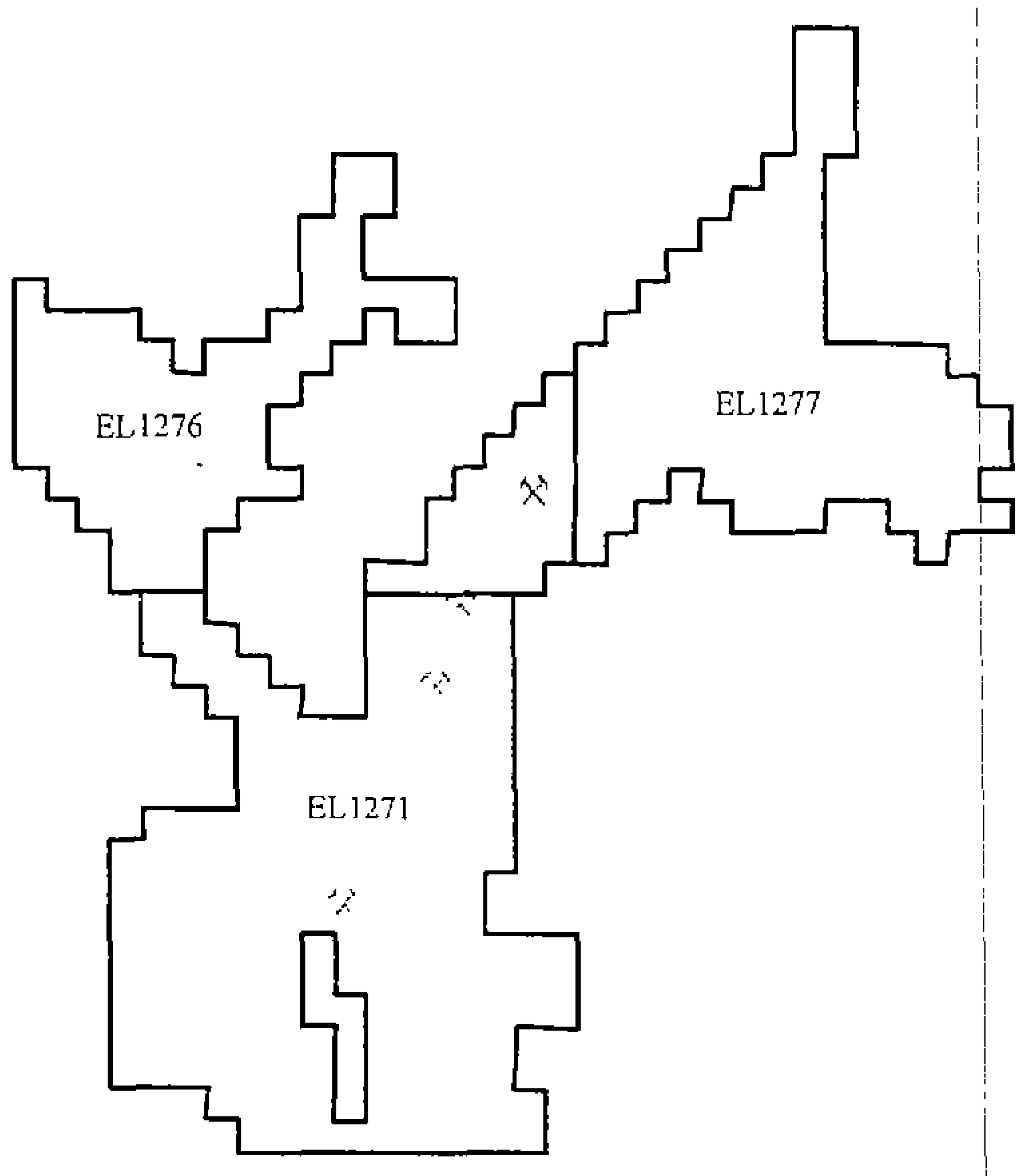
OTTER GOLD NL

ANNUAL REPORT EL 1271, EL 1276 AND EL 1277

APPENDIX 1

CONTRACTORS REPORTS PETROLOGY AND STRUCTURAL GEOLOGY



Contents

Applied Petrological Services

PETROLOGICAL STUDIES
OF
RAB DRILL CHIP SAMPLES
FROM
WTRB030 AND WTRB035, WILD TURKEY PROSPECT, TANAMI

FOR
OTTER EXPLORATION NL

July 1997

APS Report 92
Project No. 04018

Main Road
St Arnaud
New Zealand

Telephone (64) (3) 5211 034
Facsimile (64) (3) 5211 034

SUMMARY

1. From the results of petrological studies of ten RAB drill chips samples from the Wild Turkey prospect, it could be suggested that the Galifrey Structure has been important in controlling the emplacement of dacite intrusions, and later positioning of broad zones of gold mineralised, discrete quartz veining and vein brecciation.

2. Rock types containing hydrothermal alteration, quartz veining and gold mineralisation include sediments (sandstones, siltstones and mudstones), which are interpreted to be host to biotite dacites, and host to or interbedded with mafic volcanic rocks (basalt intrusions ?). The sandstone lithologies are lithic/feldspar quartz arenites in composition.

3. Hydrothermal wallrock replacement and vein mineralogy found in all rock types comprises quartz + sericite/illite + pyrite + Ti-oxides ± carbonate ± chlorite. Supergene alteration is represented by quartz + kaolinite + hematite + hydrated Fe-oxides.

4. Gold mineralisation coincides with discrete but extensive quartz veining/vein brecciation in all rock types. Primary and supergene gold is identified. Primary (native) gold is associated with early vein quartz and pyrite. Supergene gold is identified with hematite and deformed/recrystallised quartz after carbonate.

INTRODUCTION

Ten drill chip samples selected from RAB drill core material submitted by Otter Exploration NL form the basis of a petrological study. Petrographic and mineragraphic descriptions form the data base for the petrological study.

The RAB drill core is from the Wild Turkey prospect, Central Desert JV (Figure 1). The angle RAB lines are located immediately to the west of the Galifrey structure, with the holes inclined to the east (Figure 1). The angled holes have been drilled into sediments. To the northwest of the RAB holes, the sediments are host to granite which is apparently truncated to the northeast by the Galifrey structure. To the south of the RAB holes, the sediments enclose pods of Gardener Sandstone.

In each drill section (Figure 2), the RAB holes have intersected sediments (mainly siltstones ?) at higher levels and "felsic" volcanics or intrusives at lower levels. The holes have intersected broad zones of low grade gold mineralisation. Typical sections include 34m @ 0.3 g/t Au, 20 m @ 0.443 g/t Au and 26 m @ 0.35 g/t Au. Most significant mineralisation at the time of petrology sample submission was 68m @ 1.5 g/t Au in WTRB 035. The mineralisation spans both sediments and felsic volcanics/intrusives.

Controls on gold mineralisation within the drilled sections are not well understood. It is thought that there may be some relationship between the coincidence of the felsic volcanic/intrusive rock, the Galifrey structure and gold mineralisation. The scope of this study is to determine what the host rocks are, describe and characterise alteration, and determine the gold association where possible.

Samples for study were selected from RAB holes WTRB030 and WTRB035. Material selected was chosen on the basis of suitability for determination of rock types, and determination of gold association. In some cases where clay alteration is strong, sample material for a single polished thin/thin section was taken over intervals of up to 6 metres. Petrographic and combined petrographic/mineragraphic descriptions are presented in Appendix One and summarised in Table 1.

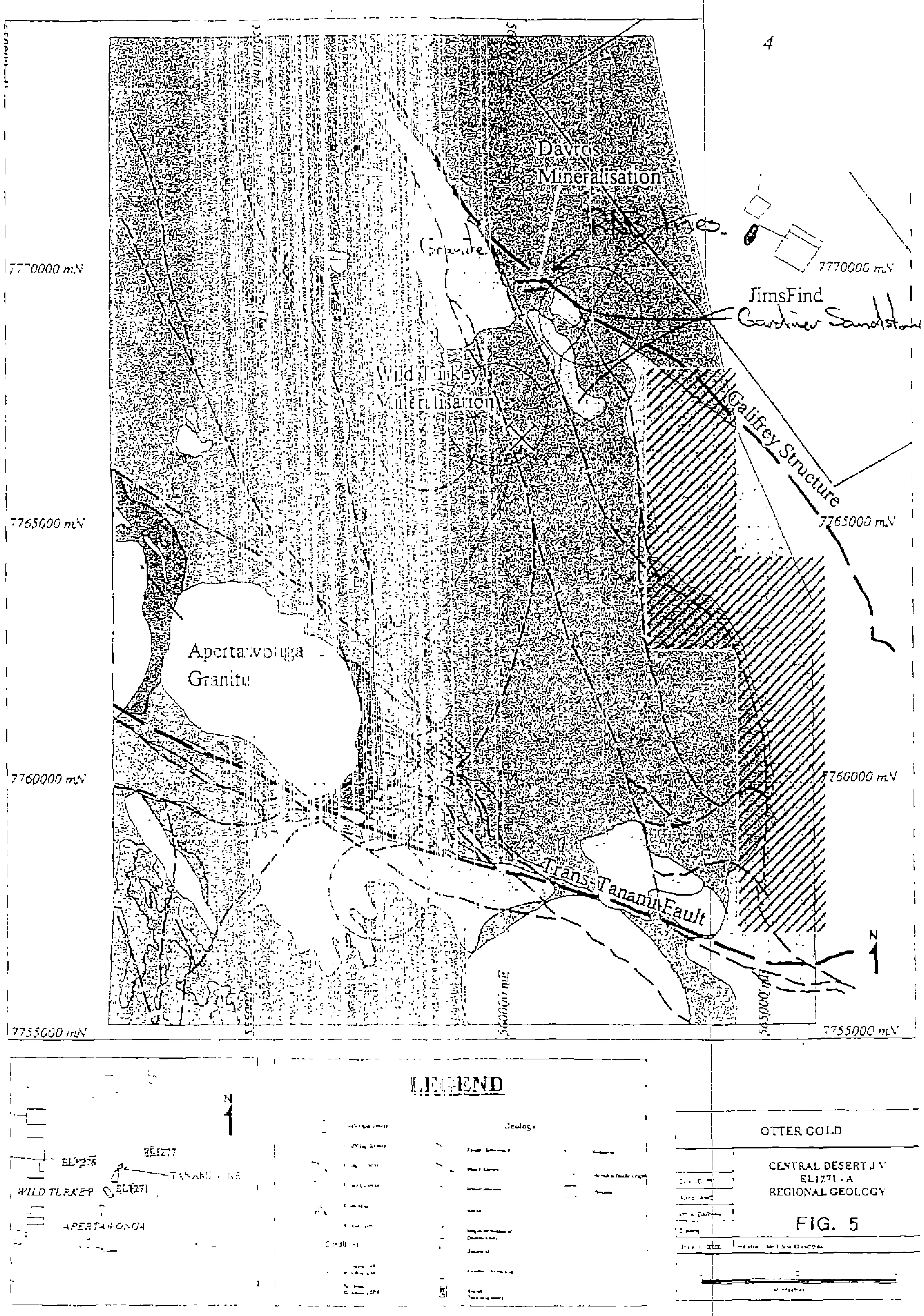


Figure 1. Prospect Location and Regional Geology

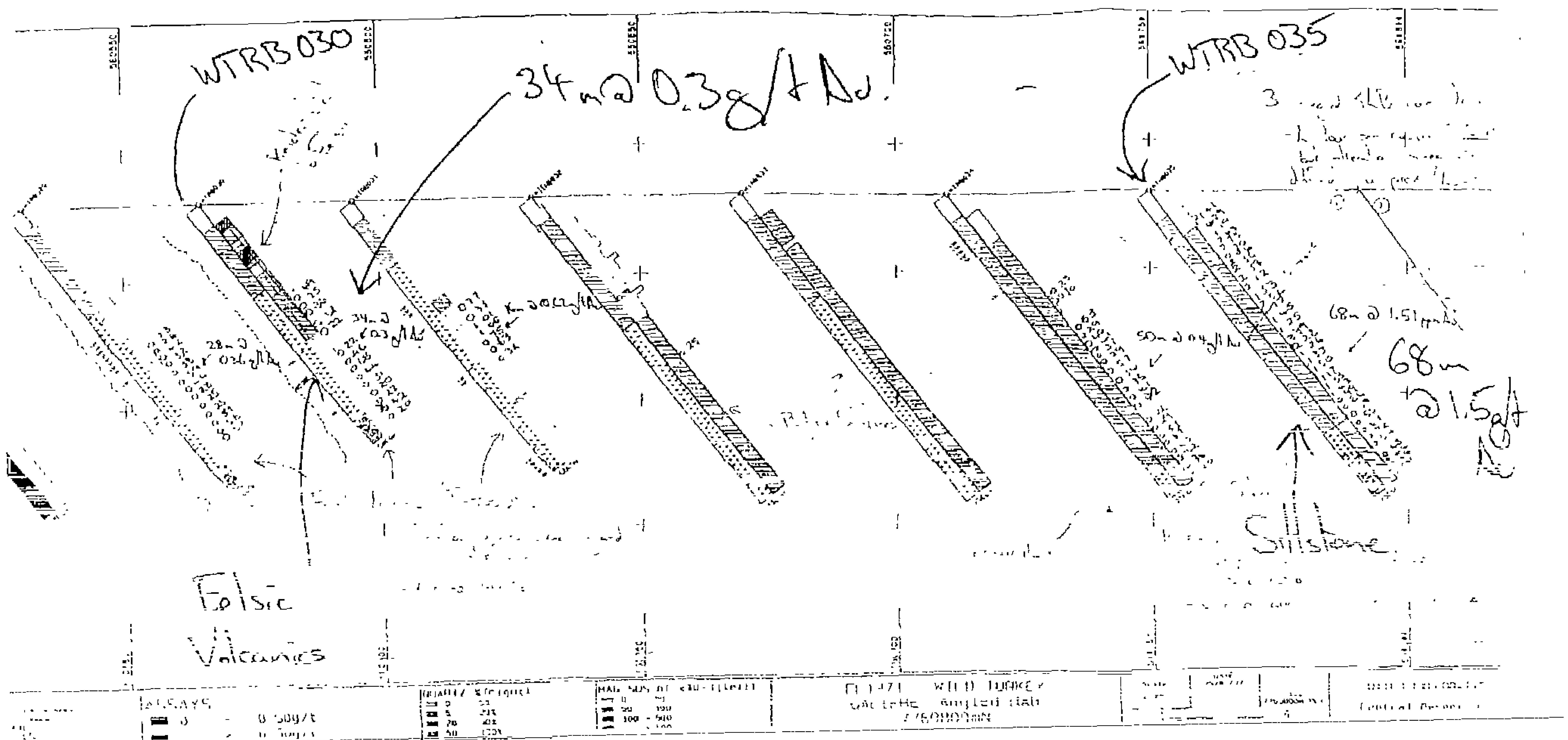


Figure 2. Drill Section Containing WTRB030 and WTRB035.

RESULTS

TABLE 1. PETROGRAPHIC/MINERAGRAPHIC SUMMARY

Sample	Lithology	Wallrock Replacement	Deposition
WTRB30/21	moderately deformed, interposed mudstone, siltstone, sandstone (lithic-feldspar quartz arenite)	65% 1. quartz, sericite/illite, pyrite, Ti-oxides 2. hematite/hydrated Fe-oxides	1. (veinlet) quartz, sericite/illite 2. (vein) carbonate (quartz, hematite/hydrated Fe-oxides)
WTRB30/41	interposed biotite dacite and sandstone (lithic feldspar quartz arenite)	60% 1. quartz, sericite, pyrite, Ti-oxides 2. hematite/hydrated Fe-oxides	1. (veinlet) quartz, sericite
WTRB30/44	moderately deformed, biotite dacite, siltstones and sandstone (lithic/feldspar quartz arenite)	75-85% 1. quartz, sericite, pyrite, chlorite, Ti-oxides 2. hematite/hydrated Fe-oxides	1. (veinlet/vein) quartz, sericite, pyrite; carbonate (quartz, hematite) 2. (shear) sericite, quartz
WTRB30/47	biotite dacite (interposed with minor amounts of lithic quartz arenite)	75% 1. quartz, sericite, pyrite, chlorite, Ti-oxides 2. hematite/hydrated Fe-oxides, kaolinite	1. (veinlets) quartz, sericite, pyrite (hematite) 2. (shearing) sericite, quartz
WTRB30/50	deformed, biotite dacite interposed with silty mudstone and lithic quartz arenite	75% 1. quartz, sericite, tourmaline, pyrite, Ti-oxides 2. hematite/hydrated Fe-oxides	1. (vein/veinlet) quartz, sericite, pyrite 2. (shear) sericite
WTRB35/14	sheared/deformed mafic volcanic rock (basalt ?)	100% 1. quartz, sericite/illite, chlorite, pyrite, Ti-oxides; carbonate 2. hematite/hydrated Fe-oxides, quartz, kaolinite	1. (vein) quartz, pyrite, sericite; carbonate (quartz, hematite) 2. (shear) sericite, quartz 3. (veinlet/vug) kaolinite, hematite/hydrated Fe-oxides
WTRB35/24-25	sheared/deformed mafic volcanic rock (basalt ?)	100% 1. quartz, sericite/illite, chlorite, pyrite, Ti-oxides; carbonate 2. quartz, hematite/hydrated Fe-oxides	1. (vein/cement) quartz, pyrite, sericite; carbonate 2. (vein) carbonate (quartz, hematite 3. (shear) quartz, sericite 4. (vein/vug) hematite/hydrated Fe-oxides

WTRB35/ 26	fractured/brecciated, mafic volcanic rock	100% 1. quartz, sericite/illite, pyrite, Ti-oxides; carbonate 2. quartz, kaolinite, hematite/ hydrated Fe-oxides	1. (vein/cement) quartz, pyrite, sericite/illite, native gold; carbonate (quartz, hematite) 2. (vein) carbonate (quartz) 3. (shear) sericite, quartz 4. (vug/veinlet) hematite, native gold, hydrated Fe-oxides, kaolinite
WTRB35/ 27-29	sheared/fractured/brecciated lithic/feldspar quartz arenite	85% 1. quartz, sericite, pyrite, Ti-oxides; carbonate 2. hematite, hydrated Fe-oxides, kaolinite, quartz	1. (veinlet/cement) quartz, sericite, pyrite 2. (vein) carbonate (quartz, hematite, native gold) 3. (shear) quartz 4. (vug, vein) hematite, kaolinite, hydrated Fe-oxides
WTRB35/ 31	sheared/fractured/brecciated mafic volcanic rock	100% 1. quartz, sericite/illite, pyrite, Ti-oxides; carbonate 2. kaolinite, quartz, hematite, Hydrated Fe-oxides	1. (vein/cement) quartz, sericite, pyrite; carbonate (quartz, hematite) 2. (vein) carbonate (quartz) 3. (shear) quartz 4. (vug/vein) hematite, kaolinite, hydrated Fe-oxides

ROCK TYPES

Sediments

Sedimentary lithologies are identified in RAB drill chips from WTRB30 (21, 41, 44, 47 and 50 metres) and WTRB35 (27-29 metres). In WTRB30 these lithologies include mudstone, siltstone and sandstone, and at 21 metres interbedding of all three textural types is present within single RAB drill chips. In WTRB35, sandstone lithologies are present in RAB drill chips in material sampled from 27 to 29 metres.

Compositionally, the sandstone lithologies within RAB drill chips in WTRB30, are described as lithic/feldspar-quartz arenites. These lithologies are generally poorly sorted with framework clast populations dominated by quartz (around 45%). The quartz is mono to polycrystalline and with undulatory extinction. Subordinate framework clasts are of feldspar or rock fragments. Where determination is possible, the feldspar is mainly plagioclase. In order of abundance the rock fragments are of metamorphic, sedimentary, granitic and dacitic lithologies. The metamorphic lithologies are characterised by plastically deformed quartz interlocking with one or more of muscovite, plagioclase and tourmaline. Other detrital fragments within the sandstones include muscovite and tourmaline.

Descriptions of siltstone and mudstone lithologies from RAB drill chips are less extensive, mainly due to a susceptibility to a greater intensity of alteration and deformation. Siltstone lithologies are characterised by silt-sized framework clasts of quartz and muscovite contained within muddy mediums. Mudstone lithologies are characterised by secondary clays after detrital clays.

Deformation fabrics within the sedimentary rocks are best illustrated within the siltstones and mudstones. Fabrics are defined primarily by rotation of detrital mica minerals into a common plane. Secondary mica minerals have formed within this plane, and/or have also been rotated or recrystallised within this plane . The preferred orientation of mica and clay minerals defines a slaty cleavage within these lithologies. Deformation fabrics in some sandstone lithologies are defined by anastomosing secondary clays about detrital quartz framework clasts.

Dacite

Fine grained acid igneous lithologies are described from RAB drill chips from WTRB30 (41, 44, 47 and 50 metres). These lithologies are characterised by relict phenocrysts of quartz and ghosted/pseudomorphed phenocrysts of plagioclase and biotite. The groundmasses are of felsitic to equigranular plagioclase and quartz. Present within the groundmass are ghosted grains of biotite and Fe/Ti-oxides (?magnetite). Embayed and partly resorbed quartz phenocrysts have igneous reaction rims of quartz and feldspar. Some of the coarser grained groundmasses are host to igneous-style quartz veining.

Mafic Volcanic

A mafic volcanic lithology is described from RAB drill chips from WTRB35 (14, 24-25, 26 and 31 metres). The mafic volcanic lithology is characterised by ghosted/pseudomorphed phenocrysts of feldspar and mafic minerals within ghosted intergranular to intersertal textured groundmasses. The feldspar phenocryst is interpreted to be plagioclase, and the mafic phenocryst pyroxene. The groundmasses are interpreted to have been composed mainly of interlocking feldspar (?plagioclase) laths interstitial to which were grains of mafics and Fe/Ti-oxides, and irregular shaped areas of devitrified glass. The mafic volcanic rock is interpreted to have undergone strong (pre alteration) tectonic deformation, including shearing and fragmentation.

ALTERATION

Hypogene

With the exception of quartz phenocrysts in dacite lithologies, and detrital quartz and muscovite within sedimentary lithologies, hypogene alteration of wallrock is complete. Wallrock replacement in all rock types is dominated by quartz and sericite/illite which are accompanied by minor to trace amounts of pyrite and Ti-oxides (mainly rutile). Associated with the quartz and sericite/illite alteration of sediments and mafic volcanics are minor amounts of chlorite and tourmaline. Pervasive carbonate is interpreted to have formed an overprint to quartz + sericite/illite alteration within the mafic volcanic rock. The carbonate is interpreted to preferentially have replaced interstitial glass within the mafic volcanic rock.

Associated with the hypogene wallrock replacement in all rock types is fracturing sealed with quartz and sericite/illite. As in the wallrock replacement assemblages minor to trace amounts of pyrite are associated with the quartz and sericite/illite. The extent of the quartz + sericite/illite veining is greatest in the mafic volcanic rock, where extensively fragmented and brecciated wallrock is cemented with voluminous quartz. In all rock types, but more particularly the mafic volcanic rock, the quartz vein/cement is overgrown by variably voluminous carbonate. Late stage fracturing (again particularly in the mafic volcanic rock) is observed and interpreted to have been sealed with voluminous carbonate.

With post-alteration, tectonic deformation (particularly in the mafic volcanic rock) the quartz and carbonate vein/cement assemblages (and wallrock replacement assemblages) have been modified: Vein quartz is plastically deformed and recrystallised, shear zones have formed within strong sericite/illite alteration marginal to deformed quartz vein/cement, and carbonate cement is interpreted to have undergone plastic and brittle deformation.

Supergene

Supergene overprinting is most obvious within the mafic volcanic rock where carbonate (of wallrock replacement and vein association) has been replaced by quartz intergrown with hematite and hydrated Fe-oxides. The quartz after carbonate, in response to tectonic deformation, has been plastically deformed and recrystallised. Residual feldspar has been altered to kaolinite. Residual cavities (resulting from leaching of carbonate) and late microfracturing are sealed with hematite, hydrated Fe-oxides and kaolinite. In all rock types pyrite is altered to hematite and hydrated Fe-oxides, and sericite/illite (and chlorite) stained with dustings of hydrated Fe-oxides.

MINERALISATION

All petrology samples were taken from mineralised RAB drill core. Most significantly mineralised RAB drill core is from WTRB35, and it is samples from this section that were targeted for identification of gold. Native gold was identified in RAB drill chips from 26 metres and 27 to 29 metres in WTRB35.

At 26 metres in WTRB35, native gold is contained within chips of vein quartz. The gold occurs interstitially to quartz and pyrite, and as overgrowths to and inclusions within pyrite (altered to hematite). In the same RAB drill chip fragment, native gold also is intergrown with hematite sealing residual cavities and overgrowing vein quartz.

At 27 to 29 metres in WTRB35 native gold is contained within drill chips of vein quartz. More specifically the gold is intergrown with recrystallised and plastically deformed, ultra fine grained quartz formed after carbonate veining. The carbonate veining is interpreted to have been cross-cutting early formed quartz veining.

COMMENTS AND INTERPRETATIONS

GEOLOGY

In the intervals of RAB drill core investigated in WTRB30, fragments altered sediment occur exclusively at 21 metres, whereas from 41 to 50 metres fragments of dacite occur together with sediment. Over the interval 41 metres to 50 metres there would appear to be no clear transition from sediments to felsic igneous rock (dacite) as is suggested in Figure 2. The occurrence of fragments of dacite and sedimentary lithology over at least a ten metre interval may be explained if:

1, the dacite fragments were representative of a multiple of extrusive units interbedded with the sediments; or

2, if the sediments were host to a multiple of dacite intrusions.

In support of the extrusive theory, there are some dacite rock fragments contained within the sediments, but these are only minor (<1%) and need not necessarily be derived from the dacites in the drill section. The framework quartz in sedimentary lithologies is predominantly with undulatory extinction, and probably mostly of metamorphic origin. Favrouring an intrusion theory, the dacite lithologies (in RAB drill chips) have textures most consistent with intrusions. These textures include the equigranular nature of the groundmasses, and reaction rims present to some quartz phenocrysts. Other evidence for an intrusion interpretation include the presence of some igneous style quartz veining in some of the coarser grained groundmasses. That the dacite fragments could be representative of small bodied intrusions is supported by the significant variation in groundmass grain-size (i.e. variation in cooling rates).

Over the interval of RAB drill chip investigated in WTRB35 (14 metres to 31 metres), the predominant rock type (host to abundant quartz veining and vein breccia cement) is interpreted to be a mafic volcanic rock. The rock is probably a basalt. Fragments of sediment are encountered at 27 to 29 metres only. The inclusion of sediments within a drill hole interval dominated by mafic volcanic rock might be to suggest that: 1, sediments were intruded by basalt; or 2, the sediments are interbedded with basaltic flows. There is insufficient petrological data to confirm whether the basaltic rock was extrusive or intrusive.

Deformation of the sedimentary lithologies, including development of slaty cleavage within the siltstones and mudstones, is interpreted to have taken place before, during and after hypogene alteration. Deformation of the dacite and mafic volcanic lithologies is less obviously manifested, and it is not totally clear whether deformation occurred prior to hypogene alteration. Within the mafic volcanic lithology, fracturing and brecciation sealed with quartz is interpreted to be tectonic, and this together with some strong plastic and brittle shearing is the best evidence for pre-alteration deformation.

ALTERATION

The pervasive quartz + sericite/illite + pyrite ± chlorite ± carbonate alteration of all lithologies may be interpreted as metamorphism/diagenesis or hydrothermal alteration. The association of quartz and carbonate veining with wallrock replacement in all rock types supports the case for flow of hydrothermal fluids through these rocks, and therefore in part hydrothermal alteration. In reality the hypogene wallrock replacement is probably representative of both hydrothermal alteration and burial metamorphism/diagenesis. Interaction between wallrock and hydrothermal fluids will have been greatest proximal to quartz veining and vein brecciation.

MINERALISATION

All RAB drill chip samples of this study are taken from intervals of anomalous gold mineralisation (WTRB030: 34 m @ 0.3 g/t Au, and WTRB035: 68 m @ 1.5 g/t Au). Common to all samples is hypogene wallrock replacement, and associated quartz veining and vein breccia cement. Most significant mineralisation coincides with rock host to most extensive quartz veining and vein brecciation (WTRB035: 68 m @ 1.5 g/t Au). Mineragraphic studies of rock most significantly mineralised (WTRB035: 68 m @ 1.5g/t Au) reveals that primarily, gold mineralisation is associated with the quartz veining/cement, and associated minor amounts of pyrite. The detail of this study is not sufficient to determine whether or not any gold mineralisation is associated with wallrock replacement.

The presence of some amounts of gold with hematite and quartz after carbonate, is evidence for a supergene (or secondary) gold association. Whether in the example of gold intergrown with quartz after carbonate, the gold was primarily associated with carbonate or mobilised from a quartz + pyrite association is not determinable. In summary, that the supergene gold still remains within the confines of primary quartz veining suggests little mobilisation or enrichment of secondary gold has taken place.

In stepping back in the assessment of gold mineralisation, it would appear that the controls on hydrothermal fluid flow, vein/vein breccia formation and therefore gold mineralisation are clearly tectonic. Quartz veining has formed within broad zones of discrete fracturing and brecciation. There is plenty of evidence for reactivation of fractures along which (gold bearing) quartz veins have formed. Whether the host lithology is sediments, dacite or mafic volcanic rock appears not to have any bearing on the distribution of quartz veining (and therefore gold mineralisation). The exception to this would appear to be that in part, most extensive veining and vein brecciation (and gold mineralisation) is contained within the mafic volcanic rock. The mafic volcanic may be more susceptible to the development of structures, and fluid-wallrock reactions necessary for gold mineralisation.

Common to the emplacement of the dacites (assuming them to be intrusions), and the location of the broad zones of discrete (gold bearing) quartz veining may be a regional structure or structures. In other words a regional structure (or structures) controlling the emplacement of dacite, may have also been responsible for the location of gold mineralisation. The proximity of the Galifrey structure to dacites and gold mineralisation (Figure 1) might suggest that it, and subsidiary (splay ?) structures, were important to the emplacement of the daciters and gold mineralisation. There need not be any reason to imply that the positioning of the dacites was important to the positioning of the later gold mineralisation.

APPENDIX ONE:

PETROGRAPHIC/MINERAGRAPHIC DESCRIPTIONS

SAMPLE NUMBER **30/21** LOCATION Wild Turkey

ROCK NAME locally hydrothermally altered, interposed sandstone (lithic-feldspar quartz arenite), siltstone and mudstone

FIELD DESCRIPTION altered siltstone

OFFCUT DESCRIPTION

An assemblage of silt to pebble-sized RAB chips. The chips are of pale to medium grey-green to grey, mostly unoxidised/unweathered, clay and siliceous altered, sedimentary rock. some of the chips are strongly oxidised (hematite rich). The sediment type is mainly mudstone and siltstone.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

RAB chips have relict fragments textures with significant variation in framework grain-size. The coarsest grained rock type comprises poorly sorted, matrix to framework clast supported populations of angular, silt to fine sand-sized framework clasts. The framework clasts are of:
quartz (45%)
muscovite (5%)
feldspar (25%)
sedimentary rock fragments (5%)
metamorphic rock fragments (5%)
tourmaline (<1%)
chert (<1%)
Matrix (15%?) is indistinguishable from altered feldspar. Where possible the feldspar fragments are interpreted to be plagioclase. The metamorphic rock fragments are of quartz and muscovite. Sedimentary rock fragments are quartz siltstones and mudstones. Finer grained fragmental lithologies within other RAB chips comprise silt to mud-sized framework clasts. Amongst the siltstone lithologies, framework clast are of quartz and muscovite. Muscovite within these finer grained chips has been rotated into a common plane defining a slaty cleavage. Within the mudstone lithologies, preferred orientations of secondary clays defines a slaty cleavage. Present amongst the drill chip fragments are angular clasts of crystalline carbonate.

ALTERATION

REPLACEMENT

With the exception of quartz and mica framework clasts in the coarser grained chips, alteration is complete (65%). Replacement minerals are quartz (40%), sericite/illite (59%), pyrite (<1%) and Ti-oxides (1%); and late hematite/hydrated Fe-oxides. Alteration of feldspar fragments, sedimentary rock fragments and matrix is dominated by sericite/illite intergrown with lesser amounts of quartz. Some amounts of detrital quartz is recrystallised. Intergrown with quartz and sericite/illite are minor to trace amounts of pyrite and Ti-oxides (rutile). The silicate assemblage is variably overprinted by hematite and hydrated Fe-oxides.

DEPOSITION

Some of the coarser grained rock types are host to veinlets of quartz. Intergrown with the quartz are minor amounts of sericite/illite. These veinlets have in places been crenulately folded into a plane in which muscovite fragments have been rotated in siltstone rock fragments. Also present are ghosted carbonate veinlets: The carbonate has been overprinted by ultra fine grained anhedral quartz and hematite.

COMMENTS

Interposed silty sandstones/sandy siltstones, siltstones and mudstones. A pre and post alteration tectonic fabric (slaty cleavage) is best defined within the finer grained rock types. A hydrothermal component to alteration is evidenced by quartz + sericite veining, ghosted carbonate veining and some relict carbonate (drill chip) fragments. Local (structurally controlled) oxidation as evidenced by strong hematite overprinting in only some RAB chips.

SAMPLE NUMBER **30/41** LOCATION Wild Turkey
ROCK NAME hydrothermally altered, metamorphosed and tectonically deformed biotite dacite and sandstone
FIELD DESCRIPTION altered sediment
OFFCUT DESCRIPTION

An assemblage of sand to pebble-sized RAB chips. The chips are of pale to medium green and red-brown, variably oxidised/weathered, hematite/hydrated Fe-oxide bearing, silicic and clay altered rock. The rock is of sediment and porphyritic, fine grained igneous lithologies.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

RAB chips are of fragmental and porphyritic textured lithologies:
The porphyritic lithologies have variably preserved, fine grained, tabular to prismatic phenocrysts contained within fine grained, ghosted, equigranular textured groundmasses. The phenocrysts are of preserved quartz, and ghosted/pseudomorphed feldspar and mica. The feldspar and mica are interpreted to have been plagioclase and biotite respectively. Quartz phenocrysts are moderately embayed and partly resorbed. The groundmasses are interpreted to have been composed of equigranular to felsitic feldspar (plagioclase ?) and quartz. Present within the groundmass are ghosted Fe/Ti-oxide (magnetite ?) and biotite microphenocrysts. Quartz phenocrysts have reaction rims of interlocking, very fine grained quartz and ?feldspar.
The fragmental lithologies have poorly sorted, matrix to framework clast supported populations of angular to subangular, silt to sand-sized clasts. Framework clasts are:
mono and polycrystalline quartz (44%)
muscovite (10%)
tourmaline (<1%)
feldspar (15%)
metamorphic rocks fragments (10%)
sedimentary rock fragments (5%)
granitic and dacite rock fragments (1%)
The peRABentage of matrix is not accurately determinable (15%?). Sedimentary rock fragments are of slaty siltstone and mudstones. Metamorphic rock fragments are of granoblastic quartz intergrown with muscovite, plagioclase and tourmaline. Granitic rock fragments are of interlocking quartz and feldspar (plagioclase and K-feldspar).

ALTERATION

REPLACEMENT

With the exception of some amounts of quartz and muscovite, alteration is complete (60%). Replacement minerals are quartz (44%), sericite (50%), pyrite (1%) and Ti-oxides (5%); and late hematite/hydrated Fe-oxides. Groundmass quartz within the porphyritic rock is recrystallised and intergrown with sericite. Biotite is altered to sericite and Ti-oxides (rutile). Feldspar phenocrysts are altered to sericite intergrown with minor amounts of quartz. Matrix, feldspars and sedimentary rock fragments within the fragmental lithic clasts are altered to intergrowths of sericite and quartz. Pyrite and Ti-oxides are disseminated about the silicate replacement assemblage. The hypogene alteration is variably overprinted by hematite and hydrated Fe-oxides.

DEPOSITION

Present within porphyritic and fragmental textured rock types are veinlets and networked veinlets of very fine to ultra fine grained anhedral quartz. Intergrown with the quartz are minor amounts of sericite. The quartz has been plastically deformed and recrystallised. In some RAB chips the porphyritic rock has been fragmented and sealed with sericite/illite. Microfractures within detrital and phenocryst quartz are annealed with ultra fine grained quartz.

COMMENTS

RAB chips are of lithic-feldspar quartz arenite and biotite dacite. The dacite has an intrusive groundmass texture. Hydrothermal alteration is evidenced in both rock types by quartz + sericite veining. Alteration and vein mineralogy in both rock types is moderately, tectonically deformed.

SAMPLE NUMBER **30/44** LOCATION Wild Turkey

ROCK NAME tectonically deformed, hydrothermally altered, biotite dacite, and siltstones and sandstones

FIELD DESCRIPTION felsic volcanics

OFFCUT DESCRIPTION

A collection of silt to coarse sand-sized RAB chips. The chips are of pale to medium red-brown and brown-grey, oxidised, hematite and hydrated Fe-oxide bearing, silicic and clay altered porphyritic rock. The phenocrysts include quartz.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The RAB chips have porphyritic textures. Moderate to abundant (25% to 45%) amounts of fine grained, tabular to prismatic, variably preserved phenocrysts are in relict, finer grained, equigranular to felsitic textured groundmasses. The phenocrysts are of preserved quartz, and ghosted/pseudomorphed biotite and feldspar (plagioclase ?). The groundmasses are interpreted to have been composed of interlocking and felsitic quartz and feldspar. Quartz phenocrysts are partly to strongly embayed/resorbed. Biotite and ghosted Fe/Ti-oxides are present as microphenocrysts.

Present are relatively sparse chips of fragmental rock comprising poorly sorted populations of silt to sand-sized framework clasts. Framework clasts are of mono and polycrystalline quartz (some metaquartzite), Mica + quartz metamorphic rock fragments, dacite fragments and mica fragments. Some fragmental texture rocks comprise silt-sized framework clasts of quartz and muscovite, in which the muscovite fragments have been rotated into a common plane (defining a slaty fabric).

ALTERATION

REPLACEMENT

With the exception of primary /detrital quartz and muscovite, alteration is complete (75-85%). Replacement minerals are quartz (40%), sericite (55%), pyrite (2%), chlorite (1%) and Ti-oxides (2%); and late hematite/hydrated Fe-oxides. Biotite is altered to sericite and Ti-oxides. Groundmass quartz (and some parts of phenocryst quartz) is recrystallised and intergrown with plates and selvages of sericite. Plagioclase phenocrysts are altered to sericite/illite. All non quartz and muscovite components within the fragmental rock types are altered to intergrowths of sericite and quartz, and minor to trace amounts of chlorite. Primary Fe/Ti-oxides are altered pyrite and Ti-oxides (rutile). Pyrite is disseminated by the silicate replacement assemblages.

DEPOSITION

Veining and micro veining in the porphyritic and fragmental rock comprises anhedral (recrystallised/deformed) quartz and lesser amounts of sericite and pyrite (altered to hematite). The vein quartz in some places is overprinted by minor amounts of carbonate. Fragmented and brecciated porphyritic rock in some chips is cemented with intergrowths of very fine quartz and sericite. The altered rock in some chips has undergone strong tectonic deformation: fragmented and sheared rock, including fragments of quartz + sericite veining are sealed with voluminous sericite/illite

COMMENTS

Biotite dacite interposed with minor voluminous of micaceous and siliceous siltstone and feldspar-lithic quartz arenite. Within both the dacite and sedimentary rock, the alteration mineralogy is moderately to strongly deformed. Pre-alteration deformation may be evidenced by a slaty fabric within siltstone lithologies. Hydrothermal veining (within both dacite and fragmental rock) is accompanied by late carbonate.

SAMPLE NUMBER **30/47** LOCATION Wild Turkey

ROCK NAME moderately deformed/sheared, hydrothermally altered biotite dacite (and sparse lithic quartz arenite)

FIELD DESCRIPTION felsic volcanics

OFFCUT DESCRIPTION

A collection of sand to pebble-sized RAB drill chips. The chips are of pale brown to brown-grey, weakly oxidised/weathered, hydrated Fe-oxide bearing, silicic and clay altered, porphyritic igneous rock.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

RAB chips have porphyritic texture. Moderate to abundant amounts of fine grained, variably preserved, tabular to prismatic phenocrysts are contained within finer grained, secondary groundmass. The groundmass in most chips are of interlocking quartz and ghosted feldspar (plagioclase). Interlokcing with the feldspar and quartz are lesser amounts of ghosted biotite and Fe/Ti-oxides (?magnetite). Other groundmasses are interpreted to have been composed of felsitic quartz and feldspar. The phenocrysts are of preserved (resorbed and embayed) quartz, and ghosted/pseudomorphed biotite and feldspar. The feldspar is interpreted to have been plagioclase. In some of the chips with coarser grained groundmasses, igneous style quartz veining is present.

Some RAB chips have fragmental textures: These rocks comprise poorly sorted framework clasts of mono and polycrystalline quartz, muscovite, metaquartzite, feldspar, and quartz + muscovite + tourmaline metamorphic rock fragments.

ALTERATION

REPLACEMENT

With the exception of some amounts of primary (phenocryst and groundmass) and detrital quartz, alteration is complete (75%). Replacement minerals are quartz (40%), sericite (50%), pyrite (2%), chlorite (2%) and Ti-oxides (6%); and late hematite/hydrated Fe-oxides and kaolinite (5%). Groundmass quartz variably recrystallised and intergrown with sericite. Biotite is altered to sericite and aggregates of Ti-oxides (rutile). Feldspar phenocrysts are altered to sericite. Primary Fe/Ti-oxides are altered to pyrite and rutile. Pyrite is disseminated about the silicate replacement mineralogy. Non quartz and muscovite components of fragmental rock material is altered to intergrowths of sericite and quartz accompanied by selvages of chlorite and grains of pyrite and rutile. The replacement mineralogy has been moderately deformed, with weak preferred orientations of sericite and recrystallisation and plastic deformation of quartz in some chips. Residual plagioclase is altered to kaolinite and the silicate alteration overprinted by hematite and hydrated Fe-oxides. Pyrite is altered to hematite.

DEPOSITION

Discrete veinlets and networks of veinlets are sealed with anhedral quartz intergrown with minor amounts of sericite. Some vein quartz is intergrown with grains and aggregates of pyrite (altered to hematite). The quartz has been moderately deformed and recrystallised. Strong shearing and fragmentation of the altered porphyritic rock is sealed with intergrown sericite/illite and anhedral quartz or voluminous, exclusive sericite/illite.

COMMENTS

The wallrock is biotite dacite. Only trace amounts of quartz sandstone are present within the RAB chip assemblage. Hydrothermal alteration is evidenced by significant amounts of quartz + sericite ± pyrite veining and veinlets. The hydrothermal alteration is overprinted by tectonic deformation.

SAMPLE NUMBER **30/50** LOCATION Wild Turkey

ROCK NAME tectonically overprinted, hydrothermally altered, biotite dacite and lithic quartz arenite and silty mudstone

FIELD DESCRIPTION felsic volcanics

OFFCUT DESCRIPTION

An assemblage of silt to pebble-sized RAB drill chips. The chips are of pale to medium brown-grey and red-brown, oxidised/weathered, hematite and hydrated Fe-oxide bearing, silicic and clay altered, porphyritic igneous rock and fragmental rock.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

RAB chips are of porphyritic and fragmental textured rock.

The porphyritic rock has abundant, variably preserved, fine grained, tabular to prismatic phenocrysts within finer grained, equigranular to felsitic textured groundmasses. The phenocrysts are of preserved (embayed/resorbed) quartz, and ghosted/pseudomorphed biotite and feldspar (?plagioclase). The coarser grained groundmasses are of equigranular quartz and (ghosted) feldspar. The finer grained groundmasses are interpreted to have been of felsitic plagioclase and quartz. Ghosted biotite and Fe/Ti-oxides form part of the coarser grained groundmasses. Quartz phenocrysts contain anhedral inclusions of relict albite. Trace amounts of relict apatite are present in the groundmass.

Fragmental textured RAB chips have poorly to moderately well sorted, matrix to framework clast supported (?), sand-sized, angular framework clasts. The framework clasts are of poly and monocrystalline quartz, muscovite, quartz + muscovite rock fragments, metaquartzite rock fragments, feldspar and dacite rock fragments. Detrital quartz has undulatory extinction. The peRABentage of matrix is not resolvable. Finer grained fragmental textured chips have silt-sized fragments of quartz and muscovite within voluminous muddy medium. Within these lithologies, a slaty cleavage is defined by preferred orientations of detrital muscovite and secondary clay minerals.

ALTERATION

REPLACEMENT

With the exception of phenocryst/groundmass and detrital quartz, alteration is complete (75%). Replacement minerals are quartz (), sericite (), pyrite (), tourmaline (trace) and Ti-oxides (); and late hematite/hydrated Fe-oxides. Biotite is altered to sericite and aggregates and grains of Ti-oxides (rutile). Plagioclase is altered to sericite. Groundmass quartz is recrystallised and intergrown with sericite after plagioclasc. Intergrown with groundmass sericite are grains and aggregates of tourmaline. Pyrite and Ti-oxides (rutile) replace primary Fe/Ti-oxides. Sericite and quartz accompanied by grains of pyrite and Ti-oxides (rutile) replace non quartz and muscovite components of the fragmental textured rock types.

DEPOSITION

Porphyritic and fragmental textured rock is host to veinlets and veins of anhedral quartz. The quartz is intergrown with minor amounts of sericite and pyrite (altered to hematite). The quartz is moderate to strongly recrystallised and plastically deformed (although the host rock does not show strong deformation). In some RAB chips fragmented/brecciated porphyritic rock is cemented with sericite or intergrowths of sericite and quartz. Strongly sheared, altered rock is sealed with voluminous sericite.

COMMENTS

Biotite dacite interposed with relatively minor volumes of quartz rich sediments. Quartz within the fragmental rocks is interpreted to mainly be of metamorphic provenance, although some significant amounts of may be of igneous provenance. The sediments have a weak to moderate tectonic fabric (mainly within silty mudstones). Both rock types have a post and/or syn hydrothermal tectonic overprint.

SAMPLE NUMBER **35/14** LOCATION Wild Turkey

ROCK NAME strongly oxidised, quartz + sericite + ?carbonate altered and quartz veined mafic volcanic rock

FIELD DESCRIPTION altered siltstone

OFFCUT DESCRIPTION

An assemblage of angular sand to pebble-sized RAB chips. The chips are of: 1, red-brown to brown, strongly oxidised/weathered, hematite bearing, silicic and clay altered ?volcanic rock; and 2, pale to medium grey and brown-grey, partly oxidised/weathered, hematite bearing, vein quartz material.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

RAB chips of altered lithologies have relict porphyritic textures. Sparse (5% to 10%), ghosted, fine grained, tabular to prismatic phenocrysts are contained within finer grained, secondary groundmasses. Phenocryst morphologies are of feldspar (plagioclase) and mafics (?pyroxene). The groundmasses have ghosted intergranular to hyalopilitic textures. The groundmasses are interpreted to have been composed of interlocking laths of plagioclase, interstitial to which were grains of mafics/Fe/Ti-oxides and irregular patches of devitrified glass. Prior to or during alteration the rock has been moderately sheared and deformed.

ALTERATION

REPLACEMENT

Alteration is complete. Replacement minerals are quartz (37%), sericite/illite (30%), chlorite (5%), pyrite (5%) and Ti-oxides (3%); carbonate (?) and late hematite/hydrated Fe-oxides (15%), kaolinite (5%) and quartz (10%). Primary silicates are altered to pervasive fine to very fine grained quartz and selvages of sericite/illite. Intergrown with quartz and sericite/illite are minor amounts of chlorite. Dispersed about the silicates are grains and aggregates of pyrite and Ti-oxides. Primary Fe/Ti-oxides are interpreted to have been replaced by pyrite and Ti-oxides (rutile). Pyrite is altered to hematite and hydrated Fe-oxides. The silicate replacement assemblage is interpreted to have been intergrown with and overgrown by carbonate. In many places the carbonate is interpreted to have formed after interstitial glass. The carbonate has been replaced by pervasive quartz and hematite/hydrated Fe-oxides. Hematite and hydrated Fe-oxides form a pervasive overprint to silicate replacement minerals. In some RAB chips, the quartz + sericite assemblage has been strongly deformed and sheared, with recrystallisation and plastic deformation of quartz and sericite.

DEPOSITION

Fracturing and brecciation are sealed with fine to very fine grained, anhedral to subhedral, prismatic to tabular quartz. Interlocking with the quartz are grains of pyrite (altered to hematite). Interstitial to quartz are selvages of sericite/illite. Overgrowing the quartz and sealing later cavities is fine grained carbonate (altered to quartz and hematite). With shearing, quartz and sericite are plastically deformed and sheared. Residual cavities and late fractures/microfractures are sealed with kaolinite (deformed) and hematite/hydrated Fe-oxides.

COMMENTS

The wallrock is interpreted to be a mafic volcanic rock, probably a basalt. Quartz + sericite alteration of the volcanic rock is strongest proximal to quartz veining. A late carbonate veining (altered to supergene quartz and hematite/hydrated Fe-oxides) is interpreted.

SAMPLE NUMBER **35/24-25** LOCATION Wild Turkey

ROCK NAME oxidised, quartz + sericite + carbonate altered, quartz + carbonate cemented, tectonically sheared/fractured mafic volcanic rock

FIELD DESCRIPTION siltstone

OFFCUT DESCRIPTION

A collection of angular, silt to pebble-sized RAB chips. The chips are predominantly of pale to medium grey and grey-brown, hematite/hydrated Fe-oxide bearing, vein quartz or silicic altered wallrock. Less abundant chips are of brown to red-brown, oxidised/weathered, silicic and clay altered, hematite/hydrated Fe-oxide bearing ?volcanic rock.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

RAB chips are mainly of vein material. RAB chips of altered wallrock has relict volcanic textures: Sparse, fine grained, ghosted, tabular to prismatic phenocrysts are contained within fine grained secondary groundmasses. Phenocryst morphologies are of feldspar and mafics (?pyroxene). The groundmasses are interpreted to have been composed mainly of plagioclase laths interstitial to which were devitrified glass, mafics and Fe/Ti-oxides (?magnetite).

ALTERATION

REPLACEMENT

Alteration of the wallrock is complete. Replacement minerals are early quartz (20%), sericite/illite (25%), chlorite (5%), pyrite (3%) and Ti-oxides (2%); carbonate (?); and later quartz (20%) and hematite/hydrated Fe-oxides (25%). Early intergrowths of anhedral quartz and sericite/illite are intergrown with and overprinted by pervasive carbonate. Some amounts of carbonate are interpreted to have formed after interstitial glass. The carbonate is replaced by quartz and hematite/hydrated Fe-oxides the latter forming and overprint to quartz and sericite/illite. Some amounts of pyrite and Ti-oxides (rutile) were intergrown with the early silicates. Pyrite is altered to hematite/hydrated Fe-oxides. Pyrite and Ti-oxides (rutile) are interpreted to have formed after primary Fe/Ti-oxides (microphenocrysts).

DEPOSITION

The fractured and brecciated wallrock is sealed initially with anhedral quartz. The quartz is accompanied by minor amounts of pyrite and sericite/illite. With subsequent shearing and deformation, the quartz and sericite are recrystallised and plastically deformed. Later fracturing is sealed with crustiform banded carbonate. The carbonate veining has been deformed and folded. With further deformation and oxidation, the carbonate has been altered to fine to very fine grained quartz and accompanying hematite/hydrated Fe-oxides. Late fracturing/microfracturing is sealed with hematite/hydrated Fe-oxides.

COMMENTS

Wallrock is a mafic volcanic rock, probably a basalt. The majority of the drill chips are of oxidised/silicic altered wallrock and deformed vein quartz material. Altered wallrock material is too soft for thin section preparation. The alteration peripheral to quartz veining is interpreted to have been dominated by sericite/illite.

SAMPLE NUMBER **35/26** LOCATION Wild Turkey

ROCK NAME oxidised, sheared/deformed, quartz + sericite + carbonate altered and cemented, fractured/brecciated mafic volcanic

FIELD DESCRIPTION siltstone

OFFCUT DESCRIPTION

A selection of angular silt to pebble-sized RAB drill chips. The chips are predominantly of pale to medium grey and brown-grey, partly oxidised, hematite/hydrated Fe-oxide bearing, silicic altered rock or silicic vein material. Less abundant are chips of pale grey to grey-brown, partly oxidised, quartz and clay altered rock.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

Most RAB chips are of quartz vein material or sheared/deformed, silicic altered wallrock. The sparse amounts of altered wallrock in RAB chips (present in section) have relict porphyritic textures. Ghosted, fine grained, tabular to prismatic phenocrysts are in finer grained secondary groundmasses. Phenocryst morphologies are most unresolvable, however some feldspar (?plagioclase) and mafic (?pyroxene) morphologies are evident. Groundmasses are interpreted to have had intergranular to hyalopilitic textures (feldspar laths and interstitial glass). Wallrock has undergone strong pre, syn and post alteration deformation.

ALTERATION

REPLACEMENT

Alteration of the wallrock is complete. Replacement minerals are early quartz (23%), sericite/illite (30%), pyrite (1%) and Ti-oxides (1%); carbonate (?); and late quartz (20%), kaolinite (10%) and hematite/hydrated Fe oxides (15%). Early alteration of primary silicates is dominated by intergrowths of quartz and sericite/illite. Pyrite and Ti-oxides (rutile) are interpreted to have been intergrown with quartz and sericite. The silicate replacement assemblage is interpreted to have been overprinted by carbonate, which is replaced by late quartz and hematite/hydrated Fe-oxides. Residual primary silicates are altered to kaolinite.

DEPOSITION

Early fracturing and brecciation of the rock is sealed with fine to very fine grained anhedral quartz. Interlocking with the quartz are grains of pyrite (altered to hematite and hydrated Fe-oxides). Interstitial to the quartz are selvages of sericite/illite. Overgrowing pyrite, present as inclusions within pyrite (altered to hematite) and interstitial to quartz are grains of anhedral to subhedral native gold. Later fracturing and cavities are interpreted to have been sealed with carbonate. With deformation and shearing, quartz is plastically deformed and recrystallised (together with sericite and ?carbonate). With later deformation and shearing, carbonate is replaced by quartz and hematite/hydrated Fe-oxides. Some amounts of native gold are intergrown with hematite, forming overgrowths to quartz (or quartz after carbonate). Residual cavities are sealed with hydrated Fe-oxides and kaolinite.

COMMENTS

Mafic volcanic wallrock. Native gold present is interpreted to be both of a primary and supergene association. Early gold is interstitial to and overgrowing quartz and pyrite. Later native gold is intergrown with hematite/hydrated Fe-oxides (in close proximity to primary gold).

SAMPLE NUMBER **35/27-29** LOCATION Wild Turkey

ROCK NAME oxidised, quartz + sericite + carbonate altered and veined, fractured/brecciated quartz arenite

FIELD DESCRIPTION siltstone

OFFCUT DESCRIPTION

A selection of angular, silt to pebble-sized RAB drill chips. The chips are of pale grey and brown grey, oxidised, hematite and hydrated Fe-oxide bearing, vein quartz material. Fractured quartz is sealed with hydrated Fe-oxides.

THIN SECTION DESCRIPTION
LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

Attached to and bordering some of the fragments of vein quartz is altered wallrock material (very minor in abundance). The wallrock material has a relict fragmental texture. The primary rock is interpreted to have comprised a population of sand-sized framework clasts interposed with unresolvable amounts of matrix. The framework clast population is interpreted to have been dominated by quartz (mono and polycrystalline). Other framework clasts include minor amounts of muscovite.

ALTERATION
REPLACEMENT

With the exception of some amounts of detrital quartz, alteration of the wallrock is complete (85%). Replacement minerals are quartz (54%), sericite (40%), ?pyrite (?) and Ti-oxides (1%); carbonate (?); and late hematite/hydrated Fe-oxides, kaolinite and quartz (5%). Detrital quartz is recrystallised and intergrown with sericite after other components (non-quartz framework clasts and matrix). Trace amounts of Ti-oxides (rutile), and some amounts of pyrite (altered to hematite) are interpreted to have been intergrown with the silicate replacement assemblage. The silicate alteration is overprinted by minor amounts of carbonate which is altered to quartz and hematite/hydrated Fe-oxides. Parts of the rock are overprinted by kaolinite.

DEPOSITION

Early fracturing and brecciation is sealed with medium to very fine grained anhedral quartz. Interstitial to the quartz are minor to trace amounts of sericite and pyrite (altered to hematite). Later fracturing is sealed with fine grained anhedral to subhedral carbonate. With deformation and oxidation the carbonate is altered to very fine to ultra fine grained quartz. Both early and late quartz are plastically deformed and recrystallised. Trace amounts of native gold occurs interstitial to plastically deformed and recrystallised quartz (after carbonate ?). Present within the quartz are inclusions of ultra fine grained carbonate. Overgrowing and intergrown with the quartz are plates and selvages of kaolinite/dickite. Late microfracturing is sealed with hematite and hydrated Fe-oxides.

COMMENTS

Wallrock is a quartz arenite and possible quartz siltstone. Strong tectonic fracturing and brecciation is sealed with early quartz and later carbonate. Most carbonate is altered to quartz, but some is preserved. Native gold present is interpreted to be of a supergene association.

SAMPLE NUMBER **35/31** LOCATION Wild Turkey

ROCK NAME oxidised/weathered, quartz + sericite + carbonate altered and veined/cemented, fractured/brecciated mafic volcanic rock

FIELD DESCRIPTION siltstone

OFFCUT DESCRIPTION

A selection of angular silt to pebble-sized RAB drill chips. The chips are of pale to medium grey and brown-grey, oxidised, hematite and hydrated Fe-oxide bearing, silicic and clay altered wallrock and silicic vein material.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

Chips of wallrock material have relict porphyritic textures. Sparse (5%), fine grained, tabular to prismatic, ghosted phenocrysts are contained within finer grained secondary groundmasses. Phenocryst morphologies are of feldspar (plagioclase ?) and mafics (pyroxene ?). Groundmass textures are interpreted to have been intergranular to hyalopilitic: i.e., composed mainly of interlocking feldspar, interstitial to which were variable amounts of Fe/Ti-oxides, mafics and glass.

ALTERATION

REPLACEMENT

Alteration of the wallrock is complete. Replacement minerals are early quartz (28%), sericite/illite (35%), pyrite (1%) and Ti-oxides (2%); carbonate (?); and late kaolinite (15%), quartz (5%) and hematite/hydrated Fe-oxides (15%). Phenocrysts and groundmass components are altered to pervasive sericite/illite and quartz dispersed with sparse grains of pyrite (altered to hematite) and Ti-oxides. Some amounts of the silicate replacement are overprinted by carbonate. The carbonate is altered to quartz and hematite/hydrated Fe-oxides, and silicates overprinted by hydrated Fe-oxides. Residual primary silicates are altered to kaolinite.

DEPOSITION

Early fracturing and brecciation is sealed with fine grained anhedral quartz. Minor to trace amounts of sericite and pyrite are intergrown with and interstitial to the quartz. The quartz is overgrown by grains of less euhedral carbonate. In some examples the carbonate is interpreted to have sealed fractures/microfractures cross-cutting early quartz cement. The carbonate has been leached, and replaced by quartz (and hydrated Fe-oxides) or the resulting cavities partly sealed with hematite/hydrated Fe-oxides. Some cavities and late microfracturing are sealed with kaolinite. With syn to post alteration deformation and shearing, quartz and quartz after carbonate is plastically deformed and recrystallised. Carbonate may have been plastically deformed prior replacement with quartz.

COMMENTS

Wallrock is a mafic volcanic rock. Kaolinite is a significant part of the supergene replacement giving the rock a pale appearance in hand-specimen. Deformation and shearing may have been contiguous throughout hypogene and supergene alteration. Quartz after carbonate contains relict inclusions of ultra fine grains carbonate.

Applied Petrological Services

PETROLOGICAL STUDIES
OF
SURFACE ROCK CHIP SAMPLES
FROM THE WILD TURKEY PROSPECT, TANAMI DESERT

FOR
OTTER EXPLORATION NL

August 1997

APS Report 93
Project No. 04019

Main Road
St Arnaud
New Zealand

Telephone (64) (3) 5211 034
Facsimile (64) (3) 5211 034

SUMMARY

1. A suite of six surface petrology samples from the Wild Turkey Prospect, Tanami Desert comprise variably oxidised/weathered, quartz veined, and quartz + sericite/illite altered biotite dacites and feldspar/lithic quartz arenites.

2. Biotite dacites of this study are compositionally and texturally similar to biotite dacites described from RAB drill core taken from hole WTRB 030 (Galifrey structure) Textures are consistent with high level and/or low volume intrusions such as dykes or sills. The presence of some igneous style quartz veining supports an intrusion interpretation. Complex flow banding fabrics reveal multiple phases of dacite intrusion.

3. Lithologies described from this study do not include granodiorites. However, contained within the dacites are nodules of granodiorite or tonalite porphyry. This would suggest a possible genetic relationship between the biotite dacites, and probable granodiorite/tonalite feeder bodies at some depth or peripheral positions.

4. The sedimentary lithologies described in this study compare favourably with those described from RAB drill core taken from holes WTRB 030 and WTRB 035 (Galifrey Structure). The sediments of this study and those from Galifrey Structure are different to those typical of the "Mt Charles Beds". Relative to the sediments of the "Mt Charles Beds", the sediments of this study are quartz-rich, and interpreted to mainly be of a regional metamorphic provenance.

5. Strong quartz + sericite/illite dominated alteration of the biotite dacites and sediments is consistent with both hydrothermal alteration and low grade burial metamorphism (or high grade diagenesis). Where the quartz + sericite/illite wallrock replacement is associated with quartz + sericite/illite ± carbonate veining, it must be suggested that hydrothermal alteration (and potentially associated mineralisation) was significant, even if only on a localised scale.

RESULTS

TABLE 1. PETROGRAPHIC SUMMARY

Sample	**Lithology**	**Wallrock Replacement**	**Deposition**
A46	feldspar-lithic quartz arenite	100% 1. quartz, sericite/illite, ?pyrite 2. hematite/hydrated Fe-oxides	1. (veinlet/vug) hematite, hydrated Fe-oxides
AL55	granodiorite/tonalite porphyry xenolithic, biotite dacite	100% 1. quartz, sericite, pyrite, Ti-oxides 2. kaolinite, quartz, hematite/hydrated Fe-oxides	1. (veinlet) quartz 2. (veinlet) hematite/hydrated Fe-oxides
AL59	flow banded, biotite dacite	100% 1. quartz, sericite/illite, Ti-oxides 2. hematite/hydrated Fe-oxides, kaolinite	1. (veinlet/vug) quartz 2. (veinlet) hematite/hydrated Fe-oxides
AL63	biotite dacite	100% 1. quartz, sericite/illite, Ti-oxides, ?pyrite 2. kaolinite, hematite/hydrated Fe-oxides	1. (veinlet) quartz; sericite/illite 2. (veinlet) hematite/hydrated Fe-oxides
AL57	lithic-feldspar quartz arenite	45% 1. quartz, sericite/illite, ?pyrite 2. hematite/hydrated Fe-oxides	1. (vein/veinlet) quartz, sericite, tourmaline
25	biotite dacite	100% 1. sericite/illite, quartz, pyrite, Ti-oxides 2. hematite/hydrated Fe-oxides	1. (vein/veinlet) quartz, sericite; carbonate 2. (veinlet) hematite/hydrated Fe-oxides

APPENDIX ONE:

PETROGRAPHIC DESCRIPTIONS

SAMPLE NUMBER **A55** LOCATION Wild Turkey

ROCK NAME strongly weathered, quartz + sericite altered biotite dacite

FIELD DESCRIPTION dacite

OFFCUT DESCRIPTION

A pale to medium brown to brown-grey, oxidised/weathered, hematite and hydrated Fe-oxide bearing, silicic and clay altered, fine grained, porphyritic, acid igneous rock. Phenocrysts are of clay altered feldspar.

THIN SECTION DESCRIPTION
LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

A porphyritic texture. Abundant (35% to 40%), fine grained, tabular to prismatic, ghosted/pseudomorphed phenocrysts are contained within a finer grained secondary groundmass. Phenocryst morphologies are of feldspar (?plagioclase) and biotite. Present are partly preserved quartz microphenocrysts. The groundmass is interpreted to have been composed of very fine grained, equigranular to felsitic quartz and feldspar (?plagioclase). Also present are ghosted Fe/Ti-oxide (?magnetite) microphenocrysts. Groundmass quartz is partly preserved. Present in the groundmass are ghosted grains of biotite. Enclosed by the porphyritic rock are fragments of equigranular to porphyritic textured rock. The xenoliths have ghosted phenocrysts of feldspar (plagioclase ?) contained within a groundmass of fine grained, equigranular quartz and feldspar (significantly coarser grained than the host groundmass).

ALTERATION
REPLACEMENT

With the exception of some amounts of primary quartz, alteration is complete. Replacement minerals are quartz (25%), sericite (20%), pyrite (?) and Ti-oxides (5%); and later kaolinite (30%), quartz (5%) and hematite/hydrated Fe-oxides (15%). Primary quartz (microphenocrysts and groundmass) is partly recrystallised. Feldspar is altered to pervasive, early sericite and later kaolinite. Biotite is altered to intergrowths of sericite and Ti-oxides and minor amounts of quartz, and later kaolinite. Intergrown with the early silicate replacement mineralogy are grains of ghosted pyrite (altered to hematite/hydrated Fe-oxides). Associated with the kaolinite overprint are dustings of hydrated Fe-oxides and hematite.

DEPOSITION

Present within feldspar phenocrysts are discontinuous igneous style veinlets of quartz. Microfracturing is sealed with hydrated Fe-oxides and hematite.

COMMENTS

A biotite dacite. Host to xenoliths or autoliths of granodiorite/tonalite porphyry. An intrusion origin is supported by the presence of weak igneous style veining. Early quartz + sericite veining is overprinted by strong weathering including kaolinite.

SAMPLE NUMBER **A46** LOCATION Wild Turkey

ROCK NAME oxidised/weathered, quartz + sericite/illite altered quartz arenite

FIELD DESCRIPTION quartz porphyritic rock with lithic fragments

OFFCUT DESCRIPTION

A medium brown, hematite an hydrated Fe-oxide bearing, oxidised/weathered, silicic altered, sandstone. Framework clasts are of quartz and lithic fragments. Present are mica fragments.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

A fragmental texture. The rock comprises a poorly sorted, framework clast to matrix supported population of fine to coarse sand-sized, angular framework clasts. The framework clasts are of:

poly/monocrystalline quartz (55%)
metaquartzite/metamorphic rock fragments (35%)
granitic/dacitic rock fragments (<1%)
muscovite (5%)
feldspar (5%)
tourmaline (<1%)

Mono/polycrystalline quartz fragments have undulatory extinction. Metamorphic rock fragments comprise quartz and lesser amounts of muscovite, feldspar and tourmaline. Metamorphic fabrics are defined within the metamorphic rock fragments by granoblastic quartz, and preferred orientations of muscovite and quartz. Feldspars are altered compositions not resolvable. The matrix may be around 15%, but is masked by secondary hematite/hydrated Fe-oxides.

ALTERATION

REPLACEMENT

With the exception of detrital quartz, muscovite and tourmaline, alteration is complete. Replacement minerals are quartz (35%), sericite/illite (20%), ?pyrite (?) and late hematite/hydrated Fe-oxides (45%). Feldspars and matrix are altered to pervasive intergrowths of quartz and sericite/illite. The silicate replacement is strongly overprinted by densely distributed hematite and hydrated Fe-oxides. Pyrite may have been part of the hypogene replacement.

DEPOSITION

Microfractures and cavities are sealed with hematite, hydrated Fe-oxides and kaolinite.

COMMENTS

A poorly sorted sandstone, A feldspar lithic quartz arenite. quartz framework clasts are interpreted to be derived from metaquartzite and other metamorphic rock types represented within the framework clast assemblage.

SAMPLE NUMBER **A57** LOCATION Wild Turkey

ROCK NAME quartz + sericite/illite altered lithic feldspar quartz arenite

FIELD DESCRIPTION rock host to dacite intrusion

OFFCUT DESCRIPTION

A mottled pale to medium grey and brown-grey, partly oxidised/weathered, hematite and hydrated Fe-oxide bearing, silicic altered, quartz veined sediment. The rock is mica bearing. Hematite and hydrated Fe-oxides are contained along joint planes.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

A fragmental texture. The rock comprises a poorly to moderately well sorted, framework clast supported population of angular to subangular, fine to medium sand-sized framework clasts. The framework clasts comprise:

mono/polycrystalline quartz (55%)
metaquartzite (15%)
metamorphic rock fragments (5%)
feldspar (20%)
muscovite (5%)
granitic and dacitic rock fragments (<1%)
tourmaline (<1%)
mafic volcanic rock fragments (<15)

Some of the polycrystalline quartz is in fact metaquartzite. The metamorphic rock fragments contain abundant quartz and lesser amounts of preserved muscovite and tourmaline, and ghosted feldspar (plagioclase ?). Fabrics within the metaquartzite and metamorphic rock are defined by granoblastic quartz, undulatory extinction of quartz grains, and preferred orientations of quartz and muscovite. Mono and polycrystalline quartz have undulatory extinction. The feldspar fragments are interpreted to be of plagioclase. The granitic rock fragments are composed of interlocking quartz and feldspar (plagioclase and K-feldspar ?). Some sparse quartz grains contain inclusions of biotite. Some metamorphic rock fragments are predominantly of muscovite exhibiting strong preferred orientations. Altered argillaceous matrix (10%) is difficult to differentiate from alteration of feldspars. Sparse mafic volcanic rock fragments have relict intersertal to intergranular textures.

ALTERATION

REPLACEMENT

With the exception of detrital quartz and muscovite, alteration is complete. Replacement minerals are quartz (40%), sericite/illite (60%), ?pyrite (?); and late hematite/hydrated Fe-oxides. Feldspar (fragments and grains within rock fragments) is altered to sericite/illite and lesser amounts of very fine to ultra fine grained anhedral quartz. Volcanic rock fragments (dacite and mafic types) are altered to intergrowths of quartz and illitic clay (sericite/illite). Minor to sparse amounts of pyrite are interpreted to have been intergrown with the sericite/illite and quartz. Pyrite is altered to hematite, and the silicate alteration is dusted with ultra fine grained hydrated Fe-oxides.

DEPOSITION

Penetrative microfractures and fractures are sealed with very fine to fine grained anhedral quartz. Interlocking with the quartz are sparse amounts of sericite and tourmaline. The quartz has been recrystallised and plastically deformed.

COMMENTS

A sandstone. A lithic feldspar arenite. Quartz fragments may be interpreted to be of metamorphic origin on the basis of undulatory extinction and other deformation features. . The proportion of metamorphic lithic fragments may be underestimated if a large proportion of the polycrystalline quartz fragments were considered derived from fragmentation of metamorphic rock.

SAMPLE NUMBER **A59** LOCATION Wild Turkey

ROCK NAME flow banded, biotite dacite

FIELD DESCRIPTION rhyolitic textured dacite

OFFCUT DESCRIPTION

A mottled pale to medium brown and yellow-brown, oxidised/weathered, hematite and hydrated Fe-oxide bearing, silicic and clay altered, flow banded, porphyritic, fine grained acid igneous rock. Flow banding is defined by the distribution of hematite/hydrated Fe-oxides. An early flow banded fabric is truncated by a later one. The rock is host to hematite/hydrated Fe-oxide stained quartz veining.

THIN SECTION DESCRIPTION
LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

A porphyritic texture. Abundant (45%), fine grained, tabular to prismatic, aggregated, variably prserved phenocrysts are contained within a finer grained groundmass. The phenocrysts are of preserved, embayed/resorbed quartz; and ghosted/pseudomorphed feldspar (plagioclase ?) and biotite, and mostly preserved quartz. The groundmass is interpreted to have been composed of graphically intergrown feldspar (plagioclase and K-feldspar ?) and quartz or quartz after glass. Interposed with the quartz/glass and feldspar are ghosted grains of biotite and Fe/Ti-oxides (?magnetite). The groundmass is interpreted to have been composed of both plagioclase and K-feldspar. The finer grained K-feldspar is graphically intergrown with quartz or quartz after glass, while euhedral grains of ?albite are enclosed by the graphic intergrowth. The flow banding is defined by the distribution of biotite and Fe/Ti-oxides (magnetite) and orientations of feldspar.

ALTERATION
REPLACEMENT

With the exception of some amounts of primary quartz, alteration is complete. Replacement minerals are quartz (40%), sericite/illite (25%) and Ti-oxides (5%); and late hematite/hydrated Fe-oxides (15%) and kaolinite (15%). Groundmass glass is altered to quartz. Groundmass quartz is recrystallised. Recrystallised groundmass quartz and/or quartz after glass is intergrown with sericite/illite formed after feldspar (plagioclase and K-feldspar). Biotite is altered to sericite/illite, quartz and Ti-oxides. Plagioclase phenocrysts are altered to sericite/illite. Residual feldspar is altered to kaolinite. Primary Fe/Ti-oxide are altered to secondary Ti-oxides and later hematite/hydrated Fe-oxides. Residual biotite is altered to hematite/hydrated Fe-oxides. Silicate replacement mineralogy is overprinted by dustings of hydrated Fe-oxides.

DEPOSITION

Fractures and microfractures are sealed with fine to very fine grained anhedral quartz. Late microfracturing is sealed with hematite/hydrated Fe-oxides.

COMMENTS

A flow banded dacite. Flow banding is defined by the distribution of biotite (partly altered to hematite and hydrated Fe-oxides). Flow banding fabrics indicate that n early flow unit was truncated by a later one. Quartz veining is related to wallrock replacement.

SAMPLE NUMBER **A63** LOCATION Wild Turkey

ROCK NAME quartz + sericite/illite altered biotite dacite

FIELD DESCRIPTION granodiorite

OFFCUT DESCRIPTION

A pale grey-brown to pink, oxidised/weathered, hematite and hydrated Fe-oxide bearing, silicic and clay altered, fine grained, porphyritic, acid igneous rock. With oxidation and weathering, the rock appears moderately leached.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

A porphyritic texture. Moderate amounts (25% to 30%) of fine grained, tabular to prismatic, variably preserved phenocrysts are contained within a finer grained groundmass. The phenocrysts are of ghosted/pseudomorphed plagioclase and biotite, and preserved, embayed and partly resorbed quartz. The groundmass is interpreted to have been composed of very fine grained, equigranular, anhedral feldspar (?plagioclase?) and quartz. Present within the groundmass are ghosted grains of Fe/Ti-oxides (?magnetite) and biotite. Quartz phenocrysts contain relict inclusions of preserved biotite. Cavities within feldspar phenocrysts are sealed with anhedral quartz enclosing euhedral feldspar (plagioclase ?).

ALTERATION

REPLACEMENT

With the exception of some amounts of primary quartz, alteration is complete. Replacement minerals are quartz (55%), sericite/illite (25%), Ti-oxides (5%) and ?pyrite (?); and later hydrated Fe-oxides/hematite (10%) and kaolinite (5%). Plagioclase (phenocrysts and groundmass) is altered to pervasive sericite/illite and minor amounts of late kaolinite. Groundmass quartz is strongly recrystallised and intergrown with sericite/illite. Biotite is altered to sericite/illite, Ti-oxides (rutile) and minor amounts of quartz. Primary Fe/Ti-oxides are altered to pyrite and Ti-oxides (rutile). Pyrite is altered to hematite/hydrated Fe-oxides. Sericite/illite in places is overprinted by dustings of hydrated Fe-oxides.

DEPOSITION

Discontinuous microfractures are sealed with very fine grained anhedral quartz. Trace amounts of sericite/illite are interstitial to the quartz. Late microfracturing is sealed with hematite/hydrated Fe-oxides.

COMMENTS

A biotite dacite. Feldspar phenocrysts are host to discontinuous igneous style quartz veinlets and cavity sealing.

SAMPLE NUMBER 25 LOCATION Wild Turkey

ROCK NAME quartz + sericite altered, quartz veined biotite dacite

FIELD DESCRIPTION quartz siltstone

OFFCUT DESCRIPTION

A mottled pale to medium grey and grey-brown, partly oxidised/weathered, hematite and hydrated Fe-oxide bearing, silicic and clay altered, quartz veined, fine grained, porphyritic, acid igneous rock. Selvages of hydrated Fe-oxides have formed along quartz veins and joint planes.

THIN SECTION DESCRIPTION
LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

A porphyritic texture. Abundant (40%), fine grained, tabular to prismatic, variably preserved phenocrysts are contained within a finer grained groundmass. The phenocrysts are of ghosted/pseudomorphed plagioclase and biotite, and mostly preserved quartz. Microphenocrysts of quartz and ghosted Fe/Ti-oxides are present. The groundmass is interpreted to have been composed of equigranular quartz and feldspar (plagioclase ?). Dispersed about the equigranular groundmass are ghosted grains of biotite.

ALTERATION
REPLACEMENT

With the exception of some amounts of primary quartz, alteration is complete. Replacement minerals are sericite/illite (55%), quartz (40%), pyrite (1%?) and Ti-oxides (4%); and late hematite/hydrated Fe-oxides. Biotite is altered to sericite intergrown with aggregates of Ti-oxides (rutile) and minor amounts of quartz. Plagioclase (groundmass and phenocrysts) is altered to pervasive sericite/illite which is intergrown with partly recrystallised groundmass and microphenocryst quartz. Formed about the silicate replacement are grains of pyrite (altered to hematite/hydrated Fe-oxides). Hydrated Fe-oxides overprint sericite in places.

DEPOSITION

An extensive network of microfracturing and fracturing is sealed with fine to very fine grained anhedral quartz. Interstitial to and as inclusions within the quartz are selvages and grains of sericite. Interstitial to and overgrowing the quartz are sparse amounts of carbonate (dolomite ?). Microfractures are sealed with hematite and hydrated Fe-oxides.

COMMENTS

A biotite dacite. The rock has an intrusive groundmass texture. Extensive quartz veining is intimately associated with wallrock replacement. Sericite in veins merges with that formed after the wallrock. Lack of deformation of the secondary mineralogy indicates burial metamorphism and hydrothermal alteration. The extent of the quartz veining indicates considerable fluid/wallrock interaction.

Applied Petrological Services

PETROLOGICAL STUDIES
OF
SURFACE AND SUBSURFACE SAMPLES
FROM
THE SUPPLEJACK LEASE, TANAMI, NORTHERN TERRITORY

FOR
OTTER EXPLORATION NL

August 1997

APS Report 94
Project No. 04020

Main Road
St Arnaud
New Zealand

Telephone (64) (3) 5211 034
Facsimile (64) (3) 5211 034

RESULTS

TABLE 1. PETROLOGICAL SUMMARY			
Sample	**Lithology**	**Wallrock Replacement**	**Deposition**
BK001	gabbro	100% 1. albite, hornblende, sericite, ilmenite, epidote, pyrite	1. (vug) hornblende, epidote; chlorite
SO527	sandstone/siltstone/mudstone (thermally metamorphosed)	100% 1. quartz, muscovite, biotite, andalusite/ cordierite, feldspar, opaques, tourmaline, epidote, apatite 2. sericite 3. kaolinite, hematite/hydrated Fe-oxides	
SO529	laminated/bedded, sandstone and siltstone/mudstone (thermally metamorphosed)	100% 1. quartz, albite, cordierite, biotite, tourmaline, apatite, opaques 2. sericite/illite, chlorite 3. kaolinite, hematite/hydrated Fe-oxides	1. (veinlet/shear) sericite/illite, chlorite
SO533	biotite granite/granite porphyry	45% 1. K-feldspar, biotite 2. sericite/illite, epidote, chlorite 3. kaolinite, hydrated Fe-oxides	1. (veinlet) K-feldspar, biotite
SO590	?biotite dacite/rhyolite or granite porphyry	85% 1. ? 2. quartz, kaolinite/halloysite, hematite/ hydrated Fe-oxides	1. (veinlet/vug) hematite, kaolinite, hydrated Fe-oxides
SO744	biotite granophyre	45% 1. sericite/illite 2. kaolinite, hematite/hydrated Fe-oxides	1. (vein) carbonate 2. (vug/veinlet) kaolinite
SO842	laminated/bedded, siltstone/mudstone (thermally metamorphosed)	100% 1. muscovite, biotite, quartz, apatite, opaques 2. illite/sericite 3. kaolinite, hematite/hydrated Fe-oxides	1. (vein/veinlet) quartz, muscovite, Fe-opaques
SO886	(granite derived) quartz bearing laterite		

SO899	(granite derived) quartz bearing laterite		
SO970	basalt	100% 1. sericite/illite, quartz, pyrite, Ti-oxides 2. hematite/hydrated Fe-oxides	1. (vein/veinlet) quartz; sericite 2. (veinlet) hematite/Fe-oxides
RB001	(early) plastically deformed, laminated, volcaniclastic silty mudstone	100% 1. quartz, sericite, Ti-oxides; carbonate 2. hematite/hydrated Fe-oxides	1. (veinlet) quartz; carbonate 2. (vein/vug) carbonate (quartz hydrated Fe-oxides) 3. (veinlet) hematite/hydrated Fe-oxides

APPENDIX ONE:

PETROGRAPHIC/MINERAGRAPHIC DESCRIPTIONS

SAMPLE NUMBER **BK001** LOCATION Blackhills

ROCK NAME metamorphosed gabbro

FIELD DESCRIPTION gabbro/amphibolite

OFFCUT DESCRIPTION

A mottled medium to dark grey-green and brown-green, Fe-opaque bearing, partly oxidised/weathered, silicic altered, fine to medium grained, mafic to ultramafic igneous rock.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

An equigranular texture. The primary composition is estimated as:
clinopyroxene (70%)
plagioclase (25%)
opaques (5%)
The rock is interpreted to have been composed mainly of tabular to prismatic clinopyroxene. Interlocking with the pyroxene were prismatic grains of plagioclase. Interstitial to the silicates were grains of Fe/Ti-oxides (magnetite or ilmenite ?). The rock has an overall doleritic texture.

ALTERATION

REPLACEMENT

Alteration is complete. Replacement minerals are albite (20%), amphibole (55%), sericite (15%), ilmenite (5%) and epidote (5%). Pyroxene is altered to pervasive amphibole (hornblende) intergrown with lesser amounts of albite and epidote. Primary Fe-opaques are altered to intergrowths of prismatic to tabular ilmenite and granular epidote. Plagioclase is altered to early albite and later sericite and epidote. Intergrown with amphibole and albite are trace amounts of pyrite.

DEPOSITION

Primary cavities are lined with amphibole and epidote which are overgrown by chlorite.

COMMENTS

A gabbro. Alteration is dominated by hornblende, representative of a thermal or regional metamorphism. Metamorphic grade is amphibolite facies.

SAMPLE NUMBER **SO527** LOCATION Supplejack

ROCK NAME weathered, thermally metamorphosed sandstone/siltstone/mudstone

FIELD DESCRIPTION ?banded, mica bearing sandstone

OFFCUT DESCRIPTION

A collection of RAB drill chips. The chips are of red-brown and green, oxidised to unoxidised/unweathered, hematite bearing, silicic altered, laminated/banded, siltstone to sandstone. The rock appears to have a crystalline fabric with biotite and white mica present.

THIN SECTION DESCRIPTION
LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

A crystalline fabric preserves a former fragmental texture. Within the former fragmental fabric is relict laminations and bedding (preserved by variation in composition and grain-size variation of secondary minerals). The predominant primary fragmental texture is interpreted to have been characterised by populations of fine sand-sized framework clasts. Some of these framework clasts are interpreted to have been quartz (25%). Other framework clasts may have included feldspar and/or rock fragments. The ghosted laminations and bedding are mostly defined by presence and absence of quartz.

ALTERATION
REPLACEMENT

Alteration is complete. Replacement minerals are quartz (20%), muscovite (25%), biotite (20%), ?andalusite/cordierite/feldspar (?), ?opaques (2%), tourmaline (1%), epidote (1%) and apatite (1%); later sericite (15%); and late kaolinite (15%) and hematite/hydrated Fe-oxides. Early alteration is dominated by equigranular quartz, biotite, muscovite and an unidentifiable silicate (andalusite/cordierite/feldspar). The unidentified silicate is altered to pervasive sericite and later kaolinite. Interlocking with the prograde alteration are minor to trace amounts of tourmaline, epidote, apatite and opaques (Fe oxides or sulphides ?). The opaque minerals are altered to hematite and hydrated Fe-oxides. The silicate replacement minerals are dusted with pervasive hematite and hydrated Fe-oxides.

COMMENTS

The primary rock is interpreted to have been an interbedded sandstone, siltstone and mudstone lithology. Prograde alteration has a strong granoblastic texture. The rock is interpreted to be a thermally metamorphosed sediment. The thermal alteration may have been a function of contact or deep burial metamorphism. An early retrograde alteration is represented by sericite.

SAMPLE NUMBER **SO529** LOCATION Supplejack

ROCK NAME thermally metamorphosed, laminated/bedded sandstone and silt/mudstone

FIELD DESCRIPTION sediment with mica

OFFCUT DESCRIPTION

A collection of RAB drill chips. The chips are of mottled pale to medium green and grey, unoxidised, partly weathered ?, opaque bearing, silicic altered, fine to medium grained crystalline rock.

THIN SECTION DESCRIPTION
LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

A crystalline fabric formed after a primary fragmental texture. The fragmental texture is interpreted to have comprised a population of fine to medium sand-sized framework clasts. The framework clast population is interpreted to have contained some amounts of quartz (30%). A relict lamination or bedding is defined by the differential distribution of prograde secondary minerals.

ALTERATION
REPLACEMENT

Replacement of the fragmental texture is complete. Replacement minerals are quartz (20%), albite (10%), cordierite (20%), biotite (15%), tourmaline (1%), apatite (<1%) and opaques (10%); and later sericite/illite (14%) and chlorite (10%); and late kaolinite and hematite/hydrated Fe-oxides. Early replacement is dominated by equigranular quartz, biotite, cordierite, albite and Fe-opaques. Intergrown with these minerals are minor amounts of tourmaline and apatite. Cordierite is replaced by sericite/illite and chlorite, and later kaolinite, while albite is partly altered to sericite/illite. Biotite is partly altered to chlorite. Fe-opaques are altered to hematite and hydrated Fe-oxides. Early silicates are partly masked by hematite and hydrated Fe-oxides in places.

DEPOSITION

Microfracturing is sealed with sericite/illite and chlorite. Cavities within shear zones (developed with biotite rich domains) are sealed with chlorite.

COMMENTS

A primary laminated/bedded sandstone and silt/mudstone. The sediment has been metamorphosed. A granoblastic texture amongst prograde replacement minerals suggests thermal metamorphism.

SAMPLE NUMBER **SO533** LOCATION Supplejack

ROCK NAME weakly altered, biotite granite or granite porphyry

FIELD DESCRIPTION biotite bearing granophyre/granite

OFFCUT DESCRIPTION

A medium brown to brown-grey, partly oxidised/weathered, ?opaque bearing, silicic altered, fine grained, porphyritic, acid igneous rock. Present are phenocrysts of quartz and feldspar.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

A porphyritic to equigranular texture. The primary composition is estimated as:
quartz (35%)
K-feldspar (45%)
plagioclase (13%)
biotite (6%)
opaques (1%)
Sparse phenocrysts of tabular, subhedral to anhedral quartz and plagioclase (albite) are contained within a voluminous, fine grained, equigranular textured groundmass. The groundmass is composed of interlocking, anhedral, tabular quartz and K-feldspar and lesser amounts of albite, biotite and Fe-oxides. Biotite most commonly occurs interstitially to feldspars and quartz. Feldspars exhibit perthitic and antiperthic textures. Present are trace amounts of apatite.

ALTERATION

REPLACEMENT

Alteration is moderate (45%). Replacement minerals are early K-feldspar (45%) and biotite (15%); later sericite/illite (22%), epidote (3%) and chlorite (15%); and later kaolinite and hydrated Fe-oxides/hematite. Albite is altered to early K-feldspar and biotite and more pervasive, later sericite/illite. Primary and secondary biotite is altered to chlorite and epidote. Primary opaques are altered to hematite and hydrated Fe-oxides. some amounts of feldspar are altered to kaolinite.

DEPOSITION

Microfractures and cavities are sealed with K-feldspar and biotite.

COMMENTS

A biotite granite or granite porphyry. Phenocryst and groundmass minerals are subhedral to anhedral in form. The rock may be migmatitic.

SAMPLE NUMBER **SO590** LOCATION Supplejack

ROCK NAME strongly weathered ?biotite dacite/rhyolite or granite porphyry

FIELD DESCRIPTION fragmental felsitic rock

OFFCUT DESCRIPTION

A selection of RAB drill chips. The drill chips are of medium brown to yellow-brown, oxidised/weathered, ?altered, fine grained, ?porphyritic, acid igneous rock. The rock has quartz phenocrysts.

THIN SECTION DESCRIPTION
LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

A relict porphyritic texture. Moderate amounts of ghosted and preserved, fine grained, tabular phenocrysts are contained within a finer grained, secondary groundmass. The phenocrysts are of mostly preserved quartz and ghosted/pseudomorphed feldspar and ?mafics. Present within the groundmass is abundant granular quartz which is interpreted to have been interlocking with feldspar (and mafics and Fe opaques ?). Primary quartz (groundmass and phenocrysts) is interpreted to have been at least 35% of the rock. Present in places are grains of ghosted biotite.

ALTERATION
REPLACEMENT

Alteration is strong. Replacement minerals are quartz (40%), kaolinite/halloysite (35%) and hematite/hydrated Fe-oxides (25%). Primary quartz is strongly recrystallised. All other primary silicates (feldspar and mafics) are altered to kaolinite/halloysite intergrown with hematite and hydrated Fe-oxides. Kaolinite is stained in places with hydrated Fe-oxides. Quartz is intergrown with kaolinite.

DEPOSITION

Microfractures and cavities (resulting from leaching) are sealed with hematite, kaolinite and hydrated Fe-oxides.

COMMENTS

An acid porphyritic igneous rock: a dacite/rhyolite or granite porphyry. There is no evidence of hypogene alteration. Any hypogene alteration has been superimposed by strong supergene alteration.

SAMPLE NUMBER **SO744** LOCATION Supplejack

ROCK NAME weathered biotite granophyre

FIELD DESCRIPTION sediment/aplite/microgranite ?

OFFCUT DESCRIPTION

A selection of RAB drill chips. The drill chips are of pale grey to brown-grey, oxidised and weathered, hematite/hydrated Fe-oxide bearing, fine grained, acid igneous rock. The rock is host to kaolinite veining.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

An equigranular to granophyric texture. The primary composition is estimated as:
quartz (40%)
K-feldspar (42%)
albite (10%)
biotite (2%)
Fe-opaques (1%)
The rock is composed of intergrown quartz and K-feldspar. In most places the quartz and K-feldspar define a granophyric texture. Grains of albite, biotite and Fe-opaques are intergrown with the quartz and K-feldspar in some places. Sparse phenocrysts of albite and microphenocrysts of quartz are present.

ALTERATION

REPLACEMENT

Alteration is moderate (45%). Replacement minerals are early sericite/illite (35%); and later kaolinite (65%) and hematite/hydrated Fe-oxides. Biotite is altered to sericite/illite. Some albite and K-feldspar are altered to sericite/illite. Significant amounts of albite and K-feldspar are altered to kaolinite. Parts of the rock are dusted with hematite and hydrated Fe-oxides. The rock is moderately to strongly sheared and deformed: quartz exhibits undulatory extinction and is recrystallised in places.

DEPOSITION

Early fracturing is sealed with fine to medium grained carbonate. Kaolinite is deposited within cavities and fractures located along shear planes.

COMMENTS

A granitic rock. The textures is characteristic of a granophyre. With deformation the rock is weathered and fractures sealed with kaolinite.

SAMPLE NUMBER **SO842** LOCATION Supplejack

ROCK NAME thermally metamorphosed laminated/bedded siltstone/mudstone

FIELD DESCRIPTION sandstone

OFFCUT DESCRIPTION

A selection of RAB drill chips. The chips are of medium grey-brown to red -brown, weathered/oxidised, ?altered sediment. The sediment in places is weakly bedded or laminated.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

A relict crystalline fabric is interpreted to have formed after a primary fragmental texture. The fragmental texture is interpreted to have been characterised by population of silt-sized framework clasts. Some of the framework clasts are interpreted to have been quartz (20%). Other framework clast types are not resolvable; feldspars and rock fragments are probable. Some parts of the rock are interpreted to have been composed of mud-sized material. Laminations or bedding are defined by grain-size variation of secondary minerals or the distribution of preserved or modified detrital quartz.

ALTERATION

REPLACEMENT

Alteration is complete. Replacement minerals are muscovite (35%), biotite (15%), quartz (25%), apatite (<1%) and Fe-opaques (10%); later illite/sericite (15%); and later kaolinite and hematite/hydrated Fe-oxides. Alteration is dominated by intergrowths of platy muscovite and biotite and granular quartz. Minor amounts of apatite and Fe-oxides are interlocking with these minerals. Primary quartz is recrystallised and intergrown with micas. Biotite is altered to some amounts of sericite/illite and later formed kaolinite. Fe-opaques are altered to hematite/hydrated Fe-oxides. Early and late silicates are superimposed with dustings of hematite/hydrated Fe-oxides.

DEPOSITION

Fracturing and microfracturing are sealed with fine to very fine grained anhedral quartz. The quartz interlocks with minor amounts of muscovite and Fe-opaques (altered to hematite/hydrated Fe-oxides).

COMMENTS

A primary siltstone to mudstone. The sedimentary rock has been metamorphosed. The equigranular to granoblastic texture of the metamorphic assemblage is suggestive of thermal metamorphism.

SAMPLE NUMBER **SO886** LOCATION Supplejack

ROCK NAME (granite derived) quartz bearing laterite

FIELD DESCRIPTION laterite enclosing dacite clasts

OFFCUT DESCRIPTION

A selection of RAB drill chips. The drill chips are of pale to medium brown to yellow-brown laterite. Enclosed by or cemented by massive hematite and hydrated Fe-oxides are angular fragments of quartz or siliceous rock.

THIN SECTION DESCRIPTION
LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

The rock comprises a poorly sorted, cement supported, population of silt to pebble-sized, angular quartz fragments. The cement comprises crustiform and colloform banded hematite and hydrated Fe-oxides. The quartz is mostly monocrystalline, but includes some polycrystalline clasts. The quartz is strongly deformed: having undulatory extinction and kink banding. The quartz is host to abundant generations of secondary, liquid-rich fluid inclusions contained along annealed microfractures. Present within some quartz fragments are grains of ghosted biotite. The biotite is altered to sericite/muscovite and Ti-oxides. Microfractures and cavities within the quartz are sealed with hematite and hydrated Fe-oxides.

COMMENTS

A laterite comprising hematite/hydrated Fe-oxide cemented, mobilised fragmented quartz. It is interpreted that the quartz has been deformed and recrystallised. The presence of ghosted grains of biotite suggests that the quartz was primarily of granitic origin.

SAMPLE NUMBER **SO899** LOCATION Supplejack

ROCK NAME (granite derived) quartz bearing laterite

FIELD DESCRIPTION laterite (dacite fragments ?)

OFFCUT DESCRIPTION

A selection of RAB drill chips. The drill chips are of medium to dark brown and red-brown laterite. Enclosed by massive hematite and hydrated Fe-oxides are fragments of quartz or other siliceous rock.

THIN SECTION DESCRIPTION
LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

Imbedded within the massive hematite and hydrated Fe-oxides (goethite/limonite) are poorly sorted, hematite/hydrated Fe-oxide supported (50%) populations of angular quartz. The quartz is both mono and polycrystalline. The quartz has undulatory extinction and kink banding, and is host to generations of ultra fine grained, liquid-rich secondary fluid inclusions. The fluid inclusions are concentrated along networks of annealed microfractures. In many examples the quartz is impregnated with hematite and hydrated Fe-oxides. Microfractures within the quartz are sealed with hematite and hydrated Fe-oxides. Some quartz fragments have ghosted inclusions of biotite.

COMMENTS

Fragments of supergene quartz enclosed by massive hematite and hydrated Fe-oxides. The supergene quartz may be a recrystallisation product of hydrothermal quartz, igneous quartz, sedimentary quartz or silicic altered wallrock. The supergene quartz appears to have been mobilised into position prior to cementation with hematite and hydrated Fe-oxides. The inclusion of biotite within some quartz fragments suggests the quartz is of igneous origin: probably granitic quartz.

SAMPLE NUMBER **SO970** LOCATION Supplejack

ROCK NAME weathered, sericite + quartz altered basalt

FIELD DESCRIPTION saprolite, volcanic rock

OFFCUT DESCRIPTION

A selection of RAB drill chips. The drill chips are of brown to red-brown, oxidised/weathered, silicic/clay altered, fine grained, porphyritic, intermediate igneous rock.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

A porphyritic texture. Abundant, fine grained, tabular to prismatic, ghosted/pseudomorphed phenocrysts are contained within a finer grained secondary groundmass. Phenocryst morphologies are of plagioclase and pyroxene. The groundmass is interpreted to have been intergranular to hyalopilitic in texture: grains of ghosted plagioclase and pyroxene were contained within a vitric medium. Present are ghosted agglomerates of pyroxene and plagioclase, and grains of Fe/Ti-oxides. The groundmass contains trace to minor amounts of relict quartz.

ALTERATION

REPLACEMENT

Alteration is complete. Replacement minerals are sericite/illite (73%), quartz (20%), pyrite (2%) and Ti-oxides (5%); and late hematite/hydrated Fe-oxides. Replacement of groundmass and phenocrysts is dominated by sericite/illite. Lesser amounts of very fine to ultra fine grained quartz are intergrown with sericite (particularly after pyroxene phenocrysts). Intergrown with the silicates are grains of pyrite, formed mainly after primary Fe/Ti-oxides. Disseminated about the groundmass are Ti-oxides (rutile/leucoxene). Pyrite is altered to hematite and hydrated Fe-oxides. The silicate replacement assemblage is overprinted by dustings of hematite and hydrated Fe-oxides.

DEPOSITION

Fractures and microfractures are sealed with fine to very fine grained anhedral quartz. Interstitial to some of this quartz are selvages of sericite. Late microfracturing and residual cavities are sealed with hematite and hydrated Fe-oxides.

COMMENTS

A volcanic rock: a basalt ? Alteration is dominated by sericite. Some vein quartz may be supergene (after carbonate ?).

SAMPLE NUMBER **RB001** LOCATION Redback SW ML 167

ROCK NAME platically deformed, laminated, volcaniclastic silty mudstone

FIELD DESCRIPTION volcaniclastic sediment

OFFCUT DESCRIPTION

A mottled medium to dark brown and yellow-brown, hematite and hydrated Fe-oxide bearing, silicic/clay altered, quartz veined, deformed and sheared, bedded/laminated mudstone and silty mudstone.

THIN SECTION DESCRIPTION

LITHOLOGY: PRIMARY MINERALOGY, TEXTURES

A primary fragmental texture. In section the rock has two main textural domains (both with laminated fabrics), one more voluminous than the other.

The more voluminous domain has a sparse to moderately abundant (35%) population of matrix supported, silt-sized framework clasts. Identifiable framework clasts are of fragments of feldspar and micas (muscovite ?), and unresolvable rocks fragments. The rock fragments may be volcanic. Present are ghosted grains of detrital Fe/Ti-oxides (?magnetite). Bedding or lamination within this domain is defined by subtle grain-size variation of framework clasts.

The less abundant domain is of altered argillaceous material. Bedding or lamination within the domain is defined by planar or poddy concentrations of ultra fine grained carbonaceous material. Carbonaceous rich domains may occur as lenses with carbonaceous poor domains. the primary composition of the non-carbonaceous component is not resolvable.

The two domains have undergone soft sediment deformation. Displacement across carbonaceous bands is present. Laminae have been plastically deformed (prior to alteration). In one part of the rock, liquefied, unlithified argillaceous material has been discordantly to concordantly injected into both domain types.

ALTERATION

REPLACEMENT

Alteration is complete. Replacement minerals are early quartz (20%), sericite (45%), Ti-oxides (5%) and carbonate (30%); and later hematite/hydrated Fe-oxides. Replacement of silt-sized and mud-sized material alike is dominated by intergrowths of very fine to ultra fine grained quartz and sericite. Dispersed about the silicate replacement mineralogy are grains and aggregates of Ti-oxides. Overprinting the silicate replacement are grains and aggregates of carbonate. The ghosted carbonate is characterised by rhombic forms (dolomite or Fe-carbonate). The carbonate is totally replaced by hematite and hydrated Fe-oxides.

DEPOSITION

Microfracturing, fracturing and cavities are sealed with anhedral to subhedral quartz. Overgrowing the quartz are ghosted grains of carbonate. the carbonate is altered to quartz and hematite/hydrated Fe-oxides. Later fracturing is sealed exclusively with carbonate (altered to quartz and hematite/hydrated Fe-oxides). Late microfracturing is sealed with hematite/hydrated Fe-oxides.

COMMENTS

A quartz poor, possibly volcaniclastic provenance. typical of other Tanami complex sediments. Relatively low grade metamorphism. Alteration is dominated by quartz and sericite. Greenschist facies metamorphism is probable. A metasomatic component to alteration is evidenced by fractures sealed with quartz and carbonate.

STRUCTURE OF THE TANAMI REGION
(TANAMI COMPLEX)

INTRODUCTION

The following interpretations are based on detailed structural mapping of the few available outcrops. The structural interpretation attempts to outline a structural evolution, which is consistent with all available data. Observed structural patterns have been used on models to help interpret geophysical data. Area wide lithological correlations are difficult with the current posthole drilling database. Despite this, similarities in lithological associations have been recognised and used to interpret a broad stratigraphy through the area.

INTERPRETED STRUCTURAL HISTORY

A main deformation phase, which has an associated axial plane cleavage, is well developed in two separate domains. Several observations suggest that there may be up to two preceding phases of deformation, although these cannot be confirmed with the current level of data available. As a result, the main deformation has been termed D_3.

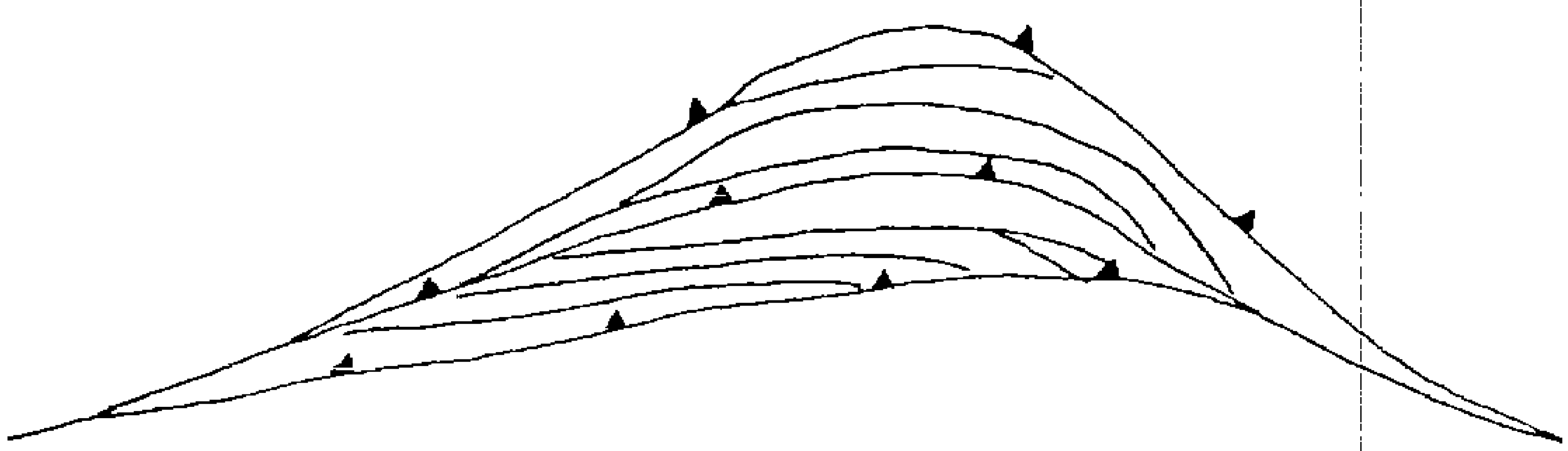
Folds of the main deformation (D_3) and later folding events cannot explain several fold interference patterns. In addition, several significantly different units (distinguished mainly on the basis of geophysical information) appear to have been assembled prior to the main deformation phase (D_3). Large faults separating these tectonic units have been interpreted These are D_1 structures and several outcrop patterns associated with such faults are typical of fold and thrust style of deformation. D_2 structures are typified at a large scale by the main syncline oriented NE on whose SE limb are the various pits in the Tanami area.

D_3 deformation is strongly domainal and is characterised by upright NW trending folds with a well-developed axial planar cleavage. This deformation also reorients and earlier D_1 "thrust-type" faults. These D_1 faults may also have been reactivated when in suitable orientations to accommodate D_3 strain.

Two fold generations post-date F_3 folds and these are most readily observed in a complex zone of folding in the Black Hills South area. F_4 folds are oriented approximately north-south and F_5 folds are oriented east-west. Large scale F_4 folds have been interpreted to control the distribution of Gardiner Sandstone north and east of the Black Hills area.

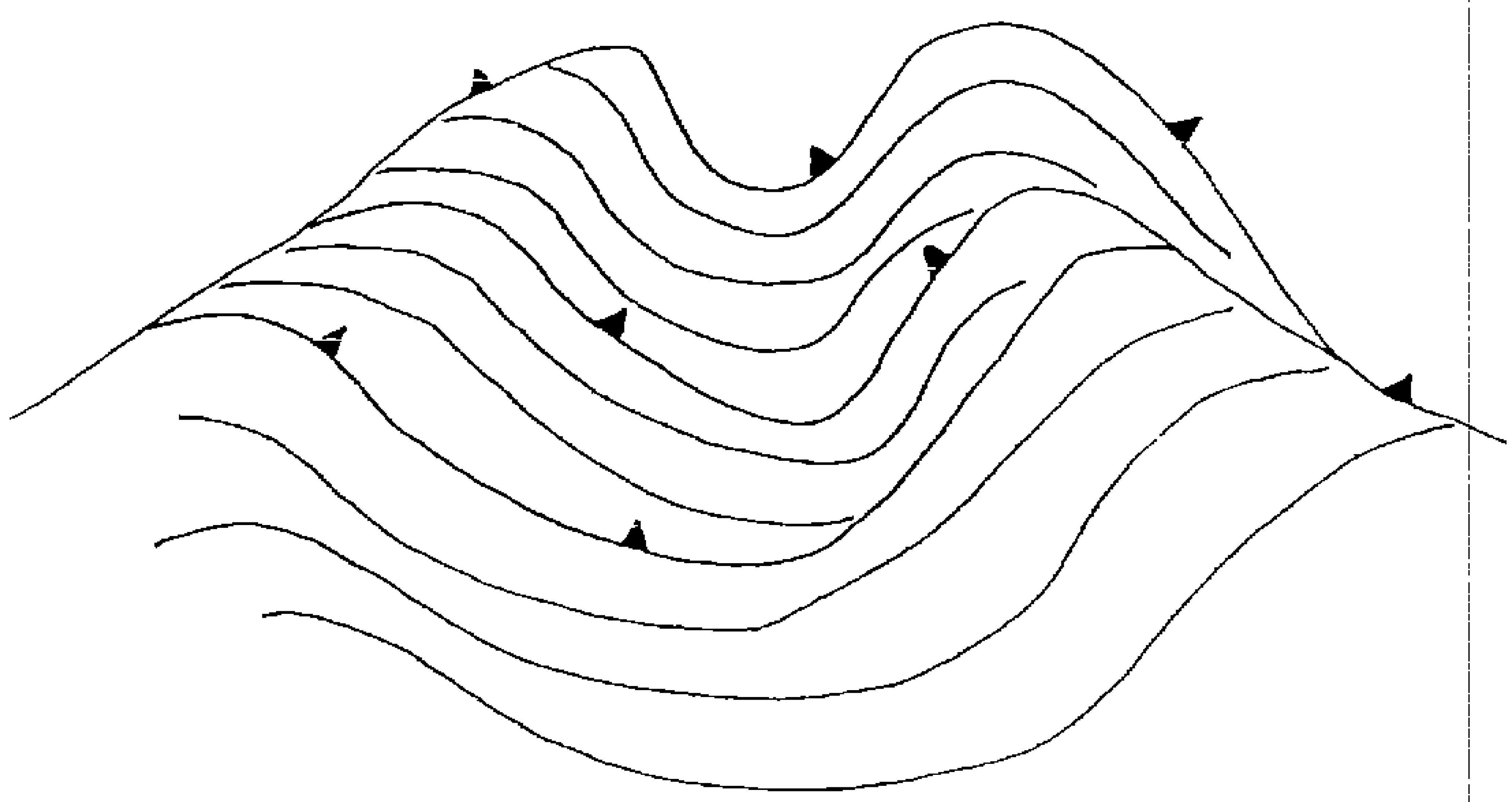
Although the Gardiner Sandstone has been considered to unconformably overlie the Mt Charles sequence, it is significantly deformed. Early folds in the Gardiner Sandstone appear to be F_3 folds and are consistent in terms of orientation, however, without an axial planar cleavage, certain correlation is difficult. Later folds also affect the Gardiner Sandstone and evidence for refolding occurs in the Apertawonga area. Folding is markedly disharmonic between the Gardiner Sandstone and the Mt Charles. Fold axial surfaces are rarely traceable through the contact between the Gardiner Sandstone and the Mt Charles Beds. This is largely due to the different mechanical properties, particularly buckling wavelengths, between a several hundred metre thick competent sandstone (Gardiner) and a multi-layered sequence of shale, chert, siltstone and sandstone (Mt Charles)

D_1



?Thrusting – amalgamation of various tectono-stratigraphic units.
Associated ?minor folding.

D_2



Upright, tight to close folding – no fabric developed.

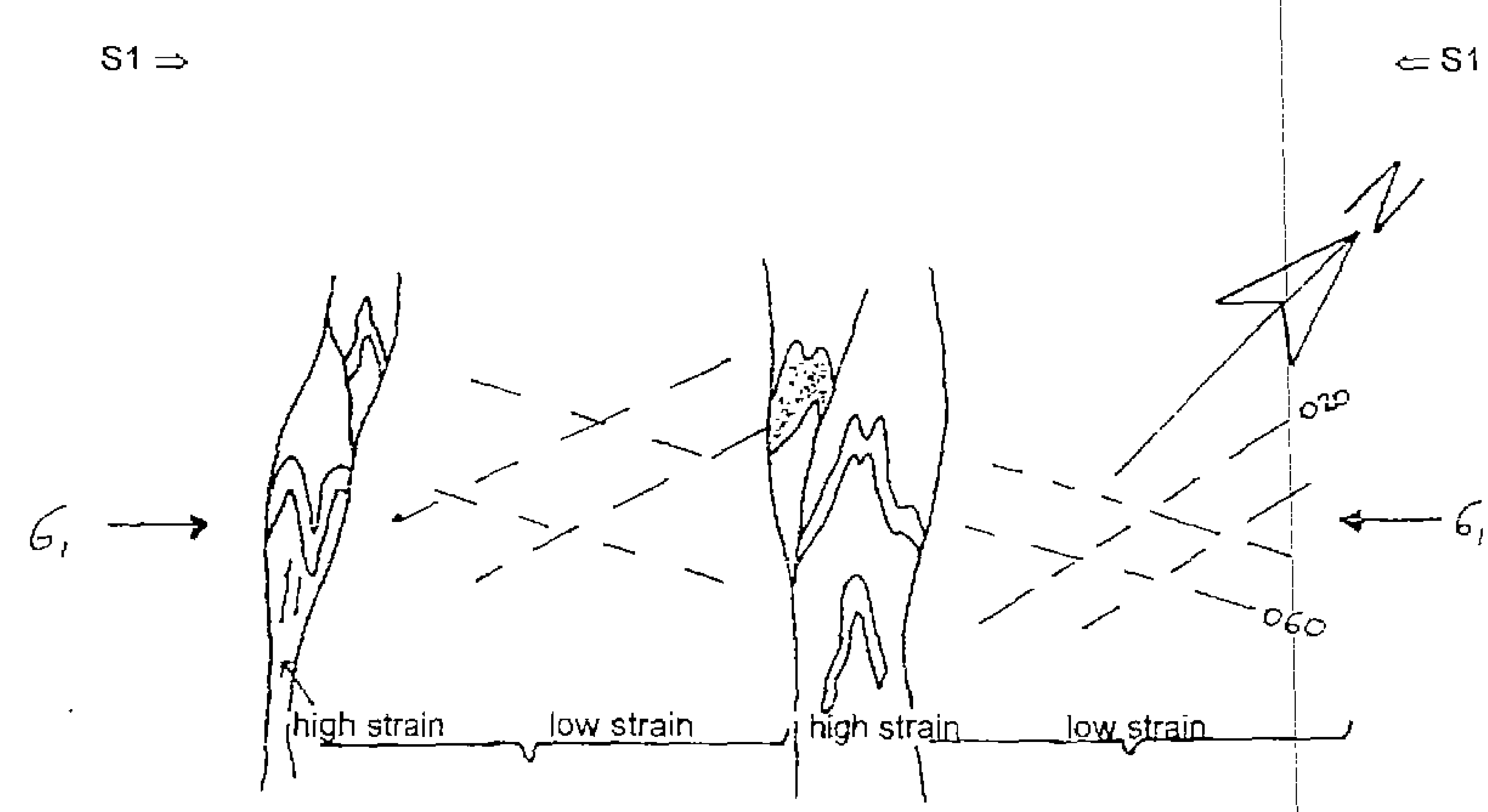
D$_3$

Domains of NW oriented intense (high strain) F_3 folding, faulting and reactivation of pre-existing (?D_1) faults.

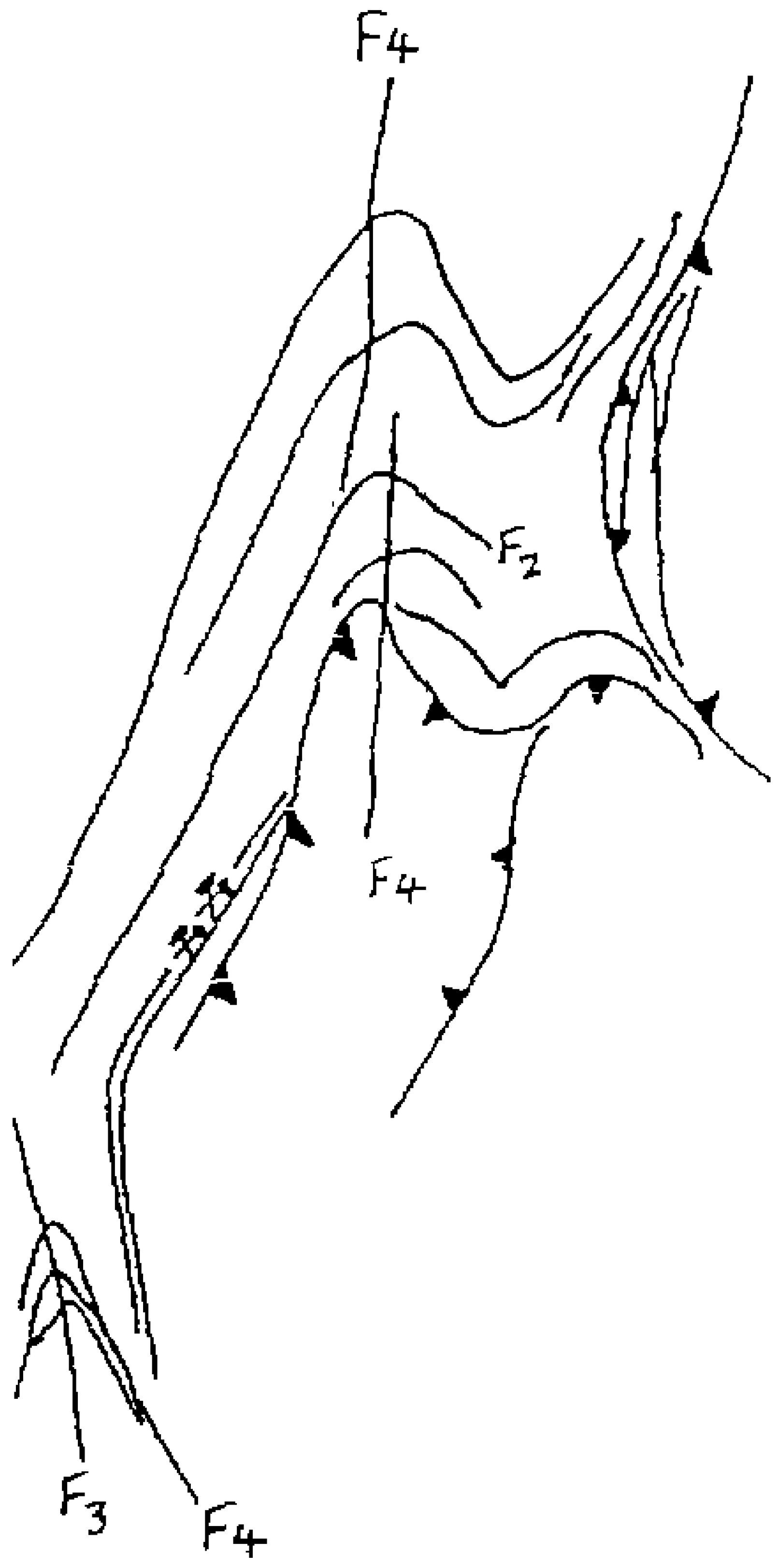
Tight folds with well-developed axial planar cleavage.

Zones of refoled fold interference patterns type 2/3.

Development of 020/060 conjugate, low strain deformation zones in areas of low intensity D_3 deformation (eg. mine sequence). Orientations consistent with far field stress directions inferred for D_3 deformation ⇒ Gold Min.

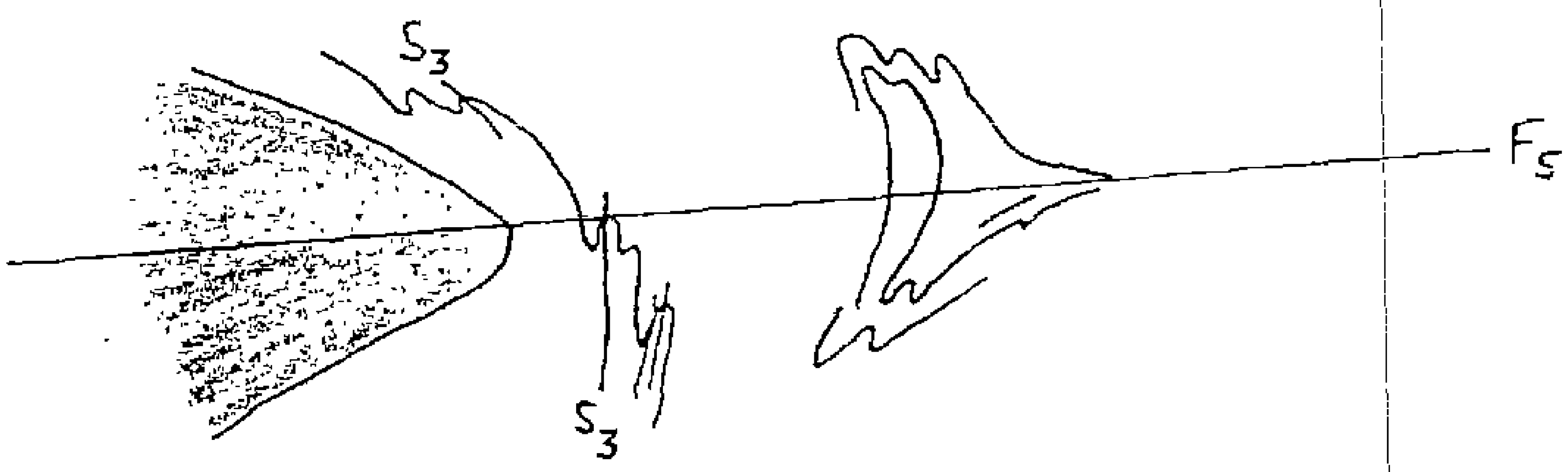


D₄



Large scale – low amplitude folding

D_5



Relationships observed at Black Hills South area.
Local development of F_5 folding.

RECOMMENDATIONS

1 Posthole drilling database needs geological re-assessment in order to resolve a more detailed litho-stratigraphy

2. All detailed mapping should be compiled at 1:10,000. This is factual data which forms part of the database and may be used for future interpretations.

3 Build up database of Tanami Complex to try and understand the nature of "Undifferentiated Tanami Complex" adjacent to the basalt-rich mine sequence. These rocks magnetically resemble those in the Titania region.

4. Validate litho-structural units interpreted on the 1:100,000 map using the re-assessed posthole drilling database and information gained in 3 on non-outcropping or drilled parts of "Undifferentiated Tanami Complex".

5. Limited stratigraphic diamond drilling should be undertaken to provide:

   - geological understanding to place posthole drilling in context with geological mapping;
   - geophysical data;
   - information regarding little known terrains, eg. Flores.