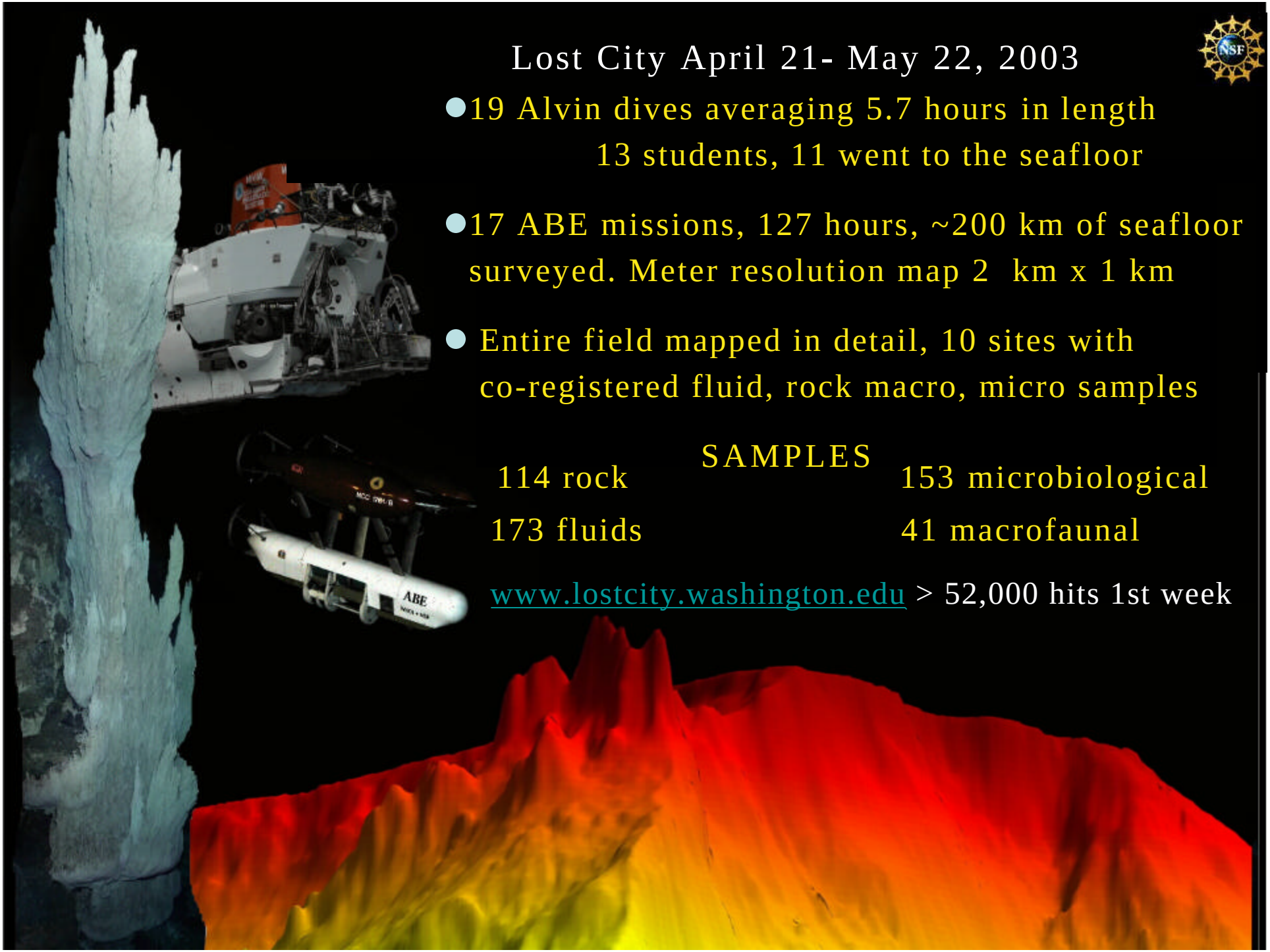


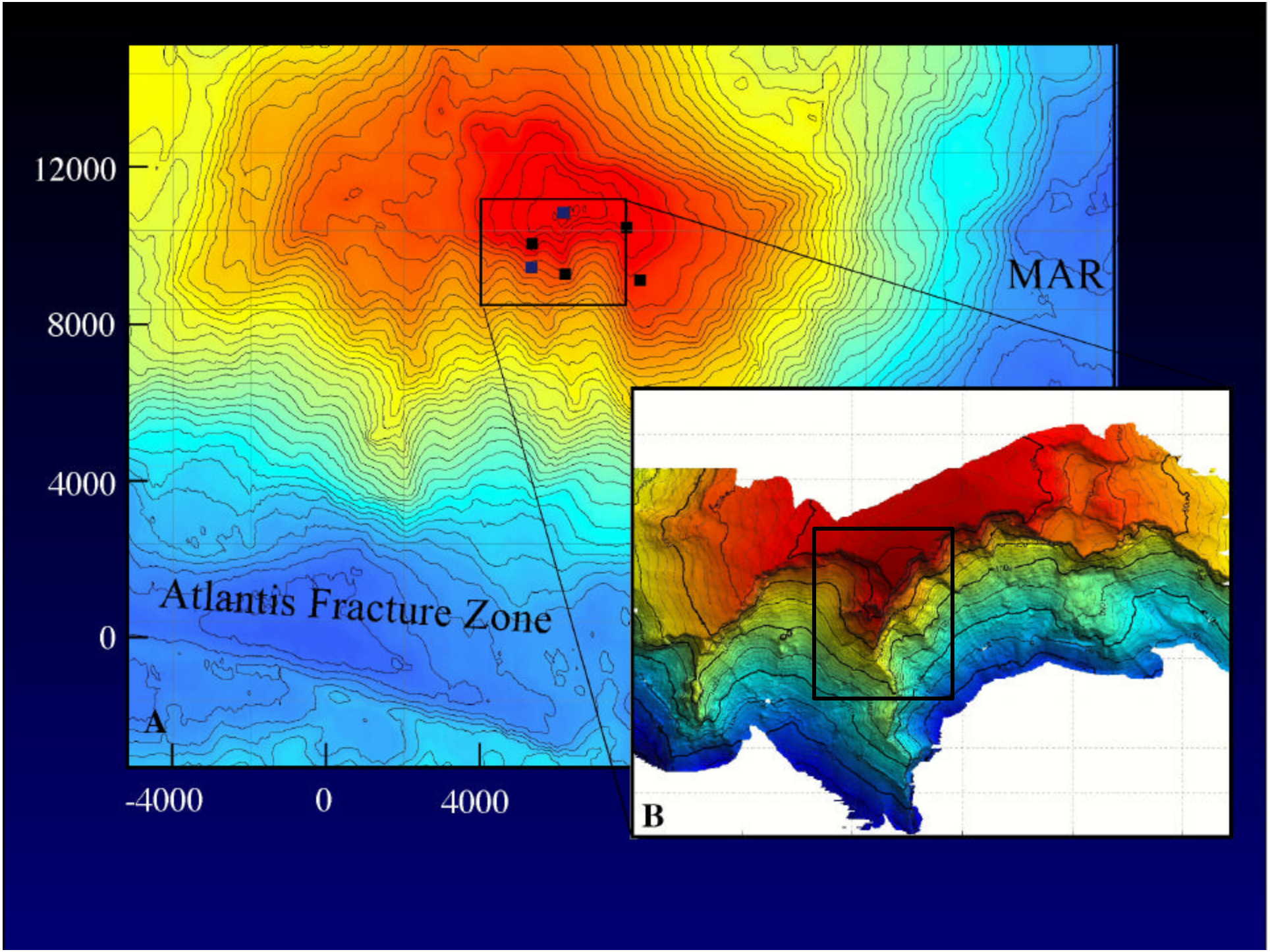
Lost City April 21- May 22, 2003

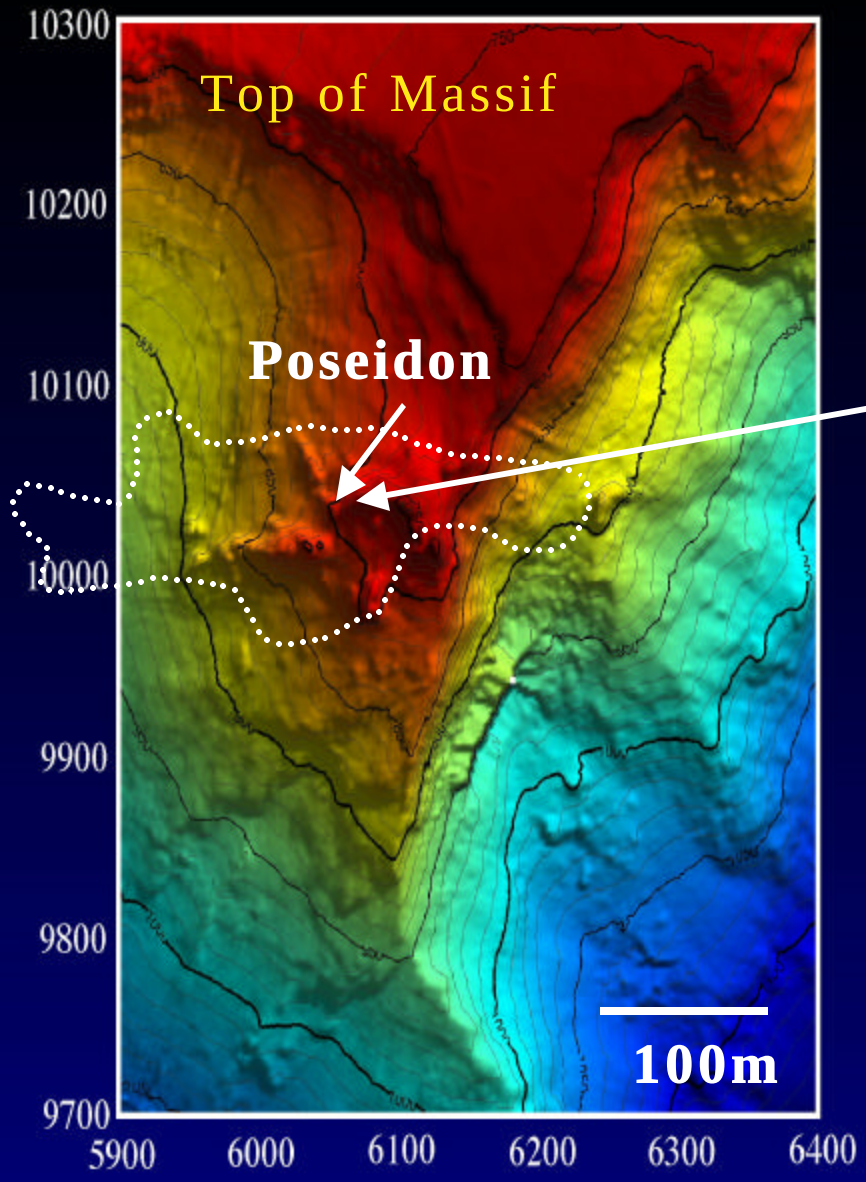
- 19 Alvin dives averaging 5.7 hours in length
  13 students, 11 went to the seafloor
- 17 ABE missions, 127 hours, ~200 km of seafloor surveyed. Meter resolution map 2 km x 1 km
- Entire field mapped in detail, 10 sites with co-registered fluid, rock macro, micro samples

SAMPLES

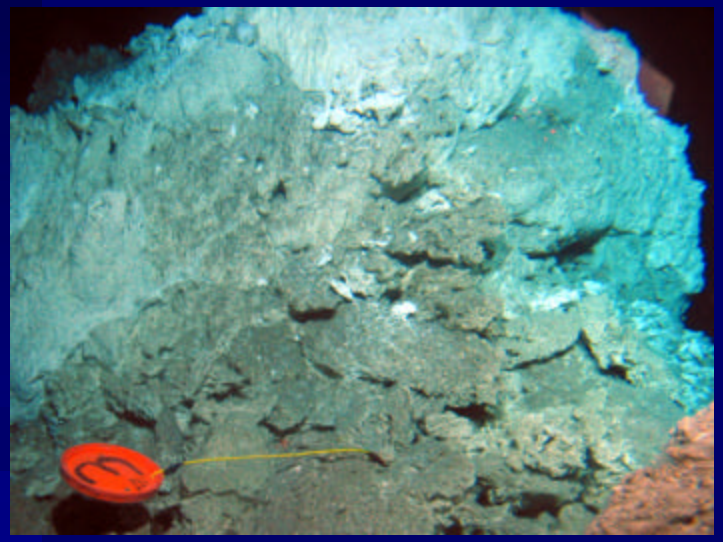
114 rock
173 fluids
153 microbiological
41 macrofaunal

www.lostcity.washington.edu > 52,000 hits 1st week

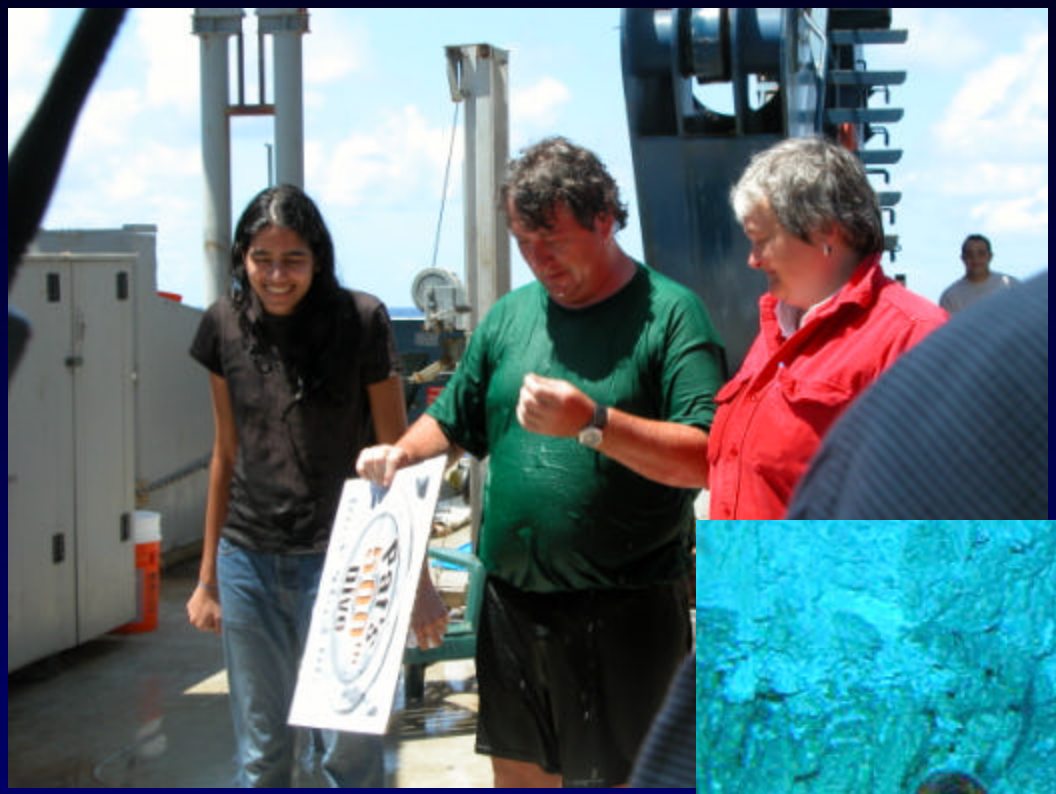

12000
8000
4000
0
-4000
0
4000
MAR
Atlantis Fracture Zone
A
B

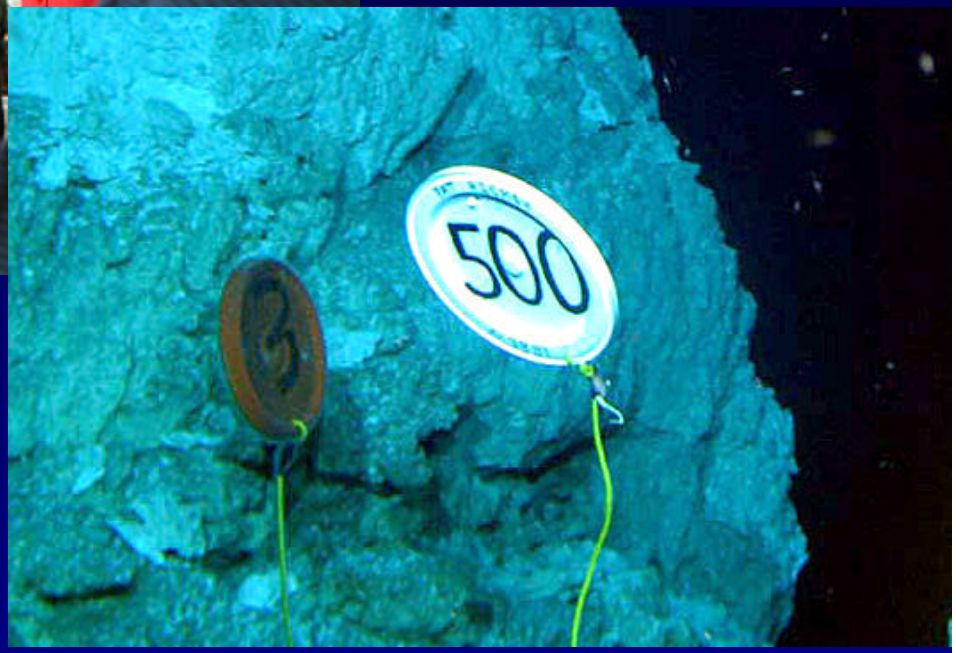


Top of 60-m tall structure
Poseidon



Expedition Leader: Pat Hickey 500th Dive in Alvin #3881





26 May - 17 June Jess Adkins (15 Dives)

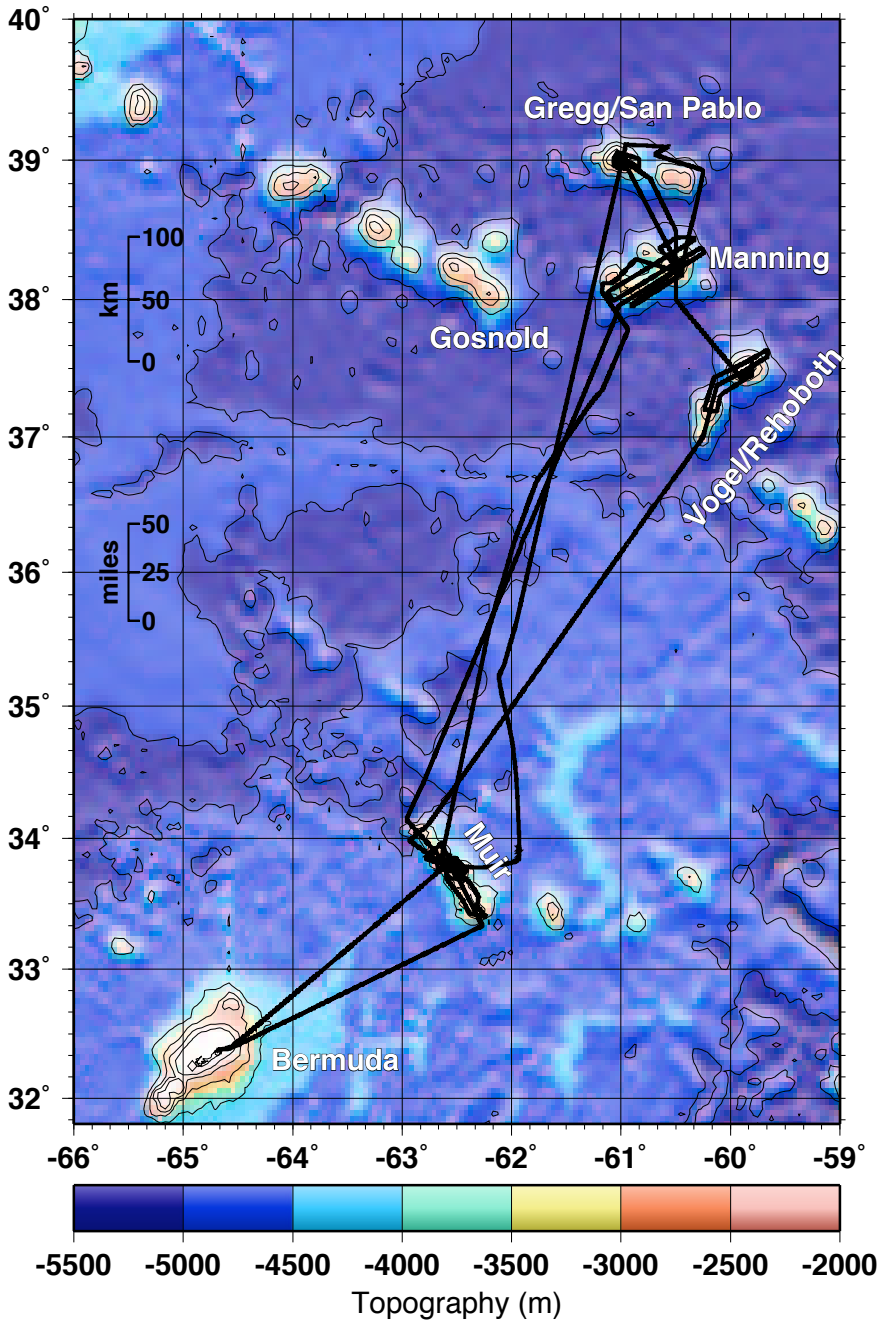
AT7-35 “Medusa”

Goals:

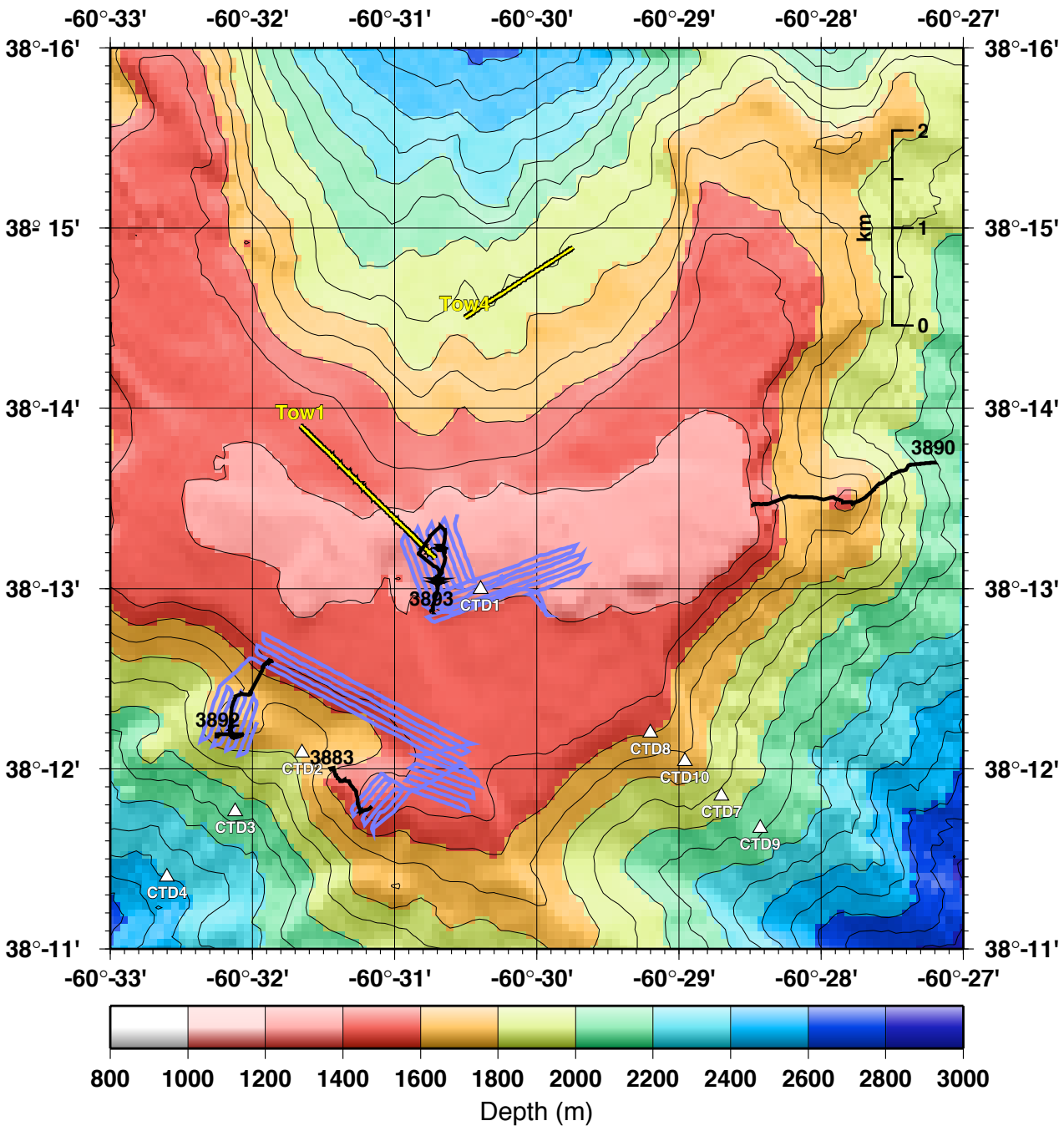
-Collect depth transects of fossil and modern deep-sea corals
-Figure out how to better collect them in the future
-Characterize the living community at seamounts
-First Paleo only cruise with Alvin, relatively new area for deep submergence
-Nested Approach to Tools...

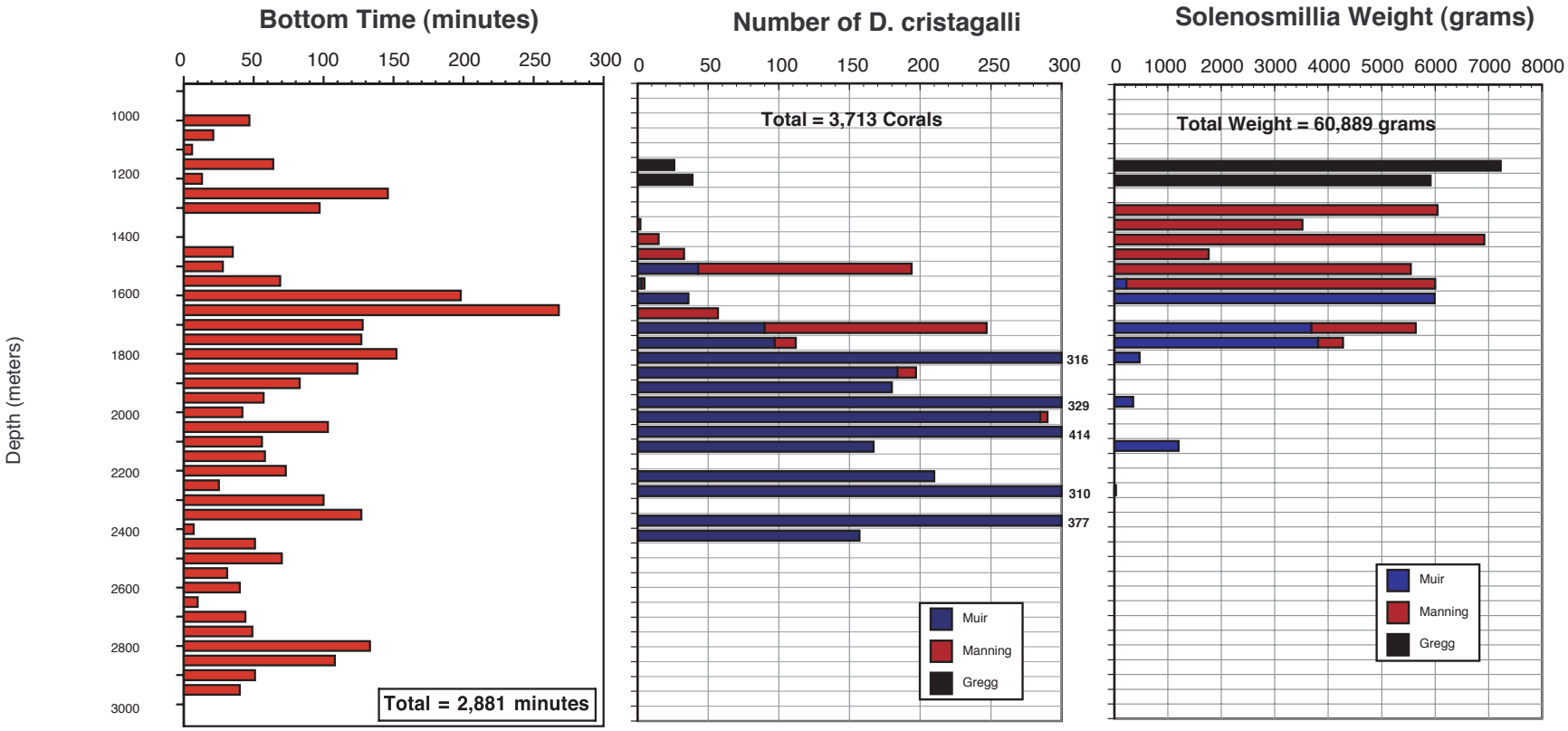
Stats

-15 Dives funded, 10 dives made
-8 ABE Dives (12), 3 Tow Cams (~10), 1 dredge
-13 CTD casts (1 hydro), 2 MITESS casts
-6 Seamounts mapped
-Alvin ops at 1,000-3,000 meters, >45 hours of bottom time
-10,000s of photos taken (ABE, Towed Camera Sled)
-Over 3,700 D. cris, over 60 kg of Solenosmillia, 156 species over 11 phyla
-Dive and Discover #7, Museum of Science Link



Desmophyllum cristagalli


-60°-33'
-60°-32'
-60°-31'
-60°-30'
-60°-29'
-60°-28'
-60°-27'
38°-16'
38º 15'
38°-14'
38°-13'
38°-12'
38°-11'
Tow4
Tow1
3890
3893
CTD1
3892
3883
CTD2
CTD3
CTD4
CTD8
CTD10
CTD7
CTD9
km
2
1
0
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
Depth (m)


Bottom Time (minutes)
Number of D. cristagalli
Solenosmillia Weight (grams)
Depth (meters)
0
50
100
150
200
250
300
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
Total = 2,881 minutes
Total = 3,713 Corals
316
329
414
310
377
0
1000
2000
3000
4000
5000
6000
7000
8000
Total Weight = 60,889 grams
Muir
Manning
Gregg

Issues for Comment

-Navy Clearance, flexibility is the key

-Transponderless Operation, Atlantis survey of Alvin

-More efficient sampling-Dredge on Alvin? Front Loader?

Problems:

-Hydrowinch, basic oceanography

-Engineering not able to solve electrical problem at sea

Reves & Sohn (6 dives) Kelley

Seismicity of TAG Experiment (STAG, Leg 1)

- R/V Atlantis Voyage 7-36, 6/21-7/8/2003
- DSRV ALVIN
- Deployed temperature probes and tide gauge on TAG mound
- Collected shrimp and high-T exit fluids
- Microbathymetric mapping w/Imagenex

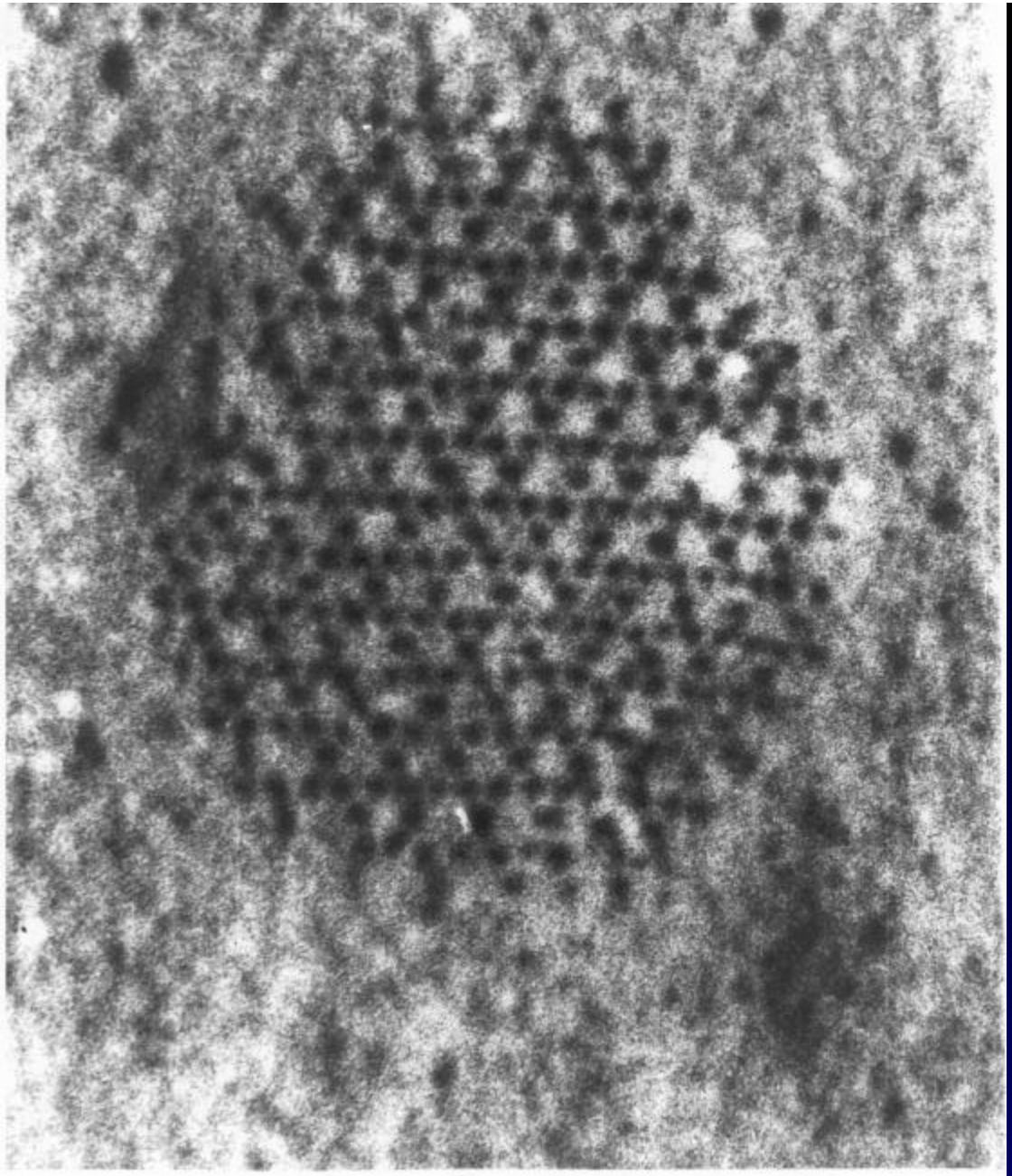
Seismicity of TAG Experiment (STAG, Leg 1)

- T-probe and tide gauge deployments successful
- First-ever enzymatically fixed shrimp samples in red light to determine if pigment on shrimp back allows for vision
- Microbathymetric mapping not completely successful - problems w/data logging and “tuning” of system

Rona (1 dive)

Paleodictyon Project Update: ALVIN Dive 3900 (7/2/03)

- **Site:** TAG hydrothermal field, 26ºN MAR
- **Purpose:** To solve the mystery of what makes the Paleodictyon pattern
- **Divers:** Pilot: Pat Hickey; Port: Peter Rona, Rutgers; Starboard: Dolf Seilacher, Yale
- **Results:** Confirmed identity of seafloor with fossil form. Analyses of cored specimens in progress to determine what made the form. Preliminary results reported at Fall 2003 AGU Abstract OS32A-0241.
- **Support:** Stephen Low Productions for IMAX film “Volcanoes of the Deep Sea”



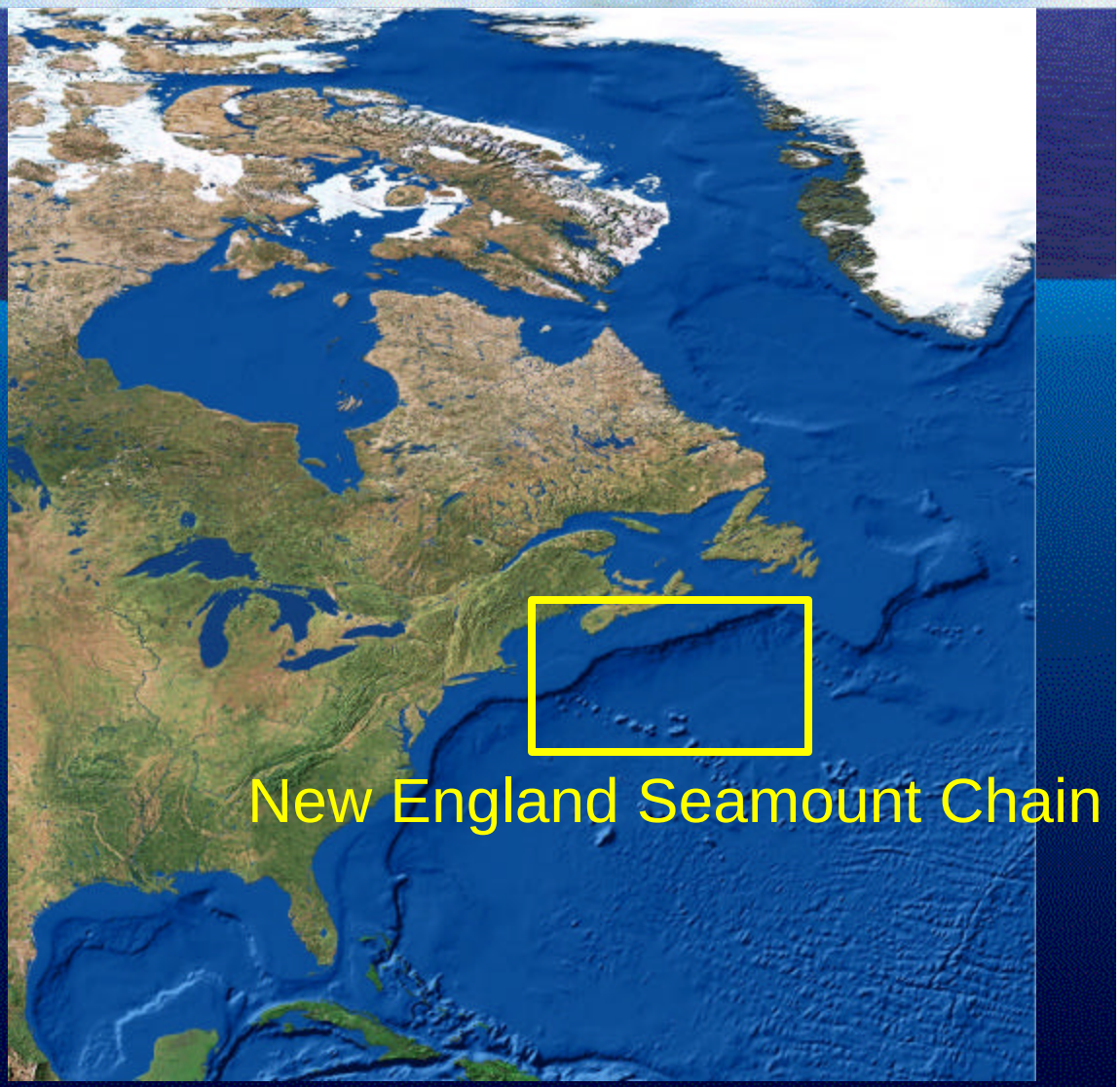
Paleodictyon, one of the oldest living fossils on Earth, photographed on the seafloor 2 miles deep in the middle of the Atlantic Ocean (photo credit, Dr. Peter Rona, Rutgers University). Actual size is about 2 inches in diameter.

NOAA?

11 July - 19 July Babb/Watling (6 Dives)

Mountains in the Sea: Exploring the New England Seamount Chain

R/V Atlantis – DSV Alvin Research Cruise
July 11-19, 2003



Multidisciplinary, Multi-institutional Research & Education Team

Principal Expedition Members, Collaborators & Roles

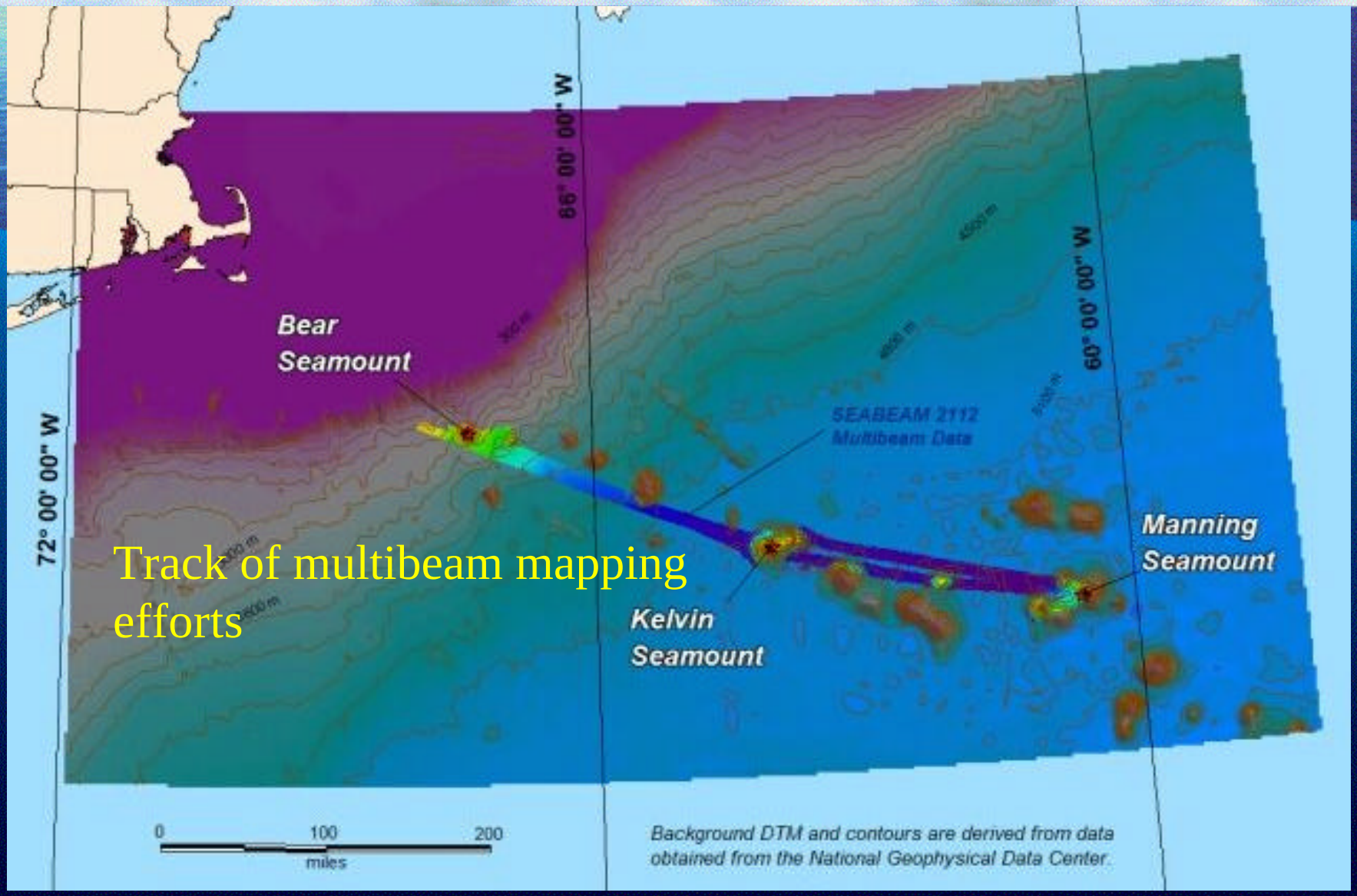
Les Watling, University of Maine Chief Scientist, deep water corals, infauna
Ivar Babb, NURC-University of Connecticut, Outreach & education, multibeam, GIS
Peter Auster, NURC-University of Connecticut, Ecology of fishes, impacts of fishing
Kevin Eckelbarger, University of Maine, Coral reproduction, ultrastructure, SEM
Scott France, College of Charleston Coral, molecular genetics
Jon Moore, Florida Atlantic University, Biogeography of fishes, deep water fauna
Lauren Mullineaux, WHOI, Seamount ecology, larval dispersal
Jess Adkins, California Institute of Technology, Paleoceanography, fossil corals
Michael Vecchione, NMFS National Systematic Lab, Cephalopods, midwater ecology
Susan Richardson, Smithsonian Institution, Foraminiferans and Xenophyophores
Diana Payne, Connecticut Sea Grant, Education Coordinator

Multiple Objectives

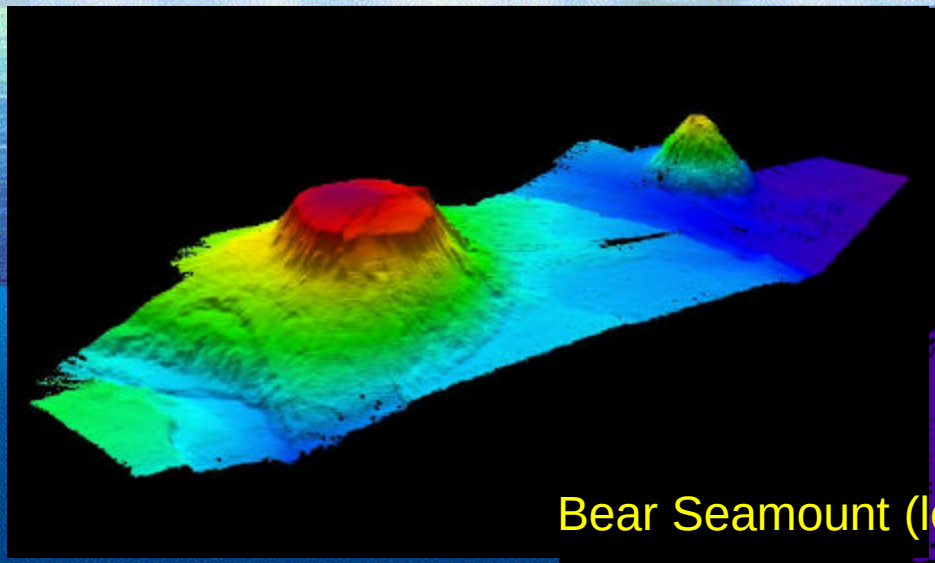
Cruise Objectives:

1. Map the distribution of the octocorals and assess the overall diversity of organisms living in the coral communities of the New England seamount chain.
2. Determine the reproductive state and potential larval strategies of seamount octocorals.
3. Investigate the colonization dynamics of dense coral aggregations.
4. Determine whether seamount octocorals are genetically isolated between seamounts and from continental slope species.
5. Determine the relationship of demersal nekton to the landscape features with and without corals.
6. Assess physical impact of bottom trawling on octocoral communities and seamount biodiversity.
7. Provide education & outreach opportunities for local teachers based on OE lesson plans & Web site

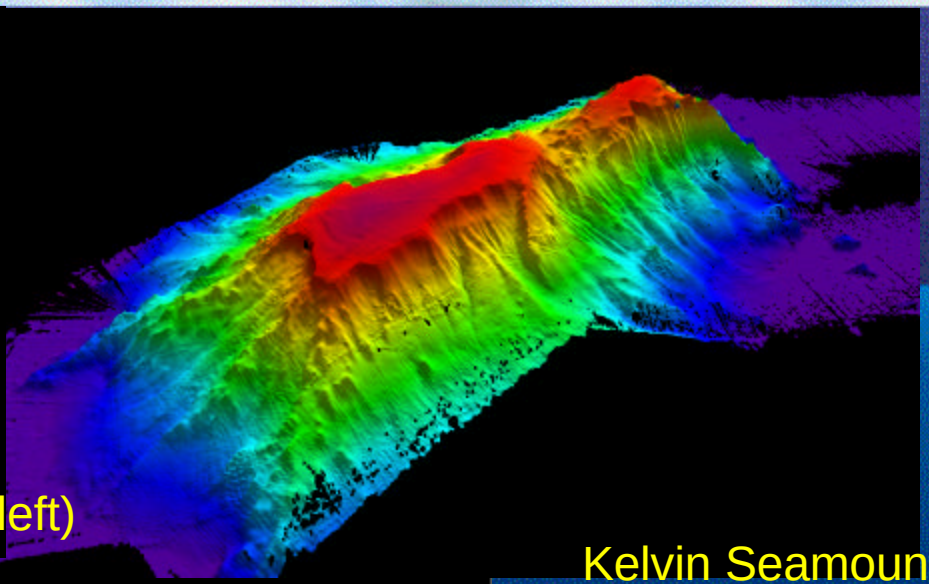
The First Phase of Exploration – Making Maps



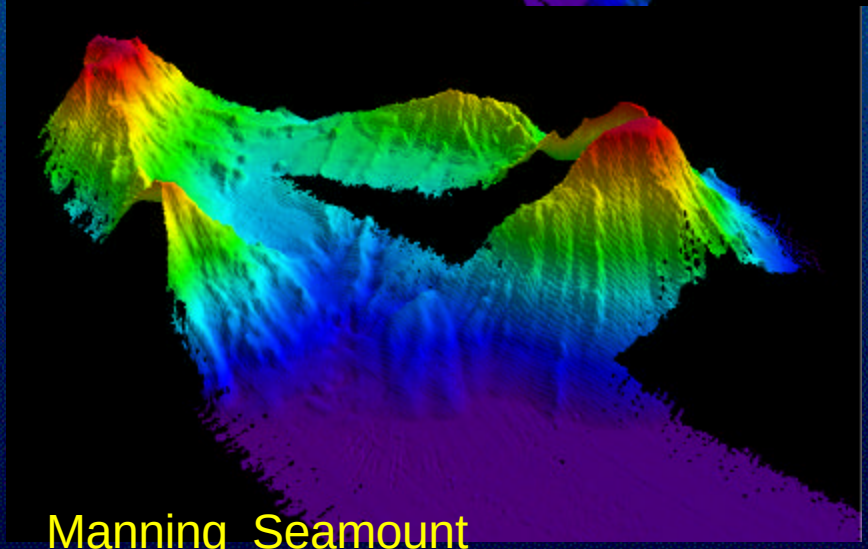
R/V Atlantis Multibeam Products



Bear Seamount (left)



Kelvin Seamount

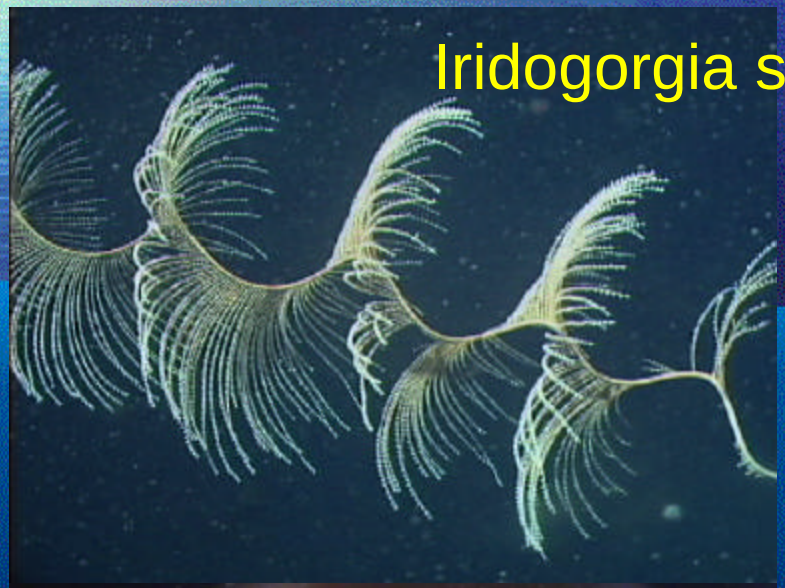


Manning Seamount

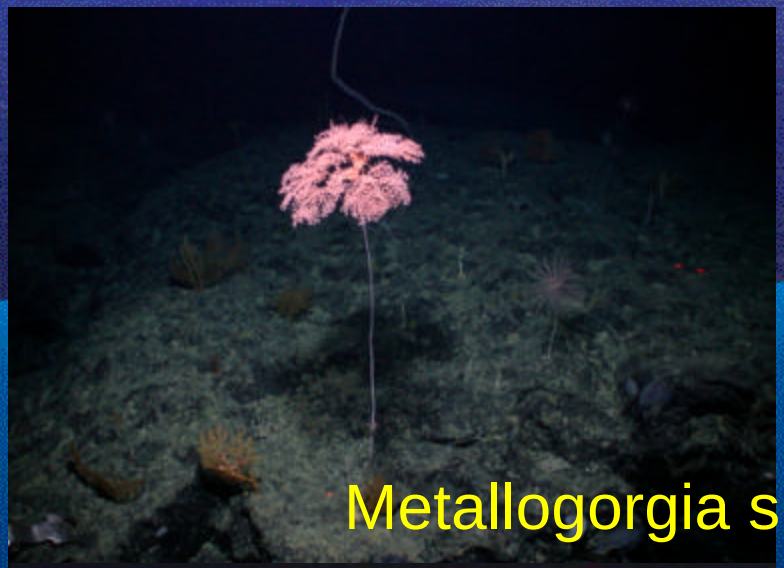
R/V Atlantis & DSV Alvin

Alvin used to collect specimens and document biodiversity with video & digital still imagery

Representative Deep Water Corals



Iridogorgia sp.

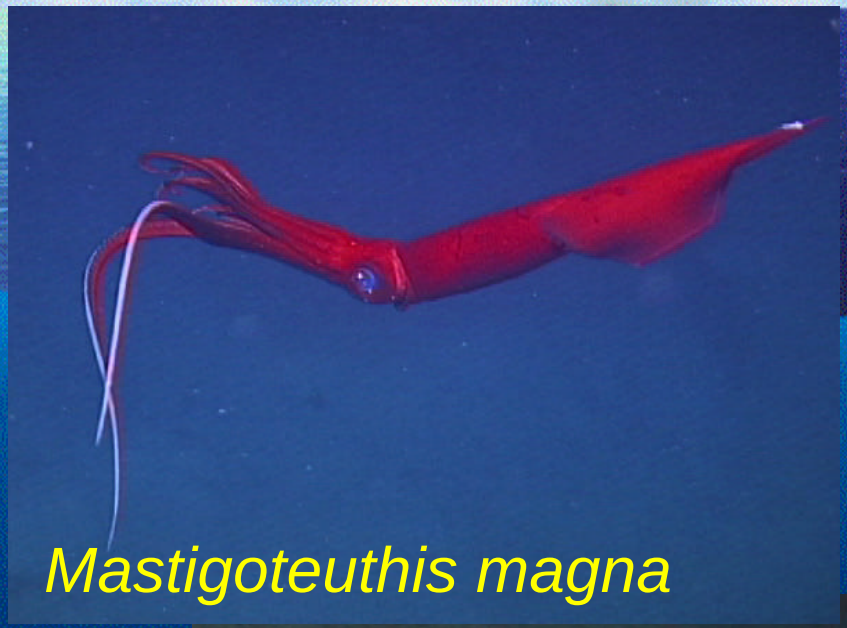


Metallogorgia sp.

Desmophyllum sp.

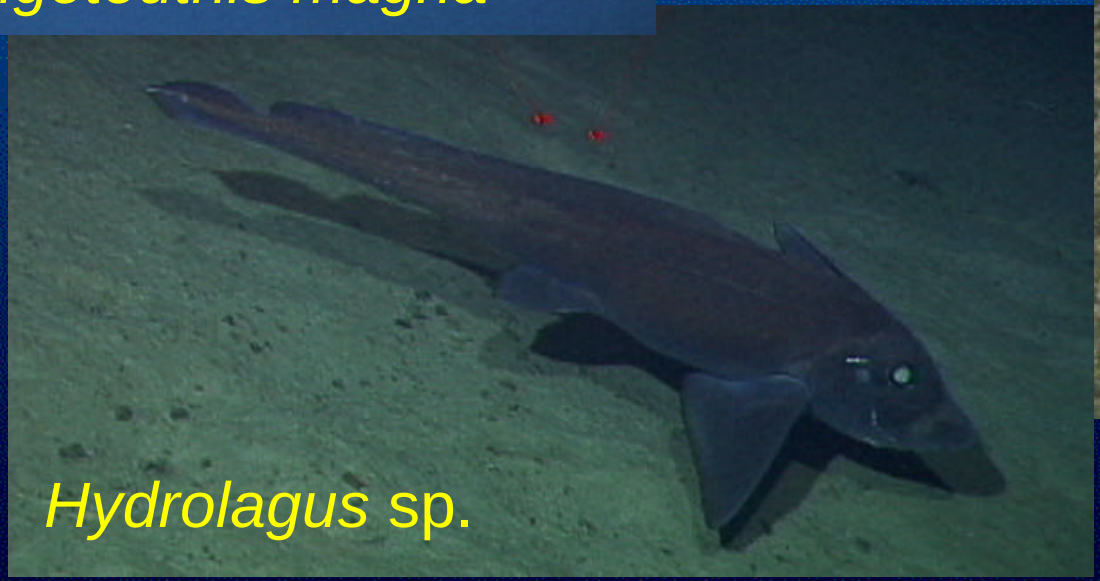
Paragorgia sp.

Other Seamount Fauna



Mastigoteuthis magna

Caelorinchus sp.



Hydrolagus sp.

Mission Highlights

- 7 Submersible Dives
- 29 hours of bottom time
- First mapping and exploration of Kelvin seamount
- Over 440 specimens collected
- A total of 36 hours of video
- Thousands of still images
- 59 coral specimens (of 24 coral species)
- Imagery and specimens are being analyzed
- Live chat session with high school students and scientists in Alvin at 1600 m

WINDOWS TO THE DEEP

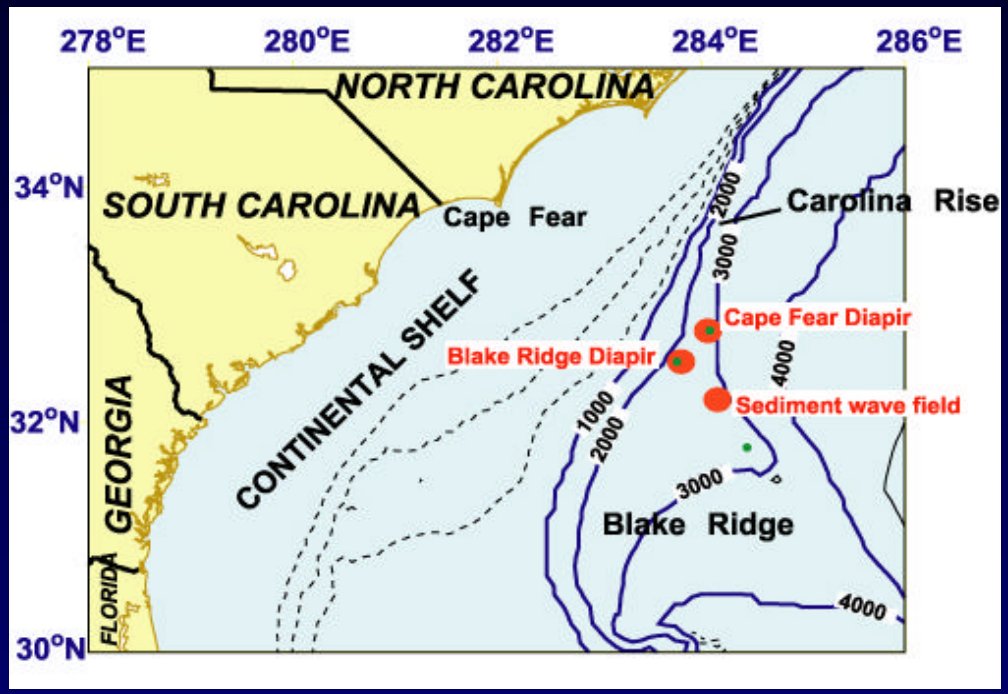
Biological Sampling and High-Resolution Mapping at Methane Seeps on the Blake Ridge and Carolina Rise

PIs: Carolyn Ruppel (Georgia Tech) and Cindy Lee Van Dover (William & Mary)

July 22 – August 3, 2003
R/V Atlantis* and *DSV Alvin

20 science party members included:

- **16 graduate, undergraduate, or just graduated students (including 1 HBCU student)**
- **Master teacher from Southeast COSEE office**
- **Broad range of disciplinary expertise**



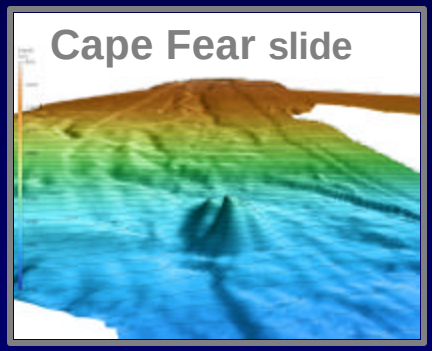
Sponsored by the NOAA Ocean Exploration Program
Mission accomplished with outstanding support and professionalism from the Alvin group and the crew of the R/V Atlantis

Performance

Alvin successfully completed 7 out of 7 scheduled dives
Water depths of 2000 to 3500 m in 3 primary locations
11 of 16 students visited the seafloor
First dives for 12 of the 13 _Alvin_ observers

Accomplishments

- Sampled sulfate - and methane-dependent seep organisms
  - Clam reproduction studies, mussel virus research, bioluminescence gene search, identification of new cold seep species
- Acquired sediment push cores
  - Link sediment biogeochemistry to distribution of chemosynthetic organisms, study redox chemistry, determine sulfate source
- Sampled bacterial mats and free-living bacteria
  - Identification of key lineages, comparison with gas hydrate bacterial populations in Gulf of Mexico [P. Sobecky group, Georgia Tech]
- Retrieved geological samples
  - Authigenic carbonate for carbon isotope study, “mud pillar” (newly identified formation), rock with fault striations from Cape Fear diapir
- Overnight operations: Mapping and subbottom imaging
  - Most complete map ever of Cape Fear submarine slide (associated with gas hydrate deposits), pseudo 3D map of methane gas chimneys [with S. Holbrook group, Wyoming]



http://oceanexplorer.noaa.gov/explorations/03windows/welcome.html

5 October - 20 October Fisher/Carney (8 dives)

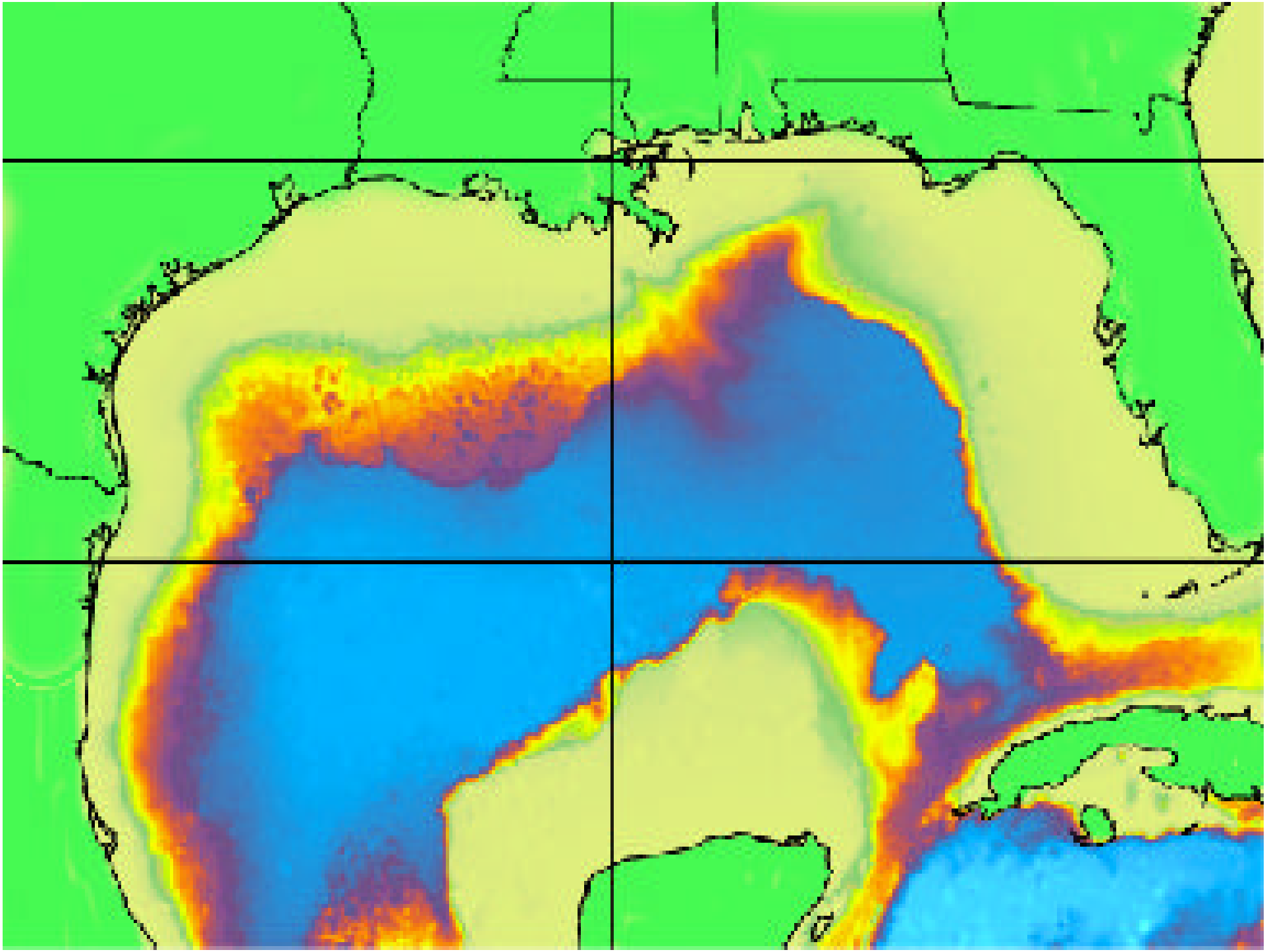
Gulf of Mexico Lower Slope
ALVIN R/V Atlantis

R. Carney, LSU & C. Fisher,PSU

NOAA-NURP, NOAA-OE, NSF

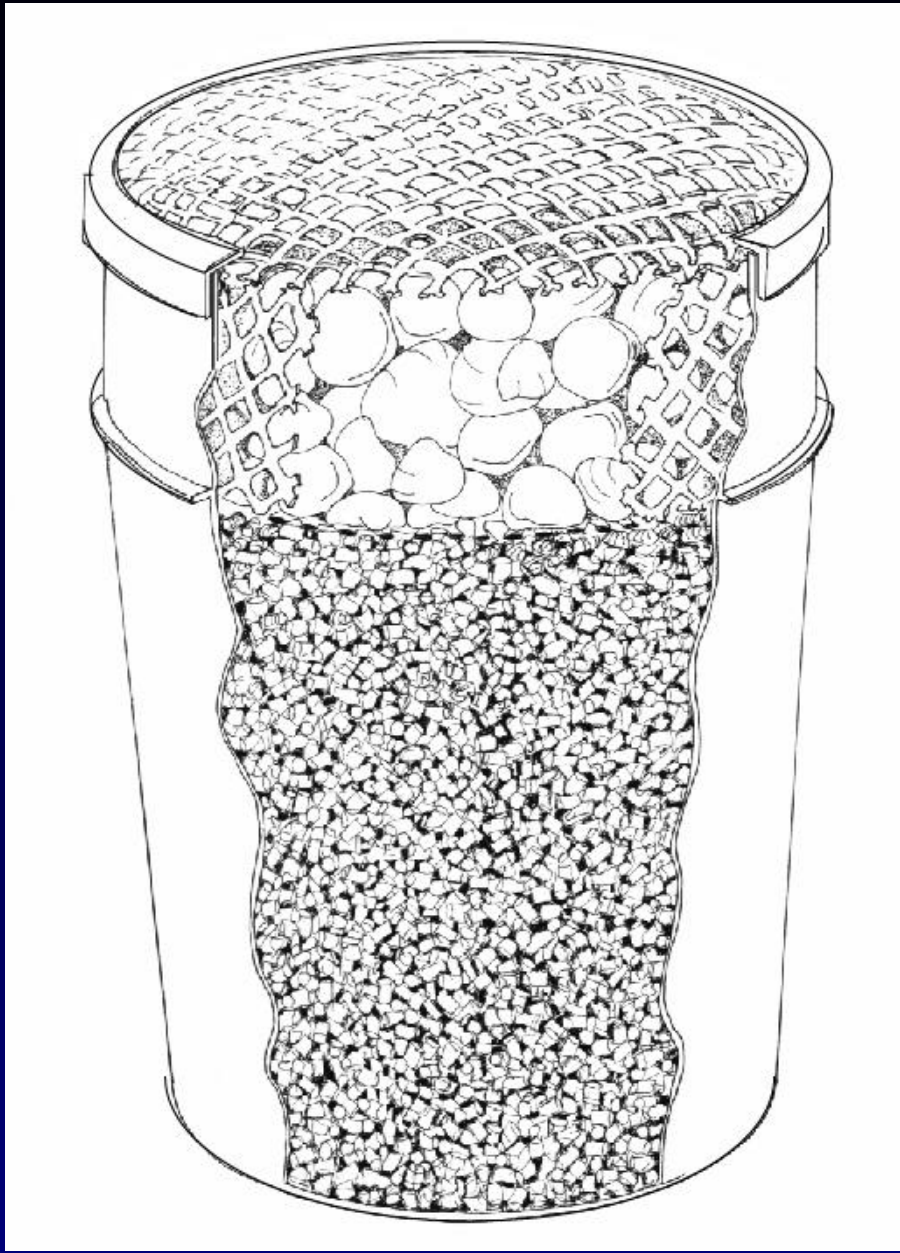
Multiple Objectives

- Deploy Sulfide Biogenerators Widely
- Biodiversity & Biogeography Sampling at Known Seeps.
- Trophic Analysis for Depth Comparisons



Sulfide Biogenerators

- Generate up to 12 millimolar H2S
- 1 of 3 prototypes supported 555 tubeworms
- Serve as “artificial seeps”
- Allow experimental testing of biogeographic range and community initiation processes.



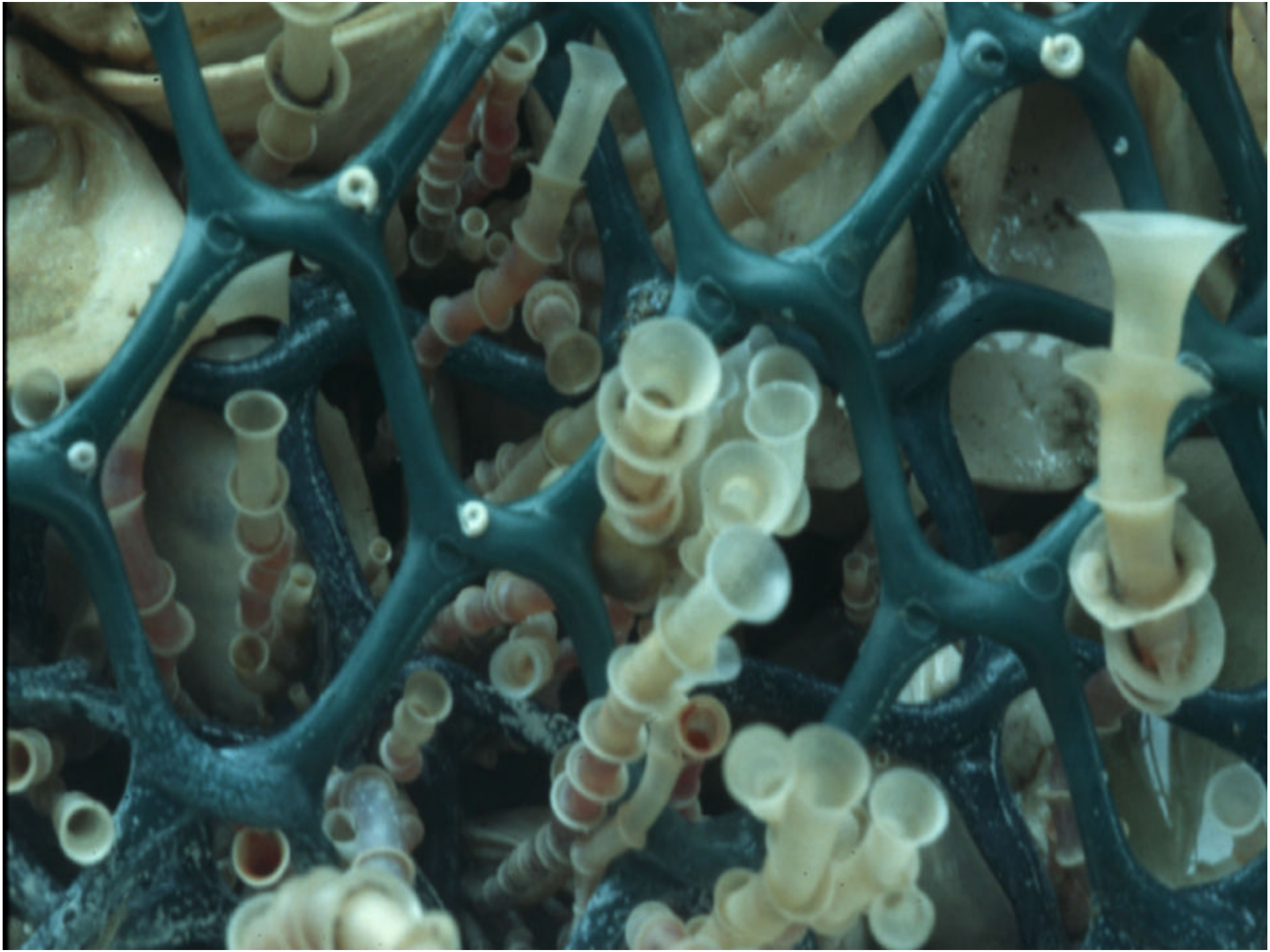
Sulfide Biogenerator

Shell Bed

Sulfate Spiked

Alfalfa pellets


Rabbit Chow
Complete Blend
RED SOX

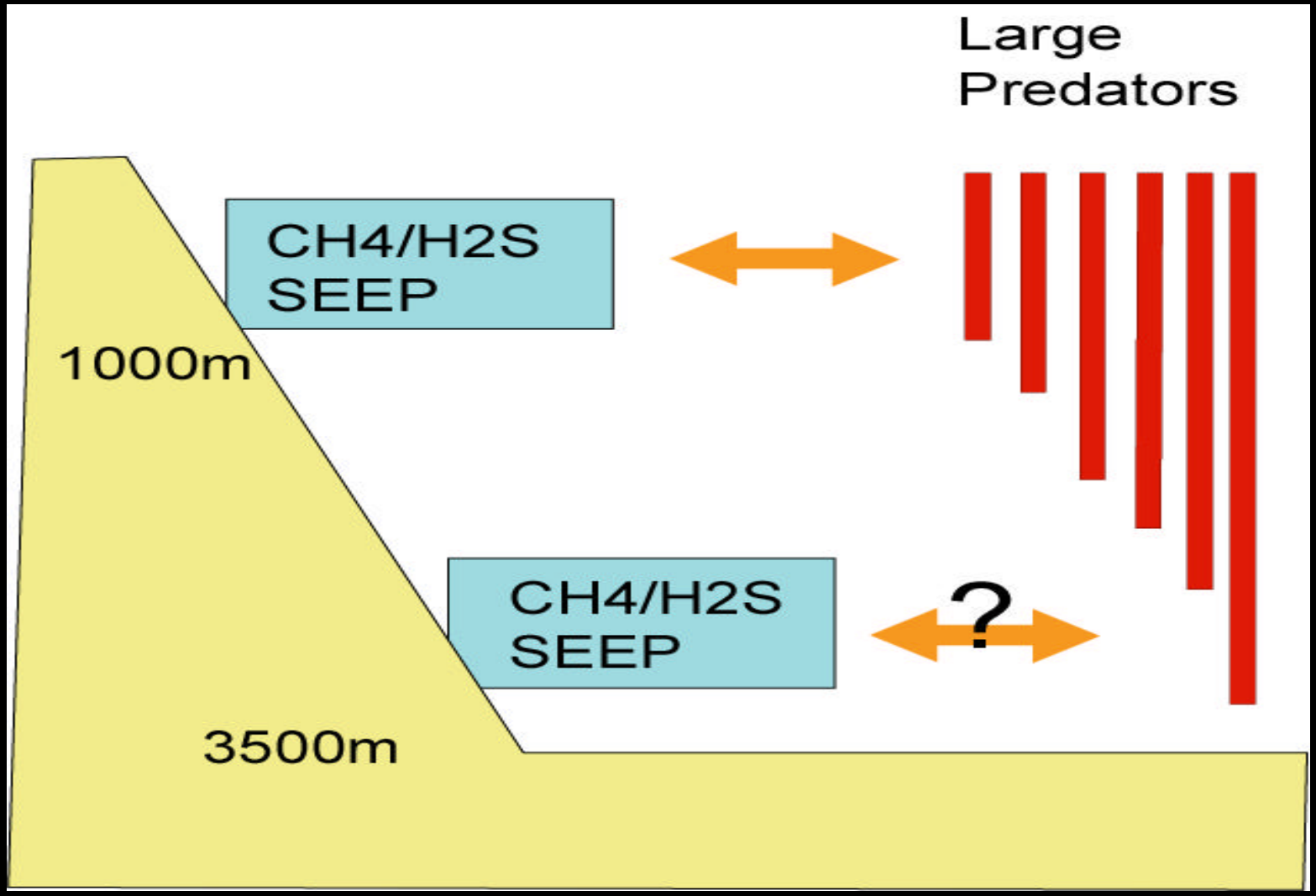


Biogeography & Biodiversity

- Emerging Picture of African – West Atlantic & Caribbean Margin Seep Network
  - Gulf of Mexico, Blake Plateau, Barbados Prism, and Angolan Margin, 500m – 4000m.
- Describe in Oceanographic Context (Silled Deep Basin) Composition
  - Gulfwide and 500m-3500m.
  - Molecular and Classic Morpho-taxonomy

“ Dune Grass” Seep

Depth Mediated Trophic Relationships



Accomplishments

- Deployed 96 sulfide biogenerators
- Extended ecological/geological sampling at 3 known sites confirming exposed hydrates at one.
- Explored 3 new sites finding “Dune-Grass” Seep at HEBBLE site off W. Fla. Escarpment

Fisher

31 October - 24 November Janet Voight (9 dives)

Karen Von Damm (3 dives)

Chuck Fisher (3 dives)

Focused Investigations of Environment & Life at Depth (FIELD)

DEB-0072695 Biotic Surveys & Inventories

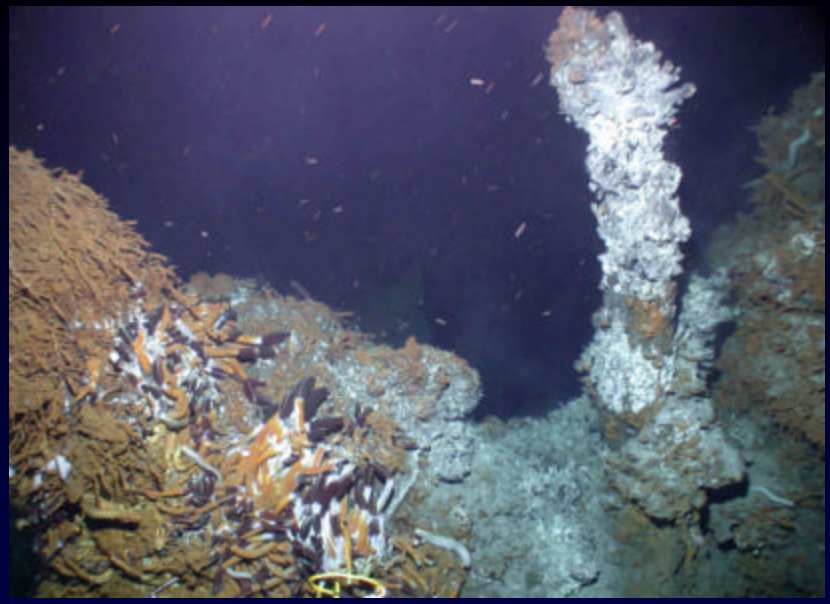
- **Atlantis 11-03**
  31 Oct. - 24 Nov 2003
- **EPR 8° 37'N to 13°N**
- **11 Alvin dives**

- **Biological collections**
- from 5! vent habitats

- Sea-Beam Surveys & Towed Camera runs
- **Out-Reach**: Expeditions@ Field Museum
- http://www.fmnh.org/expeditions/janet2_expedition/about.html

Research Discoveries!

Stauromedusae Field



Re-activated TAG-Sized Massive Sulfide

NEW Lava Flow

EXCELLENT Cruise

One Major Problem:

Bow thruster failed after 9 dives, but impact minimal

Deployable *In situ* electrochemical analyzer (ISEA) for remote and automatic analysis of O_2, H_2S and sulfur species in hydrothermal vent environments

Principle Investigator: George W. Luther, III

Cruise Dates Nov. 28 - Dec. 21, 2003

Funding: NSF/OTIC

Vehicle: Alvin

In situ electrochemical analyzer (ISEA) monitors chemical redox parameters in diverse marine environments

George W. Luther,III, Brian T. Glazer, Robert E. Trouwborst, Shufen Ma, Gregory K. Druschel, Charoenkwan Kraiya, Timothy Shank and Donald B. Nuzzio

College of Maine Studies, University of Delaware,Lewes, DE 19958; Woods Hole Oceanographic Institution, Woods Hole, MA 02543; Analytical Instrument Systems, Ringoes, N.J. 08551

INTRODUCTION

Our group has developed solid state voltammetric electrodes to measure redox chemistry. The electrodes have been deployed to profile the water column of the Chesapeake Bay, the Black Sea, hydrothermal vents and to profile microbial mats and sediments. The electrode s are robust and are now being tested for longer term deployments. At the right, Glass or PEEK (polyethyletherketone) encases the actual electrode material.

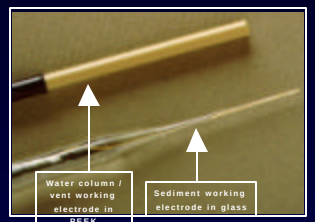
Voltammetry is a non-selective technique that can measure a suite of dissolved chemical species [e.g.; O_2, H_2S, Fe(II), Mn(II), Fe(IIII) compounds, molecular clusters such as FeS – see Table below]. Unlike single point measurements such as potentiometry (e.g.; ion selective electrodes) and amperometry (e.g.; Clark O_2 sensor), voltage is scanned as current is measured in voltammetry. This is analogous to scanning wavelength and measuring absorbance in UV-VIS spectroscopy.

Chemical data are needed to assess the health of ecosystems and to understand how chemistry/biology interact. We have even used the sensor to probe for life forms.

CHEMICAL SPECIES THAT CAN BE MEASURED SIMULTANEOLSY IN A SINGLE APPLIED VOLTAGE SCAN

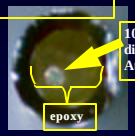
Reaction (- scan; 200 mV/s; 25°C)	Ep (V) vs SCE
1a) $O_2 + 2H^+ + 2e^- \rightarrow H_2O_2$	-0.30
1b) $H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$	-1.30
2a) $HS^- + Hg \rightarrow HgS + H^+ + 2e^-$	adsorption onto Hg <-0.62
2b) $HgS + H^+ + 2e^- \leftarrow HS^- + Hg$	-0.62
3a) $Hg + S_x^{2-} \rightarrow HgS_x + 2e^-$	adsorption onto Hg <-0.62
3b) $HgS_x + 2e^- \leftarrow Hg + S_x^{2-}$	-0.62
3c) $S_x^{2-} + x H^+ + (2x-2)e^- \rightarrow x HS^-$	-0.62 (varies with v)
4) $2RSH + Hg \leftarrow Hg(SR)_2 + 2H^+ + 2e^-$	< -0.62
5) $2S_2O_3^{2-} + Hg \leftarrow Hg(S_2O_3)_2^{2-} + 2e^-$	-0.15
Redox metals measurable	
1) $FeS + 2e^- + H^+ + Hg \rightarrow Fe(Hg) + HS^-$	-1.15
2) $Fe^{2+} + Hg + 2e^- \leftarrow Fe(Hg)$	-1.43
3) $Mn^{2+} + Hg + 2e^- \leftarrow Mn(Hg)$	-1.55
4) Fe^{3+}(organic) $+ e^- \rightarrow Fe^{2+}$(organic)	-0.2 to -0.9
Trace metals measurable	
5) $Cu^{2+} + Hg + 2e^- \leftarrow Cu(Hg)$	-0.18
6) $Pb^{2+} + Hg + 2e^- \leftarrow Pb(Hg)$	-0.46
7) $Cd^{2+} + Hg + 2e^- \leftarrow Cd(Hg)$	-0.62
8) $Zn^{2+} + Hg + 2e^- \leftarrow Zn(Hg)$	-1.05

Electrodes



Gold Electrode Tip Preparation

After epoxy injection before sanding and polishing - GLASS



Final polish (GLASS)- 0.24 micron

After polarization (PEEK) – note H_2 gas evolving

Instrumentation

Hydrothermal vent work

On the left, the ISEA has a battery for power and a pressure housing that contains the analyzer, a computer and a multiplexer so that 4 working electrodes can be used in series. The ability to use 4 working electrodes allows the user to place the four electrodes at the same location for reproducibility testing or four different locations to maximize data collection. The working electrodes are on 5 meter wires. The counter and reference electrodes are placed in plastic tubes with holes for water contact and at the front of the orange battery so that they cannot be broken.

Deep Sea Battery

Pressure housing

Cu tubing housing electrode wire

E) Shows a PEEK electrode coming out of Cu tubing that was bent from the ISEA to the *Riftia* tube. The organism actually moves out of its tube and touches the electrode with a VEMVO thermocouple

A) Shows the ISEA deployed in a *Riftia* field (TICA); B) shows a PEEK electrode on the remora of a single *Riftia*; C) shows that the organism did not push the electrode off: D) shows that the PEEK electrode can survive a crab attack.

Conclusions

The electrodes have been used and tested to 250 atm pressure and 120 °C. During a cruise at 9°50' N East Pacific Risae in Dec. 2003, the ISEA was deployed twice; once in survey mode on the DSV *Alvin* and another time as in slides A-E on the bottom for a period of 5 days. The 4 electrodes were run continuously including electrochemical conditioning between each scan to maintain electrode integrity. Dissolved O_2, free sulfide (H_2S/HS^-) and Mn^{2+} data were obtained at 4 separate *Riftia* tubeworms during the 5 day deployment. Although temperature only varied between 2 – 9 °C, these 3 chemical species varied by over an order of magnitude. The data will be presented in depth elsewhere.

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