Anaerobic Oxidation of Methane by Sulfate Reduction

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Anaerobic oxidation of methane coupled to sulfate reduction (SR-AOM) was discovered 37 years ago, but the exact nature of the process still remains poorly understood (Reeburgh 1976). Researchers have not been able to firmly establish the reaction mechanism, fully understand the factors that control oxidation rates, or isolate the responsible organisms. The main difficulty lies in the low growth yield (0.05 g dry weight/carbon oxidized) and long doubling time (up to 7 months) from *in vitro* incubations (Meulepas et al, 2009; Nauhaus et al, 2007; Thauer et al, 2008). So far, two groups of microorganisms have been identified to mediate in cooperation the anaerobic oxidation of methane (AOM) coupled to sulfate reduction: anaerobic methanotrophic archaea (ANME) with three distinct clusters, namely ANME-1 (distantly related to the *Methanosarcinales* and *Methanomicrobiales*), ANME-2 (within the *Methanosarcinales*) and ANME-3 (closely related to the *Methanococcoides*), and sulfate reducing bacteria (SRB) closely related to the *Desulfosarcina-Desulfococcus* branch of the *Deltaproteobacteria* (Caldwell et al, 2008; Knittel and Boetius, 2009; Zhang et al, 2011). A very important aspect of SR-AOM is its possible application for desulfurization of wastewater where methane can be used as a sole electron donor. Methane is easily available and relatively cheap (two times cheaper than H_2) compared to the commonly used electron donors for sulfate removal. Additionally, the use of methane would close its cycle of utilization, decrease the emission of one of the most important greenhouse gases and reduce the risk of excess carbon source in the treatment effluent. Before this biotechnological application is applicable some challenges need to be overcome.

The current research will try to overcome these challenges by using different strategies (figure 1): use of microbial mats obtained from marine sediments where AOM is observed as enrichment starting material; enrichment of the microorganisms in a membrane bioreactor which has high biomass retention; use of alternative substrates for sulfate reducing bacteria (electron acceptors and electron donors); modification of the environmental conditions. The ultimate goal of this research is to develop a feasible biotechnological process to use methane as a sole electron donor for biological desulfurization.

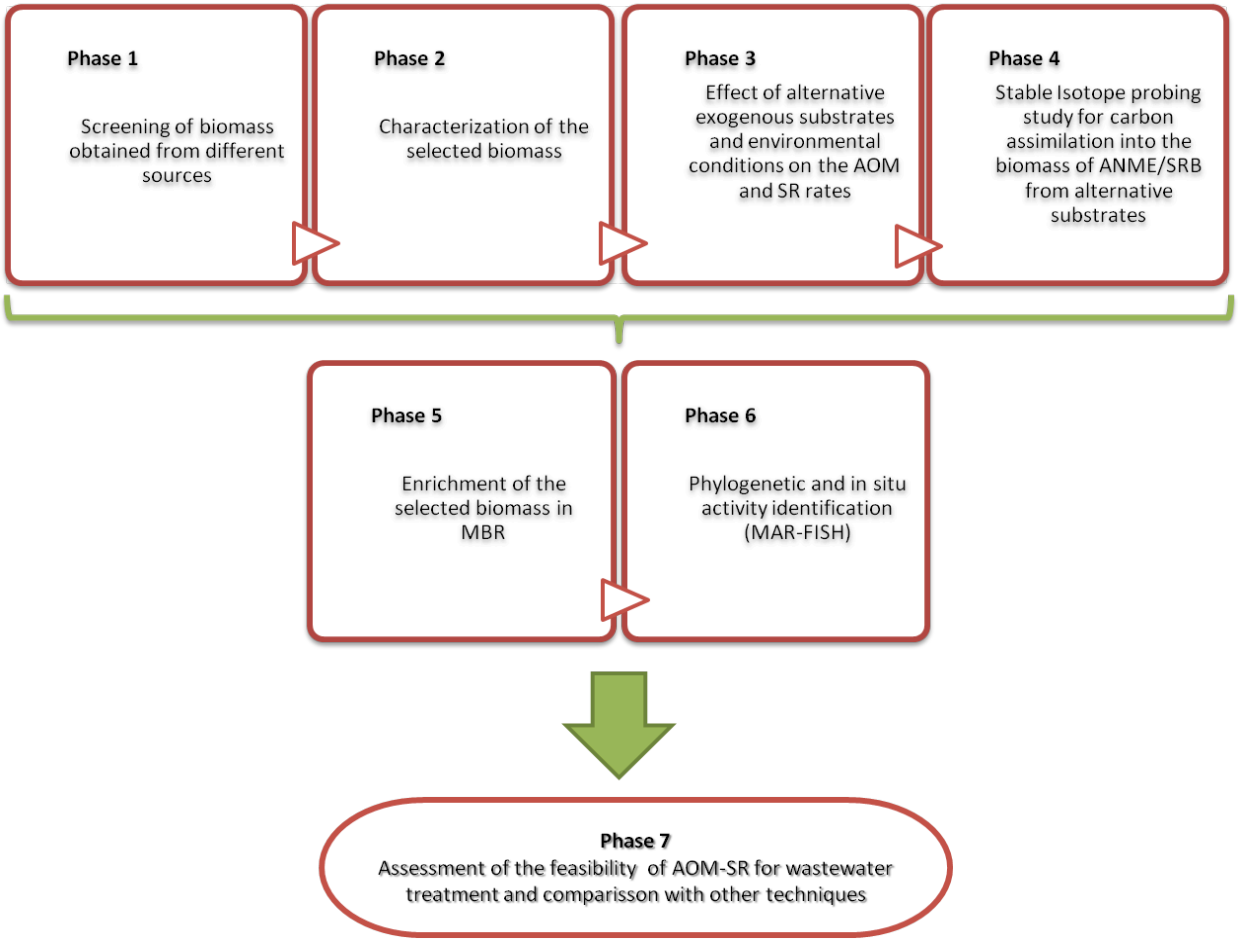

Figure 1. Overview of the research plan

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