

Conditions for Formation of Extremely Severe Ice Seasons in Northeastern Barents Sea from Early 1950s to Present

G. K. Zubakin, A. A. Lebedev, V. V. Ivanov and I. V. Buzin
Arctic and Antarctic Research Institute, State Institution, St. Petersburg, Russia

L. I. Eide
Hydro Oil & Energy, Oslo, Norway

Ice cover significantly hinders the development of hydrocarbon deposits in the northeastern Barents Sea shelf. This article presents an analysis of 10 seasons with the most severe ice conditions from the early 1950s to the present. This period is covered by information of good quality, which allows a reliable assessment of ice regime components. Analysis of selected seasons is given, and conditions of their formation are described. The conditions for the formation of extremely severe seasons depend on the development of synoptic processes (stable advection of cold air masses), the presence of residual ice, and the decreased heat content of the water incoming with the Nordcapp Current.

INTRODUCTION

The development of hydrocarbon structures in the northeastern Barents Sea is complicated by its ice cover, which makes it difficult to develop and construct production facilities and conduct transport operations, and which creates risks for field operation. The Shtokman gas-condensate field (SGCF) is at 73°40'N latitude (northern boundary) along the 43°E meridian in the southern part of the Sea's northeast (Fig. 1). In extremely severe years, ice of different thickness, concentration and hummock and ridge concentration is observed in the SGCF area for 5 to 6 months.

The main features of the Barents Sea ice conditions are known (Vinje, 1985, 2001; Zubakin, 1987; Zubakin et al., 2004). Mironov's recent publication (2004) contains information on ice conditions in the different regions of the Barents Sea, and Buzin's paper (2006) describes the main features of the ice regime in the northeast. However, assessments of these publications describe mainly mean climatic conditions. While a knowledge of mean parameters of ice conditions is undoubtedly important, an understanding of the formation of extreme ice conditions is necessary for the successful exploitation of hydrocarbon fields in the Barents Sea. This article is in many respects a pioneering one for this region and for the entire Russian Arctic.

The choice of the second part of the 20th century for an estimation of extreme ice conditions is not random. First, this period, which investigators call the Arctic warming period (1930s–1950s), ended by the end of the 1950s. Second, and most important, the study period is covered by data of acceptable quality (regular airborne ice reconnaissance from 1955 to 1992 and satellite information from 1970 to the present), which allows us to make a reliable assessment of ice regime components.

As noted (Zakharov, 2004; Zubakin et al., 2006), the Arctic warming period was followed by cooling periods and more severe ice conditions. For the 20th century, Zakharov (2004) dis-

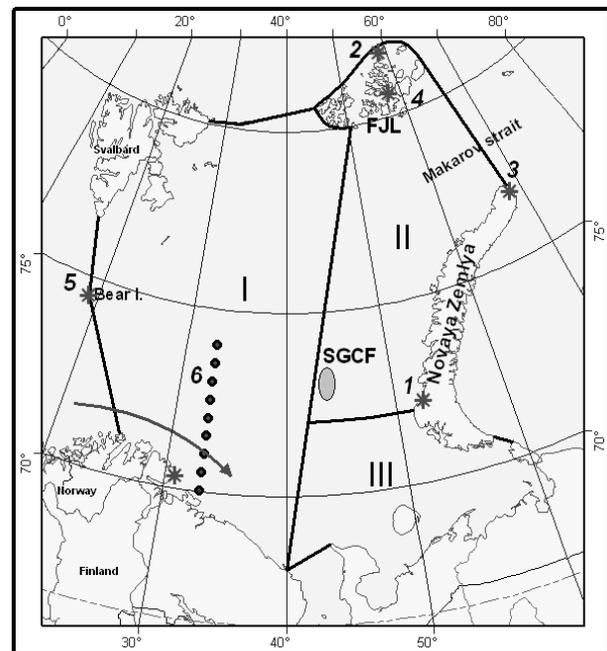


Fig. 1 Parts of Barents Sea: (I) western, (II) northeastern and (III) southeastern. Asterisks = polar stations: (1) Malye Karmakuly, (2) Rudolf Island, (3) Cape Zhelaniya, (4) Hayes Island, (5) Bear Island. Transect (6): Kola meridian; arrow: Nordcapp Current.

tinguishes 4 inner-century stages in the development of sea ice: 2 stages of ice coverage increase (1900–1918, 1938–1968) and 2 stages of ice coverage decrease (1918–1938, 1968–1999) standing out against the century's background of ice coverage decrease in the Arctic. In the Barents Sea, the late 1950s and the entire decade of the 1960s are especially prominent against the general background. Then one can note the late 1970s–early 1980s, followed by a significant warming event during 1989–1996, which was in its turn followed by the late 1990s and the early 21st century (2003)—years of increased sea ice coverage (Fig. 2).

Received March 24, 2007; revised manuscript received by the editors July 19, 2007. The original version (prior to the final revised manuscript) was presented at the 17th International Offshore and Polar Engineering Conference (ISOPE-2007), Lisbon, July 1–6, 2007.

KEY WORDS: Ice cover, severe ice conditions, criteria, large-scale atmospheric processes, residual ice, heat content.