2. Gamma-ray

Half life times

- $^{238}$U: $4.46 \times 10^9$ yr
- $^{232}$Th: $1.39 \times 10^{10}$ yr
- $^{40}$K: $1.3 \times 10^9$ yr
- $^{137}$Cs: 30 yr

2. Gamma-ray: What is it?

- Alpha: He, shielded by paper
- Beta: 1 electron, shielded by aluminum
- Gamma: EM radiation, shielded by 4 m lead
3. Gamma

Half thickness:
- Air 121 m
- Water 14 cm
- Rock 6 cm
- Dry soil 10 cm

90% of radiation from top 30 cm of soil

1 vol.% more soil moisture = 1% more attenuation

4. Measurement gamma ray

Sensing system The Mole consists of:
- CsI crystal
- Photomultiplier
- Multi-Channel Analyser (MCA)
- USB connection to laptop
- Laptop
- GPS
- Dedicated data log software

4. Measurement gamma ray

Spectrum analysis:
- Windows/ROI analysis
- Full Spectrum Analysis (FSA)
- Multivariate (PLSR, data mining, regression trees)
- Deterministic

4. Measurement gamma ray

Full Spectrum Analysis
- Standard spectra of 1 Bq/kg of a nuclide
- Sensor (crystal) specific
- Incorporates sensor calibration
- Chi-squared algorithm

5. From gamma to soil properties

Which properties can be mapped?
- Soil texture, clay, loam, grain size
- Nutrients, soil organic matter, pH, Fe, K
- Basis for soil models / pedotransfer functions

Depends on the size and scale of calibration dataset
5. From gamma to soil properties

Sampling/calibration
- Nutrients – Field/local scale
- Texture – Regional scale
- Parent material – Global scale possibly

Different calibration approaches:
- Separate spectrum analysis (ROI, FSA)
- Incorporated spectrum to soil data conversion (multivariate, deterministic)

Field day

Site 40 by 60 meter
5 rows
Very wet conditions

Field day

Spectrum analysis
Moving average
11 seconds

Field day

Total counts

Field day

K40

Field day

uranium
Thank you for your attention.

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