



HUNTINGTON
HYPER SPECTRAL

HyLogged Mineralogy of Drill Hole 45134 YT02 Selina 2 Tasmania

Prepared for Yunnan Tin December 2016

Final

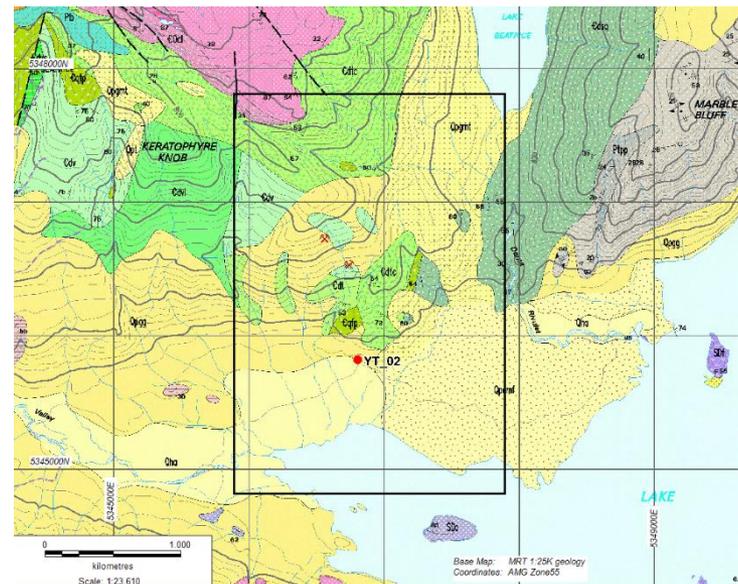
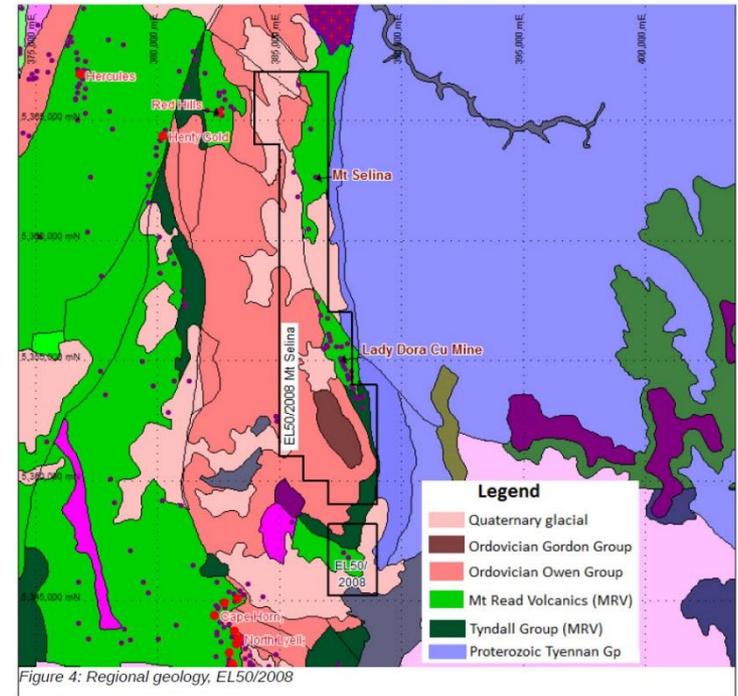
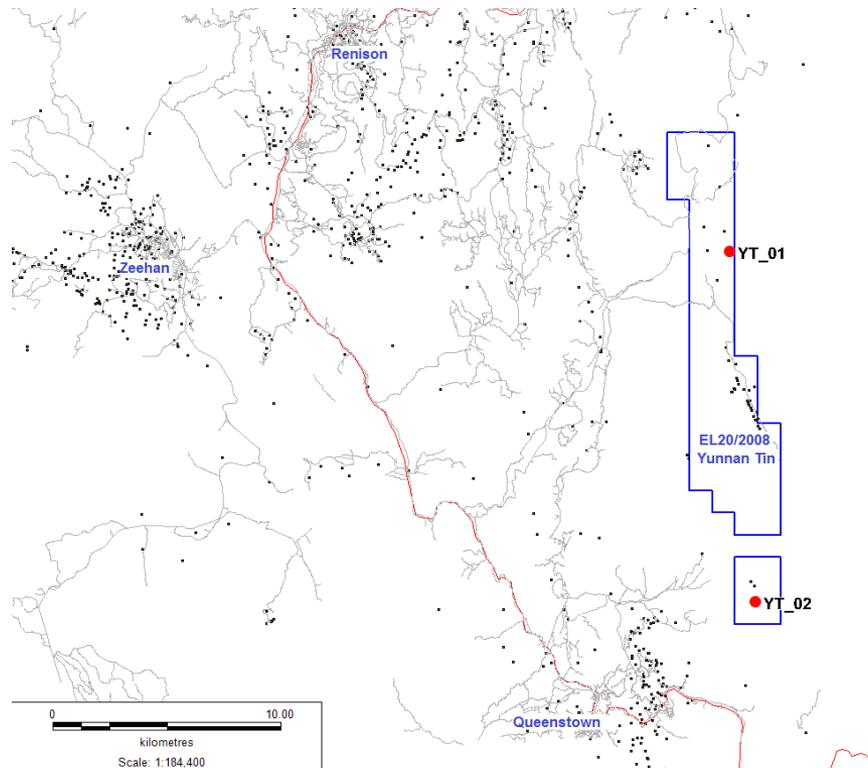
Contact

M +61 (0)408 221 934

34 Craiglands Avenue
Gordon NSW 2072
Australia

Introduction & Location

Two drill holes, YT01 & YT02, known as Selina 1 & Selina, located in EL 20/2008 have been HyLogged to objectively characterise their contained host rock & alteration mineralogy. This page provides location for the two holes, and YT02 Selina 2 in particular, NE of Queenstown, Western Tasmania.



Selina 2 Metadata

45134_YT02_Selina_tsg

Metadata | Sizes | Description | TSA Summary

Hole name: 45134 YT02 Selina Logger: HyLogger 3-6

Project: EL50/2008 Mt Selina - YT02 - Western Tasmania

Owner/Cust: YTC Resources Yunnan Tin

Author: J F Huntington (CSIRO)

Drilled: 2014-12-23 08:44 Scanned: 2016-01-05 10:17

Latitude: 5345995.000000 Long: 387918.000000 Datum: MGA94 Zone 55

Azimuth: 77.000000 Incl: -50.000000 RL: 245.000000

OK Cancel

45134_YT02_Selina_tsg

Metadata | Sizes | Description | TSA Summary

Samples: 97755 total; 77714 (79.49%) after masking; sample=8mm

Wavelength: 380 to 2500 by 4 nm, chans=531

Depth: 0.00524 to 651.99 m, span=651.99 (517.03 after masking)

Scalars: System=46, core=11, user=90, total=147

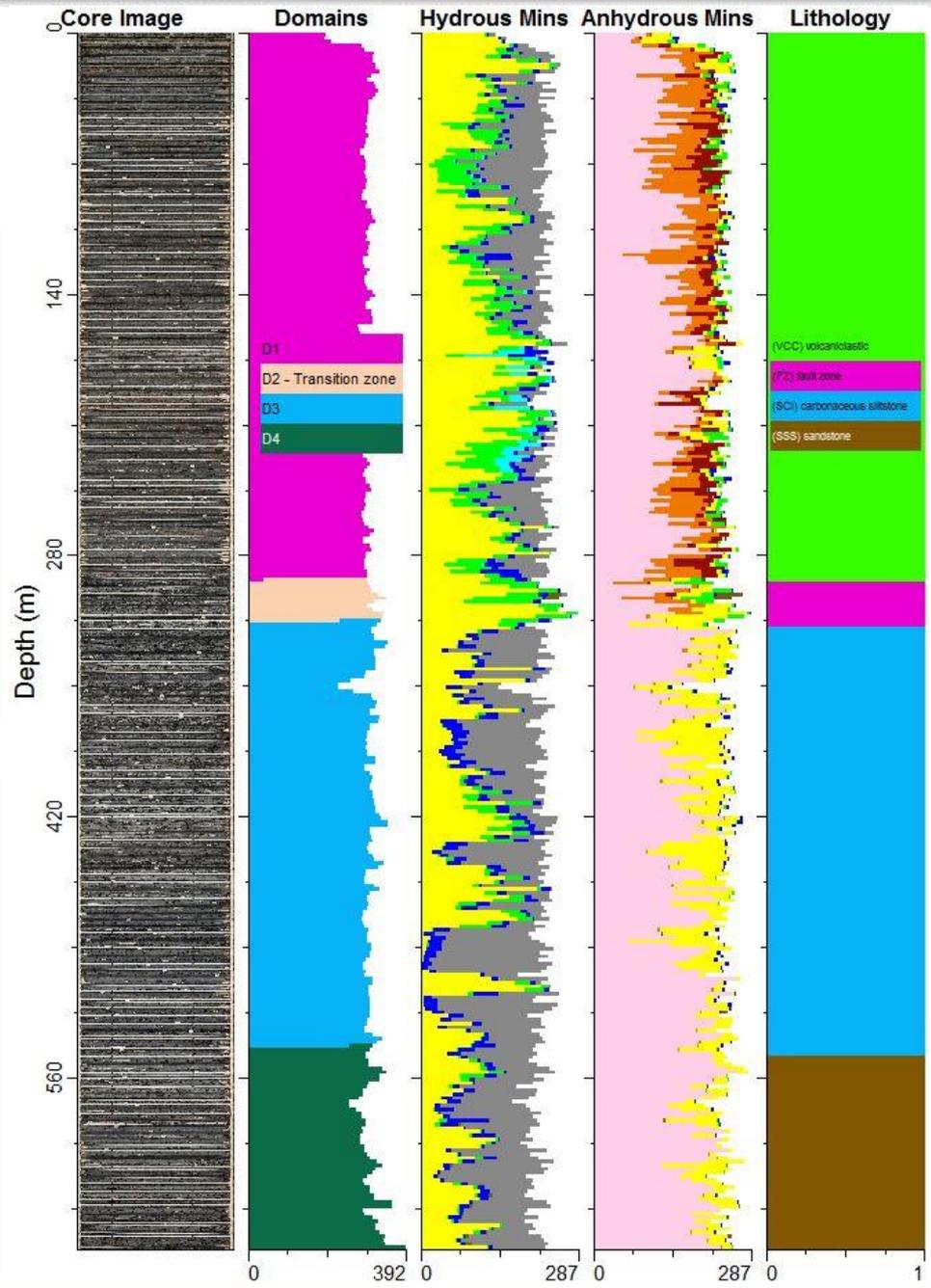
Linescan: Lines per sample=124, width=1380, JPEG quality=80

Profilometer: Measurements per sample=128

Disk size (MB): Sp1:405, Sp2:263, img:1531, prof:48, pic:0, tot:2247.36

Size / m (MB): Sp1:0.62, Sp2:0.40, img:2.35, prof:0.07, pic:0.00, tot:3.447

OK Cancel

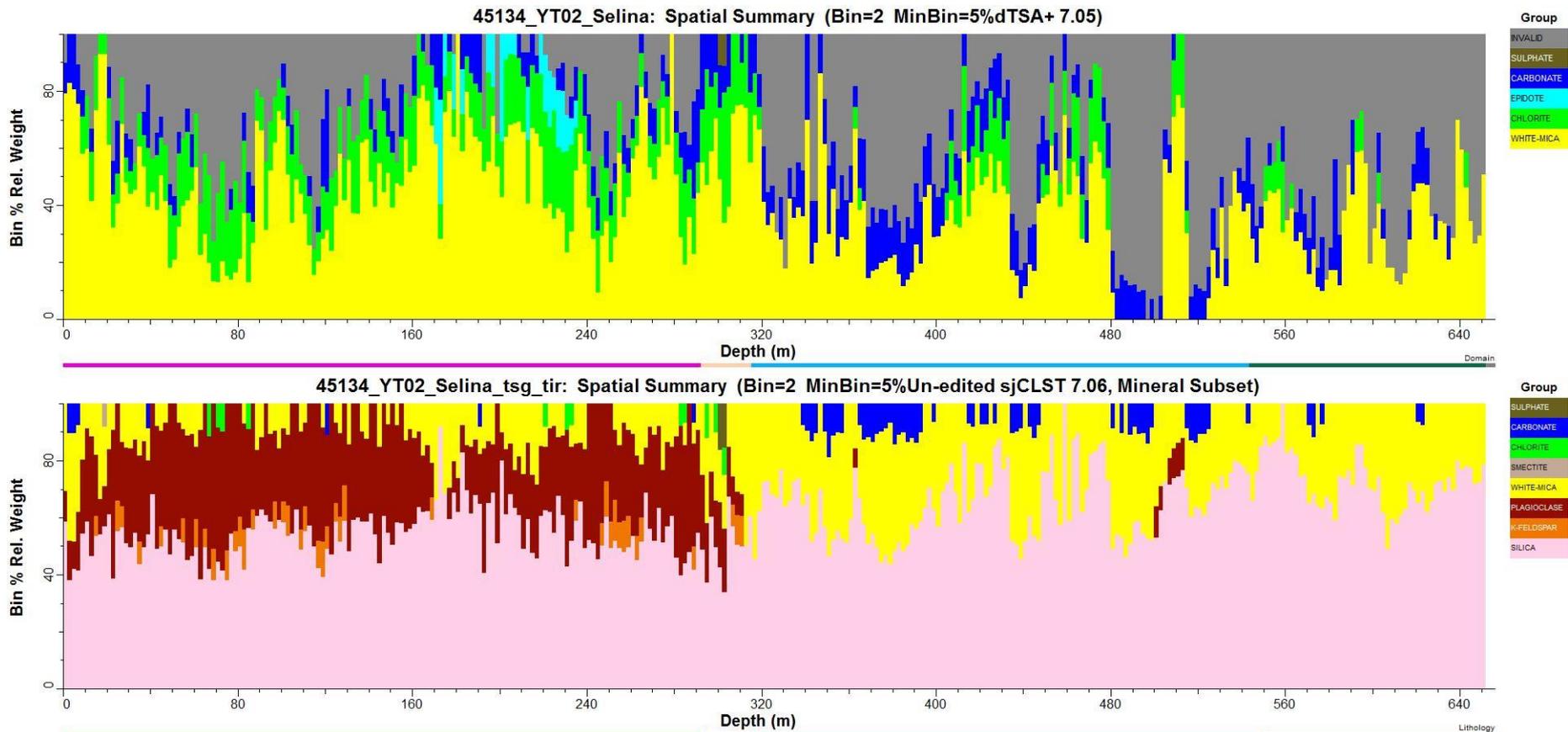


Provided Log

	Depth From	Depth To	Lithology	Lithology Description
11421	0.00	293.00	(VCC) volcaniclastic	Chloritic(green)-hematitic(purplish red), matrix-supported(massive, angular-subround crystal and lithic fragment), polymict, chaotic, lithic rich(subangular-subround mudstone, quartzite and breccia clasts), volcaniclastic breccia. Vein:qtz-cct+cht+fpr, variety of orientations. 169-183m large qtz-cct-cht-kfpr-epd(yellowish green)? vein with mnt rich sandstone wallrock intervals. Intermediate-strong magnetic response. Disseminated hematite. Top few meters weathered. Sharp contact. Lynchford Member?
11422	293.00	316.80	(FZ) fault zone	Fault breccia. Chloritic-sericitic, lithic rich(angular-round light grey carbonaceous rock), sandstone matrix supported(altered, green), breccia. Texture: slickenfibres, debris flows. Vein:quartz-carbonate-chlorite. Massive sulphide: @296.5m. Zn~500ppm, Pb~250ppm, Cu, As, pyrite... Gradational contact. Basement? low metamorphic grade Tyennan Region Metasediments?
11423	316.80	479.00	(SCI) carbonaceous siltstone	Mainly dark grey siltstone with angular-round carbonaceous clasts, minor green silicified, graded sandstone. Texture:debris and mass flows, load structure(flame). Vein: quartz-carbonate. Carbonate depositional system(slope facies)? Tyennan Region Metasediments?
11424	479.00	548.00	(SCI) carbonaceous siltstone	Mainly laminated dark grey siltstone and light grey carbonaceous rock with silicified greenish-grey sandstone bed. Texture: bedded, laminated. Vein: quartz-carbonate. Tyennan Region Metasediments?
11425	548.00	653.00	(SSS) sandstone	EOH. Mainly silicified laminated/bedded medium-grey sandstone and dark-grey siltstone, minor carbonaceous rock. Vein: quartz-minor carbonate. Tyennan Region Metasediments?

Selina 2 - Mineral Group Summary

Top - Relative abundance of hydrous minerals + carbonates / 2 m interval. Greys = aspectral
Bottom - Relative abundance of anhydrous minerals + carbonates / 2 m interval
Upper ribbon shows spectro-mineralogical domains, the lower ribbon logged lithologies



Relative abundance of main hydrous mineral groups + carbonates / 3m

A – White micas

B – Epidote - in the middle of D1

C – Sulphates - peaks in the fault zone

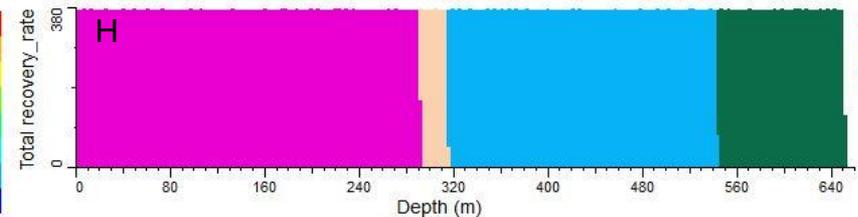
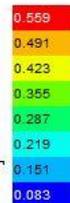
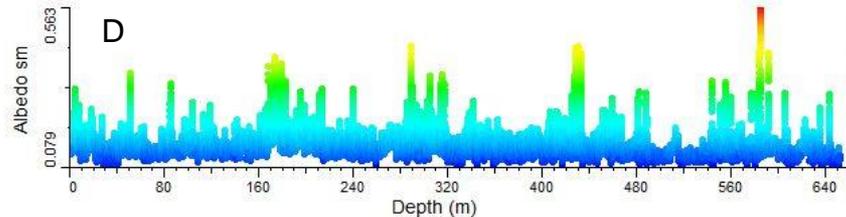
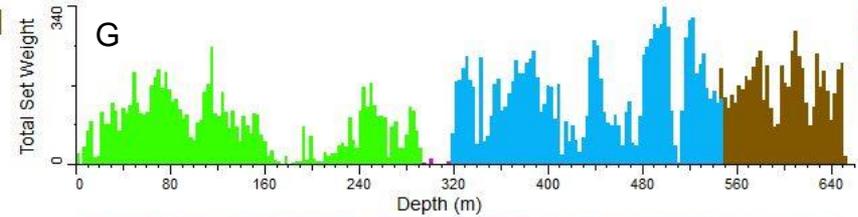
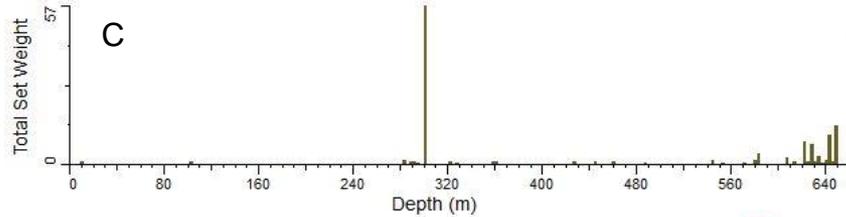
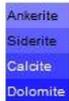
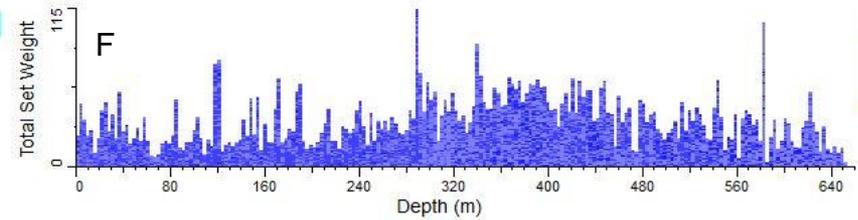
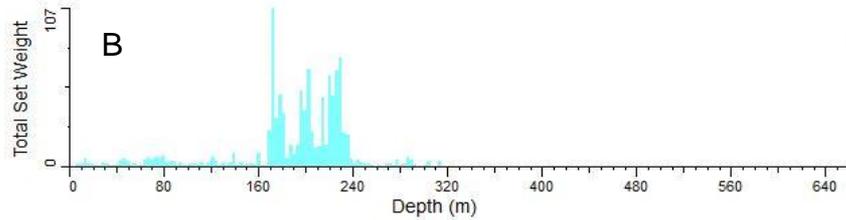
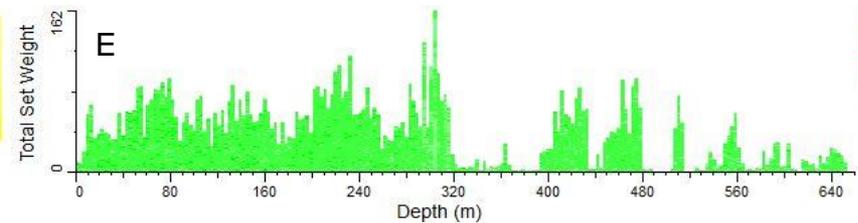
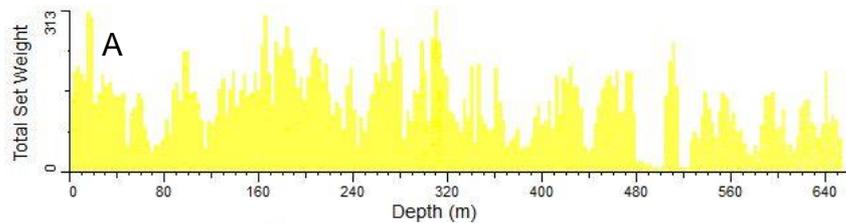
D – Core brightness - highs are mainly quartz veins

E – Chlorite - Different between domains 1 & 2 to 4

F – Carbonates - Mostly in D2 & in centre of hole

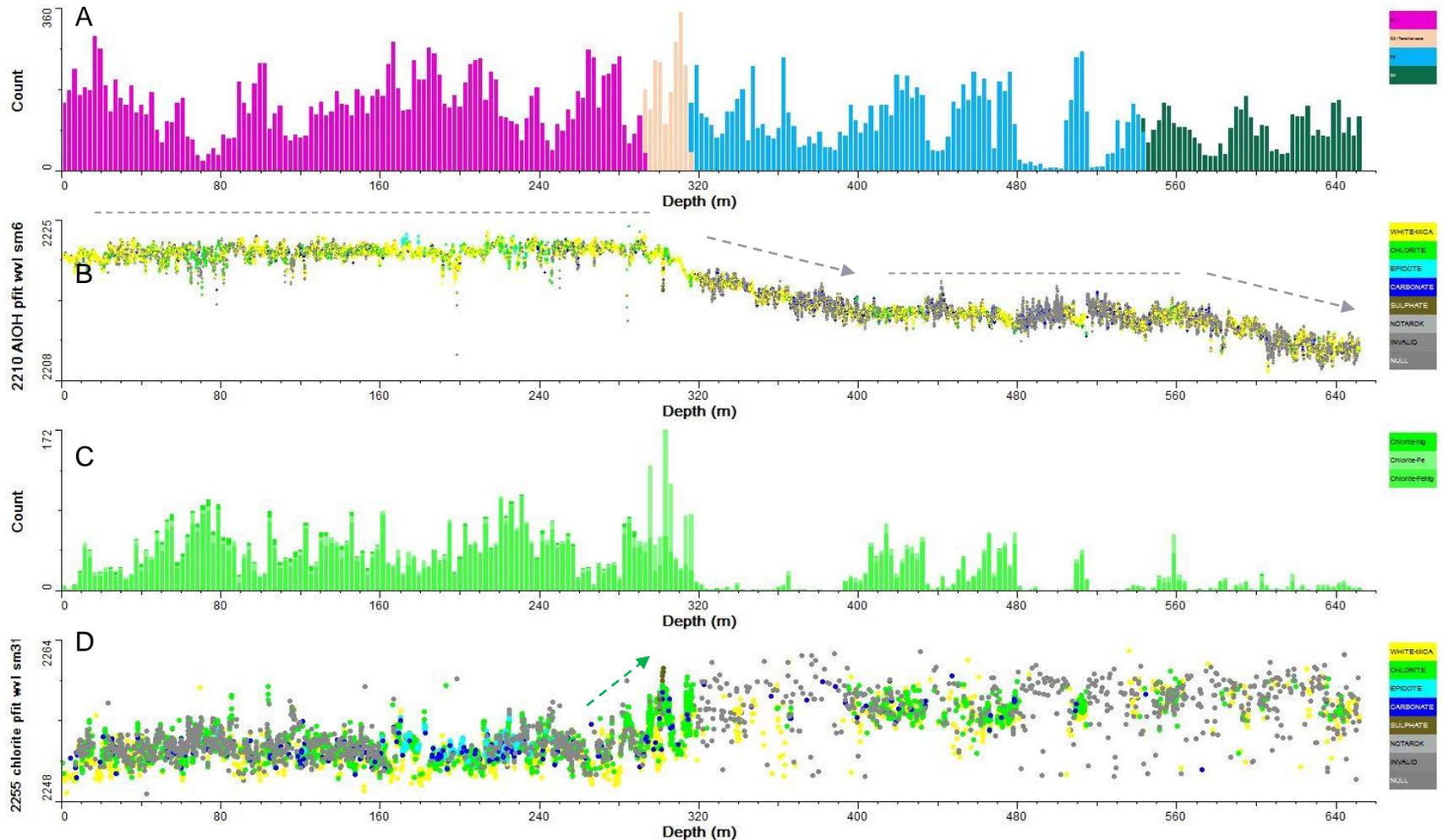
G – Aspectral - dark or featureless spectra coloured by lithologies

H – Domains - D1 mauve, D2 Fault zone pink, D3 blue, D4 green



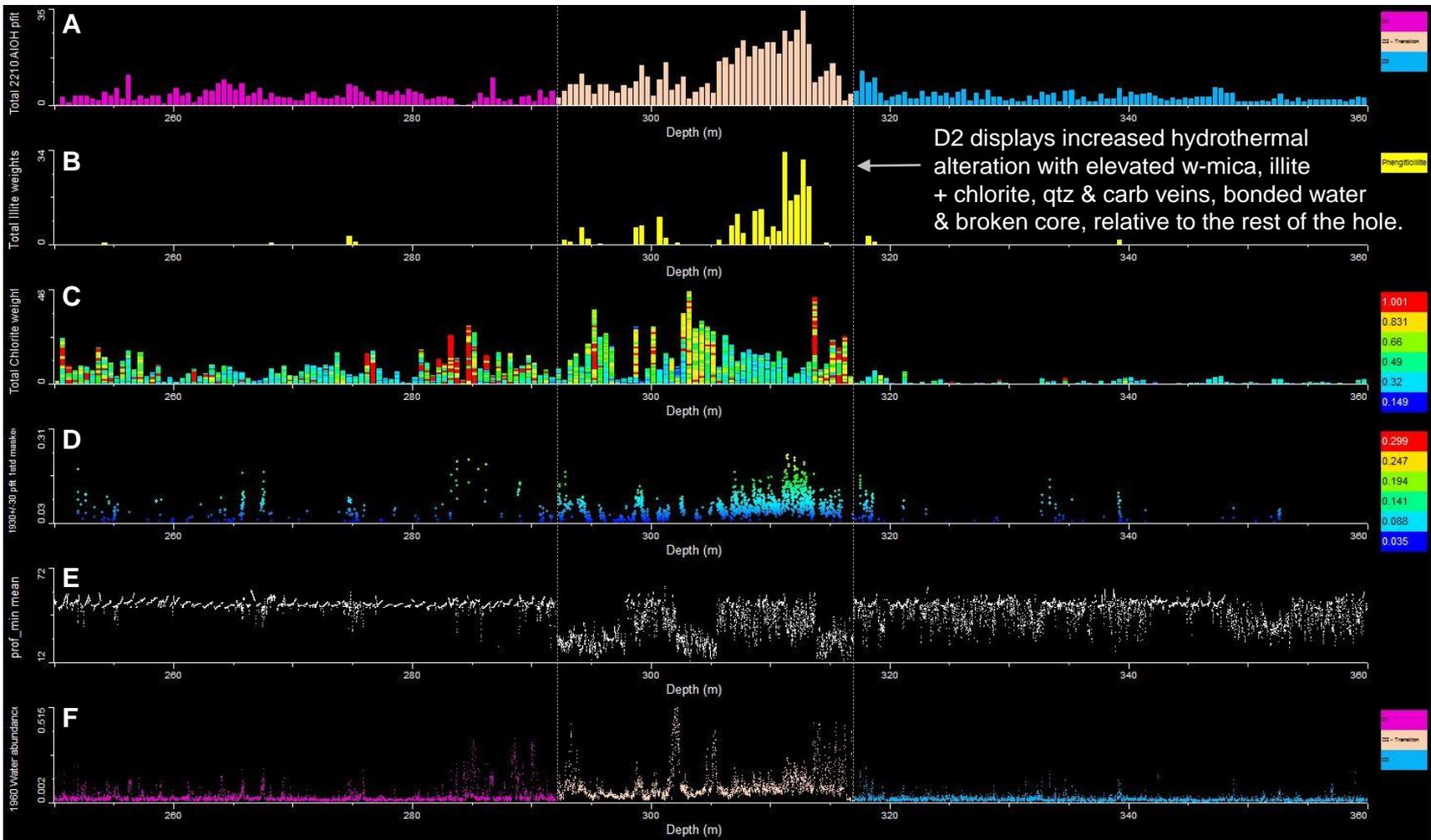
White-mica & Chlorite Abundance & Composition

A – White mica abundance coloured by domains. **B** – White mica composition. Al-poor in D1 then changes at the fault zone and grades across D2 and D3 with 3 possible sub-domains (dashed lines). **C** - Chlorite abundance is dominant in D1 and zoned in D3. **D** - Chlorite composition shows relatively more Mg-rich in D1 and more Fe-rich in D3 with possible gradation near fault zone (arrowed).



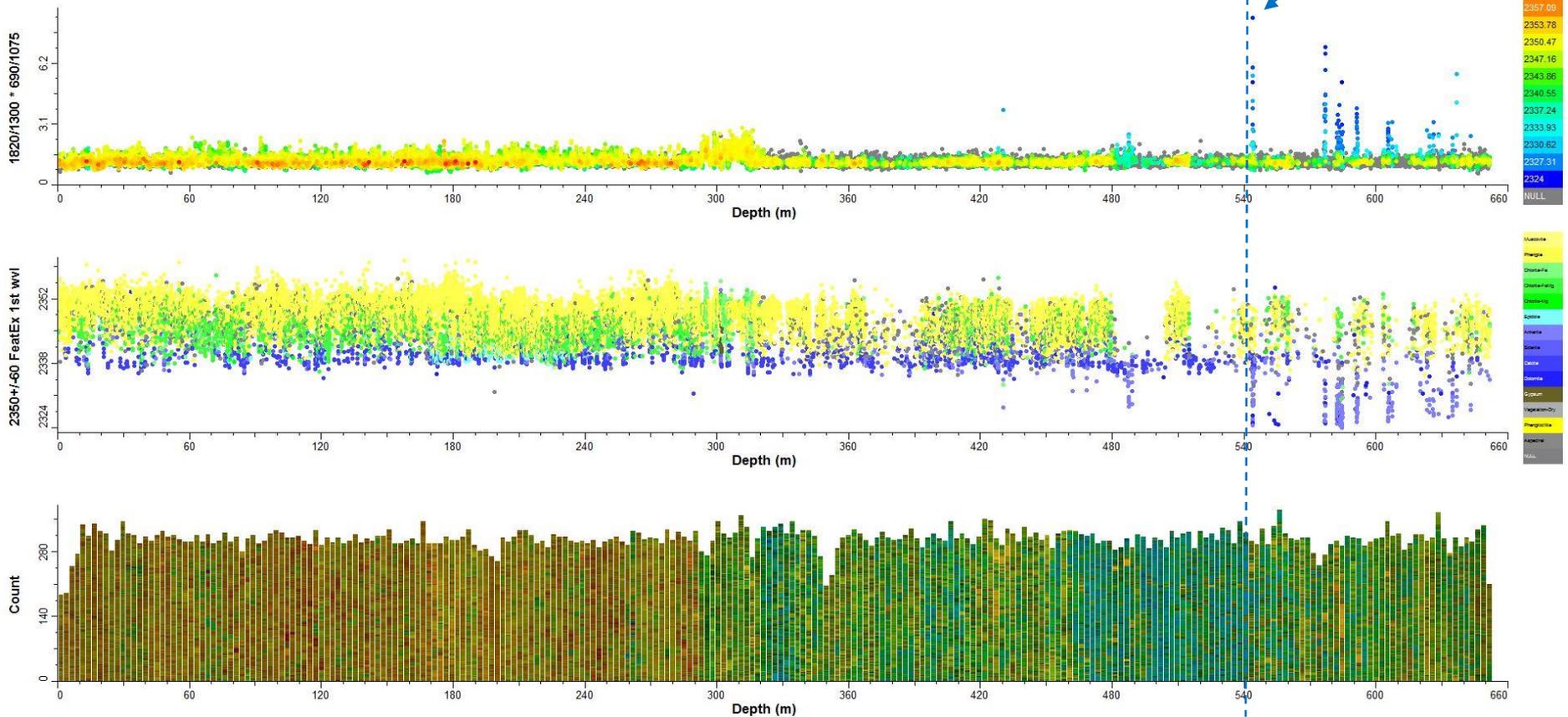
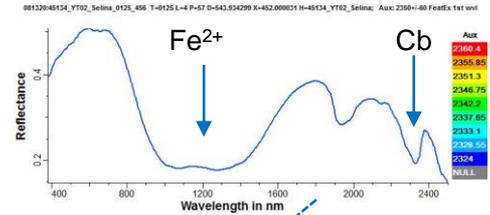
Fault Zone – Alteration – Zoomed-in View

A – Weighted AIOH feature depth per 0.5 m coloured by domains. **B** – Illite weights, **C** - Chlorite abundance. **D** – 1930 bonded water abundance (qtz veins + gypsum masked out), **E** – Core integrity (profilometer depth). **F** – Qtz+Carb veins.



Ferroan carbonate abundance and composition

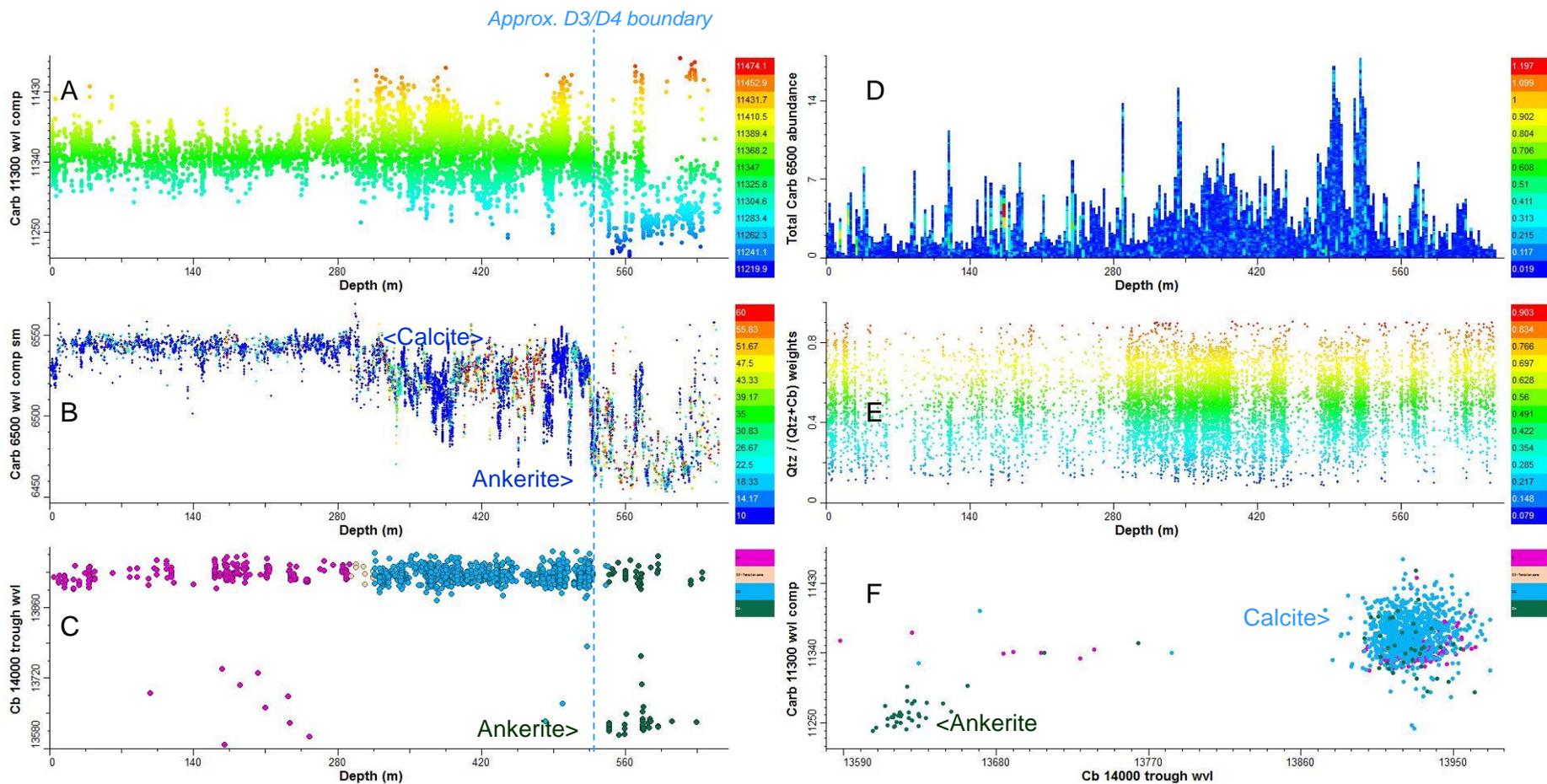
- A - Fe²⁺ feature depth for ferroan carbonate (ankerite) (see inset)
- B - 2350+/-60 nm feature depth showing short wvl carbonates in blue below 543m defining the start of domain D4 the logged Sst unit.
- C - Core colour



Carbonate relative abundance and composition

- A – 11300 Cb wvl composition variation. Note change @543m
- B – 6500 Cb wvl composition variation, colour by SWIR spectral ratio. Smoothed. Note change below ~543m
- C – 14000 Cb wvl composition coloured by domains

- D – 6500 Cb relative abundance
- E – Quartz / carbonate ratio showing alternating concentration below 400m, and increased overall abundance below 293m.
- F – 11300 vs. 14000 Cb plot differentiating the calcitic and ankerite domains

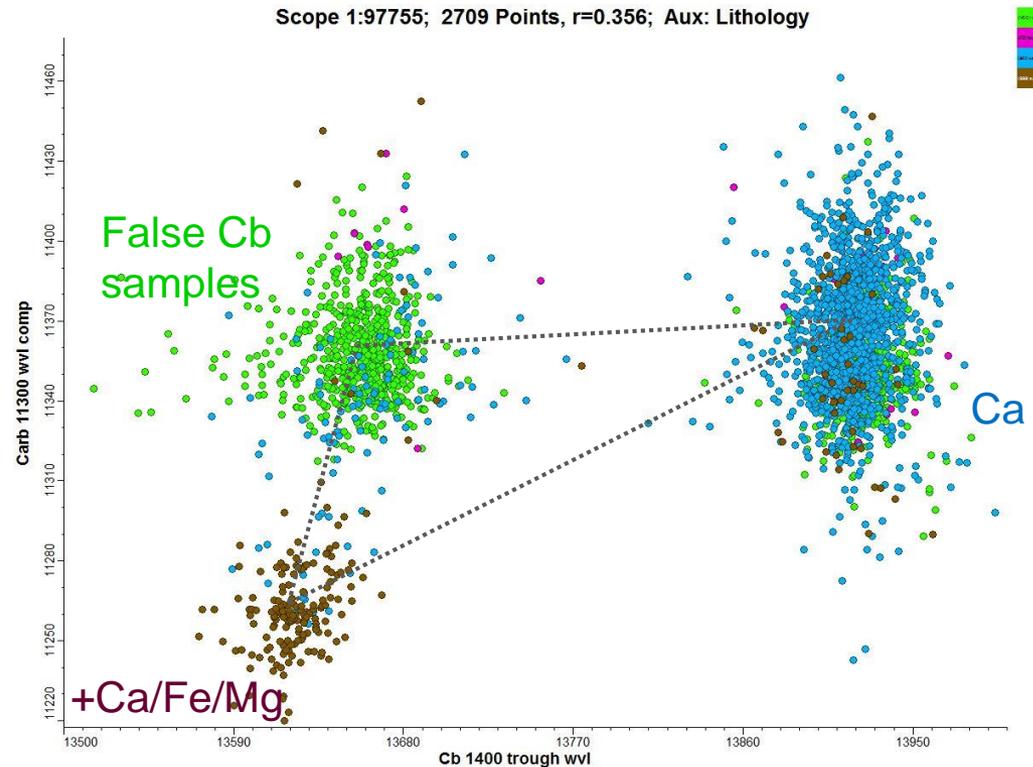


Carbonate composition vs. lithology - 1

A plot of the wavelength of the 14000 Cb absorption vs. the wavelength of the 11300 nm Cb peak (*Green & Schodlok, 2016*) coloured by the logged lithologies separates the three lithologies into three end-member domains based on their compositional characteristics.

This apparent three end-member subspace is however erroneous, as co-occurring feldspars (K & Plag), particularly in the volcanoclastic domain 1, plus epidote, have features that mimic or confound the 14000/11300 Cb behavior (*Green & Schodlok op. cit.*).

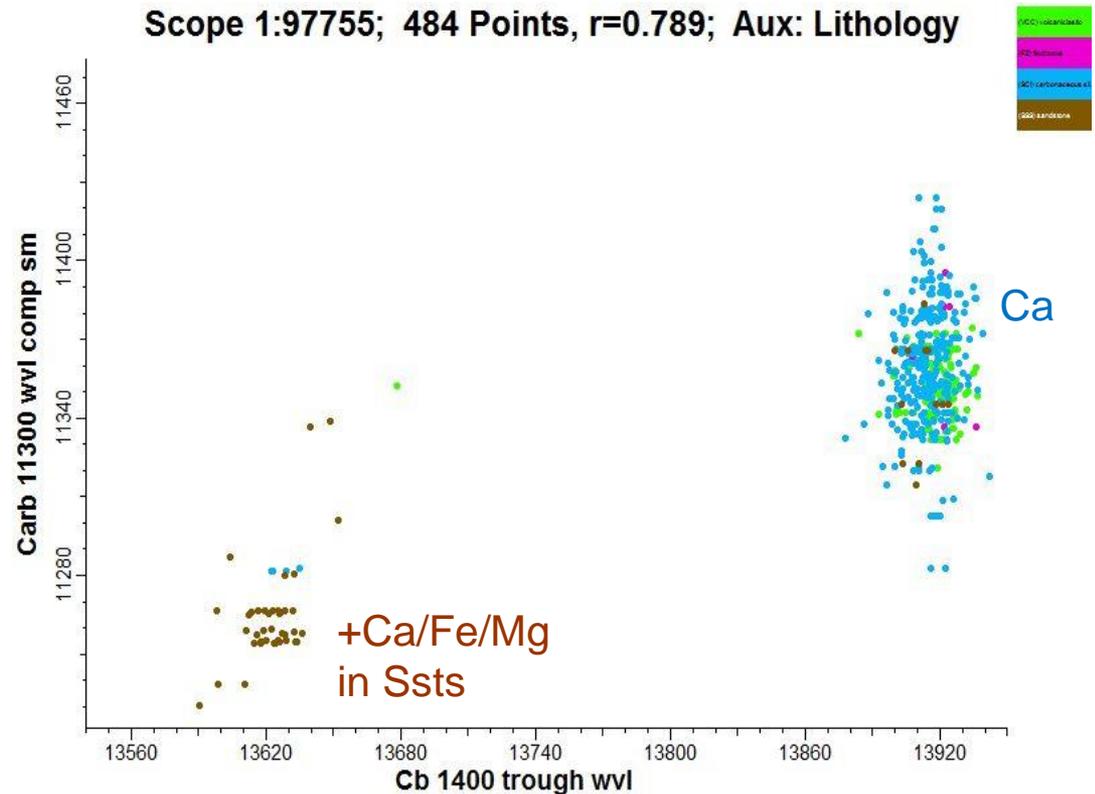
Co-occurring feldspars and epidote with carbonates need to be masked out.



Carbonate composition vs. lithology - 2

On this filtered plot the samples continuing all feldspars and epidote have been eliminated. Only two populations remain.

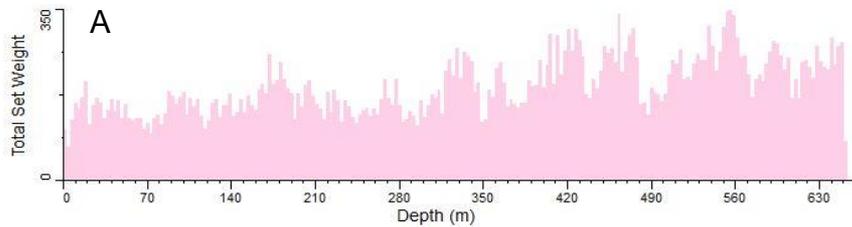
- A longer wavelength calcite domain occurring in the volcanoclastics and carbonaceous siltstone.
- A shorter wavelength ankerite-like domain occurring in the sandstone.



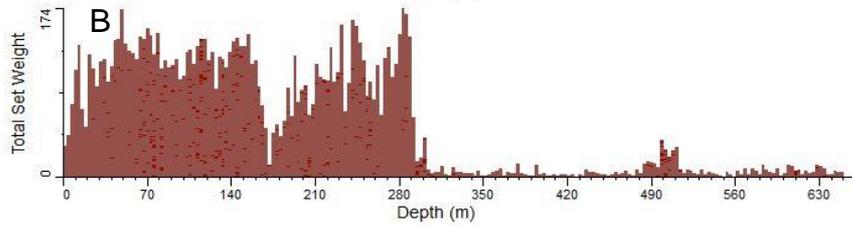
Relative abundance of main anhydrous mineral groups + carbonates & sulphates / 3m

A – Quartz
 B – Plagioclase – mainly in D1
 C – Epidote – in the middle of D1
 D – Felsic / mafic index – separate main mineral groups

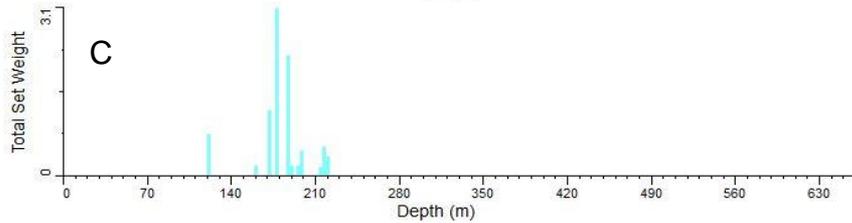
E – K-spar – mainly in D1
 F – Carbonates – most in D2 & in centre of hole
 G – Sulphates – mainly in fault zone (D2)
 H – Domains - D1 mauve, D2 Fault zone pink, D3 blue, D4 green



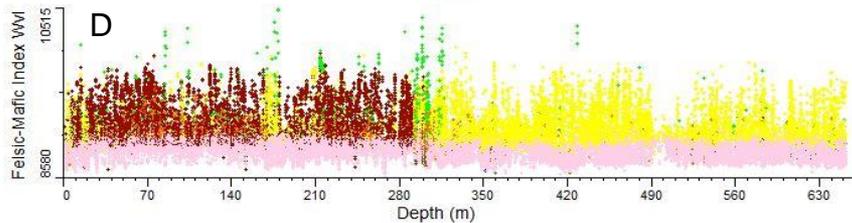
Quartz



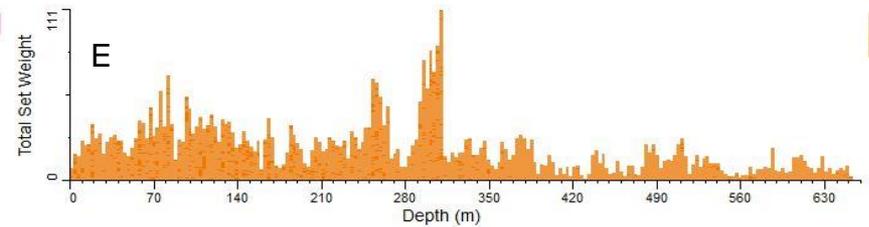
Albite
 Labradorite
 Andesine
 Oligoclase



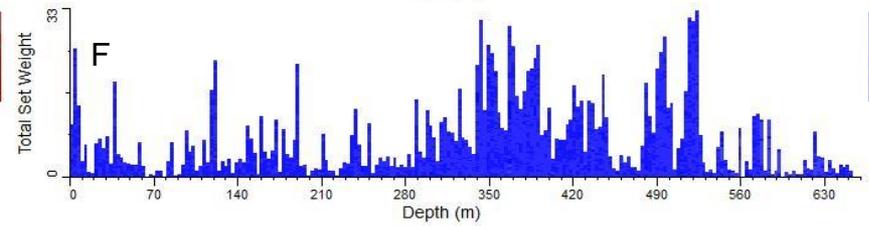
Epidote



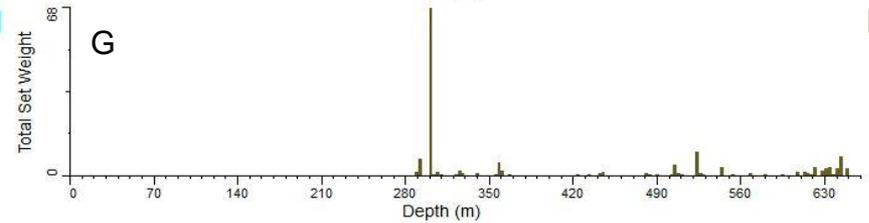
SILICA
 K-FELDSPAR
 PLAGIOCLASE
 AMPHIBOLE
 QUARTZ
 BIOTITE
 EPIDOTE
 CARBONATE
 SULPHATE
 MULL
 NULL



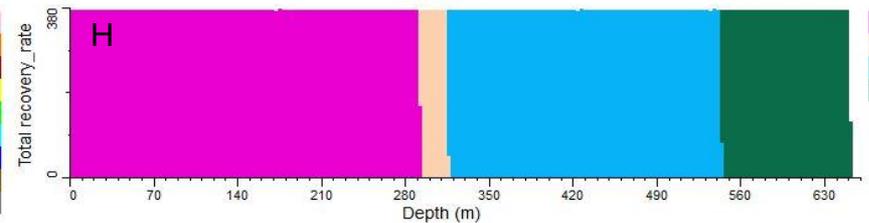
Microcline
 Orthoclase



Ankerite
 Siderite
 Calcite
 Dolomite



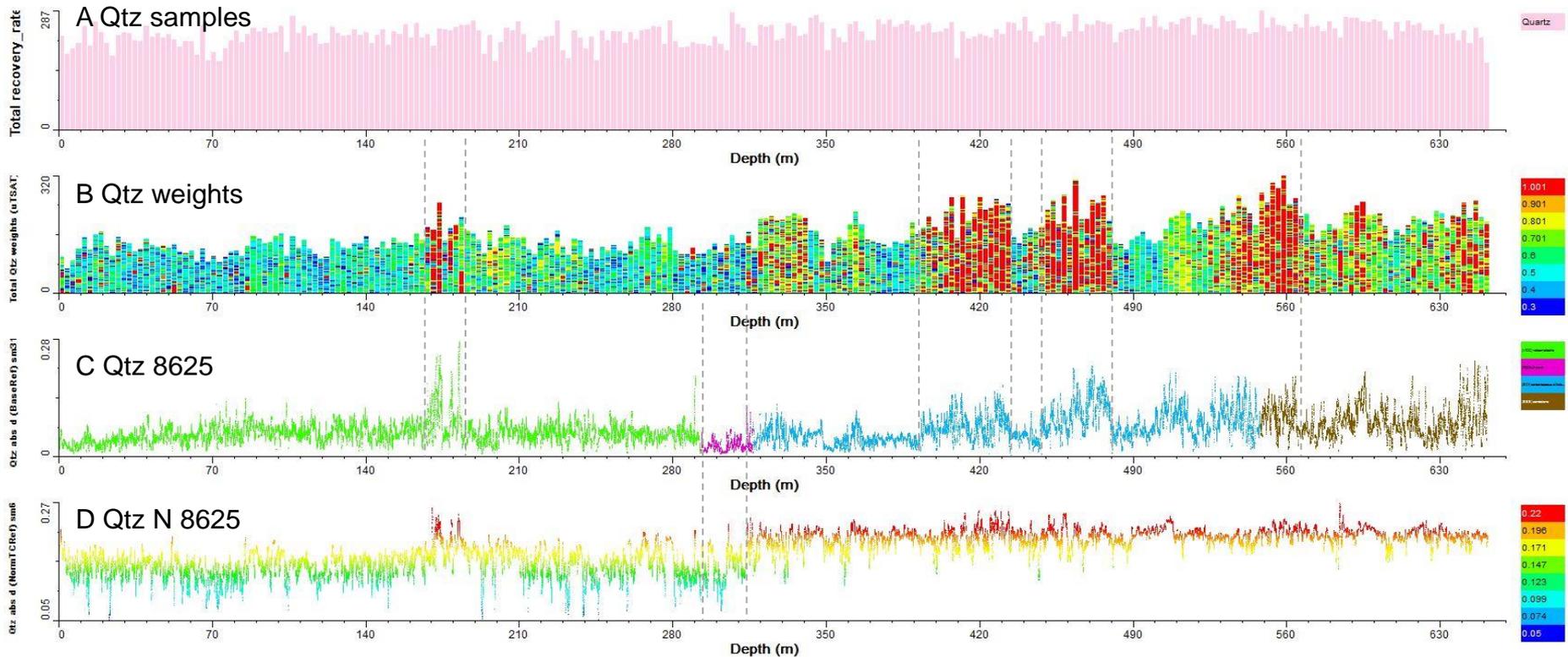
Gypsum



D1
 D2
 D3
 D4

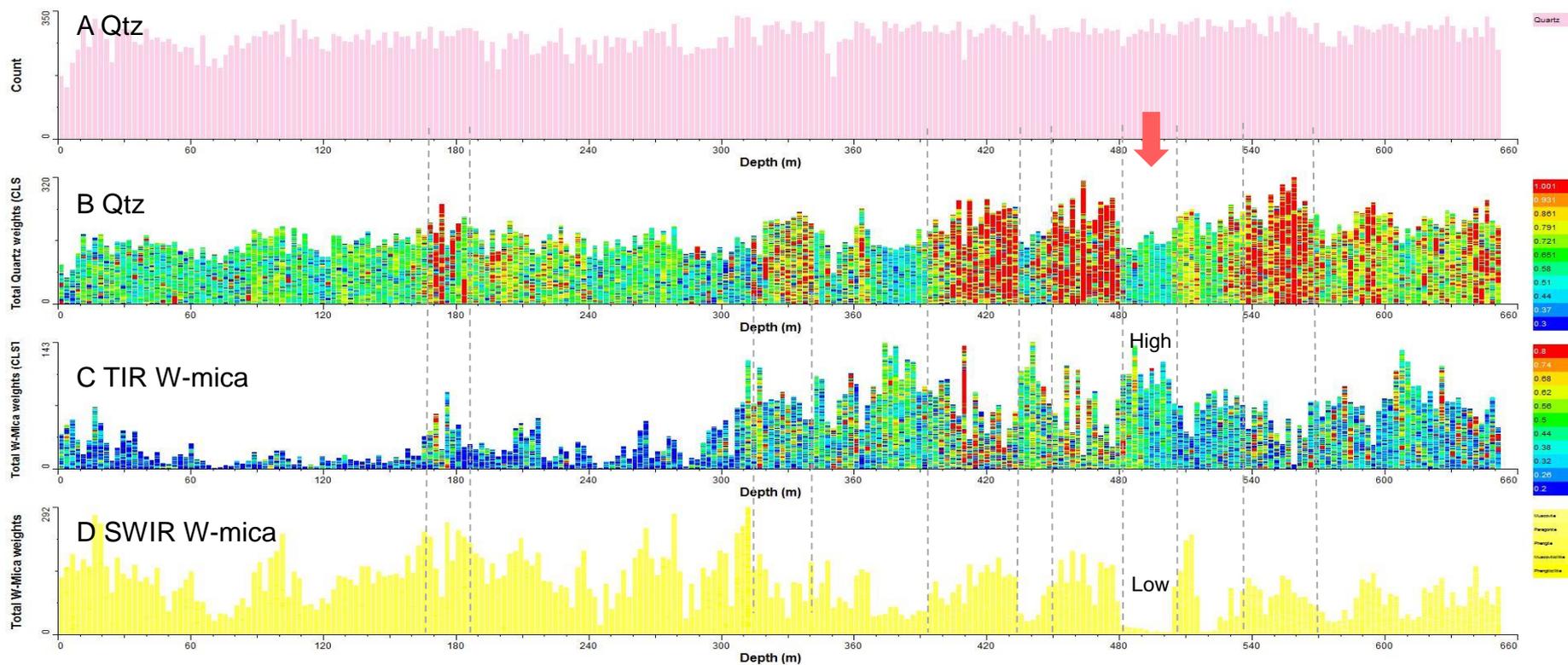
Quartz distribution - 1

On a sample basis quartz appears ubiquitous but varies considerably in relative proportion with other minerals. Plot **A** all quartz-bearing samples; Plot **B** histogram of quartz proportions (weights) per 2.5m interval emphasizes qtz-rich zones especially in domain 3; Plot **C** depth of qtz 8625nm absorption scalar coloured by logged lithology showing the same as plot **B** but on a per sample basis; Plot **D** half metre smoothed, normalised 8625 nm absorption depth, emphasizing the overall lower relative quartz abundance in domain 1, due to mixing with ubiquitous feldspar, w-mica and chlorite versus a simple qtz+w-mica +/- carbonate & k-spar assemblages in D3 and D4.



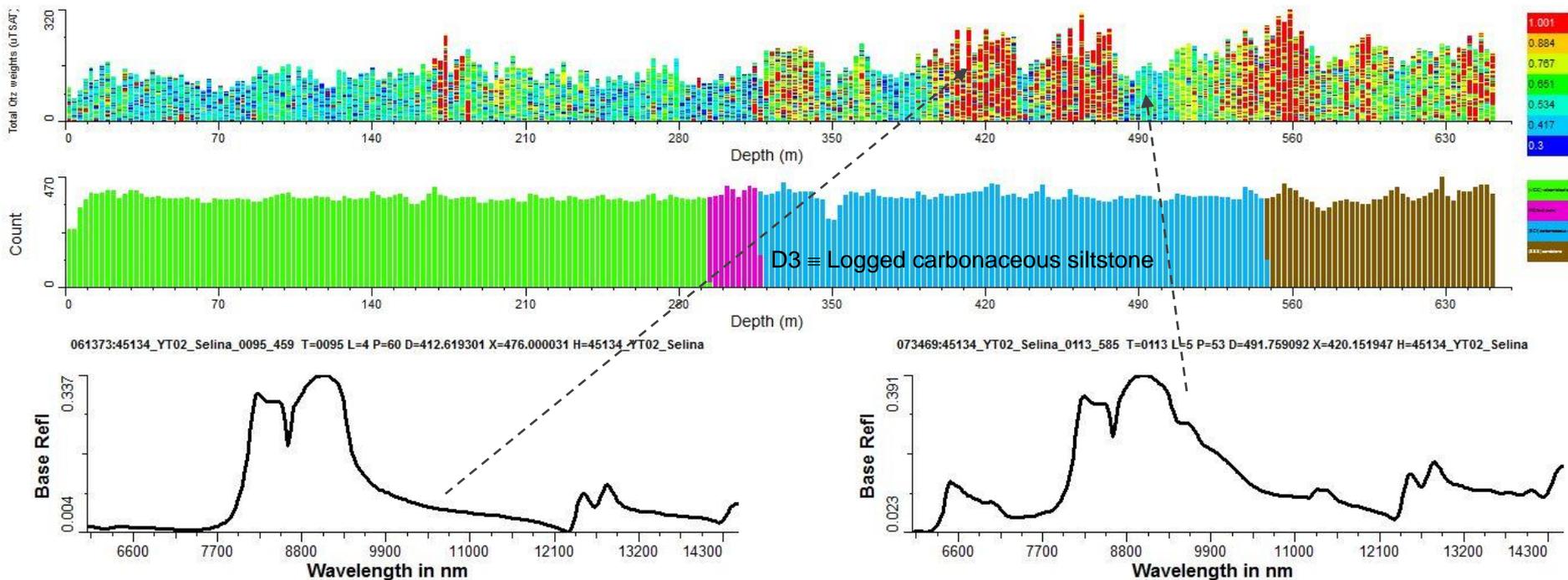
Quartz distribution - 2

These plots illustrate that relative quartz lows in plot **B** (arrowed) correspond to relative white mica highs in the TIR W-mica proportions (plot **C**). This is at variance with the white mica distribution mapped in the short wave infrared (plot **D**), where white micas are commonly more sensitive. The white mica lows in domain 3 in Plot **D** correspond to zones of SWIR spectral classifications. The cause of this disparity is probably due to the carbonaceous nature of some of these rocks. Organics have the effect of “suppressing” SWIR spectra signatures. Thus, in this instance, the thermal infrared is providing a better recognition of the true mineral assemblage in these qtz + w-mica +/- microcline +/- carbonate intervals in domain 3.



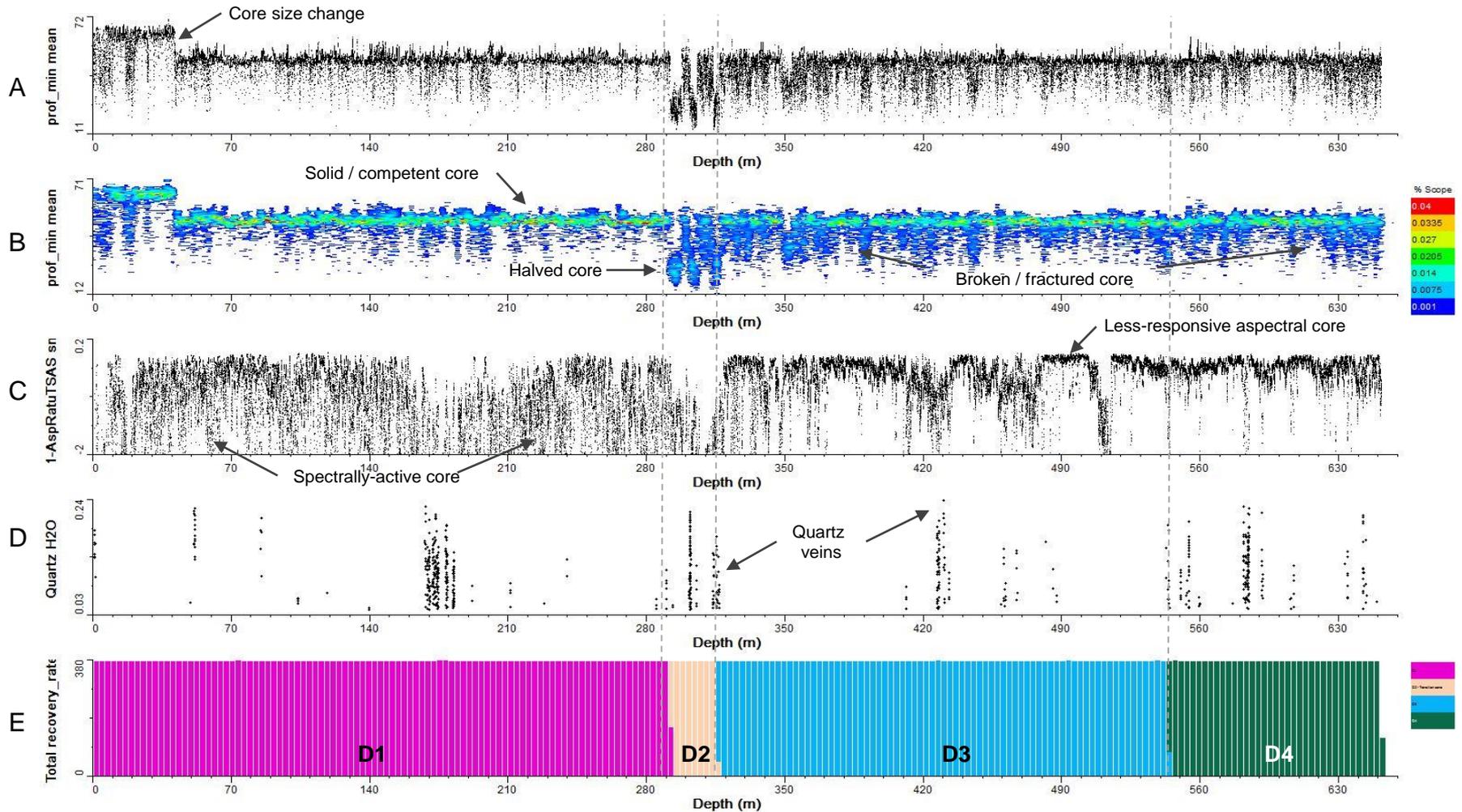
D3 ≡ Carbonaceous siltstone lithology subdivision

D3 is fairly lithologically heterogeneous with coarser-grained qtz dominant bands (lower left) & finer grained foliated qtz + muscovite +/- carbonate (+/-K-spar) (lower right). Image textures clearly v. different.



Core Integrity / Competency

A – Core height – defines both core diameter & broken core. **B** – Density function of plot A emphasizing the less broken, more competent core in domain 1, an increase in fractured core in the fault zone (apart from the halved core, arrowed), an increase in broken, less competent core, particularly in the upper part of domain 3, and generally more zones of broken core in domains 3 & 4. **C** – Spectral ratio. Samples higher on the plot are more spectral, caused by broken rock or organics. **D** – Quartz veins, **E** – Domains.



Domain Metadata

Summaries of each domain's depth extents and mineral group content are given below and can be found in TSG's domain editor. The drill hole ribbon is shown on the left of each screen.

Domain Editor
 Current sample=1222, depth=10.403
 Domain 1 of 4

Prev (none) Next D2 - Transition,

Start Linked 1 (0.00524) Curr Goto

End Linked 42984 (292.26) Curr Goto

Colour R 234 G 0 B 208

Name D1 - Volcaniclastic

Coarse volcanoclastic with qtz, qtz, w-mic and chlorite. An interval of epidote matches same in Selina-1.

Quartz K-Feldspar Albite Plagioclase-Ca
 Plagioclase-Na W-Mica Prehnite Chlorite
 Epidote Carbonate-Fe-Mn Carbonate-Ca-Mg
 Gypsum Artifact

SWIR 28 active CLS TSA Clear

VNIR <default> CLS TSA Clear

TIR 26 active CLS TSA Clear

Aux S n/a CLS Clear

Aux T n/a CLS Clear

New Split Copy attributes Delete

Fill above Fill below Merge above Merge below

Init Auto TSA Redo CLS Export Undo Close

Domain Editor
 Current sample=42985, depth=292.27
 Domain 2 of 4

Prev D1 - Volcaniclas, Next D3, 46905:81269

Start Linked 42985 (292.27) Curr Goto

End Linked 46904 (317.01) Curr Goto

Colour R 251 G 209 B 175

Name D2 - Transition

Spectrally transitional in mica & chlorite composition matches fault zone, increased w-mica, strong illite development, increased

Quartz K-Feldspar Albite Plagioclase-Ca
 Plagioclase-Na W-Mica Prehnite Chlorite
 Carbonate-Fe-Mn Carbonate-Ca-Mg Gypsum
 Artifact

SWIR 27 active CLS TSA Clear

VNIR <default> CLS TSA Clear

TIR 23 active CLS TSA Clear

Aux S n/a CLS Clear

Aux T n/a CLS Clear

New Split Copy attributes Delete

Fill above Fill below Merge above Merge below

Init Auto TSA Redo CLS Export Undo Close

Domain Editor
 Current sample=46905, depth=317.01
 Domain 3 of 4

Prev D2 - Transition, Next D4, 81270:97755

Start Linked 46905 (317.01) Curr Goto

End Linked 81269 (543.61) Curr Goto

Colour R 8 G 178 B 247

Name D3

Interbedded dark fine carbonaceous beds with brighter qtz + muscovite. A description of the d D4 not precise.

Quartz K-Feldspar Albite Plagioclase-Ca
 Plagioclase-Na W-Mica Chlorite Carbonate-Fe-Mn Carbonate-Ca-Mg Gypsum
 Artifact

SWIR 26 active CLS TSA Clear

VNIR <default> CLS TSA Clear

TIR 25 active CLS TSA Clear

Aux S n/a CLS Clear

Aux T n/a CLS Clear

New Split Copy attributes Delete

Fill above Fill below Merge above Merge below

Init Auto TSA Redo CLS Export Undo Close

Domain Editor
 Current sample=81270, depth=543.61
 Domain 4 of 4

Prev D3, 46905:81269 Next (none)

Start Linked 81270 (543.61) Curr Goto

End Linked 97755 (651.99) Curr Goto

Colour R 10 G 108 B 72

Name D4

Equivalent to sst lith domain. Defined by change in carb composition to more ankerite-like.

Quartz K-Feldspar Albite Plagioclase-Ca
 Plagioclase-Na W-Mica Chlorite Carbonate-Fe-Mn Carbonate-Ca-Mg Gypsum
 Artifact

SWIR 26 active CLS TSA Clear

VNIR <default> CLS TSA Clear

TIR 25 active CLS TSA Clear

Aux S n/a CLS Clear

Aux T n/a CLS Clear

New Split Copy attributes Delete

Fill above Fill below Merge above Merge below

Init Auto TSA Redo CLS Export Undo Close

TSG Version 8 Saved Layouts

For those with access to TSG files for this dataset, previously saved Layout displays are available. These are listed below. These are shown on the lower left for the primary VNIR/SWIR dataset, and for those saved in the secondary TIR dataset on the lower right. The free TSG-Viewer is available for download from www.thespectralgeologist.com

Primary file hydrous mineral layouts

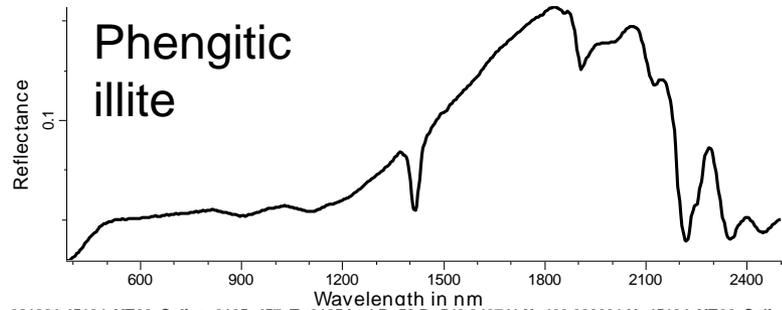
Load file 1: Hydrous mineral grps summary
Load file 2: W-Mica + chlor ab + composition
Load file 3: Carbonate ab + composition
Load file 4: Core colour plots
Load file 5: Anhydrous min grps +carb+epi
Load file 6: Quartz + carbonate veins
Load file 7: Ferroan carbonate distribution
Load file 8: Core integrity analysis
Load file 9: Working plots
Manage...

Secondary file anhydrous mineral layouts

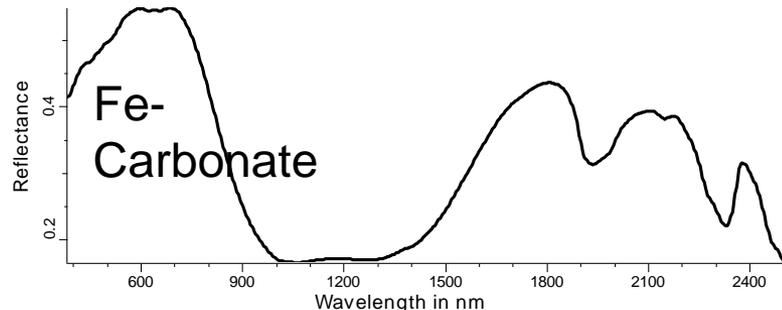
Load file 1: Anhydrous grps summary
Load file 2: FMI + Carb abundance
Load file 3: Carbonate distribution + comp
Load file 4: Quartz analysis
Load file 5: Qtz+ TIR W-mica analysis
Load file 6
Load file 7
Load file 8
Load file 9
Manage...

Examples of Selina VNIR/SWIR Spectra

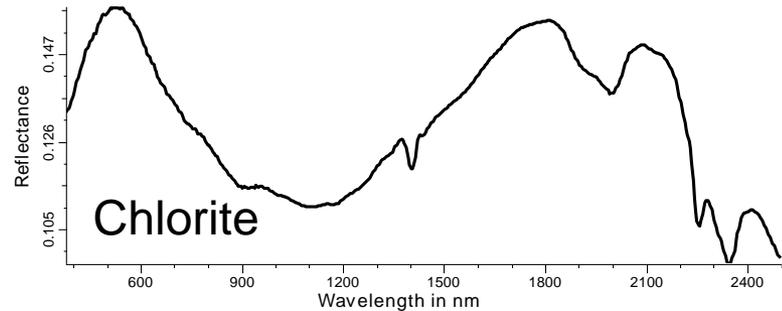
046102:45134_YT02_Selina_0072_483 T=0072 L=4 P=84 D=312.155240 X=668.000000 H=45134_YT02_Selina



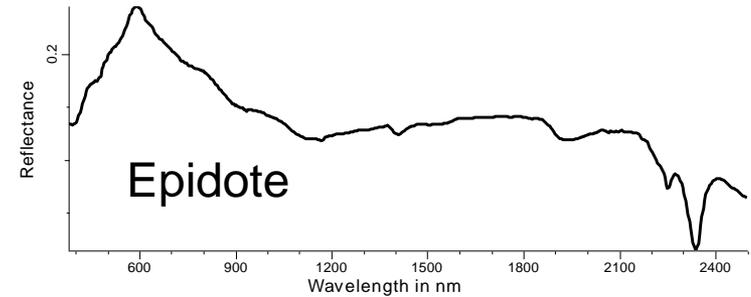
081321:45134_YT02_Selina_0125_457 T=0125 L=4 P=58 D=543.940741 X=460.000031 H=45134_YT02_Selina



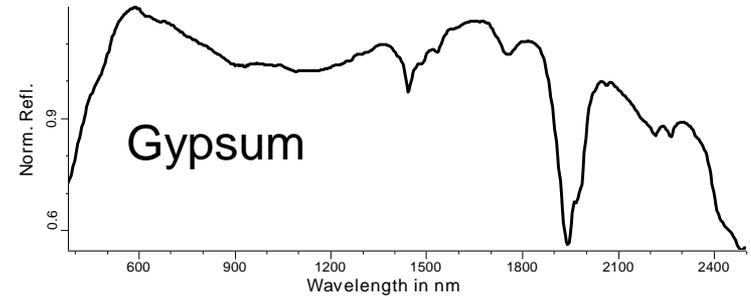
069086:45134_YT02_Selina_0107_192 T=0107 L=2 P=59 D=461.991023 X=468.000031 H=45134_YT02_Selina



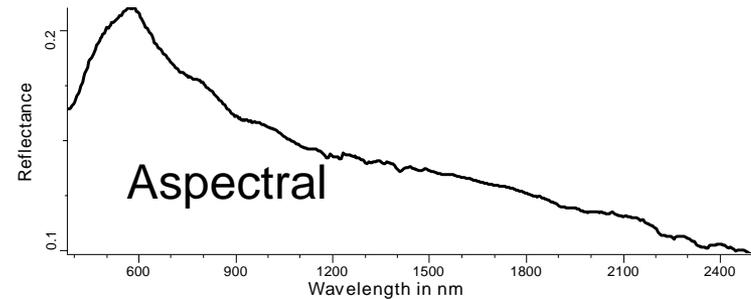
033567:45134_YT02_Selina_0053_583 T=0053 L=5 P=51 D=228.189137 X=404.151947 H=45134_YT02_Selina



044474:45134_YT02_Selina_0070_185 T=0070 L=2 P=52 D=301.977970 X=412.000031 H=45134_YT02_Selina

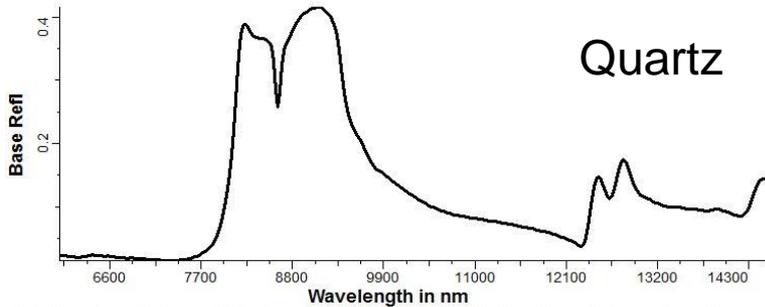


008754:45134_YT02_Selina_0016_375 T=0016 L=3 P=109 D=59.802771 X=868.151978 H=45134_YT02_Selina

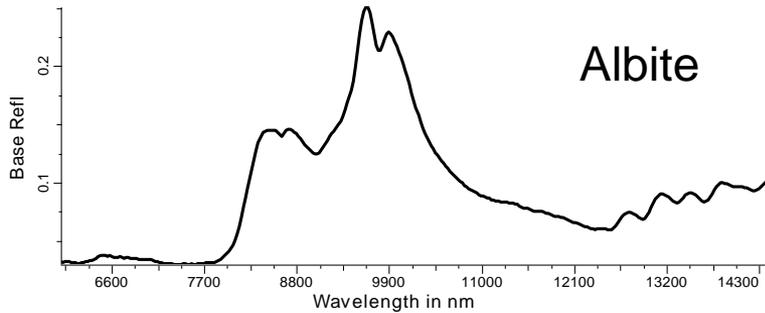


Examples of Selina TIR Spectra

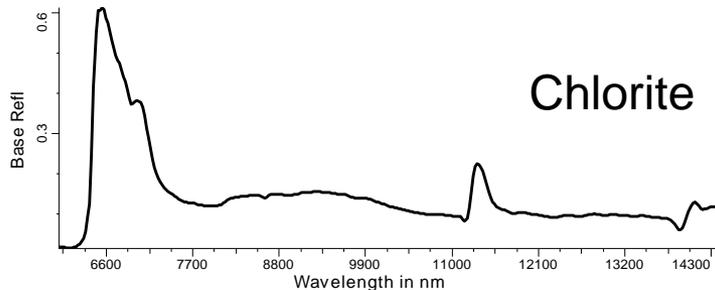
082826:45134_YT02_Selina_0127_632 T=0127 L=5 P=100 D=554.079467 X=796.151978 H=45134_YT02_Selina



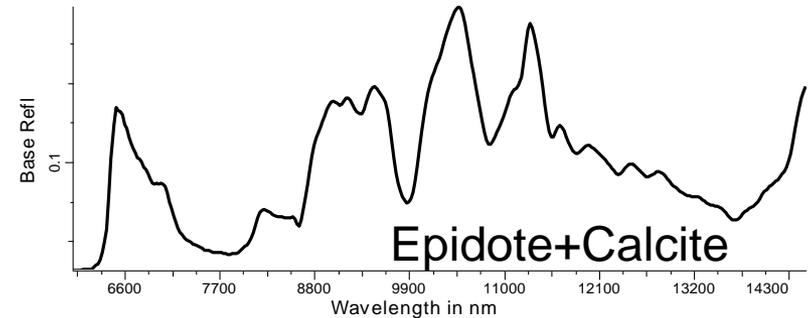
028430:45134_YT02_Selina_0046_101 T=0046 L=1 P=101 D=192.992586 X=804.151978 H=45134_YT02_Selina



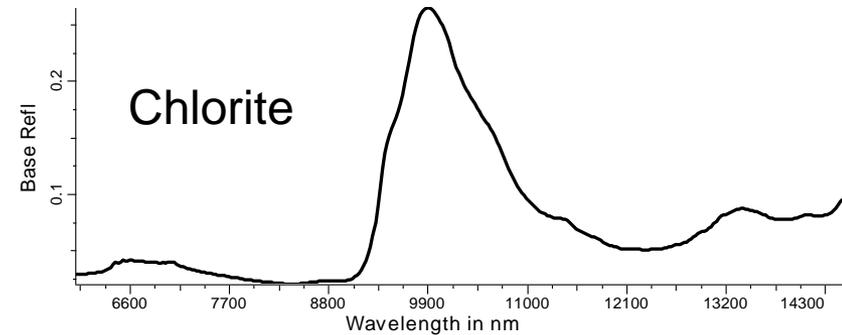
042449:45134_YT02_Selina_0067_155 T=0067 L=2 P=22 D=288.641579 X=172.000000 H=45134_YT02_Selina



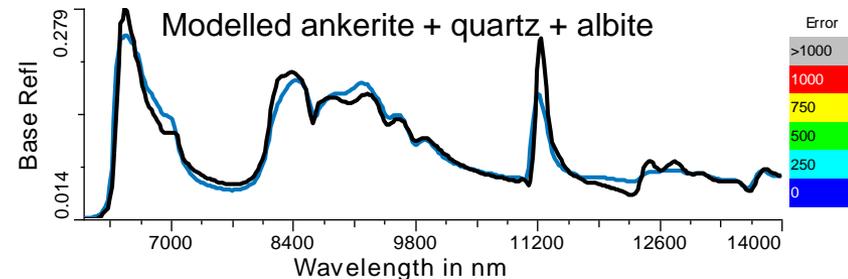
026247:45134_YT02_Selina_0042_578 T=0042 L=5 P=46 D=177.979781 X=364.151947 H=45134_YT02_Selina



043983:45134_YT02_Selina_0069_359 T=0069 L=3 P=93 D=298.886283 X=740.151978 H=45134_YT02_Selina



087275:45134_YT02_Selina_0134_426 T=0134 L=4 P=27 D=584.439527 X=212.000000 H=45134_YT02_Selina



57% Ankerite + 27% Quartz + 15% Albite ASP=1.434 ALB=0.101 SNR=281 SRSS=118 NIL=0.107 dT=1.208 TNorm=0.402

Selina 2 Conclusions

- The HyLogging data provide excellent objective discrimination of the major lithological units as well as their incremental subdivision over what was previously logged, and also defines local, fault-related alteration.
- The hyperspectral data indicate that Selina 2 comprises two major spectro-mineralogical domains separated by a ~26m fault zone, viz:
 - *The upper domain, D1, equates to the logged (VCC) volcanoclastic unit, consisting of dominant quartz, plagioclase, w-mica, chlorite, minor K-spar, and minor epidote. Within D1 epidote is fairly spatially constrained.*
 - *The lower domain below the D2 fault (that can be split into two on only subtle evidence) comprises an upper, logged, carbonaceous siltstone (SCI) (D3) and*
 - *a lower sandstone (SSS) unit (D4).*
 - *Both domains D3 and D4 comprise quartz, w-mica, chlorite, carbonate and only possible minor albite in one place. K-spar is absent. The lower sst unit is defined as above but with a different ferroan carbonate species and only very minor chlorite.*
 - *The carbonaceous siltstone, D3, can be subdivided spectrally into coarser qtz dominated sandstone intervals and finer-grained, foliated qtz + muscovite +/- carbonate (+/-K-spar) siltstone (?) units.*
- Domain D2 suggests a fault-related alteration zone separating the D1 and D3 lithologies. The alteration comprises elevated white mica (sericite) abundance, increased illite (with its characteristic bonded water signature), elevated chlorite, increased qtz/carbonate veining and more intensely fractured and broken core.
- Within D3 and D4 interesting gradational, facies-style changes in mica and carbonate spectral properties are worthy of validation and further investigation.
- HyLogging data shows that lithological discrimination can, in part, be determined by examining the rock competency using the laser profilometer / core height and breakage scalars.
- The more prominent quartz and quartz-carbonate veins are easily mapped spectrally. No spectral evidence of sulphides or magnetite was detected.
- The HyLogging data provide a long-lasting, digital, mineralogical & image record of the Selina drill hole that can be used in regional characterisation, stratigraphic correlation & alteration search as more drill holes become available.

Recommendations

- Any interpretations requiring confirmation or unusual features validated should be checked against QXRD analysis.
- HyLogging of drill hole data generates its greatest benefit when conducted as soon as possible after drilling. It is then that the logging geologist can take best advantage of the objective mineralogical characterisation provided, while the core is easily available, and may guide further sampling strategies and help identify subtle or cryptic alteration zones.
- A free TSG-Viewer is available from www.thespectralgeologist.com for examining the HyLogging and processed TSG data, including the high resolution drill core and tray images.



HUNTINGTON
HYPERSPECTRAL

Acknowledgements

Core scanning, initial masking and depth reconciliation was undertaken by staff of the NVCL HyLogging node at Mineral Resources Tasmania (MRT).

The MRT HyLogging unit is funded by AuScope Pty Ltd, MRT and is maintained by CSIRO.

HyLogging, HyLogger and TSG are trademarks of the CSIRO.

Dr Jon Huntington
Huntington Hyperspectral Pty Ltd
ABN 89 132 966 584

Contact

M +61 (0)408 221 934

34 Craiglands Avenue
Gordon NSW 2072
Australia