



DEEPARCH

Research Group, MIT

Technology, Archaeology, and the Deep Sea

Deep Sea Archaeology
Research Group - MIT



Value of Precision in Archaeology

Massachusetts Institute of Technology

Brendan Foley and Brian Bingham

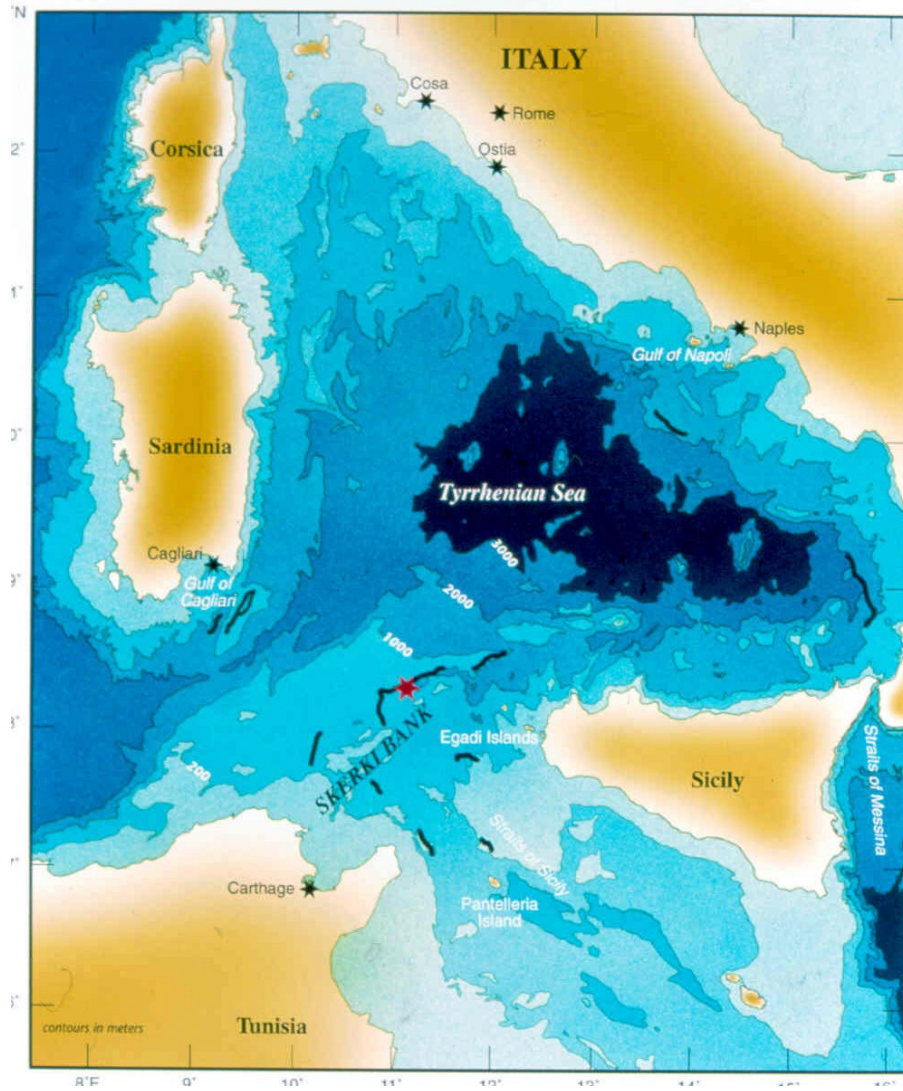
Technology, Archaeology, and the Deep-Sea
April, 2002

Levels of Survey: Broad to precise

- Different information expected from varying phases of survey
- Navigation needs for each phase differ
 - Phase I: Broad area
 - Phase II: Target identification
 - Phase III: Precise survey
 - Phase IV: Intrusive investigation



Phase I: Target Acquisition



Phase I: Broad area

Range of coverage:

- hundreds of linear km
- wide swath width sensors

Precision of navigation:

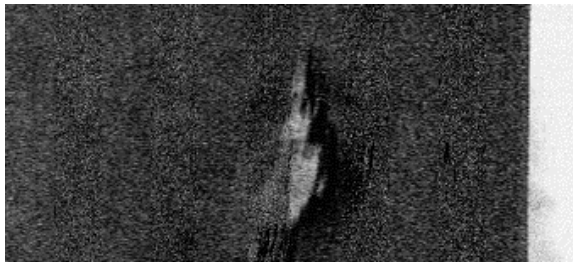
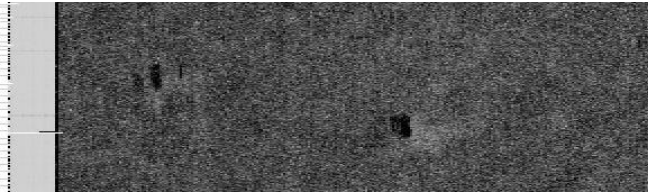
- tens of meters in world coordinates
- just good enough to get back to the target for Phase II

Constructed from existing archaeological / geological information

Negligible new archaeological information extracted

Phase I - Data Products

Sonar Targets



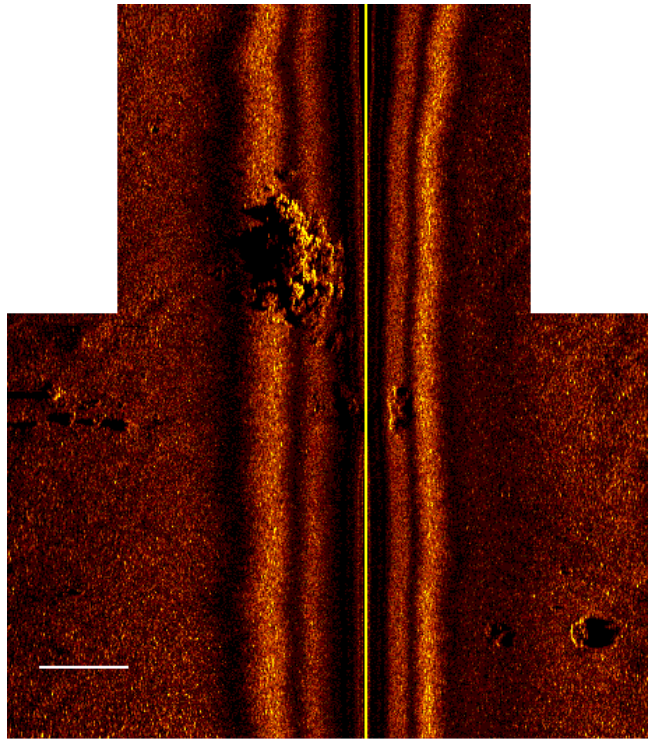
Target List

isis 262.03.1 95/09/19 18:19:00 10982 292 61125 23682
isis 262.05.1 95/09/19 18:47:00 9789 348 59776 23771
isis 262.08.1 95/09/19 19:17:00 6743 346 57139 25310
isis 262.15.1 95/09/19 22:28:00 1599 330 52615 27935
isis 262.16.1 95/09/19 22:28:00 1396 349 52822 28460
isis 262.17.1 95/09/19 22:29:00 1488 330 52581 28041
isis 262.18.1 95/09/19 14:49:00 1449 331 52568 28082
isis 262.19.1 95/09/19 22:30:00 1449 332 52579 28091
isis 262.20.1 95/09/19 22:30:00 1247 330 52429 28227
isis 262.21.1 95/09/19 22:30:00 1270 326 52361 28147
isis 262.29.1 95/09/19 22:41:00 240 315 51728 28966
isis 262.30.1 95/09/19 22:41:00 115 299 51646 29070
isis 262.31.1 95/09/19 22:41:00 87 315 51668 29103
isis 262.32.1 95/09/19 22:41:00 96 314 51671 29094
isis 262.33.1 95/09/19 22:41:00 59 280 51621 29125
isis 262.34.1 95/09/19 22:41:00 70 278 51616 29114
isis 262.35.1 95/09/19 22:41:00 86 247 51572 29121
isis 262.36.1 95/09/19 22:41:00 67 245 51583 29137
isis 262.37.1 95/09/19 22:42:00 72 178 51566 29211
isis 262.38.1 95/09/19 22:43:00 69 195 51563 29190
isis 262.39.1 95/09/19 22:44:00 205 174 51448 29273
isis 262.40.1 95/09/19 22:45:00 337 161 51371 29396
isis 262.41.1 95/09/19 22:45:00 374 161 51343 29421
isis 262.42.1 95/09/19 22:46:00 538 159 51229 29540
isis 262.43.1 95/09/19 22:51:00 863 162 50956 29720
isis 262.46.1 95/09/19 22:56:00 1535 172 50287 29912
isis 262.48.1 95/09/19 23:03:00 2301 182 49449 29895
isis 262.50.1 95/09/19 23:06:00 2673 176 49200 30280

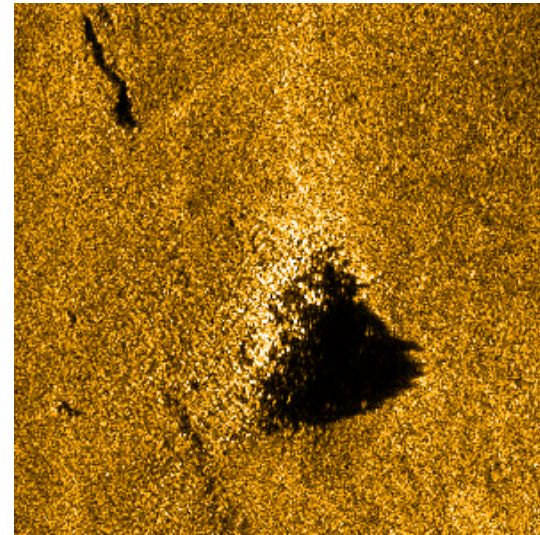


Need to Ground Truth

Even with good sonar data,
we still need to see targets



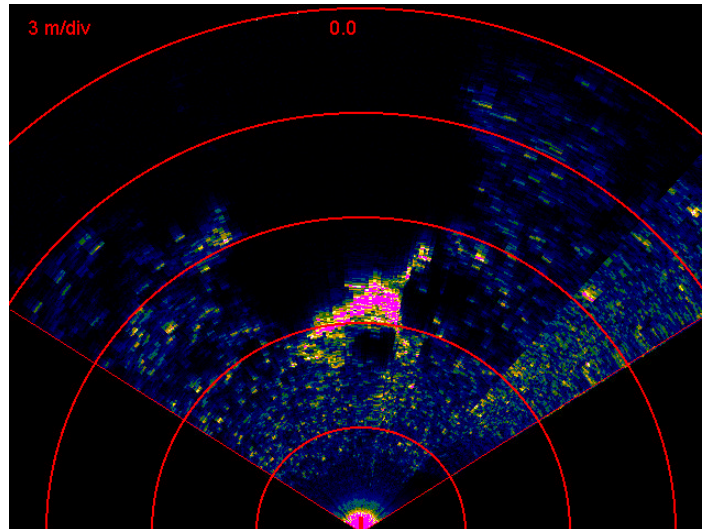
Rock pile - Sinop, Turkey



Shipwreck - Nisiros, Greece

Phase II – Target Identification

- Area of coverage = hundreds of m²
- Navigation precision <5 m
- Good enough to get to sonar target (with a little help)



- Collect basic information: is the site significant?

Phase II – Data Products

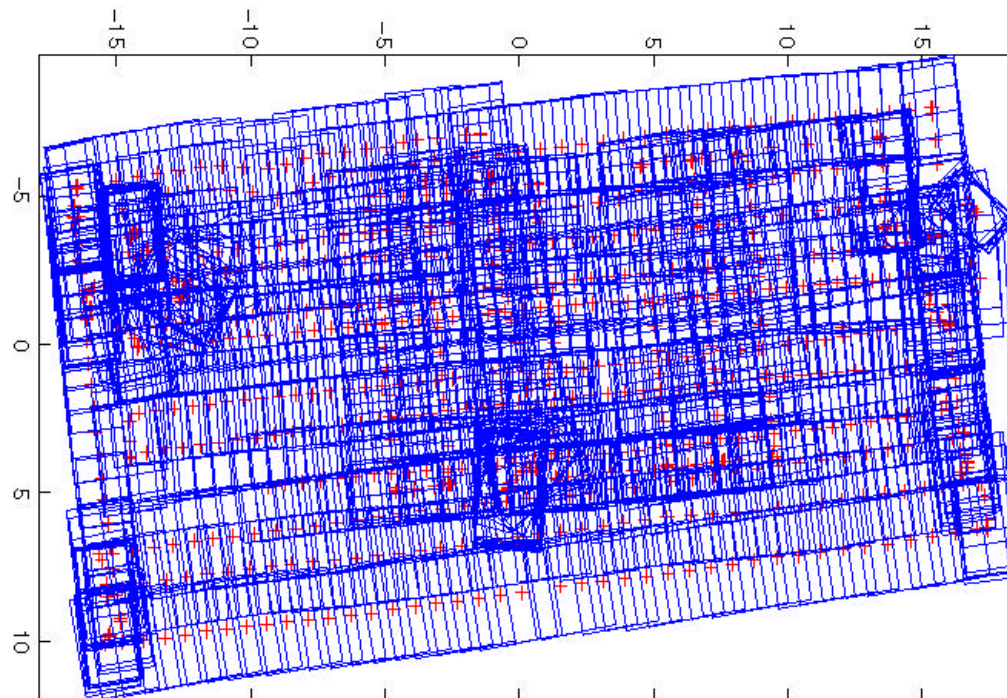
Video and still camera images



For most sites, no additional data will be collected

Phase III – Site Investigation

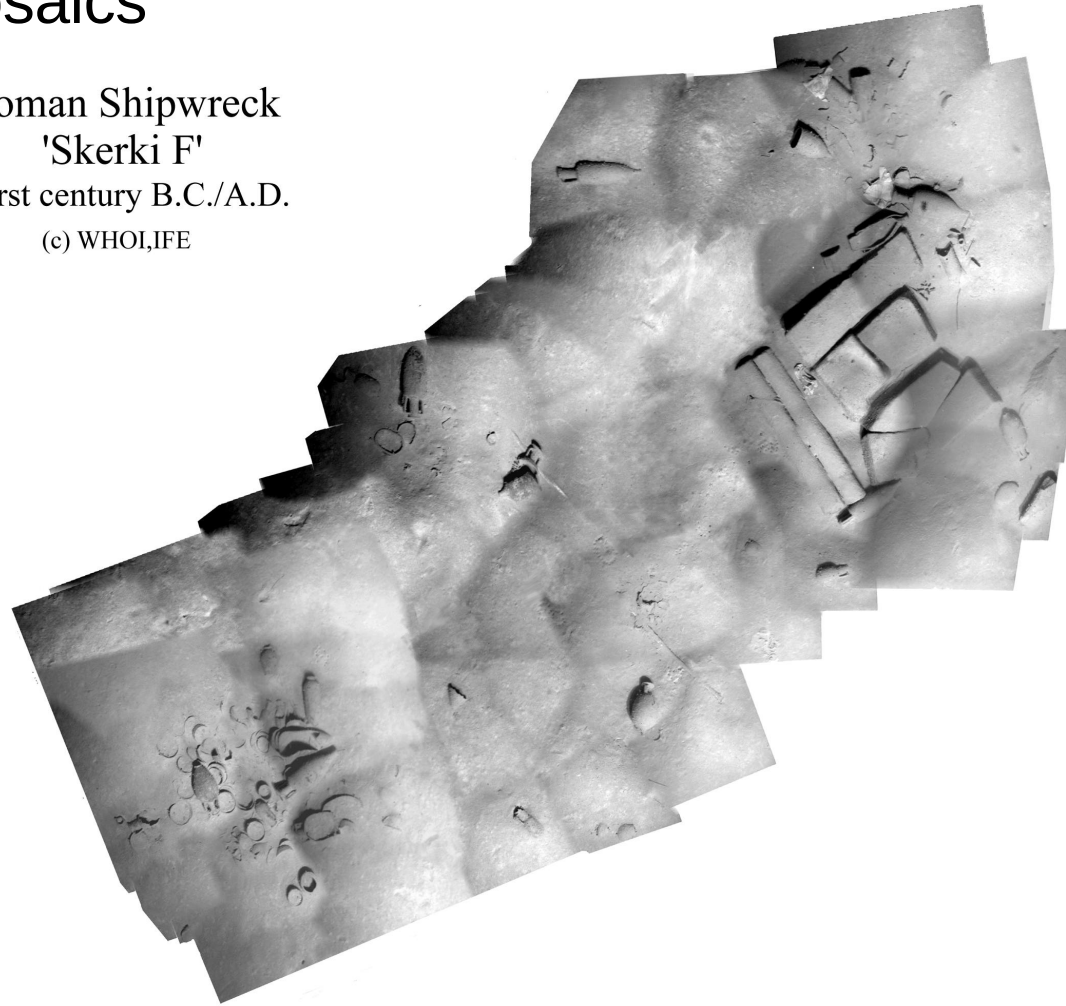
1. Area of coverage tens of m^2 with small footprint sensors
2. Navigation and control must be as precise as possible
3. Tasks include mapping sites to archaeological standards



Phase III - Data products

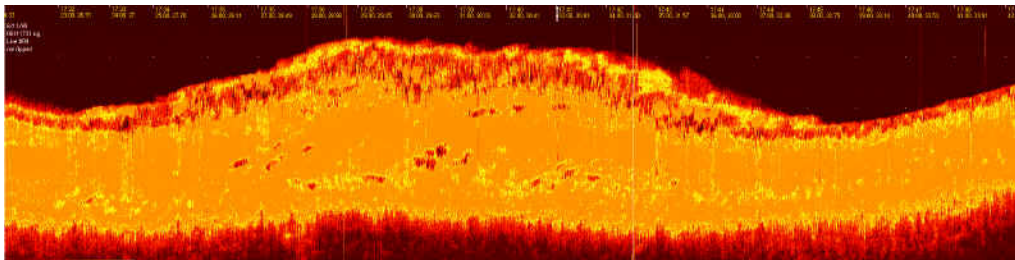
- Photomosaics

Roman Shipwreck
'Skerki F'
First century B.C./A.D.
(c) WHOI, IFE



Phase III - Data products

- Microbathymetric plots
- Subbottom profiling, magnetometry, florescence, others?

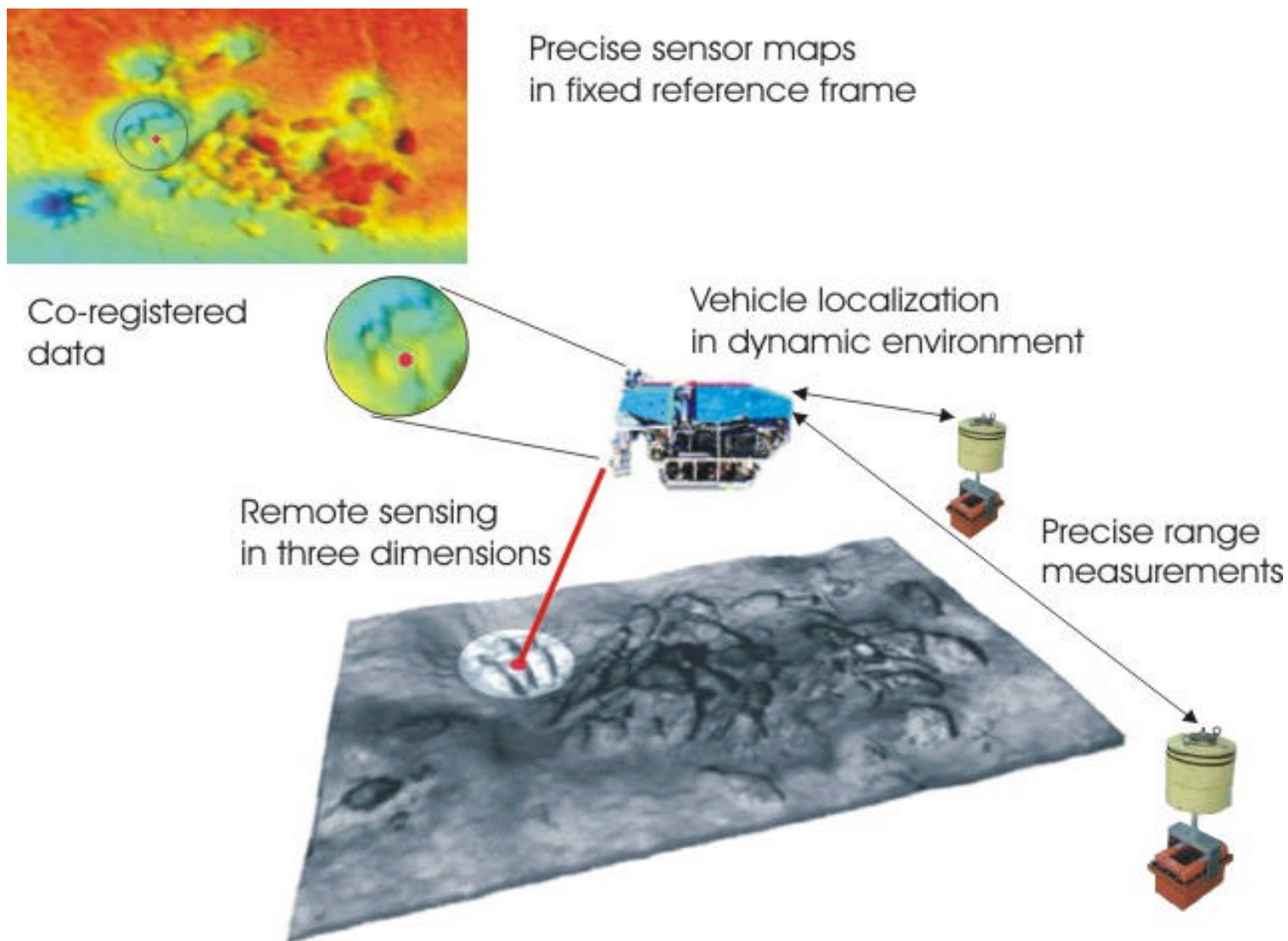


- Recovery of objects



- Preparation for Phase IV: Excavation

Inventing Precision



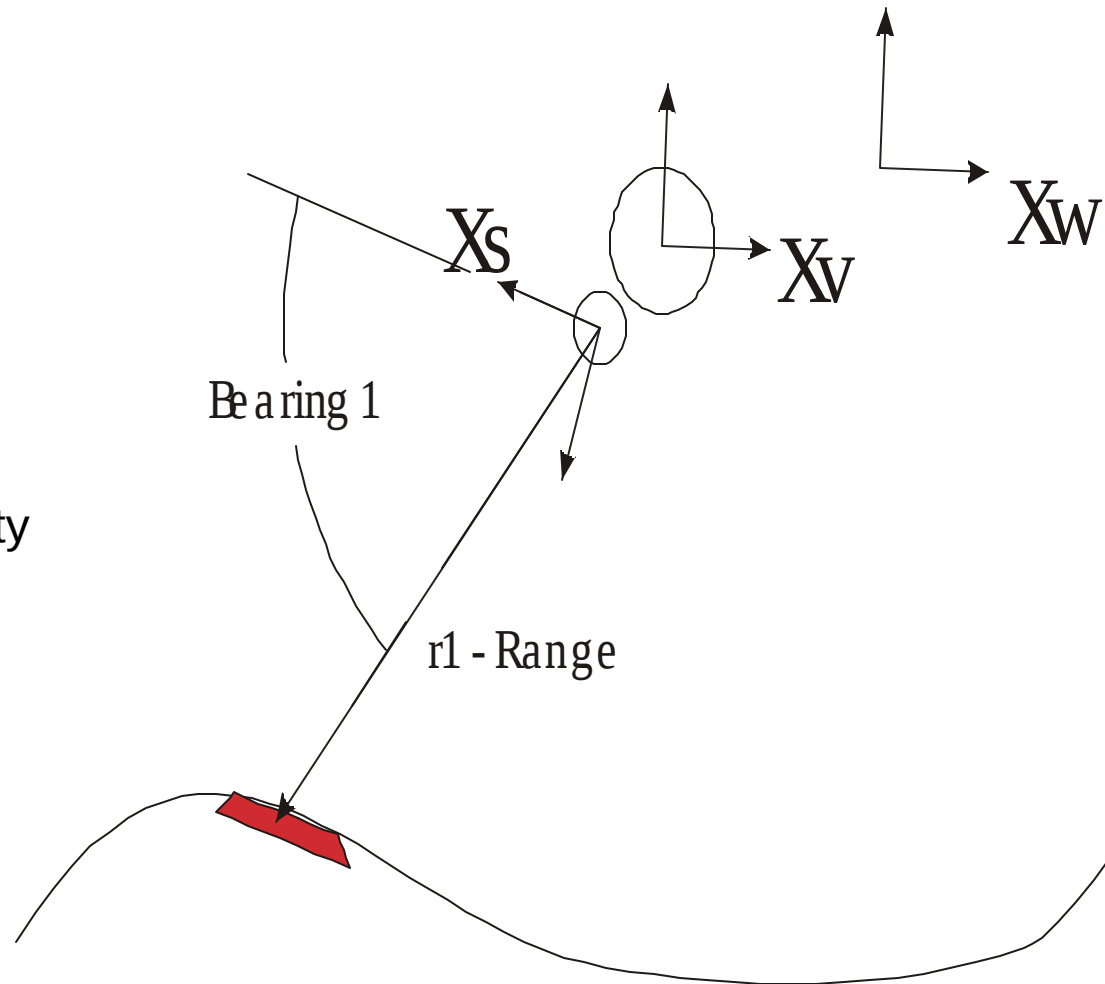
Uncertainty in Surveying

Uncertainty Sources

- Sensor
- Calibration
- Localization

Specifying Precision

- Balancing uncertainty
- System's viewpoint



Key Issues and Concepts

Sensors

- Fixed vs. relative
- Range, resolution, and update rate
- Redundant and complementary

Co-Registered Datasets

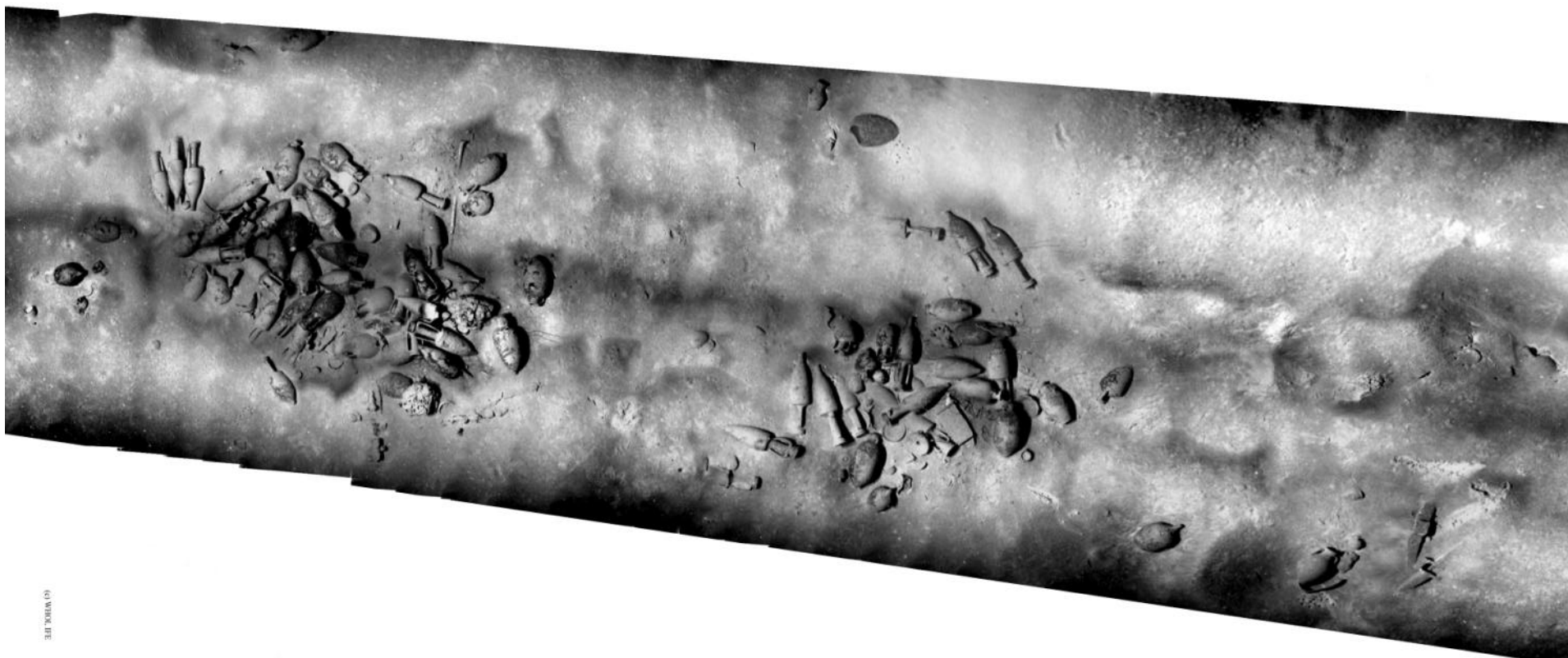
Navigation

- Localization
- Control
- Re-navigation

Autonomy and Robustness

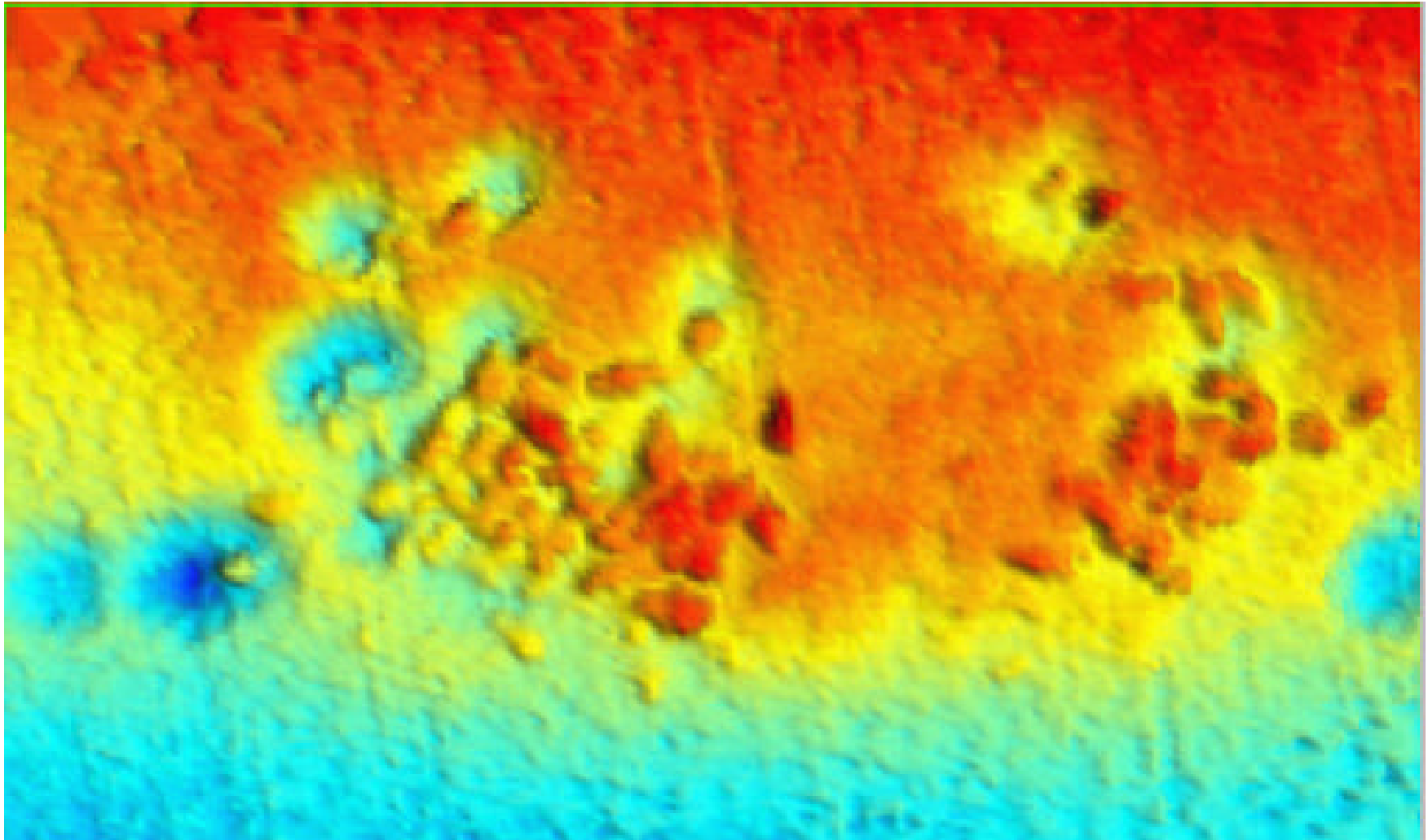


Images: Skerki D Photomosaic



GO WILD LIFE

Map: Skerki D Microbathymetry



Conclusions

Three stage model for deep-sea archaeology

- Increasing need for precision navigation at each stage

Specification for precision survey

- Image quality and map resolution

Precision navigation is essential to deep-sea archaeology



Acknowledgements

Deep Submergence Lab at Woods Hole Oceanographic:
Dana Yoerger, Hanumant Singh, Jonathan Howland, and
Louis Whitcomb

Robert Ballard, Dwight Coleman and the Institute For
Exploration

Marine Sonic Technology: Marty, Thom, and Pete Wilcox

Prof. David Mindell, MIT

