Interpretation and application of mineralogy results

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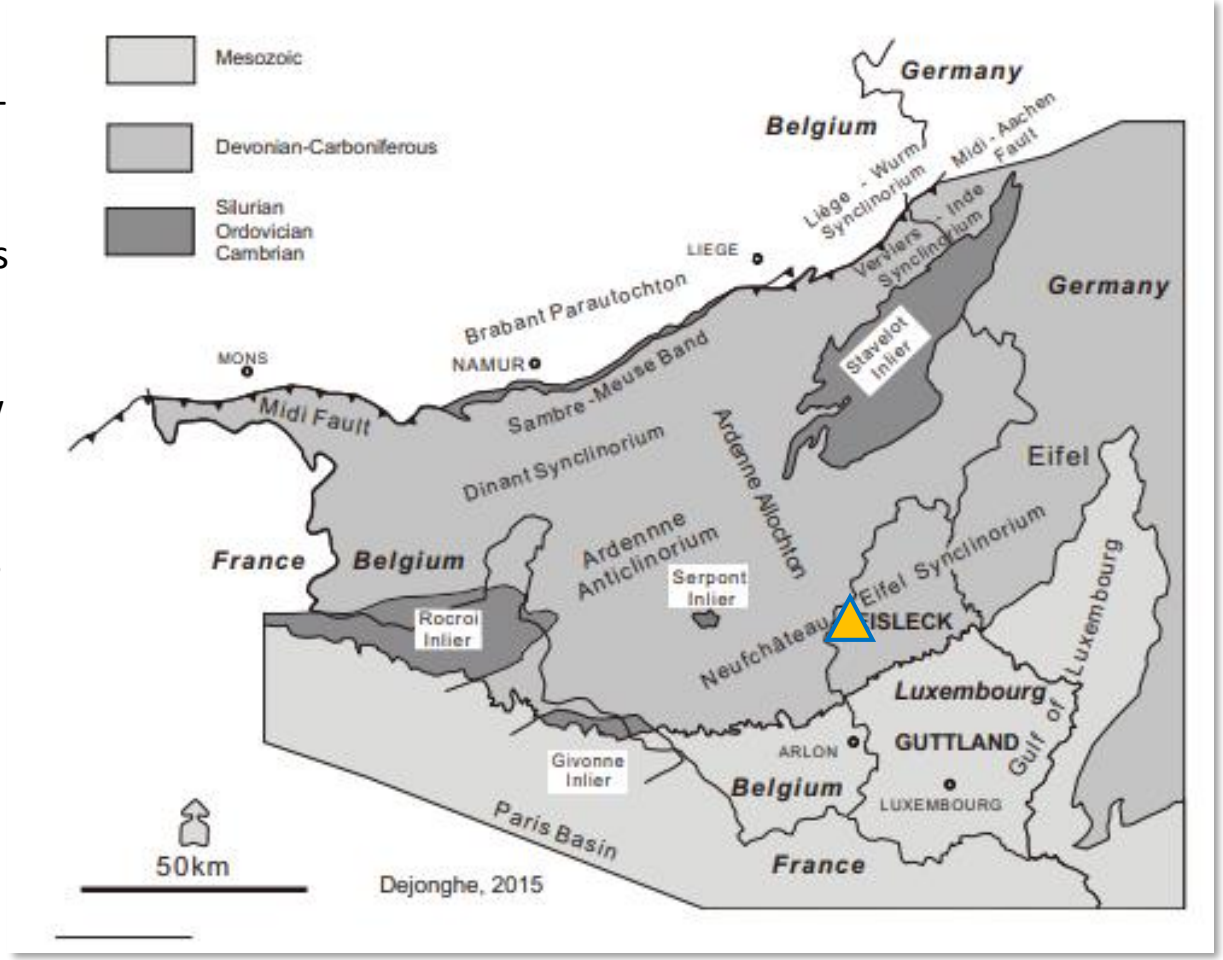
Study case of 2 soil profiles in Éislek (LU) Ardennes (Lower Devonian)

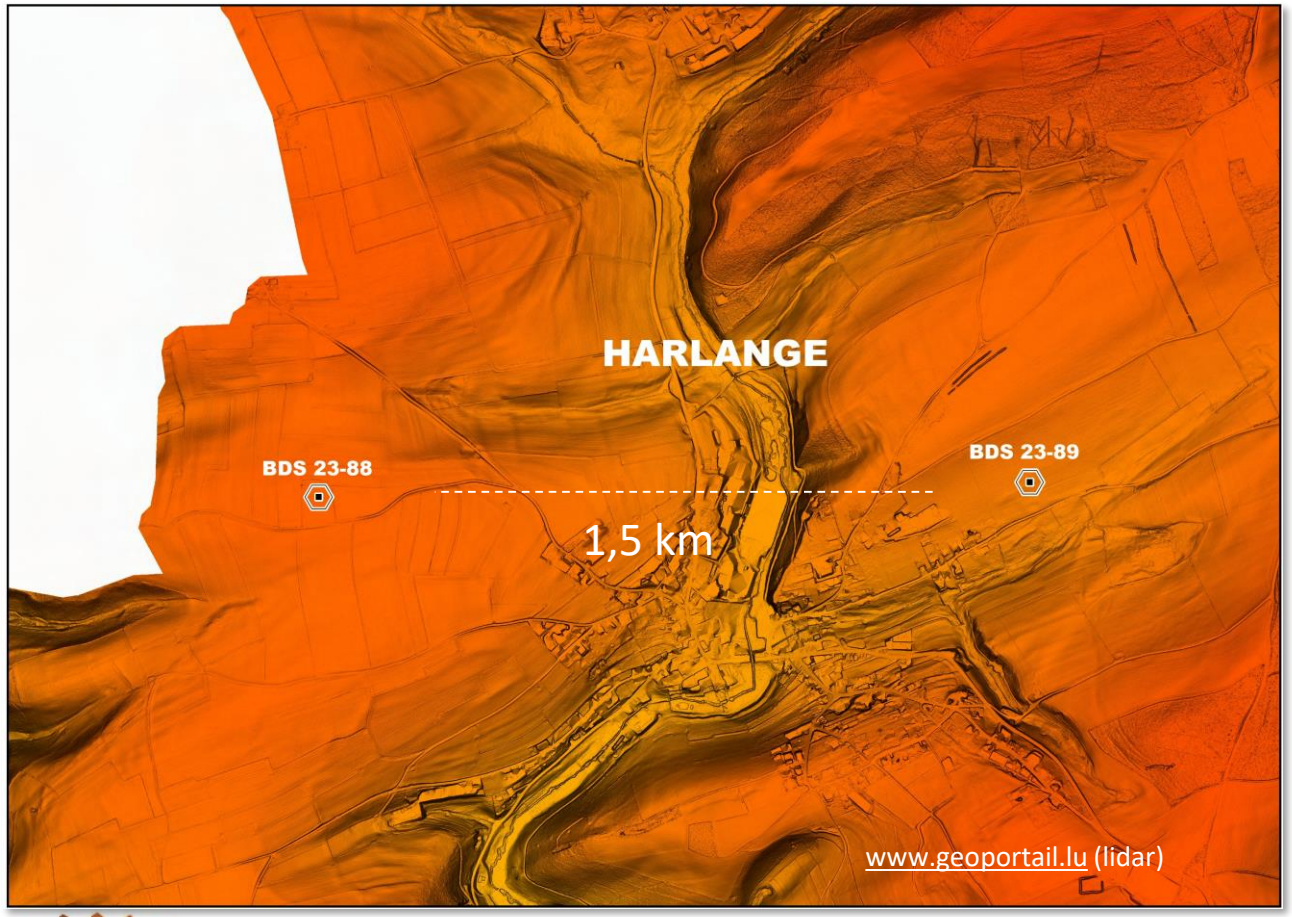
- Shaly loamy soils on the shales of E3 - *Schistes de Wiltz*
- Main pedogenesis processes: degradation and weathering of shales

CHALLENGES

- Coarse fragments cause problems by classical particle size distribution (low reproductibility for silt and sand fraction) – coarse fragments
- Hydrology: texture classification does not match with hydrological properties of soils (well drained)
- Discrepancy between theoretical erosion risk (based on texture class) and reality (very good infiltration)
- Classification: Cambisol, Luvisol, Umbrisol?



Harlange (LU) – Ardennes/Lower Mountain Lower Devonian (E3) - *Schistes de Wiltz /Shales*



BDS 23-89

BDS 23-88

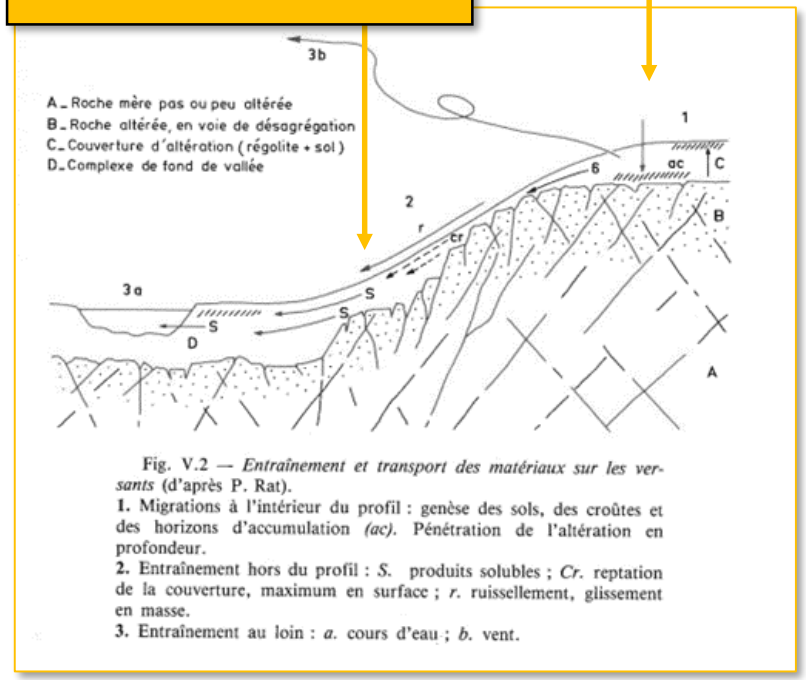


Fig. V.2 — *Entraînement et transport des matériaux sur les versants* (d'après P. Rat).
1. Migrations à l'intérieur du profil : genèse des sols, des croûtes et des horizons d'accumulation *(ac)*. Pénétration de l'altération en profondeur.
2. Entraînement hors du profil : *S.* produits solubles ; *Cr.* reptation de la couverture, maximum en surface ; *r.* ruissellement, glissement en masse.
3. Entraînement au loin : *a.* cours d'eau ; *b.* vent.

Endoleptic

Stagnosol [Loamic, Aric, Cambic, Humic, Amphiskeletic]

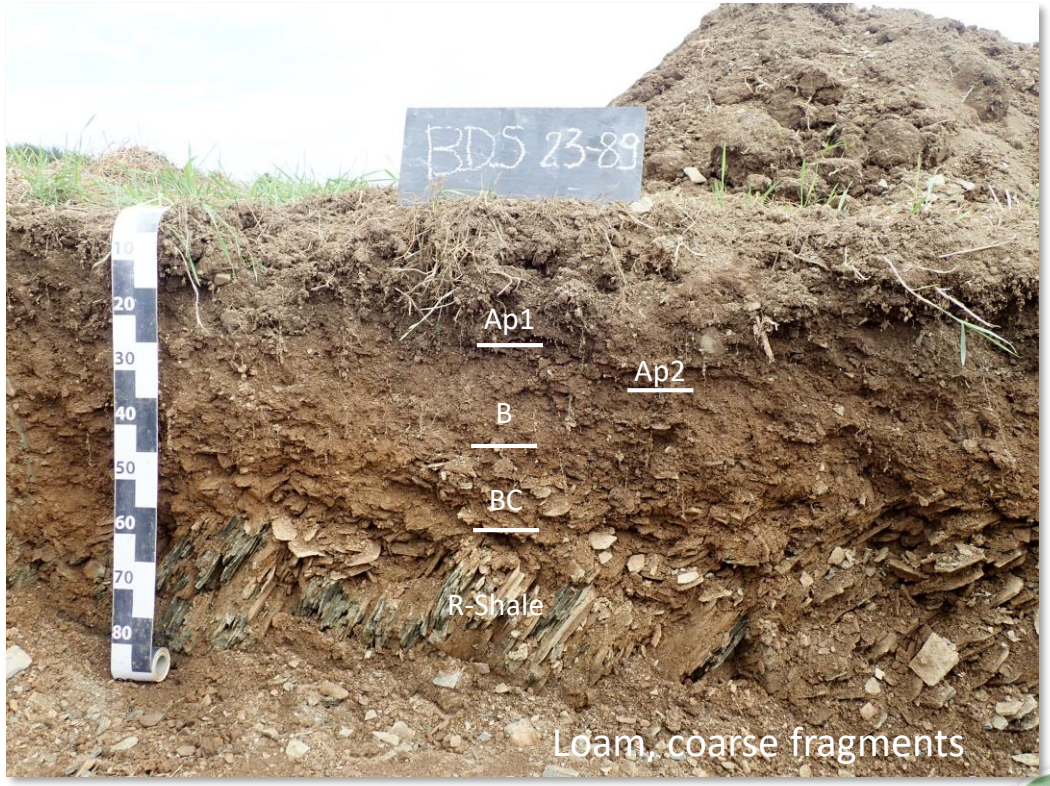
Amphiskeletic, Endoleptic

Cambisol [Loamic, Aric, Humic]

(WRB2022)

BDS23-88: plateau (fuGdbf4)

BDS23-89: gentle slope (Gbbf2)



Analytical Investigations

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Physico-chemical (ASTA)

- Texture - clay (<2um), silt (2-50um), sand (50um – 2mm)
- pH_{H2O}, pH_{KCl}, pH_{CaCl2},
- P, K, Mg, Na (VDLUFA)
- TOC, TIC (DryCombustion)
- ETM, Al_{ox}, Fe_{ox}
- BD, Ksat
- Stoniness

Mineralogy (R. Butz-Braun)

- Sample < 6,3 um
- Comparable to N.Fagel (ULiège)
- XRD on bulk powder and following Rietveld refinement
- XRD on oriented mounts
  Air dried, EthylenGlycol-saturation, heating at 350° C and 550° C as well as after solvation with $MgCl_2$, KCl and HCl

Pedogenesis - Classification

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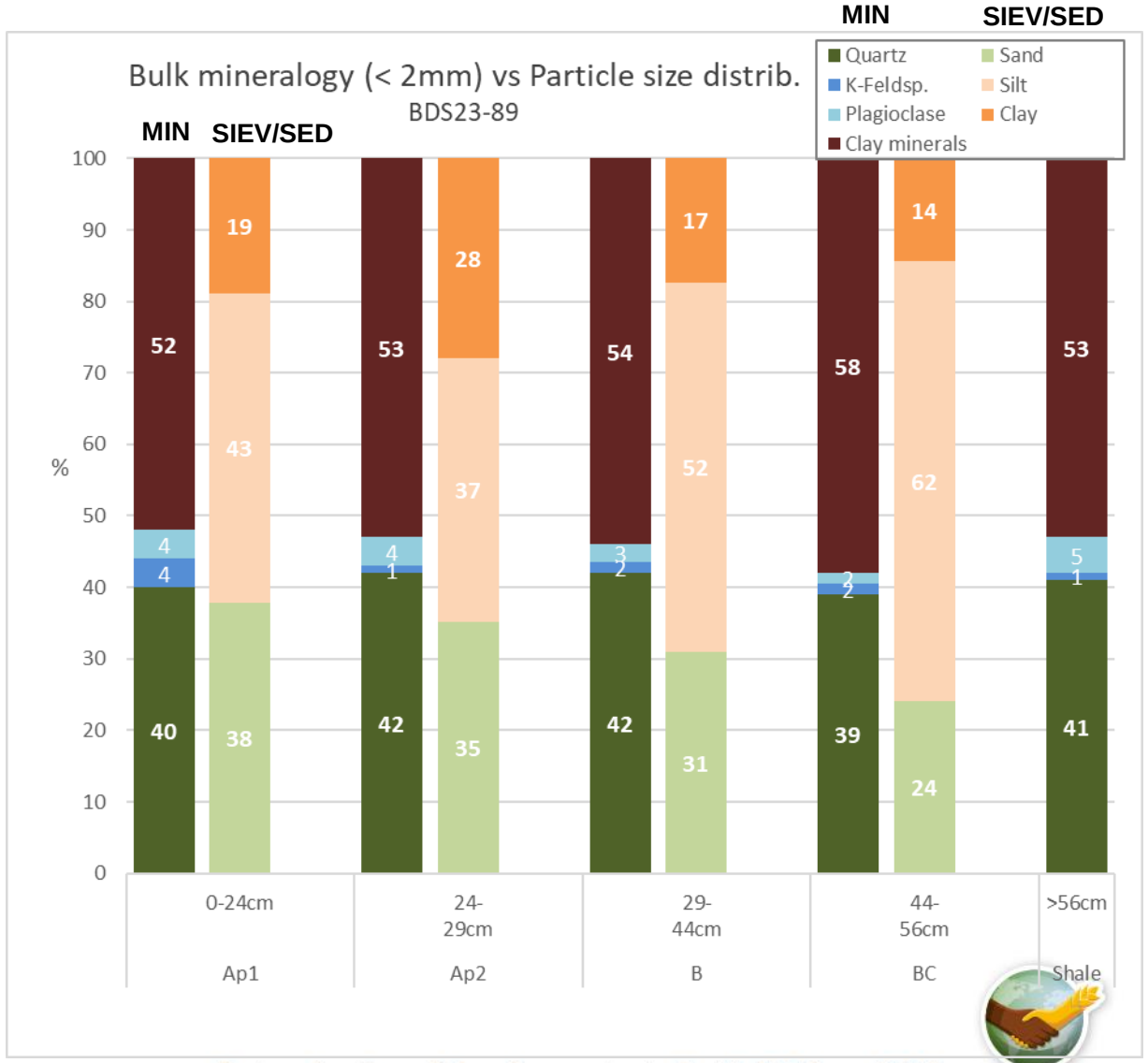
- MINERALOGY and PARTICLE SIZE DISTRIBUTION are not directly comparable, but…

- MINERALOGY: Proportion of clay minerals and primary minerals nearly identical between parent material and solum
- Apparently no influence of alloctone (aeolian) material
- Periglacial solifluction took place on the slope but no lithic discontinuity between parent material and solum
- Discrepancy between sedimentary clay fraction and mineralogical clay—> which clay determination for SOC/clay ratio?

- PARTICLE SIZE DISTRIBUTION : Results of particle size distribution (especially sand/silt fraction) highly depending on sample preparation (crashing or not of coarse fragments)
- Sum of silt and sand fraction seem to be stable



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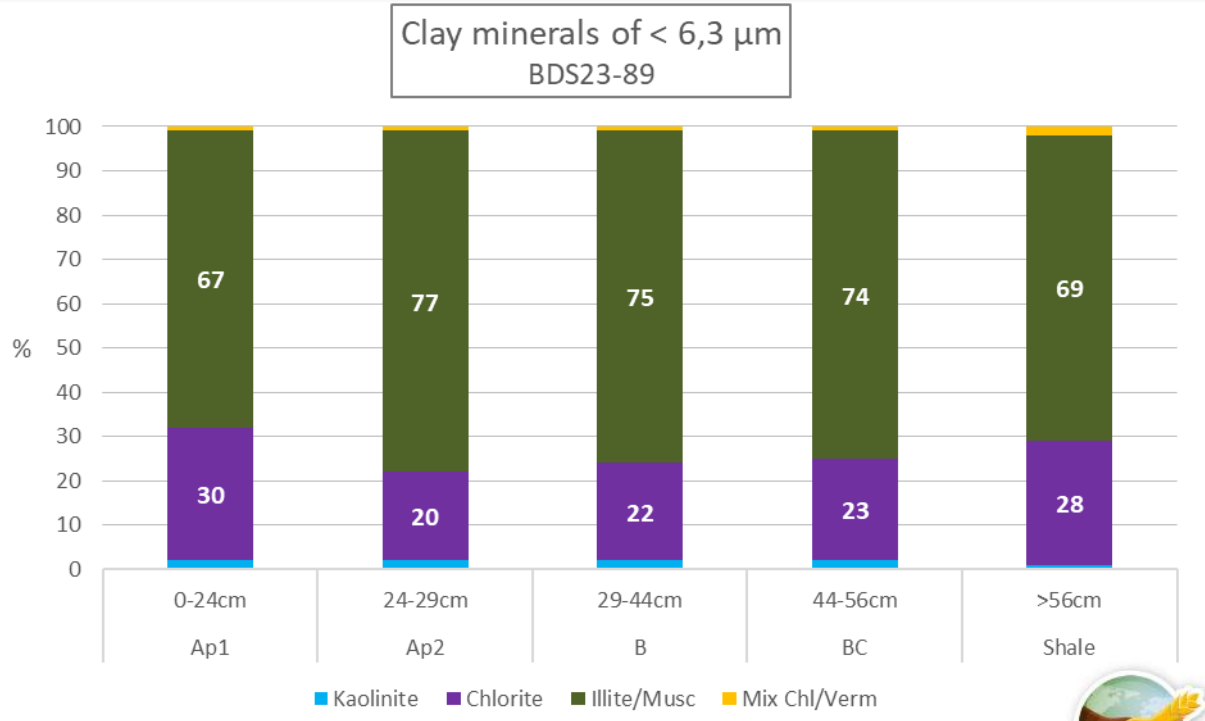
- Inheritated chlorite and illite/muscovite from parent material (sericite) -> pedogenese = mainly degradation and weathering of parent material (shale)
- Primary chlorite are source of Mg (brucite interlayers)→ fertiliser recommandations
- Primary illite and K-Feldspar are source of K → fertiliser recommandations

- To be further deepend :
  - origin of good structural stability of soils?
  - origin of high Phosphor Sorption Capacity (PSC = Al_{ox} + Fe_{Ox})?



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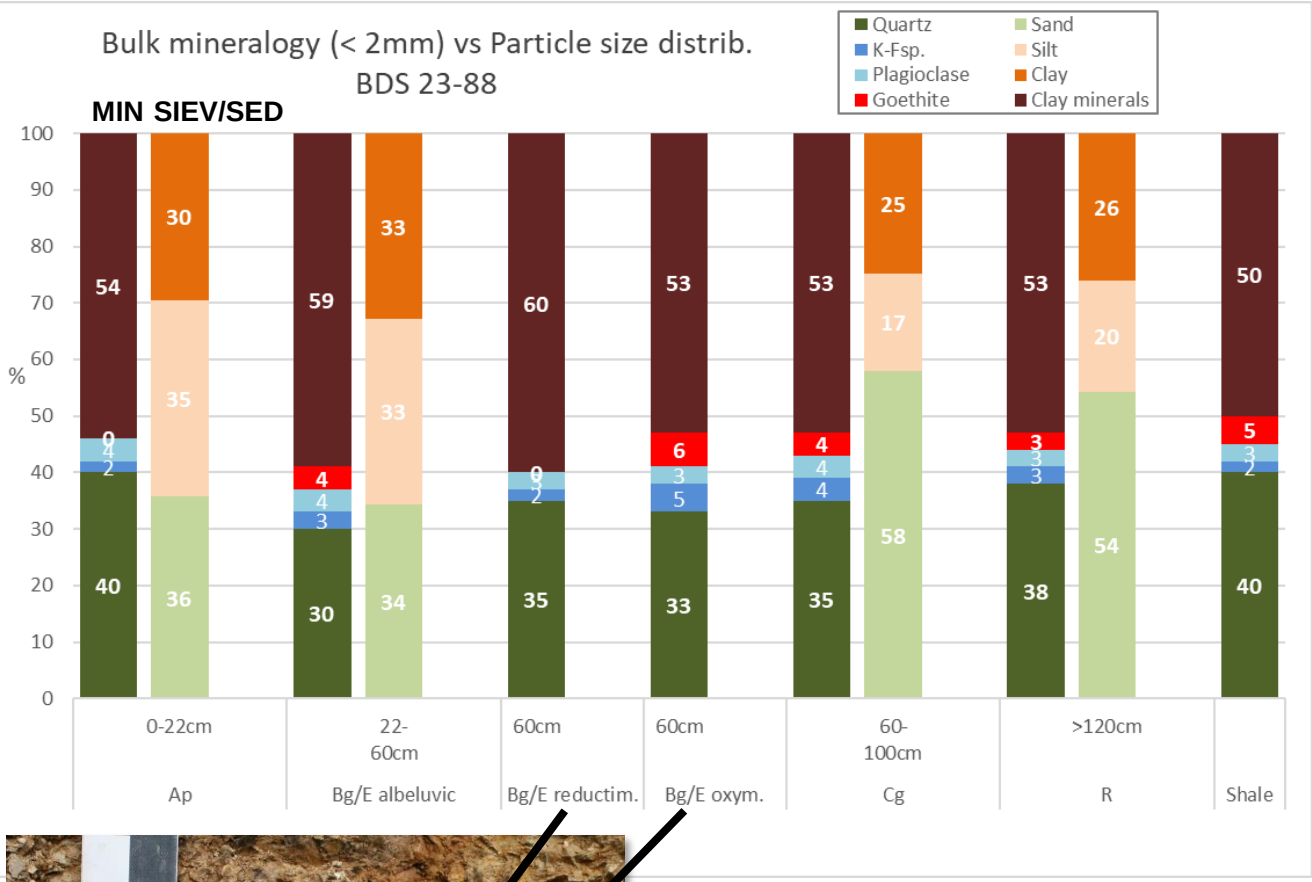
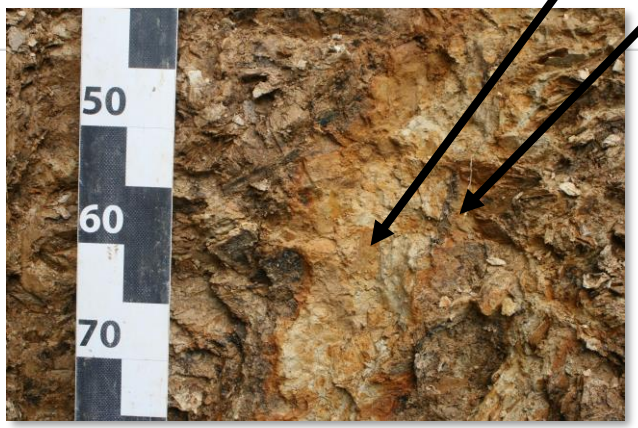
- Inheritated albeluvic tongues from ice wedges with stagnic properties (oxymorphic and reductimorphic features) from periglacial times→ STAGNOSOLS
- No lithic discontinuity between parent material and solum
- Loss of iron in reductimorphic zones, underlines stagnic properties
- Not obvious clay illuviation in Bg horizon: ~~Btg/E~~ → Bg/E ; no authentic albeluvic glossae (according to WRB2022) but only albeluvic tongues
- Parent material different to former profile (BDS24-89) - presence of goethite and kaolinite, absence of chlorite





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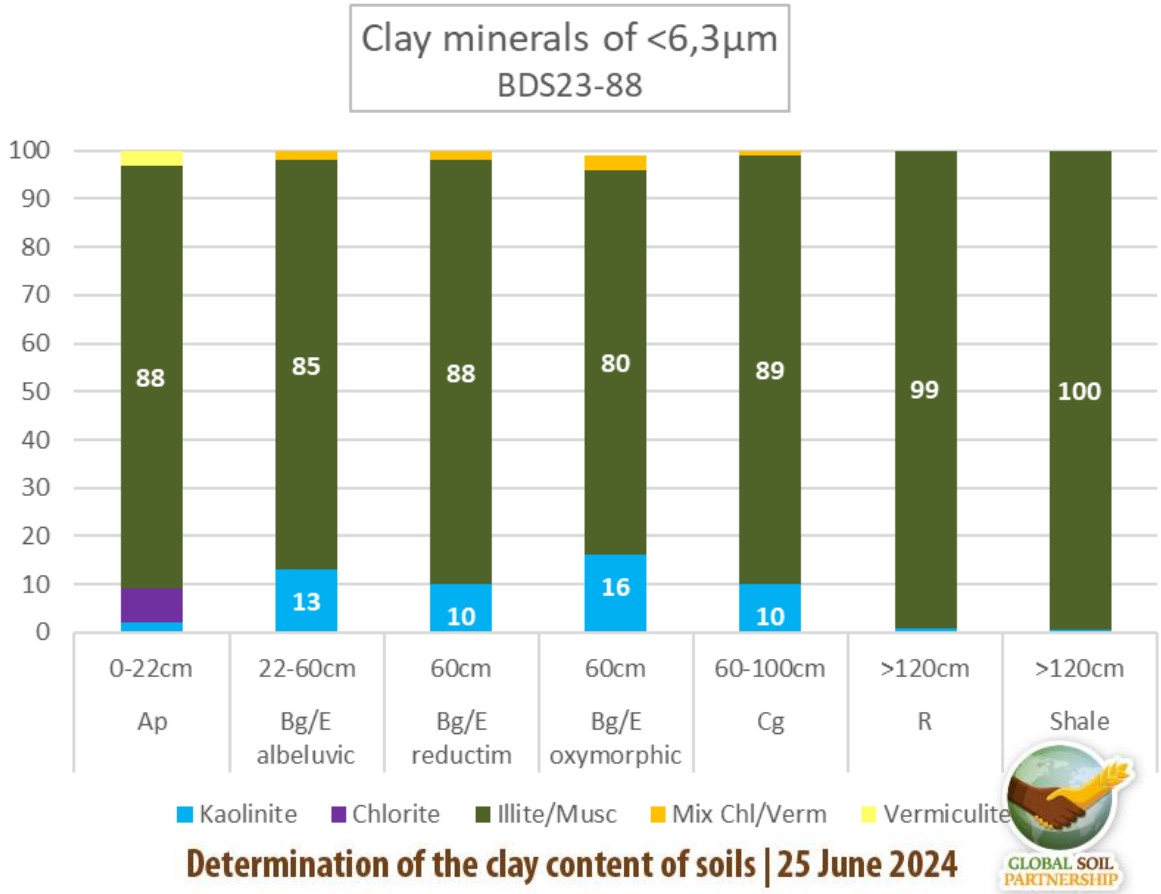
- No chlorite in parent material and solum, except topsoil (influence from surroundings)
- Presence of kaolinite (in situ deep weathering from tertiary)



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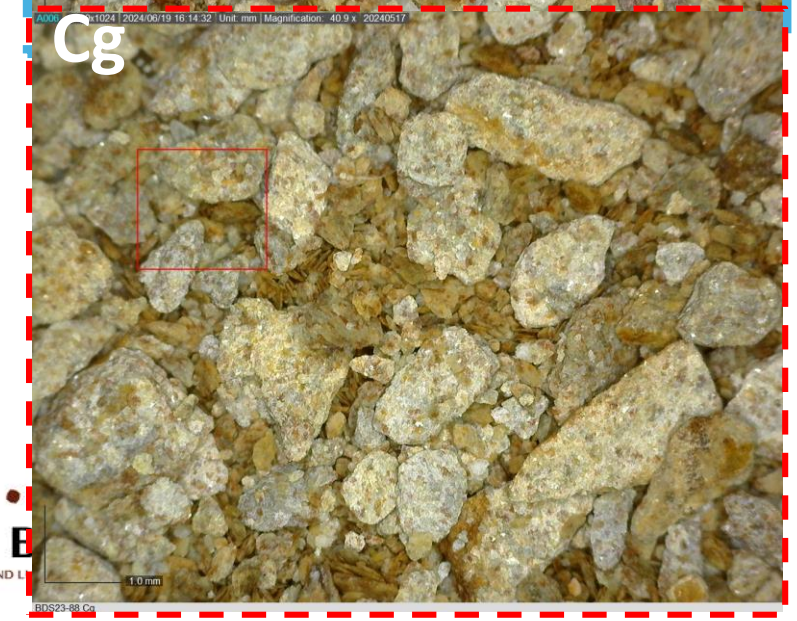
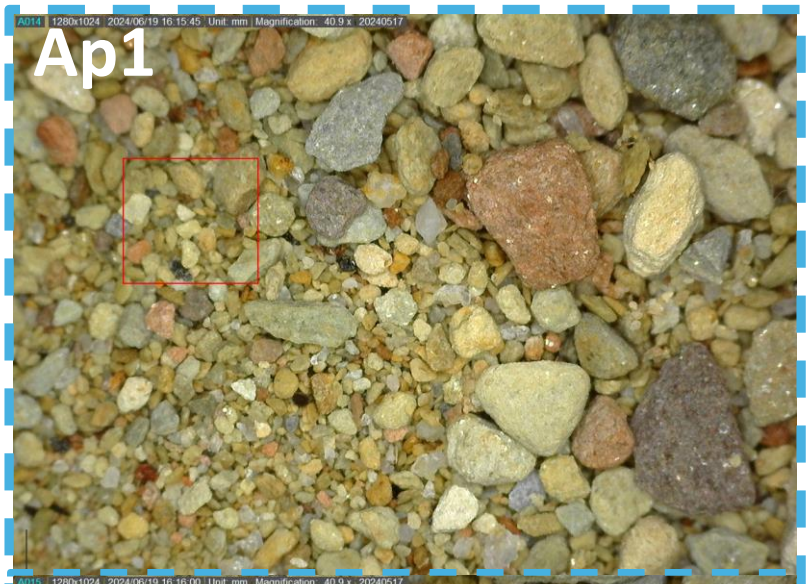
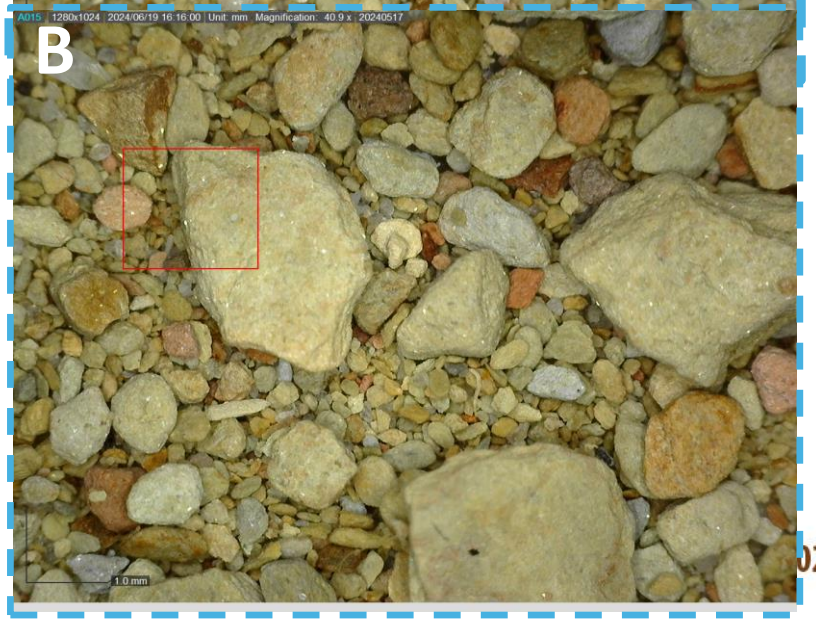


Sand fraction from sieving (particle size distribution)

BDS 23-89





Conclusions

Soils developed on devonian shales present several challenges:

- Low reproductibility of the sand and silt fraction by particle size distribution because of the interference of coarse fragments
- Loamy texture determined by particle size distribution does not match in the field with the admitted hydrological properties of similar textures derived from aeolian material
- Investigations in mineralogical determinations could not be directly compared with the results of particle size distribution,

But where complementary

- for understanding the structure of the soils and elements of past pedogenesis processes
- for classification purposes

To be clarified in the future

- which clay determination methodology for SOC/clay ratio?

Food and Agriculture Organization of the United Nations

Thank you

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