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Maturity and organic facies of Mesozoic and Palaeozoic petroleum from off- and onshore Scandinavia

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Introduction

In Lower Palaeozoic times, large parts of the Scandinavian region of the NW Europe were covered by the Lapetus Ocean. Shales, mudstones and carbonates were deposited on the mainland of Scandinavia, and in offshore areas east, south and west of the Scandinavian mainland. Some of these sediments, like the Upper Cambrian - Lower Ordovician Alum Shale, have certainly generated petroleum.

On- and offshore oil and gas fields in the Baltic countries Latvia and Lithuania are sourced from Cambrian, Ordovician and Silurian marine shales. In Scandinavia, insoluble bitumen, oil stains and oils in inclusions found on the Scandinavian onshore prove that Lower Palaeozoic petroleum systems have been active in this region. Insoluble bitumen found in Upper Palaeozoic rocks in the Norwegian North Sea suggest that Lower Palaeozoic petroleum also have been present in the North Sea region.

This study presents an evaluation of Palaeozoic and Mesozoic source rocks and oil stains from Norway, Sweden, Scotland and Spitsbergen. We use established organic geochemical methods to characterise marine and lacustrine samples in order to better understand the thermal maturity and organic facies of Palaeozoic source rocks and petroleum in the Scandinavian on- and offshore region.

Sample set

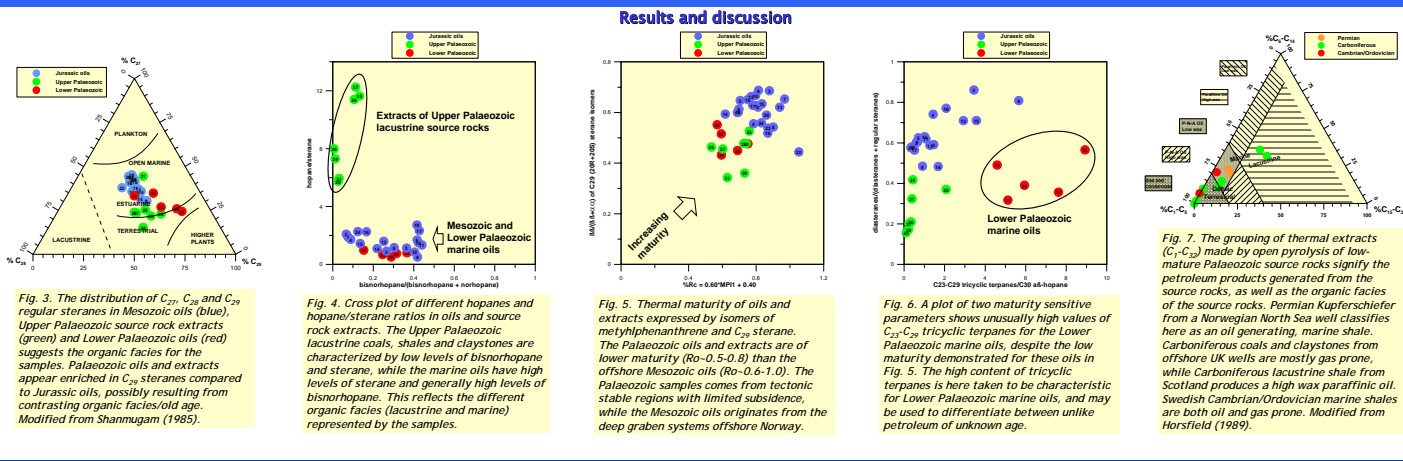
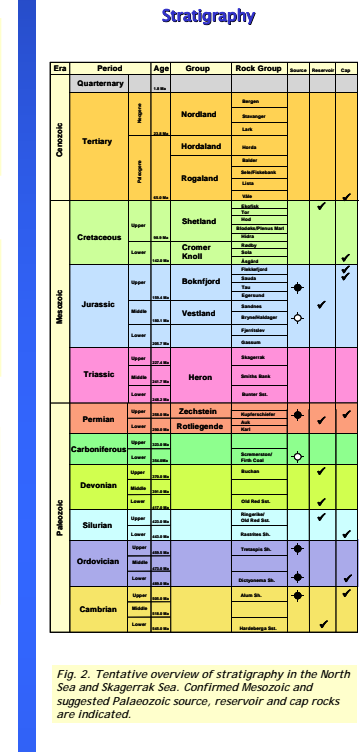
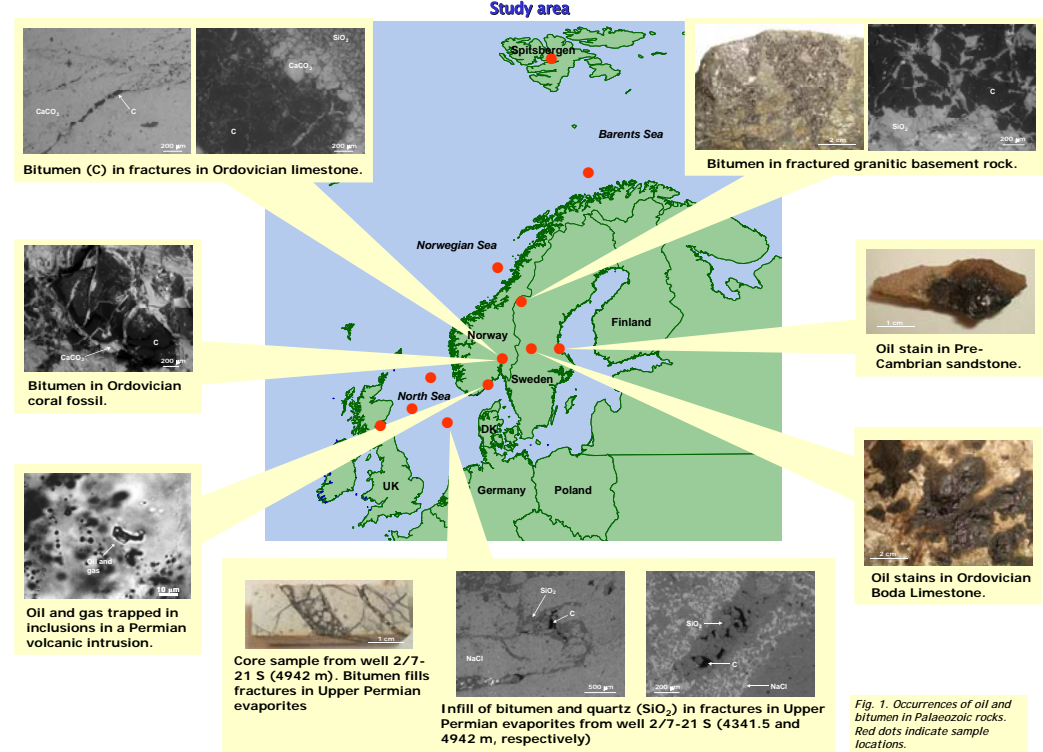
Sample No.	Well Name	Age	Location	Rock Type
1	2/7-21 S	Permian	Norway	Evaporite
2	2/7-21 S	Permian	Norway	Evaporite
3	2/7-21 S	Permian	Norway	Evaporite
4	2/7-21 S	Permian	Norway	Evaporite
5	2/7-21 S	Permian	Norway	Evaporite
6	2/7-21 S	Permian	Norway	Evaporite
7	2/7-21 S	Permian	Norway	Evaporite
8	2/7-21 S	Permian	Norway	Evaporite
9	2/7-21 S	Permian	Norway	Evaporite
10	2/7-21 S	Permian	Norway	Evaporite
11	2/7-21 S	Permian	Norway	Evaporite
12	2/7-21 S	Permian	Norway	Evaporite
13	2/7-21 S	Permian	Norway	Evaporite
14	2/7-21 S	Permian	Norway	Evaporite
15	2/7-21 S	Permian	Norway	Evaporite
16	2/7-21 S	Permian	Norway	Evaporite
17	2/7-21 S	Permian	Norway	Evaporite
18	2/7-21 S	Permian	Norway	Evaporite
19	2/7-21 S	Permian	Norway	Evaporite
20	2/7-21 S	Permian	Norway	Evaporite
21	2/7-21 S	Permian	Norway	Evaporite
22	2/7-21 S	Permian	Norway	Evaporite
23	2/7-21 S	Permian	Norway	Evaporite
24	2/7-21 S	Permian	Norway	Evaporite
25	2/7-21 S	Permian	Norway	Evaporite
26	2/7-21 S	Permian	Norway	Evaporite
27	2/7-21 S	Permian	Norway	Evaporite
28	2/7-21 S	Permian	Norway	Evaporite
29	2/7-21 S	Permian	Norway	Evaporite
30	2/7-21 S	Permian	Norway	Evaporite
31	2/7-21 S	Permian	Norway	Evaporite
32	2/7-21 S	Permian	Norway	Evaporite
33	2/7-21 S	Permian	Norway	Evaporite
34	2/7-21 S	Permian	Norway	Evaporite
35	2/7-21 S	Permian	Norway	Evaporite
36	2/7-21 S	Permian	Norway	Evaporite
37	2/7-21 S	Permian	Norway	Evaporite
38	2/7-21 S	Permian	Norway	Evaporite
39	2/7-21 S	Permian	Norway	Evaporite
40	2/7-21 S	Permian	Norway	Evaporite
41	2/7-21 S	Permian	Norway	Evaporite
42	2/7-21 S	Permian	Norway	Evaporite
43	2/7-21 S	Permian	Norway	Evaporite
44	2/7-21 S	Permian	Norway	Evaporite
45	2/7-21 S	Permian	Norway	Evaporite
46	2/7-21 S	Permian	Norway	Evaporite
47	2/7-21 S	Permian	Norway	Evaporite
48	2/7-21 S	Permian	Norway	Evaporite
49	2/7-21 S	Permian	Norway	Evaporite
50	2/7-21 S	Permian	Norway	Evaporite

Methods

The sample set contains oil stains, outcrop samples, core chips and cuttings from selected locations and wells in the North Sea and adjacent areas. The samples represent Cambrian, Ordovician, Carboniferous and Permian sediments of both marine and continental origin. A number of Mesozoic oils are included in the sample set for comparison.

- Analytical procedures:
- Soxhlet extraction of sediments with DCM:MeOH (97:3)
 - GC-FID and GC-MS analysis of solvent extracts
 - Kerogen up-concentration from sediment samples using HF and HCl acid
 - PY-GC of kerogen concentrates, (open pyrolysis, 300°C-600°C in 10 minutes in a helium atmosphere)

Table 1. The sample set.



Conclusions

- Mesozoic and Palaeozoic source rocks and oils may be differentiated by the use of specific characteristics, summarized to the right →
- Mesozoic oils are more mature (0.6 to 1.0 in relation to vitrinite reflection) than Palaeozoic oils and rock extracts (0.5 to 0.8) in relation to vitrinite reflection)
- The contrasting thermal maturities reflects the deeper burial of Mesozoic source rocks in the rift grabens offshore Norway, as opposed to the Palaeozoic samples collected from Palaeozoic offshore structural highs or from geologically stable onshore locations
- Paralic Carboniferous coals and claystones from the North Sea generate mainly gas under open pyrolysis, although some oil prone samples occur
- Carboniferous, lacustrine shale from onshore Scotland generates a high-wax oil under open pyrolysis
- Marine Cambrian-Ordovician and Permian shales generate both gas and oil products under open pyrolysis

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For laboratory facilities: University of Oslo, Norway; GFZ, Potsdam, Germany

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