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Elucidation of biotic and abiotic processes governing manganese redox cycle in sediment of passive mine drainage treatment plants

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High concentrations of manganese (Mn) are shown to affect human health and ecosystems. As a result, passive treatment systems are designed to remove Mn from mine drainage water before discharge [1]. In France, the treated mine water is subjected to a discharge limit generally set at 1 $mg.L^{-1}$ or less for Mn. However, maintaining long-term Mn removal efficiency proves challenging in such passive treatment plants. Indeed, Mn removal is known to be dominated by biologically-mediated oxidative processes [2], but the associated processes are not fully understood, which limits the efficiency of such treatments. In particular, the role of microorganisms in association to abiotic factors remains poorly documented in these environments, preventing an accurate estimation of Mn trapping in stable secondary phases. To investigate passive treatment performance, the sediment-water interface of a passive treatment plant composed of *phragmites* (reed grass) wetlands was monitored. Diffusive equilibrium in thin films probes, deployed in sediments, show areas with significant Mn concentrations suggesting that reductive dissolution mechanisms are occurring. Diagenetic profiles were also observed, suggesting that biotic processes partly control Mn evolution in the sediments. Moreover, Mn plaques were observed on the roots surface of *phragmites* (Figure 1), which may originate from Mn(II) oxidizing rhizobacteria [3]. Raman spectroscopy and X-ray diffraction analyses suggest that Mn-bearing minerals are amorphous. Sediments sampled at different depths, and *phragmites* roots surfaces, display different Mn mineralogical structures as observed by SEM, and their nature will be determined using X-ray Absorption Spectroscopy. Also, in order to correlate Mn mineralogy with microbial communities of the sediments, illumina sequencing of 16S rRNA genes will be performed.

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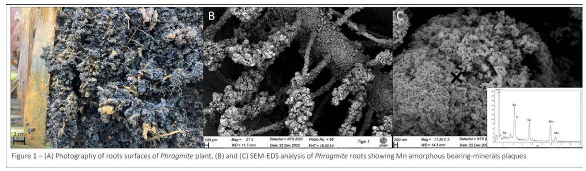

Figure 1 – (A) Photography of roots surfaces of *Phragmite* plant, (B) and (C) SEM-EDS analysis of *Phragmite* roots showing Mn amorphous bearing-minerals plaques