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The following title was submitted:

Analysis of Mt. Fitton Airborne Hyperspectral Data: A Comparison of Spectral and Spatial Resolution over a Geological Terrain

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Abstract (words):

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Mt. Fitton is located in the Northern Flinders Ranges, 750km north of Adelaide in South Australia. The geology of the region is dominated by a sequence of metasediments containing Australia's largest talc deposits, which are mined on an industrial basis.

Two different types of airborne hyperspectral data were available for this study. The first, regarded as conventional 128-channel HyMap data, covered 0.42-2.48 µm in 14-18 nm wide channels. The second, from an earlier HyMap pre-cursor scanner, acquired 96 channels covering 0.53-2.41 µm in 10-15 nm wide channels. This second sensor had been specifically modified to acquire 10.4 nm wide channels in the geologically-important shortwave infrared (SWIR) part of the spectrum. The idea being that this increased spectral resolution, compared with the conventional HyMap data, may allow mineralogical endmembers to be (a) identified more easily and more quickly, and (b) may allow more subtle endmember variations to be identified and mapped.

Comparison of spectra extracted from calibrated and atmospherically-corrected data, showed that the narrow band configuration of the HyMap precursor scanner allowed more subtle detail to be seen in the spectra. For example, in some instances the broadband HyMap sensor only gave the impression of an absorption doublet, whilst the HyMap pre-cursor scanner resolved this feature as a genuine doublet.

Both datasets were processed using conventional ENVI hyperspectral analysis tools. The basic processing strategy applied included (i) extraction of SWIR channels, (ii) transformation to MNF space, (iii) Pixel Purity Index, (iv) n-dimensional visualisation of the data cloud,

(v) extraction of discrete endmembers, (vi) production of Mixture Tuned Matched Filtered (MTMF) and SAM images and finally, (vii) thresholding and blending of results with background images to produce a suite of new mineralogical image maps.

Analysis of both sets of HyMap data allowed a total of fifteen separate endmembers to be identified from the data cloud. Examination of the MTMF mapping results showed that some of the apparently separate endmember spectra identified produced similar results, despite subtle spectral variations. As a result nine nine "thrustworthy" endmember MTMF "abundance" maps were finally extracted from both datasets.

Geological endmember maps were produced for the following minerals and mineral groups; talc, tremolite?, chlorite + A1(OH) clay, dolomite, magnesite, short-wavelength A1-rich mica and long-wavelength A1 – poor mica, in addition to dry vegetation and shade. Field validation using a PIMA-II spectrometer confirmed that the majority of localities on these endmember image maps were correctly identified and mapped with both sets of HyMap data.

Therefore despite the higher spectral resolution of the HyMap precursor scanner in the SWIR region, no additional endmembers were discriminated or mapped, over the conventional HyMap data. However, the higher spectral resolution did increase confidence and aid the identification of mineralogical features at the spectral interpretation and naming stage.

An additional goal of this study was to resample the HyMap precursor data to the spatial (30 m) and spectral bandwidth (16 nm) of the proposed ARIES-1 satellite. The ENVI processing applied to the full resolution airborne data was re-applied to the lower resolution ARIES-1 data. This study showed that an equivalent number of spectral endmembers could be mapped using the stimulated ARIES-1 data. Final MTMF "abundance" images appeared coarser than the airborne images, due obviously to the larger pixel size, however overall mineral distribution patterns were the same as those derived from the airborne data. Final endmember maps were combined with 10m panchromatic data to produce a series of 10m map products.

These results therefore suggest that, beyond certain critical spatial and spectral thresholds, the number of endmembers that can be extracted from a hyperspectral data cloud are more dependent on the degree of spectral variation between endmember classes than the spectral and spatial resolution of the scanner. This overall spectral variation is expressed over all wavelengths and not just those around certain specific absorption features. Such is the value of sampling the terrain with an over-determinated system (i.e. more bands than materials). This argument was in part supported when a conventional Landsat TM scene of Mt. Fitton was unmixed, allowing two of the airborne mineral maps (talc and dolomite) to be reproduced.

The analysis bodes well for increasing the efficiency of geological mapping and the success of exploration with airborne hyperspectral sensors such as HyMap and future spaceborne systems such as ASTER, Hyperion and ARIES-1.