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Geological and paleogeographic implications of late Cretaceous pockmarks: a 3D seismic study onshore South Denmark

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The objective of this presentation is to introduce hereto not described elongated pockmarks observed at an intra-Chalk Group (Late Cretaceous) surface and to present the geological and paleogeographic significance of the observations. The study utilizes an onshore 3D seismic survey, located at the southern flank of the Ringkøbing-Fyn High (RFH) at the Sundeved peninsular in southern Denmark to perform the detailed analysis of the Chalk Group in the area. The top of the Chalk Group, which do not feature any pockmarks, is located at 200-400mbsl and dips smoothly towards the SSW. It is offset by arrays of normal faults, which detach at the top of the Zechstein. The Chalk Group in the study area shows two distinct seismic facies. A lower facies with relatively high intensity coherent reflections and an upper facies with much less pronounced and diffuse internal reflectivity. The surface separating the two facies, features abundant circular (c. 0.3km wide) to elongated (0.3km x 2km) NW-SE striking depressions, which we interpret as pockmarks. The N-S striking faults in the study area offset the elongate pockmarks and thus clearly post-date the pockmark formation. However, the E-W striking faults appear to have formed at the same time as the pockmarks which adjacent and parallel to the E-W striking faults are mainly circular and only observed in the hangingwall block. No significant faulting or other evidence of vertical migration routes directly beneath the pockmarks has been observed. Borehole information, however, indicates a slightly increased clay-content in the sediments filling the pockmarks, as well as an increase in seismic velocity at the pockmarked surface indicative of hard ground development. Thus fluid expulsion and initial pockmark formation apparently coincided with a period of ceased sedimentation. The pockmarks were later excavated by submarine currents controlled by the orientation of the underlying RFH, very similar to elongated pockmarks reported in the Cenozoic succession of the central North Sea.
North West Europe was during the Late Cretaceous characterized by episodes of localized inversion superimposed on the thermal subsidence following the cessation of the Middle and Late Jurassic rifting as well as major eustatic sea-level changes. Along the margins of the basin, the Chalk Group appears eroded resulting from mainly Quaternary and partly Paleocene erosion. However, thickness variations of the Chalk Group in the interior of the basin are interpreted to reflect differential subsidence across basement structures such as the Central Graben, the Sorgenfrei-Tornquist-Zone and the RFH, the latter subdividing the basin into a northern and southern part. The basin geometry may have influenced submarine currents which had a significant effect on the depositional geometries of the chalk north of the RFH and in the Central Graben area.
The study thus suggests that a major change in chalk sedimentation style took place during the early parts of the Late Cretaceous, probably steered by a tectonically controlled change in basin geometry. The triggering of the fluid escape leading to pockmark formation may thus have been tectonic but enhanced by a sudden early Late Cretaceous eustatic sea-level drop.