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Europese Unie
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# A drone as platform for airborne gamma-ray surveys to characterize soil and monitor contaminations

rijksuniversiteit groningen

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# Gamma-ray spectrometry

Gammaray spectrometry systems are widely used in geophysics for prospecting, pollution studies and precision agriculture.



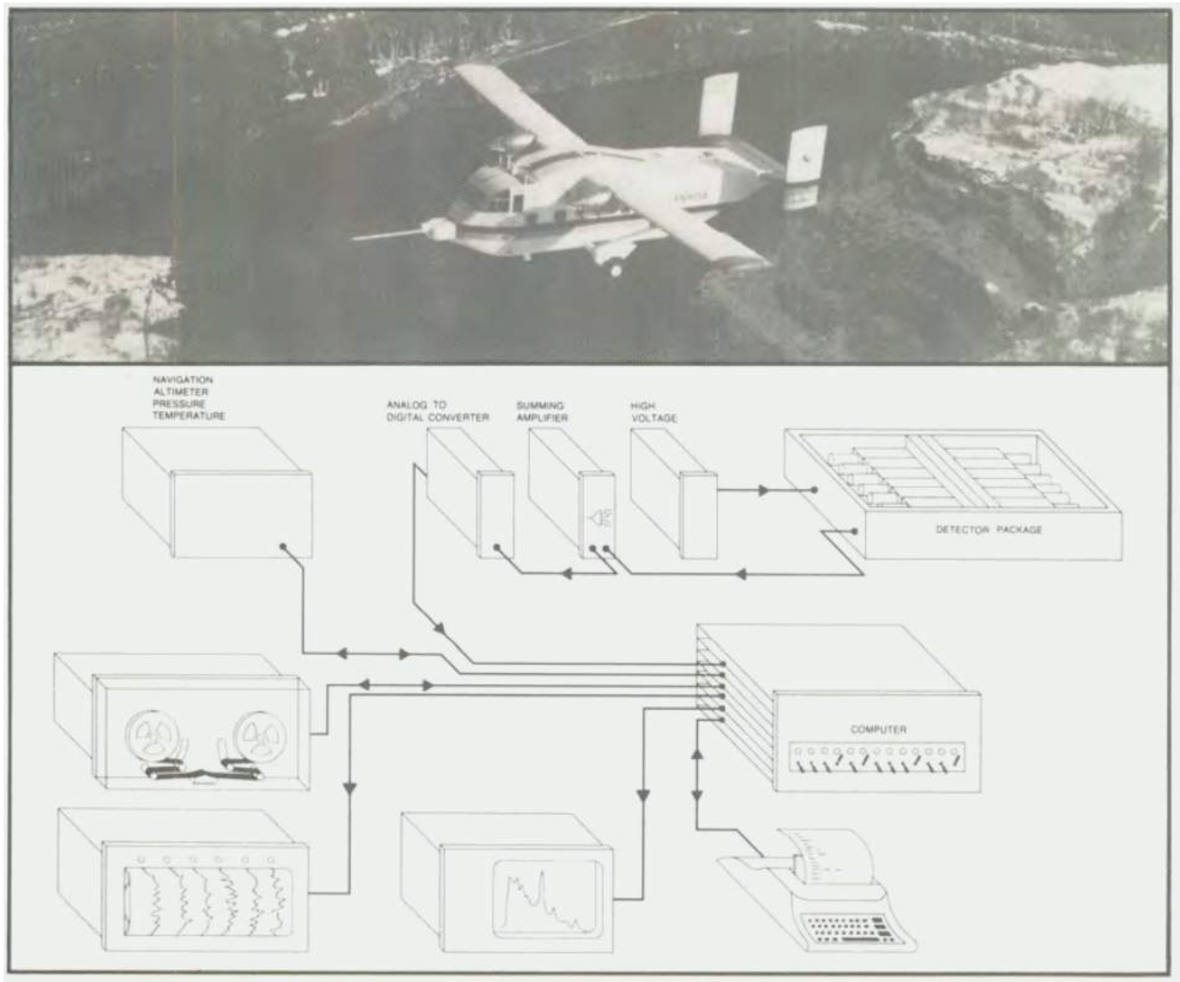
Credit: Gordon Cooper & Edgar Stettler

# Gamma-ray spectrometry

**DRONES ARE HERE AND ARE CHANGING THE WAY WE DO GEOPHYSICS DRASTICALLY**

But are they fit for radiometrics?

# Detector development



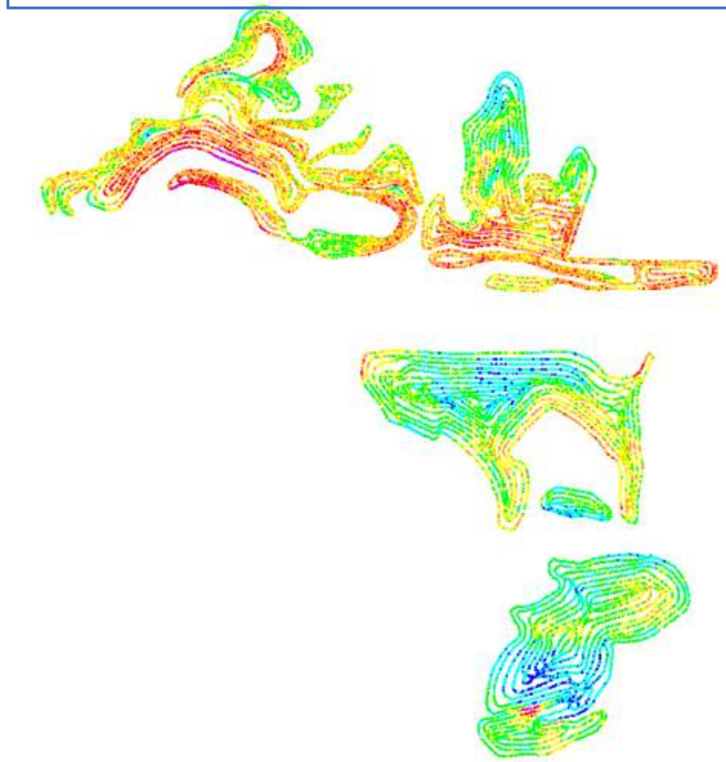

*Seligman, H. (1992). Airborne gamma ray spectrometer surveying, technical reports series no. 323: International Atomic Energy Agency, Vienna, 1991. 97 pp. Austrian Schillings 340.*

Miniaturization & smart algorithms have lead to *autonomous functioning* spectrometer system that can automate the data processing <u>during</u> the measurement

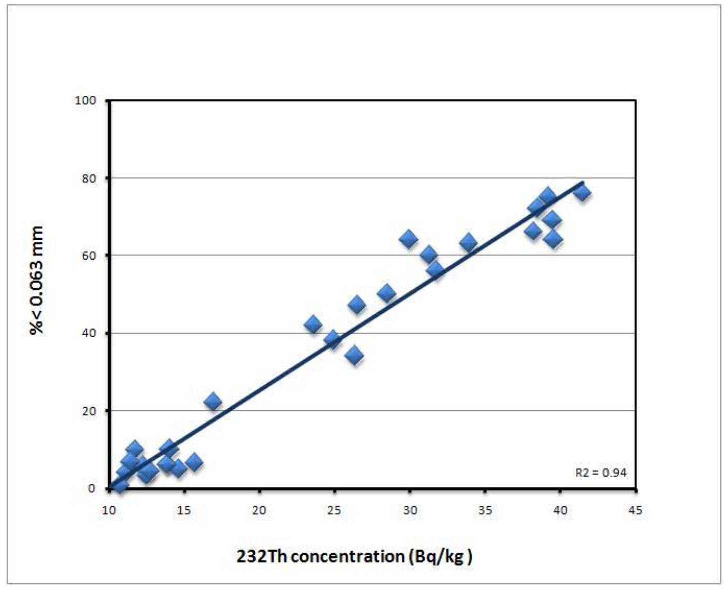
1 liter NaI crystal, 6.1 kg

# From fielddata to maps

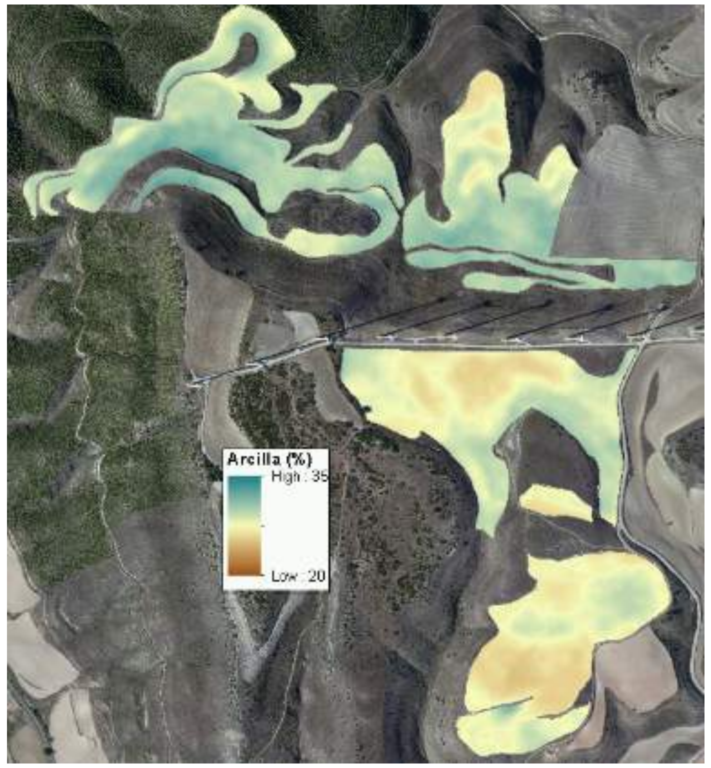
Gamma spectrometer (field)



Sample analyses (lab)



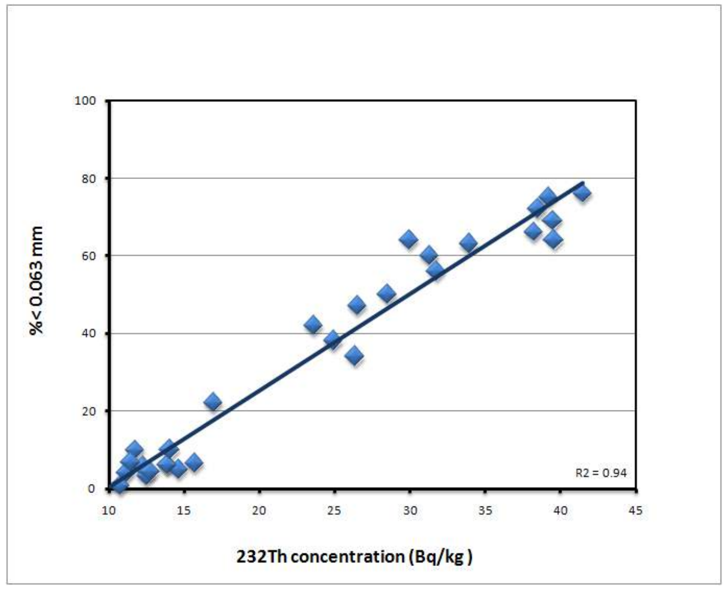

Clay content




Concentrations of radionuclides:
$^{40}K$, $^{238}U$, $^{232}Th$ and $^{137}Cs$

# Application models

Sample analyses (lab)




**Precision agriculture**

Texture (Grain size, clay/silt content, organic matter)

**Miner prospecting**

E.g. uranium, thorium, iron or rare earth metals

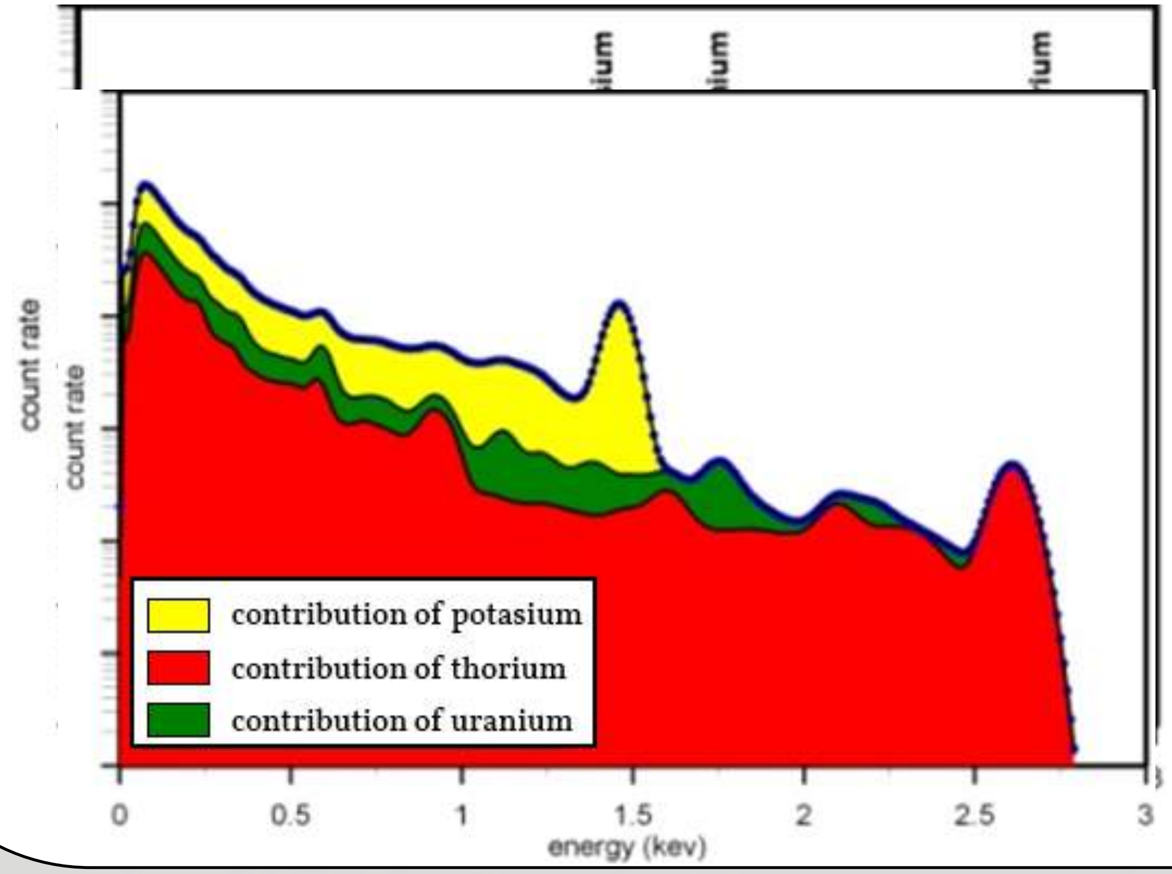
**Pollution**

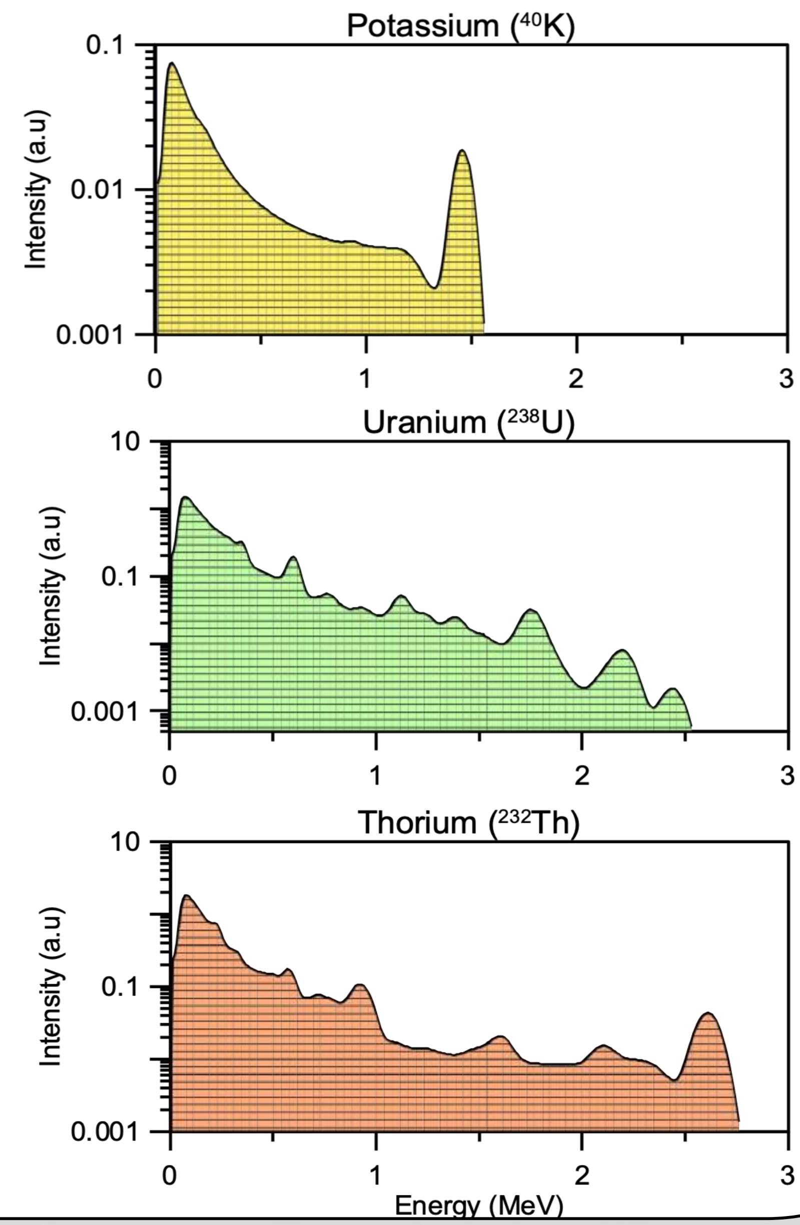
Heavy metal pollution (Pb, Ni, Cd, Hg, Zn)

Organic pollution (PCB’s, PAH, dioxins)

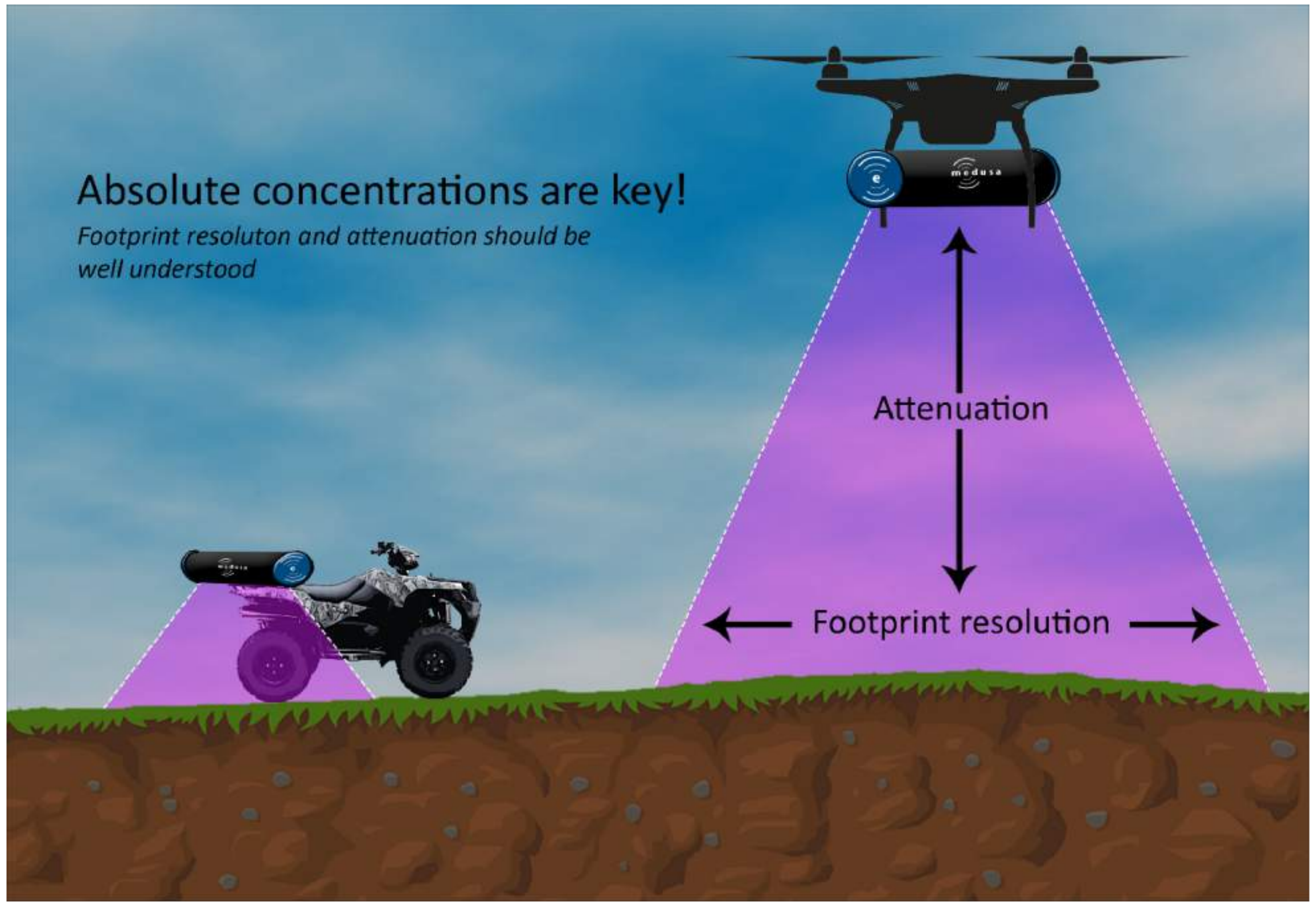
# Analysis methods for small detectors

- Windows methods
- Full Spectrum Analysis (FSA)
- Increase the yield vs size of detector



# Analysis methods for small detectors




**Two competing processes at play:**

1. Increase in footprint with an increase in source-detector separation

2. Increased attenuation in the ground and air

*Both processes have been studied and methods have been developed for the case of airborne data collection, however this method breaks down in the range of 5-40 meter height in which the drone operates*[1].

*[1]IAEA, Nicolet, J. P., & Erdi-Krausz, G. (2003). Guidelines for radioelement mapping using gamma ray spectrometry data. International Atomic Energy Agency, (5), 179.*

# Case study I: precision farming

## Ground

- MS-2000,
  2 L CsI crystal
- Walking survey
- Elevation 0.8 m
- Measurement frequency of 1 Hz.
- Bare soil

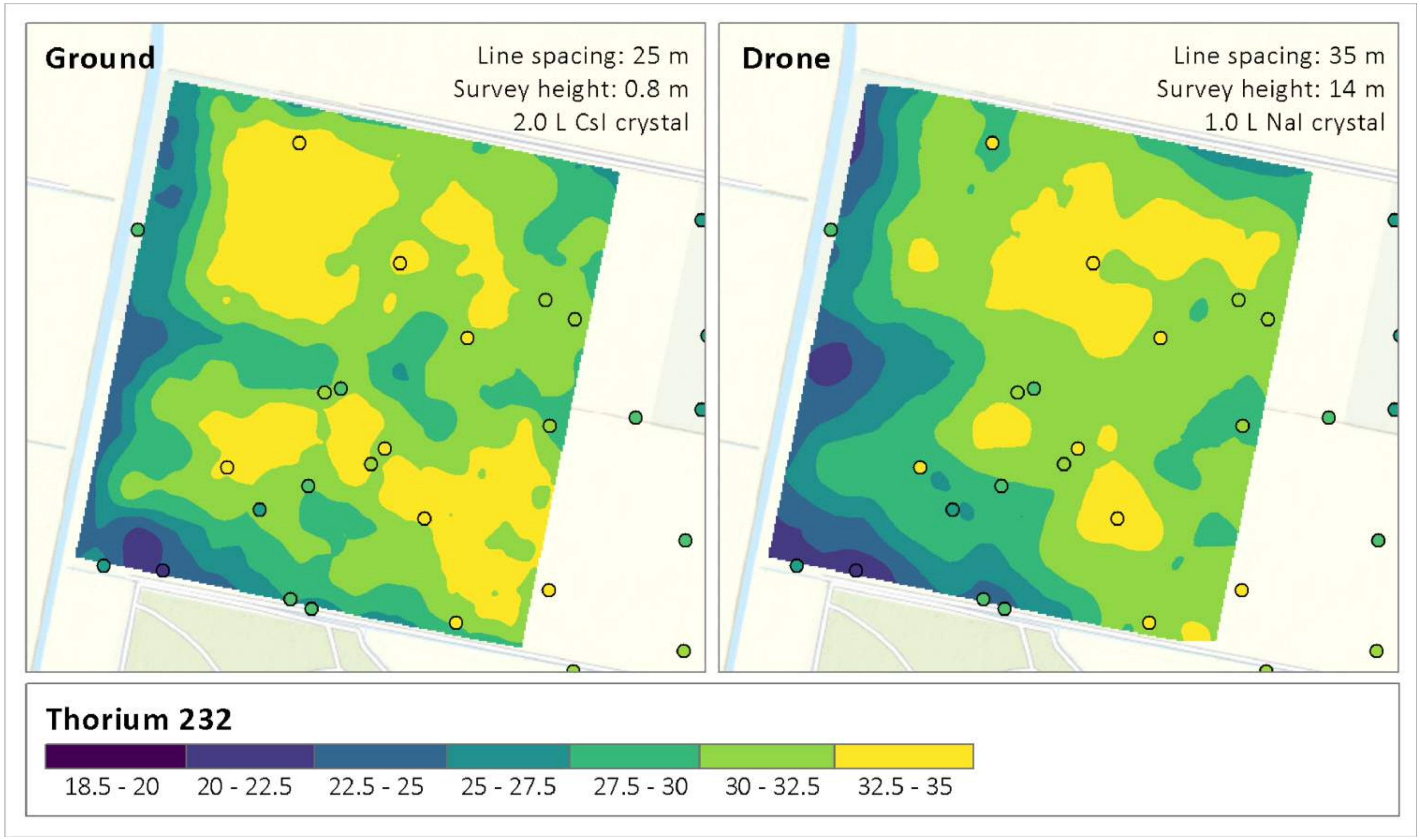
## Drone

- MS-1000,
  1 L NaI crystal
- Drone survey
- Elevation 15 m
- Measurement frequency of 1 Hz.
- Vegetation started to grow

## Sampling

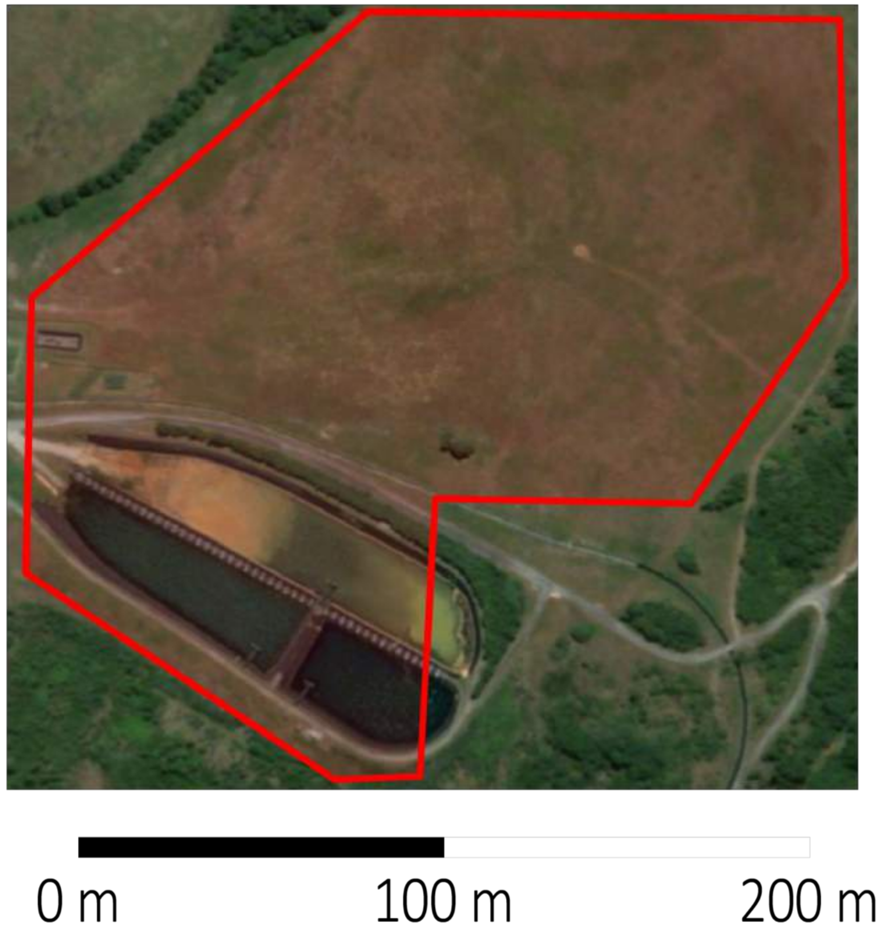
- 14 samples for calibration
- 44 samples for validation
- Analysed on:
  - Radionuclides
  - Grain size
  - Clay and loam content
  - Organic matter

# Case study I: precision farming



# Case study II: Mapping mine tailings

Aerial view



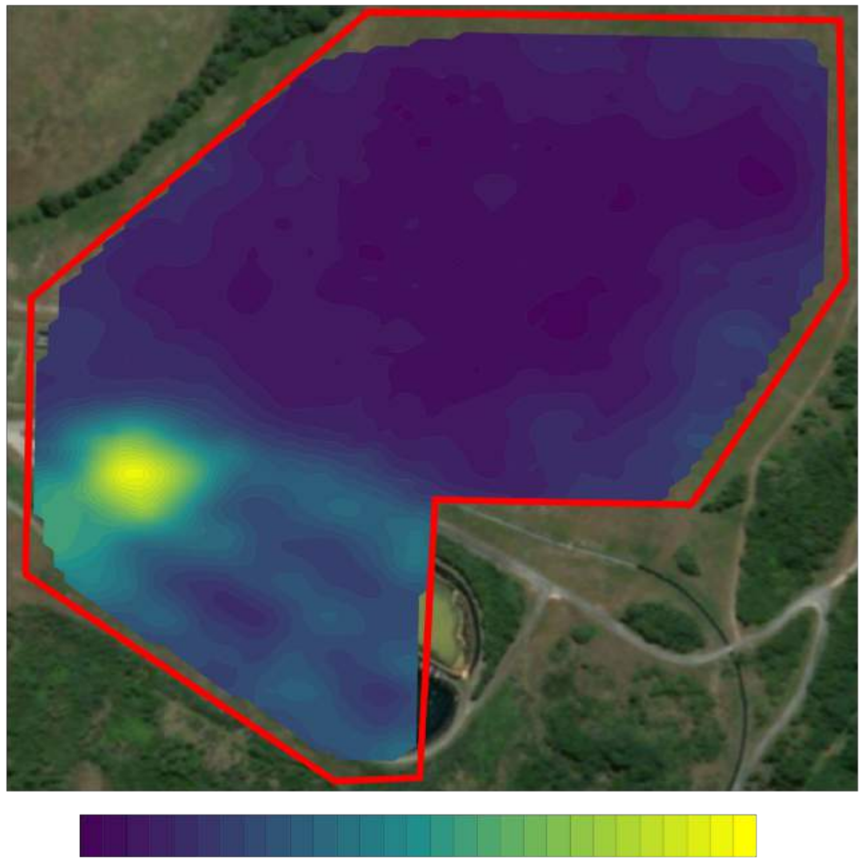

## Drone

- MS-1000,
  1 L NaI crystal
- Elevation 15 m
- 10-15 km/h flying speed
- Spacing: 10m.
- Measurement frequency of 1 Hz.
- Rocky terrain

# Case study II: Mapping mine tailings

Aerial view


Uranium concentration




## Drone

- MS-1000,
  1 L NaI crystal
- Elevation 15 m
- 10-15 km/h flying speed
- Spacing: 10m.
- Measurement frequency of 1 Hz.
- Rocky terrain

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# Conclusions

- Airborne gamma-ray spectrometry as tools to ‘fingerprint’ soils
- Not a replacement but an extension to the current analysis toolbox.

- Small scale applications
    - Precision agriculture
    - Site remediation at legacy mine tailing locations
    - Pollution mapping

- Autonomous realtime system enables new applications.
    - Direct feedback to improve the yield of the survey
    - Realtime source-tracking

- Outlook
    - Geometric corrections and improved analysis methods
    - Even smaller detectors (350 ml NaI)