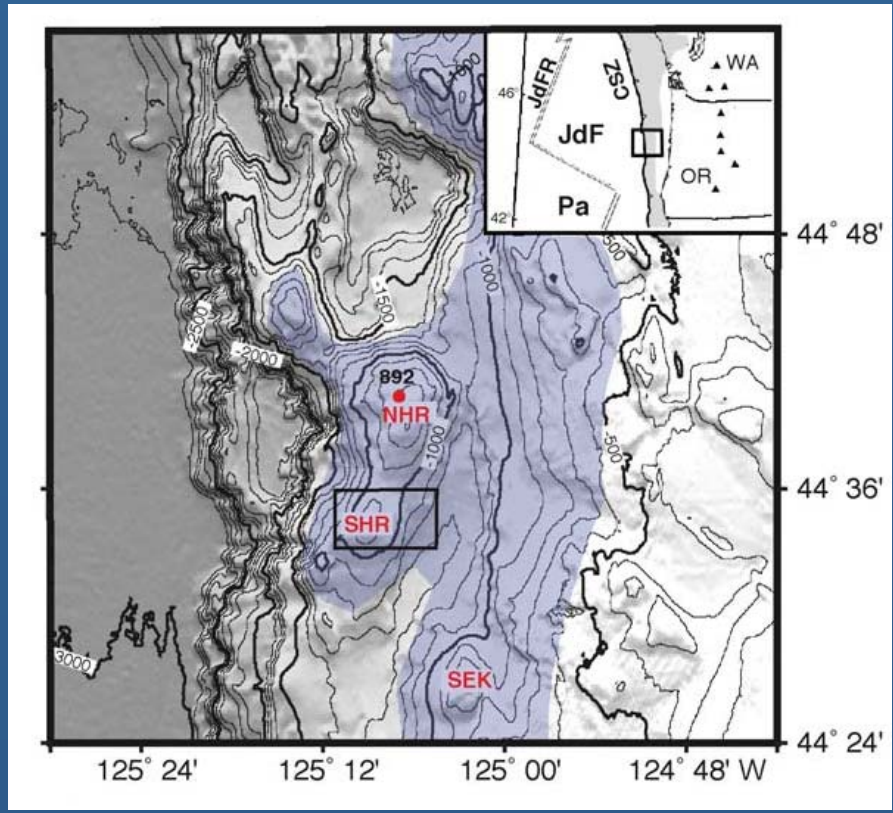
In Situ Raman Analyses of Natural Gas and Gas Hydrates at Hydrate Ridge, Oregon

E. T. Peltzer[1], Sheri N. White[1], R. M. Dunk[1], P. G. Brewer[1], A. D. Sherman[1], K. Schmidt[1], K.C. Hester[2], and E. D. Sloan[2]

[1]Monterey Bay Aquarium Research Institute, Moss Landing, CA
[2]Colorado School of Mines, Golden, CO

Hydrate Ridge Expedition

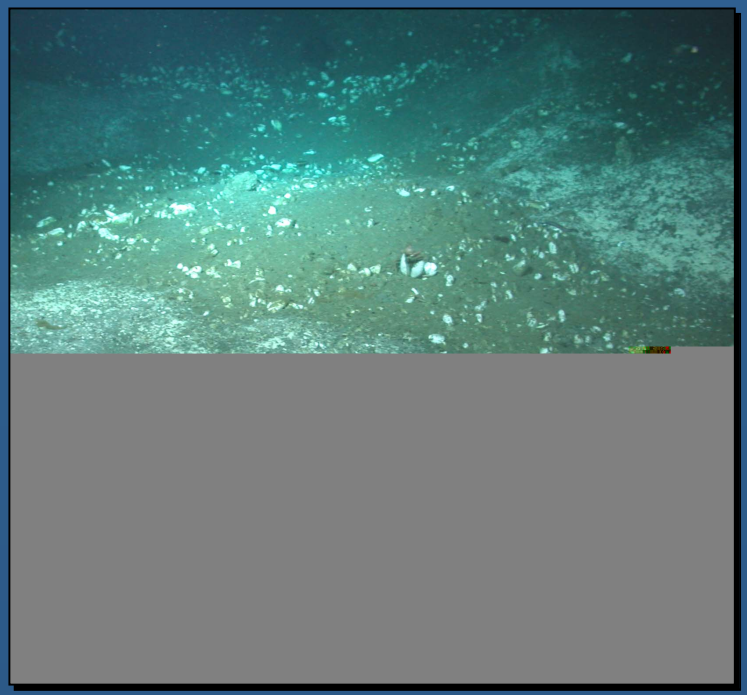
- July 2004
  - *R/V Western Flyer*
  - *ROV Tiburon*
- Cascadia margin
  - North Hydrate Ridge
    - 590 m depth
  - South Hydrate Ridge
    - 780 m depth



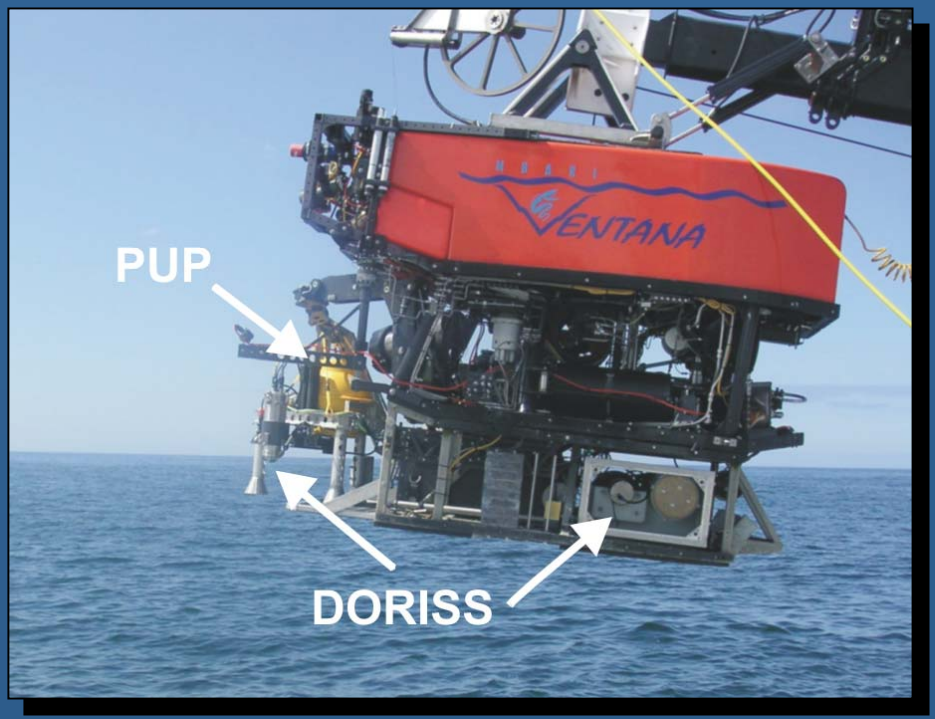
Tréhu, et al., 2004

Hydrate Ridge

- Hydrate is formed in the subsurface and held in place by the sediment
- Suess, et al. (2004) suggest that free gas is present within the hydrate fabric

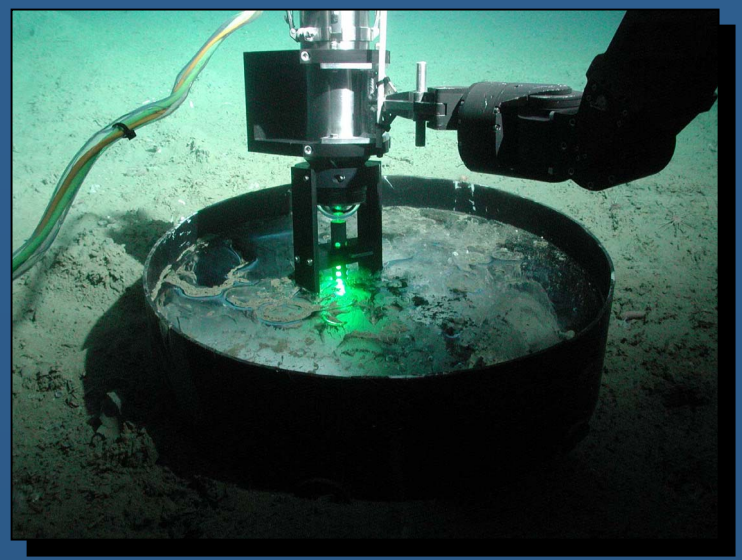


DORISS/PUP Deployment

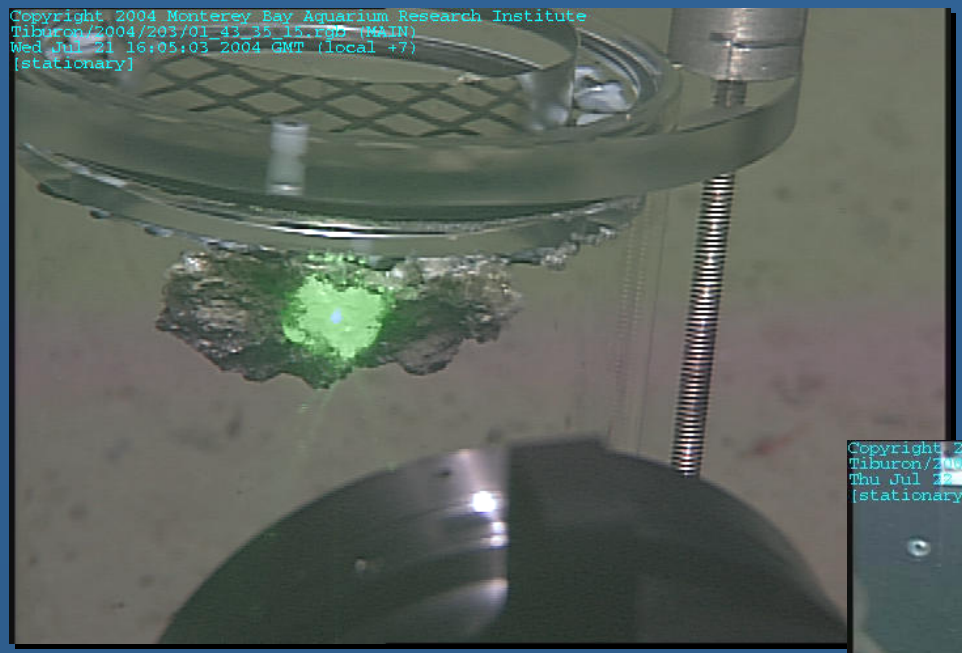


- Probe head is positioned by the ROV manipulator or PUP

- Electronics and spectrometer housings carried in toolsled
- Probe head and PUP carried on front porch

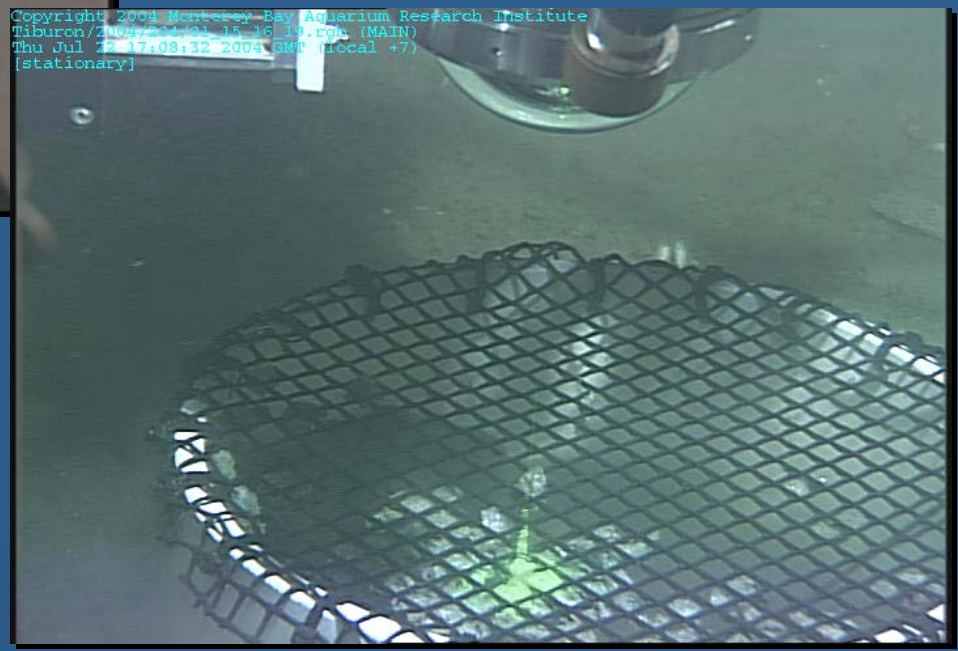


Hydrate Analysis

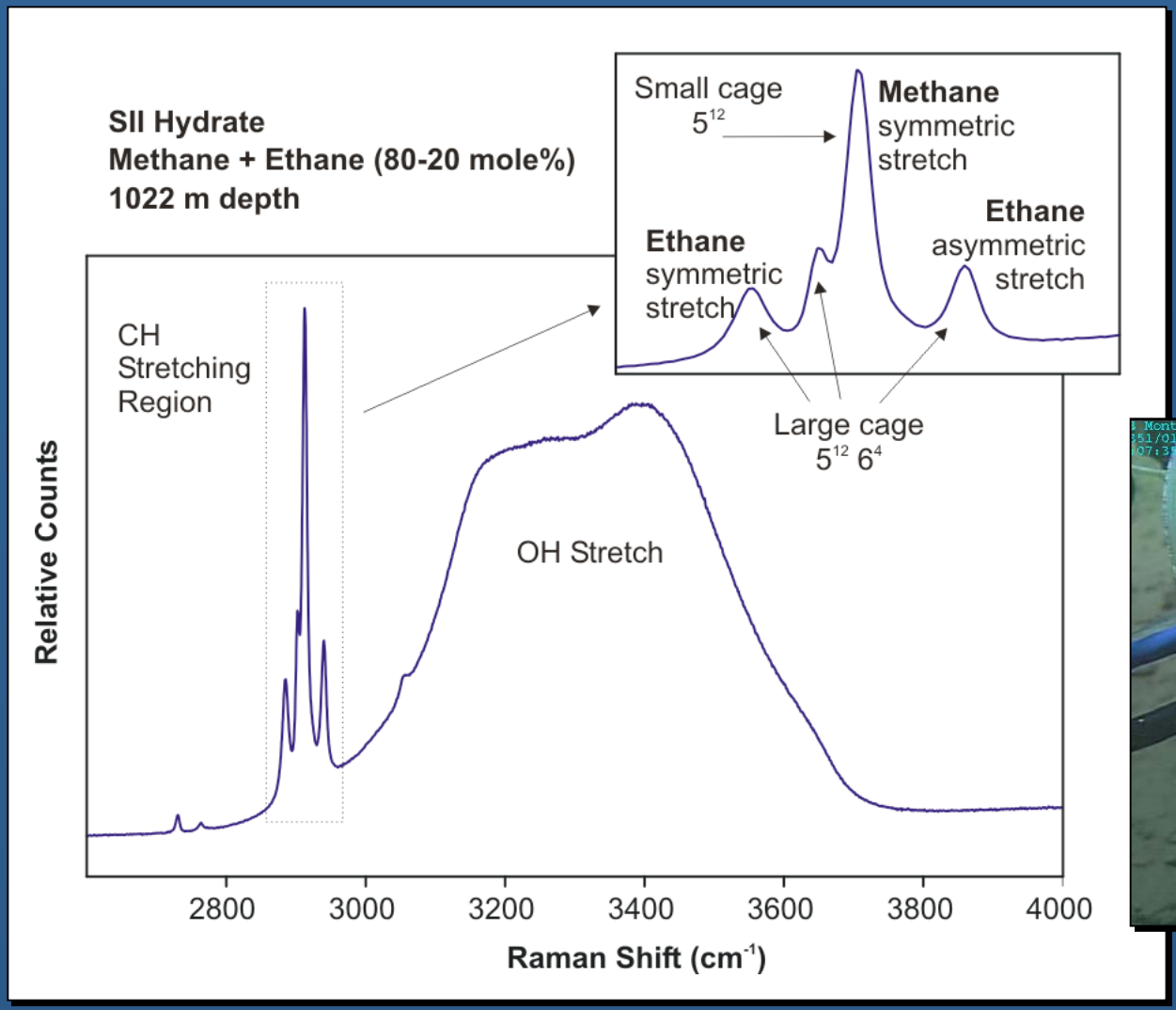


- Hydrates were excavated from the seafloor

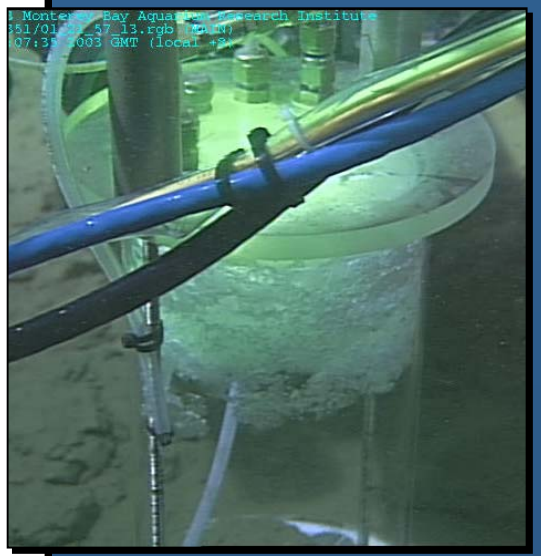
- Hydrate was held in place in a glass cylinder or a mesh-topped corral



Monterey Bay Experiment

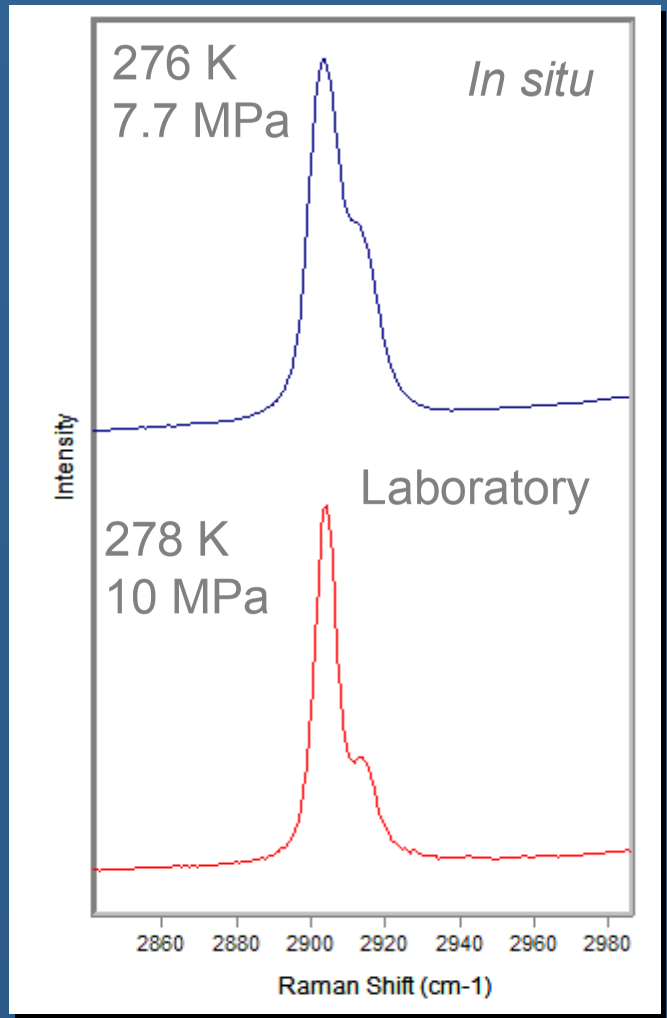


Hydrate formed *in situ* from a 80-20 methane-ethane mixture

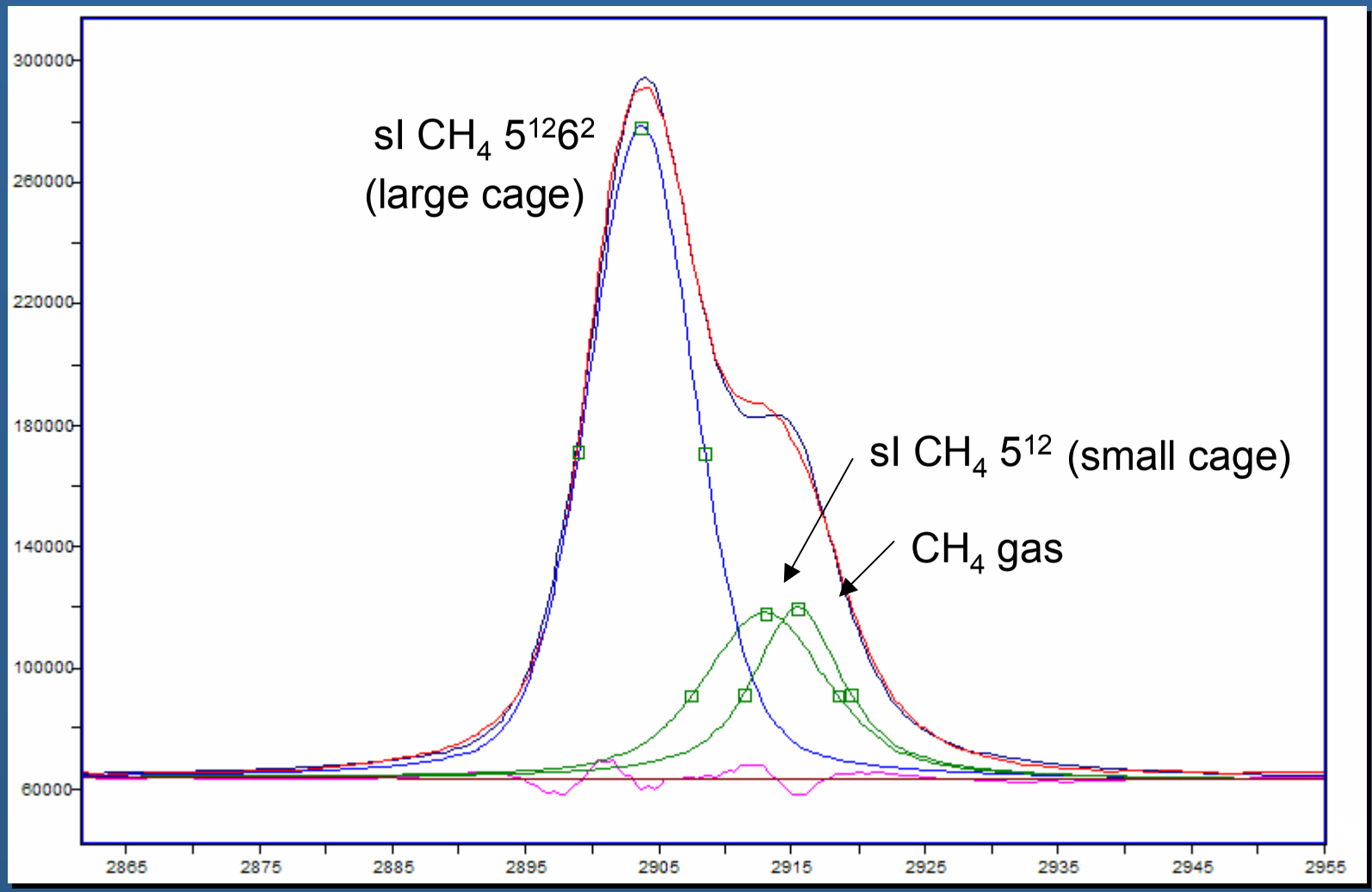


Hydrate Ridge Analysis

- Hydrate is structure I
  - Methane present in both large and small cages (3:1 ratio)
  - No other hydrocarbons are observed
- *In situ* data shows more of a shoulder than a second (small cage) peak

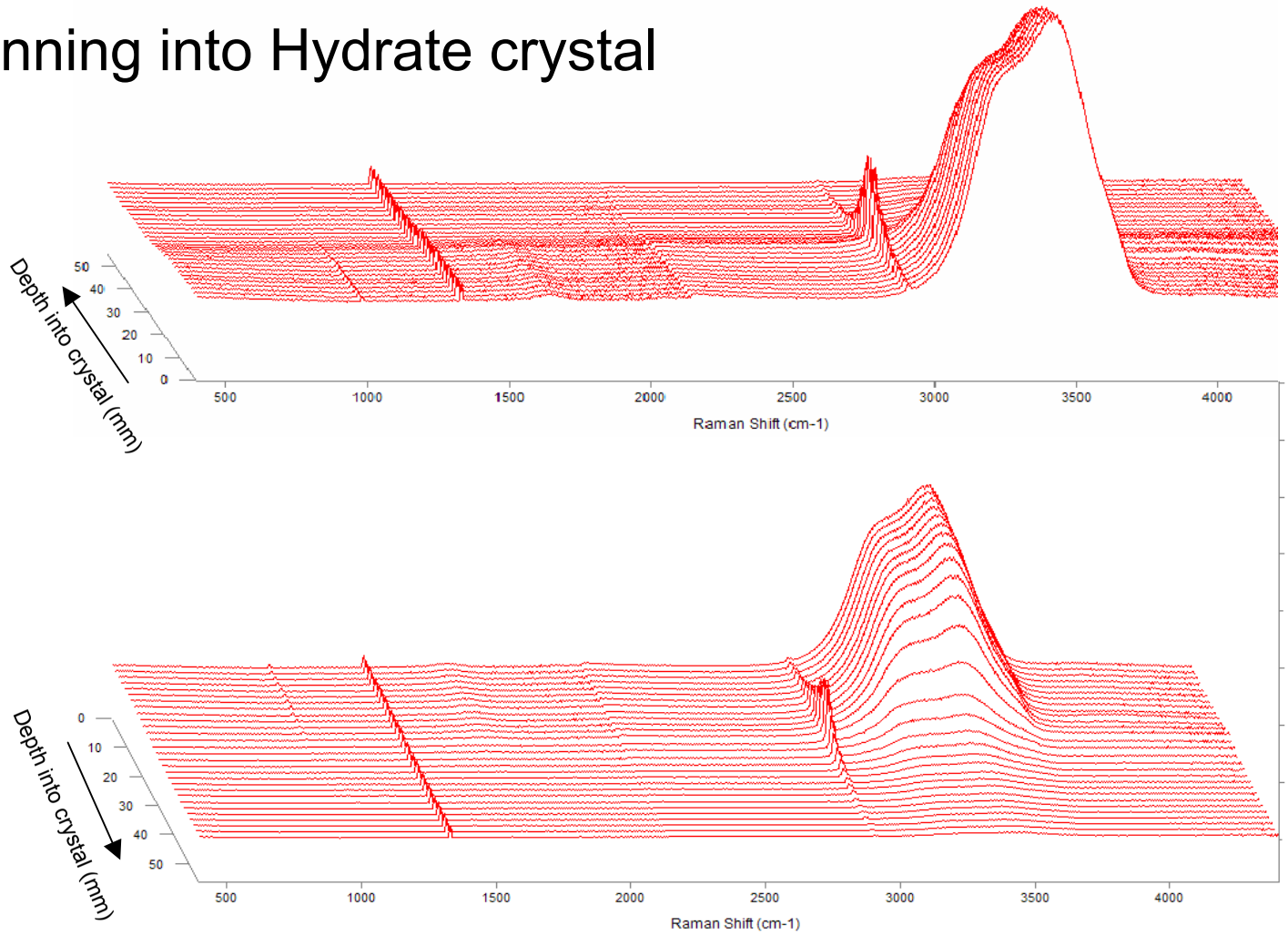


Hydrate Ridge Analysis

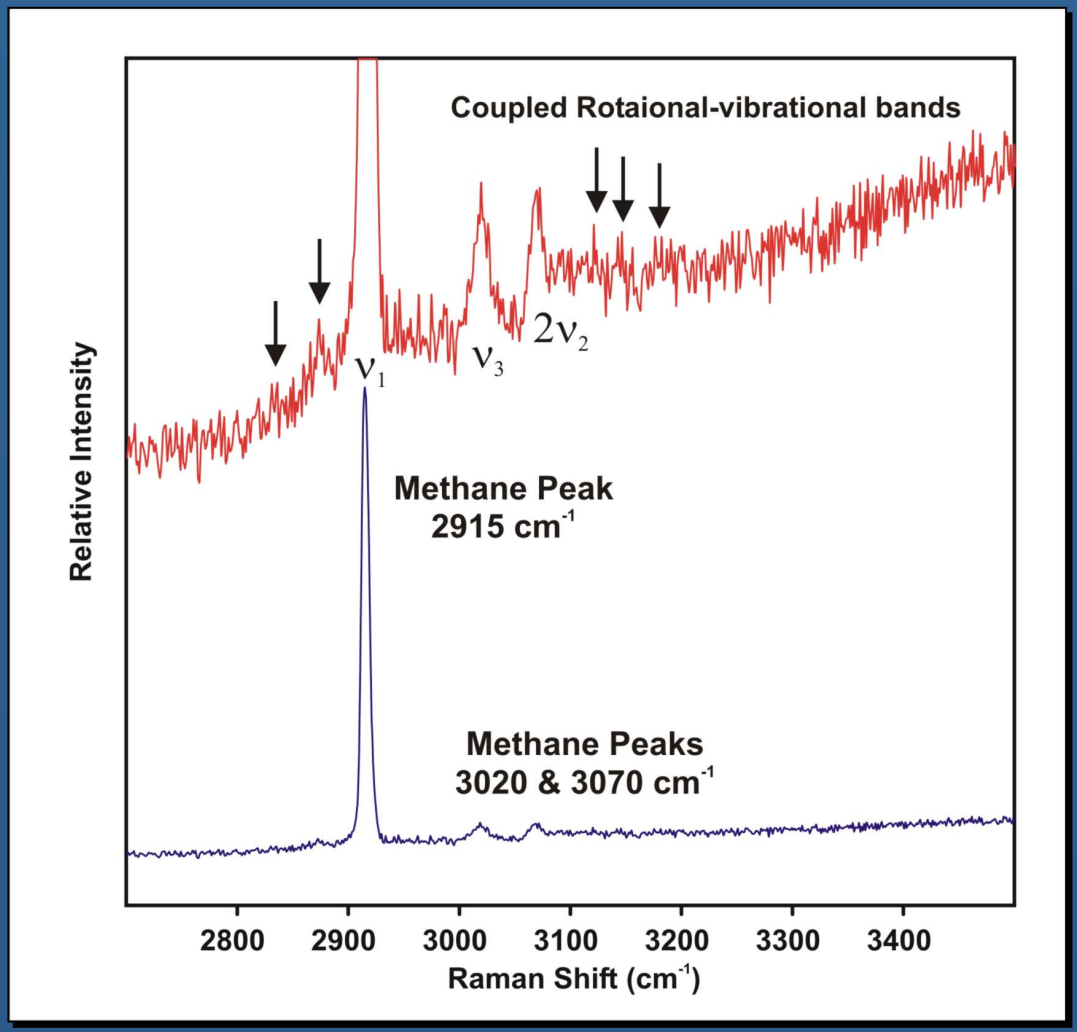


Hydrate Ridge Analysis

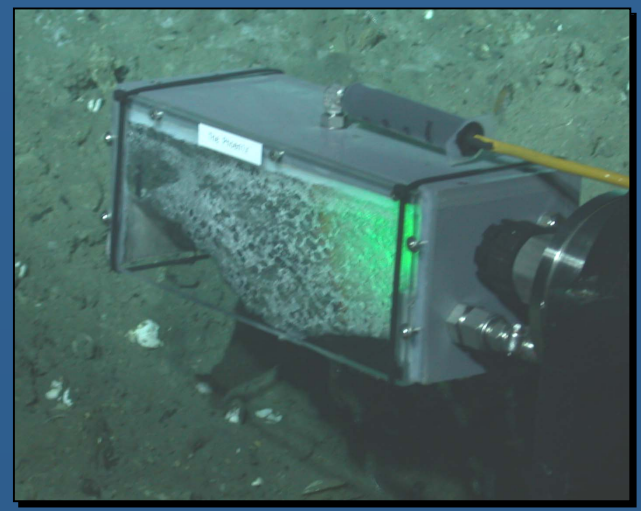
Scanning into Hydrate crystal

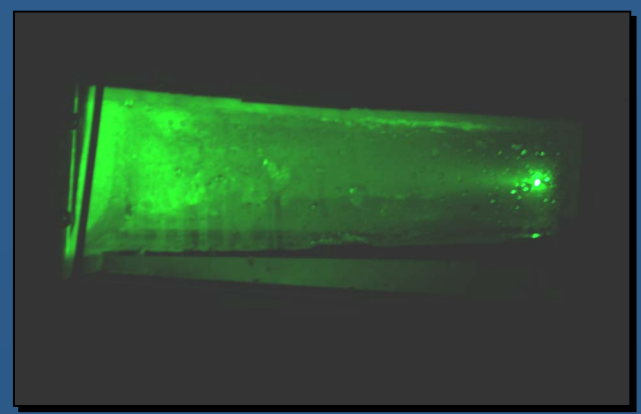


Natural Gas Analysis



Gas collected in heated cube





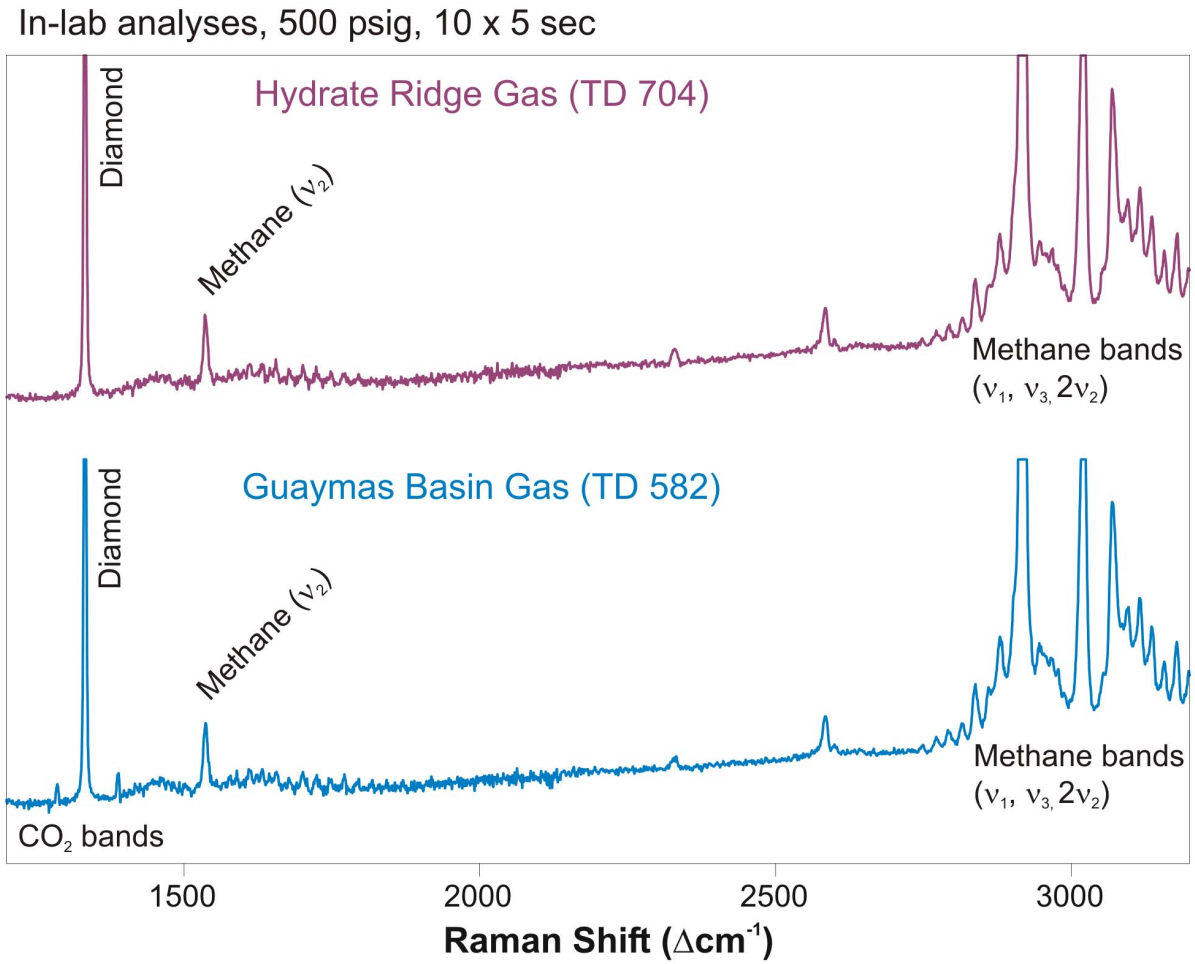
Natural Gas GC Analysis

Compound	Mole % (mean)
N_2	0.79
CO_2	0.16
Methane	98.56
Ethane	0.089
Propane	0.023
i-Butane	0.006
n-Butane	0.008
i-Pentane	0.005
n-Pentane	0.000

Natural Gas Analysis

~0.16 mole% CO_2

~3.0 mole% CO_2



Acknowledgements

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- Pilots of the *ROV Tiburon*
- Technical support of John Ferreira, Peter Walz, Mark Brown

- David & Lucile Packard Foundation
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Publications

Brewer, P.G., G.E. Malby, J.D. Pasteris, S.N. White, E.T. Peltzer, B. Wopenka, J. Freeman, & M.O. Brown, Development of a laser Raman spectrometer for deep-ocean science, *Deep Sea Res. I*, 51:739-753, 2004.

Pasteris, J.D., B. Wopenka, J. Freeman, P.G. Brewer, S.N. White, E.T. Peltzer, G.E. Malby, Raman spectroscopy in the deep ocean: successes and challenges, *Appl. Spectrosc.*, 58(7): 195A-208A, 2004.

White, S.N., P.G. Brewer, E.T. Peltzer, Determination of gas bubble fractionation rates in the deep ocean by laser Raman spectroscopy, *Mar. Chem.*, in press, 2004.

Posters

OS43B-558 *In Situ* Raman Spectra from the Sea Cliff Hydrothermal Field (Gorda Ridge)

OS43B-557 First Attempts at Direct Raman Detection of the Oceanic Carbonate System