

INTRODUCTION

Repeated uplift and erosion of the Barents Sea might play a crucial role in the distribution, alteration and composition of accumulated hydrocarbons. Commonly biomarkers are used to infer post-emplacement alteration or migration induced alteration processes in oil-oil and oil-gas/condensate correlation studies. However, the concentration of the biomarker compounds decreases with increasing maturity and biomarkers can almost be absent in high maturity oils and condensates. Here, the use of light hydrocarbons (LHC) is of greatest importance as these make up a significant volume of oils and gas/condensates (England et al., 1987) with up to 16mol% of a standard 0.3kg/kg North Sea oil. Furthermore represent LHC a highly mobile phase, which allows an insight of recent migration processes. In this context, special focus has to be brought on cap-rock properties as they play a critical role in petroleum systems.

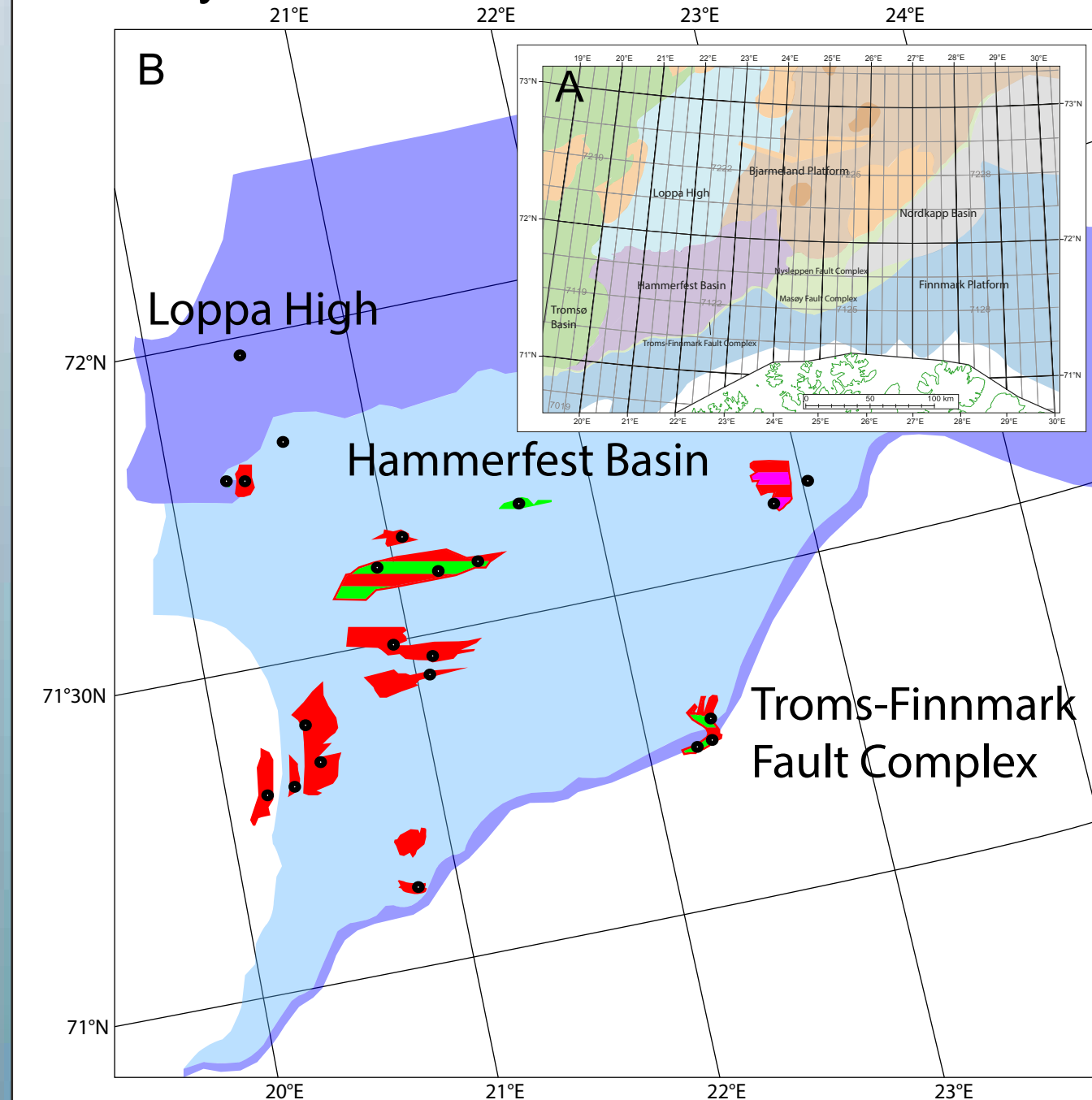


Figure 1: A) Overview map of the SW-part of the Norwegian Barents Sea with its main structural elements. The black square indicates the study area. B) The study area covers the southern part of the Loppa High, the Hammerfest Basin and the Troms-Finnmark Fault Complex. Black dots indicate well locations from which the samples derived. The sample area experienced an uplift of approximately 500m to 1500m (Ohm et al., 2008)

OBJECTIVES

This study examines oil and gas/condensate samples from the Hammerfest Basin and the Loppa High (Figure 1) in terms of biodegradation, evaporative fractionation and long-distance migrated hydrocarbon phases, whereby the properties of seal-rocks may play a crucial role.

MATERIALS & METHODS

Geochemical analysis was carried out on 32 oil and condensate samples from the Hammerfest Basin and Loppa High. The parameters are based on results obtained from Gas-Chromatography - Flame Ionization Detection (GC-FID), which allows a near perfect separation of the gasoline range compounds (n-C4-n-C8) (Fig.2). Peak areas were determined and LHC parameter ratios were calculated as suggested by Thompson (1987) and Halpern (1995).

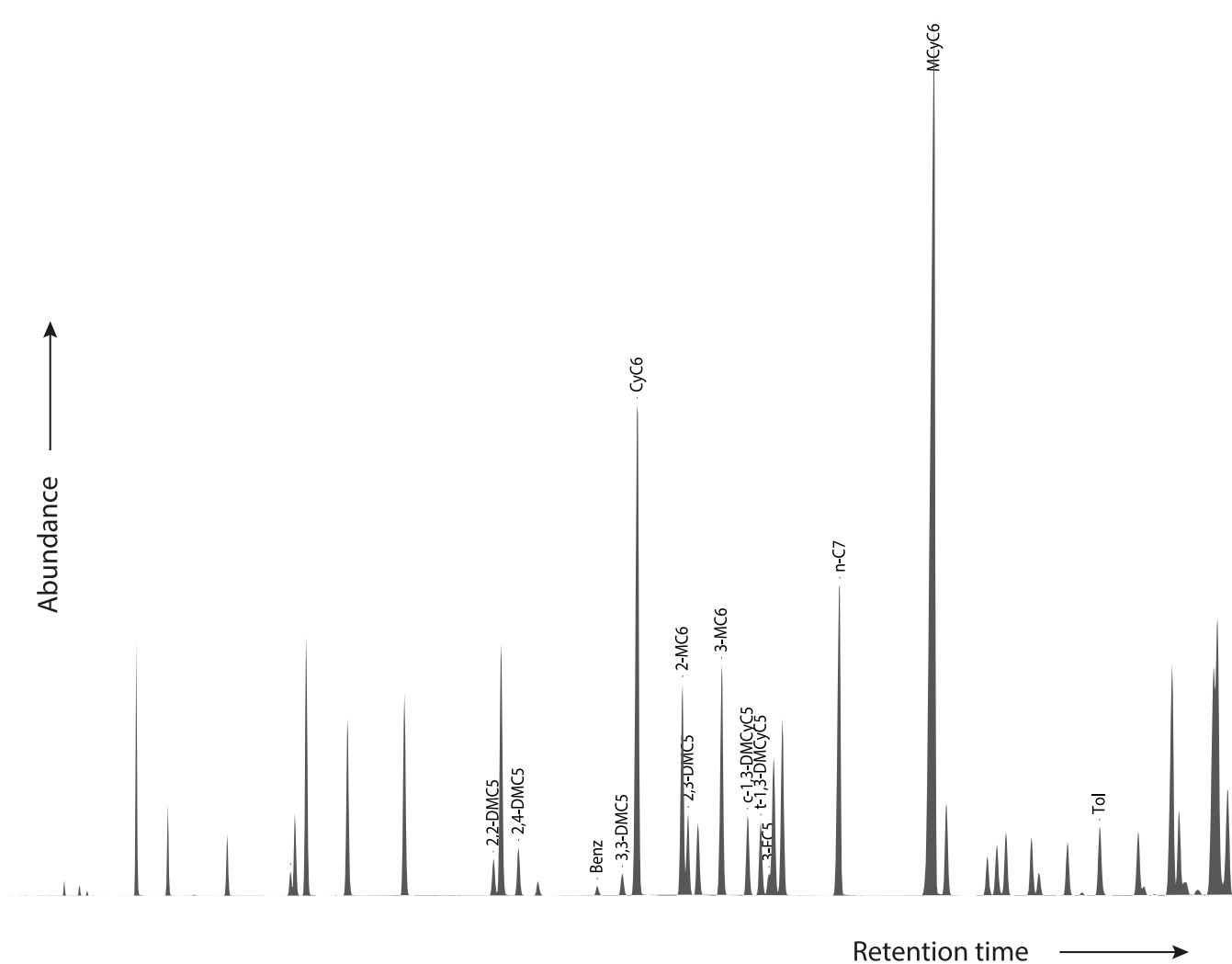


Figure 2: Representative chromatogram of the LH fraction obtained from GC-FID. Corresponding peak names are given in (Fig.3). This sample from the Tornerose field represents both a biodegraded and a long-distance migrated LHC phase. Note the diminished benzene and toluene peaks.

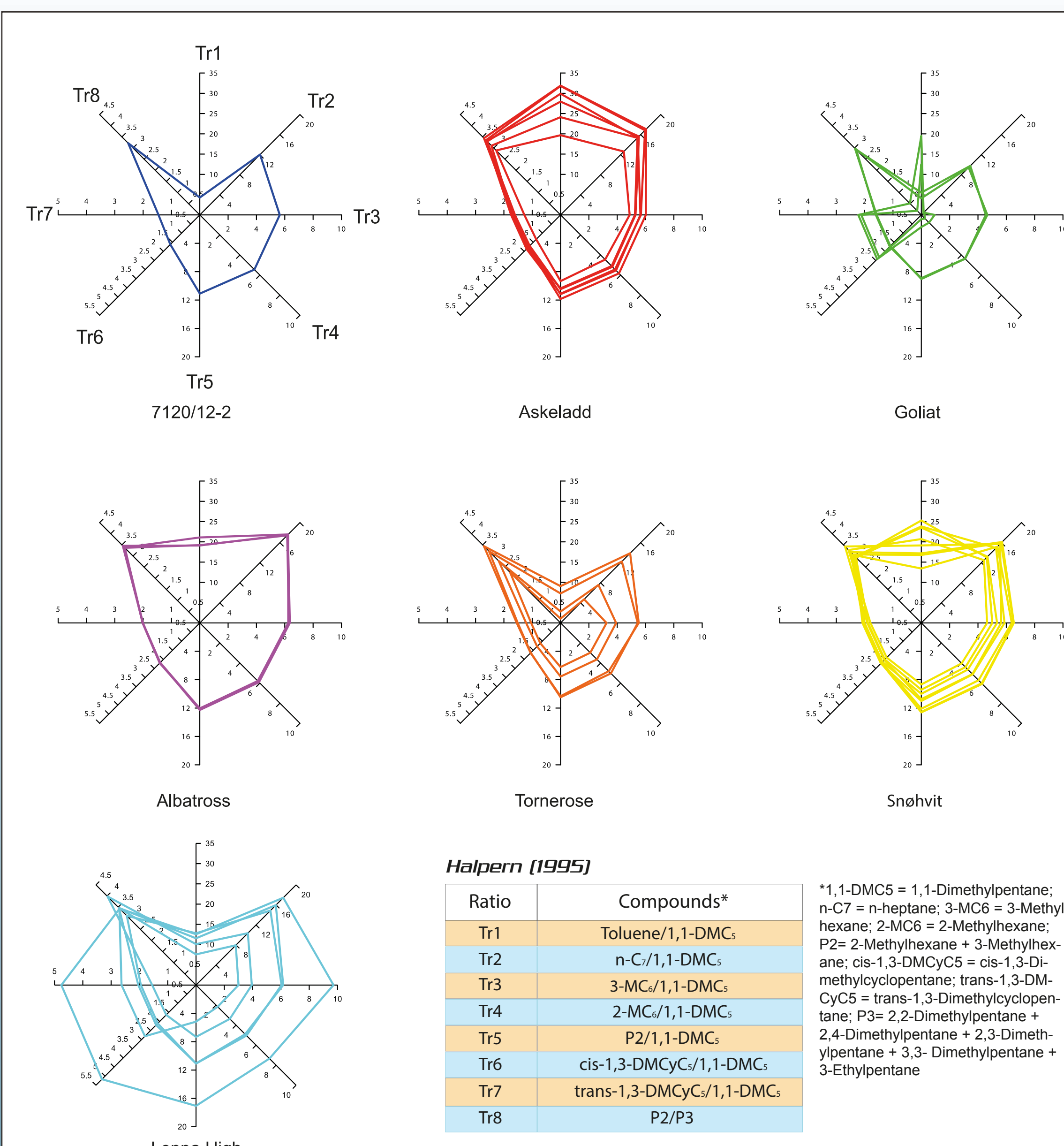


Figure 3:

C7-Oil Transformation Star Diagrams (C7-OTSD) after Halpern (1995). Axes are representatively labeled on the first C7-OTSD. Low Tr1 values indicate long-distance migration characterized by low toluene content. Water soluble aromatics get "stripped out" in effective carrier systems. Biodegradation is indicated by diminished Tr1-Tr5 and Tr7-Tr8 values, with Tr8 the most resistant against biodegradation. Two Goliat oils, two Tornerose oils and two Loppa High oils represent biodegradation. Oils and condensates from Snøhvit, Albatross and Askeladd fields seem to be unaltered in terms of biodegradation and long-distance migration and thus are suggested to be derived from a local source. Overall high values for one Loppa High sample indicates a fresh gas charge which masks the palaeo-signature.

SUMMARY

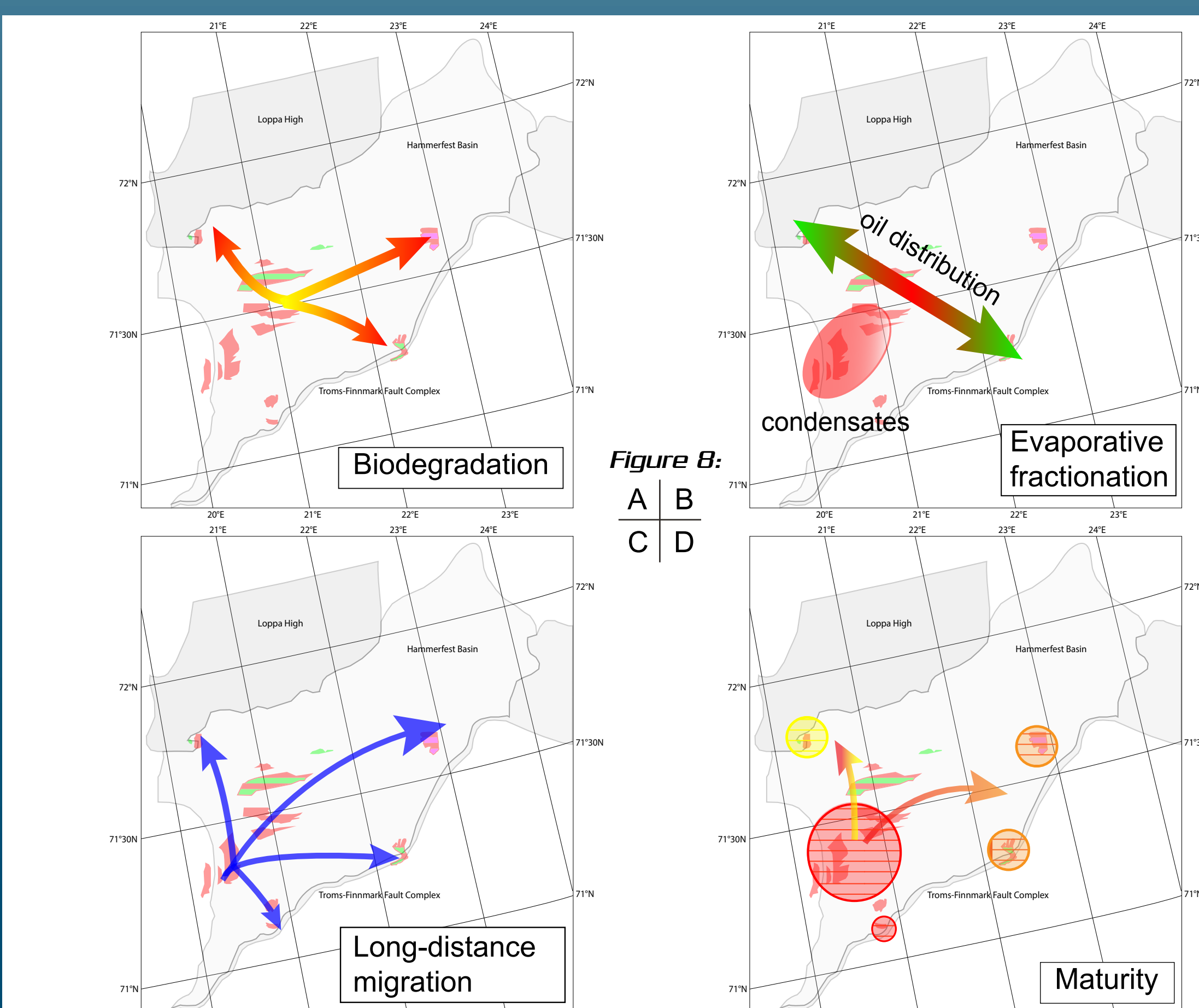


Figure 4:

RESULTS

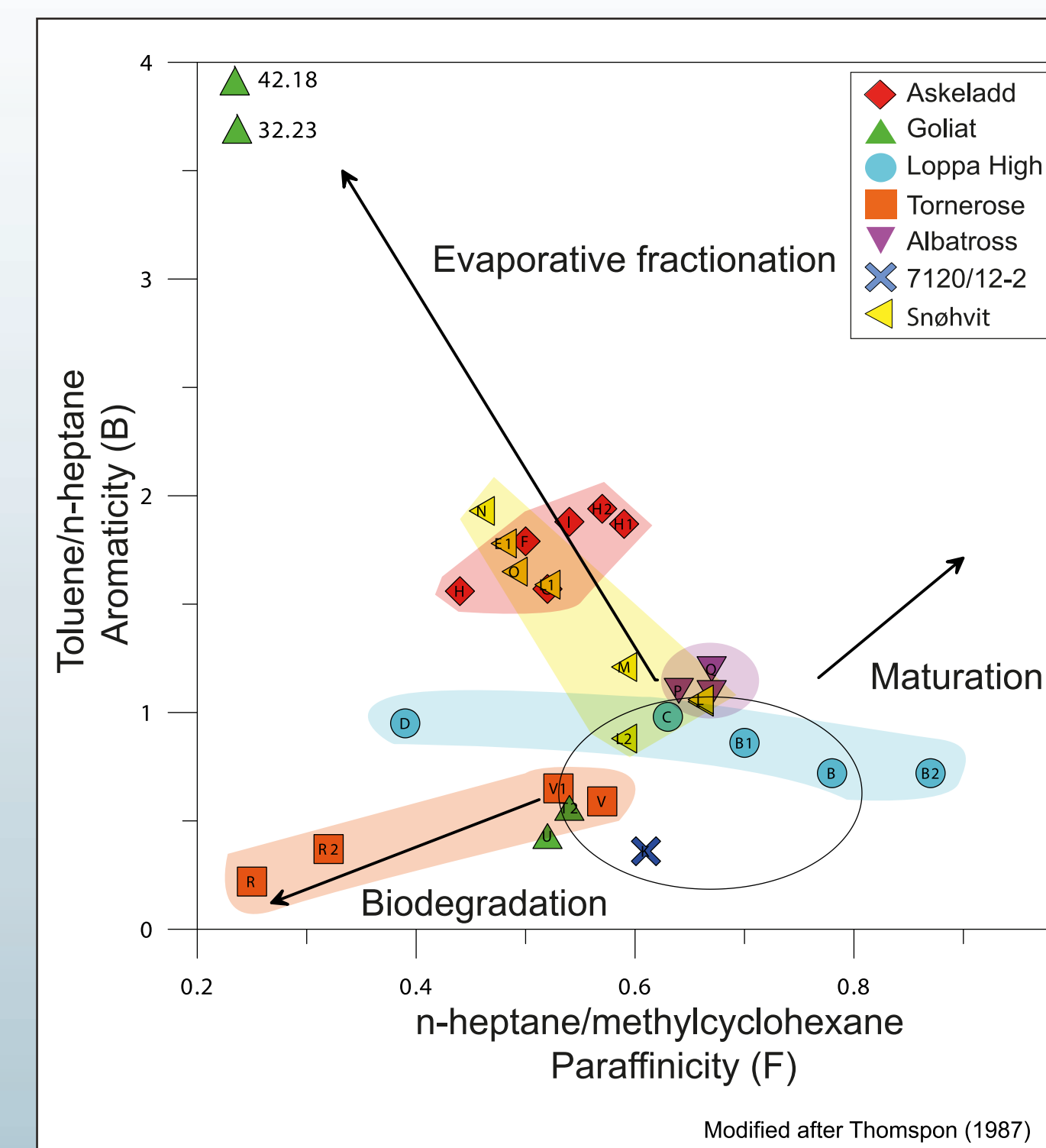


Figure 5:

Plot of the Heptane vs. the Isoheptane value indicating two Goliat oils and one sample from the Loppa High as biodegraded. Note that all the samples plot in the mature window, whereas samples from the Loppa High and Snøhvit are indicated by lowest maturities. Condensates from the Askeladd field and the 7120/12-2 well are characterized by highest maturities. These condensates are believed to be derived from deep parts of the western Hammerfest Basin where the source rocks passed the late oil window.

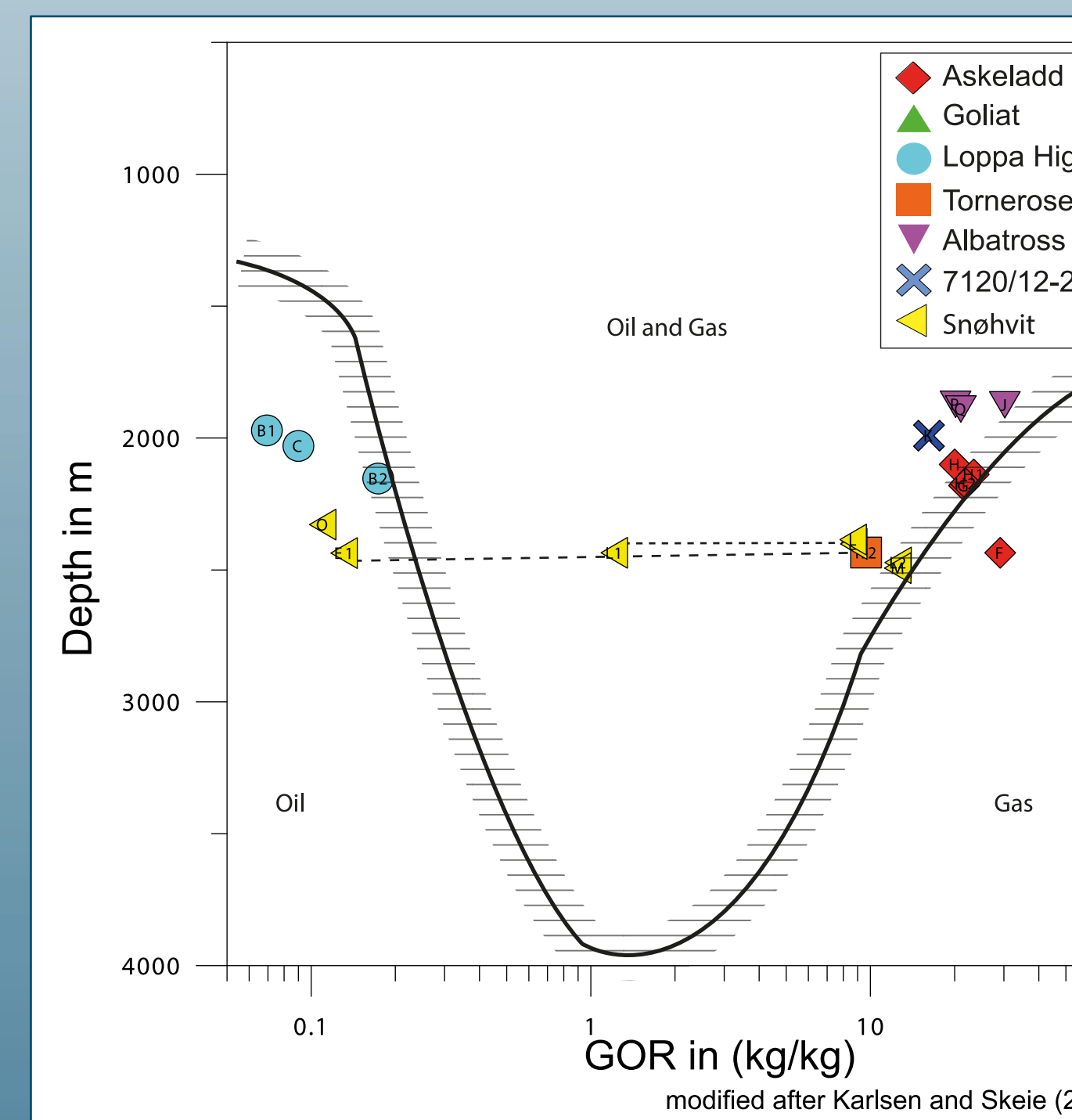


Figure 6:

Plot of gas to oil ratio (GOR) vs. depth (England and Mackenzie, 1989) for selected samples. The phase envelope is drawn after Karlsen and Skeie, (2006). The Loppa High oils are undersaturated, which is probably related to gas leaking out of brittle caprocks. Undersaturated Snøhvit oils represent phase fractionation. The dotted lines indicate a coexisting underlying oil leg and overlying gas cap. The condensates plot close to the phase envelope and thus stay in saturation.

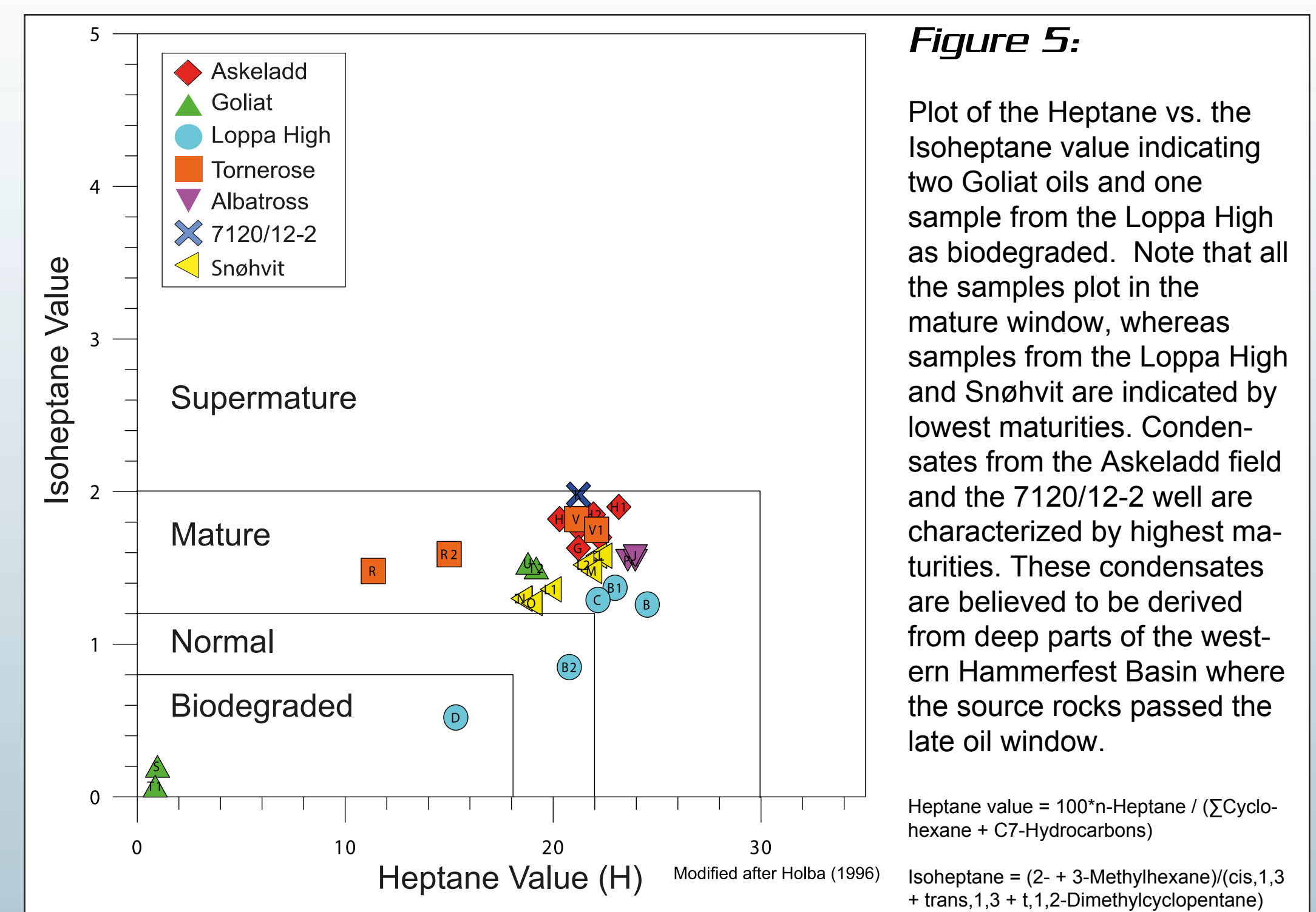


Figure 7: Two crossplots (A) and (B) modified after Chung et al., (2004) illustrating different maturities in the study area. The Loppa High samples show the lowest maturity. Samples from the Goliat plot in two groups characterizing different source rock maturities. The condensates from the Askeladd and 7120/12-2 discoveries show the highest maturities indicating that the source rock probably reached late-oil window maturities. Snøhvit condensates show slight higher maturities than Snøhvit oil which points towards generation at a later stage. These results correlate very well with observations made in Fig.5.

CONCLUSIONS

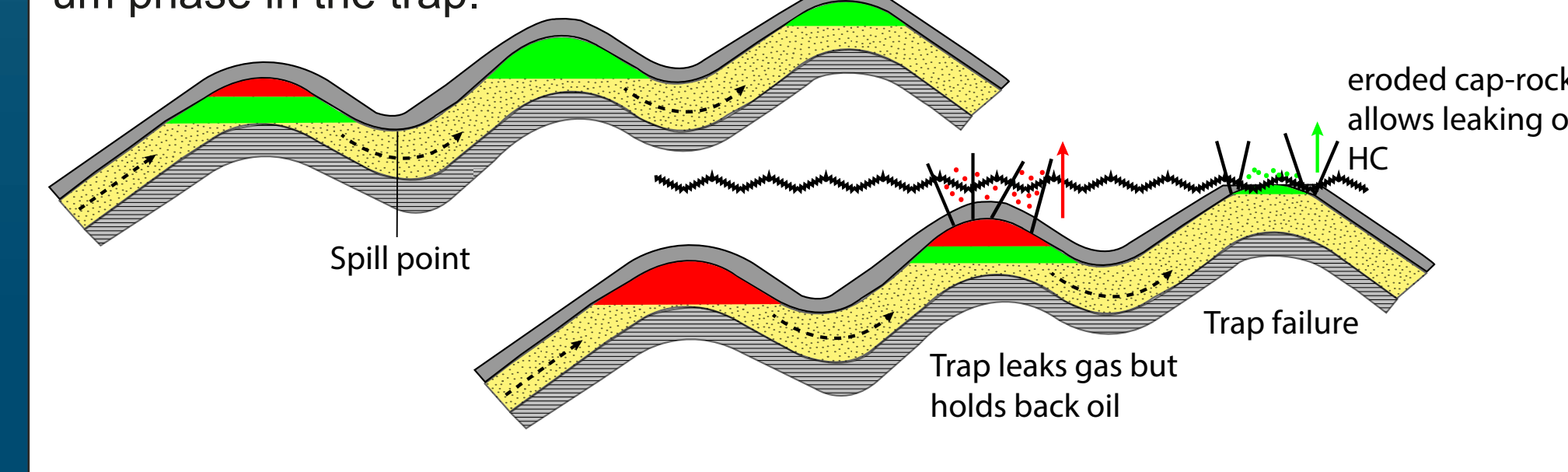
Biodegradation occurs only on the margins of the Hammerfest Basin where tectonized cap-rocks are present favoring the intrusion of water or traps are exposed closer to aquifers (Fig.8A).

Fractionated oils and condensates occur mainly in the Hammerfest Basin and derived locally through vertical migration (Fig.8B).

Water soluble aromatic compounds (toluene, benzene) are stripped out in effective carrier systems indicating long-distance migration (Fig.8C).

The margins around the Hammerfest Basin act like a center of attraction to migrating hydrocarbons (Fig.8B/C)

Cap-rock properties play a crucial role in distribution and composition of petroleum. Uplift induced expansion of gas pushes the oil downdip below closure leading to remigration. The type of the cap-rock determines the petroleum phase in the trap.



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