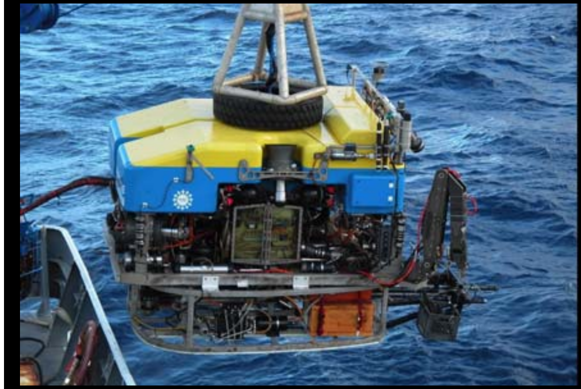
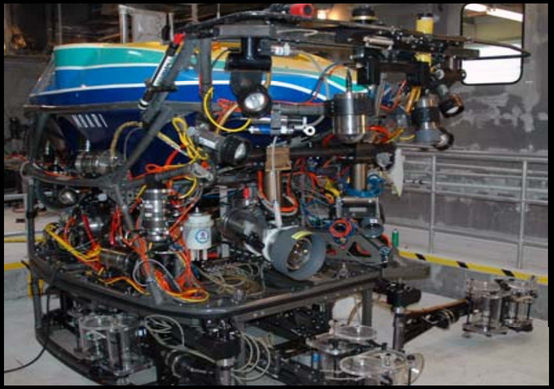
Technical Advancement of Remotely Operated Vehicles & Submersibles
January 23-24, 2008

GOAL: Outline capabilities that will be needed to support deep submergence research in all areas of the deep ocean and for support of ocean observatory initiatives

~30 participants





Seafloor Integrated Study Sites - Exploration Science and Operational Needs - Fornari

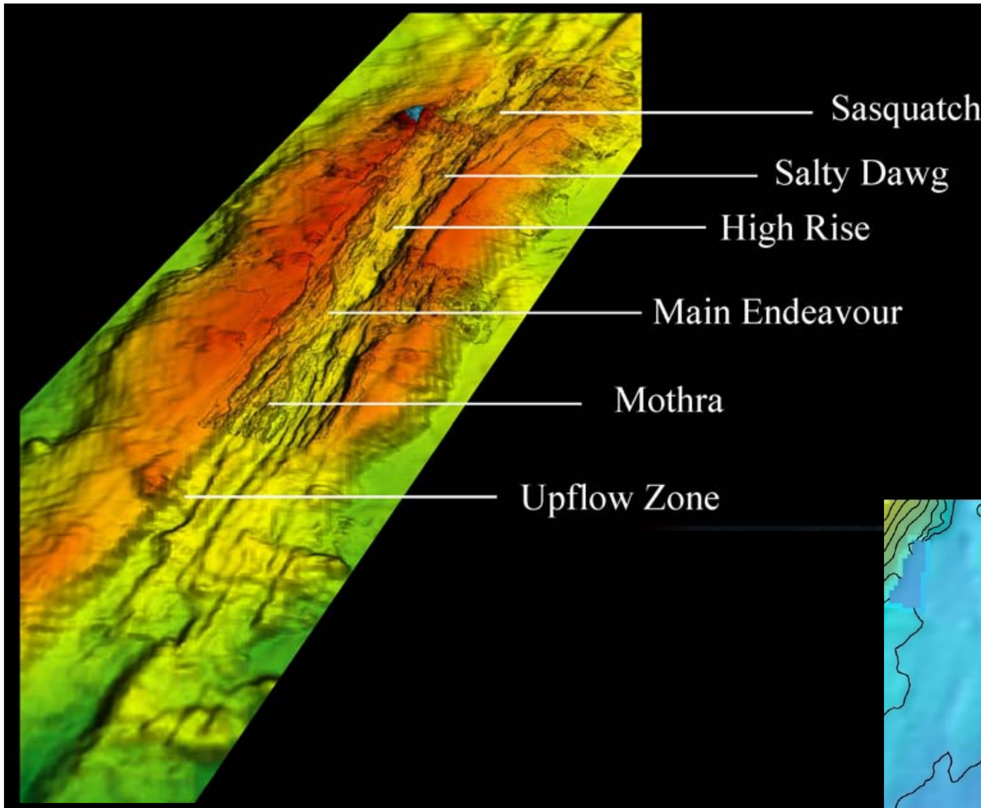
The Future

Studies at seafloor and near-seafloor sites that use deep submergence vehicle systems in the US and abroad should be able to rely on

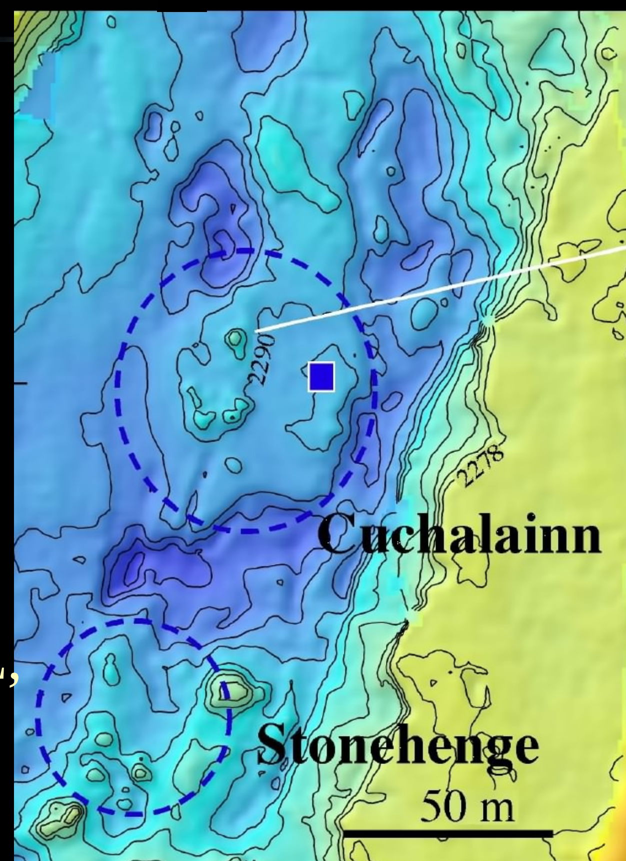
1) a 'baseline' of state-of-the-art technical capabilities (e.g., vehicle nav. and attitude, sensors, operational reliability and stability)
2) data commonality/formats
3) sampling capabilities across the disciplinary spectrum that permit precise/oriented collection of rocks, animals, water

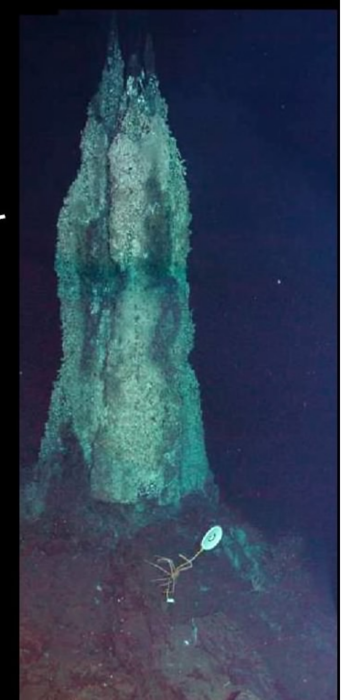
9°N EPR

Evolving theme- how well can we share sensors and capabilities across institutional-international boundaries. How insure effective sharing?



Future Experiment/Survey Requirements ISS Sites





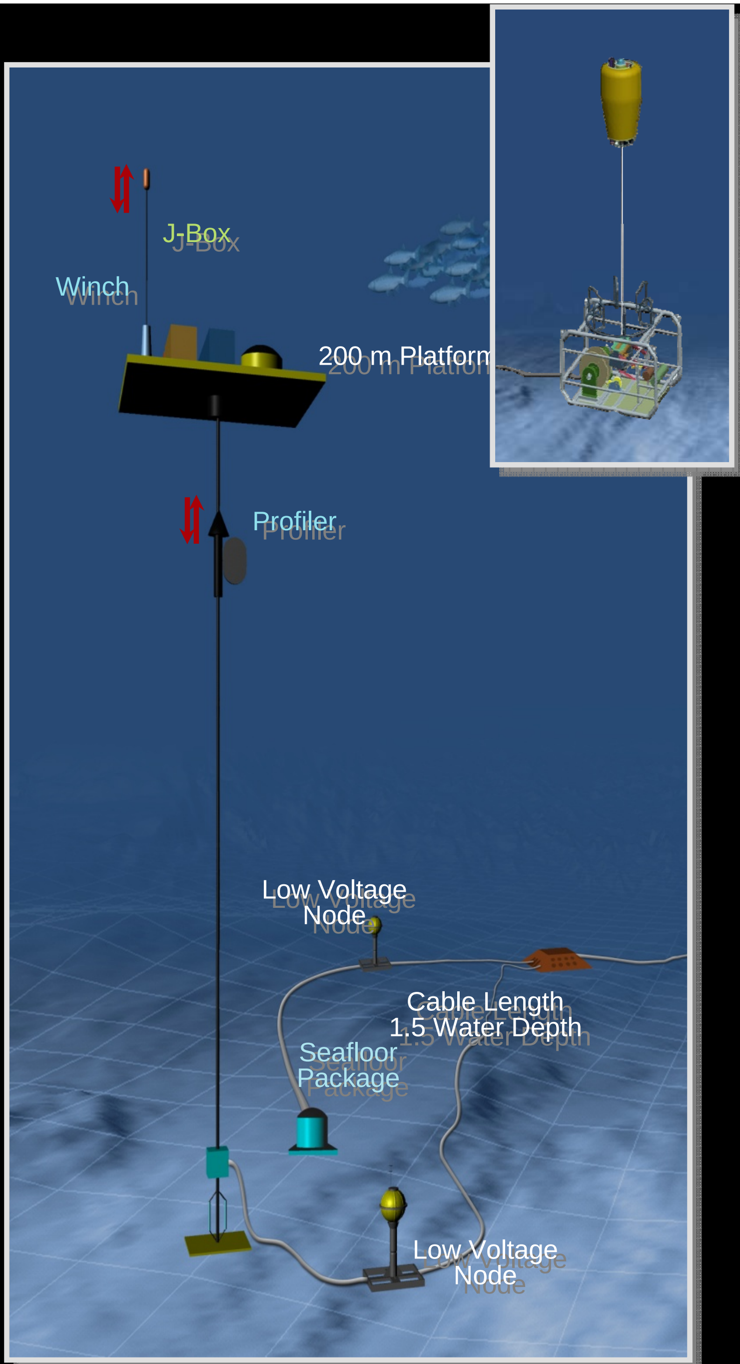
Produce bathymetric maps at 1 m resolution over km’s of seafloor and < 1 m maps for localized experiment areas. Must have on-bottom infrastructure - LBL,USBL, benchmarks, tide gauge, etc.

Imaging tools/sensors, high-def/stills, scaling/lasers, laser-line scanners, high-intensity HMI or LED light-posts, magnetic gradiometer, precision gravimeter, Eh sensor, laser or LED data comms, LED/HMI lighting, stereo-photography

Sampling tools: ability to tie sampling precision to map-based products, including: multi-chamber / variable size / filtering pump systems (slurps), oriented drills, biological samplers/bioboxes - in situ injection chambers, in situ geochemistry sensors (mass specs, Raman laser, etc)

Elevators, smart (ie, positioning), equipment/sensor loaded elevators

Reoccurring Theme: At point where we need to spend more time focusing on sensors and sensor development, but many are big ticket items. How can we capitalize on this? Share across facilities

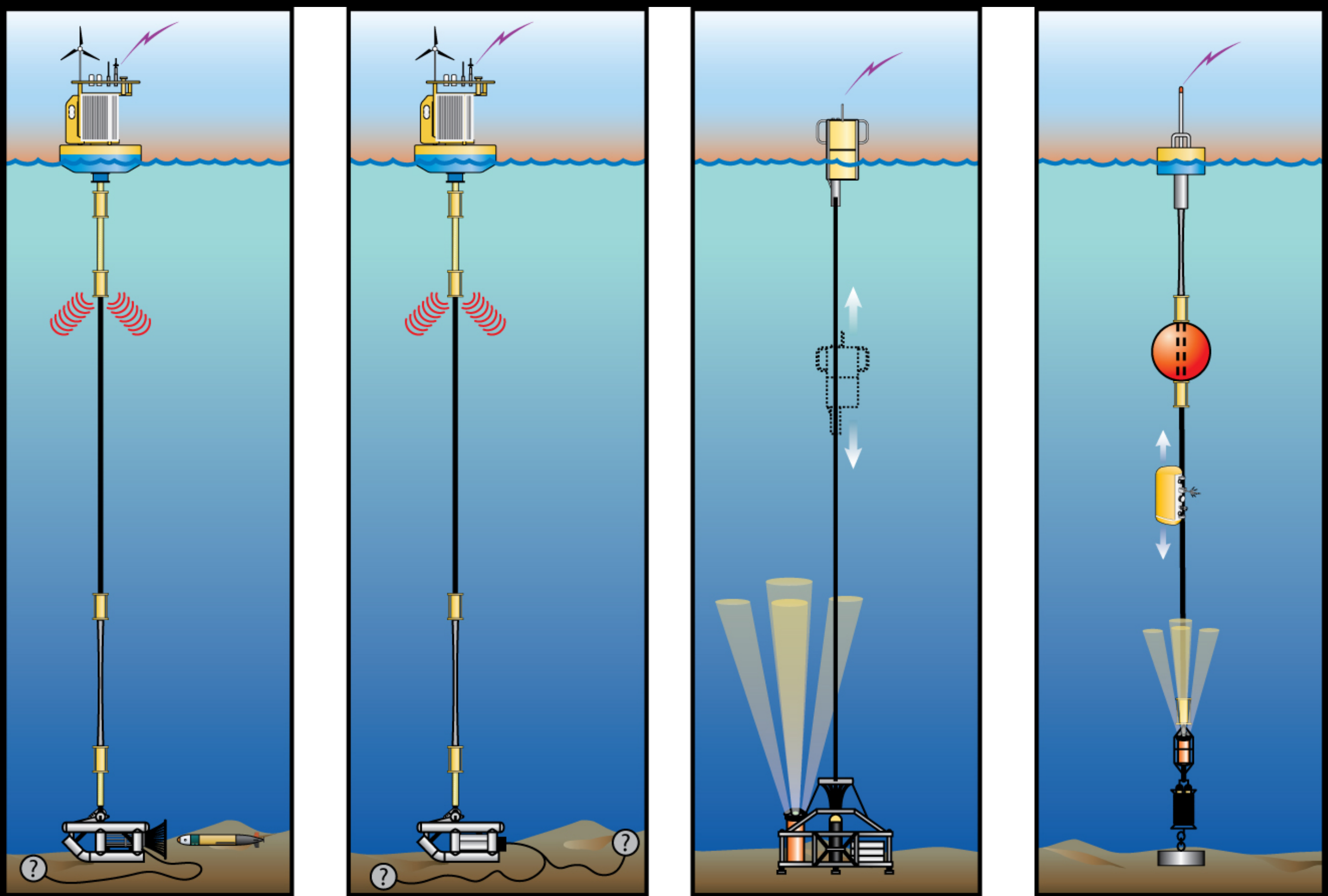


Moorings

ROV Requirements - Bruce Howe

- Cabled systems:
  - RSN and Endurance moorings
  - Laying secondary seafloor cables
  - Bottom secondary infrastructure and instrument packages
- Autonomous Endurance and Pioneer moorings
- Global sites:
  - Central “Acoustic” mooring
  - Profiler mooring
  - Flanking moorings
  - Bottom secondary infrastructure and instrument packages

Coastal Moorings - Pioneer



Pioneer AUV Dock Mooring

Pioneer Mooring

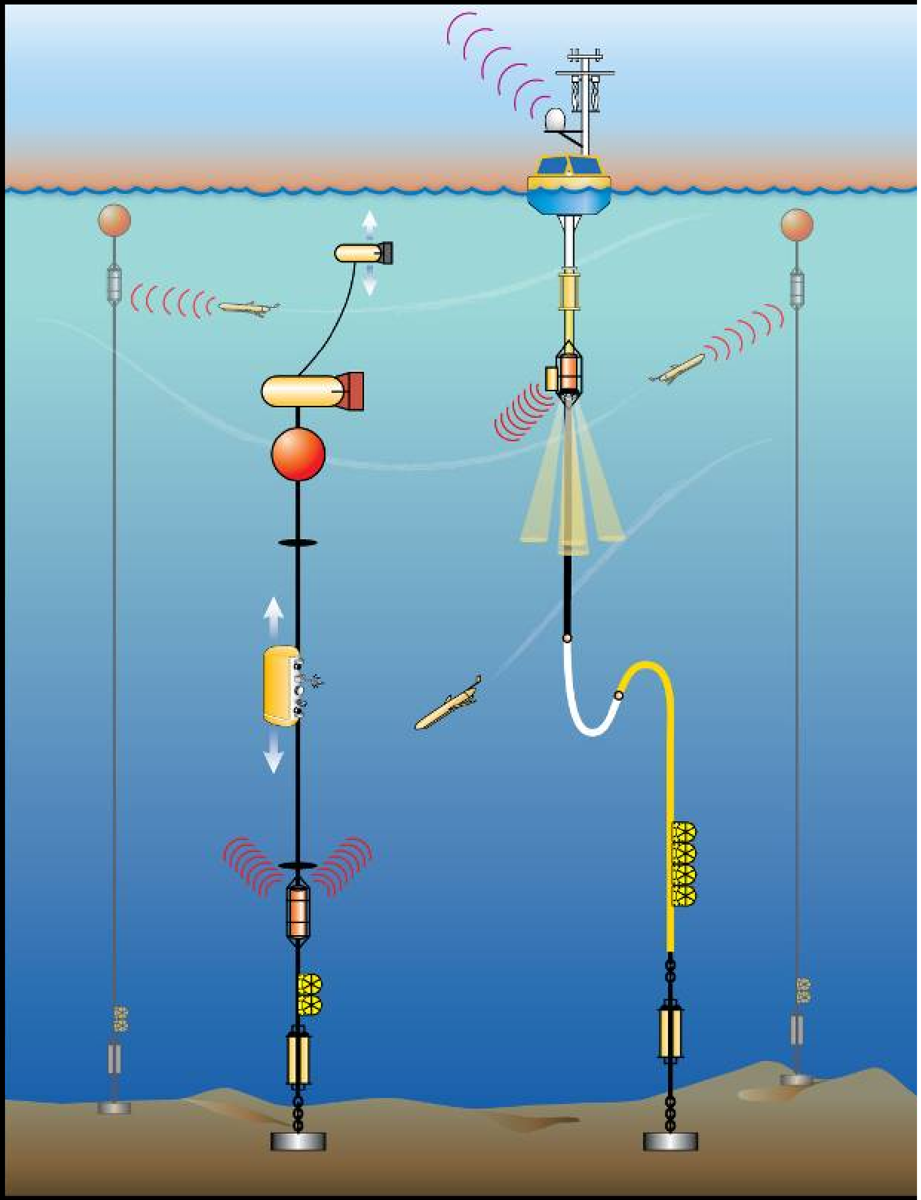
Pioneer Winched Profiler Mooring

Pioneer Profiler Mooring

Global Moorings

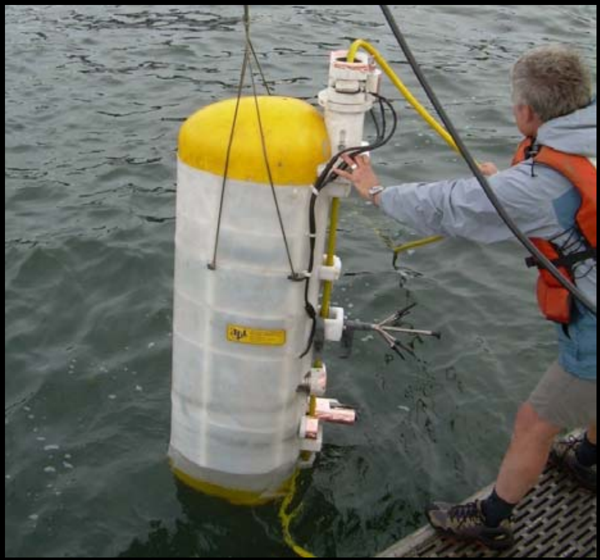
- Papa - 50N
- Irminger Sea - 50N
- Southern Ocean / Chile - 55S

- Primary mooring with acoustic/satellite telemetry
- Nearby profiler mooring
- Two flanking moorings
- Gliders



ROV's will need to:

- Service sensor packages (install, inspect, clean, replace in-place)
- Install/remove profilers for servicing
- In-place calibration, e.g, ROV has calibrated "standards", sits/attached to in-situ sensors for "a while" while both sensors collect data simultaneously. Operate at shelf to "full" ocean depth 80- 5000 m.
- Seafloor cable of all kinds: lay, recover, bury, connect, service
- Buoyancy control & work near/around vertical mooring



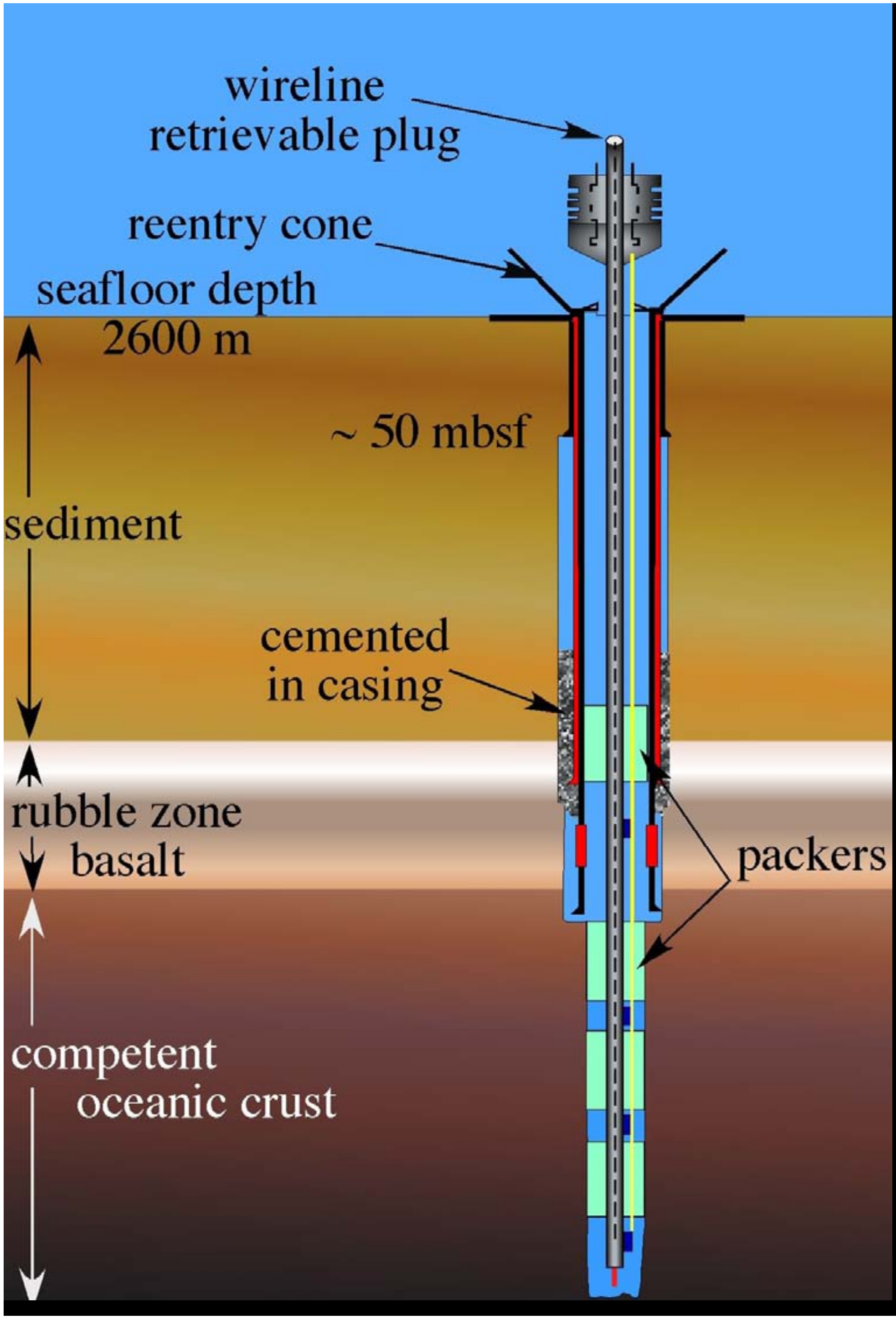
- Specialized connection tools - UW mateable connectors tailored to ROV tools?
- Manipulate heavy/awkward packages with ROVs, e.g., winch systems and profilers, AUV docks, replace entire winch and profiler packages-deploy large packages
- Through-frame lift capability (100’s of kg?)
- Elevator systems – state-of-practice? Improve?
- Provide “Science Connector” to allow ROV to power and communicate with seafloor packages
- Unconventional “ROVs” - cranes/arms/ for future seafloor “laboratories”

Historically there has been some success at sharing.., but

Historically there has been some success at sharing but there is a need for better communication across all operators.

Action Item

Compile on a single web site accessible information on underwater assets, tools, and sensors (e.g. numerous AUV's underway)



CORKS/IODP - Keir Becker

9 multizone corks have been deployed

Drill ships do installation, submersibles service them

Sensors suspended in hole

Next challenge is a full blown wireline reentry capability with an ROV of manned submersible, recover logger/string and install replacement logger-string

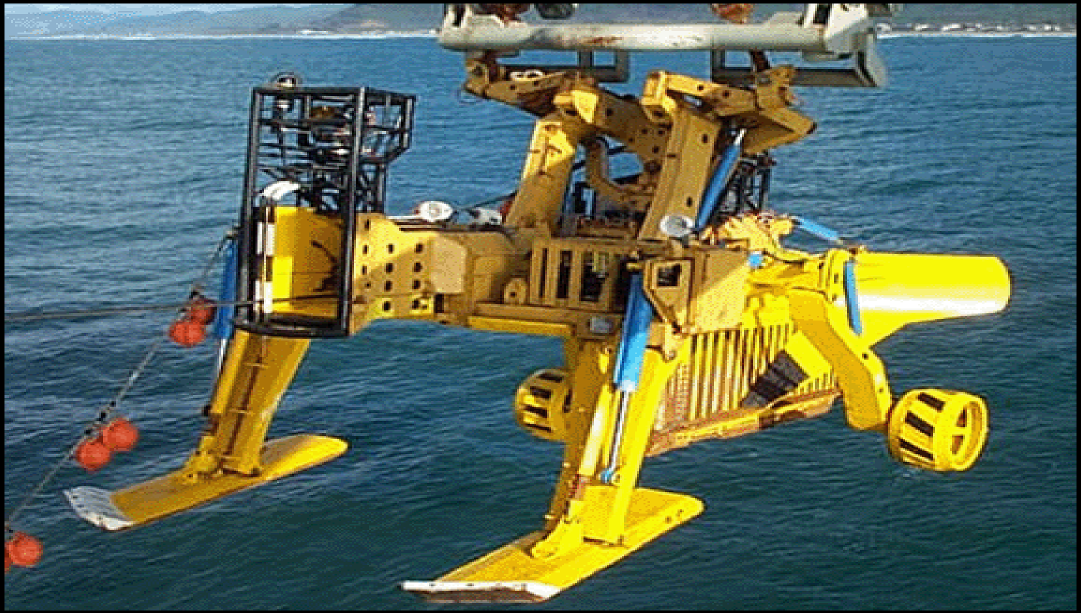
ION- install seismometers in seismic observatory holes- cement in or use silica beads

Cabled Observatory Needs

Mike Kelly

SEA PLOWS

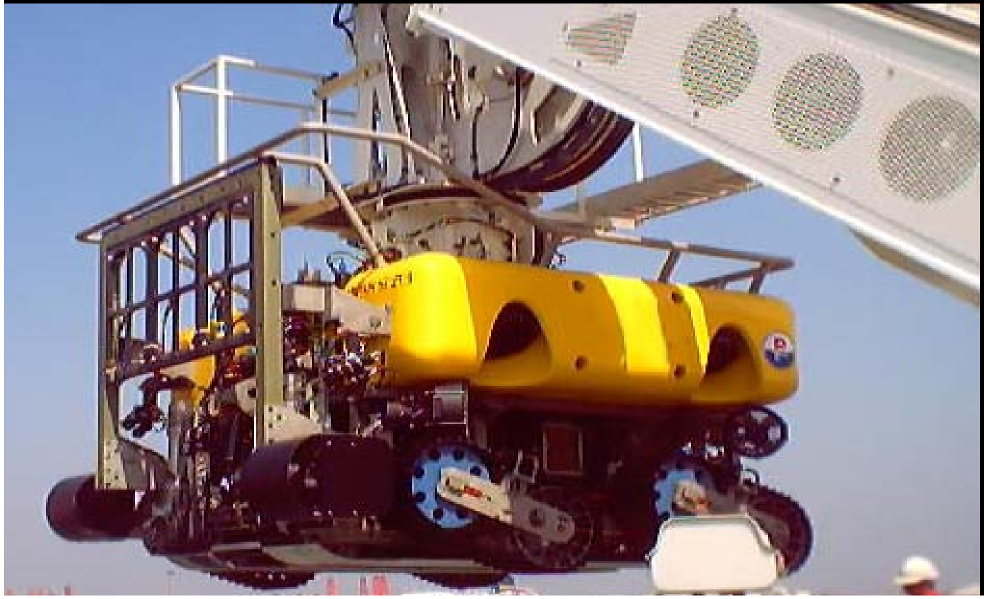
- Approximately 75% of undersea cable failures are caused by external aggression in water depths of less than 1500m
- Armoring alone will not protect cables, so burial into the bottom is required



- Burial depths
  1 - 3 meters
- Tow tensions
  20 - 60 tons
- Speeds
  0 - 3 kts

- Not all cable can be buried by plow
  - Cable or pipeline crossings
  - Branching units
  - Plow maintenance
- Need capability to repair faulty cables
  - Rebury cables for repair access
  - Cut and recover cable ends for repair
  - Retro-burial at completion of the repair

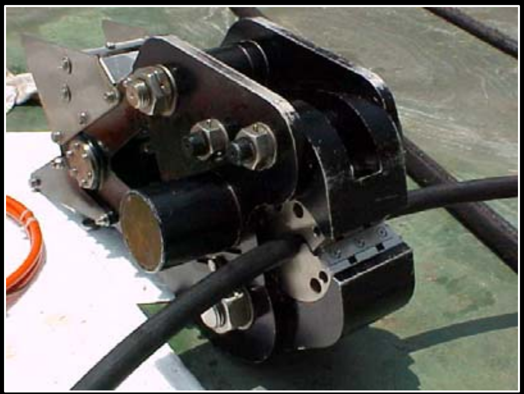
TYPICAL MAINTENANCE ROV



- Perry Slingsby Triton ST200 has become one of industry standards

Typical ROV Specifications

Video courtesy of Tyco Telecommunications



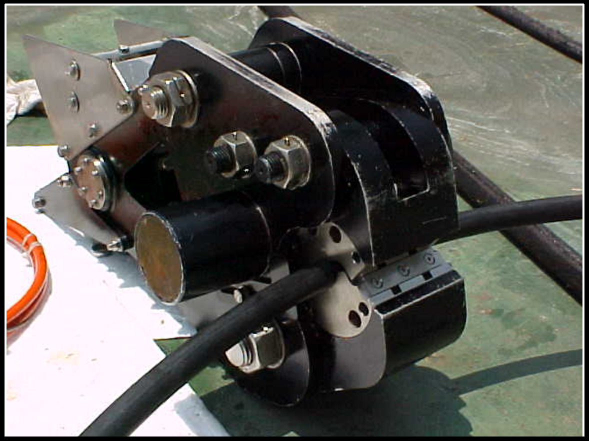
- Rated < 3000m, but typically operates in no more than 1500m
- Horsepower, 150 - 500 hp
- Burial speeds, 0.25 kts
- Burial depth, max 1m
- Survey speeds, 1-2 kts
- Tracking system, active/passive
- Burial system, waterjet bellows
- Force feedback manipulators
- Full data logging capability
- Special cutter tools
- Active/Passive cable detection
- Fly away capable, but usually dedicated platform

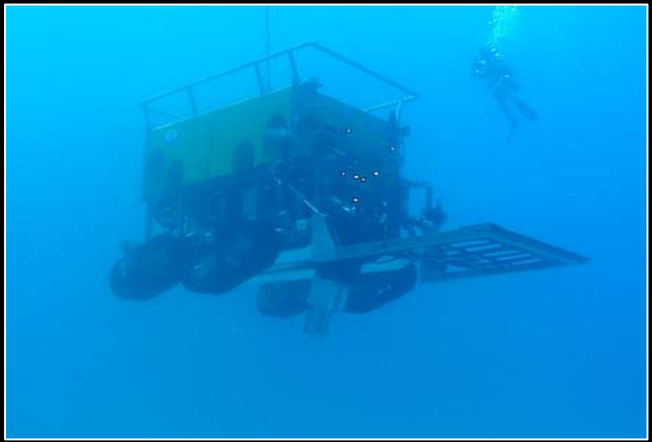
OTHER KEY FEATURES

- “Cutter” can hydraulically cut cables with diameters in excess of 100 mm
- “Grabber” can lock onto cable end with recovery line attached

- Active and Passive tracking of buried cables
  - Regulatory burial surveys
  - Detecting location of electrical faults in cables
  - Identifying coded cables

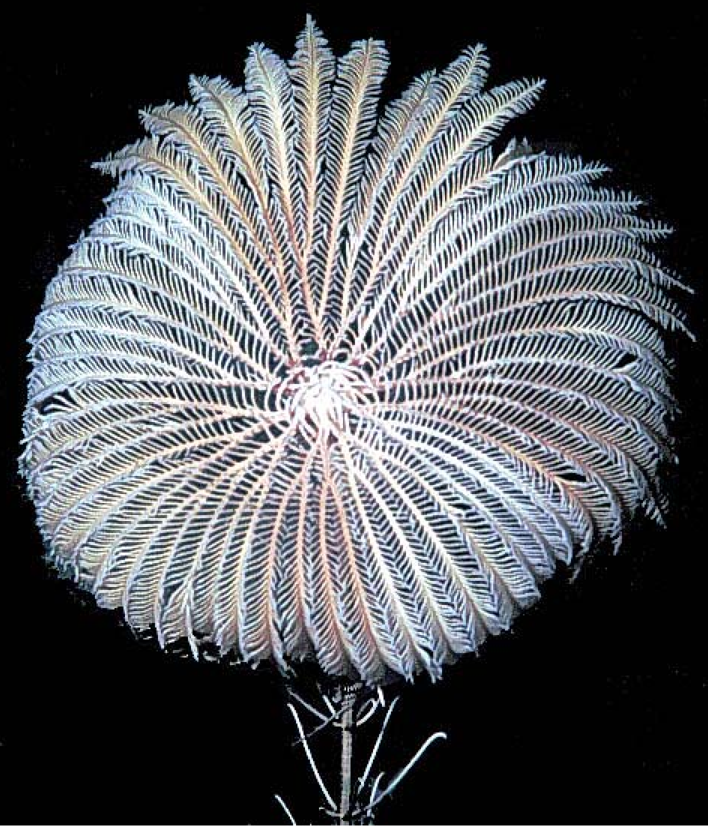
- Ability to lay up to 5-8 km of cable





Biology Needs and Wishes
Craig Young

Sensors can measure background information about the chemical and physical environment, but most physiological and ecological studies require either imaging or collections, generally both.

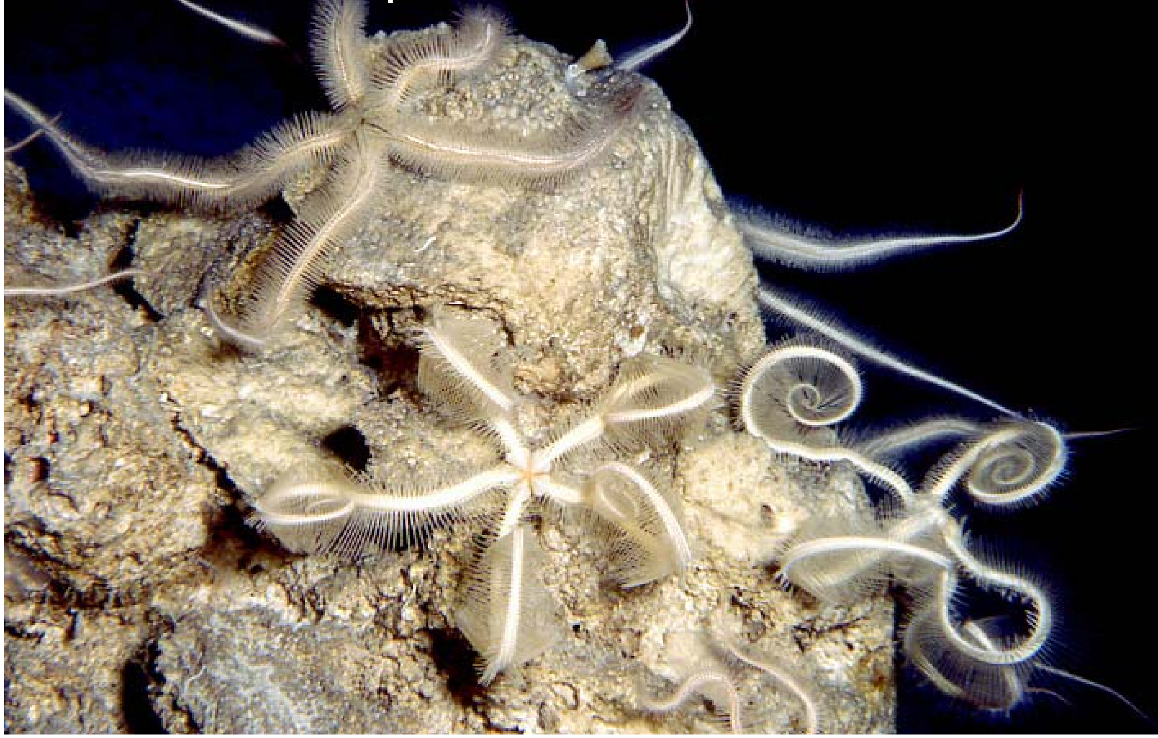


Sensors

Chemical probes with real-time readout and data loggers

- Methane
- Sulfide
- Oxygen
- pH

Good biologically-relevant, chemistry has limited what numerous scientists have tried to do at seeps and vents for many years



Mass spectrometer

A full-time mass spectrometer - envision a variety of inlets, wands, etc for different purposes. A few could be available (background seawater flowing by as the default) and different PIs could design their own for specific purposes.

Ability to connect external fiber optic sensor (spectrometer) that can be used for chemical sensors to a spectrometer inside sphere.

Imaging: Video & Stills

Excellent quality video, including broadcast quality options

- Downward looking transect video, permanently mounted
- Infrared Camera System
- Video camera mounted low (on work platform) perhaps in a cage
- Excellent high-resolution still images, not from video grabs
- Camera mounted near bottom with excellent macro capability
- Downward-mounted camera and lights for transects and spatial grids.
- Permanently mounted pair of cameras for stereo imaging.

Collections

- More push cores (n=48 or so per dive)

- Larger and more suction chambers. Thicker acrylic for thermal insulation.

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- Collection (Bio) boxes as standard equipment, not user provided. Seals always maintained.

- Hydraulics to open and shut collection boxes (as in ROPOS and JSL) would save lots of time.

- Bushmaster and mussel pot as standard quantitative sampling equipment (not user provided).

- Rock drilling for biological samples; ways to break rocks *in situ*.

- Clam bucket or Pac-man scoop (as in JSL, ROPOS)

Collections (continued)

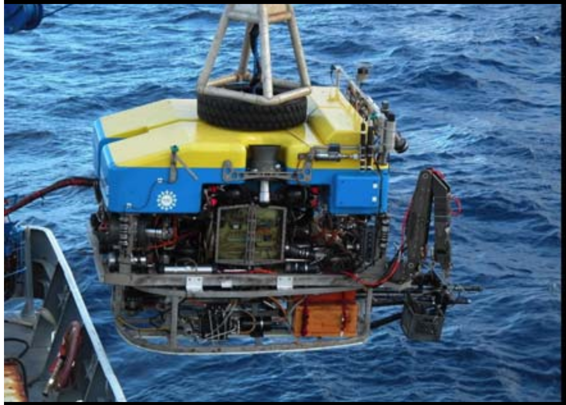
- High-volume suction sampler for larvae and other plankton.
- Chamber that can bring up animals under natural conditions of pressure and temperature
- Device to preserve DNA *in situ*.
- Flow-through genetic probes.

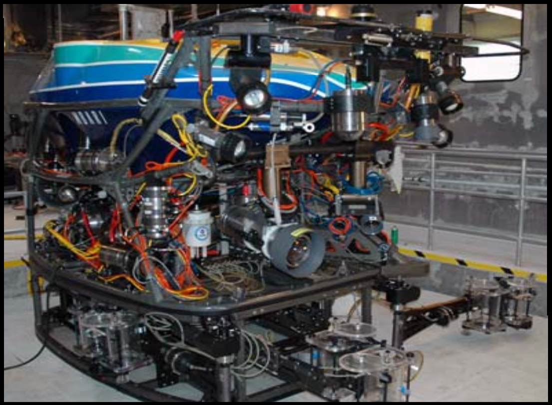
Preservation of samples *in situ* would be a great advantage, particularly for transcript or enzyme work that allow recovery of a wider variety of subsamples (DNA, RNA, proteins, stable isotopes, etc

Presentations lead to a long discussion…

- Vast array of needs and wishes that cross numerous disciplines
- Not enough people, time, or funds to do all we need at any 1 facility
- Need to try and achieve some commonality in vehicles
- Concept of pooled equipment, some specialized some not

Need for a different management/funding/scheduling structure for national - international assets. Should be charged with developing protocols that ensure cost effective use of the spectrum of assets available





In summary these presentations

- Sensors & Data Loggers
- Imaging
- Collection tools
- Navigation