

# DEEP SUBMERGENCE VEHICLES EXPEDITIONS & OBSERVATORIES

Deb Kelley

University of Washington

dskelley@uw.edu



AXIAL SEAMOUNT



GRAYS HARBOR



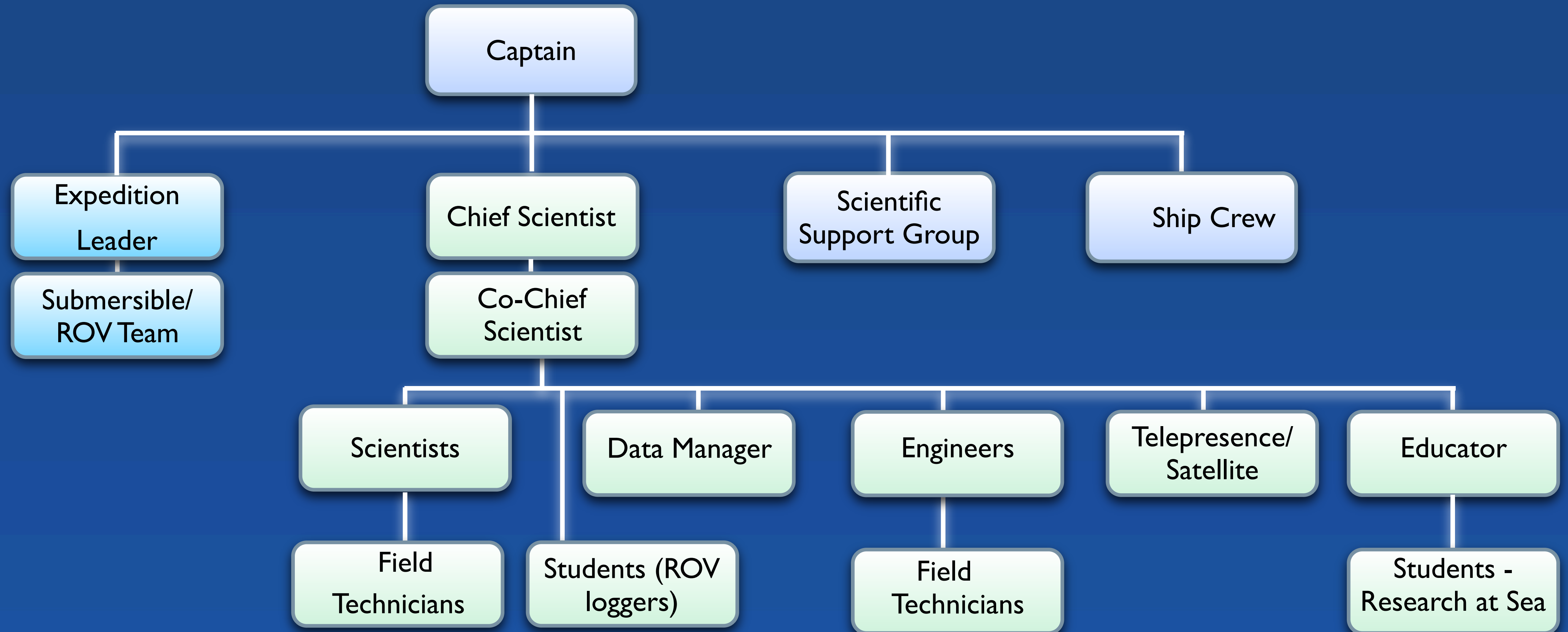
HYDRATE RIDGE





# CHAIN OF COMMAND - SAFETY IS FIRST

Significant interaction between Captain, Chief Scientist and Expedition Leader





# COMMON THREADS



- ▶ Proposals - talk with operators - provide believable schedule
- ▶ Early Detailed Planning and Communication Key
- ▶ Detailed Dive Plans Essential
- ▶ Concomitant ROV and AUV operations semi-routine
- ▶ Optimize efficient use of assets; weather awareness
- ▶ Force feedback arms, numerous cameras, good nav common
- ▶ Sensors and sampling devices becoming more complex



# DSRV Alvin

4500 m

5 view ports



*0800-1600 typical*

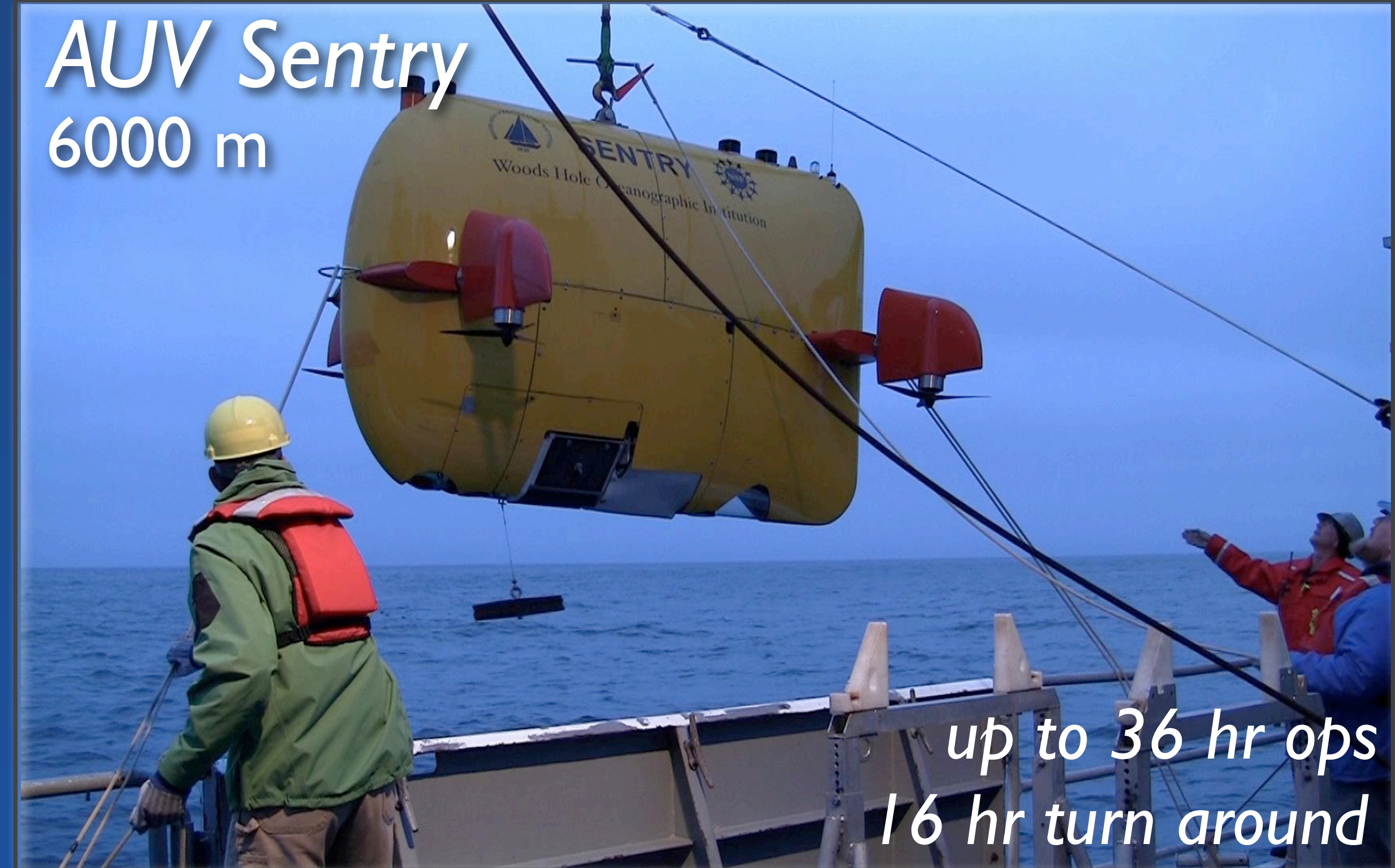
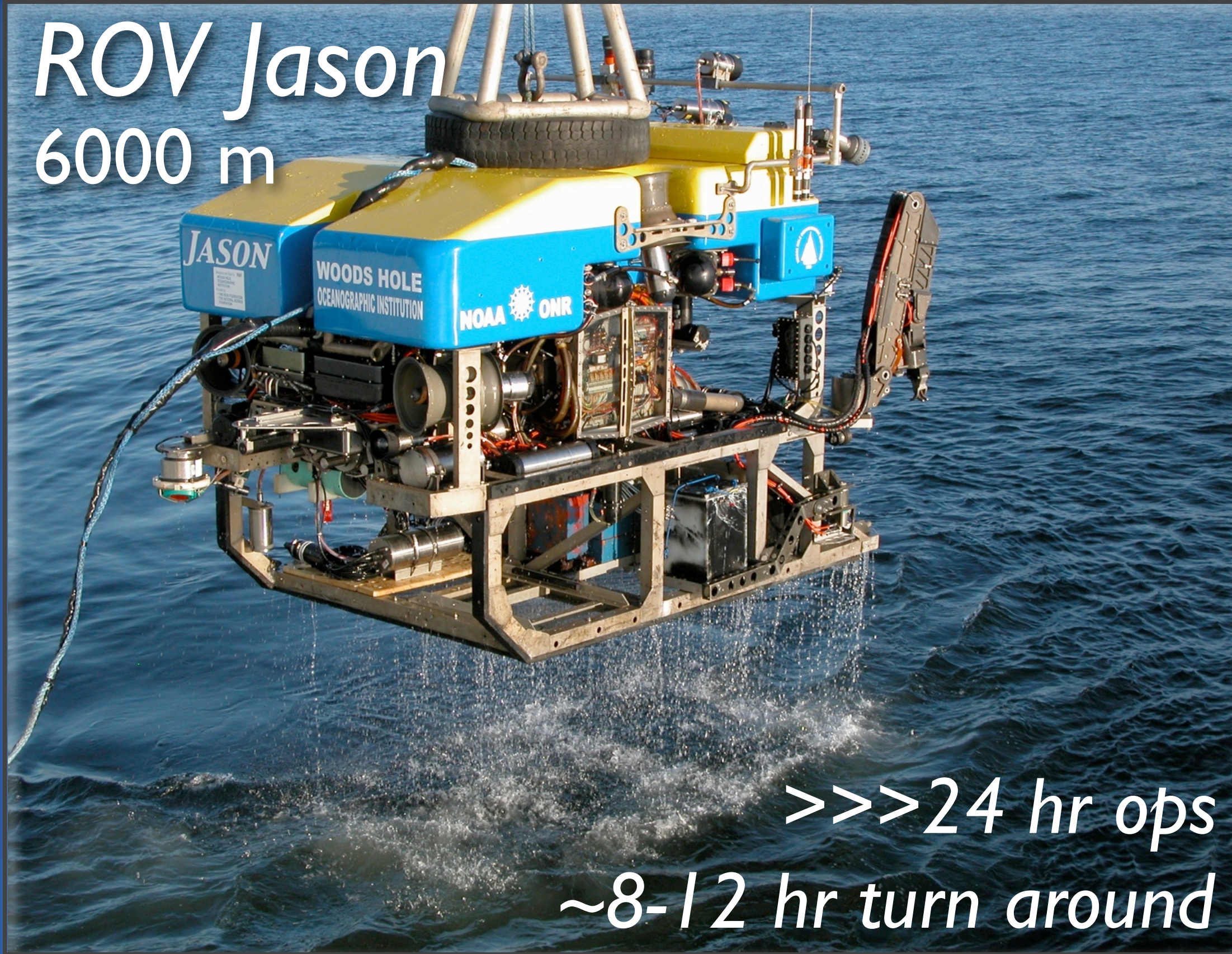
<http://www.whoi.edu/main/hov-alvin>

- ▶ 2 observers; 1 pilot - every 5th dive = pilot in training
  - ▶ Lead observer port side; minimal communication to ship
- ▶ 6-10\* hrs of operation (0730 start); payload 400 lbs
- ▶ Geological, biological, fluid sampling, temperature
  - ▶ Rock box, magnetometer, sediment cores
  - ▶ Biobox, slurp samplers
  - ▶ CTD, major Ti-water samplers (gas tights - PI provided)
- ▶ Reson mapping system; numerous cameras
- ▶ External ports available for PI sensors
  - ▶ RS232 & 485 ethernet interfaces available
  - ▶ Pressure test certification and smoke test required
  - ▶ Precruise testing, documentation critical (boxes of parts bad)

Early & continued interaction with expedition leader and all science personnel key



# Nested Operations - Concomitant Use of ROV Jason and AUV Sentry

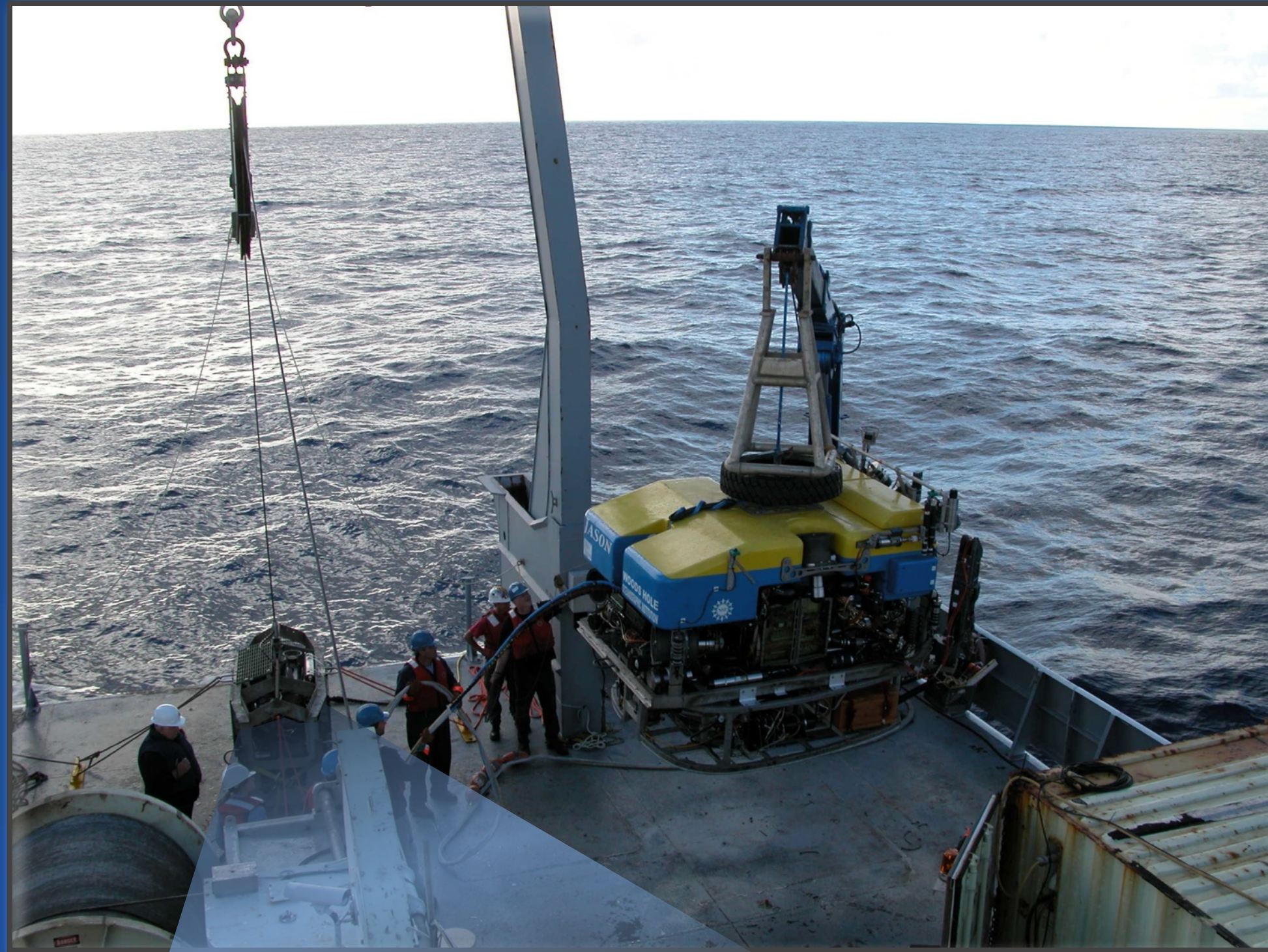


- ▶ Real-time imagery, data, sensor adaptation
- ▶ Reson mapping, photomosaicking
- ▶ Solid, fluid, biological sampling
- ▶ Horizontal Drilling (basement & smokers)
- ▶ Interactive telepresence

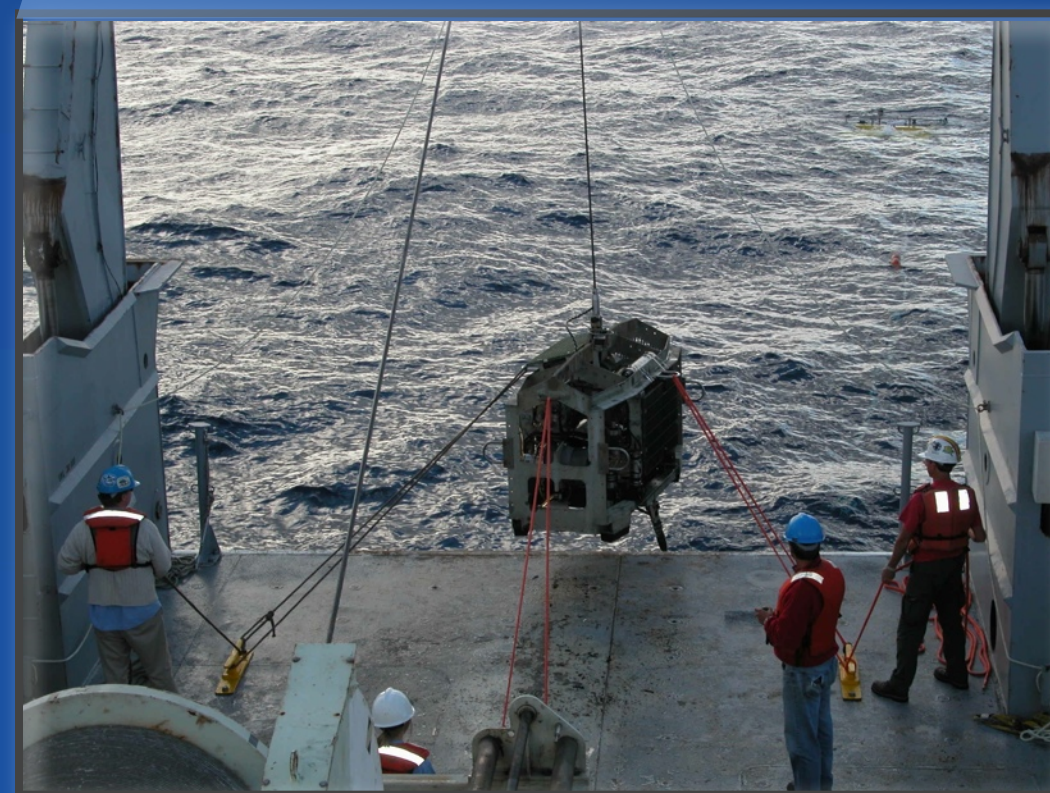
- ▶ Bathymetric survey (Reson ~ 1 m resolution)
- ▶ Plume detection & characterization
- ▶ Mass spectrometer, Eh, fluorometer
- ▶ Down-looking Photomosaics
- ▶ Sidescan and Sub-bottom imaging



# NDSF ROV Jason & Medea



# URI-OE-Ballard ROV Hercules & Argus



Medea

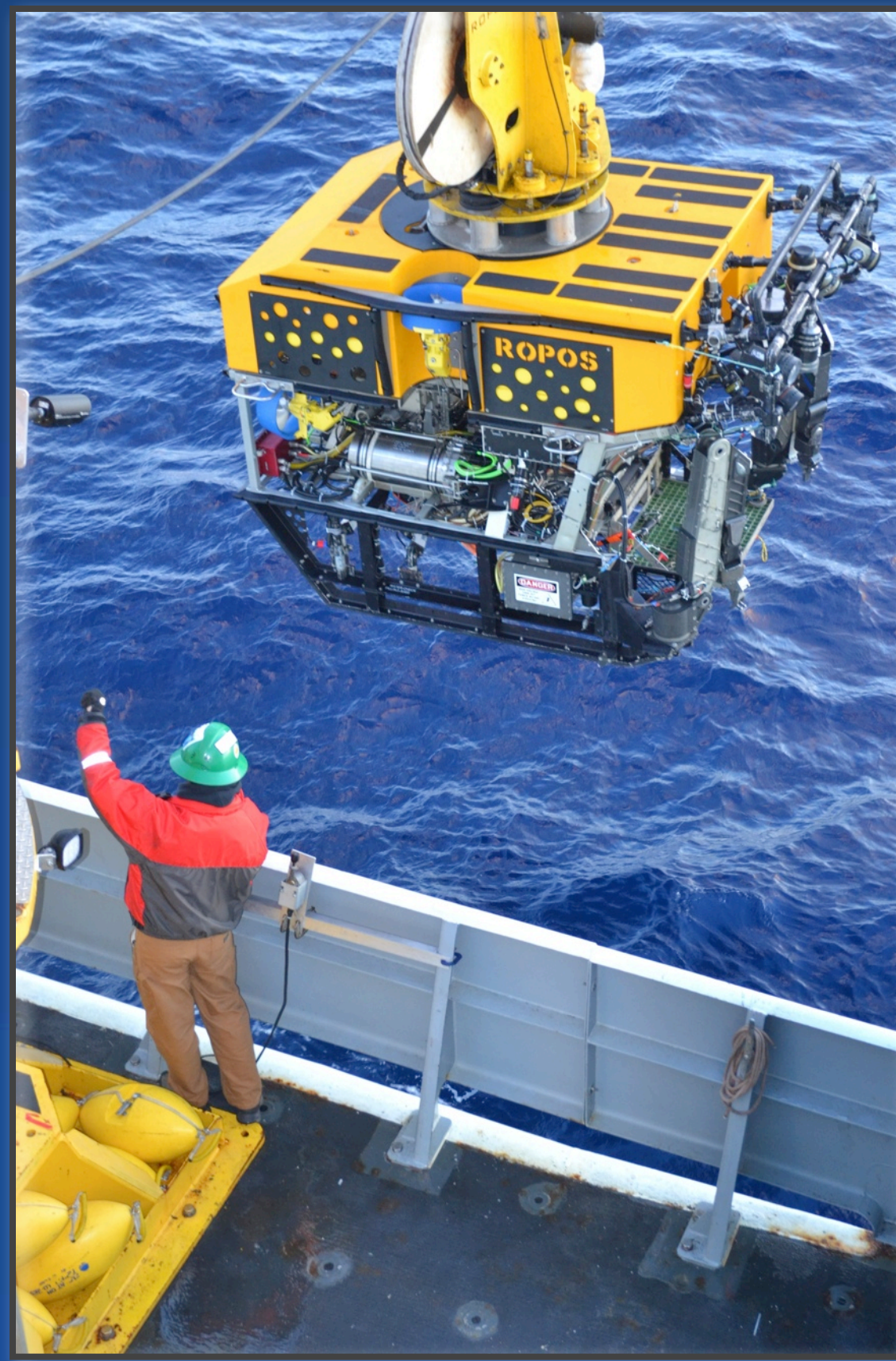


## “Eye in the Sky”

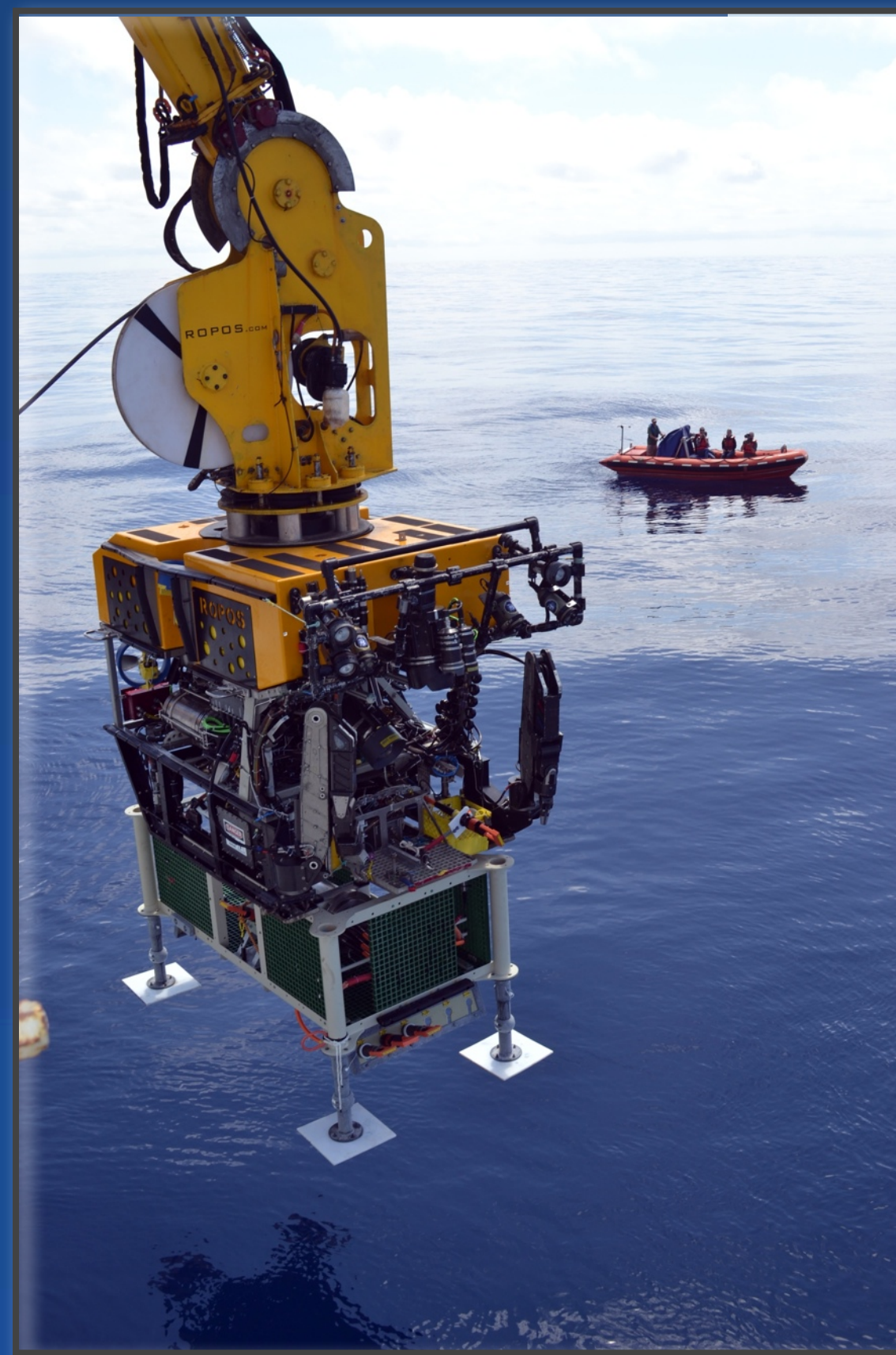
- ▶ 50 & 30 m tether, respectively
- ▶ Ship, ROV, ‘clump weight’ dance

Argus

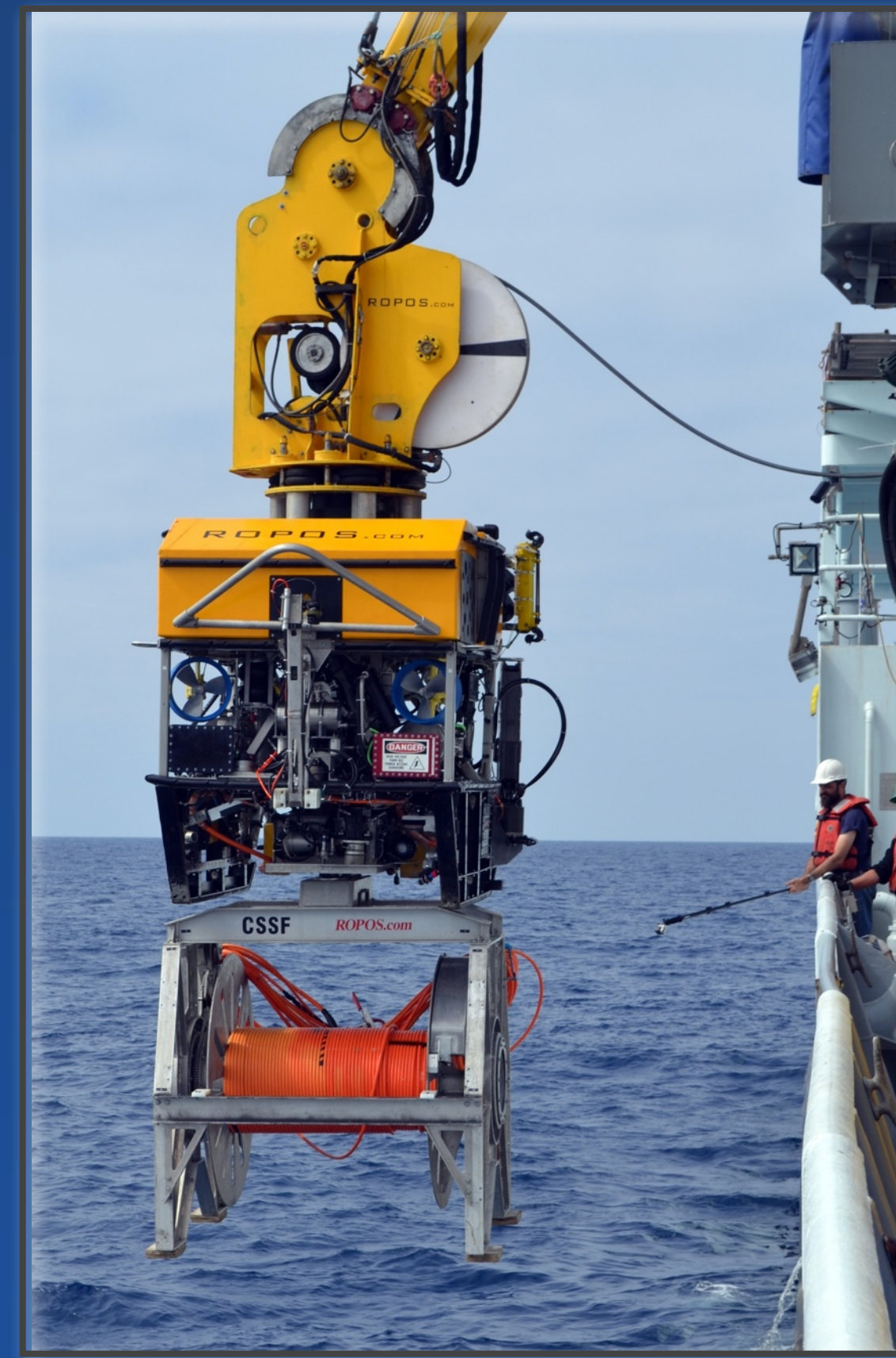




Science



Junction Box-Elevator



Cable Laying

# ROV ROPOS

Canadian Scientific  
Submersible Facility

- ▶ 1 part vehicle (no clump weight)
- ▶ Designed for science and observatory work
- ▶ Installation of cables, junction boxes, instruments
- ▶ 4,000 lb heavy lift capability with direct latching to infrastructure



## ROV ROPOS Control Room on R/V Thompson



- ▶ Allows ~15 scientists, engineers, students in control room comfortably

## ROV Operations are Round the Clock

- ▶ Watches vary - 4 hrs on, 8 off to 12 on 12 off
- ▶ 1 person in hot seat
- ▶ 3-4 loggers - metadata important
  - ▶ Even Logger
  - ▶ Digital Still Images
  - ▶ Video Management
- ▶ Huge amount of data - UW 2013 cruise 30 Tb video imagery, 20-30,000 images routine
- ▶ Intense operations common - more than one thing going on - management critical



Jason Virtual Control Van

The interface displays three monitors at the top: MONITOR 1: SubSea1 (showing a crab), MONITOR 2: SubSea2 (showing the ROPOS), and MONITOR 3: SubSea3 (showing the ROPOS arm). Below the monitors is a data panel with the following information:

<b>DAQ.tn252.Jason</b> Lowering: J2-508	<b>Time:</b> 2010/08/01 05:35:05	<b>Hdg:</b> 272.10 <b>Lat:</b> 44 34.172058 N <b>Lon:</b> 125 8.815422 W	<b>Alt:</b> 1.59 <b>Depth:</b> 773.44 <b>Bathy:</b> 775.03	<b>DegC:</b> 4.003 <b>Cond:</b> 3.234 <b>Salin:</b> -999.000 <b>SVel:</b> -999.000 <b>MagX:</b> 6293.3 <b>MagY:</b> -15193.3 <b>MagZ:</b> 40660.0 <b>MagT:</b> 43859.8
--	----------------------------------	--	--	---

Additional data: **Type:** EVT **NavSrc:** JAS2 **AttSrc:** **X:** 28160.70 **Y:** 26246.12 **Z:** **Pitch:** -4.3 **Roll:** -5.7

**Event:** DLG Frame\_Grab:

**Cruise Timebar:** J: J2-507 J2-508 J: (Progress bar from 10% to 90%)

**Search/Filter:** Show All Find 2010/08/01 05:35:05 show all results only

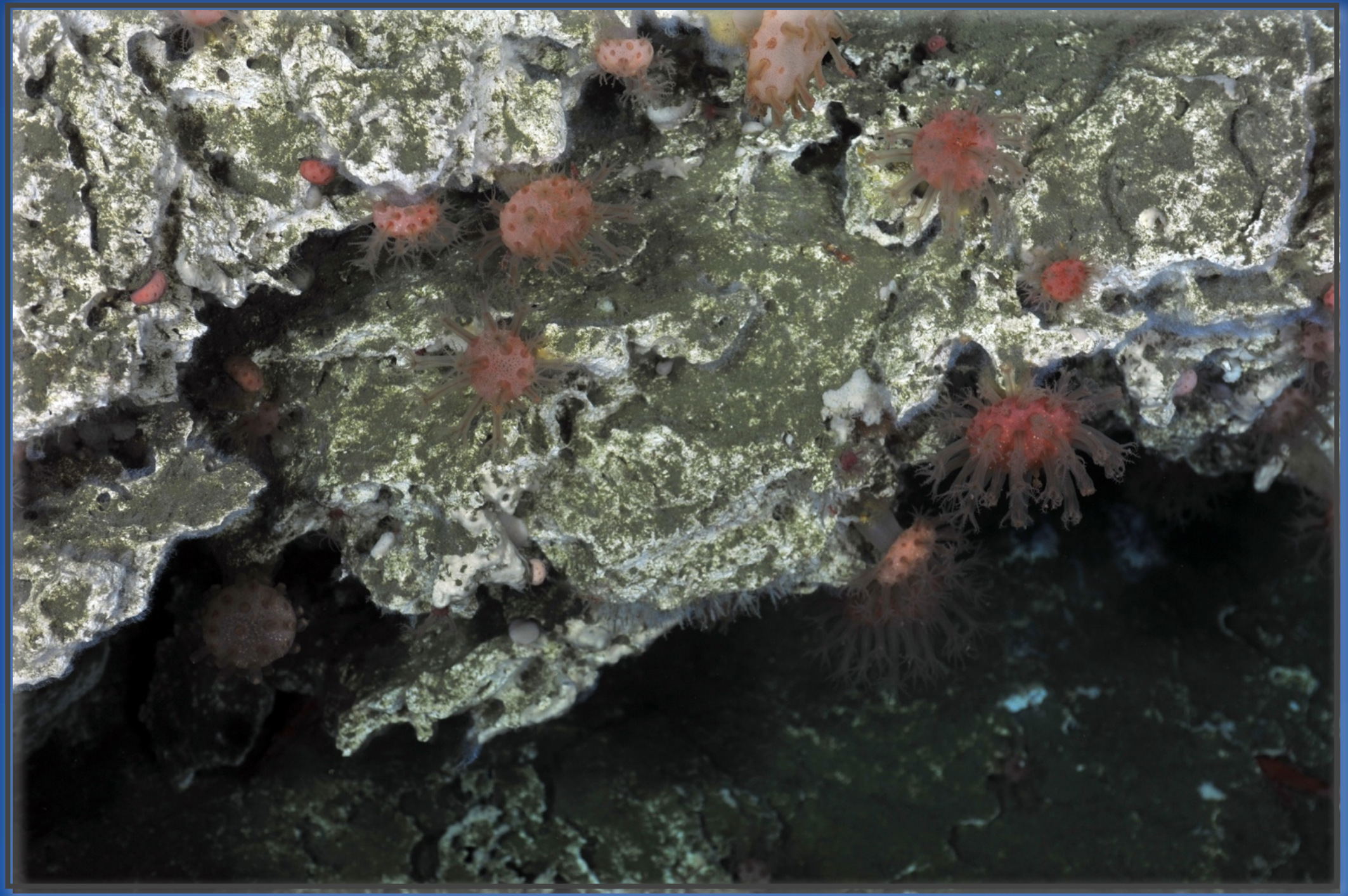
**Navigation:** 5509 of 5925 Goto 5509 RefreshRate: 10

**Event Log:** 5509. 2010/08/01 05:35:05 EVT Frame\_Grab: 5510. 2010/08/01 05:35:12 EVT Frame\_Grab: 5511. 2010/08/01 05:35:22 EVT Frame\_Grab: 5512. 2010/08/01 05:35:33 ASNAP 5513. 2010/08/01 05:36:03 ASNAP

**Footer:** tn252 - Juan de Fuca CRUISE INFO | SELECT ANOTHER CRUISE Jason Virtual Control Van Done

# Jason Virtual Van

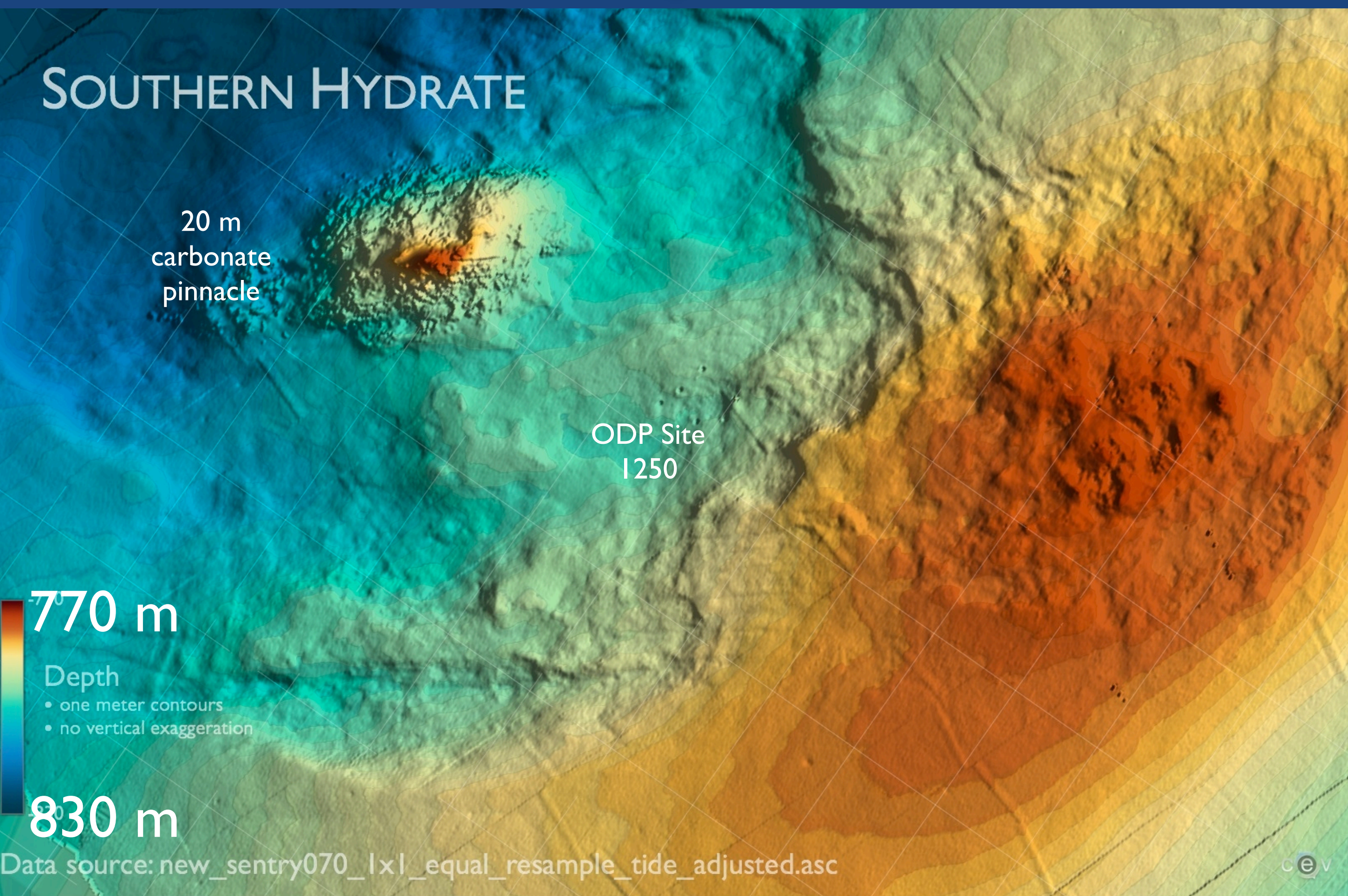
- ▶ Frame Grabs Automatically
- ▶ Location Data
- ▶ Even Description



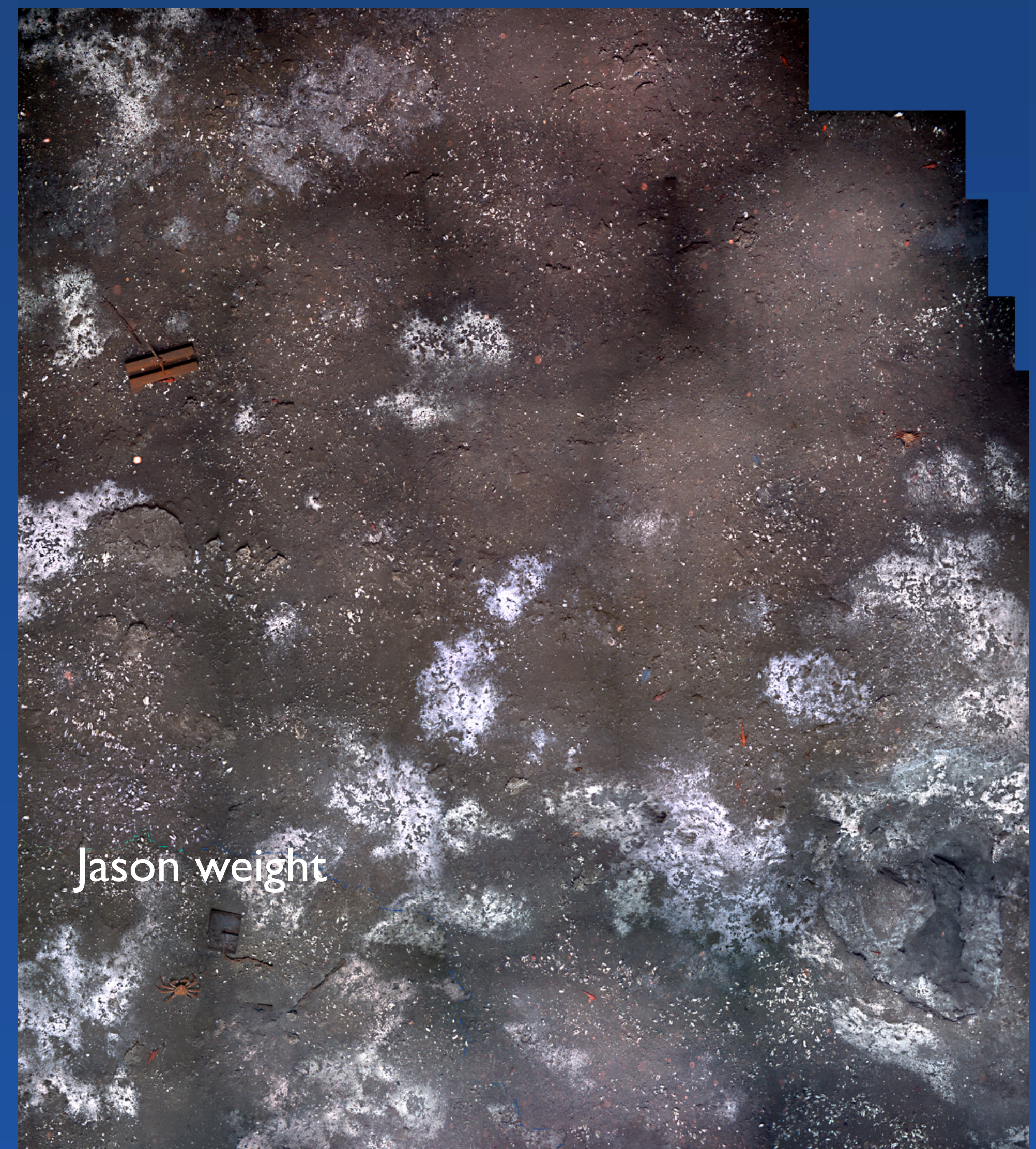
ROPOS Integrated Real-Time Logging System - Digital Still Image



# AUV Sentry RESON Data



## ROV Jason Photos



← 10 m →

Mosaic: M. Elend, University of Washington

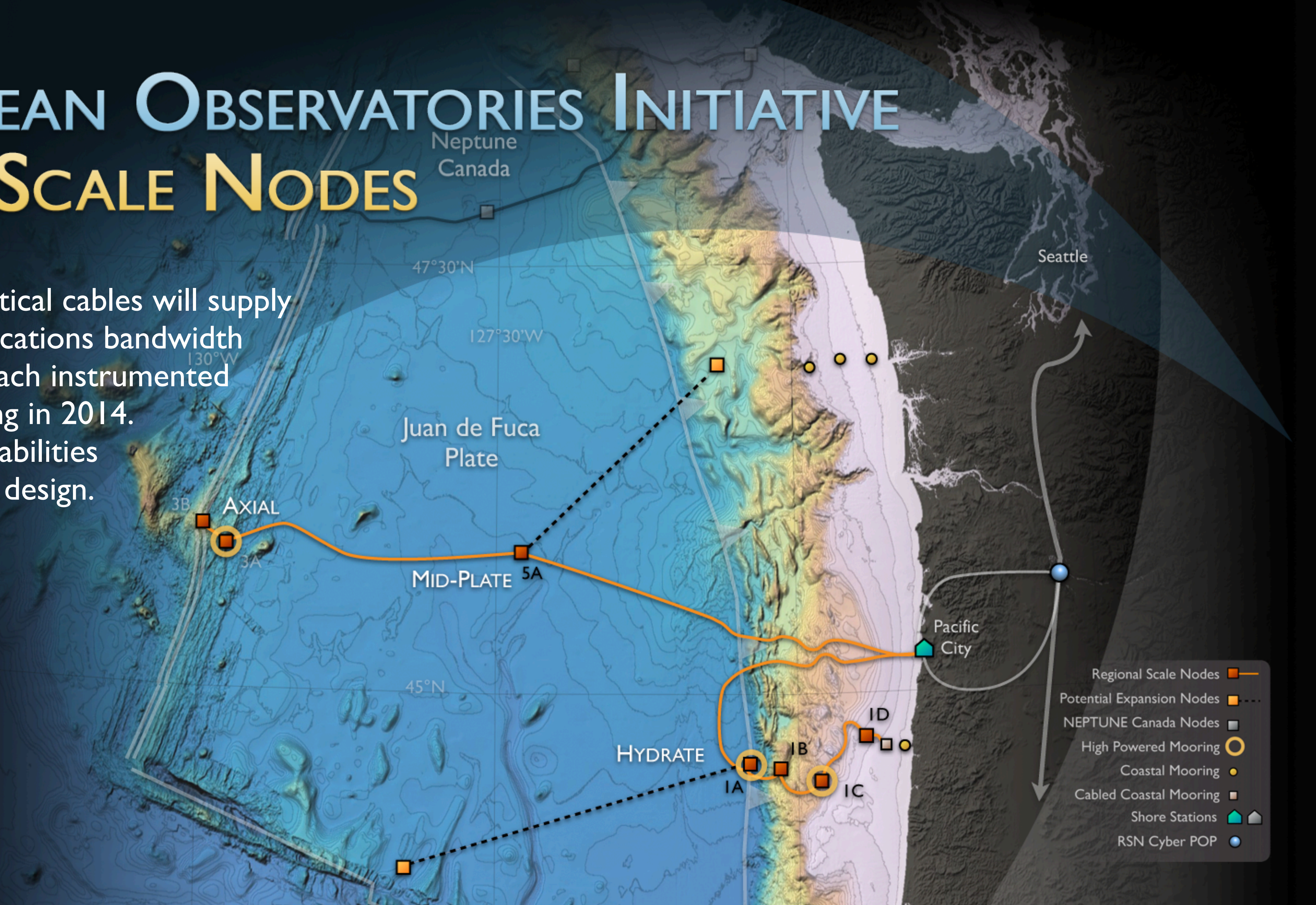
> 100 images



# NSF's OCEAN OBSERVATORIES INITIATIVE

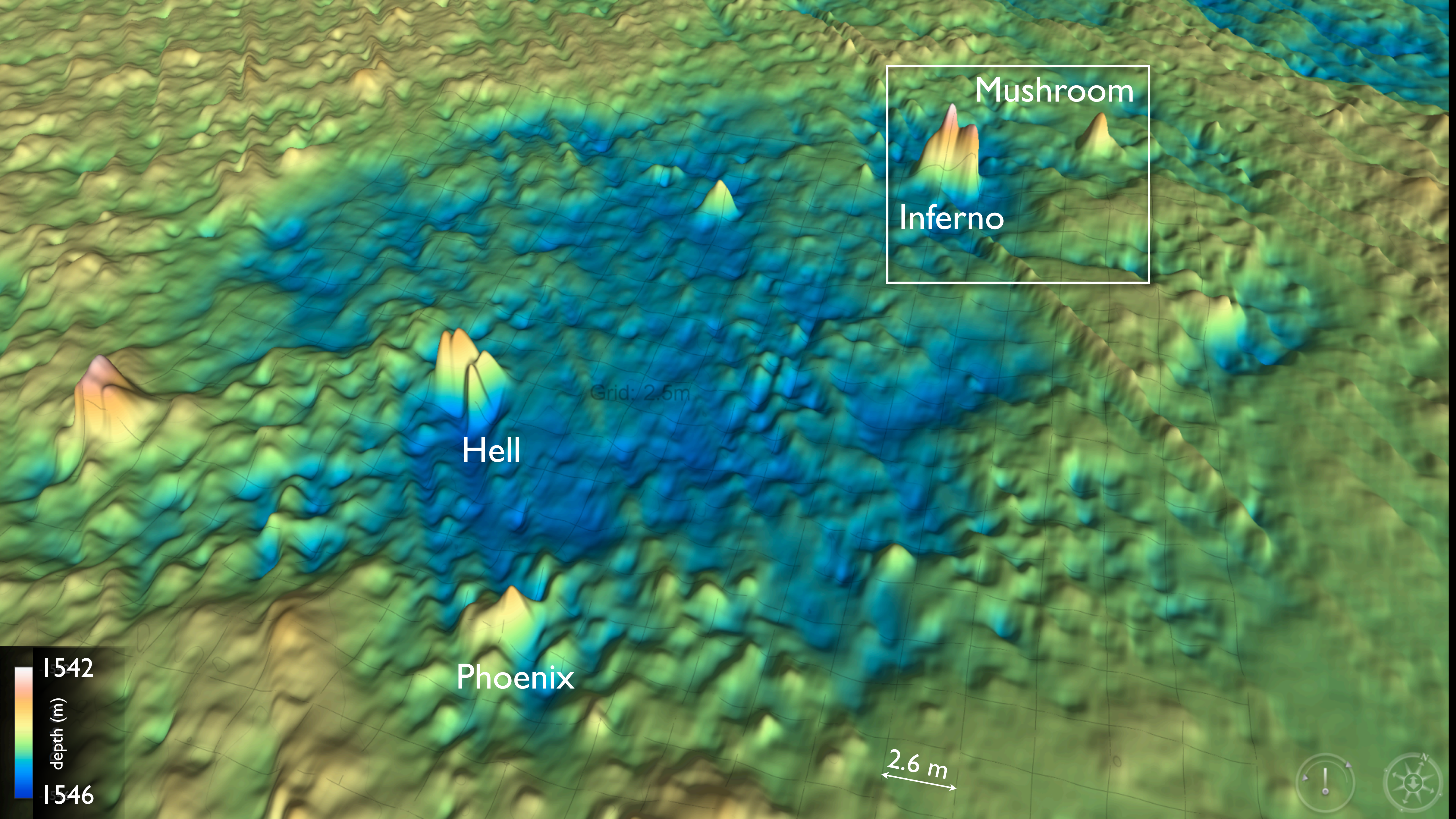
## REGIONAL SCALE NODES

A network of electro-optical cables will supply 10 Gbps of telecommunications bandwidth and 8 kW of power to each instrumented node upon commissioning in 2014. Significant expansion capabilities are built into the system design.



[www.interactiveoceans.washington.edu](http://www.interactiveoceans.washington.edu)





Mushroom

Inferno

Grid: 2.5m

Hell

Phoenix

2.6 m

1542

depth (m)

1546



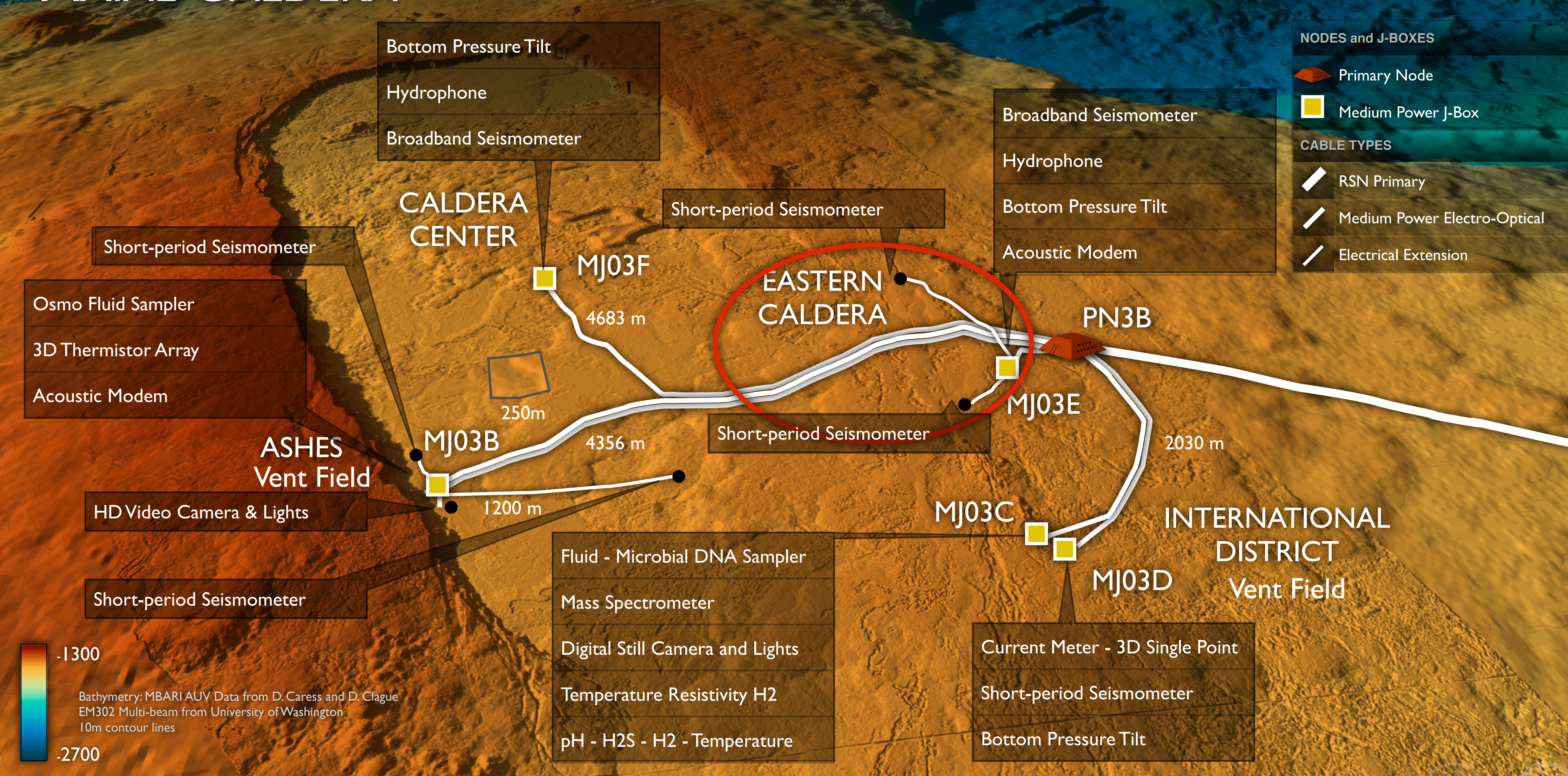
# ASHES VENT FIELD MOSAIC

6,000 images



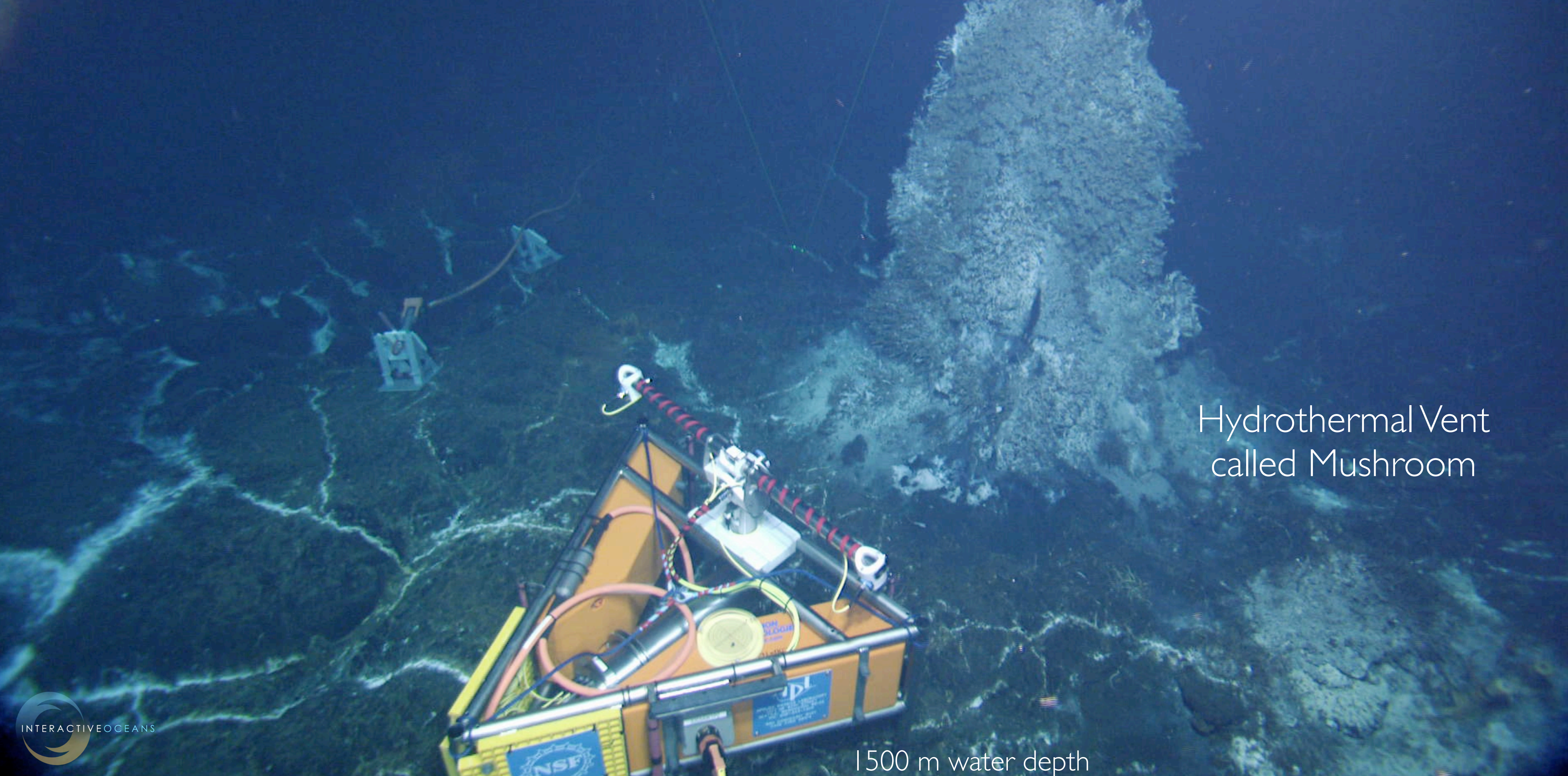
**ASHES VENT FIELD:** HD video, 3D temperature array, short-periods and fluid sampler will characterize changes in vent biology in response to changes in seismicity, temperature and chemistry





# AXIAL CALDERA: Eastern Caldera MJ03E





Hydrothermal Vent  
called Mushroom

1500 m water depth



**CAMHD SUBNET:** CAMHD301 connected to 60 m and 4229 m of cable. During ( ) hrs of testing, pan, tilt, lights, and camera fully functional - streamed video live





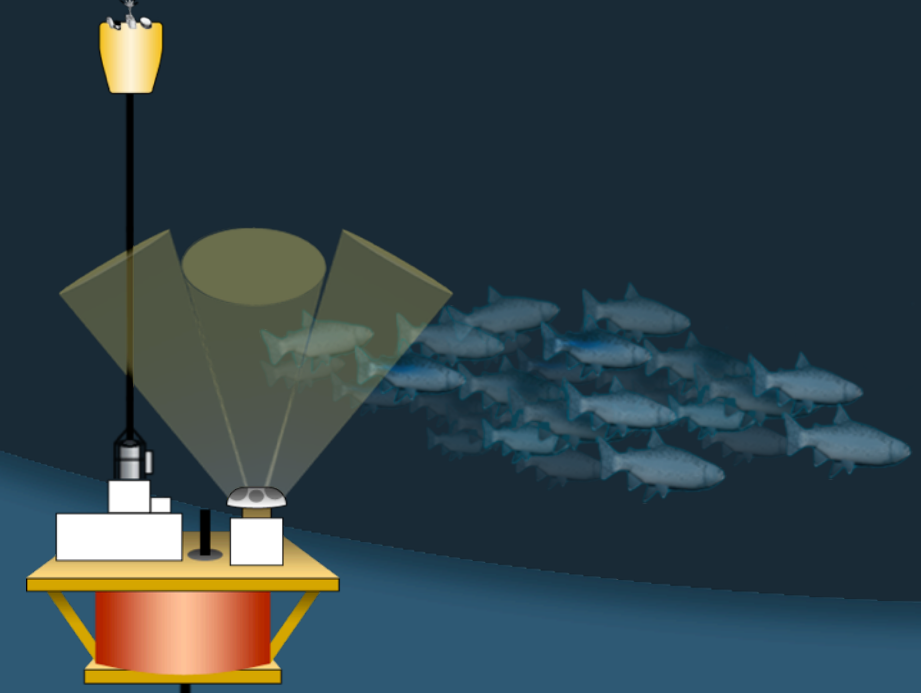
~2.54 m

**HD CAMERA:** Dive 1636 -Pan, Tilt, Lights fully tested for 8 hrs.





# SENSOR CONFIGURATIONS



MOORING

- Axial Caldera Seafloor
- Southern Hydrate Ridge Seafloor
- Basic Core Seafloor
- Mooring Float
- Mooring Winch
- Mooring Seafloor

