



1. GEOLOGICAL MAPPING AT 1:10 000 SCALE OF

THE GEORGE-AMANGAL AREA

2. PHOTOGEOLOGICAL MAPPING AT 1:20 000 SCALE OF

THE AREA FROM WATERHOUSE TO GEORGE

GEORGE-WATERHOUSE WEST PROJECT

Northern Territory

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RR0346b George_10k_geol_BJC_0710.wor	George Geology Map	1:10,000
RR0356 AdelR_20k_geol_BJC_0910.wor	George-Waterhouse West Photogeology Map	1:20,000

1. SUMMARY

An area of 230 square km located south and west of the township of Adelaide River in the Northern Territory has been remotely photomapped at 1:20k scale including an area of 55 sq. km field mapped at 1:10k scale over the George-Amangal tenements south from Adelaide River Township.

The basic aim was to produce standard lithostructural geology maps with some consideration for the lithostructural sequence, models for exploration, identification of critical areas for checking and testing the model, identification of prospective areas and techniques for exploration.

Five separate geomorphic systems have been defined for this area namely a High Plateau, an Incised Tableland, an Etch Plain, Hills and Ridges and the Flood Plain of the Adelaide River.

The pre-Cainozoic bedrock includes the Archaean Waterhouse Complex, four Palaeoproterozoic rock Groups and the intrusive Zamu Dolerite, the Mesoproterozoic Depot Creek Sandstone and the Cretaceous Petrel Formation.

The general disposition and radioactive characteristics for each of these Geomorphic Systems and the Rock Formations has been described.

The recessive Coomalie Dolomite is the most U radioactive unit in the mapped area followed by the conformably overlying South Alligator Group. This is where many of the known U occurrences sit. The Burrell Creek Formation is the most extensively exposed Formation in the mapped area and hosts the vein type deposits at the Adelaide River and George Mines.

A stratigraphy can be mapped for the Burrell Creek Formation although most of the rocks could be described as monotonous interbedded greywacke and siltstone. However, the Adelaide River Mine is located at the contact of the strongest contrasting rock units mapped.

The megascale structure of the mapped area is dominated by the doming around the Waterhouse Complex and by the open folding best seen in the Burrell Creek Formation. The pre-eminent fault is the Adelaide River Fault and by analogy with the Hays Creek, Bella Rose and Giants Reef Faults it must be taken seriously in any U exploration program. Also of significance is the fact that the Riverside, Kylie, Spring Creek, Burnetts and Southeast Kylie prospects are in proximity to discrete faults that cut across the stratigraphy.

In regard to the Depot Creek unconformity it is not feasible to predict where it once was above any particular location. It may be used to upgrade a target if present but not to downgrade a target if absent.

The maps can be used to prioritize airborne radiometric anomalies but are unlikely to generate targets by themselves. An anomaly would increase its priority if.....

1. It is in close proximity to the Depot Creek Sandstone.
2. It is along an obvious lithologically contrasted contact, especially graphitic against dolomitic.

3. It is cut by an obvious cross structure.
4. It is very close to the Adelaide River Fault.
5. There is a geomorphic reason why it may be subdued.
6. It is close to a fold axis (preferably anticlinal).

One essential thing to do when ground checking anomalies is to come at it from downstream with spectrometer in hand looking for mineralized float.

All of the known occurrences including the new discoveries at Hays Creek are along the lineation of the intersection of a set of parallel structures with a preferred stratigraphic contact. At known locations it is considered prudent to look into the strata that hosts known mineralization.

2. INTRODUCTION

The total area mapped covers 230 square km located south and west of the township of Adelaide River in the Northern Territory as shown on Figure 1. Access from Darwin is by way of the Stuart Highway (Hwy1).

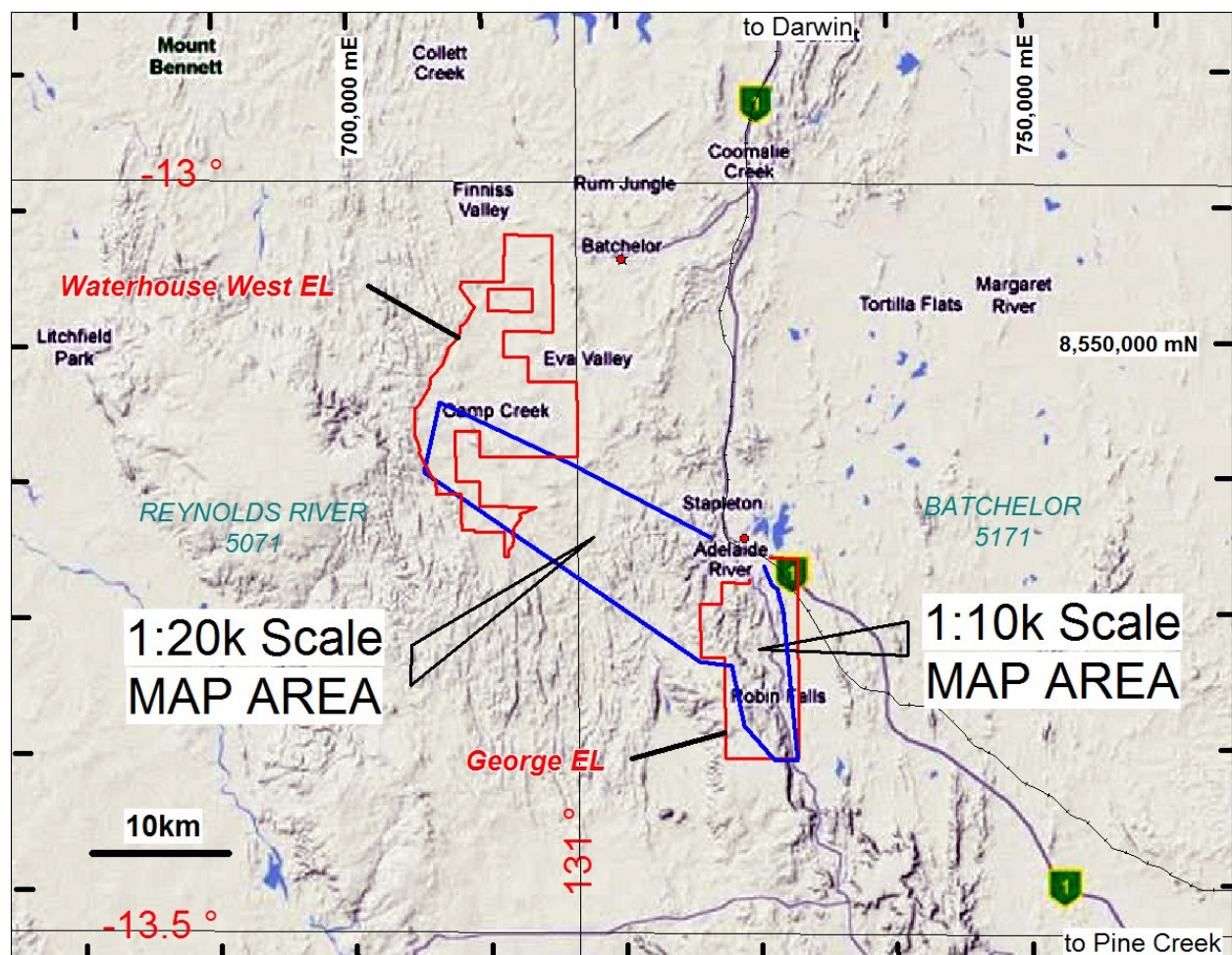


Figure 1: George-Amangal-Waterhouse West Project showing the Areas Mapped.

Ian Faris commissioned the study. The basic aim was to produce standard lithostructural geology maps showing the basic bedrock units and structure, any folds and bedding trends, faults and fractures and any cover rocks or regolith units that substantially conceal the basement. Also, some consideration for the lithostructural sequence, models for exploration, identification of critical areas for checking and testing the model, identification of prospective areas and techniques for exploration.

Two maps were commissioned as follows:

1. For the **George-Amangal** tenements a geology map at 10k scale based on 20k scale aerial photography with some field traversing. It was specifically requested to (a) determine the styles and sequence of deformations, (b) identify any key stratigraphic markers (visible or magnetic) focussing on geological contacts and (c) ascertain whether there is a diagnostic coincidence of parameters for the known uranium mineralisation.
2. For the area from **George up to Waterhouse West** a photogeology map at 20k scale based on 20k scale aerial photography without field traversing. It was specifically requested to (a) assess the role of NW-SE trending features and (b) the role of the Depot Creek unconformity

2.1 Data Sets Used

This area is covered by good quality 1:20k scale, stereo, colour photos (about 50 frames) as listed in Table 1. Photo centres are plotted on the Geological Maps, Plans RR0346b & RR0356.

Survey Description	Scale	RUN	Frames
Darwin Rural Skymap, Sept 1997	20 000	27	170
"	20 000	28	176-182
"	20 000	29	035-043
"	20 000	30	051-062
"	20 000	31	089-093
"	20 000	32	106-112
"	20 000	33	135-139
"	20 000	34	112-116

Table 1: List of Aerial Photographs

Free, raw **Landsat** data were obtained from the www.Landsat.org website as listed in Table 2 and processed by the Author. The primary algorithm used was 7R-4G-2B, PAN-sharpened for the ETM data.

Run No.	Scene No.	Description
106	69	1989 Landsat 5
106	69	2001 Landsat 7ETM+

Table 2: List of Landsat Scenes

Also obtained and processed was the 90m Shuttle (**SRTM**) data which was re-gridded to 30m resolution as well as complete coverage of recent Quickbird or SPOT imagery downloaded from Google Earth and enhanced using Photoshop.

Royal supplied some in-house 100m LS magnetics and radiometrics, Ikonos imagery and digitized previous mapping over the George tenement and the Rum Jungle medium resolution airborne radiometrics and magnetics and various published maps for the whole area.

The mapping was therefore largely based on interpretation of aerial photographs and refined using high resolution Ikonos, enhanced Quickbird and SPOT and Landsat imagery and airborne radiometrics and magnetics. Published 1:100k geology maps were used as a guide. One week was spent on the George tenement in the company of Bethany Lawrence and about 20km of foot traversing was completed and 242 structural measurements taken.

2.2 Map Specifications

The final maps has been produced for use at a scale of 1:10,000 for the George mapping and 1:20,000 for the remote mapping using the Map Grid of Australia GDA94 Zone 52 Projection. The map is entirely digital and can be read using MAPINFO software.

The maps have been registered using $\pm 5\text{m}$, hand-held GPS tracklogs. Imagery downloaded from Google fitted this tracklog almost perfectly ($\pm 15\text{m}$). Also, the DTM and contours from the in-house airborne survey conformed with the Google images. The Ikonos images were slightly rotated and shifted a little to fit these other data. The Rum Jungle airborne data as supplied have also been re-registered.

A new drainage and cultural topographic base was produced from the Quickbird and SPOT and 2m contour data with some refinement using the higher resolution Ikonos.

Edge and internal distortion have been largely removed from the airphoto interpretation overlays such that distortion plus displacement for the maps should be better than $\pm 20\text{m}$.

3. GEOLOGY

3.1 Geomorphology

The lowest point in the mapped area is 54 metres above sea level in the floor of the Adelaide River just south of the Adelaide River Township; the highest point is 250 metres ASL on the Cretaceous sandstone mesa in the far south of the George tenement.

Five separate geomorphic systems (distinctive physiographic+regolithic terrains) have been defined for this area as shown on Figure 2. The basement geology has a strong control over each of these systems such that the geomorphic systems sometime closely coincide with geological units at Formation scale.

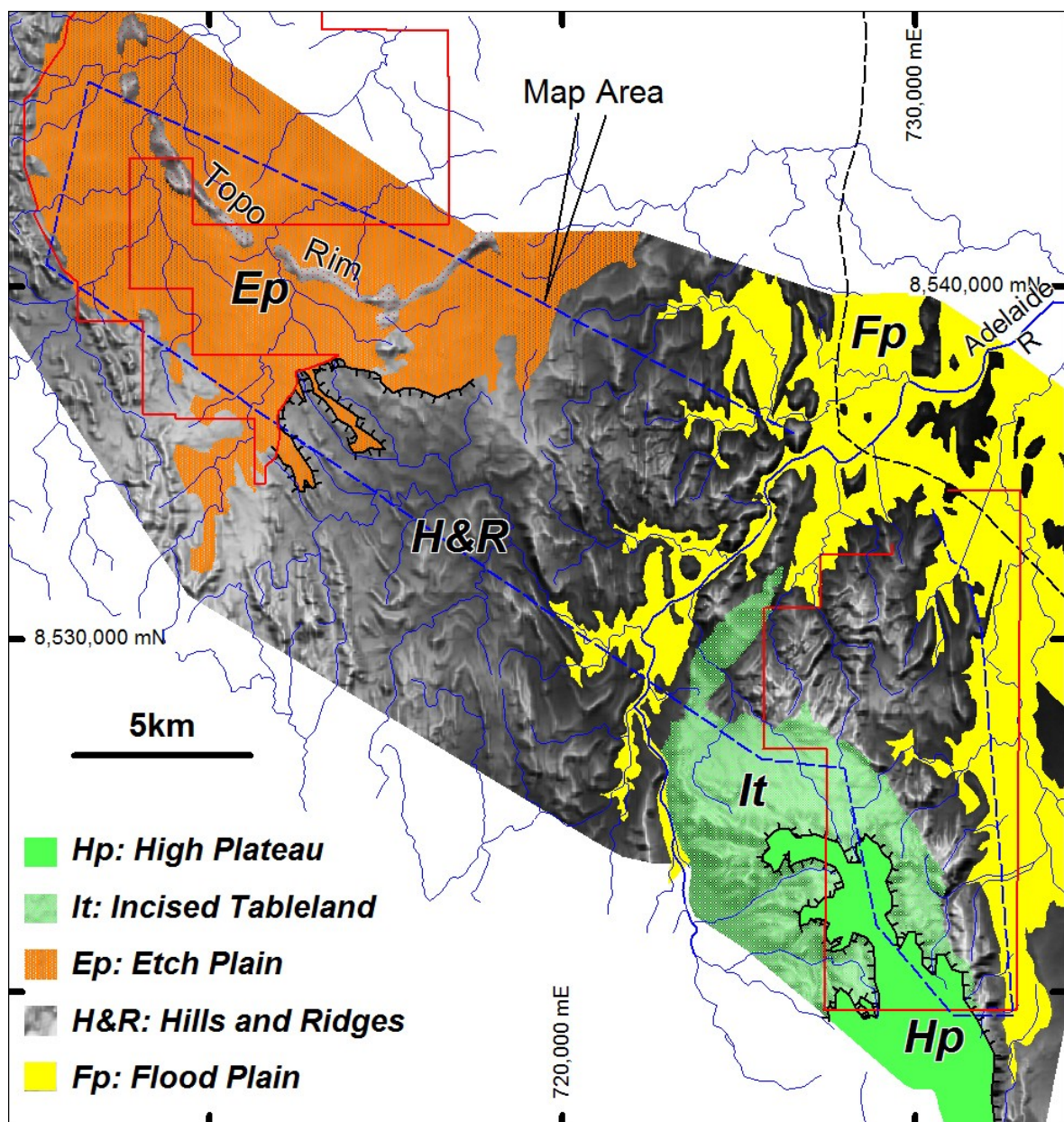


Figure 2: George-Waterhouse West Area Geomorphic Systems

High Plateau:

A substantial remnant of the Cretaceous Petrel Formation sandstone caps a flat mesa from 230m to 260m ASL in the south of the mapped area. Erosion of this plateau is at an escarpment face the **top** of which is the pre-Cretaceous surface. This palaeosurface appears to be quite flat and is at about 225-235m ASL. The Depot Creek Sandstone is exposed on the escarpment face.

Incised Tableland:

The pre-Cretaceous surface is being cut back at an escarpment face to expose the unconformably underlying Depot Creek Sandstone of Mesoproterozoic age. The gently undulating, flat-shallow dipping sandstone forms a tableland which is being incised by consequent streams on its back and obsequent streams cutting away at a subtle foreslope escarpment. Substantial deposits of yellow sand form outwash fans on the tableland.

This undulating surface, has been repeatedly subjected to faulting such that, in the mapped area, its base may be anywhere from 90m ASL to 240m ASL. It is therefore not possible to estimate how far above any point on the present surface this palaeosurface was. If there is a "normal" base level then it is about 100-120m ASL but it can be up to 240m ASL along steeper dipping margins or can be abruptly faulted up or down by 60 to 160m.

An essentially similar but thin and linear tableland rims the Waterhouse Complex in the north-west of the mapped area. This will be discussed further below (see Etch Plain).

Etch Plain:

The upper Finnis River (the north flowing Little Finnis and Finnis River South Branch) are consequent streams which are draining a gently undulating etch plain. This plain is probably an incised remnant of the Bradshaw regolith which is a thin laterite covering much of northern Australia.

The upper limits of the plain, ie, its southern edge, is a drainage divide at about 120m ASL defining the Finnis and Adelaide River catchments. Laterite duricrust is exposed but is being encroached from the south-east by the Adelaide River system along a breakaway. Most of the plain is covered in a thin veneer of sand and silt (allowing cultivation) but the Finnis River system is cutting into it and exposing bedrock in the stream floors.

A topographic rim up to 150m ASL just outside the Waterhouse Complex has been breached by the Little Finnis and Finnis R South Branch to allow access to the upper etch plain. The rim is

made up of the basal unit of the Palaeoproterozoic Mount Partridge Group (Crater Formation) and remnants of the Depot Creek Sandstone.

The pattern of radiometric responses in the zone surrounding the Waterhouse Complex is a direct result of the present disposition of the Etch Plain as the surficial material is deficient in K.

Hills and Ridges:

Much of the bedrock exposure south-east of the etch plain is in quite rugged, ridge and valley terrain with a dendritic drainage pattern (locally tending toward trellis drainage). This is almost exclusively built on the open-folded turbiditic sediments of the Burrell Creek Formation.

From the break in slope at the base of the hills and ridges, some rock is exposed and the regime is largely erosional with some local aprons and fan-shaped repositories. These complex repositories of sand, silt and clay (above the Adelaide River flood plain) are likely to partially mask bedrock radiometric responses.

Flood Plain of the Adelaide River:

The lowest country is composed of flat plains which begin at the base of the colluvial slopes and further out, surround local gentle rises. These depositional units are composed of dark soils and clay which are prone to inundation during the wet season. This sheet is now being incised to form stream bank terraces and the beginnings of an inverted topography.

The terraces and flats generally conceal bedrock radiometric responses, however, some responses are in situ in the drainage floors. Several strong radiometric U anomalies exactly coincide with ephemeral bogs especially in the south of the George tenement along the western margin of the flood plain.

3.2 Lithostratigraphy & Structure

The pre-Cainozoic bedrock includes the Archaean Waterhouse Complex, four Palaeoproterozoic rock Groups and the intrusive Zamu Dolerite, the Mesoproterozoic Depot Creek Sandstone and the Cretaceous Petrel Formation (see Figure 3).

The following descriptions, oldest to youngest, are mainly about the individual airphoto and radiometric expressions specific to the mapped area with some outcrop-scale descriptions where such has been observed in the George tenement.

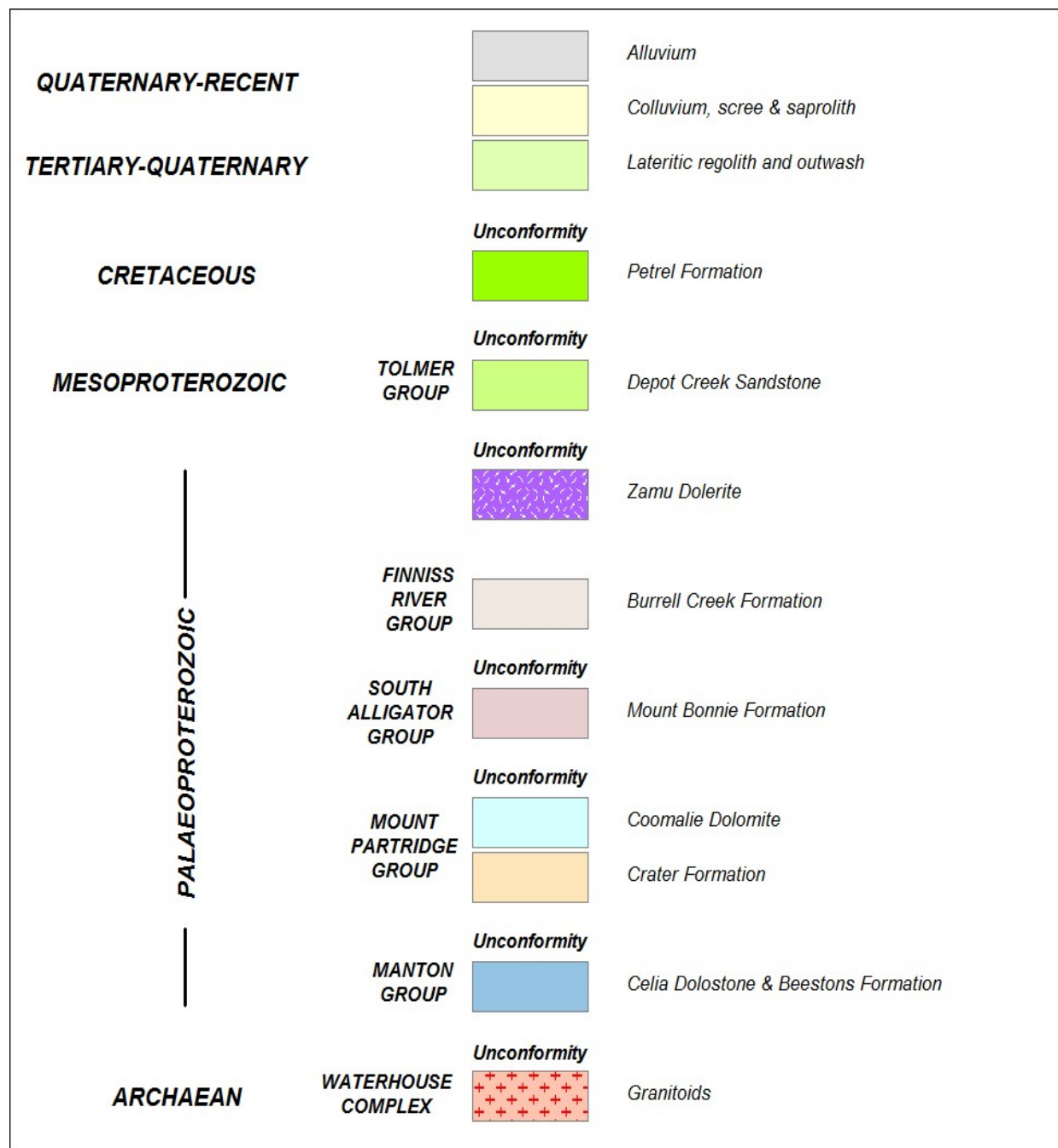


Figure 3: George-Waterhouse West Area Stratigraphic Column

Archaean Waterhouse Complex:

These are the oldest exposed rocks in the mapped area and are described as granitoids on published maps. Topography is essentially recessive with local hilly outcrops. Apart from an obvious rectilinear jointing (ENE & SE) not much else can be interpreted from the airphotos.

The rocks are anomalous in K, Th and U and the margins are easily mapped. The combined radiometric elements makes the Complex "shine" on radiometric maps of any scale.

Palaeoproterozoic Manton group:

The Beestons Formation and conformably overlying Celia Dolostone outcrop extensively along the southern and eastern margins of the Waterhouse Complex but only the southern tail of this belt occurs within the mapped area and outcrop is poor. Further west around the Complex's margin the Group has been removed by erosion during the pre-Mount Partridge Group unconformity. The base of the Manton Group is a depositional contact with the Waterhouse Complex. The Group is not particularly radioactive in any element.

Palaeoproterozoic Mount Partridge Group:

There are two distinctively different Formations within this Group, the basal Crater Formation and the conformably overlying Coomalie Dolomite. The Crater Formation is probably turbidite. It rims the Waterhouse Complex and dips consistently away to the south-west. It is remarkably consistent in thickness as if it once was a sheet of sediment about 150-200m thick resting on the Waterhouse dome. Its radiometric response suggests it was derived from the Waterhouse Complex. The base of the Group is a depositional contact with the Waterhouse Complex and the Manton Group.

The Coomalie Dolomite is a recessive unit but its airphoto colour and texture is distinctive. It is the most U-radioactive unit in the mapped area. Although the U anomalism is variable it is devoid of Th or K response.

Palaeoproterozoic South Alligator Group:

Unconformably above the Coomalie Dolomite is a poorly exposed unit described on published maps as sericite-quartz-chlorite schist which outcrops continuously around the Waterhouse Complex. Closer to the Complex dips are consistently moderate away from the Complex, ie, as a dome but there is a strong suggestion of open folding further away from the Complex. Unfortunately the photo expression is not clear enough to allow interpretation of folding because of the ubiquitous sandy sheetwash cover and isolated outliers of the unconformably overlying Burrell Creek Formation.

The radiometric response is also complicated by the cover rocks but is probably moderate uranium background and low K and Th.

Palaeoproterozoic Burrell Creek Formation:

This is the most extensively exposed Formation in the mapped area and the only one traversed during the field mapping. It is a typical turbidite, well bedded at most scales but locally

containing thick greywacke-only beds. Like most turbidites it is difficult to map because of common lensing of units and internal folding related to deposition.

The unconformity at its base is probably the most angular of the Palaeoproterozoic unconformities and so, in the vicinity of the Waterhouse Complex where its base is often exposed, there are numerous outliers resting on all the older Palaeoproterozoic rock Groups.

In the George area where the Formation has been traversed on foot and where high resolution mags and rads is available, a stratigraphy can be mapped although 95% of the rocks could be described as monotonous interbedded greywacke and siltstone. There are subtle variations in the thicknesses of the beds and the relative amounts of greywacke vs. siltstone and the occasional sandstone/conglomerate marker as well as some beds with mud-balls. These variations are expressed well at photoscale as a ridge and valley topography. Radiometric maps are dominated by the potassium response of the turbidites but there are also moderate background levels of Th and U. A broad stratigraphy can be mapped due to subtle differences in K and Th which both increase with more siltstone in the sequence. Where the magnetic data are of sufficiently high resolution such as at George, the stratigraphy can be refined by these subtle differences combined with a couple of definite markers.

The maps show a lot of bedding trend lines but not much in the way of internal stratification. That which is shown has sharp boundaries for only two units, viz, a pink siltstone (designated Pb-si2 & Pb-si3) and a unit containing conglomerate and sandstone lenses (designated Pb-sc). All other boundaries although accurate enough, are somewhat subjective.

In outcrop, most beds show evidence of a layer parallel foliation. Published literature, especially NTGS *and* GA mapping include this in D1 & 2 tight to isoclinal folding events. The author suggests that these are related to basin formation and are largely diagenetic (also see Section 3.3-Megascale Structure).

The bedding and its internal foliation are pervasively cleaved by the dominant structural element which is an open-spaced cleavage (C1) which is cross cut by an irregular open-spaced cleavage (C2) and there is often a flat cleavage seen in the better exposures (see Figures 4 & 5). No kinking has been observed in relation to the C2 fractures.

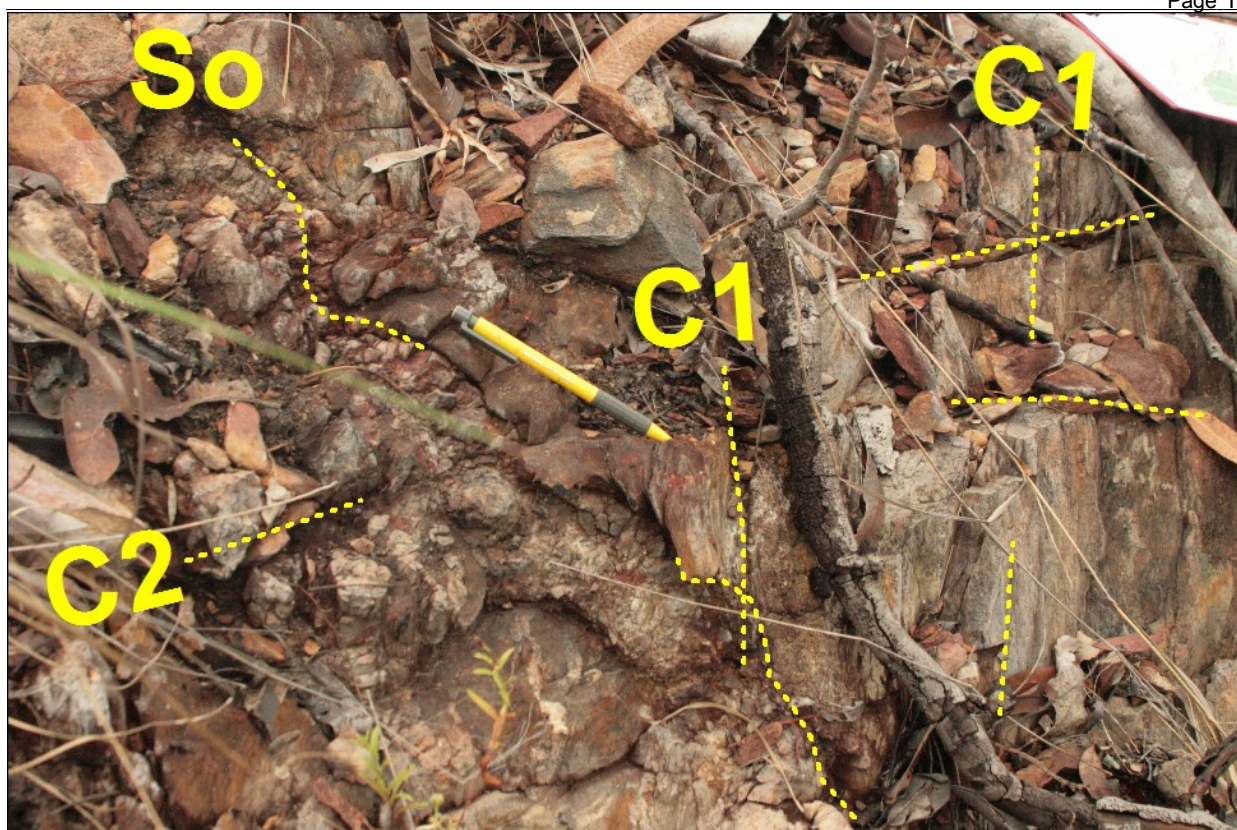


Figure 4: Two open-spaced cleavages cutting folded Burrell Creek Fmn bedded siltstone.

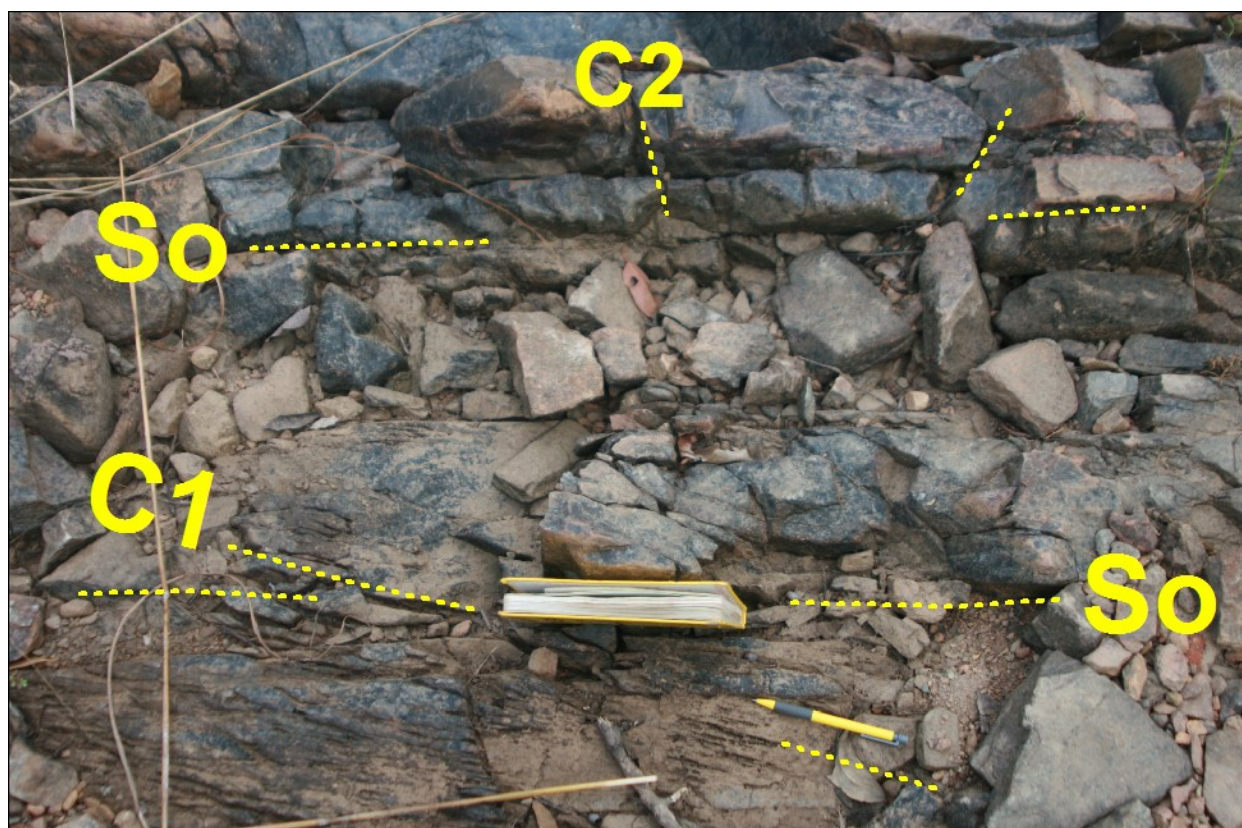


Figure 5: Two open-spaced cleavages cutting Burrell Creek Fmn bedded greywacke/siltstone.

The C1 cleavage is the axial plane cleavage of the main folds that are shown on the maps and obvious in all types of imagery. These folds all have shallow to flat plunges resulting in a dome and basin pattern typical of such turbiditic sequences. The structure stereograms below (Figure 6) quantify these field observations and match what can be seen from photomapping.

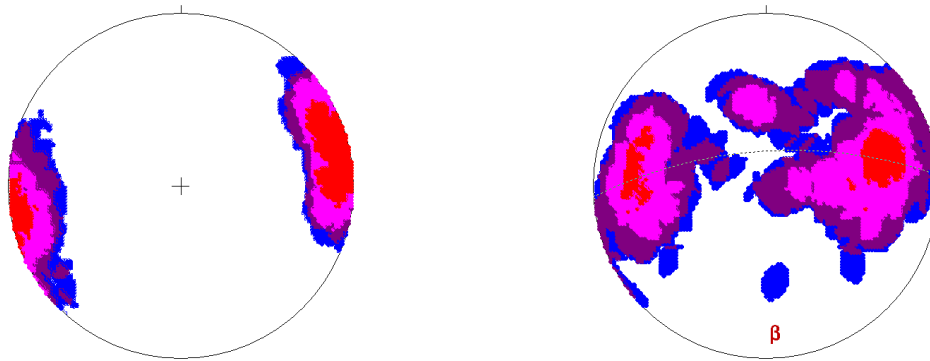


Figure 6: Structure stereograms of (LEFT) 54 open-spaced cleavage measurements (C1) and (RIGHT) 143 bedding (S0) measurements from the George area. The cleavage stereogram confirms the steep axial plane of the simple folding which trends at 177° and the bedding stereogram confirms the openness of the folding. The calculated β axis is 15° towards 176°.

There are a large number of axial plane faults some of which have been classed as dominant on the maps. In the George area these mostly dip steeply to the west. They have often been mistaken for bedding on the published maps.

The folds are upright and open with shallow plunges. Local variations in the plunge (up to 60°) are probably related to diagenetic folding during deposition (also see Section 3.3- Megascale Structure).

For what it's worth, the turbidites are probably a continental shelf sequence, not deltaic, not pelagic.

Palaeoproterozoic Zamu Dolerite:

Two lens-shaped sills of dolerite each about 1.6km long have been photo-mapped just south of the Waterhouse Complex at the contact of the Coomalie Dolomite and the South Alligator River Group. Low outcrops are surrounded by deep red soils.

Radiometrically, the sills and their colluvial soils are similar to the Coomalie, ie, some U but no Th or K.

Mesoproterozoic Depot Creek Sandstone:

This is the basal Formation of the Tolmer Group (maybe youngest Palaeoproterozoic). It occurs in two main areas. Firstly, in the south of and just west of the George tenement, well bedded, cross-bedded sandstone and quartz pebble conglomerate form an undulating incised tableland extensively covered in yellow sands. The margin dips shallowly to moderately (10-30°) to the south-west but is partly faulted. Often marginal to the base there is evidence of a zone of iron rich regolith which may be remnants of the pre-Depot Creek surface and may equate with the Buckshee Breccia. Secondly, Buckshee Breccia and Depot Creek Sandstone outcrop as linear cappings along the topo rim just outside the Waterhouse Complex. The north-eastern margin here is largely faulted and this is most likely a normal fault.

The RL of the base of the sandstone in all areas varies up to 100m and this seems to be a result of major cross-faults. There is also little doubt that the pre-Depot Creek surface was quite undulating.

The open-spaced cleavage (C1) which is pervasively developed in all older rocks is absent.

The Depot Creek Sandstone and its outwash sands can be reliably mapped based on their total lack of radiometric potassium, uranium or thorium.

Cretaceous Petrel Formation:

This flat bedded, unmetamorphosed sandstone forms the highest ground and has been mapped in the south of the George tenement. It outcrops on a strongly vegetated flat top plateau. The base of the sandstone is very flat and easily mapped on airphotos and is sharply defined on radiometric maps.

The Cretaceous sandstone can be reliably mapped based on its total lack of radiometric potassium.

3.3 General Observations and Uranium Mineralization

Megascale Structure:

The megascale structure of the mapped area is dominated by the doming around the Waterhouse Complex and by the open folding best seen in the Burrell Creek Formation.

The Palaeoproterozoic Manton and Mount Partridge Groups are in depositional contact with the Waterhouse Complex. The doming must be somewhat diapiric as the basal Palaeoproterozoic

rocks dip too steeply to match their depositional characteristics...and yet the contact is not faulted!

The folding in the Burrell Creek Formation is basically simple and typical of such turbidite sequences. I believe that the essential shape is determined during basin formation. The flat but undulating folding with local monoclines (D1 & D2 events) that creates subtle domes and basins is enhanced by later fracture cleavage type folding (D3 event). The result is fold axial lines with variable trends (eg NS at George but NW-SE closer to the Waterhouse Complex).

Faulting:

The most serious faults border blocks with contrasting axial trends and fold plunges such as the pre-eminent Adelaide River Fault. This comprises two roughly parallel structures as shown on the 20k scale map (Plan RR0356). By analogy with the Hays Creek, Bella Rose and Giants Reef Faults it must be taken seriously in any U exploration program.

An interesting plot of all fault line segments shown on the 20k scale map shows a broad rectilinearity to the faulting. The dominant trend is ENE (av 074°) with the next dominant trending NE (av 040°) (see Figure 7).

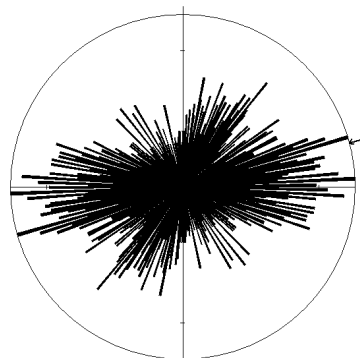


Figure 7: Rose diagram of 2451 fault segments interpreted from air photos.

While there are some faults trending NW-SE they are not part of a set. However, there are two ESE trending rather special faults shown on the 1:10k map one cutting through the Adelaide River Mine and another cutting through the George Mine. Of interest therefore, is a dominant fault, trending 110° just west of the Adelaide River (centre coords 723590E/8532720) which may connect with the Adelaide R Mine fault.

Also of significance is the fact that the Riverside, Kylie, Spring Creek, Burnetts and Southeast Kylie prospects are in proximity to discrete (ie, obvious on photos and mappable) faults that cut across the stratigraphy.

The role of the Depot Creek Unconformity:

There are many great U deposits in close proximity to such unconformities. Most Canadian geologists would not dare explore if they didn't have this. Then there are examples where there is no such thing in sight.

I suggest it be used to upgrade a target but not downgrade a target if it is absent.

In general it is not feasible to predict where the unconformity once was at any particular location.

Grass roots Exploration for Uranium:

There is really nothing to discount the occurrence of an orebody anywhere in the mapped area (or anywhere in the Pine Creek Province) thereby justifying blanket airborne radiometrics. Also maps such as those presented here are not going to allow prediction of new orebody locations. If they are used for this purpose it will be very subjective. However, the maps can be used to prioritize anomalies. An anomaly would increase its priority if.....

1. It is in close proximity to the Depot Creek Sandstone.
2. It is along an obvious lithologically contrasted contact, especially graphitic against dolomitic.
3. It is cut by an obvious cross structure.
4. It is very close to the Adelaide River Fault.
5. There is a geomorphic reason why it may be subdued.
6. It is close to a fold axis (preferably anticlinal).

The absence of any of these factors does not discount a deposit. Also, orebodies can be discovered, mined and forgotten before the geology is properly understood, eg, I am not the first to be confused by the stratigraphy at Kylie which is just as likely to be hosted by Whites Formation.

One essential thing to do when ground checking anomalies is to come at it from downstream with spectrometer in hand looking for mineralized float.

Exploration of existing occurrences:

All of the known occurrences (including the new discoveries at Hays Creek) are essentially along the lineation of the intersection of a set of parallel structures with a preferred stratigraphic

contact. At any of these locations it would be unwise, however, to dwell on any particular structural attitude eg, the steep NS fault at Adelaide River. However, it is considered prudent to look into the strata that hosts known mineralization at any one location.

These are not user-friendly targets as they normally have a shoot-like disposition and drilling either hits or misses. Essential to any search for continuations is a good knowledge of the shape of the preferred stratigraphic level. Detailed mapping, so rarely done properly, is by far the most cost effective thing to do, supported by either ground EM or 3D-IP. A good base data set like this costs less than a wasted diamond drill hole!

4. LOCALITY

PINE CREEK	1:250,000 Sheet	SD 52 08
Reynolds River	1:100,000 Sheet	5070
Batchelor	1:100,000 Sheet	5171

APPENDICES

From Ian Faris 1 Oct 2010

In the report though what I'd like to see comments on are:-

- Your marker horizons. Do you think it is a single repeated horizon, or 2-3 horizons, or multiple horizons that you can follow on the airphotos but not a distinctive horizon that can be followed across large distances. How is each horizon defined? Are they all image related or are some, for example, radiometrics+imagery+magnetics related.
- I'd also be keen to see in the report a bit more on the diagenetic folding you mention, and how it compares with the conventional structural picture of this area and how these folds can be identified in the field, if possible, c.f. later folding. We discussed it but if new people come onto the projects they'll be scratching their heads. I have attached a conventional understanding of the structure in this area to compare against.

Ian,

I'll answer these questions together as they relate to each other and to the intrinsic nature of turbidite sequences.

The **marker horizons** are meant to provide some assistance with viewing the shape of the folding. They are also drawn to try to define the all important rheological contrast that might help you find mineralization. They are "multiple horizons that you can follow on the airphotos but not a distinctive horizon that can be followed across large distances". They are exclusively interpreted from airphotos. As a rule, as soon as I met a substantial fault or had to cross over some alluvials, the continuity was lost. They are really the same as the bedding or cleavage trend lines but are bedding or cleavage trend polygons. I would have liked to, like any photo mapper, have found them to be a genuine marker, ie, a synchronous bed of uniform composition and when I started the interp over the Burrell Creek up on Run 29/Frame 36 that's what they looked like. However, as I progressed, the continuity stopped. Even more frightening is the likely possibility that they and the ridges that define them are topographically enhanced by close-to-bedding-faults like the one that runs up the prominent ridge from 731340E/8527560N to 731340E/8527560N.

All I could say is there seems to be a broad suggestion they are close to the regional contact between the lower Pb-gw-si unit and the overlying Pb-si unit. However, even this broad subdivision is not necessarily a synchronous horizon because of the very **nature of turbidite deposition** which I will now explain further.

We are taught at Uni that sediments are laid down, dry out, turn hard and then fold. Turbidites do not follow this simple routine. You have to picture them sloughing down into the sea from the mountains then sloughing again, sub marine, and this is happening over a prolonged period, sufficient for some beds to harden while others are soft and others have been hardened then liquified again when shaken, etc, etc. In other words, a bit of a mess can result. If the mush sloughs over a submarine cliff face a monoclinial shape will result. There can be local (sometimes major) overturning when a soft layer tries to roll down a hard layer or even in between hard layers. Note, from this point of basin development onward, I don't use the word bed because what may once have been laid down synchronously with a single provenance has since been churned, mixed and relayered. Evidence for bulk relayering is generally in the form of a layer parallel foliation which is almost always a pervasive fabric in finer grained turbidites. This is the academics' D1 foliation and what I call a diagenetic foliation. Evidence for monoclines is bending of D1 foliation and rapid changes in plunge plus turbid deformation. D1 has nothing to do with folding of lithified sediments but rather the grains in a turbidite bed aligning themselves while they are still mud. D2 is a mixture of soft sediment and somewhat brittle deformation.

If overturning is accomplished, or on the tops and bottoms of slipped beds, there will be slippage planes. These slippage planes will last forever as foliation-parallel faults and one special manifestation of such faults are cherts/ BIFs. Everything is cold but the pressures can be enormous due to the weight of overlying wet sediment. So the minerals will align, the layers will churn and fold but hardly metamorphose.

Two other features of turbidites (and the curses placed upon photomappers) is lensing of beds and the repeating of bedding texture/composition combinations over time. There's not a lot you can do with a greywacke and while it is normally fun to map changes in fine detail and define distinctive Bouma sequence in outcrop, such is generally a nightmare at photoscale and it all starts to look the same....unless you are lucky enough to find some "markers!" One underrated form of deformation is that which results from rotating currents within a basin, ie, stirring the paint tin.

I am not the only one to have faced these problems. The Melbourne Trough, the Bendigo Trough, classic turbidites are still largely unmapped and can only be subdivided by time lines based on fossils. These sequences all have the same descriptions. I was given the task of mapping the Bendigo Trough in 1984 for CRA. I diligently mapped nearly a thousand road cuttings and interpreted 450 RC9 airphotos and came up with embarrassingly very little. I mapped a large area of the Ashburton Basin in 1996 and couldn't draw a sensible map.

Now, the Burrell Creek is one of the better turbidite basins (for photomapping). There are some units shown on the George map that are 8km strike (eg Pb_sc). But even this is just a collection of sandstone and conglomerate lenses within a greywacke-siltstone sequence.

The confidence in drawing these boundaries at George comes from a combination of photo and image expressions, mags and K-radiometrics, each of good resolution. My field notebook is full of "greywacke-siltstone". There is not a lot of turbidity to be seen in outcrop and the monoclines that characterize early (diagenetic D1 & D2) deformation in other basins are not glaringly obvious. You have to trust me that they are there, manifest as bends in the strike and inexplicable changes in fold plunges.

When the basin had hardened it probably looked like a depression of dried mud characterized by subtle lows and highs (flat domes and basins). This inherent shape is retained even though later brittle folding (D3, D4) tries to change it. However, all that these later deformations do is enhance it. The steep axial plane cleavage of D3 (my C1 fabric) gives an impression of steeper dips than are actually present at photoscale. If you look at my map you will note that the average photo interpreted dip is much shallower than the measured dips. This is because the airphoto dips are seeing the enveloping surface, to a degree the ghost of the original basin!

There are topo marker horizons traceable for up to 25km in the Burrell Creek Formation. The degree to which these are synchronous is debatable and from experience I would bet they are not synchronous at all or even consistent lithologically.

There is nothing in the published structural history that conflicts with my view, it's just that the Govt Geos have been very structurally empirical whereas I'm trying to paint a picture of sloughing mushes.