Possible Channel Spectra in VNIR/SWIR Hylogger Data

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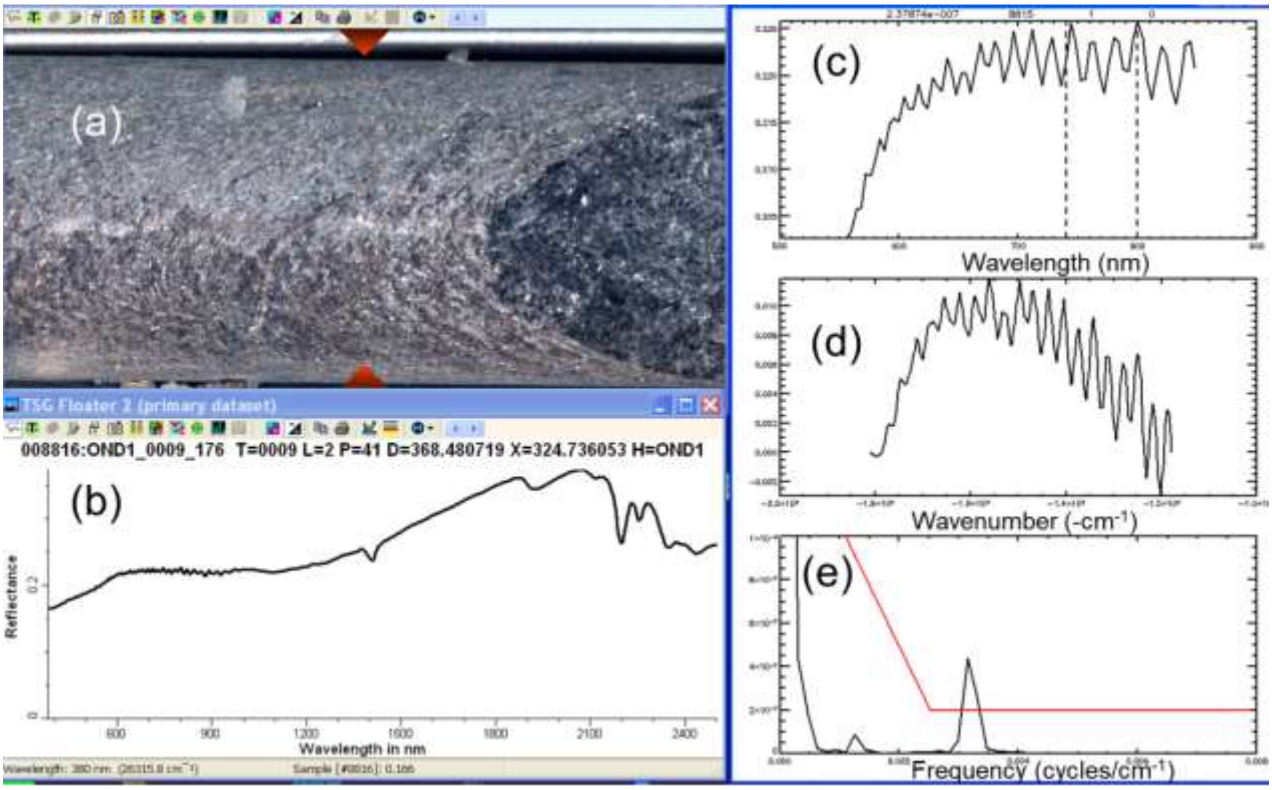
This note documents a search for unusual, highly periodic patterns in HyLogger VNIR/SWIR data. These were first noticed by Neil Pendock who pointed them out to Alan Mauger. Alan found some very obvious examples in a confidential hole and we then set out to find more examples by searching the CorStruth database.

The figure below shows a typical result from the WA hole OND1. The standard VNIR/SWIR spectrum (b) shows the offending pattern between about 600 nm and 1000 nm. When the region between 550 nm and 850 nm is extracted and plotted (c) we can see that the amplitude corresponds to about 0.5% reflectance and the frequency changes as a function of wavelength. This region was chosen because it is relatively free from major spectral variability which would interfere with subsequent (FFT) filtering.



When the spectrum in (c) is transformed to the wavenumber domain (d) the peak-to-peak spacing becomes more uniform and the power spectrum (e) suggests a frequency of approximately 0.0031 cycles/cm^{-1} and a constant spacing between the maxima in (d) of ~322 cm^{-1}.

This suggests the pattern is what is known as a channel spectrum which is caused by successive constructive and destructive interference effects when radiation is reflected from a partially transparent thin layer.

In this situation the wavelength spacing between successive maxima in the pattern over a thin layer of thickness *d* and refractive index *n* is given by

$$\lambda_m - \lambda_{m+1} = \frac{\lambda_m \lambda_{m+1}}{2dn}$$

In the wavenumber domain the spacing between the maxima is constant given by

$$\Delta\nu = \nu_{m+1} - \nu_m = \frac{1}{2dn}$$

If we take a typical value of $n \sim 1.5$ and apply it the results from the above example where $\Delta\nu = 322$ cm^{-1} we get $d \sim 10$ µm.

A crude frequency domain filter was constructed to find unmasked samples where the power spectrum (as illustrated in (e)) rose above the red line indicating an anomalous high(ish) frequency response. The initial run of this filter had a strong response to the presence of REE (Nd) spectra and so a secondary test on two Nd absorption features was applied to reject these samples.

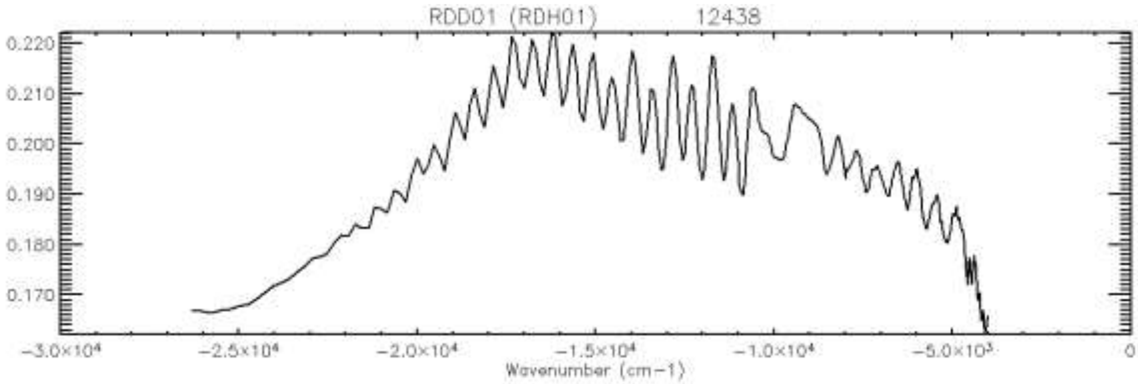
From an inspection of holes with a lot of positive responses it is clear that the filter misses quite a lot of low amplitude targets but, without a proper study of the target and background distributions, it was decided to set a relatively high threshold to avoid a vast number of false positives.

The search process found 412 holes with at least one positive response and a total of 11724 positive responses overall. The results are summarized in the Appendix. Of course this is a miniscule proportion of the approximately 92.6 million unmasked samples in the CorStruth database.

The following general observations apply:

- All the positive responses that have been checked so far appear to be associated with strongly foliated rocks, very commonly, with high dark mica content.
- The vast majority of responses are single isolated samples with no similar response nearby.
- There appear to be a range of wavenumber-domain periodicities. This filter will not detect $\Delta\nu$ values greater than 1000 cm^{-1} and few samples have been seen with $\Delta\nu$ values less than 250 cm^{-1}. This means that the range of thickness (*d*) we appear to be detecting is between 3 µm and 13 µm.
- Some samples appear to have multiple periodicities in the above range.

- Usually the effect is seen only in the VNIR part of the spectrum but it is sometimes seen to extend into the SWIR as in the example below. Theoretically for, materials of this approximately this thickness, these effects could appear out into the TIR region but this is highly unlikely because of the low transmission of most silicates in this region.



- More generally, there seems to be little that can be done with samples that show this effect. It seems to be result of a very rare combination of surface and source orientation over foliated geology. For the time being it is, at least partially explained, and can be ignored or masked out in processing.

Appendix

These are the holes where channel spectra were detected ten or more times. The full results are available in an Excel Spreadsheet (GM_Channel_Spectra.xlsx)

Hole	State	Occurrences
8418373_NBDH037	NT	4626
DD84CDD2	WA	3225
DD84CDD1	WA	939
BRGD001	WA	538
CH15	WA	329
RDD01	WA	203
OND1	WA	58
134164_DD88LR20	SA	53
PLRCD001	WA	50
976439_Stavely12_sonic	Vic	36
187410_KGD01C	SA	35
272689_WPDD1	SA	35
969794_MCD001	Vic	33
DD81MR1	NSW	33
NC_0038_1	WA	29
PLRCD005	WA	27
8440854_Undandita_1A	NT	25
13358_BRD5_Bulgobac_River	Tas	25
Solanum 1	WA	24
965828_SNDD005	Vic	23
HRD003	NSW	22
171750_MM14	SA	20
SMD164	WA	20
CB11DD005	WA	19
Ungani Far West 1	WA	19
SMD166	WA	19
HRYRCD-01	WA	18
BRDD004	WA	18
290348_KTDD_160	SA	18
GBD011	WA	17
134163_DD88LR19	SA	16
PLRCD006	WA	16
BRDD003	WA	15
50221_397R	Tas	15
BRWD0014	WA	14
SMD169	WA	14
8434927_MRD002	NT	14
8446303_Manbulloo_S1	NT	13
ZNDD003	WA	12

C8	WA	12
290347_KTDD_149	SA	12
BRWD0018	WA	12
269223_DDHURAN1	SA	12
6313_HP2_Mt_Block	Tas	11
239767_KD_11	SA	11
BRDD002	WA	11
19763_MJ021_Mt_Julia	Tas	11
293063_HDD-046	SA	11
8447038_WRDD0138	NT	11
AHDH0008	WA	11
1852244_MD1A	NT	10
41036_MCD35	Tas	10