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The association of soil organic matter with mineral surfaces depends on clay content in an arable Cambisol

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The amount and distribution of mineral-associated soil organic matter (MOM) depends on the availability of adsorptive mineral surface area. In soils with low content of fine-sized mineral particles, the available mineral surface is limited in comparison to soils with high content of fine-sized mineral particles. Accordingly, the spatial distribution of MOM from soils with various contents of fine-sized mineral particles should reflect different structural organization of organo-mineral associations. In this study, we analyzed MOM and further indicators of its binding in the topsoil (020 cm) of an arable Cambisol. The sampled site showed a gradient in the content of clay-sized particles (6-35 %) under similar soil management and biomass input. We obtained fine silt-sized (26.3 μm) and clay-sized (0.22 μm) mineral-associated (>1.6 g cm^3) fractions from a combined density and size fractionation. We measured solid-state ^{13}C nuclear magnetic resonance spectra and analyzed the specific surface area of the fractions by N_2-BET with and without NaOCl oxidation. The spatial distribution of MOM was determined by nanoscale secondary ion mass spectrometry (NanoSIMS) at a lateral resolution of approximately 100 nm. We found that the mineral-associated carbon concentration of the fine silt and clay-sized fractions decreased from 80 to 40 mg g^{-1} when the content of clay-sized particles increased from 6 to 15 %. In the clay-rich soils the mineral-associated carbon remained constant at approximately 40 mg g^{-1} for higher contents of clay-sized particles from 15 to 30 %. In addition, the ^{12}C and $^{12}C^{14}N$ ion distributions obtained from NanoSIMS indicated a much higher coverage of mineral surface with MOM in the sandy soils than in the clay-rich soils. Our data shows that both the concentration and coverage of MOM is increased in soils with a lower content of fine-sized mineral particles, when the input of organic material to the soil is similar.