

Supplementary Information to:

Deep-sea gas hydrate mounds and chemosynthetic fauna discovered at 3640 m on the Molloy Ridge, Greenland Sea

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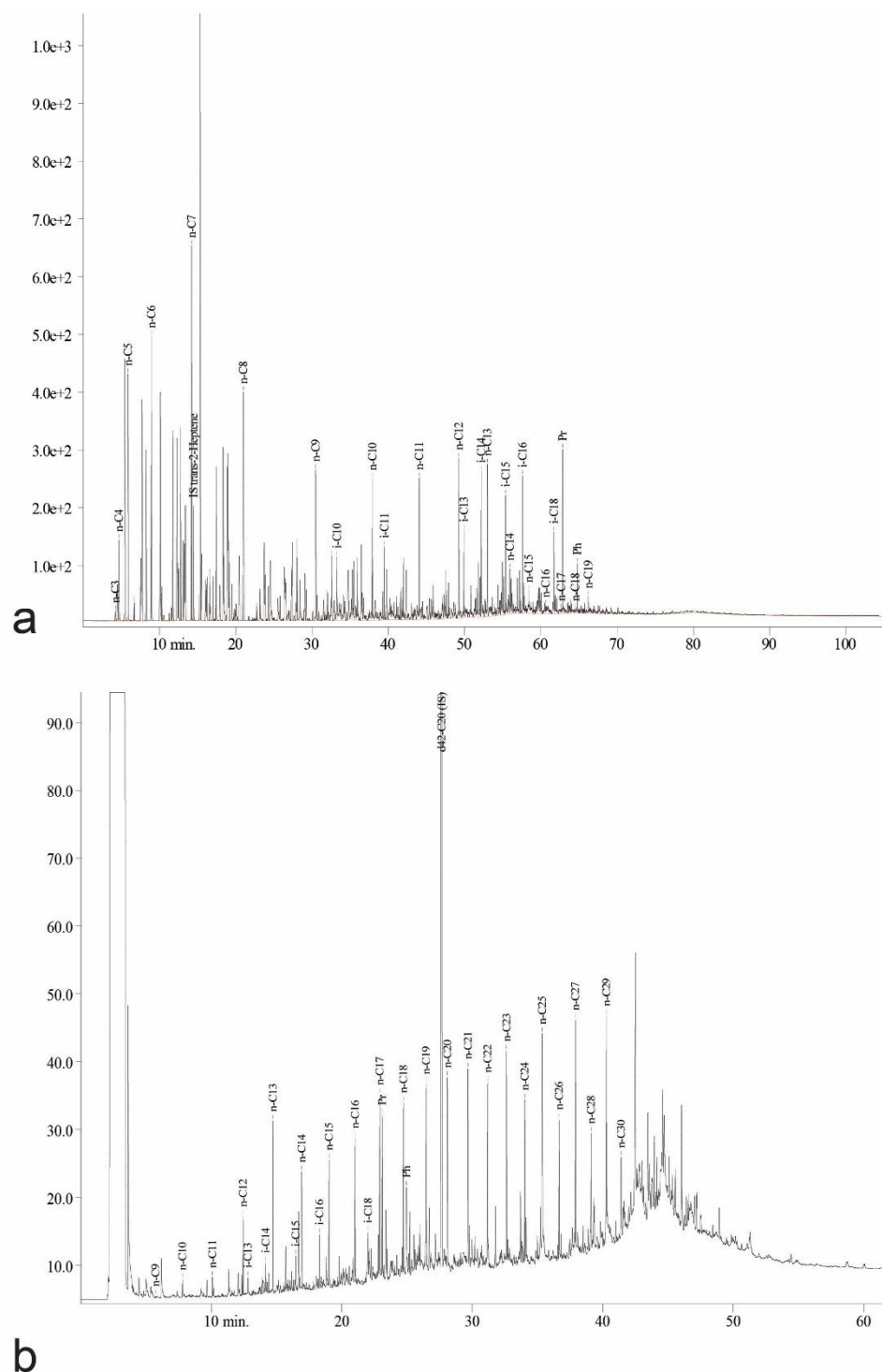
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Supplementary Figures

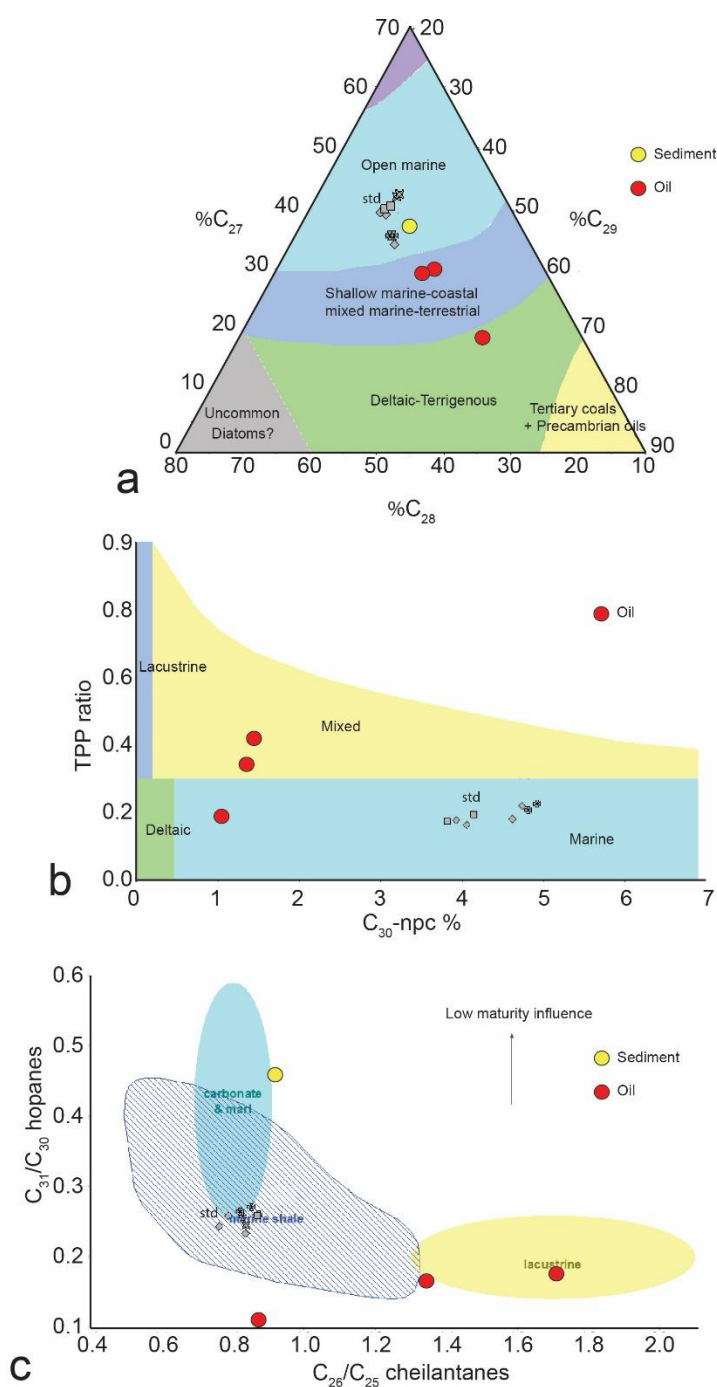
Supplementary Figure 1. ROV frame showing the gas hydrate sampling. **a** ROV frame showing the sampling event of the gas hydrate from the flank of one of the Freya gas hydrate mounds with a blade corer manipulated by the ROV arm. The coordinates on the ROV frame indicate where the sample has been taken. **b** The image shows the successful retrieval of the gas hydrate sample using the blade corer (**a**) once on deck. The photo has been taken by Alex D. Rogers. The sample has been used for the oil and gas analyses presented in this paper, as reported in Supplementary Figures 2-3 and Figure 4.



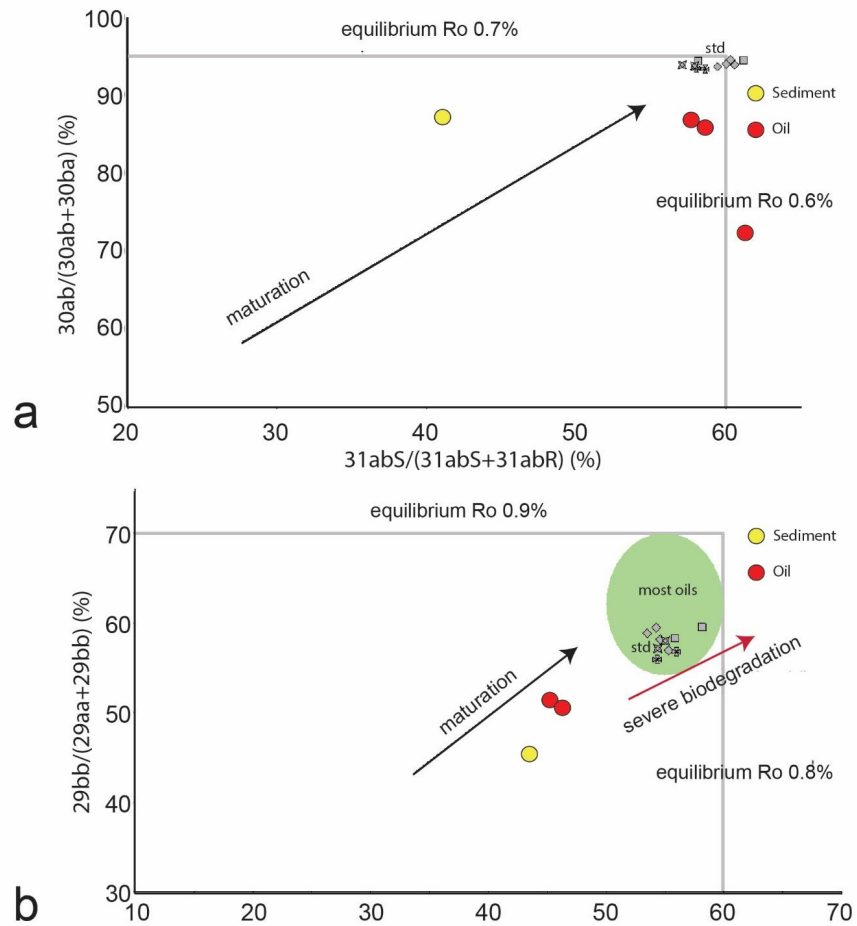
Supplementary Figure 2. n-Alkanes chromatograms of the oil from Freya gas hydrate mounds. Extract gas chromatograms showing n-alkanes distribution in oil extracted from **a** hydrate sample and **b** in the sediment (both collected from blade cores). The oil distribution shows a gas condensate signal with unusually abundant acyclic isoprenoids. The sediment shows odd-over-even preference among n-C₂₃-n-C₃₃ members, consistent with a contribution from immature higher plant material.



Supplementary Figure 3. Source rock proxies. **a** Sterane ternary diagram of the percentage of C_{27} , C_{28} , and C_{29} obtained from the m/z 218 fragmentogram used to assess the paleo-depositional environment of the source rock¹. The steranes of Molløy seep point to a transitional marine-terrestrial environment whereas the sediment sample displays a more open marine composition. **b** Tetracyclic polyprenoid (TPP) ratio ($TPP = 2(TPPa)/(2(TPPa) + 27\text{-nor}C_{26})$) versus content of C_{30} 24-n-propyldiacholestanes ($C_{30} / (C_{27} + C_{28} + C_{29} + C_{30})$) for oil samples indicating an evident fresh/brackish association (correlating with abundant angiosperm inputs) with some minor marine contribution. **c** C_{31}/C_{30} hopanes versus C_{26}/C_{25} tricyclic terpanes (cheilanthanes) plot showing a distinct lacustrine contribution.



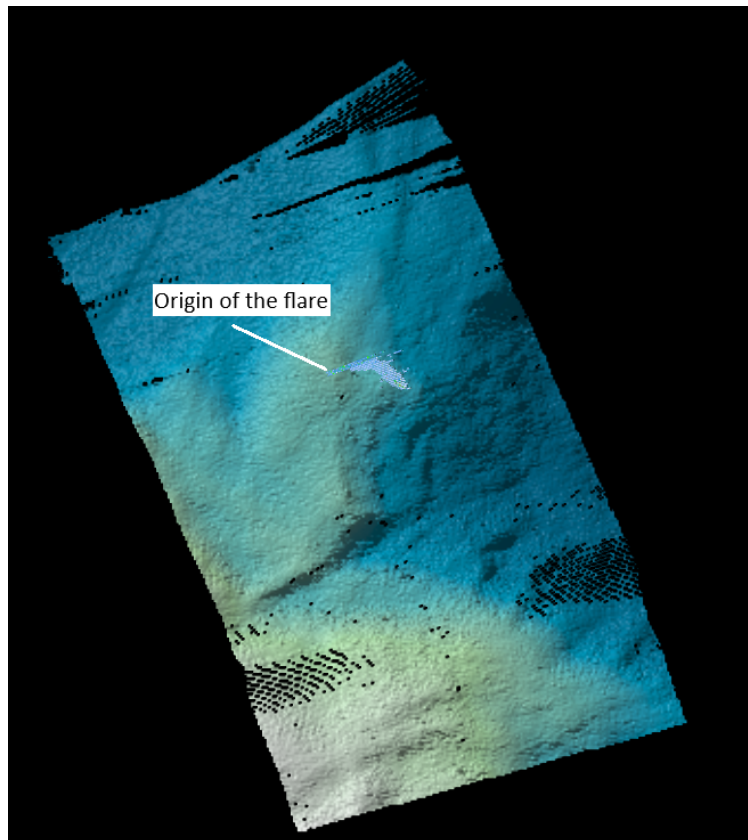
Supplementary Figure 4. Oil maturity proxies. Maturity indications from isomerism of hopanes (a) and steranes (b) suggesting a wet-gas/pre-oil window.



Supplementary Figure 5. All-pairwise faunal similarity matrix (Sørensen Index values) for high-Arctic (>72 °N) cold seeps and hydrothermal vents, calculated from family presence/absence data using faunal records from this study and published literature (see Table 2 for data sources). Darker shading indicates higher % similarity values. Freya = Freya gas hydrate mounds; Jøtul = Jøtul vent field; Vestnesa = Vestnesa Ridge seeps; PKF = Prins Karls Forland seeps; S+B = Storfjordrenna+Bjørnøyrenna (data combined for analysis as separate inventories are unavailable in the literature); HMMV = Håkon Mosby Mud Volcano; Loki = Loki's Castle vent field; Aurora = Aurora Vent Field

	<i>Freya</i>	<i>Jøtul</i>	<i>Vestnesa</i>	<i>PKF</i>	<i>S+B</i>	<i>HMMV</i>	<i>Loki</i>
<i>Jøtul</i>	59						
<i>Vestnesa</i>	46	29					
<i>PKF</i>	17	11	11				
<i>S+B</i>	26	12	38	20			
<i>HMMV</i>	29	18	32	11	32		
<i>Loki</i>	47	32	27	23	29	41	
<i>Aurora</i>	29	38	13	0	0	4	19

Supplementary Figure 6. Origin of the flare at Freya gas hydrate mounds. Fledermaus plot showing where the flares originate on the topography as processed with Qimera and acoustic backscatter processed with FMMidwater using the shipboard MBES at the Freya gas hydrate mounds (79.6° N, depth 3640 m).



References

1. Huang, W.-Y. & Meinschein, W. G. Sterols as ecological indicators. *Geochimica et Cosmochimica Acta* **43**, 739–745 (1979).

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