# Progress in the EU project Greenpeg

The partner IFU is part of the GREENPEG project for geophysical surveying and drone-based data acquisition. Therefore, IFUs responsibilities mainly lay in drones (UAVs) as the intermediary part between airborne and ground acquisition. While the three demonstration sites are all of scientific and economical interest, all three are very different in terms of vegetation cover, terrain as well as occurring pegmatite types. While the Norwegian Tysfjord area is mostly wide and open, the demonstration sites in Leinster (Ireland) and Wolfsberg (Austria) are mostly forest-covered and steeper.

In the first period of the project, partner IFU was focusing on developing, setting up and testing the hardware for ground- and drone-based hyperspectral data acquisition. This includes the heavy-duty drone system and the acousto-optical monochromator for hyperspectral imaging.

IFU developed a spectral scanning system to collect hyperspectral information with high spatial resolution of land surfaces in the visible and near-infrared wavelength range (450-990 nm). The system uses an acousto-optic filter to capture images of selected (specific) wavelengths at a speed of up to 100 frames per second (10 ms per frame). This hyperspectral camera system can be used for detailed hyperspectral analysis of e.g. rock cores in the lab as well as attached to a drone to collect high resolution hyperspectral landscape information. The camera system measures the amount of reflected radiation. By using a white calibration target with known reflectance properties and an incident light sensor (lux meter) we are able to convert the digital numbers from the images to reflectance values.



In addition to the lab analysis where we tested the hyperspectral camera on rock cores collected at the Norwegian Tysfjord site as well as from the Leinster core store and Wolfsberg sites, field measurements on outcrop with vegetation were possible from the ground as well. A higher lateral resolution could be achieved on single targets which can be analyzed from a shorter distance (compared to the drone flight height). At each measurement campaign, we took images every 1 nm wavelength step to get the full reflectance spectrum of the white calibration reflectance target and each rock sample (from 450 to 990 nm) – per sample 540 images/frames.


**Figure 1: (a) Calibration of the hyperspectral system and (b) ground measurements (examples at (c) 560 and (d) 700 nm)**



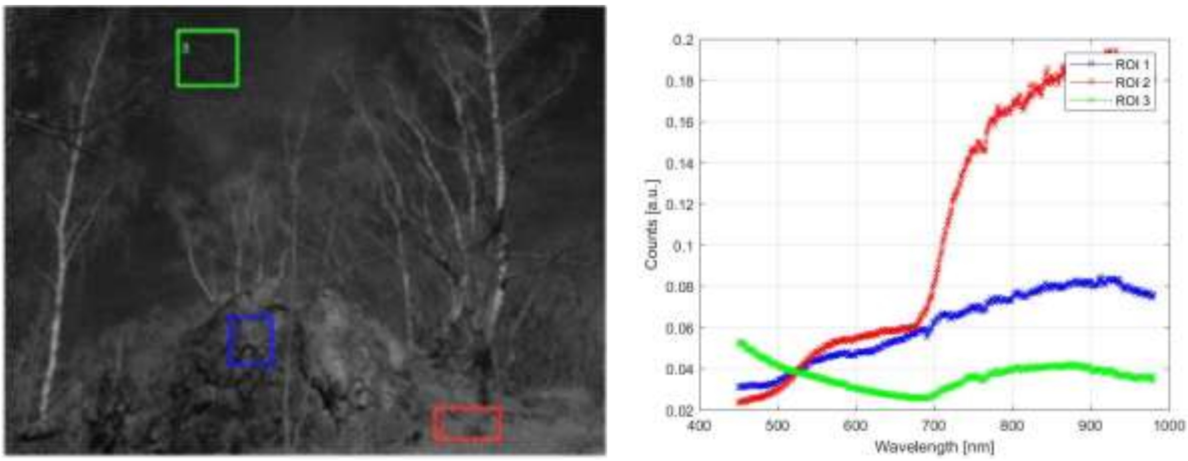


**Figure 2: Example Spectra of the ground measurements for different ROIs**

A lot of testing was needed for the hyperspectral drone system to work. We set up a custom-built drone using the open Pixhawk flight controller standard. Besides from building up the drone, this step also includes finding optimal settings for a variety of customizable drone-specific parameters, e.g. engine speeds, dGPS setup, and also creating flight routes with GCPs for the different demonstration sites. This drone system carries and communicates with the hyperspectral imaging system attached. The imaging system itself is designed to execute custom survey jobs while still being light and easy to handle. The hyperspectral camera was also tested on some regional sites with no actual mining background. This is needed to get information on which wavelengths to look at and what survey speeds and area coverages we can expect.

The drone flights can be programmed in advance. The measurements can be done manually or automatically using an integrated trigger function which will execute the measurement on predefined waypoints. Additionally, a brightness sensor was integrated to correct for light variations during the flight.

The workflow of a field measurement is shortly described in the video.

**Figure 3: Hyperspectral Imaging System equipped on the drone**

**Figure 4: Drone survey with the hyperspectral imaging system**

**Figure 5: Drone survey with the hyperspectral imaging system**

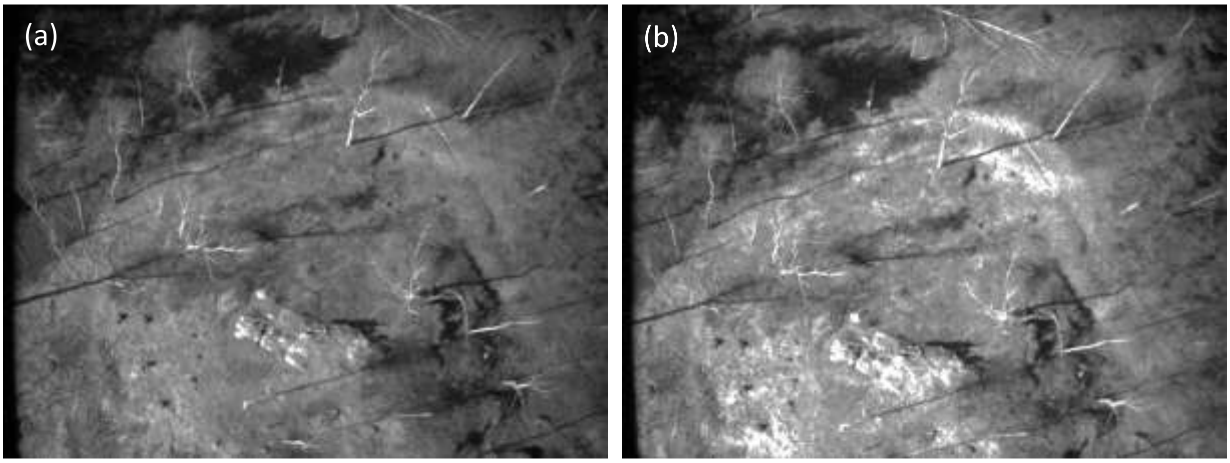


**Figure 6: Single monochromatic images from the drone survey ((a) 550 and (b) 660 nm)**

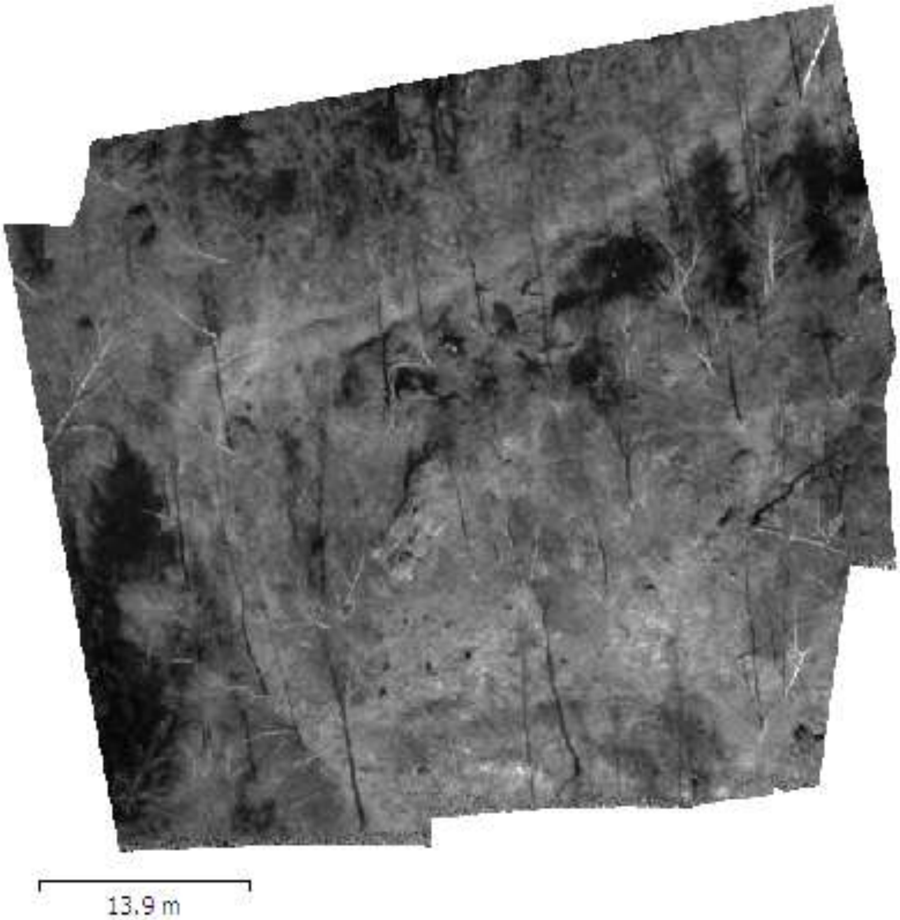




**Figure 7: Resulting spectral map (example at 660 nm) from the drone survey**

In summary, our developed droneborne, hyperspectral system is ready to fly over the Greenpeg test sites in the upcoming field season. It is able to measure single, monochromatic images or full spectra at programmed measurement points to cover large areas with the drone. The next step would be to correlate the spectral information to the pegmatites.

IFU GMBH

Privates Institut für Umweltanalysen



If you are interested or have any questions, please do not hesitate to contact us:

IfU GmbH Privates Institut für Umweltanalysen
Gottfried-Schenker-Str. 18
09244 Lichtenau

phone: +49 37208/8890
e-mail: info@ifu.de

www.ifu.de