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The Challenges of Deep-Water Arctic Development

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The oil and gas industry has demonstrated the ability to drill and develop offshore oil and gas resources in first-year sub-Arctic ice and in shallow-water high-Arctic environments. However, development in deep water (water depths exceeding 100 m) remains a formidable challenge due to small, unpredictable open-water windows and large environmental loads from multi-year ice features. This paper provides an overview of recent projections of undiscovered Arctic hydrocarbon resource potential and the geographical distribution of the resource potential thought to lie in deep water. The unique environmental conditions are summarized along with their impact on the cost of supply outlook for Arctic resources relative to other hydrocarbon supplies. The key technical challenges facing deep-water high-Arctic development are reviewed along with the current industry efforts aimed at meeting the challenges.

INTRODUCTION

According to a 2008 Circum-Arctic Resource Assessment by the U.S. Geological Survey (USGS) (Bird et al., 2008), the Arctic could hold about 22% of the world's remaining undiscovered hydrocarbons. It is frequently described in the media as the final true frontier for hydrocarbon exploration. Resource projections such as these, coupled with diminishing supplies of conventional oil resources and higher oil prices, have resulted in intensified acreage acquisition and exploration activities in the Arctic. Arctic exploration is expanding well beyond the shallow-water depths of current industry production experience, which is limited to bottom-founded structures and gravel islands in depths less than 40 m. In fact, much of the undrilled prospective acreage lies in so-called deep water, that is, beyond the 100-m water-depth contour).

The expanding search into the deep-water Arctic is to some extent underpinned by industry confidence that the necessary enabling technology will emerge if the prize is large enough. Such confidence is supported by industry's long-standing record of overcoming major technological hurdles to safely and economically produce large hydrocarbon accumulations in harsh environmental conditions around the globe. True to form, the growing interest in the deep-water Arctic is driving a wave of exciting R&D work as the industry prepares itself for this next big challenge. This paper examines recent projections of the Arctic hydrocarbon resource potential and the many challenges of deep-water Arctic development, starting with cost-of-supply and competition from other hydrocarbon supplies such as unconventional gas, and extending through the major technological hurdles.

DEFINITION OF DEEP WATER IN HIGH ARCTIC

The term deep water takes on a different meaning in ice-load-dominated Arctic environments than in traditional oil and gas offshore environments, which are dominated by wind, wave and current loads. For the offshore Arctic, the term is typically defined as that exceeding about 100 m. Fig. 1 shows the 100-m contour above the Arctic Circle. For reasons relating to the magnitude of ice-induced overturning moments and practical structure dimensions, the 100-m mark is considered to be about the maximum water depth for bottom-founded structures in Arctic sea ice environments, especially where multi-year ice conditions may occur (Paulin et al., 2008).

While there have been no deep-water hydrocarbon developments in the Arctic, there is an almost 50-year history of development in shallow-water sea ice environments. The first offshore platform to be located in a dynamic, first-year sea ice environment was installed by Shell in 1964 in the Middle Ground Shoal field in 30-m water depth in Alaska's Cook Inlet (Visser, 1969). The early Cook Inlet platforms were ice-strengthened extensions of the steel-piled jacket designs of the day, with 4 large vertical legs extending up through the ice zone, and cross-bracing set deep enough to avoid ice interaction (Fig. 2).

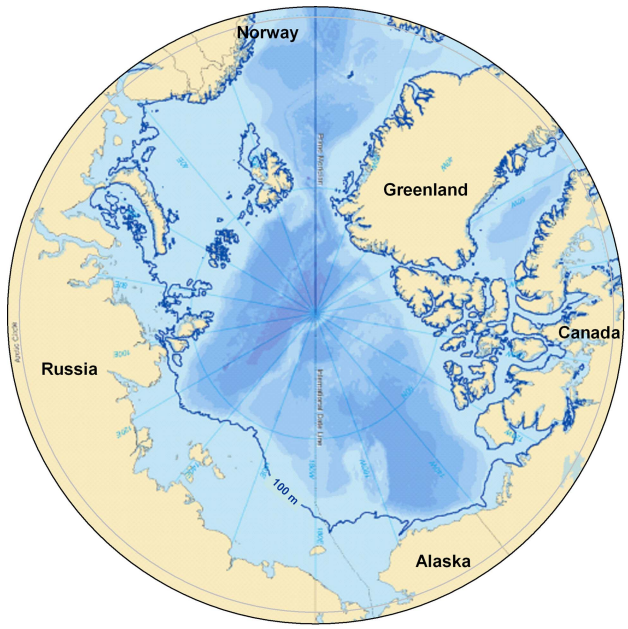

Fig. 1 100-m water-depth contour above Arctic Circle; bathymetry data from International Bathymetric Chart of Arctic Ocean (Jakobsson et al., 2008)

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