Circum-Arctic Petroleum Systems: Where Is the Potential and What Are the Risks?

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ABSTRACT

The Arctic has long been considered the last great frontier for hydrocarbon exploration, and before the most recent oil price decline, the region seemed poised to undergo a major exploration effort. Arctic operating conditions are challenging, and many plans for Arctic exploration have been postponed or terminated. This provides the industry with a significant opportunity to re-evaluate the risks and potential rewards offered by the region. This paper assesses the regions evolution and investigates likely impacts on the distribution of play elements and their associated risks. In many Arctic basins, geological data are limited. Using a global geodynamic model, an understanding of the kinematic history and likely temporal configuration of basins and hinterlands can be acquired. Used in conjunction with geochemical data and regional analogues, this geodynamic framework allows the likely deposition extent and age of potential source rocks across the circum-Arctic to be constrained and predicted. As an example, data from the Lomonosov and Alpha Ridges demonstrate the occurrence of potential source rock horizons in even the distal portions of the Arctic basins. Placing this in a regional geodynamic context, it is possible to extrapolate the likely extent of these deposits into the frontier Laptev Shelf, where they can act as a possible source rock in this frontier region. Through the addition of geochronological and rock property data, it is possible to make predictions regarding likely regional reservoir extent and quality. As an example, the thick Triassic sediments in the Barents Sea appear to offer good reservoir potential. However, prospects, such as Aurelia and Norvarg, have been rendered uneconomic because of poor reservoir quality caused by sandstone originating from Uralian arc complexes. Contemporaneous Caledonian-derived sediments are likely to have better reservoir characteristics, as demonstrated by the Goliat field, and a regional geological workflow is used to highlight their likely distribution. This approach is combined with a regional depth framework that allows a first pass screening of basins where maturity or porosity depth cutoffs are used to spatially define zones of likely effective source kitchens and working reservoirs. These combined methods are used to evaluate a range of play elements across the Arctic and speculate about areas for likely future success.