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Effects of calcium carbonate and peat addition on agricultural acid sulfate soil microbiology and geochemistry

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Natural sulfide rich deposits are common in coastal areas worldwide and in Finland, they occur along the Baltic Sea coast. When artificial drainage for land use such as agriculture, forestry, and building of infrastructure exposes these deposits to atmospheric oxygen, iron sulfide minerals in the soils are rapidly oxidized. This process turns the sulfide rich soils into acid sulfate (AS) soils and mobilizes large quantities of acidity and leachable toxic metals that cause severe environmental problems. It is known that acidophilic microorganisms living in AS soils catalyze iron sulfide mineral oxidation although few studies regarding microorganisms in AS soils have been published. It has also been found that incorporation of basic materials into AS soil can raise the pH while addition of organic material can prevent oxidation, promote sulfate reduction, and thus reduce acidity and the release of toxic metals. The aim of this laboratory experiment was to investigate the microbiological and geochemical effect of adding different materials to agricultural AS soil under aerobic and anaerobic conditions. Different biodegradation fractions of peat were used as organic material since it is an abundant organic material in northern wetlands. However, since it is acidic, it was mixed with ultrafine-grained calcium carbonate before addition to raise the pH of the soil. High throughput 16S rRNA gene sequencing on community DNA extracted from intact bacterial cells identified microbial populations most similar to moderate and extreme acidophiles in the untreated control. The low pH in the control soils enabled acidophiles, such as *Thiomonas cuprina*, to catalyze iron sulfide oxidation that increased the leaching of sulfate and metals from the soil under aerobic conditions. In contrast, anaerobic conditions resulted in stable sulfate and metal concentrations and indicated low activity of acidophiles. In the calcium carbonate and peat treated AS soils, the acidophilic like populations were altered and likely inactivated under both aerobic and anaerobic conditions, since no oxidation of iron sulfides or sulfate and metal leaching could be seen. These results indicate that addition of peat in combination with a raise in pH could be a good mitigation strategy for agricultural AS soil.

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