Drones in Mineral Exploration

Radai Oy
Radai Oy

• Established in 2013
• Location in Finland
• Personnel, eight people.
Radai Oy

Provides geophysical surveys – using drones

- Magnetic surveys
- Gas surveys
- Radiometric surveys
- Sonar surveys
UAV characteristics

- Terminology: UAV, RPAS, Drone
- Frame type: multicopter, fixed-wing
- Payload 0.5 – 5 kg (typically)
- Flight times; 0.5 – 2 hour (typically)
Radai UAV system for magnetic surveys

- Custom-made UAV
- Wingspan 2 m, mass 3.5kg
- Autopilot follows waypoints designed for the survey
- Real-time telemetry link & control station with a PC surveillance software
- 3-component flux-gate magnetometer
  - ±1 nT resolution, 15 Hz sampling (1-2 samples/m)
- Base station magnetometer
RadaiPros – magnetic data processing tool

- Raw mag data analysis (orientation, heading, raw vs calibrated...)
- Mag data calibration options
- Basestation corrections
- Exclude UAV turnings
- DEM model of survey area
- Flight altitude related to DEM
RadaiPath – UAV waypoint generation tool

- Design survey areas
- Design flight mission
- Integration to DEM
- Background maps
- Custom flight lines
TerrainScout vs. Albatros NT/VT

- **TerrainScout:**
  - Wingspan 2.1 m
  - Mass 2.6 kg
  - Payload 1 kg
  - Flight time up to 40 min

- **Albatros NT/VT:**
  - Wingspan 2.8 m
  - Mass 3 kg
  - Payload 2 kg
  - Flight time up to 2 h
CASE STUDY: Ryssänlampi Magnetic Survey 2016

- TEKES project of GTK, University of Lapland, and mining companies
- Survey site is located about 35 km NE from Rovaniemi
- Area 1.5 km² (c. 31 line-km with 50 m line spacing)
- 56+28 line-km & 40000+20000 points of (edited) data
- Flight time ≈ 2 hours, mean speed ≈ 12.1 m/s

Surveys 2015/08 vs. 2016/03

50 m line separation, 40 m altitude, 4 flights

30 m line separation, 30 m altitude, 3 flights
Surveys 2016/03 vs. 2017/10

30 m line separation, 30 m altitude, 3 flights

30 m line separation, 40 m altitude, 2 flights
Surveys 2016/03 vs. 2017/10

Radai Survey 2016/03 (ELM at 40 m)

Radai Survey 2017/10 (ELM at 40 m)
CASE STUDY:
Radai gamma radiation system 2016

• Custom-made quadcopter
• Payload 4 kg, flight time 40 min
• Autopilot follows waypoints designed for the survey
• Dual Bismuth Germanate (BGO) detector 106 cm³
  • High sensitivity performance
  • Energy response from 25 keV – 3000 keV
  • Weight 3.5 kg
Radai gamma radiation system 2016

<table>
<thead>
<tr>
<th>UAV parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation mode</td>
<td>Quad-copter</td>
</tr>
<tr>
<td>Electric engine</td>
<td>4 x W</td>
</tr>
<tr>
<td>Axis span</td>
<td>1.0 m</td>
</tr>
<tr>
<td>Propellers</td>
<td>50 cm</td>
</tr>
<tr>
<td>Mass</td>
<td>8 kg (10 kg w batteries)</td>
</tr>
<tr>
<td>Payload</td>
<td>&lt; 5 kg</td>
</tr>
<tr>
<td>Flight speed</td>
<td>0-25 m/s</td>
</tr>
<tr>
<td>Flight time</td>
<td>up to 40 m</td>
</tr>
</tbody>
</table>

Fig. 2.1. Radai’s Terrain Scout 3.2 UAV.
Gamma radiation survey
Total intensity

Figure S.9. Total intensity at 5 m flight height (survey C251).

Figure S.10. Total intensity at 10 m flight height (survey C252).

Figure S.11. Total intensity at 30 m flight height (survey C253). Note the different color scale used in the figure.
UAV regulations in Europe

- European nations has own regulations for UAV legislation.
- Differences between national regulations
Aviation Regulations in Finland

• TRAFI is the civil aviation regulatory authority in Finland
• OPS M1-32 rule, active since 1.1.2017
• Limitations for UAVs:
  o Weight < 25 kg, altitude < 150 m, “distance < 500 m”
• Operation modes:
  o VLOS - Visual Line of Sight (always visible)
  o E-VLOS - Extended VLOS (co-pilots see)
  o B-VLOS - Beyond VLOS (closed airspace)
Regulations for geophysical surveys

Relevant to check national legislation for geophysical surveys
Policy challenges for UAV business

- B-VLOS operation permission
- UAV regulations in all European countries.
- UAV pilot certifications
- Legislation for geophysical surveys
Thank you !