MINERALOGICAL REPORT No. 9019

by Alan C. Purvis, PhD

February 16th, 2007

TO :	Mr Jeremy Wykes Cameco Australia Pty Ltd PO Box 35921 WINNELLIE NT 0820
YOUR REFERENCE :	Order No. TBA
MATERIAL & IDENTIFICATION :	30 core/rock samples from Cameco's Plateau Project, Arneham Land, NT
WORK REQUESTED :	Thin and polished thin section preparation, description and report with comments as specified.
SAMPLES & SECTIONS :	Returned to you with this report.
DIGITAL COPY :	Enclosed with hard copy of this report.

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SUMMARY COMMENTS

This is the second of four reports on a total of sixty-three core and outcrop samples from Arnhem Land in the Northern Territory, received early November with a covering letter from Jeremy Wykes. It describes samples from the Plateau Project area, with twelve core samples from drillhole PLD001 (eleven thin sections and one polished thin section) and eighteen thin sections of outcrop samples. Sample numbers and selected field data provided by Cameco are included as pages 5 and 6 of this report before the individual descriptions.

The core samples include four samples of sandstone, one sample of a contact between sandstone and an altered mafic inclusion and seven samples that contain or consist of altered dolerite, including four that contain or largely consist of felsic dykes and segregations. The outcrop samples include one sample of highly altered quartzofeldspathic gneiss, seven samples referred to Tin Camp Granite in the notes (with one quartz-rich breccia that is probably not granitic), three samples referred to as altered dolerite (only one is genuine dolerite) and seven samples of Kombolgie Subgroup sediments.

The **altered gneiss (PL060020)** has quartz and sericite/illite/phengite + hematite and leucoxene, and seems to have been quartzofeldspathic with minor biotite. It may represent quartz diorite gneiss.

The **Tin Camp Granite (PL06002, 05, 10, 11, 15 and 16)** is heterogeneous and altered and/or brecciated. Sericite is ubiquitous, although some samples retain fresh plagioclase, and clays, sericite or chlorite, with lamellar leucoxene, have replaced biotite. K-spar, where abundant, is mostly reddish and clouded and may have been affected by low-temperature hydrothermal processes, except in **PL060016**, which has perthitic orthoclase. Accessories include zircon, monazite and apatite, and some samples have apparently primary muscovite. Sample **PL06002** has abundant biotite as decussate thin flakes, but the other samples are either leucocratic **(PL06005, 10 and 11)** or have normal platy biotite **(PL060015 and 16)**. Samples PL060015 and 16 are also brecciated, with clays and vein-quartz in **PL060015** and abundant fractured and fragmented fine-grained material in **PL060016**. Sample **PL060009** is listed as Tin Camp Granite, but is a quartz-rich breccia and may represent brecciated sandstone.

Various types of **sandstone and conglomerate** were selected for this report. Those in the drillhole occur at **75.85, 159.3, 236.3, 464.5** (with a mafic dyke), and **472.5m**. These include fine to very coarse-grained sandstone, locally bimodal or interbedded, mostly with optically continuous overgrowths and hematite, locally with illite **(75.85, 159.3 and 236.3m)**, kaolinite or dickite **(159.3m)** and microcrystalline alunite-group mineral possibly the Sr-light rare-earth element-Al phosphate-sulphate mentioned by Beaufort et al (2005), possibly a solid solution of florencite [$CeAl_3(PO_4)_2(OH)_6$] and svanbergite [$SrAl_3(PO_4)(SO_4)(OH)_6$],also at **159.3m**. This mineral is considered by Beaufort et al (2005) to be part of the early diagenetic assemblage, contemporaneous with illite and dickite. The kandite in the sandstone at 159.3m is too fine-grained to allow discrimination between kaolinite and dickite in thin section: coarse-grained dickite is commonly twinned, but kaolinite and fine-grained dickite do not show twinning in thin section.

Outcropping sandstones and conglomerates are found in **PL060012** and **13**, both characterised by loosely aggregated rounded single-crystal quartz grains without optically continuous overgrowths, but with sparse illite ± quartz and interstitial microcrystalline quartz or apparently isotropic material. **PL060014** has abundant illite but no kaolinite or dickite as suggested in the notes supplies. This sandstone also has sparse optically continuous overgrowths, again showing that optically continuous overgrowths and illite are not mutually exclusive. **PL060018** is medium to coarse-grained sandstone with illite-quartz, rare quartz-tourmaline aggregates and rare anatase. **PL060021** is a quartz-rich granule conglomerate with optically continuous overgrowths and interstitial illite + quartz as well as stylolitic grain boundaries and illite-lined stylolites. This again suggests a sequence of optically continuous overgrowths followed by illite followed by stylolitic grain boundaries and stylolites. Very coarse-grained sandstone in sample **PL060025** has the same diagenetic sequence, but bimodal sandstone in **PL060026** has stylolitic grain boundaries in areas dominated by coarse-grained sandstone and interstitial silt to fine-grained sandstone in other areas.

The **dolerite** chilled margin in **PLD001** at **464.5m** has chlorite-hematite-leucoxene alteration of the groundmass, chloritised feldspar microphenocrysts and leucoxene ex-skeletal opaque oxide. Other dolerites sampled in core **(546.10, 558.05, 585.05, and 597.15m)** have mostly fresh or weakly sericitised plagioclase, clinopyroxene that is partly fresh and partly replaced by actinolite or smectite ± chlorite ± carbonate ± pyrite and fresh or altered opaque oxide, with leucoxene ± ilmenite ± pyrite. Apatite is less abundant and finer-grained than in dolerite in drillhole NMD002 (see Report No. 9014). Felsic veins and segregations at **558.05, 585.85, 597.15 and 644.05m** have plagioclase, K-spar, quartz, sericite, clays, carbonate and sparse sulphide and seem to be broadly andesitic, possibly representing late magmatic segregations that have formed in situ (644.05m) or migrated into fractures in the dolerite. Dolerite at **617.75m** has abundant potassium as sericite and areas of chlorite-quartz-K-spar mesostasis, and the vein at **644.05m** may be richer in K-spar than the other dykelets. Dolerite from

633.4m has an alteration envelope with abundant adularia, passing into albite-sericite-altered plagioclase. The envelope is adjacent to a vein with carbonate, quartz, smectite, prehnite and adularia, with narrow fractures containing pumpellyite and carbonate.

Outcropping dolerite (PL060024) is fine-grained apart from abundant large plagioclase phenocrysts largely flooded by sericite, and has albite-sericite-altered groundmass plagioclase, abundant actinolite and interstitial patches of chlorite and/or prehnite. Sample **PL060023** is quartz-sericite/illite-hematite/limonite-leucoxene-altered quartz dolerite-related granophyre and sample **PL060022** is quartz-sericite/phengite altered possible felsic igneous rock or sandstone, but is not dolerite.

REFERENCE

BEAUFORT, D., PATRIER, P, LAVERRET, E., BRUNETON, P AND MONDY, J: Clay alteration associated with Proterozoic unconformity-related uranium deposits in the East Alligator River Uranium Field, Northern Territory, Australia: *Economic Geology*, **100**, 515-536

Hole	Sample	TS type	Describe?	Rock type	Questions?
Plateau Project Samples					
PLD001	PLD001 75.85 ✓	std	Y	Sandstone	What is the cause of the seeming bedding controlled limonite spots? Are they pseudomorphs after some earlier mineral. Nature of cement if present.
PLD001	PLD001 159.30 ✓	std	Y	sandstone	Mottled yellow clay and purple digenetic hematite. Diagenetic history if possible. Nature of interstitial cement. What is the overprinting relationship between the two.
PLD001	PLD001 236.30	std	Y	sandstone	Diagenetic history. Nature of cement and overprining relationships between purple digenetic hematite and orange "bleached" area.
PLD001	PLD001 464.50	std	Y	Dyke in dolerite?	What is the nature of the aphanitic dark material? Is it a chilled mafic dyke?
PLD001	PLD001 472.50	std	Y		What is the greenish material? What is its relationship to the purple material?
PLD001	PLD001 546.10	std	Y	Dolerite	Describe and compare with 617.75 and 644.05. The gamma background is twice as high for 617.75 and 644.05. Is this because of increased potassium content in the form of alteration or alkali feldspar?
PLD001	PLD001 558.05	std	Y	Dolerite	Is this a chilled mafic dykelet in host dolerite?
PLD001	PLD001 585.85	std	Y		What is this material. It appears to be intruding a dolerite sill. Is is a dyke or cooked sediment?
PLD001	PLD001 597.15	std	Y	Dolerite	Another of these "dykelets" intruding dolerite. Is it a dyke or is it an altered vein of some sort?
PLD001	PLD001 617.75	std	Y	Dolerite	Describe and compare with 546.10. The gamma background is twice as high for 617.75 and 644.05. Is this because of increased potassium content in the form of alteration or alkali feldspar?
PLD001	PLD001 633.40	polished	Y	Vein in dolerite	Mineralogy of vein and associated selvage, including sulfide mineralogy. Is it all just pyrite?
PLD001	PLD001 644.05	std	Y	Vein in dolerite	Nature of the veinlet?
outcrop	PL060002	std	Y	Granitoid	Tin Camp Granite, locally cut by qtz and qtz-hem veins. Locally elevated radioactivity, though not in veins. More than one alteration event?
outcrop	PL060005	std	Y	Granitoid	Tin Camp Granite. Same phase of intrusion as PL0600002? Similar alteration?
outcrop	PL060009	std	Y	Granitoid	PL060009 and PL060010 are from an outcrop where main mass of Tin Camp Granite (PL060009) appears to be cut by later dykes of fine granitoid material (PL060010). Are they very different to eachother? How do they compare to PL060002 and 0005?
outcrop	PL060010	std	Y	Granitoid	PL060009 and PL060010 are from an outcrop where main mass of Tin Camp Granite (PL060009) appears to be cut by later dykes of fine granitoid material (PL060010). Are they very different to eachother? How do they compare to PL060002 and 0005?
outcrop	PL060011	std	Y	Granitoid	Another dyke cutting the Tin Camp Granite. What is the pale green mineral?
outcrop	PL060012	std	Y	Sandstone	Sandstone that sits about 20 m above contact with Tin Camp Granite. Does this sandstone look like it has had a pluton emplaced close to it?
outcrop	PL060013	std	Y	Sandstone	Sandstone sample about 20 m higher stratigraphically than PL060012.

Hole	Sample	TS type	Describe?	Rock type	Questions?
outcrop	PL060014	std	Y	Sandstone	Sandstone from the center of a kaolinite hyperspectral anomaly. Is this reflected in the mineralogy? What is the pale yellow clay phase?
outcrop	PL060015	std	Y	Granitoid	Locally (relatively) radioactive Tin Camp Granite. How dow it compare with other Tin Camp Granite samples?
outcrop	PL060016	std	Y	Granitoid	Locally (relatively) radioactive Tin Camp Granite. How dow it compare with other Tin Camp Granite samples?
outcrop	PL060018	std	Y	Sandstone	Mamadawerre sandstone. Nature of alteration/diagenesis/deformation, if any
outcrop	PL060020	std	Y	Gneiss?	Basement rock
outcrop	PL060021	std	Y	Sandstone	Mamadawerre sandstone. Nature of alteration/diagenesis/deformation, if any
outcrop	PL060022	std	Y	Dolerite?	Mafic rock from basement inlier. Mapped as Zamu dolerite, but that implies foliated orthoamphibolite. More like Oenpelli dolerite?
outcrop	PL060023	std	Y	Dolerite?	Mafic rock from same vicinity as PL060022. Similarities? It has what appear to be large qtz grains. Are they phenocrysts? Are they being resorbed?
outcrop	PL060024	std	Y	Dolerite	This sample comes from the same outcrop within 20 cm of PL060023. Is it different?
outcrop	PL060025	std	Y	Sandstone	Gummarimbang sandstone.
outcrop	PL060204	std	Y		Describe

INDIVIDUAL DESCRIPTIONS

1. **Plateau Project Core Samples: PLD001**

PLD001, 75.85m **Quartz-rich coarse-grained sandstone with abundant quartz-rich cement containing limonite-clay patches and microcrystalline aggregates of a probable alunite-group mineral (possibly phosphate ± sulphate mineral with Ca, Sr, Ba, Pb or REE).**

Field Note: *Sandstone: what is the cause of the seeming bedding controlled limonite spots: are they pseudomorphs of some earlier mineral? Nature of cement, if present?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	*Abundance*	*Origin/location*
Quartz-1	Dominant	Detrital
Quartz-2	Abundant	Interstitial
Zircon	Rare	Detrital
Clay (illite?) ± limonite	Minor	Interstitial
Alunite-group mineral?	Very minor	interstitial

This is an unusual sandstone as it has abundant rounded single-crystal quartz grains and less abundant cherty to microcrystalline polycrystalline quartz grains to 1mm in diameter, including quartz with hematite and leucoxene (silicified volcanics?). The quartz includes grains with biotite and fibrous possible sillimanite or rutile and has been partly cemented by optically continuous overgrowths. However, most of the cement is fine-grained quartz within which there are irregular patches and intergranular films of possible illite ± limonite. The largest patch is 1mm long and 0.5mm wide. There are also areas from 0.1mm to 0.5mm in diameter that contain or consist of small rhombohedral crystals of a possibly alunite-related mineral, possibly with phosphate ions as well as or instead of sulphate ions. Such minerals may contain various combinations of Ca, Sr, Ba, Pb and rare-earth elements, and may require X-ray diffraction or SEM/Probe analysis.

PLD001, 159.30m **Quartz-rich medium to coarse-grained sandstone with optically continuous overgrowths, interstitial illite (1), kaolinite (2) and voids + microcrystalline and microplaty hematite (3).**

Field Note: *Mottled yellow clay and purple diagenetic hematite: diagenetic history and nature of interstitial cement? What is the overprinting relationship between the two?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Quartz	Dominant	Detrital + overgrowths
Polycrystalline quartz + leucoxene, hematite	Sparse	Lithic grains
Sericite/illite	Very minor	Interstitial
Kaolinite	Very minor	Interstitial, with illite
Hematite	Sparse	Earthy + crystalline
Anatase	Rare	Detrital or authigenic?
Zircon	Trace	Detrital, in quartz
Voids	Minor	Leached clay?

This is again medium to coarse-grained sandstone with mostly single-crystal quartz grains to 1mm in diameter, commonly with cores rimmed by hematite and zones with fluid inclusions and optically continuous overgrowths. There are also clouded polycrystalline grains that may represent altered acid volcanics. In addition to optically continuous overgrowths there are areas composed of various combinations of illite and kaolinite, with illite as possible residual flakes and aggregates around the margins and extending into quartz overgrowths, and patches of microcrystalline hematite. Small crystals of platy hematite occur rarely, to 0.5mm long, but are mostly in small voids. Similar voids are commonly rimmed by illite and/or kaolinite and may have formed due to leaching. Small aggregates of anatase occur sparsely and may be authigenic but may have replaced detrital rutile, for example, as there is trace zircon in and between quartz grains. The illite may predate the kaolinite and the hematite.

PLD001, 236.3m **Interbedded fine-grained and very coarse-grained sandstone with optically continuous overgrowths and illite ± hematite ± quartz-anatase-zircon cement (illite followed by hematite in darker areas).**

Field Note: *Diagenetic history: nature of cement and overprinting relationships between purple diagenetic hematite and orange 'bleached' areas.*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Quartz	Dominant	Detrital + overgrowths
Sericite/illite	Minor	Interstitial/on stylolites
Hematite	Very minor	With illite
Zircon	Rare	Detrital

This is a well-bedded sandstone with thinner bedding laminations largely composed of quartz less than 0.25mm in grainsize and other layers to 1.5mm in grainsize, indicating interbedded fine and very coarse-grained sandstone. Sparse polycrystalline quartz grains occur, but most of the grains are rounded with optically continuous overgrowths especially in the coarser layers. In the hand specimen there are rounded areas that appear purplish and pale orange areas between them. Illite and hematite occur in interstitial patches and as intergranular films, with illite in layer-parallel stylolites, mostly in fine-grained sandstone. Hematite is largely present in the purplish areas, with interstitial films that seem to be white in low-angle incident light and may correspond to a quartz-anatase-zircon cement in both the purple and orange areas. Rare fine-grained detrital zircon is present, to 0.15mm in grainsize.

PLD001, 464.5m

Contact between quartz-rich sandstone with optically continuous overgrowths and veins and chlorite-hematite-leucoxene-altered chilled dyke with quartz (xenocrysts or in vesicles?).

Field Note: *What is the nature of the aphanitic dark material: is it a chilled mafic dyke.*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	*Abundance*	*Origin/location*
1. Sandstone		
Quartz	Dominant	Detrital + overgrowths
Quartz-2	Very minor	In fractures
2. Dyke		
Chlorite-leucoxene ± hematite	Abundant	Replacing groundmass
Chlorite, no leucoxene	Minor	Ex-microphenocrysts
Quartz	Minor	Possibly xenocrystal

Most of this thin section is occupied by quartz-rich sandstone with single-crystal quartz grains to 0.8mm in diameter (coarse-grained sandstone) cemented by optically continuous overgrowths. Narrow fractures, roughly parallel to the contact with an adjacent dyke, are filled with fine-grained quartz.

The contact with the dyke is sharp and most of the dyke is clouded with leucoxene, with irregular areas also flooded by hematite. Small platy microphenocrysts, probably of plagioclase, have been altered to chlorite without leucoxene. Small grains of quartz are most abundant (5%) more than 3-4mm from the contact and may be in microvesicles but could also be partly digested xenocrysts. Fractures containing chlorite and hematite extend from the contact into the dyke, with features resembling perlitic cracking also in the marginal, less quartz-rich areas.

PLD001, 472.5m

Quartz-rich coarse-grained sandstone with optically continuous overgrowths: earthy hematite is present in purple areas but there is no obvious green mineral.

Field Note: *What is the greenish mineral and what is its relationship to the purple material?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Quartz	Dominant	Detrital + overgrowths
Hematite	Very minor	Interstitial in purple areas
Zircon, apatite, biotite	Trace	In quartz

This is another sandstone with mostly single-crystal quartz grains to 1mm in diameter (coarse-grained sandstone) and optically continuous overgrowths. Cores are defined by fluid inclusions or hematite. Some clouded polycrystalline grains occur, possibly representing silicified acid volcanic with minor hematite and leucoxene. There are also rare grains of vein-quartz. Purplish areas have hematite in the optically continuous overgrowths but there is no obvious mineral in the greener areas in this sample, as seen in hand specimen. Rare single-crystal quartz grains enclose zircon, biotite or apatite.

PLD001, 546.10m **Partly altered dolerite with early amphiboles followed by smectite-carbonate-pyrite aggregates.**

Field Note: *Dolerite: compare with 617.75 and 644.05m: the gamma background is twice as high for 617.75 and 644.05: is this because of increased potassium content in the form of alteration or K-spar?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Plagioclase	Major	Igneous
Clinopyroxene	Abundant	Igneous
Oxide	Common	Igneous
Granophyre, quartz	Sparse	Igneous
Apatite	Trace	Igneous
Hornblende-tremolite-actinolite	Sparse	Deuteric?
Smectite	Minor	Secondary
Carbonate	Very minor	Secondary
Pyrite	Very minor	Secondary

This sample is weakly altered dolerite with mostly fresh zoned plagioclase to 3mm in grainsize, with sparse smectite in fractures, and interstitial clinopyroxene to 2mm in grainsize, mostly microfissured, with smectite in the fractures, and partly altered to smectite ± carbonate ± pyrite. Small patches of zoned amphibole rim some of the pyroxene, with cores of brown hornblende followed by colourless and pale green zones. Granular magnetite is mostly fresh but may have contributed to the smectite-carbonate-pyrite aggregates. Granophyre and late magmatic quartz are rare and apatite is much less abundant compared to the altered, partly uranium-veined dolerites from Namarrkon.

PLD001, 558.05m **Altered dolerite with smectite-carbonate-leucoxene-pyrite and sparse sericite, cut by a felsic dykelet or segregation with clays and chlorite.**

Field Note: *Is this a chilled mafic dykelet in host dolerite?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	*Abundance*	*Origin/location*
1. Dolerite		
Plagioclase	Major	Igneous
Clinopyroxene	Minor	Igneous
Granophyre/mesostasis	Very minor	Igneous
Apatite	Sparse	Igneous
Green amphibole	Sparse	Rims on pyroxene
Sericite	Rare	In plagioclase
Smectite ± chlorite	Abundant	Ex-pyroxene
Carbonate	Sparse	Ex-pyroxene
Leucoxene-ilmenite aggregates	Minor	Ex-oxide
Pyrite	Minor	Mostly in leucoxene
2. Dykelet		
Plagioclase	Abundant	Igneous
K-spar	Abundant	Igneous
Quartz	Minor?	Igneous
Chlorite	Very minor	Secondary
Oxide ± sulphide	Sparse	Accessory
Carbonate-chlorite	Sparse	In fractures

The edges of this thin section contain dolerite similar to that described above, with a relatively felsic, fine-grained dykelet in the centre of the thin section. The dolerite has abundant weakly sericitised plagioclase to 2.5mm in grainsize and fresh or altered clinopyroxene. On one edge of the thin section more than $^1/_2$ of the pyroxene is fresh, with very minor green amphibole and patches of smectite ± chlorite + carbonate, but on the other edge there is little or no fresh pyroxene, with almost complete alteration to green smectite ± chlorite ± carbonate and sparse amphibole. Abundant skeletal opaque oxide in both areas has been altered to leucoxene with residual lamellae and rims of ilmenite as well as irregular masses of pyrite. Sparse granophyre is disseminated and is visible on the stained offcut as small patches with K-spar. On one side there is also a small area of microgranular quartzofeldspathic mesostasis with minor chlorite and apatite. Minor prismatic apatite is also present within plagioclase.

There is a sharp contact between the dolerite and the dykelet, although there is also a small fragment of altered dolerite in the dyke. The dyke is mostly fine-grained but seems to be dominated by small, elongate plagioclase laths. Interstitial K-spar and less abundant quartz are apparent, although the grainsize is small and clay clouding obscures the mineralogy to some extent. Chlorite is evident within and between plagioclase laths and there are very small crystals of opaque oxide and probable sulphide. Narrow fractures contain chlorite and carbonate. The mineralogy of the dyke is to some extent similar to that of the small patch of mesostasis in the dolerite, suggesting that this is a felsic derivate of the dolerite, possibly andesite or dacite to rhyodacite. The exact classification may require geochemistry, however.

PLD001, 585.85m **Altered dolerite with a pinkish altered felsic dyke, similar to that in the previous sample, with a vaguely andesitic composition.**

Field Note: *What is this material: it appears to be intruding a dolerite sill: is it a dyke or cooked sediment.*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral/component	***Abundance***	***Origin/location***
Altered dolerite	Very minor	Igneous
Plagioclase, pinkish	Major	Igneous
K-spar	Minor?	Igneous
Quartz	Very minor	Igneous
Oxide ± sulphide	Sparse	Igneous
Chlorite ± carbonate	Sparse	Ex-mafic grains
Quartz-chlorite-carbonate	Very minor	In fractures

There is a very small patch of altered dolerite in one corner of this thin section, but most of the thin section is occupied by similarly felsic material to that in the previous sample, but with less abundant quartz. The dolerite has abundant plagioclase and partly smectite-altered clinopyroxene as well as weakly leucoxene-altered opaque oxide and irregular patches of pyrite.

The dyke is dominated by flow-oriented, pinkish, clouded plagioclase laths mostly less than 0.5mm long with interstitial material that seems to include K-spar as well as very minor quartz. Granular to dendritic opaque oxide is disseminated as well as sparse sulphide and elongate mafic crystals have been altered to chlorite ± carbonate. There are also narrow quartz-carbonate-chlorite veins along two margins of the thin section. This dyke is vaguely andesitic in composition, but may represent a felsic segregation related to the dolerite.

PLD001, 597.15m	**Altered dolerite, with secondary K-spar as well as smectite-carbonate-pyrite alteration, cut by a reddish felsic dyke of andesite or trachyandesite composition with reddish plagioclase and chlorite-carbonate-altered mafic grains. Fractures contain quartz, chlorite, carbonate, sulphide and opaque oxide.**

Field Note: *Another of these dykelets intruding dolerite: is it a dyke or and altered vein?*

Component	***Abundance and notes***
Dolerite	The dolerite in this thin section has abundant altered plagioclase with some residual material and abundant secondary K-spar, locally with albite, chlorite or chlorite-smectite (corrensite?) and, in some areas, abundant microfissures filled with pyrite. The pyroxene has been replaced by chlorite-rich to carbonate-rich aggregates but the opaque oxide is mostly fresh. There is also rare quartz and apatite, less than in most dolerite samples.
Felsic dyke	This is mostly composed of unoriented small plagioclase laths, redder in colour and more iron-stained compared to the previous samples, with interstitial K-spar and quartz as well as chlorite ± smectite ex-mafic grains. Opaque oxide and sulphide are also disseminated, with granular and dendritic opaque oxide as in the previous sample.
Fractures	Narrow fractures contain chlorite, carbonate, quartz, sulphide and opaque oxide

The dyke again seems to have an andesite or trachyandesite composition. Secondary K-spar in the dolerite is unusual in this batch.

PLD001, 617.75m

Dolerite with albite-sericite and sparse K-spar in altered plagioclase, fresh and clay-altered plagioclase and mesostasis altered to chlorite ± smectite, quartz and K-spar: opaque oxide and apatite are fresh.

Field Note: *Describe and compare with 546.10m: the gamma background is twice as high for 617.75 and 644.05m: is this because of increased potassium in the form of alteration or alkali feldspar?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Albite-sericite ± K-spar	Major	Ex-plagioclase
Clinopyroxene	Abundant	Fresh igneous
Chlorite-smectite or smectite	Common	Ex-pyroxene
Unidentified small grains	Sparse	In chlorite ± smectite
Chlorite-quartz-K-spar aggregates	Minor	Interstitial
Oxide	Minor	Primary igneous
Apatite	Rare	Accessory igneous

This dolerite differs from the others from this drillhole in having abundant sericite and very minor localised K-spar in plagioclase, as well as minor albite as the main background to sericite. The former plagioclase laths are as much as 3-4mm long. There is also au abundant fresh clinopyroxene as well as areas of secondary smectite or chlorite-smectite ex-pyroxene. The clay aggregates also contain small, weakly anisotropic grains that may be garnet, hydrogarnet or clinozoisite, rarely accompanied by microcrystalline titanite. Areas of probable mesostasis are altered to chlorite ± smectite with disseminated quartz, secondary K-spar and apatite. Disseminated granular oxide in this sample is fresh, however.

Elevated beta readings from this sample seem to reflect abundant potassium as sericite and less abundant K-spar.

PLD001, 633.4m

Albite-sericite-clay-chlorite-pyrite-altered dolerite passing into a reddish K-spar-clay-rich alteration zone adjacent to a zoned vein with carbonate, quartz, prehnite and smectite. There are also pumpellyite-carbonate veins and late carbonate veins.

Field Note: *Mineralogy of vein and associated selvedge, including sulphide mineralogy: is it all pyrite?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
1. Dolerite		
Albite-sericite-chlorite passing into adularia-chlorite/smectite	Major	Ex-plagioclase
Clinopyroxene	Minor	Residual igneous
Smectite ± chlorite ± garnet/clinozoisite?	Common	Ex-pyroxene
Magnetite	Minor	Igneous
Apatite	Very minor	Igneous, accessory
Quartz-K-spar ± smectite/chlorite	Minor	Mesostasis, altered
Pumpellyite	Rare	In pyroxene sites
Pyrite	Minor	secondary
2. Veins		
Carbonate	Abundant	
Quartz	Minor	
Prehnite	Minor	In zones in the main vein
Smectite	Minor	
Adularia	Very minor	
Pumpellyite-albite	Sparse	In fractures in the dolerite

This sample has a wide carbonate-rich vein with an alteration selvedge about 15mm wide on either side of the vein. In the alteration halo, the plagioclase in the dolerite has been altered to low temperature K-spar, probably adularia, becoming redder and more hematite-stained towards the main vein. The adularia is accompanied by smectite and passes into areas with albite, sericite and chlorite ± smectite in the plagioclase. There is some fresh clinopyroxene, but most of the pyroxene has been altered to smectite ± chlorite, mostly deep green in colour (Fe-rich) with a high birefringence. Small weakly anisotropic grains occur in these areas, and may be garnet, hydrogarnet or clinozoisite, with rare titanite in some areas. Rare deep green pumpellyite (Fe-rich) occurs in some areas of altered pyroxene. Reddish K-spar is also a component in altered mesostasis, with quartz and apatite, with or without smectite ± chlorite. The opaque oxide is fresh but there are areas rich in hopper-like pyrite crystals, mostly on the edge of the alteration halo or in albitised areas.

Narrow veins, in the alteration halo and or in albitised areas, have orange to deep green pleochroic probable pumpellyite and water-clear albite. The main vein is zoned and asymmetrical with zones as follows:

1. Smectite ± chlorite ± prehnite (very narrow).
2. Clear unstained adularia (to 0.6mm).
3. Lenses of prehnite with lenses of carbonate and green or brown smectite (to 2mm).
4. Sparry/columnar quartz with lenses of carbonate (0.5mm to 2mm).
5. Carbonate with irregularly disseminated prehnite and lamellae of clouded or clear smectite (3-6mm).

There are also late-stage carbonate-filled fractures in the dolerite.

PLD001, 644.05m

Altered dolerite, with albite, sericite and smectite, containing areas of altered mesostasis (feldspars, quartz, smectite and opaque oxide) and a lens of mesostasis-like material that may represent a late magmatic segregation.

Field Note: *Vein in dolerite: nature of the veinlet?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Albite-sericite ± K-spar	Abundant	Ex-plagioclase
Clinopyroxene	Abundant	Igneous
Smectite	Minor	Ex-pyroxene?
Magnetite	Minor	Magmatic
Feldspar-quartz ± smectite ± apatite	Abundant	Mesostasis and vein

This sample has areas of altered dolerite and a somewhat lenticular vein or segregation that has irregular boundaries, is 1-8mm wide, and seems to have extensions into the dolerite. Areas of mesostasis in the dolerite are also very similar in mineralogy and texture to the vein, suggesting that the vein is a segregation of late magmatic mesostasis. The dolerite has mostly albite-sericite-altered plagioclase to 3mm in grainsize and largely fresh granular pyroxene and opaque oxide, as well as relatively minor patches of smectite. Sparse K-spar is evident in the altered feldspar but is more abundant in areas of mesostasis, where it seems to be interstitial to small partly skeletal plagioclase laths. These areas also have clays, dendritic opaque oxide and apatite, with apatite also enclosed in altered plagioclase.

There are lenses along the margins of the vein that are very similar to areas of mesostasis, with fine-grained feldspars, dendritic opaque oxide, minor clays and quartz but mostly free of red hematite staining. The bulk of the vein has red hematite staining and less clay than the marginal lenses and the mesostasis, but seems to be rich in feldspars, with moderately abundant K-spar indicated by the stained offcut. Quartz and plagioclase are also abundant as well as minor smectite and opaque oxide.

2. Plateau Project: Outcrop Samples

PL06002 **Biotite monzogranite with sericite ex-plagioclase, clays ex-biotite and clouded, untwinned K-spar.**

Field Note: *Tin Camp Granite: locally cut by quartz and quartz-hematite veins: locally elevated radioactivity, though not in veins: more than one alteration event?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Sericite	Abundant	Ex-plagioclase
Clouded K-spar ± sericite	Abundant	Weakly altered K-spar
Quartz	Abundant	Igneous, deformed
Clays with limonite and leucoxene ± quartz	Minor	Ex-biotite
Zircon ± monazite ± leucoxene	Rare	Accessories

Most of this sample is granular with quartz, totally sericitised plagioclase and clouded untwinned K-spar mostly from 0.5mm to 3mm in grainsize. There is relatively abundant altered biotite as thin flakes to 5mm long in a trellis-like arrangement. These have clay-sericite alteration with some flakes having quartz in lamellae parallel to the cleavage. Very small crystals of zircon ± monazite occur, as well as possible anatase of leucoxene as inclusions in altered biotite. The mineralogy suggests monzogranite but the K-spar may have been modified by low-temperature hydrothermal fluids in addition to those that caused sericitisation of plagioclase and clay alteration of biotite.

PL060005 **Sericite-quartz-leucoxene-altered monzogranite with clouded K-spar, sericitised biotite and quartz-sericite veins: differs in original mineralogy and texture from PL060002.**

Field Note: *Tin Camp Granite: same phase of intrusion and same alteration as PL060002?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Sericite ± quartz, muscovite, albite	Abundant	Ex-plagioclase
Quartz	Abundant	Primary
Clouded K-spar ± sericite	Abundant	Primary/modified?
Muscovite-leucoxene	Minor	Ex-biotite
Quartz-sericite	Minor	In veins

This is a coarse-grained granitoid compared to the previous sample, although the quartz is mostly less than 3mm in grainsize. Sericitised plagioclase to 4mm in grainsize usually has patches of quartz ± albite and sparse coarse-grained muscovite, while largely interstitial K-spar is clouded and as much as 8mm in grainsize, with sparse sericite. There may be more abundant K-spar compared to the previous sample. The quartz is weakly deformed and some of the altered biotite id kinked, with lamellar sericite or muscovite and sparse leucoxene, suggesting relatively Ti-poor mica. The biotite is much less elongate than that in the previous sample.

Rare veins, about 0.5mm wide, have segments of sericite and segments of quartz as well as partial rims of microcrystalline quartz.

PL060009 **Breccia of quartz and sericite-rich possible fragments in a heterogeneous quartz-sericite-hematite matrix: may represent a quartz-sericite-flooded breccia of sandstone and vein-quartz?**

Field Note: *PL060009 and PL060010 are from an outcrop where the main mass of Tin Camp Granite (Pl060009) appears to be cut by later dykes of fine-grained granitoid (PL060010): are they very different to each other? How do they compare to PL060002 and PL060005?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Quartz-1	Abundant	Fragments
Quartz-2	Abundant	Microcrystalline matrix
Sericite	Abundant	Fragments and matrix
Hematite	Minor	Disseminated
Leucoxene	Rare	Disseminated
Zircon?	Rare	Accessory

This sample has poor textural preservation but has sparse larger single-crystal and polycrystalline quartz fragments to 6mm long in a heterogeneous matrix of quartz, sericite and hematite. The quartz includes abundant single crystal grains to 2mm in diameter as well as areas of microcrystalline quartz and large sericite-rich domains, all with irregularly disseminated fine-grained hematite. There may be millimetre to centimetre-scale fragments but the textures are too poorly preserved. However this sample seems to be a breccia, possibly granitic, but possibly a quartz-sericite-flooded breccia of sandstone and vein-quartz.

PL060010 **Highly altered, poorly preserved probable granitoid with quartz, sericite, quartz-sericite aggregates and hematite: may have been weakly brecciated.**

Field Note: *PL060009 and PL060010 are from an outcrop where the main mass of Tin Camp Granite (Pl060009) appears to be cut by later dykes of fine-grained granitoid (PL060010): are they very different to each other? How do they compare to PL060002 and PL060005?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Dense sericite ± hematite	Abundant	Ex-plagioclase
Quartz	Abundant	Primary and in veins?
Quartz-sericite ± hematite	Abundant	Interstitial and ex-feldspar?

This sample is more obviously granitic than the previous sample, with partly fractured and fragmented quartz to 6mm in grainsize and dense sericite ± hematite replacing large grains of probable plagioclase. These are separated by mostly fine-grained, heterogeneous quartz-sericite aggregates that are partly in fractures but are possibly partly ex-K-spar. Some hematite also occurs along fractures and in stylolite-like veins. There is no real evidence of former biotite and no obvious zircon and some incipient brecciation may have occurred.

PL060011 **Altered monzogranite with muscovite, sericite, microcrystalline quartz, and sericite-chlorite-smectite-leucoxene/anatase (green) ex-mafic aggregates**

Field Note: *Another dyke cutting Tin Camp Granite: what is the pale green mineral?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	*Abundance*	*Origin/location*
Quartz	Abundant	Primary
Sericite ± quartz, clouded	Abundant	Ex-plagioclase
Clouded K-spar ± sericite	Abundant	Primary, modified
Muscovite	Very minor	Deuteric?
Sericite and smectite ± chlorite + leucoxene or anatase	Minor	Ex-biotite ± hornblende
Zircon	Sparse	Accessory.
Microcrystalline quartz ± sericite	Sparse	Interstitial + veins

This is a much better preserved granitoid compared to the previous sample, with quartz as partly ragged grains to 3mm in diameter and plagioclase altered to sericite ± microcrystalline quartz. Clouded K-spar is also abundant, to 4mm in grainsize, with inclusions of quartz, altered plagioclase and sericitised biotite. Rarely, the K-spar has been overprinted by possibly deuteric muscovite. Altered mafic clots, to 4mm long, have minor muscovite or sericite as well as possible chlorite-smectite ± smectite (green in thin section), studded with leucoxene/anatase patches and granules. These mafic aggregates seem to have been mostly biotite but may have contained hornblende. Rare zircon occurs, to 0.2mm long. In some areas there are fractures with quartz and sericite, but some patches of sericite-rich altered plagioclase seem to pass into more quartz-rich partly interstitial aggregates.

PL060012 **Sandstone with interstitial illite and zoned quartz-rich aggregates (microcrystalline to microsparry): an unusual diagenetic assemblage.**

Field Note: *Sandstone that sits about 20m above the contact with Tin Camp Granite: does this sample look like it has had a pluton emplaced close to it?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Quartz-1	Abundant	Detrital
Clays ± hematite/limonite	Sparse	Lithic clasts
Illite ± limonite	Minor	Interstitial aggregates
Quartz (microcrystalline to microsparry)	Common	Interstitial, rims illite
Unidentified (anatase or fluid inclusions?)	Minor	Rims detrital quartz

This sandstone is unusual in having loosely aggregated rounded single-crystal quartz grains to 2mm long without optically continuous overgrowths. Rare inclusions of biotite and apatite occur in this quartz. There are also sparse polycrystalline quartz clasts and lithic clasts varying from illite-rich to limonite-rich (± quartz). Mostly rounded aggregates of partly microporous decussate illite are common, but are mostly separated from the detrital quartz by zoned aggregates of microcrystalline to microsparry quartz (pm opal?) and unidentified narrow rims that are white in low-angle incident light.

This sandstone has an unusual diagenetic history, but it is uncertain to what extent this reflects proximity to granitoid.

PL060013 **Quartz-rich poorly sorted sandstone with illite ± quartz and unidentified isotropic interstitial material.**

Field Note: *Sandstone sample about 20m higher than PL060012*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Quartz	Abundant	Detrital
Decussate illite	Very minor	Interstitial
Quartz-illite aggregates	Very minor	Diagenetic?
Isotropic material	Common	Interstitial

This is a weakly bedded, poorly sorted sandstone with rounded single-crystal quartz grains from < 0.1mm to 1.5mm in diameter (fine to very coarse-grained sandstone) and sparse polycrystalline quartz to 2.5mm. The quartz is again loosely aggregated and has abundant isotropic interstitial material, unidentified from thin section or hand specimen and not obviously chlorite or opal. Within this material there are sparse aggregates of decussate illite as in the previous sample and irregular patches of microsparry quartz, partly rimmed by illite or microcrystalline quartz and enclosing sparse decussate illite. There are rare very small patches of hematite and of cryptocrystalline material that is partly bluish in transmitted light.

This sample may need further X-ray diffraction or SEM/microprobe analysis.

PL060014 **Pebbly quartz-rich sandstone with patches rich in interstitial illite but no visible kaolinite**

Field Note: *Sandstone from centre of a kaolinite hyperspectral anomaly: is this reflected in the mineralogy? What is the pale yellow clay phase?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Quartz	Dominant	Detrital + overgrowths
Illite	Minor	Interstitial
Biotite, zircon, unidentified needles	Rare	In quartz.

There are abundant single-crystal quartz grains to 1mm long in this sample, as well as sparse polycrystalline grains, granules and small pebbles to 5mm in diameter. Although well-defined cores and optically continuous overgrowths are rare, most of the grain boundaries are planar and seem to have been modified by diagenesis. However, several areas, making up perhaps $^{1}/_{3}$ of the thin section, have patches of interstitial sericite or illite, mostly decussate and less clearly microporous than in other samples of sandstone. Illite may make up 5-10% of these areas, but there is no kaolinite or dickite visible in this thin section.

PL060015 **Partly brecciated inequigranular K-spar-rich granitoid with clays in plagioclase and after biotite and fragments of coarse-grained vein-quartz.**

Field Note: *Relatively radioactive Tin Camp Granite: how does it compare with other Tin Camp Granite samples?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Quartz-1	Abundant	Igneous
Quartz-2	Common	Vein quartz?
K-spar	Major	Igneous
Plagioclase, clays and limonite	Minor	Altered igneous
Brown clay ± limonite	Minor	Ex-biotite?
Muscovite	Very minor	Secondary?
Limonite-filled fractures	Minor	Tectonic fissures

This sample is heterogeneous and has some areas of fractured and fragmented granitoid with limonite-filled fractures and areas with large fragments of probable vein-quartz, to 12mm long and 4mm wide. The original granitoid is rich in anhedral K-spar from 0.2mm to 3mm in grainsize with inequigranular quartz and sparse plagioclase partly altered to clays and limonite. Some of the K-spar has inclusions of quartz with an almost graphic texture. Sparse biotite has been altered to brown clays ± limonite and there are sparse patches and crystals of muscovite. Brecciated areas have inequigranular fragments of the same minerals in a microcrystalline matrix, mostly quartzofeldspathic, and there are limonite-filled fractures throughout. There is rare apatite to 0.3mm in grainsize but no zircon was seen.

PL060016 **Brecciated monzogranite with clay-altered biotite and sparse muscovite: the matrix is comminuted granitic material, with quartz-clay-chlorite-fluorite-filled fractures**

Field Note: *Relatively radioactive Tin Camp Granite: how does it compare with other Tin Camp Granite samples?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Quartz	Abundant	Igneous
K-spar (perthitic)	Abundant	Igneous
Plagioclase ± sericite	Common	Igneous
Chlorite/corrensite ± clay, leucoxene	Very minor	Ex-biotite
Muscovite	Very minor	Primary or secondary?
Comminuted quartz and feldspars	Abundant	Matrix to fragments
Chlorite	Minor	Secondary: in matrix.
Clays	Minor	Secondary: in matrix.
Fluorite	Very minor	Secondary: in matrix.

This sample represents brecciated monzogranite that is coarser-grained than that in the previous sample, with quartz-rich lenses to 6mm long, composed of grains mostly less than 3mm long, and mostly fractured and partly fragmented K-spar (perthitic orthoclase) to 6mm in grainsize. Plagioclase is less abundant and finer-grained, to 2mm in grainsize, with sparse sericite ± limonite, and is also fractured. Altered biotite has been partly kinked and has been replaced by chlorite-clay-leucoxene aggregates. Very minor muscovite occurs in the granite.

The granite occurs as fractured and partly fragmented masses to 15mm long with interstitial areas of comminuted quartzofeldspathic material, mostly as angular small fragments, with areas flooded by clays and patched that contain microcrystalline quartz as well as chlorite and/or fluorite. Fluorite rimmed by chlorite is commonly colourless but separate irregular patches of fluorite are purple, suggesting radioactive damage. Quartz, clays, chlorite and fluorite also occur in narrow fractures within more coherent granitoid fragments.

PL060018 **Undeformed, bedded quartz-rich medium to coarse-grained sandstone with diagenetic illite-quartz aggregates, rare partly authigenic tourmaline and rare anatase. Detrital zircon is present.**

Field Note: *Mamadawerre Sandstone: nature of alteration/diagenesis/deformation if any?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	*Abundance*	*Origin/location*
Quartz	Dominant	Detrital
Zircon	Rare	Detrital
Illite ± quartz	Common	Diagenetic
Anatase	Rare	Diagenetic?
Tourmaline	Rare	Partly authigenic

This is composed of layered but poorly sorted sandstone with rounded single-crystal quartz grains as the main detrital component, apart from sparse polycrystalline quartz clasts and rare zircon to 0.2mm, within and between quartz grains. Zircon within quartz is euhedral, whereas that between quartz consists of crystal fragments. Some layers have abundant grains less than 0.5mm (medium-grained sandstone) with other layers having grains to 1mm in diameter (coarse-grained sandstone) and rare very coarse sand to 1.5mm in diameter. Some grains seem to have stylolitic grain boundaries and others have intergranular films of illite, but the main interstitial material is decussate or microspherulitic illite in patches from 0.1mm to 1mm long. The illite is mostly intergrown with fine-grained quartz and rarely microporous, but there are rare aggregates of anatase. Rarely, quartz was seen to enclose optically continuous patches of green or greenish brown tourmaline with fibrous authigenic overgrowths. The sandstone is undeformed, however.

PL060020 **Altered gneiss with sericite, hematite and leucoxene as well as residual quartz.**

Field Note: *Basement rock: gneiss?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Quartz	Common	Metamorphic
Sericite/illite/phengite	Dominant	Ex-feldspar, biotite
Hematite	Common	Ex-feldspar, biotite
Leucoxene	Minor	In biotite sites

There is a weak foliation in this sample partly defined by elongate grains and lenses of quartz, to 5mm long, and abundant bands of massive sericite, most of which may represent former feldspar. Irregular, partly contorted masses and filaments of earthy hematite are abundant and include lamellae patches, some of which contain or consist of lamellar leucoxene, indicating former biotite. The original rock may have had 10-15% quartz and 5-7% biotite as well as 80-85% feldspar.

PL060021 **Quartz-rich granule conglomerate with:**

1. **Optically continuous overgrowths.**
2. **Illite ± quartz ± hematite/limonite.**
3. **Stylolitic grain boundaries.**

Field Note: *Mamadawerre Sandstone: nature of alteration/diagenesis/deformation if any?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Quartz	Dominant	Detrital + overgrowths
Hematite	Sparse	Rims on detrital grains
Illite-hematite/limonite-quartz aggregates	Very minor	Diagenetic

This is a granule conglomerate with rounded single-crystal and polycrystalline quartz grains mostly from 0.8mm to 4mm in diameter. The detrital cores are commonly rimmed by hematite and have irregular but commonly wide optically continuous overgrowths. Some of the polycrystalline grains, which include vein-quartz and quartzite fragments, also have polycrystalline optically continuous overgrowths. However, there are also interstitial areas that contain or consist of decussate or poorly oriented illite, with or without quartz, partly overprinted by earthy hematite or limonite. Some of the illite occurs in, or on the margins of optically continuous overgrowths, but some areas have illite and iron oxide without optically continuous overgrowths. There are also sparse stylolitic grain boundaries without optically continuous overgrowths or illite.

PL060022 **Quartz-phengite-hematite/limonite aggregate with quartz veins: silicified rock of uncertain origin (felsic?), but not dolerite.**

Field Note: *Dolerite: mafic rock from basement inlier: mapped as Zamu Dolerite (foliated orthoamphibolite): more like Oenpelli Dolerite?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Quartz-1	Major	Hydrothermal
Sericite/phengite/illite	Abundant	Hydrothermal?
Hematite/limonite	Common	Weathering
Quartz-2	Minor	In veins

This sample is not mafic but is dominated by inequigranular quartz, mostly from 0.25mm to 2.5mm in grainsize. Irregular flakes and aggregates of pale yellow, possibly phengitic mica occur in and between the quartz grains and are partly stained by hematite or limonite. There is also a vein, 3mm wide, of granular to prismatic quartz. There is a suggestion that some of the quartz may represent silicified granophyre, but no evidence of opaque oxide or apatite. This would allow a quartz-mica-altered (greisenised) granophyre or granitoid but not altered normal dolerite.

PL060023 **Quartz-sericite-hematite/limonite-leucoxene-altered quartz dolerite-related granophyre (Oenpelli Dolerite?)**

Field Note: *Dolerite: mafic rock from the same vicinity as PLo60022: any similarities? It has what appear to be large quartz grains: are they phenocrysts being resorbed?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	*Abundance*	*Origin/location*
Quartz	Abundant	Magmatic ± secondary
Quartz with hematite ± sericite	Common	Ex-granophyre
Sericite ± limonite/hematite	Common	Ex-plagioclase ± pyroxene
Limonite + leucoxene	Sparse	Ex-opaque oxide

This sample contains only quartz hematite/limonite, sericite and leucoxene and is derived from a rock with abundant granular quartz and altered granophyre, both to 2mm in grainsize, with hematite, quartz and sericite replacing feldspar in the granophyre. Aggregates with abundant sericite ± hematite/limonite ex-plagioclase are abundant with plagioclase mostly less than 1mm long and interstitial hematite/limonite ex-pyroxene. Some areas of oxide can be seen in low-angle incident light to contain leucoxene and were formed from fine-grained opaque oxide. Neither apatite nor zircon is evident, but this represents quartz-sericite-altered and oxidised quartz dolerite-related granophyre.

PL060024 **Plagioclase-porphyritic fine-grained dolerite with sericite ± albite ex-plagioclase, actinolite ex-pyroxene and interstitial patches of chlorite and/or prehnite: there is also rare pyrite and zircon.**

Field Note: *Dolerite: This sample comes from the same outcrop within 20cm of PL060023: is it different?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Plagioclase ± sericite	Abundant	Plagioclase phenocrysts
Clinopyroxene	Sparse	Residual igneous
Albite-sericite-clay	Abundant	Ex-groundmass plagioclase
Actinolite	Abundant	Ex-pyroxene
Chlorite	Minor	Secondary
Prehnite	Minor	Secondary
Oxide	Sparse	Residual
Sulphide (pyrite?)	Rare	In opaque oxide
Zircon	Trace	Accessory

This sample is very different to the one described above, and represents altered plagioclase-porphyritic microdolerite. Scattered plagioclase phenocrysts to 8mm long retain some feldspar but have minor to dominant sericite alteration and locally enclose chloritised mafic grains. The groundmass is mostly fine-grained but has residual ophitic clinopyroxene to 3mm in grainsize as well as albite-sericite-altered small plagioclase laths, mostly less than 1mm long. Most of the pyroxene has been replaced by fibrous green amphibole, but there are also interstitial patches composed of chlorite and/or prehnite. Fine granular opaque oxide is mostly fresh but rarely replaced by probable pyrite. Rare zircon was seen as crystals 0.1mm long in amphibole.

PL060025 **Quartz-rich very coarse-grained sandstone with optically continuous overgrowths, patches of illite ± quartz ± hematite/limonite, stylolitic grain boundaries and stylolites (with or without films of illite) and rare zircon.**

Field Note: *Gumbarrirnbang Sandstone*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Quartz	Dominant	Detrital + overgrowths
Hematite	Sparse	Rims on detrital quartz
Illite ± hematite/limonite	Very minor	Interstitial/on stylolites
Microcrystalline APS?	Rare	Interstitial
Zircon, biotite	Trace	In and between quartz

This sample is composed of quartz-rich very coarse-grained sandstone with most grains from 0.5mm to 2mm in diameter, rimmed by thin films of hematite and largely cemented by optically continuous overgrowths, rarely with crystal-lined cavities. Sparse polycrystalline quartz grains have polycrystalline optically continuous overgrowths as in PL060021. However, there are areas with interstitial patches of partly microporous decussate illite, locally cutting quartz, with a weak limonite staining or with hematite/limonite. Sparse cryptocrystalline patches may represent the same possible phosphate-sulphate mineral seen in another sandstone in this batch (Sr-REE-rich?) and very rare small green crystals were seen. In some areas there are stylolitic grain boundaries with or without films of illite along the grain boundaries, and more continuous illite-lined stylolites are also evident. Minor biotite and rare zircon occur within quartz and there is also rare zircon about 0.1mm in grainsize between quartz grains.

PL060204 **Bimodal quartz-rich silty sandstone with abundant medium to coarse sand showing stylolitic grain boundaries and interstitial angular silt to fine sand. Hematite/limonite occurs as films on grain boundaries and between the smaller grains, and there is rare zircon.**

Field Note: *Description?*

PETROGRAPHY:

A visual estimate of the modal mineral abundances:

Mineral	***Abundance***	***Origin/location***
Quartz-1	Dominant	Medium to coarse sand
Quartz-2	Abundant	Silt to fine sand
Hematite/limonite	Common	Interstitial
Zircon	Rare	Accessory.

This sample has abundant subrounded to rounded mostly single-crystal quartz grains from 0.25mm to 1mm in diameter (medium to coarse-grained sandstone) but has various interstitial areas infiltrated with abundant angular chips of quartz that are mostly from silt size (<60µm) to 0.15mm long. Where the larger grains are in contact there are mostly stylolitic grain boundaries with films of hematite or limonite in many areas, but elsewhere there is interstitial silt to fine sand with hematite/limonite ± clay between the smaller grains. Rare zircon, to 0.1mm in diameter, is partly enclosed in quartz.

This is a bimodal quartz-rich silty sandstone.