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Chasing Groundwater in Marine Sediments with Noble Gases

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The question if ocean shelf sediments contain fresh groundwater of terrestrial origin ('off-shore freshening groundwater': OFG) recently gained scientific interest with OFG being even explored as potential drinking water resource [1].

Most evidence for low-salinity porewater in ocean sediments comes from geophysical methods, while direct geochemical evidence is scarce. However, anecdotal observations exist, such as fresh artesian water encountered during ocean drilling [2].

Atmospheric noble gases (aNG) enter surface and groundwater during gas-liquid partitioning near the air-water interface, with their concentrations reflecting the physical and hydraulic conditions constraining water recharge. As NGs, unlike other solutes such as salinity, are strictly chemically inert, their patterns do hardly change and remain 'stable', preserving environmental information from recharge [3]. NG can distinguish pore water origins (marine vs. terrestrial), as solubility depends on salinity and temperature. Terrestrial groundwater is easily identified by excess air, an aNG surplus characteristic for ground water.

To test whether NGs can identify terrestrial water in ocean sediments, we analysed NG concentrations and isotopic ratios in porewaters from a 10 m sediment core in the Mecklenburg Bay, Baltic Sea, which underwent significant sea level and hydrological changes over the past 20 kyr during the Pleistocene-Holocene transition [4].

The NG concentrations are high, exceeding any reasonable seawater equilibrium and are enriched in lighter NGs, characteristic of groundwater. This suggests the pore water originated as terrestrial groundwater recharged under Holocene conditions [4].

Based on our findings that NG can identify terrestrial groundwater in ocean sediments the ECORD/IODP expedition 501 (www.ecord.org/expedition501) will apply noble gas analysis to search for fresh water in sediments off the Massachusetts coast.

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