



HAL
open science

Gas hydrates, fluid venting and slope stability on the upper Amazon deep-sea fan

D. Praeg, C Silva, A T Reis, J-M Ketzer, S Migeon, Vikram Unnithan, Rodrigo J Perovano, Alberto Cruz, Christian Gorini

► To cite this version:

D. Praeg, C Silva, A T Reis, J-M Ketzer, S Migeon, et al.. Gas hydrates, fluid venting and slope stability on the upper Amazon deep-sea fan. I Simpósio Brasileiro de Geologia e Geofísica Marinha (I SBGGM), Nov 2018, Rio de Janeiro, Brazil. P2GM Projetos e Produções, Rio de Janeiro, Brasil, 31, pp.217-218, Anais do I Simpósio Brasileiro de Geologia e Geofísica Marinha (I SBGGM). <hal-02156661>

HAL Id: hal-02156661

<https://hal.science/hal-02156661v1>

Submitted on 17 Jun 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

Gas Hydrates, Fluid Venting and Slope Stability on the Upper Amazon Deep-Sea Fan

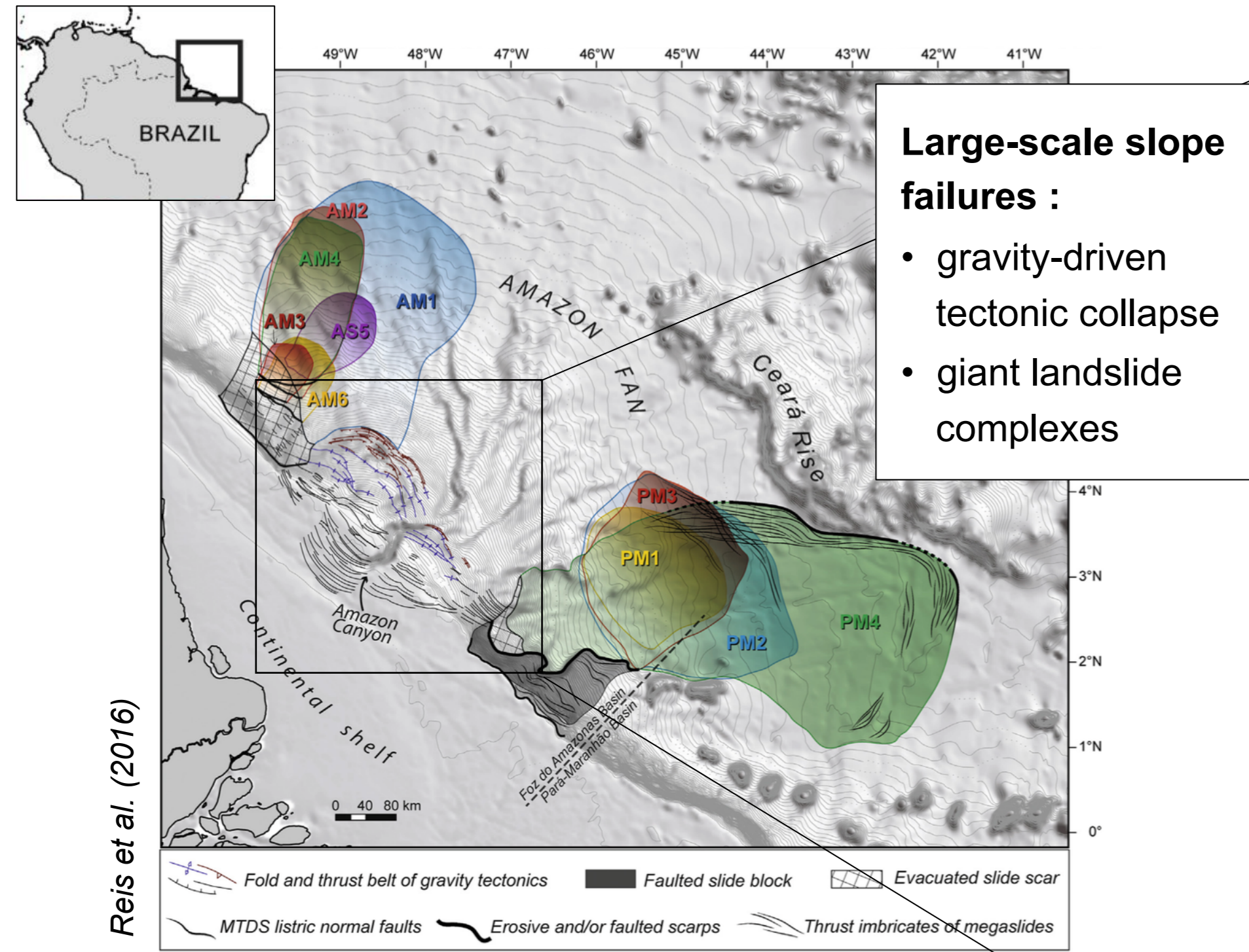
Praeg D (daniel.praeg@geoazur.unice.fr)¹⁻³; Silva C¹; Reis AT⁴; Ketzer JM⁵; Migeon S³; Unnithan V⁶; Perovano R⁴; Cruz A⁷; Gorini C⁷



¹Universidade Federal Fluminense (UFF), Niterói RJ; ²Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), Porto Alegre RS; ³Géozur, Valbonne, France; ⁴Faculdade de Oceanografia, Universidade do Estado do Rio de Janeiro (UERJ); ⁵Linnéuniversitetet, Sweden; ⁶Jacobs University Bremen, Germany; ⁷Sorbonne Université, Paris, France



1. Amazon fan & slope instabilities



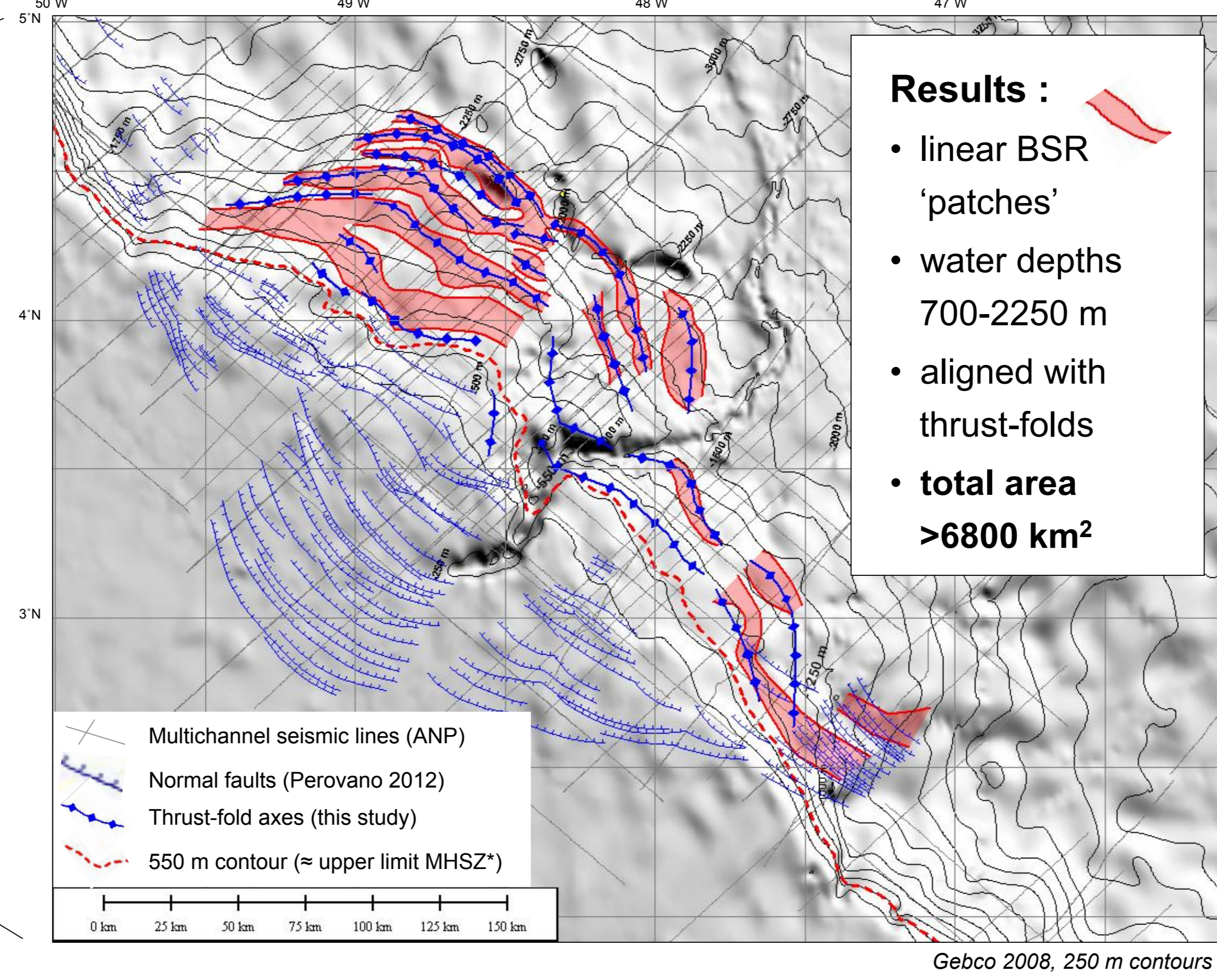
Large-scale slope failures :

- gravity-driven tectonic collapse
- giant landslide complexes

Possible triggers of recurrent upper slope failures :

- Changes in gas hydrate stability (Maslin et al. 1998)
- Syn-sedimentary collapse tectonics (Reis et al. 2016)

2. Mapping bottom simulating reflections (BSRs)



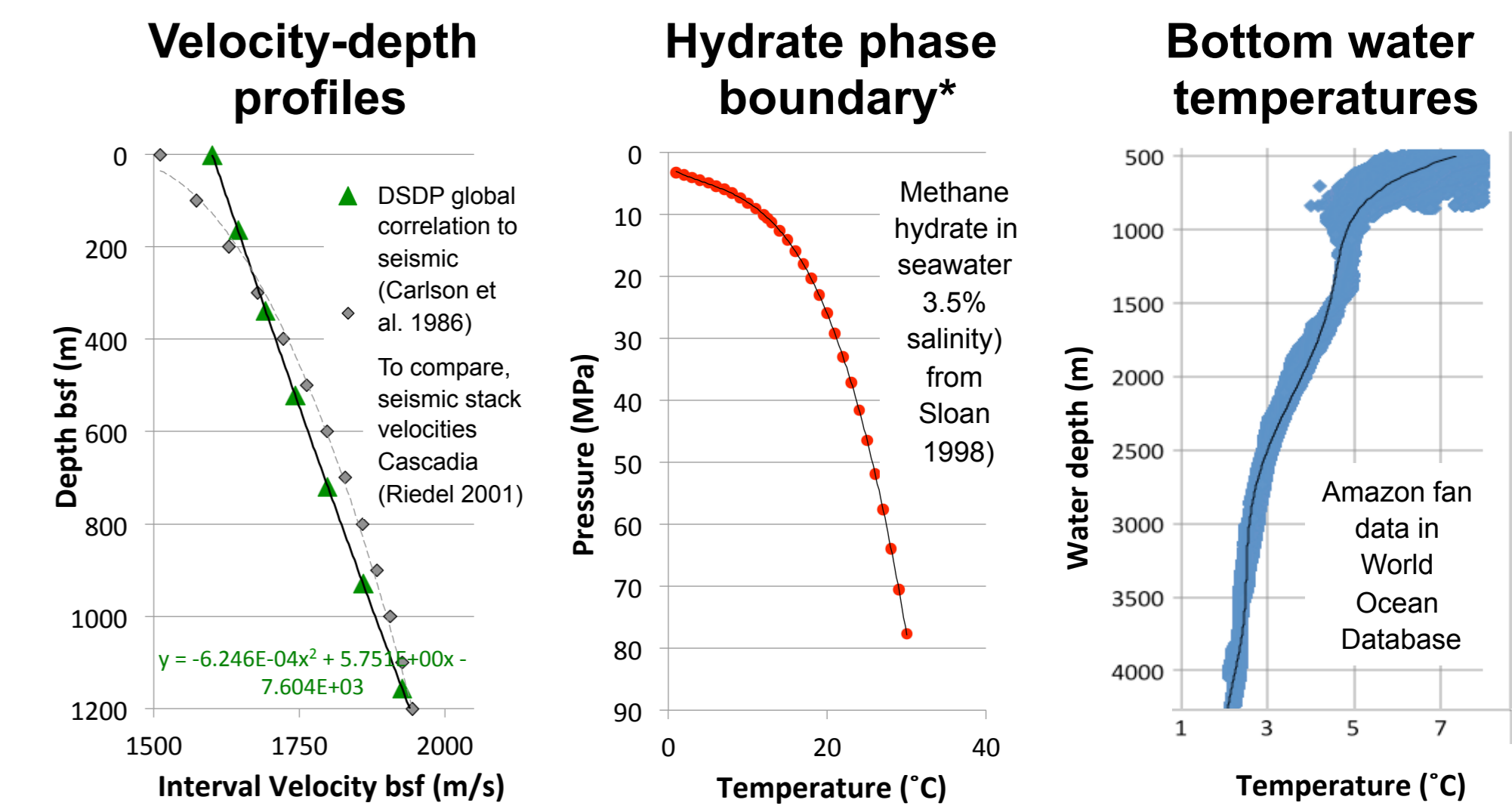
Results :

- linear BSR 'patches'
- water depths 700-2250 m
- aligned with thrust-folds
- total area >6800 km²

3. BSR depth inversion to temperatures

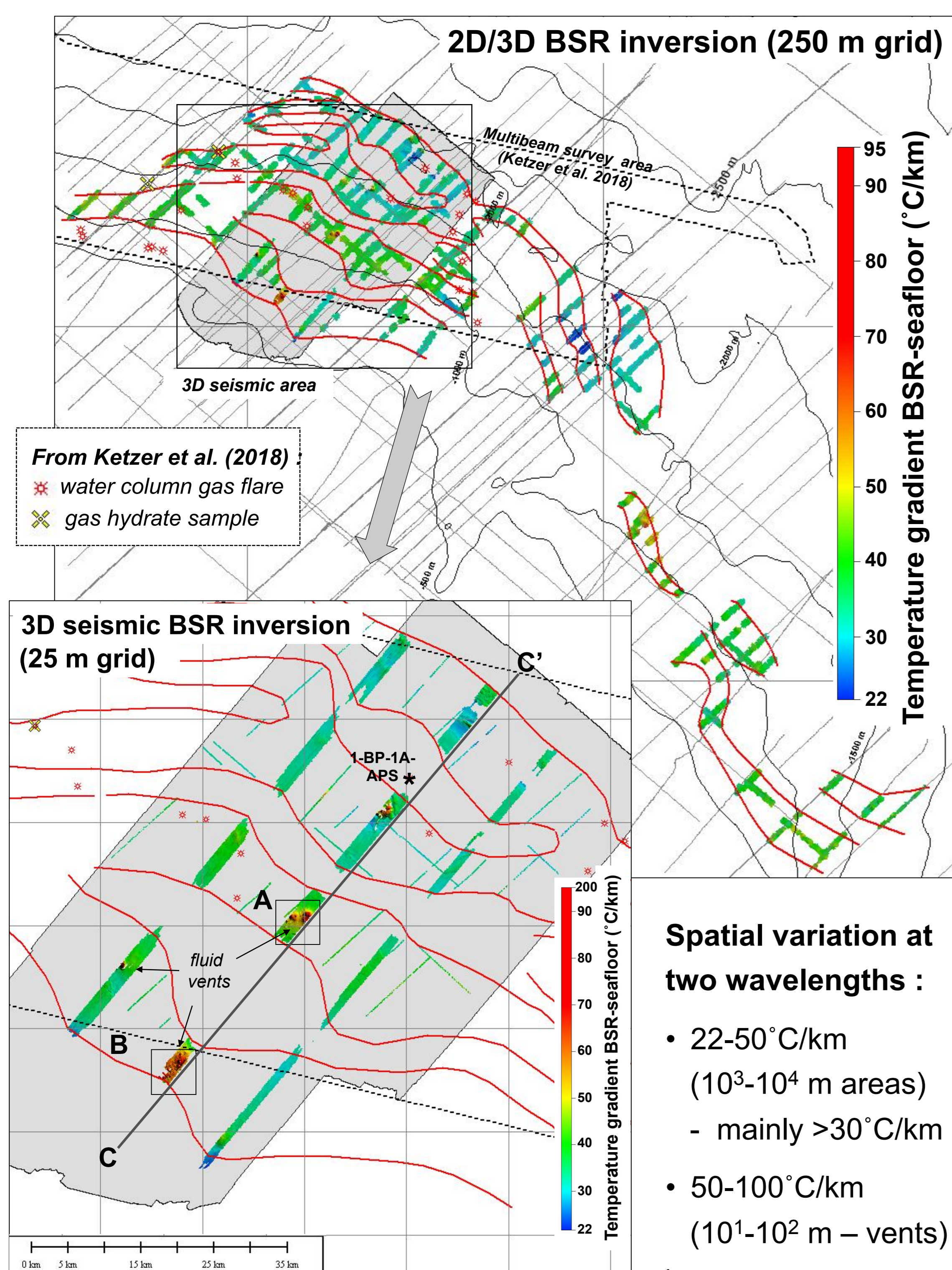
Inversion method (after Riedel et al. 2010)

- BSR TWT → depth (velocity profile from Carlson et al. 1986)
- Depth of BSR → hydrostatic pressure
- Pressure at BSR → temperature at phase boundary (MHSZ*)
- Bottom water temperatures (WOD) → geothermal gradients



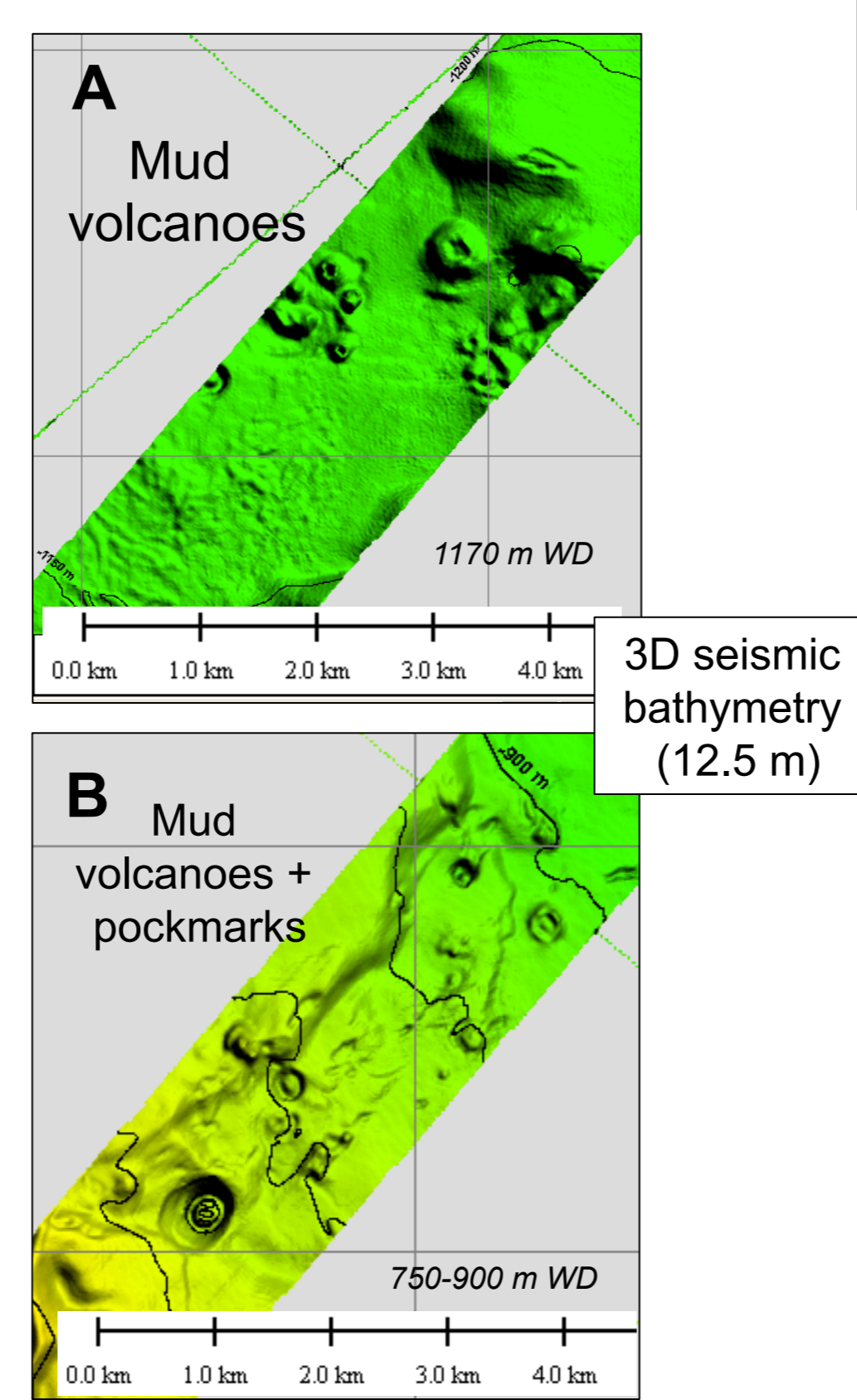
*MHSZ = Methane hydrate stability zone

4. BSR patches → spatially variable temperature gradients + seafloor fluid vents

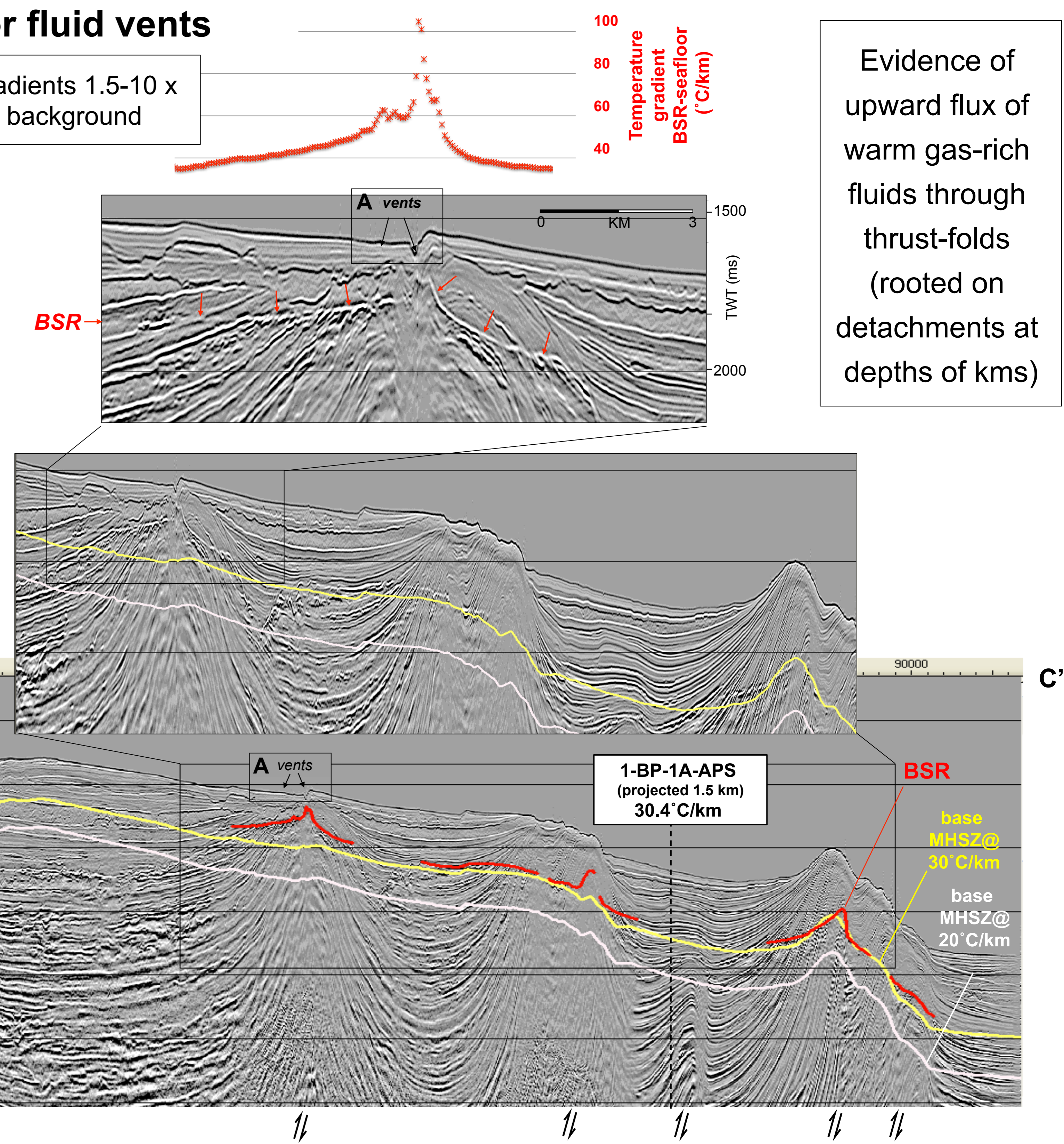


Spatial variation at two wavelengths :

- 22-50 °C/km (10³-10⁴ m areas)
- mainly >30 °C/km
- 50-100 °C/km (10¹-10² m - vents)



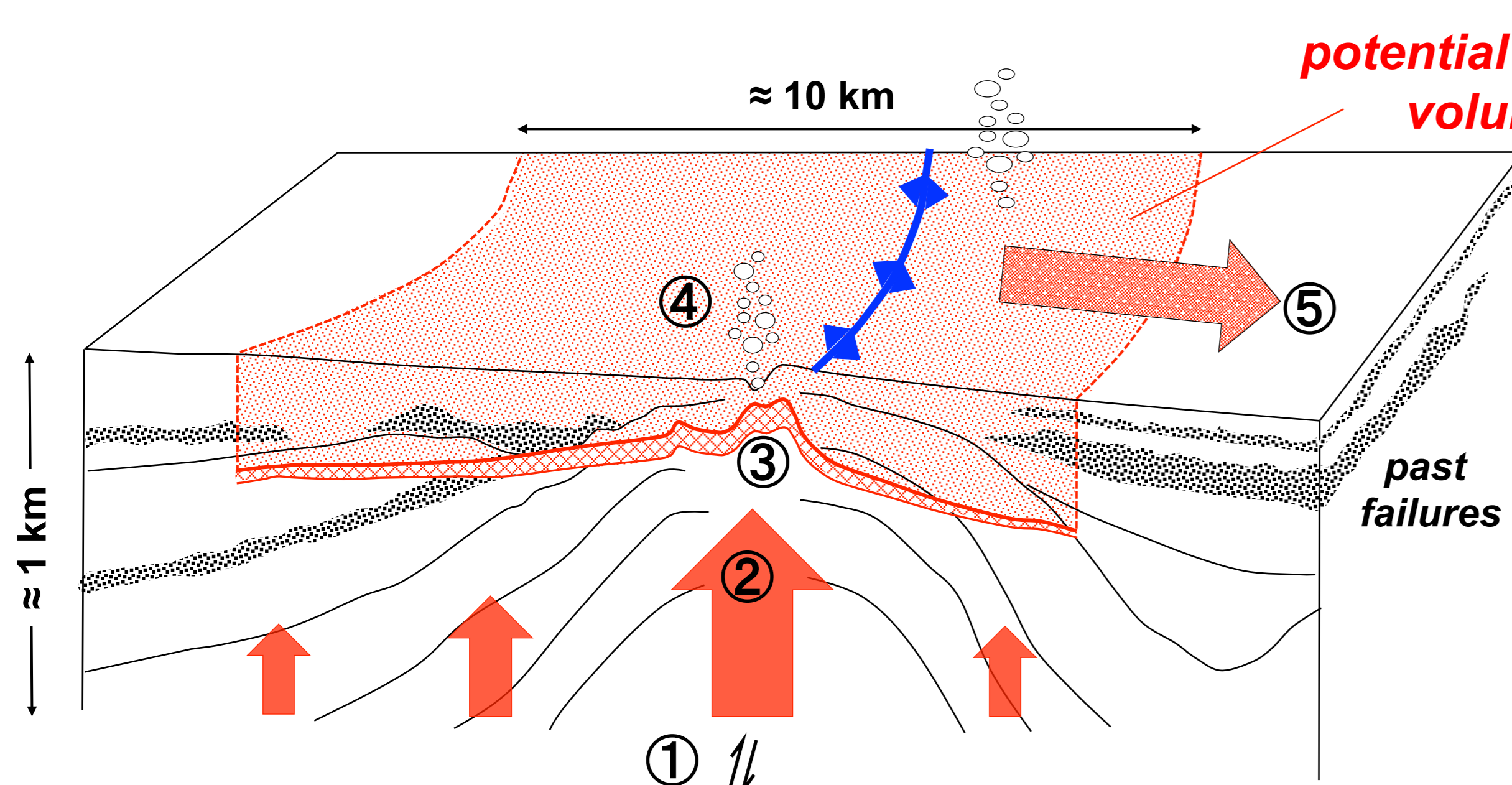
Gradients 1.5-10 x background



Evidence of upward flux of warm gas-rich fluids through thrust-folds (rooted on detachments at depths of kms)

5. Bottom-up gas hydrate & slope dynamics

- Changes in upward flux of fluid (heat) will modify gas hydrate stability from below
- Increased flux during thrust episodes will thin hydrate-rich zone over wide areas
- Reduced sediment strength at base of stability zone may trigger large landslides



- thrust-faulting
- upward flux of fluids & heat
- thinning of hydrate-rich stability zone
- enhanced fluid venting
- upper fan slope failure

6. Conclusions

- Elongate BSR patches on the upper Amazon fan linked to upward flux of gas-rich fluids through thrust-folds recording collapse above deep detachments
- Tectonically-driven changes in fluid flux will thin gas hydrate-rich zones from below and may trigger recurrent giant slope failures from the upper fan
- Bottom-up mechanism independent of climate-driven changes in hydrate stability

References

- Carlson RL et al. (1986). Empirical reflection travel time versus depth and velocity versus depth functions for the deep-sea sediment column. *Journal of Geophysical Research* 91 (B8), 8249-8266.
- Ketzer JM et al. (2018) Gas seeps and gas hydrates in the Amazon deep-sea fan. *Geo-Marine Letters* 38 (5), 429-438
- Maslin M et al. (1998) Sea-level and gas-hydrate-controlled catastrophic sediment failures of the Amazon Fan. *Geology* 26:1107-1110.
- Perovano R (2012) Análise estrutural da tectônica gravitacional na bacia da Foz do Amazonas a partir da interpretação de dados sísmicos e de modelagem experimental. *PhD thesis*, Universidade Federal Fluminense, Niterói, pp. 296.
- Reis AT et al. (2016) Effects of a regional décollement level for gravity tectonics on late Neogene to recent large-scale slope instabilities in the Foz do Amazonas Basin, Brazil. *Marine and Petroleum Geology* 75:29-52.
- Riedel M et al. (2010) Characterizing the thermal regime of cold vents at the northern Cascadia margin from bottom-simulating reflector distributions, heat-probe measurements and borehole temperature data. *Marine Geophysical Research* 31 : 1-16.