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Bubble growth and migration in sediments tracked by X-ray computed microtomography

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Biogenic methane gas bubble formation and migration in surface aquatic sediments is an important process for global biogeochemistry cycling at sediment-water interface. However, the mechanisms of bubble migration in sediment are still unclear. A long-term (20 d) laboratory incubation was done to study methane bubble growth and migration mechanisms in homogenized natural sediments (clay, sand). During the incubation experiment, X-ray computed microtomography (micro-CT) was employed to track bubble formation dynamics. At the end of bubble growth experiment, two micro-CT column scans were done to track bubble migration patterns in sediment in response to a scheduled water level change. The incubation shows capillary invasion and sediment expansion were both important in bubble growth in the two investigated sediments. Associated with sediment expansion, a significant gas-enriched upper layer (8 cm) was observed in sand. Bubbles were observed to move only in the surface layer of sand, in contrast to the entire depth in clayey sediment. Bubble migration in sediments was primarily determined by the mobility of bubbles, which was determined by the relative size of pores (in sediment) and bubbles. The findings will provide a solid basis for a methane bubble release model in sediments.