



OFFSHORE SAFETY DIRECTIVE: FORWARD PARADIGMS OF RISK AND SAFETY

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What effects Risk/Liability/Compensation?

- Novel Activities
 - New Benefits
 - New Risks
- New players and stakeholders
- Change in Scale of Events
- New Location of Events, in what Jurisdiction(s)

- The more factors, above, engaged the more the need to rethink liability, compensation, and financial security

Looking Ahead on Liability, Compensation, and Financial Security

- Directive reflects a body of knowledge, built on previous experiences and events in the offshore industry
- There are on-going events in the offshore industry that might provide insight into the present functioning of the Directive
- Some of these are **paradigm changing**; which also raises a question of how well the Directive functions to raise safety standards for novel and incoming changes in operational activities
- These changes will materially impact on policy and planning for **liability**, **compensation**, and **financial security** in advance of operations

Changes Impacting Offshore Safety

- Possibilities for Smaller Actors to have Larger Impacts
- New Offshore Possibilities – From Elephants to Cows, from Blue Whales to Dolphins
- New Resource Risks – Offshore Methane Hydrates, from Deep Rocks to Shallow Mudlines
- Improving on Safety Case Implementation

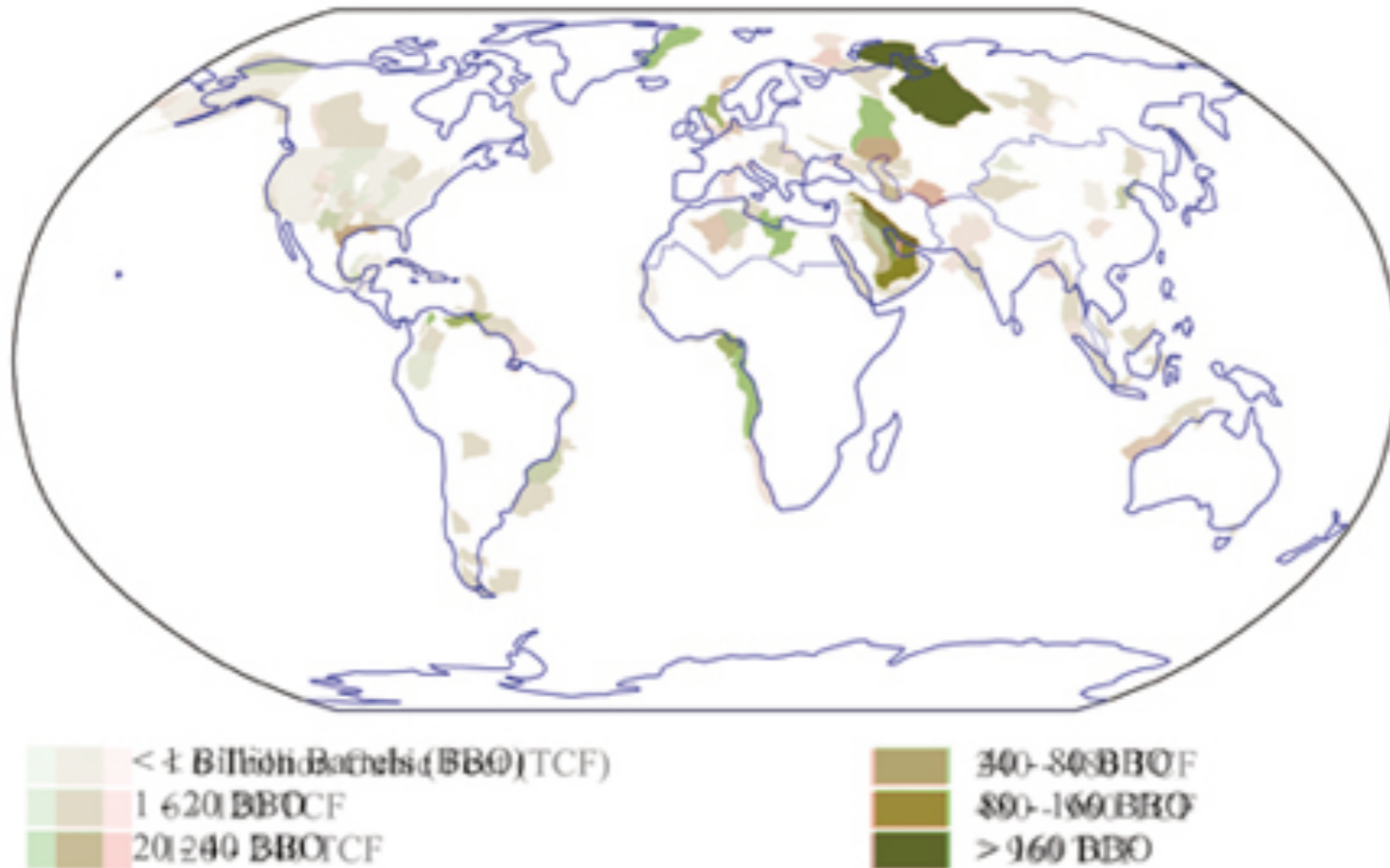
New Offshore Possibilities -- From Elephants to Cows, from Blue Whales to Dolphins

- The improving ability to 4D scan for resources will lead to reduced risk of dry holes while also increasing reliability on volumes in reservoirs.
- Improvements in drilling technology have led to reduced costs thereof, as seen occurring in the onshore shale fracturing developments
- While this combination of changes has mostly been onshore so far, it is foreseeable that these trends, to commercially develop smaller assets, will extend to the offshore
- This reduction in capital mass per well could also led to new circumstances in offshore safety planning – same as it did onshore
 - Smaller Assets in Play
 - Smaller Capital Pools Required
 - Space for Smaller Investors/Operators

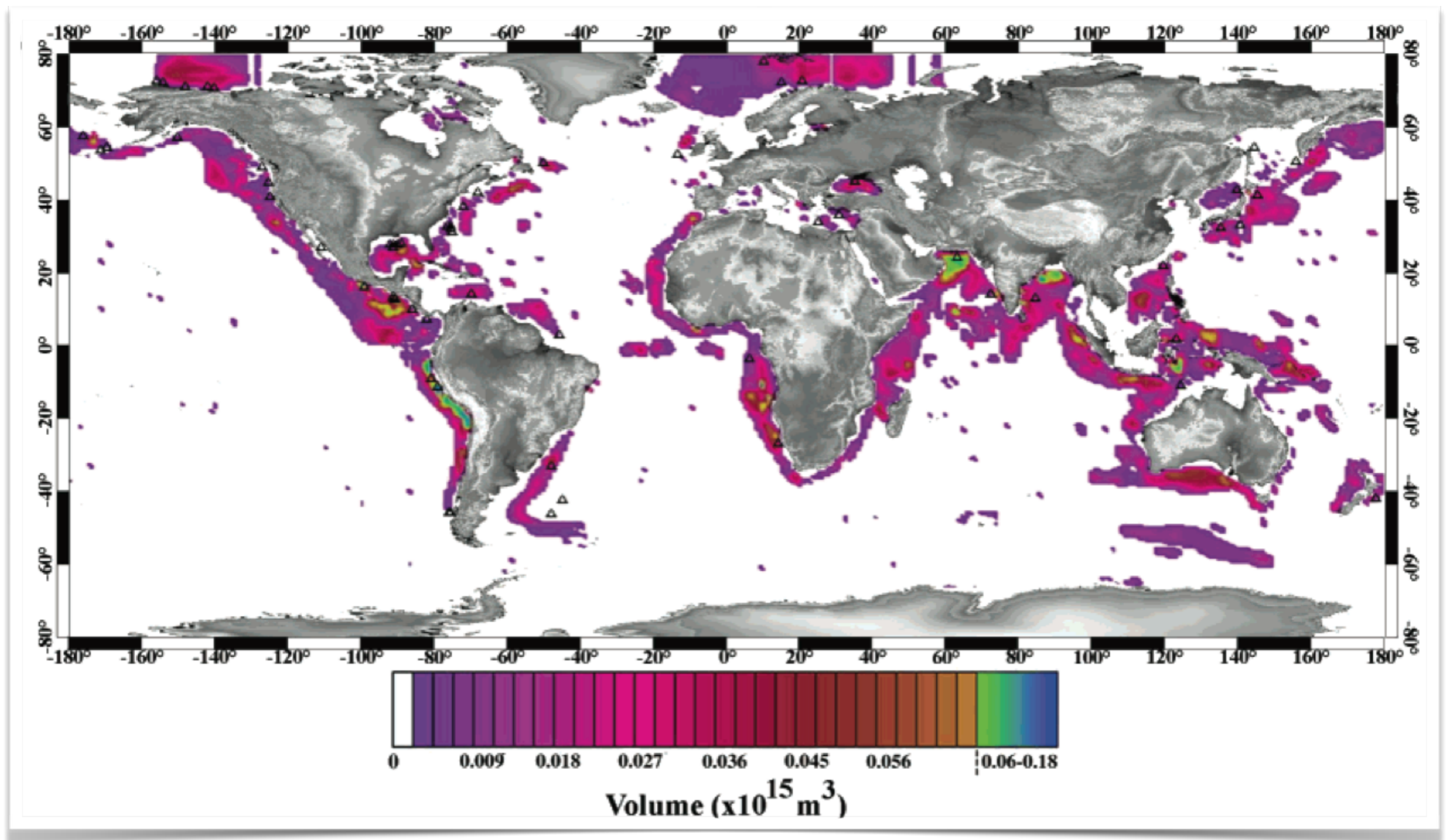
New Discoveries – Offshore Methane Hydrates, from Deep Rocks to Shallow Mudlines

- Present Offshore Directive presumes conventional petroleum assets, those laying deeply under rock and other geological structures
- New offshore actors are moving to develop offshore methane hydrates (OMH):
 - OMH are a methane resource that lays under the mud in the benthic offshore
 - Methane hydrates casually appear as accumulated snow, with the methane molecules locked in molecular-scale ice cages — **85% H₂O** and **15% CH₄**
- The risks shift from “Exxon Valdez” or “BP Macondo” crude oil hazard paradigms to more novel risks of offshore landslides, tsunamis, and massive/continuous methane leaking and venting, both into the water column and into the atmosphere, with the associated risks to climate change and loss of oceanic biota
- There is also an increased risk of international/transboundary loss of human life
- Need to develop awareness of these novel environmental and safety risks, and implement within framework of Offshore Directive, for OMH production will likely arrive in a surprising manner, much as shale fracturing did a decade or so ago
- **Needs for liability, compensation, and financial security might resemble the early nuclear industry more than the traditional oil and gas paradigms**

Map of Conventional Petroleum Assets... vs

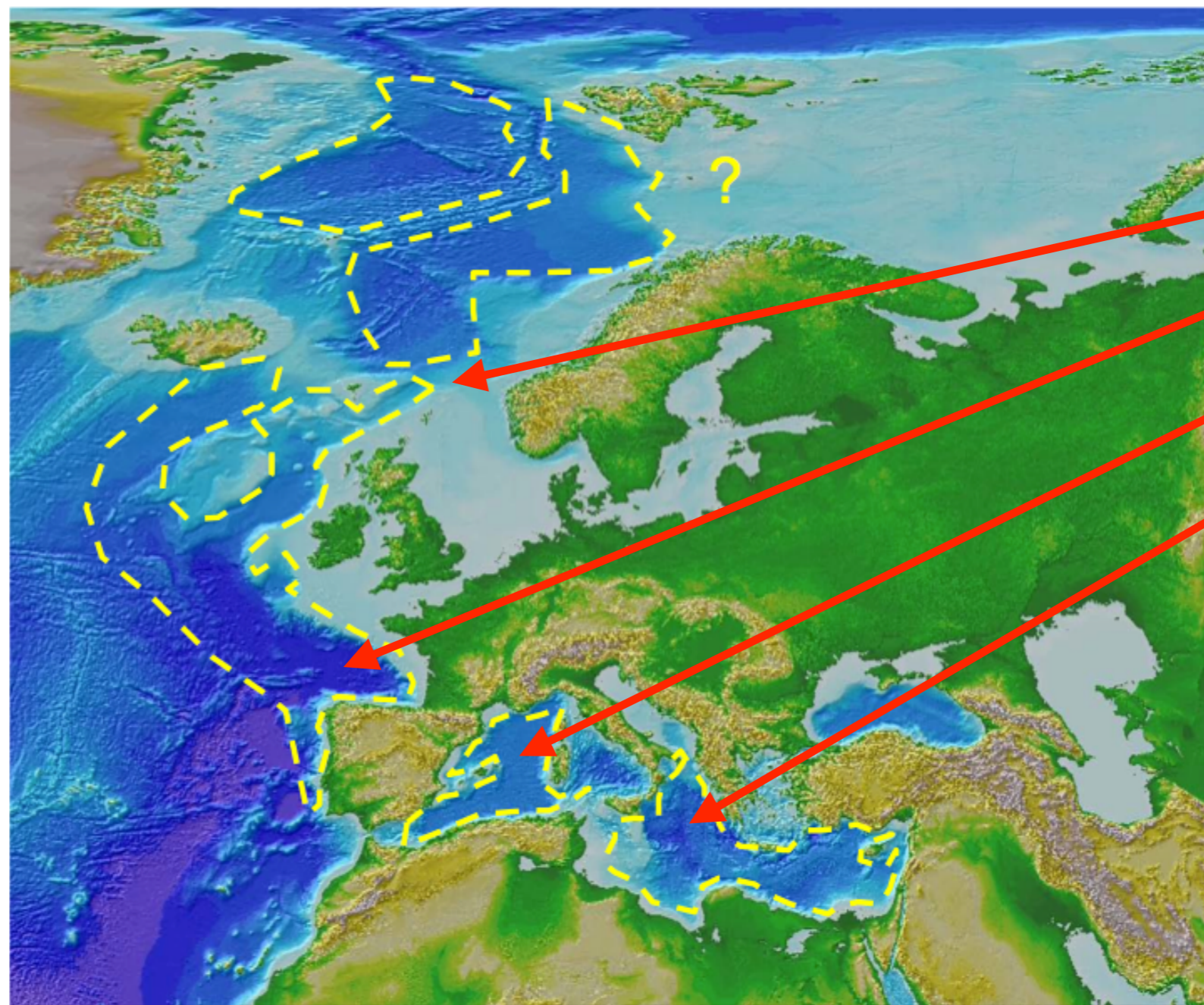


... where the OMH are found.

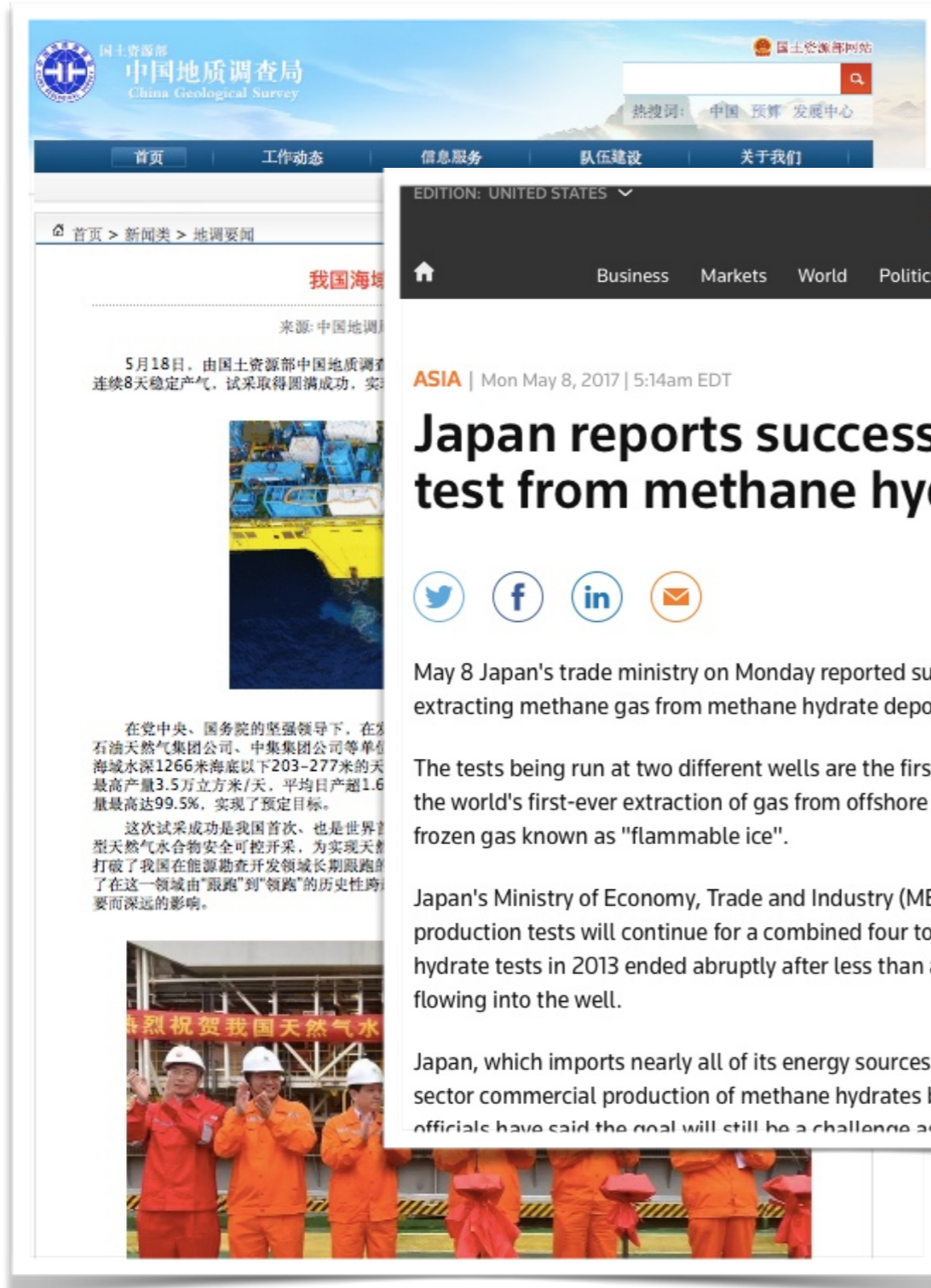


Remember, OMH are both methane and freshwater resources

Forecasted OMH in EU Waters




Technology is there now – Commercial terms developing



中国地质调查局
China Geological Survey

5月18日，由国土资源部中国地质调查局组织实施的南海天然气水合物试采工程，已连续8天稳定产气，试采取得圆满成功，实现了预定目标。

在党中央、国务院的坚强领导下，在石油天然气集团公司、中集集团公司等单位的大力支持下，南海天然气水合物试采工程自2013年启动以来，克服了重重困难，取得了举世瞩目的成就。这次试采成功是我国首次、也是世界首次实现天然气水合物安全可控开采，为实现天然气水合物商业化开发迈出了重要一步，打破了我国在能源勘查开发领域长期跟跑的局面，在这一领域由“跟跑”到“领跑”的历史性跨越，具有里程碑意义和深远的影响。



REUTERS

ASIA | Mon May 8, 2017 | 5:14am EDT

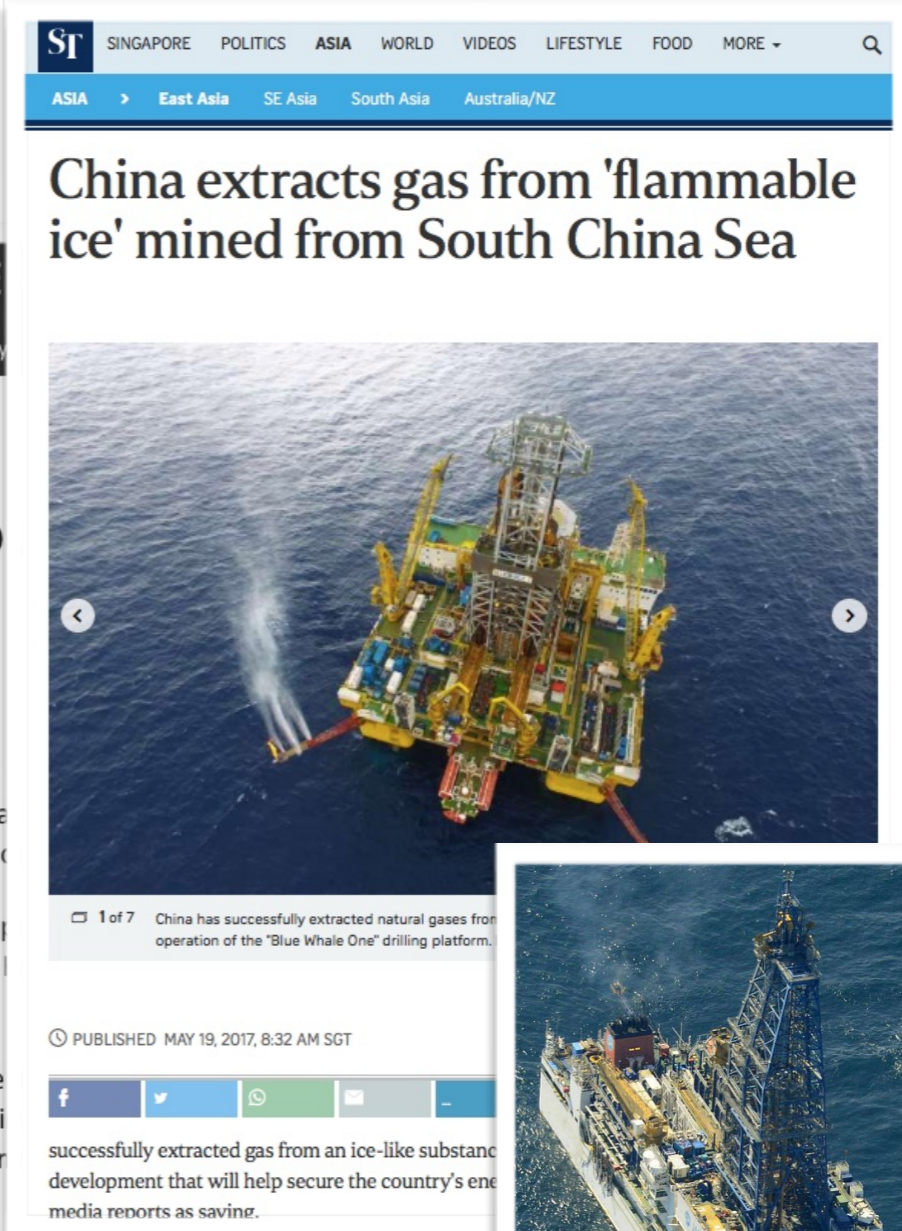
Japan reports successful gas test from methane hydrate

May 8 Japan's trade ministry on Monday reported success in producing gas by extracting methane gas from methane hydrate deposits offshore Japan's coast.

The tests being run at two different wells are the first since 2013, when Japan conducted the world's first-ever extraction of gas from offshore deposits of methane hydrate, a frozen gas known as "flammable ice".


Japan's Ministry of Economy, Trade and Industry (METI) said the methane hydrate production tests will continue for a combined four to five weeks. Japan's first methane hydrate tests in 2013 ended abruptly after less than a week due to problems with gas flowing into the well.

Japan, which imports nearly all of its energy sources, has been aiming to launch private sector commercial production of methane hydrates by between 2023 to 2027, but METI officials have said the goal will still be a challenge as many obstacles remain to be overcome.



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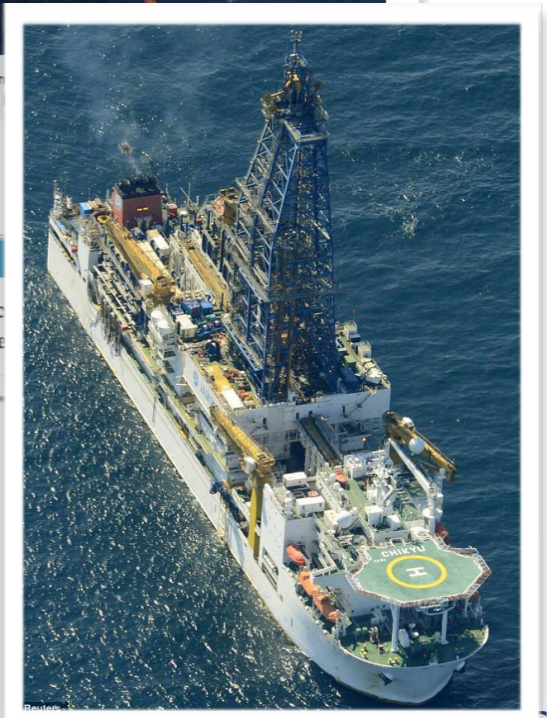
China extracts gas from 'flammable ice' mined from South China Sea



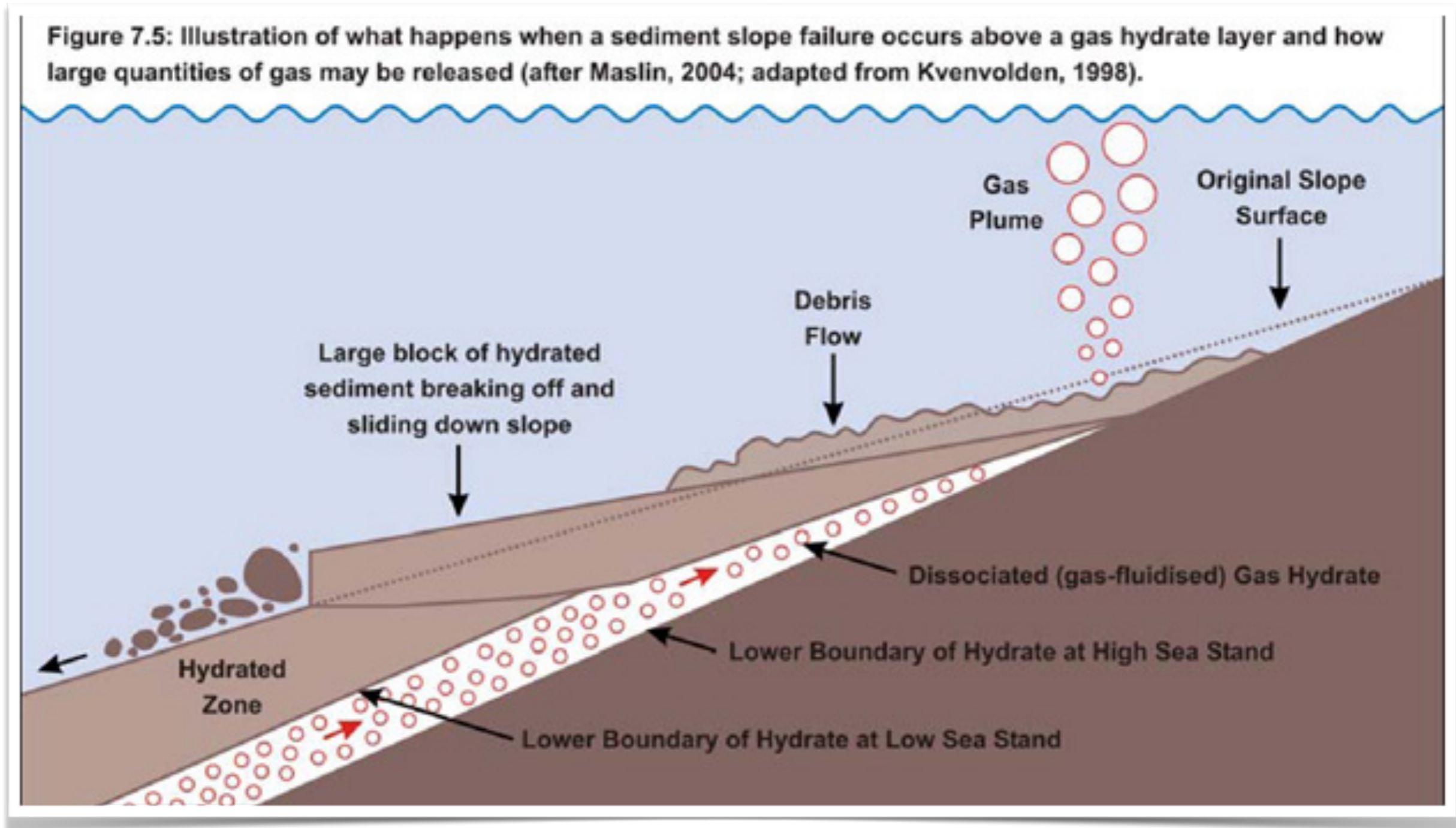
1 of 7 China has successfully extracted natural gases from methane hydrate deposits in the South China Sea during the operation of the "Blue Whale One" drilling platform.

PUBLISHED MAY 19, 2017, 8:32 AM SGT

China has successfully extracted gas from an ice-like substance known as methane hydrate, a development that will help secure the country's energy supply, according to media reports as saving.



Novel Safety Risks from OMH Extraction



Forecasted Area of Subsea Instability (Landslides, Tsunami)

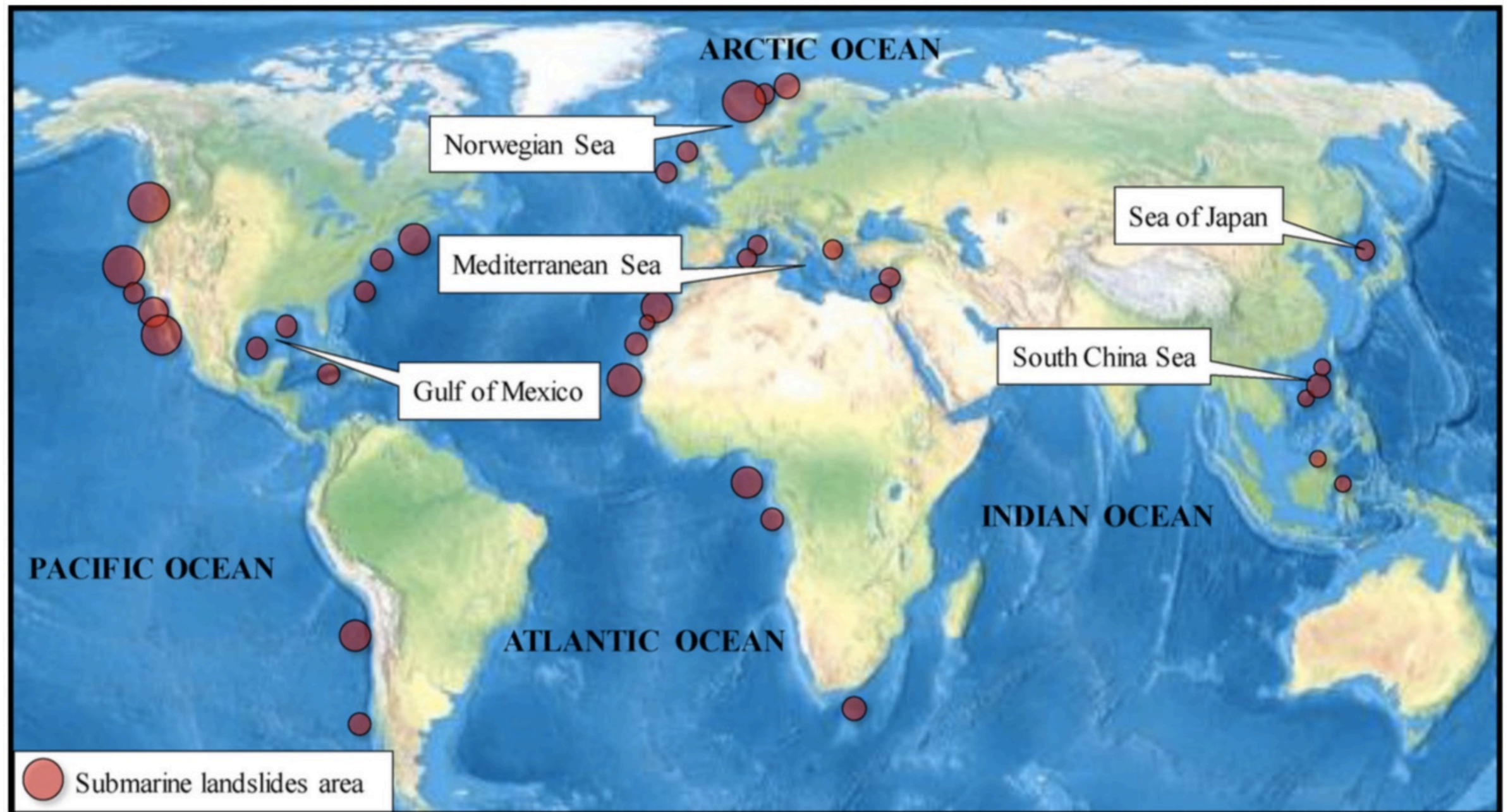
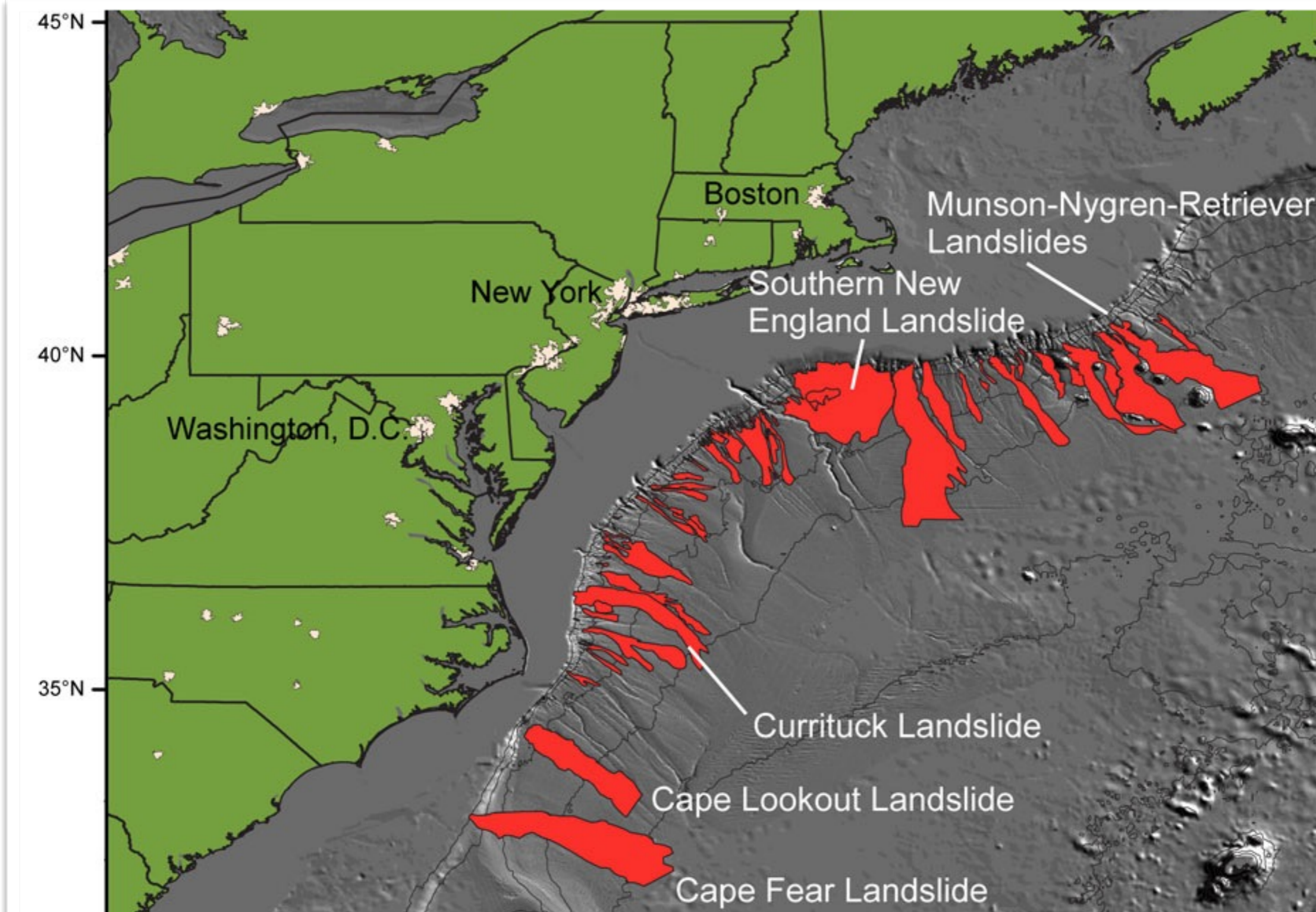


Fig. 2. Regional distribution of main areas for submarine landslides.

Evidence of Ancient Landslides



Improving on Safety Case Implementation

- It is difficult to prove that the “paper” exercise of the safety case/major hazard report actually translates into meaningful action on the ground.
- In particular, to what extent is the key concept of the safety case/MHR being a living document actually implemented in practice?
- Does industry remains reactive, rather than proactive in the way that the idea of the living document would imply - do blind spots remain?
- **‘Borrowing’ from the Banks?**
 - Might hypothetical scenario “stress testing” be a method of interest
 - Team of diverse stakeholders could design hazard scenarios, which the operators could simulate across their systems to learn of capacity to respond to events
 - Discovery of preparedness, or lack thereof, could enable parties to engage in robust prevention planning

Thank You

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