Mapping and quantifying methane emissions from contaminated fibrous sediment

Alizée P. Lehoux[1], Erik Sahlée[1], Sarah Josefsson[2], Julie Falise[1], Daniel Sopher[2]

[1]Department of Earth Sciences, Uppsala University, Villavägen 16, 752 36 Uppsala, Sweden
[2]Geological Survey of Sweden, Box 670, 751 28 Uppsala, Sweden

Phone: +46 18 471 18 38
E-mail: alizee.lehoux@geo.uu.se

Conference theme number(s): 6

Introduction: Contaminated fibers have been discharged from pulp and paper mills for decades in many countries over the world, until stricter regulations came into force – in 1969 in Sweden. These deposits have accumulated and formed large banks (so-called fiberbanks). They have been identified as a risk for the environment in terms of the release of contaminants, such as heavy metals and Persistent Organic Pollutants [1,2]. Presently, there are more than 383 sites which may be polluted with these sediments in Sweden [1]. In addition, significant emissions of greenhouse gases, primarily methane, have been measured from these sediments in the laboratory [3]. Hence, an additional concern is that emissions from fiberbanks could account for a significant part of Sweden's total emissions. This study aims to develop a field technique to characterize the emissions of methane from fiberbanks in natural conditions.

Methods: In this study, a drone equipped with a methane sensor was used to survey several fiberbank sites. The drone also carried an anemometer, a thermometer, and additional sensors to measure air pressure, relative humidity and positioning.

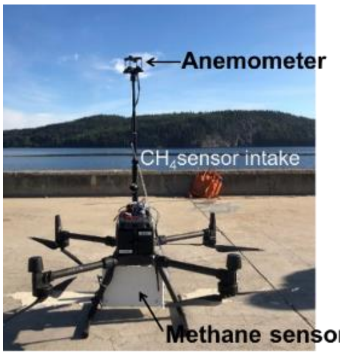

Fig. 1: *The drone system ready to fly*

Depending on the wind speed, different measurements strategies were used with the drone. If the wind speed was low, horizontal mapping (measurements at the same altitude over an area) was performed to detect emission hotspots. If the wind speed was higher than 2 m/s a mass balance method was applied to estimate the emissions from the fiberbank. This was performed by measuring the wind speed and methane concentration in a vertical cross section, as a fence, across the emission plume down wind of the fiberbank.

Results and discussion: Horizontal mapping allowed for the detection of ebullition events from the fiberbanks. These events lead to an increase of methane concentration in the air from background concentrations (around 1.9 ppm) to peak concentrations of between 2 and 2.6 ppm. Across the area of the fiberbanks methane is released more consistently at very active points ("hotspots") and more sporadically at other points. Hence, repeated horizontal mapping is required to adequately characterize the areas with more sporadic emissions.
Measurements along fences (vertically stacked profiles) allowed for the estimation of the extent of the methane plume emitted by the fiberbanks as well as an evaluation of the average flux. In one site, we evaluated this flux to be about 13.1 kg of methane per day.
During fieldwork, some measurements were conducted about 10 hours after an earthquake (magnitude 2.6) occurred. These showed very high concentrations of methane (up to 7.7 ppm) above the water surface. This shows that many methane bubbles were suddenly released, highlighting the fact that fiberbanks are likely to emit large amounts of methane if disturbed (such as following a submarine slide, boat traffic, waves and after certain types of dredging).
Finally, it is important to keep in mind that the methane production will increase with increasing temperatures, leading to higher emissions [3]. Hence, careful remediation actions are likely to be needed in the near future.

Acknowledgements: This study is funded by VINNOVA (project no. 2021-04569).

References: [1] Norrlin & Josefsson (2017) *SGU report*, 7 ; [2] Göransson et al. (2021) *Front Marine Sci* **8**: 729243; [3] Lehoux et al. (2021) *Sci Total Environ*, **781**: 146772.