Current NRL Methane Hydrate Research

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- Coastal Ocean
- Arctic Permafrost
- NRL Activity
- NRL Plans
Presentation Outline

• Brief Overview
• Alaminos Canyon
• Hikurangi Margin
• Mid Chilean Margin
• Arctic Ocean planning
General Overview

Seismic profiles – BSR and seismic wipe out

Piston coring – Porewater geochemistry, shallow sediment carbon cycling and porewater geochemistry and microbial ecology, community diversity, carbon flux to water column, stable and radio carbon, other elements

Heat flow – Vertical fluid migration
Vertical Methane Flux

\[ \text{CH}_4 + \text{SO}_4^{2-} \rightarrow \text{HCO}_3^- + \text{HS}^- + \text{H}_2\text{O} \]

- A. Shallow BSR, high heat flow, sulfate dep.
- B. No BSR, high heat flow, shallow SMT
- C. BSR, intermediate heat flow, SMT
- D. No BSR, low heat flow, deep SMT
General Research Objectives

- Determine porewater gas source(s).
- Estimate the vertical methane flux in terms of the sulfate-methane transition (SMT) and sulfate gradients.
- Provide supporting data on vertical methane flux with comparison of chloride, sulfide, dissolved inorganic carbon (DIC), and $\delta^{13}$C DIC analysis of porewater.
- Integrate data interpretation with seismic, heat flow and geochemical data.
- Study the shallow biogeochemical cycling of deep sediment methane.
- Relate the vertical methane flux to horizontal and vertical variation in the microbial community diversity.
- Characterize methane seeps into the water column.
### Coastal SMI Summary

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**Notes:**
- SMT: Sediment Magnitude of Turbulence
- TWT: Two-Way Travel Time
- Gas venting: Potential hydrate
- Regional Depth to Base of Gas Hydrate stability
- Depth (km)

**Image:**
- Diagram showing depth traversal and potential gas hydrate layers.
- Coastline and oceanic features marked.

**Context:**
- Coastal SMI analysis for various regions.
- Comparison of sediment magnitude and travel times across different locations.

**Legend:**
- SMT: Sediment Magnitude of Turbulence
- TWT: Two-Way Travel Time
- Regional Depth to Base of Gas Hydrate stability
- Depth (km)
Alaminos Canyon, Block 818

Lead Scientists:
Richard Coffin, NRL
Leila Hamdan, NRL
Kelly Rose, NETL
Ross Downer, Milbar Hydrotest Inc.
Joan Gardner, NRL
Rick Hagen, NRL
Warren Wood, NRL

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Seismic Profile Review

Inlines 986, 1006, 1016, 1026, 1046
Geochemical – Seismic Overview

Depth (km)


SO₄²⁻ mM

0 5 10 15 20 25 30 cmbsf

0 200 400 600 800 cmbsf

Crossline

14000 13960 13920 13880 13840 13800 13760 13720 13680 13640

Inline 986

Depth (km)

2.68

2.98

3.28
Sulfate – Methane Profiles

**Crossline**

**Inline 986**

Potential hydrate
Gas venting
Free gas

**SO₄²⁻ mM**

**Core 9**

**Core 4**

**Core 7**

**Core 21**

**CH₄ mM**

- sulfate
- methane

- 0.000
- 0.002
- 0.004
- 0.006
- 0.008
- 0.010
- 0.012

- 0.0
- 0.2
- 0.4
- 0.6
- 0.8
- 1.0
- 1.2

- 0
- 2
- 4
- 6
- 8
- 10
- 12
- 14
- 16
- 18

- 0
- 5
- 10
- 15
- 20
- 25
- 30

- 0
- 200
- 400
- 600
- 800
- 1000

- 0
- 500
- 1000
- 1500
- 2000

- 0
- 5
- 10
- 15
- 20
- 25
- 30

- 0
- 200
- 400
- 600
- 800
- 1000

- 0
- 200
- 400
- 600
- 800
- 1000
Poranghau Ridge, Hikurangi Margin

New Zealand

Richard Coffin, Leila Hamdan, John Pohlman, NRL, DC
Warren Wood, NRL Stennis
Ingo Pecher, Stuart Henrys and Jens Greinert, GNS, NZ
Andrew Gorman, University of Otago, NZ
Porewater Geochemical Profiles

- Methane (mM)
- Sulfate (mM)
- DIC (mM)
- TDS (mM)
- Porosity
Thermal Gradients

De-trended Thermal Gradients

Deviation from 55 mK/m (Degrees C)

-0.04 -0.02 0 0.02 0.04

Depth (m)

Landward of Ridge

Seaward of Ridge

Warren Wood – NRL-Stennis
CSEM Application
CSEM DATA

Katrin Schwalenberg, BGR - Hanover
Porangahau Ridge Overview

a) Low-permeability slope sediments.
b) Expulsion of fluids sourced in the accretionary prism c) Seismic high reflectivity band marks local shoaling of the BGHSZ.
c) BSR observed on the landward side of the ridge
d) Core of the anticline with older, probably fractured and permeable material.
e) Resistivity anomaly above the high amplitude reflection band indicated elevated gas hydrate concentrations.
f) Advective heatflow and shallow sulfate profiles
**Mid Chilean Margin**

<table>
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<tr>
<th>Name</th>
<th>Institution</th>
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<tbody>
<tr>
<td>Dr. Juan Díaz</td>
<td>PUCV, Chile</td>
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<tr>
<td>Dr. Richard Coffin</td>
<td>NRL, DC</td>
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<tr>
<td>John Pohlman</td>
<td>VIMS, VA</td>
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<td>Dr. Leila Hamdan</td>
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<td>Dr. Shelby Walker</td>
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<td>Ross Downer</td>
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<td>Eleonora Barroso</td>
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$\delta^{13}C$ DIC and CH$_4$
Beaufort Sea Research Planning

Thomas Bianchi, TAMU
Richard Coffin, NRL
Roswell Downer, Milibar
Lars Golmen, NIVA
Jens Greinert, University of Ghent
Leila Hamdan, NRL
David Kirchman, University of Delaware
Thomas Lorenson, USGS
Ingo Pecher, Heriott-Watt University
Christopher Osburn, UNCS
Stephen Masutani, UH
John Morse, TAMU
Kelly Rose, NETL
Joseph Smith, NRL
Tina Treude, IFM-GEOMAR
Shari Yvon-Lewis, TAMU
Warren Wood, NRL
Brandon Yosa, UH
Research Plan

- Gas Hydrate Stability
- Tundra Input and Cycling
- Seismics
- Water Column Methane Cycling
- Methane Cycling
- Free Methane Gas
- Permafrost
- TGHS
- Hydrates
- CDOM
- TDOM
- CO₂
- AOM
- DOM
- HCO₃⁻
- Hydrate CH₄
- Gas CH₄
- HCO₃⁻ AOM
- Hydrate CH₄
- Flux to the Atmosphere
- CO₂
- HCO₃⁻
Publications

Pier Reviewed (Published, In Press and Submitted)


Reports