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Few recurring types of microdomains define smallest units of soil functioning

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Soil aggregation is a key factor for a number of important biogeochemical processes (e.g. soil organic matter stabilization and nutrient and pollutant sorption) in soils. Although there is a large number of studies on the factors controlling such soil processes, it is still challenging to study these processes in-situ. However, it can be assumed that the spatial arrangement of organic and mineral soil constituents in soil aggregates, and thus the aggregate structure determine the processes happening at the aggregate scale. Using nanoscale secondary ion mass spectroscopy and a novel digital image processing approach, we extensively analyzed the spatial distribution of ions characteristic for mineral and organic soil components on the micrometer-scale in an intact soil aggregate. We were surprised that 40 spatially independent measurements could be statistically clustered in just two complimentary types of micrometer-sized domains. Each domain is characterized by a micro-architecture built of a definite mineral assemblage with various organic matter forms and a specific pore system. Each of these microdomains fulfil different functions in soil. Our results demonstrate that the manifold mineral and organic soil components arrange in a limited number of micro-architectures because of self-organization and feedback mechanisms. These microdomains are the smallest units in soil that fulfill specific functionalities.