USING TIR AND SWIR AIRBORNE IMAGING SPECTROMETRY TO MAP DOMINANT MINERALOGY IN A COMPLEX ALTERATION SYSTEM

B. FAGBOHUN, C. HECKER, F.J.A. VAN RUITENBEEK
- No SWIR features for non OH-bearing Silicates => TIR emissivity spectra needed
TECHNIQUES USED

- Minimum Wavelength Mapping
  => Dominant minerals in SWIR & TIR

- LWIR Lab analysis on field samples
  => determine thresholds for classification

- Decision tree classification
  => combine step 1 and 2 into SWIR&TIR mineral assemblages
Continuum removed

Dominant absorption features:

<table>
<thead>
<tr>
<th>wav.</th>
<th>depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.205 μm</td>
</tr>
<tr>
<td>2</td>
<td>2.165 μm</td>
</tr>
<tr>
<td>3</td>
<td>2.386 μm</td>
</tr>
</tbody>
</table>
Second order fit on 3 points:
\[ f(w) = ax^2 + bx + c \]
\[ w_{\text{min}} = -\frac{b}{2a} \]
\[ \text{depth} = 1 - f(w_{\text{min}}) \]

Shifts in the order of 1 nm can be detected.

Source: van Ruitenbeek et al (2014)
*Planetary and space science*, 101, pp.108-117
WAVELENGTH & DEPTH

Identification of feature

<table>
<thead>
<tr>
<th>Wavelength</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 nm</td>
<td>0%</td>
</tr>
<tr>
<td>2500 nm</td>
<td>20%</td>
</tr>
</tbody>
</table>

Abundance
HSV FUSION OF WAVELENGTH & DEPTH

Fused image

Legend

Minerals

calcite
white micas
alunite
buddingtonite

Wavelength (μm)

Depth (%)
TEST AREA: YERINGTON, NEVADA
GEOLOGIC OVERVIEW YERINGTON (ANN-MASON)

cross section from 1 to 6 km paleodepth

Source: Hecker (2012) PhD
AIRBORNE IMAGING SPECTROSCOPY DATA

Data courtesy Aero.org and SpecTIR

VNIR-SWIR ProSpecTIR sensor
128 bands LWIR SEBASS sensor
Wavelength mapping on ProspecTIR-VS between 2.1-2.4µm

A: Skarn and Hornfels
Epidote, amphibole, carbonate

B: Porphyry regime
Actinolite, chlorite, epidote, sericite
Wavelength mapping on SEBASS between 8.05-11.65µm

A: Skarn and Hornfels
   Garnet and carbonate

B: Porphyry regime
   Plagioclase and quartz
COMBINED MINWAV INTERPRETATION

SWIR

LWIR
Classification Including lab spectra

1: Epithermal regime
2: Transition between porphyry-epithermal regime and epithermal regime.
3: Epithermal regime and transition between porphyry-epithermal regime.
4: Transition between porphyry-epithermal regime and epithermal regime.
5: Porphyry regime, skarn
6: Porphyry regime
7: Porphyry regime
8: Porphyry regime
9: Skarn
Classification of airborne data based on interpolated minimum wavelength using decision tree

Within blue boundary: Epithermal regime
Within red boundary: Porphyry regime
Within black boundary: Skarns and Hornfels
CONCLUSIONS

- Min Wavelength Mapping
  - Works for LWIR too!
  - Highlight minerals and compositions
  - Intuitive; great for overview, across flightline
  - but ignoring spectral details

- Decision tree
  - simple, transparent model to combine SWIR and TIR
  - No a priori knowledge needed
  - samples needed; operator interpretation needed
USING TIR AND SWIR AIRBORNE IMAGING SPECTROMETRY TO MAP DOMINANT MINERALOGY IN A COMPLEX ALTERATION SYSTEM

B. FAGBOHUN, C. HECKER, F.J.A. VAN RUITENBEEK

c.a.hecker@utwente.nl