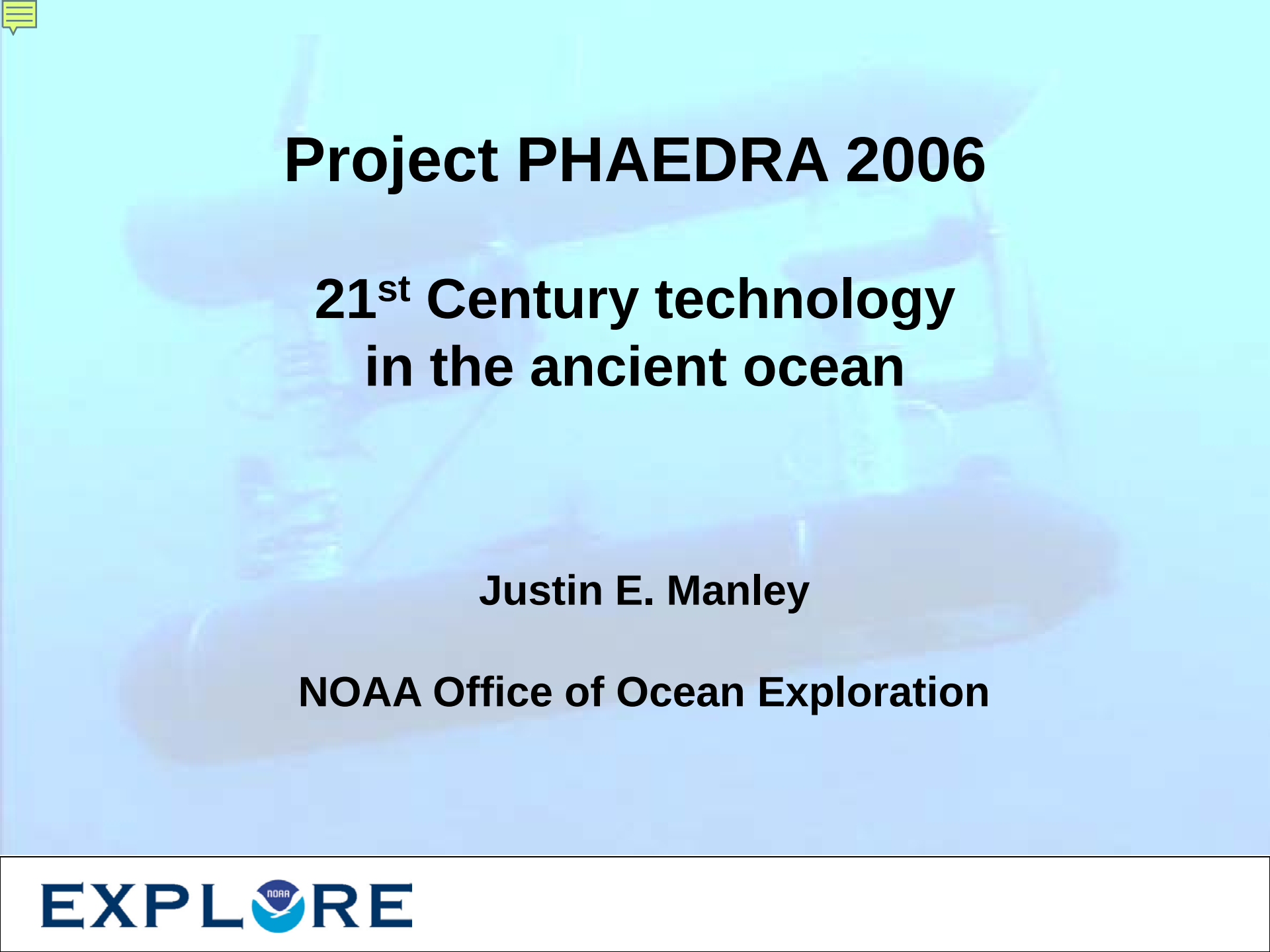




Project PHAEDRA 2006

21st Century technology in the ancient ocean

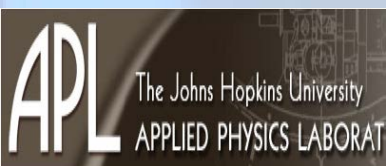
Justin E. Manley

NOAA Office of Ocean Exploration

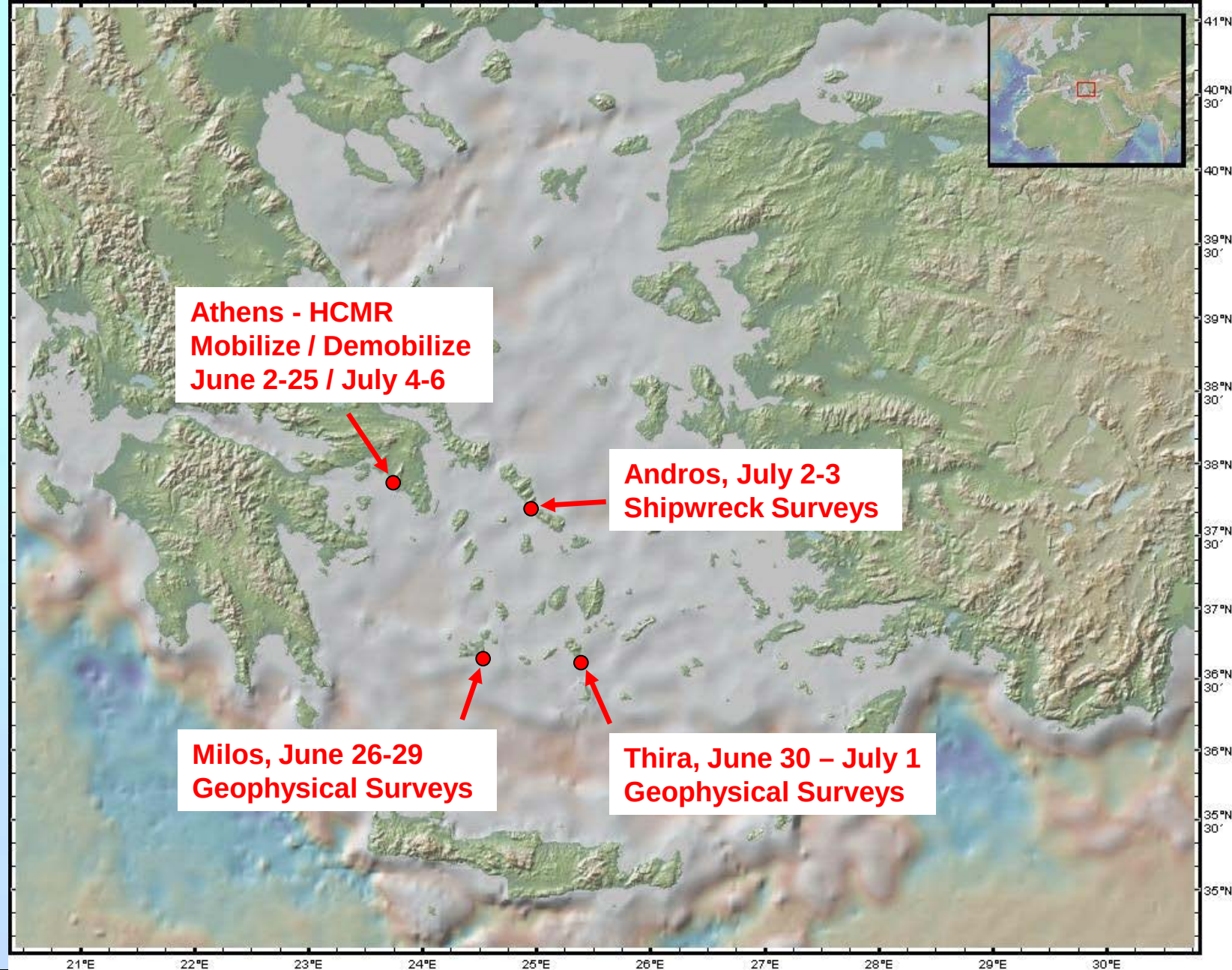
Project PHAEDRA

- Partnership for Hellenic/American Exploration in the Deep Regions of the Aegean
- Ocean Exploration Signature Expedition
 - NOAA web site coordinator
 - Data manager
- Also a technology development showcase
 - Instruments funded by OE
 - AUVs are of strong interest to NOAA

A Diverse Team



- Hellenic Centre for Marine Research
- Euphorate of Underwater Antiquities
- Woods Hole Oceanographic Institution
- Olin College
- Johns Hopkins University
- Massachusetts institute of Technology
- NOAA



R/V Aegaeo



Undersea Systems

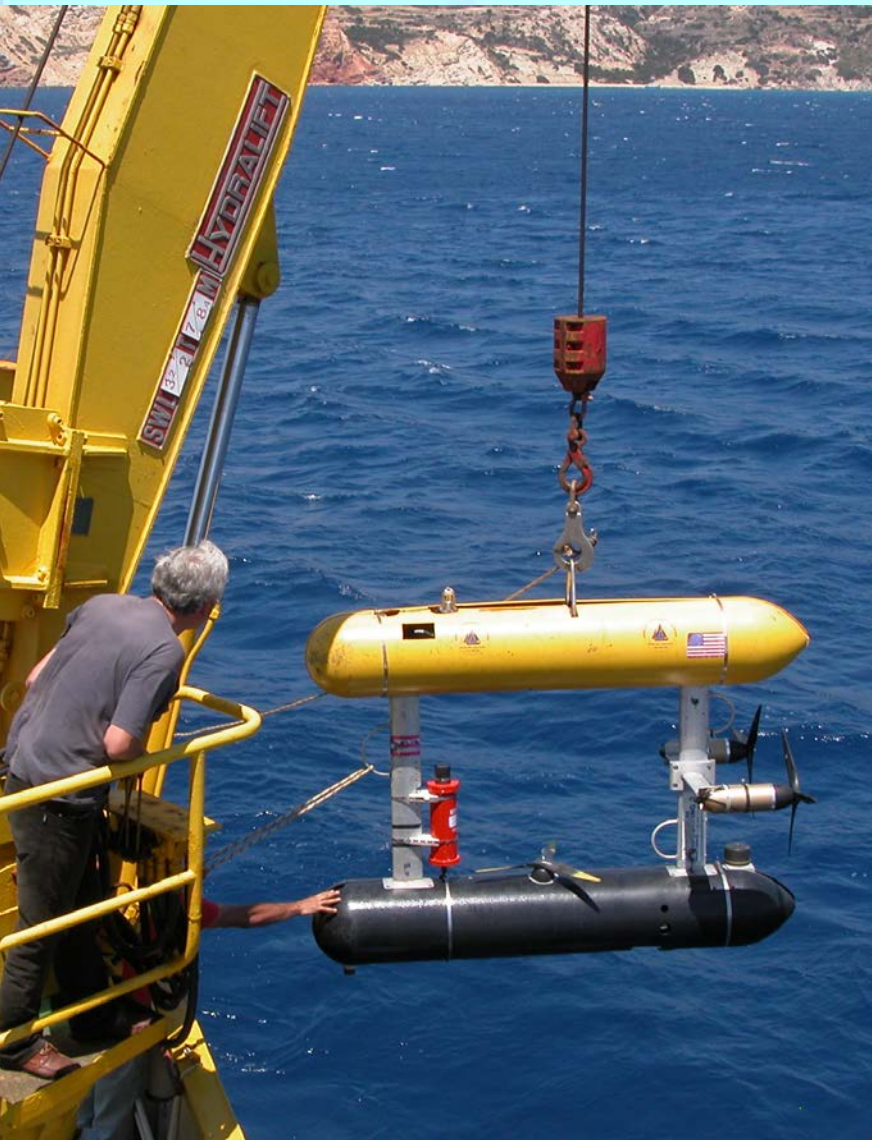
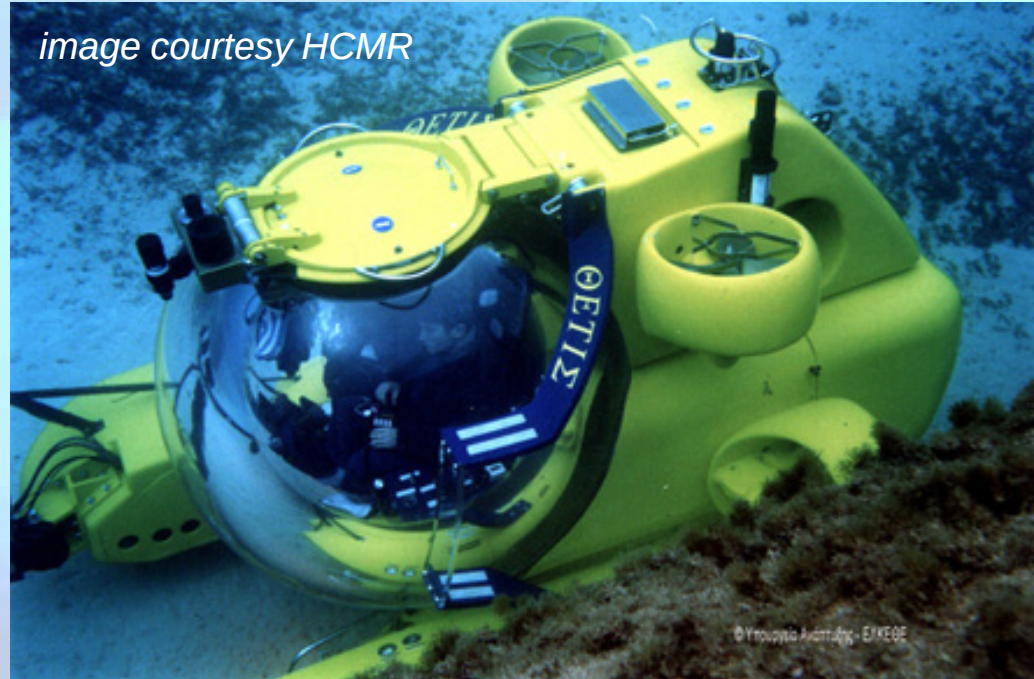


image courtesy HCMR



HCMR 2-person submersible, Thetis

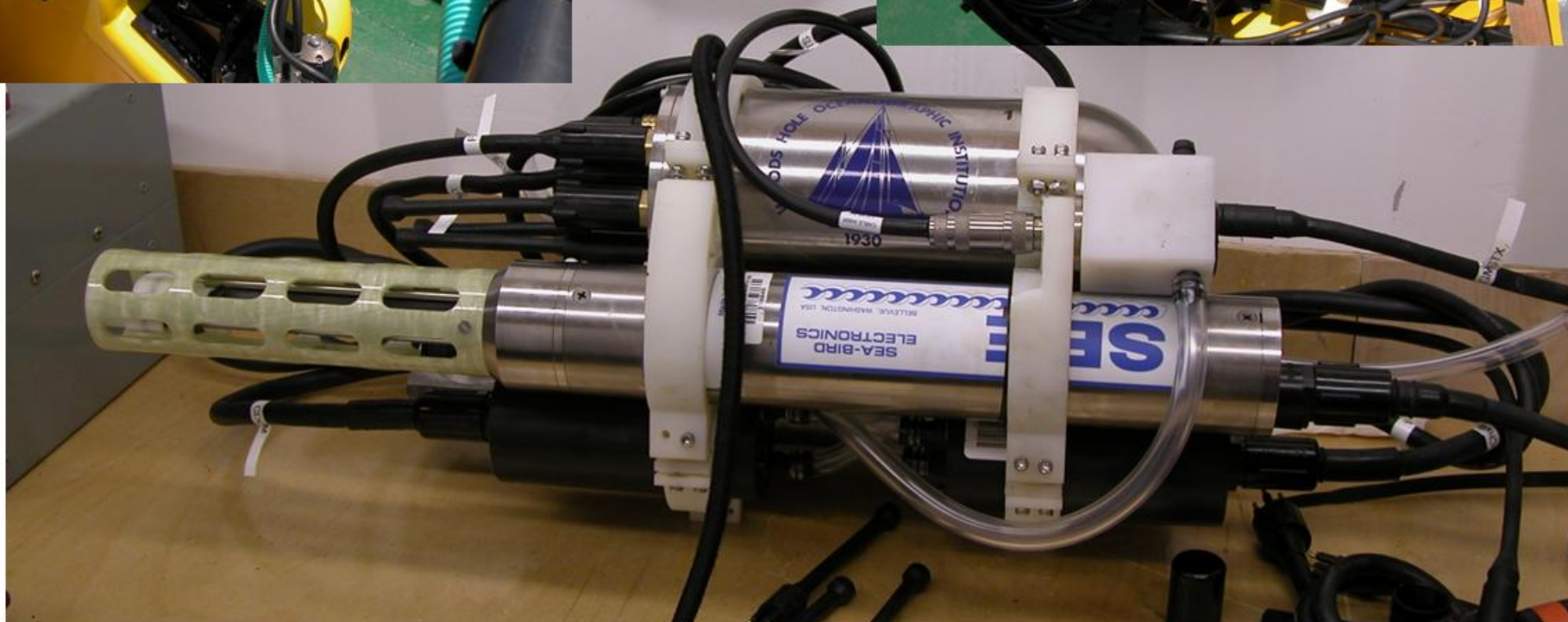
WHOI AUV, SeaBED

New Instrumentation on Thetis

in situ mass-spectrometer,
Gemini, for dissolved gasses
and isotopes



Sonde array:
CTD, D.O.
fluorimeters,



Sampling

- Niskin Bottles
 - Ground truth mass-spec
- “Slurp gun”
 - Collect biological samples
- Push cores
 - Collect sediment samples



Ship/Lab Based processing
To ground truth *Gemini* data



Precision Navigation



Long Baseline (LBL)
acoustic transponders

Precise timing to GPS
PPS signal

Doppler Velocity Log

Acoustic modem for
one-way travel time



Transponders are logistically expensive

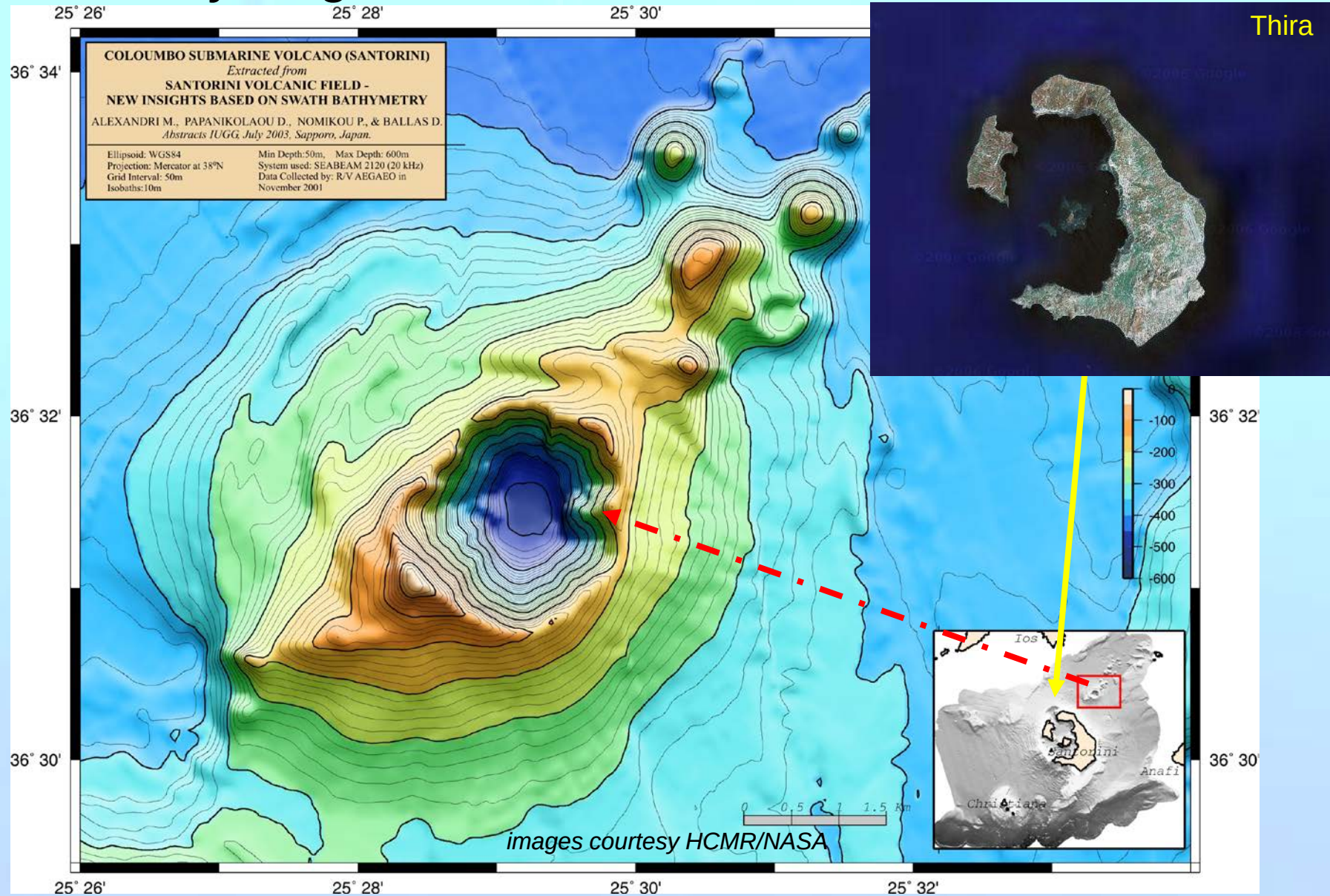


image courtesy Matt Grund, WHOI

Technology Enables Science

- Oceanography
 - Geochemistry of volcanic seabed regions
- Archaeology
 - Ancient wrecks in the “sea of Odysseus”
- Exploration methodology
 - Comparative data sets help distinguish wrecks from rocks
 - Rapid mapping techniques allow those data sets to become statistically meaningful
 - In situ sensors allow rapid evolution of science mission

Many Aegean islands are extinct volcanoes

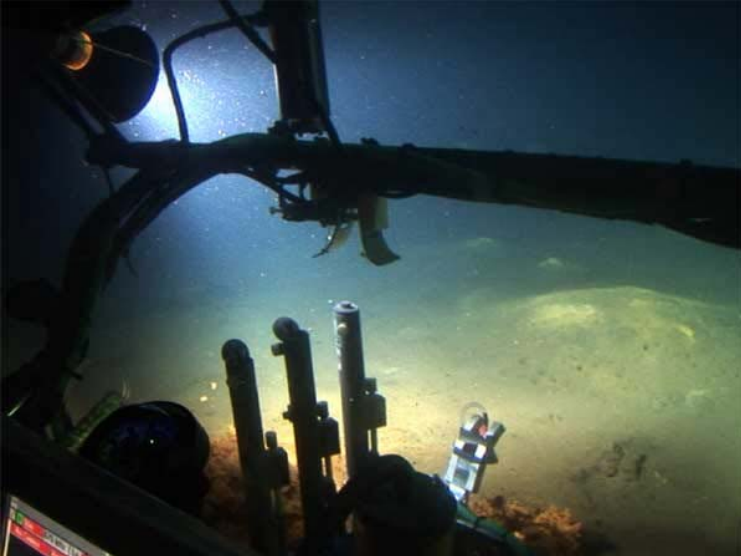


Geology
everywhere!





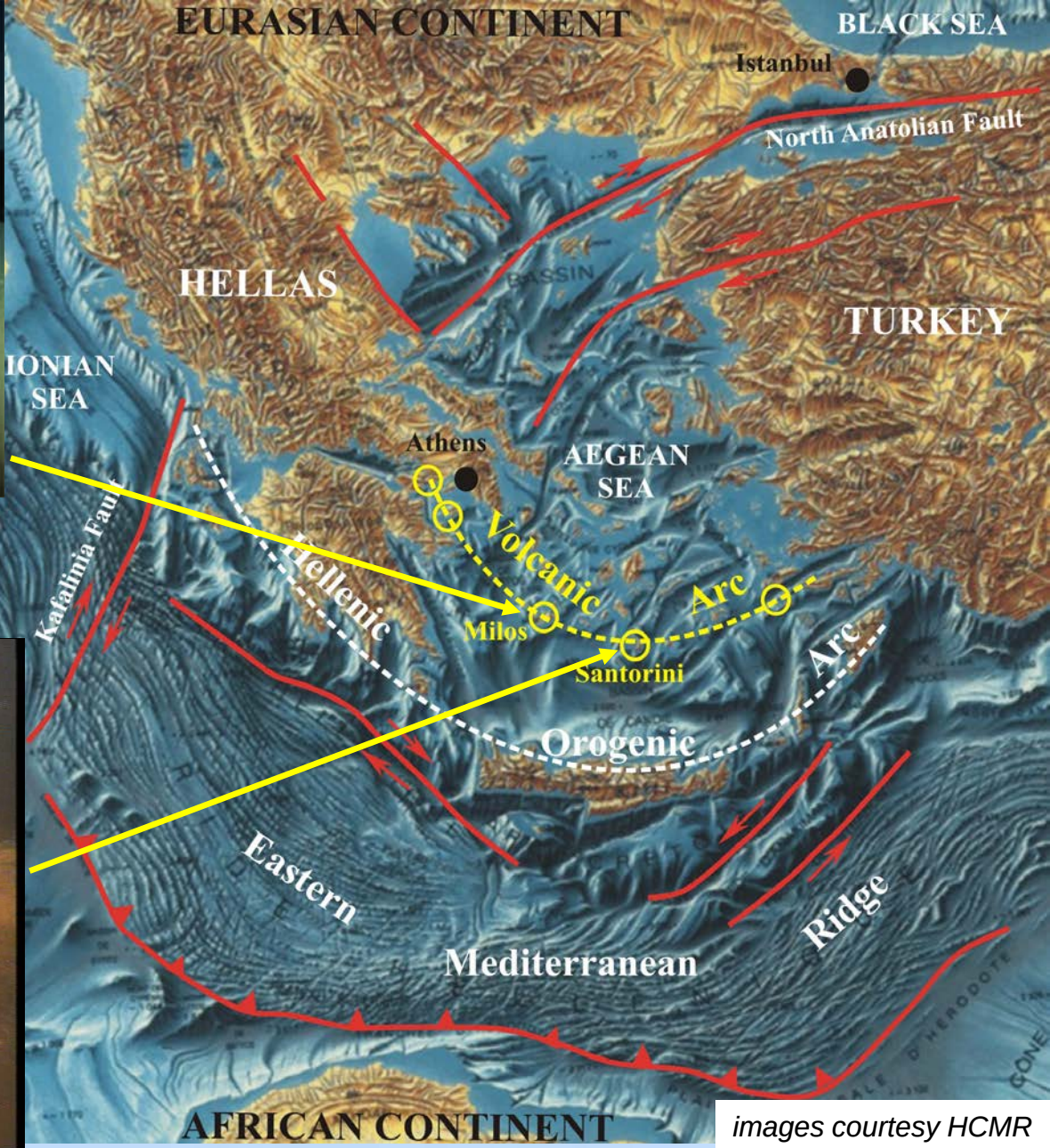
image courtesy HCMR



HOV view of Milos site &
ROV view of Thira site

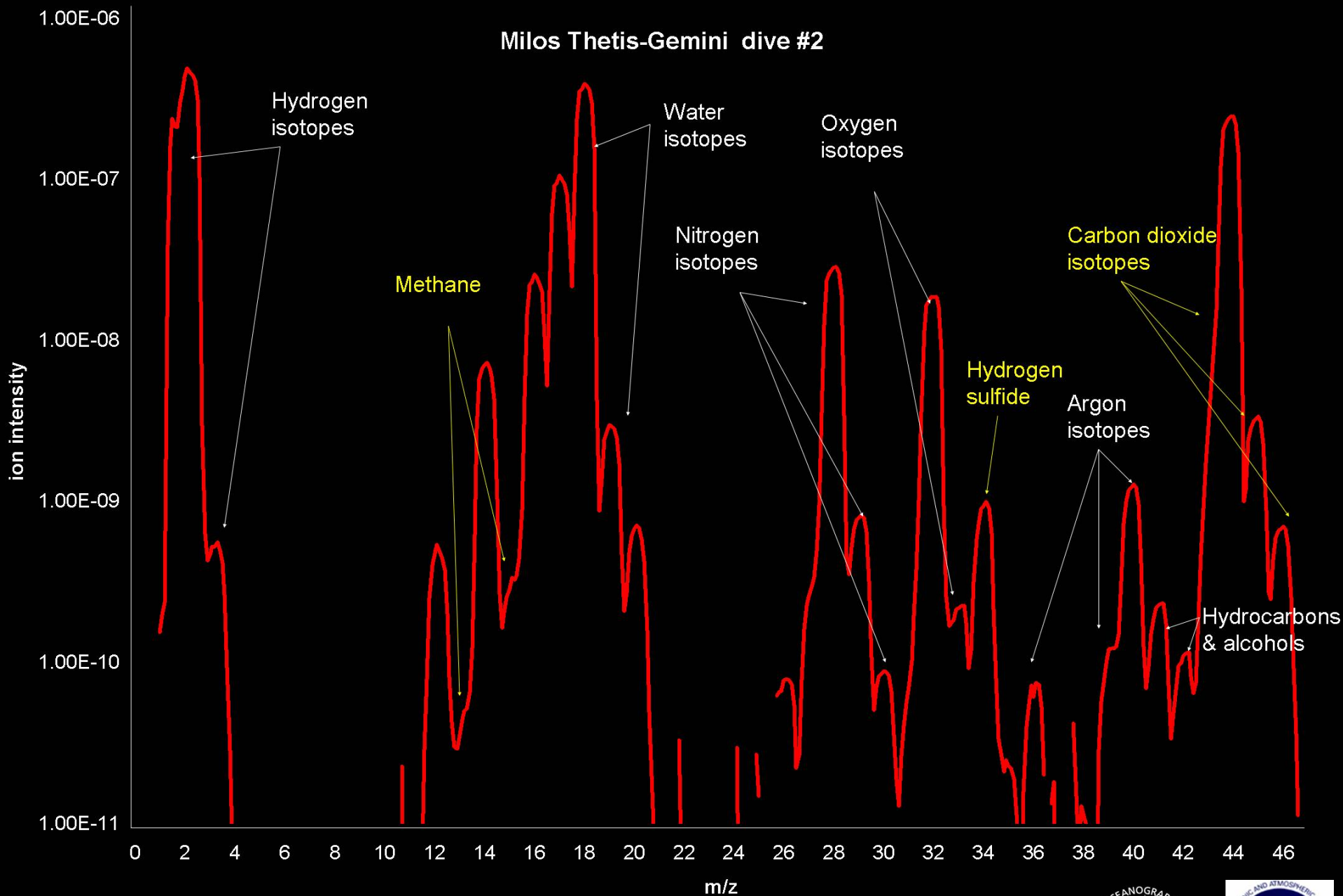


↓082 P339 C246 A00.8



images courtesy HCMR

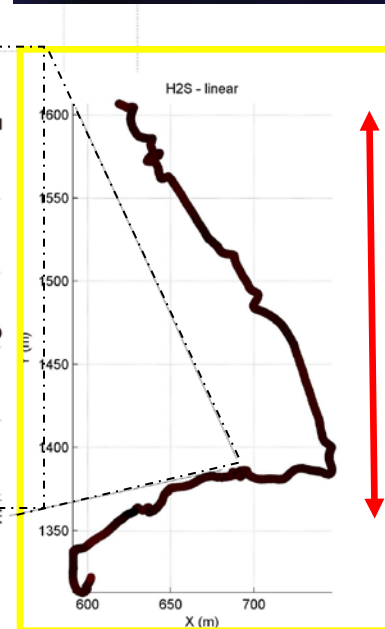
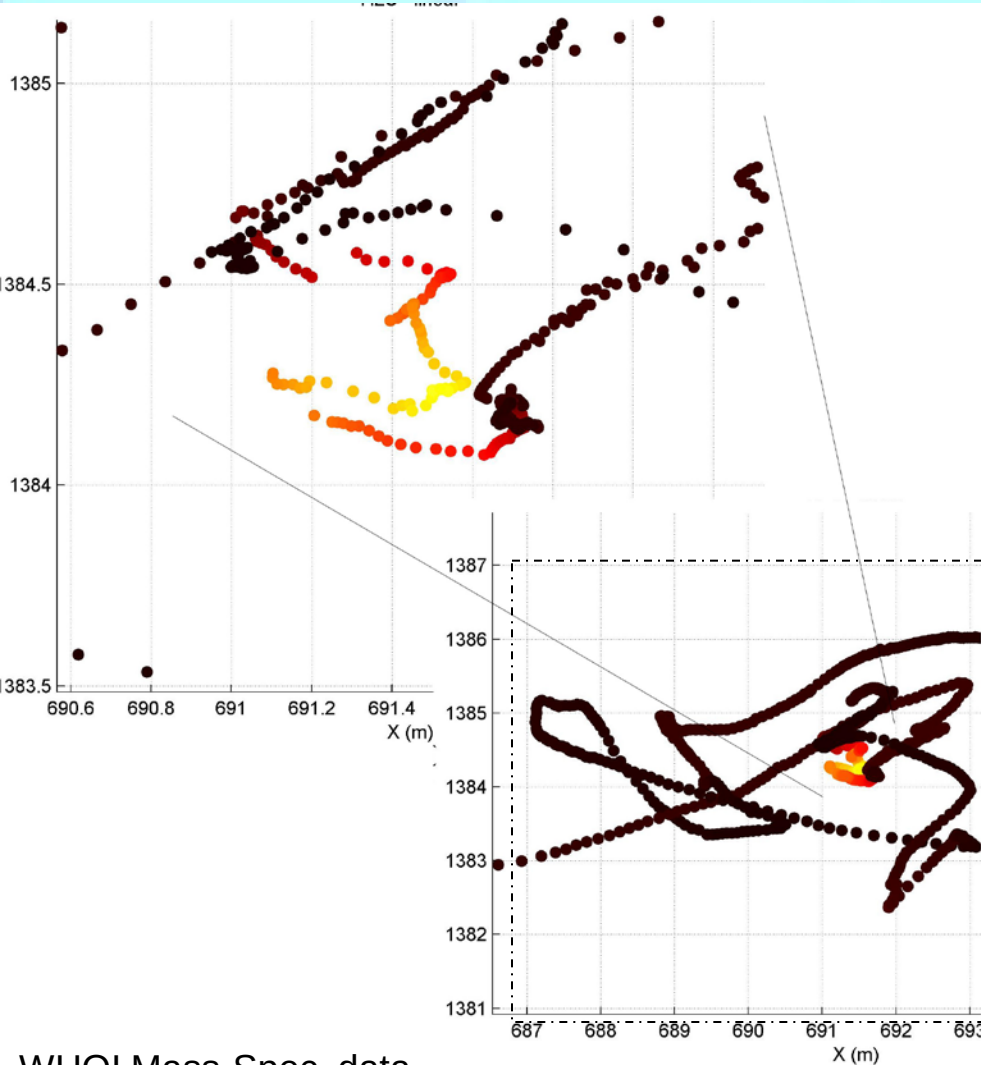
Milos Thetis-Gemini dive #2



Richard Camilli
WHOI Deep Submergence Laboratory

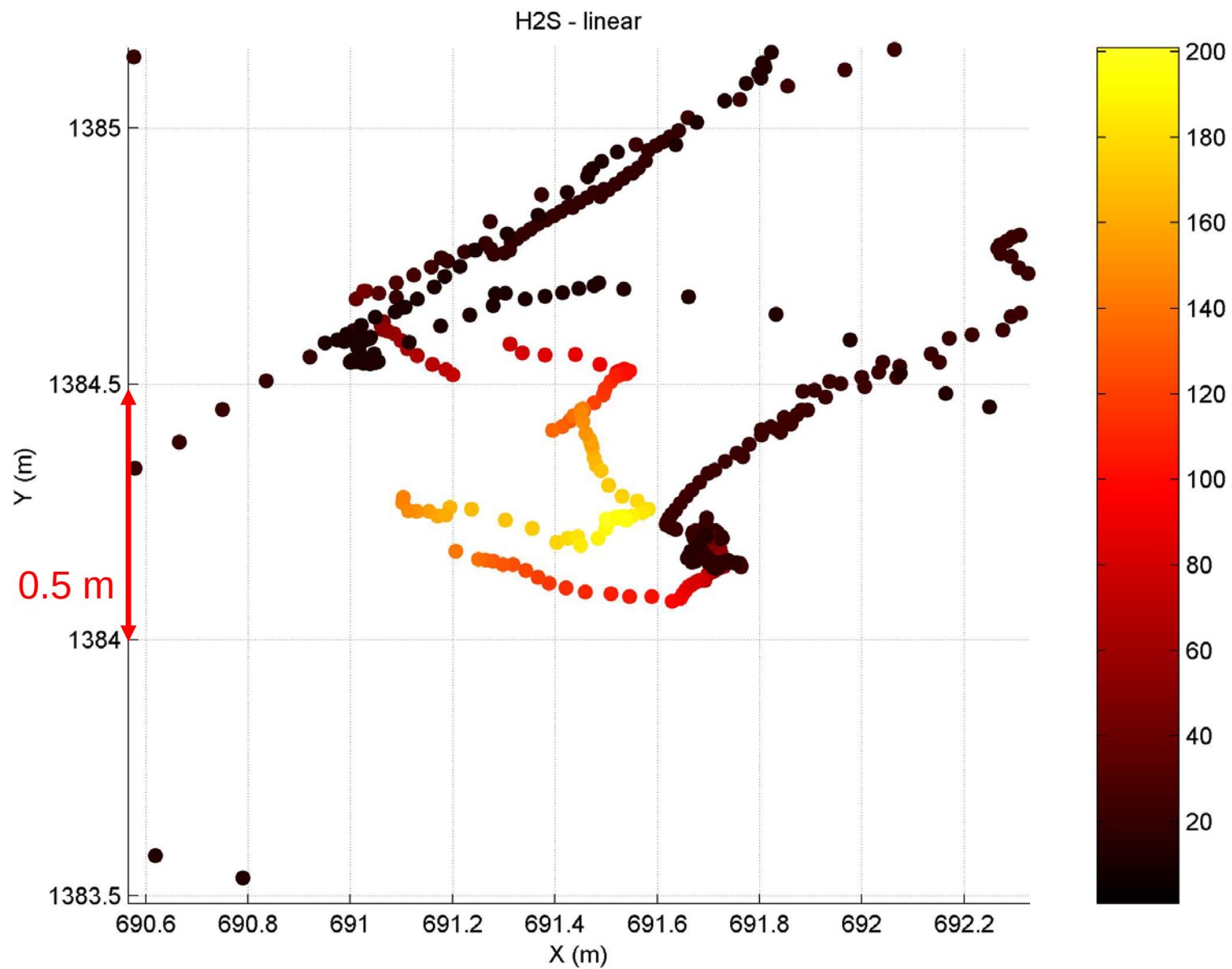


A question of scale



WHOI Mass-Spec. data,
Hydrogen Sulfide Concentration

data plots courtesy WHOI/Olin College



Technology (instrument & navigation) enabled:

- Discovery of cold seeps “undiscoverable” by other means
- Verification (negative data) of vent/seep activity within Milos caldera
- “Discovery” of non-chemically active region (thought to be vents) in Thira caldera
- Chemical “mapping” of Andros shipwreck

Shipwreck Survey

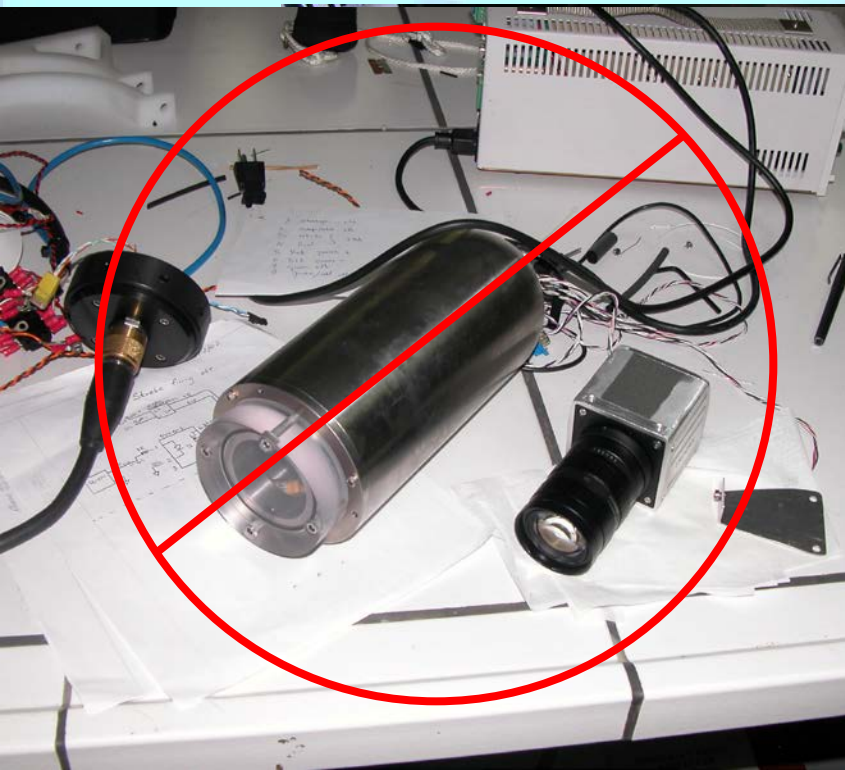


- Limited ship time due to permit delays
- Weathered out of ancient site at Kythnos
- Backup site at Andros was “occupied”
- What to do?

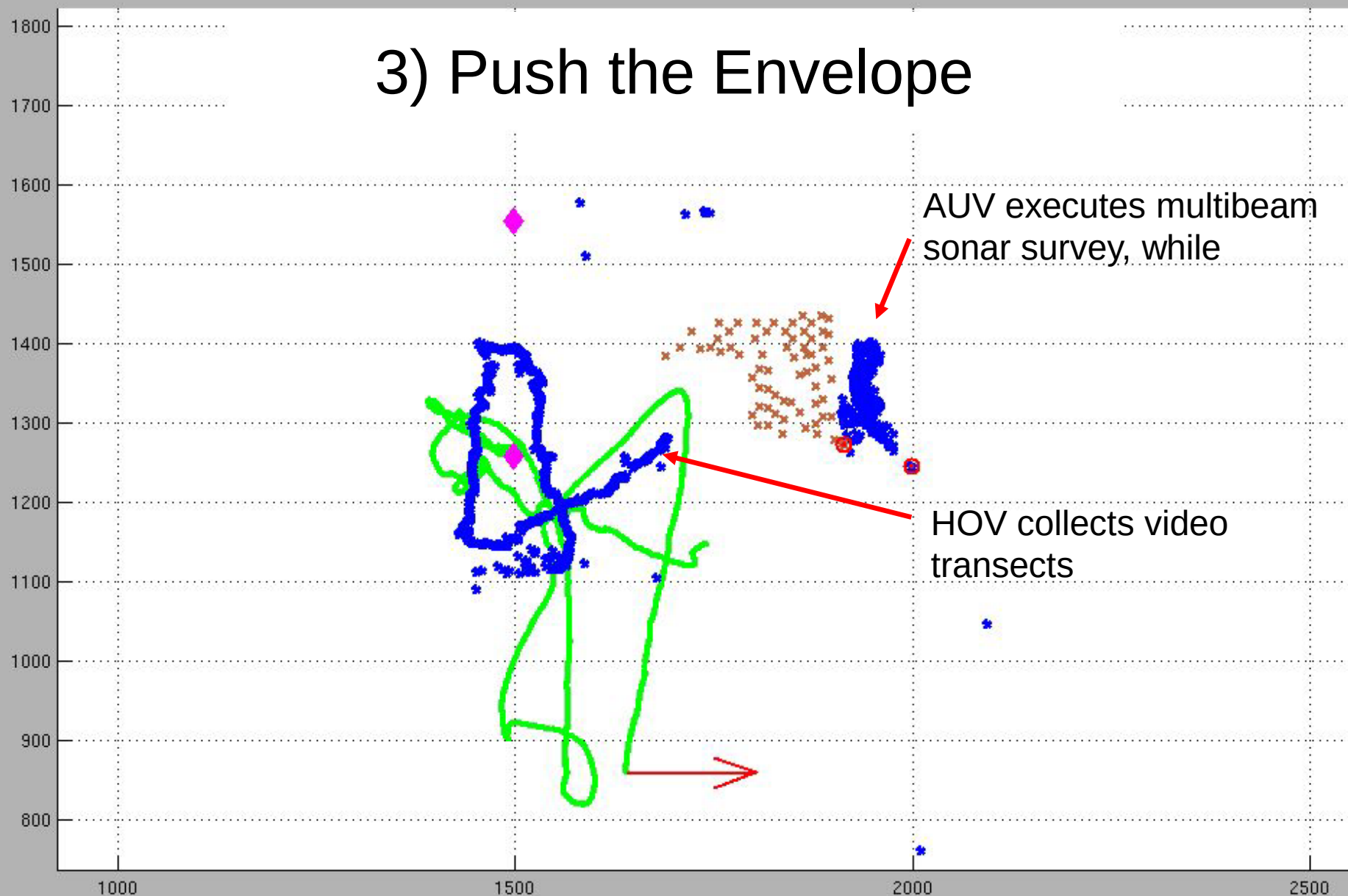
1) Clear the site



2) Improvise



3) Push the Envelope



First Known Combined HOV/AUV Survey



- Two complete video surveys (HOV)
- One chemical survey/map (HOV)
- Two multibeam sonar surveys (AUV)
- All in less than 18 hours!

What is it good for?

- Currently no data products from 2006 available
 - Processing underway
 - Greek Ministry of Culture restricts release of images and data
- 2005 results
 - Integrated camera/sonar on AUV
 - Ancient wreck
 - But lacking chemical survey data

Ancient shipwreck becomes modern habitat

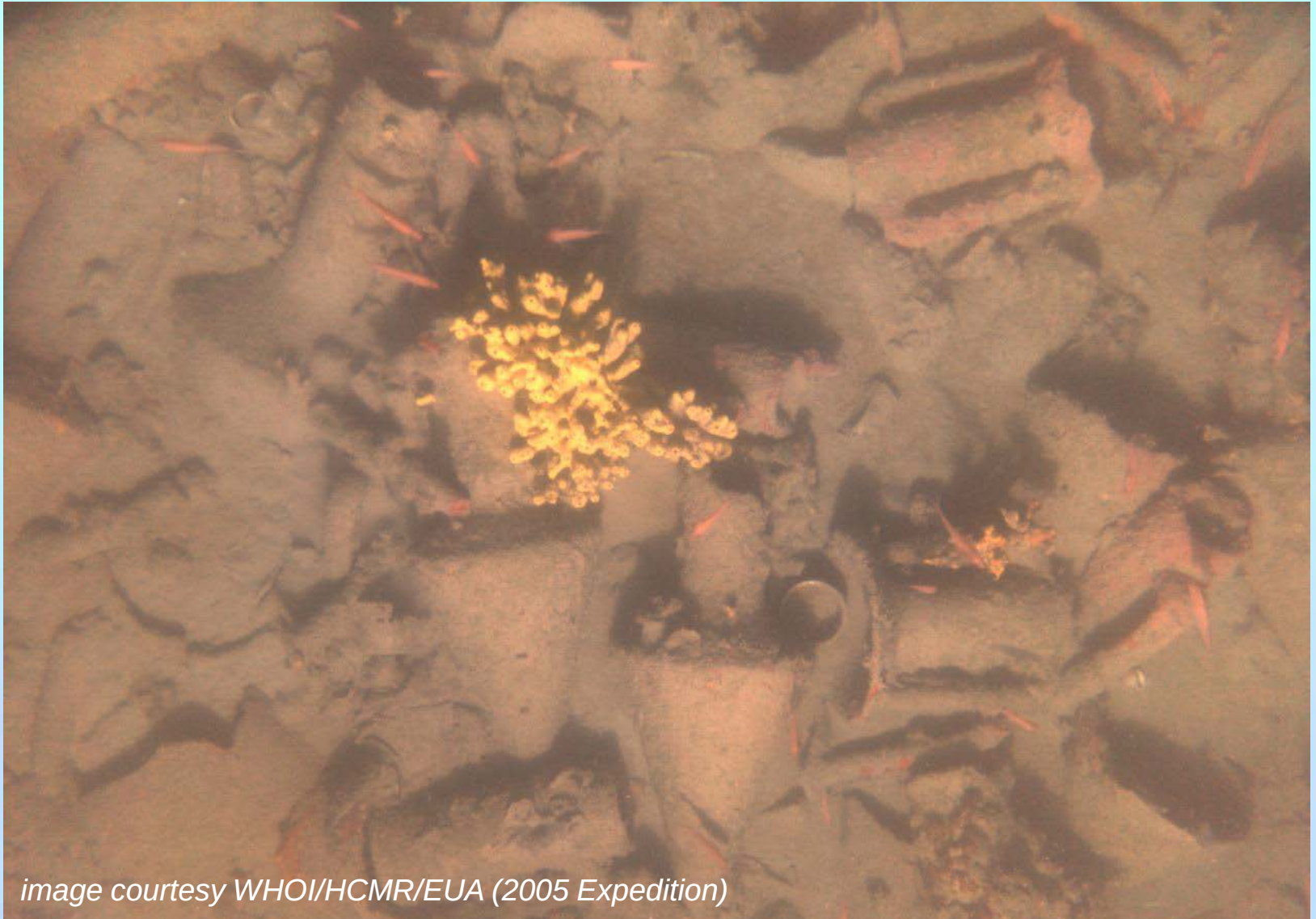
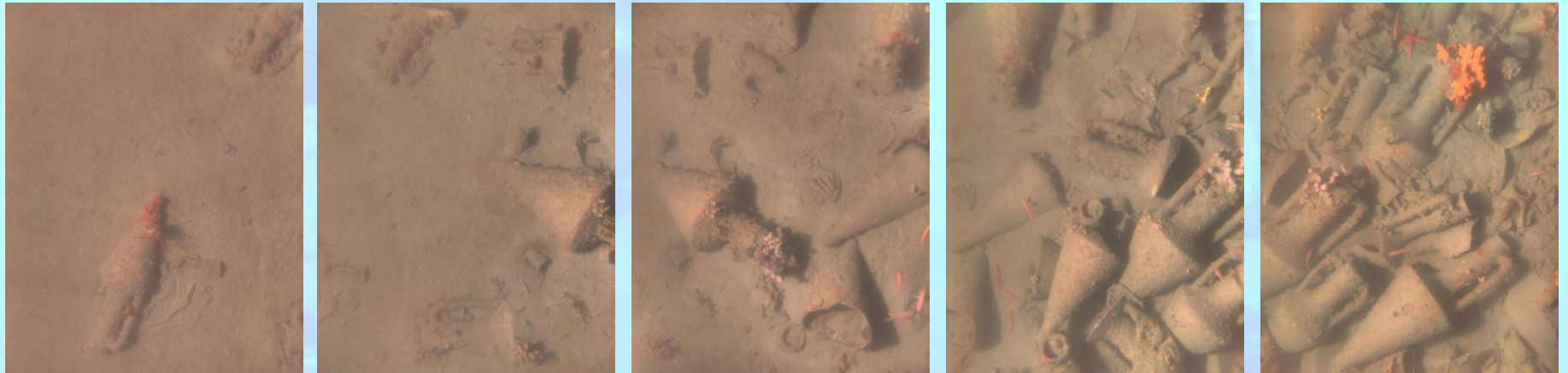


image courtesy WHOI/HCMR/EUA (2005 Expedition)

Multiple images provide context

1) Individual images collected by SeaBED every 3 seconds

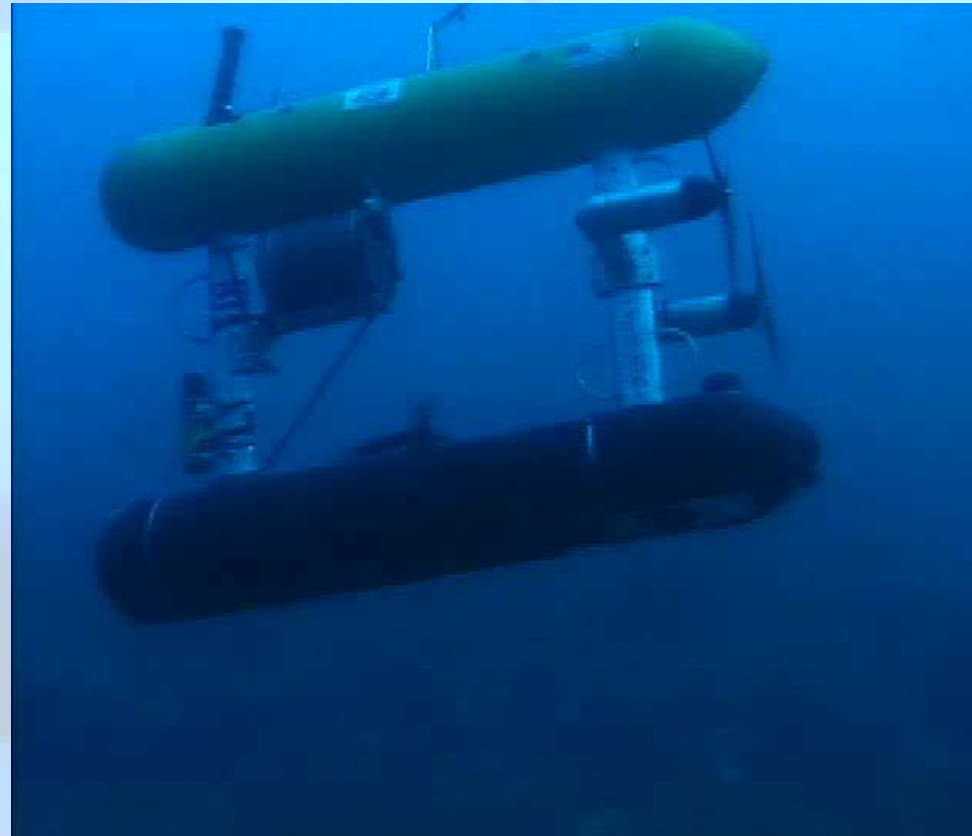
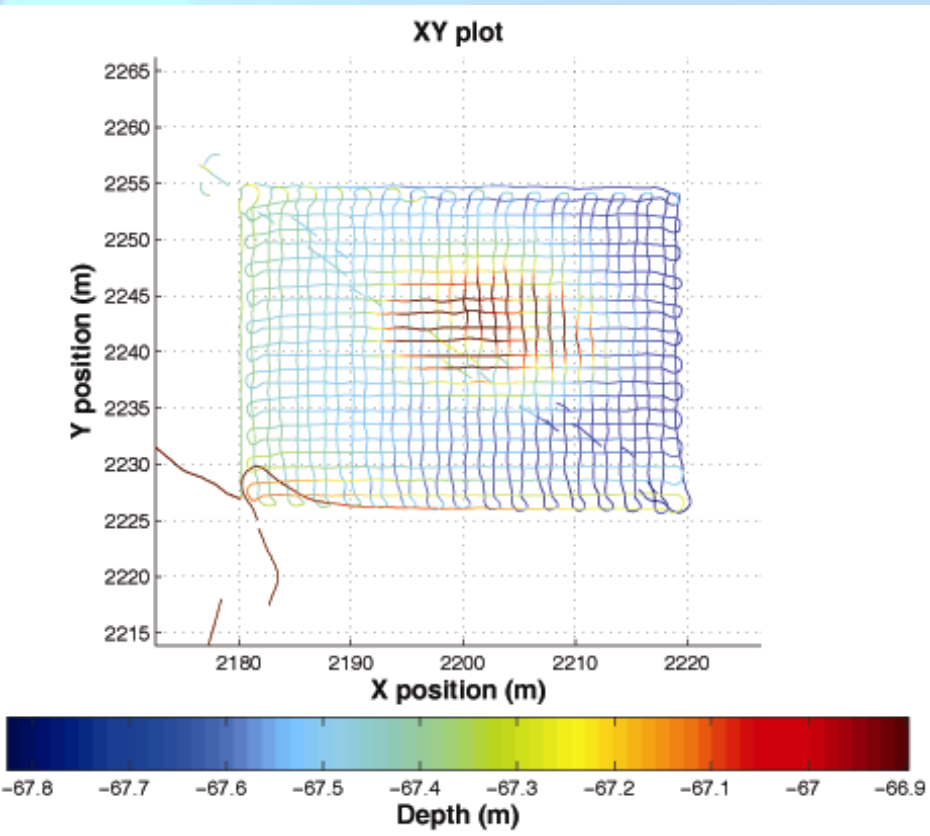


2) later assembled into photomosaic strips with automated software



images courtesy WHOI/HCMR/EUA (2005 Expedition)

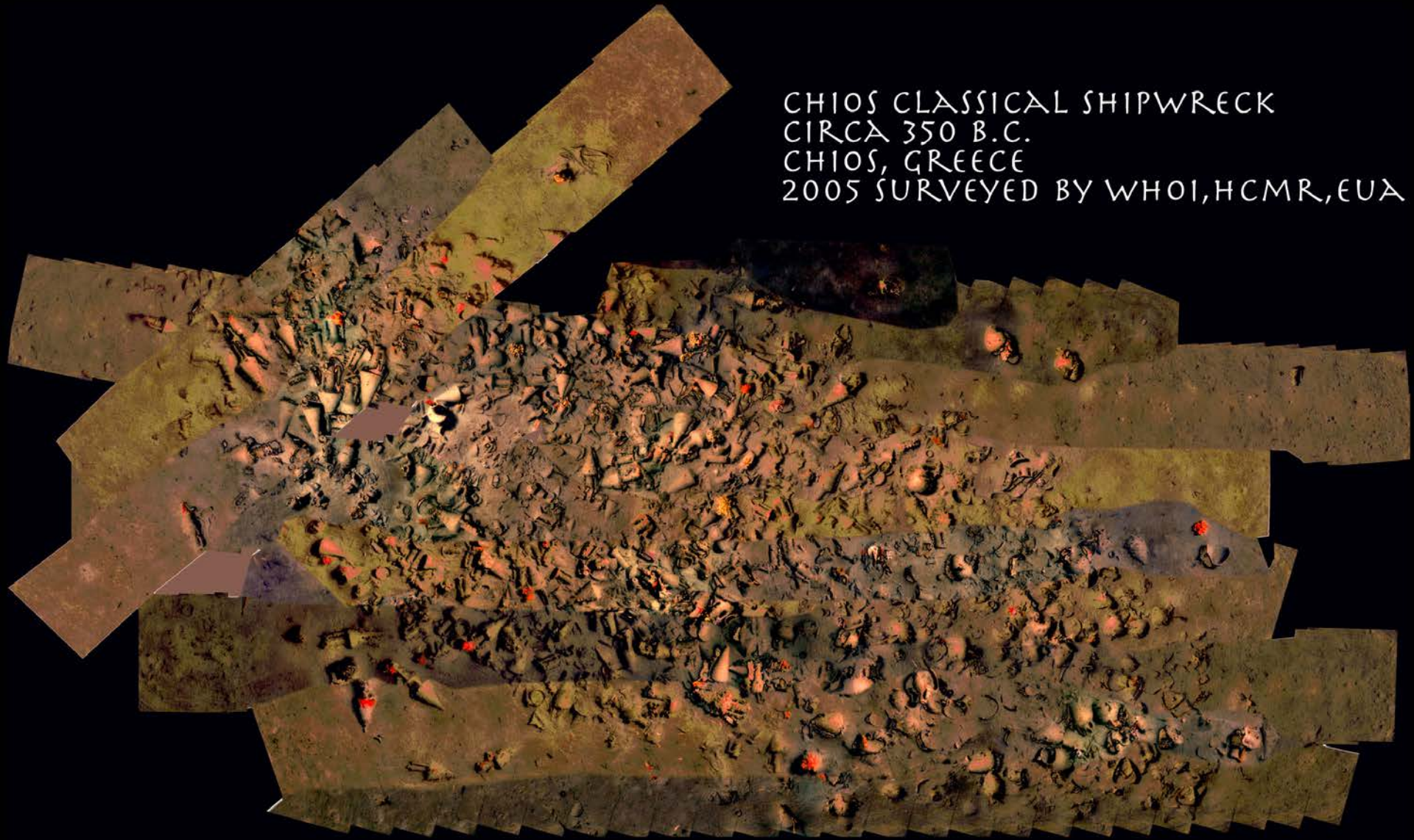
Precision Navigation and Control are Critical



images courtesy WHOI/HCMR/EUA (2005 Expedition)

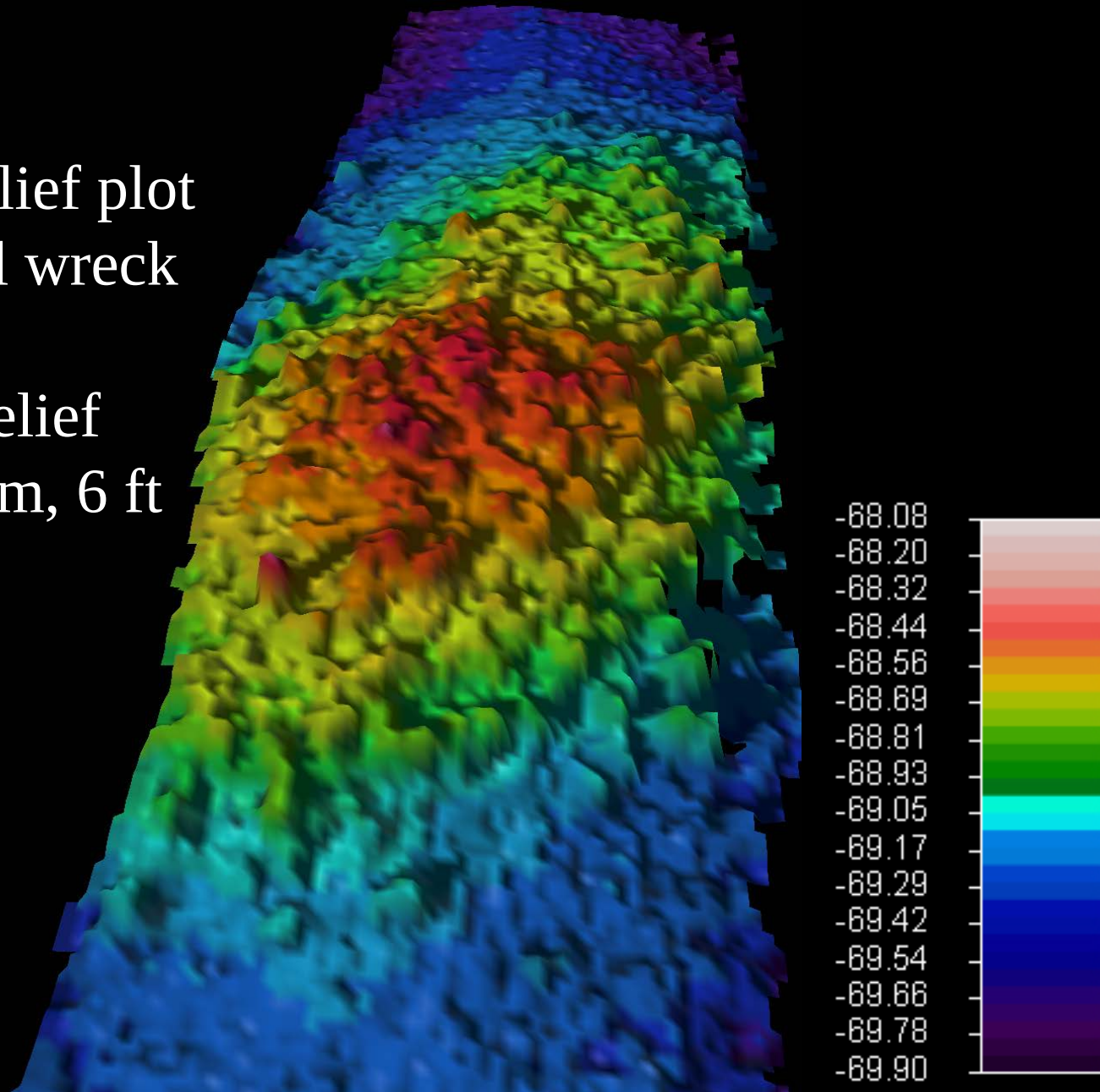
Results are impressive

CHIOS CLASSICAL SHIPWRECK
CIRCA 350 B.C.
CHIOS, GREECE
2005 SURVEYED BY WHOI, HCMR, EUA

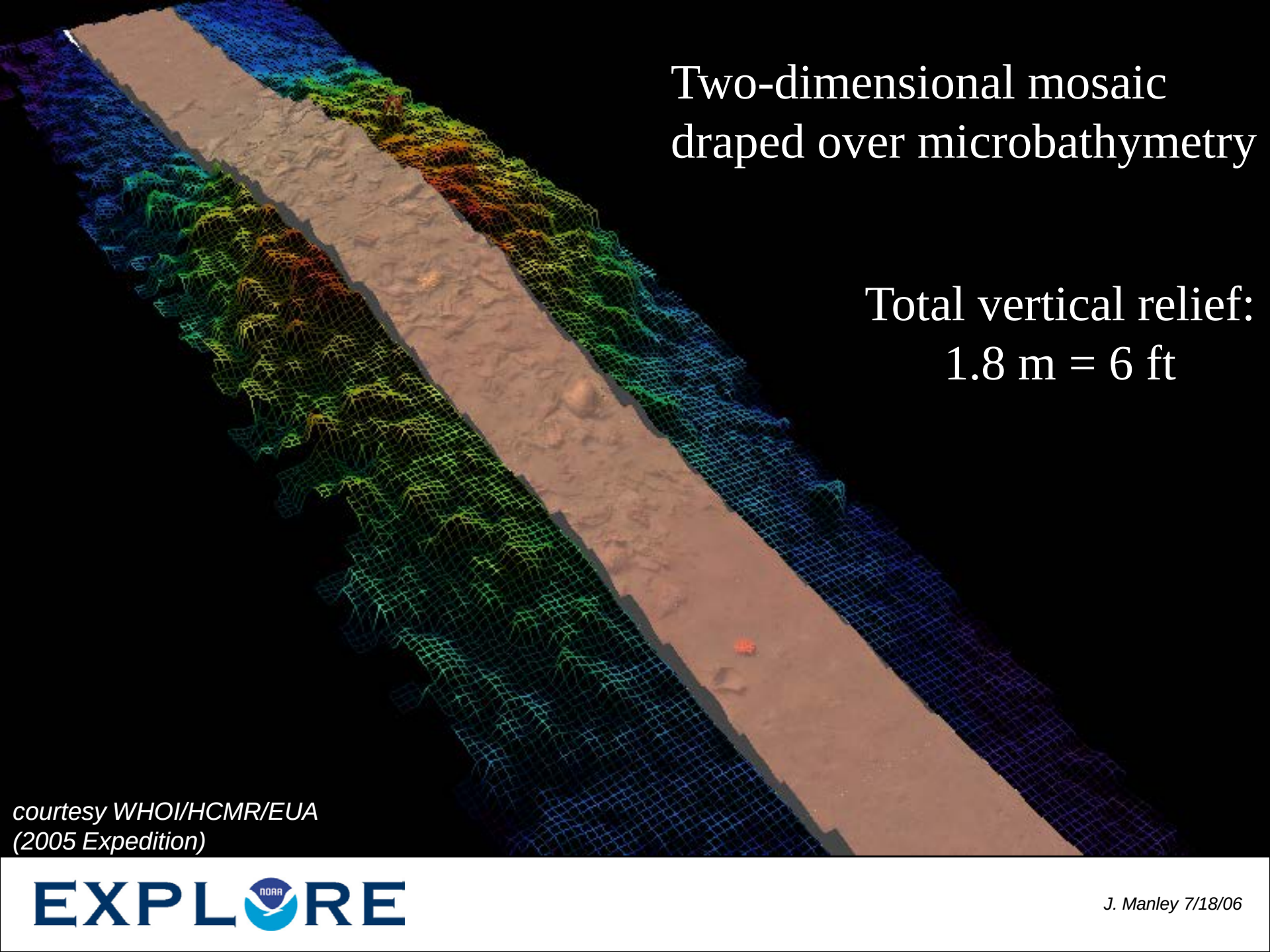


Contour and relief plot Chios Classical wreck

Total vertical relief
over site = 1.8 m, 6 ft



courtesy WHOI/HCMR/EUA
(2005 Expedition)



Two-dimensional mosaic
draped over microbathymetry

Total vertical relief:
 $1.8 \text{ m} = 6 \text{ ft}$

*courtesy WHOI/HCMR/EUA
(2005 Expedition)*

Next Steps

- Combine all three technologies
 - In situ chemical sensing
 - Multibeam survey
 - Photomosaics
- Refine the one-way-travel time navigation
- Perfect the data product (and create new ones)
- Rinse and repeat
 - Collect new statistical data on wrecks distributed across the Mediterranean Sea
 - Apply to global oceanographic subjects as well

Beyond Ocean Exploration

- Environmental monitoring
 - Habitat maps combining bathymetry and in situ oceanographic data (backed up by QA/QC via traditional methods)
- Offshore oil
 - Dissolved gas sensing is possible in situ
 - Reduced time to leak detection/repair
 - Improved prospecting
- Defense/Homeland Security
 - Unexploded ordinance detection
 - Improvised marine IEDs
 - Narcotics

Questions

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