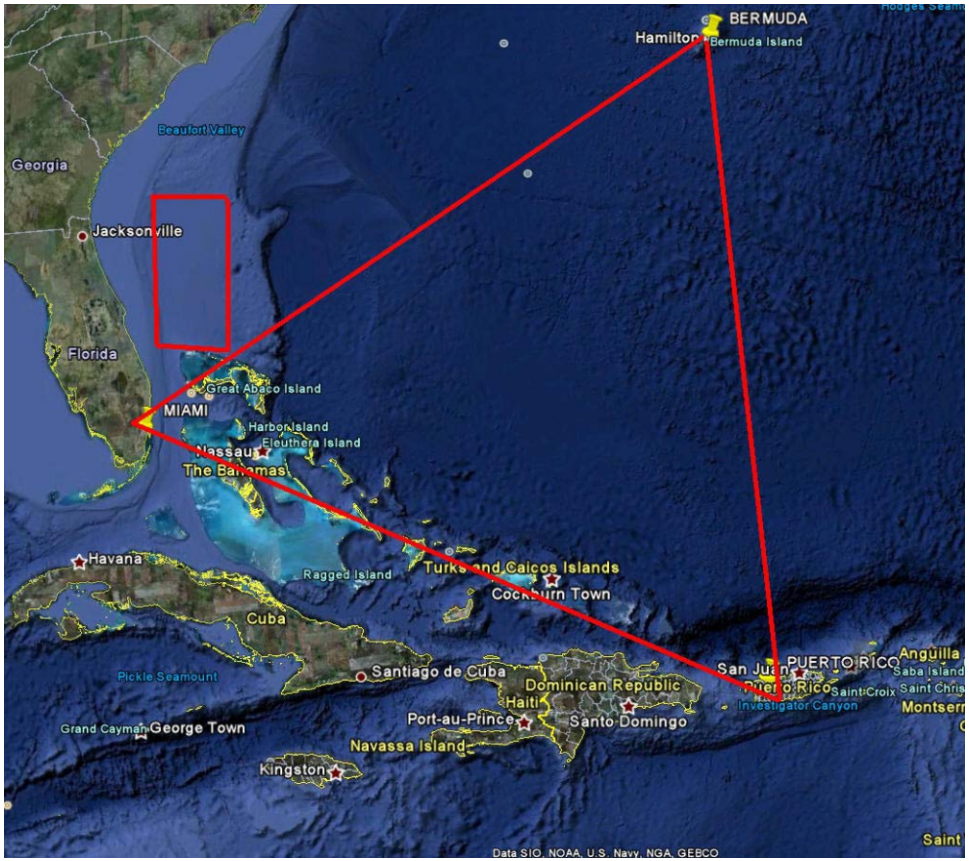
Gas hydrates;
As mythical as they are real

By Martin Galavazi

Fugro Offshore Geotechnics

14 March 2013

Go on.....blaim it on the gas hydrates



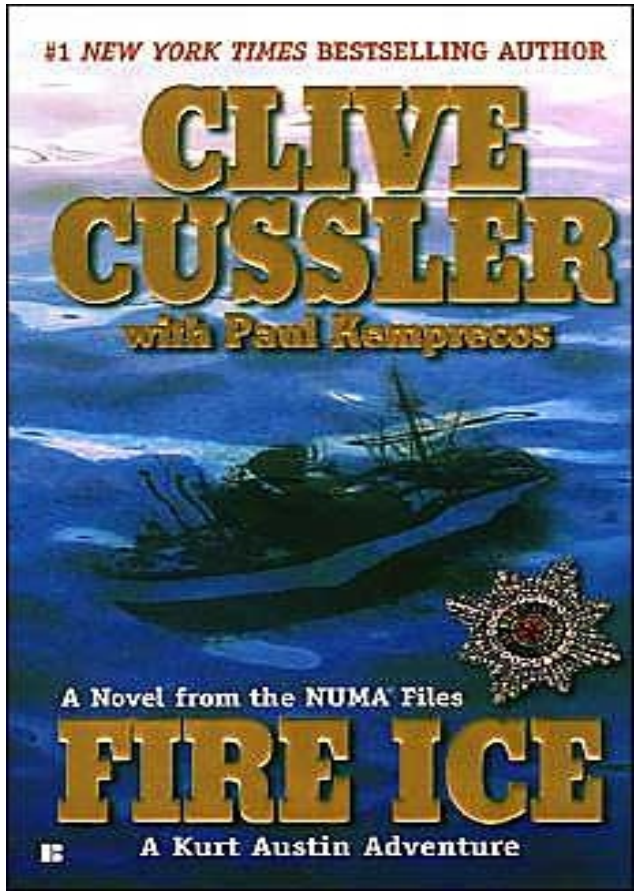
- ③ Bermuda Triangle
- ③ Sinking Ships
- ③ Tsunamis

- ③ Storegga Slide
- ③ Clathrate Gun for runaway climate change

- ③ Vast Energy Source

Hyping Methane Release by Popular Media

Nefarious Russian plot to melt all the gas hydrate on the U.S. eastern continental slope to gas major population centers along Eastern Seaboard



Marine methane explosions through time cause global disasters and it will happen in the future

… and more hyping

BBC NEWS WORLD EDITION

Thursday, 11 August 2005

Siberia's rapid thaw causes alarm

The world's largest frozen peat bog is melting, which could speed the rate of global warming, New Scientist reports.

The huge expanse of western Siberia is thawing for the fi
formation, 11,000 years ago.

The area, which is the size of France and Germany combi
of tonnes of greenhouse gases into the atmosphere.

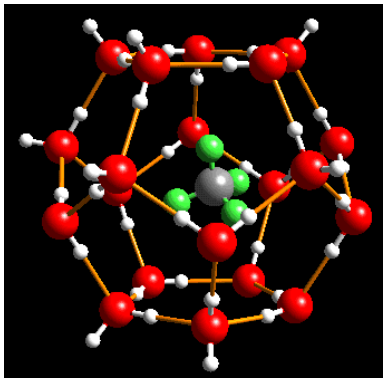
This could potentially act as a tipping point, causing globa
scientists fear.

The situation is an "ecological landslide that is probably ir
undoubtedly connected to climatic warming," researcher S
State University, Russia, told New Scientist magazine.

The whole western Siberian sub-Arctic region has started

But what are they?

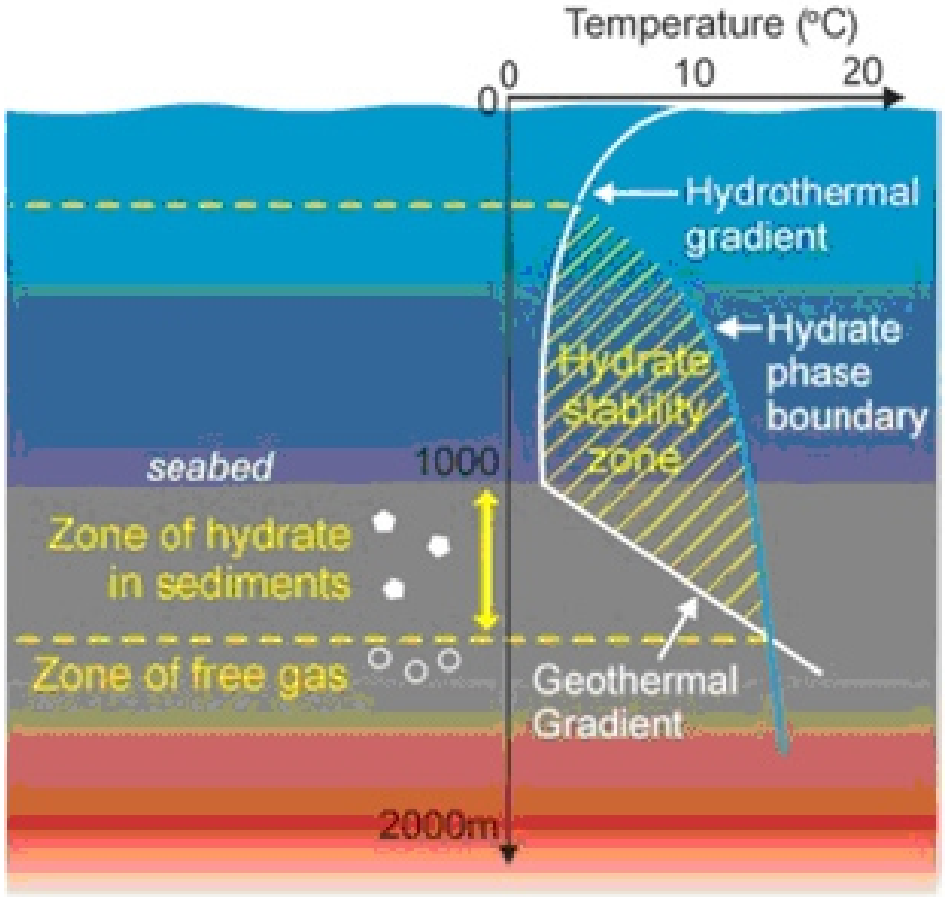
- “Mineralization of gas and water”
- A cage of ice entraps a gas molecule, mostly methane
- They are stable at moderately low temperatures and moderately high pressures
- **1 m^3** of Methane Hydrate releases approximately **165 m^3** of methane gas and **~0.8m^3** of water



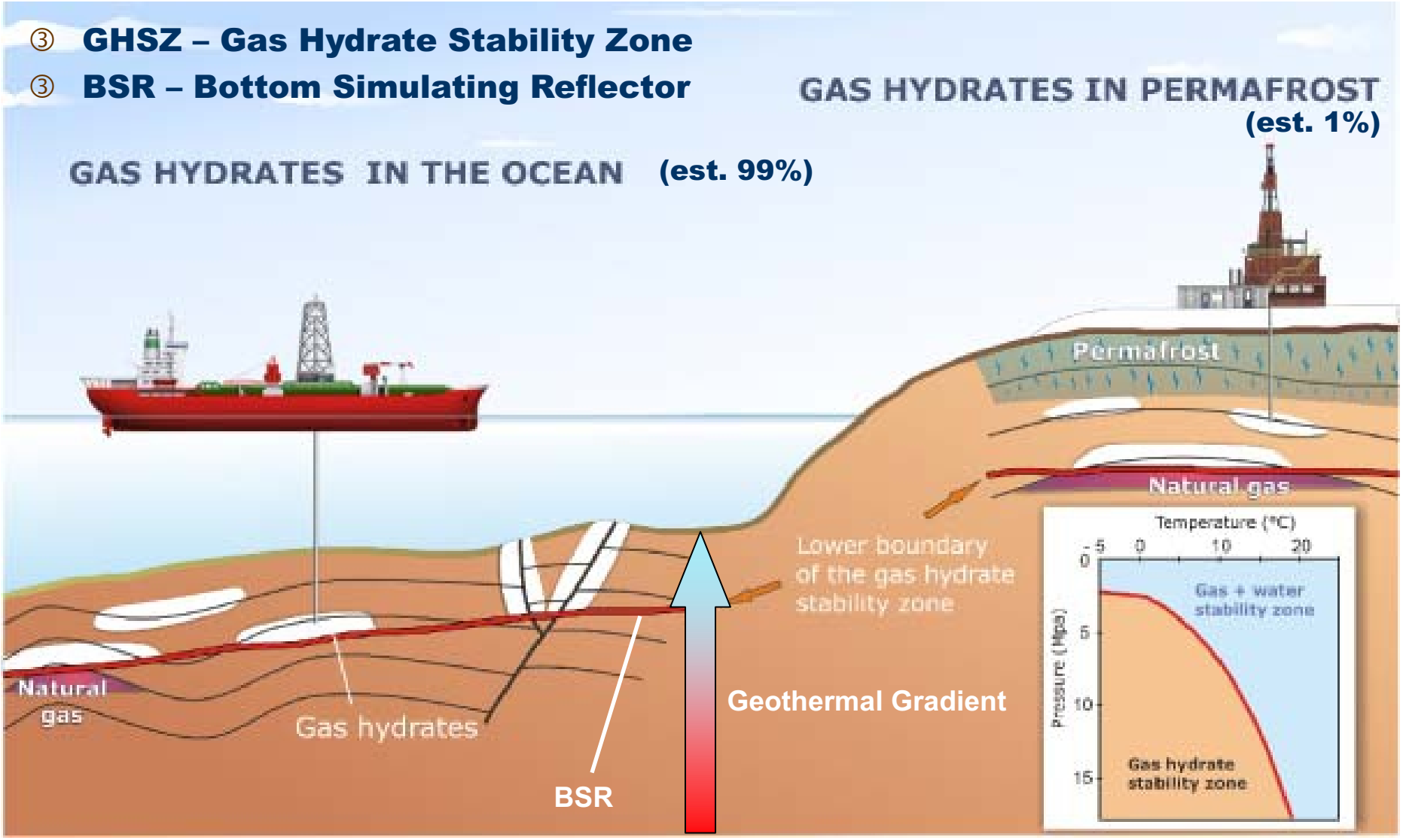
Hydrate stability zone

Three phases:

- Water
- Free gas (usually methane)
- Gas hydrate



Where are hydrates stable



Modified from: http://iopscience.iop.org/1748-9326/4/3/034007/fulltext

Why the interest?

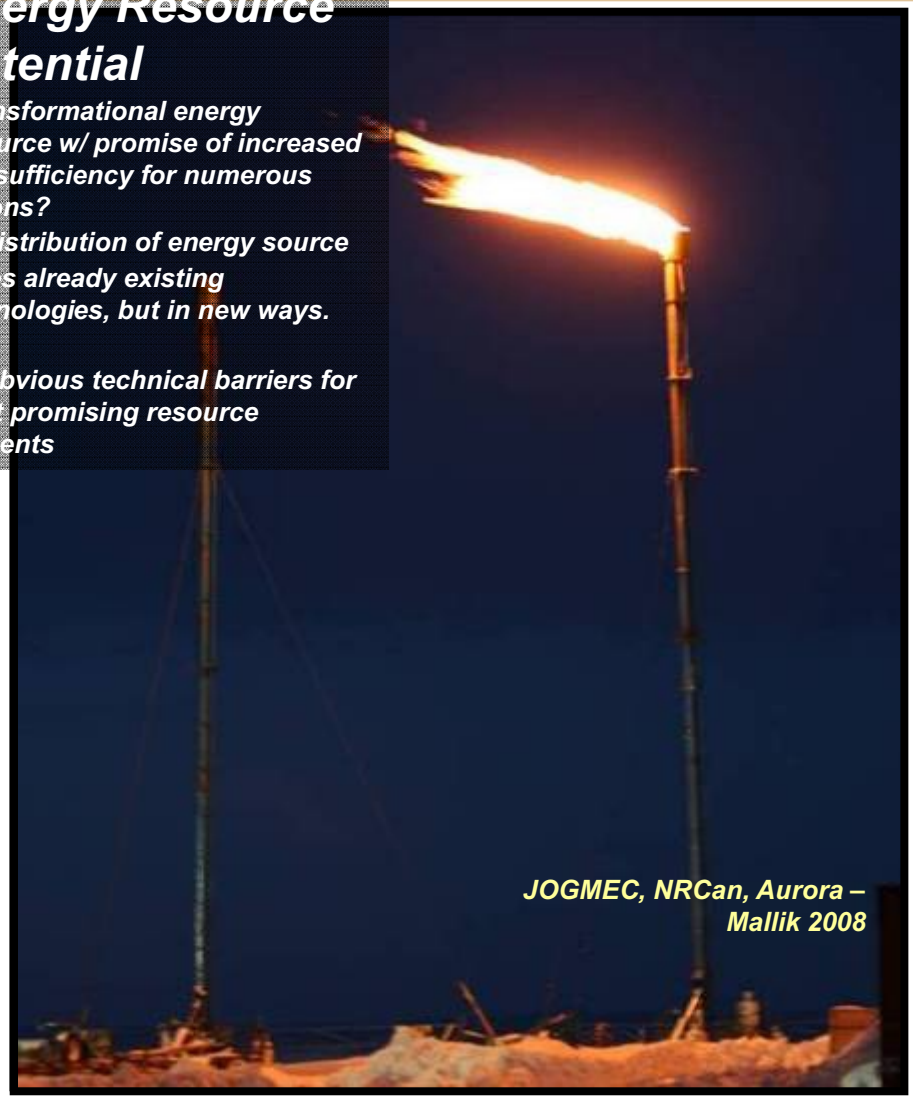
Hazards

- *Plugging of pipelines*
- *Drilling hazard (Drilling through, Producing through, Producing from)*

Energy Resource Potential

- *transformational energy resource w/ promise of increased self-sufficiency for numerous nations?*
- *redistribution of energy source*
- *uses already existing technologies, but in new ways.*

No obvious technical barriers for most promising resource elements

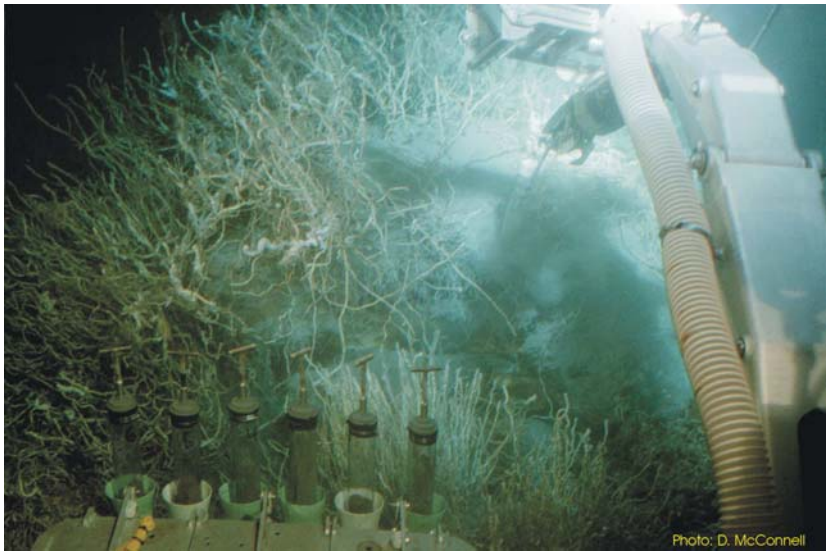


Global Environment

- *unique deep sea biological communities*
- *sea-floor instability*
- *unique component of global carbon cycle?*
- *contributor to global climate change?*

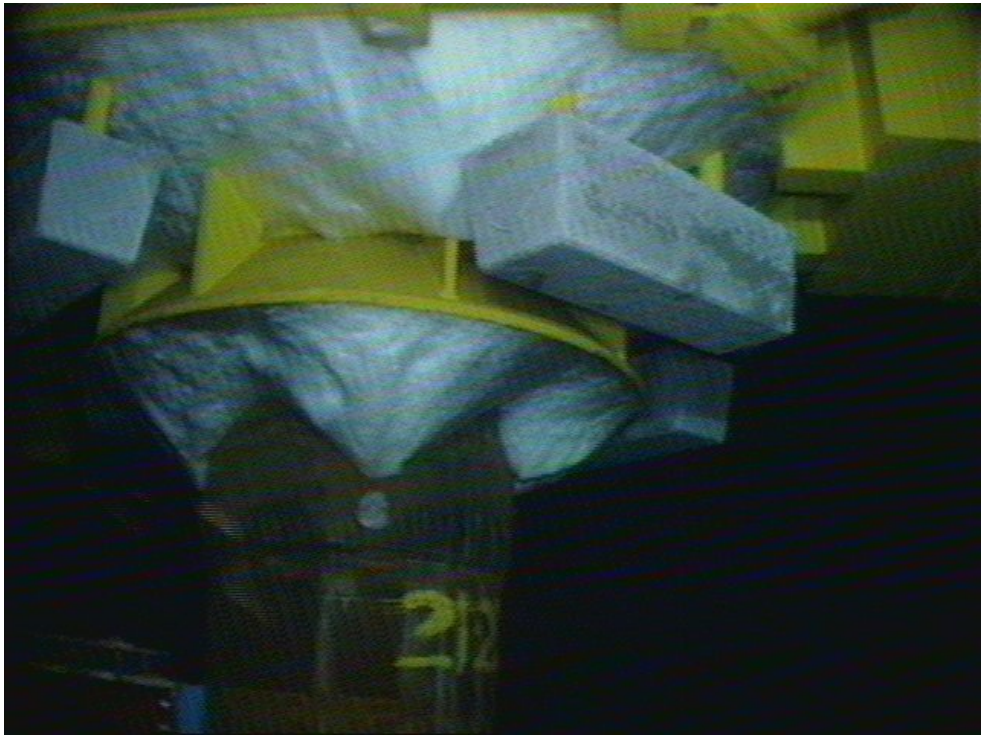
Gas Hydrate Resource Evaluation

Formation of Gas Hydrates

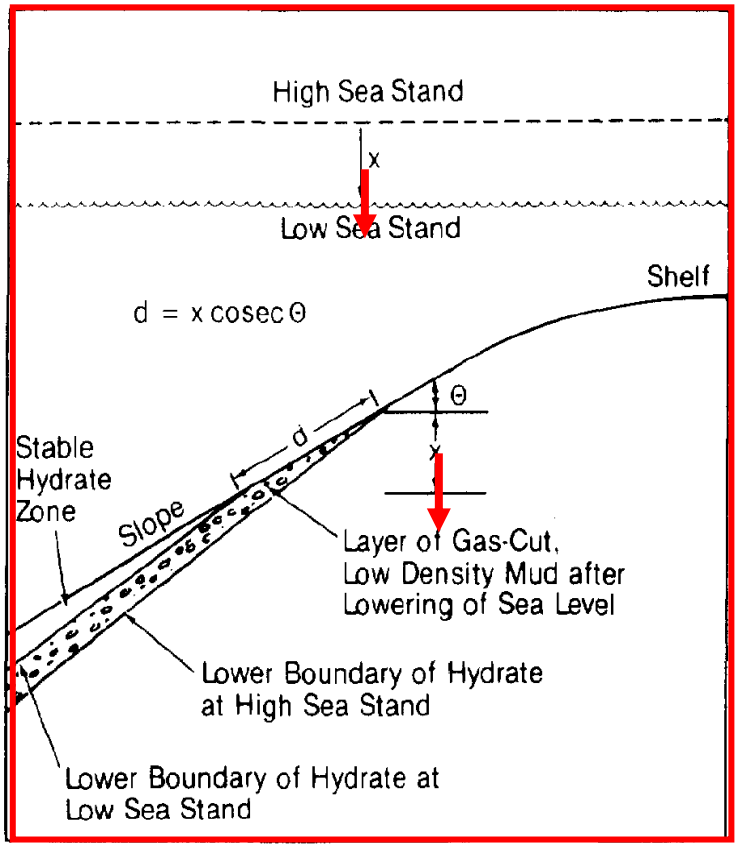


They are either formed by:

- ***Natural processes***; or
- ***Artificial processes***, i.e. HC production activities such as leakage

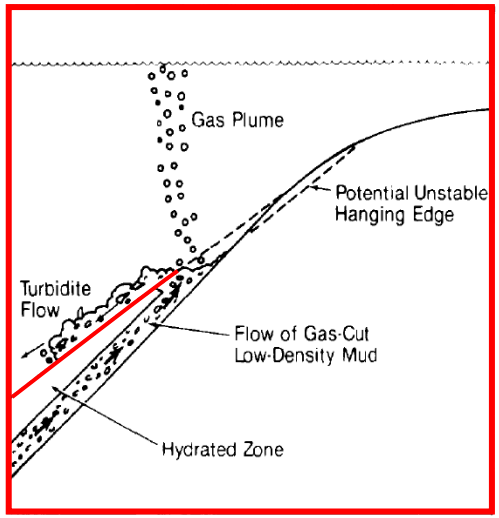


Hydrates as hazard - Slope Instability by pressure reduction

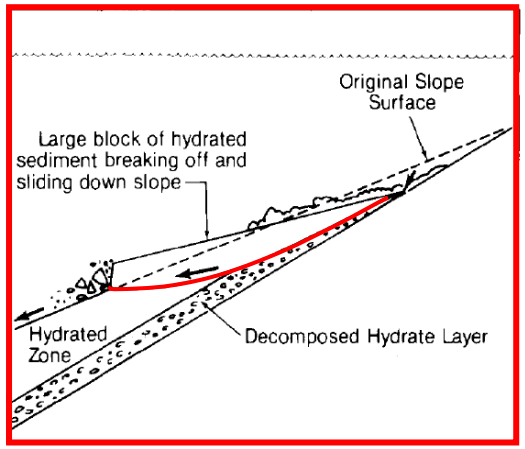


McIver (1982)

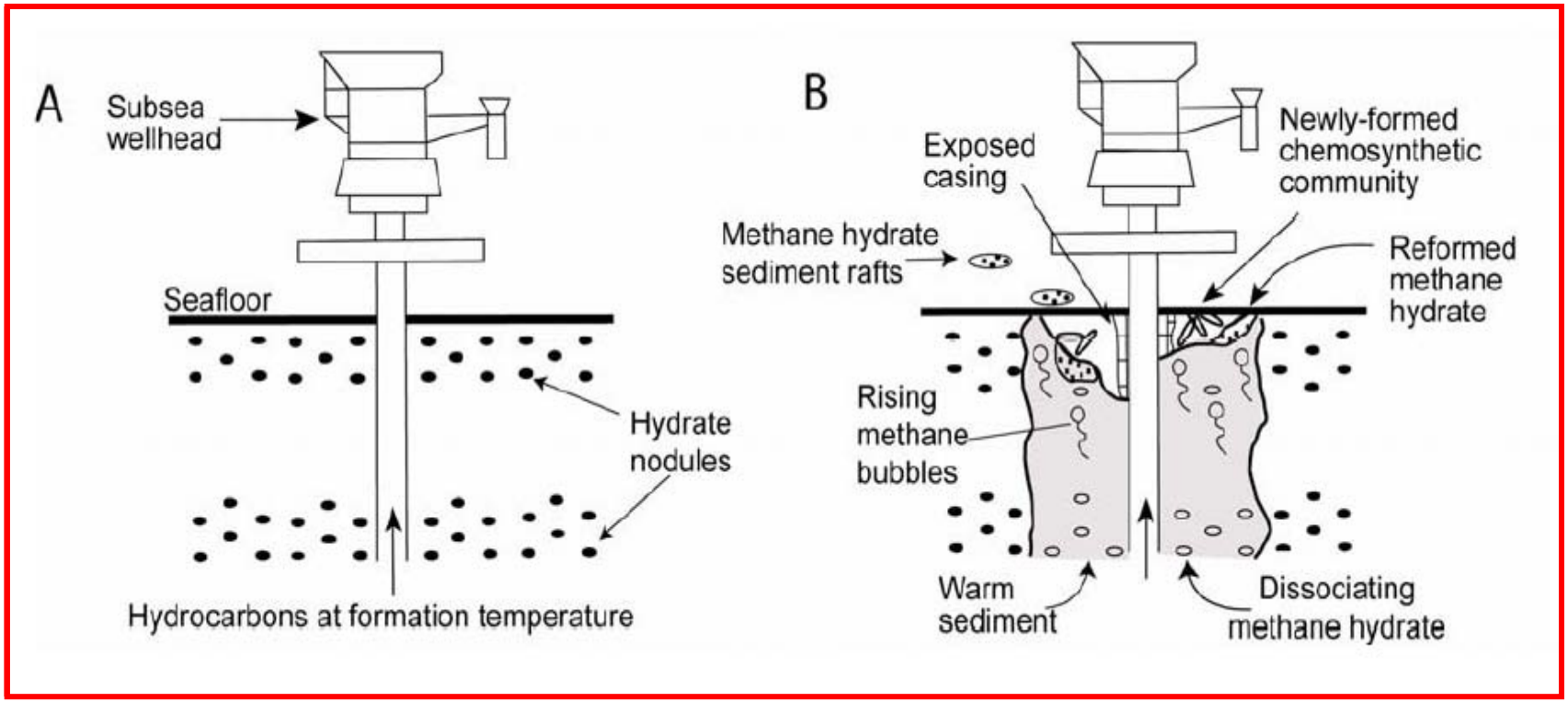
Cause Turbidity Currents



Act as Glide Plan for Mass Failure

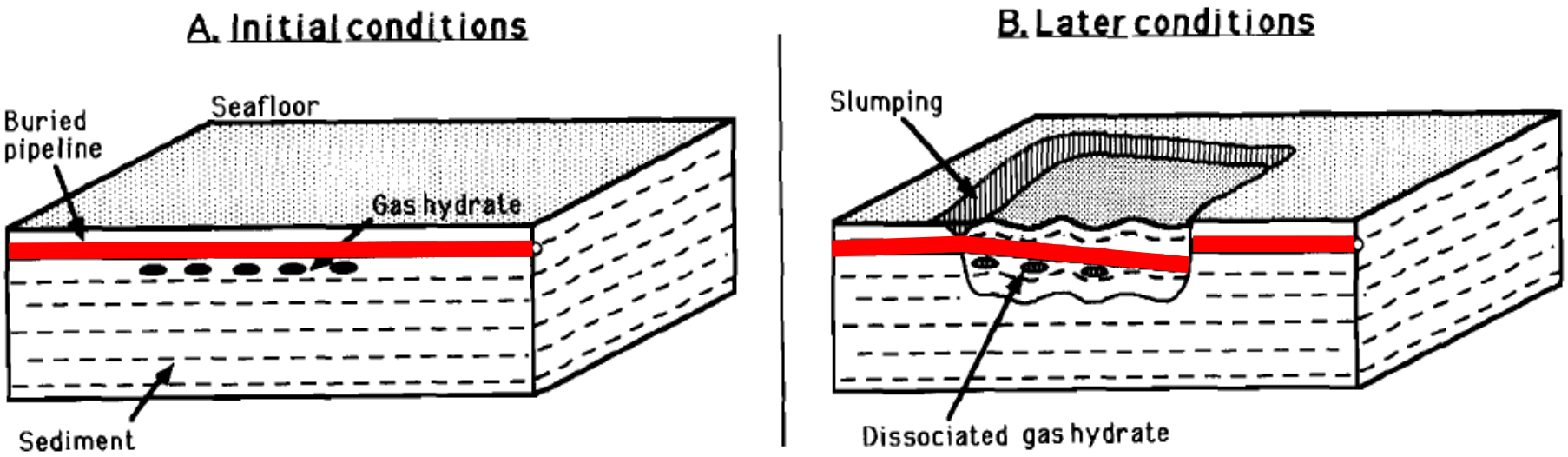


Hydrates as hazard - Wellhead instability by heating



Borowski and Paull (1997)

Hydrates as hazard - Seafloor Instability by heating



Borowski and Paull (1997)
Hovland and Gudmestad (2001)

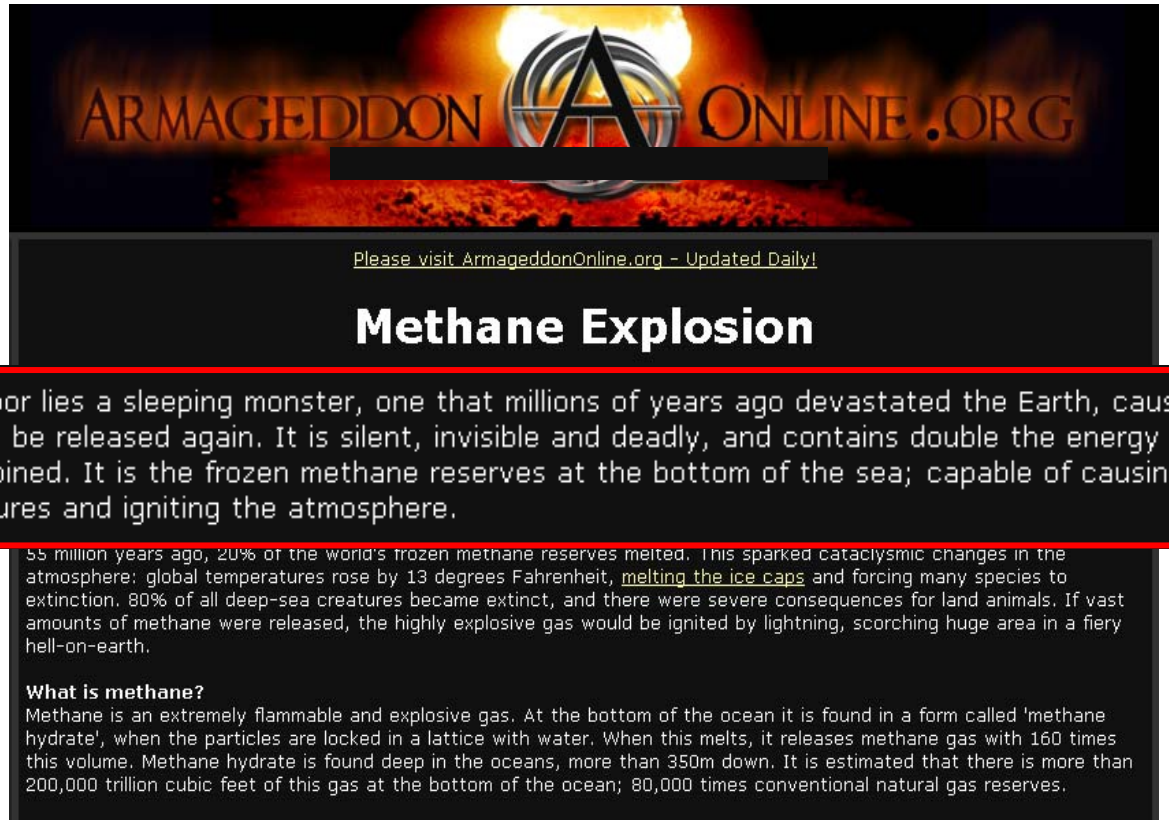
Are gas hydrates a real hazard?

- Theories about gas hydrate hazards stand firmly, however no convincing real-world evidence to date
- Limited effect of temperature on stability may account for this
- ***No conclusive standpoint*** in academia nor industry whether hydrates are a real hazard

Global environment

Global Environment
- unique deep sea biological communities
- unique component of global carbon cycle?
- contributor to global climate change?

Global environment - Back to the hyping



Contrary Evidence to Massive Methane Release

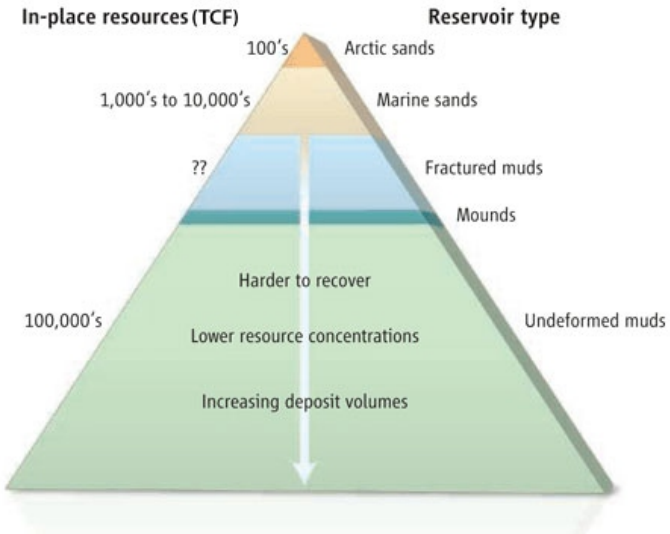
- ***Isotopic studies*** of methane in ice cores suggest that the contribution of gas hydrate to the atmosphere must have been minor (Sowers, 2006)

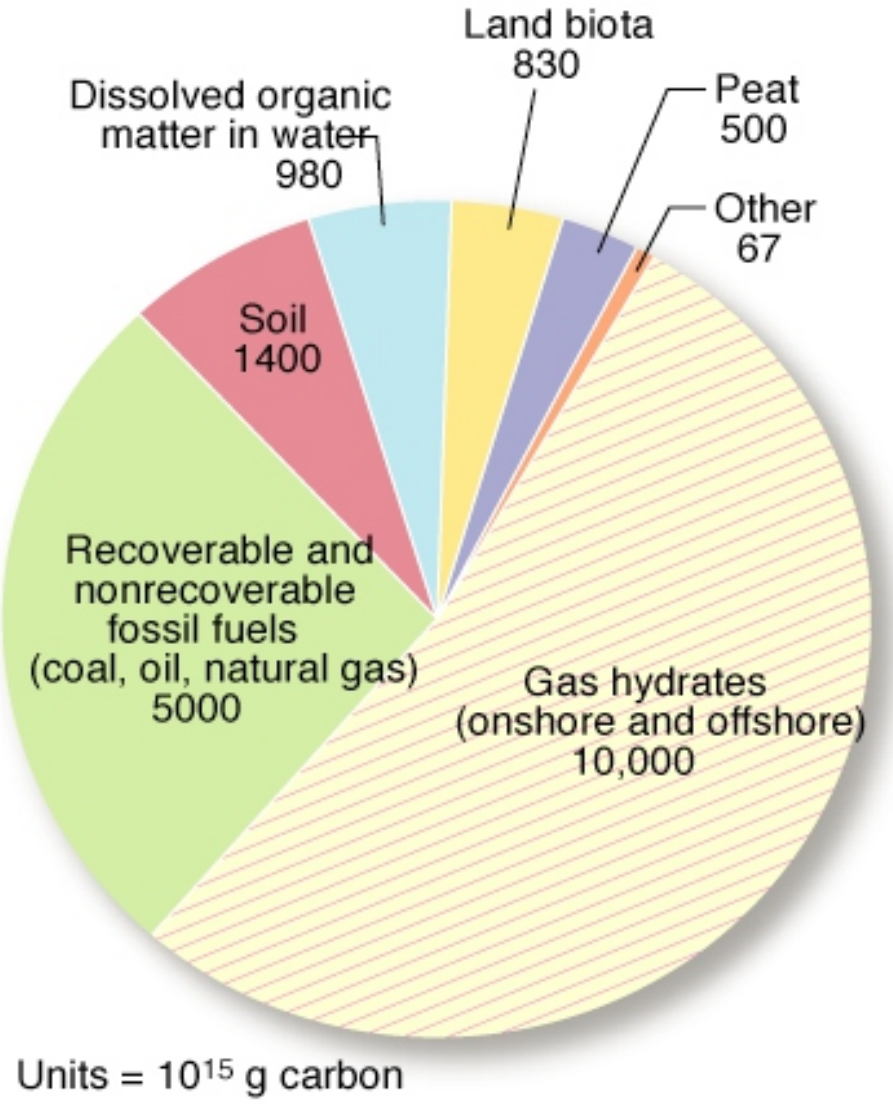
- Budget calculations for the ***global carbon cycle*** suggest that the input of methane (gas hydrate) from the oceans also may be minimal (Maslin and Thomas, 2003)

- Melting of gas hydrate occurs ***very slowly*** over a significant time period (Sultan, 2007)

Potential Energy Source

- Hydrate is estimated to bind immense amounts of methane in sediments
- Large research effort on locating GH resources and developing means for GH production
- Japan, US, India, China, Korea, New Zealand, Taiwan, Mexico, Brazil, Uruguay, Vietnam, Colombia, others





Gas hydrates as resource

- ③ In last 10 years several successful short-duration onshore production trials
- ③ Two days ago JOGMEG (Japan national oil comp.) announced worlds-first successful offshore production trials

12 March 2013 Last updated at 09:53 GMT

Japan extracts gas from methane hydrate in world first

Japan says it has successfully extracted natural gas from frozen methane hydrate off its central coast, in a world first.

Methane hydrates, or clathrates, are a type of frozen "cage" of molecules of methane and water.

The gas field is about 50km away from Japan's main island, in the Nankai Trough.

Researchers say it could provide an alternative energy source for Japan which imports all its energy needs.

Methane hydrate is also known as burnable or flammable ice

Related Stories

Ways to produce methane from gas hydrates

③ Production by hydrate dissassociation

- Raising temperature
- Reducing pressure (most effective and practical)
- Inject ‘anti-freeze’, such as salts or chemicals
- Methane replacement (for instance by injection of CO_2)

‘Exploring the dark’

Fugro involvement through the years

- NANKAI Trough (1999), Offshore Japan
- HYACE Trials – ODP Leg 194 (2001), Offshore WA
- ODP Leg 201 (2002), Offshore Peru
- ODP Leg 204 (2002), Offshore Oregon

- Chinguetti (2003), Offshore Mauritania
- JIP (2005), Gulf of Mexico
- Cascadia Margin IODP Leg 311 (2005), West Coast Canada

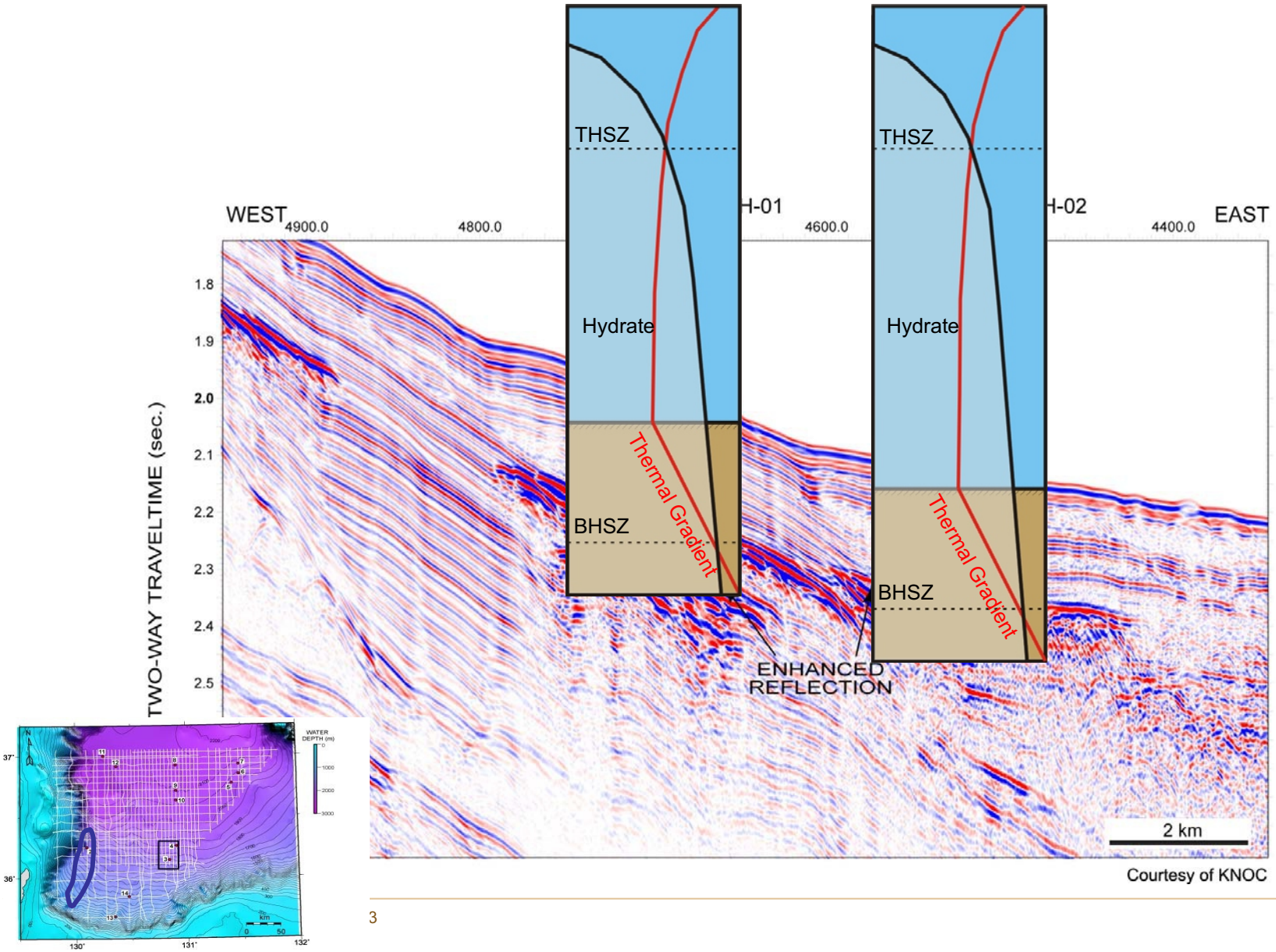
- Offshore Field Development (2006), Offshore Malaysia
- DGH, Indian National GH Program (2006), Offshore India
- GMGS, China National GH Program (2007), South China Sea
- KNOC, Korean National GH Program (2007), East Sea
- KNOC, Korean National GH Program (2010), East Sea
- NANKAI Trough (2011), Offshore Japan
- GMGS, China National GH Program (2013), South China Sea

Hydrate detection and quantification

Reflection seismics

- ③ Geophysical downhole logging
- ③ Sampling
- ③ Testing

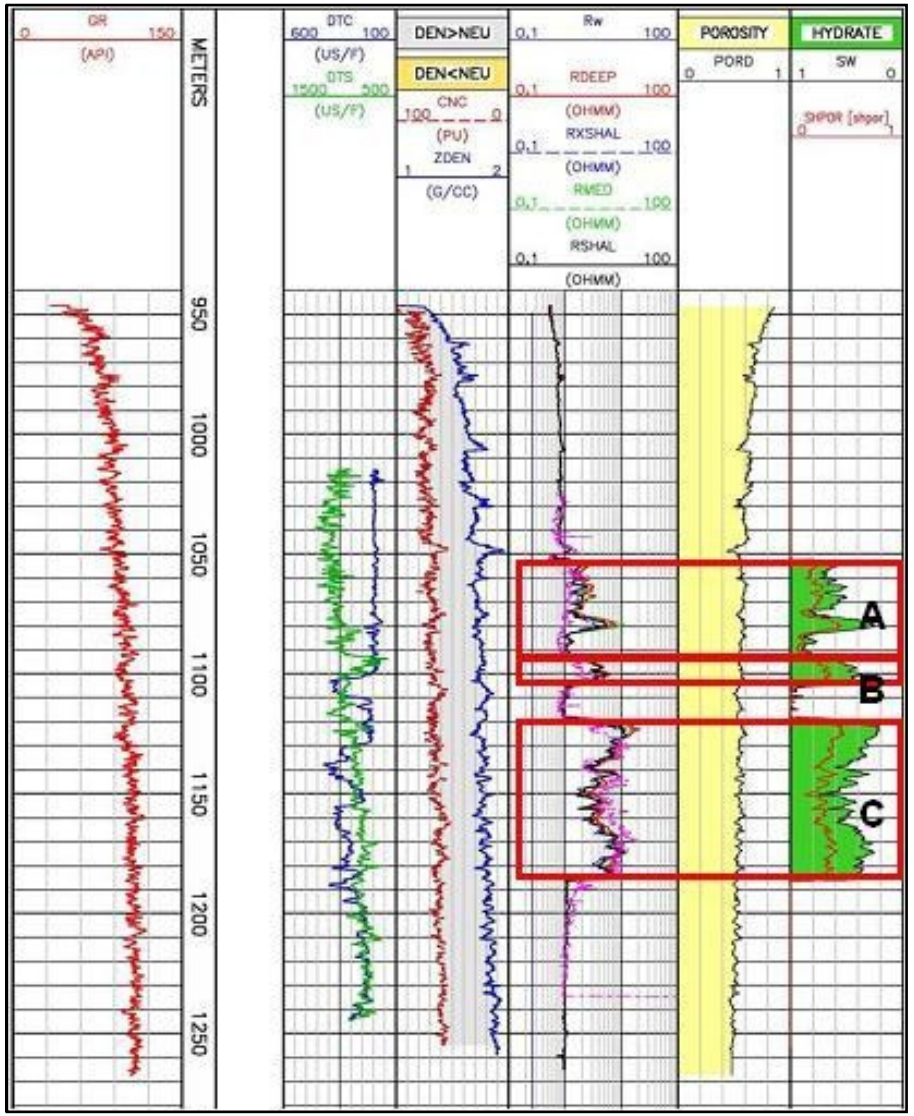
Thermal gradient – base hydrate stability zone Korea



Geophysical Logging

Wireline logging signature:

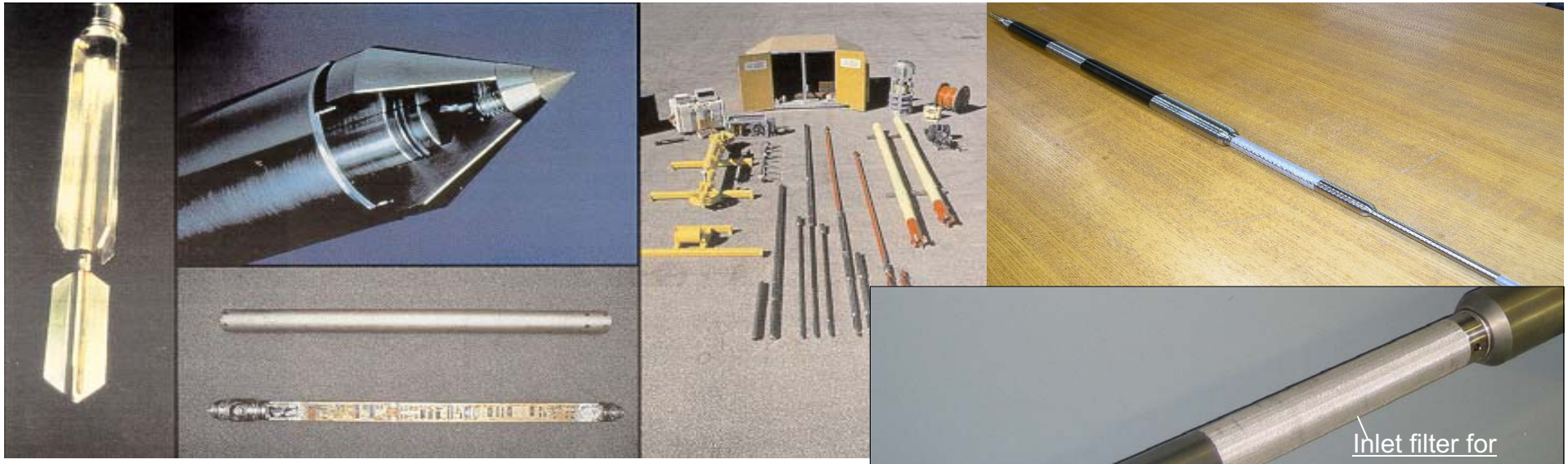
- ③ Electrical resistivity (very high)
- ③ Neutron porosity (slight increase)
- ③ S-wave velocity (very high)
- ③ P-wave velocity (high)
- ③ Natural gamma ray (unaffected)
- ③ Gamma density (slight decrease)
- ③ Calliper (ragged/oversized)

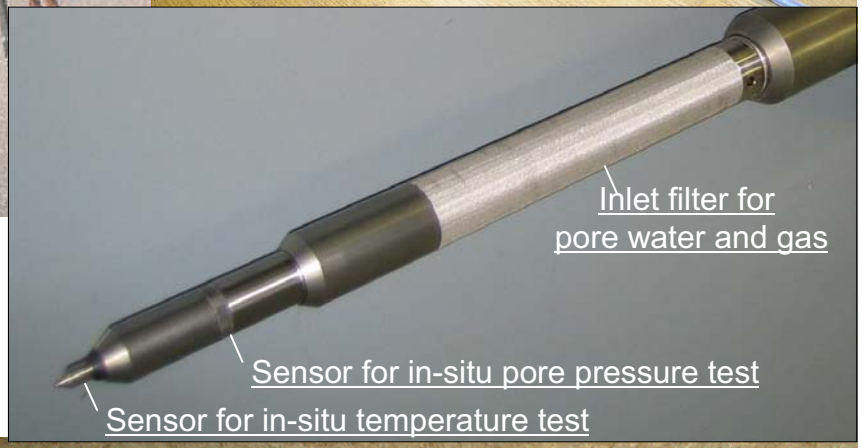


Sampling massive seabed hydrates

2:04 min

In Situ Testing Systems

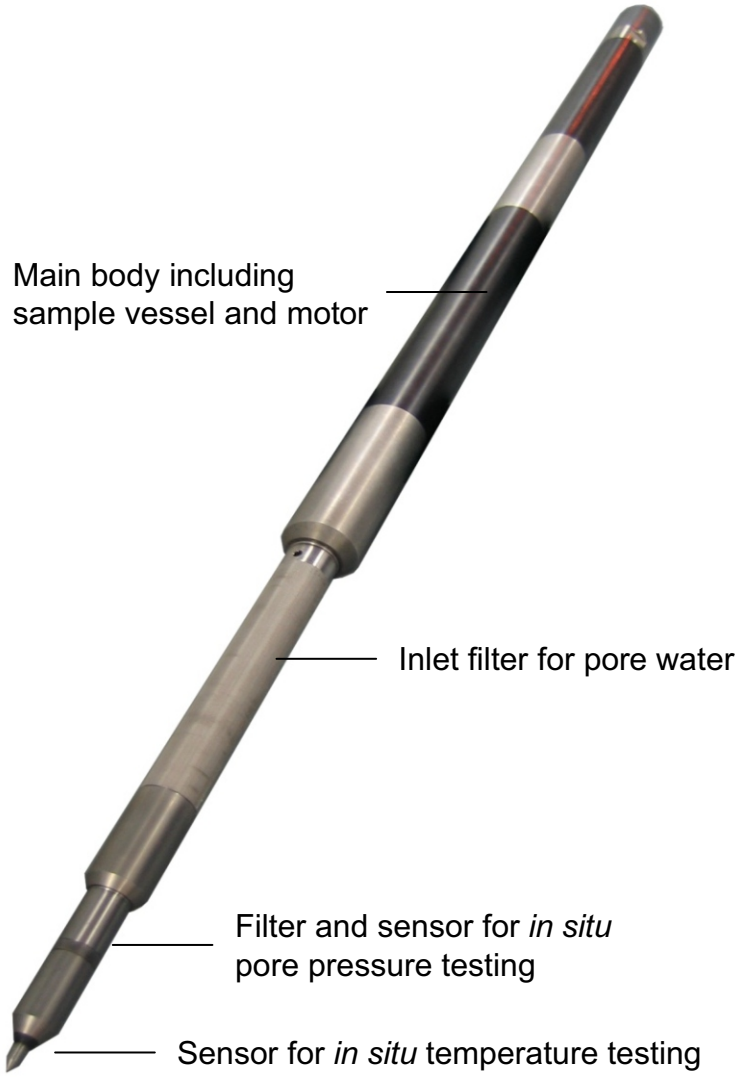




- Temperature
- Pore Water Sampling (PWS)
- Pore Pressure
- Electrical Conductivity (Resistivity)
- Piezocone Penetrometer Testing (PCPT
- Thermal Conductivity
- Vane Shear
- Ball Penetrometer

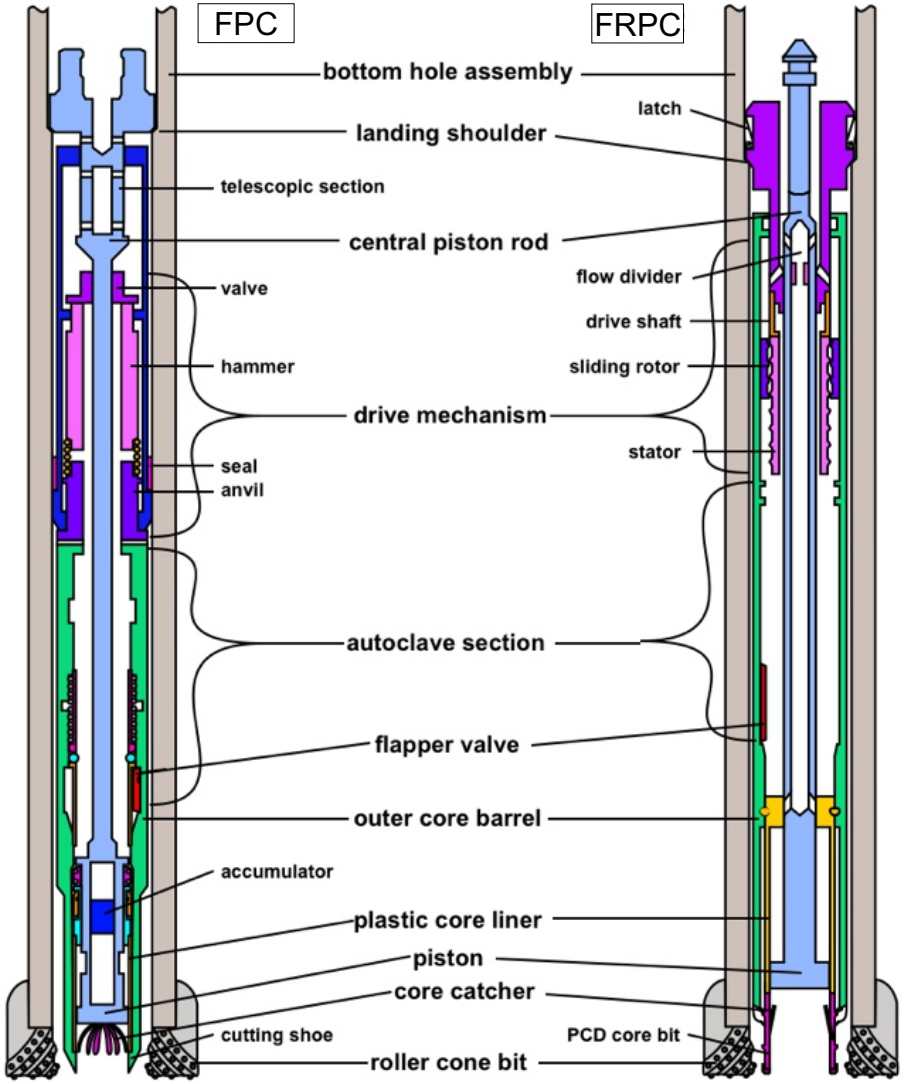
Pore Water Sampler

- Operates to 3000 m water depth
- in situ pressure and temperature testing
- Real time monitoring of tests and real time controlled thru logging cable
- WISON EP (4.5 m stroke) downhole push system
- Analysis of pore water sample - gas chromatograph (composition/ saturation of porewater)

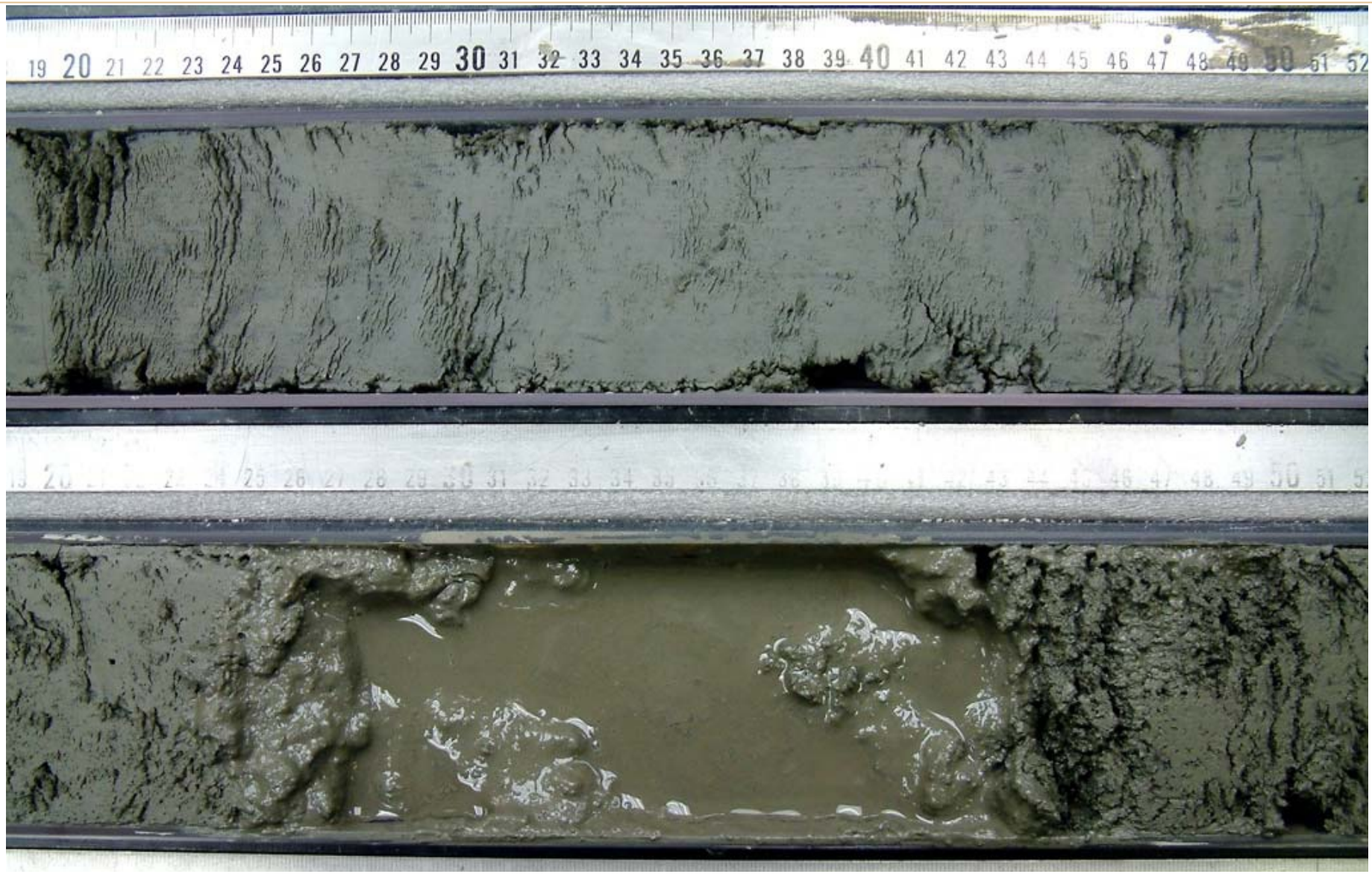


Pressure Corers – FPC & FRPC

- ③ Downhole tools for sampling and deck-to-deck measurement of internal temperature and pressure
- ③ FPC: push + hydraulic percussion
- ③ FRPC: hydraulic rotary coring

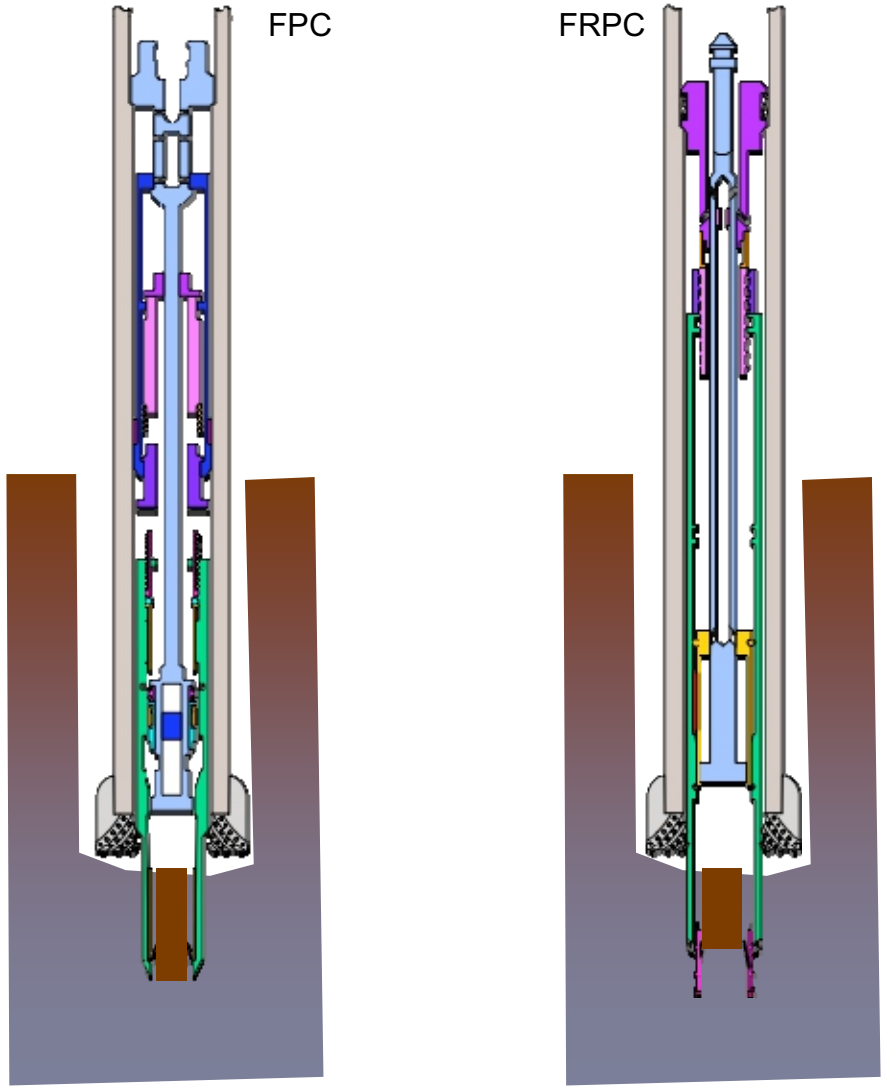


Benefit of Pressure Cores



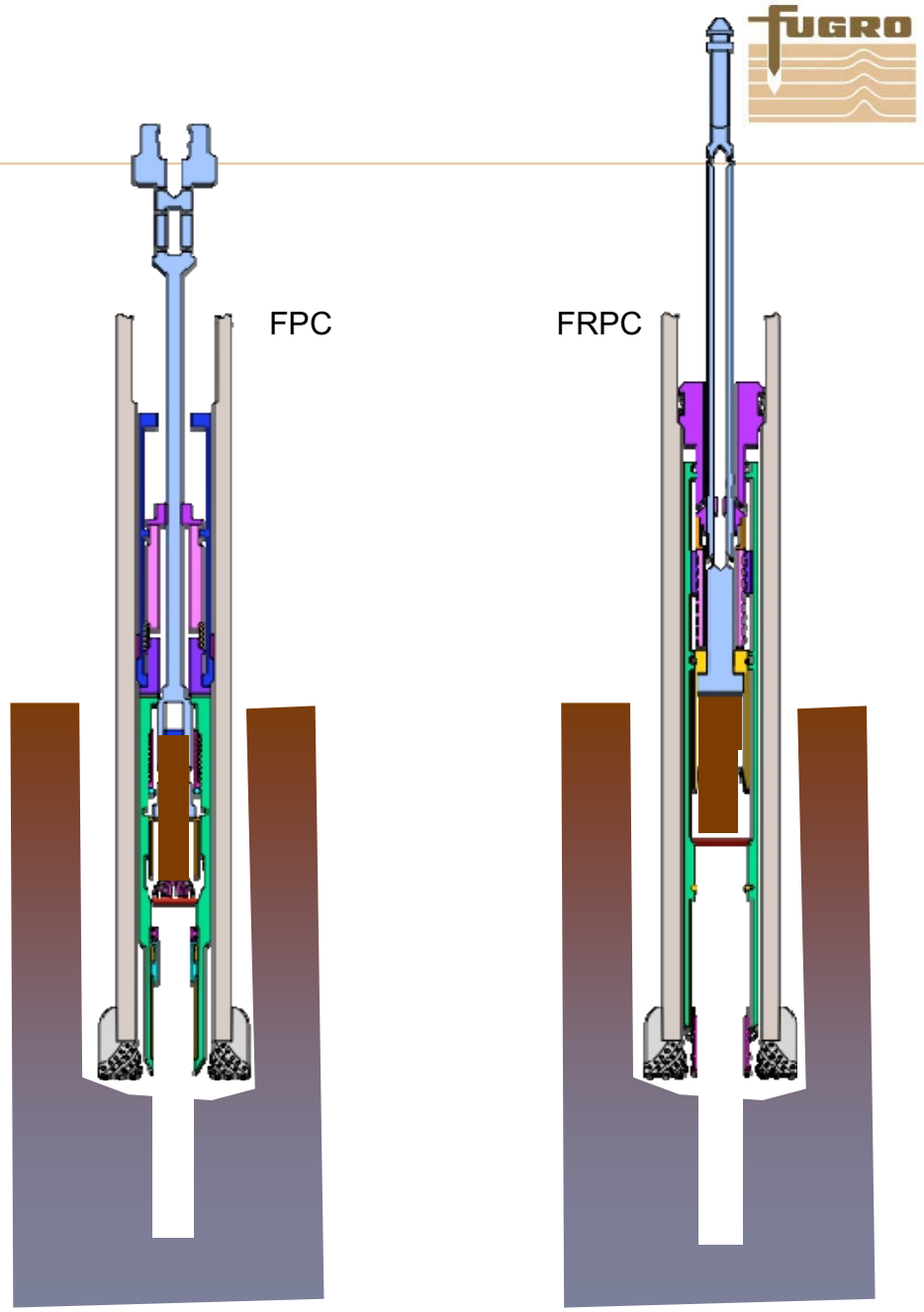
Wireline Pressure Coring: Coring operations

③ Core is cut in undisturbed formation ahead of the drill bit



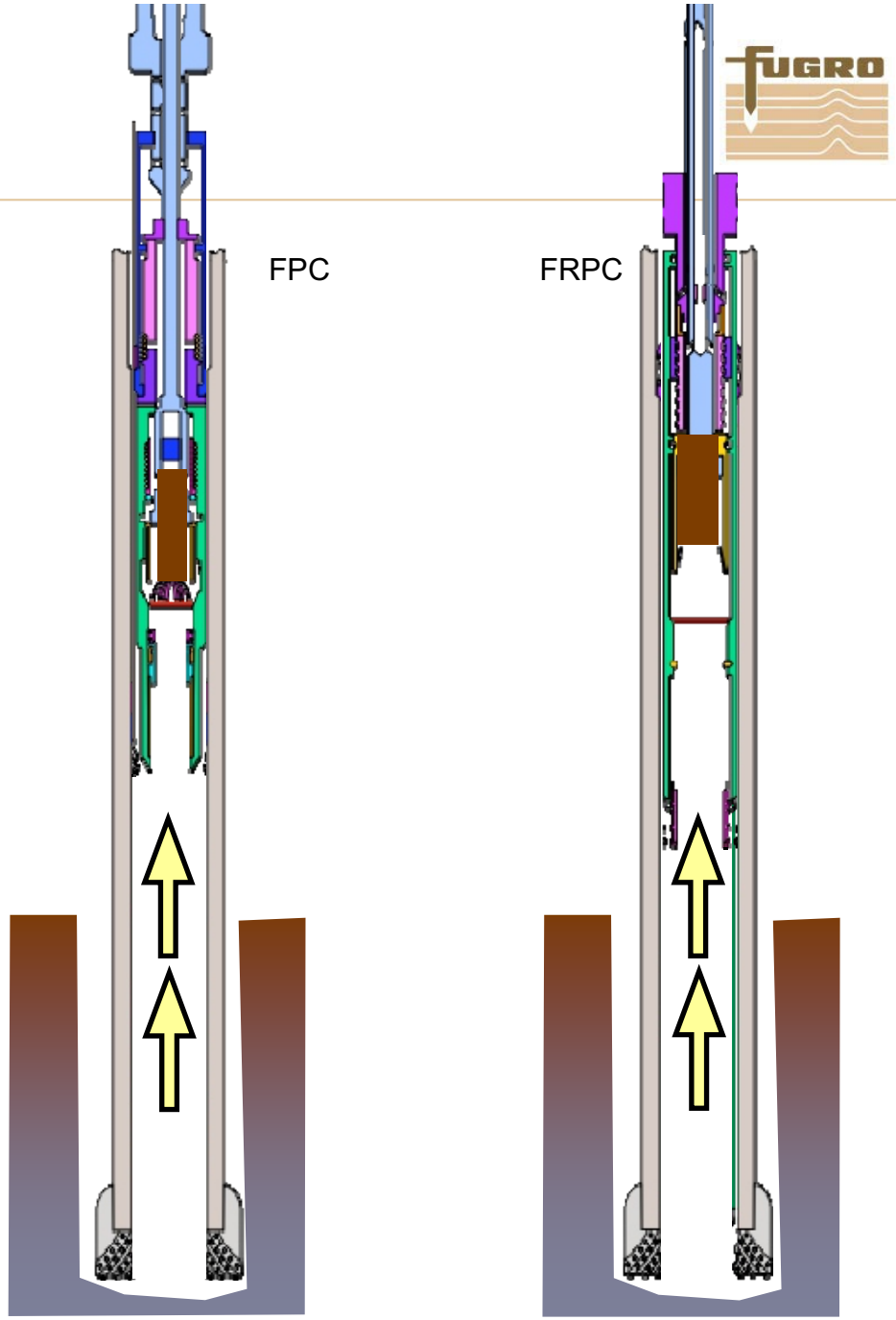
Wireline Pressure Coring: Retraction

③ Core is retracted into the autoclave pressure chamber

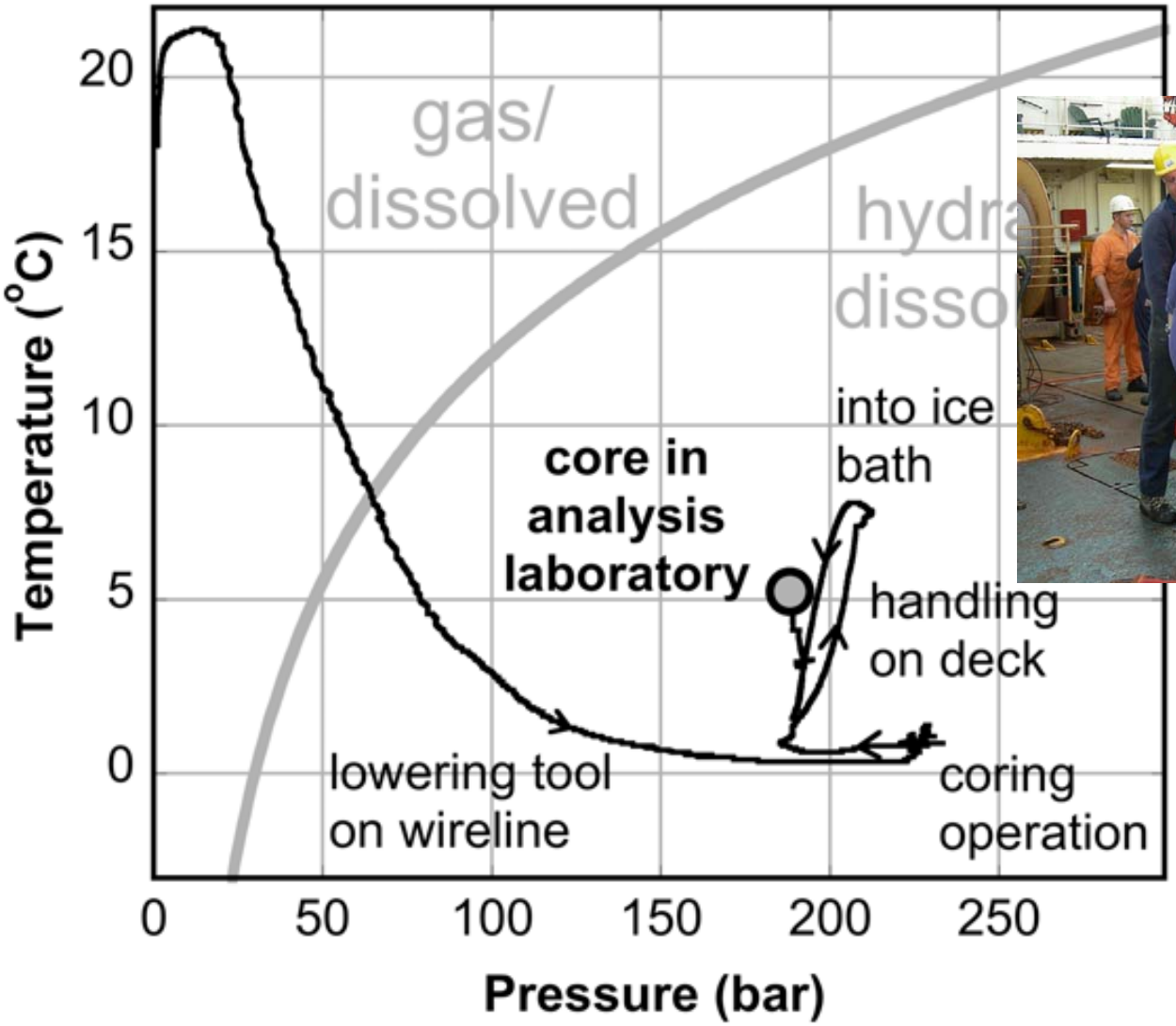


Wireline Pressure Coring: Retrieval

③ Core is sealed in autoclave and retrieved to the drill floor

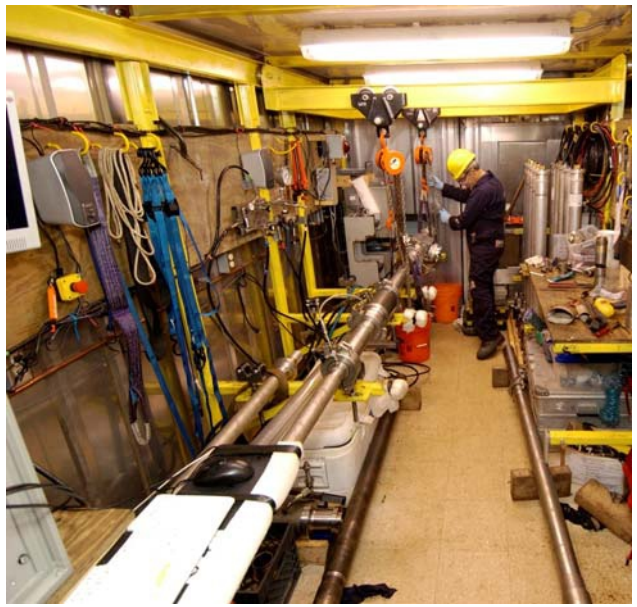


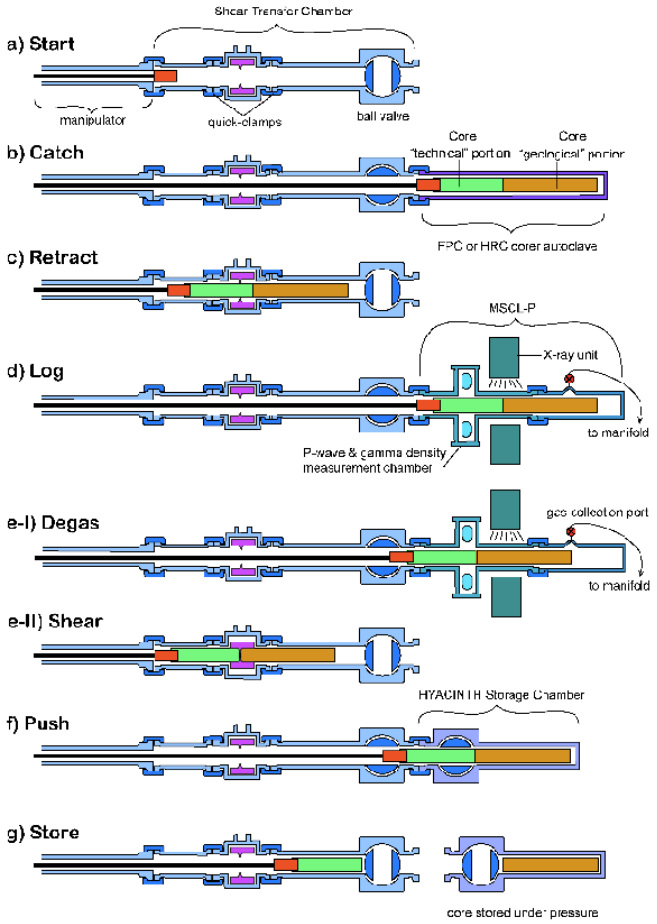
Pressure core handling



Pressure Core Analysis

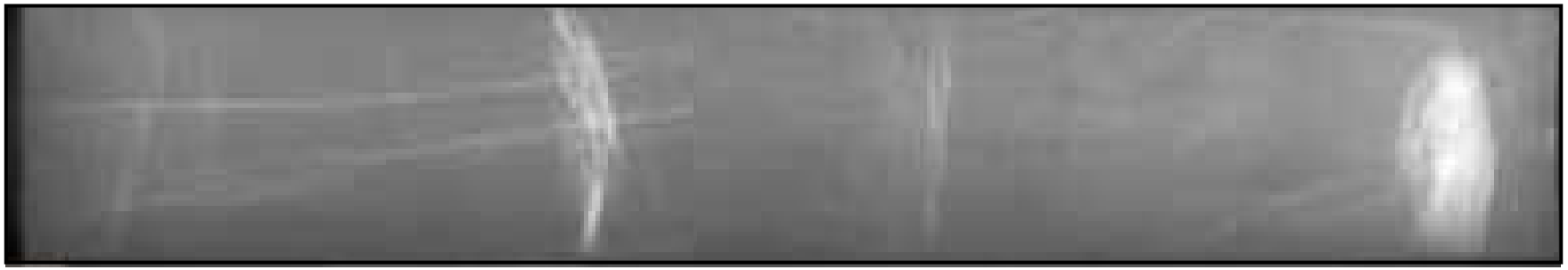
- ③ Why collect pressure cores if you have to release the pressure to analyze the core?
- ③ The pressure coring tools were built together with the analysis system.



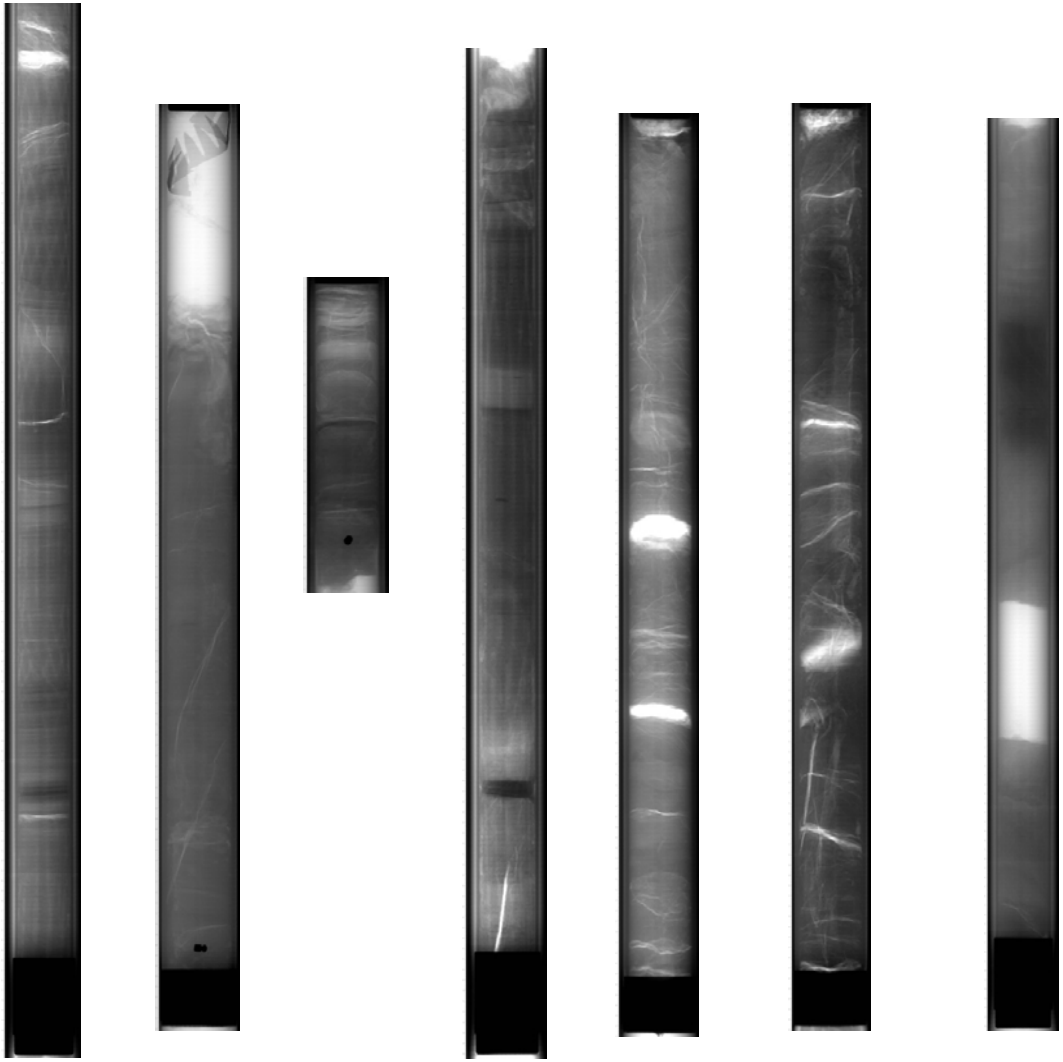


Pressure Core Analysis

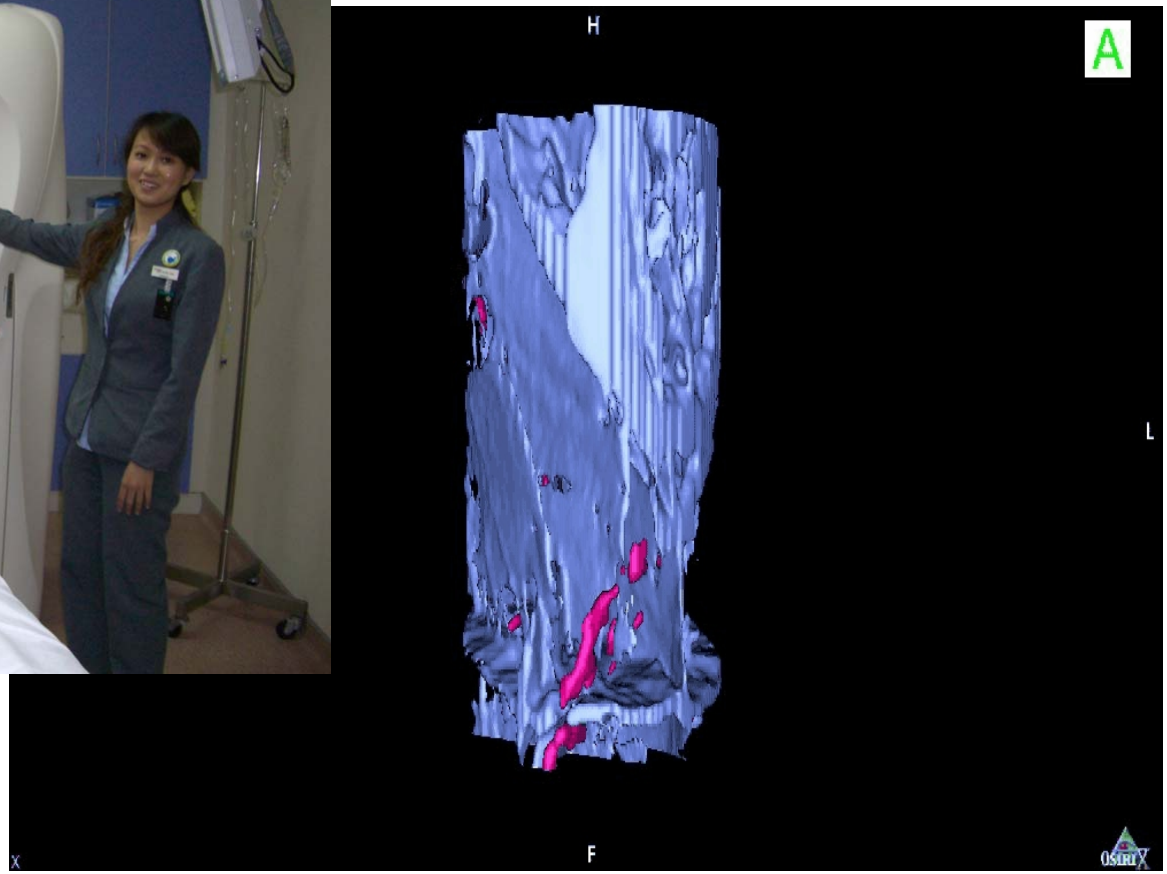
- Multi-sensor core logging (including density, P-wave and x-ray)
- Controlled depressurization of gas for gas chromatograph analyses (similar to pore water sampler) and precise gas hydrate quantification
- Extrude samples for geotechnical/geological analysis
- Selected parts of de-pressurized sample can be squeezed in a press to extract pore water
- Geochemical testing on extracted pore water



Pressure cores with hydrate veins and layers, offshore Korea



Evaluation, interpretation of investigation results - CT Scan



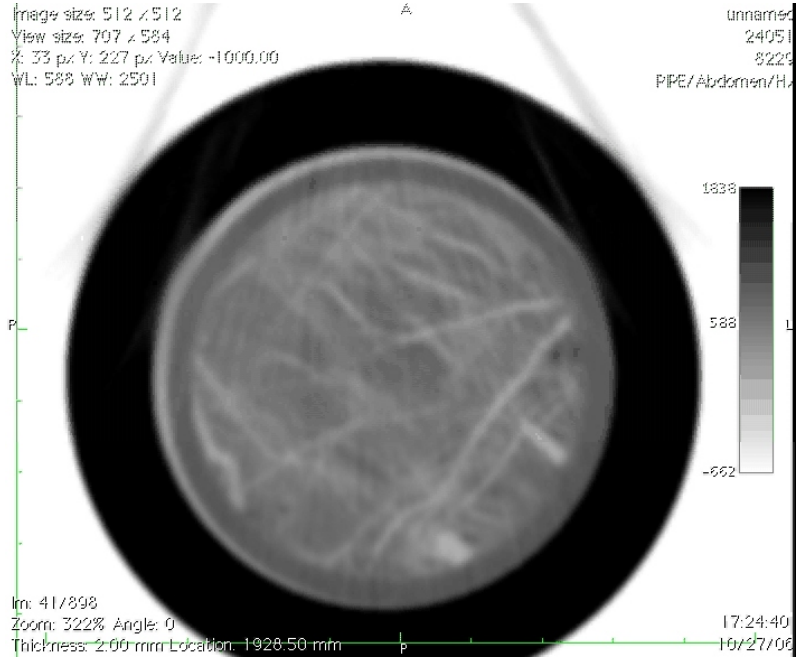
Conclusions - Detection and quantification

③ Hydrate detection and quantification

- Remote sensing techniques
- In-situ measurements
- Pressure cores
- Pore water samples

③ Quantification

- Volume
- Concentration
- Distribution



Fugro's future plans for hydrate investigation

- ③ Continue to be actively involved at the forefront of offshore gas hydrates investigations and research initiatives.
- ③ Improve current suite of tools - improved sampling and in-situ testing of gas hydrate bearing strata
- ③ Design, build and operate equipment that is specifically designed to meet gas hydrate project requirements
  - longer cores
  - higher pressure capability)
  - Integrated sub sampling / testing systems
  - Advanced testing equipment for geomechnical, geophysical, geochemical testing of pressure core sub samples
- ③ Monitor developments in the Alaskan Arctic and Japan's First Offshore Marine Production Tests for Methane Hydrates

Conclusions

Evaluation and quantification

Extensive suite of tools available for evaluation and quantification of marine gas hydrate deposits

Gas hydrates

③ A hazard?	Possibly
③ An environmental threat?	Unlikely
③ A resource	Likely in due time

Very strong geopolitical drive (energy independance)

So ‘shale gas’ beware, ‘gas hydrates’ are on your heels!

Thank you!