XPS reveals differences in surface elemental composition of soil microaggregates along a clay content gradient

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Soil microagggregates (SMA) are considered most relevant for carbon sequestration but their formation is still poorly understood. Parallel to the aggregation experiments using well-defined components (see Dultz et al. Goldschmidt 2017 Abstracts), the MadSoil Research Group aims at the investigation of the surface elemental composition of natural SMA. Here, we are using X-ray photoelectron spectroscopy (XPS) with a restricted analysis depth (max. 10 nm), allowing to detect even subtle differences in element contents within the particle surface layer[1]. We analyzed the 250-53-μm SMA fraction in either free (FR) or occluded (OCC) form along a clay content gradient (range 8-30% clay) of a Luvisol. Results indicate some influence of clay content on surface elemental composition and reveal marked differences between FR and OCC. For OCC maximum O and Al and minimum C and Si content at intermediate clay percentage (18%) was observed. Further, N content decreased with clay percentage. Contrasting, FR showed decreasing C content with increasing clay percentage and roughly constant N, Si, and Al contents. To differentiate the outermost surface composition from the more internal one, in a first approach the samples were exposed to slight shearforce between two glass slides to destroy SMA structure. The most striking result of this procedure was a smaller in N content (especially FR) and a trend of greater C content in internal layers for all clay percentage. This may give hints on differences in turn over of organic matter between outmost and more internal SMA layers and may point to the protection function of SMA for organic C.

[1]Woche, S.K., Goebel, M.-O., Mikutta, R., Schurig, C., Kaestner, M., Guggenberger, G., Bachmann, J. (2017) Soil wettability can be explained by the chemical composition of particle interfaces - An XPS study. Scientific Reports 7, doi:10.1038/srep42877.