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Rust precipitates in drainage systems of peaty acid sulphate soils in Finland

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Clogging of subsurface pipe drainage systems by rust precipitates is a problem in many cultivated areas and especially on the coast of Ostrobothnia, northwestern Finland. The subsurface drainage pipes need to be flushed every few years to remove the rust, which causes additional maintenance costs. These problems are particularly common in acid sulphate (AS) soils that have peat horizons on top of sulfidic materials. These soils are often wet, and the drainage water contains high dissolved iron concentration, commonly above 20 mg l^{-1}. Reducing conditions prevail in certain horizons and oxidation of sulfidic minerals and low pH are typical of the horizons above, all resulting in mobilization of several elements. Upon entering the aerobic drainage pipe dissolved iron is oxidized and readily precipitates as rust. In dry summers, the precipitate is typically hardened and the whole pipe drainage system can be blocked. Minerals containing sulphur (S) may also be precipitated in the pipes. The fresh precipitates can adsorb heavy metals that occur in substantial concentrations in AS drainage waters. In this study, 10 rust samples were collected from ditches and wells. All sites, except one, had a 20-70 cm peaty topsoil. A comprehensive chemical analysis was carried out and the precipitates were investigated with a scanning electron microscope (SEM). Colours of the samples were strong brown or reddish yellow (Munsell notation 7.5YR 5/6-6/8). Silicon content was only 0.3-0.9%, indicating the absence of actual soil material in the precipitates. The material contained 27-49% organic matter (1.9 x C), co-precipitated from the humic substances of drainage water. Iron was by far the most abundant element. If all Fe is contained in ferrihydrite (66% Fe), this mineral constituted 35-63% (mean 46%) of the precipitate while aluminium hydroxide (34% Al) constituted 0.7-9% (mean 5%). Even though most drainage waters were rich in S (commonly above 40 mg l^{-1}, the maximum S concentration of the precipitates was only 1.9% and the mean at 0.7%. Sulphur-containing minerals jarosite and schwertmannite were not detected in the SEM images, either, suggesting that these minerals are not precipitated from AS drainage waters. Dissolved heavy metals are leached from AS soils but they were not markedly co-precipitated in our samples. The mean concentration of Cd was only 1 mg kg^{-1} and Ni 12 mg kg^{-1}, Cr 33 mg kg^{-1}, Cu and Zn 32 mg kg^{-1} while Mn was more abundant, 355 mg kg^{-1}. In our peaty AS soils there is thus substantial mobilization of Fe and a flux out of the soil and a new solid phase is formed in the drainage pipes and ditches constituting mostly of iron hydroxide and humic substances. If dredged, application of this material onto the fields seems not to pose major environmental hazards.