AAPG HEDBERG CONFERENCE
"Hydrocarbon Habitat of Volcanic Rifted Passive Margins"
SEPTEMBER 8-11, 2002, STAVANGER, NORWAY

Alternative Source Rock in the North Atlantic Passive Margin – Cretaceous in the Møre and Vøring Basins, Offshore Norway.

Kjell Øygard, Rune Olsen
BP Norge AS, P.O.Box 197, 4065 Stavanger, Norway

Historically, the upper Jurassic sequences have been regarded as the main source rock intervals for the Norwegian Continental Shelf. Unfortunately, in large areas of the Møre and Vøring Basins, the upper Jurassic, and even the lower Cretaceous sediments are deeply buried and extremely unlikely to be a source for liquid hydrocarbon accumulations. Basin modeling results indicate that the Jurassic source rocks, the Spekk, Melke and Åre Formations, are exhausted for hydrocarbon generation by early Tertiary time in large areas of the Møre and Vøring Basins.

The C13 isotope of the gas components C2 - nC4 from the discoveries in both the Nyk and Ormen Lange wells is rather heavy, which indicate that the source for these hydrocarbons is not from a late mature source rock, but an early to mid mature source rock. In the Nyk well, the heavy propane isotope is due to biodegradation. Also, the C13 isotope of the C1 gas is heavier than the regional trend and could be the result of a mixing of multiple sources and maturities, such as the Jurassic age Åre, Melke and Spekk Formations and source sediments of Cretaceous age.

The precursors of the 24–norcholestane biomarkers are diatoms, which increase in population from Jurassic through Cretaceous and into Tertiary time. This is demonstrated in a plot published by Holba et al., 1998. The age specific biomarker, nordiacholestane ratio (24/(24+27)), Figure 1, indicates that hydrocarbons stains in sandstones in sequences from Danian to Coniacian in the Gjallar, Vema, Nyk and Ormen Lange wells, as well as the 6507/2–2 well within the K72 level (Lysing Fm.), have a younger source rock than the Jurassic. Extracts from the Cretaceous source rocks from Albian age (K54) up to and into the Late Paleocene (K72) (figure 2) show a high nordiacholestane ratio, similar to what is found in the reservoir section in the Gjallar, Vema, Nyk and Ormen Lange wells, as well as the K72 interval (Lysing Fm.) in well 6507/2–2.

In the Turonian-Cenomanian, a major anoxic event, which is the main condition for evolvement of source rocks, has been recognized throughout the northern epicontinental seas and continental Europe.

With the present, limited well control, the total organic carbon content and source rock quality of the Cretaceous source rock in the Møre and Vøring Basins varies considerably both laterally and vertically from well to well. In the Vema well, 6706/11-1,

the source rock potential in the Cretaceous down to 3750 m (K74) is lean, but source potential increases slightly to 1.0 – 1.1 % TOC and HI at 120 – 200 mg/g TOC at K72 level. In Well 6506/6-1, the TOC varies between 0.6 – 2.8 %, and the average initial TOCo and HIo at the K66 level is 1.8 % and 170 mg HC/gTOC, respectively. The K66 level in Well 6506/11-3 is a good source rock, with TOC values up to 4 % and HI values up to 200 mg HC/g TOC. Fair source rock quality for gas generation is found in the Gossa High wells, 6305/3-1, 6305/12-1 and -2.

To fully understand the variability of this Cretaceous source interval, the initial potential of the interval needed to be calculated. This was done by using Organofacies Modeling, as presented at this conference (Mann et al.). The results of the modeling have been projected onto a map view based on the Cretaceous isochore map and estimated water depth at that time, which takes into account the estimated reworking of organic matter. The initial TOC and HI maps were used in estimating the volumes expelled. The source interval of Albian (K54) to Coniacian age (K72) in the Møre Basin is not a 'high quality source' and is characterized by interbedded source and non-source intervals. The resulting source has a predominant potential to expel C1–5 (gas); however some heavier components in the C6+ range (oil) will be expelled.

The isochore of the source interval from Albian to Coniacian age in the Møre and Vøring Basins is, in most of the area, from 1200 to 4400 m thick. Based on these maps, the basin modeling suggests that there have been several magnitudes more gas and some C6+ generated and expelled than discovered in these areas from the Cretaceous source rock.

References:

HOLBA, A. G., TEGELAAR, E. W., HUIZINGA, B. J., MOLDOWAN, J. M., SINGLETARY, M. S., CAFFREY, M. A. & DZOU, L. I. P, 1998. 24-Nordiacholestane as age-sensitive molecular fossils. *Geology*, **26/9**, 783-786.

MANN, U., ZWEIGEL, J., ØYGARD K., GJELDVIK G., 2002. Source rock prediction in deepwater frontier exploration areas: An integrated study of the Cretaceous in the Vøring Basin. *Presented at this conference*.

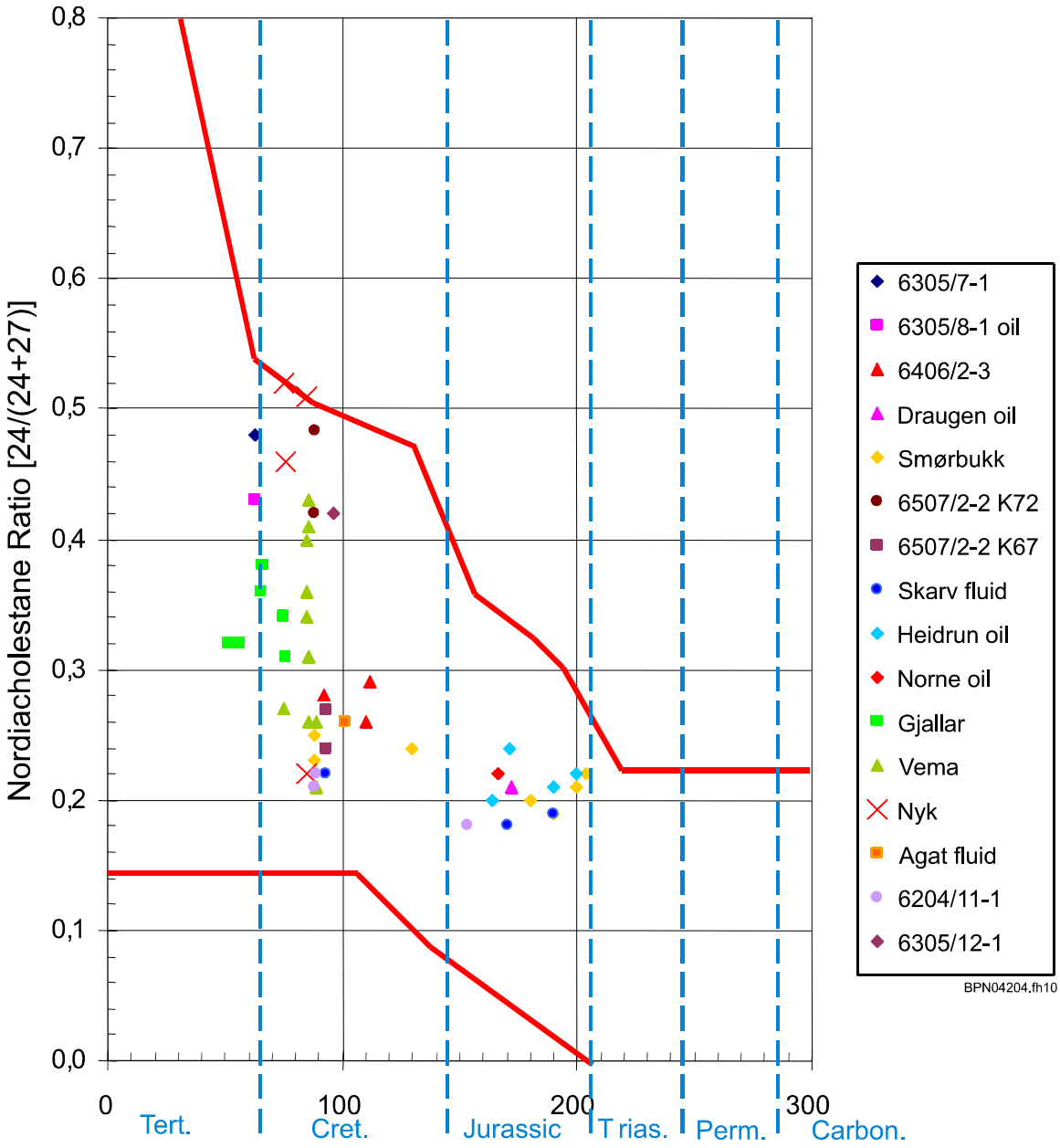

Figure 1. Plot of Nordiacholestane ratio against Geological Time for reservoir fluid and extracts data (Calibtrated after Holba et al 1998).

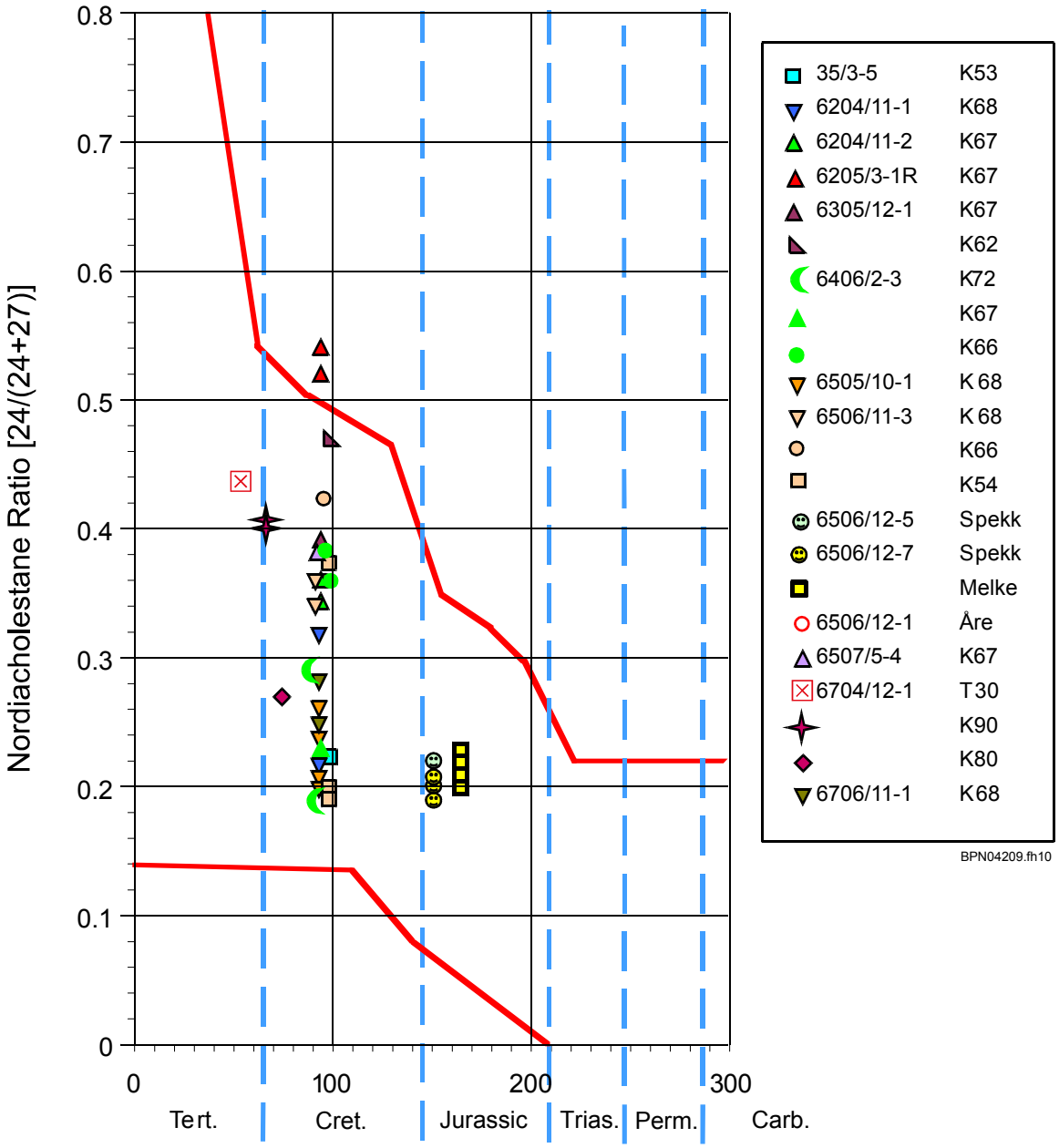

Figure 2. Plot of Nordiacholestane ratio against Geological Time for source rock samples (Calibtrated after Holba et al 1998).