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Eocene Source Rock Potential in the Arctic Beaufort-Mackenzie Basin

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Summary

Over 40 years of hydrocarbon exploration in the Beaufort-Mackenzie Sea and adjacent land areas has revealed substantial hydrocarbon reserves and potential for future discoveries. A multi-disciplinary study in the Beaufort-Mackenzie Basin is being carried out by the Geological Survey of Canada (Calgary) to better understand petroleum systems in this region. Natsek E-56, an oil and gas well from the Beaufort-Mackenzie Delta, was selected for detailed study because it preserves fossiliferous marine and terrestrial deltaic strata deposited during two major Eocene climate events that may affected source rock deposition in the circum-Arctic region: the Paleocene/Eocene Thermal Maximum (PETM) at ~55.5 Ma and the early mid-Eocene Azolla event at ~49 Ma.

In recent years the majority of interest, in terms of oil exploration in Arctic regions, has been directed towards the Azolla event. Sediments from Natsek E-56 contain evidence of Azolla deposits, however, just prior to the PETM Rock-Eval data from Natsek E-56 records an interval of organic rich (~30% TOC), black oil shale coaly deposits. These organic-rich pre-PETM coaly deposits are characterized by elevated hydrogen-rich organic matter (S2 carbon) which suggests increased input of algal matter similar to the sapropelic boghead coal formed in lacustrine environments in vicinity of the Beaufort-Mackenzie delta plain. Compared to the high productivity pre-PETM environment, lower potential, reworked S3 organic matter accumulated during the marine environmental conditions associated with the Azolla event. The difference in depositional environments archived in Natsek E-56 suggests greater source rock potential in the Beaufort-Mackenzie region exists during the high productivity interval just prior to the onset of the Eocene than during the Eocene Azolla Event.

The majority of work on Azolla deposits has been from the Lomonosov Ridge; a seafloor feature that currently rises 3 km above the adjacent abyssal plains. Regional Arctic data suggests that during the restricted marine conditions of the Eocene, the Lomonosov Ridge may have separated the Arctic Ocean into two distinctive bodies of water creating differing depositional environments. It is possible that the separation of the basin may have allowed for higher Azolla accumulation in the eastern side of the modern-day Arctic Ocean compared to the Beaufort-Mackenzie. This has implications for interpretation of petroleum potential of the Arctic Ocean.