



Remediation of acid sulphate soils by addition of organic matter

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Acid sulfate soils with hypersulfidic material ($\text{pH} > 4$) are formed under reducing conditions and contain iron sulfides (mostly pyrite). When these hypersulfidic soils dry pyrite can be oxidized, which leads to the formation of sulfuric acid and the formation of sulfuric soils ($\text{pH} < 4$). Remediation is possible by re-submerging sulfuric soils and adding organic matter. Microbial degradation of organic matter under water-saturated and anaerobic conditions generates electrons which are accepted by a sequence of electron acceptors including nitrate, Mn and Fe oxides, and sulfate. When sulfate is reduced, this can result in the re-formation of pyrite with an increase in pH. The aim of our study was to investigate remediation of sulfuric soils by adding different amounts and sources of organic carbon (OC) and gaining insights into processes by an innovative approach using a range of methods. Soil samples of the subsoil of an oxidized sandy sulfuric soil ($\text{pH} 2.5$) from South Australia were submerged in a laboratory incubation experiment. OC was added as wheat straw, lactate and a mixture of both (added amounts of OC ranged between 500 and 2000 mg OC per g soil-OC). The sulfuric soils were incubated for two months during which pH and redox potential were measured regularly.

Addition of wheat straw induced the pH to increase to $\text{pH} > 6$, which remained stable, irrespective of the amount of OC added. Addition of a 1:1 wheat straw-lactate-mixture resulted in a rapid pH increase to $\text{pH} > 7$. Addition of lactate alone did not result in a stable pH increase. Measurements of carbon dioxide and hydrogen sulfide emissions revealed microbial activity in all soils, with highest values being with the 1:1 straw-lactate-mixture. Quantification of sulfate reducing bacteria by RT qPCR showed that sulfate reducing bacteria were present in all treatments. Their abundance was not positively correlated to the amount of added OC. The OC content of the samples and the proportion of available particulate organic matter was determined prior to and after incubation to calculate fluxes and losses. When a high amount of OC was added a considerable proportion of OM (approximately 20 %) became associated with the mineral phase during the incubation period. Chemical composition of the particulate organic matter was determined by solid-state C-13 NMR-spectroscopy. A high amount of undecomposed straw was still present at the end of the incubation. This unprocessed straw could function as OC reservoir and ensure long-term remediation success. The soil solution was analysed by ICP-OES at the start and the end of the incubation to detect metals and other potentially toxic elements, which could affect microbial activity. Concentrations of aluminium decreased during incubation in treatments which had a high pH. Iron and sulfur concentrations in the soil solution were low in treatments with good remediation results indicating a re-formation of iron sulfide.