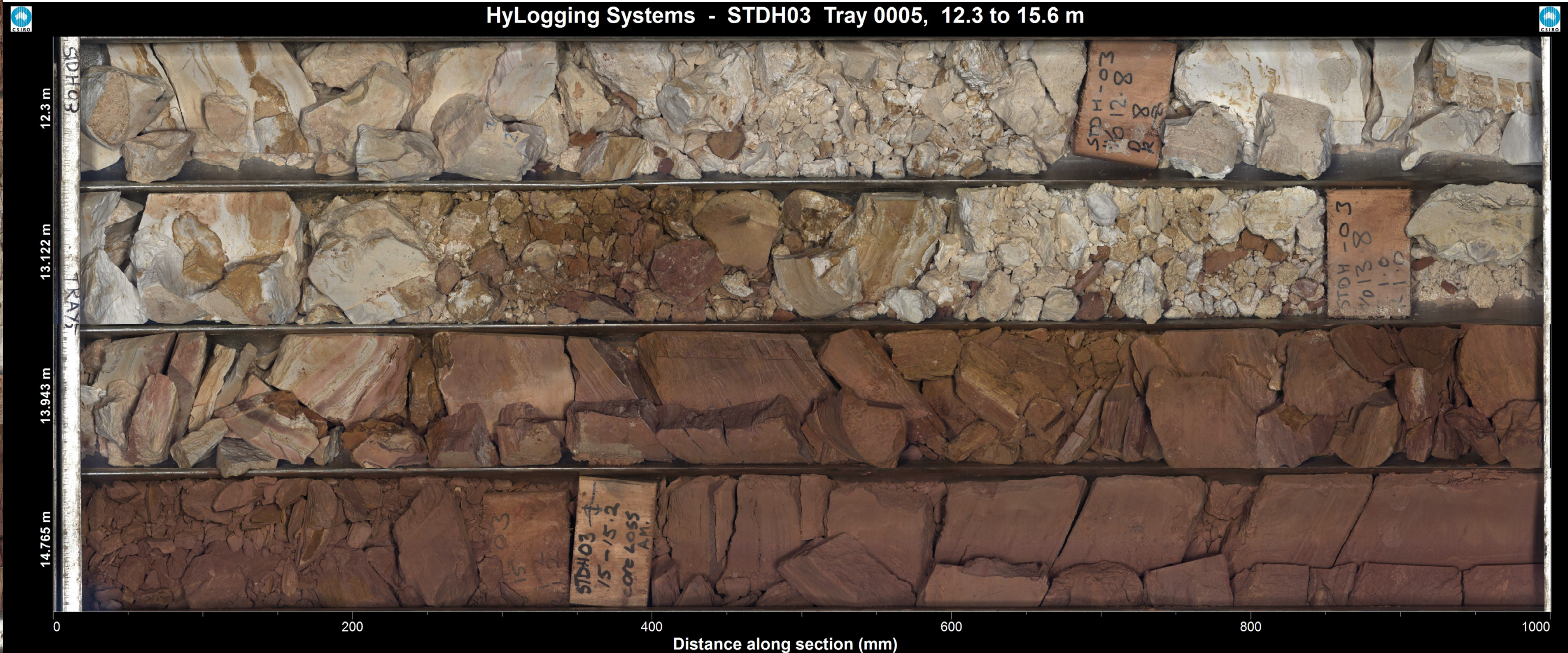
NORTHERN TERRITORY GOVERNMENT

NORTHERN TERRITORY GEOLOGICAL SURVEY

HyLogger Data Package 0073

HyLogger drillhole report for STDH03, Stromberg prospect, Pine Creek Orogen, Northern Territory.

Belinda Smith



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EDITOR: GC MacDonald. GRAPHICS AND LAYOUT: KJ Johnston.

Northern Territory Geological Survey
3rd floor Paspalis Centrepoint Building
Smith Street Mall, Darwin
GPO Box 4550
Darwin NT 0801, Australia

Arid Zone Research Institute
South Stuart Highway, Alice Springs
PO Box 8760
Alice Springs NT 0871, Australia

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

The Spectral Geologist Advisory

The results in this report were obtained using The Spectral Geologist (TSG) software. The software uses The Spectral Assistant (TSA) 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. The unmixing is an interpretation result of 'best fit'. TSA abundances are relative abundances, only the two (or three) most spectrally active minerals identified in the Short Wave Infrared (SWIR) and the three (sometimes four) most spectrally active minerals in the Thermal Infrared (TIR) wavelengths are reported. If there are more than two or three minerals actually present in the sample in the SWIR (or three to four 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 is unlikely in that geological environment, introducing a further 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 and spectral characteristics of that domain.

Since April 2017, the TIR spectral responses may also be matched to minerals using joint Constrained Least Squares (jCLST), which is an unmixing classifier that replaces the earlier system TSA (sTSAT) used in TSG versions 7 or earlier. In TSG8, jCLST is the default system unmixing algorithm, which interprets the TIR data using the results from the SWIR spectra, and using scalars focussing on selected features in the Visible Near Infrared (VNIR) and TIR wavelengths. TSG8 datasets may have TIR mineral results reported as domained TSA (dTSAT), user TSA (uTSAT) or domained CLS (TIR-CLS1).

Any results from the TIR should be used with caution as algorithms and TSA libraries are in a constant state of revision. More information about the samples in the TIR reference library can be found in Schodlok *et al* (2016a).

These results were published using TSG Version 8.0.3.2 dated September 2018.

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

STDH03: Introduction

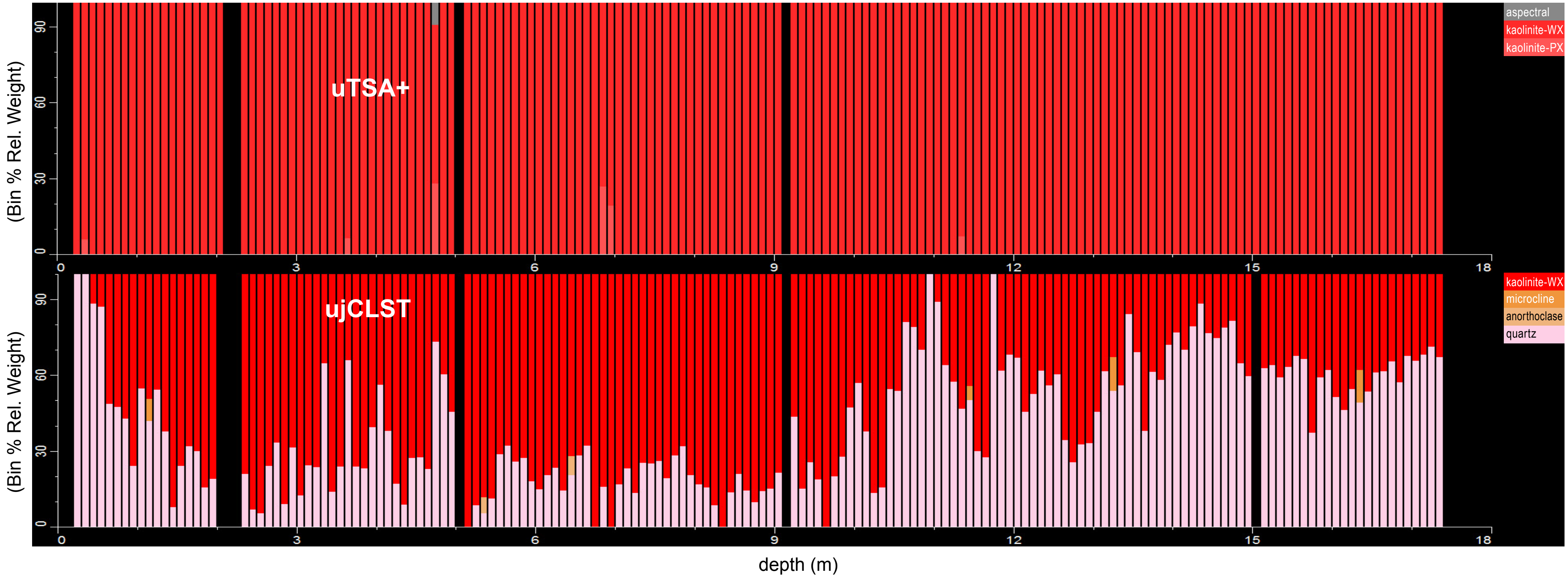
Hole ID	STDH03	**Unique identifier**	8458271
Geological terrane	Pine Creek Orogen	**Total depth**	17.8 m
Latitude GDA94	-14.341068°	**Longitute GDA94**	131.037150°
Easting MGA94	719706 (Zone 52)	**Northing MGA94**	8413585 (Zone 52)
Dip	-70°	**Azimuth**	139° (True)
Logged by	TUC Resources	**Logged report ref**	Chapman (2012)
Start core depth	0.2 m	**End core depth**	17.8 m
Date HyLogged	January 2013	**HyLogged by**	Darren Bowbridge
Date of HyLogger report	December 2018	**HyLogger report author**	Belinda Smith
TSG version and build	8.0.3.2 (September 2018)	**TSG product level**	3 (Huntington 2010)

Summary of information about STDH03:

- Core loaned to NTGS for scanning as part of a rare earths (REE) spectral characterisation project (Smith and Huntington 2013).
- STDH03 is not in the NTGS Drill Core Library as NTGS did not elect to acquire the drill core when Spectrum Rare Earths (previously TUC Resources) relinquished EL 25222.
- Chapman (2012) reported coordinate and assay data for STDH03 but not lithology. Stromberg prospect is described as 'near surface HREE mineralisation' within xenotime. The HREE comprise dysprosium (Dy), yttrium (Y), erbium (Er) and terbium (Tb) reported as a proportion of TREO (total rare earth oxide). Mineralisation is described as 'multiple flat-lying zones…. Interpreted to be thicker closer to faults'.
- STDH03 was drilled to provide metallurgical testwork samples. This work aimed to determine possible processing methods, minimum cut-off grade, and achievable concentrate grade.
- In December 2015, Spectrum Rare Earths relinquished Stromberg and other REE tenements, citing negative market factors, plus challenging metallurgical characteristics of the rare earths in the area (including Skyfall deposit).

This HyLogger Data Package aims to note unusual VNIR / SWIR spectral characteristics in STDH03. These spectral features are interpreted to result from the presence of rare earth elements (REEs).

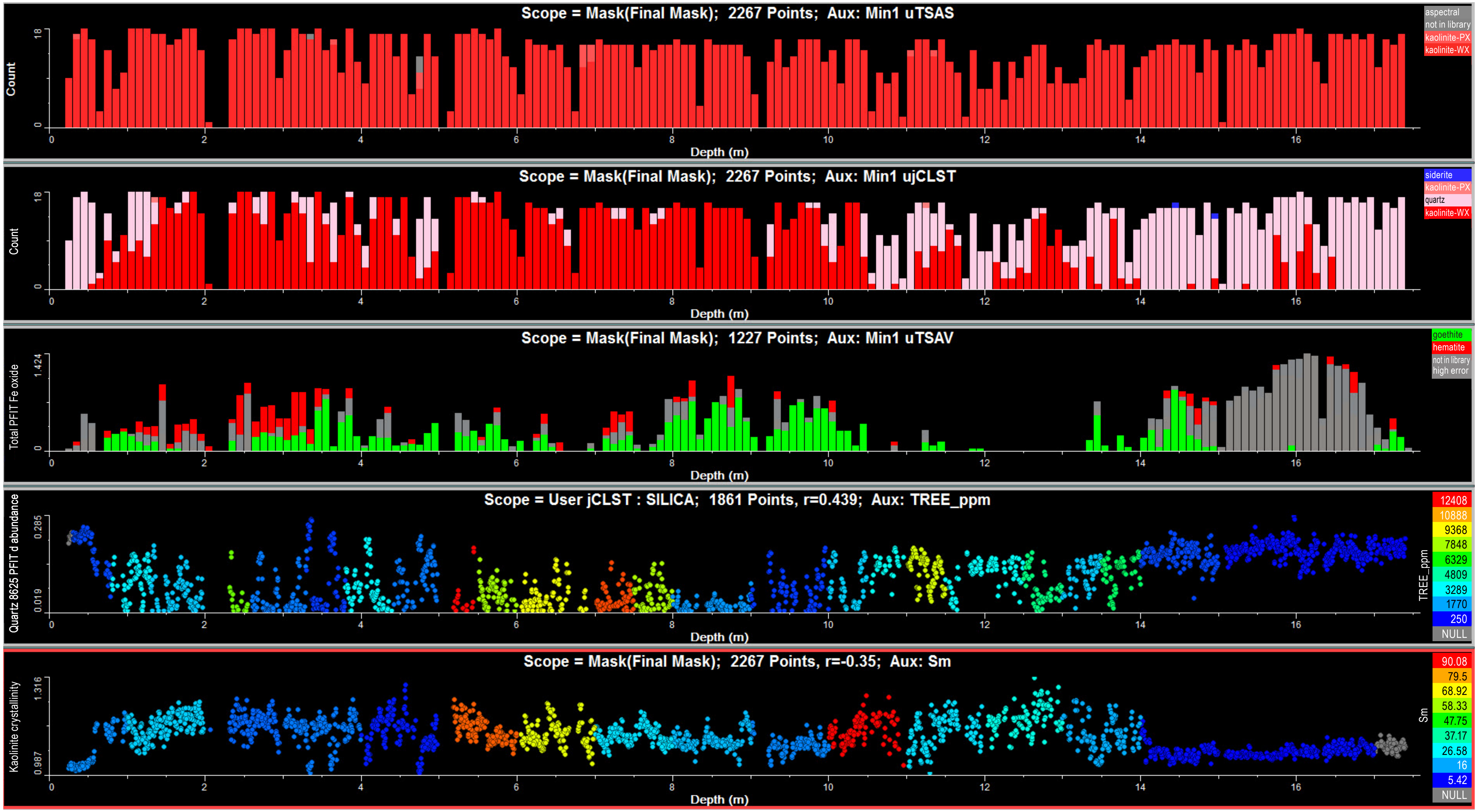
STDH03: Mineral summary – all minerals, uTSA (not domained)



From Summary Screen: Row 1 is the domained SWIR results using TSA+. Row 2 is the TIR results derived from using a joint CLS algorithm (ujCLST: see Guide to Scalars for a description of both TSA+ and jCLST). As the mineralogy is quite restricted and consistent, the TIR-CLS was not calculated. STDH03 is a short hole (only 17.8 m deep) and has a uniform mineralogy of kaolinite (red colour, both plots) and quartz (pink colour in TIR). There is possible minor feldspars but this has not been validated. Kaolinite is dominant from about 1.5 m to 10.5 m, with significantly less quartz in this interval.

STDH03: Summary

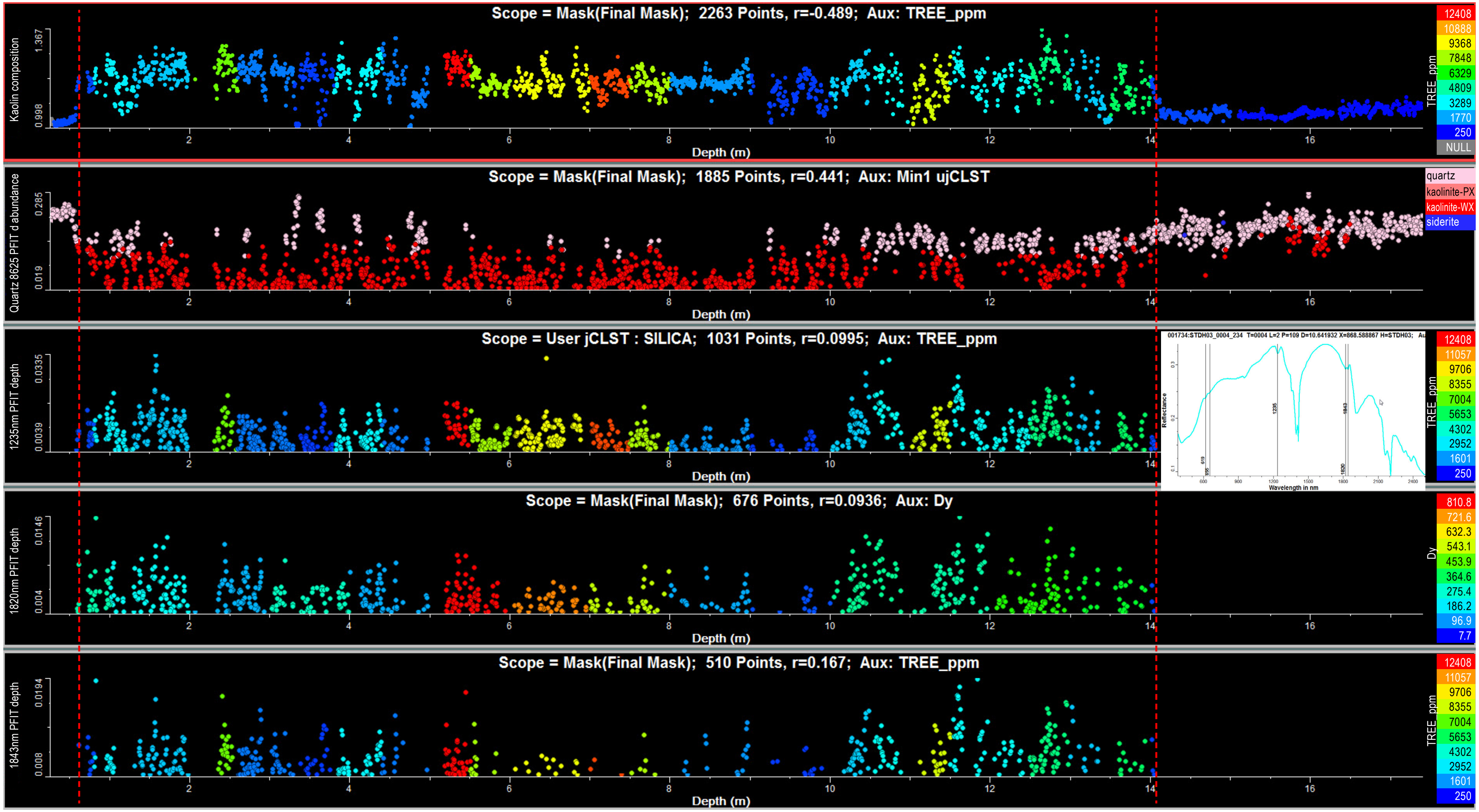
(View | Plot Layouts Load file 1_VNIRSWIR: Summary)



Row 1 plots the dominant SWIR mineral (kaolinite). Row 2 plots the dominant TIR mineral (kaolinite, with increasing quartz with depth). Row 3 plots the dominant VNIR mineral (hematite/goethite in first 4 m, then dominantly goethite to about 15 m). Spectra do not match to TSA Fe oxides from 15 m (grey colour). Row 4 plots the quartz abundance (measured by the depth of the 8625 nm quartz feature) coloured by the total rare earths (TREE; in Chapman, 2012). Row 5 plots the kaolinite crystallinity (a CSIRO batch scalar) coloured by Sm assays. Note that the quartz abundance is lowest, and kaolinite crystallinity is highest in the intervals containing rare earths.

STDH03: Spectral features vs TREE assays

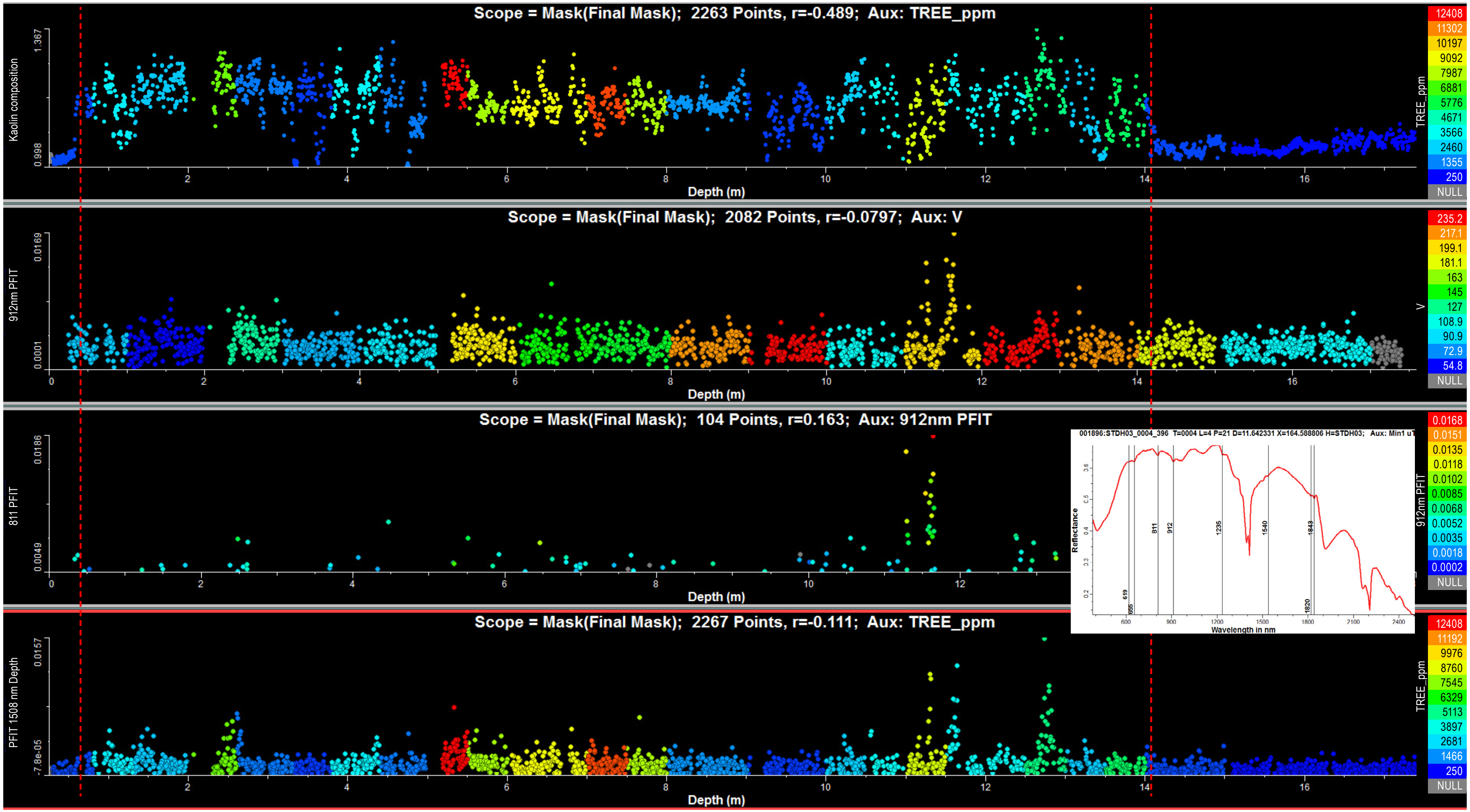
(View | Plot Layouts Load file 2_VNIRSWIR: Spectral features vs grade)



Row 1 plots the kaolin composition (from SWIR spectra), coloured by the TREE assays. Note the sharp difference between low assay values (dark blue) with low kaolinite crystallinity, and elevated TREE assays with higher kaolinite crystallinity (similar to row 5 on previous page). Row 2 plots the quartz abundance coloured by the dominant TIR mineral. This confirms that the spectra with the deepest 8625 nm quartz feature match to quartz, with the lower abundance values matching to kaolinite. Rows 3 – 5 match to spectral features at 1235 nm, 1820 nm and 1843 nm respectively (see inset image for typical spectrum), coloured by assays. Note that these features do not occur in the zones 0–0.5 m and below 14 m; these zones also do not have anomalous REE assays. Dashed lines mark the boundary between elevated REE assays and coincident spectral features.

STDH03: Spectral features in Visible Near Infra Red

(View | Plot Layouts Load file 3_VNIRSWIR: Spectral features in VNIR)



Row 1 plots the kaolin composition (from SWIR spectra), coloured by the TREE assays (also plotted as row 1 on previous page). Note the sharp difference between low assay values (dark blue) with low kaolinite crystallinity, and elevated TREE assays with higher kaolinite crystallinity. Row 2 plots matches to 912 nm feature, coloured by vanadium assays. Row 3 plots 811 nm feature, which occurs mainly about 11.5 m, coloured by 912 nm feature. Row 4 plots matches to 1508 nm feature, which Jon Huntington (pers comm) observes as present in xenotime samples from WA Museum. Inset image shows spectrum at 11.64 m in STDH03 that has these spectral features. Dashed lines mark the boundary between elevated REE assays and coincident spectral features (see previous page).

STDH03: Summary of HyLogger data interpretation

- This HyLogger Data Package does not follow the standard HDP format due to the uniform mineralogy of the short cored interval. However, this HDP documents some spectral features that are likely to be related to the xenotime-hosted HREE content within the well-crystalline kaolinite clays.
- Assay results reported in Chapman (2012) have been imported into the TSG dataset to allow comparison of assay results with spectral features.
- Anomalous REE assays correlate with a zone of well-crystalline kaolinite (SWIR), decreased quartz content (TIR) and common goethite (VNIR).
- It is not possible to directly correlate individual spectral features to assays. This may be due to a difference in scale (assays are at 0.5 – 1.0 m intervals; spectral features are variable on a centimetre scale).
- Spectral features were noted at various wavelengths (not all spectral features occur simultaneously). There is an apparent coincidence of the 811 nm and 912 nm feature, but this is limited to about 11.6 m. The most pervasive features throughout the anomalous REE intervals are features at 1235 nm / 1820 nm / 1843 nm. It is unclear whether these features are related to the REE presence, or due to the high crystallinity of the kaolinite.
- A 1508 nm feature is not common but is present. This feature is noted in xenotime-bearing samples elsewhere (Jon Huntington, pers comm 2018).

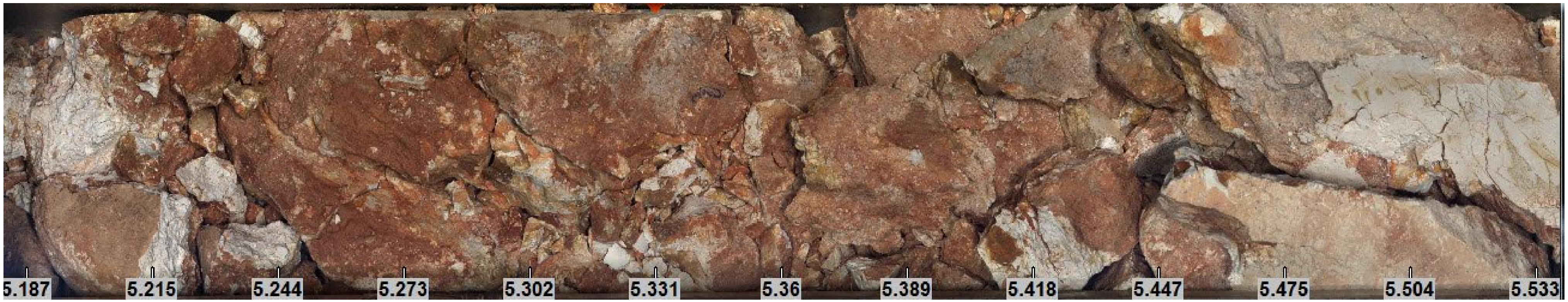


Image of well-crystalline kaolinitic clays (with goethite) in the interval with the highest Total Rare Earths assay values.

References

Chapman A, 2012. Combined annual exploration report GR042-09 (CR109) EL25222, EL25223, EL25224, EL25229, EL29026, EL29242 for period ending 8th November 2012. Daly River Project NT. Report 2012-05. *Northern Territory Geological Survey Open File Company Report* CR2012-1068.

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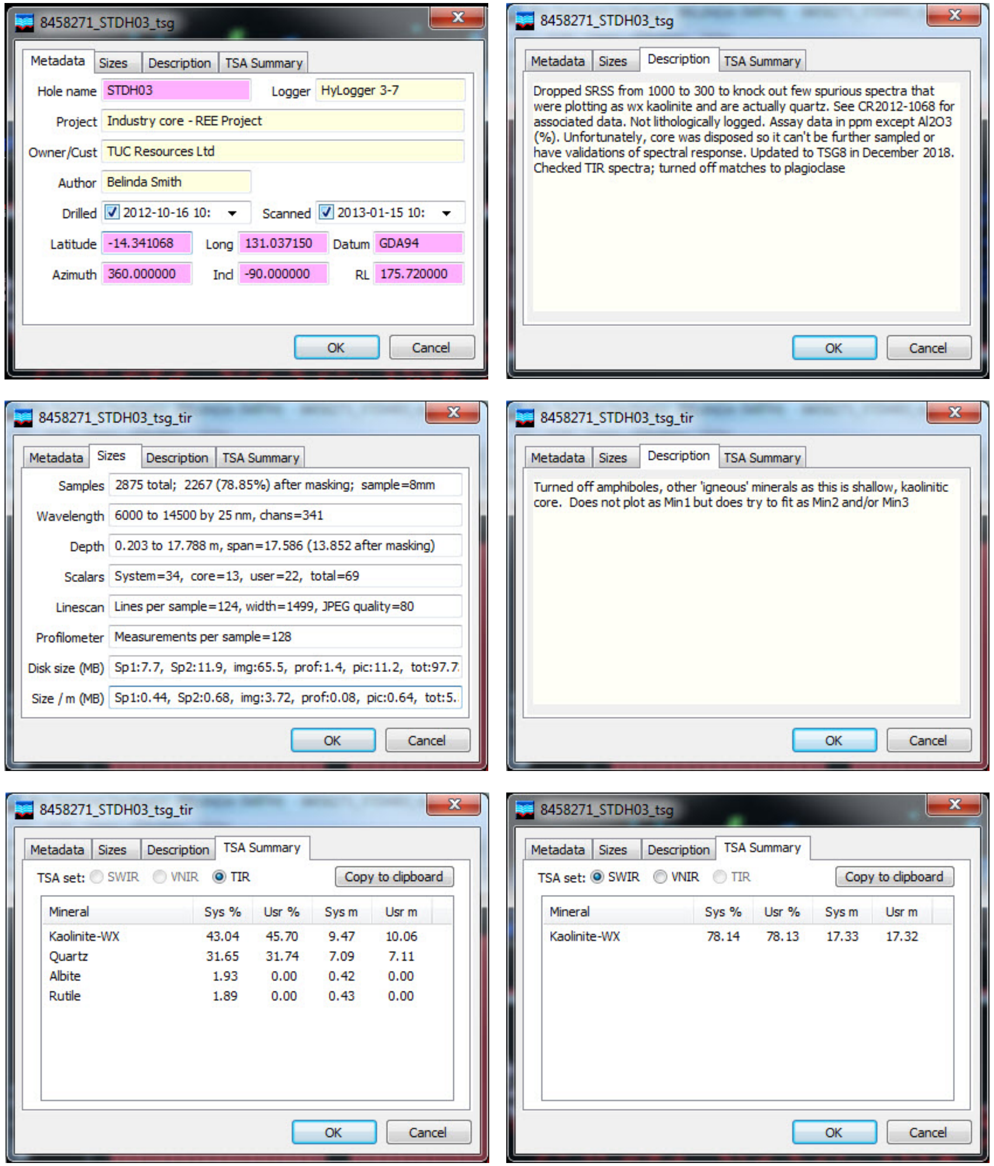
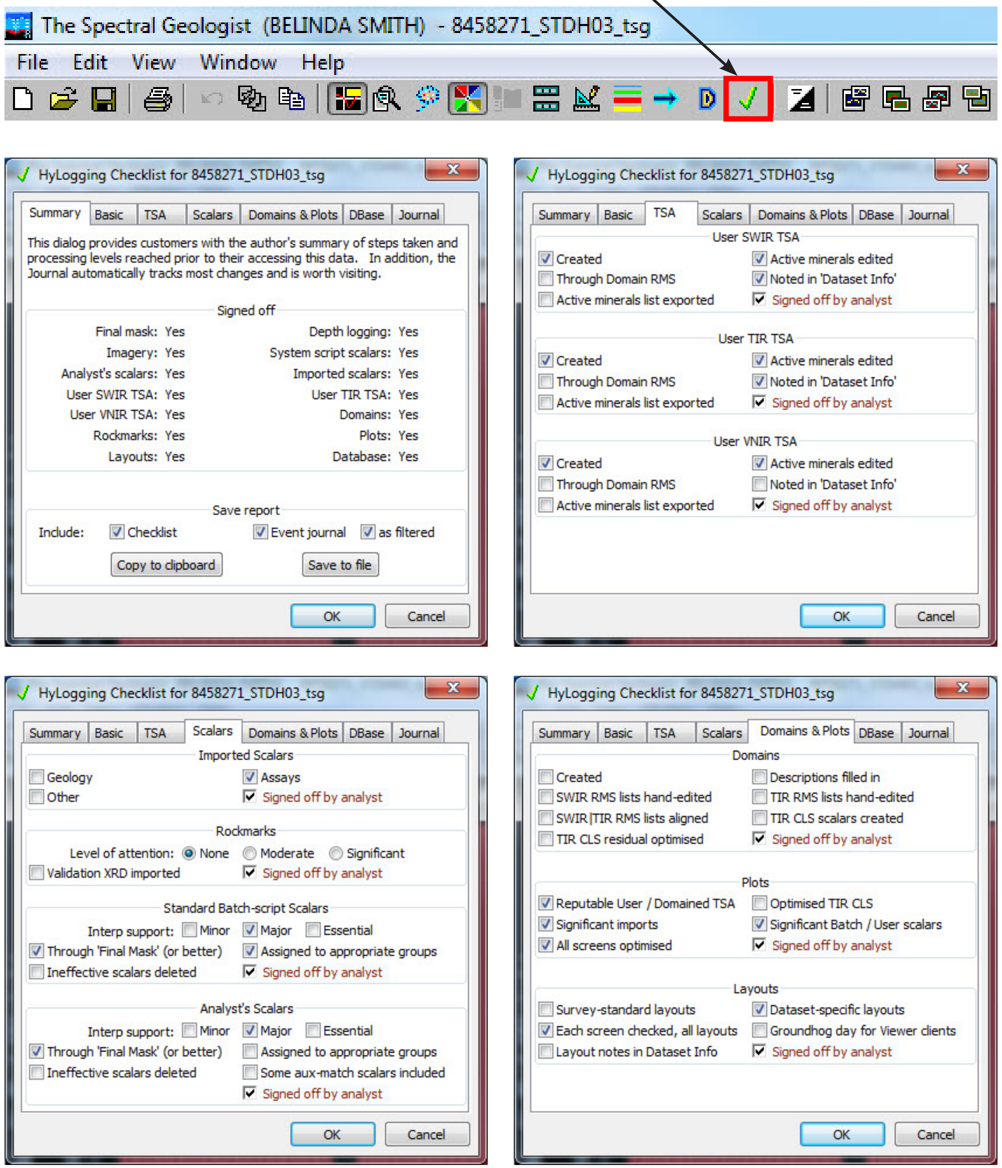
STDH03: TSG metadata

File | Dataset Info



From HyLogger Checklist icon



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 Schodlok *et al* (2016b).

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 that does not match a TSA library spectrum within the SRSS error cut-off. 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.
AusGIN	Australian Geoscience Information Network (Geoscience portal): http://portal.geoscience.gov.au/gmap.html is a web portal that hosts NVCL data.
AuScope	The national provider of integrated research infrastructure, of which the NVCL is an infrastructure programme. The AuScope portal (http://portal.auscope.org/portal/gmap.html) hosts NVCL data.
CLS	Constrained Least Squares – an alternative unmixing classifier that uses a RMS to minimise non-unique mineral modelling. Used mainly to model TIR spectra that can have several mixed mineral matches.
Corstruth	A webpage that plots the results (as a pdf summary) from an automated analysis of HyLogger data in the NVCL; www.corstruth.com.au
domain	A zone within a drillhole interpreted to contain a restricted set of minerals that are different to adjacent zones. Unmixing algorithms applied to domained datasets use a RMS that has been defined for each domain by the processing geologist.
FTIR	Fourier transform infrared spectrometer.
HgCdTe	Mercury cadmium telluride used in infrared detectors.
HQ	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 2500 to 6000 nm.
NVCL	National Virtual Core Library; the library of nationally available TSG datasets
scalar	Any set of imported or calculated values associated with spectral data loaded in TSG.
RMS	Restricted mineral set. The processor limits the set of possible mineral matches based on the geological understanding and spectral characteristics of the domain.
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). In HyLogging applications it nominally covers 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 mixtures of two or more 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. http://thespectralgeologist.com/
TIR	Thermal infrared (light). In HyLogging applications it nominally covers the range 6000–14000 nm.
VIS	Visible (light). The human eye is nominally sensitive between 390 and 750 nm.
VNIR	Visible near infrared (light). In HyLogging applications it nominally covers the range 380–1000 nm.
volume scattering	Radiation that is reflected after some absorption into the rock and 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	Wavelength - used 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:

811 PFIT	PFIT scalar to measure the depth of a trough minima between 795-825 nm with a depth >0.005; polynomial order 7; hull envelope divided by reflectance reported as relative depth.
912nm PFIT	PFIT scalar to measure the depth of a trough minima between 900-930 nm with a depth >0; polynomial order 5; hull envelope divided by reflectance reported as relative depth.
1235 PFIT depth	PFIT scalar to measure the depth of a trough minima between 1210-1270 nm with a depth >0.00406; polynomial order 3; hull envelope divided by reflectance reported as relative depth.
1820 PFIT depth	PFIT scalar to measure the depth of a trough minima between 1810-1828 nm with a depth >0.004; polynomial order 3; hull envelope divided by reflectance reported as relative depth.
1843nm PFIT depth	PFIT scalar to measure the depth of a trough minima between 1830-1860 nm with a depth >0.008; polynomial order 3; hull envelope divided by reflectance reported as relative depth.
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. For example, 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 that have been interpreted in detail.
Carbonate 6500 nm 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 11300 nm 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 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.
Colour tot_sat	TSG standard scalar; it calculates the colour (separately per band) from the visible interval of the reflectance spectra 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 use a feature extraction algorithm in TSG to calculate the depth, width and/or wavelength position of a spectrum’s absorption features. It uses pre-calculated feature extraction information from TSG’s default algorithm.

(continued on next page)

Guide to scalars in figures produced using TSG software (continued)

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) that 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.
Hydrocarbon presence	A PFIT scalar designed to measure the presence of an absorption feature at 1730 nm, which is often found associated with oil bleeds. Another scalar designed to identify hydrocarbons is the 23140 nm PFIT scalar. Using both scalars together can identify oil bleeds when the spectral response is preserved (it can deteriorate over time).
jCLST, ujCLST, djCLST	The jCLST algorithm has been developed by Andy Green (OTBC Pty Ltd; www.corstruth.com.au) as a replacement for sTSAT, which unmixes the TIR spectra on a sample by sample basis without reference to the results in the VNIR or SWIR (which can commonly return spurious mineral matches). In comparison, jCLST interprets TIR data using the results from a modified TSAT, TSA+ and from scalars using selected features in the VNIR and TIR. 'ujCLST' is the author-derived results from manually excluding some minerals during processing. 'djCLST' is author-derived results from manually domaining the drillhole into zones of similar mineralogy and restricting the minerals available for the jCLST algorithm in each domain.
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).
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 2155–2180 nm to determine the relative depth using a >0.01 cut-off, 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 1508 nm D	PFIT scalar to measure the depth of a trough minima between 1490-1515 nm with a depth >0; polynomial order 4; hull envelope divided by reflectance reported as relative depth.
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.
Prehnite 1475 nm PFIT	PFIT scalar to measure the wavelength of a trough minima between 1460–1485 nm with a depth >0.009; polynomial order 6; hull envelope divided by reflectance reported as a relative depth. Used to confirm prehnite, with the depth of the 1475 nm feature indicative of abundance.
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 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 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)'.

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Guide to scalars in figures produced using TSG software (continued)

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 also 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, uTSA+, dTSA+	Mineral result from matching to the short wave iInfrared (SWIR) spectra against the TSA library. In TSG versions 7 and earlier; ‘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. In TSG versions 8 and later, TSA+ uses some information derived from selected features in both the SWIR and TIR to make a more informed choice about mineral mixtures. The ‘d’ indicates the results are ‘domained’.
sTSAT, uTSAT, dTSAT	Mineral results from matching to the thermal infrared (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. ‘dTSAT’ indicates the results are ‘domained’.
sTSAV, uTSAV	Mineral result from matching to the visible near infrared (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.
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).
Tourmaline PFIT 2366 nm	PFIT scalar to measure the wavelength of a trough minima between 2360–2375 nm with a depth >0.015; polynomial order 5; root mean square error (RMSE)<=0.06; hull envelope divided by reflectance reported as a relative depth. Used to search for tourmaline in mixtures with chlorite and white micas (which may have overlapping features at around 2206 nm and 2244 nm).
uTSA*	The result from TSA. 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.
uTSAT invalid	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 that 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.
WM crystallinity	Arithmetic scalar measuring D2200 white mica divided by D1900 masked by the Final Mask. White mica crystallinity measures the depth of the AlOH absorption feature relative to the depth of the water feature. A deeper water feature indicates lower crystallinity and may indicate an illitic white mica (which may also have some compositional substitution).

Excerpt from Huntington and 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.

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.