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The role of SOM and $CaCO_3$ on soil aggregate development in reclaimed soils

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Soil organic matter (SOM) and extracellular polymeric substances (EPS) from biological processes are considered to be major contributors in aggregate formation. But there is limited knowledge on soil structural formation after reclamation – the step when SOM content is low and soil properties are mostly controlled by the parent material. In our study we used a chronosequence approach in the reclaimed open-cast mining area near Cologne, Germany to elucidate the development of soil structure and soil organic matter during initial soil formation in a loess material. We selected six plots with different ages of agricultural management after reclamation (0, 1, 3, 6, 12, and 24 years after first seeding). In each reclaimed field 12 spatially independent locations were sampled with stainless steel cylinders (100 cm^3) at two depths in the topsoil (1-5 cm and 16-20 cm). Samples were wet sieved into four aggregate size classes of <63 µm, 63-200 µm, 200-630 µm and 630-2000 µm. Each aggregate size class was characterized by organic carbon (OC), total nitrogen (TN) and $CaCO_3$ concentration. The chemical composition of the SOM of selected samples was characterized using solid-state 13C NMR spectroscopy.

Wet sieving into aggregate size classes showed different trends along the chronosequence. Contradicting relation between $CaCO_3$ and OC contribution to aggregate size classes display two different mechanisms on soil aggregate formation in young loess derived soils. $CaCO_3$ influenced aggregation predominantly in finer aggregate size classes, where the highest concentration and contribution was measured. SOM, on the other hand, played an important role on formation of large macro-aggregates after organic manure application in year 4. Furthermore, the loss of total OC after year 12 was connected with the loss of OC contributing to the largest aggregate size class. Our findings reveal that SOM and $CaCO_3$ role on stabilizing aggregates is not equally distributed and is aggregate size class dependent.