Looking Forward: Chemo III in 2007

Charles Fisher and Chemo III PIs

Pennsylvania State University

Outline

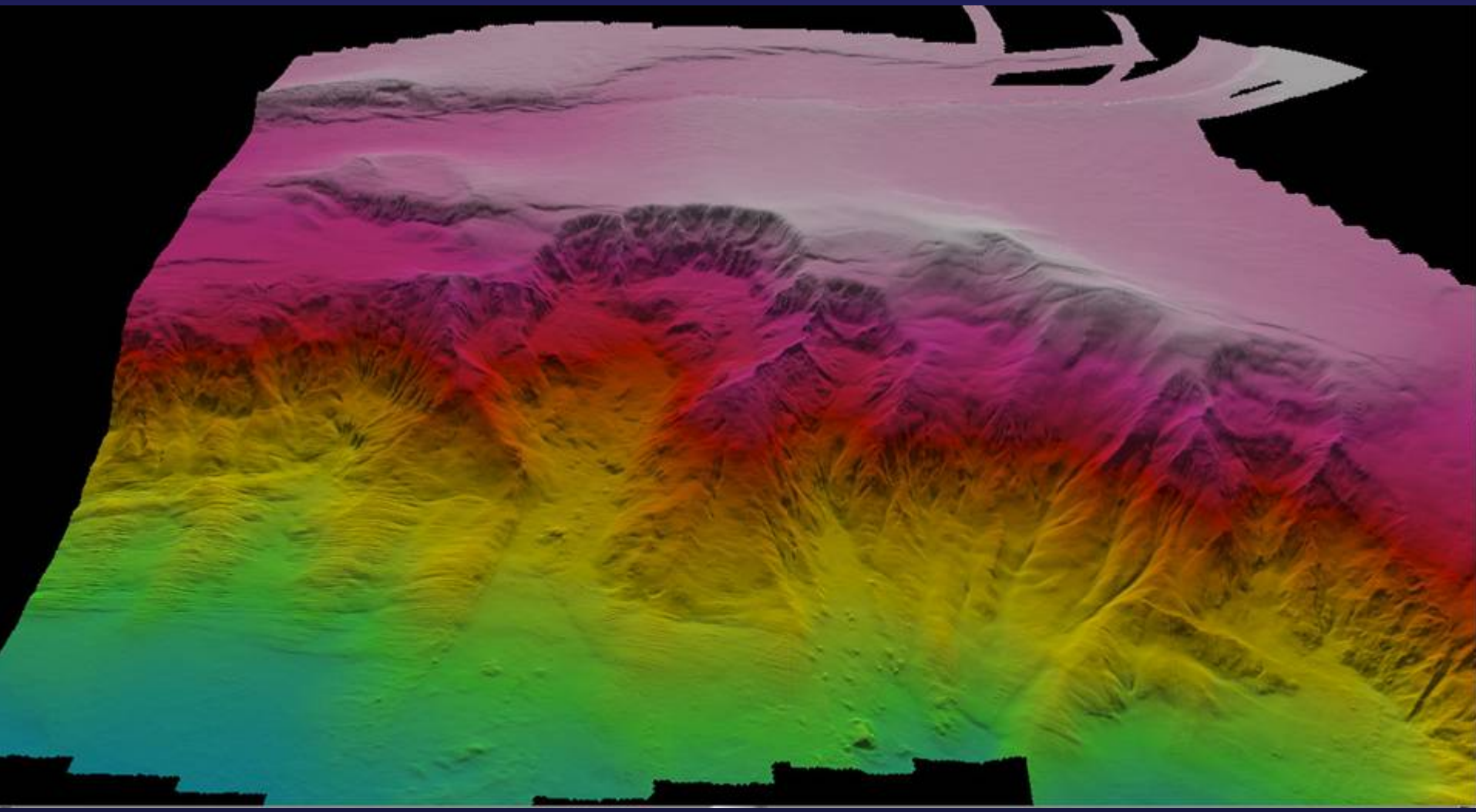
- AUV Surveys
- Ron Brown/Jason II Cruise
- Education and Outreach Update

AUV Surveys

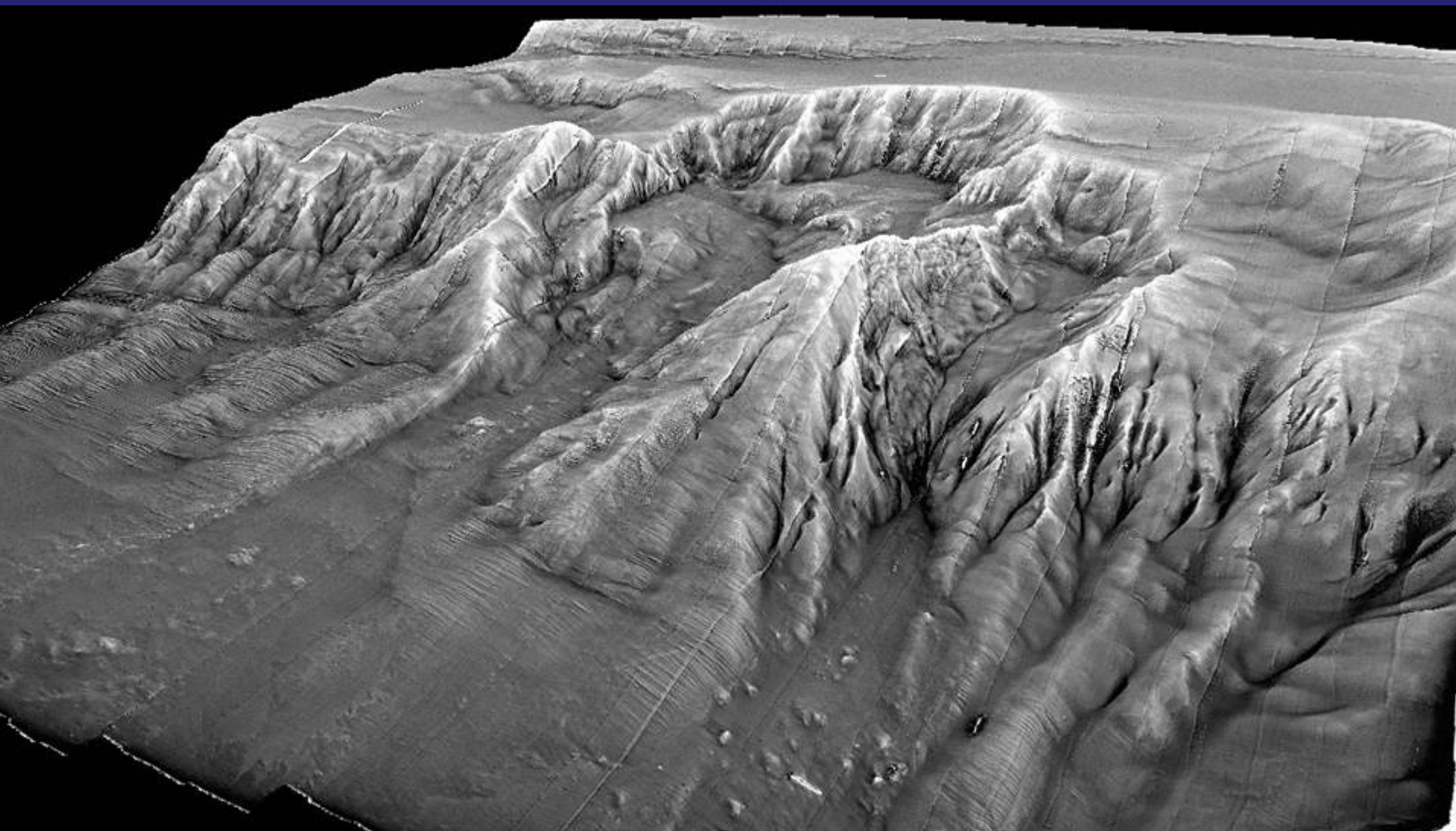
- We have contracted C & C technologies to use Hugin AUV to map 4 sites
  - Multibeam, sidescan, and sub-bottom profile
  - Centered on study areas of sites
    - AT 340
    - GC 852
    - AC 601
    - WR 269

- Bathymetric maps will be used as underlay during ROV deployments

Mad Dog – AUV Seabed Multibeam

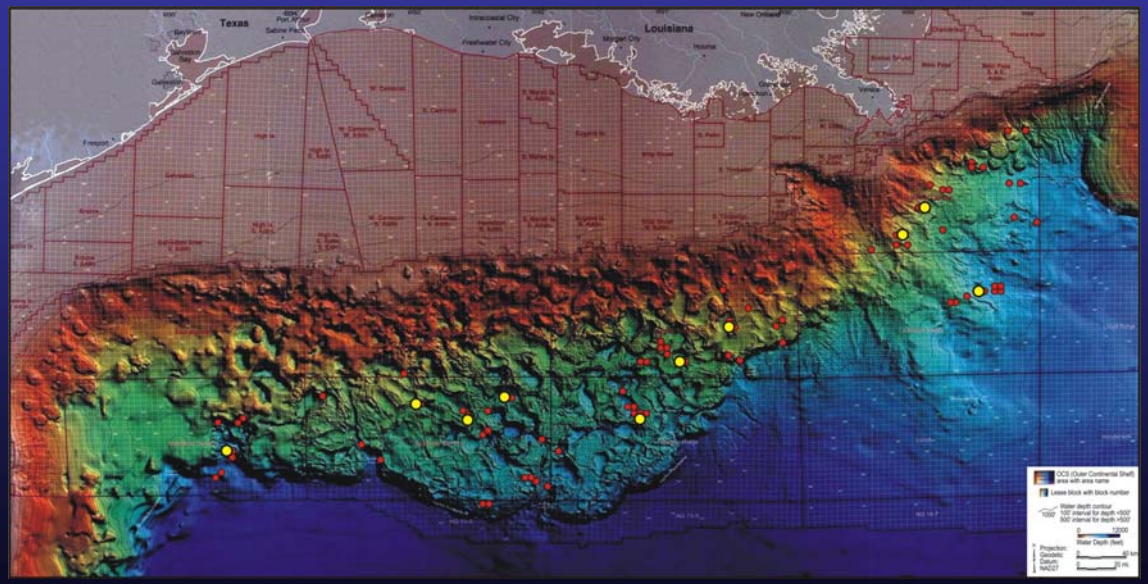


Mad Dog –
AUV Seabed Sidescan Sonar



Ron Brown/Jason II Cruise
4 June to 6 July (+/-)

- Currently scheduled to depart from Ft. Lauderdale FL and return to St. Petersburg FL.
- Basic cruise plan will be to transit to easternmost site and conduct one mapping/recon/imaging/ limited collection dive at each site (including some new ones) as we work west, then work our way back east.



The NOAA Ship Ronald H. Brown

- Spacious and stable
  - (274'; ~4,000 ft^2 of lab space)
  - Scientific party of 32 (includes Jason Group)
- Fully capable for Jason II ops (sister ship to Atlantis)

Jason II

Matt Heintz

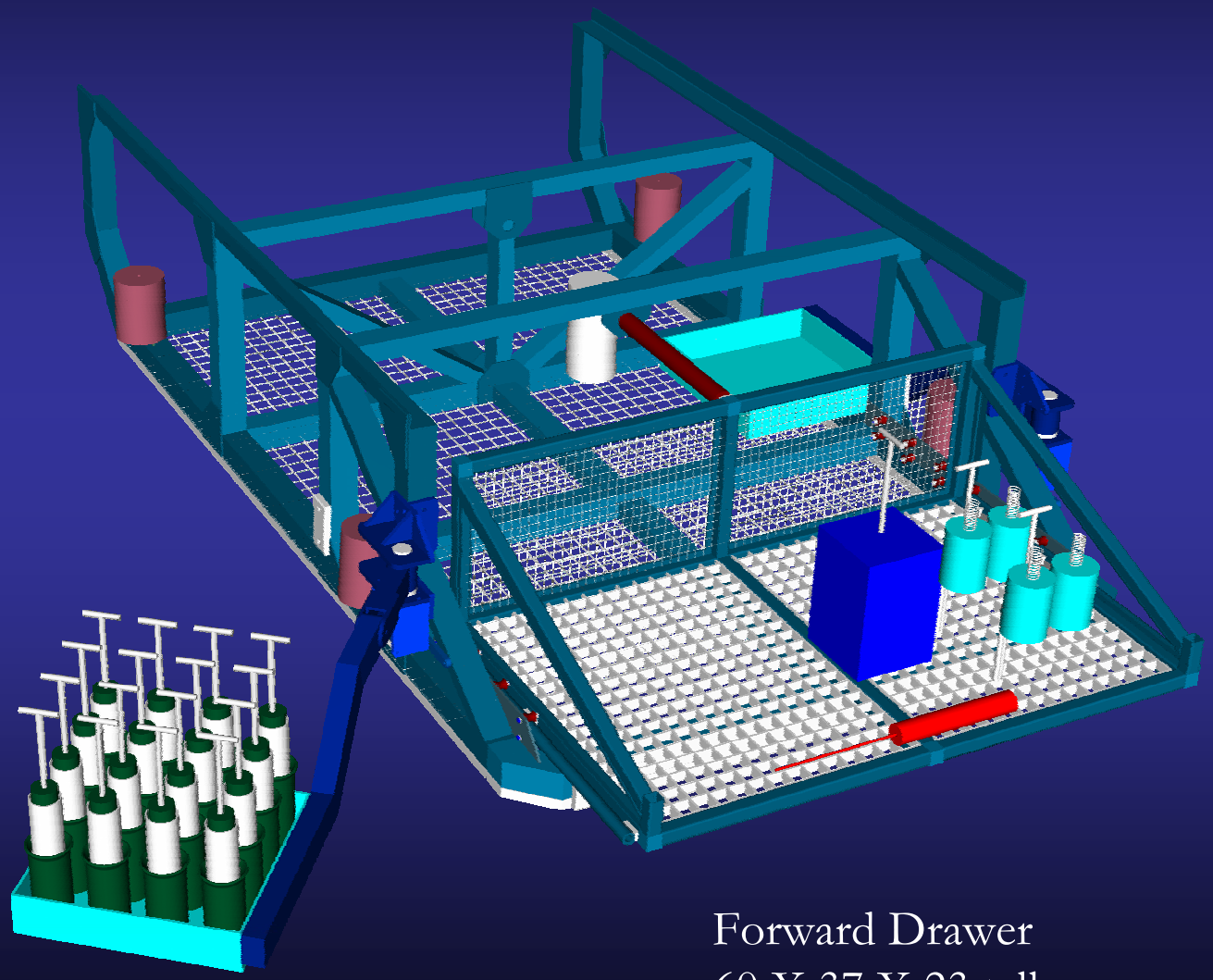
mheintz@whoi.edu

Deep Submergence Laboratory

Woods Hole Oceanographic Institute

NOAA
NSF
ONR
WOODS HOLE OCEANOGRAPHIC INSTITUTION
1930
PREDATOR

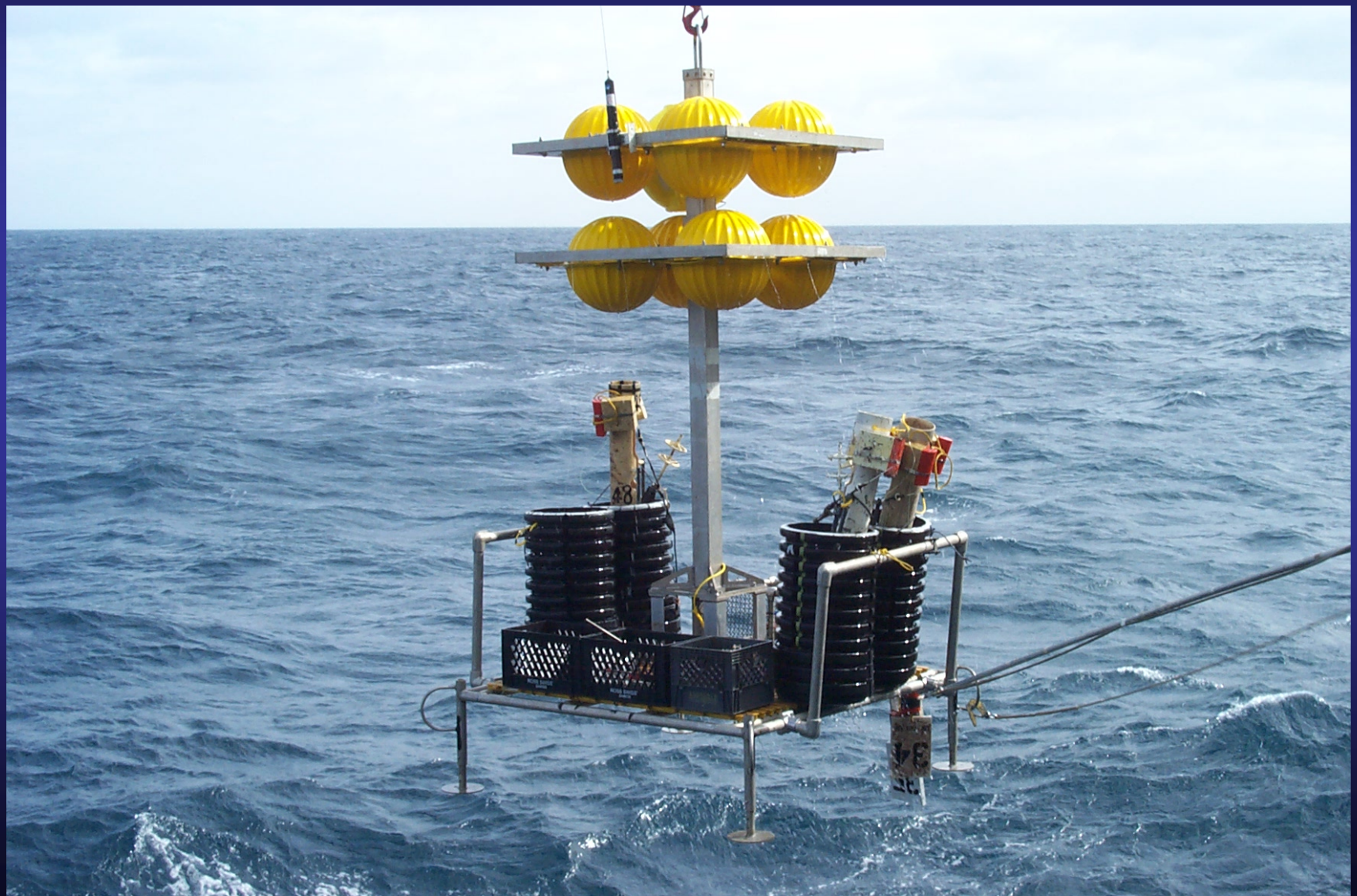
Tool Sled



2 swing arms
20 X 20 X 23

Forward Drawer
60 X 37 X 23 tall

Elevators
(allow multiple collections during long “dives”)



Control Van

(allows bathroom breaks)

June 2007 Field Objectives

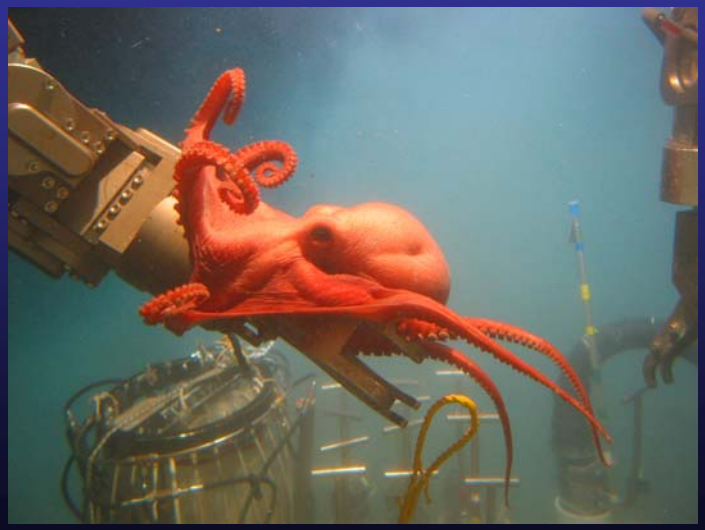
- Fill in holes in microbiology, geology, geochemistry and macrobiology collections
- Continue temporal studies
- Acquire and use high-resolution multibeam and reflectivity maps of sites
- Use Jason navigational and imaging abilities for detailed community characterization

June 2007 Field Objectives: Collections

- For site characterizations
  - Assorted site-specific disciplinary “holes”
- For characterizations of different community types (concentrated on a few sites)
  - Better collection method for large-mussel communities
  - Focused micro, geochem, meiofauna efforts on urchin and pogo communities
- To test hypotheses of depth patterns in community composition
  - Biggest holes in shallower depths (between about 600 and 1300 m)
  - Will require working at two to three “new” sites.

June 2007 Field Objectives: Collections

- To test hypotheses of community succession
  - Collection of stained tubeworms will largely fill holes
  - … problems with large-mussel communities
- To test hypotheses of nutritional ties to background fauna
  - Need additional trapping on site
  - Need targeted collections of mobile fauna



June 2007 Field Objectives: Temporal Studies

- Recover and re-deploy time lapse camera(s)
  - Monitor and quantify visitation by mobile fauna
  - Currently deployed at GC 852 among seep fauna
  - 2 new systems can be deployed during the cruise for days to month

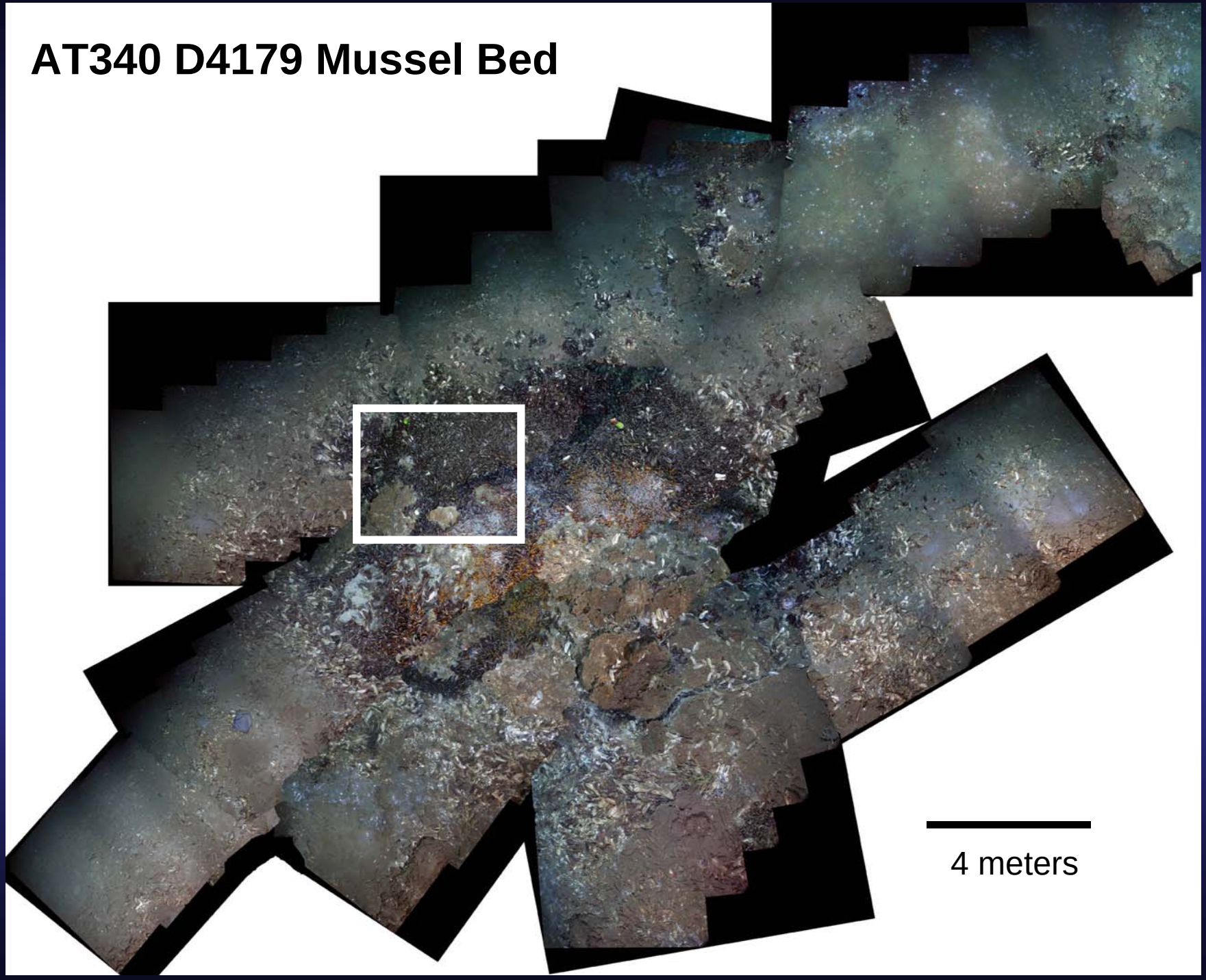
June 2007 Field Objectives: Temporal Studies: Tubeworm Growth

- Recover stained tubeworms
  - A total of 15 aggregations are stained
    - A range of sizes
    - 7 at AT 340
    - 4 at GC 852
    - 4 at AC 818
  - Goal is at least 2 recovered from each by Bushmaster
  - 3–4 small aggregations could be recovered by “hand”
  - Document general growth pattern in all other stained aggregations (good imaging)
  - AND …

June 2007 Field Objectives: Temporal Studies

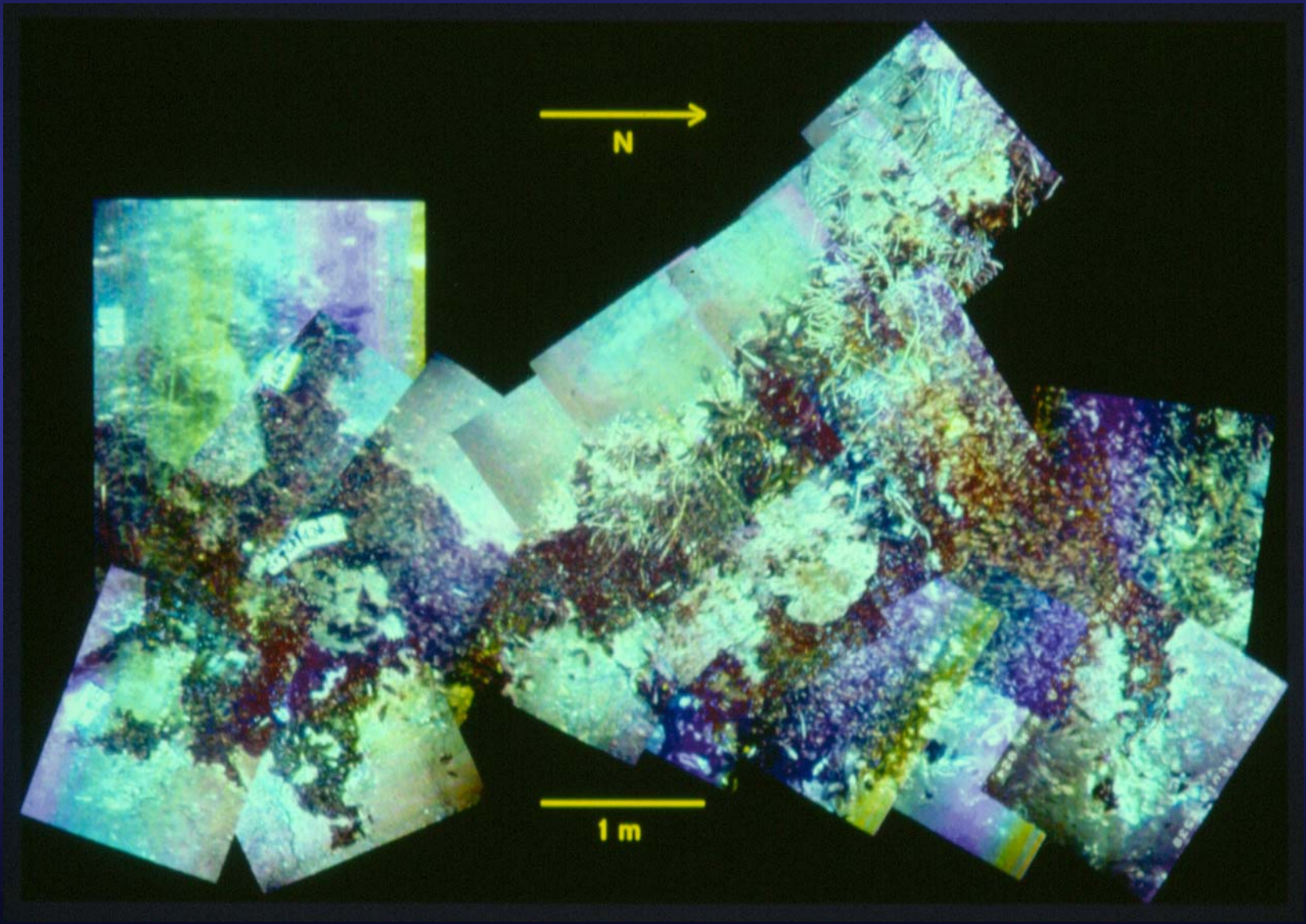
- Re-occupy and re-acquire imagery at mosaics and well imaged markers
- Best mosaics are:
  - Large mussel bed area in AT 340
  - “Mussel Brick Road” in AT 340
  - Main Coral area in GC 852
  - Pogonophoran field in WR 269

AT340 D4179 Mussel Bed



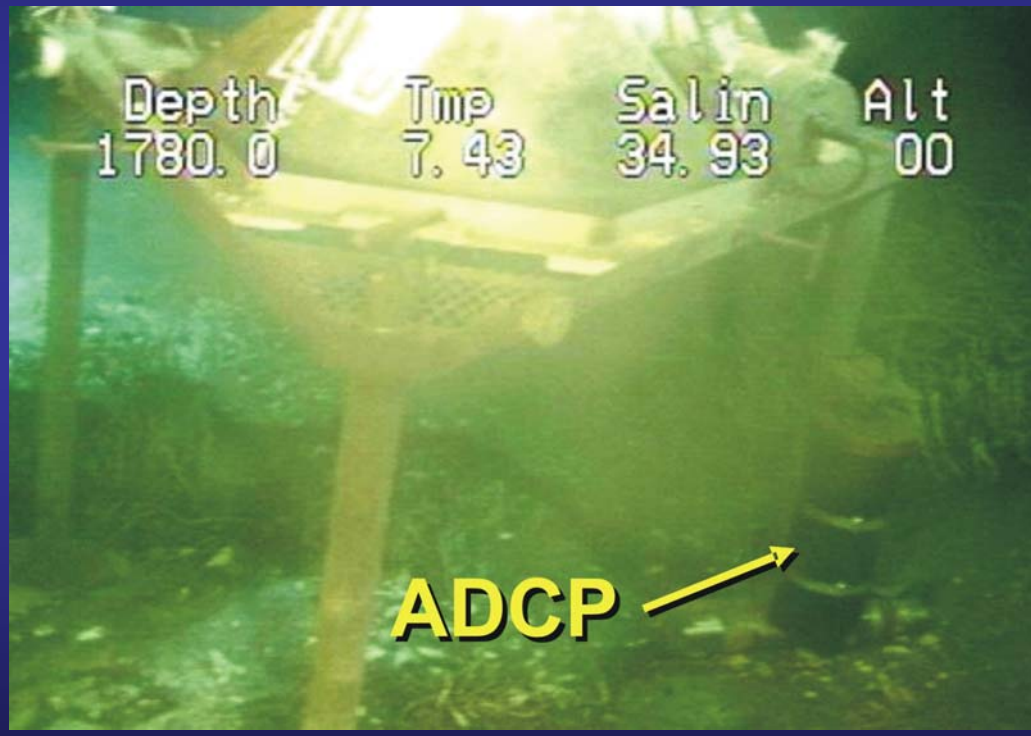
AC 645 Markers 43 and 44 (2006)

AC 645 Mussel Mosaic (1992) (Markers 42, 43, & 44)



June 2007 Field Objectives: Temporal Studies

- Continue /initiate temporal monitoring studies?
  - Deploy 2-3 rotary cameras for one year
  - Deploy hydrate monitoring "observatory"
    - Measure gas emission, pressure, currents, and temperature
    - Deploy additional temperature recorders
  - Create additional mosaics
  - Stain additional tubeworms

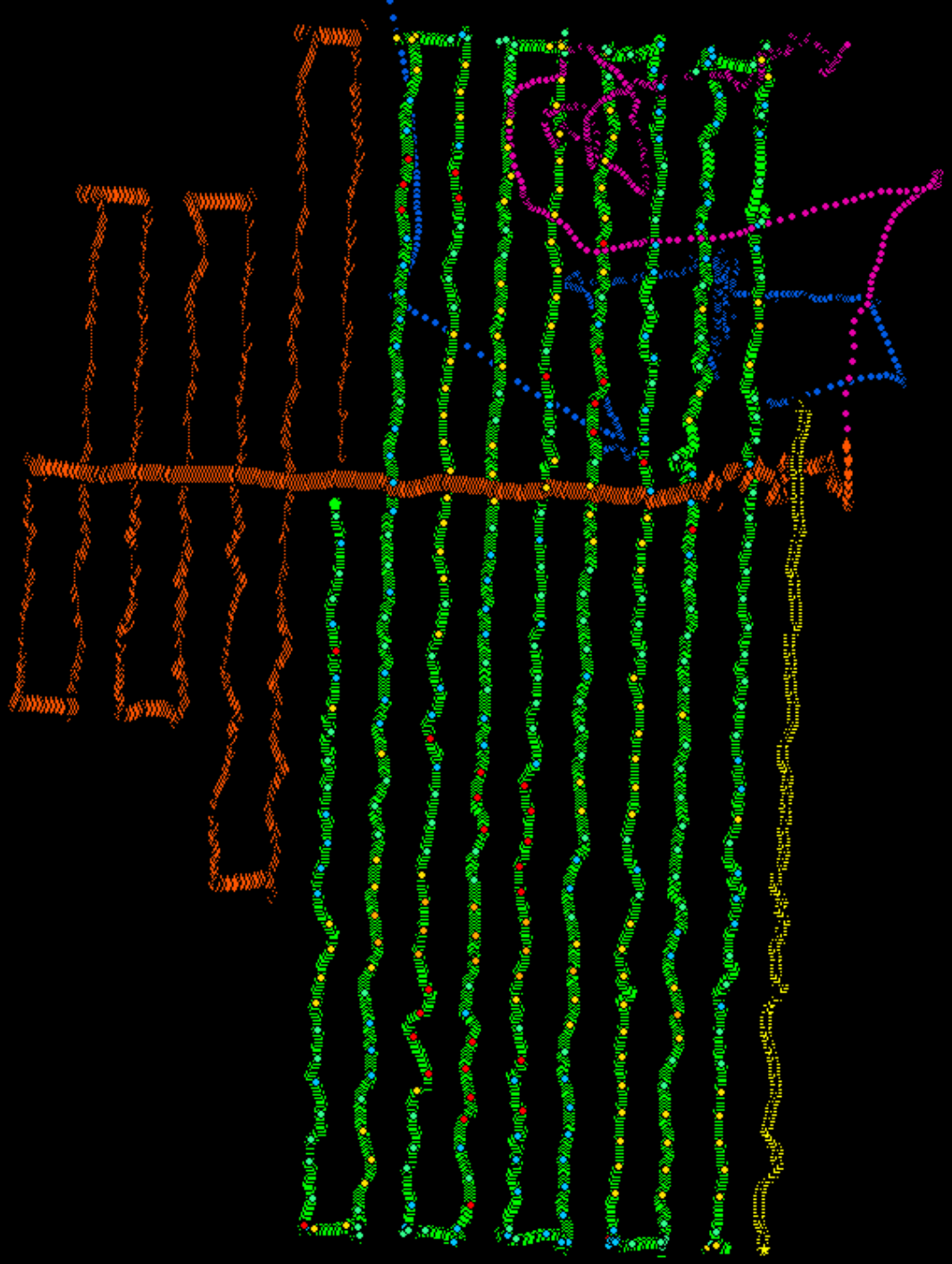


June 2007 Field Objectives: Maps and Excellent Navigation

- Acquire SM 2000 multibeam data (sub-meter scale resolution) over all key areas of sites during first dives at all sites
- Areas covered will depend on site and include sufficient area for nesting and conciliation of Jason navigation with Hugin maps
  - Data will be processed during the cruise and used on subsequent dives
- When visibility and altitude permit, acquire imagery at same time
- Re-acquire sufficient benchmarkers for conciliation with Alvin navigation
- Conduct all work in well-defined navigational space

June 2007 Field Objectives: Maps and Excellent Navigation

- Use Jason II navigated imaging capabilities
  - For large scale transects
  - For mosaics (repeat and additional)
  - In conjunction with chemical sensors for community and site characterization



GIS layers

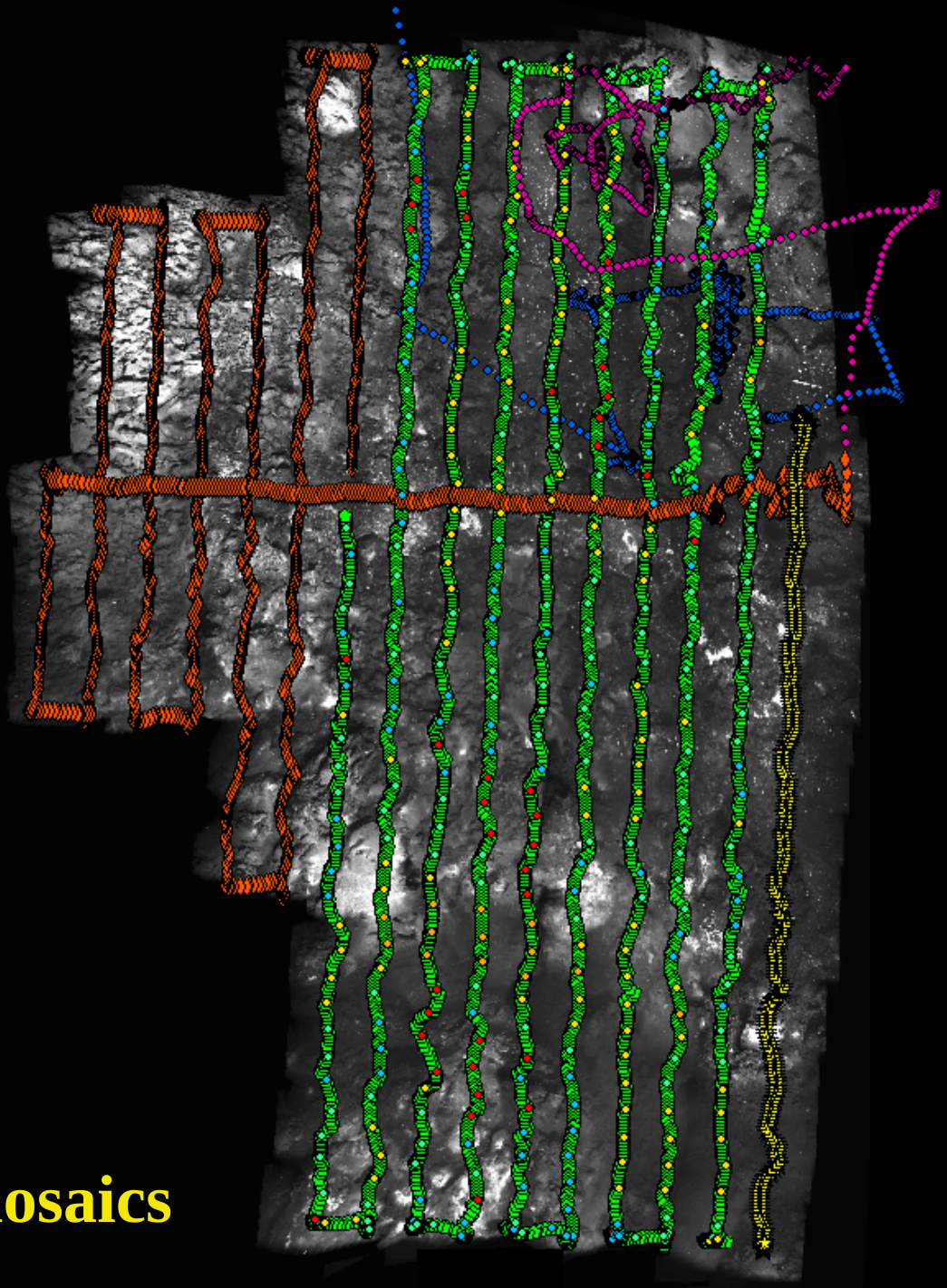
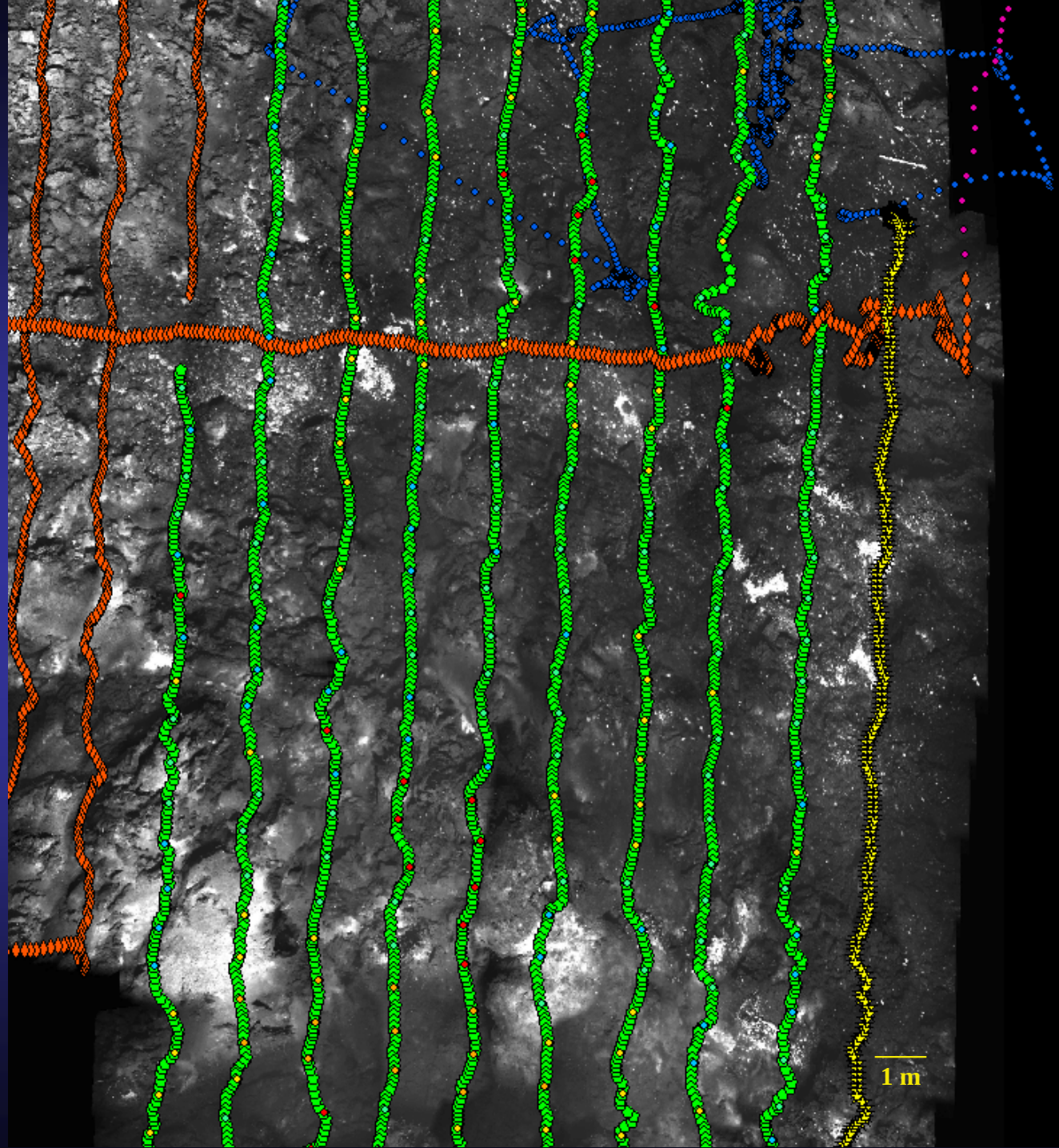
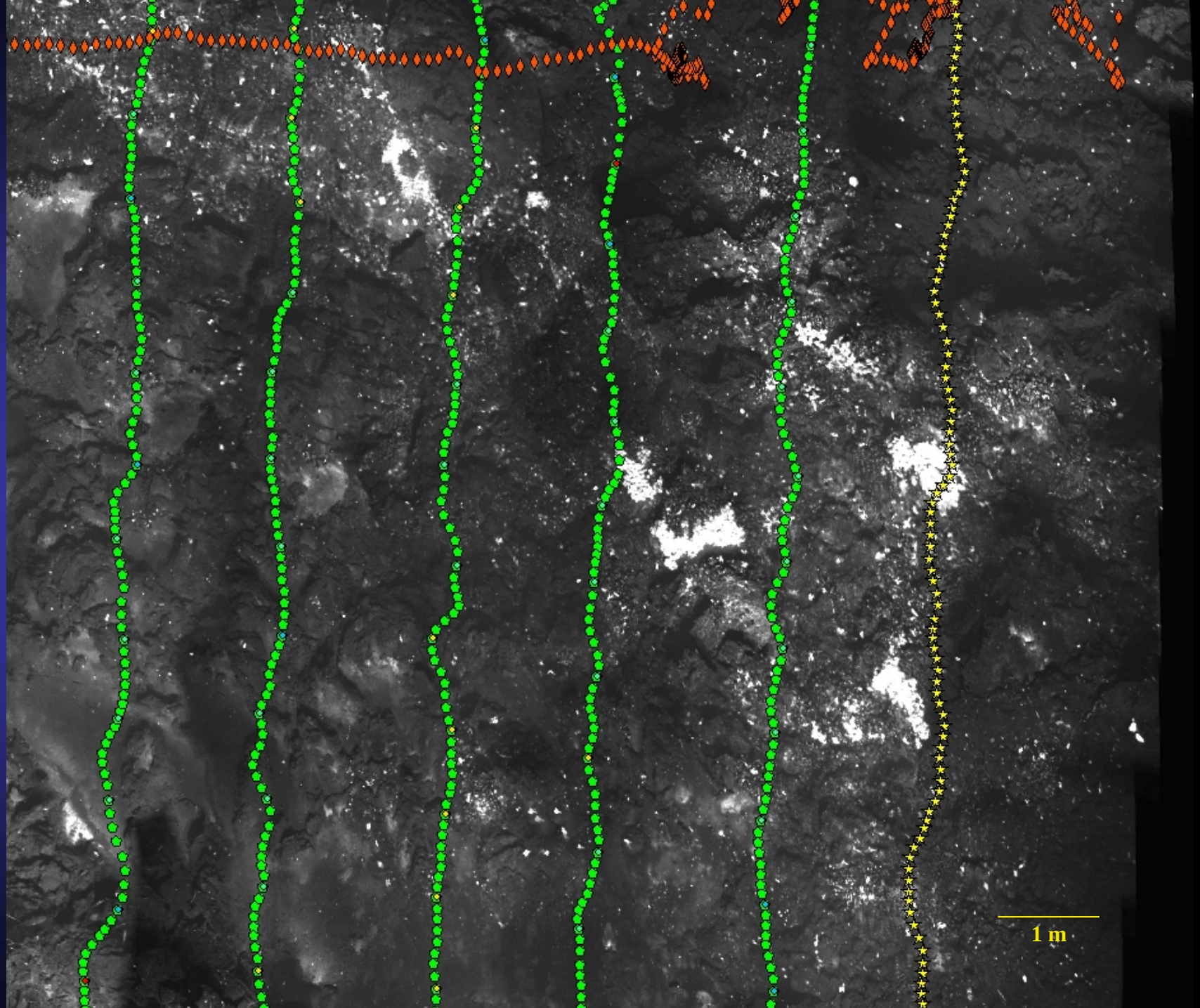


Image mosaics

1 m


1 m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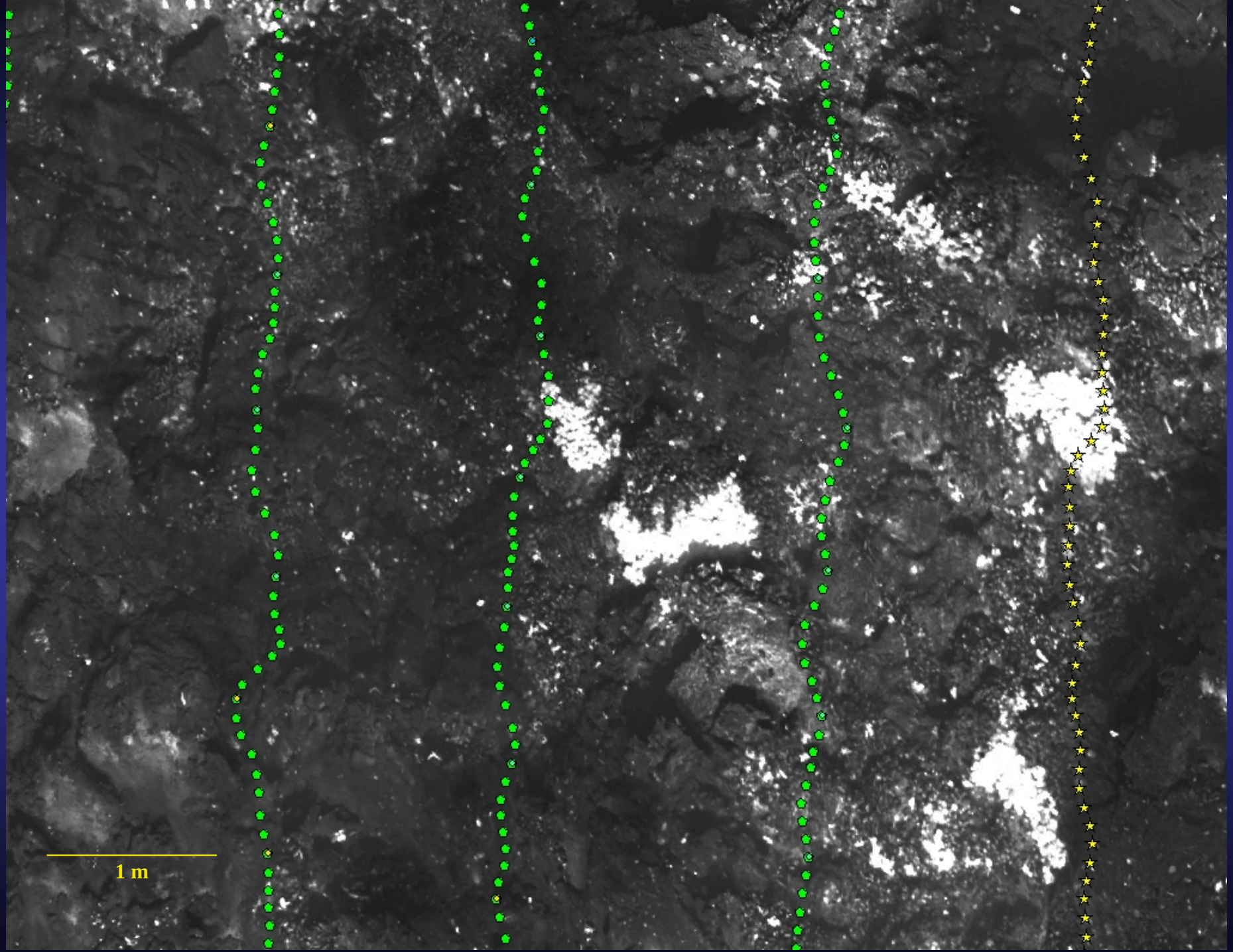
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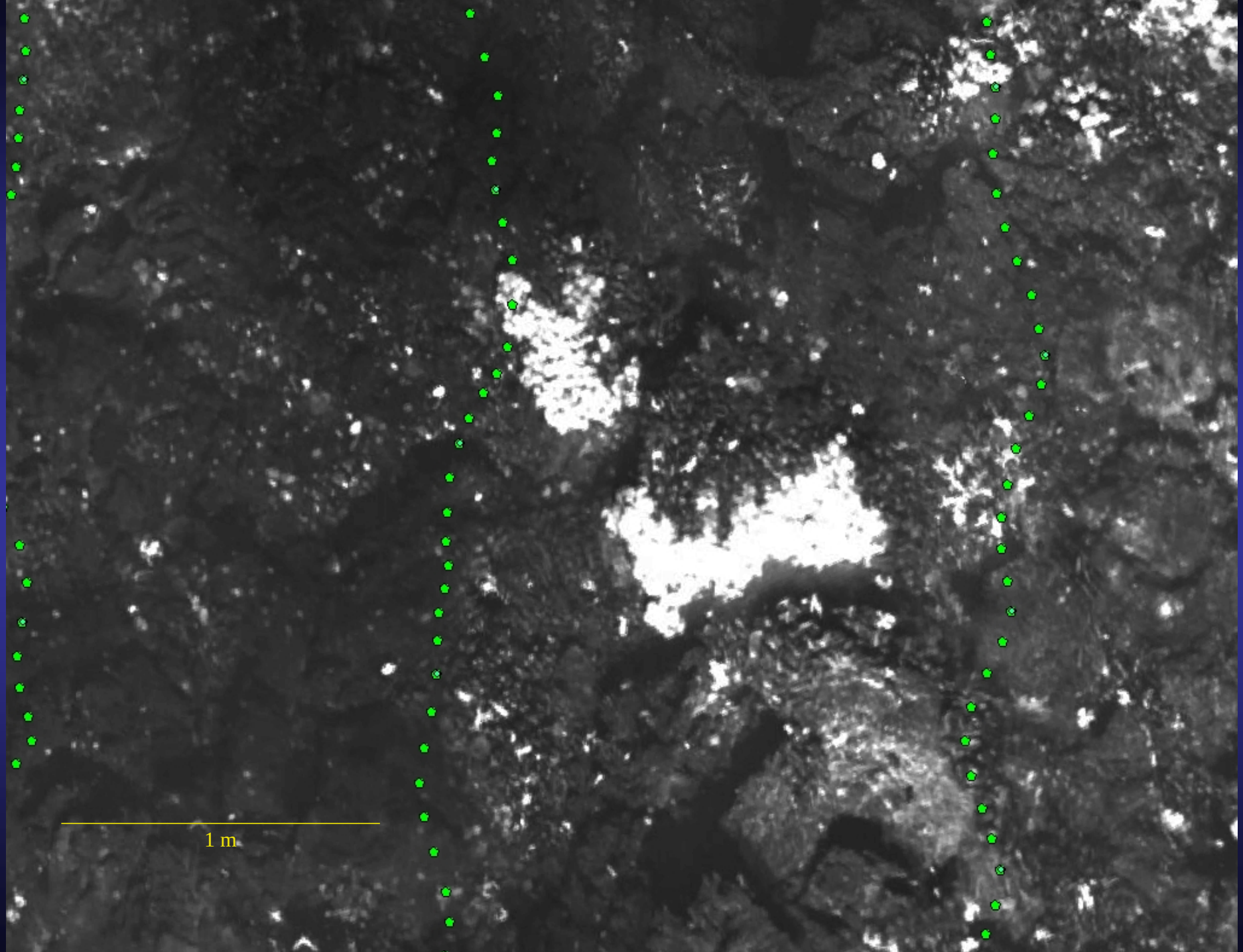
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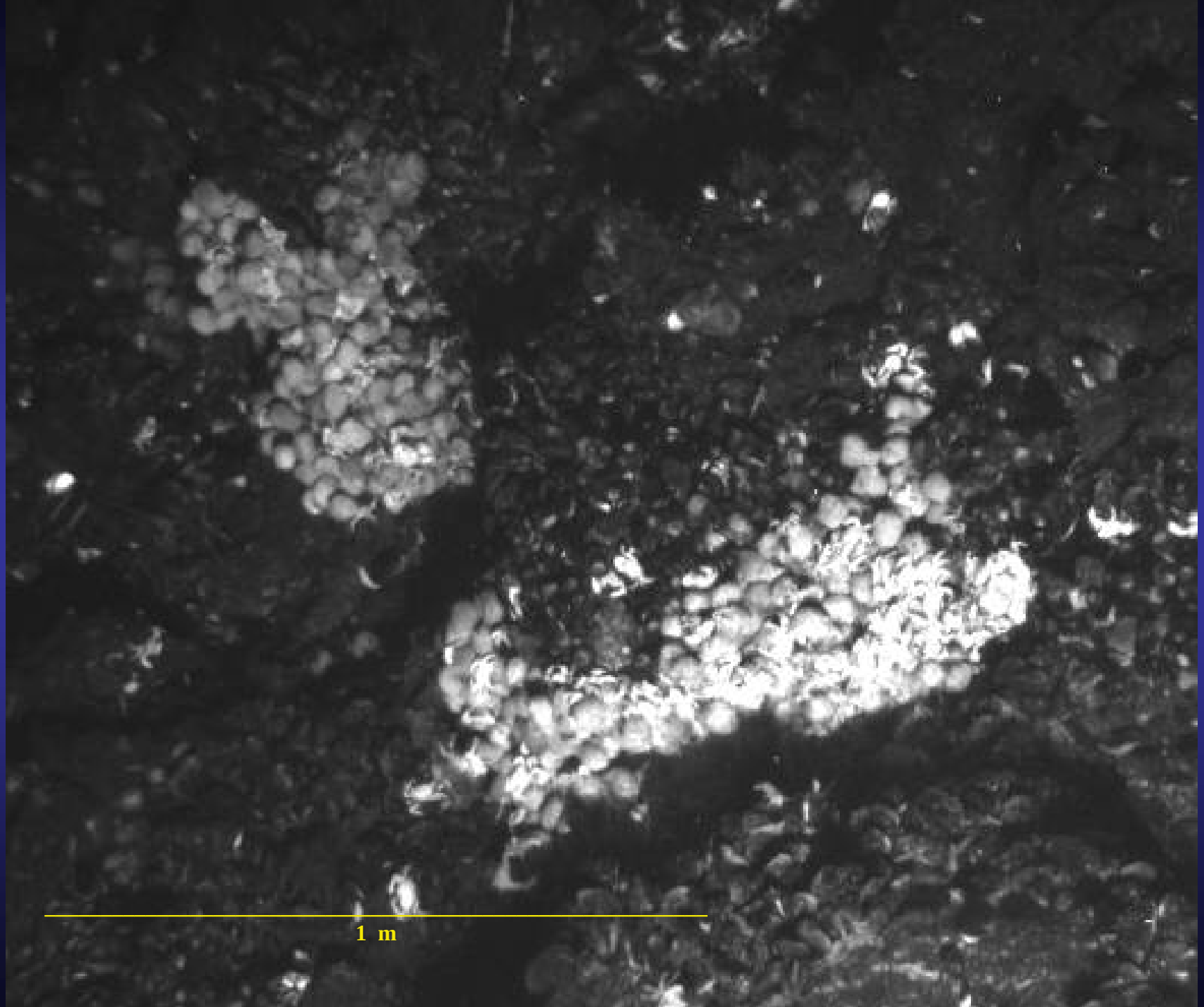
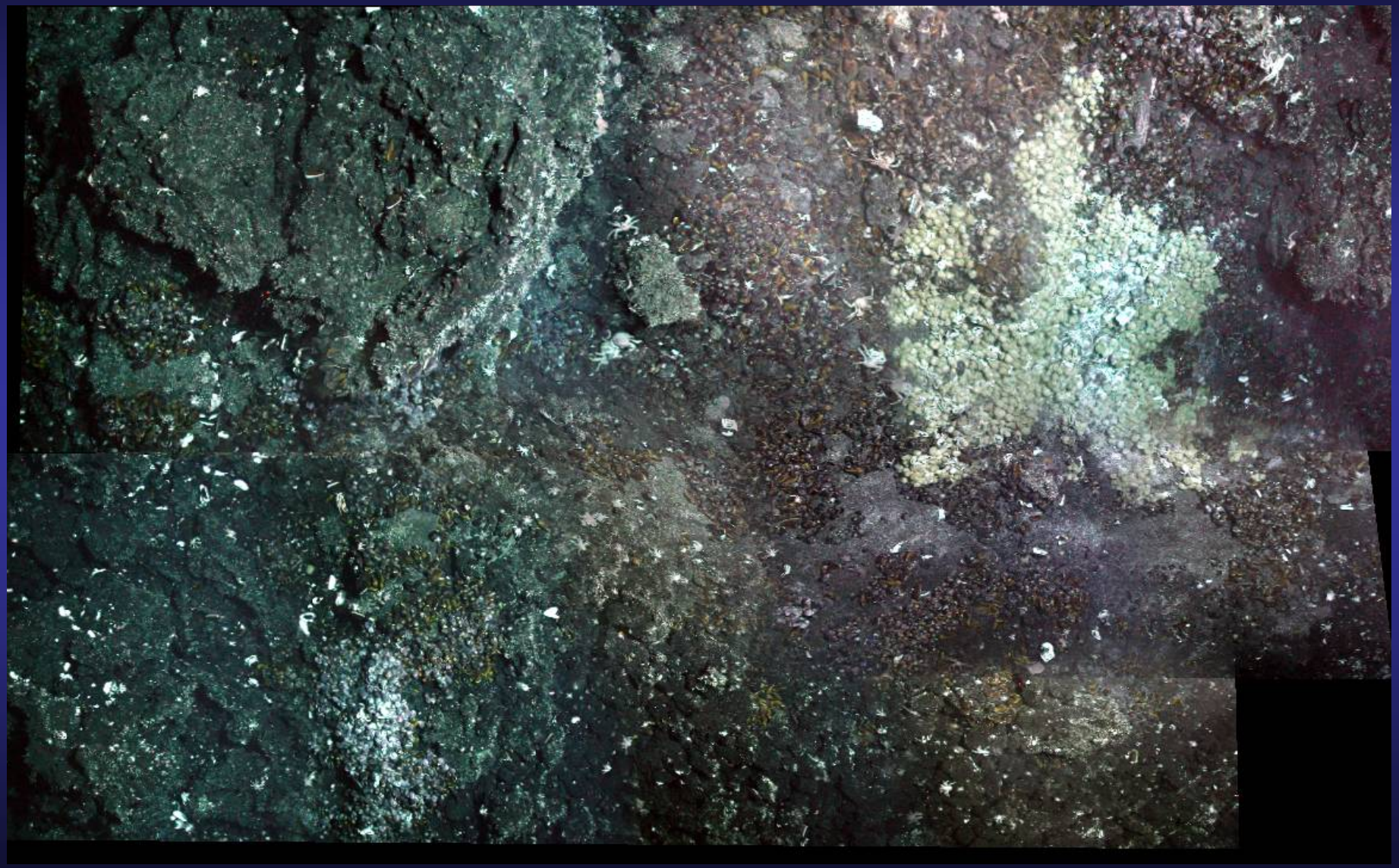
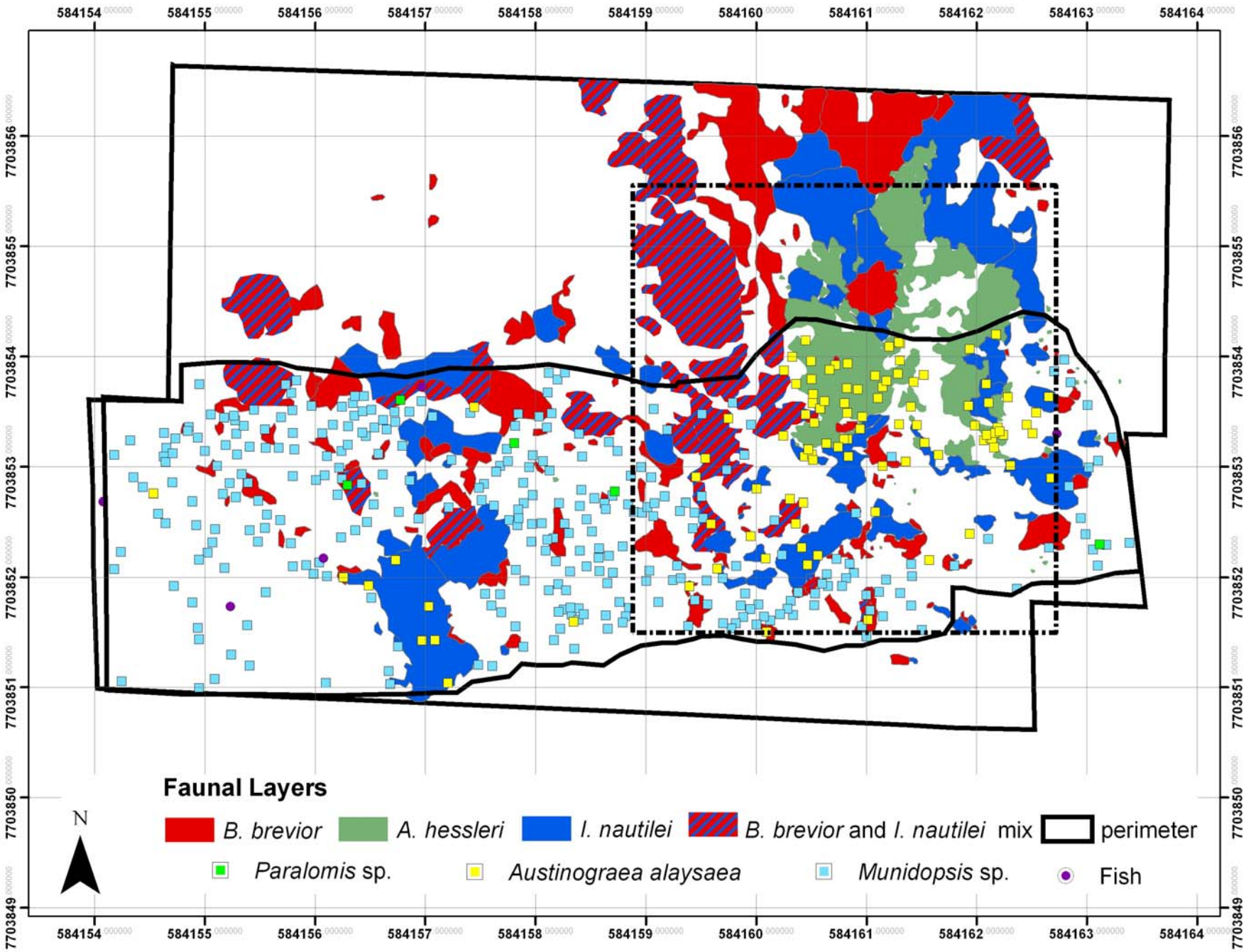

1 m

ABE




584154
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584164
7703856
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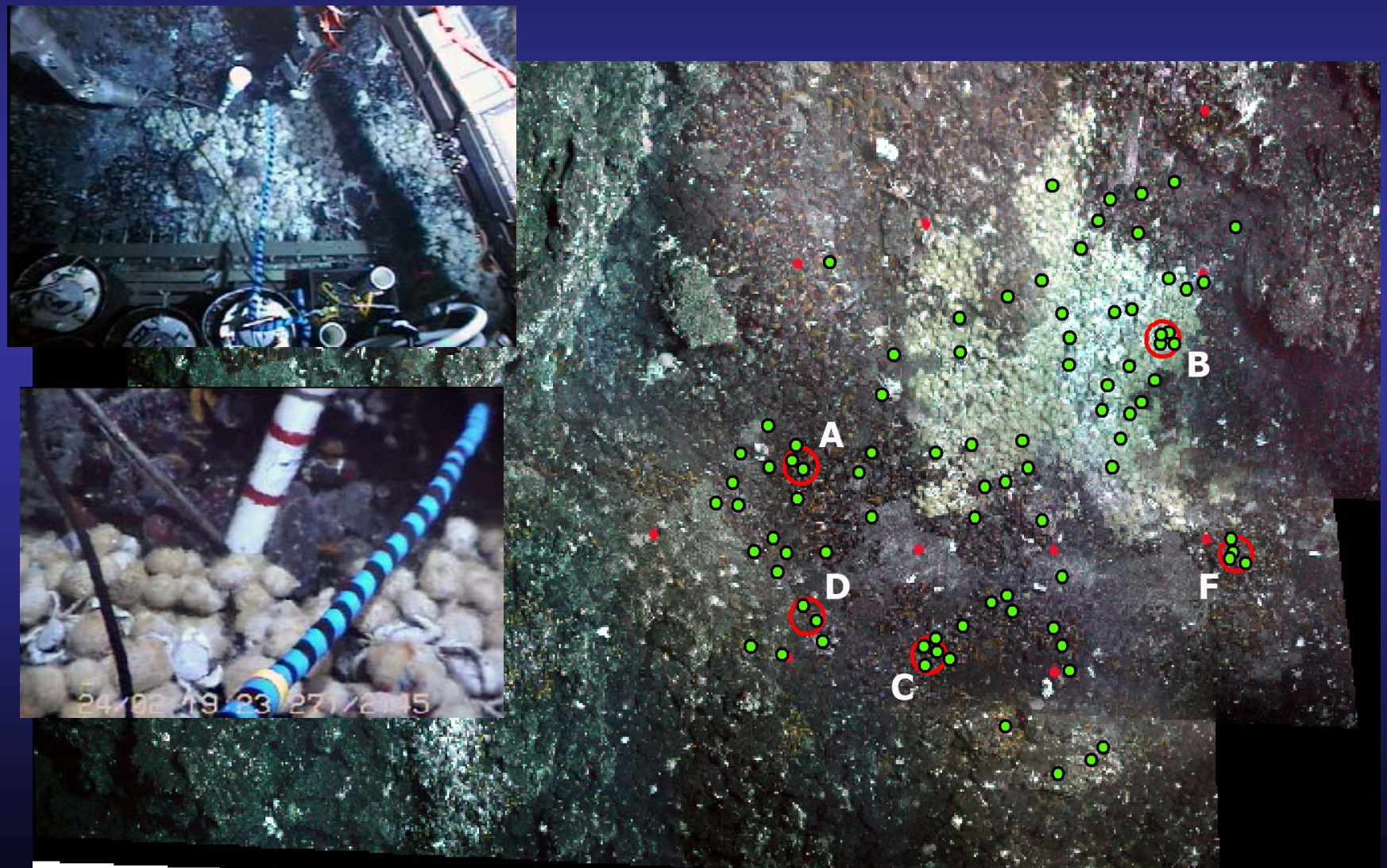
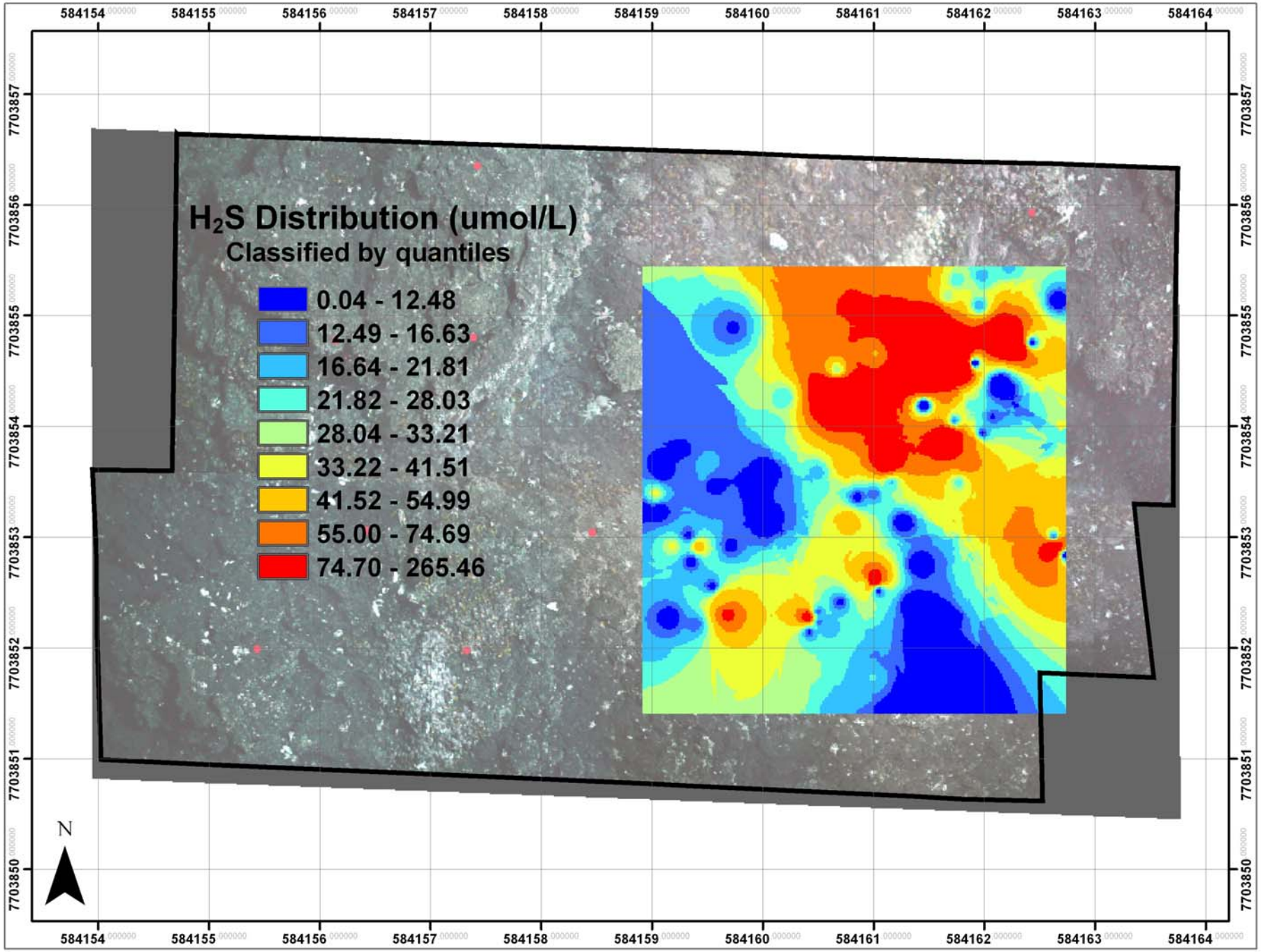
Faunal Layers
B. brevior
A. hessleri
I. nautilei
B. brevior and I. nautilei mix
perimeter
Paralomis sp.
Austinograea alaysaea
Munidopsis sp.
Fish
N

Chemical Scans and Collections, Guided by the “5m Overnight Mosaic”




H2S Distribution (umol/L)
Classified by quantiles
0.04 - 12.48
12.49 - 16.63
16.64 - 21.81
21.82 - 28.03
28.04 - 33.21
33.22 - 41.51
41.52 - 54.99
55.00 - 74.69
74.70 - 265.46
N
584154
584155
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584163
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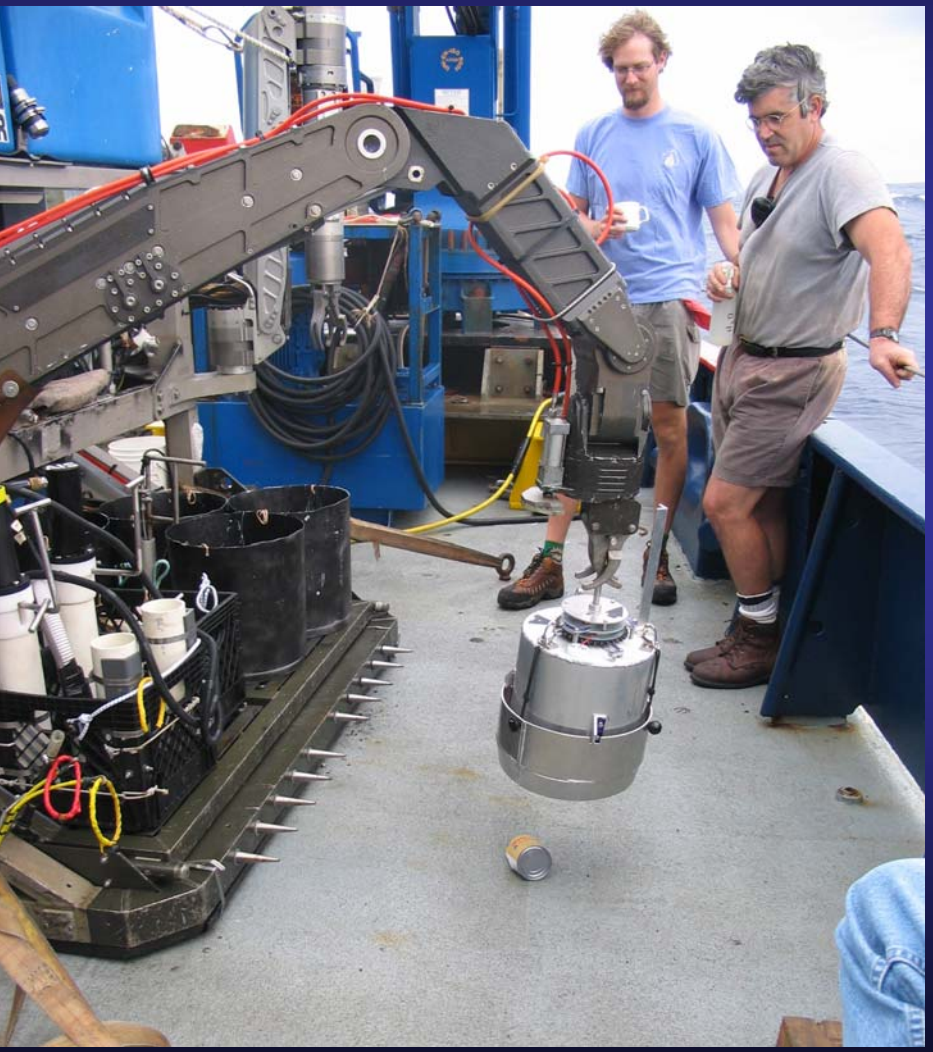
Mussel (and Snail) Pots

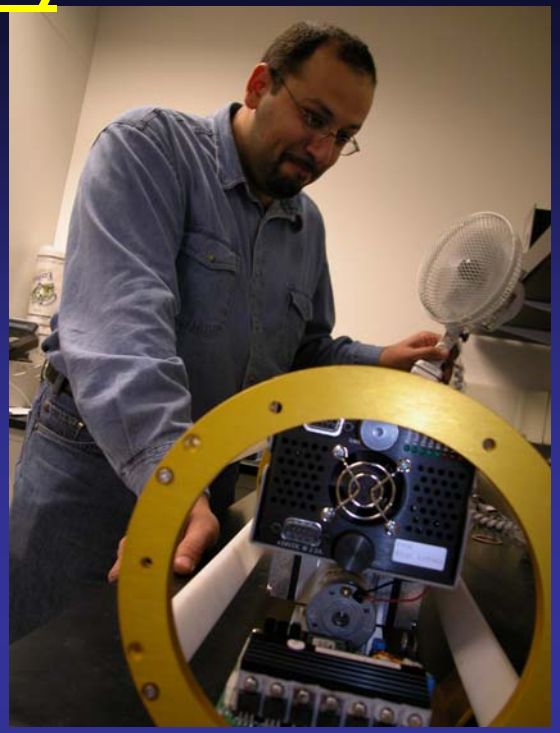


HydroC™ – Hydrocarbon / Methane Sensor

- No side effects from H_2S, O_2, turbidity, temperature, pressure.
- Measuring range:
  - 100 nmol/l - 50 µmol/l
- Operational depth: 4000m.
- Resolution 10 ppm.
- Accuracy ± 3% of reading
- Response time:
  - Up to 10 seconds.
- Titanium housing : 9 x 38 cm.
- Weight in air / water:
  - 4.2 kg / 2.1 kg approx.

In situ Mass spec chemical analyzer (IsMass)

- Quadrupole mass spectrometer
- Membrane inlet system
- Used from ROV Ventana at 1400m for 30 days
- Membrane inlet system tested for 6 days continuous use in the lab at 600 ATM
- Can detect low levels and quantify hydrogen sulfide, oxygen, carbon dioxide
- In line pH sensor
- Pressure housing mounted back, sample acquired through wand
- Analysis time 5-10 min/sample



Peter Girguis, Harvard

Education Outreach GOM *Classroom to Sea* Labs

Liz Goehring

Pennsylvania State University

Overview of E&O Plan

Develop and disseminate *Classroom to Sea* labs that feature the cold seeps environment of the Gulf of Mexico.

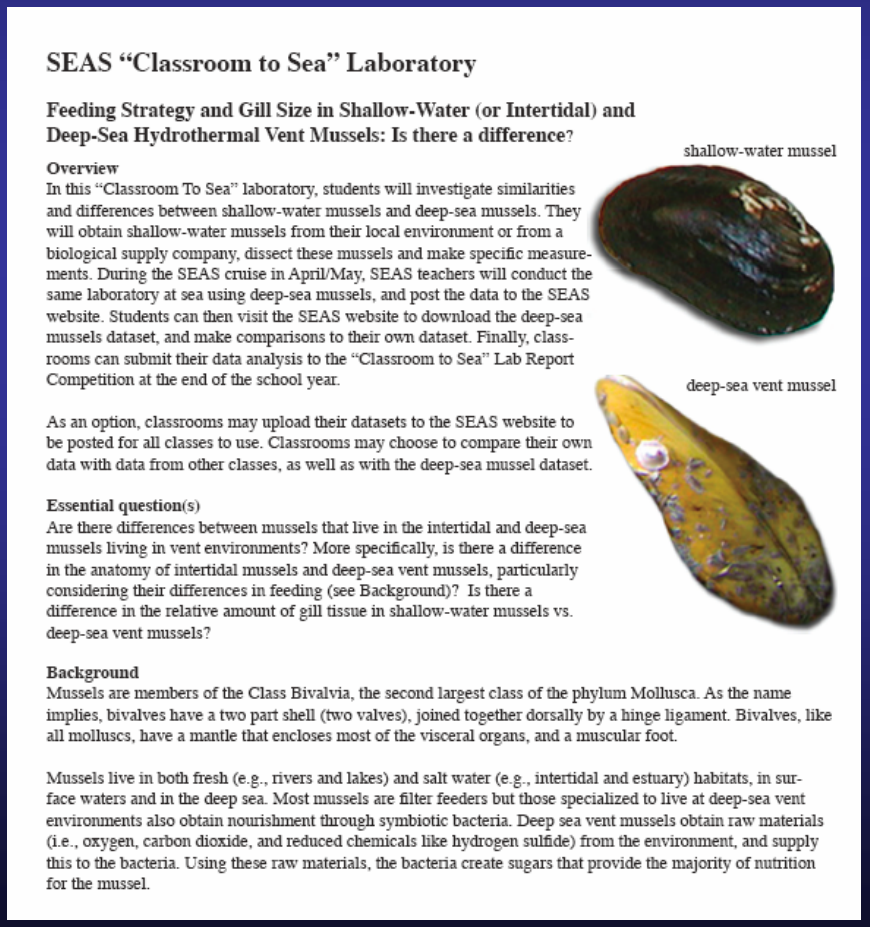
Classroom to Sea (comparative) lab

- ✓ helps students understand deep-sea science through direct comparison with local/familiar environment

Two phases:

1: Explore & Develop

2: Integrate with GLOBE



SEAS "Classroom to Sea" Laboratory

Feeding Strategy and Gill Size in Shallow-Water (or Intertidal) and Deep-Sea Hydrothermal Vent Mussels: Is there a difference?

shallow-water mussel

deep-sea vent mussel

Overview

In this "Classroom To Sea" laboratory, students will investigate similarities and differences between shallow-water mussels and deep-sea mussels. They will obtain shallow-water mussels from their local environment or from a biological supply company, dissect these mussels and make specific measurements. During the SEAS cruise in April/May, SEAS teachers will conduct the same laboratory at sea using deep-sea mussels, and post the data to the SEAS website. Students can then visit the SEAS website to download the deep-sea mussels dataset, and make comparisons to their own dataset. Finally, classrooms can submit their data analysis to the "Classroom to Sea" Lab Report Competition at the end of the school year.

As an option, classrooms may upload their datasets to the SEAS website to be posted for all classes to use. Classrooms may choose to compare their own data with data from other classes, as well as with the deep-sea mussel dataset.

Essential question(s)

Are there differences between mussels that live in the intertidal and deep-sea mussels living in vent environments? More specifically, is there a difference in the anatomy of intertidal mussels and deep-sea vent mussels, particularly considering their differences in feeding (see Background)? Is there a difference in the relative amount of gill tissue in shallow-water mussels vs. deep-sea vent mussels?

Background

Mussels are members of the Class Bivalvia, the second largest class of the phylum Mollusca. As the name implies, bivalves have a two part shell (two valves), joined together dorsally by a hinge ligament. Bivalves, like all molluscs, have a mantle that encloses most of the visceral organs, and a muscular foot.

Mussels live in both fresh (e.g., rivers and lakes) and salt water (e.g., intertidal and estuary) habitats, in surface waters and in the deep sea. Most mussels are filter feeders but those specialized to live at deep-sea vent environments also obtain nourishment through symbiotic bacteria. Deep sea vent mussels obtain raw materials (i.e., oxygen, carbon dioxide, and reduced chemicals like hydrogen sulfide) from the environment, and supply this to the bacteria. Using these raw materials, the bacteria create sugars that provide the majority of nutrition for the mussel.

An Example – The Mussel Lab

Shallow-water vs. cold-seep mussel anatomy

- Lab instructs students to compare proportion of gill tissue to total body tissue
  - Shallow-water mussel gill to total body proportion ~ 10%
  - Deep-sea vent/seep mussels proportion ~ 30% because of chemosynthetic symbionts
- Students learn about important concepts of remote environment through hands-on comparison.

Rationale

- Labs teach critical inquiry skills**
  - "real science" lab techniques
  - data analysis with actual data
  - scientific writing/reporting
- Labs foster authentic student inquiry through practice with and participation in research process

** called for by National Science Education Standards

NEW: Partnering with GLOBE FLEXE

- June 2006, we received NSF grant to integrate SEAS with **GLOBE: FLEXE** (**F**rom **L**ocal to **Ex**treme **E**nvironments)
  - ✓ uses comparative lab approach of SEAS
  - ✓ partners deep-sea scientists with education specialists
  - ✓ incorporates education innovations (eg: peer review)
- GLOBE (www.globe.gov), a web-based science education program in 109 countries, offers a significant network for dissemination.

The GLOBE Program

Students collaborate with scientists

Hands-on science

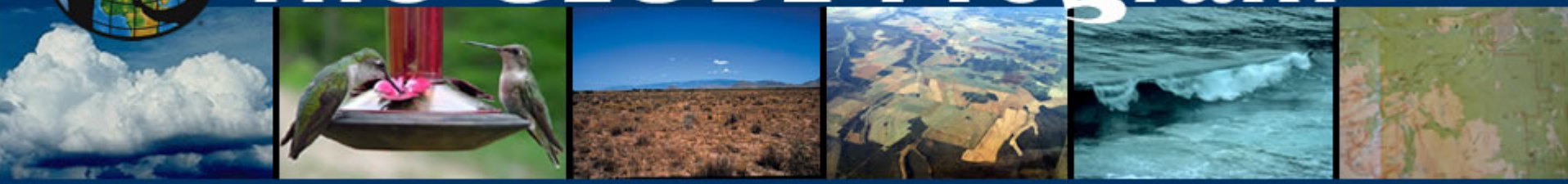
http://www.globe.gov

International Program in 100+ countries

Atmosphere/Climate
Hydrology
Soil
Land Cover/Biology
Phenology

Over 15 million environmental measurements taken

The GLOBE Program



- GLOBE reach is unprecedented
- International in scope: 100+ countries
- Enormous in scale
  - 17,000+ schools
  - 31,000+ teachers
  - 1,000,000+ students
  - 15,000,000+ environmental measurements
  - 140+ Publications
  - Materials translated in 6 U.N. languages
  - 10 Years of Evaluation data (SRI)

NSF-NASA Suggestions

- Encourage partnerships between GLOBE and NSF and NASA-funded integrated Earth system science programs.
- Leverage existing resources and expertise.
- Build bridges between top Earth system science programs and scientists, and GLOBE’s worldwide community.

FLEXE and Other Earth System Science Projects Will:

- Broaden the pool of scientists involved in GLOBE.
- Give the worldwide GLOBE community access to the top scientists in earth system science and their colleagues around the world.
- Provide the GLOBE community access to programs that are on the cutting edge of earth system science research.
- Position GLOBE to be more competitive for broader impact awards to help it achieve sustainability.

Phase I: Explore & Develop

Objective: develop and test *Classroom to Sea* labs that feature GOM chemosynthetic communities and pertinent lab techniques.

Tasks 2006

- ✓Worked with scientists on May cruise to develop/test ideas for labs
  - ✓Developed prototype lab on oxidation
- ✓Collected data on seep mussels, and background information for existing mussel lab
- ✓Piloted teacher testing labs in classroom setting in 2006–2007 school year.

Phase II: Integrate & Disseminate

Objective: integrate materials collected (mussel data, temp data) with FLEXE / GLOBE.

Tasks 2007

- Develop materials to feature cold seeps as "extreme" environment in FLEXE/GLOBE.
- Integrate GOM mussel data with SEAS mussel lab and new FLEXE/GLOBE learning activities
- Develop two-day short course for teachers
- Work with COSEE-CGOM to advertise/recruit teachers, secure venue, administration

Needs

From Scientists

- Continued input, “face time,” and guidance
- Berth space (for one educator on June cruise)

From GOM-COSEE and NOAA OE

- GOM curricula currently available
- Assistance planning and conducting teacher course for summer 2007