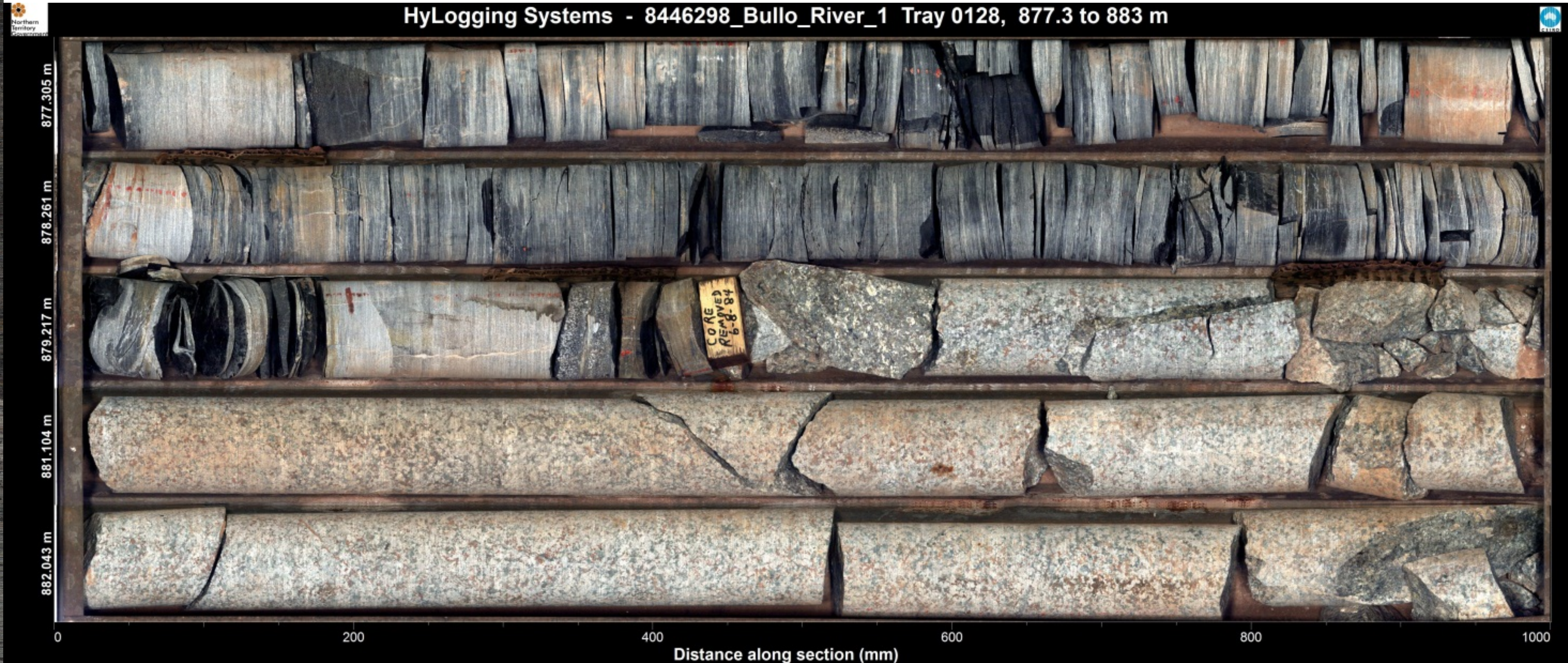
NORTHERN TERRITORY GEOLOGICAL SURVEY

# HyLogger Data Package 0040

## HyLogger drillhole report for Bullo River 1, Victoria Basin, Northern Territory.


**Belinda R Smith**

DEPARTMENT OF MINES AND ENERGY
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CHIEF EXECUTIVE: Ron Kelly

NORTHERN TERRITORY GEOLOGICAL SURVEY
EXECUTIVE DIRECTOR: Ian Scrimgeour

BR Smith
HyLogger drillhole report for Bullo River 1, Victoria Basin, Northern Territory.

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# The Spectral Geologist Advisory

The results in this report were obtained using The Spectral Geologist (TSG) software. The software uses The Spectral Assistant (TSA) as a default to identify minerals and their abundances for the Short Wave Infrared (SWIR) and Thermal Infrared (TIR) spectrum. TSA is a general unmixing algorithm and is trained on a relatively small subset of commonly-occurring minerals. It does not make the right identifications all of the time. TSA abundances are relative abundances, only the two most prevalent minerals identified in the Short Wave Infrared (SWIR) and the three most prevalent minerals in the Thermal Infrared (TIR) wavelengths are reported. If there are more than two minerals actually present in the sample in the SWIR (or three minerals in the TIR) then this is not reflected AT ALL in the reported abundances. Minerals are reported as a fraction of the overall spectral fit rather than actual quantifiable concentrations (total minerals present add up to 1). The SWIR wavelength only identifies hydrous silicates and carbonates. It does not reflect the TOTAL mineralogy of the sample. NTGS processed datasets exclude some minerals in the TSA library if the mineral is a poor spectral fit or unlikely in that geological environment, introducing an element of interpretation.

Since April 2014, the TIR spectral responses have also been matched to minerals using Constrained Least Squares (CLS), which is an alternative unmixing classifier. CLS uses a Restricted Mineral Set (RMS) to minimise non-unique mineral modelling in the TIR spectrum. The RMS is determined by the processor who interprets 'domains' (hole intervals interpreted to have similar mineralogy) and then limits the set of possible mineral matches based on the geological understanding of that domain. Any results from the TIR should be used with caution as algorithms and TSA libraries are in a constant state of revision. These results were published using TSG Version 7.1.0.062 dated October 2013.

Please note: the results in this report are an interpretation from the spectral response.

# Bullo River 1: Introduction

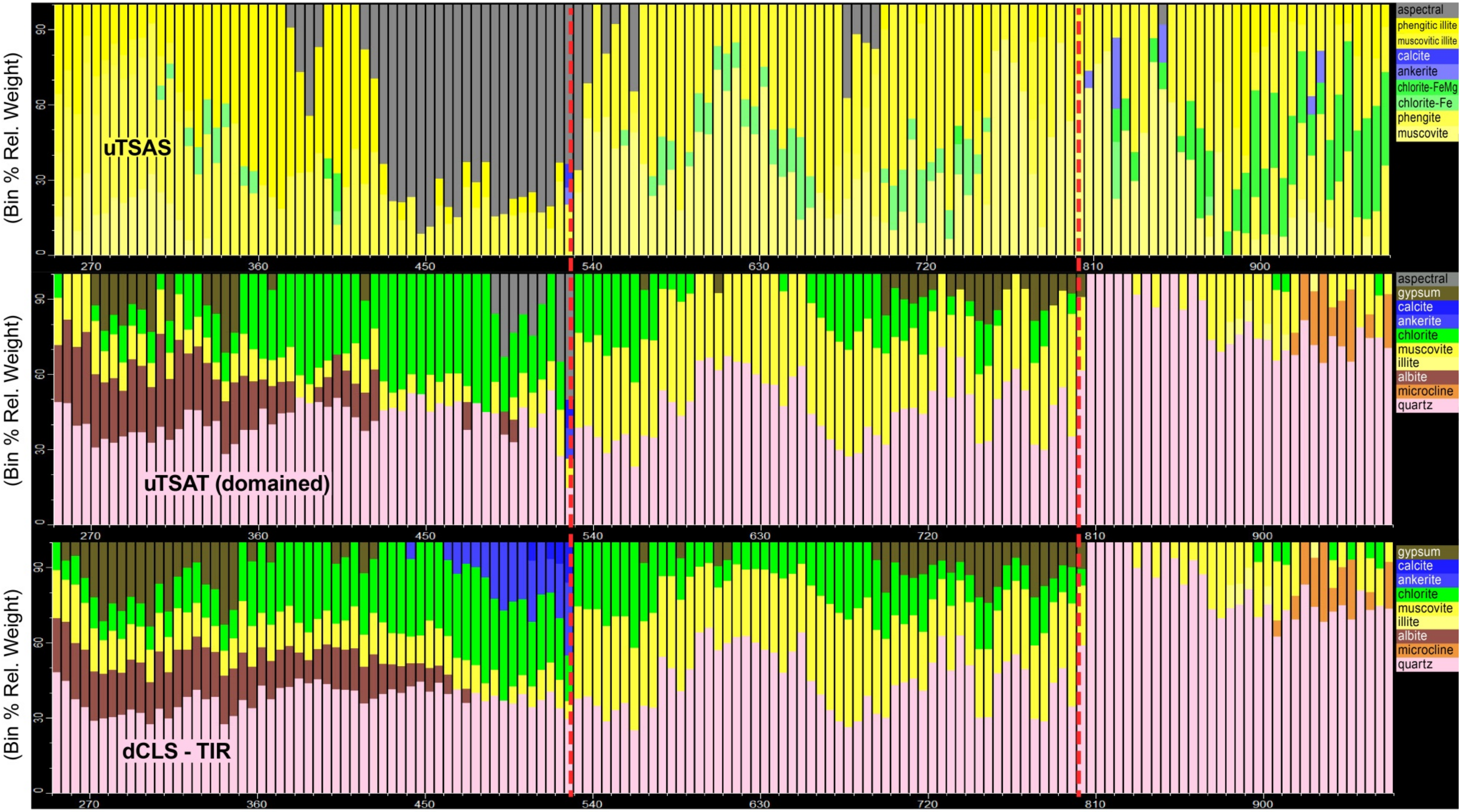
| | | | |
|---|---|---|---|
| **Hole ID** | Bullo River 1 | **Unique identifier** | 8446298 |
| **Geological terrane** | Victoria Basin | **Total depth** | 969.6 m |
| **Latitude GDA94** | -15.59526° | **Longitude GDA94** | 129.631241° |
| **Easting MGA94** | 567673 (Zone 52) | **Northing MGA94** | 8275734 (Zone 52) |
| **Dip** | -90° | **Azimuth** | 360° |
| **Logged by** | Queensland Petroleum Pty Ltd | **Logged report ref** | PR19840057 (Well 0236) |
| **Start core depth** | 250.6 m | **End core depth** | 969.6 m |
| **Date HyLogged** | October 2014 | **HyLogged by** | Darren Bowbridge |
| **Date of HyLogger report** | April 2015 | **HyLogger report author** | Belinda Smith |
| **TSG version and build** | HotCore Build 62 (Oct 2013) | **TSG product level** | 3 (Huntington, 2010) |

Summary of information from PR1984-0057

- Drilled to test a large surface-mapped faulted structure and to test the hydrocarbon prospectivity.
- Intersected the Saddle Creek Formation to 50 m and the Angalarri Formation to 803 m. However at around 530 m, the Angalarri Formation has lower resistivity, higher sonic velocity and a 'more shaly gamma response'. Below the Angalarri Formation is the Jasper Gorge Sandstone (from 803 m to 880 m).
- Basement from 880 m is a weakly altered, graphic granite. Dunster et al (2000) considered that the granite may be part of the Bow River Granite suite, which has implications for the structural interpretation of the Halls Creek – Victoria River Fault Zone.
- The fine sandstones of the Angalarri Sandstone and the Jasper Gorge Sandstone both returned poor porosity results (1.5 – 5% porosity) and no permeability.
- The ripple cross-laminated shales and sandstones of the lower part of the Angalarri Formation returned traces of C1 to C3 gas. This indicates that the thin shales were releasing traces of gas while drilling.

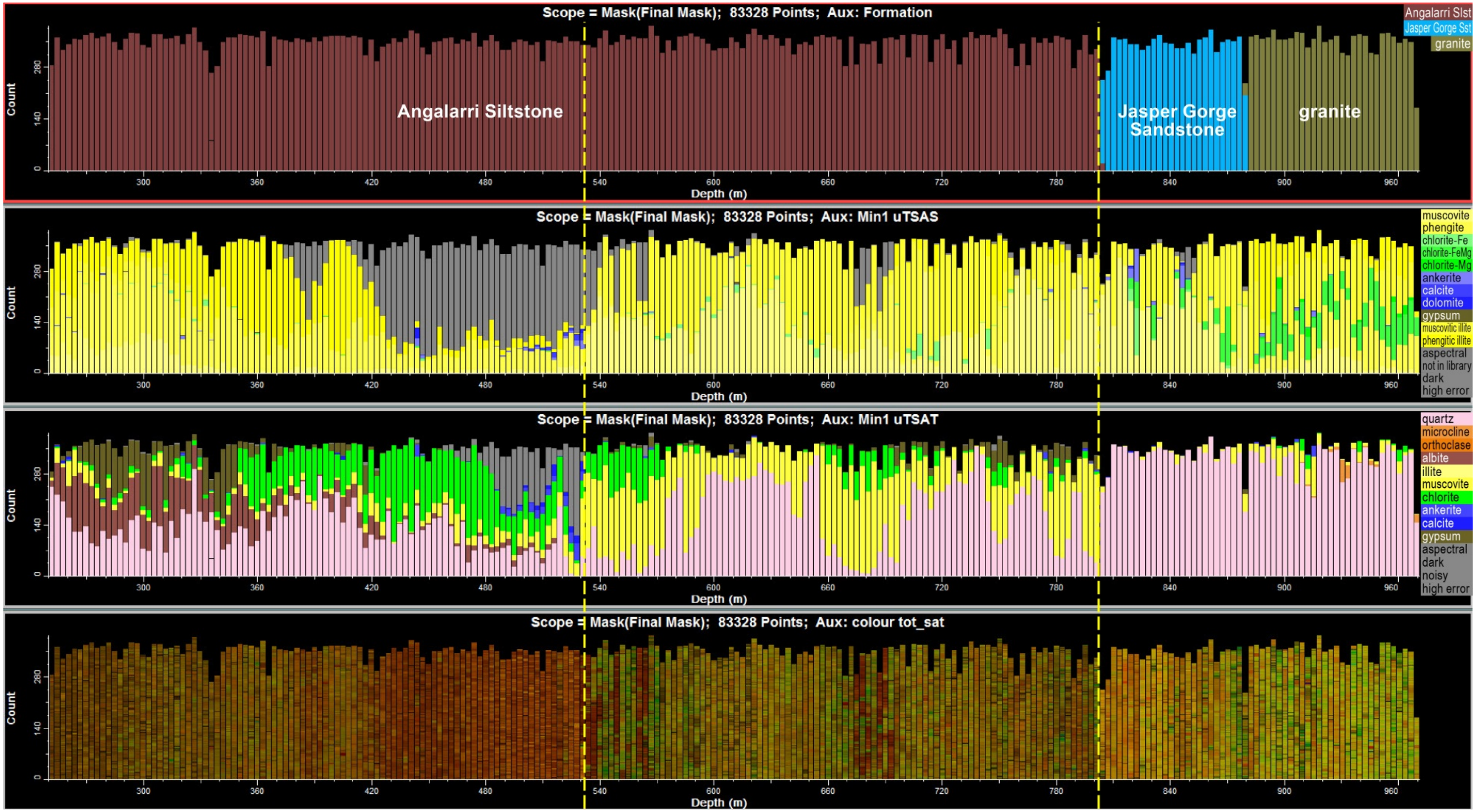
Reference: Dunster JN, Beier PR, Burgess JM and Cutovinos A, 2000. 1:250,000 Geological Map Series Explanatory Notes (2nd Edition) AUVERGNE SD52-15. *Northern Territory Geological Survey*.

# Bullo River 1: Mineral summary – all minerals, TSA and CLS



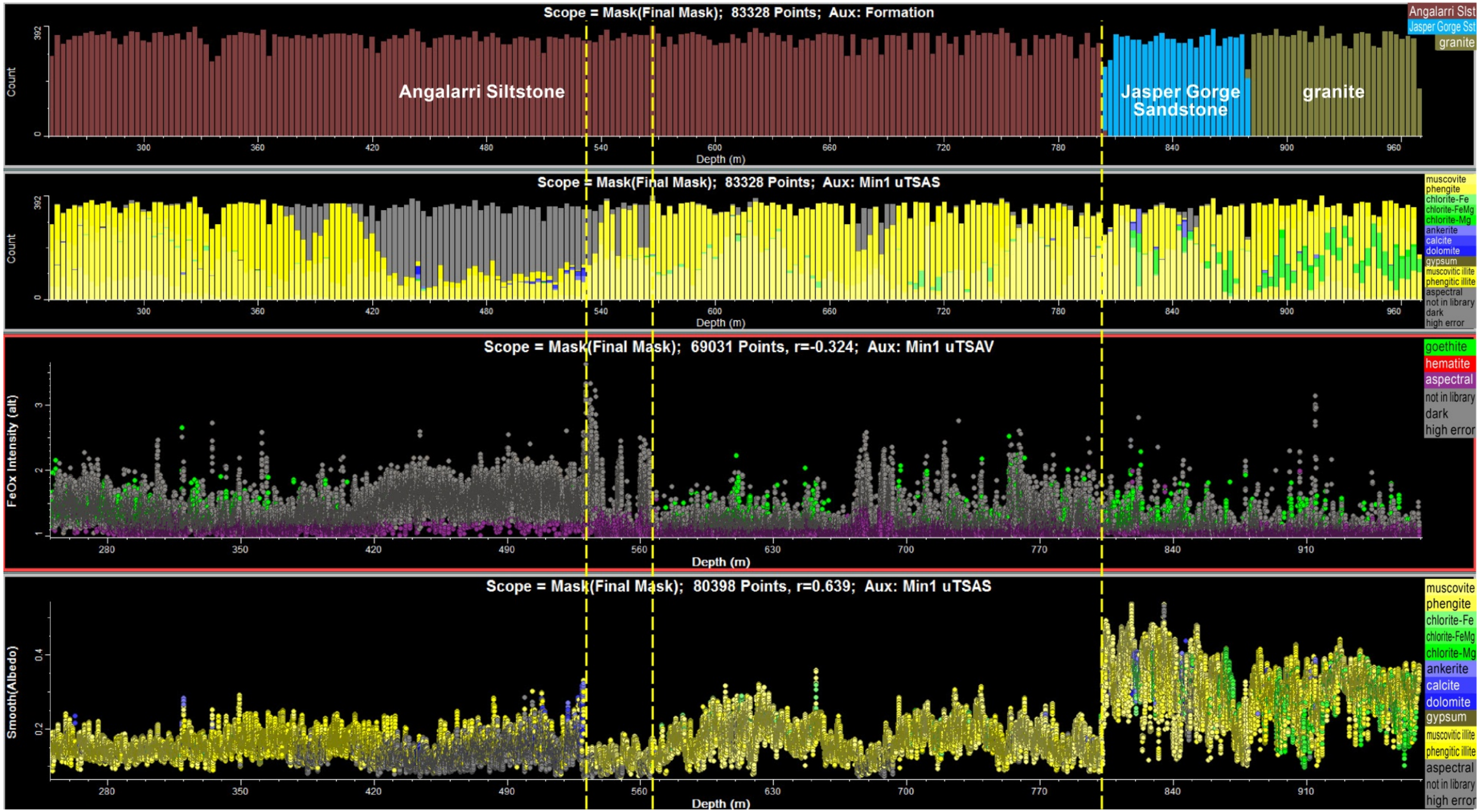

From Summary Screen: Row 1 shows SWIR mineral summary. Rows 2 and 3 show TIR mineral summary. Row 2 is the (domained) TIR mineral summary using the TSA algorithm and row 3 is the (domained) TIR mineral summary using the CLS algorithm. Domaining of the holes into zones of similar mineralogy was applied for the TIR as minerals such as plagioclase were plotting in minor amounts throughout the hole. Domaining uses a restricted mineral set for the algorithms to access in mineral matching. Dotted lines show mineral zones. There is a change in mineralogy around 520 m, from aspectral (grey colour, in TSA) to quartz + white mica and chlorite. The aspectral response is erroneously plotted as carbonate in the CLS (because the CLS algorithm does not give aspectral results but will attempt to match to a mineral). Another change is around 805 m, to quartz-rich mineralogy (in TIR, rows 2 and 3).

# Bullo River 1 Mineral summary



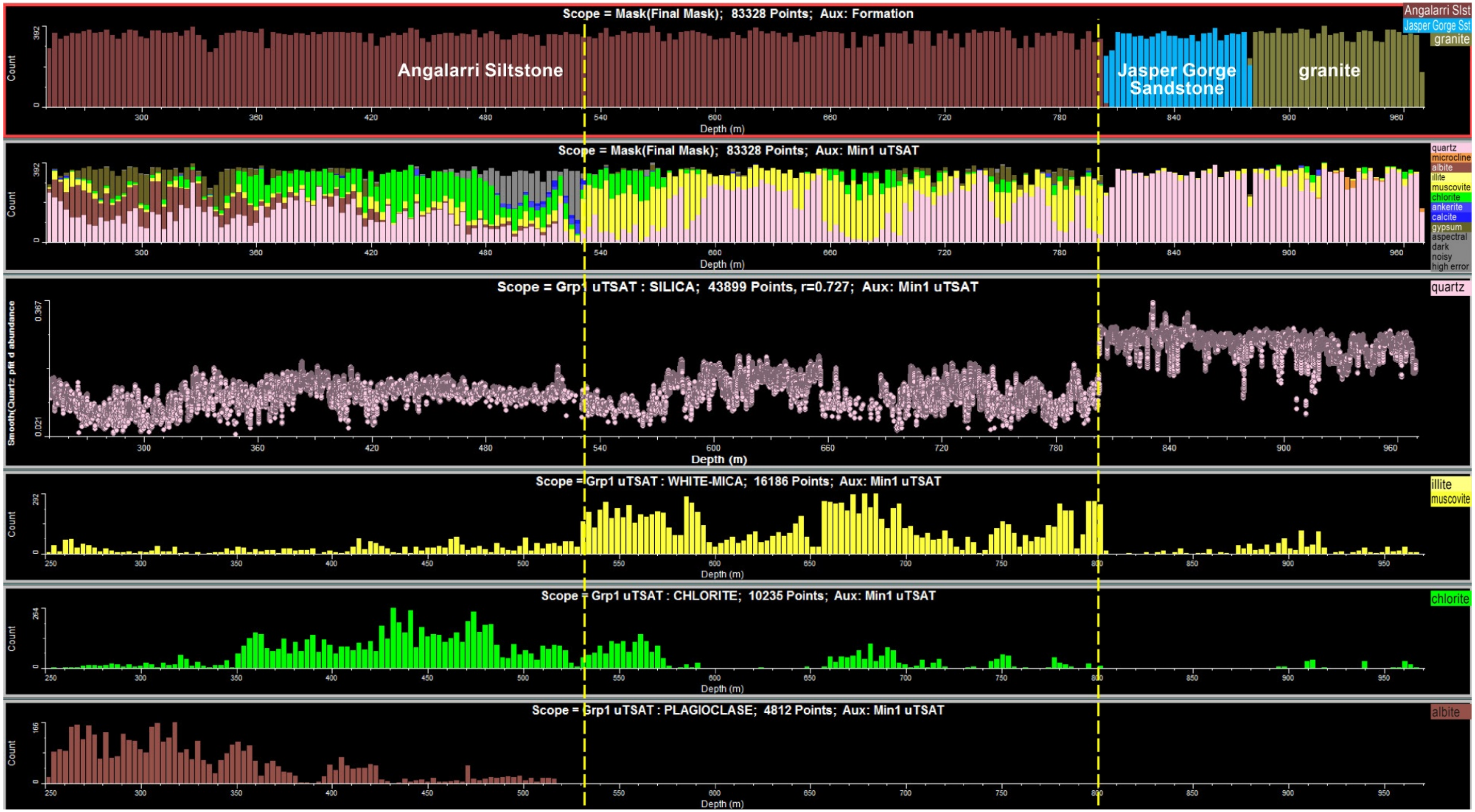

Row 1 shows logged stratigraphy. Row 2 is the dominant mineral in the SWIR (TSA). Row 3 is the dominant mineral in the TIR (TSA). Row 4 is core colour. Dotted lines show mineralogy changes. The Angalarri Silstone has several gradational changes in mineralogy. Near the top of the cored section is possible plagioclase, gypsum and quartz. This gradationally becomes more white mica and chlorite-rich (row 3; ca 350 m to 520 m). From ca 420–420 m there is an aspectral response (see page 11). The contact between the Angalarri Siltstone and the underlying Jasper Gorge Sandstone is quite sharp, with more quartz in the Sandstone and a core colour change. The boundary between the Jasper Gorge Sandstone and the granite basement is mineralogically indistinct.

# Bullo River 1: SWIR and VNIR mineral summary



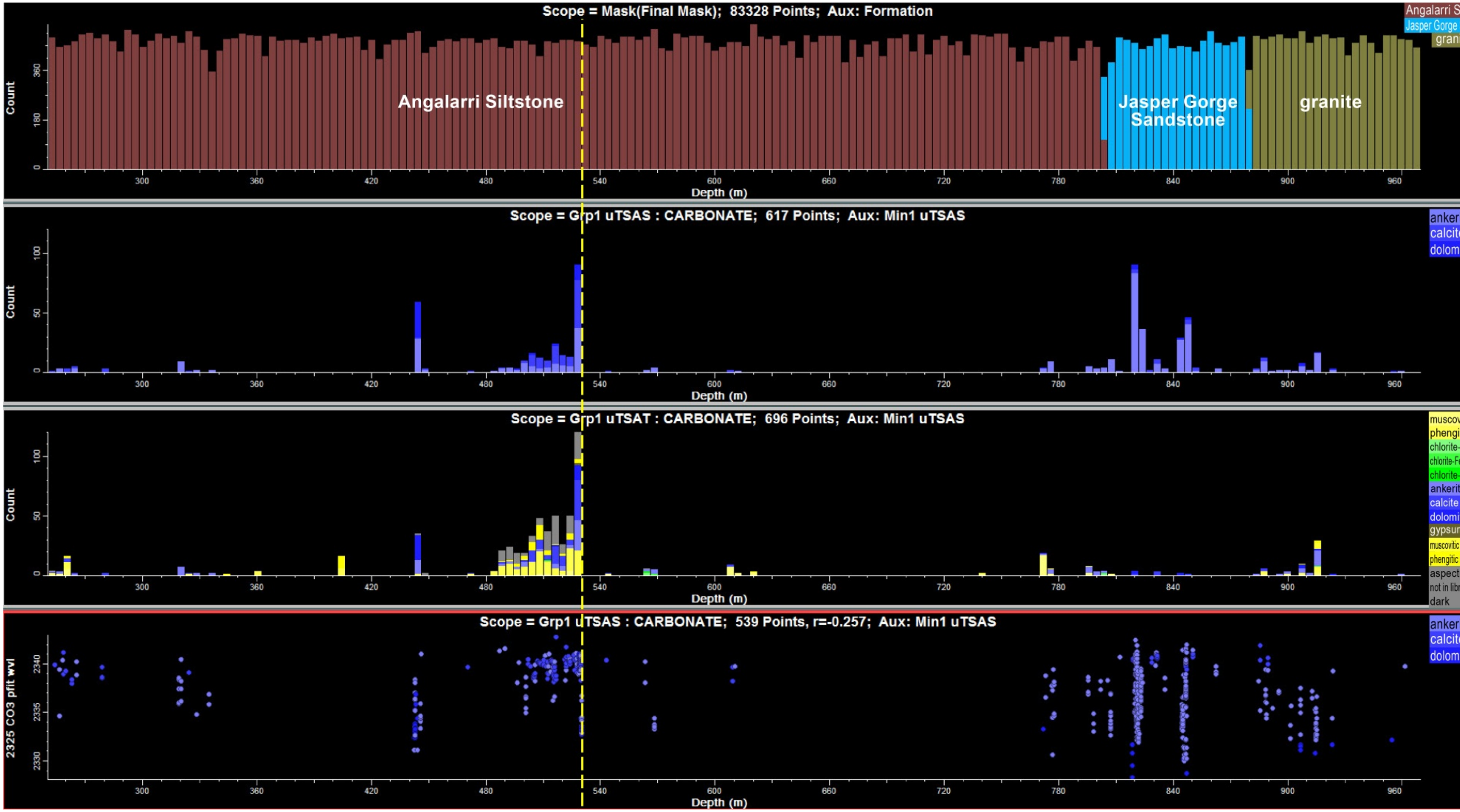

Row 1 is logged stratigraphy. Row 2 is dominant mineral in SWIR. Row 3 is the dominant mineral in the VNIR plotted against the FeOx intensity. Row 4 is smoothed albedo coloured by SWIR Min1. Dotted lines show changes in FeOx intensity and/or albedo. There is a sharp decrease in albedo (and increase in FeOx intensity) around 530 m, corresponding with a change to a laminated reddish green siltstone. High FeOx intensity correlates with redbeds, that are common between 530m and 565 m. The albedo change at 803 m marks the change between the darker silty units of the Angalarri Siltstone and the paler sandstones of the Jasper Gorge Sandstone.

# Bullo River 1: TIR mineral summary



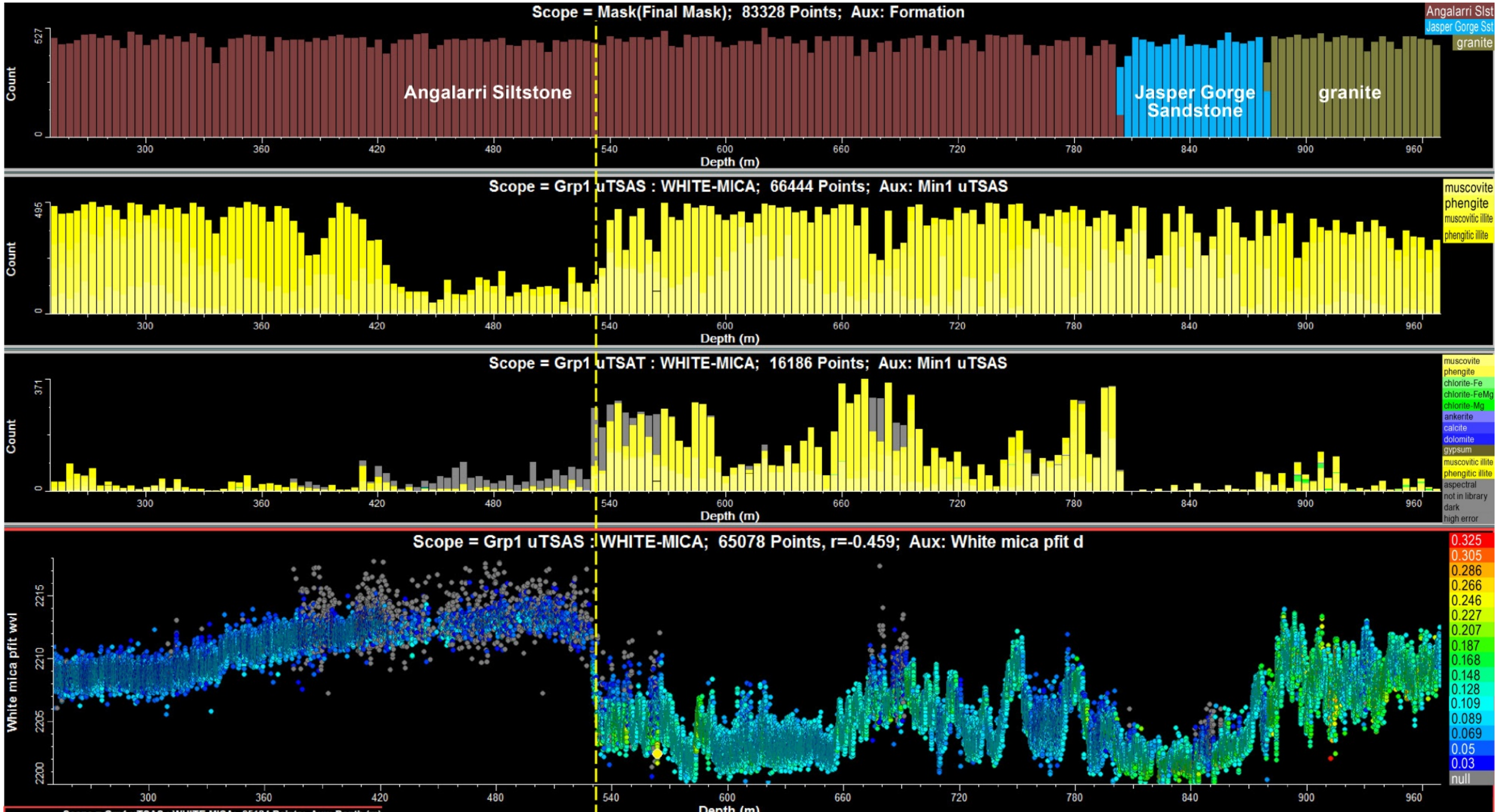

Row 1 shows logged stratigraphy. Row 2 shows the TIR mineralogy (domained and matched using the TSA algorithm). Row 3 plots the TIR spectra that match to (dominantly) quartz (TSA) plotted by the depth of the characteristic quartz reflectance feature (corresponding to abundance of quartz). Rows 4, 5 and 6 plots the spectra which match dominantly to white mica, chlorite and plagioclase respectively. The plagioclase (row 6) should be confirmed using an external technique such as XRD or petrography. Note the stratigraphic boundary between the Angalarri Siltstone and the Jasper Gorge Sandstone marks a change in the quartz abundance and white mica. White mica appears most common between around 530 m to 803m. This interval is where the downhole geophysical logs noted 'lower resistivity, higher sonic velocity and a 'more shaly gamma response' (in PR1984-0057).

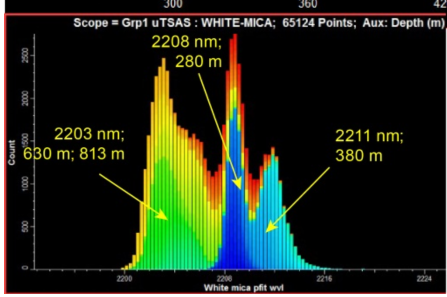
# Bullo River 1: Carbonates




Row 1 is logged stratigraphy. Row 2 is the distribution of the spectra which match dominantly to carbonate in the SWIR. Row 3 is the distribution of spectra which match dominantly to carbonate in the TIR, coloured by the dominant SWIR mineral. Row 4 the SWIR carbonate-dominant spectra, plotted by the wavelength of the diagnostic SWIR carbonate feature. This shows that the wavelength of the diagnostic carbonate feature is quite variable in the Jasper Gorge Sandstone, and that the SWIR spectra have more matches to carbonate in the Jasper Gorge Sandstone than the TIR spectra. When checking the spectra, it is possible that the TSA algorithm is matching more to carbonate when chlorite is a possible better match. In the Angalarri Sandstone, there is some carbonate (to dotted line) but the in this case the TIR spectra match more to carbonate than the SWIR spectra. A closer look at the spectra shows that there is a lot of volume scattering which is causing more spectra to match to carbonate. In conclusion, there is minor carbonate present but it is possibly over-represented, with the SWIR perhaps showing the best distribution in the Angalarri Siltstone and the TIR (TSA) showing the best distribution in the Jasper Gorge Sandstone.

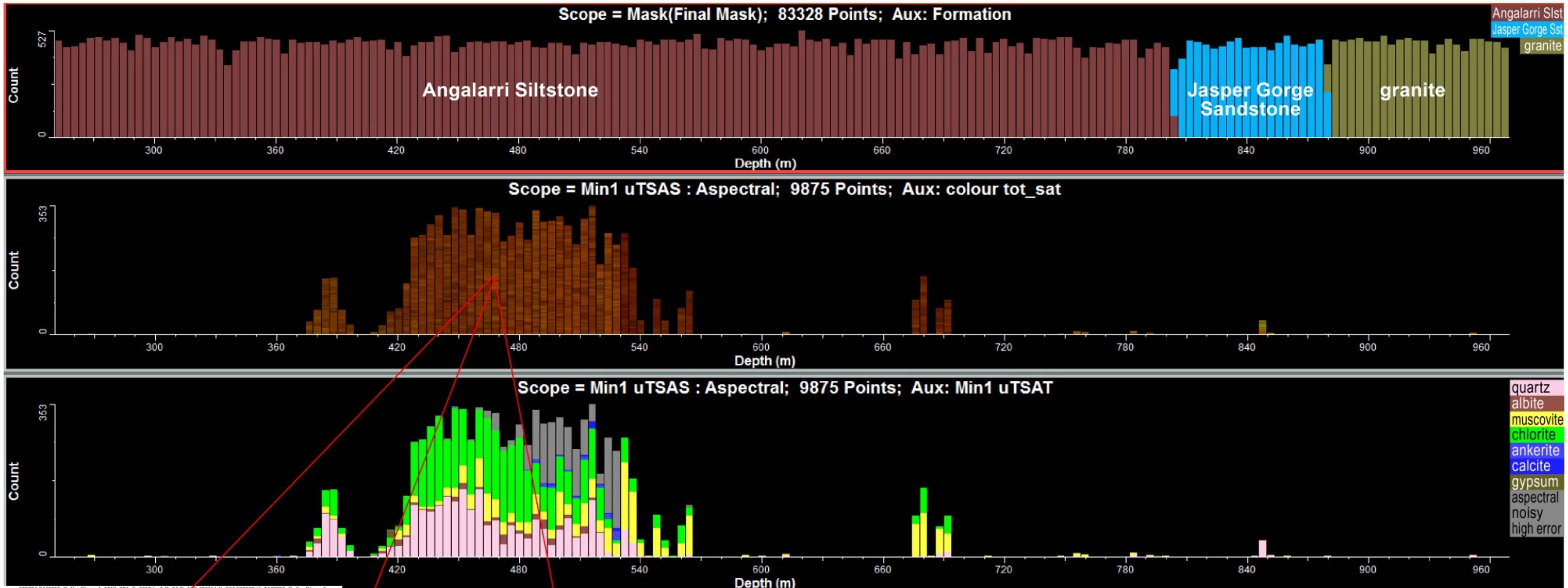
# Bullo River 1: White micas

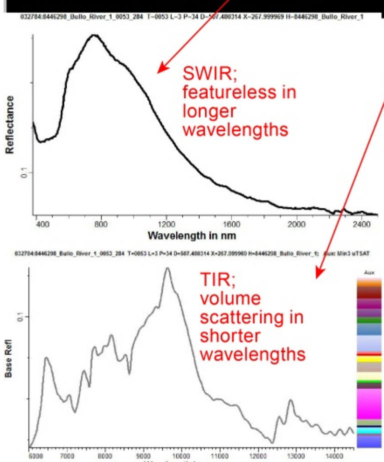



Row 1 shows logged stratigraphy. Row 2 plots the SWIR spectra that match to white mica as the dominant mineral. Row 3 plots the TIR spectra that match to white mica as the dominant mineral. Row 4 is the SWIR white micas plotted by the wavelength of the diagnostic white mica absorption feature, coloured by the depth of the absorption feature. Variations in the wavelength indicate white mica composition changes, while the depth of the absorption feature reflects white mica abundance. Inset left plots the wavelength and indicates possibly 3 populations centred around 2203 nm, 2208 nm and 2311 nm (coloured by depth down the hole). Dotted line shows the sharpest change in white mica composition (at around 530 m in the Angalarri Siltstone) with a decrease in the wavelength of the white mica feature (from around 2211 nm to 2205 nm) and an increase in the occurrence of the white mica. This is at the depth where the geophysical logs noted lower resistivity and higher sonic velocity. There is also local variability in the white mica composition in this basal part of the Angalarri Siltstone (as noted by the sharp changes in wavelength in row 4). The Jasper Gorge Sandstone has an overall short wavelength white mica (more Al-rich) compared with the underlying granite or the Angalarri Siltstone.

# Bullo River 1: Aspectral response in SWIR




core imagery that matches with the SWIR and TIR spectra (left)

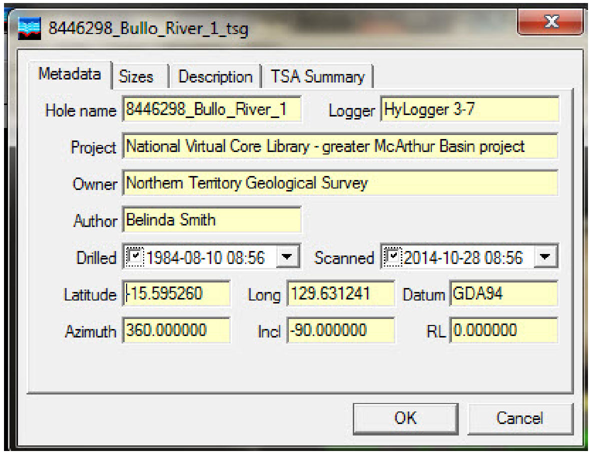
Row 1 is logged stratigraphy. Row 2 is the SWIR aspectral response coloured by the core colour. Row 3 is the SWIR aspectral response, coloured by the dominant TIR mineral. An aspectral response in the SWIR could be from dark core (giving a noisy SWIR response), or from minerals not in the SWIR TSA library, or from minerals that do not have a mappable absorption feature in the SWIR (such as quartz and anhydrous silicates). From 415 m to 540 m, the aspectral response is from redbeds and variable brown grey siltstones, which have a ‘quenched’ response in the SWIR (low albedo in the longer wavelengths with no discernible absorption features). The TIR shows variable matches to quartz but there are spectra that return an aspectral TIR response due to volume scattering. Petrography would be required to determine why the spectral response has been affected in this way.

# Bullo River 1: Summary of HyLogger data interpretation

- The mineralogy is dominantly white mica and quartz, with variable chlorite. The upper part of the hole may have ?plagioclase, gypsum and chlorite.
- The geophysical log noted lower resistivity and higher sonic velocity in the Angalarri Siltstone from 530 m. This corresponds to an increase in Al-rich white mica.
- The Jasper Gorge Sandstone has a higher quartz content and a shorter wavelength white mica compared with the rest of the hole.
- The Jasper Gorge Sandstone is mineralogically indistinguishable from the underlying granite at the hole summary level. The chlorite in the granite is slightly more Mg-rich and there is microcline present in the granite.


**The contact between the Angalarri Siltstone (left) and the underlying Jasper Gorge Sandstone (right) is sharp at 803 m in Bullo River 1.**

# Bullo River 1: TSG metadata

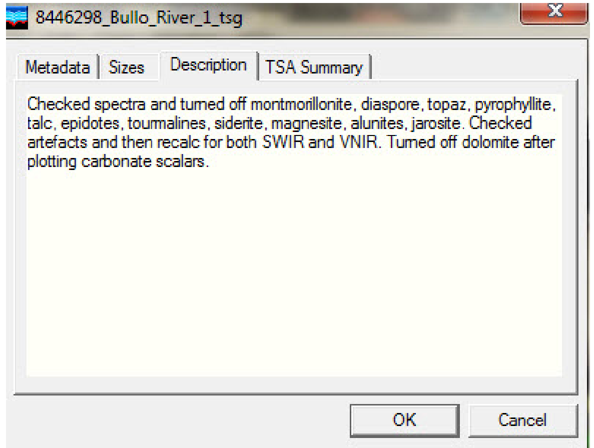


8446298_Bullo_River_1_tsg

Metadata | Sizes | Description | TSA Summary

| | |
|---|---|
| Hole name | 8446298_Bullo_River_1 |
| Logger | HyLogger 3-7 |
| Project | National Virtual Core Library - greater McArthur Basin project |
| Owner | Northern Territory Geological Survey |
| Author | Belinda Smith |
| Drilled | 1984-08-10 08:56 |
| Scanned | 2014-10-28 08:56 |
| Latitude | -15.595260 |
| Long | 129.631241 |
| Datum | GDA94 |
| Azimuth | 360.000000 |
| Incl | -90.000000 |
| RL | 0.000000 |

OK Cancel

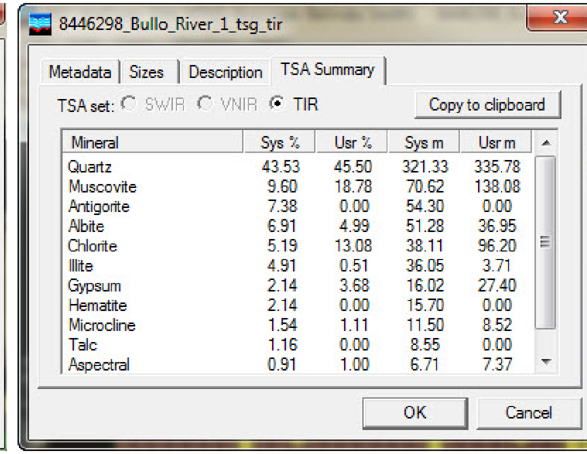


8446298_Bullo_River_1_tsg

Metadata | Sizes | Description | TSA Summary

Checked spectra and turned off montmorillonite, diaspore, topaz, pyrophyllite, talc, epidotes, tourmalines, siderite, magnesite, alunites, jarosite. Checked artefacts and then recalc for both SWIR and VNIR. Turned off dolomite after plotting carbonate scalars.

OK Cancel



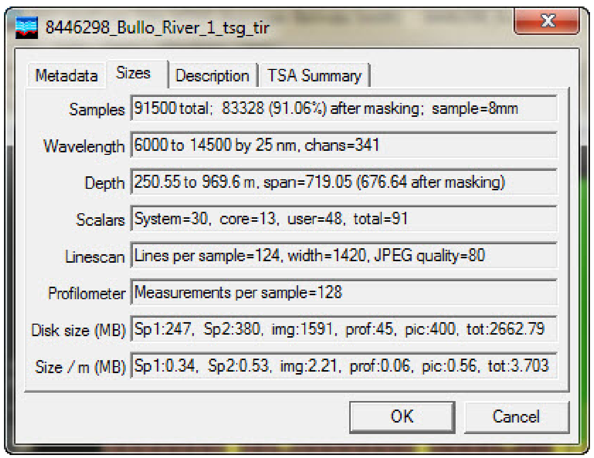
8446298_Bullo_River_1_tsg_tir

Metadata | Sizes | Description | TSA Summary

TSA set: SWIR VNIR TIR (TIR selected) — Copy to clipboard

| Mineral | Sys % | Usr % | Sys m | Usr m |
|---|---|---|---|---|
| Quartz | 43.53 | 45.50 | 321.33 | 335.78 |
| Muscovite | 9.60 | 18.78 | 70.62 | 138.08 |
| Antigorite | 7.38 | 0.00 | 54.30 | 0.00 |
| Albite | 6.91 | 4.99 | 51.28 | 36.95 |
| Chlorite | 5.19 | 13.08 | 38.11 | 96.20 |
| Illite | 4.91 | 0.51 | 36.05 | 3.71 |
| Gypsum | 2.14 | 3.68 | 16.02 | 27.40 |
| Hematite | 2.14 | 0.00 | 15.70 | 0.00 |
| Microcline | 1.54 | 1.11 | 11.50 | 8.52 |
| Talc | 1.16 | 0.00 | 8.55 | 0.00 |
| Aspectral | 0.91 | 1.00 | 6.71 | 7.37 |

OK Cancel

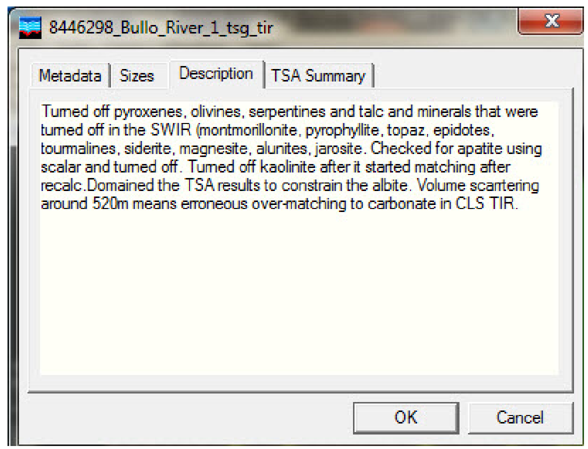


8446298_Bullo_River_1_tsg_tir

Metadata | Sizes | Description | TSA Summary

| | |
|---|---|
| Samples | 91500 total; 83328 (91.06%) after masking; sample=8mm |
| Wavelength | 6000 to 14500 by 25 nm, chans=341 |
| Depth | 250.55 to 969.6 m, span=719.05 (676.64 after masking) |
| Scalars | System=30, core=13, user=48, total=91 |
| Linescan | Lines per sample=124, width=1420, JPEG quality=80 |
| Profilometer | Measurements per sample=128 |
| Disk size (MB) | Sp1:247, Sp2:380, img:1591, prof:45, pic:400, tot:2662.79 |
| Size / m (MB) | Sp1:0.34, Sp2:0.53, img:2.21, prof:0.06, pic:0.56, tot:3.703 |

OK Cancel

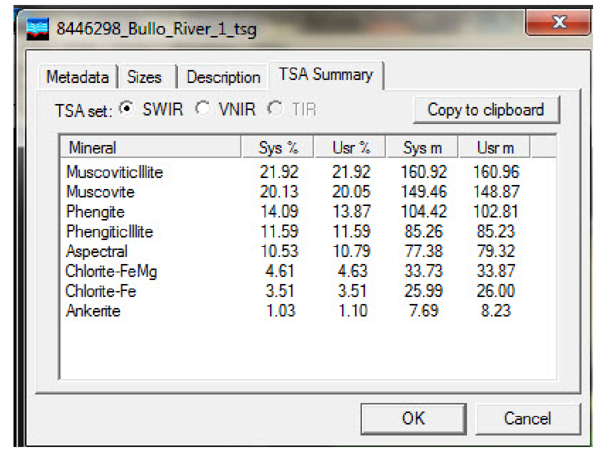


8446298_Bullo_River_1_tsg_tir

Metadata | Sizes | Description | TSA Summary

Turned off pyroxenes, olivines, serpentines and talc and minerals that were turned off in the SWIR (montmorillonite, pyrophyllite, topaz, epidotes, tourmalines, siderite, magnesite, alunites, jarosite. Checked for apatite using scalar and turned off. Turned off kaolinite after it started matching after recalc.Domained the TSA results to constrain the albite. Volume scarntering around 520m means erroneous over-matching to carbonate in CLS TIR.

OK Cancel



8446298_Bullo_River_1_tsg

Metadata | Sizes | Description | TSA Summary

TSA set: SWIR VNIR TIR (SWIR selected) — Copy to clipboard

| Mineral | Sys % | Usr % | Sys m | Usr m |
|---|---|---|---|---|
| MuscoviticIllite | 21.92 | 21.92 | 160.92 | 160.96 |
| Muscovite | 20.13 | 20.05 | 149.46 | 148.87 |
| Phengite | 14.09 | 13.87 | 104.42 | 102.81 |
| PhengiticIllite | 11.59 | 11.59 | 85.26 | 85.23 |
| Aspectral | 10.53 | 10.79 | 77.38 | 79.32 |
| Chlorite-FeMg | 4.61 | 4.63 | 33.73 | 33.87 |
| Chlorite-Fe | 3.51 | 3.51 | 25.99 | 26.00 |
| Ankerite | 1.03 | 1.10 | 7.69 | 8.23 |

OK Cancel

# HyLogger specifications

The TSG dataset originated from HyLogger™3–7. The HyLogger instrument rapidly measures reflectance spectra and also captures continuous high-resolution digital colour imagery of drill cores in their original trays.

HyLogger 3–7 was built by CSIRO (CSERE, North Ryde, NSW) and delivered to NTGS in February 2010 as part of the AuScope National Virtual Core Library (NVCL) project, which was a collaboration between Federal Government's Department of Innovation, Industry Science and Research, CSIRO and state and territory Geological Surveys.

The HyLogger has a continuous motion table that moves at 48 mm/second, three spectrometers (a silicon-detector grating spectrometer for the [380, 1072] nm VNIR interval, an InSB-detector FTIR (Fourier Transform Infrared) spectrometer for the [1072, 2500] nm SWIR interval and a further FTIR spectrometer with a HgCdTe photoconductive detector for the [6000, 14500] nm TIR interval. The spectrometers measure 12 spectra per second, or one spectrum for each 4 mm at the standard table speed of 48 mm/second. The camera is a Basler piA1900-32gc camera, taking 12 frames per second (or one for every 4 mm).

Full details of the HyLogger specifications can be found in: Mason P and Huntington JF, 2012. HyLogger 3 components and pre-processing: an overview. *Northern Territory Geological Survey, Technical Note* 2012-002.

# Glossary

Glossary of acronyms and technical terms commonly used in HyLogging spectroscopy.

| | |
|---|---|
| albedo | Normally applied to the mean broadband brightness of a spectrum over a specified wavelength range. A white or altered sample will commonly have a high albedo, whereas a graphitic rock will have a very low albedo. |
| aspectral | An aspectral response is a spectrum which does not match a TSA library spectrum within the SRSS error cutoff. An aspectral response may be due to many different factors including; dark/noisy spectrum; a mineral not in the TSA library; a silicate mineral without any absorptions in the SWIR (such as olivines, pyroxenes, feldspars, quartz without fluid inclusions). |
| AlOH | Aluminium hydroxide. |
| CLS | Constrained Least Squares – an alternative unmixing classifier that uses a Restricted Mineral Set to minimise non-unique mineral modelling. Used mainly to model TIR spectra, which can have several mixed mineral matches. |
| domain | A zone within a drillhole interpreted to contain a restricted set of minerals that are different to adjacent zones. |
| FTIR | Fourier transform infrared spectrometer. |
| HgCdTe | Mercury Cadmium Telluride used in infrared detectors. |
| HQ | Shorthand for hull quotient (a type of background corrected spectrum). |
| InSb | Indium antimonide – used in infrared detectors. |
| MCT | Mercury Cadmium Telluride used in infrared detectors. |
| MgOH | Magnesium hydroxide. |
| nm | Nanometre, being one billionth of a metre. A HyLogger 3 operates between 380 and 14,500 nm, with no measurements between 2,500 to 6,000 nm. |
| scalar | Any set of imported or calculated values associated with spectral data loaded in TSG. |
| SEM | Scanning Electron Microscopy is a type of electron microscope that images the sample surface by scanning it with a high energy beam of electrons, giving information on sample composition and other properties. SEM results may be used to validate mineral identification by the HyLogger. |
| SNR | Signal-to-noise ratio. |
| SRSS | Standardised residual sum of squares (TSA's measure of mineral identification error). Low SRSS values are more reliable than high ones. The current 'bad' threshold is 1000. |
| SWIR | Shortwave infrared (light). Nominally covering the range 1000–2500 nm. |
| TSA | 'The Spectral Assistant' – CSIRO trademarked algorithm that uses training libraries of pure spectra to match an unknown spectrum to a single mineral or to identify a mixture of two minerals. Part of the TSG software package. |
| TSG | 'The Spectral Geologist' – CSIRO-developed specialist processing software, designed for analysis of field or laboratory spectrometer data. |
| TIR | Thermal infrared (light). Nominally covering the range 6000–14000 nm. |
| VIS | Visible (light). The human eye is nominally sensitive between 390 and 750 nm. |
| VNIR | Visible near infrared (light). Nominally covering the range 380–1000 nm. |
| volume scattering | Radiation that is reflected after some absorption into the rock, which changes the spectral shape and features. TIR spectral interpretation assumes that there is only surface scattering in a spectrum. Volume scattering leads to errors in TSA and CLS modelling. |
| wvl | Abbreviation for wavelength, found in TSG scalar names. |
| XRD | X-Ray Diffraction - an analytical technique that reveals information about the crystallographic structure, physical properties and chemical composition of a sample. It is based on observing the scattered intensity of an X-ray beam hitting a sample and measuring the scattered angle and wavelength or energy. |

# Guide to scalars in figures produced using TSG software

The terms used in the titles, x and y-axis for figures produced from TSG are described in the table below:

| | |
|---|---|
| 2200 wvl 2nd deepest | FeatEx scalar that measures the wavelength of the second deepest absorption feature from 2200nm +/- 50nm. Designed to measure the wavelength of the kandite doublet, which has a variable wavelength depending on whether it is kaolinite or dickite. |
| 2325 CO3 Pfit wvl | PFIT scalar to measure the wavelength of a trough minima between 2290–2370 nm with a depth >0.05; polynomial order 8; hull envelope divided by reflectance reported as wavelength at minimum in nm. Used mainly to analyse carbonate composition changes by observing wavelength changes in the dominant absorption feature for carbonate in the SWIR. |
| Al smectite abundance | Developed by CSIRO in 2011 as multiple feature extraction method (MFEM) batch script, this (unvalidated) scalar maps montmorillonite and beidellite abundance by measuring the continuum removed depth of a fitted 4th order polynomial between 2120 and 2245 nm. |
| Apatite 9200 pfit d | PFIT scalar created by J.Huntington to confirm the TSA apatite response. Measures the wavelength of the minimum trough between 9192 nm and 9270 nm with a depth of >0.0006; polynomial order 6; hull envelope subtract base reflectance to give a relative depth. |
| Aux | Aux in a plot indicates the parameter that is colouring the points (bars in bar plot, points in scatter plot) in a figure. Eg; Aux: stratigraphy indicates that the colours relate to stratigraphy. The key to the Aux colours are on the right side of each plot. |
| Aux match scalar | Aux matching involves simple curve matching between spectra in a main dataset and spectra in a Aux (Auxiliary or Custom) dataset. The Aux dataset is usually a custom library containing special hand-chosen spectra which have been interpreted in detail. |
| Carbonate 6500nm wvl | Experimental batch scalar created by CSIRO derived from the reflectance of the 6500 nm wavelength peak. Used to determine differences in the wavelength of the peak around 6500 nm, which shifts with different carbonate compositions. |
| Carbonate 11300nm wvl | PFIT scalar to measure the wavelength of the peak maxima between 11000–11580 nm with a height of >0.04; polynomial order 9; hull envelope subtract base reflectance to give wavelength at maximum. |
| Christiansen Minimum | Experimental batch scalar created by CSIRO which plots the Christiansen Minimum wavelength. The Christiansen Minimum occurs when the refractive index of the sample approaches the refractive index of the (medium) air surrounding the mineral grains, resulting in minimal scattering and minimal reflectance (Conel, 1969). The Christiansen Minimum wavelength varies according to composition, so measuring the Christiansen Minimum wavelength can differentiate igneous rock compositions in the TIR. |
| Colour tot_sat | TSG standard scalar; it calculates the colour (separately per band) from the linescan raster and it is enhanced by a ‘total saturation’ (the S band is ‘wired to 1’; no pastels’). Refer to TSG Help Manual for more explanation. |
| Count | The feature frequency plots are bar plots with y-axis = count. The count is cumulative number of features within a bin. The bin size will vary according to the x-axis, which might be depth, wavelength in nanometres etc. |
| FEATEX scalar | “FEATEX” scalars uses a Feature Extraction algorithm in TSG to calculate the depth, width and/or wavelength position of a spectrum’s absorption features. The FEATEX scalar uses pre-calculated feature extraction information using TSG’s default algorithm. |
| Felsic-Mafic Index Wvl | Experimental batch scalar created by CSIRO which maps the peak wavelength between 7500 and 12000 nm from a 4th order polynomial. Shorter wavelengths are more felsic than longer mafic ones. Most carbonate-bearing samples are excluded. |
| FeOH pfit DEPTH | PFIT scalar to measure the depth of a trough minima between 2240–2270 nm with a depth >0.04; polynomial order 10; hull envelope divided by reflectance reported as relative depth. |
| FeOH pfit wvl | PFIT scalar to measure the wavelength of a trough minima between 2245–2260 nm with a depth >0.04; polynomial order 10; hull envelope divided by reflectance reported as wavelength at minimum in nm. Used mainly to analyse chlorite composition changes. |
| FeOx Intensity (alt) | TSG standard scalar (batch scalar) which ratios the reflectance at 742 nm / reflectance at 500 nm to give the Fe slope. |
| Grp 1 Min | Group (coarse level) index of the primary mineral group component in a TSA result. Mineral groups include carbonates, white micas, pyroxenes etc. Grp2 Min would be the secondary/minor mineral group component in a mineral mix. |

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| Hydrocarbon Presence | A PFIT scalar designed to measure the presence of an absorption feature at 1730nm which is often found associated with oil bleeds. Another scalar designed to identify hydrocarbons is the 23140nm PFIT scalar. Using both scalars together can identify oil bleeds when the spectral response is preserved (it can deteriorate over time). |
| Kaolin composition | A CSIRO-built batch scalar in TSG that measures the composition and crystallinity of kaolin group minerals ranging from well-ordered kaolinite to halloysite to dickite (and nacrite) using the algorithm [(R2138+R2173)/(R2156) [(R2156+R2190)/R2173]] KC. |
| Kaolinite pfit 2160 doublet d | A PFIT scalar measuring the relative depth of the kandite doublet absorption feature, as an analogue for crystallinity / abundance of kaolinite. Used to confirm that TSAS-assigned well-crystalline and poorly-crystalline kaolinite are present. PFIT used hull envelope divided by reflectance; focussed on 2155 – 2180nm to determine the relative depth usinga >0.01 cutoff, polynomial order 3, masked through Final Mask. |
| Mask (Final Mask) | Mask scalars are used to filter out unwanted spectra caused by scanning tray edges, core blocks etc. TSG uses the Final Mask as the default mask for both SWIR and TIR datasets and will synchronise the mask for both datasets. Many in-built TSG scalars are calculated after being filtered through the Final Mask. |
| Min 1 | Mineral index of the primary mineral for a TSA singleton match or primary mixture component. Min 2 is the subordinate/minor mineral in a TSA mineral mix. |
| PFIT scalar | “PFIT” scalars take a section of the spectrum specified by the user, optionally does a local continuum removal, fits a polynomial and calculates a result directly from the polynomial’s coefficients. PFIT scalars are used to define the wavelength of noted spectral features. |
| Quartz 8625 PFIT d abundance | Experimental PFIT scalar to measure the ‘abundance’ of quartz in a sample by measuring the depth of reflectance minima at 8625 nm, which is characteristic of the presence of quartz. Scalar measure returns relative depth in nm, by subtracting the low side of the minima from normalised TC reflectance using a depth >0.02 between 8580–8700 nm. |
| Quartz 8625 PFIT d MAV | Smooths the 8625 PFIT d abundance scalar (above) by smoothing using the mean through a moving window. The output smooths out the effect of outliers to display gross changes in the quartz abundance in plots. |
| Quartz Absorption Depth | Experimental batch scalar created by CSIRO designed to measure the depth of the characteristic quartz reflectance feature at 8625 nm. Similar to the Quartz 8625 PFIT d abundance scalar, but can be more effective in masking out spurious matches to some sulphates which formed from the core decomposition after drilling (refer Sever No.1 drillhole). |
| Quartz_H2O | An inbuilt batch scalar found in HotCore. Described as ‘normalised ratio that maps samples with appreciable (1950 nm) water absorption in fluid inclusions, found mostly in quartz (and some carbonates)’. |
| Scope | The Scope option allows users to filter their data to visualise the behaviour of selected classes (eg; stratigraphy, mineral groups) and samples in different XY plots. The Scope indicates how many samples out of the total samples in the dataset are currently displayed in this plot window. |
| Smooth (Albedo) | TSG standard scalar (batch scalar) which first calculates the reflectance albedo over 450–2450 nm with basic channel outlier masking, then averages the numeric response (smooths) of the albedo. May be called Albedo Rmean Smooth or Smoothed Albedo. |
| Smoothed scalar | Created by ‘smooth an existing scalar using a moving window’. Generally uses averaging of the numeric response to create a smoothed scalar. |
| sTSAS, uTSAS | Mineral result from matching to the Short Wave Infra Red (SWIR) spectra against the TSA library. ‘sTSAS’ is the default system match. ‘uTSAS’ is the author-derived result from manually excluding some minerals and artefacts (eg; wooden core blocks, plastic chip tray spectra) during processing. |
| sTSAV, uTSAT | Mineral results from matching to the Thermal Infra Red (TIR) spectra against the TSA library. ‘sTSAT’ is the default system match. ‘uTSAT’ is the author-derived result from manually excluding some minerals and artefacts during processing. |

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| sTSAV, uTSAV | Mineral result from matching to the Visible Near Infra Red (VNIR) spectra against the TSA library. 'sTSAV' is the default system match. 'uTSAV' is the author-derived result from manually excluding some minerals and artefacts (eg; galvanised tray spectral matches) during processing. |
| TIR-CLS1_CLS_min_1 | Combined Least Squares (CLS) Scalar showing the dominant modelled mineral (using the CLS unmixing algorithm) from the TIR wavelength range. For this scalar, the number of minerals allowed in the CLS mineral output is 3 (shows the 3 most dominant) although the scalar can allow for up to 6 minerals. The minerals available for modelling in the domain (Restricted Mineral Set or RMS) is selected during the interpretation / processing stage. |
| TIRDeltaTemp | An inbuilt TSG scalar that measures the change in temperature between the instrument response measured from the rock and the background response. Plotting this scalar can highlight sulphides or arterfacts (such as metal tray edges, metal depth marker tabs or instrument issues). |
| uTSA* | The result from TSA (The Spectral Assistant, which is the algorithm used for unmixing and classifying spectral responses relative to the included TSG reference library of minerals). The prefix 'u' is for 'user' and refers to the fact that TSA is trained on a reference library of minerals that have been limited by the author from the system set of minerals called sTSA* during the processing of the dataset. The minerals that are excluded from being matched to the TSA library are those which are considered to be unlikely in that geological environment and do not visually match the spectra well. |
| uTSAT Invalid | A scalar created to mask out both Final Mask and 'aspectral', 'noisy' or 'null' for uTSAT Min 1 minerals. Plots which use uTSAT plot only spectra which were successfully matched in the TSA library, so noisy spectra (which may be noisy due to rubbly core, volume scattering etc) don't detract from displaying the dominant mineral or mineral group in the TIR. If a hole has a lot of 'invalid' spectra due to rubbly core, it may over-emphasise minor minerals in the TIR which are perhaps within unbroken core and may not reflect accurate mineral proportions. |
| White mica Pfit wvl | PFIT scalar to measure the wavelength of a trough minima between 2190–2229 nm with a depth >0.04; polynomial order 10; hull envelope divided by reflectance reported as wavelength at minimum in nm. Used mainly to analyse white mica composition changes by observing wavelength changes in the dominant absorption feature for white mica in the SWIR. |
| White mica Pfit d | PFIT scalar to measure the depth of a trough minima between 2190–2229 nm with a depth >0.12; polynomial order 10; hull envelope divided by reflectance reported as relative depth. |

# Excerpt from Huntington & Mason 2010

## 1.1 Basic HyLogging Product Levels

0. **Machine Data** package (QCed & archived by collecting team / agency: i.e. all repeats taken care of and data checked).
1. **TSG Data** package - TSG imported and formatted data (see note about TSG-QC outputs)
   - 1A. TSG imported imagery, spectra and supporting data (nothing else done). Raw system TSA run on import but no checking. Depths only based on tray starts & ends.
   - 1B. Final masked, basic depth-logged data, imagery enhanced, new tray imagery & mosaics created.. Further updates possible.
   - 1C. All standard "system" scalars (includes basic masked and reviewed TSA mineralogy) created & checked.
   - 1D. User TSA results included (i.e. retrained TSA) and all Scatter screens changed to uTSAS. Minimum database entry point.
   - 1E. Non-standard mineralogical (manually-generated) "user" scalars added, thresholded and checked. Might include an Aux match library or stats (PC) analysis.
   - 1F. All metadata tables updated. Optimum database loadable level. Further updates possible.
2. **Integrated Data** package - Imported numeric or class scalars added into TSG and depths adjusted if required to fit assay intervals.
3. **Published Data** package - Signed-off for public (NVCL) database publication. Default set of products (for web discovery) identified and tagged.
4. **Down-sampled Data** package - Optional down-sampled version of all of above.
5. **Project data** package. Abstracted data from many holes integrated in some way.

From 'Whats New in TSG-Core™ Version 7 and HyLogger-2 Implications' (CSIRO, unpubl). The HyLogger Product level refers to the level of processing of a dataset. This dataset is at 'Level 3' as it has imported stratigraphic information.