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Soil deposition and weathering interactively controlling the stabilization of soil organic carbon

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A significant part of the soil organic carbon (SOC) stock that is eroded in uplands is re-deposited and buried in colluvial settings. Understanding the stability of buried C could be of key importance for the global C cycle, but factors controlling the stabilization of this buried SOC pool are not fully understood, especially the role of soil minerals in weathering sequences. Our study aims to investigate the effects of soil deposition on physical and geochemical SOC stabilization mechanisms along a mineralogical gradient. For this, we carried out SOC physical fractionation, incubation and soil mineral quantification experiments on soils from depositional settings. Our results show that, on average, depositional sites have the lowest total reserve in base (TRB) and hence have a more advanced weathering stage, relatively to stable sites. Significant correlations ($p<0.001$) between C:Mpy (pyrophosphate exactable C:sum of Al and Fe oxides) and TRB indicated that weathering can facilitate the chelation mechanism of SOC stabilization by creating organo-metal complexes. Relative to stable profiles, depositional profiles generally have a larger proportion of 2:1 expandable clay-sized minerals (smectite and vermiculite), which are characterized by high specific surface area, leading to organo-mineral C protection. Our results also showed that SOC fractions (micro-aggregates, aggregated silt & clay and coarse POM) were closely related ($p<0.001$) to poorly crystalline Al and Fe oxides, indicating that the presence of these oxides can control the formation of aggregates and influence C stabilization. However, due to continuous soil weathering in burial sites, reactive minerals will be transformed into less reactive forms over time and this may temporally limit SOC protection in buried sites.