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Low intensity ultrasonic vibration amplitude as a tool for characterisation water stable soil aggregates

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Ultrasonic dispersion of soil aggregates is a useful method to determine soil aggregate stability. Commercially available ultrasonic devices, however, operate at relatively high ultrasonic power, which hampers the analysis of less stable aggregates. Ultrasonic power is controlled in these devices with rather low accuracy and is used for correlation with the process of soil disaggregation. Self-developed ultrasonic equipment remedies these shortcomings by using low intensity ultrasonic vibrations. The vibration amplitude rather than the ultrasonic power is used to control the magnitude of loading in the dispersion experiment. Under well-defined geometrical conditions, the vibration amplitude strongly correlates with the magnitude of the acoustic pressure waves emitted into the fluid that cause disaggregation of soil particles.
Samples of aggregates 2 000 - 250 μm of a degraded loamy silt chernozem, a loamy clay cambisol and a loamy sand cambisol had been collected under different tillage regimes in Austria: conventional tillage (CT) with mechanical weed control, reduced tillage (RT) and no tillage (NT) with inter cropping in winter.
The cavitation threshold of gas saturated de-ionized water was determined at an ultrasonic vibration amplitude of 0.5-0.6 μm at 20 kHz frequency (acoustic pressure 0.9-1.1 bar) with a diode array spectrophotometer. Subsequent experiments were performed near this limit to be able to characterize weakly aggregated soils.
Measuring soil aggregate stability (SAS) according to DIN norm showed greater aggregate stability of cambisol than of chernozem, however, could hardly show influences of tillage.

Better results were obtained with the USAS (ultrasound soil aggregate stability) method, which on the one hand validated the SAS results. On the other hand it was possible to show an influence of soil tillage on aggregate stability, which significantly decreased from NT to RT and to CT for both soil types. The measurements correlated with total organic carbon content in aggregates that was greater in no tillage than in conventional tillage and larger in cambisol than in highly degraded chernozem.

The data suggest that the dynamic of soil dispersion depends on the absorbed ultrasonic energy and the vibration amplitude. Promising results were obtained at ultrasonic vibration amplitudes of 0.5 μm and 2 μm, respectively. Dispersion experiments at 5 μm did not allow for a differentiation between soil types nor tillage variant, which indicates that low intensity vibrations should be used to monitor differences in aggregate stabilities.