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DISSERTATION TITLE: *Diversity of Petroleum in terms of Source Rock Properties and Secondary Alteration Processes — A study of source rocks, migrated petroleum, oils and condensates from the Norwegian Continental Shelf*

Organic geochemical analyses of rocks, oils, condensates and gas can be used to infer the diversity of petroleum compositions. This has implication for the understanding of petroleum systems and can provide useful data for future oil and gas exploitation in the Norwegian Continental Shelf, particularly in frontier provinces such as the Barents Sea and Svalbard.

This PhD project investigates geological and geochemical conditions controlling the presence of oil and gas on the Norwegian Continental Shelf. Analysis of Mesozoic age cores from the southwestern Barents Sea and outcrops from sites on Svalbard reveals that the Middle Triassic Botneheia and Steinkobbe formations and the Upper Jurassic Hekkingen Formation are good to excellent source rocks for oil generation. However, the organic matter quality of these sediments and hence their hydrocarbon generation potential vary laterally. More oil-prone source rocks have, in general, developed in western areas such as the Svalis Dome and Svalbard compared to the southern and eastern areas such as the Hammerfest Basin and Nordkapp Basin. Analyses of thermally low mature rocks indicate that the Botneheia and Steinkobbe formations are more oil-prone than the Hekkingen Formation, which is traditionally considered as the major source for oil in the southwestern Barents Sea.

The observed variation in hydrocarbon potential of the rocks is mostly a function of organic facies rather than thermal maturity levels. However, the Hekkingen-equivalent Agardhfjellet Formation in central Spitsbergen is currently gas-prone, due to over maturity related to high paleo-burial temperature. Analysis of rock samples from onshore sites on Spitsbergen indicates that oil has migrated in Svalbard and probably has originated from the Botneheia and Agardhfjellet formations. This oil can be categorized into two groups based on composition. The outcropping rocks in which this migrated oil occurs are analogous to well-known offshore reservoirs in the Barents Sea. This improves the understanding of the subsurface petroleum systems in the Barents Sea and other arctic basins.

Further study of oils and condensates from the southwestern Barents and also from the Embla Field (Norwegian Central Graben) is presented. The findings indicate that the oils and condensates have been affected by several alteration processes, including biodegradation, water washing, and evaporative fractionation during migration and in the reservoir. Alteration-induced signatures can be used to infer the distribution of petroleum and the filling history of a trap. The PhD project is a collaboration between the University of Oslo and Lundin Norway.