Integration of drone-borne hyperspectral and geomagnetic data. A combined approach in geologic remote sensing. A test from the Siilinjärvi carbonatite, Finland.

Robert Jackisch1, Robert Zimmermann1, Sandra Lorenz1, Ari Saartenoja2, Markku Pirttiäjärvi- Bjørn Henning Heincke2 and Richard Gloaguen1

1Helmholtz-Zentrum Dresden-Rossendorf, Helmholtz Institute Freiberg for Resource Technology, Germany (r.jackisch@hzdr.de)
2Radai Oy, Oulu, Finland (ari.saartenoja@radai.fi) 

GEUS Geological Survey of Denmark and Greenland (bhm@geus.dk)

Introduction

The world's need for critical materials sees a surge since the last two decades. Most of Europe's larger mineral deposits have been discovered and exploited by now. A rising need to include formerly unattractive or inaccessible prospects is apparent. Here, using drones for detailed prospecting of small areas comes at hand. Drones have the advantage of being cost-efficient, easily deployable and having a short turn-around time for high resolution data. We integrate several remote sensing applications. In particular, we combine the advantage of lightweight drone technology with a snapshot hyperspectral camera and a magnetometer. The project name, MULSEDRO, stands for MultiSensorDROnes.

Methods and Test area

Tholeg - “THO-R-PX8” Octocopter
- 5 kg payload
- 30 min max. flight time
- Vapor-Magnetometer
- Hyperspectral camera (HS)

Radai Oy – “Albatros” Fixed wing
- 2 kg payload
- 2.5 m wingspan
- 90 min flight time
- Fluxgate magnetometer

DMT Pilot 3D Positioning system
- 2 kg weight
- Integrated positioning system
- Inertial measurement unit and stereo camera for orientation under GPS loss

Ground validation

We expect to identify surficial rock formations using HSI data and estimate their subsurface proportions with magnetics. The data sets are processed through a framework of dedicated correction tools.

Validation of the data sets follows a workflow by a combination of in-situ and laboratory measurements to characterize rock forming minerals. X-ray fluorescence, X-ray diffraction, near-field spectroscopy (350 – 2500 nm) and optical microscopy.

Results

- Digital elevation models (Structure-from-Motion Multi-View-Stereo photogrammetry)
- Corrected hyperspectral data (MEPhySTo toolbox; Jakob et al. 2017)
- Calibrated Magnetic data (e.g. orientation, diurnal and external induced field fluctuations)

We delineate carbonate dykes and associated fenitisation in hyperspectral data. We observe a trend with similar orientation in magnetic readings. We interpret the results as a new enrichment of magnetite, among other iron minerals, in the carbonate host rocks.

Outlook

The results are promising and we demonstrate that drone-based exploration becomes more accurate, affordable, intuitive and accessible to the mining sector and the geoscientific community.

Open questions:

1. The acceptable resolution difference between the magnetic data and hyperspectral surface information?
2. How to decrease the engine noise without limiting the flight performance?
3. Sufficient spectral range of hyperspectral sensors?

References


Results

• Digital elevation models (Structure-from-Motion Multi-View-Stereo photogrammetry)
• Corrected hyperspectral data (MEPhySTo toolbox; Jakob et al. 2017)
• Calibrated Magnetic data (e.g. orientation, diurnal and external induced field fluctuations)

We delineate carbonate dykes and associated fenitisation in hyperspectral data. We observe a trend with similar orientation in magnetic readings. We interpret the results as a new enrichment of magnetite, among other iron minerals, in the carbonate host rocks.

Outlook

The results are promising and we demonstrate that drone-based exploration becomes more accurate, affordable, intuitive and accessible to the mining sector and the geoscientific community.

Open questions:

1. The acceptable resolution difference between the magnetic data and hyperspectral surface information?
2. How to decrease the engine noise without limiting the flight performance?
3. Sufficient spectral range of hyperspectral sensors?

References
