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Coupling seismic geomorphology and clumped isotope analysis in the Danian Ekofisk Formation of the Danish Central Graben – evidence for giant pockmark formation

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Integration of seismic geomorphology with geochemistry in a carbonate depositional system has shown to be a powerful tool in palaeo-reconstruction of seafloors and for understanding seismic geometries. We present a case study of round to highly elongated depressions (100-500 m across, 0.1 – 1.5 km long, 25-75 m deep) within the Danian Ekofisk Formation in the Danish North Sea. Drill cutting material from horizontal wells show that the infill consists of Danian chalk and marl deposits. Clumped isotope data show a positive linear trend between cementation temperatures and positive formation fluid δ^{18}O values, independent of location (infill or not). This is common for normal (closed) burial diagenesis as the ^{16}O is preferentially taken up in the cement phase, enriching the formation fluid with respect to ^{18}O. There is thus no evidence for post-depositional dissolution to form the depressions (e.g. hypogenic karst), and therefore they are interpreted to rather reflect Danian seafloor topography. The depressions occur on top of an inverted structure, and are closely associated with faults that offset thick organic-rich successions. Basin modelling shows that several source rocks were mature at the start of the Danian, and therefore the depressions are interpreted to represent giant pockmarks formed by episodic fluid expulsion. This study thus shows how seismic geomorphology provides a convenient spatial framework that aids data integration from wells and basin models, and helps to improve geological understanding of morphologies observed within seismic data.