Supplementary Appendix SB

Sedimentary deformation relating to episodic seepage in the last 1.2 million years: a multi-scale seismic study from the Vestnesa Ridge, eastern Fram Strait

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**1** **Conditions for gas hydrate model**

We consider a variable water depth in the 2D model over the 2.84 km bathymetry transect that crosses faults F1 and F2. The porosity and thermal diffusivity data profiles (Figure 1) derive from the basin modelling study by Daszinnies et al. (2021). The porosity information is constrained by the ODP data several km north and south of Vestnesa Ridge. We consider that the data retrieved from Lunde and Lomvi pockmark locations (east of Vestnesa Ridge) are representative for the Vestnesa Ridge section west of these locations. The calculation domain was divided into eight different layers (Figure 1).

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**Figure 1.** Porosity and thermal diffusivity data profiles used in the calculation.

We use the bottom water temperatures (BWT) based on benthic foraminifera proxies (El bani Altuna et al., 2021) from 34 ka to 13 ka (Figure 2). As there is no Holocene (13 ka to present) BWT data available using benthic foraminifera, we use present day BWT at Vestnesa Ridge and reconstruct the BWT profile using the same magnitude of BWT changes from the south (Ezat et al., 2014) averaged with an additional BWT data profile from the central Fram Strait (Ezat et al., 2021).



Figure . Bottom water temperature variations used in the calculation.

A thermal gradient of 90 °C/km (Plaza-Faverola, 2020) and salinity of 34.5 ‰ (Plaza-Faverola et al., 2017) conditions were considered constant for the entire calculation.  
The sea-level changes were imposed through 8 different steps (Figure 3) and are based on the data from Peltier et al. (2006).



Figure . Sea-level changes used in the calculation.

We chose a gas composition of 0.9975 methane and 0.0025 ethane (Plaza-Faverola et al., 2017). The present thermal field and the position of the BSR at three different periods are shown in Figure 4. The evolution of the BSR and thermal field throughout the entire calculation duration can be viewed in the attached video (Video 1).



Figure . Calculated temperature field at present day and imposed boundary conditions. BSR positions at three different time-periods (0 kyr, -16 kyr and -33.5 kyr) are also indicated.

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**Video 1.** Evolution of the BSR and thermal field throughout the entire calculation duration.