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The contribution of deep soil horizons to persistent organic carbon sequestration in French forest soils

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Despite having low carbon (C) content, subsoils are often considered as great contributors to total soil organic carbon (SOC) stocks. Organic matter in subsoils is also relatively more stabilized through organo-mineral associations than in topsoils. However, subsoil SOC is not often taken into account and specifically its stability remains largely unknown. The objective of this work was thus to specifically investigate the contribution of subsoil SOC to persistent SOC sequestration in forests under contrasted pedoclimates.
We used the 102 permanent forest sites of the Metropolitan French national network for the long-term monitoring of forest ecosystems ("RENECOFOR" network; ICP-forest level 2) and 1/ calculated the proportion of total SOC stock located in the deep soil layer (40–80 cm) compared to the topsoil (0–40 cm and specifically to the surface 0–10 cm layer). We then 2/ assessed the stability of their SOC using three methods: soil respiration test (10-week laboratory incubation), particulate organic matter (POM) isolation by size-density fractionation (> 50μm; d < 1.6 g·cm−3) and Rock-Eval 6 (RE6) thermal analysis. The size of the centennially persistent SOC (CPsoc) pool in the deep layers was estimated by a regression model that used RE6 parameters as predictors and that was calibrated in long-term experimental sites in Northwest Europe. 3/ We finally assessed the contribution of the deep soil layer (40–80 cm) to the total persistent SOC stock.
On average 16% +/- 10% of the total C stock (0–80 cm) was stored in the deep layer, while 35 +/- 9% of the total stock was stored in the 0–10 cm layer.
Labile SOC as estimated by respired-C and POM-C was lower in the deep layer compared with the surface layer. SOC was also more thermally stable in deep layers than in surface layers. All these results suggesting a decrease of the proportion of the labile SOC with depth. Accordingly, the predicted CPsoc was 72% (sd = 12%) in the deep layer and 39% (sd = 10%) in the surface layer. However, 20% +/- 14% of the total persistent C stock (0–80 cm) was present in the deep layer, while 28 +/- 9% of the total stable C was in the surface (0–10 cm) layer.
In conclusion, although deep soil carbon is enriched in persistent SOC, it contributes only to 20% of the total persistent C stock in French forest soils.