# Anaerobic oxidation of methane by anaerobic archaea and aerobic bacteria in lake sediments

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In ocean sediments, anaerobic oxidation of methane (AOM) coupled to sulfate reduction serves as efficient methane sink. Previous work has suggested that AOM in lakes, where sulfate concentrations are generally much lower than in the ocean, is primarily coupled to the reduction of nitrate, manganese-, and /or iron oxides. Based on AOM rate measurements and 16S rRNA gene-sequencing data from sediments in Lake Cadagno (Switzerland), and incubation experiments with different electron acceptors, we show that anaerobic methanotrophic archaea do not necessarily rely upon these oxidants directly, but perform canonical sulfate-dependent AOM, which under sulfate-starved conditions is supported by metal (Mn, Fe) oxides through oxidation of reduced sulfur species to sulfate. This way, sulfate-dependent AOM may be "disguised" as AOM coupled to manganese or iron reduction. In a number of other Swiss lakes, we observed high rates of methane oxidation in anoxic sediments where Type-I aerobic methanotrophs dominated the bacterial methanotrophic community. Our results confirm a high degree of metabolic versatility of methane-oxidizing microorganisms in lakes, and indicate that both archaeal and bacterial AOM may play an important role in mitigating methane emissions in freshwater environments.