



Methane bubble ascent within muddy aquatic sediments under different ambient methane source strengths

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Methane (CH_4) is the simplest and, the most common hydrocarbon in nature. It is considered as one of the most adverse greenhouse gases, at least 25 times more potent than carbon dioxide. When concentration of the dissolved methane in pore waters exceeds the solubility of the gas (affected in turn by temperature, pressure, salinity and by other factors) methane bubbles nucleate. Gas migration in fine-grained cohesive muddy aquatic sediments is accompanied by sediment fracturing. When gas pressure is high enough to overcome compression, friction, and cohesion at grain contacts, gas migrates by pushing the grains apart. These sub-vertical fractures provide lowered-resistance conduits for migration of other bubbles that can destabilize sediment structure resulting even in slope failure. Therefore, understanding the processes governing bubble propagation within fine-grained aquatic sediment is important. Previous models showed that bubbles propagation within fine-grained muddy aquatic sediments can be modeled using principles of linear elastic fracture mechanics. Mass transfer between the bubble rising with high velocity and the surrounding sediments was mostly ignored. We use a coupled macroscopic mechanical/reaction-transport numerical model under a variable source strength profile associated with bio-chemical processes of methane production and consumption within the sediment, as it occurs in nature. The model shows that changes in the dissolved methane concentrations strongly affect bubble ascent velocity, sometimes leading to its retardation below the sediment-water interface