cement in the rock nor a distinct matrix. The poorly to moderately sorted clasts are densely packed. A few grains of pyrite occur in several quartzite clasts.

A 2mm wide zone on one edge of the section displays intense sericitization of formerly graphitic slate. The alteration corresponds with a zone a few millimetres wide in the core.

A few thin fissure veins (0.2mm wide) of quartz cut the rock and its sericitized zone. They carry traces of apatite.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-70%</td>
<td>clasts of carbonaceous phyllite</td>
</tr>
<tr>
<td>30-40%</td>
<td>clasts of fine quartzite or recrystallized chert</td>
</tr>
<tr>
<td>1-2%</td>
<td>sericitized clasts in a narrow alteration zone</td>
</tr>
<tr>
<td>0.3-0.4%</td>
<td>veins of quartz with apatite</td>
</tr>
<tr>
<td>0.1%</td>
<td>pyrite in siliceous clasts</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This sample is interpreted to be a sedimentary breccia composed of clasts of richly carbonaceous phyllite and fine quartzite or recrystallized chert. A few specks of pyrite occur in the siliceous clasts, but not in the phyllite. Intense sericitization has eliminated carbonaceous matter in an inconspicuous narrow zone of alteration and there are some later, thin fissure veins of quartz with apatite.
Sample Number: CH DDH16 45.50m

Identification: Intensely sericitized and chloritized microdiorite or dolerite cut by quartz-chlorite veins with selvedges of probable manganese oxide

Description:

The sample is a drill core specimen of dark greenish grey, fine to medium-grained, altered rock with tight joints and associated, thin black selvedges. Two joint surfaces on the specimen are chloritic and slickensided.

A staining test produced some diffuse reaction, but revealed no K-feldspar.

In thin section the sample is seen to be intensely hydrothermally altered. Poorly preserved primary textures are consistent with a porphyritic basic or intermediate igneous rock with subhedral phenocrysts, about 1mm in size, set in an hypidiomorphic groundmass with laths and prisms about 0.2mm long.

Phenocrysts altered mainly to pale green chlorite have textures suggestive of former pyroxene, whereas others composed mainly of sericite resemble former plagioclase. The groundmass has grains variously altered to chlorite and sericite. There are some grains of apparently primary quartz and many formerly opaque oxide grains, now altered to very cloudy sphene and leucoxene.

The black selvedges noted in hand specimen are seen to be thin zones of impregnation by earthy opaques, probably manganese oxides, adjacent to thin fracture veins carrying quartz, chlorite and minor opaques. The veins are about 0.2 to 0.5mm wide and the selvedges are a fraction of a millimetre to about 2mm wide. Within the selvedges the black mineral shows a preference for microfractures. Several barren thin fissure veins of quartz post-date the selvedges.

An approximate mode is:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Mineral</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-70%</td>
<td>sericite</td>
</tr>
<tr>
<td>25-30%</td>
<td>chlorite</td>
</tr>
<tr>
<td>1-2%</td>
<td>quartz</td>
</tr>
<tr>
<td>2-3%</td>
<td>sphene/leucoxene</td>
</tr>
<tr>
<td>0.5-1%</td>
<td>veins of chlorite-quartz-opaque</td>
</tr>
<tr>
<td>1-2%</td>
<td>selvedges of earthy opaques (probably manganese oxide)</td>
</tr>
<tr>
<td>0.2-0.3%</td>
<td>barren veins of quartz</td>
</tr>
</tbody>
</table>

Comments and Interpretations:

This sample is interpreted to have originated as porphyritic pyroxene microdiorite or dolerite. It has undergone intense hydrothermal alteration to produce sericite, chlorite and sphene/leucoxene.

Fissure veinlets of quartz with chlorite and an opaque mineral (probably a manganese oxide) have associated selvedges impregnated with an earthy opaque mineral (probably manganese oxide). The probable manganese oxide is of hydrothermal origin and it is cut by some barren quartz veins.
Sample Number: CH DDH16 109.55m

Identification: Breccia of intensely altered porphyritic basalt or fine dolerite clasts cemented by calcite with minor quartz and traces of hematite

Description:

The sample is a drill core specimen of breccia, displaying angular olive, altered, fine to medium-grained lithic clasts, about 1 to 80mm in size, cemented by white carbonate and minor quartz. There are a few moderate orange pink spots and veinlets in the lithic clasts and several white calcite fissure veins cut the clasts and the cement.

A staining test revealed no K-feldspar.

In thin section the clasts are seen to be intensely altered, but primary igneous textures are well preserved and are consistent with a distinctly porphyritic volcanic or subvolcanic rock of probably basic composition. Many subhedral prismatic phenocrysts, about 0.2 to 1.5mm in size, are set in an hypidiomorphic groundmass with laths and prisms about 0.1mm long.

The phenocrysts have shapes quite consistent with pyroxene, but they have been pseudomorphed by cherty or fine quartz with chlorite and calcite. The groundmass consists of chloritized grains of inferred pyroxene, chloritized-sericitized grains of inferred plagioclase and sphene or rutile aggregates after inferred opaques. There is no obviously primary quartz. Hematite forms a few veinlets and patches.

Between the clasts there is a cement composed mainly of calcite. In places it is accompanied by some early, fine cherty quartz with faint hematite pigmentation. Some earthy hematite also occurs locally in massive calcite. There are a few examples of coarser quartz at the core of calcite fillings.

An approximate mode of the bulk rock is:

- 88-92% clasts of altered basalt or fine dolerite
- 8-12% cement of calcite with minor quartz and hematite

An approximate mode of the clasts is:

- 20-25% inferred pyroxene phenocrysts, replaced by cherty and fine quartz with chlorite and calcite
- 35-45% groundmass chlorite
- 30-35% groundmass sericite
- 3-4% groundmass sphene or rutile
- 0.1% hematite pigment

Comments and Interpretations:

This sample is considered to be a hydrothermal breccia generated by disruption and carbonate cementation of altered porphyritic basalt or fine dolerite.

The inferred basalt/dolerite is finer grained than the three microdiorite/dolerite samples from DDH15 and that from 45.50m in DDH16 and it carries no obvious primary quartz.

Alteration in the basalt/dolerite involves pervasive chlorite and sericite along with very obvious silicification and carbonate development in the phenocrysts. Carbonate and silica characterise the cement in the breccia.
APPENDIX 4

Geophysical Logging
THE BROKEN HILL PROPRIETARY COMPANY LIMITED

BRISBANE

MEMO FROM: DOUG PRICE

MEMO TO: F. LECKIE

FOR ATTENTION BY:

SUBJECT: E8/16/3-K : CORONATION HILL - GEOPHYSICAL LOGGING

10 December 1985

Diamond drillholes DDH5 to DDH16 were geophysically logged in two stages:

(a) DDH5 to DDH10 were logged in August 1985
(b) DDH11 to DDH16 were logged in November 1985.

All the above holes were logged with an SIE T500 digital logging unit, with the data being stored on Phillips' type data cassettes. For presentation the data were transferred to Hewlett Packard data cassettes and then plotted on a flat bed plotter.

The aim of the logging was to identify intersections of radioactive rocks. Electric logging (S.P. and resistance) which involved very little extra cost was run to obtain rock boundary data with the added benefit of determining depth to water table.

LOGGING SUMMARY

<table>
<thead>
<tr>
<th>Hole</th>
<th>Electric</th>
<th>Gamma</th>
<th>S/N Gamma Tool</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDH5</td>
<td>Complete</td>
<td>Complete</td>
<td>780</td>
<td>Hole blocked at 44m</td>
</tr>
<tr>
<td>DDH6</td>
<td>Complete</td>
<td>0-44m</td>
<td>780</td>
<td></td>
</tr>
<tr>
<td>DDH7</td>
<td>Complete</td>
<td>Complete</td>
<td>780</td>
<td></td>
</tr>
<tr>
<td>DDH8</td>
<td>Complete</td>
<td>Complete</td>
<td>780</td>
<td></td>
</tr>
<tr>
<td>DDH9</td>
<td>Nil</td>
<td>Complete</td>
<td>780</td>
<td></td>
</tr>
<tr>
<td>DDH10</td>
<td>Nil</td>
<td>Complete</td>
<td>780</td>
<td>Electric probe too light for 45° holes see later</td>
</tr>
<tr>
<td>DDH11</td>
<td>Complete</td>
<td>Complete</td>
<td>1131</td>
<td></td>
</tr>
<tr>
<td>DDH12</td>
<td>Complete</td>
<td>Complete</td>
<td>1131</td>
<td></td>
</tr>
<tr>
<td>DDH13</td>
<td>Complete</td>
<td>6m-145m</td>
<td>1131</td>
<td>Probe jammed behind casing</td>
</tr>
<tr>
<td>DDH14</td>
<td>Complete</td>
<td>Complete</td>
<td>1131</td>
<td></td>
</tr>
<tr>
<td>DDH15</td>
<td>Complete</td>
<td>Complete</td>
<td>1131</td>
<td></td>
</tr>
<tr>
<td>DDH16</td>
<td>Complete</td>
<td>Complete</td>
<td>1131</td>
<td></td>
</tr>
</tbody>
</table>

The electric probe used in the first phase of logging had insufficient weight to fall down the angled holes DDH9 and DDH10.

Following the first phase of logging, gamma probe no. 780 was calibrated in the test pits at ANDEL in Adelaide. If we assume that all the radioactivity is due to uranium and its decay products, and provided that the uranium is in equilibrium, then the following approximations hold

<table>
<thead>
<tr>
<th>Count rate</th>
<th>Grade %e U-238</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 cps</td>
<td>0.05%</td>
</tr>
<tr>
<td>5000 cps</td>
<td>0.23%</td>
</tr>
<tr>
<td>10,000 cps</td>
<td>0.46%</td>
</tr>
<tr>
<td>20,000</td>
<td>1.02%</td>
</tr>
<tr>
<td>28,000 (obtained in DDH7)</td>
<td>1.74%</td>
</tr>
</tbody>
</table>

.../2
0.92\% \text{ } \text{U}_3\text{O}_8 \text{ is the highest grade test pit at AMDEL. Calculated equivalent grades above this figure are not reliable.}

For the second phase of logging the same calibrated probe was taken to Coronation Hill, however, the probe was badly damaged in transit. A replacement probe was obtained and this was fortunately a combined gamma/electric tool which with its added weight enabled electric logs to be run down the angled holes DDH11 to DDH16. As this probe has not yet been calibrated no grades can be assigned to the results for these latter holes.

Results

(a) Gamma Logs

As the main purpose of the logging was to identify sections of high radioactivity, the gamma logs were plotted at a coarse scale of 0 to 5000 cps. This unfortunately suppresses any lithological character in the logs, however with the data stored digitally the logs can be replotted at any future date.

The maximum count rate of 28247 cps was observed in DDH7, which, subject to assumptions given earlier equates to an equivalent grade of 1.7\% \text{ } \text{U}_3\text{O}_8. This figure was exceptional as all the high intervals were less than 5000 cps.

Given the history of uranium production from Coronation Hill it is likely that uranium is responsible for the radioactivity but until the intervals are assayed this is supposition.

(b) Electric Logs

The water level in each hole can easily be read from the logs. As the holes had been drilled at least a week before logging this level is expected to approximate the standing water table. You will note that this level is only 4-6\text{m} below the surface in holes DDH11 to DDH14.

The resistance logs show little correlation with the lithologies in all holes except DDH15 and DDH16. Similarly the S.P. is very flat in all holes except DDH15 and DDH16.

As these latter two holes are effectively not in the mineralized area while the remainder are the loss of lithological correlation and the flat S.P. response can be attributed to the alteration that has been recognized in the mineralized area.

D. PRICE
LOG SUMMARY: BOREHOLE CH 4

GEOL  RES  SP  GAMMA

<table>
<thead>
<tr>
<th>ohm</th>
<th>mV</th>
<th>cps</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>500</td>
<td>1k</td>
</tr>
<tr>
<td>250</td>
<td>500</td>
<td>0</td>
</tr>
</tbody>
</table>

Depth Scale:
- 0 to 80

Geological Interpretation:
- Layered sedimentary rocks
- Variations in resistivity and electromagnetic properties
LOG SUMMARY: BOREHOLE CH6

GEOL  RES  SP  GAMMA

ohm  mV  ops

500  1k  1500  250  375  500  0  2500  5k

20
40
60
80
100
120
<table>
<thead>
<tr>
<th>GEOL</th>
<th>RES</th>
<th>SP</th>
<th>GAMMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>ohm</td>
<td>mV</td>
<td>ops</td>
<td></td>
</tr>
</tbody>
</table>

[Graphical representation of geologic and electrical data]
LOG SUMMARY: BOREHOLE CH13

GEOL RES SP GAMMA

ohm mV cps

250 500 750 0 250 500 0 2500 5k

0 20 40 60 80 100 120 140

[Graph and data points]
# LOG SUMMARY: BOREHOLE CH16

<table>
<thead>
<tr>
<th>GEOL</th>
<th>RES</th>
<th>SP</th>
<th>GAMMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>ohm</td>
<td>mV</td>
<td>cps</td>
<td></td>
</tr>
</tbody>
</table>

![Graph showing geology, resistivity, spontaneous potential, and gamma ray readings.](image-url)