Northern Territory Government

NORTHERN TERRITORY GEOLOGICAL SURVEY

HyLogger Data Package 0030

HyLogger drillhole report for AY06DD01,
Georgina Basin, Northern Territory.

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The Spectral Geologist Advisory

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

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

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

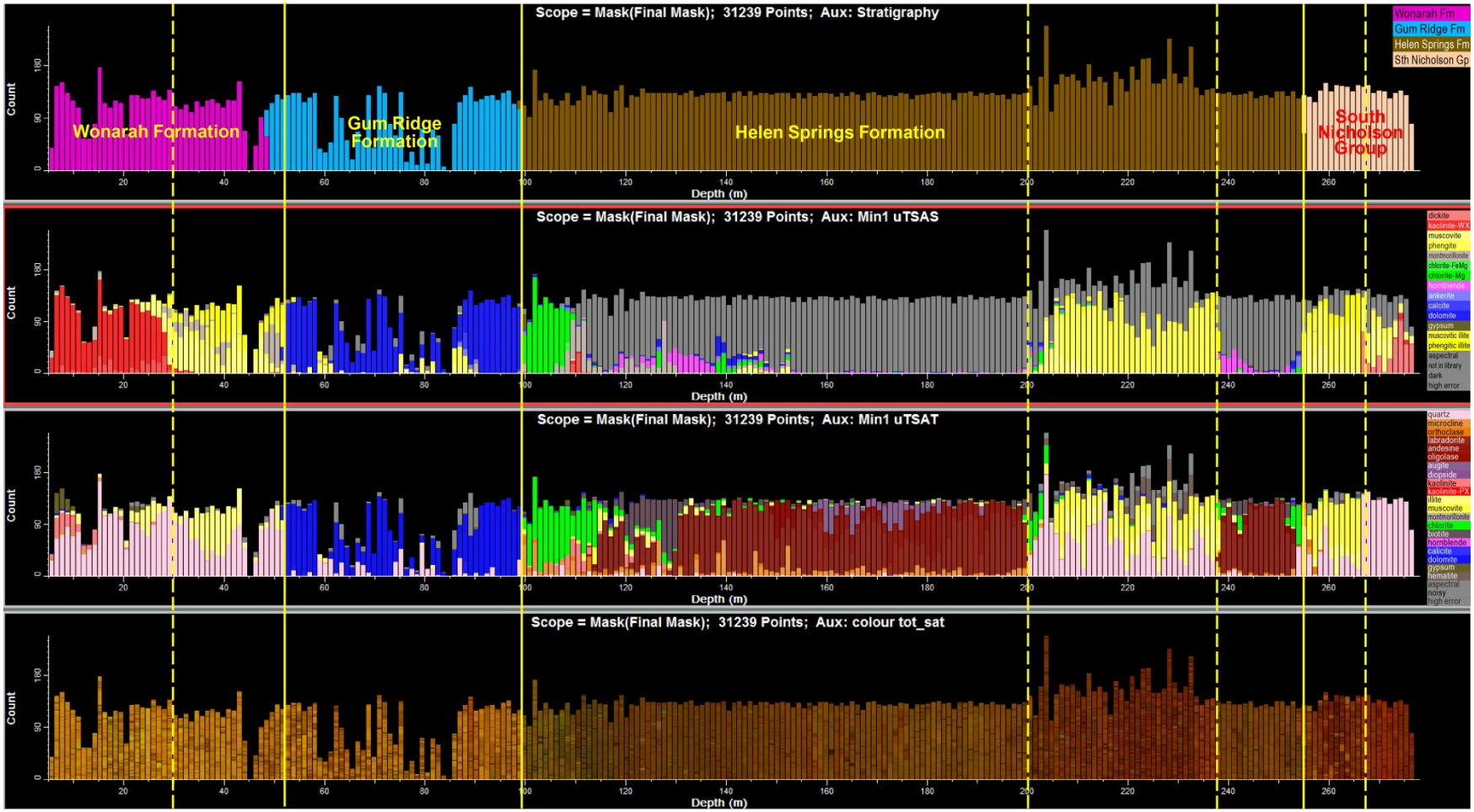
AY06DD01: Introduction

Hole ID	AY06DD01	**Unique identifier**	2232986
Geological terrane	Georgina Basin	**Total depth**	276.5 m
Latitude GDA94	-19.83585°	**Longitude GDA94**	136.30152°
Easting MGA94	636296 (Zone 53)	**Northing MGA94**	7806158 (Zone 53)
Dip	-90°	**Azimuth**	360°
Logged by	CRA Exploration Pty Ltd	**Logged report ref**	NTGS Record 2008-001
Start core depth	5.8 m	**End core depth**	276.5 m
Date HyLogged	February 2013	**HyLogged by**	Darren Bowbridge
Date of HyLogger report	May 2014	**HyLogger report author**	Belinda Smith
TSG version and build	HotCore Build 62 (Oct 2013)	**TSG product level**	3 (Huntington, 2010)

Summary of information from NTGS Record 2008-001

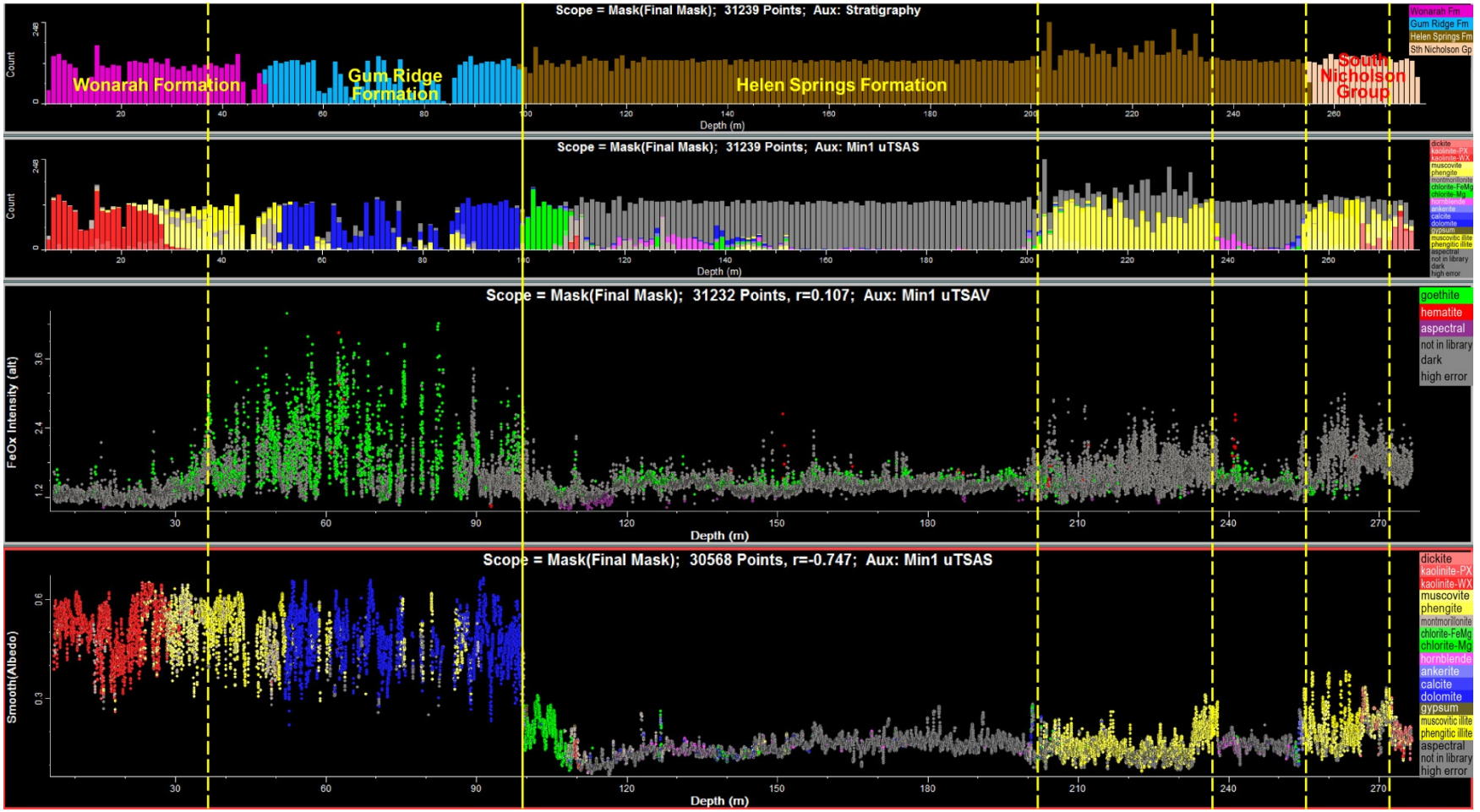
- Stratigraphic hole drilled by NTGS in 2006, specifically to identify the host formation of the Wonarah phosphate deposit.
- No indication of oil staining on core.
- Drillhole intersected a complete record of Cambrian succession in the Barkly sub-basin.
- Helen Springs Volcanics was an ‘unexpectedly great thickness’.
- Fossil identifications assigned the lower half of the Middle Cambrian interval as the Gum Ridge Formation.

AY06DD01: Mineral summary



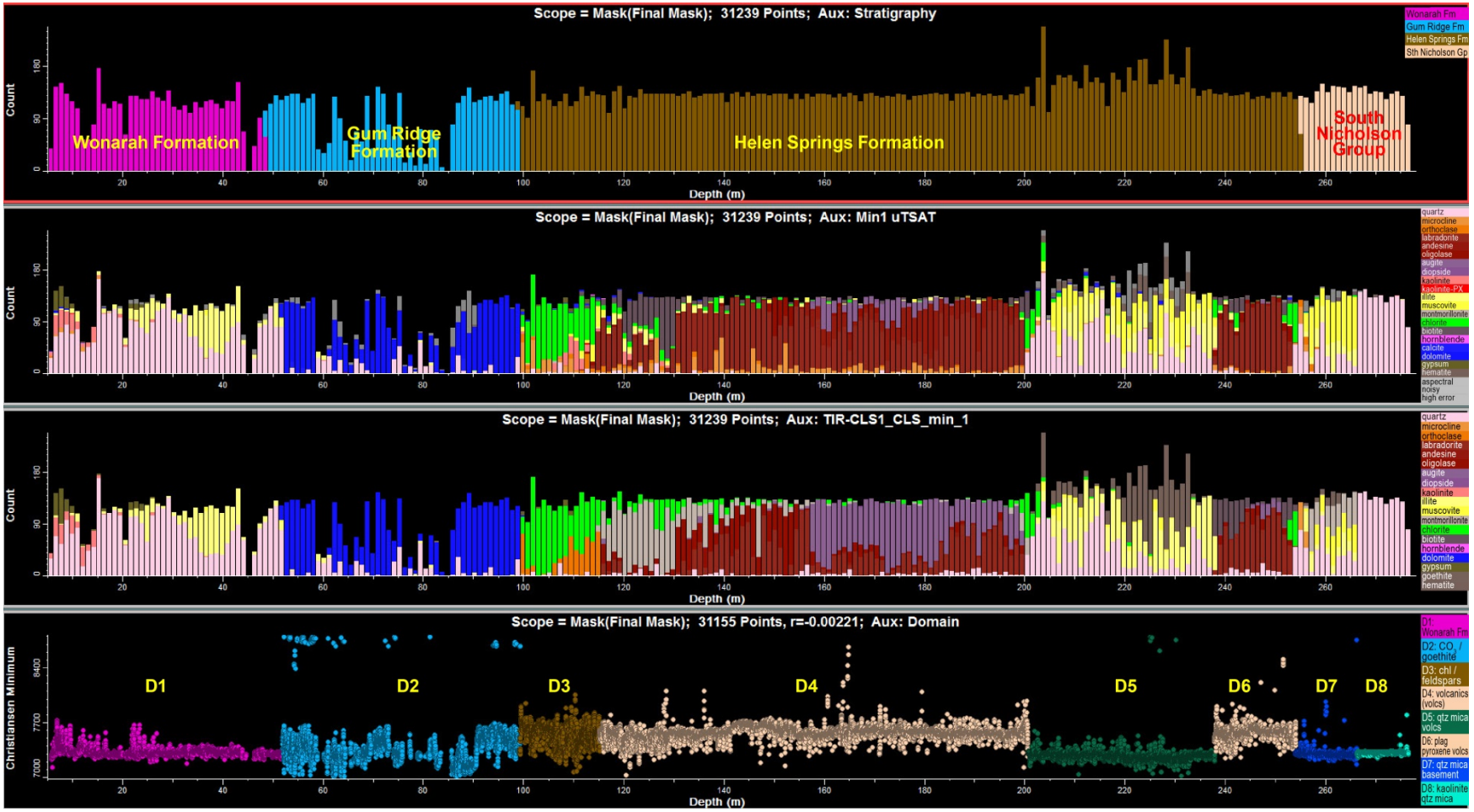
Row 1 is logged stratigraphy. Row 2 is the dominant mineral from the SWIR (red colours are kaolin minerals; grey colour is 'aspectral'). Row 3 is the dominant mineral from the TIR (dark red is plagioclase; pink is quartz; blue is carbonates). Row 4 is the core colour. Solid yellow lines show mineral/core colour changes at logged stratigraphic boundaries, while dotted lines show mineral/core colour changes within stratigraphic intervals. The logged contact between the Gum Ridge Fm and the Wonarah Fm is about 3 m different from the mineralogy change. The other stratigraphic boundaries are defined by mineralogy changes. There are also mineralogy changes within stratigraphic units; The Helen Springs Volcanics is separated into 3 mineralogically distinct areas, comprising 2 plagioclase/pyroxene-rich zones fringed by chlorite and separated by a quartz-white mica zone. The South Nicholson Group basement has also a quartz-white mica zone and a quartz zone with kaolinite at depth.

AY06DD01: SWIR and VNIR mineral summary



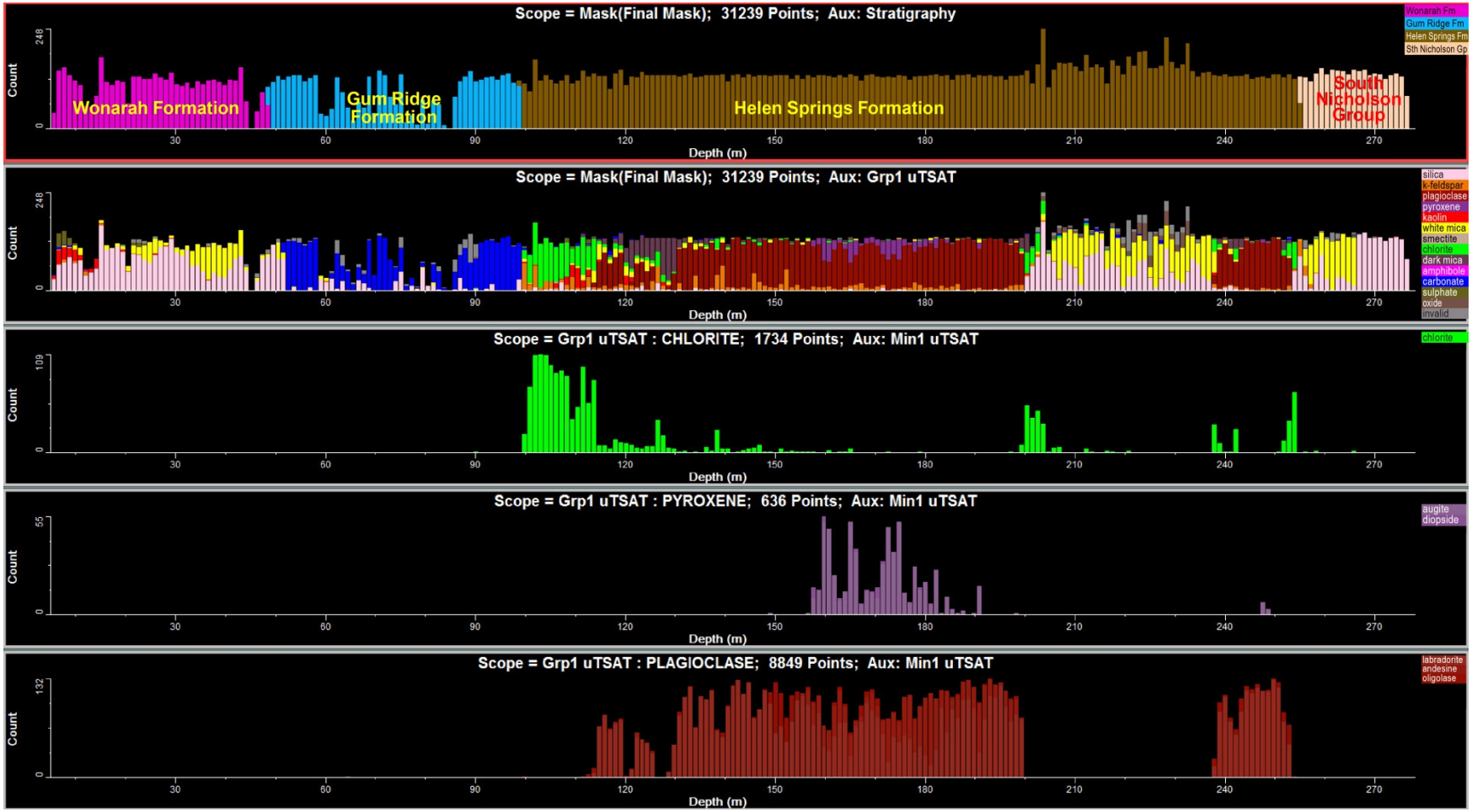
Row 1 is logged stratigraphy. Row 2 is dominant mineral in SWIR. Row 3 is the dominant mineral in the VNIR plotted against the FeOx intensity. Row 4 is smoothed albedo coloured by SWIR Min1. Dotted lines show changes in either albedo and/or FeOx intensity. There is a sharp change in albedo between the Gum Ridge Fm and Helen Springs Volcanics, and there are zones of notably higher FeOx alteration in the Gum Ridge Fm, the quartz-white mica zone of the Helen Springs Volcanics and the upper part of the South Nicholson Group. The hematite (red colour, row 3) in the upper part of the Helen Springs Volcanics is hematite associated with quartz veining in the volcanics.

AY06DD01: TIR mineral summary



Row 1 shows logged stratigraphy. Row 2 shows the dominant mineral in the TIR. Row 3 shows the dominant mineral from CLS. Row 4 shows the mineral domains, an interpreted boundary based on the presence/absence of minerals compared with the surrounding lithology. In Scarborough 1 (HDP0012), the domains were mainly chosen on the presence/absence of kaolin group minerals, feldspars and chlorite. Rows 2 and 3 are a comparison of the dominant TIR mineralogy derived by 2 different algorithms; TSA and CLS. Montmorillonite at top of D4 fits better than white mica and looks more like montmorillonite in SWIR. There appears to be a higher proportion of pyroxene in CLS compared with TSAT results. Dickite noted in D8 in SWIR was not matched in TIR (although some features suggest kaolin minerals present). The kaolin and amphiboles noted in TSAT in D7 (secondary mineral in mineral mix) are not noted in SWIR and did not need to be present for matching in CLS.

AY06DD01: TIR mineral summary cont'd

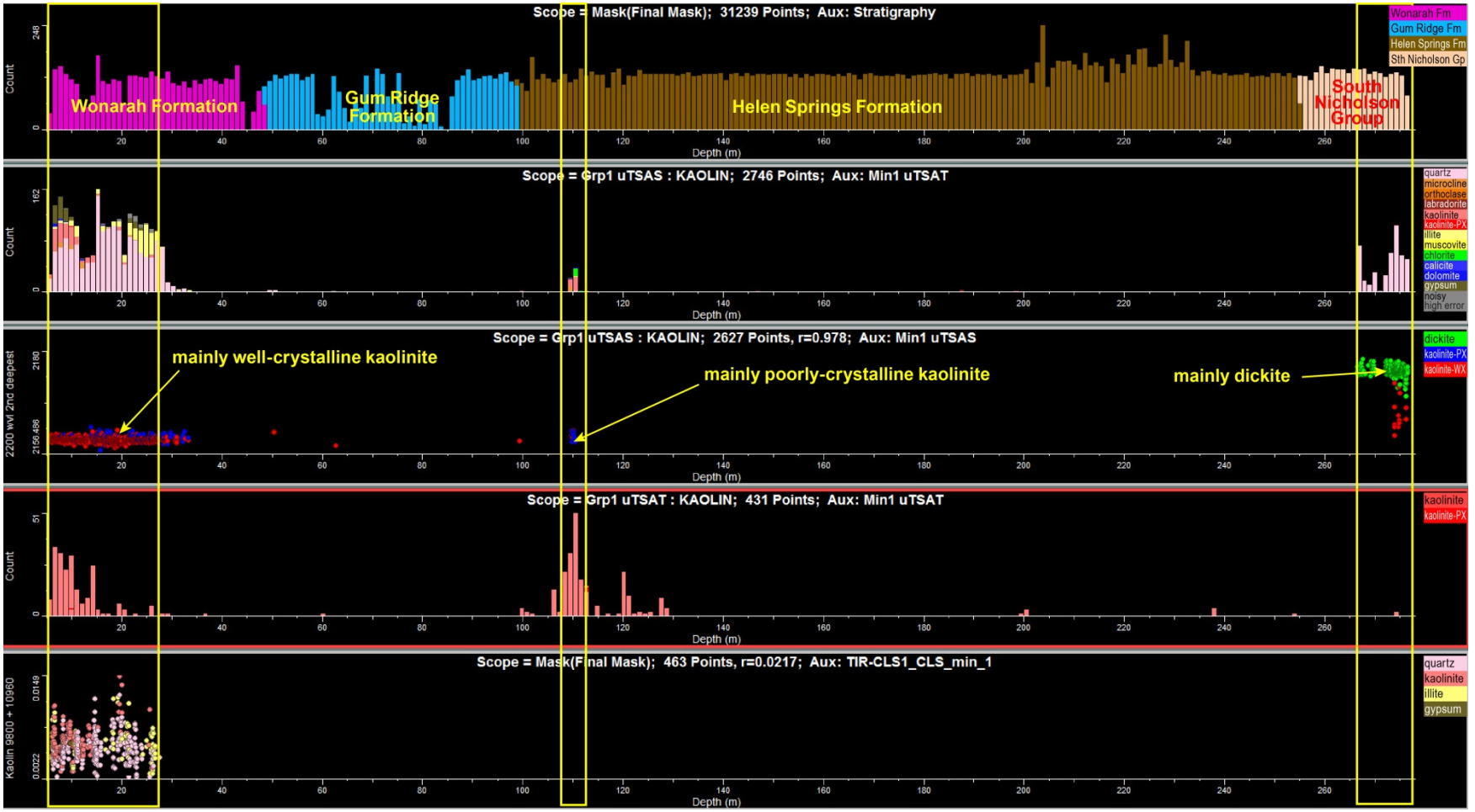


The Helen Springs Volcanics shows several distinct mineral zones, suggesting different rock types. Plagioclase (row 5) +/- pyroxene (row 4) are separated by a quartz-muscovite sequence that petrographic results (Slide 13) indicate is a greywacke. Chlorite (row 3) fringes the boundaries of the volcanic rock (pyroxene plus plagioclase) which is probably the result of alteration at the contacts. From this it seems there are 2 separate igneous rock units. Originally logged as a basalt, petrography results named samples from this unit as 'dolerite'.

AY06DD01: Carbonates

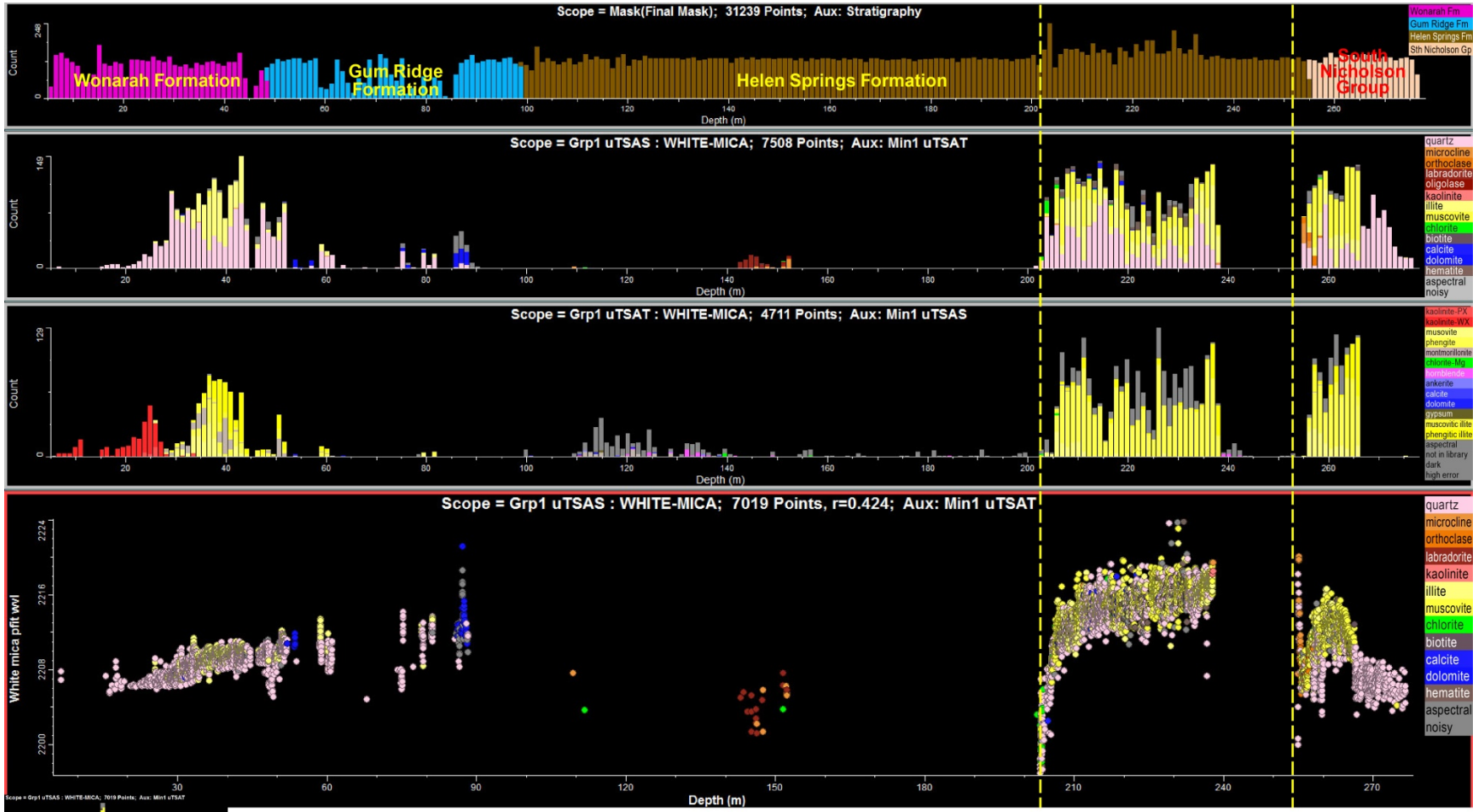
Row 1 shows logged stratigraphy. Row 2 plots the spectra which is dominantly carbonate in the SWIR (coloured by the dominant TIR mineral). Row 3 plots the diagnostic SWIR absorption wavelength for carbonates for the spectra which has carbonate as the dominant SWIR mineralogy (coloured by SWIR carbonate mineral). Row 4 plots the spectra that are dominantly carbonate in the TIR by a diagnostic TIR reflectance wavelength (6500 nm) for carbonates. Most of the carbonates are in the Gum Ridge Fm and are mainly uniformly dolomitic except for a zone around 86–88 m (dotted lines) which shows a change in carbonate composition (?ankerite or perhaps ferroan dolomite?). Other scattered spectra shows some carbonate present (carbonate veining).

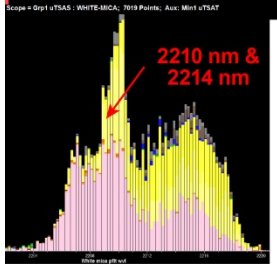
AY06DD01: Kaolin group minerals



Kaolin group minerals appear to occur in 3 locations in AY06DD01. Rows 2 and 3 shows the kaolin group distribution in the SWIR, with row 3 plotting the wavelength of the second-deepest AlOH kandite doublet feature. Dickite (green, near base of hole) has a longer wavelength than kaolinite (red and blue colours, row 3). Rows 4 and 5 plot kaolinite minerals in the TIR. Row 4 shows uTSAT kaolinite distribution, and row 5 plots the characteristic reflectance features of kaolinite (coloured by CLS mineral 1). The Wonarah Fm has kaolinite in the top part of the hole. The kaolinite near the top of the Helen Springs Volcanics is in veins and is over-plotted in the TIR (compare TIR here with CLS, which removes the spurious matches). The dickite near the base of the hole has the characteristic kandite doublets and does have some TIR features, but these are subtle and were not recognised in the modelling by either the TSA or CLS algorithm.

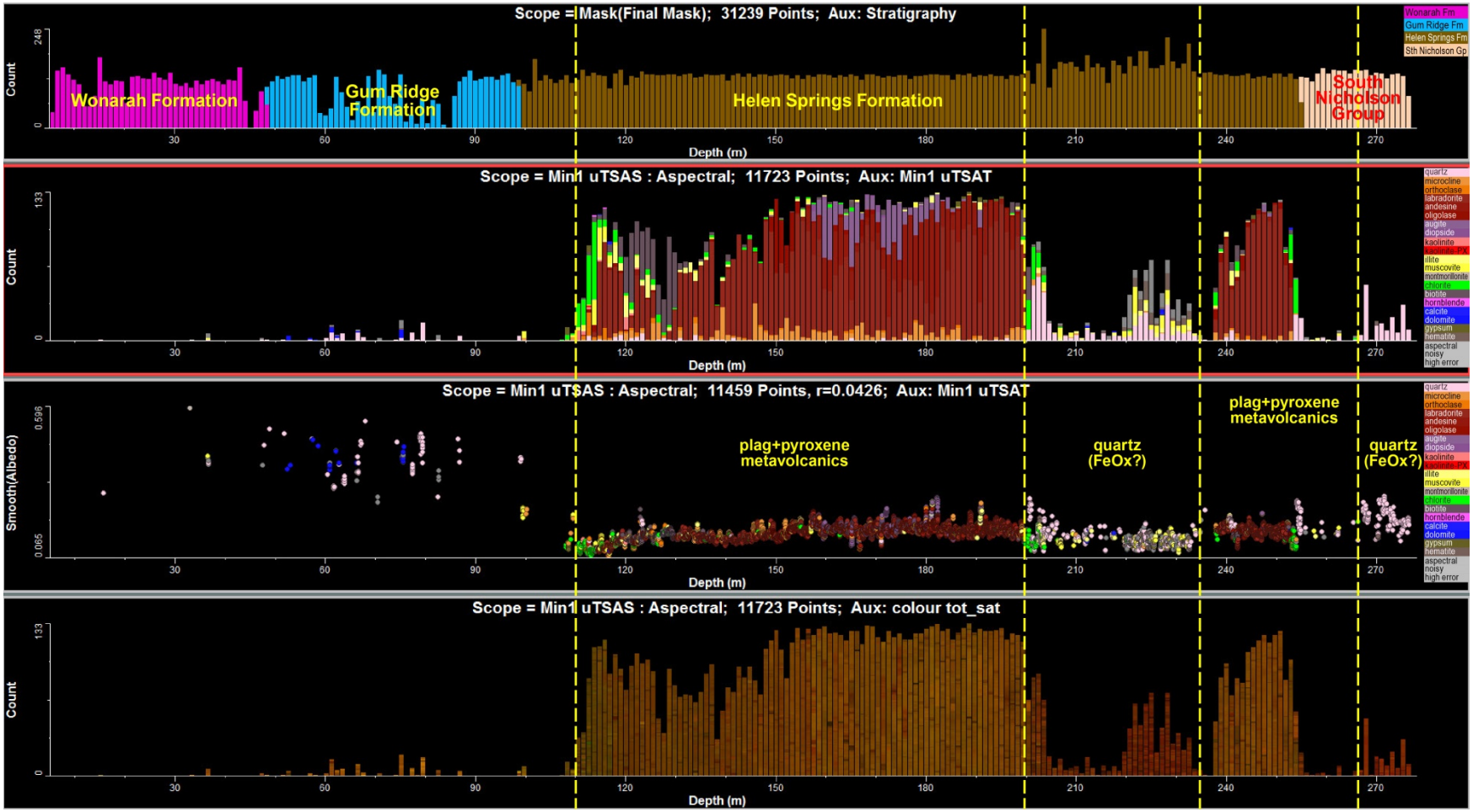
AY06DD01: White micas





Row 1 shows logged stratigraphy. Row 2 shows spectra which are dominantly white micas in the TIR (coloured by the dominant SWIR mineralogy). Row 3 shows SWIR spectra that are mainly white mica coloured by the dominant TIR mineralogy. Row 4 plots the wavelength of the diagnostic absorption for SWIR white micas (coloured by dominant TIR mineralogy) which shows a sharp change in wavelength (white mica composition) around 203 m (boundary between the logged metasediment and metavolcanics in the Helen Springs Volcanics). The inset shows a histogram of the wavelength of the diagnostic absorptions for white micas in AY06DD01. This indicates that there are 2 different white mica populations: one centred around 2210 nm and one around 2214 nm. This difference can also be noted in the South Nicholson Group (row 4).

AY6DD01: Aspectral response in SWIR



An aspectral response in the SWIR means that the spectra could not be matched to the TSAS library but it can be subdivided depending upon other features (such as colour, albedo, depth of 1900 nm absorption response). Row 1 shows logged stratigraphy. Row 2 is the aspectral response coloured by the TIR mineralogy. Row 3 shows aspectral response plotted by albedo (coloured by TIR mineral match). Row 4 shows colour. There are 4 main zones of aspectral SWIR response in AY06DD01 (dotted lines). The aspectral response is due to the presence of silicate minerals which have no diagnostic absorption features in the SWIR. The metavolcanics are dominantly plagioclase/pyroxene (light brown colour). The quartz white-mica (reddish colour) highlights ferruginous metasediments.

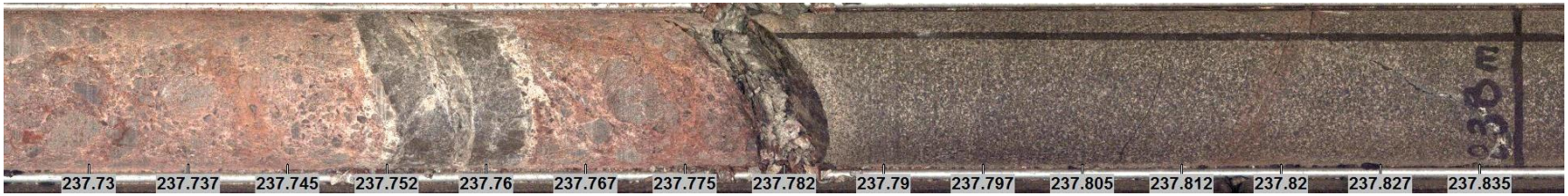
AY06DD01: Petrography vs HyLogger results

Depth (m)	Rock Name	Minerals	Description / Remarks	HyLogger Mineralogy	Comments
171.1	plagioclase-porphyritic dolerite	abundant plagioclase, clinopyroxene, common smectite. Vein quartz/carbonate	Weakly altered dolerite with a cross-cutting quartz vein. Plagioclase phenocrysts with abundant groundmass plagioclase with weak sericite alteration. The smectite may have replaced olivine or another altered pyroxene.	SWIR; 'aspectral', minor hornblende. TIR; labradorite/anorthite/oligoclasie, muscovite, augite/diopside. Minor quartz (vein?). Some goethite/hematite in VNIR.	HyLogger response for adjacent area as quartz-carbonate vein shows quartz. Mainly plagioclase but unsure of which plagioclase mineral. Some pyroxene (matches to both diopside and augite). Aspectral in SWIR due to plagioclase and pyroxene having no features in SWIR. Strong ferrous response in VNIR/SWIR.
209.8	quartz lithic greywacke	limonite+ sericite + quartz, lesser microcline.	Field rock name of basalt; petrographic rock name is greywacke. Matrix-rich sand-sized sediment or greywacke with abundant lithic grains. Veins of quartz with interstital carbonate	SWIR (aspectral / phengite); TIR quartz/muscovite/hematite/illite. VNIR has 'not in library'.	Definite Fe oxide response in VNIR (possibly from limonite?). Strong quartz in TIR with lesser illite/white mica. Not seeing microcline in spectra.
233.9	quartz mudstone breccia	sericite 50%; chert 36%; quartz 10%; Fe oxides 3%; dolomite <1%	breccia of quartz and ?mudstone lithoclasts now altered to chert + sericite	SWIR - phengite, phengitic illite; TIR quartz/muscovite/hematite/illite. VNIR has 'not in library'.	Sericite corresponds to muscovite/illite/phengite. Fe oxides not matched in VNIR but has Fe oxide feature.
242.2	fine-grained dolerite	abundant plagioclase, common clinopyroxene, minor smectite, v. minor quartz +/- K feldspar; sericite, accessory apatite	Partially sericitised plagioclase phenocrysts with a fine-grained plagioclase groundmass (rarely sericitised). An alkali feldspar vein has sparse plagioclase and quartz.	SWIR - 'aspectral' or 'not in library' with sporadic matches to hornblende with minor montmorillonite. TIR; labradorite, anorthoclase, Fe smectite, muscovite	Sample matched nearby as actual site is on cut core. Matches consistently to labradorite (plagioclase) in TIR with variable anorthoclase/albite/oligoclase/quartz. SWIR has minor matches to hornblende with minor montmorillonite
255	dolomitic sublitharenite / brecciated mudstone	quartz (47%), chert 25%, dolomite 25%, muscovite + sericite 3%	contact between basal Helen Springs Volcanics (with reworked quartz grains from Sth Nicholson Gp) and brecciated mudstone from Sth Nicholson Gp. Mudstone silicified to chert/sericite. Represents a regolith that was actively eroded to release quartz sand and lithic granules	SWIR - phengite (minor calcite some spectra); TIR microcline, quartz, albite, labradorite	Can see minor carbonate in TIR but not as primary TSA match. Microcline response strong (?)
276.2	quartz arenite	quartz (89%), chert 5%; Fe oxides/clays 5%; muscovite 1%; accessory tourmaline	bimodal quartz arenite with lenticular tracts of micaceous mudstone	SWIR; dickite, minor muscovite TIR; quartz, kaolinite	Can definitely see kaolin group in SWIR and quartz with minor kaolinite in TIR. VNIR has 'not in library' for Fe oxides.

NTGS Record 2008-001 has several petrography samples. The above table compares mineralogy from the petrography report with HyLogger data. Microcline is not recognised in quartz lithic greywacke in TIR spectra but it is also a minor constituent. Kaolinite is not recognised in petrography samples but has very clear spectral features and is less likely to be easily distinguished in thin sections. Fe oxides seem present in spectra but mainly returned as 'not in library' in VNIR. Some samples (like 'fine-grained dolerite' at 242.2 m) appears to have heterogeneous mineralogy (from petrography) and the corresponding spectra showed mineral variation (between spectra). 'Aspectral' SWIR is often due to quartz-rich rock.

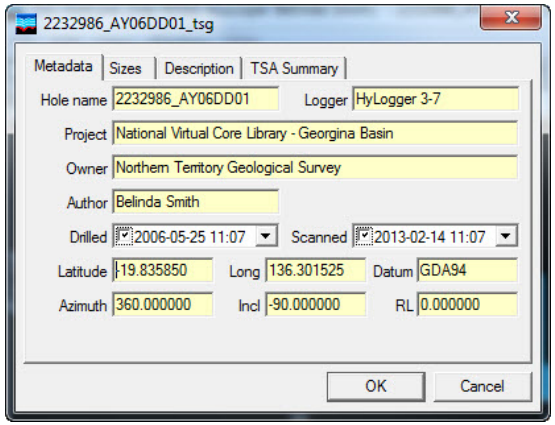
AY06DD01: Summary of HyLogger data interpretation

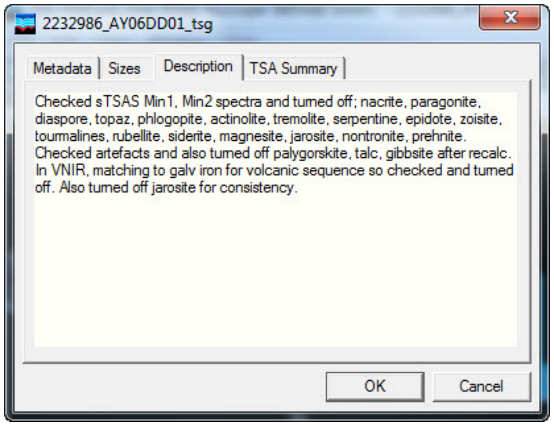
- There are very distinct mineralogy zones, sharply defined by stratigraphic contacts.
- There are also sharp contacts in mineralogy within stratigraphic units, such as the quartz/white mica zones (metasediments) within the Helen Springs Volcanics.
- There are possibly 2 (or more) white mica populations, possibly within the South Nicholson Group.
- Chlorite occurs as a selvedge around the metavolcanics (dolerite?).
- The HyLogger results noted kaolinite which did not appear present in thin sections but may have been identified as ‘clays’ in thin sections. XRD would be required to confirm the kaolinite although the spectral response shows clear kandite doublets that would characterise kaolin minerals.

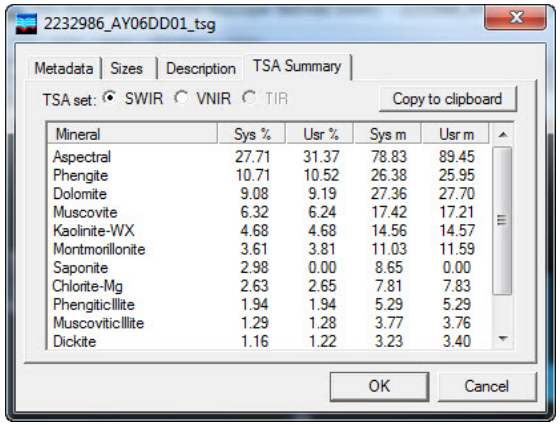


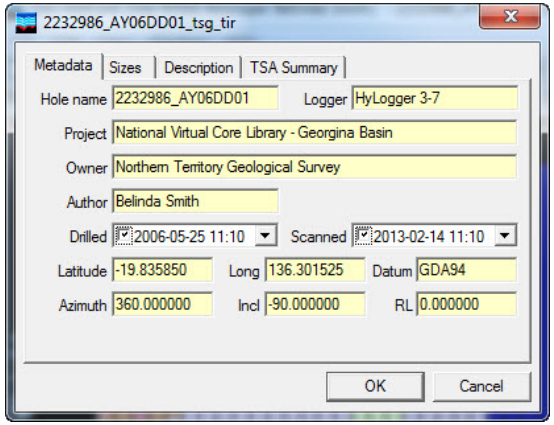
Contact between brecciated conglomerate (left) with metavolcanics of the Helen Springs Volcanics in AY06DD01

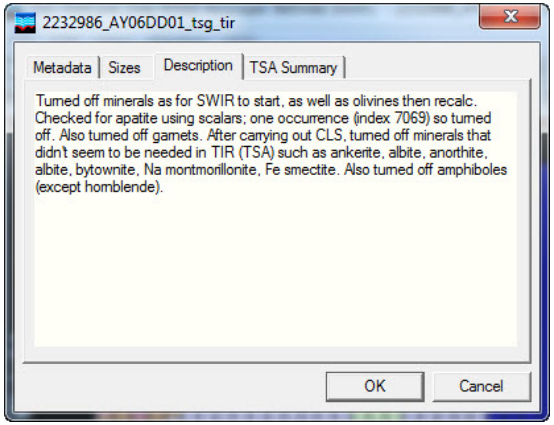
AY06DD01: TSG metadata

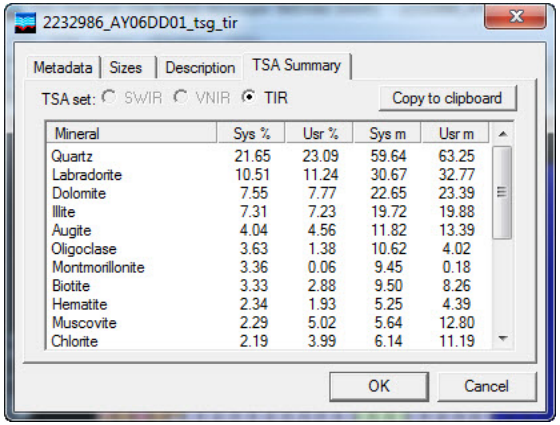












HyLogger specifications

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

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

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

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

Glossary

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

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

Guide to scalars in figures produced using TSG software

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

2200 wvl 2nd deepest	FeatEx scalar that measures the wavelength of the second deepest absorption feature from 2200nm +/- 50nm. Designed to measure the wavelength of the kandite doublet, which has a variable wavelength depending on whether it is kaolinite or dickite.
2325 CO3 Pfit wvl	PFIT scalar to measure the wavelength of a trough minima between 2290–2370 nm with a depth >0.05; polynomial order 8; hull envelope divided by reflectance reported as wavelength at minimum in nm. Used mainly to analyse carbonate composition changes by observing wavelength changes in the dominant absorption feature for carbonate in the SWIR.
Apatite 9200 pfit d	PFIT scalar created by J.Huntington to confirm the TSA apatite response. Measures the wavelength of the minimum trough between 9192 nm and 9270 nm with a depth of >0.0006; polynomial order 6; hull envelope subtract base reflectance to give a relative depth.
Aux	Aux in a plot indicates the parameter that is colouring the points (bars in bar plot, points in scatter plot) in a figure. Eg; Aux: stratigraphy indicates that the colours relate to stratigraphy. The key to the Aux colours are on the right side of each plot.
Aux match scalar	Aux matching involves simple curve matching between spectra in a main dataset and spectra in a Aux (Auxiliary or Custom) dataset. The Aux dataset is usually a custom library containing special hand-chosen spectra which have been interpreted in detail.
Carbonate 6500nm wvl	Experimental batch scalar created by CSIRO derived from the reflectance of the 6500 nm wavelength peak. Used to determine differences in the wavelength of the peak around 6500 nm, which shifts with different carbonate compositions.
Carbonate 11300nm wvl	PFIT scalar to measure the wavelength of the peak maxima between 11000–11580 nm with a height of >0.04; polynomial order 9; hull envelope subtract base reflectance to give wavelength at maximum.
Christiansen Minimum	Experimental batch scalar created by CSIRO which plots the Christiansen Minimum wavelength. The Christiansen Minimum occurs when the refractive index of the sample approaches the refractive index of the (medium) air surrounding the mineral grains, resulting in minimal scattering and minimal reflectance (Conel, 1969). The Christiansen Minimum wavelength varies according to composition, so measuring the Christiansen Minimum wavelength can differentiate igneous rock compositions in the TIR.
Colour tot_sat	TSG standard scalar; it calculates the colour (separately per band) from the linescan raster and it is enhanced by a 'total saturation' (the S band is 'wired to 1'; no pastels'). Refer to TSG Help Manual for more explanation.
Count	The feature frequency plots are bar plots with y-axis = count. The count is cumulative number of features within a bin. The bin size will vary according to the x-axis, which might be depth, wavelength in nanometres etc.
FEATEX scalar	"FEATEX" scalars uses a Feature Extraction algorithm in TSG to calculate the depth, width and/or wavelength position of a spectrum's absorption features. The FEATEX scalar uses pre-calculated feature extraction information using TSG's default algorithm.
Felsic-Mafic Index Wvl	Experimental batch scalar created by CSIRO which maps the peak wavelength between 7500 and 12000 nm from a 4th order polynomial. Shorter wavelengths are more felsic than longer mafic ones. Most carbonate-bearing samples are excluded.
FeOH pfit DEPTH	PFIT scalar to measure the depth of a trough minima between 2240–2270 nm with a depth >0.04; polynomial order 10; hull envelope divided by reflectance reported as relative depth.
FeOH pfit wvl	PFIT scalar to measure the wavelength of a trough minima between 2245–2260 nm with a depth >0.04; polynomial order 10; hull envelope divided by reflectance reported as wavelength at minimum in nm. Used mainly to analyse chlorite composition changes.
FeOx Intensity (alt)	TSG standard scalar (batch scalar) which ratios the reflectance at 742 nm / reflectance at 500 nm to give the Fe slope.
Grp 1 Min	Group (coarse level) index of the primary mineral group component in a TSA result. Mineral groups include carbonates, white micas, pyroxenes etc. Grp2 Min would be the secondary/minor mineral group component in a mineral mix.
Hydrocarbon Presence	A PFIT scalar designed to measure the presence of an absorption feature at 1730nm which is often found associated with oil bleeds. Another scalar designed to identify hydrocarbons is the 23140nm PFIT scalar. Using both scalars together can identify oil bleeds when the spectral response is preserved (it can deteriorate over time).

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

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

Excerpt from Huntington & Mason 2010

1.1 Basic HyLogging Product Levels

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

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