Supplementary material

Estimating sedimentation rates for wells and seismic units

To investigate how the sedimentation rate changed across the PETM, we have estimated and compared sedimentation rates from well data (1D) with regional sediment volumes from the four seismic units UT3-UY3 that capture the full shelf to deep-water depositional system.

1D sedimentation rates have been estimated for wells 6204/12-2 and 6204/11-1. For highest possible resolution we used the original Equinor biozones and calculated sedimentation rate from the preserved thickness in each zone. The results are presented in Supplementary Table 2. The estimates are sensitive to unconformities and missing strata in some biozones and in general, these show high variability in sedimentation rates between zones and wells. However, PETM sedimentation rates of 270-350 m/Myr (assuming PETM duration of 0.2 Myr) are generally an order of magnitude higher than pre and post PETM rates, but biozone 21.2 in the Selandian and biozone 19.7 in the Ypresian in well 6407/12-2 show similar rates.

The Three-dimensional (3D) surface-based approach has lower resolution (sometimes several biozones are combined), but provides a more regional estimate of the sediment supply to the entire basin. For seismic units UT3-UY3, the areal extent of the volume estimates is constrained to areas of active deposition as imaged in Figure 5. The volume of PETM material was calculated between surface T3 and T4. Away from the channel complexes and the proximal shelfal part of the system, the thickness of the PETM is below seismic resolution. As wells suggest that the PETM typically is 10-20 m thick in the distal deep-marine part of the basin (Supplementary Table 1), we have assumed a high and low case of 20 and 10 m thickness in these areas, respectively. In addition, sedimentation rates are highly sensitive to the age model. We have calculated two end member scenarios with a PETM duration of 0.1 and 0.2 Myr. In Supplementary Table 3, we compare the high and low cases with the 1D sedimentation rate from wells. In Table 3, sedimentation rates are presented pr unit (UT3-UY3) and not per Biozone as in Table 1.

The results show PETM supply rates of 185-470 km^3/Myr, which is between 4 and 10 times higher than the pre-PETM rate during UT3. For comparison, PETM rates of 185-470 km^3/Myr is about 2-4 times higher than the post PETM rates during deposition of UY1, and less than 3 times higher than the rate of 153 km^3/Myr during UY2. There are uncertainties in this calculation, and the most significant is the assumption of a closed sediment budget and the fact the part of the older units are removed by later seafloor erosion (Fig 2). Figure 4 show that the proximal part of UT3 has been eroded at the seafloor and the volume (and therefore also the estimated sedimentation rate) of this unit is therefore underestimated. In contrast, the remaining part of UY1 and UY2 are well preserved, and we believe that the differences between the PETM rate and the post-PETM rate in UY1/UY2 provides the best estimate for change in sediment supply across the hyperthermal.

Well	Thickness	Lithology	GR response
6407/12-2	54 m	Sandy and silty grey claystone	incresing - decreasing
6407/11-1	20 m	Silty green, grey and brown claystone	incresing - decreasing
6407/7-9S	<10 m	Grey claystone	incresing - decreasing
6407/8-6	<10 m	Brown-grey siltstone with traces of sandstone	incresing - decreasing
6406/9-3T2	<10 m	Grey claystone with traces of siltstone	minor increasing -decreasing

Supplementary Table 1: Thickness, lithology and Gamma Ray (GR) characteristics of the PETM succession in wells where the PETM has been identified from biostratigraphic data.

	6407/12-2				**6407/11-1**			
Unit	Biozone	Thickness (m)	Time (Myr)	Sedimentation rate (m/Myr)	Biozone	Thickness (m)	Time (Myr)	Sedimentation rate (m/Myr)
UY3	19.4	6	1.1	5	19.4	not present	1.1	not present
UY3	19.5	6	1.2	5	19.5	not present	1.2	not present
UY3	19.6	80	1.2	67	19.6	80	1.2	67
UY1-UY2	19.7	140	0.8	175	19.7	20	0.8	25
UY1	PETM	54	0.2	270	PETM	70	0.2	350
UT3	20.1	not present	1.3	not present	20.1	10	1.3	8
UT2	20.2	50	0.9	56	20.2	30	0.9	33
UT2	20.3	90	1.2	75	20.3	20	1.2	17
UT1	21.1	10	0.4	25	21.1	not present	0.4	not present
UT1	21.2	40	0.2	200	21.2	40	0.2	200
UT1	21.3	50	0.6	83	21.3	20	0.6	33
UT1	21.4	90	1.15	78				

Supplementary Table 2: Calculated sedimentation rates for 6204/12-2 and 6204/11-1 per biozone. Grey colors refer to stratigraphic units in Fig 3.

Unit	Volume (km^3)	Time (Myr)	Sediment supply from seismic surfaces 10-20 m and 0.1-0.2 Myr (km^3/Myr)	Sedimentation rate **6407/12-2** (m/Myr)	Sedimentation rate **6407/11-1** (m/Myr)
UY3	82	3.5	23	20	16
UY2	61	0.4	153	125	50
UY1	45	0.4	111	100	38
PETM	37-47	0.1-0.2	185-470	300	350
UT3	59	1.3	46	23	8

Supplementary Table 3: Calculated sedimentation rates for each of the seismic units (UT3-UY3). The volume of the PETM was calculated between surface T3 and T4 (Fig 4). Outside the main depocenter and the channels, the PETM has no mappable thickness and has been assumed to have an average thickness of 10-20 m across the study area based on well observations. Significantly thicker PETM and/or shorter duration of the PETM will increase the sedimentation rate. The two columns to the right compare the aggregated 1D sedimentation from Supplementary Table 1 for each unit. Grey colors refer to stratigraphic units in Fig 3.