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Gas migration beneath Laacher See: acoustic imaging of shallow CO□ in the sediment and water column

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The East Eifel Volcanic Field in the west of Germany has received increased scientific attention in recent years due to new findings on ongoing deep magma-related seismicity and regional uplift. Related CO_2-degassing phenomena in the region have also been investigated, more specifically in and around the Laacher See volcanic lake, formed by a series of eruptions ca. 13 ka BP. Present-day degassing activity in the Laacher See caldera is most notably evidenced by several gas seeps (i.e. mofettes) in the lake and its surrounding shore, emitting CO_2 of magmatic origin. During two surveys in 2019 and 2021, several geophysical techniques were used to image and monitor this CO_2 seepage, both in the water column and in the sedimentary infill of the lake. A multibeam echosounder was used to locate gas flares in the water column, visible by their high backscatter intensity, as well as the bathymetric expression of gas escape features on the lake floor. Additionally, high-resolution seismic reflection profiles were acquired with different acoustic sources at different frequencies. These profiles were used to identify accumulated gas in the subsurface, evidenced by enhanced reflections and acoustic blanking.

Our results show that accumulated gas is present at different depths in the lake subsurface, from ca. 2 m to more than 25 m below the lake floor, making it possible to map out areas with high concentrations of free gas at different levels. Locations of subsurface gas accumulations often coincide with areas that have a high concentration of gas flares in the water column. Furthermore, depressions resulting from gas escape (i.e. pockmarks) can be identified on the lake floor bathymetry, linking the upward migration of CO_2 gas in the subsurface to the seepage in the water column. Our data confirm that gas is actively migrating through the sedimentary infill and water column of Laacher See and illustrate the need for monitoring these gas migration processes, which can ultimately contribute to a better volcanic hazard assessment in the Eifel region.