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CORRELATIONS OF OCEANIC SPREADING RATES AND HIATUS SURFACE AREA IN THE NORTH ATLANTIC REALM

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1. Appendix 1 – Calculation of hiatus area in Figure 7

The area of hiatus the northern part (30°W to 40°E and 80°N to 45°N) of hiatus maps using the *grdvolume* function of GMT tool, considering all hiatus values above 0.

Age (Ma)	66	55	34	23	5
Area ($10^7 * km^2$)	0.22	0.3	0.08	0.45	0.26

TABLE DR1. Width and duration of magnetic lineations for the western North Atlantic sea floor

Lineation name in this paper ²	Width (km)	Duration of isochron intervals (m.y.)	Isochron Names ¹	Isochron Ages ¹ (Ma)
A	7	0.8	C2	1.8 – 2.6
B	12	1	C2An	2.6 – 3.6
C	5	0.6	C2Ar	3.6 – 4.2
D	15	1	C3n.1n(y) – C3n.4n(o)	4.2 – 5.2
E	7	0.8	C3r.4r	5.2 – 6.0
F	8	0.6	C3A1n – C3A2n	6.0 – 6.7
G	10	0.8	C3A2n(o) – C4n1n(y)	6.7 – 7.5
H	9	0.6	C4n1n(y) – C4n2n(o)	7.5 – 8.1
I	13	1	C4n2n(o) – C4An(o)	8.1 – 9.1
J	7	0.8	C4An(o) – C5n.1n(y)	9.1 – 9.78
K	20	1.2	C5n.1n(y) – C5n.2n(o)	9.78 – 11.0
L	18	1.4	C5n.2n(o) – C5An.2n(o)	11.0 – 12.4
M	20	1.2	C5An.2n(o) – C5ACn(y)	12.5 – 13.7
N	40	3.5	C5ACn(y) – C5Dn(y)	13.7 – 17.2
O	34	2.6	C5Dn(y) – C6n(o)	17.2 – 19.7
P	130	13.6	C6n(o) – C13n(y)	19.7 – 33.2
Q	75	6.4	C13n(y) – C18n.1n(o)	33.2 – 39.8
R	40	3.6	C18n.1n(o) – C20n(o)	39.8 – 43.5
S	51	4.3	C20n(o) – C21n(o)	43.5 – 47.8
T	28	2	C21n(o) – C22n(o)	47.8 – 49.7
U	41	2.2	C22n(o) – C23n.2n(o)	49.7 – 51.9
V	63	2	C23n.2n(o) – C24n.3n(o)	51.9 – 53.9
W	78	3.8	C24n.3n(o) – C25n(o)	53.9 – 57.7
X	43	1.5	C25n(o) – C26n(o)	57.7 – 59.2
Y	86	3.3	C26n(o) – C27n(o)	59.2 – 62.5
Z	38	6.8	C27n(o) – C31n(o)	62.5 – 69.3

TABLE DR2. Overview of geological data related to erosion and uplift in Europe.

Time	Location	Source	Interpretation
Base Paleocene	British Isles	Thermochronology (Green et al., 2002) Backstripping analysis (Mackay et al., 2005)	Transient uplift of 180–425 m occurred during Paleocene times.
	North Sea	Stratigraphy (Anell et al., 2012; Evans, 2003)	The studies report thick deposits of presumably eroded material adjacent to the northern North Sea, the Scottish Highlands and the East Shetland Platform with thinner deposits next to southern Norway
	Scandes	Landform study (Lidmar-Bergström and Näslund, 2002) Thermochronology (Hendriks et al., 2007; Hendriks and Andriessen, 2002)	Uplift of the Scandes during late Cretaceous–Paleocene time.
Base Eocene	Rhine Graben	Geological study (Ziegler, 1992)	Magmatic dyke intrusions are documented in the Cretaceous–Late Paleocene strata.
	Pyrenees	Stratigraphy (Burbank et al., 1992)	The main stages of shortening in the Pyrenees took place from Paleocene to Early Oligocene
	Porcupine	Subsidence modelling (Jones et al., 2001)	Transient uplift of 300–600 m at Paleocene–Eocene boundary.
Faroe-Shetland			
	Faroe-Shetland	Stratigraphy (Champion et al., 2008; Lundin and Doré, 2002)	Transient uplift of about 550 m in 3 m.y.; Dome formation.
Base Oligocene	Upper Rhine	Paleotectonic maps (Dèzes et al., 2004).	Oligocene activation of the fault systems with main rifting stage in the Oligocene.

TABLE DR2 - Continuation

	Graben, Bohemian Massif		
Base Miocene	Porcupine	Stratigraphy (Stoker et al., 2005; Stoker and Shanon, 2005)	The Base Miocene and Mid-Miocene significant unconformities recognized in the Rockall Porcupine and Faroe-Shetland due to tectonism Formation of domes.
	Paris Basin & Western Approaches	Paleotectonic maps (Dèzes et al., 2004)	Basin inversions.
	Mediterranean	Geodynamic models based on sedimentary and structural data (Séranne, 1999)	28–20 Ma rifting in the Western Mediterranean and Late Ruppelian unconformity in the Gulf of Lion (Southern France).
	West Siberian Basin	Subsidence modelling (Vibe et al., 2018)	No subsidence since the Middle Oligocene.
Base Pliocene	British Isles	Thermochronology (Holford et al., 2005)	~1.5 km Neogene (20–0 Ma) uplift inferred by the AFT and compaction studies in the Mochras (NW Wales) borehole.
	North Sea	Stratigraphy (Anell et al., 2012; Evans, 2003)	Mid- to Late Miocene hiatus of 5–12 m.y.
	Scandes	Isostatic modelling and study of landforms (Riis, 1996; Riis and Fjeldskaar, 1992; Stuevold and Eldholm, 1996; Lidmar-Bergström et al., 2013). Thermochronology	~1000 m of Neogene uplift in Southern Scandinavia and acceleration denudation in the northern Scandes.

TABLE DR2 - Continuation

	(Hendriks and Andriessen, 2002; Japsen et al., 2014)	
Western Barents Sea	Stratigraphy (Eidvin et al., 2014) Thermochronology (Zattin et al., 2016)	Documented hiatus in the Vestbakken Volcanic Province from the Lower Miocene to Late Pliocene. Thermochronology data indicates an exhumation event of ~1000 m magnitude.
Western Greenland	Thermochronology (Japsen et al., 2005)	Documents an uplift around 11-10 Ma and 7-2 Ma .

4. References for Table DR2:

- Anell, I., Thybo, H., Rasmussen, E., 2012, A synthesis of Cenozoic sedimentation in the North Sea: *Basin Research* 24, 154–179.
- Burbank, D.W., Puigdefabregas, C.A.I., Munoz, J.A., 1992, The chronology of the Eocene tectonic and stratigraphic development of the eastern Pyrenean foreland basin, northeast Spain: *Geological Society of America Bulletin* 104, 1101–1120.
- Champion, M.E., White, N.J., Jones, S.M., Lovell, J.P.B., 2008, Quantifying transient mantle convective uplift: An example from the Faroe-Shetland basin: *Tectonics* 27.
- Dèzes, P., Schmid, S.M., Ziegler, P.A., 2004, Evolution of the European Cenozoic Rift System: interaction of the Alpine and Pyrenean orogens with their foreland lithosphere: *Tectonophysics* 389, 1–33.
- Eidvin, T., Riis, F., Rasmussen, E.S., 2014, Oligocene to Lower Pliocene deposits of the Norwegian continental shelf, Norwegian Sea, Svalbard, Denmark and their relation to the uplift of Fennoscandia: A synthesis: *Marine and Petroleum Geology* 56, 184–221.
- Evans, D., 2003, The Millennium Atlas: *Petroleum Geology of the Central and Northern North Sea*: London, Geological Society of London, the Geological Survey of Denmark and Greenland and the Norwegian Petroleum Society.
- Green, P.F., Duddy, I.R., Hegarty, K.A., 2002, Quantifying exhumation from apatite fission-track analysis and vitrinite reflectance data: precision, accuracy and latest results from the Atlantic margin of NW Europe: *Geological Society of London, Special Publications* 196, 331–354.
- Hendriks, B., Andriessen, P., Huigen, Y., Leighton, C., Redfield, T., Murrell, G., Gallagher, K., Nielsen, S.B., 2007, A fission track data compilation for Fennoscandia: *Norsk Geologisk Tidsskrift* 87, 143.
- Hendriks, B.W., Andriessen, P.A., 2002, Pattern and timing of the post-Caledonian denudation of northern Scandinavia constrained by apatite fission-track thermochronology: *Geological Society of London, Special Publications* 196, 117–137.

- Holford, S.P., Green, P.F., Turner, J.P., 2005, Palaeothermal and compaction studies in the Mochras borehole (NW Wales) reveal early Cretaceous and Neogene exhumation and argue against regional Palaeogene uplift in the southern Irish Sea: *Journal of the Geological Society* 162, 829–840.
- Japsen, P., Green, P.F., Lidmar-Bergström, K., Bonow, J.M., Erlström, M., 2014, Burial and exhumation history of southern Sweden estimated from apatite fission-track data, stratigraphic landform analysis and the geological record: *Geophysical Research Abstracts Vol. 16, Vienna, EGU General Assembly 2014*, p. 6814.
- Japsen, P., Green, P.F., Chalmers, J.A., 2005, Separation of Palaeogene and Neogene uplift on Nuussuaq, West Greenland: *Journal of the Geological Society* 162, 299–314.
- Jones, S.M., White, N., Lovell, B., 2001, Cenozoic and Cretaceous transient uplift in the Porcupine Basin and its relationship to a mantle plume: *Geological Society of London, Special Publications* 188, 345–360.
- Lidmar-Bergström, K., Bonow, J.M., Japsen, P., 2013, Stratigraphic Landscape Analysis and geomorphological paradigms: Scandinavia as an example of Phanerozoic uplift and subsidence: *Global and Planetary Change* 100, 153–171.
- Lidmar-Bergström, K., Näslund, J.O., 2002, Landforms and uplift in Scandinavia: *Geological Society of London, Special Publications* 196, 103–116.
- Lundin, E., Doré, A.G., 2002, Mid-Cenozoic post-breakup deformation in the “passive” margins bordering the Norwegian–Greenland Sea: *Marine and Petroleum Geology* 19, 79–93.
- Mackay, L.M., Turner, J., Jones, S.M., White, N.J., 2005, Cenozoic vertical motions in the Moray Firth Basin associated with initiation of the Iceland Plume: *Tectonics* 24.
- Riis, F., 1996, Quantification of Cenozoic vertical movements of Scandinavia by correlation of morphological surfaces with offshore data: *Global and Planetary Change* 12, 331–357.
- Riis, F., Fjeldskaar, W., 1992, On the magnitude of the Late Tertiary and Quaternary erosion and its significance for the uplift of Scandinavia and the Barents Sea, in: *Structural and Tectonic Modelling and Its Application to Petroleum Geology*: Amsterdam, Elsevier, pp. 163–185.
- Séranne, M., 1999, The Gulf of Lion continental margin (NW Mediterranean) revisited by IBS: an overview: *Geological Society of London, Special Publications* 156, 15–36.
- Stoker, M.S., Hoult, R.J., Nielsen, T., Hjelstuen, B.O., Laberg, J.S., Shannon, P.M., Praeg, D., Mathiesen, A., Van Weering, T.C.E., McDonnell, A., 2005, Sedimentary and oceanographic responses to early Neogene compression on the NW European margin: *Marine and Petroleum Geology* 22, 1031–1044.
- Stoker, M.S., Shannon, P.M., 2005, Neogene evolution of the NW European Atlantic margin: Results from the STRATAGEM project: *Marine and Petroleum Geology* 22, 965–968.
- Stuevold, L.M., Eldholm, O., 1996, Cenozoic uplift of Fennoscandia inferred from a study of the mid-Norwegian margin: *Global and Planetary Change* 12, 359–386.
- Vibe, Y., Bunge, H.-P., Clark, S.R., 2018, Anomalous subsidence history of the West Siberian Basin as an indicator for episodes of mantle induced dynamic topography: *Gondwana Research* 53, <https://doi.org/10.1016/j.gr.2017.03.011>

Zattin, M., Andreucci, B., de Toffoli, B., Grigo, D., Tsikalas, F., 2016, Thermochronological constraints to late Cenozoic exhumation of the Barents Sea Shelf: Marine and Petroleum Geology 73, 97–104.

Ziegler, P.A., 1992, European Cenozoic rift system: Tectonophysics 208, 91–111.

TABLE DR3. Rotations used to calculate the velocity of Europe relative to North America

Time (Ma)	Euler pole lat.	Euler pole lon.	α	Source
0.78	62.7	138.1	-0.157	Merkouriev and DeMets (2014),
1.78	62.8	137.93	-0.37	Timescale GTS12, noise reduction by
2.58	62.94	137.79	-0.54	Redback
3.6	63.16	137.58	-0.76	
4.19	63.31	137.44	-0.89	
5.24	63.64	137.17	-1.11	
6.03	63.93	136.94	-1.29	
6.73	64.2	136.75	-1.44	
7.53	64.52	136.53	-1.64	
8.11	64.75	136.37	-1.8	
9.11	65.18	136.06	-2.07	
9.79	65.5	135.84	-2.26	
11.06	66.03	135.47	-2.61	
12.47	66.49	135.16	-2.99	
13.74	66.86	134.87	-3.33	
14.61	67.23	134.61	-3.58	
15.97	67.82	134.16	-3.99	
17.23	68.35	133.73	-4.36	
18.06	68.69	133.44	-4.6	
18.75	68.98	133.2	-4.8	
19.72	69.39	132.89	-5.08	
20.1	68.91	132.51	-5.09	Gaina (2002), Timescale GTS12
33.16	68.22	131.53	-7.65	
39.63	67.72	133.91	-9.25	
47.35	65.38	138.44	-10.96	
49.34	64.52	138.18	-11.5	
53.98	63.07	144.26	-12.82	
57.1	56.17	145.06	-13.24	
69.2	54.45	147.06	-15.86	
79.9	63.4	147.75	-18.48	