Hydroacoustic imaging of underwater gas seepage: investigating the use of echosounders for fluid discharge detection in a nearby natural laboratory (Laacher See, Germany)

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The detection of fluid escape at the seafloor has been the subject of marine research for decades, with several geophysical techniques being used for mapping and visualization of gas migration and seepage in the water column, at the seabed, and in the shallow subsurface. To determine the most suitable set and configuration of geophysical equipment for gas seepage detection, a nearby testing site with active degassing is extremely useful for experimentation. The Eifel region in the west of Germany is such a location thanks to the presence of active CO_2-degassing phenomena related to volcanic activity, especially in the Laacher See volcanic lake. This lake, formed after a series of eruptions 13 ka BP (Reinig et al., 2021), provides a calm, lacustrine environment with a maximum water depth of 51 m that is highly suitable for testing out geophysical equipment (Goepel et al., 2014).

During two surveys in 2019 and 2021, several geophysical techniques and settings were used to image and monitor CO_2 seepage and migration, both in the water column and in the sedimentary infill of the lake. A Norbit WBMS multibeam echosounder was used to identify the bathymetric expression of gas escape features on the lake floor and to locate gas (bubble) seeps in the water column visible by their high backscatter intensity. High-resolution sub-bottom profiles, acquired with an Innomar SES-2000 quattro parametric echosounder (10 kHz), show the presence of accumulated gas in the subsurface, as evidenced by enhanced seismic reflections and acoustic blanking. Accumulated gas is present at different depths (5 to > 25 m below the lake floor) in the lake subsurface, making it possible to map areas with high concentrations of free gas at different levels. The results show that the subsurface gas accumulations often coincide with gas seepage in the water column, with subtle changes being identified over the two-year time interval.

Our data confirm that gas is actively migrating through the sedimentary infill and water column of Laacher See and illustrate that the integration of echosounder data from different sources can provide a complete picture of the CO_2 gas location and discharge in the lake. This set-up of echosounders has therefore the potential to also be applied in other (marine) environments for similar research goals. In the broader interest of volcanism-related research, the monitoring of these gas migration processes at Laacher See can ultimately contribute to a better volcanic hazard assessment in the Eifel region.

References

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