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Turnover of subsoil organic carbon controlled by substrate limitation and aggregation?

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Subsoils (>30 cm depth) store more than 50% of the total soil organic carbon (SOC) and subsoil SOC is characterised by high mean residence times compared to topsoil SOC. However, little is known about the mechanisms controlling the turnover of SOC in the subsoil. The purpose of this study was to evaluate the effect of temperature, substrate limitation and aggregation disturbance on subsoil SOC turnover. We assumed that temperature limits SOC turnover in subsoil, but the temperature response of SOC is obscured by an increasing stabilization of organic material with soil depth. In a laboratory incubation experiment the production of CO_2 from undisturbed and disturbed soil samples and disturbed soil samples with added ^{13}C labelled roots were investigated at two different temperatures (10 and 20˚C). Soil samples were taken from 2-12 cm (depth 1), 30-60 cm (depth2) and 130-160 cm (depth 3) in a deciduous forest from a podzolic Cambisol and were placed in microcosms with an inner diameter of 14.2 cm and a height of 20 cm for depth 1 and 40 cm for depth 2 and 3. The microcosms were incubated for 30 days at 60% of water holding capacity.

The incubation experiment showed an average increase of 80-150% in CO_2 production for disturbed and undisturbed samples in depth 1 and depth 2 with increasing temperature. However, this was not observed in depth 3. This temperature influence was not found in the disturbed samples with added substrate. Instead, the increase in CO_2 production of the labelled samples from depth 2 and 3 had a lag time of 5 to 8 days compared to samples from depth 1. Reasons for this delayed reaction on substrate might be dormant microorganisms in the subsoil at the beginning of the incubation experiment or spatial separation of microorganisms and the labelled substrate. Disturbance of the samples from depth 1 and 2 initially increase the CO_2 production, but this effect was minor after day 15. Contrary to expectation, the CO_2 production in depth 3 was greater in the undisturbed samples than in the disturbed samples, reasons for that will be discussed. The factors controlling the SOC turnover in soils differs between the topsoil and the subsoil and cannot be transferred from topsoil to subsoil.