One of Europe's largest methane ebullition field lies at 400 m below sea level in the Baltic Sea

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Introduction

A time series of rising methane bubbles is shown in the background of this poster. These data were acquired at the Landsort Deep using a moored, upward-looking EK80 autonomous system (Fig. 1c). Methane ebullition* occurs here due to the euxinic waters below depths of approximately 80 m and the high accumulation of organic matter on the seafloor, which together promote anomalously high biogenic methane production within the sediments. The extension of the ebullition field is around 17 km² (Stranne et al., in prep.), nearly three times the size of Vienna's Prater Park.

*Methane ebullition: rapid and direct release of methane bubbles from the sediments into the water.

Rise velocities

Data analysis shows two different groups of bubbles based on their rise velocity. One of them with velocities around 0.07 m/s and the other around 0.2 m/s (Fig. 2). This indicates that the bubbles analysed within this dataset are mainly represented by two size ranges, the faster ones being bigger bubbles.

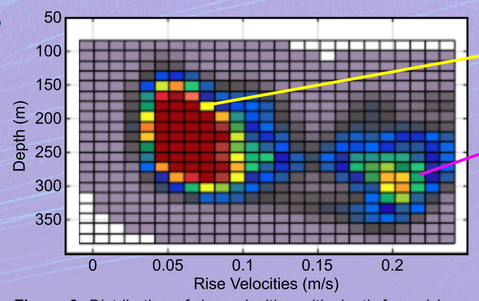

Figure 2. Distribution of rise velocities with depth for a 1-hour time bin.

Setting and methods

Landsort Deep:

- Deep and narrow trough fault (Fromm, 1943; Fig. 1b)
- Drift deposit along the fault axis
- Higher-than-average sedimentation rates (1 cm/yr; Jofesson, 2022)
- Highly organic sediment (TOC average of 11.4 wt%; Ketzer et al., 2024)
- Halocline at depths around 80 m; euxinic water below

Data acquisition:

- Simrad ES38-18DK transducer pinging in broadband mode
- Moored to the seafloor and oriented upward (Fig. 1c)
- Operated through a Wideband Autonomous Transceiver (WBAT)
- 35-45 kHz, 2 ms pulse length, 0.55 Hz ping rate, transmit power of 450 W

Data processing:

- ESP3 (Ladroit et al., 2020) for match filtering, applying calibration, and bubble tracking
- MATLAB for time-depth binning and plotting

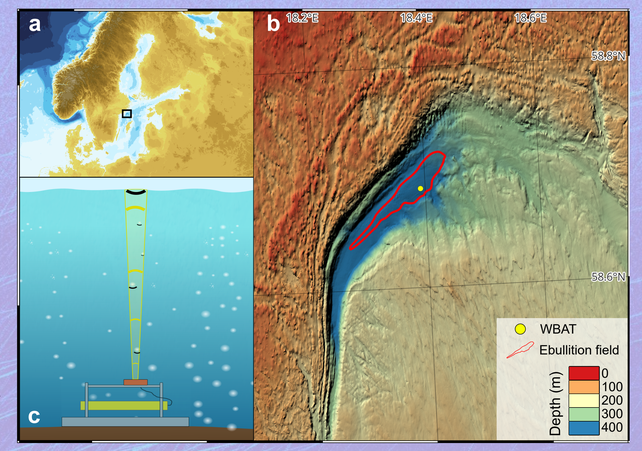

Figure 1. Map of the Landsort Deep and surroundings with a sketch of the acoustic system used. (a) Overview map of the Baltic Sea showing the location of panel (b) in a black box. Bathymetry from IBCAO ver 5.0 (Jakobsson et al., 2025). (b) Bathymetric map of the Landsort Deep and surroundings showing the extent of the ebullition field (Stranne et al., in prep.) and the location of the acoustic system. Bathymetry from EMODnet Bathymetry Consortium (2024). (c) Sketch of the autonomous EK80 system, moored to the seafloor, looking upwards, and showing how the sound beam is reflected by the bubbles and by the sea-air interface.

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Bubble size

Applying McGinnis et al. (2006), and assuming the bubbles are clean (i.e., without oil or hydrate coating), the slow-rising bubbles appear to have diameters of at least 13 mm, while faster-rising bubbles have diameters greater than 19 mm (Fig. 3). Within the dataset, two outliers exhibit very fast rise velocities, with estimated diameters of at least 30 mm.

The slow-rising bubbles, being the smallest in this dataset, are 2 to 10 times larger than those documented in the literature (e.g., Weber et al., 2014; Lohrberg et al., 2020).

Preliminary analysis of frequency-modulated target strength suggests similar size ranges for the two main bubble groups. However, the outliers are estimated to have diameters as large as 120 mm!

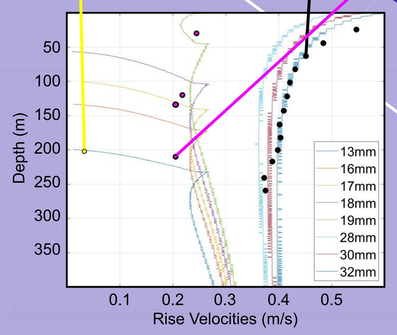

Figure 3. Modeled rise velocities for bubbles of different diameters. The rise velocities estimated from this dataset are shown as colored points: yellow for the slow-rising bubbles, pink for the faster ones, and black for the outliers.

Intermittent and sporadic ebullition

Bubbles form and migrate within porous sediment. Gas accumulates beneath impermeable layers, which can lead to the formation of cracks in the overlying sediment due to overpressure. Trains of bubbles escape the sediment through these cracks. This process occurs at a single point until the gas beneath the crack is fully released, after which it begins at another location. On larger spatial scales, multiple cracks can open simultaneously, giving the appearance of a continuous flux.

This presentation participates in OSRP

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Abstract

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