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Aquitard controls on gaseous CH_4 production in an Arsenic contaminated aquifer

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Biogeochemical gas production resulting in free gas phase formation, can severely affect local groundwater and solute transport in aquifers. Such gas-water interactions are important in aquifers affected by terrigenic arsenic (As), which are commonly associated with the biogeochemical production of CH_4. In addition, the role of overlying or embedded aquitards, which are believed to contribute to the As mobilisation process in adjacent aquifers, has recently been challenged [1,2,3,4]. These observations prompted the analysis of a heterogeneous aquitard which overlies a high CH_4 gas producing zone of an As contaminated aquifer. To assess how such aquitards physically contribute to the underlying local CH_4 gas production, a sediment core was acquired and analyzed for noble gases. Noble gases are ideal tracers in this context, since their inertness allows physical processes to be robustly identified.

Results reveal that a large part of the investigated aquitard pore space is unsaturated in two separate layers, resulting in perched groundwater which is constrained by an air-like gas. The unsaturated layers have increased sand content and higher hydraulic conductivity. This interlayering of unsaturated and saturated zones, identifies the aquitard's stratigraphy as key in determining the hydrostatic pressure, which in turn is the main control of in-situ CH_4 saturation concentrations in the groundwater of the underlying aquifer – an observation not previously accounted for. Due to the partly unsaturated conditions, the hydrostatic pressure at our study site is up to 30% lower than previously anticipated. Further, such partly unsaturated conditions might provide preferential pathways for water flow, thus fostering solute transport which ultimately affects As mobilisation [3,4].

In addition, groundwater samples collected throughout the study site confirm widespread degassing (of the groundwater). The most significant gas loss was observed immediately below the studied sediment core and coincides with some of the highest CH_4 and As concentrations in the groundwater.

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