NTGS HyLogger Data Package 0008

HyLogger drillhole report for MacIntyre 1, Georgina Basin, Northern Territory.

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HyLogger drillhole report for MacIntyre 1, Georgina Basin, Northern Territory.


Keywords: HyLogger, Georgina Basin, Northern Territory, boreholes, mineralogy, reflectance, cores, spectra, spectroscopy

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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.
Summary of information from PR1990-0018

- Originally referred to as MacIntyre No.1; truncated to MacIntyre1 for database purposes.
- Drilled as a petroleum well by Pacific Oil and Gas.
- Drilled to test a closed structure defined by the 1988 Bundey River seismic survey.
- MacIntyre 1 also drilled to test the thickness, quality and maturation level of source rocks and presence of any reservoir facies horizons within the Arthur Creek Formation.
- Well stopped 40 m short of proposed 1000 m depth due to the lack of any hydrocarbon indications.
- Original Pacific Oil and Gas stratigraphic log showed an unlikely lower contact for Arthur Creek Formation (based on mineralogy). The log also identified the Elkera Formation, Grant Bluff Formation and Elyuah Formation as underlying the Arthur Creek Formation. Re-logging by NTGS in 2007 aligned the Arthur Creek Formation basal contact to a more likely location and re-logged the lower part of the hole as Thorntonia Limestone overlying Neoproterozoic sediments (replacing Elkera, Grant Bluff and Elyuah Formations).
MacIntyre 1: Mineral summary – all minerals, TSA and CLS

From Summary Screen: top row shows (processed) SWIR mineralogy (‘uTSAS’), middle and bottom rows show TIR mineralogy calculated using the TSA (‘uTSAT’) and domained CLS (‘dCLS – TIR’) algorithms respectively. Dotted lines show mineralogy changes: at 802 m there is a change from SWIR aspectral to dolomite, with increasing quartz / white mica going downhole. There is another change around 895 m with a marked decrease in carbonates and sharp increase in white micas and quartz, reflecting a change in depositional environment.
Row 1 shows logged stratigraphy. Row 2 shows SWIR mineralogy (Min1), which is a mineral mix, but carbonates (mainly dolomite) are most common throughout the hole. Row 3 shows TIR mineralogy, which is mainly quartz (pale pink) for Neoproterozoic sediments at base of hole, and a mix of carbonates and quartz for the Arthur Creek Fm and Chabalowe Fm. Row 4 is the core colour. Dotted lines indicate changes in either mineralogy and/or core colour. The most notable change in both core colour and mineralogy is at the base of the Arthur Creek Formation contact with the Thorntonia Limestone (around 802 m). Within the Thorntonia Limestone is a facies change from dominantly dolomite to less dolomite with some minor quartz/white mica at the base. The top of the Neoproterozoic has reddish sediments (redox boundary?) and a sharp change to dominantly quartz and white micas.
Row 1 shows logged stratigraphy. Row 2 shows SWIR (Min1) plotted by (smoothed) albedo. There are zones within the Arthur Creek Fm that show decreasing albedo with depth that correlate with increases in more carbonaceous silty layers. Row 3 shows FeOx intensity coloured by core colour; this highlights a zone which isn’t hematite or goethite in the TSA VNIR library (row 4) but has a strong FeOx response. Imagery inset shows the reddish ‘Fe Oxide’ core giving this response.
MacIntyre 1: TIR mineral summary

Row 1 is logged stratigraphy. Row 2 is TIR (Mineral 1). Row 3 is quartz ‘abundance’. Row 4 is the TIR Mineral 1 where white mica is dominant. Dominant TIR mineralogy is quartz and carbonates (carbonates examined in more detail on page 11). Dotted lines show the most notable mineralogy changes; one is around 802 m (contact between Arthur Creek Formation and Thorntonia Limestone). Quartz abundance (measured by the depth of the quartz-characteristic 8625 nm feature) is distinctly higher in the Neoproterozoic sediments compared with the rest of the drillhole, which has significant carbonate content.
Row 1 is logged stratigraphy. Row 2 is TIR sulphate coloured by SWIR mineral colour. Rows 3 and 4 are the results of matching 2 different anhydrite spectra from the Johns Hopkins University TIR spectral library to the spectra in Macintyre1, coloured by the dominant TIR mineral. As the current TIR library does not have anhydrite, the algorithm tends to match to the nearest fit TIR gypsum (khaki colour) but if this was gypsum, it would also match to SWIR gypsum. Row 2 shows that the TIR sulphate matches are mainly to carbonate in the SWIR (blue colour, row 2). Dotted boxes show zones which matched to TIR gypsum (in error), as well as a strong match to both JHU anhydrite library spectra (inset shows anhydrite spectrum). The Chabalowe Fm has appreciable anhydrite, with some sporadic anhydrite in the rest of the hole. Petrography in PR1990-0018 also noted anhydrite.
Row 1 is logged stratigraphy. Rows 2 and 3 are matches to apatite, where apatite is the dominant mineral (row 2 is from TSAT; row 3 is from CLS algorithms respectively). Row 4 is using a scalar to filter out spectra with reflectance features diagnostic of apatite. Rows 5 and 6 show apatite matches for both Min 1 as well as present as a minor mineral (Min 2 or Min 3). Row 5 is from the TSA, while row 6 is from CLS. Dotted boxes show intervals which have apatite for all rows. This is to illustrate that apatite is present, but that there are some false matches in rows 2 and 3. An example of a false match would be around 789 m; in row 3 it returns a match to apatite but does not show as apatite elsewhere. Examining the spectrum shows that it is a noisy spectral response. Row 6 shows that using the CLS algorithm is likely to ‘over-match’ spectra as having apatite present. It is recommended to use a scalar (row 4) in conjunction with the TSA / CLS algorithms to determine presence of minor minerals such as apatite.
The carbonates in MacIntyre1 show some consistent composition changes (using 3 different wavelength ranges which have diagnostic features indicating carbonate composition). Row 2 shows wavelength changes in the SWIR, while rows 3 and 4 show changes in wavelengths within the TIR. Dotted lines highlight changes in composition (from changes in wavelength). Plots are coloured by either the dominant TIR mineral (uTSAT) or SWIR (uTSAS). There are at least 4 different carbonate zones within the Arthur Creek Formation; commonly alternating between dolomite-rich (maroon) and calcite-rich (light green). There is a sharp change between the calcites of the Arthur Creek Formation and the underlying Thorntonia Limestone (which is dolomitic).
Row 1 is logged stratigraphy. Row 2 is SWIR white micas (Min1 = white mica) plotted by the AlOH wavelength and coloured by the white mica mineral. Row 3 is the TIR white micas (Min1 = white mica) coloured by the SWIR mineral. In the SWIR, white micas are recorded in the Chabalowe Formation and from the basal part of the Thorntonia Limestone to the end of hole (Neoproterozoic sediments). The white micas from the lower Thorntonia Limestone to EOH are dominantly phengitic, with a wavelength clustered around 2214 nm. The sparse white micas in the Chabalowe Formation are dominantly muscovitic, clustering around 2208nm (ie a different white mica population). In the TIR, there is a group of white micas around ~770 – 802 m, which is within the carbonaceous sediments in the Arthur Creek Group (these show as ‘aspectral’ in the SWIR). These may or may not be white micas and would need checking by another method (eg XRD) to validate this response.
Zones returning an aspectral response in the SWIR can be quite different spectrally. In MacIntyre1 the aspectral response is plotted by core colour (row 2) and by the TIR mineral (row 3). Dotted squares show differences in the aspectral response. The dark sediments of the Arthur Creek Formation (which has a low albedo and noisy SWIR response) has a darker core colour, with some noise in the TIR (grey colour, row 3). The middle part of the Thorntonia Limestone plots as carbonates in the TIR, but it is quite noisy which may be partly due to the effects of volume scattering from a fine-grained sediment. The FeOx sediment around 880 – 885 m (discussed on page 7) has a 'quenched' (no absorption features) SWIR response. Other aspectral zones in the Chabalowe Formation and Arthur Creek Formation may be from being quartz-rich sediments (quartz has only indirect spectral response in the SWIR) so this may be highlighting sandier intervals.
MacIntyre 1: Summary of HyLogger data interpretation

- Most notable mineral boundary is the contact between the carbonaceous sediment in the lower Arthur Creek Formation and dolomitic Thorntonia Limestone (see image below).
- MacIntyre1 is dominantly carbonate-rich, with sharp changes in carbonate composition between dolomite and calcite (which may be a mixed carbonate in some locations).
- There are 2 different stratigraphic logs for this hole (in PR1990-0018 and DIP007). The stratigraphic log from DIP007 is used here. It appears to show the lower Arthur Creek Formation boundary in the ‘correct’ location and also shows the Thorntonia Limestone as underlying the Arthur Creek Formation. However, the basal Thorntonia Limestone is markedly different to the dolomitic upper part of the Thorntonia Limestone. There is no distinct mineralogy change at the logged contact between the basal Thorntonia Limestone and the top of the Neoproterozoic sediments. This contact should be re-examined. The Pacific Oil & Gas logs show the mineralogy changes being the boundaries of the Elkera Formation and Grants Bluff Formation respectively (no Thorntonia Limestone logged by Pacific). However, the Pacific Oil & Gas logs did not show the basal Arthur Creek Formation contact at 802 m, but much lower down in the drillhole (849.5 m). This hole should be re-examined for stratigraphic correlations.
- There is a distinctive reddish FeOx sediment at the top of the Neoproterozoic sediments. This is quite different to any other interval within MacIntyre1 and may reflect a redox boundary.
- The Arthur Creek Formation is mineralogically variable. Changes in mineralogy and albedo may reflect sedimentary cycles.

Sharp change of lithology from the Arthur Creek Formation (on left; to 802.6 m) to the underlying Thorntonia Limestone (on right).
MacIntyre 1: TSG metadata

Metadata | Size | Description | TSA Summary
--- | --- | --- | ---

Selected with same minerals to switch off as in SWIR (refer Description in SWIR file) and turned off omegas and alines as unlikely in this geological environment. Checked for TSA and turned off red, blue. After doing CLS and domaining, checked and turned off hematite, plagioclase, prehnite, epidote. Arfvedsonite is over-represented; at least a mixed carbonate of longer wavelength (e. not dolomite). Volume scattering in carbonates also affects carbonate mineral matches.

Metadata | Size | Description | TSA Summary
--- | --- | --- | ---

Checked minerals and turned off kaolin group minerals, montmorillonite, diaspore, gibbsite, tosz. Fe oxihosphate, hornblende, actinolite, saponite, talc, zoisite, tremolite, tremolite Fe, adobe, magnesite. Checking min 2 showed good grouping of FeMg chlorite and Mg chlorite so left on for now, just that Min 1 chlorite appears incorrect. Turned off saponite, prehnite, montmorillonite, biotite. Checked actinolite. Turned off talc, silicate (K, Na and Al), paragonite after checking Min 2. After recalc, turned off polygonal, pyrophyllite, paragonite, talc. Checked epidote using 155nm scaling (since removed with no matches so turned off epidote). Carbonate wi specification influenced by mixing with AOM minerals (incl. w-mica), so probably only calcite & dolomite (i.e. anfibole & adobe not) TSA w-mica in carbonate zones is over-estimated.

Metadata | Size | Description | TSA Summary
--- | --- | --- | ---

Samples | 56250 total: 58314 (88.44%) after masking; sample=3mm
--- | --- | --- | ---

Wavelength | 6000 to 14500 by 25mm, channel=341
--- | --- | --- | ---

Depth | 549 to 960.65, span=411.64 (411.32 after masking)
--- | --- | --- | ---

Scales | System=30, core=13, user=35, total=78
--- | --- | --- | ---

Lineset | Lines per sample=124, width=1330, JPEG quality=80
--- | --- | --- | ---

Projected | Measurements per sample=128
--- | --- | --- | ---

--- | --- | --- | ---

Size / m (MB) | Sp1:0.57, Sp2:0.57, img:2.32, prof:0.07, pic:0.49, tot:3.807
--- | --- | --- | ---
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).

## Glossary

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

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Albedo</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>AlOH</strong></td>
<td>Aluminium hydroxide.</td>
</tr>
<tr>
<td><strong>FTIR</strong></td>
<td>Fourier transform infrared spectrometer.</td>
</tr>
<tr>
<td><strong>HgCdTe</strong></td>
<td>Mercury Cadmium Telluride used in infrared detectors.</td>
</tr>
<tr>
<td><strong>HQ</strong></td>
<td>Shorthand for hull quotient (a type of background corrected spectrum).</td>
</tr>
<tr>
<td><strong>InSb</strong></td>
<td>Indium antimonide – used in infrared detectors.</td>
</tr>
<tr>
<td><strong>MCT</strong></td>
<td>Mercury Cadmium Telluride used in infrared detectors.</td>
</tr>
<tr>
<td><strong>MgOH</strong></td>
<td>Magnesium hydroxide.</td>
</tr>
<tr>
<td><strong>nm</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Scalar</strong></td>
<td>Any set of imported or calculated values associated with spectral data loaded in TSG.</td>
</tr>
<tr>
<td><strong>SEM</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>SNR</strong></td>
<td>Signal-to-noise ratio.</td>
</tr>
<tr>
<td><strong>SRSS</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>SWIR</strong></td>
<td>Shortwave infrared (light). Nominally covering the range 1000–2500 nm.</td>
</tr>
<tr>
<td><strong>TSA</strong></td>
<td>‘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.</td>
</tr>
<tr>
<td><strong>TSG</strong></td>
<td>‘The Spectral Geologist’ – CSIRO-developed specialist processing software, designed for analysis of field or laboratory spectrometer data.</td>
</tr>
<tr>
<td><strong>TIR</strong></td>
<td>Thermal infrared (light). Nominally covering the range 6000–14000 nm.</td>
</tr>
<tr>
<td><strong>VIS</strong></td>
<td>Visible (light). The human eye is nominally sensitive between 390 and 750 nm.</td>
</tr>
<tr>
<td><strong>VNIR</strong></td>
<td>Visible near infrared (light). Nominally covering the range 380–1000 nm.</td>
</tr>
<tr>
<td><strong>wvl</strong></td>
<td>Abbreviation for wavelength, found in TSG scalar names.</td>
</tr>
<tr>
<td><strong>XRD</strong></td>
<td>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.</td>
</tr>
</tbody>
</table>
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:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2200 wvl 2nd deepest</td>
<td>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.</td>
</tr>
<tr>
<td>2325 CO3 Pfit wvl</td>
<td>PFIT scalar to measure the wavelength of a trough minima between 2290–2370 nm with a depth &gt;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.</td>
</tr>
<tr>
<td>Apatite 9200 pfit d</td>
<td>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 &gt;0.0006; polynomial order 6; hull envelope subtract base reflectance to give a relative depth.</td>
</tr>
<tr>
<td>Aux</td>
<td>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.</td>
</tr>
<tr>
<td>Aux match scalar</td>
<td>Aux matching involves simple curve matching between spectra in a main dataset and spectra in an Aux (Auxiliary or Custom) dataset. The Aux dataset is usually a custom library containing special hand-chosen spectra which have been interpreted in detail.</td>
</tr>
<tr>
<td>Carbonate 6500nm wvl</td>
<td>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.</td>
</tr>
<tr>
<td>Carbonate 11300nm wvl</td>
<td>PFIT scalar to measure the wavelength of the peak maxima between 11000–11580 nm with a height of &gt;0.04; polynomial order 9; hull envelope subtract base reflectance to give wavelength at maximum.</td>
</tr>
<tr>
<td>Christiansen Minimum</td>
<td>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.</td>
</tr>
<tr>
<td>Colour tot_sat</td>
<td>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.</td>
</tr>
<tr>
<td>Count</td>
<td>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.</td>
</tr>
<tr>
<td>FEATEX scalar</td>
<td>“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.</td>
</tr>
<tr>
<td>Felsic-Mafic Index Wvl</td>
<td>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.</td>
</tr>
<tr>
<td>FeOH pfit DEPTH</td>
<td>PFIT scalar to measure the depth of a trough minima between 2240–2270 nm with a depth &gt;0.04; polynomial order 10; hull envelope divided by reflectance reported as relative depth.</td>
</tr>
<tr>
<td>FeOH pfit wvl</td>
<td>PFIT scalar to measure the wavelength of a trough minima between 2245–2260 nm with a depth &gt;0.04; polynomial order 10; hull envelope divided by reflectance reported as wavelength at minimum in nm. Used mainly to analyse chlorite composition changes.</td>
</tr>
<tr>
<td>FeOx Intensity (alt)</td>
<td>TSG standard scalar (batch scalar) which ratios the reflectance at 742 nm / reflectance at 500 nm to give the Fe slope.</td>
</tr>
<tr>
<td>Grp 1 Min</td>
<td>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.</td>
</tr>
<tr>
<td>Hydrocarbon Presence</td>
<td>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).</td>
</tr>
</tbody>
</table>
Guide to scalars in figures produced using TSG software

<table>
<thead>
<tr>
<th>Scalar Type</th>
<th>Definition and Usage</th>
</tr>
</thead>
</table>
| 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 \[
\frac{(R_{2138}+R_{2173})}{(R_{2156})} \quad \frac{(R_{2156}+R_{2190})}{R_{2173}} \] KC. |
<p>| Kaolinite pfit 2160 doublet d | A PFIIT 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. PFIIT used hull envelope divided by reflectance; focussed on 2155 – 2180nm to determine the relative depth using a &gt;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 &gt;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. |
| 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, uTSAV | Mineral results from matching to the Thermal Infra Red (TIR) spectra against the TSA library. ‘sTSAV’ is the default system match. ‘uTSAV’ is the author-derived result from manually excluding some minerals and artefacts during processing. |
| 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. |</p>
<table>
<thead>
<tr>
<th>Scalar</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIR-CLS1_CLS_min_1</td>
<td>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.</td>
</tr>
<tr>
<td>uTSA*</td>
<td>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.</td>
</tr>
<tr>
<td>uTSAT Invalid</td>
<td>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.</td>
</tr>
<tr>
<td>White mica Pfit wvl</td>
<td>PFIT scalar to measure the wavelength of a trough minima between 2190–2229 nm with a depth &gt;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.</td>
</tr>
<tr>
<td>White mica Pfit d</td>
<td>PFIT scalar to measure the depth of a trough minima between 2190 - 2229 nm with a depth &gt;0.12; polynomial order 10; hull envelope divided by reflectance reported as relative depth.</td>
</tr>
</tbody>
</table>
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.