

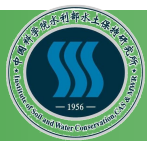
Crusting cause changes in soil erodibility: assessment and consequences for erosion modeling.

An example from the Loess Plateau (China)

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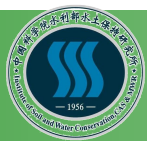
Context of the study: soil erodibility

- Erodibility is the sensitivity of the surface material that can be detached by overland flow

➔ A key parameter of erosion models

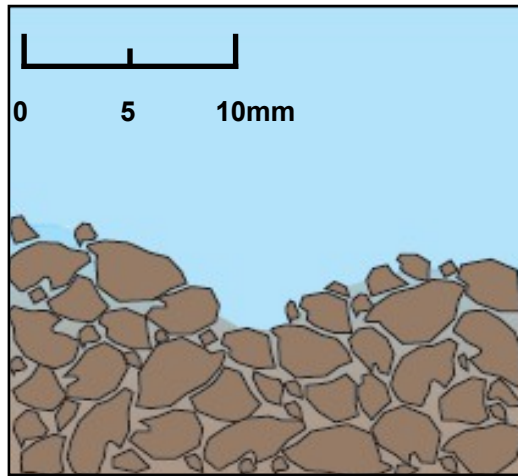
- Different types of soil present different erodibilities
- For a given soil, surface properties can change with time due to rain drop impact and overland flow

➔ How to estimate erodibility at a given location at a given time?



Mechanisms of top soil crust formation

Initial state

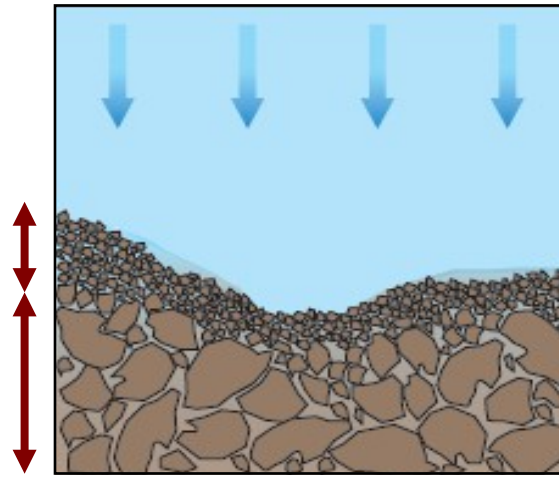


Structure after ploughing

Millimetric sized aggregates

Important structural porosity at the surface

Structural crust

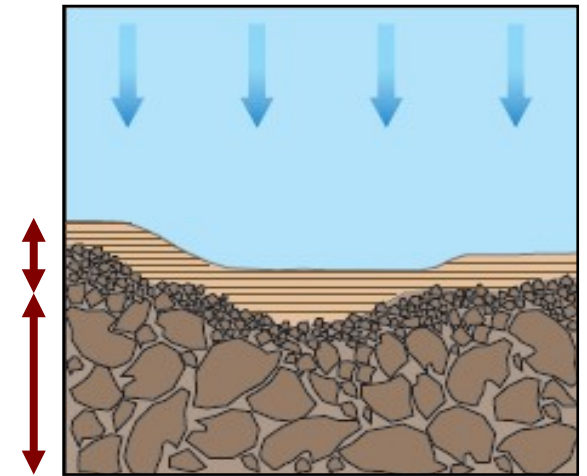


Aggregate breakdown under raindrop impact

Structural crust formed by microaggregates

Structural porosity decreasing at the surface

Sedimentary crust



Erosion and splash provoke the particle deposit

Formation of a compact sedimentary crust

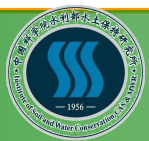
Structural porosity totally disappeared at the surface

Consequences:

Soil structure perturbation

Impair crop emergence

Modify gas emissions



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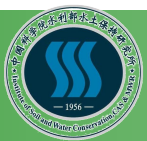


Aggregate stability

- Aggregate stability is the capacity of an aggregate to keep its size and not break into smaller fragments when it is submitted to a stress.

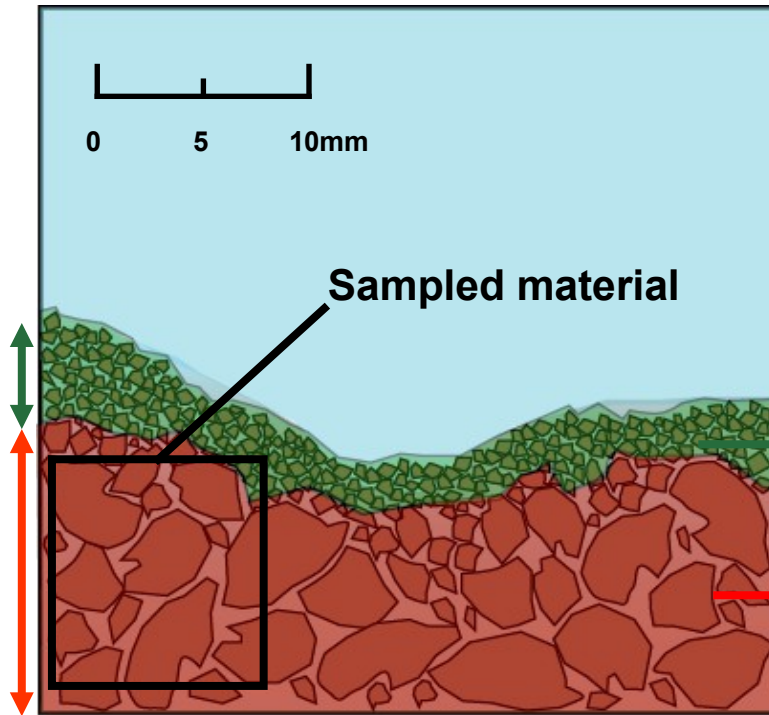
→ Empiric property that is measured by various tests

- Aggregate stability is used to estimate
 - The sensitivity to crust formation
 - The soil erodibility



Sampling problem

5



- Usually, aggregate stability is assessed on samples collected from the undercrust material

→ Estimation of erodibility may not be valid for the top surface

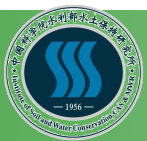
Soil surface with crust

Underlying material

Darboux and Le Bissonnais (2007) found large differences in aggregate stability between the crust and the underlying material

Undercrust \geq Structural crust $>$ Sedimentary crust

This laboratory experiment used a limited scope of soil and limited conditions



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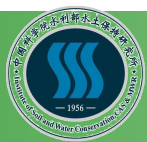


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Purposes of the present study

- To compare the aggregate stability of crusts and the aggregate stability of underlying materials in the field
- To explain the difference in aggregate stability between crust and undercrust using other soil and site properties



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Material & Method : Sampling sites

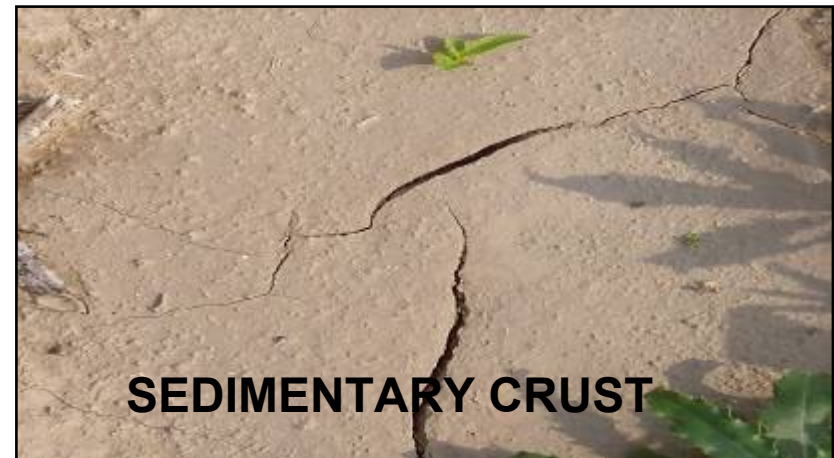
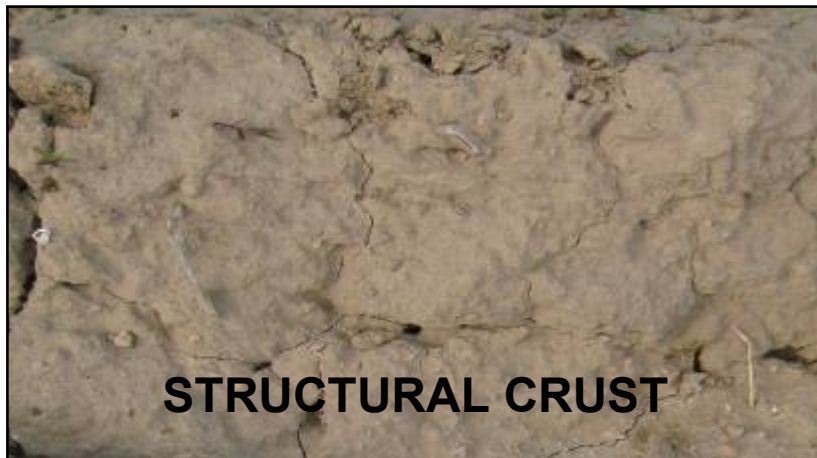
- Ziwuling area in the South of Loess Plateau
- 7 sites geographically close together (15 km radius) were sampled (september 2009)
- Different land uses were represented



Site and subsites	Land use	Slope gradient
A	Cultivated corn field	5°-10°
B	Apple orchard, shoulder of a terrace	5° - 30°
C	Cultivated radish crop, sampling in the ridges and the furrows	5°-10°
D, E	Ziwuling experimental station, rill area	5° - 35°
F, G	Ziwuling experimental station, gully area	35° - 40°

Material & Method : Sampling method

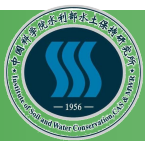
- Prior to sampling, the soil surface was described to identify the type of crust



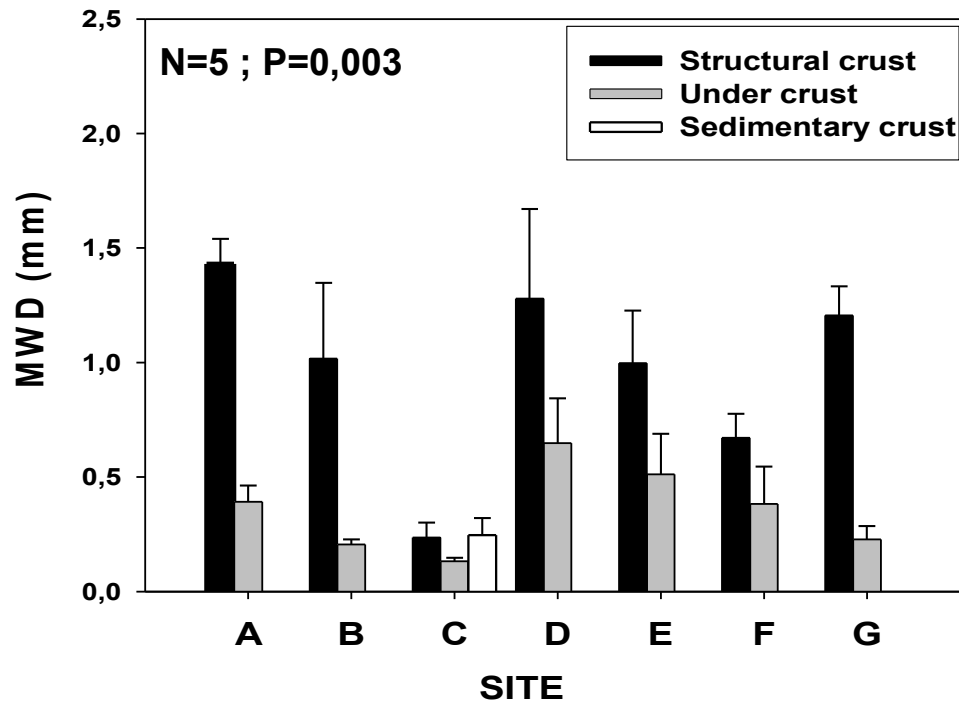
- For each sites, 5 plots (1m² each) were defined to collect samples
- Paired samples were collected (crust and under crust) from each plot

Material & Method : measurement

- Aggregate stability : Le Bissonnais' method (1996) *becoming ISO standard*
 - Fast wetting test: slaking
 - Slow wetting test: differential swelling of clays
 - Stirring test: kinetic energy
- Other soil properties as explanatory factors :
 - Soil texture
 - Soil organic matter
 - Water content
 - CEC
 - pH



Results: aggregate stability



- **Aggregate stability of the crust was larger than the stability of its underlying material**
- Results are different from Darboux and Le Bissonnais (2007)

They used a different type of soil and controlled conditions

The present study was made in field conditions where more factors interact



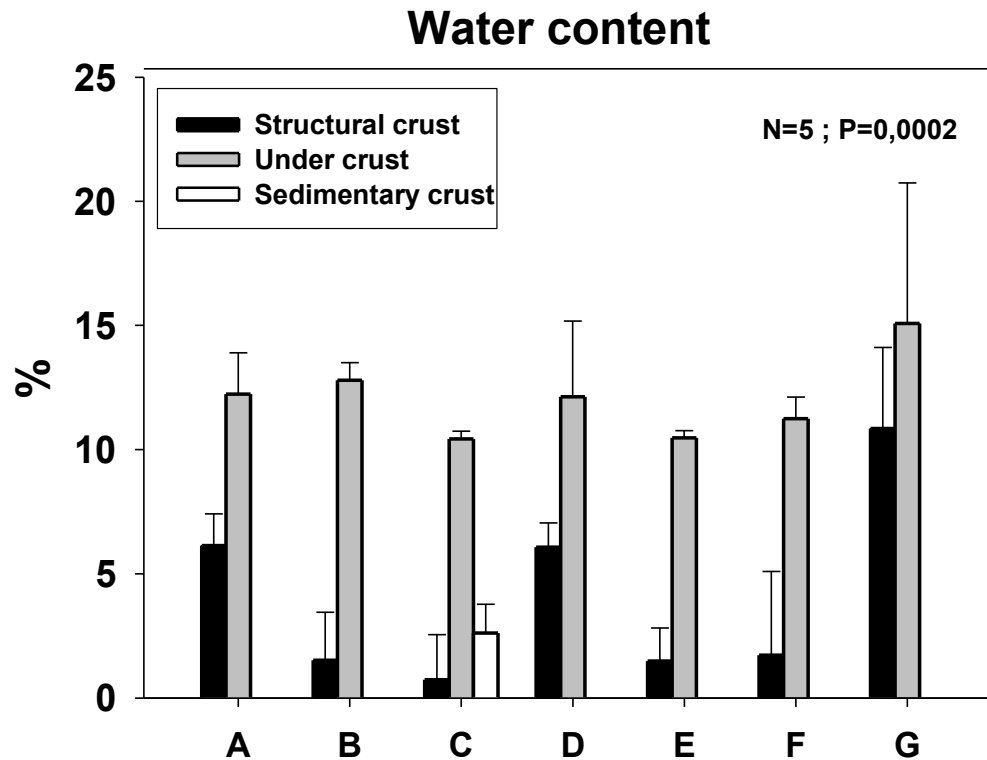
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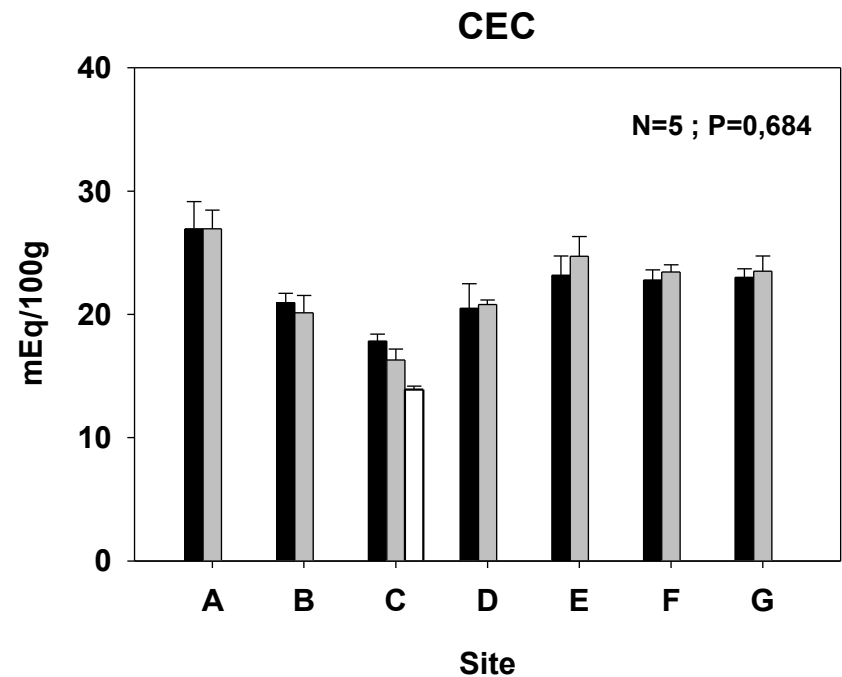
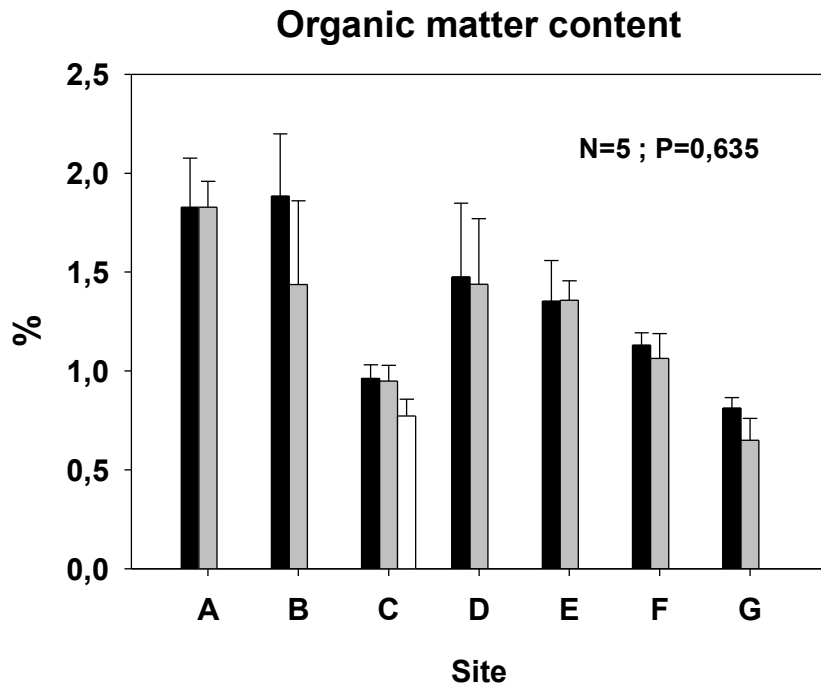


Results: potential explanatory factors¹¹



- Water content differed between samples and sites
- Higher in the undercrust than in crust

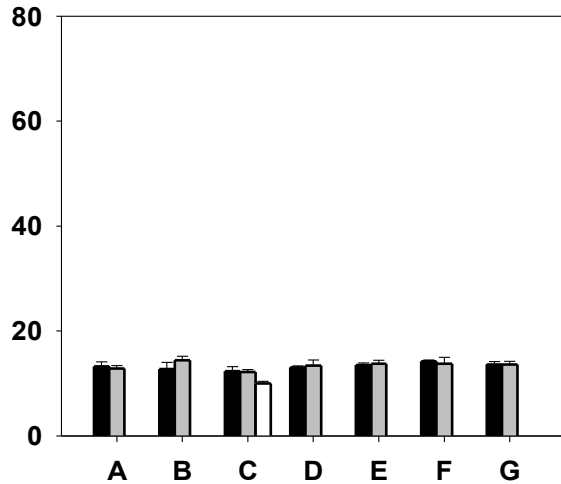
Results: potential explanatory factors



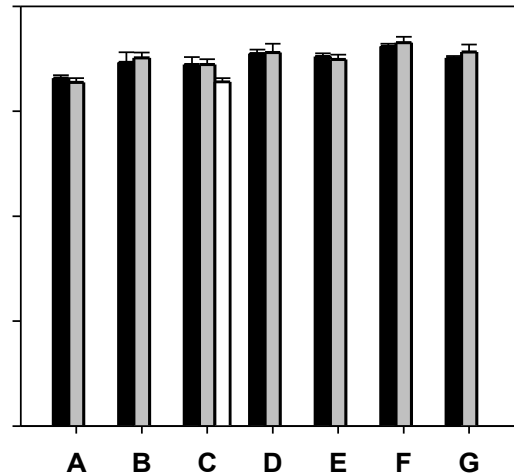
- Organic matter content and CEC of crust and undercrust were identical but differed between sites

Results: potential explanatory factors¹³

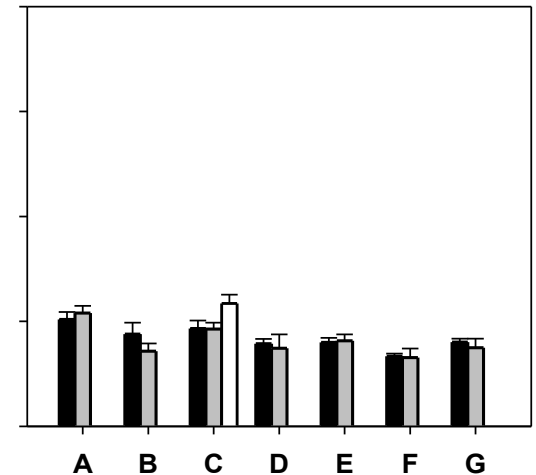
Clay content



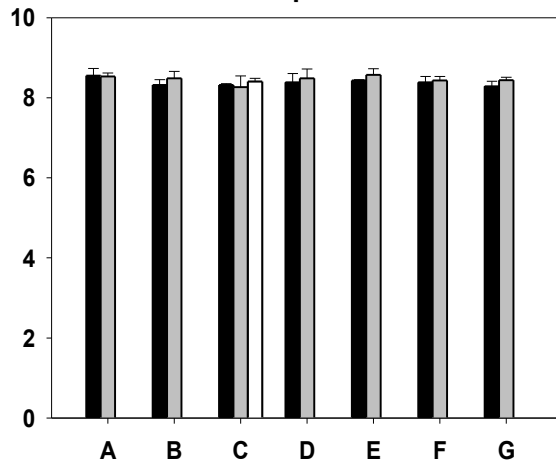
Silt content



Sand content



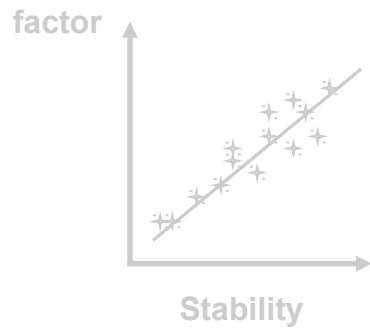
pH



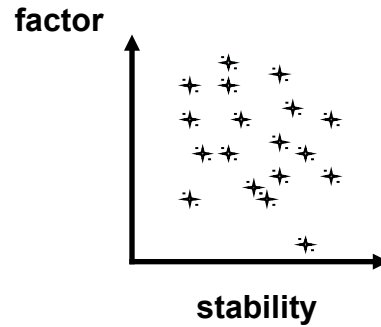
Site

- pH and texture were identical for all samples and sites

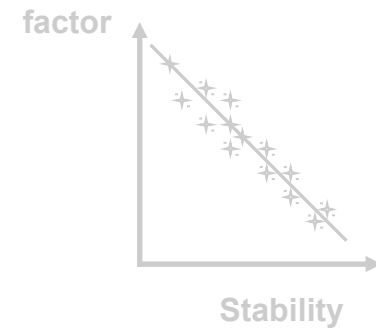
Relationships between aggregate stability¹⁴ and explanatory factors



Correlation?



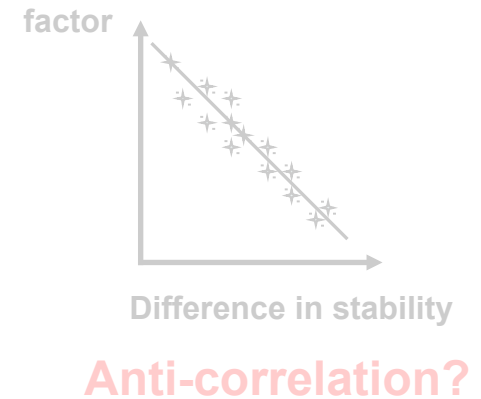
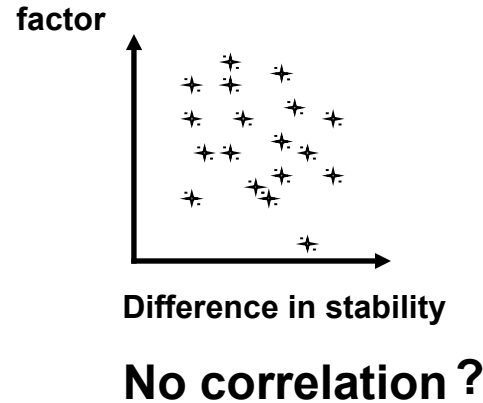
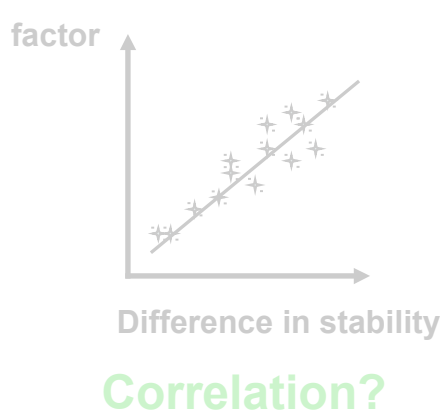
No correlation?



Anti-correlation?

- The relationships between the studied factors and aggregate stability are not statistically significant (best $r^2=0,4$).
- The chosen explanatory factors cannot explain aggregate stability variation.

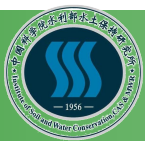
Relationships between aggregate stability¹⁵ and explanatory factors



- The relationships between explanatory factors and the differences in aggregate stability between crust and undercrust is not statistically significant (best $r^2=0,25$)
- The chosen explanatory factors cannot explain the difference in aggregate stability between crust and underlying material.

Conclusion

- The samples from the crust presented higher aggregate stability than the underlying material.
- Those results confirm that erodibility varies during time with the changes of properties of the top soil induced by crusting
- Those results also confirm that soil erodibility has to be estimated on the exact material that undergoes erosion : the soil surface material
- Using material collected from the plough layer may lead to large bias in erodibility estimation, and may distort the results of erosion models.
- The chosen explanatory factors can not explain those variations in stability.
- This work emphasized the need to understand the factors controlling changes in aggregate stability



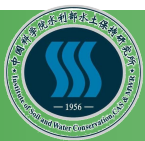
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