HyLogger Data Package 0057

HyLogger drillhole report for MBXDD002, Matchbox Project McArthur Basin, Northern Territory.

Belinda Smith
BR Smith
HyLogger drillhole report for MBXDD002, Matchbox Project, McArthur Basin, Northern Territory.


Keywords: HyLogger, McArthur Basin, Northern Territory, boreholes, mineralogy, reflectance, cores, spectra, spectroscopy, Emmerugga Dolostone, Mara Dolostone Member, Myrtle Shale, Leila Sandstone

Northern Territory Geological Survey
3rd floor Paspalis Centrepoint Building Arid Zone Research Institute
Smith Street Mall, Darwin South Stuart Highway, Alice Springs
GPO Box 4550 PO Box 8760
Darwin NT 0801, Australia Alice Springs NT 0871, Australia

For further information contact:
Minerals and Energy InfoCentre
Phone: +61 8 8999 6443
Website: http://www.minerals.nt.gov.au/ntgs
Email: geoscience.info@nt.gov.au

© Northern Territory Government, January 2016

NTGS Disclaimer: While all care is taken to ensure that information contained is true and correct at this time, changes in circumstances may impact on the accuracy of its information. The Northern Territory of Australia gives no warranty or assurance, and makes no representation as to the accuracy of any information or advice in these results. You should not rely upon information in this publication for any purpose of making any serious business or investment decisions without obtaining independent and/or professional advice in relation to your particular situation. The Northern Territory disclaims any liability or responsibility or duty of care for any loss or damage caused by any use of, or reliance on the information in this publication. Logged stratigraphy is summarised from company reports and NTGS has not checked the validity of these observations.
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 7.1.0.066 dated August 2015.

Please note: the results in this report are an interpretation from the spectral response.
MBXDD002: Introduction

<table>
<thead>
<tr>
<th>Hole ID</th>
<th>MBXDD002</th>
<th>Unique identifier</th>
<th>8445469</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geological terrane</td>
<td>McArthur Basin</td>
<td>Total depth</td>
<td>294.6 m</td>
</tr>
<tr>
<td>Latitude GDA94</td>
<td>-16.85318°</td>
<td>Longitude GDA94</td>
<td>135.79152°</td>
</tr>
<tr>
<td>Easting MGA94</td>
<td>584 320 (Zone 53)</td>
<td>Northing MGA94</td>
<td>8136 587 (Zone 53)</td>
</tr>
<tr>
<td>Dip</td>
<td>-65°</td>
<td>Azimuth</td>
<td>344.8°</td>
</tr>
<tr>
<td>Logged by</td>
<td>MMG Australia Ltd</td>
<td>Logged report ref</td>
<td>McGilvray et al (2014)</td>
</tr>
<tr>
<td>Start core depth</td>
<td>0 m</td>
<td>End core depth</td>
<td>294.6 m</td>
</tr>
<tr>
<td>Date HyLogged</td>
<td>October 2013</td>
<td>HyLogged by</td>
<td>Darren Bowbridge</td>
</tr>
<tr>
<td>Date of HyLogger report</td>
<td>January 2016</td>
<td>HyLogger report author</td>
<td>Belinda Smith</td>
</tr>
<tr>
<td>TSG version and build</td>
<td>HotCore Build 66 (Aug 2015)</td>
<td>TSG product level</td>
<td>3 (Huntington, 2010)</td>
</tr>
</tbody>
</table>

Summary of information from McGilvray et al (2014)

- Drilled under the Geophysics and Drilling Collaborations programme (Round 6: 2013/14).
- MMG are exploring for sediment-hosted base metal mineralisation in the Batten Trough area. MBXDD002 targets an intersection between a NW-trending splay of the Abner Fault and a small mapped syncline.
- MBXDD002 is interpreted to intersect the Mara Dolostone Member (of the Emmerugga Dolostone), Myrtle Shale and the Leila Sandstone (EOH).
- Only minor pyrite was noted mainly as fracture coatings in shales and siltstones. Fault-affected Leila Sandstone has minor chalcopyrite blebs.
- Maximum assay values of 1050 ppm Cu (209–210 m), 29 ppm Zn (154–155 m) and 18ppm Pb (126–127 m).
- MBXDD002 failed to intersect Barney Creek Formation but did intersect Myrtle Shale. No significant mineralisation was found. The interpreted stratigraphy in MBXDD002 is not easily reconciled with NTGS mapping. MMG note that MBXDD002 will be useful in re-interpreting the local geology.
From Summary Screen: Row 1 shows SWIR mineral summary. Rows 2 and 3 show TIR mineral summary. Row 2 is the TIR mineral summary using the TSA algorithm. Row 3 is the TIR mineral summary using the CLS algorithm. The CLS mineral matches are after domaining the hole into zones of similar mineralogy and using a restricted mineral set. Dotted lines show mineral zones. The main change is at 235 m where the mineralogy is more uniformly carbonate-rich. The CLS results show more chlorite through the upper part of the hole that is not reflected in either the SWIR or TIR TSA results. Any interpretation of chlorite in the upper part of the hole should be validated with another technique (XRD or petrography).
Row 1 shows the logged stratigraphic sequence. 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 some mineralogy changes. The contact between the Myrtle Shale and Leila Sandstone is characterised by an increase in quartz (in the Leila Sandstone) and a colour change (row 4). There is no discernible change in the SWIR as the mineralogy change is gradational at this logged contact. The contact between the Myrtle Shale and the overlying Mara Dolostone Member is not mineralogically discernible from the dominant mineral matches or core colour. Ahmad et al (2013) describe this contact as conformable. The overlying Tertiary sediments appear more carbonate-rich than the underlying Mara Dolostone Member.
Row 1 is the logged stratigraphic sequence. Row 2 is the dominant mineral in the SWIR (mainly dolomite; blue colour). 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 some of the albedo changes that are cyclic between carbonate-rich (logged as bichoerm stromatolitic dolomitic sandstones) and white mica-rich lithologies (logged as green/grey siltstones). Ahmad et al (2013) describe the Mara Dolostone Member as ‘silicified stromatolitic units alternating with silty or non-stromatolitic units’ and these units can be noted by the change in SWIR mineralogy and albedo. Many of the goethite peaks in row 3 reflect FeOx on fractures (see inset image, near row 3) that are common in the Mara Dolostone Member.
Row 1 is the logged stratigraphic succession. Row 2 is the dominant mineral in the TIR (using TSA). Row 3 shows the TIR spectra that match dominantly to quartz, plotted against the (smoothed) depth of the characteristic quartz reflectance feature in the TIR (depth of the feature is analogous to abundance). Abundant quartz is indicated at 64.5, 93.5, 177.2, 218.6, 230.7 and 281m. The quartz distribution in row 3 appears ‘spotty’ as there are quartz zones alternating with carbonates and white micas for much of the hole. Row 4 shows the TIR spectra that match dominantly to feldspars. These are almost entirely absent in the Leila Sandstone and overlying Tertiary sediments.
Row 1 shows the logged stratigraphic succession. Row 2 plots the SWIR spectra that match dominantly to carbonate, plotted by the wavelength of the characteristic carbonate reflectance feature in the SWIR (wavelength changes indicate carbonate composition changes). The data points are coloured by the depth of the carbonate feature, which indicates abundance of carbonate. The Leila Sandstone shows the strongest carbonate response (from 236 m, see dotted line), which is also tightly clustered around 2323 nm (dolomite). A strong response around 118 m (red dots) is from an open calcite-lined fracture. Rows 3 and 4 plot the TIR spectra that match dominantly to carbonate, plotted by the wavelength of characteristic features around 6500 nm (row 3) and 11300 nm (row 4). Row 3 is coloured by the dominant SWIR mineral and row 4 is coloured by the depth (strength) of the 11300 nm feature. These results generally correlate with those found in the SWIR with Leila Sandstone showing a consistent strong response, and Mara Dolostone Member and Myrtle Shale showing cyclic zones.
Row 1 shows the logged stratigraphic succession. Row 2 shows the distribution of SWIR spectra that match dominantly to white mica. Row 3 plots the SWIR white micas (from row 2) by the wavelength of the characteristic white mica feature (usually between 2190 nm and 2220 nm). Most of the white mica in the Mara Dolostone Member and the upper part of the Leila Sandstone is phengitic, with wavelengths ranging from 2214–2225 nm. These are long wavelengths for white micas in the McArthur Basin and have a slight trend to longer wavelengths going from the Mara Dolostone Member to the upper part of the Myrtle Shale. Row 4 plots the TIR spectra that match dominantly to white mica, coloured by the dominant SWIR mineral. Row 5 plots the depth (analogous to strength) of the white mica feature in the SWIR, coloured by the wavelength of the feature. This shows the white mica in the Mara Dolostone Member has discrete zones of abundance, surrounded by zones that are less abundant (possibly mixed with carbonates and quartz).
MBXDD002: Chlorites

Row 1 shows the logged stratigraphic succession. Row 2 shows the distribution of SWIR spectra that match dominantly to chlorite. Row 3 plots the SWIR chlorites (from row 2) by the wavelength of the characteristic FeOH feature (usually between 2242 nm and 2262 nm; Ausspec 2008). There is an increase in the number of spectra that match to chlorite towards the base of the Myrtle Shale. Most of the chlorite has features with a short FeOH wavelength (2245–2251 nm: Mg-rich chlorite). Row 4 plots the TIR spectra that match dominantly to chlorite, coloured by the dominant SWIR mineral. Row 5 plots the depth (analogous to strength) of the FeOH feature in the SWIR, coloured by the wavelength of the feature. This shows the chlorites at the base of the Myrtle Shale are the most abundant within MBXDD002. There is also a small chlorite zone in the Leila Sandstone (around 265 m) that appears to be from a small fracture / crush zone.
The Mara Dolostone Member shows sedimentary cycle changes with changes in mineralogy (white mica/carbonate: page 7) and also in carbonate composition (page 9).

The conformable contact between the Mara Dolostone Member and underlying Myrtle Shale is mineralogically indistinct.

The Myrtle Shale shows increasing chlorite and decreasing quartz towards the basal contact.

There are spectra that have absorption features around 2340 nm within the Myrtle Shale. These features are not clearly a white mica or a chlorite and may be a mixed layer mineral (?). XRD validation is recommended. Geochemical plots by McGilvray et al (2014) indicated the presence of both white mica and chlorite in the Myrtle Shale. The HyLogger data shows it may be a mineral mix.

Mineralogy change in Mara Dolostone Member: Left of red dotted line is dolomite; right is dominantly white mica, which also appears bedded. However, the mineralogy change can be subtle to detect visually as not all white mica-rich sediments are bedded and some carbonates appear to have bedding.
MBXDD002: References


MBXDD002: TSG metadata

Checked mineral spectra and turned off saponite, diaspore, Fe chlorite, phlogopite, talc, epidote, serpentine, roxite, Fe toomeline, tourmaline, dolomite, topaz, acnholite, hornblende, R1 trilite, magnetite sidelite. Turned off paragonite after checking with white rock std scale. Turned off calcite after checking with carbonate SWIR scalar.

Turned off same minerals as for SWIR as a starting point, along with garnet, granatite and spinel. Checked for spiltite using scales and turned off.

Volume scattering through most of the hole (from upper zone downwards) which makes spectral matching difficult.
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 and Huntington (2012).
## Glossary

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

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>albedo</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>aspectral</td>
<td>An aspectral response is a spectrum that 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).</td>
</tr>
<tr>
<td>AlOH</td>
<td>Aluminium hydroxide.</td>
</tr>
<tr>
<td>CLS</td>
<td>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 that can have several mixed mineral matches.</td>
</tr>
<tr>
<td>domain</td>
<td>A zone within a drillhole interpreted to contain a restricted set of minerals that are different to adjacent zones.</td>
</tr>
<tr>
<td>FTIR</td>
<td>Fourier transform infrared spectrometer.</td>
</tr>
<tr>
<td>HgCdTe</td>
<td>Mercury Cadmium Telluride used in infrared detectors.</td>
</tr>
<tr>
<td>HQ</td>
<td>Shorthand for hull quotient (a type of background corrected spectrum).</td>
</tr>
<tr>
<td>InSb</td>
<td>Indium antimonide – used in infrared detectors.</td>
</tr>
<tr>
<td>MCT</td>
<td>Mercury Cadmium Telluride used in infrared detectors.</td>
</tr>
<tr>
<td>MgOH</td>
<td>Magnesium hydroxide.</td>
</tr>
<tr>
<td>nm</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>scalar</td>
<td>Any set of imported or calculated values associated with spectral data loaded in TSG.</td>
</tr>
<tr>
<td>SEM</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>SNR</td>
<td>Signal-to-noise ratio.</td>
</tr>
<tr>
<td>SRSS</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>SWIR</td>
<td>Shortwave infrared (light). Nominally covering the range 1000–2500 nm.</td>
</tr>
<tr>
<td>TSA</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>TSG</td>
<td>‘The Spectral Geologist’ – CSIRO-developed specialist processing software, designed for analysis of field or laboratory spectrometer data.</td>
</tr>
<tr>
<td>TIR</td>
<td>Thermal infrared (light). Nominally covering the range 6000–14000 nm.</td>
</tr>
<tr>
<td>VIS</td>
<td>Visible (light). The human eye is nominally sensitive between 390 and 750 nm.</td>
</tr>
<tr>
<td>VNIR</td>
<td>Visible near infrared (light). Nominally covering the range 380–1000 nm.</td>
</tr>
<tr>
<td>volume scattering</td>
<td>Radiation that is reflected after some absorption into the rock that 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.</td>
</tr>
<tr>
<td>wvl</td>
<td>Abbreviation for wavelength, found in TSG scalar names.</td>
</tr>
<tr>
<td>XRD</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>Scalar Name</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 that 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>Al smectite abundance</td>
<td>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.</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. E.g; 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 a Aux (Auxiliary or Custom) dataset. The Aux dataset is usually a custom library containing special hand-chosen spectra that 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 that 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 that 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 that 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) that 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>
</tbody>
</table>

Continued on next page
| **Hydrocarbon Presence** | A PFIT scalar designed to measure the presence of an absorption feature at 1730nm that 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 pf1 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 usings a >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** | Smoothes the 8625 PFIT d abundance scalar (above) by smoothing using the mean through a moving window. The output smoothes 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 that 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) that 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. ‘sTSAV’ is the default system match. ‘uTSAT’ is the author-derived result from manually excluding some minerals and artefacts during processing. |
### Guide to scalars in figures produced using TSG software

<table>
<thead>
<tr>
<th>Scalar</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>sTSAV, uTSAV</td>
<td>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 (e.g., galvanised tray spectral matches) during processing.</td>
</tr>
<tr>
<td>TIR-CLS1_CLS_min_1</td>
<td>Combined Least Squares (CLS) Scalar showing the dominant modeled 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 modeling in the domain (Restricted Mineral Set or RMS) is selected during the interpretation/processing stage.</td>
</tr>
<tr>
<td>TIRDeltaTemp</td>
<td>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 artefacts (such as metal tray edges, metal depth marker tabs or instrument issues).</td>
</tr>
<tr>
<td>uTSA*</td>
<td>The result from TSA (The Spectral Assistant that 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 that 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 that use uTSAT plot only spectra that 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 analyze 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 ‘What's 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.