Distribution, characterization and source of seabed gas seeps in the Tampen area of the Norwegian North Sea

Authors: Adriano Mazzini, Stéphane Polteau, Stefan Buens, Rune Mattingsdal, Oystein

The Norwegian Continental Shelf (NCS) is a region with 100,000s of active and extinct natural occurring methane seeps (NOMS) that are sustaining oases of unique ecosystems. These emissions are sourced from thermogenic and microbial methane. In addition, vigorous seafloor gas emissions (i.e., gas flares) are also found at, or in the vicinity of numerous wells (i.e. WAMS: well-associated methane seep). The NCS hosts more than 5000 wells, ~2,000 of these are plugged and abandoned, and another 2,245 in operation heading for decommissioning in the next decades. Here we integrate the results of multidisciplinary surveys conducted in the Tampen area (western Norwegian Channel) where the highest NOMS and WAMS and related gas flare concentration so far has been observed in the Norwegian part of the North Sea.
We combine a large 800 km2 multibeam and water column survey with high resolution seismic profiles and gas geochemistry analyses from active seepage sites. A detailed mapping of the area reveals the presence of nearly 2000 gas flares, 175 of which are WAMS. The vast majority of the WAMS are associated with plugged and abandoned wells. Geochemical analyses of both WAMS and NOMS show that methane is the main seeping gas with a shallow microbial signature. Reflection seismic data confirm the presence of shallow gas deposits trapped in the topmost glaciogenic wedge of the west shoulder of the Norwegian Channel. Selected profiles have been used to trace back the potential fluid migration pathways from deeper units where mature source rocks and reservoirs are located. We suggest that deep-seated tectonic discontinuities facilitate vertical migration while shallower clinoforms and sub-horizontal sedimentary interfaces control lateral fluid movements. The identified gas flares have been grouped in different classes according to width, height and intensity in order to have a catalogue comparable with other gas flares observed on the NCS. We further recently measured flux using a Remote Operating Vehicle to quantify the volume of methane emissions at selected seepage sites.
These findings are relevant for 1) scaling up our local observations and measurements to the large regions surveyed by multibeam echosounder; 2) understanding the environmental impact of gas flare activity on the ocean capacity to act as a sink to carbon release in the atmosphere, 3) developing monitoring strategies over future CO2 and hydrogen storage projects in depleted reservoirs, and 4) designing novel mitigation strategies for WAMS on the NCS.