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Freeze Coring: Sediment Disturbances

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Field studies over the last decades show that sediment in freshwater impoundments can act as an important source of greenhouse gases (GHG) like methane and carbon dioxide (Bastviken et al. 2011). Under anaerobic conditions, enhanced mineralisation of organic matter within the sediment favours methane bubble formation. To investigate the influencing sediment parameters and relevance of the emissions, the acquisition of undisturbed sediment samples under near in-situ conditions are compulsory required for a wide variety of scientific and engineering studies.
Over the last decades, various devices for sediment sampling have been developed, each best suited to a particular set of conditions. There is still a lack for a simple, quick and inexpensive coring method for sampling gas-bearing and water-saturated sediments. Common tube sampler, such as gravity corer, can cause negative effect that disturbed the sediment and bubble composition, such as:
(i) whilst inserting and taking out the tube sampler, the sediment core of tube sampler may be liquefies or lost,
(ii) gas bubble expansion, resulting from a decreasing hydrostatic pressure during core recovery, can change the size and position of the samples,
(iii) and a gradual production of free gas, which can occur for hours after the core was withdrawn (i.e. during transportation).
To overcome these limitations and to use the advantages of the sediment freeze-coring technique, a novel freeze coring method was developed at Cologne University of Applied Science. Freeze-coring is a good way to obtain undisturbed sediment samples, unaffected by the fast degassing of methane bubbles that may occur after a drop in hydrostatic pressure (Verschuren 2000). This novel freeze corer, freezes the sediment inside of a double-walled corer by a strong coolant (mixture of dry-ice and ethanol), which is added into the space between the corer walls.
This simple and robust sediment corer was studied in laboratory and in field conditions at Lake Kinneret (Israel), Urft Dam and Lake Olsberg (Germany). Lab and field measurements were carried out to quantify the coring disturbances of the freeze-corer, especially how freezing affects the gas and the structure within a sediment core, comparing to a common tube sampler. The obtained cores were scanned with a Dual-Layer X-Ray Computed Tomography (CT) scanner. This new CT techniques allows to obtain both density and atomic number distribution within the sediment core and to visualize coring disturbances.
Frist results show significant differences of more than 20% in the recovery ratio (depth of penetration/length of sediment core) between gravity and freeze corer. Further analyses are ongoing to identify the different coring disturbance, such as bending or smearing, and the effect of freezing the sediment.

References:
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