

The role of carboxyl groups in inhibiting and retarding microbial remineralisation of organic carbon (OC) during adsorption with iron (oxyhydr)oxides.

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Organic carbon (OC) preservation is crucial to the global carbon cycle and its role in regulating both atmospheric CO₂ and O₂ concentrations over geological time [1]. More recently it has become clear that iron (oxyhydr)oxides play an important role in the stabilisation of OC in both soils and sediments, as a significant fraction of OC that avoids degradation has been found to be associated with reactive iron minerals [2, 3]. In order for OC to avoid degradation and become preserved, OC must escape microbial remineralisation [4] but despite several decades of research, the precise mechanism by which OC is sequestered to iron minerals, and whether and to what extent this mechanism protects OC from microbial remineralisation has rarely been directly tested [5]. Here we take a direct mechanistic approach, utilising STXM NEXAFS spectroscopy to determine OC sequestration mechanisms and microbial incubation experiments to test whether the adsorption of carboxyl-rich OC can protect adsorbed OC from microbial remineralisation and to what extent the carboxyl-richness of the adsorbing OC molecules are a controlling factor on the rate of OC remineralisation and thus its long-term preservation in sediments. Our results show that carboxyl-rich OC undergoes multi-carboxyl ligand exchange with ferrihydrite, and with increasing carboxyl-richness this sequestration mechanism increasingly protects OC from microbial remineralisation, by slowing down microbial oxidation.

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[5] Kleber, Bourg, Coward, Hansel, Myneni & Nunan (2021), *Nature Reviews Earth & Environment*, 2(6), 402-421.