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Influence of mineral characteristics and long-term arable and forest land use on stocks, composition, and stability of soil organic matter

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A land use change from arable to forest is discussed as an option to sequester carbon and mitigate climate change but land use specific mechanisms responsible for soil organic matter stabilization are still poorly understood. In this study we aimed to analyze the impact of soil mineral characteristics on organic carbon (OC) stocks and on the composition as well as on the stability of mineral associated organic matter (OM) of arable and forest topsoils. We selected seven soil types of different mineral characteristics. Topsoil samples of each soil type were taken from a deciduous forest and an adjacent arable site, which have been continuously used for more than 100 years. The sequentially extracted Na-pyrophosphate soluble OM fractions (OM(PY)), representing mineral associated OM, were analyzed on their OC and 14C content and characterized by infrared spectroscopy. We found land use effects on the soil OC stocks and OC amounts separated by OM(PY) (OCPY) (forest > arable) as well as on the stability of OM(PY) (arable > forest). For the forest and arable topsoils, a linear relationship was found between the stocks of OC and exchangeable Ca. Only for the near neutral arable topsoils, correlation analyses indicate increasing OCPY contents with an increase in oxalate soluble Fe and Al, exchangable Ca, and Na-pyrophosphate soluble Mg and Fe contents. The stability of OM(PY) of the arable topsoils seems to increase with the specific surface area of the mineral phase and the content of exchangeable Ca. For the acidic forest topsoils, the stability of OM(PY) seems to increase with increasing pH, the C=O group content of OM(PY) and, the Na-pyrophosphate soluble Mg contents. The results indicate cation bridging of OM to mineral surfaces in near neutral arable soils and OM-crosslinking in acidic forest soil as important mechanisms for the stabilization of OM(PY).