CHARACTERISTICS AND EFFECTS OF NATURAL GAS SEEPAGE ON THE BARENTS SEA SEABED

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Summary

Since 2007 Lundin Norway has developed an extensive seabed investigation program focusing on seabed morphology and its relation to mapped subsurface geology, habitats for different life-forms, geohazards that might be relevant to future drilling, but also features that can be directly related to petroleum exploration and high-grading deeper hydrocarbon reservoirs. The main study area in this context has been the Barents Sea, especially around current Lundin-operated exploration licenses, where subsurface prospectivity can be associated to seismically defined shallow gas anomalies as well as sites of potential gas seepage. To date Lundin Norway has collected several thousand km^2 of multibeam echosounder data, high resolution interferometric synthetic aperture sonar data (HISAS), millions of black and white and colour photographs of the seafloor, hundreds of drop cores and dozens of biological, carbonate crust and physical gas samples.

The seafloor data collected during a number of surveys spanning the period 2008 to 2016 have yielded important observations about the nature of the seabed such as pockmarks, iceberg plough marks, glacial prod marks, carbonate crusts, bacterial mats and ongoing/past gas seepage. These observations have provided the basis for interpretation of seabed morphology and its relation to mapped subsurface geology, habitats for different life-forms and geohazards that might be relevant to future drilling, but also features that can be directly related to petroleum exploration and mapping of deeper hydrocarbon reservoirs.

Seafloor samples (gravity cores, grab samples, carbonate crust) from inside and outside pockmarks have been studied using an interdisciplinary approach by applying geophysical, organic geochemical, biogeochemical and microbiological methods. Most observations indicate that the majority of seafloor features related to gas or liquid seepage are inactive at present. Their origin is presumably connected to gas hydrate decomposition during the last ice-sheet retreat, involving unloading of the sedimentary sequences and temperature increase. Detailed examination and sampling of active gas leakage sites (identified by sonar and high resolution seabed mapping) using remotely operated vehicles (ROV's) has revealed strong thermogenic gas leakage occurring today. In such sites the carbon isotopic signals obtained from carbonate crusts indicate that they were formed by metabolisation of the gas via anaerobic methane oxidation. Thus, carbonate crusts can be used to identify and distinguish sites of thermogenic vs. biogenic gas leakage. Thermogenic gas-derived carbonate crusts have additionally been dated using the Uranium-Thorium method, and ages between 8 and 15 thousand years dominate, but also younger ages occur commonly. These results point towards multiple episodes of gas leakage in the (geologically) recent past.

Sites of active gas leakage are characterised by abundant macro- and micro-fauna, as well as extensive occurrence of microbial mats. Such sites are hot-spots of biological activity, as also evidenced by abundant fishing related trawl marks on the seafloor. Our ongoing R&D program now focusses on building a seafloor lander equipped with a variety of sensors to monitor gas seepage rates, temperature, pressure, water composition and biologic activity for the period of one year in order to cover as many temporal scales as possible. We hope thus to better understand the periodicity and rates of natural gas leakage as well as the effects on seafloor ecosystems.

It is our belief that this approach of integrating seafloor data with more traditional geophysical tools as well as systematic chemical, physical and biological sampling significantly enhances our understanding of the dynamic processes occurring and controlling present and past petroleum seepage in an arctic environment.