SUPPLEMENTARY MATERIAL FOR:

CORRELATION BETWEEN TECTONIC STRESS REGIMES AND METHANE SEEPAGE ON THE WEST-SVALBARD MARGIN

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Tectonic model parameters

Table 1. Model parameters for the two rectangular planes (Okada, 1985) used to approximate the deformation due to oblique spreading along Molloy Ridge (MR) and Knipovich Ridge (KR)

Ridge	Length (km)	Depth to lower boundary (km)	Depth upper boundary (km)	Dip (°)	Strike (°)	East midpoint (UTM, m)	North midpoint (UTM, m)	Right-lateral motion* (mm/yr)	Vertical motion (mm/yr)	Opening* (mm/yr)
MR	57	900	10	-90	28	380.000	8820.000	1.8	0	13.9
KR	180	900	10	-90	-3	467.000	8616.000	8.6	0	11.1

* Calculated by assuming a half spreading rate of 7 mm/yr in the direction of N125°E on both the MR and KR.

Sensitivity tests

To test the robustness of the modelling, in particular with respect to the change from tensile stress on the eastern Vestnesa Ridge (VR) to strike-slip stress along the western VR, we examine the influence of varying the following model parameters: spreading along the Molloy Ridge (MR) and the Knipovich (KR), depth of brittle-ductile transformation (upper boundary of planes), and elastic moduli (Poisson's ratio and shear modulus).

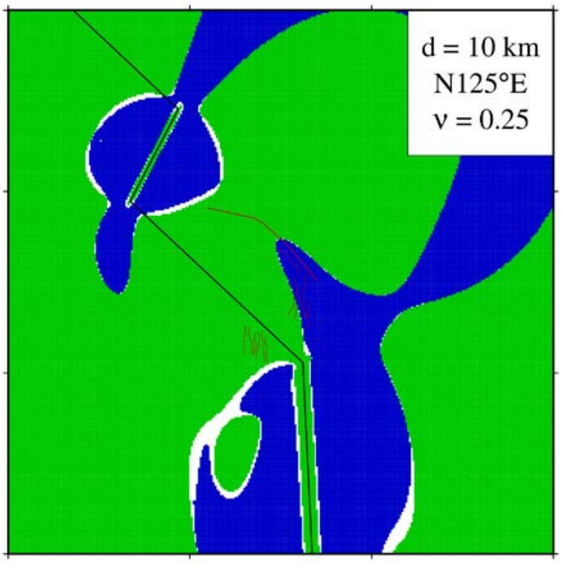

Fig. S1: Our preferred model with depth, d = 10 km to the upper boundary of the dislocations, a spreading direction of N125°E and a Poisson's ratio ν = 0.25. Green = strike-slip stress, blue = tensile stress, red = compressive stress regime. The crest of Vestnesa ridge and faults are marked with thin red lines.

Spreading along MR and KR: We used a spreading direction of N125°E along the Molloy Ridge (MR) and the northern part of the Knipovich Ridge (KR) from recent plate motion models by Altamimi et al., (2002), Argus et al., (2010), and DeMets et al., (2010). Other recent plate models give slightly different spreading directions, i.e. N120°E (Drewes, 2009) or N133°E (Kreemer et al., 2014). The direction of N133°E is parallel to the trend of the Molloy Transform Fault (MTF). The use of these alternative spreading directions would either broaden or reduce the zone of tensile stress at eastern VR, however, the zone is still present also with a spreading direction of N133°E (Fig. S2). Changing the spreading rate would only affect the magnitude of the predicted stresses, which are not considered in the present study.

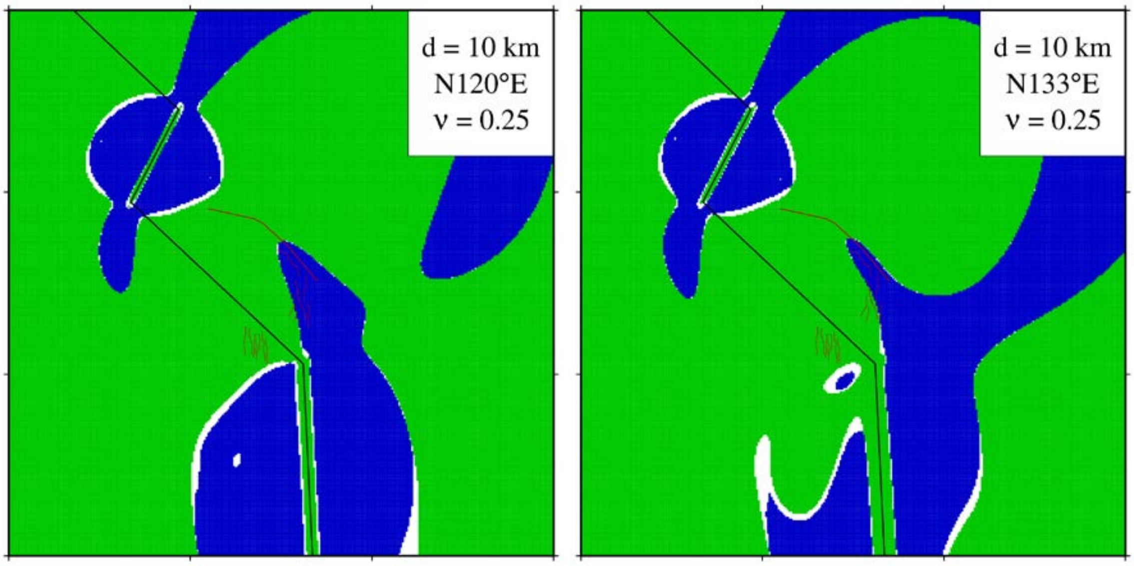

Fig. S2: Varying the spreading direction.

Depth to upper boundary (i.e., the depth of the brittle-ductile transition in the model): The actual depth is not well constrained in the study area, but farther south along the Atlantic Ocean, Keiding et al.

(2008) estimated the depth along part of the Mid-Atlantic plate boundary in Iceland to be 6-7 km using the same modelling technique and constraint from GPS observations. Hence, the 10 km used in our models may be on the deeper side. Changing the depth to more shallow values, decreases the zone of tensile stress at eastern VR, but it is still apparent with an upper boundary depth of 5 km (Fig. S2).

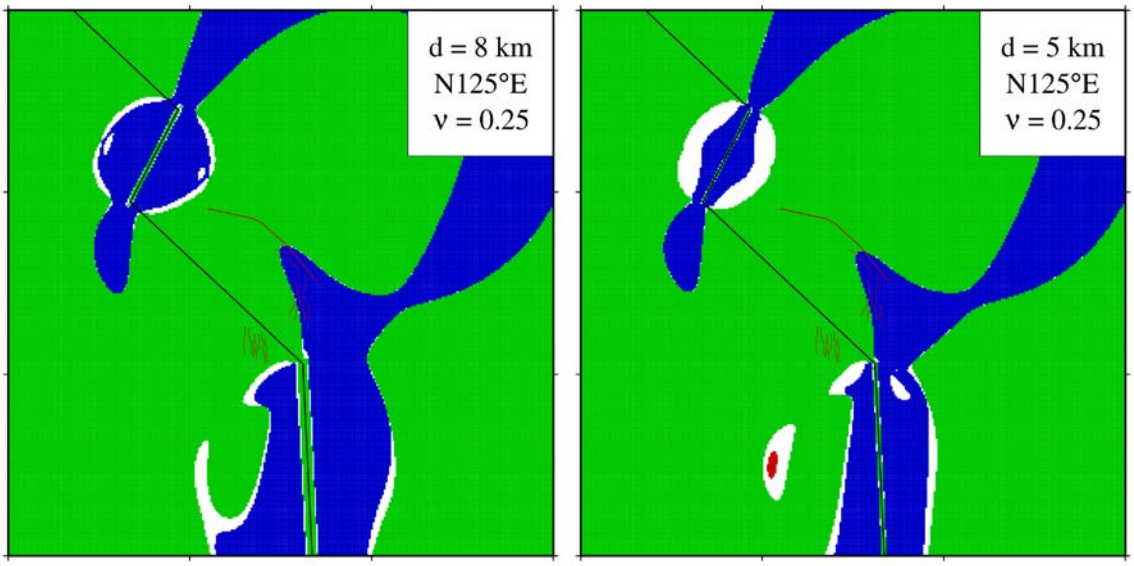

Fig. S3: Reducing the depth to upper boundary of dislocation.

Elastic moduli: The typical range of Poisson's ratio for rocks is 0.1-0.35 (e.g., Gercek, 2007). Varying the Poisson's ration within this range results in markedly different stress patterns to the sides of the spreading ridges, however, the zone of tensile stress at eastern VR remains almost unaltered (Fig. S4). Varying the shear modulus will only affect the magnitude of the predicted stresses, which are not considered in the present study.

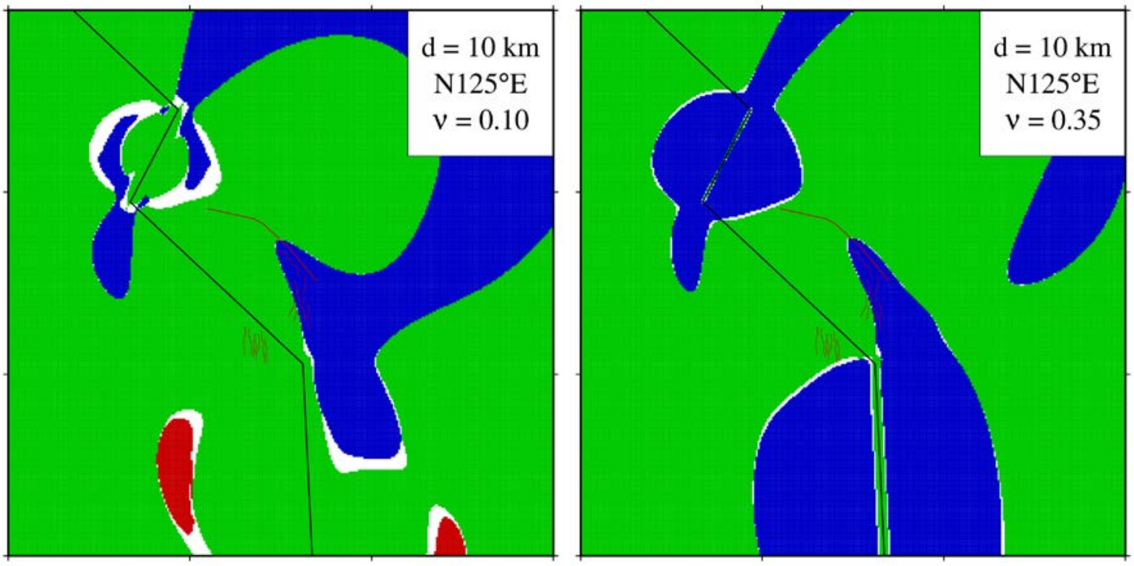

Fig. S4: Varying Poisson's ratio.

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