Methane Hydrate E&P

Myths and Realities

Art Johnson
Hydrate Energy International

Commercializing Methane Hydrates

Houston

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What is Gas Hydrate?

Gas hydrate is a crystalline solid consisting of gas molecules, primarily methane, each surrounded by a cage of water molecules.

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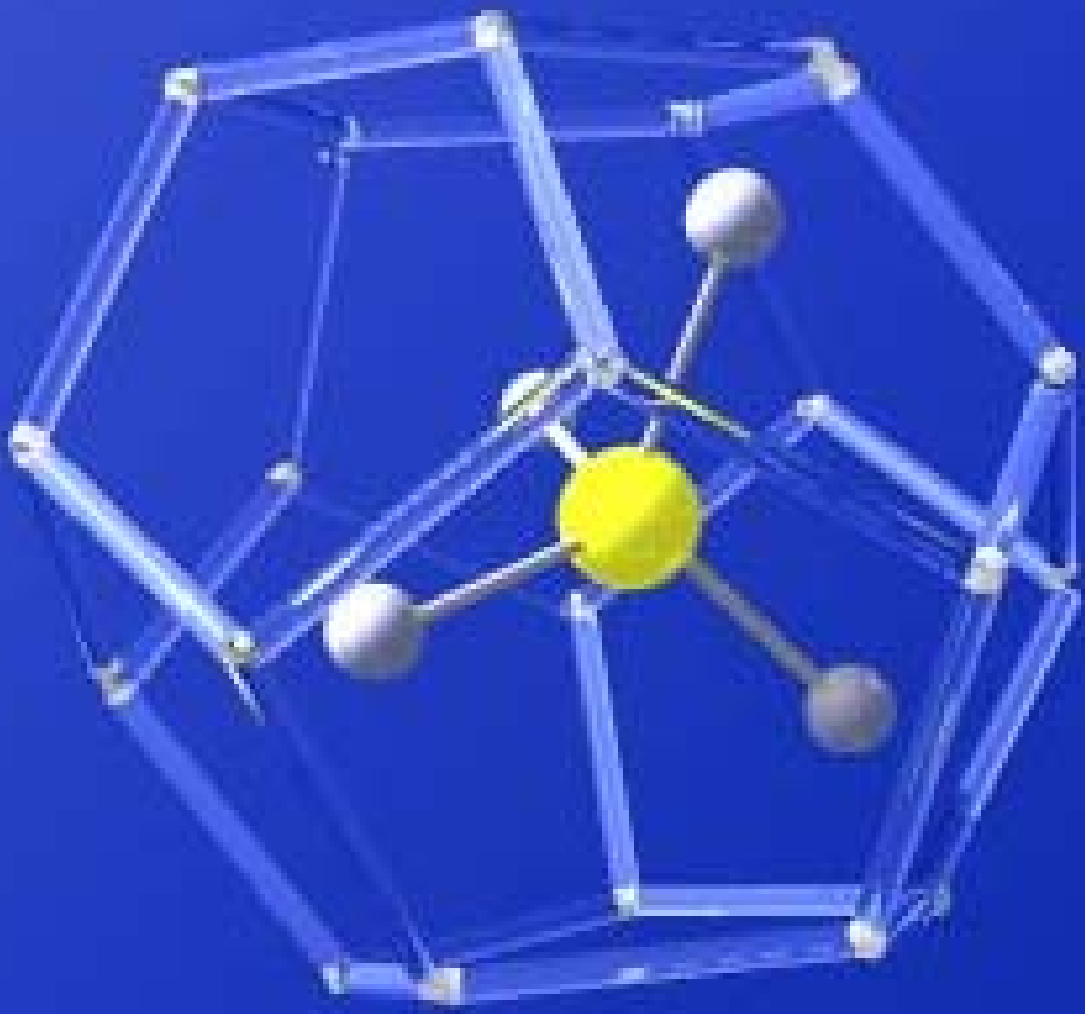

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Gas hydrate forms when gas and water combine under the appropriate conditions of pressure and temperature.

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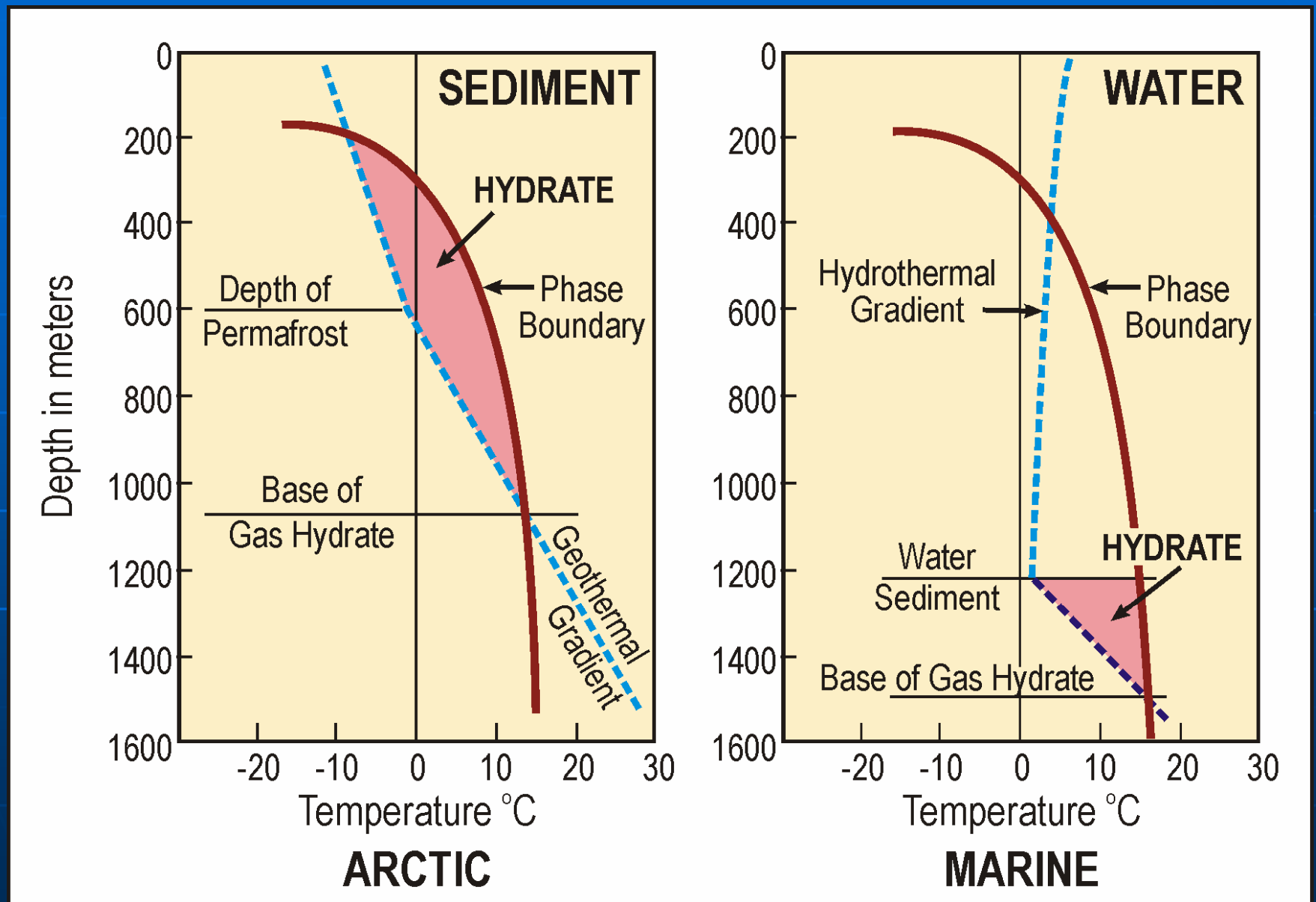
SEDIMENT
HYDRATE
Depth of
Permafrost
Phase
Boundary
Base of
Gas Hydrate
Geothermal
Gradient
Depth in meters
0
200
400
600
800
1000
1200
1400
1600
-20
-10
0
10
20
30
Temperature °C
ARCTIC
WATER
Hydrothermal
Gradient
Phase
Boundary
Water
Sediment
HYDRATE
Base of Gas Hydrate
Temperature °C
MARINE

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Why are we interested in Gas Hydrate?

1. When gas hydrate is warmed or depressurized, it reverts back to gas and water (it dissociates)

2. The gas hydrate structure concentrates natural gas

3. There is a lot of gas hydrate in the world

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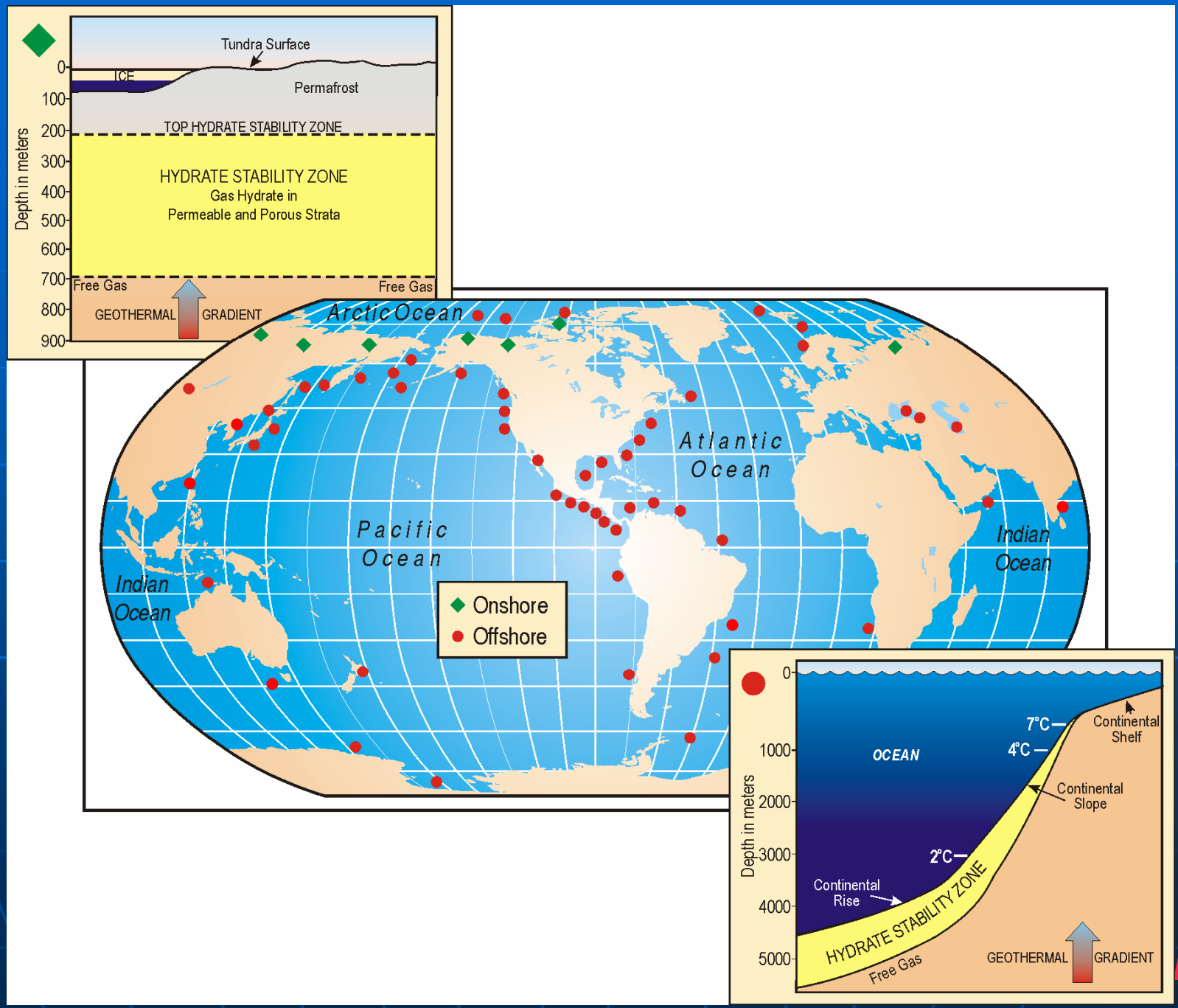
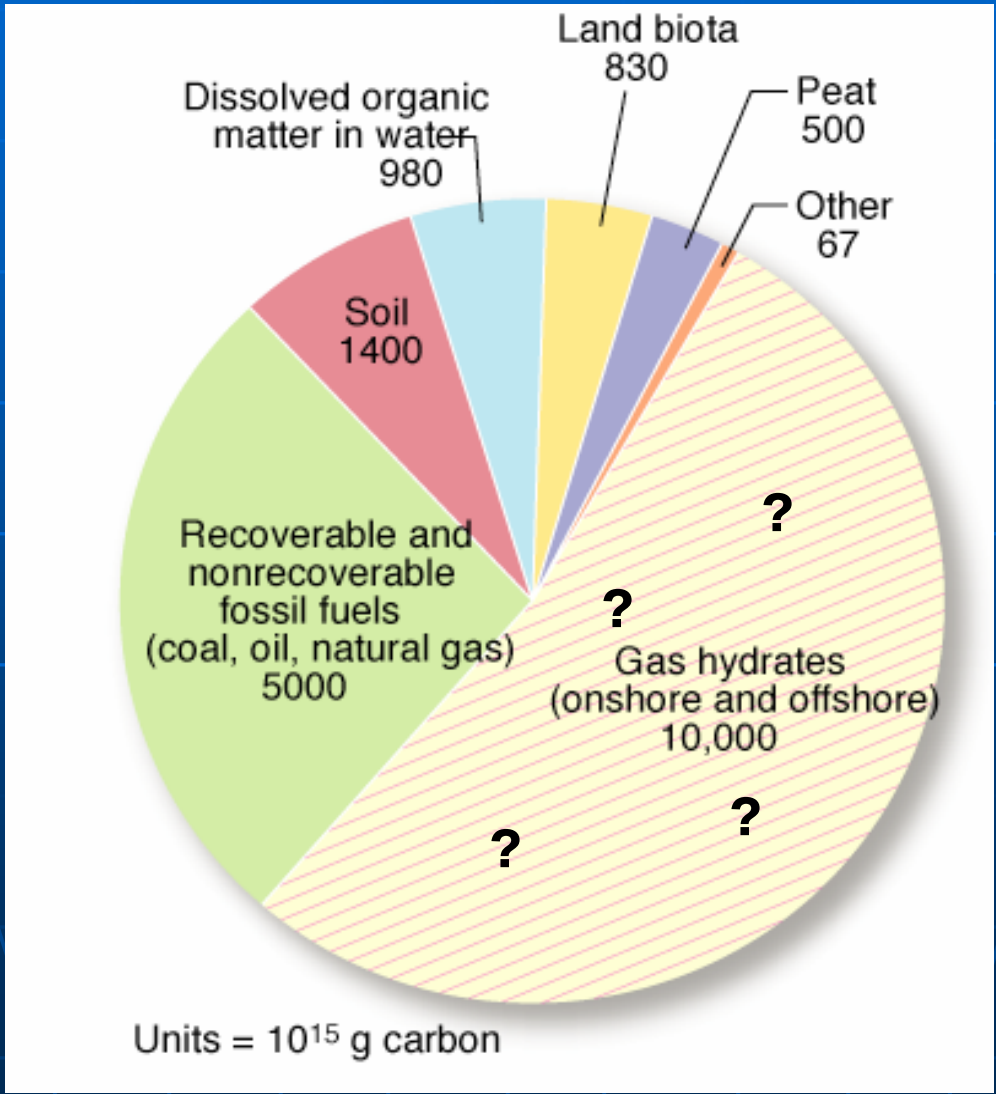

Tundra Surface
ICE
Permafrost
TOP HYDRATE STABILITY ZONE
HYDRATE STABILITY ZONE
Gas Hydrate in
Permeable and Porous Strata
Free Gas
Free Gas
GEOTHERMAL
GRADIENT
Depth in meters
0
100
200
300
400
500
600
700
800
900
Arctic Ocean
Atlantic Ocean
Pacific Ocean
Indian Ocean
Indian Ocean
Onshore
Offshore
OCEAN
7°C
4°C
2°C
Continental Shelf
Continental Slope
Continental Rise
HYDRATE STABILITY ZONE
Free Gas
GEOTHERMAL
GRADIENT
Depth in meters
0
1000
2000
3000
4000
5000

Organic Carbon Distribution



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Implications

- Seafloor Stability/Safety
- Global Climate Change
- Energy Resource

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- Seafloor Stability/Safety
- Global Climate Change
- Energy Resource

The Wrong Question:

- How many hydrate molecules are there in the world?

The Right Questions:

- How much hydrate is concentrated in reservoirs where it can be safely & commercially recovered?
- How can we locate and develop those reservoirs?

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A Term You Will Hear A Lot During This Conference:

Petroleum System

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Industry Perspectives on Gas Hydrate

Old View:

- Not commercial for 20-30 years
- Expensive
- Can't compete with other resources
- Entirely New technology required
  - "Not what our company does"
- "Not in my lifetime"

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A Few Gas Hydrate Myths

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Myth #1: The “BSR”

The Myth: Hydrate-bearing sediments can be identified by the presence of a “Bottom Simulating Reflector” on seismic data

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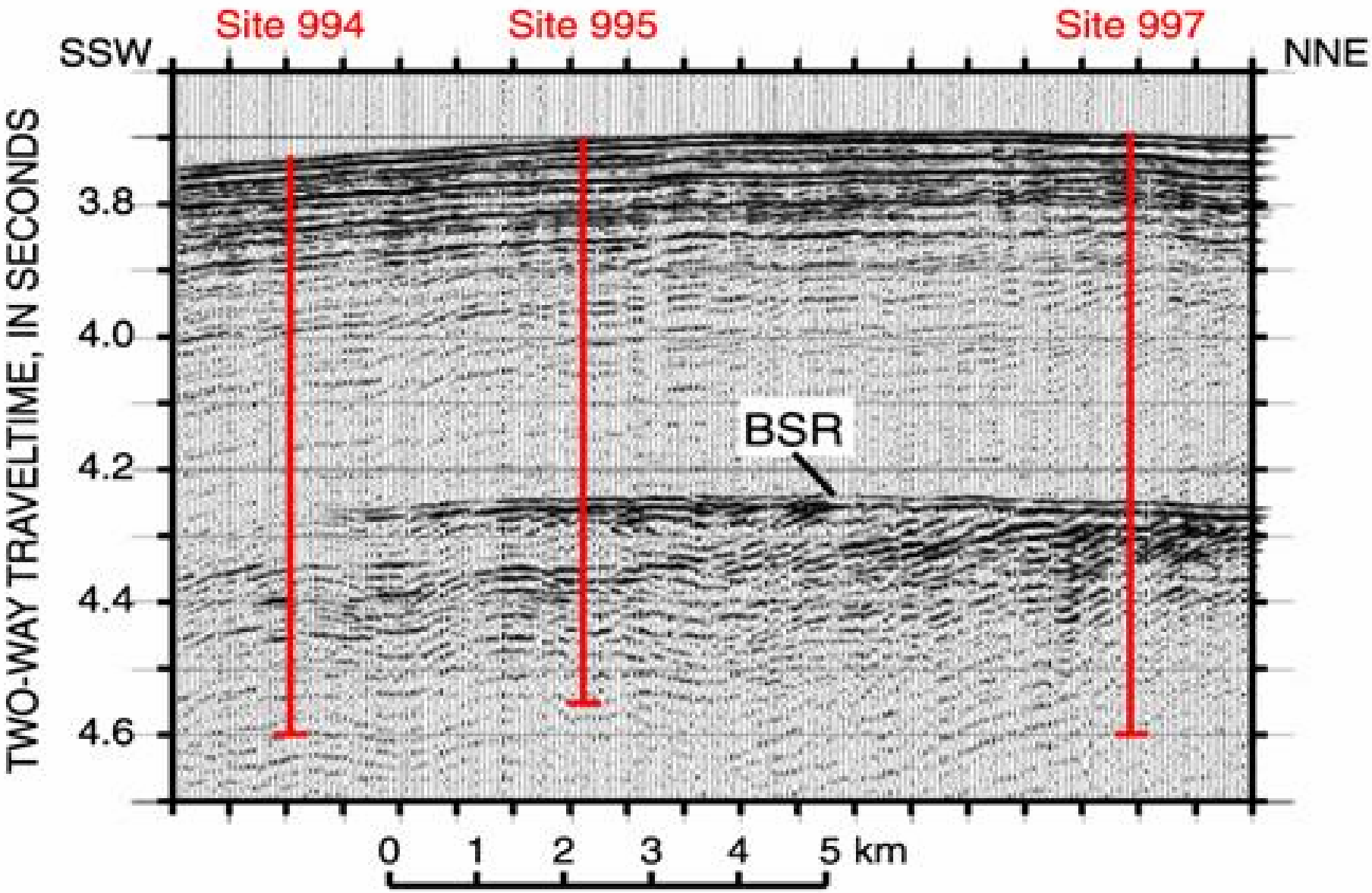
Blake Ridge BSR



The Problem with a “BSR Hunt”

- BSRs tell us nothing about the concentration of hydrate in sediment
- BSRs are rare in many basins that are known to contain gas hydrates
- The strongest BSRs occur in shales, not with reservoir-quality sands
- Identification of a BSR requires that strata are not parallel to the seafloor

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A Valid Role for BSRs

- BSRs define the hydrate/free gas phase boundary
- Finding a BSR allows a validation or invalidation of the assumptions of hydrothermal gradient, geothermal gradient, and gas composition

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Fundamentals of Hydrate Prospecting

Petroleum System

Myth #1: The “BSR”

Reality:

Commercial gas hydrate prospects require

- Appropriate P-T conditions
- Reservoir-quality lithology (sand)
- Adequate gas flux

A BSR is not required

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Myth #2: The Blake Ridge

The Myth: The best hydrate resources for the U.S. are at the Blake Ridge (Carolina Offshore). The Gulf of Mexico is not very prospective

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Myth #2: The Blake Ridge

Initial Reports from Academia:

- No sands within the HSZ in the Gulf
- Seafloor hydrate mounds and shallow fracture-fill are the only plays
- Strip mining or a new extraction method required

Based on piston cores & submarines

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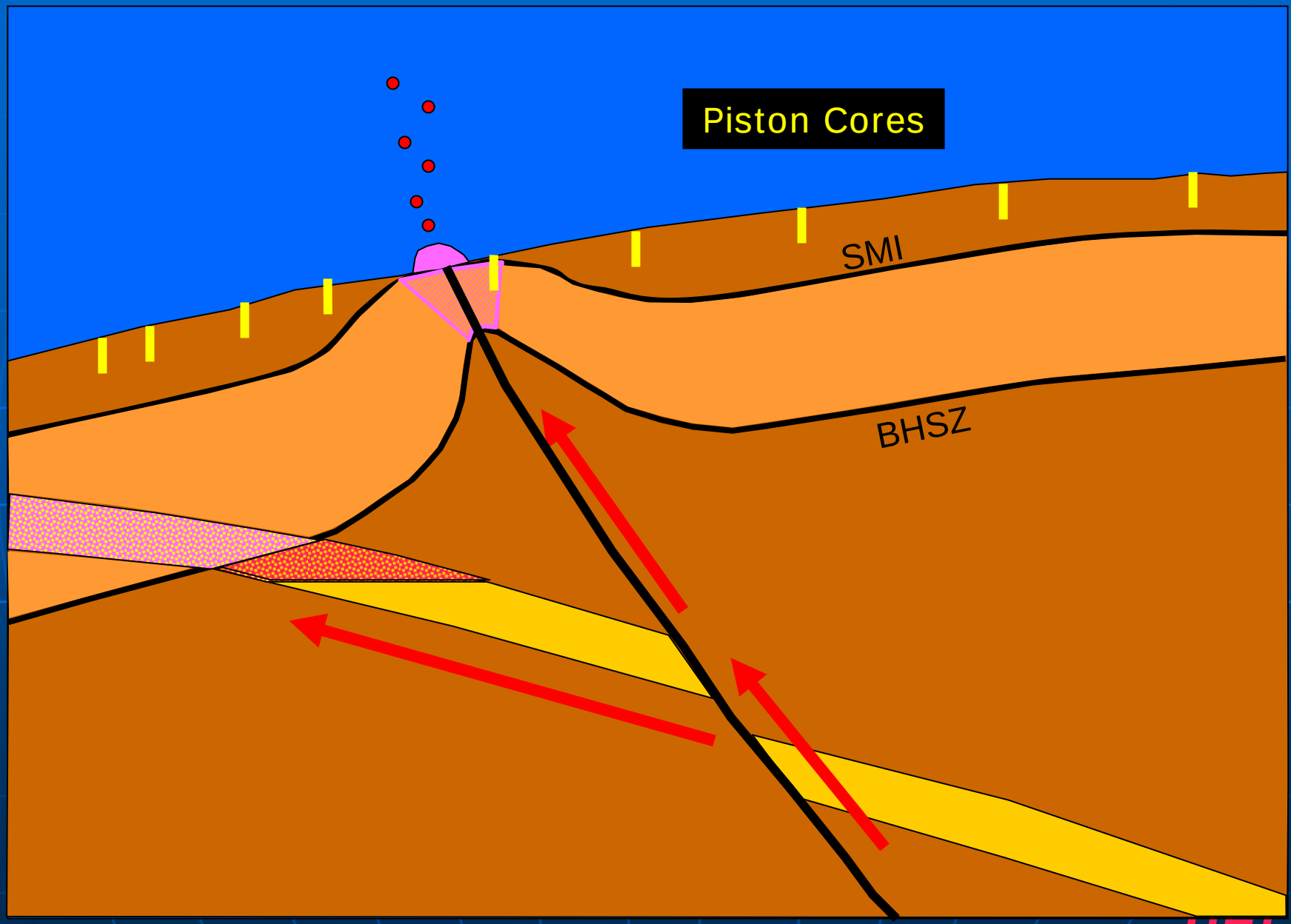
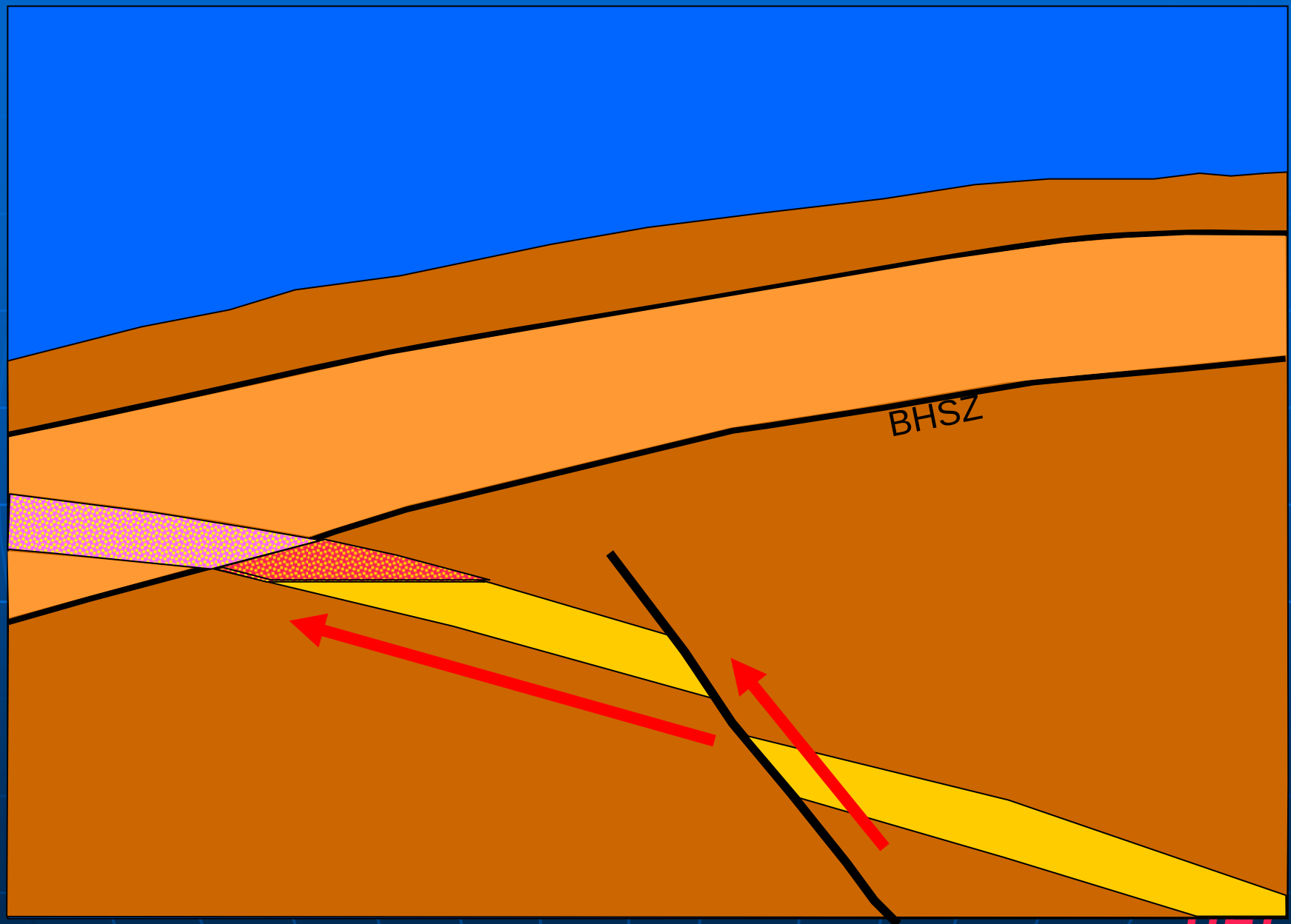
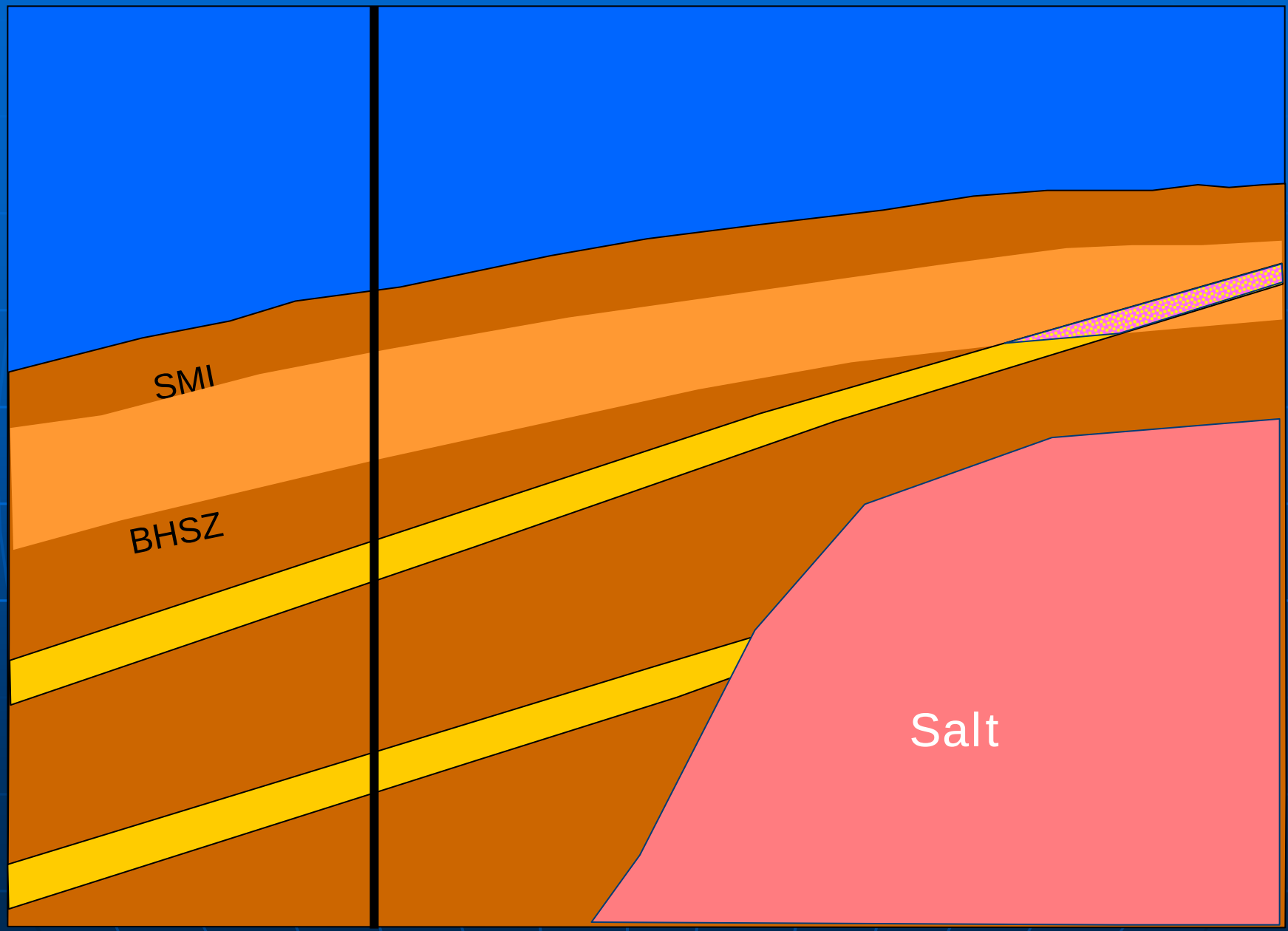

Piston Cores
SMI
BHSZ


BHSZ


SMI
BHSZ
Salt

Myth #2: The Blake Ridge

Reality:

- The Gulf of Mexico has all of the components needed for commercial gas hydrate prospects
  - Also abundant infrastructure
  - No moratorium in key areas

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Myth #3: The Timeline

The Myth: Commercial Development is 20-30 years away and will involve entirely new technology

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2002 Canadian Production Test

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Global Activity
Recent and Current

- Japan – Drilling Program 2004
  - 32 wells
- India – Drilling Program 2006
  - 39 wells
- MMS Assessment 2006
  - Possible impact on lease valuations

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Global Activity
Recent and Current

- Canada & Japan – Arctic Production Test 2006-2007

- U.S. North Slope –Hydrate Well 2007 (BP)

- Gulf of Mexico – Multi-Well Consortium Drilling Program 2007?
  - Site selection in progress

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Global Activity
Recent and Current

- Canada & Japan – Extended Production Test 2007-2008
- India – Production Test 2008
- Seismic Surveys currently being shot specifically for hydrate assessment

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Global Activity
Recent and Current

- China – 2007 Hydrate Drilling Program

- South Korea – 2007 Hydrate Drilling Program

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Global Activity
Recent and Current

National Gas Hydrate Programs/Research

- U.S.
- Japan
- India
- Canada
- China
- Korea
- Mexico
- Chile
- Ireland

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Key Challenges

- Identifying/Quantifying Prospects
- Production Technology
- Economic Viability
- Transporting “Stranded” Gas

  - Ultimate Recovery per Well
  - Flow Rates
  - Operating Expense

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Myth #3: The Timeline

Reality:

All the pieces are coming together very quickly.

Existing technology is being leveraged.

New technology is rapidly emerging.

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Myth #4: Hydrates are irrelevant to our current business

The Myth: Hydrates have no net present value so they can be ignored in deepwater lease sales

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Myth #4: Hydrates are irrelevant to our current business

Reality: Within the life of a deepwater lease, commercialization of gas hydrates is likely.

Hydrate resources will have value for lease owners.

Hydrate resources will eventually be included in MMS bid assessments.

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Changing Industry Perspectives on Gas Hydrate

New View:

- Commercial in 5-10 years
  (limited production sooner)
- More expensive, but not prohibitive
- Existing technology can be leveraged
- Needs to be considered

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Critical Questions for this Conference

- Is there room in gas markets for production from hydrate?
- What is the current status of exploration technology and where is it headed?
- What is the current status of production technology and where is it headed?

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Critical Questions for this Conference

- What are the business aspects of pursuing hydrate development?
- What is the outlook for the Gulf of Mexico and Alaska?
- What are some key players doing?

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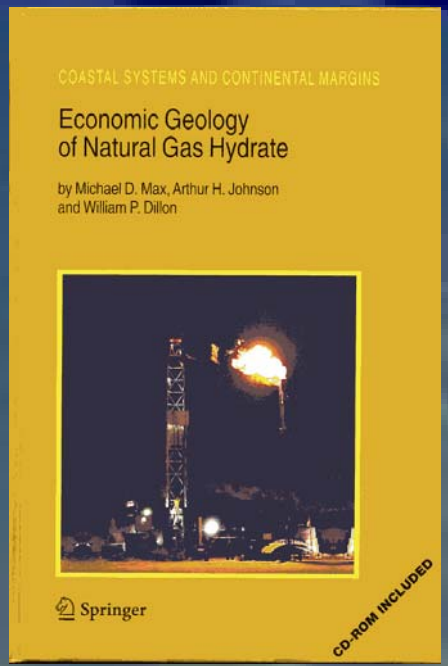
Thank You



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hydrate-energy.com

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