

Creatures of the Deep & “Treasure Maps” of the Ocean Floor

Dawn Wright
Esri Chief Scientist



Explornography [n.]

“The vicarious thrill of exploring when there is nothing left to explore”

(John Tierney, *New York Times*, July 26, 1998)



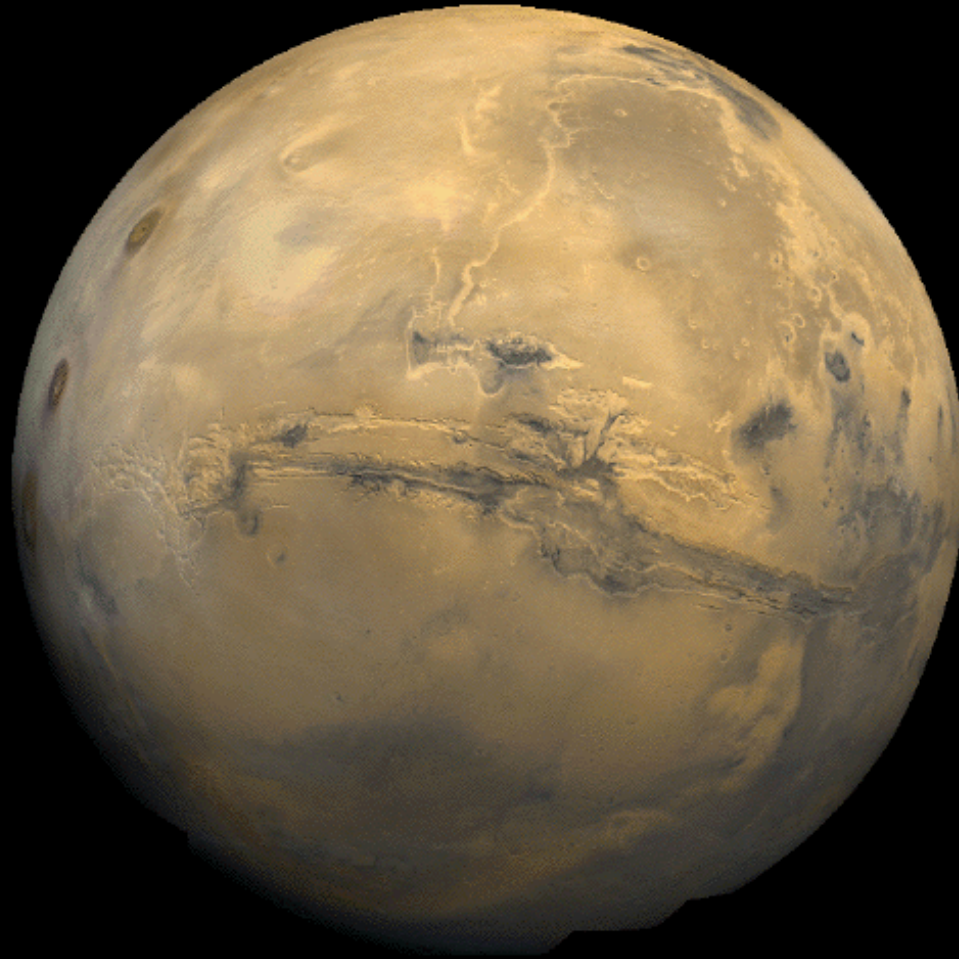


Image courtesy of the National Air and Space Museum

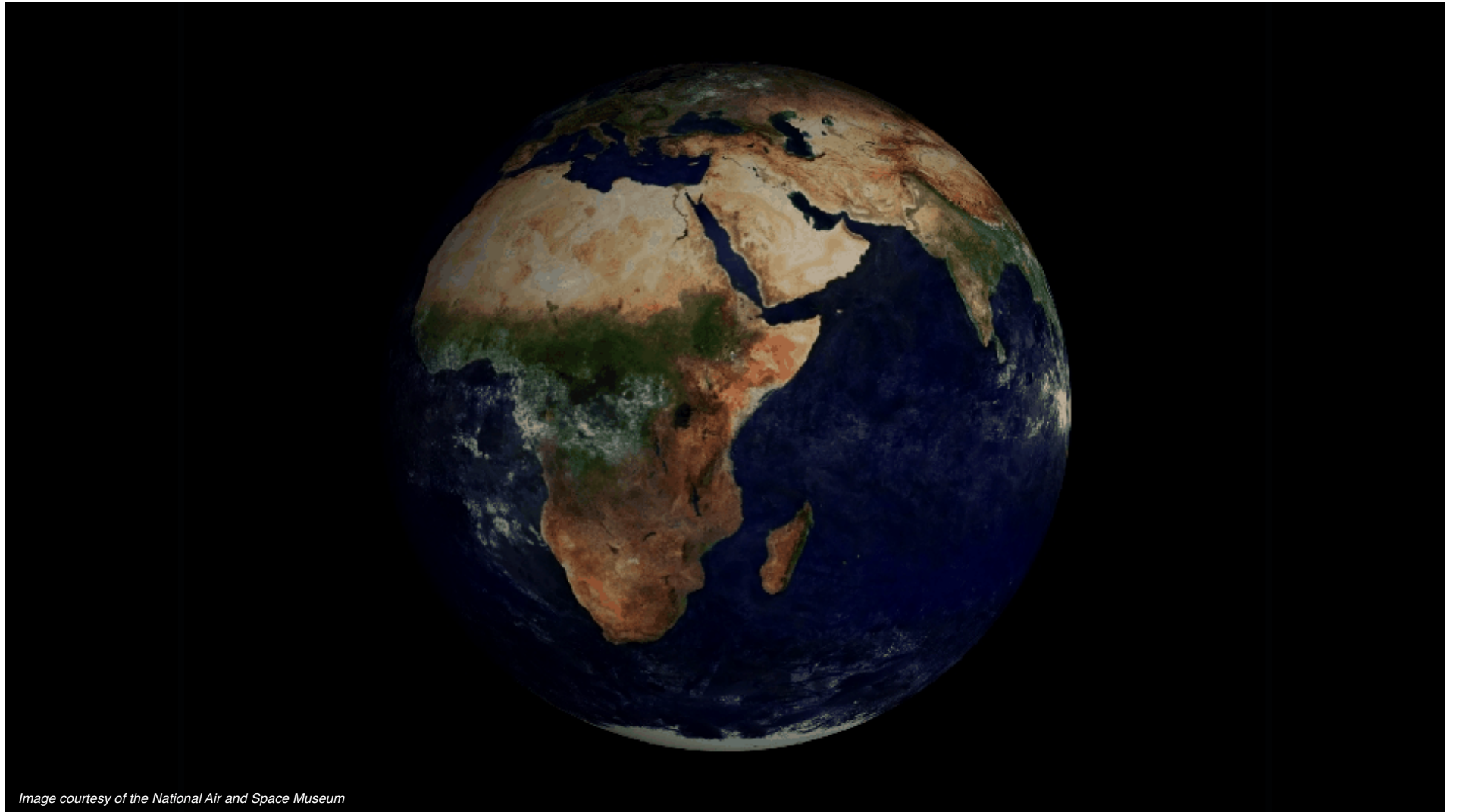


Image courtesy of the National Air and Space Museum

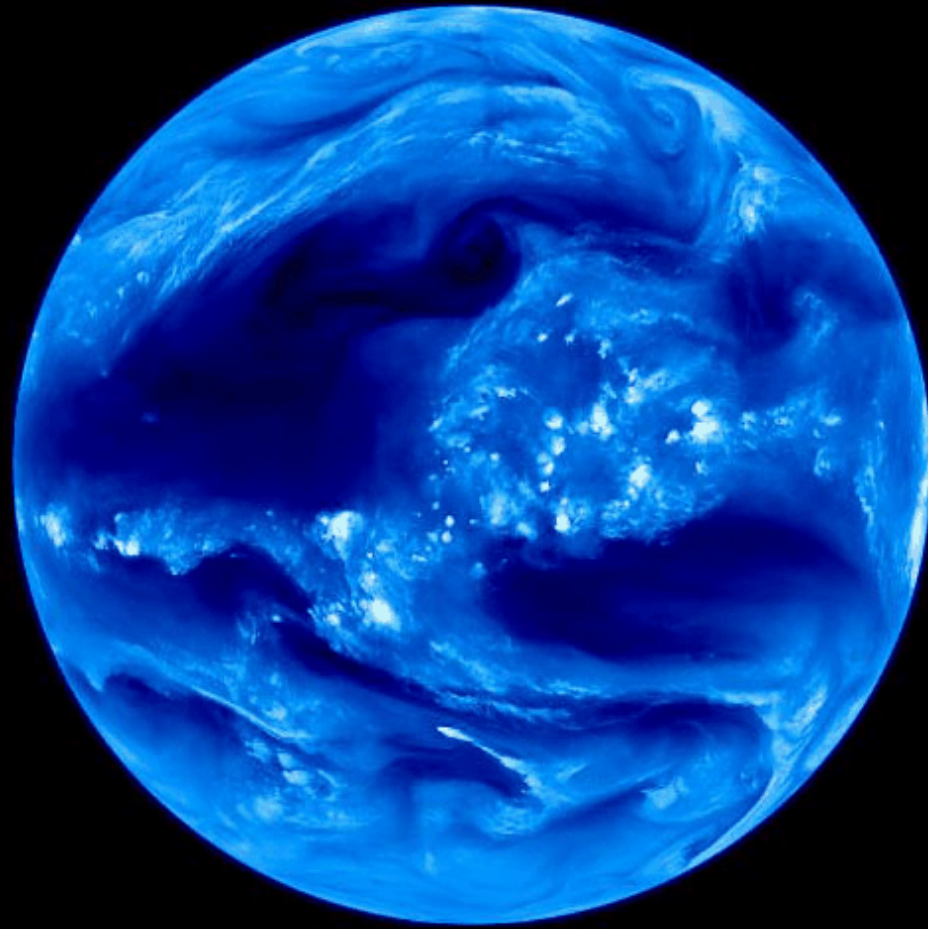


Image courtesy of the National Air and Space Museum

Movies

NASA Perpetual Ocean Movie

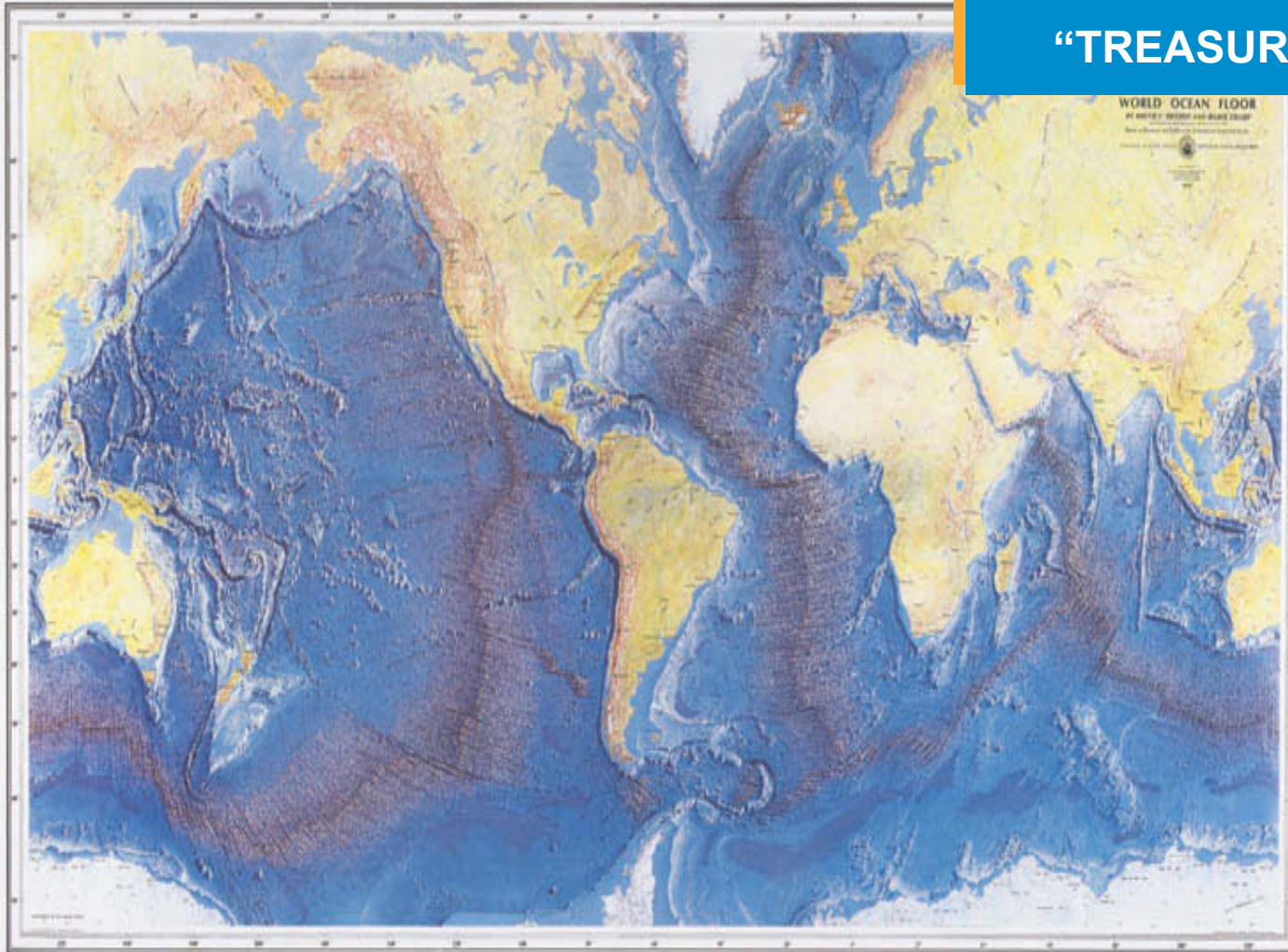
Tens of thousands of ocean currents are captured in this scientific visualization created by NASA's Goddard Space Flight Center in Greenbelt, Md. The visualization uses data from a model of global ocean circulation to create a simple, visceral experience. The animation clearly shows how bigger currents like the Gulf Stream in the Atlantic Ocean and the Kuroshio in the Pacific carry warm waters across thousands of miles at speeds greater than four miles per hour (6 kilometers per hour); how coastal currents such as the Agulhas in the Southern Hemisphere transport equatorial waters towards the Poles; and how thousands of other ocean currents are confined to particular regions and form slow-moving, circular pools called eddies, the storm systems of ocean circulation.

The visualization shows ocean surface currents for the June 2005 to December 2007 period. It was produced using a solution from the Estimating the Circulation and Climate of the Ocean (ECCO) project. ECCO is a joint project between the Massachusetts Institute of Technology (MIT) and NASA's Jet Propulsion Laboratory, Pasadena, Calif. ECCO uses the MIT general circulation model to synthesize satellite data into complete descriptions of the time-evolving ocean circulation.

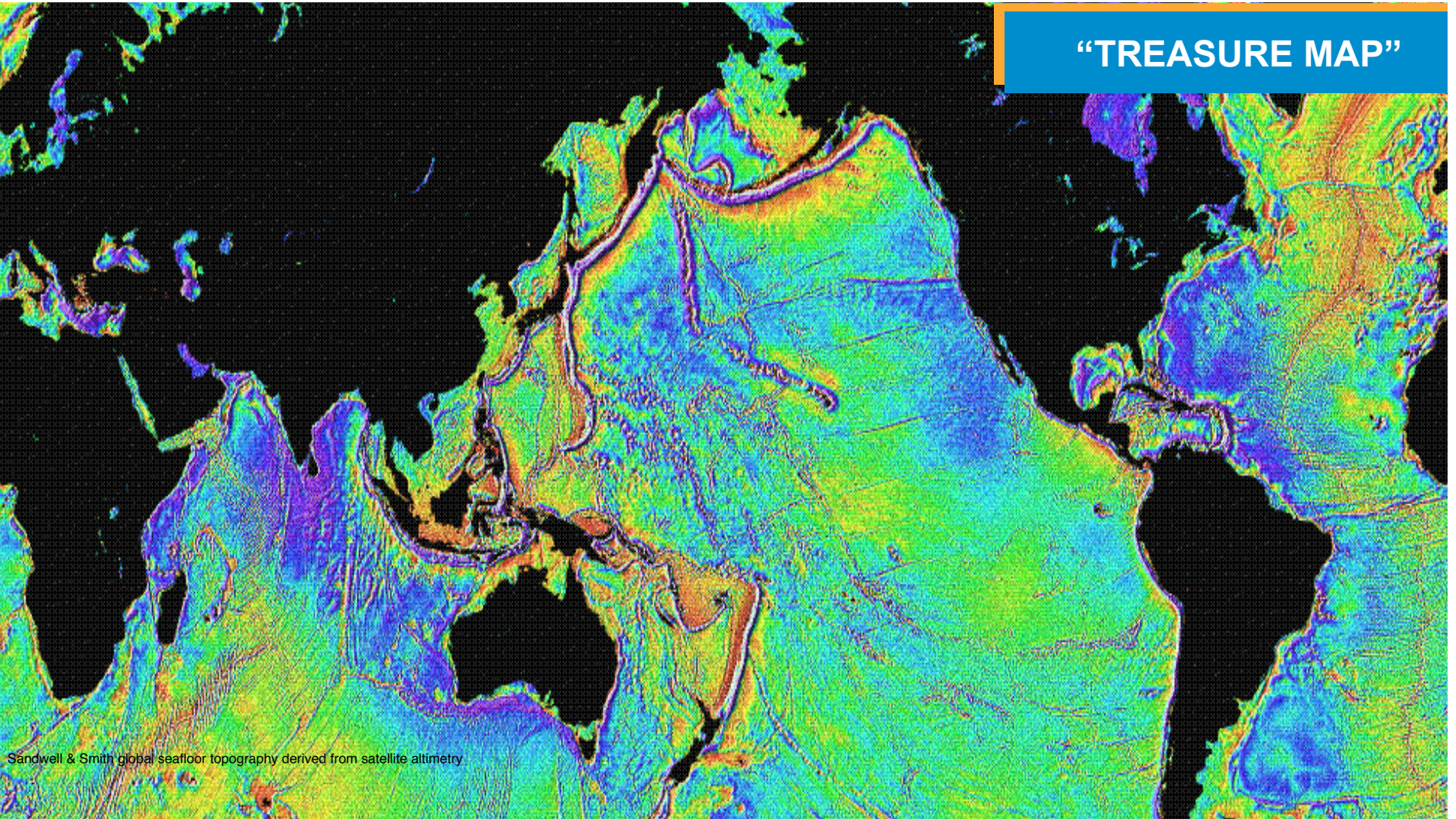
The following data are used by the ECCO project: sea surface height from NASA's Topex/Poseidon, Jason-1, and Ocean Surface Topography Mission (OSTM)/Jason-2 missions; gravity from the NASA/German Aerospace Center (DLR) Gravity Recovery and Climate Experiment (GRACE) mission; surface wind stress from NASA's QuikScat mission; sea surface temperature from the NASA/JAXA Advanced Microwave Scanning Radiometer-EOS (AMSR-E); sea ice concentration and velocity data from passive microwave radiometers; and temperature and salinity profiles from floats of the international Argo ocean observation system, from shipborne casts, and from moorings.

The ECCO model-data syntheses are among the largest computations of their kind ever undertaken. They are made possible by high-end computing resources provided by NASA's Ames Research Center, Moffett Field, Calif.

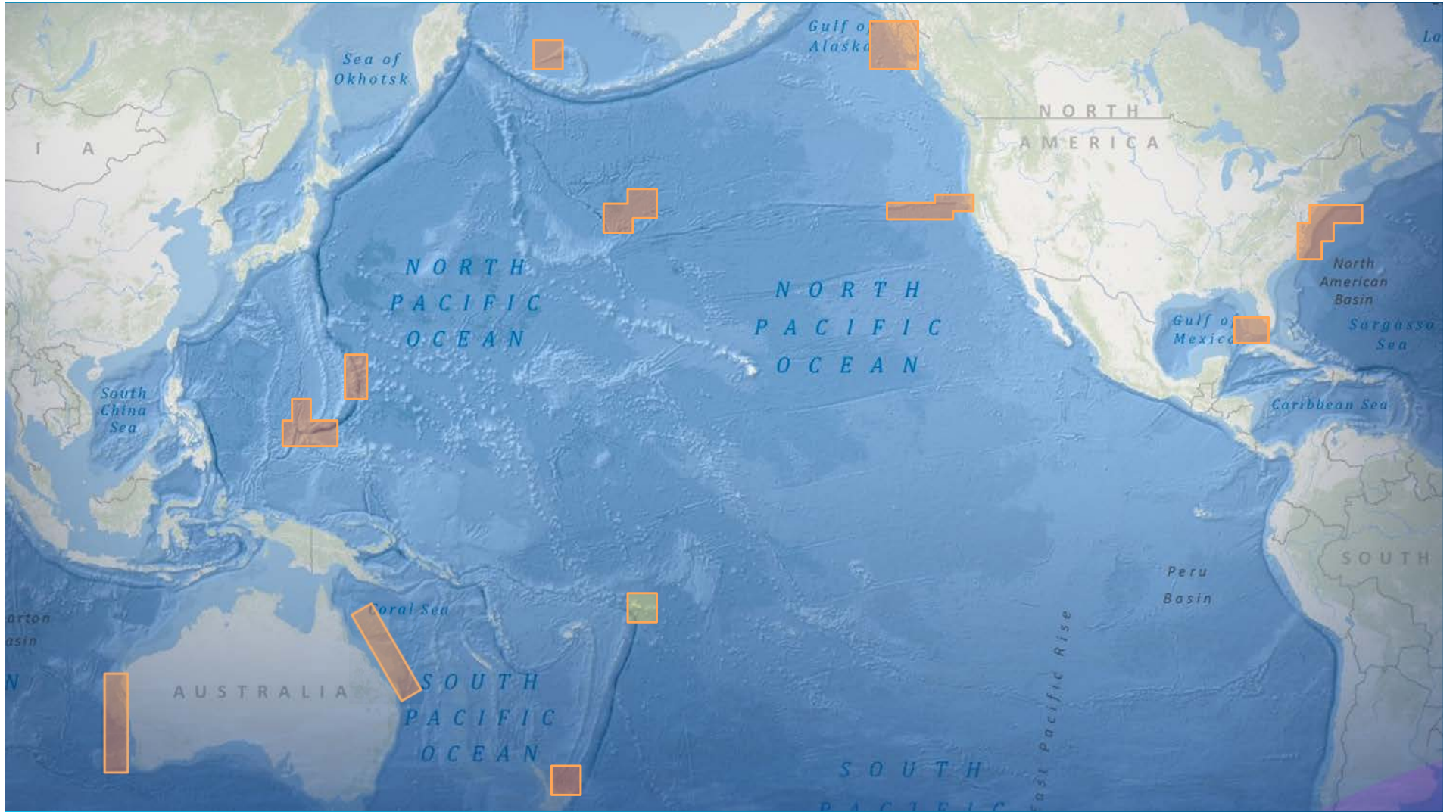
“TREASURE MAP”



“TREASURE MAP”

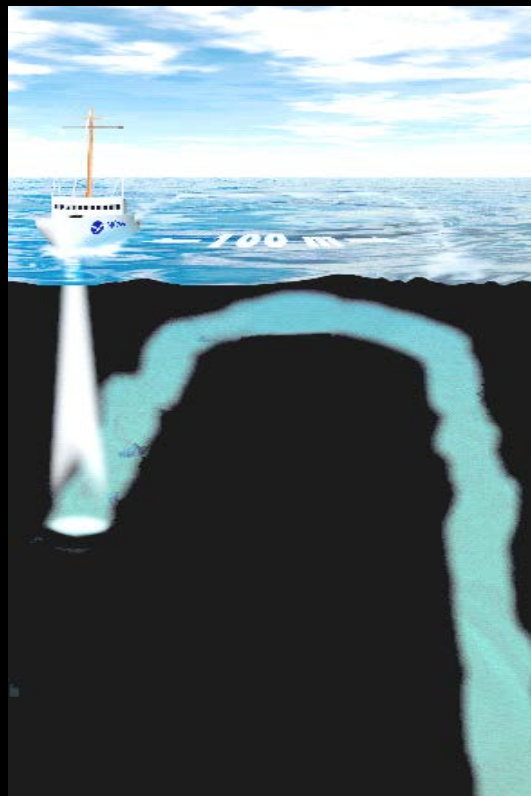


Sandwell & Smith global seafloor topography derived from satellite altimetry

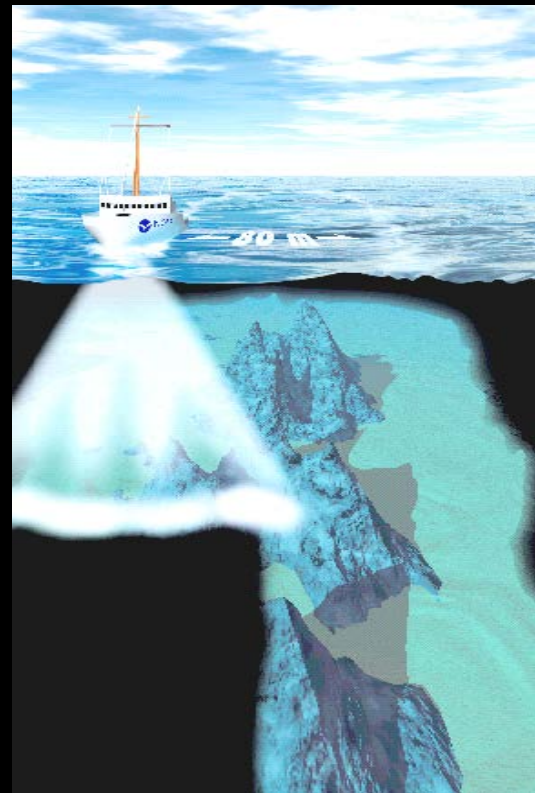


Seafloor Mapping

Single Beam

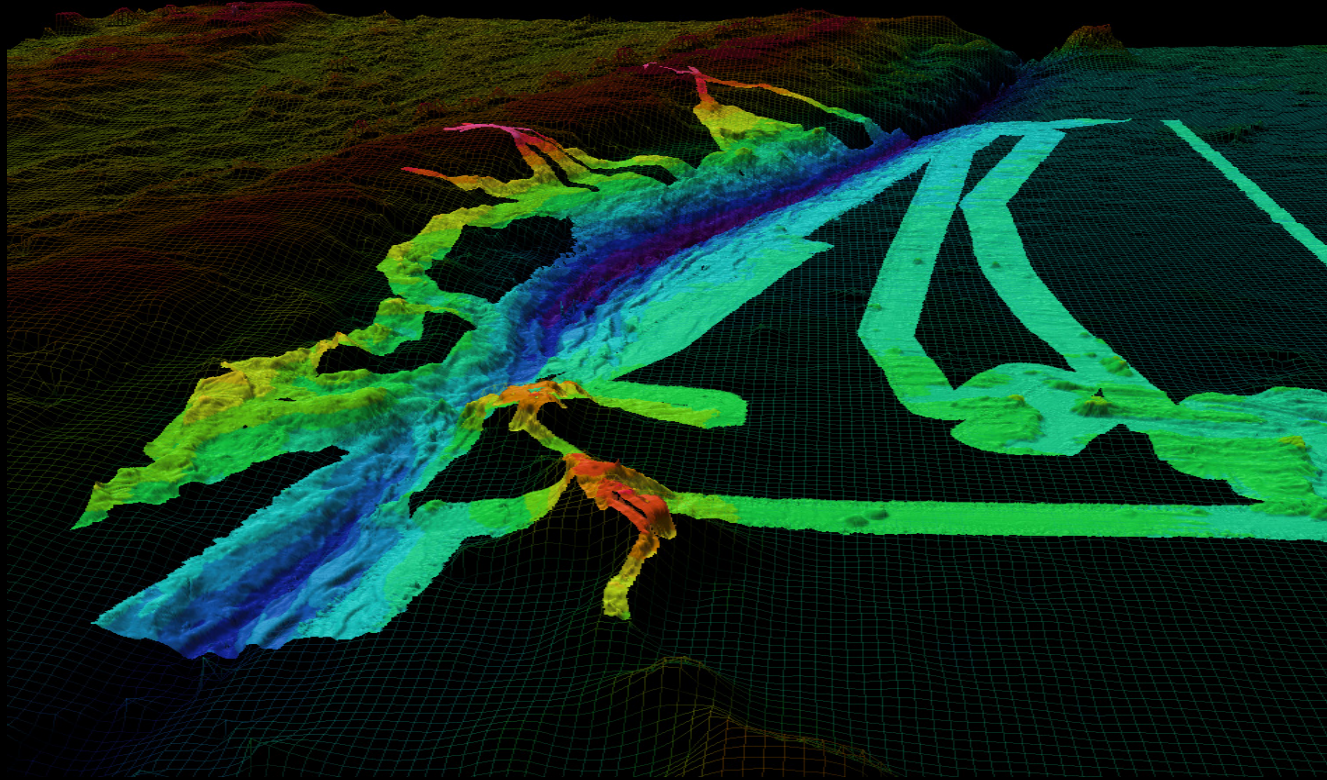


Multibeam

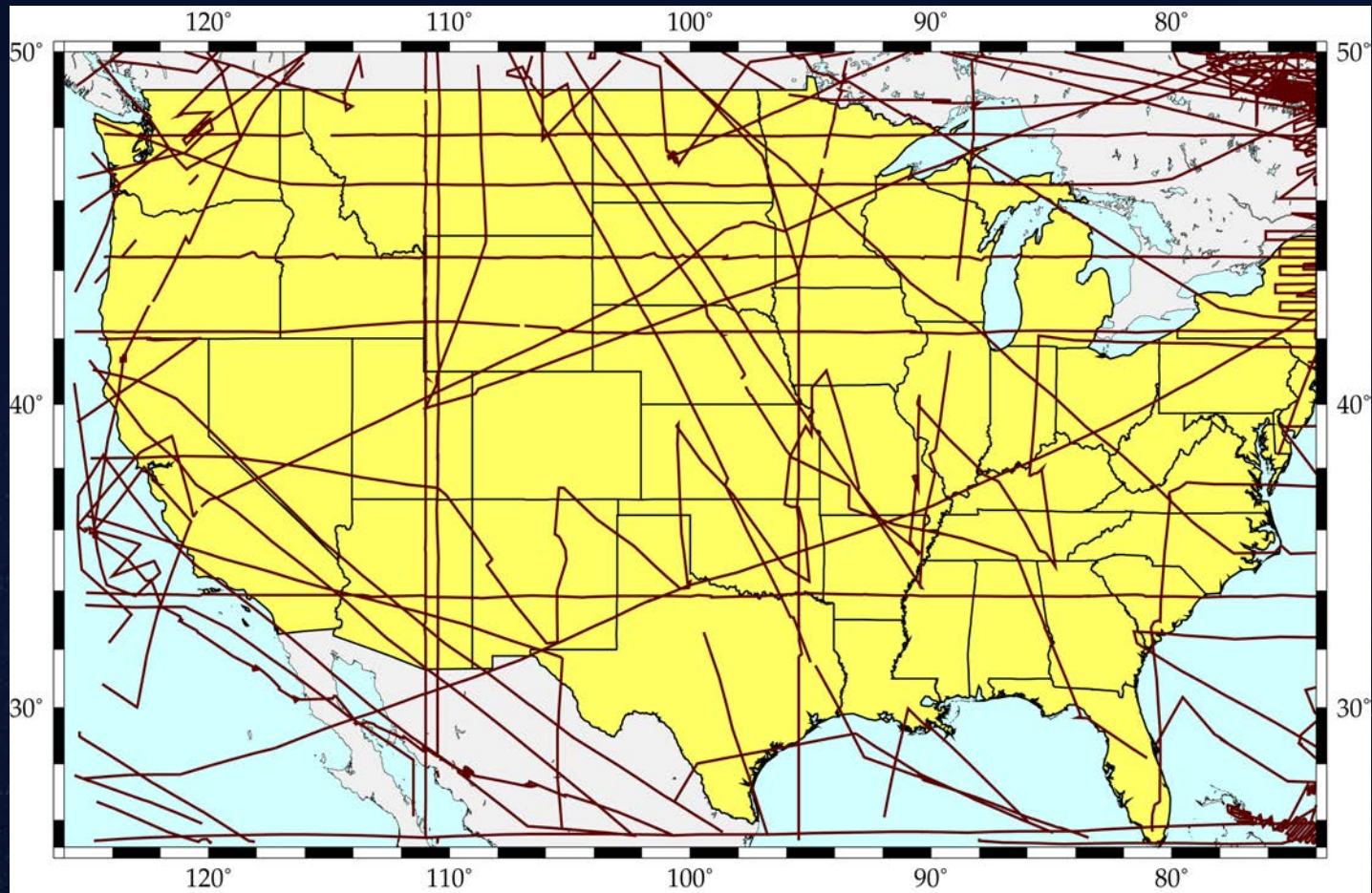


Images courtesy of NOAA and UNH

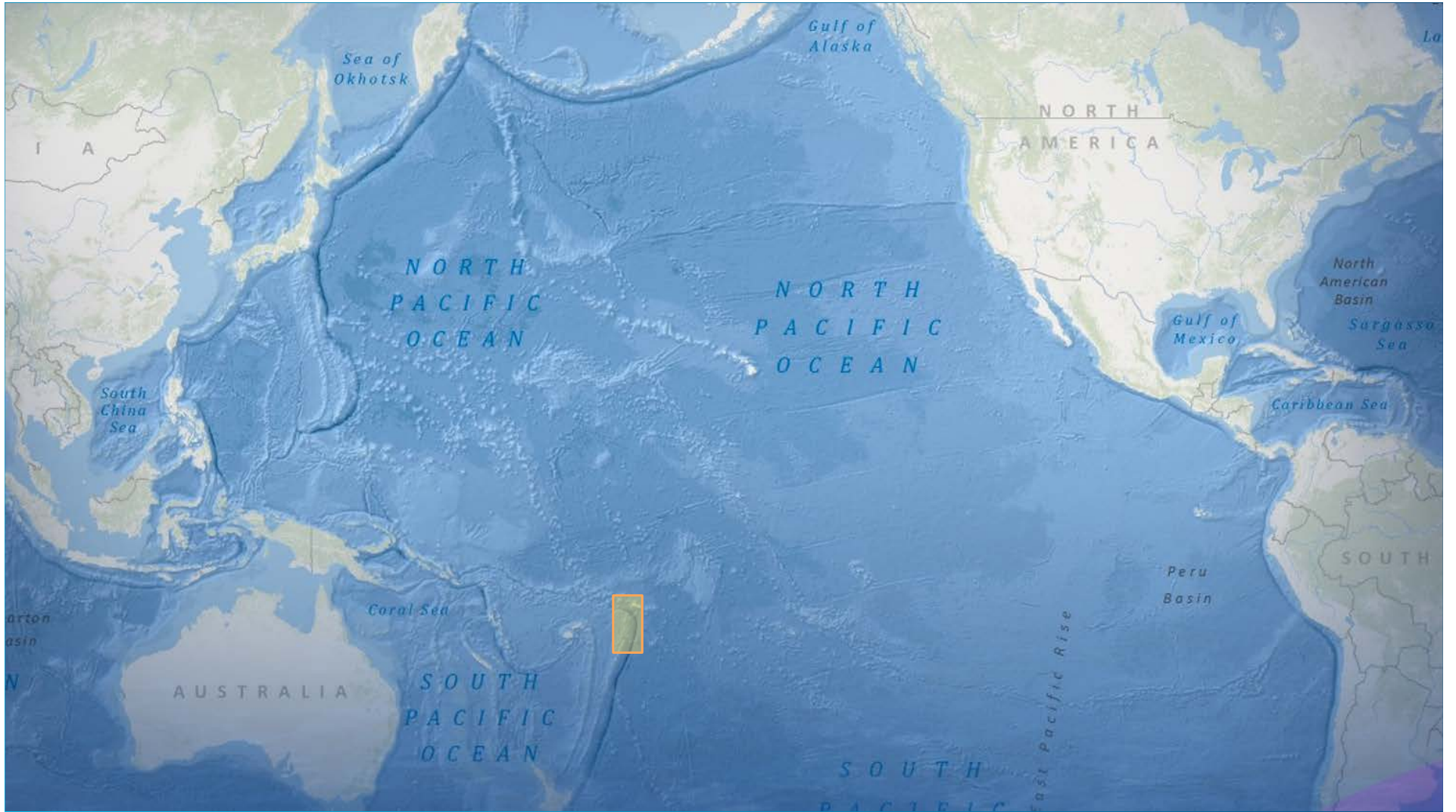
Only 5-15% of global seafloor charted with ships - “we need ~125 more years!” *



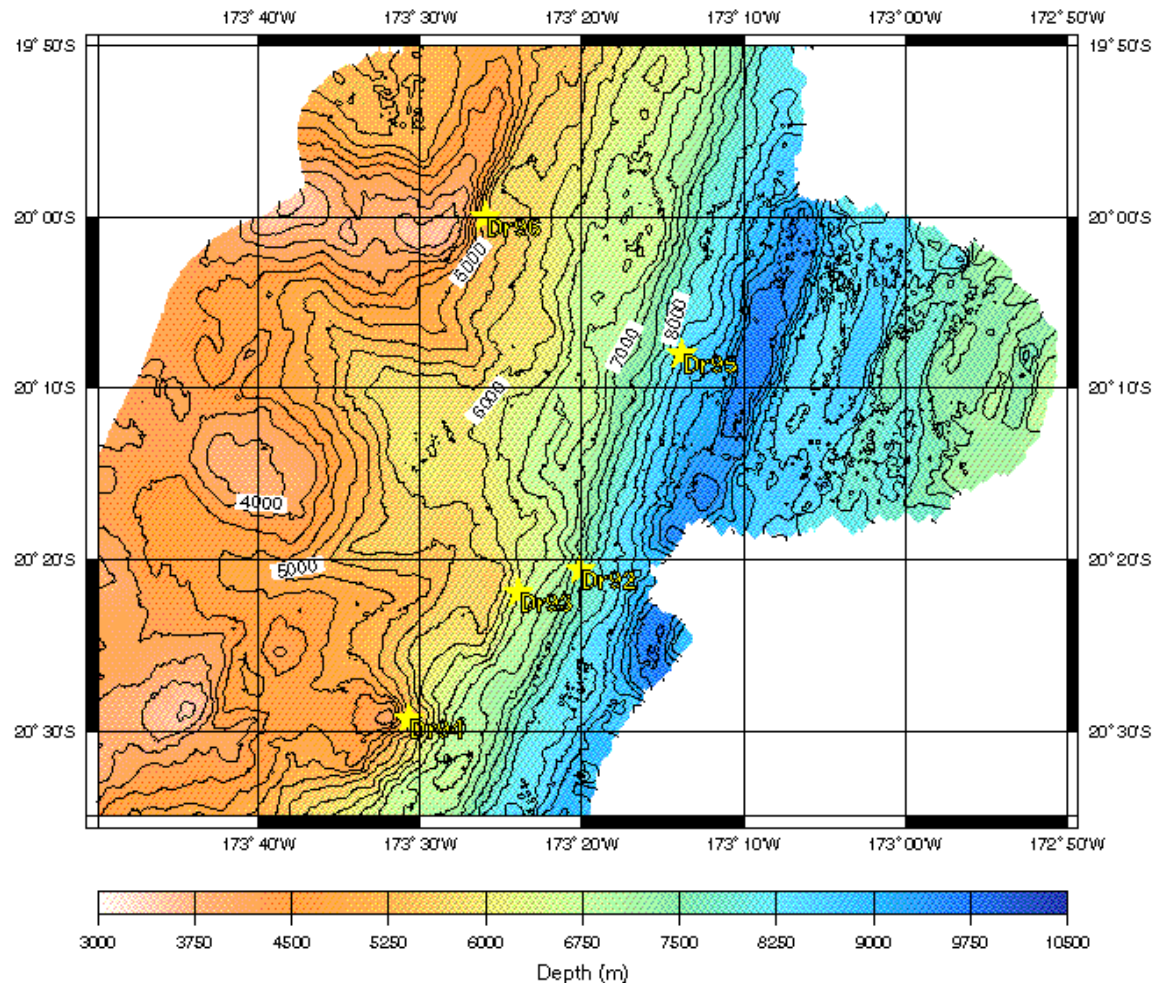
**Sandwell et al., 2003, Eos article
Graphic courtesy of Christina Massel, Steve Miller, Scripps Institution of Oceanography*

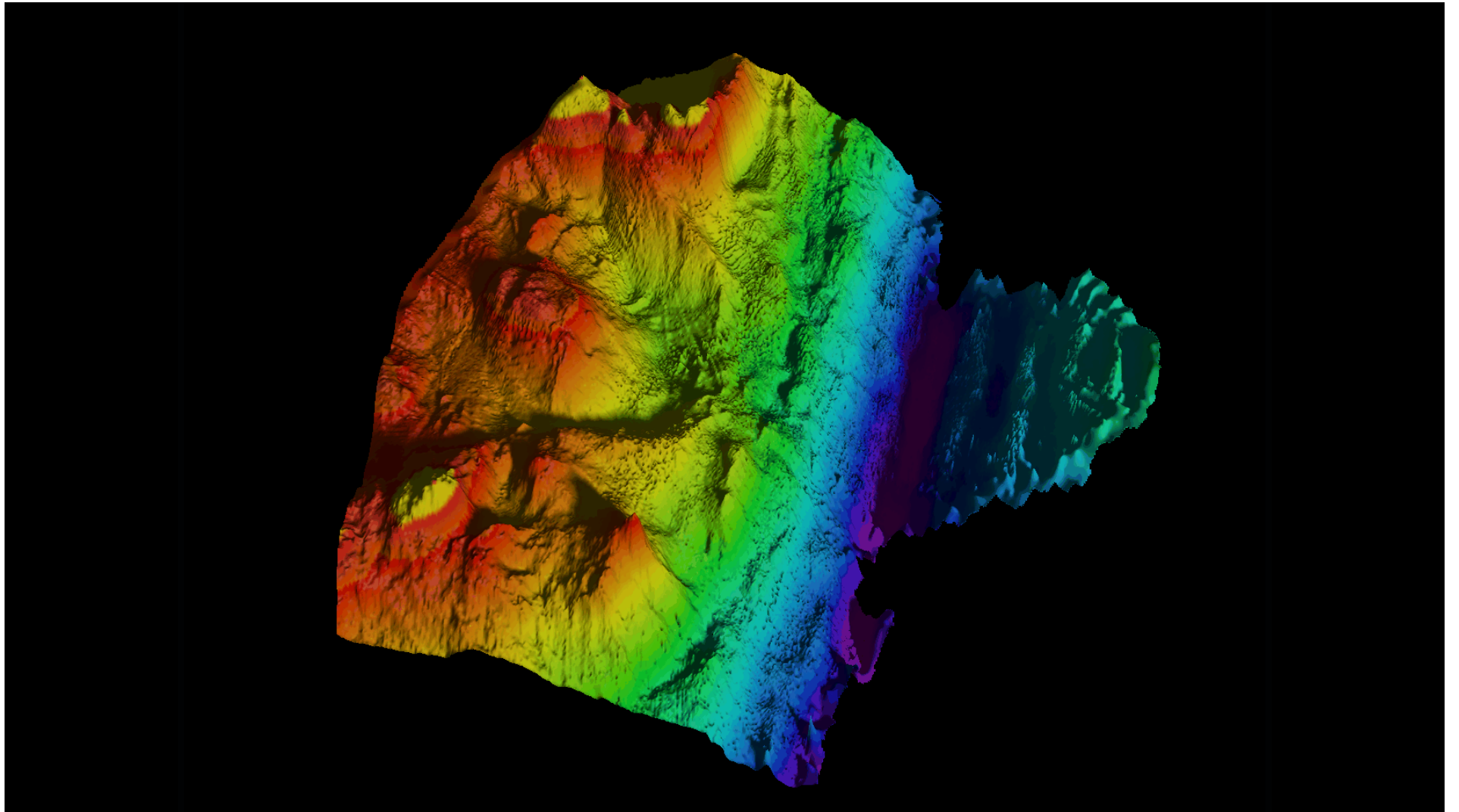


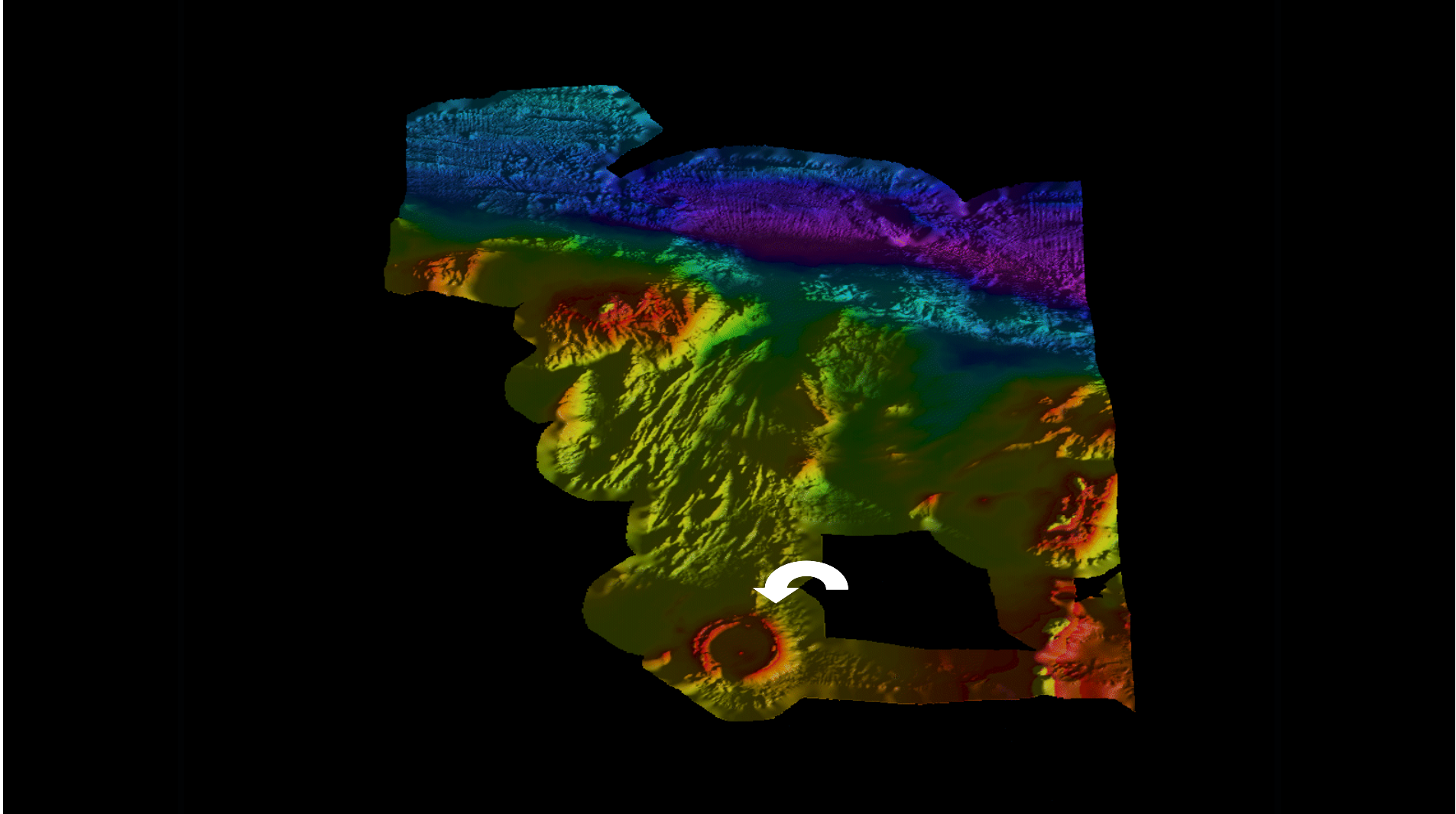
Slide courtesy of Dave Sandwell, Scripps Institution of Oceanography

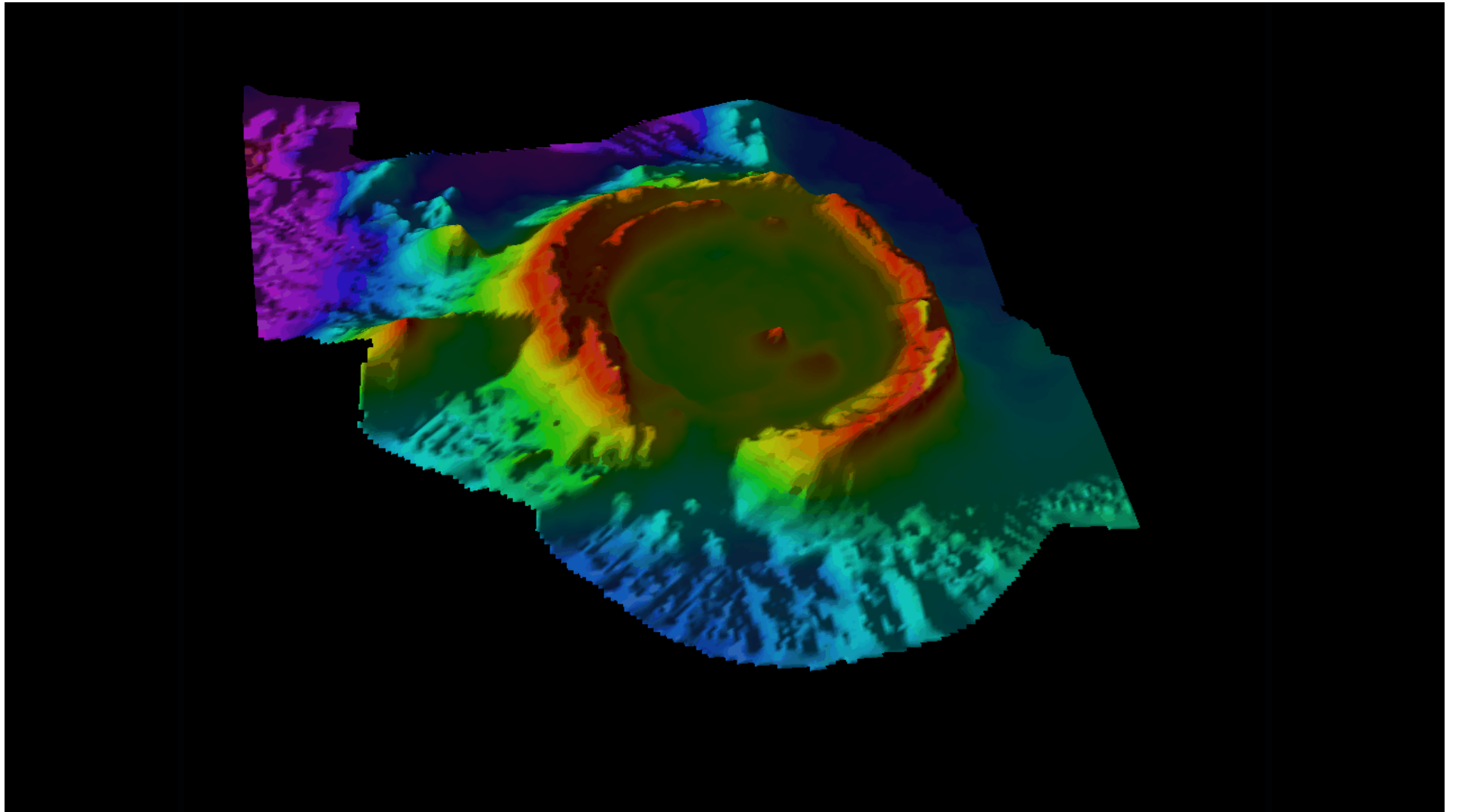


Survey at 20-20S - 250 m Contours - 200 m Bathymetry Grid

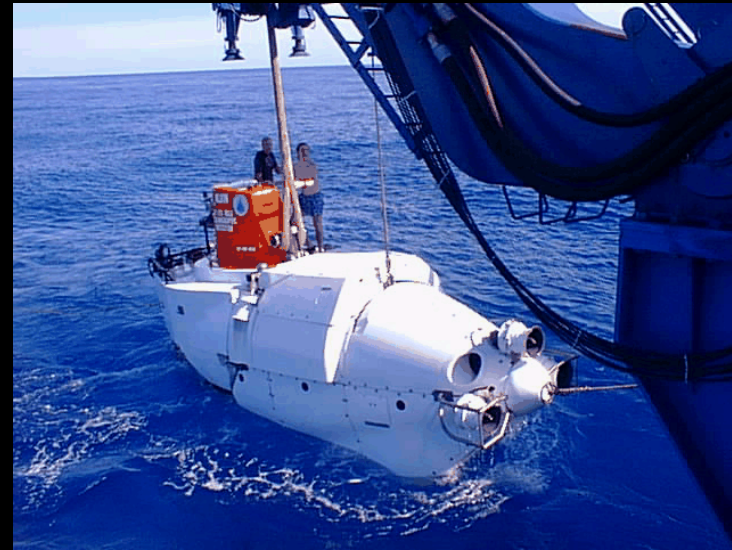
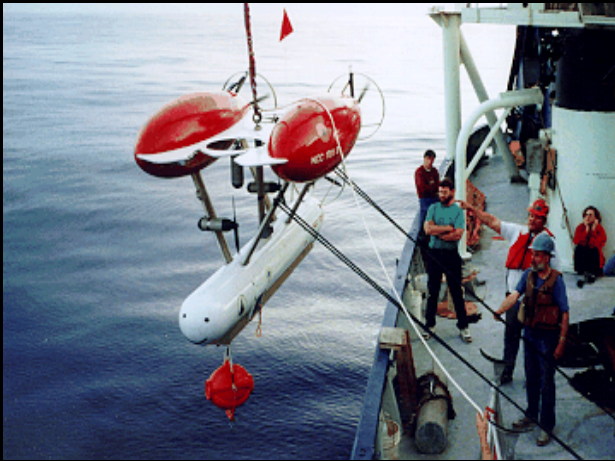








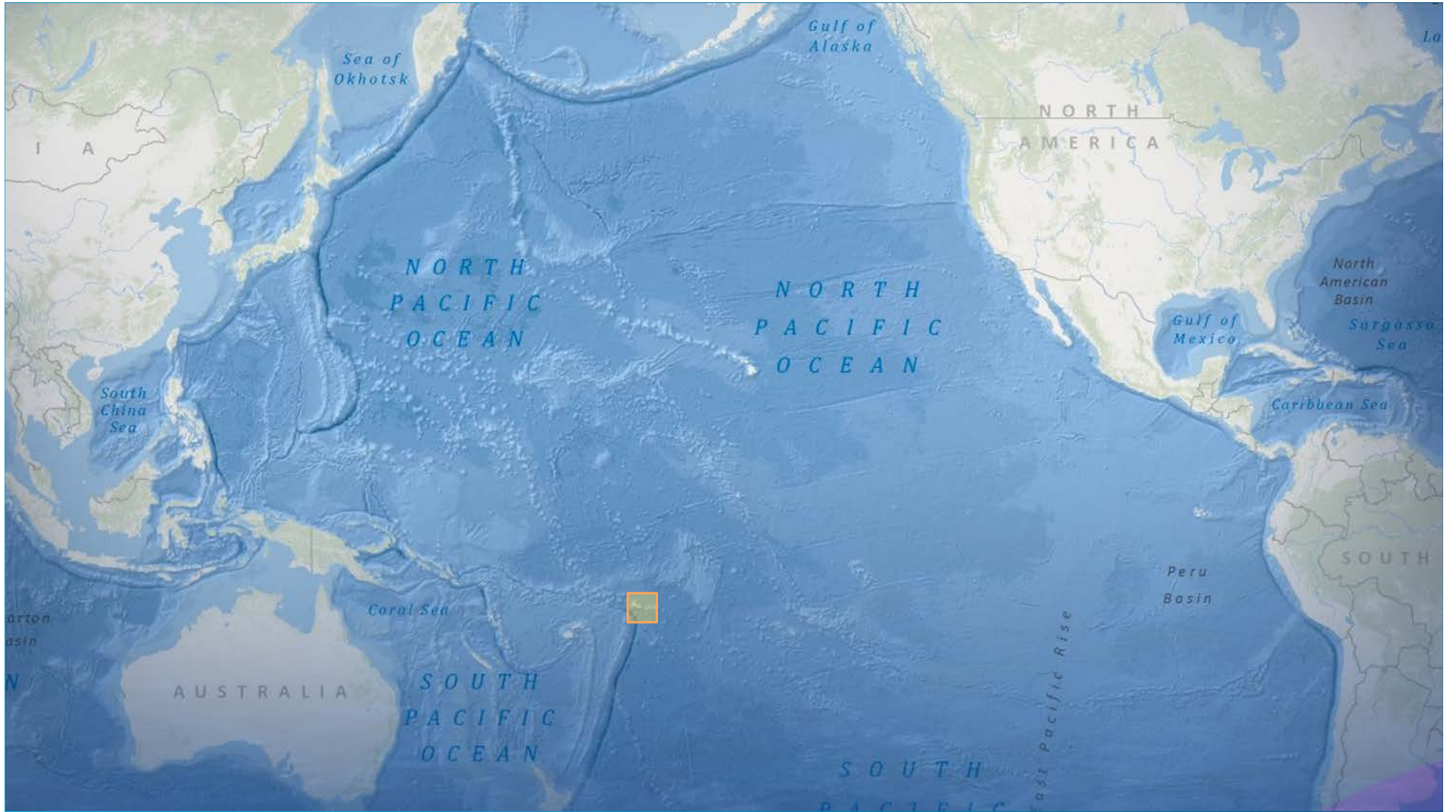
Fine Scale Mapping and Sampling

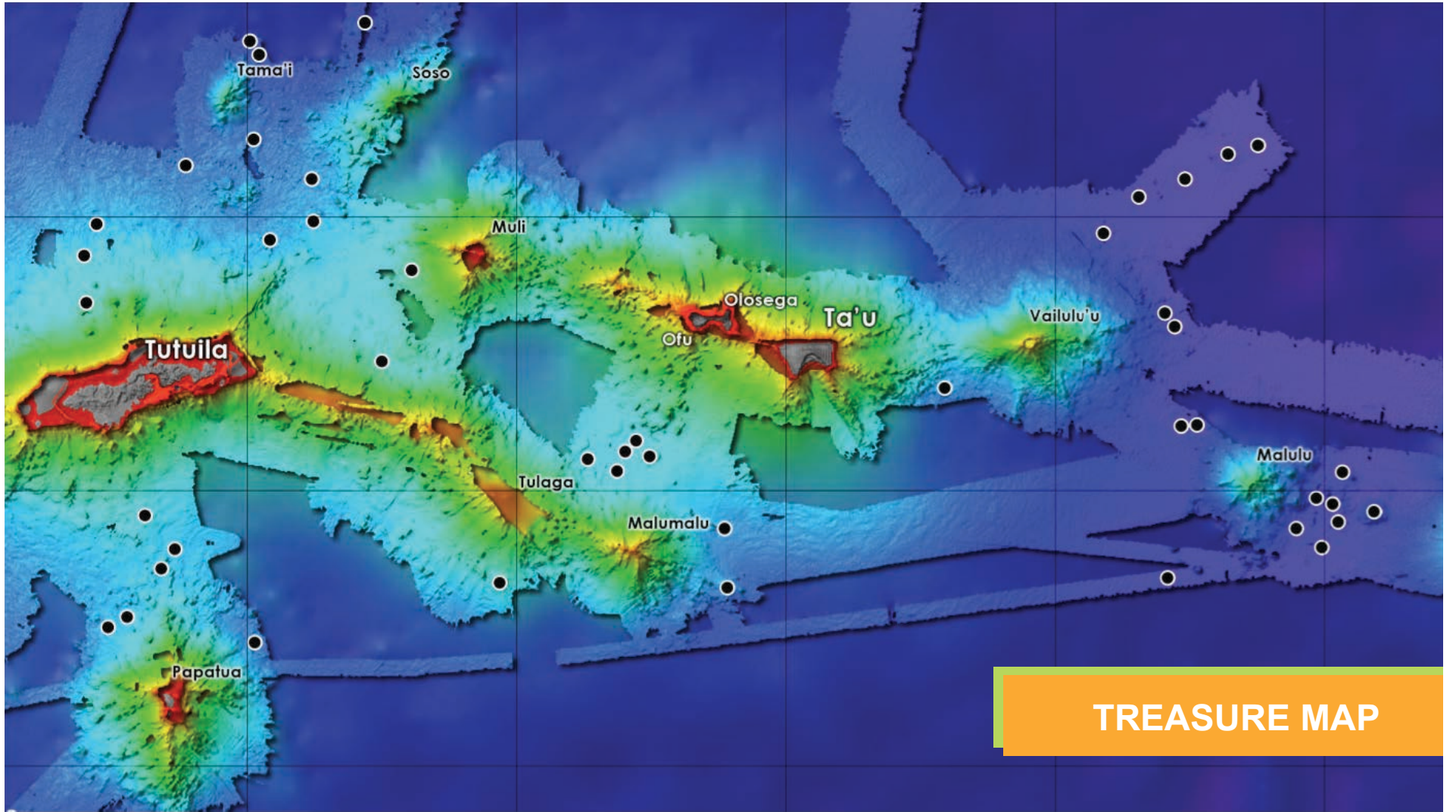


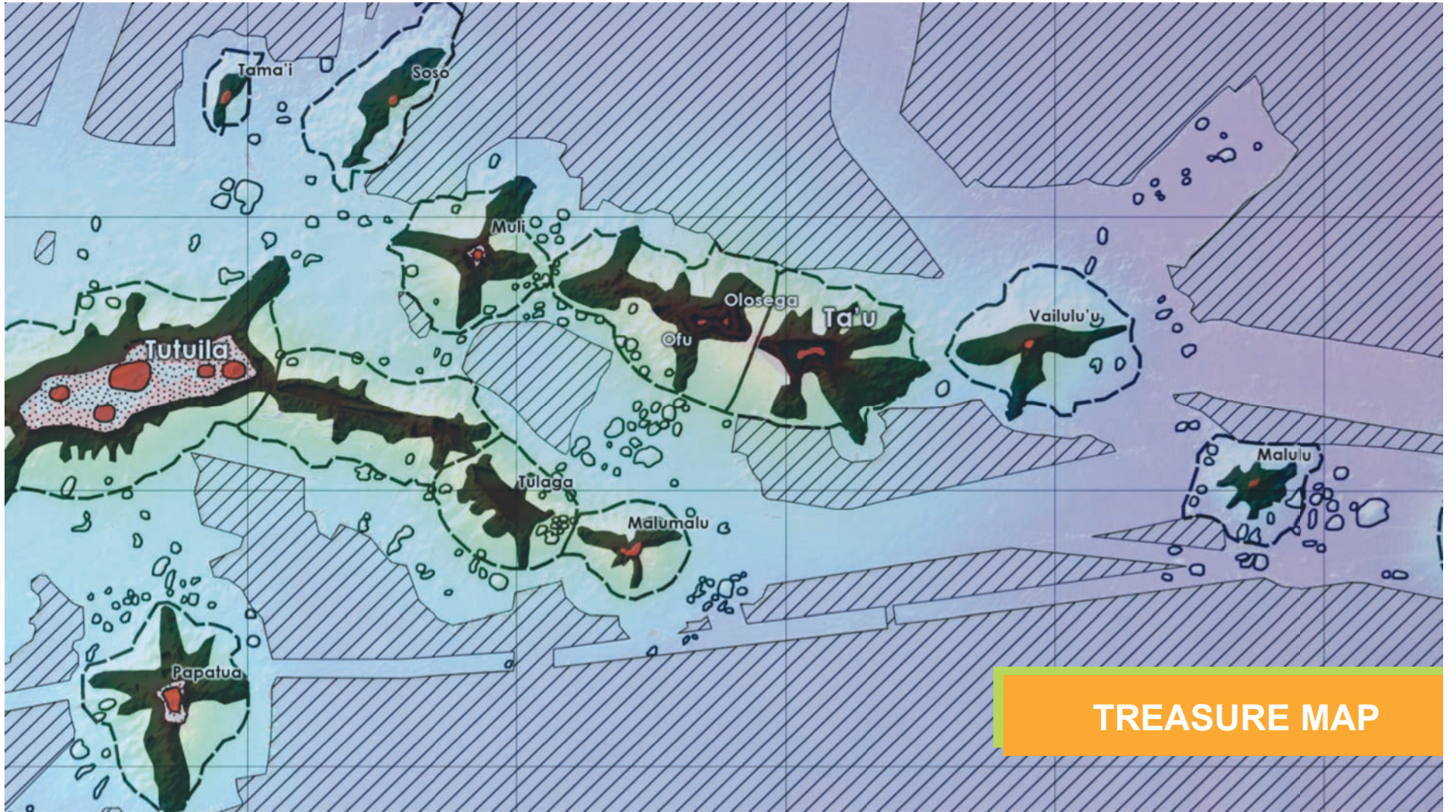
National Marine Sanctuaries



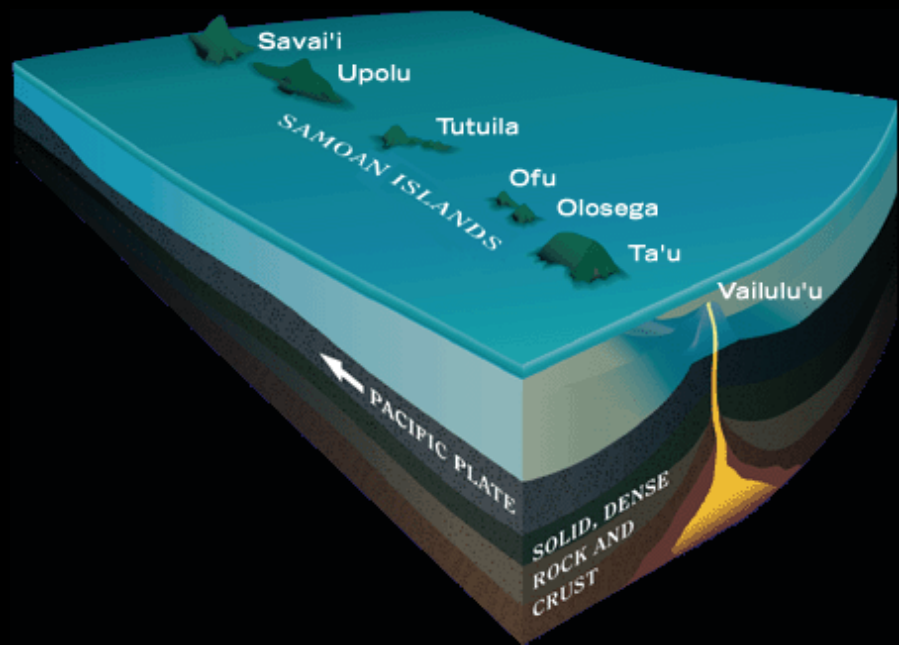
Map courtesy of NOAA National Marine Sanctuary System







TREASURE MAP



Artwork by Jayne Doucette, Woods Hole Oceanographic Institution

American Samoa Tutuila and Aunu'u



Courtesy: National Park Service



*Emily M. Larkin
Department of Geosciences
Oregon State University
June 1, 2003*



*Fagatele Bay
National Marine
Sanctuary*

Map by former Oregon State U. grad student Emily Larkin

National Marine Sanctuary of American Samoa

Natural & human impacts

- Crown-of-thorns invasion, hurricanes, bleaching
- Illegal fishing, sewage outfall



Photos courtesy of NOAA National Marine Sanctuary System

National Marine Sanctuary of American Samoa Research

- **Prior to 2001...**
 - Sanctuary largely unexplored below depths of ~30-60 m
 - no comprehensive documentation of the plants, animals, and submarine topography.
- **Little is known of tropical “twilight zone”**
 - shelf-edge (50-120 m deep) of coral reef habitats throughout the world
- **Best combination of terrain analysis techniques?**
- **Extension of satellite-based scheme**
 - What is a viable classification acoustically?

Benthic Habitats of American Samoa

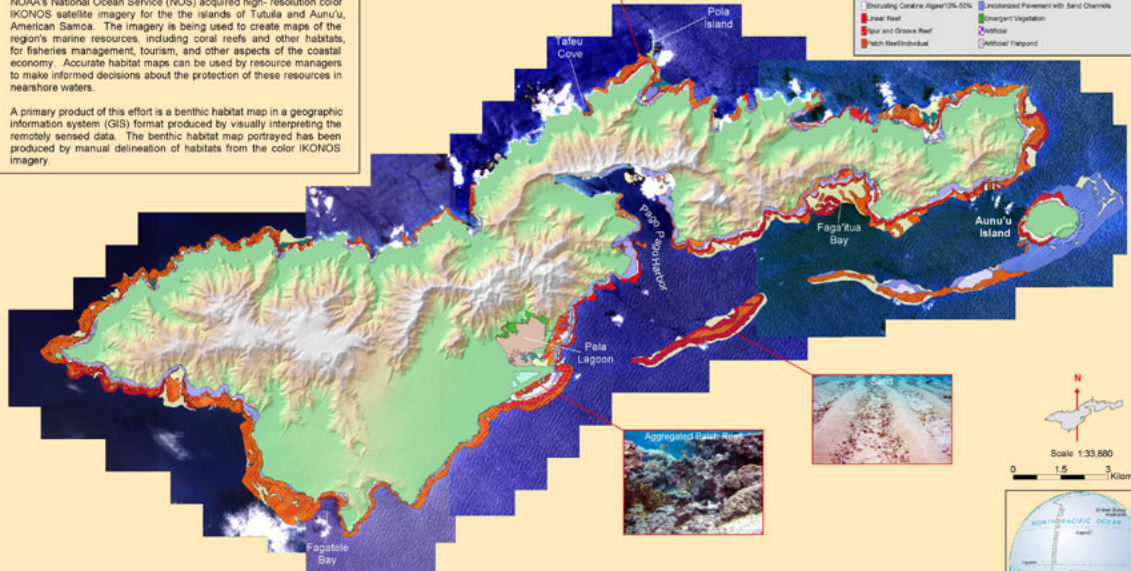
Products Derived for Tutuila and Aunu'u Islands from IKONOS Satellite Imagery

Benthic Habitat Mapping

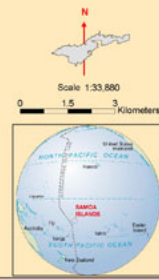
This draft benthic habitat map was developed by the American Samoa mapping team. The team includes staff from the American Samoa Government (Department of Marine and Wildlife Resources, Environmental Protection Agency, Department of Commerce), the National Oceanic and Atmospheric Administration's (NOAA) Fagatele Bay National Marine Sanctuary, the National Ocean Service, the Department of Interior's National Park of American Samoa, and Analytical Laboratories of Hawaii.

NOAA's National Ocean Service (NOS) acquired high-resolution color IKONOS satellite imagery for the islands of Tutuila and Aunu'u, American Samoa. The imagery is being used to create maps of the region's marine resources, including coral reefs and other habitats, for fisheries management, tourism, and other aspects of the coastal economy. Accurate habitat maps can be used by resource managers to make informed decisions about the protection of these resources in nearshore waters.

A primary product of this effort is a benthic habitat map in a geographic information system (GIS) format produced by visually interpreting the remotely sensed data. The benthic habitat map portrayal has been produced by manual delineation of habitats from the color IKONOS imagery.



Benthic Habitat Classification Scheme	
Land	Dark Blue
Seagrass 90%-100%	Light Green
Seagrass 70%-90%	Medium Green
Seagrass 50%-70%	Dark Green
Seagrass 30%-50%	Light Yellow
Seagrass 10%-30%	Yellow
Nonseagrass 90%-100%	Light Blue
Nonseagrass 70%-90%	Medium Blue
Nonseagrass 50%-70%	Dark Blue
Nonseagrass 30%-50%	Very Dark Blue
Nonseagrass 10%-30%	Black
Colonized Pavement	Orange
Colonized Volcanic Rock/Islands	Red
Colonized Pavement with Sand Channels	Light Orange
Uncolonized Pavement	Yellow-Orange
Reef Rubble	Light Blue
Including Corals Algae 90%-100%	Dark Blue
Including Corals Algae 70%-90%	Medium Blue
Including Corals Algae 50%-70%	Light Blue
Including Corals Algae 30%-50%	Very Light Blue
Uncolonized Volcanic Rock/Islands	Dark Blue
Uncolonized Pavement with Sand Channels	Light Blue
Emergent Vegetation	Green
Artificial	White
Artificial Fillground	Light Blue
Dark Blue	Dark Blue
Light Blue	Light Blue
Medium Blue	Medium Blue
Dark Blue	Dark Blue
Very Dark Blue	Very Dark Blue
Black	Black
Orange	Orange
Light Orange	Light Orange
Yellow-Orange	Yellow-Orange
Light Blue	Light Blue
Medium Blue	Medium Blue
Dark Blue	Dark Blue
Very Dark Blue	Very Dark Blue
Black	Black



NOAA Center for Coastal Monitoring and Assessment
<http://biogeo.noaa.gov>



Map courtesy of NOAA Center for Coastal Monitoring and Assessment

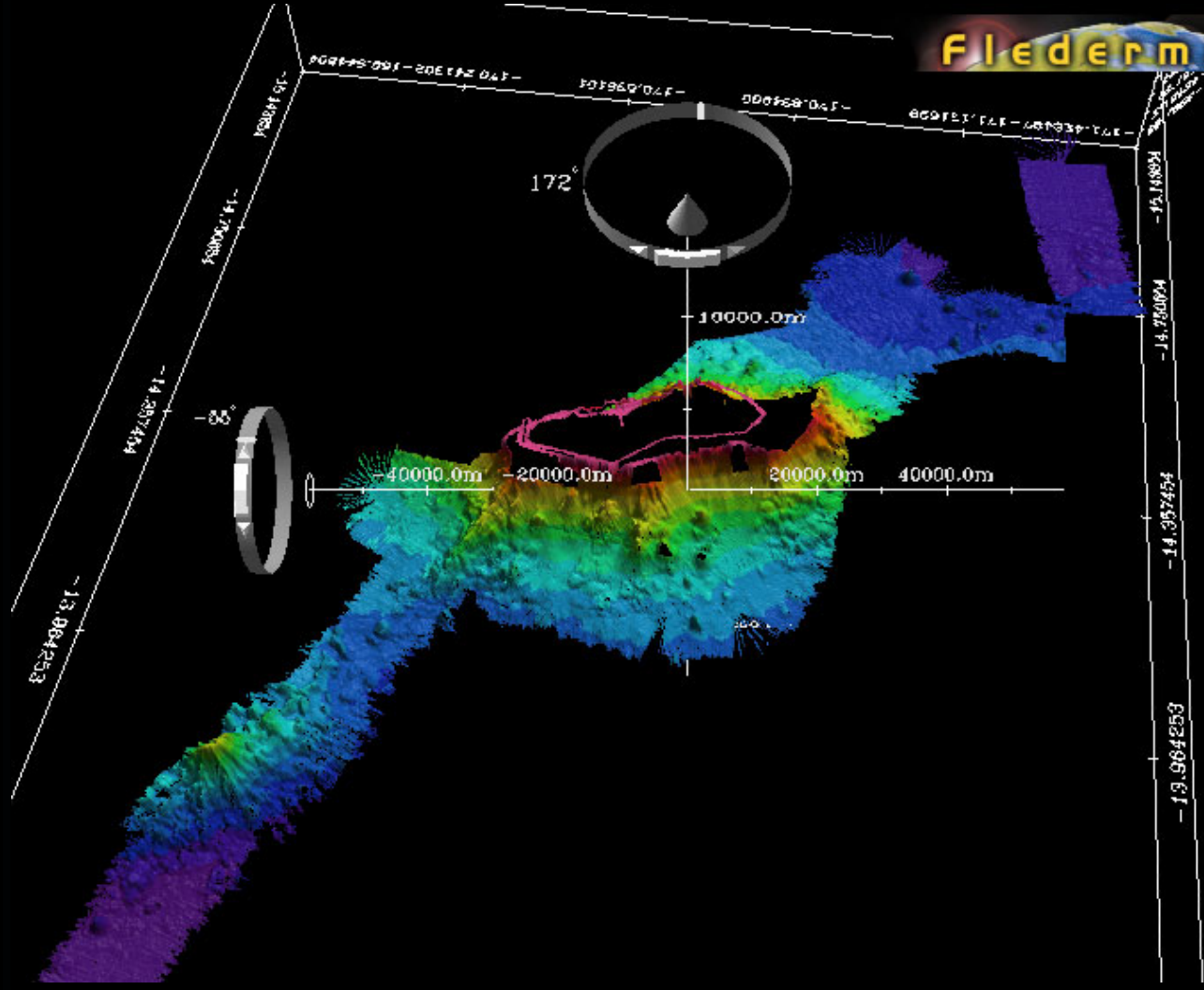
American Samoa Tutuila and Aunu'u



Courtesy: National Park Service



*Emily M. Larkin
Department of Geosciences
Oregon State University
June 1, 2003*



American Samoa

Tutuila and Aunu'u



Courtesy: National Park Service



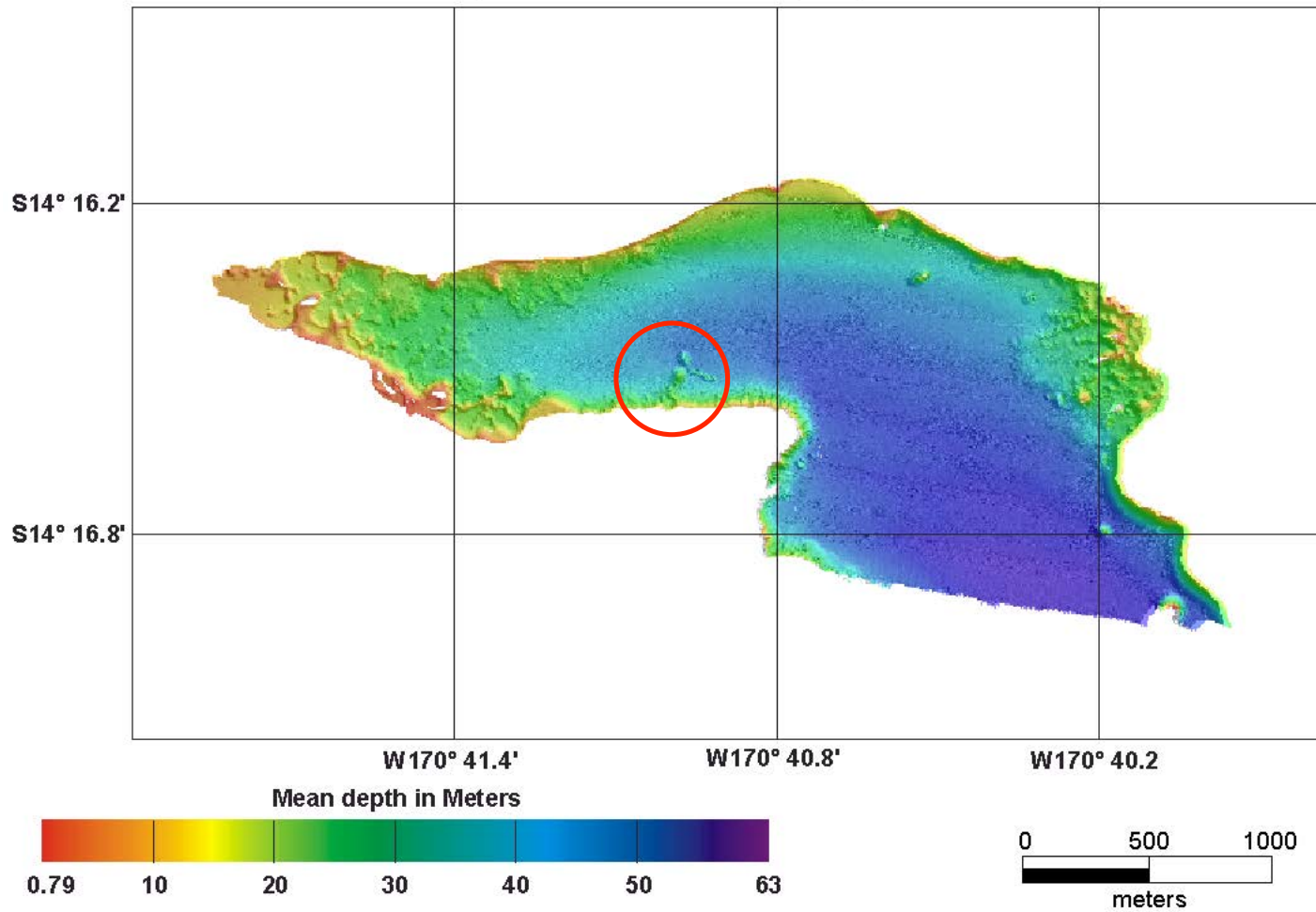
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* NOT FOR NAVIGATION

Pago Pago Harbor, American Samoa

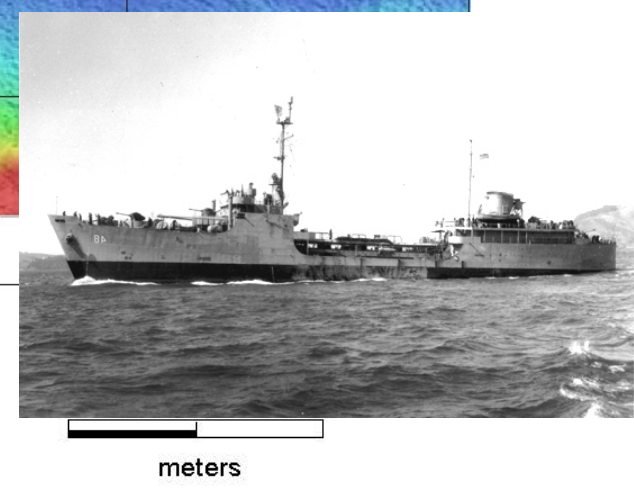
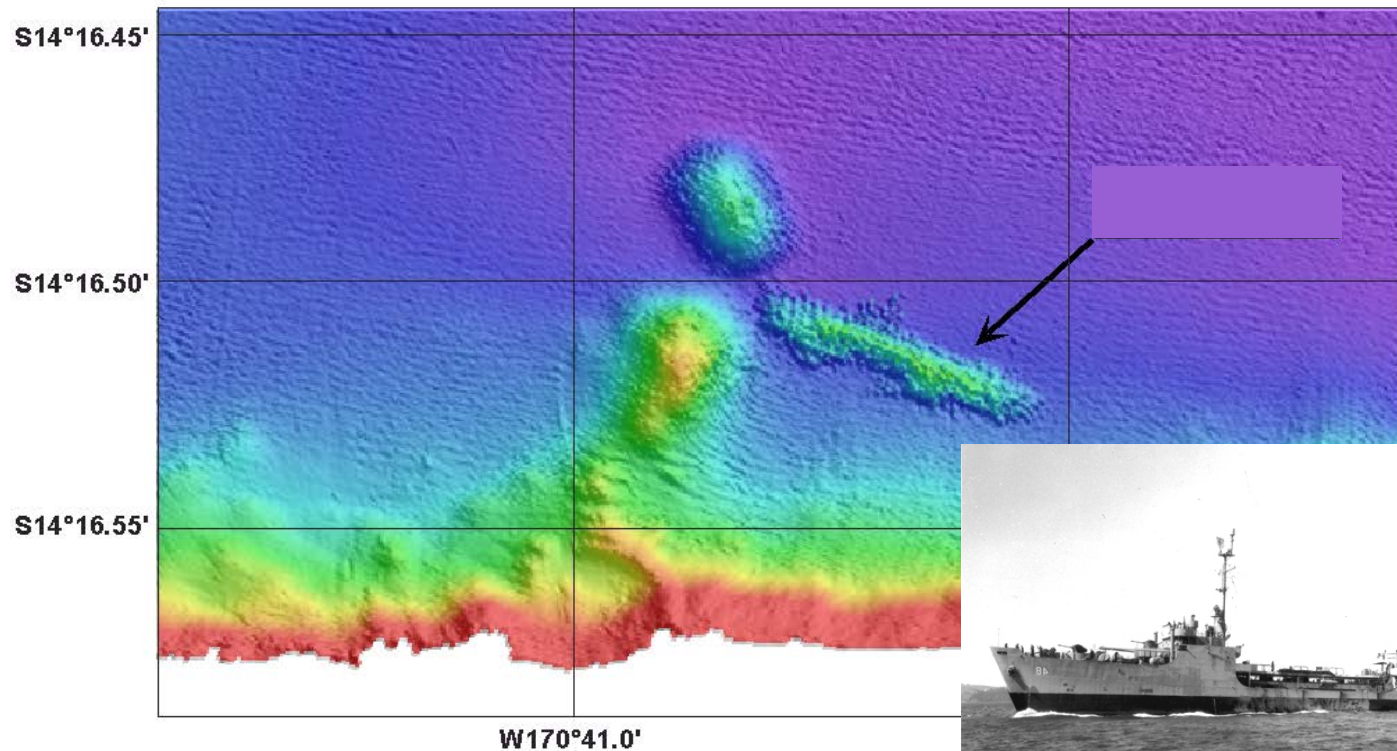
processed at 1 meter per pixel



* NOT FOR NAVIGATION

Pago Pago Harbor, American Samoa

processed at 1 m per pixel



American Samoa Tutuila and Aunu'u

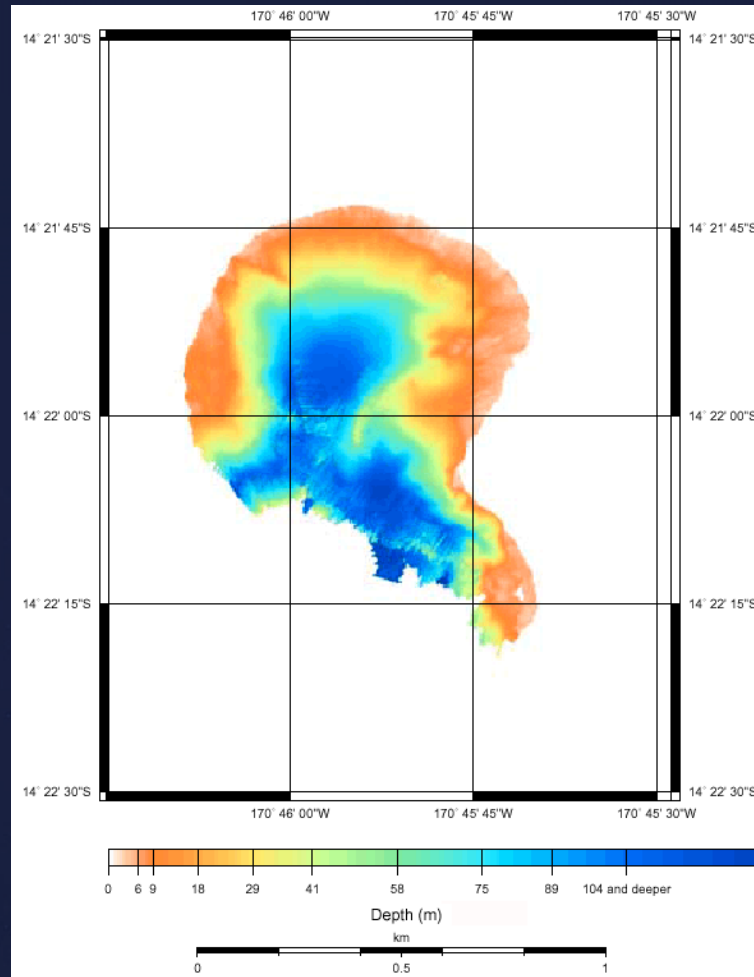


Courtesy: National Park Service

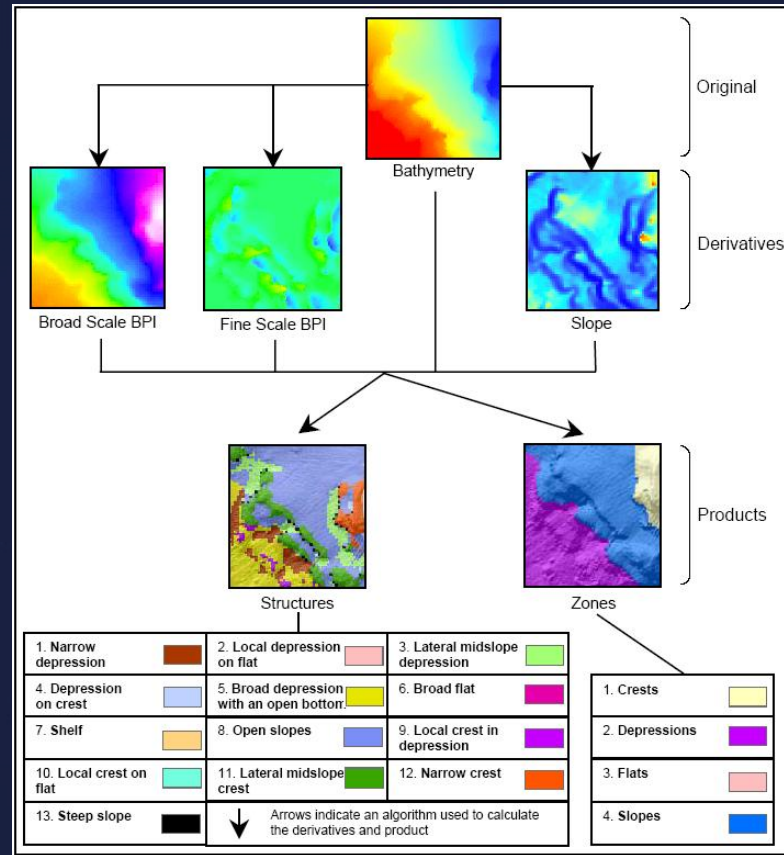


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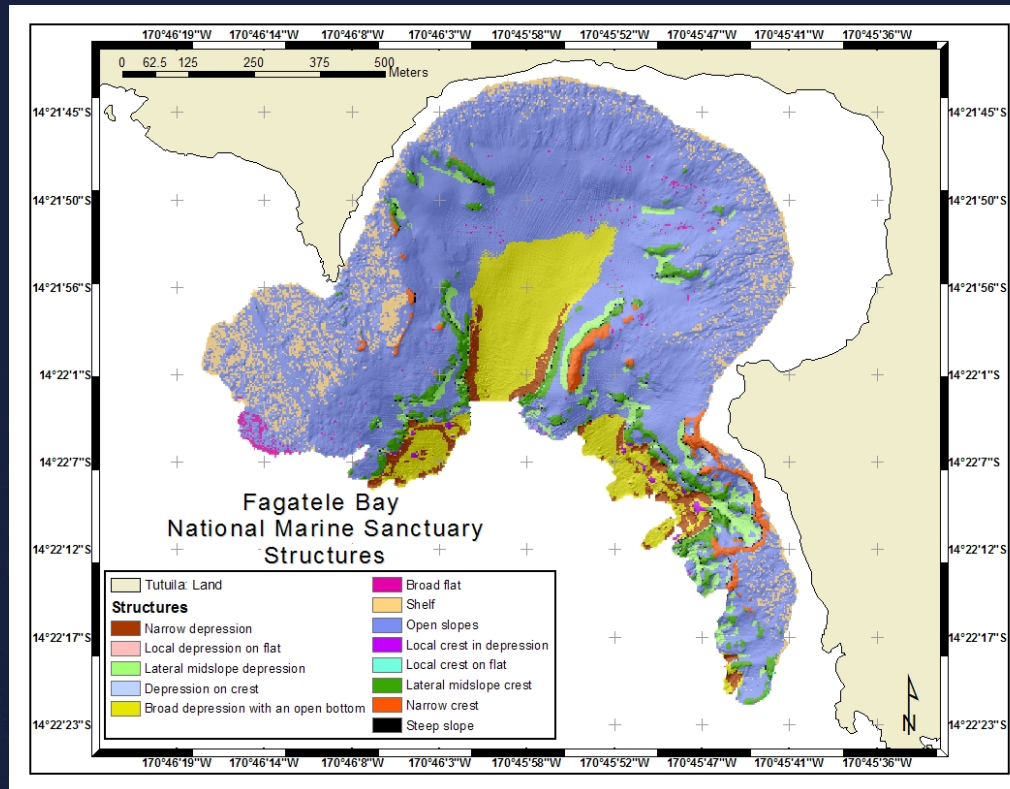
Fagatele Bay,
American Samoa,
Initial Bathymetry



Geographic Information System (GIS) Terrain Analysis and Classification



TREASURE MAP



Hawaii Undersea Research Lab Submersible Dives



R/V Ka 'imikai-o-Kanaloa



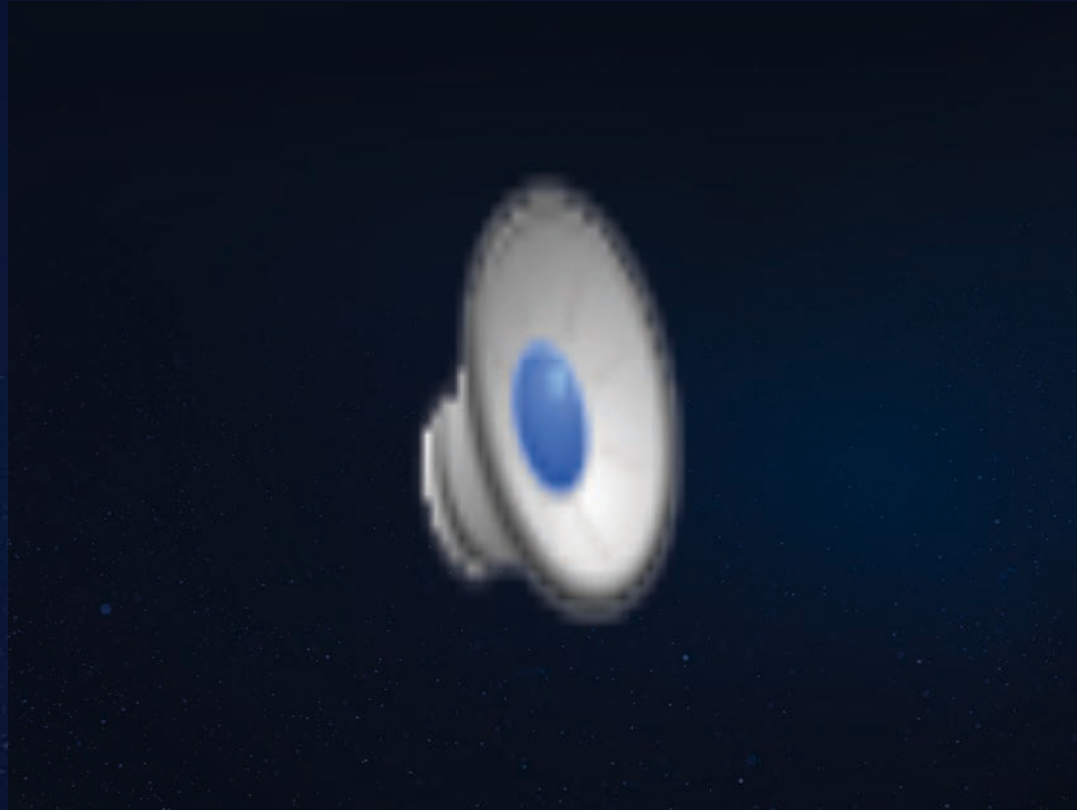
Pisces V



CREATURES

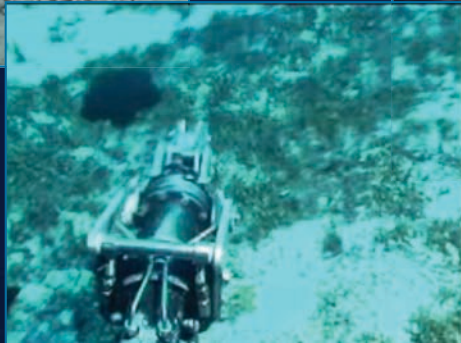
Courtesy of Lisa Levin, Scripps Institution of Oceanography

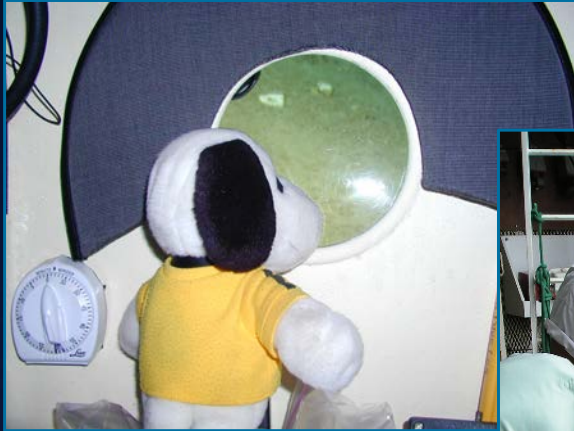
Costa Rica “Yeti” Crabs



Courtesy of Lisa Levin, Scripps Institution of Oceanography; Thurber et al., 2011

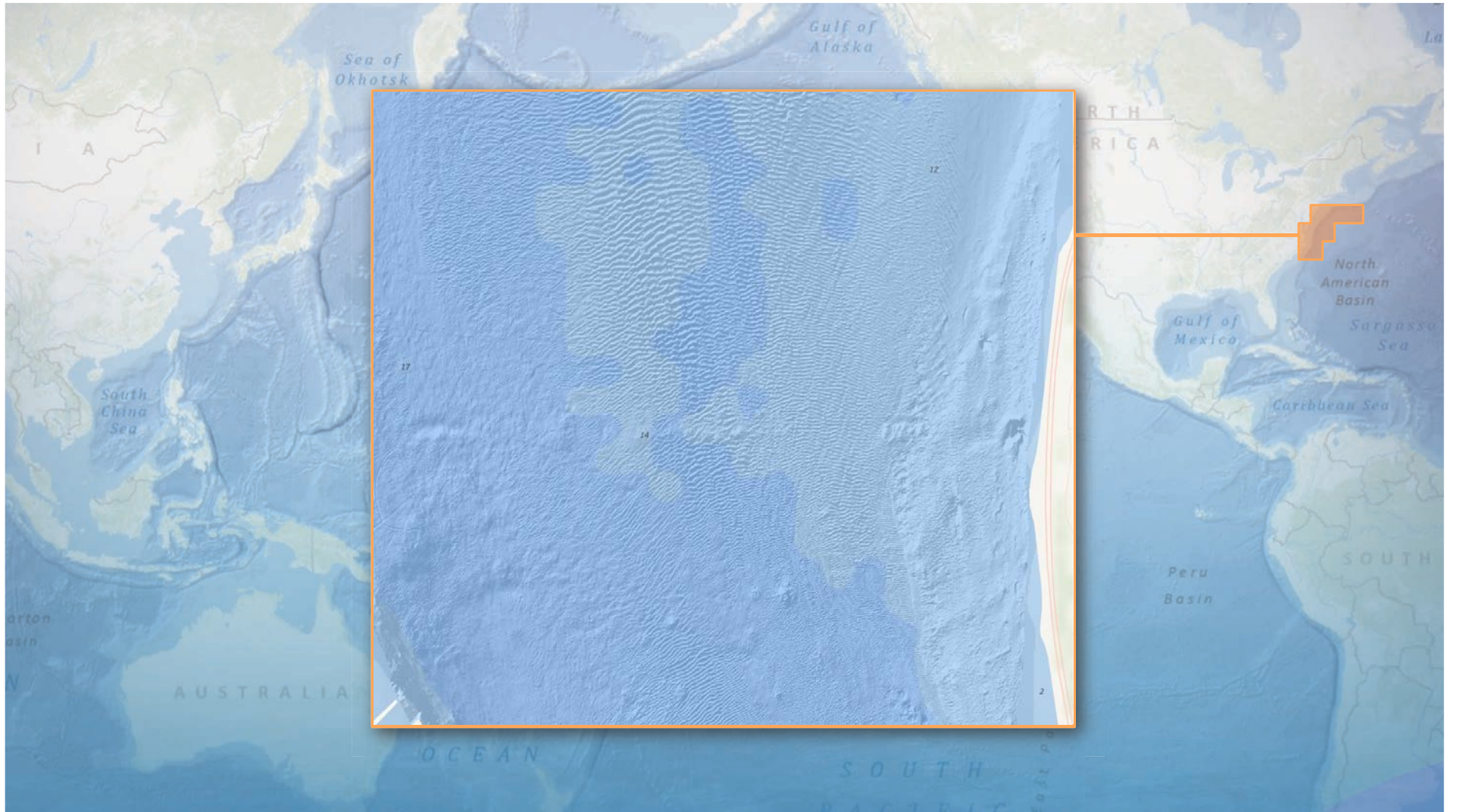


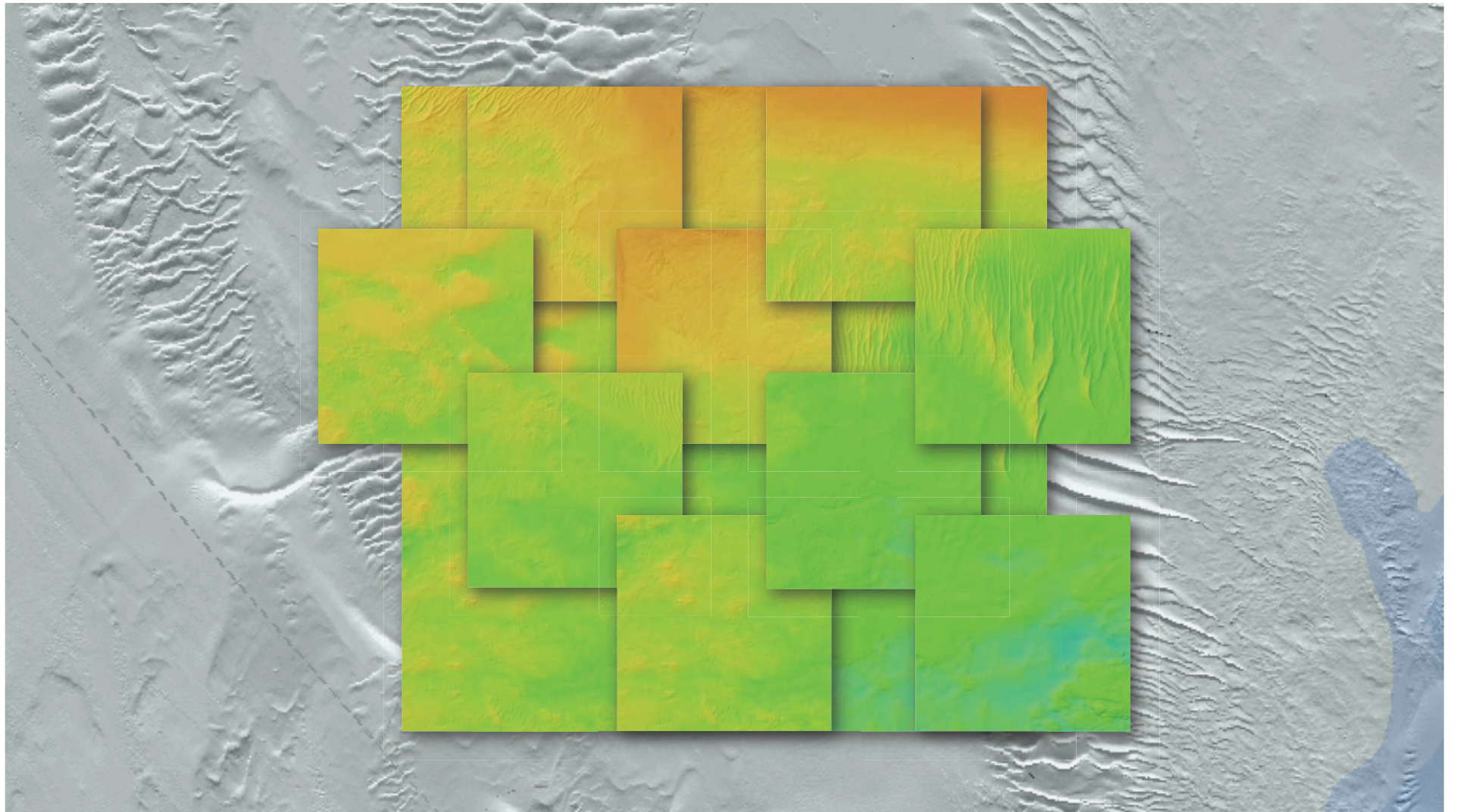


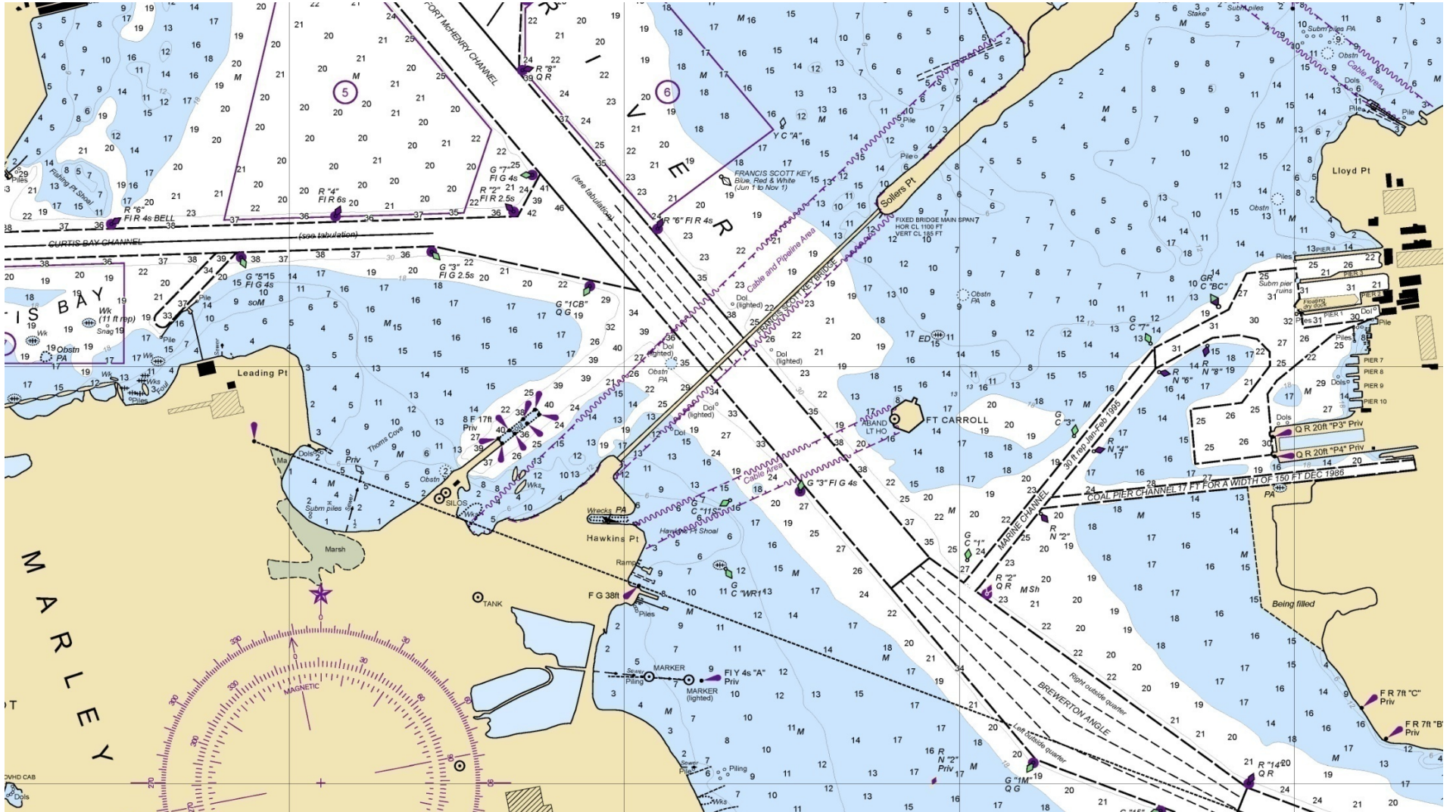


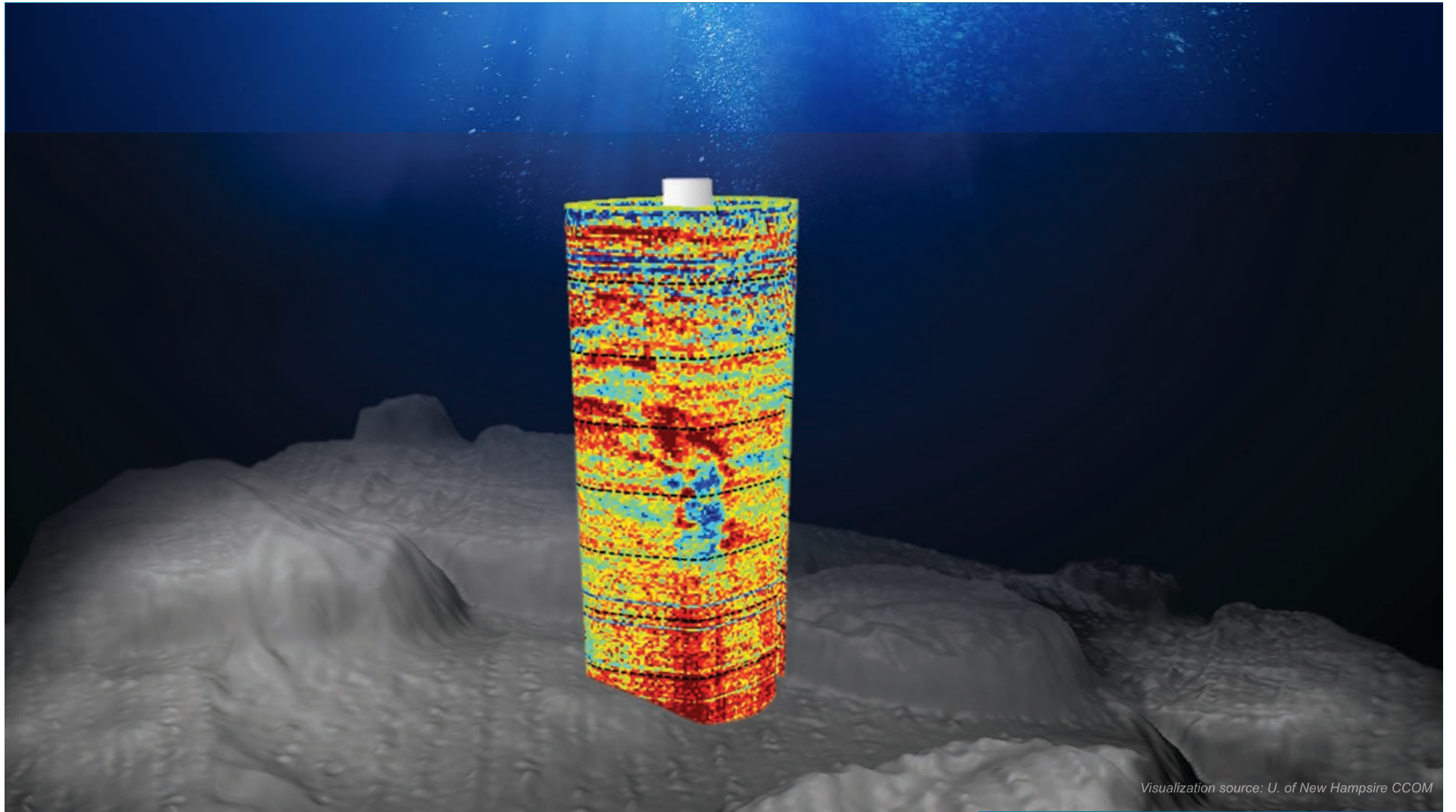
Ocean Basemap



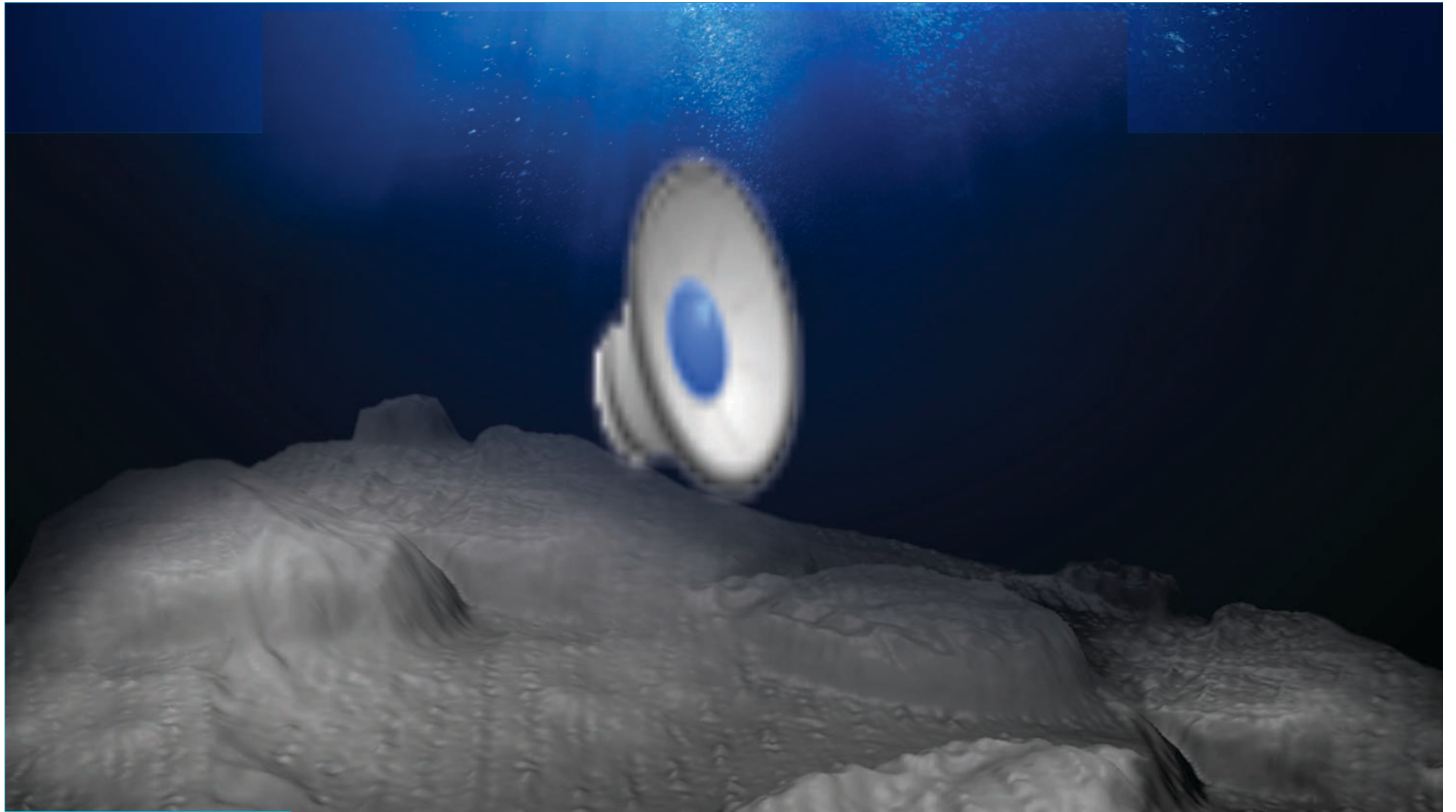








Visualization source: U. of New Hampshire CCOM



Story Maps: A New Medium

esriurl.com/ocnstories

The screenshot shows a Story Map interface. On the left, a dark grey panel contains the text 'esriagram presents SHARK GIS' in white, with a white shark fin icon at the bottom. On the right, a dark blue panel contains the title 'SharkGIS' and a paragraph of text. At the top right of the right panel, there are social media icons for Facebook, Twitter, and LinkedIn, followed by the Esri logo and the text 'A story map'. A vertical list of dots on the right side of the text panel indicates a scrollable list of items, with a home icon at the top and a downward arrow at the bottom.

esriagram
presents
**SHARK
GIS**

A story map     esri

SharkGIS

Human fascination with sharks dates back ages—long before *Jaws* or *Sharknado*. What is it about these mysterious creatures of the deep that sparks so much interest across time and cultures? In honor of Shark Week, we're taking a closer look at sharks using media and maps to better understand the ocean's fiercest predator.

Story Maps: A New Medium

esriurl.com/ocnstories



A story map     esri
SharkGIS

Ferocious Man-Eater?

Let's cut to the chase. The great white is probably the world's most notorious shark. While *Jaws* didn't do any favors for the white shark's reputation, nature filmmakers and shark advocates are trying to change public perception. In reality, *National Geographic* reports that humans are not the preferred prey of the great whites. Just try not to look like a seal the next time you go to the beach.

One Misunderstood Fish: The Great White



Video: *Endless Ocean*

Photo: Lwp Kommunikáció via Flickr

Story Maps: A New Medium

esriurl.com/ocnstories

storymaps.esri.com

Little Cayman Island: Exploring one of the World's Premier Diving Destinations

Explore reefs, shipwrecks and the acclaimed Bloody Bay Wall, considered the Caribbean's most sensational wall dives.

A story map



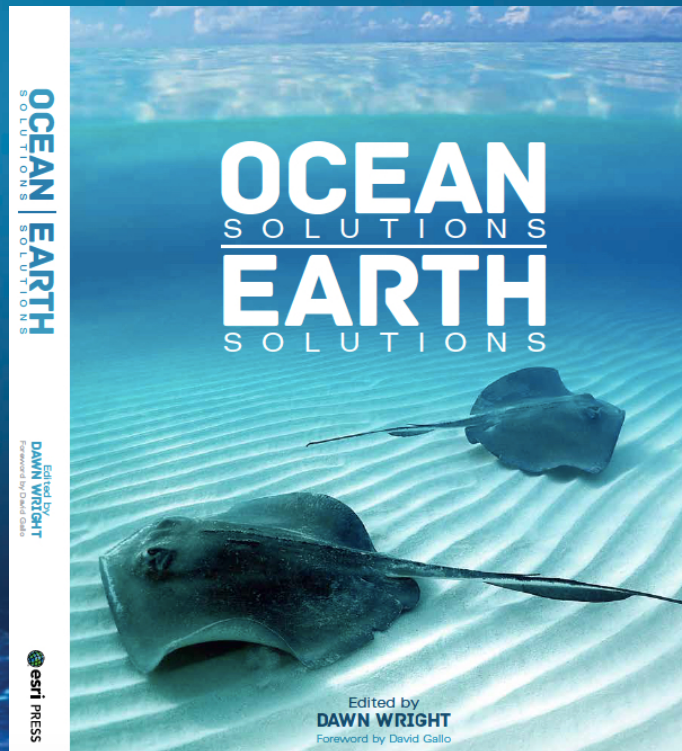
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Thank You

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