Carbon release from tropical forest soils informed by soil chemistry, fertility, and carbon quality derived from geochemistry of the parent material

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Motivation of the study

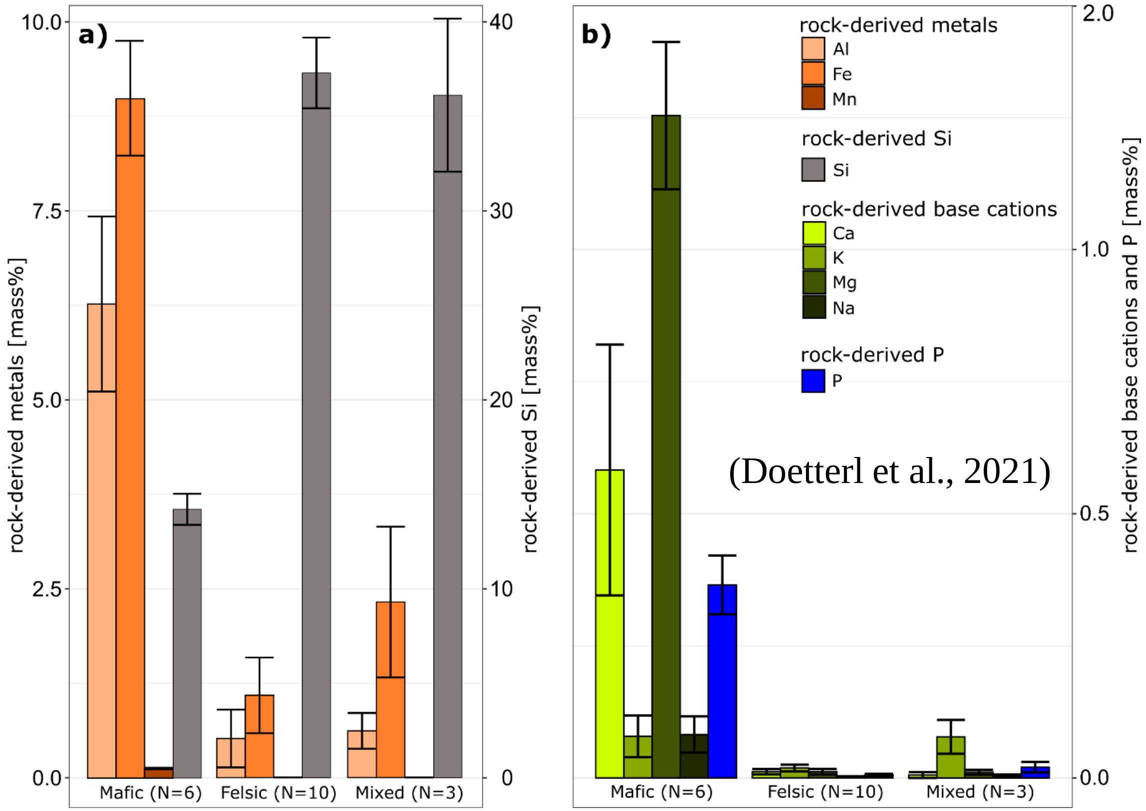
- Heterotrophic soil respiration is an important component of the global terrestrial carbon (C) cycle, driven by environmental factors acting from local to continental scales. However, for tropical Africa, these factors and their interactions remain largely unknown

- In this study, we try to answer if C release through heterotrophic respiration from forest soils in the humid tropics follows predictable patterns related to geochemical soil properties

- We hypothesize that, in the absence of anthropogenic disturbance, soil geochemistry derived from its parent material has a lasting effect on soil C respiration due to its influence on stabilization mechanisms and soil fertility, even in deeply weathered natural tropical soils

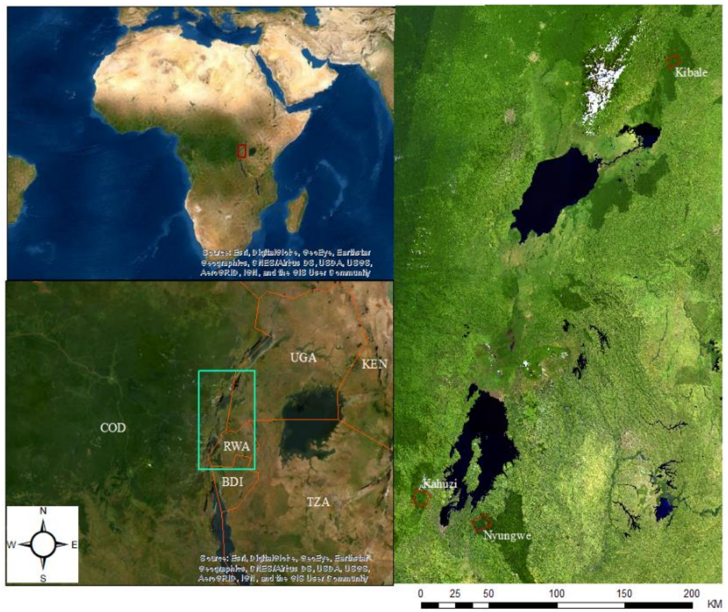
Study sites and experiment

- We collected samples along geochemical gradients From mafic to felsic to mixed geochemistry



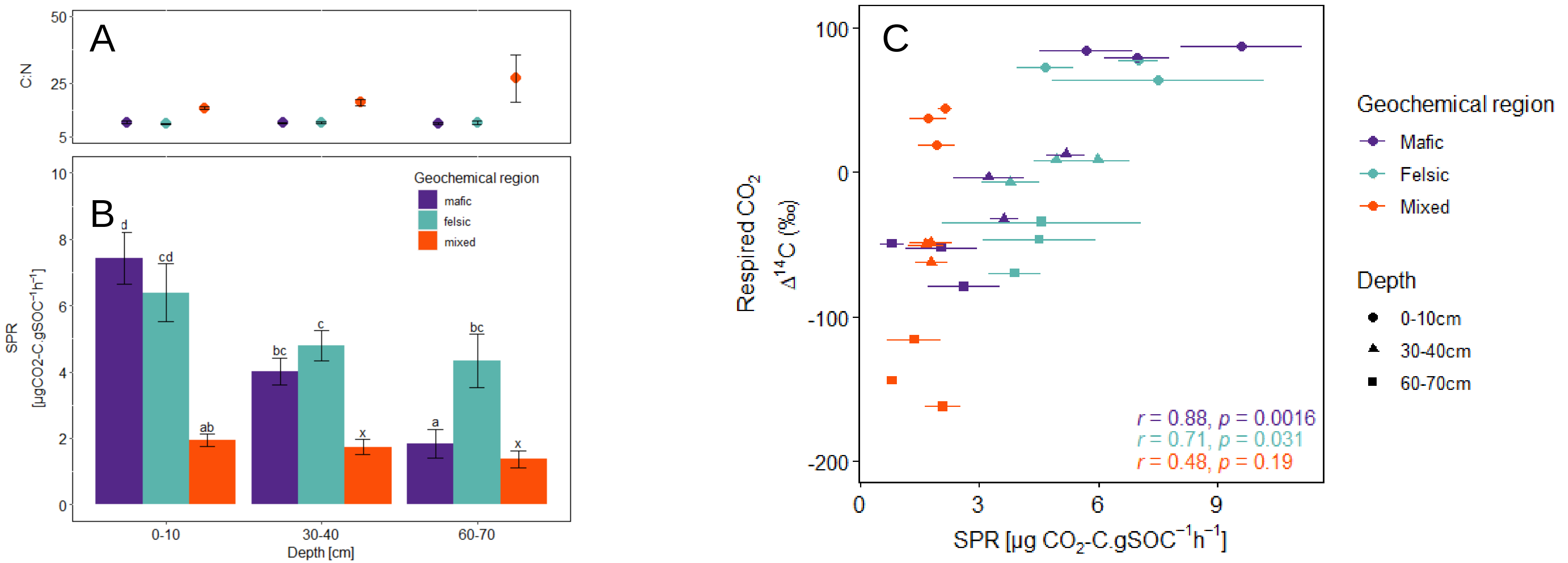
Chemical composition of rock samples representing the parent material of three geochemical regions

- Our study sites are located along the East African Rift Valley in DR Congo, Rwanda and Uganda



- We incubated the samples under stable environmental conditions and measured the heterotrophic respiration expressed per C unit(SPR) and dry soil (TPR) as well as $\Delta^{14}C$ for three depth intervals with contrasting biological, physical and chemical properties

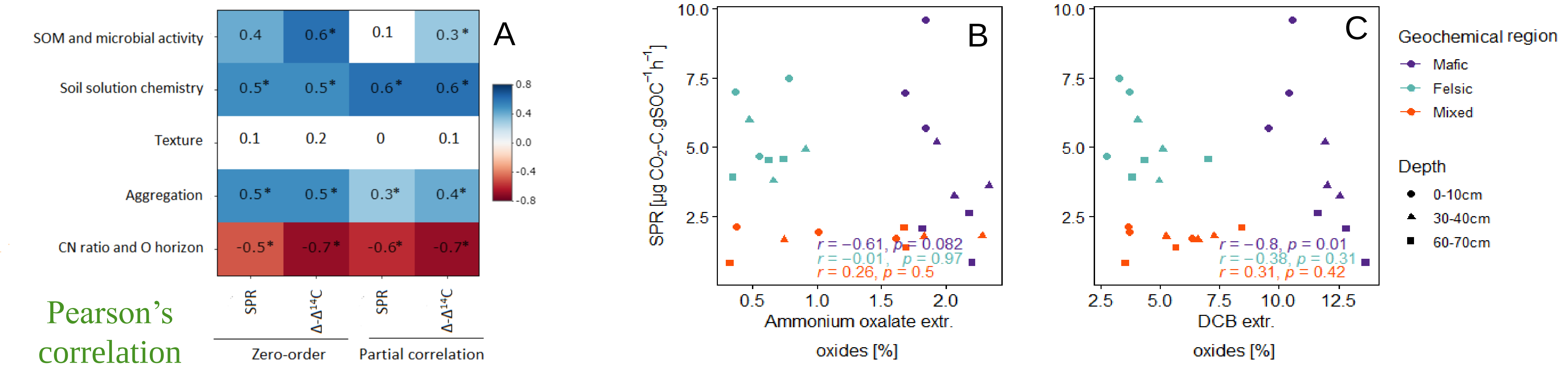
Results- SPR was lower and decreased more strongly with depth in mafic soils and was highly correlated with lower $\Delta^{14}C$ reflecting older SOC



- SPR was lower and decreased more strongly with depth in mafic soils (75% decrease in deep subsoil compared to topsoil) than in felsic soils (33% decrease compared to the topsoil) (Panel B)

- In mixed sediment sites, low SPR was highly associated with poor quality fossil organic C as indicated by lower $\Delta^{14}C$ and higher CN values and lower nutrient availability (N&P) to microbial decomposers. Microbes still access some of the old C in under ideal conditions (panel A,B, &C)

Results- Soil chemistry namely fertility and the presence pedogenic oxides drive SPR in highly weathered tropical soils



- The chemistry of the soil solution (soil fertility indicators) independent of soil depth, played an important role in explaining SPR (panel A)

- Although the mafic soils are more fertile than soils in the felsic or mixed sediment region, SPR was indirectly controled by C stabilization mechanisms through aggregation, as indicated by the presence or absence of pedogenic oxides between geochemical regions (panel A,B,C)

Conclusions

- Our study shows that geochemical differences in the parent material of tropical soils continue to influence the SOC stocks and C turnover by creating barriers to microbial decomposers through organo-mineral complexes or stimulating microbial activity through nutrient supply, even after many millennia of weathering

- In the presence of mineral-C stabilization or poor quality organic C such as that available in mixed sediment region, microorganism discriminate these sources of C in favor easily accessible C

- Geochemistry of the soil parent material and its lasting role on pedogenesis are key factors to consider to improve our understanding of C release from tropical forest soils

- These findings could potentially be an important improvement for predicting future C turnover and the representation of tropical forest soils in land surface models

Further information

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Controls on heterotrophic soil respiration and carbon cycling in geochemically distinct African tropical forest soils

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