Can soil mineralogy predict radiocaesium bioavailability?

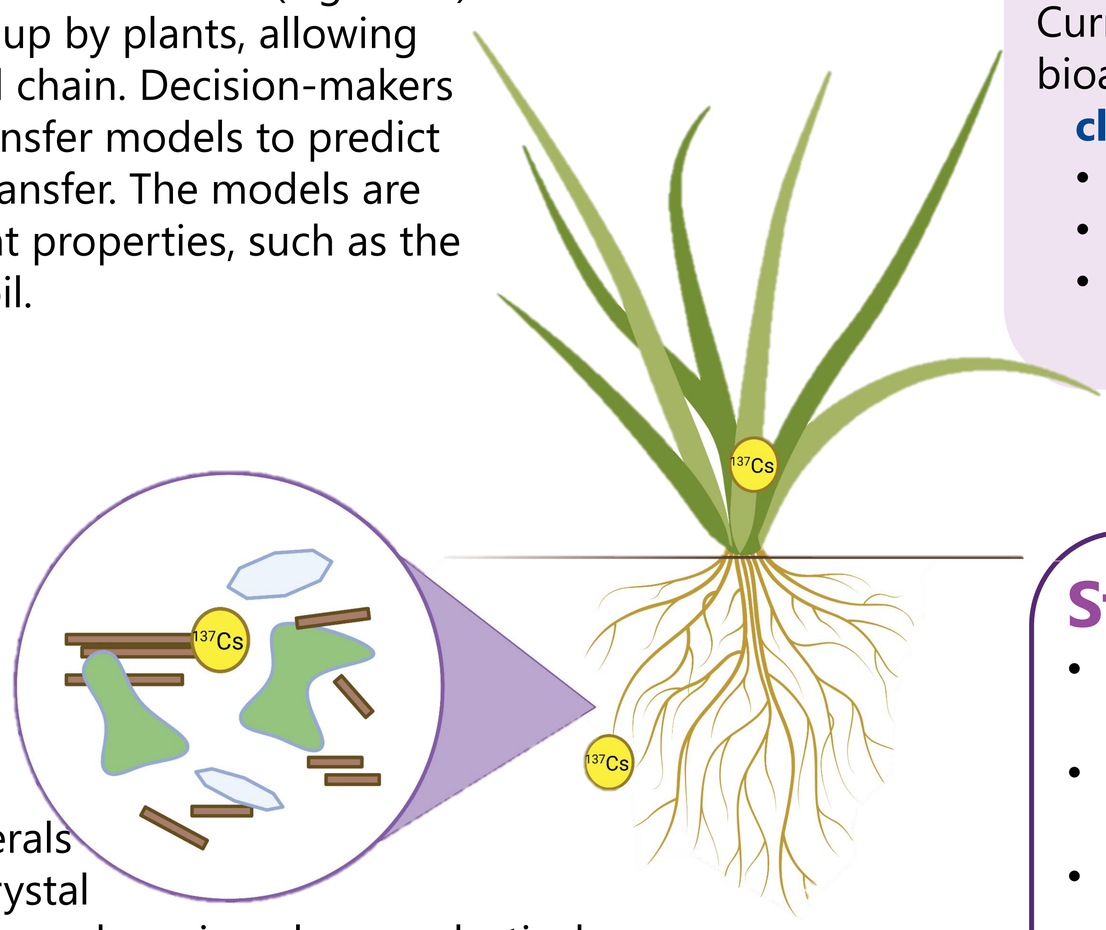
Margot Vanheukelom[1,2], Lieve Sweeck[1], Erik Smolders[2]
margot.vanheukelom@sckcen.be
linkedin.com/in/margotvhk (or scan QR-code)

[1]Biosphere Impact Studies, Belgian Nuclear Research Centre (SCK CEN), Belgium
[2]Division of Soil and Water Management, University of Leuven, Belgium

Context

The emission of radioactive caesium (e.g. ^{137}Cs) in the soil can be take up by plants, allowing ^{137}Cs to enter the food chain. Decision-makers use ^{137}Cs soil-plant transfer models to predict areas at risk of ^{137}Cs transfer. The models are based on soil and plant properties, such as the **clay content** of the soil.

clay content
= the amount of particles in the soil with an equivalent spherical diameter smaller than 2µm



Clay mineralogy

Soils contain clay minerals with distinct layered crystal structure. Certain 2:1 type clay minerals can selectively absorb ^{137}Cs so that it is *not available* to the plant. Clay minerals determine the fate of Cs in the soil-plant system.

Problem

Current models poorly predict Cs bioavailability in soils on a worldwide scale.

clay content

- = particle size measure
- ≠ type of clays present
- ≠ selectivity of soil particles for ^{137}Cs absorption

Strategy

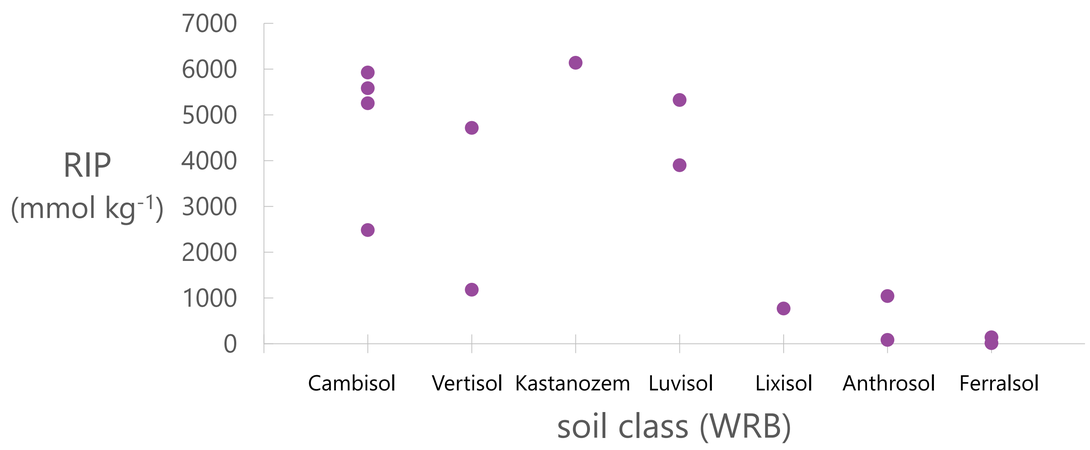
- collect soils of contrasting parent rock and weathering stage
- quantifying mineralogy
  → extent of ^{137}Cs retention
- conducting laboratory pot experiment
  → ^{137}Cs bioavailability

➔ Improve Cs soil-plant transfer predictions by integrating **clay mineralogy**

Methods

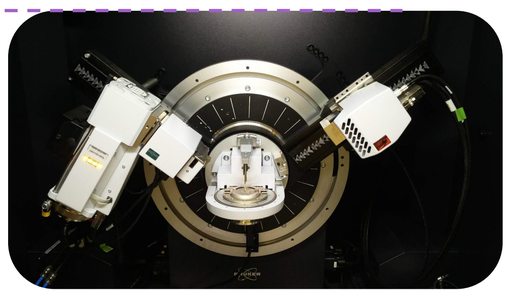
Soil collection

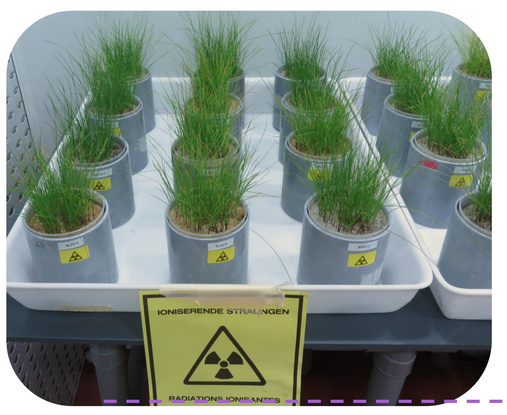
RIP* = $K_c(Cs{:}K)\cdot[FES] \approx K_D\cdot[K^+]$
➔ K_D = RIP/$[K^+]$



Mineralogy quantification

- soil powder + 10 w/w% ZnO
- X-ray diffraction



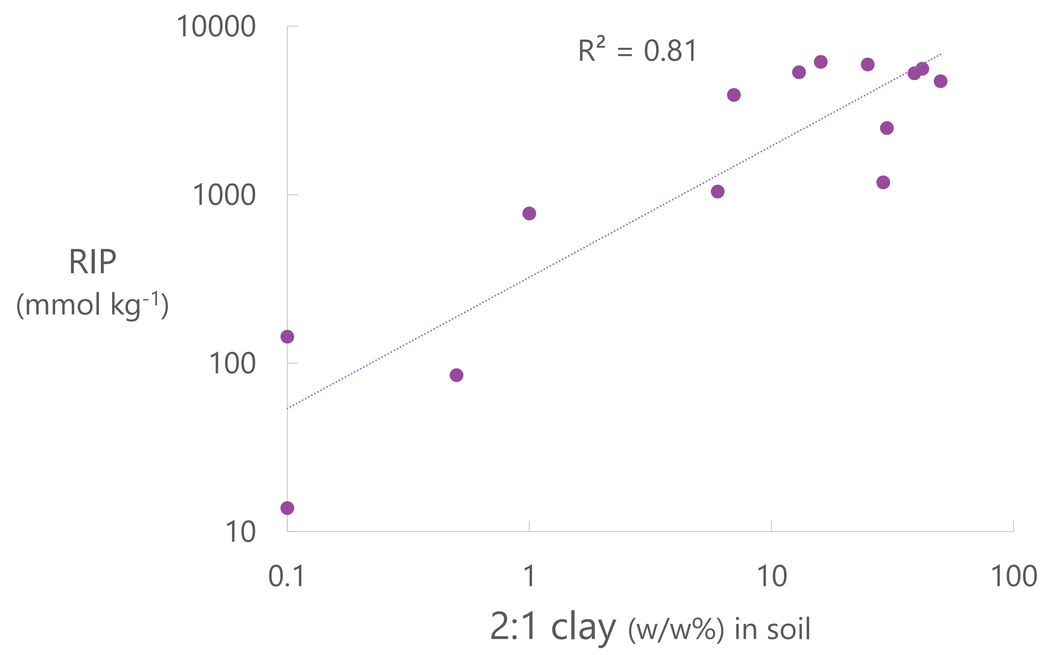


Pot experiment

- soils spiked with ^{137}Cs + fertiliser
- ryegrass (*Lolium perenne* L.)
- growth period of 30 days

Results

If the content of 2:1 type clay minerals in the soil increases, the selective absorption of ^{137}Cs increases.



Expectations

The role of soil mineralogy on ^{137}Cs bioavailability will become clear after

- quantifying the mineralogy
- analysing soil chemical properties

Further research

X-ray diffraction method is laborious and expensive…

Mineral properties
- model coefficients: mineral data from literature
  - e.g. RIP of pure minerals

Soil properties
- model input data: soil maps
  - e.g. SoilGrids (clay%, CEC, SOC, pH, exch K, …)

Link with pedotransfer functions
- e.g. CEC/clay% to predict type of minerals

*RIP = Radiocaesium Interception Potential, a measure for the selective absorption of ^{137}Cs