LDEO Office of Marine Operations:

R/V *Marcus G. Langseth*

Lamont-Doherty Earth Observatory
Columbia University | Earth Institute

LDEO Ships: R/V Vema (1953-1981)

LDEO Ships: R/V Conrad (1962-89)

LDEO Ships: R/V Ewing (1990-2005)

R/V Marcus G. Langseth (2007- Present)

R/V Langseth Specifications

Research Vessel Marcus G. Langseth Specifications	
Built	1991 (Western Legend)
Conversion	2007 (Marcus G. Langseth)
Length (LOA)	71.5 m/235 ft
Beam (moulded)	17.0 m/ 56 ft
Draft (max)	5.9 m/19.5 ft
Lightship Displacement	2698 LT
Full Load Displacement	4125 LT
Crew	~20
Scientific Personnel	~35
Speed Cruising/Full	11/13 Kts
Range	13,500 Nm
Main Engines	2 x Bergen BRG-6 Diesel
Horsepower	2650kW/ 3550 Hp (each)

Processed multibeam data, showing iceberg gouges on the Chukchi Shelf. The depths are color-coded: Blue is deep and red is shallow.

Langseth MCS Capability

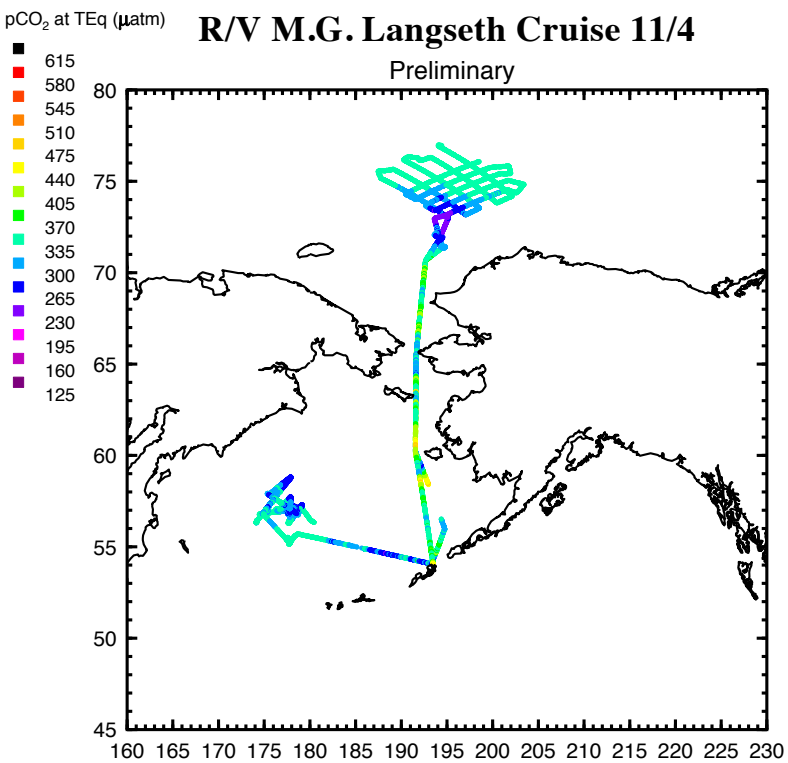
Multi-Channel Seismic

- Four identical 9-airgun arrays. Each has 1650 cubic inches volume.
- Up to four 6 km streamers for 3D MCS

R/V Langseth Science Capability

Other Acoustic Sources

- Kongsberg EM 122 Swath Bathymetric Sonar (12 kHz)
- Knudson 320 B/R sub-bottom profiler (2.0-6.0 kHz)
- Acoustic Doppler Current Profilers (ADCP Teledyne 75)



Other Routine Data Sets

- Gravity Anomaly
- Magnetic Anomaly
- Surface water pCO2

Location of 2008 Science Missions

Lamont-Doherty Earth Observatory
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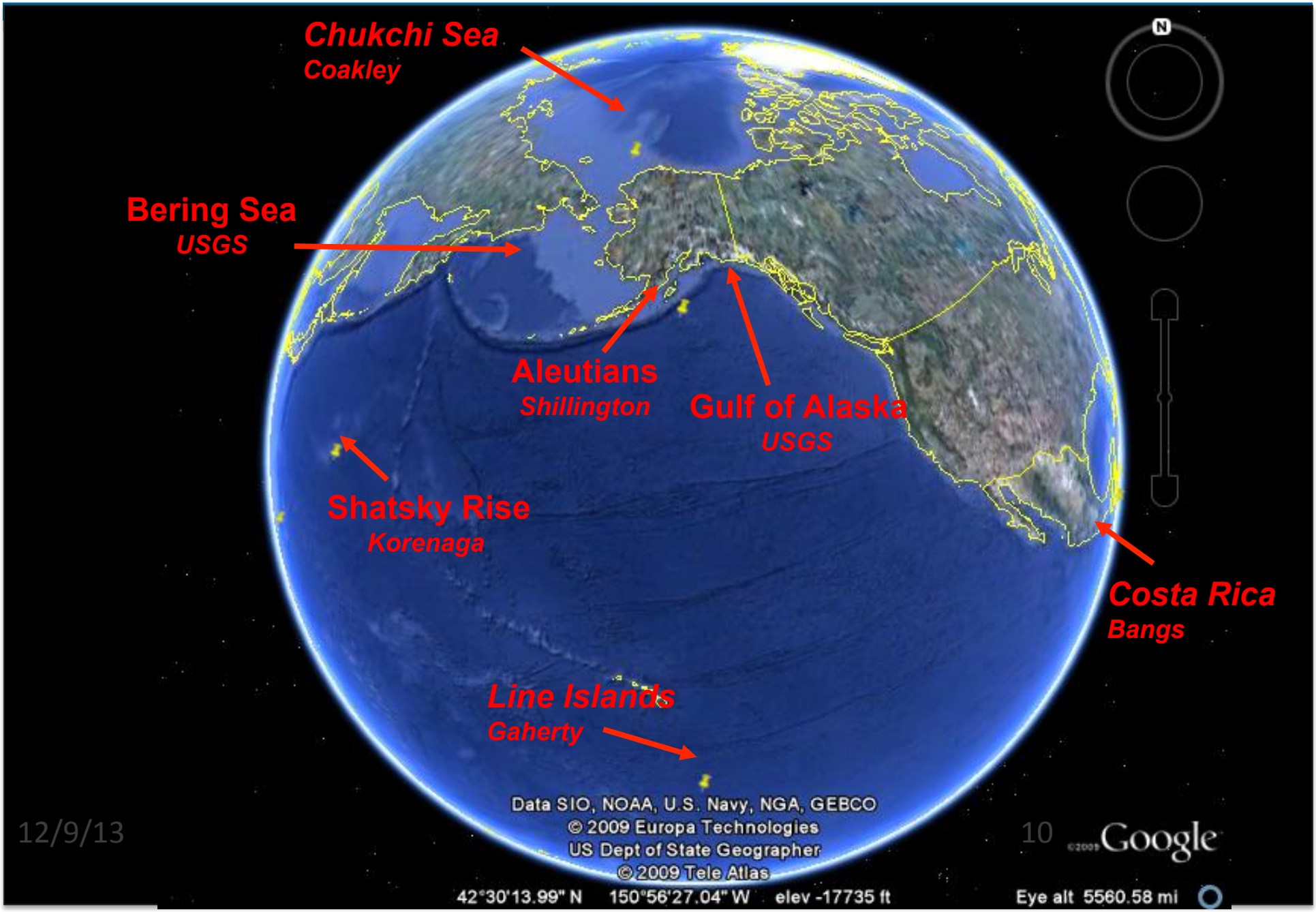
Location of 2010-11 Science Missions

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE



Location of 2012 Science Missions

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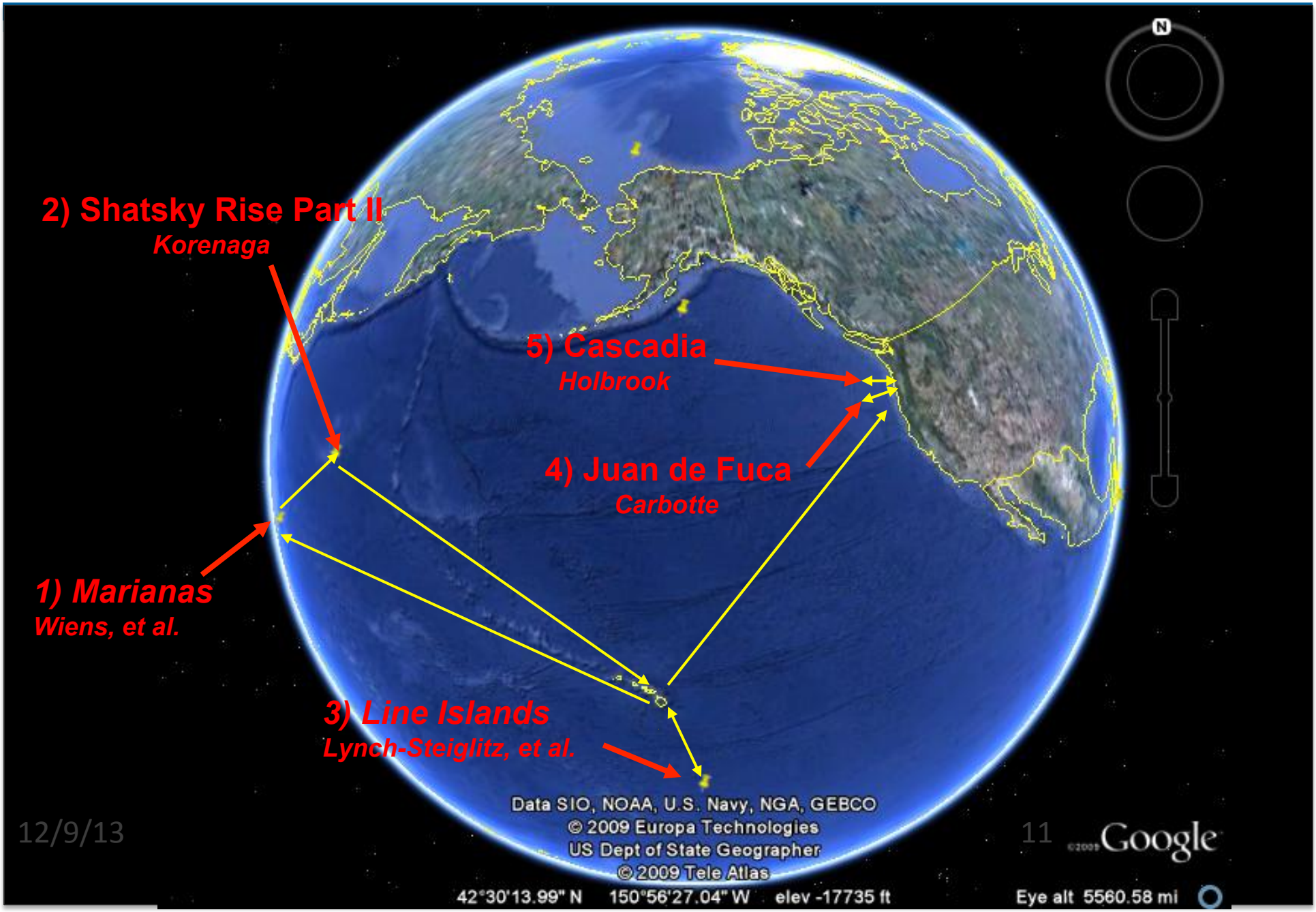
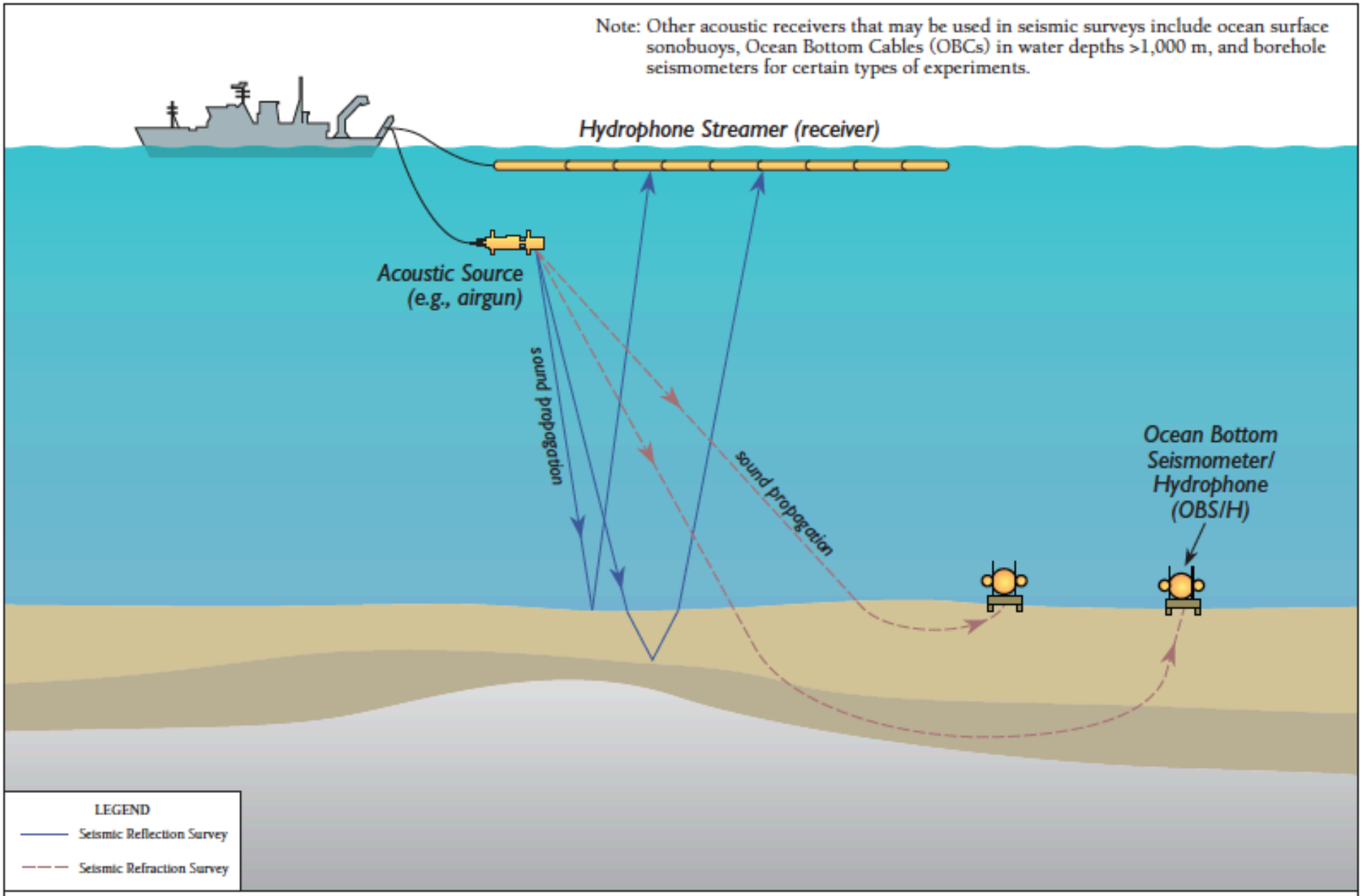


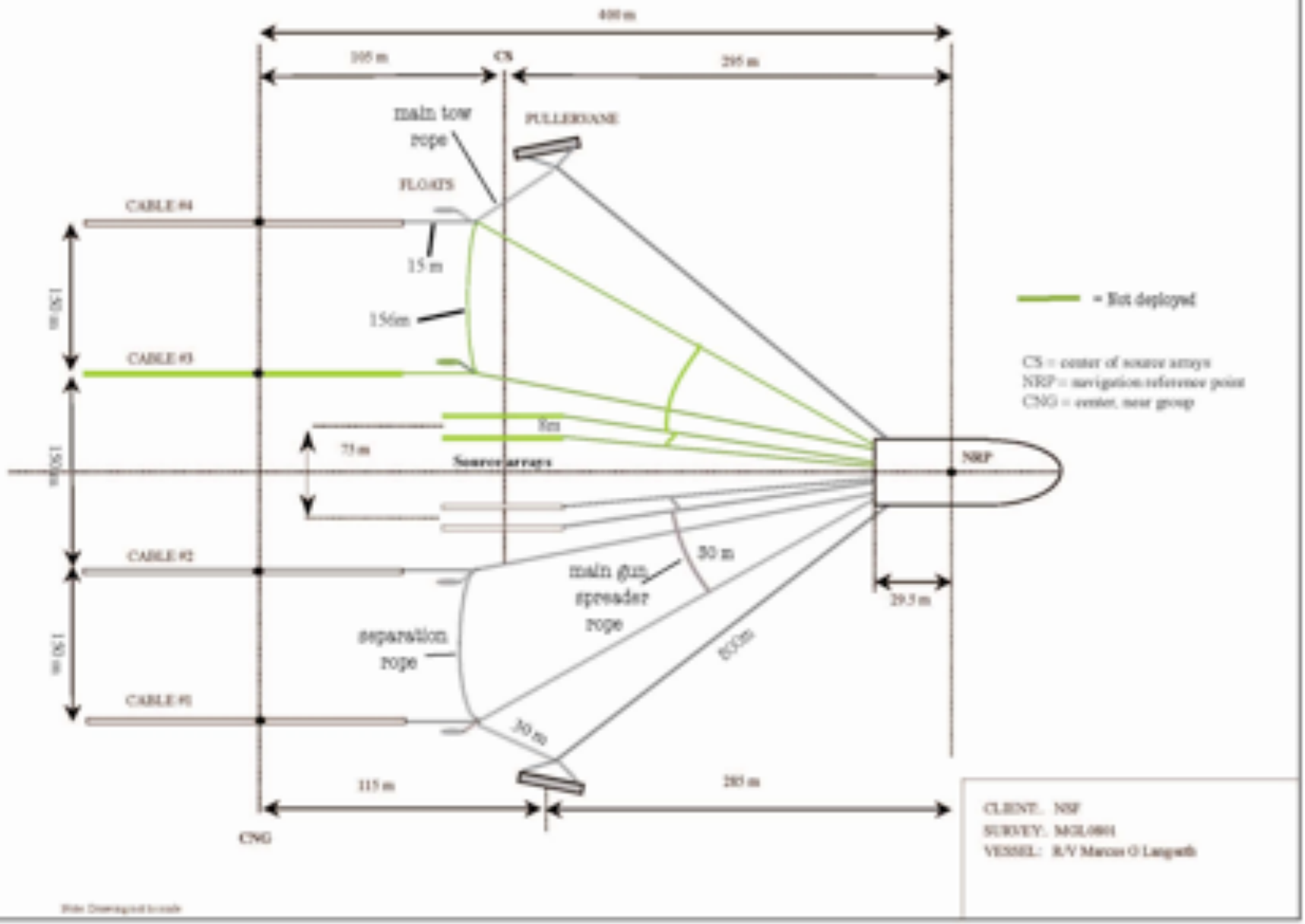


Not to Scale

Figure 2-1
General Concept of Marine Seismic Reflection and Refraction Surveys

(Source: NSF PEIS)

TOWING CONFIGURATION AND OFFSETS

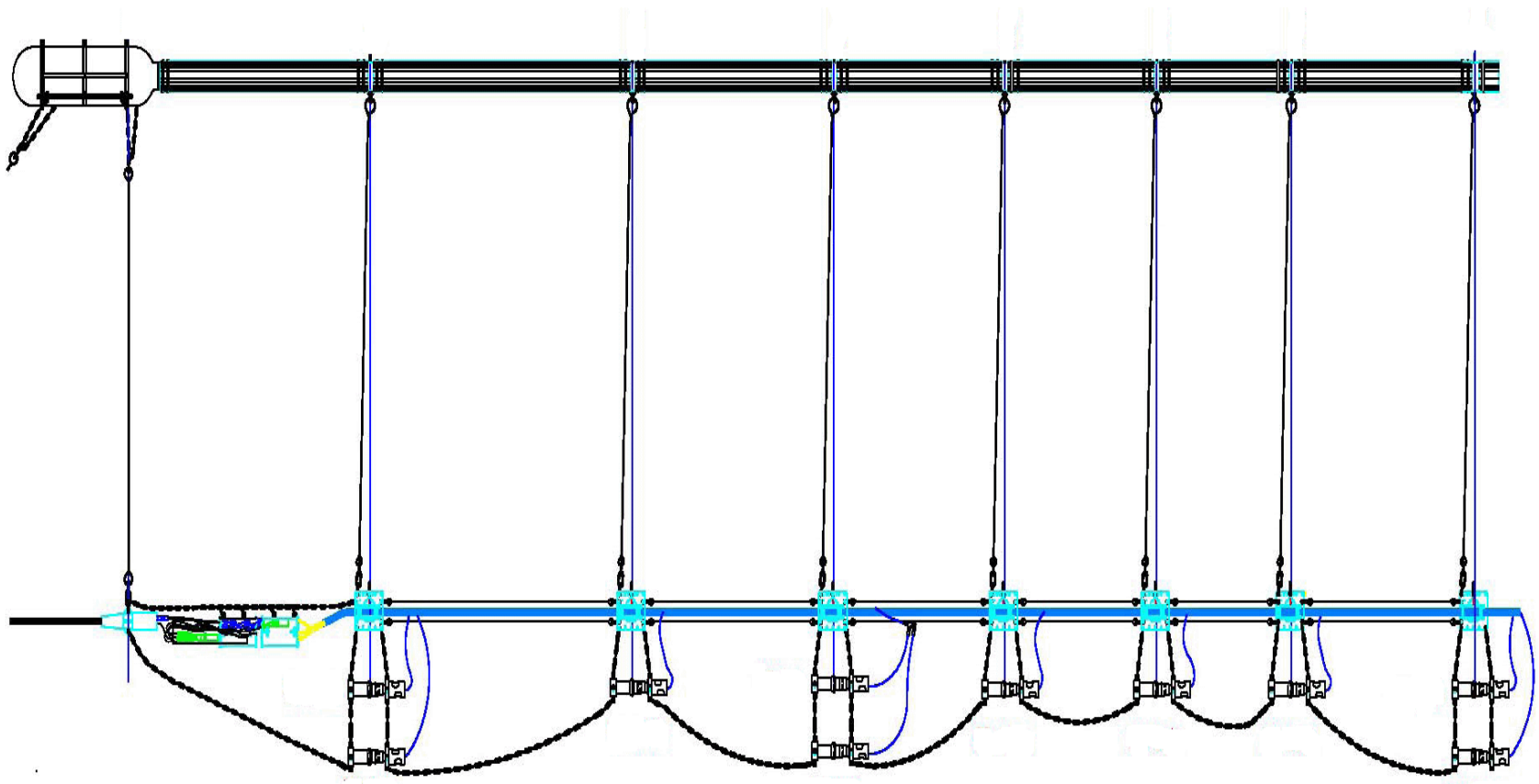


Langseth Seismic Setup

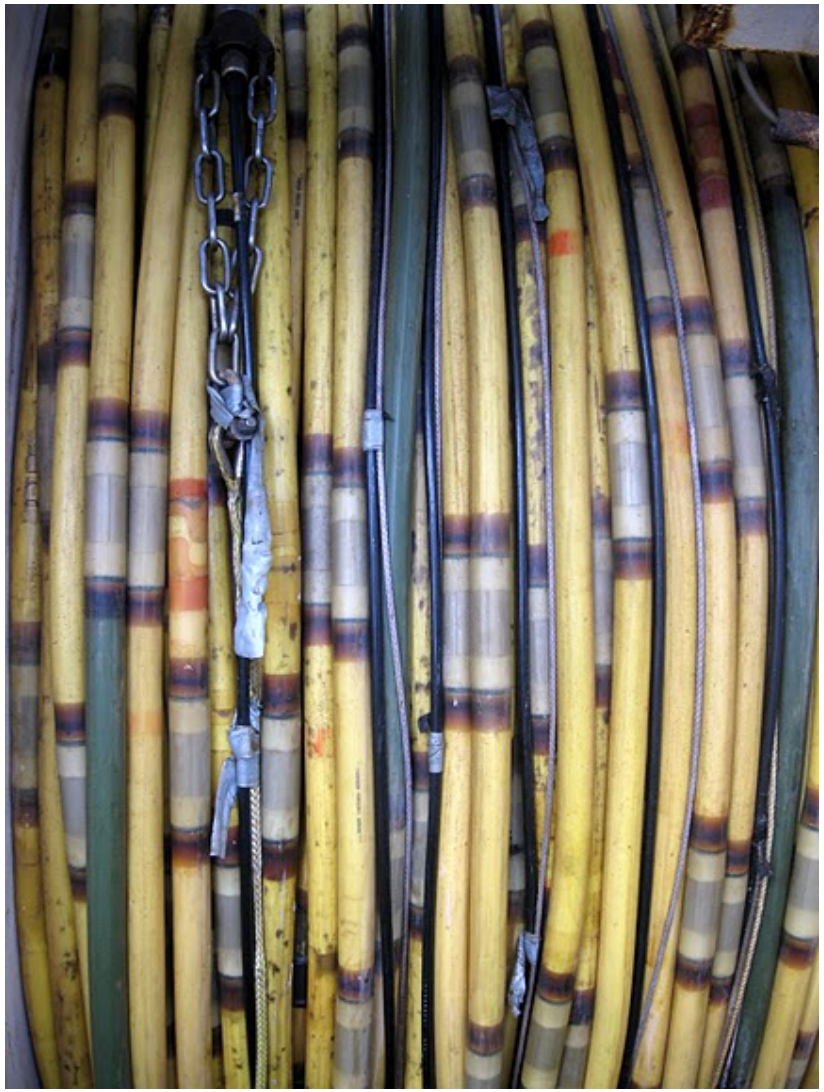
MARCUS G. LANGSETH

Langseth Sound Source Arrays

Seismic source array



Hydrophone Streamers



<u>Langseth Maximum Array:</u>
4 hydrophone streamers
6 kilometers long each

Ocean Bottom Seismometers

Langseth Main Lab

NSF Form:

INFORMATION REQUIRED FOR ENVIRONMENTAL COMPLIANCE DOCUMENTS

- Information is needed to complete the necessary environmental compliance actions for the proposed seismic survey activities. Under the terms of the marine Mammal Protection Act (MMPA) of 1972, an Incidental Harassment Authorization (IHA) is required for seismic programs conducted by U.S. citizens and/or from a U.S. research vessel. Additionally, pursuant to the National Environmental Policy Act (NEPA) and/or Executive Order 12114, Environmental Effects Abroad of Major Federal Actions, federal agencies must consider the environmental impacts of their actions. As such, NSF must prepare environmental analysis to help inform what potential impacts on the environment may result from the proposed activities (NSF-funded research and/or the use of the NSF owned research vessel (R/V) Langseth). Depending upon the nature and location of the proposed activities, compliance with other federal regulations, such as the Endangered Species Act (ESA), Coastal Zone Management Act, and National Historic Preservation Act, may be necessary.

National Marine Fisheries Service (NMFS) Requirements: IHA and BO

Every US/NSF Funded Project Requires:

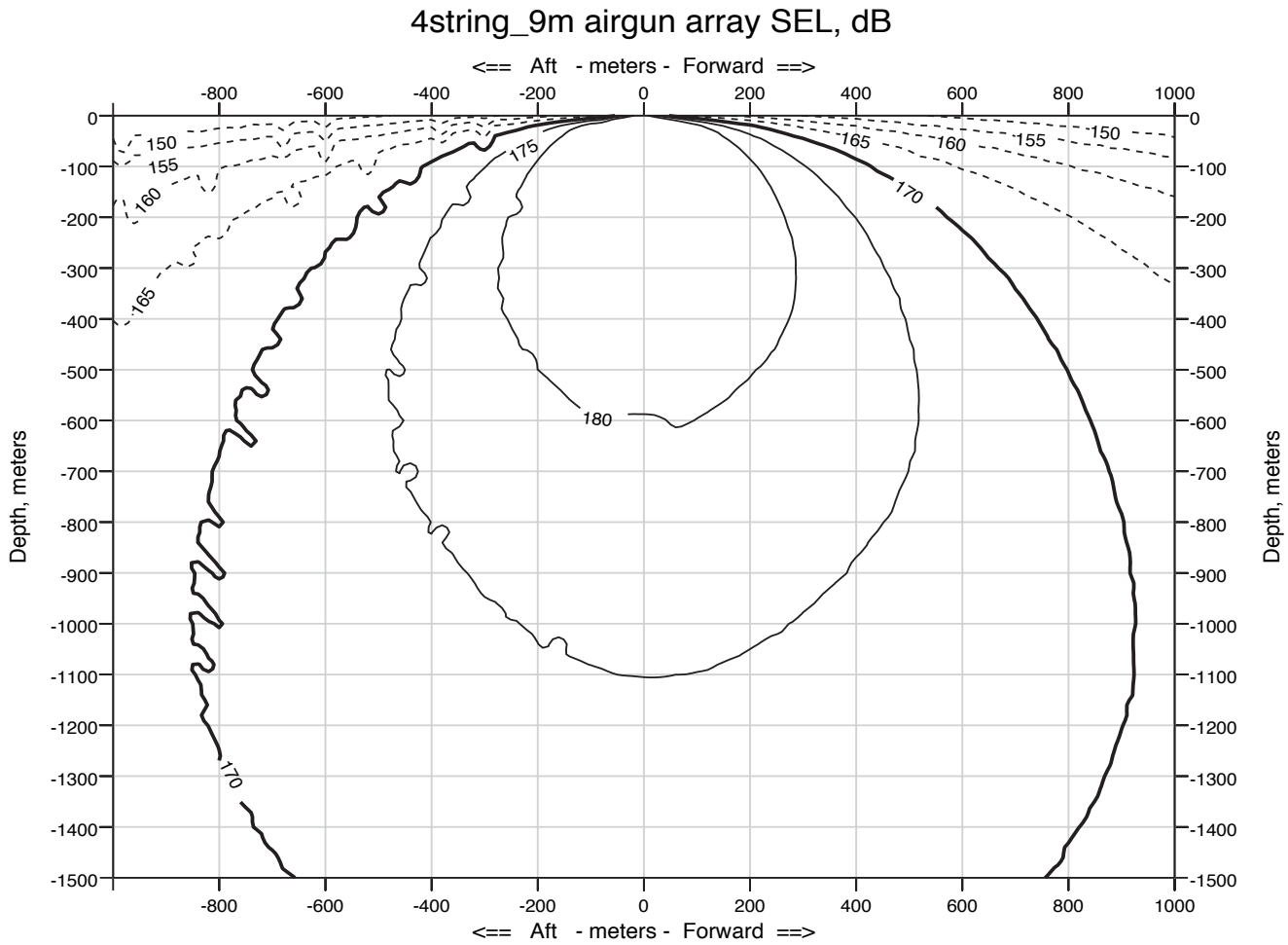
Environmental Assessment (EA)

Permits:

IHA => Incidental Harassment Authorization

BO=> Biological Opinion

Acoustic Modeling Requirements:



National Marine Fisheries Service (NMFS) Estimate of "Takes" from Environmental Assessment

	Reported density[1] (#/1000 km^2) in depth range (m)			Ensonified area (1000 km^2) in depth range (m)			Calculated Take[2] in depth range (m)				% Regional pop'n[3]	Requeste Level B Ta Authorizat
Species	<100	100-1000	>1000	<100	100-1000	>1000	<100	100-1000	>1000	All		
Mysticetes												
North Atlantic right whale	*0*	*0*	*0*	*19.65*	*9.64*	*45.75*	*0*	*0*	*0*	*0*	*0*	***0***
Humpback whale	*0.68*	*0.60*	*1.02*	*19.65*	*9.64*	*45.75*	*13*	*6*	*47*	*66*	*0.57*	***66***
Minke whale	0.02	0.02	0.04	19.65	9.64	45.75	0	0	2	2	0.01	**2**
Sei whale	*0*	*0*	*0*	*19.65*	*9.64*	*45.75*	*0*	*0*	*0*	*0*	*0*	***0***
Fin whale	*<0.01*	*0.01*	*0.01*	*19.65*	*9.64*	*45.75*	*0*	*0*	*0*	*1*	*<0.01*	***1***
Blue whale	*0*	*0*	*0*	*19.65*	*9.64*	*45.75*	*0*	*0*	*0*	*0*	*0*	***0***
Odontocetes												
Sperm whale	*0.04*	*0.61*	*3.01*	*19.65*	*9.64*	*45.75*	*1*	*6*	*138*	*144*	*1.09*	***144***
Pygmy/dwarf sperm whale	0.60	0.52	0.89	19.65	9.64	45.75	12	5	41	57	14.49	**57**
Beaked whales[4]	<0.01	0.11	0.54	19.65	9.64	45.75	0	1	25	26	0.74	**26**
Rough-toothed dolphin	0.28	0.25	0.42	19.65	9.64	45.75	6	2	19	27	N/A	**27**
Bottlenose dolphin	34.5	328.5	52.8	19.65	9.64	45.75	677	3167	2417	6261	6.66	**6261**
Pantropical spotted dolphin	13.1	11.4	19.5	19.65	9.64	45.75	257	110	893	1260	28.39	**1260**
Atlantic spotted dolphin	237.8	84.9	69.2	19.65	9.64	45.75	4674	819	3167	8660	16.99	**8660**
Spinner dolphin[b]	0	0	0	19.65	9.64	45.75	0	0	0	0	0	**0**
Striped dolphin	<0.01	0.34	2.01	19.65	9.64	45.75	0	3	92	95	0.10	**95**
Clymene dolphin	6.26	5.46	9.32	19.65	9.64	45.75	123	53	427	602	N/A	**602**
Common dolphin	6.75	130.5	28.0	19.65	9.64	45.75	133	1258	1283	2674	2.21	**2674**
Atlantic white-sided dolphin	0	0	0	19.65	9.64	45.75	0	0	0	0	0	**0**
Fraser's dolphin[b]	0	0	0	19.65	9.64	45.75	0	0	0	0	0	**0**
Risso's dolphin	2.08	5.33	1.92	19.65	9.64	45.75	41	51	88	180	0.88	**180**
Melon-headed whale[b]	0	0	0	19.65	9.64	45.75	0	0	0	0	0	**0**
Pygmy killer whale[b]	0	0	0	19.65	9.64	45.75	0	0	0	0	0	**0**
False killer whale[b]	0	0	0	19.65	9.64	45.75	0	0	0	0	0	**0**
Killer whale[b]	0	0	0	19.65	9.64	45.75	0	0	0	0	0	**0**
Pilot whale	2.68	52.3	19.8	19.65	9.64	45.75	53	504	908	1465	0.19	**1465**
Harbor porpoise	0	0	0	19.65	9.64	45.75	0	0	0	0	0	**0**

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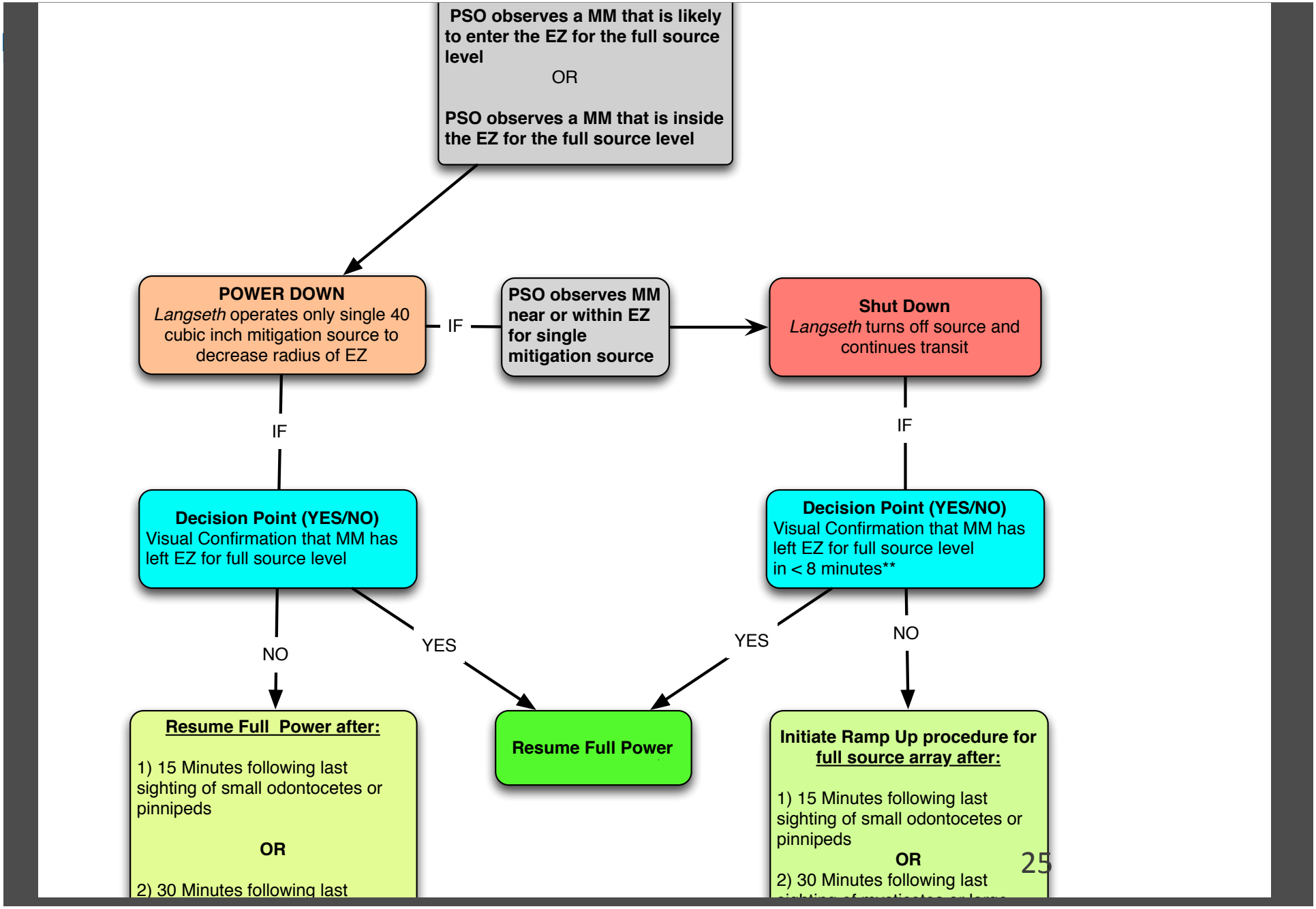
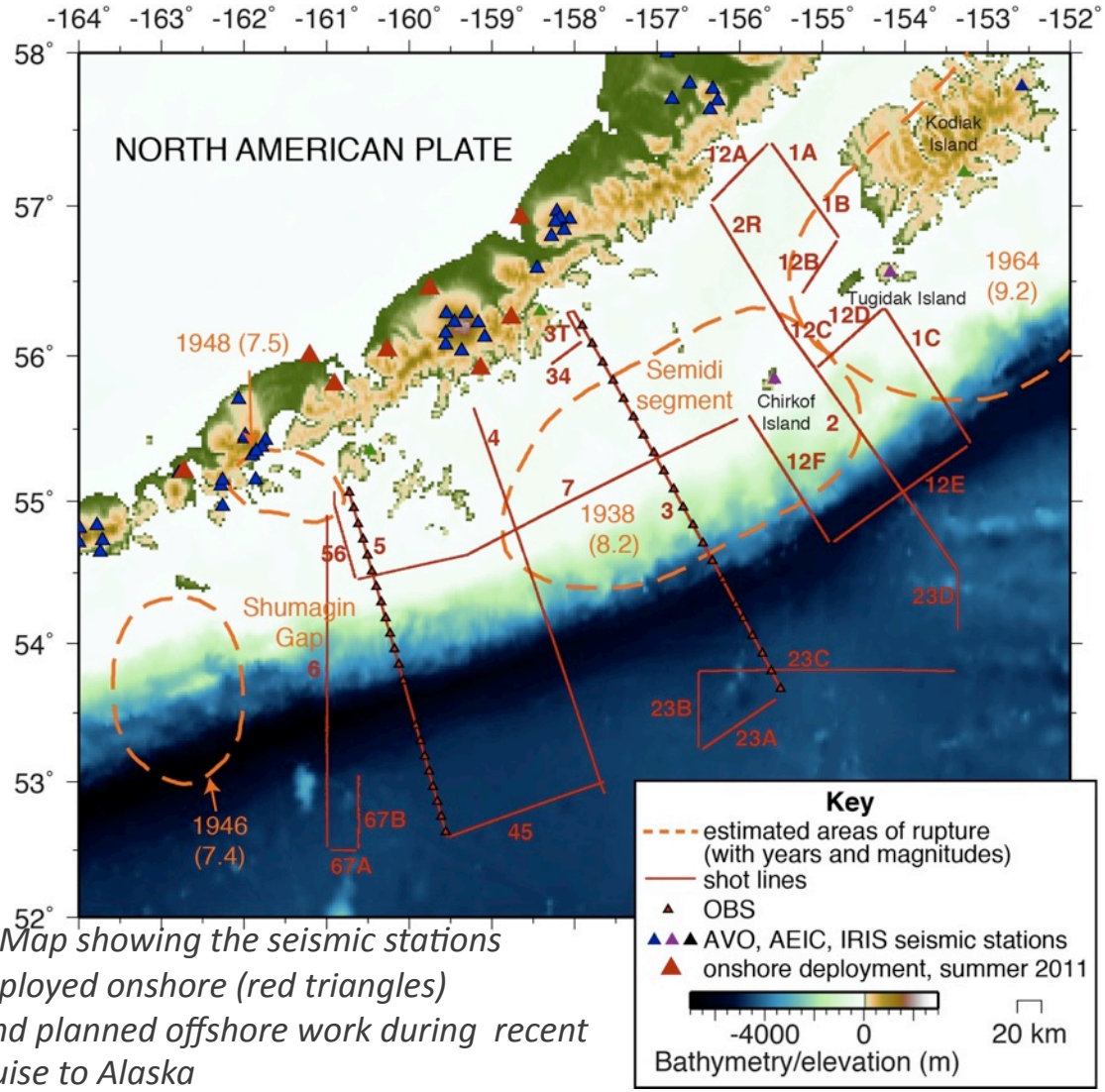
Marine Mammal Observation Procedures



2011 Imaging the Sources of Great Alaskan Earthquakes

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

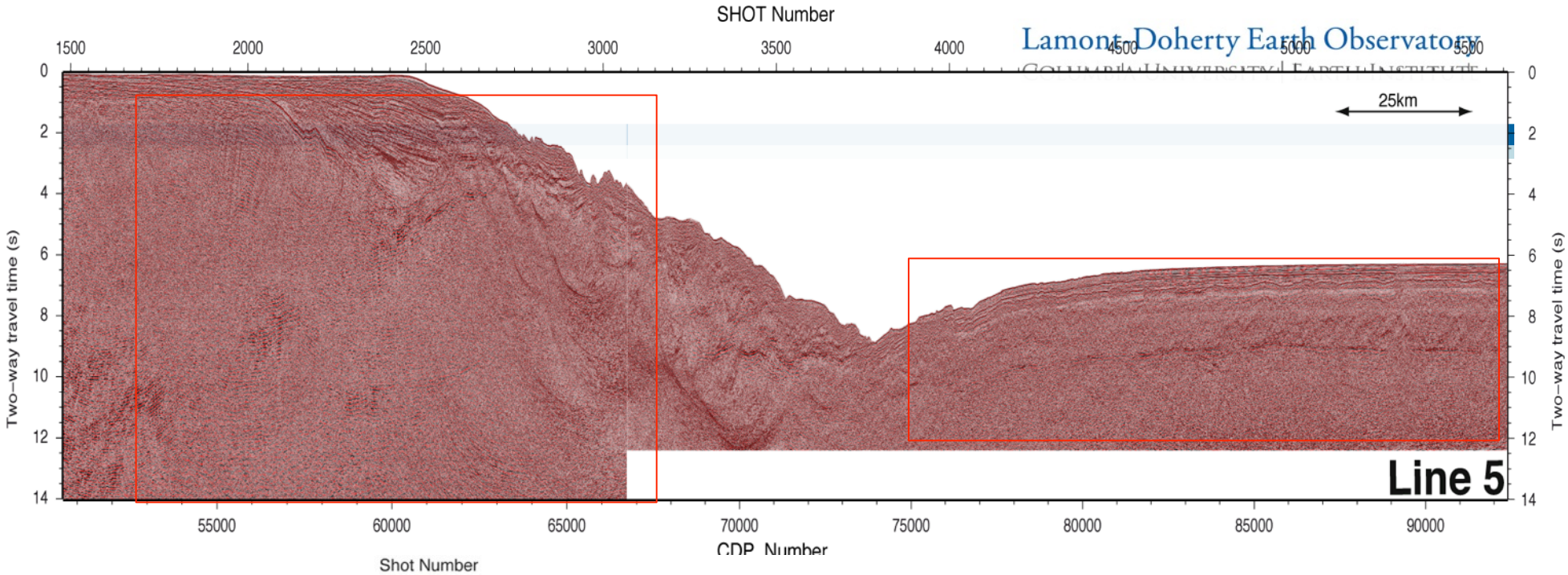


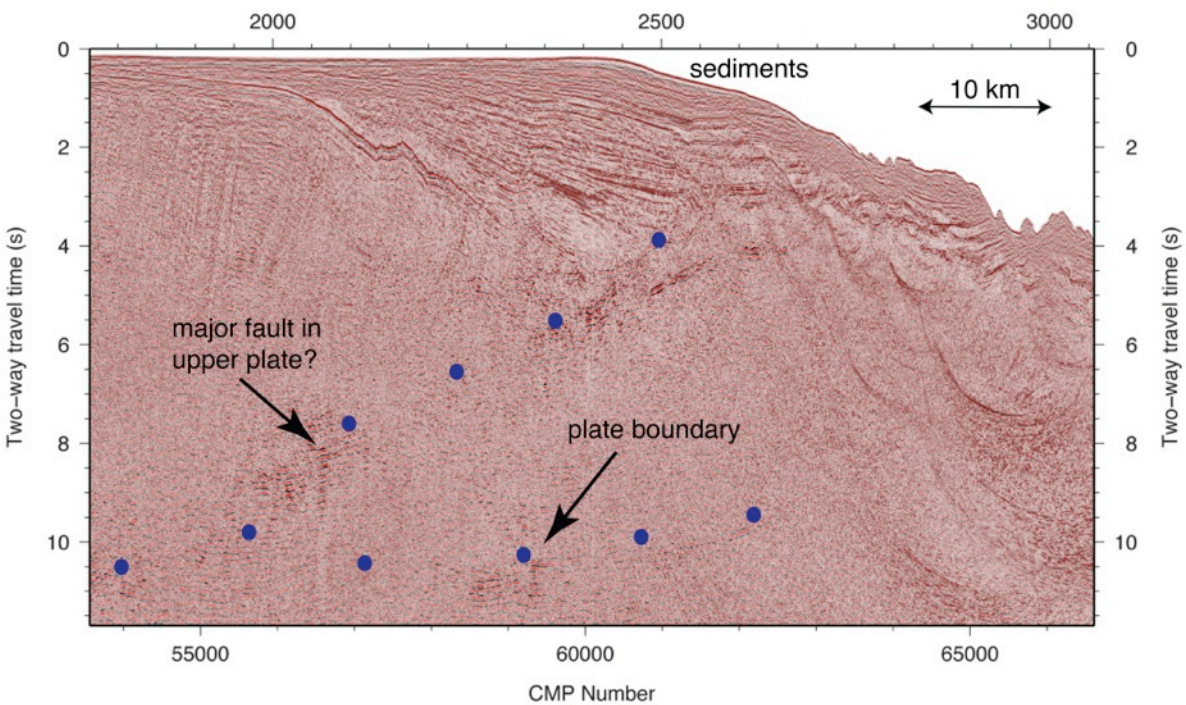
▲*Map showing the seismic stations deployed onshore (red triangles) and planned offshore work during recent cruise to Alaska*

Aleutian Megathrust Project-July 2011

A major tectonic boundary on the seafloor off Alaska has produced fatal earthquakes and tsunamis similar to the recent one in Japan. In 1964, the second largest quake ever recorded happened here, and other parts of the fault may be building energy for another event. Scientists from Lamont-Doherty Earth Observatory are aboard the R/V *Langseth* to better understand what causes these quakes, which will help assess the hazard for Alaska and beyond. (Shillington)

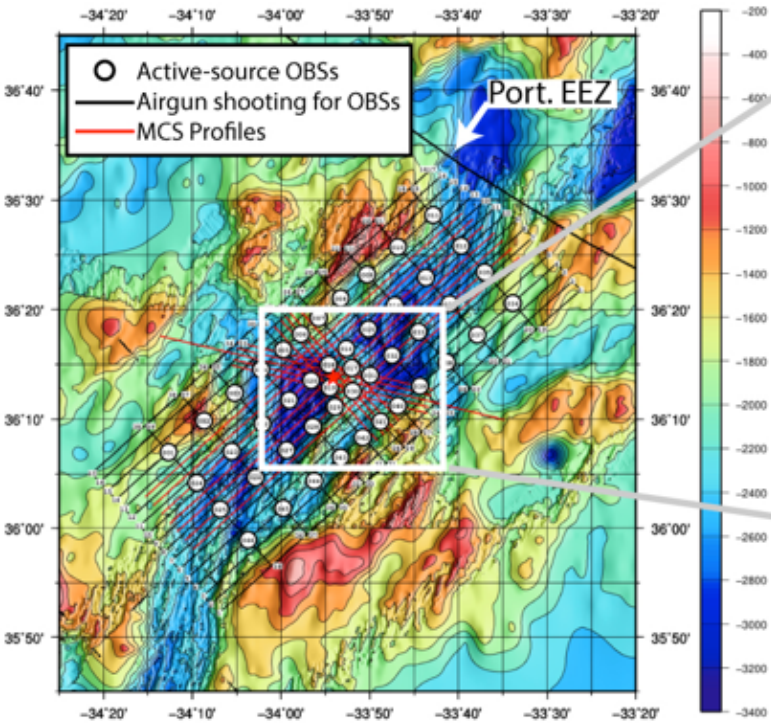
http://www.ldeo.columbia.edu/research/blogs/imaging-sources-great-alaskan-earthquakes





A profile across the entire subduction zone in Shumagin Gap. Unlike most other parts of the Alaska-Aleutian subduction zone, this region has not ruptured in a great earthquake in over 200 years.

Canales- 2D MCS/OBS Rainbow Hydrothermal Vent Field



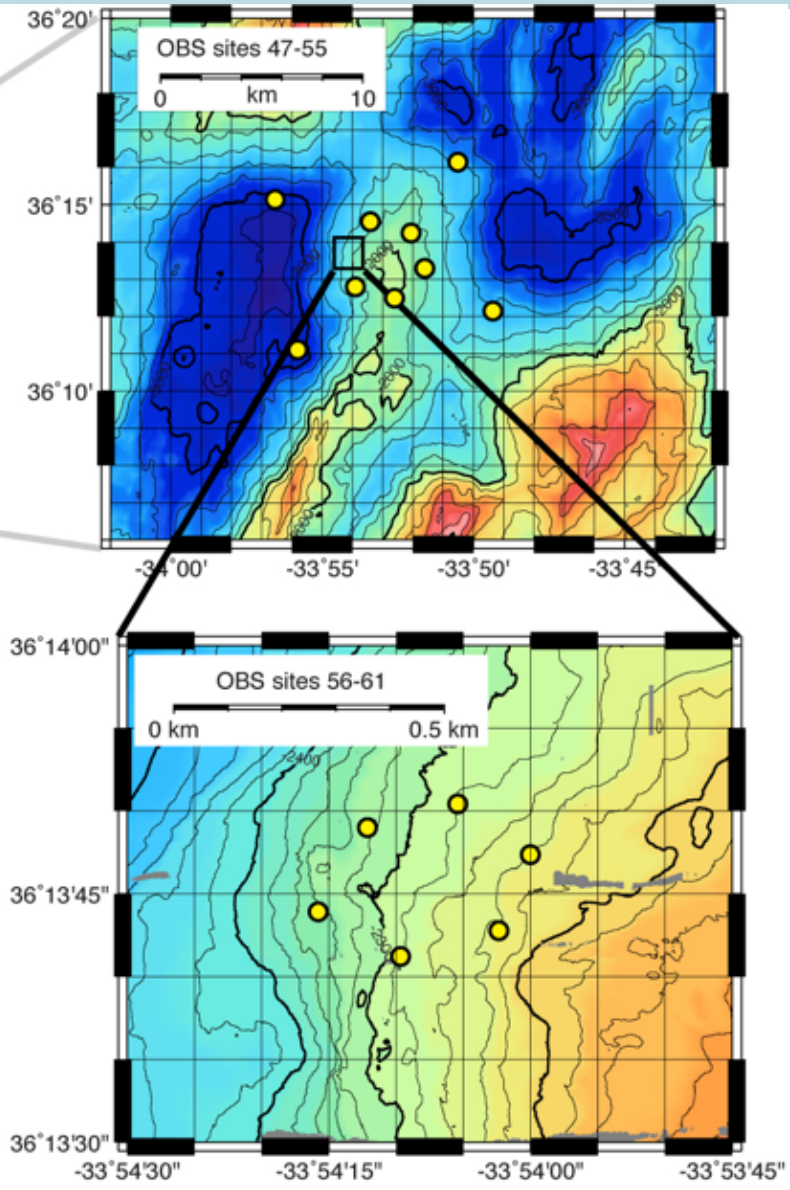
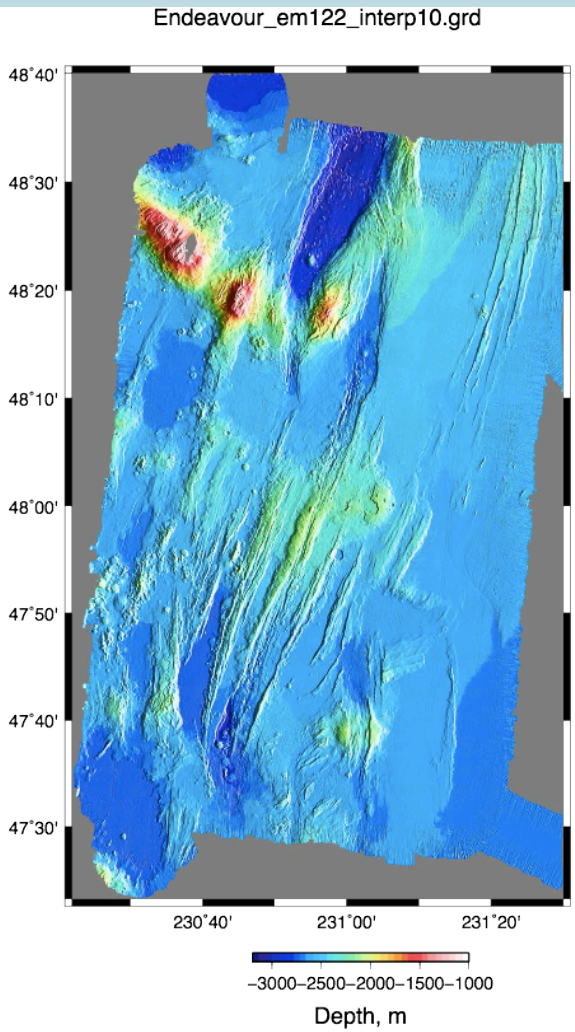
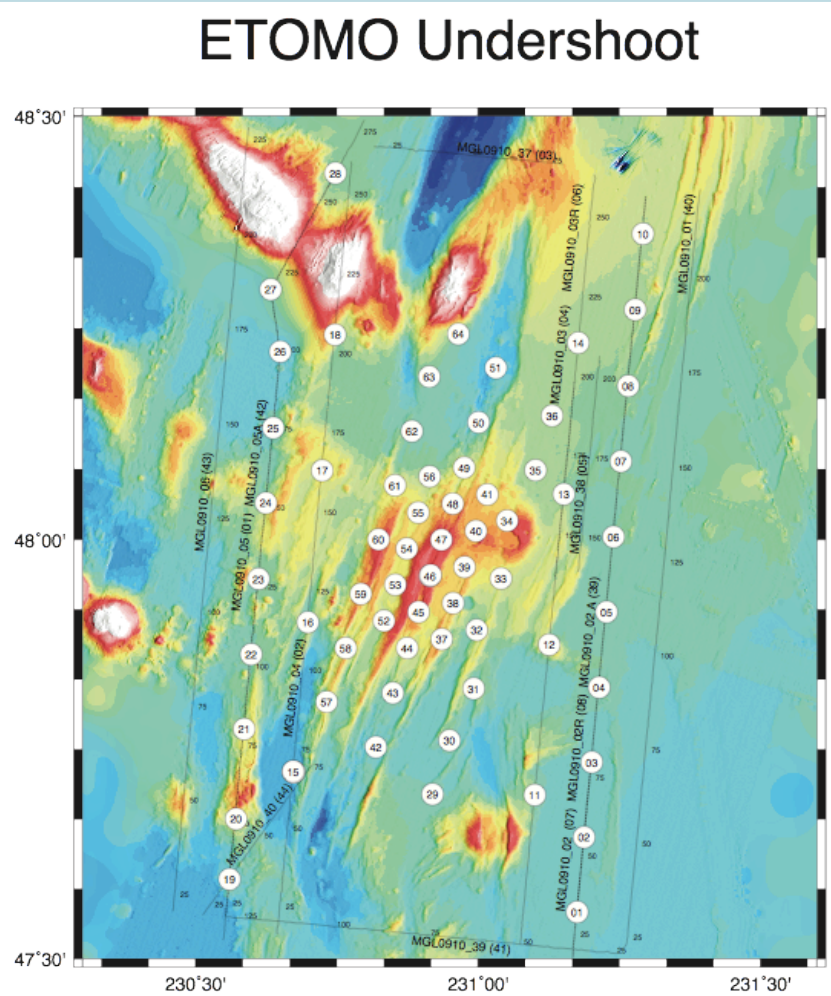


Table 1. Main Cruise Plan

Transit from port to 1st OBS site	6 days
Deploy 46 OBS	2
Shoot Refraction lines	9.5
Recover 26 OBS	3
Shoot MCS lines	7
Deploy/Recover streamer/gun for MCS	3
Recover 20 OBS	2.5
Redeploy 15 OBS	1
Transit to port	2
Contingency	4
Total	**40 days**

Endeavour Seismic Tomography Experiment
Toomey et al., 2009

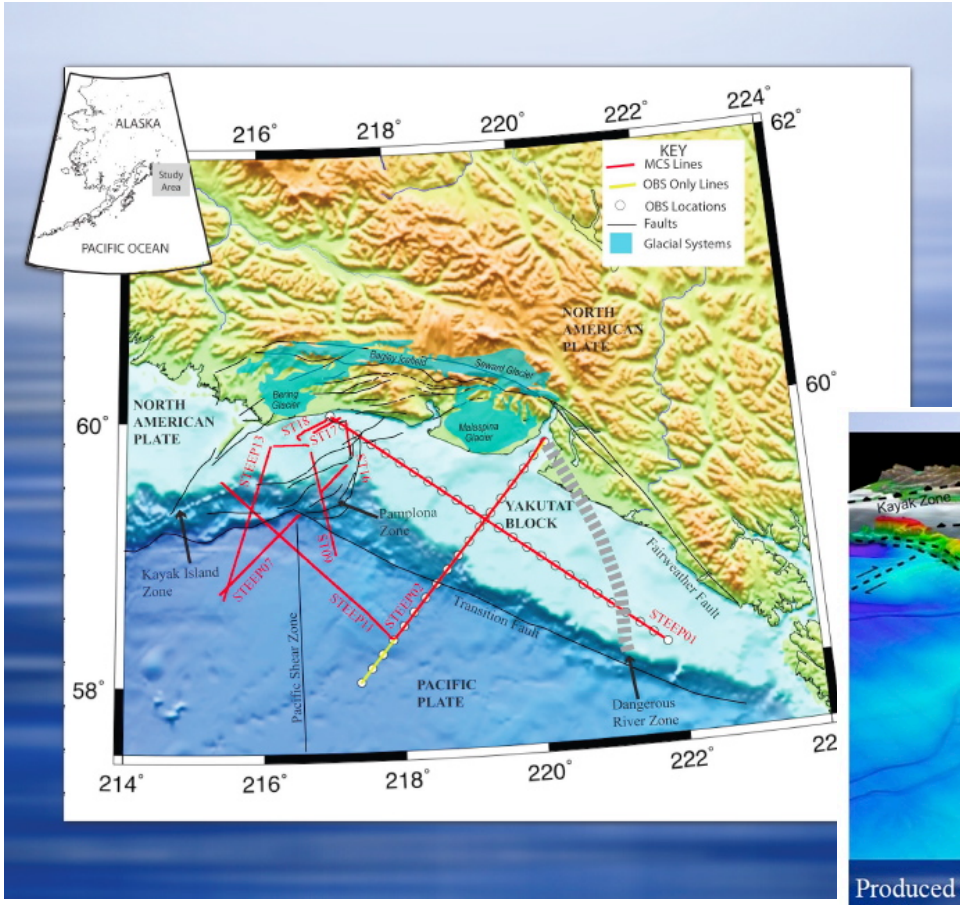


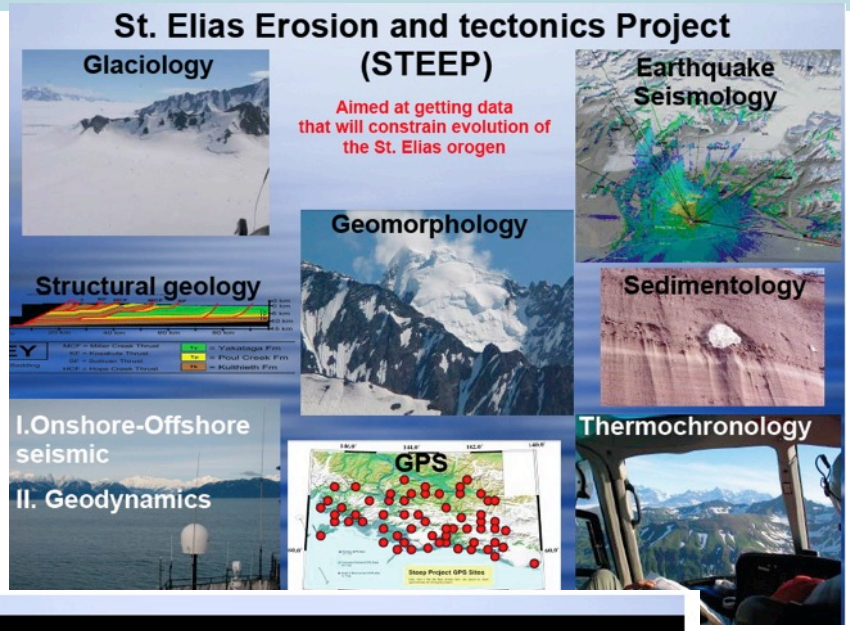


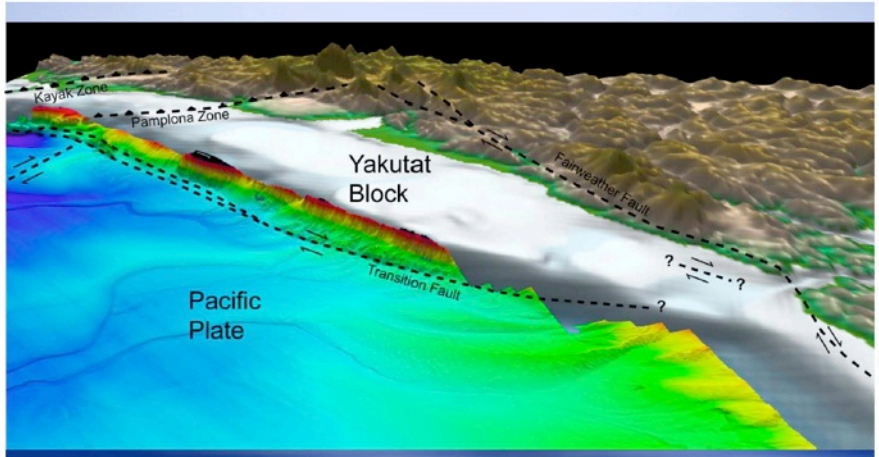
R/V Langseth conducted a seismic tomography experiment on the Endeavour segment of the JdF Ridge. During the 30-day leg, 68 four-component, ocean bottom seismometers (OBSs) were deployed in a 90x50 km2 area. (Toomey, 2009)

2008 – Yakutat Bay- (Gulick)

Imaging and Mapping Tectonic-Climate Interactions in the Gulf of Alaska:







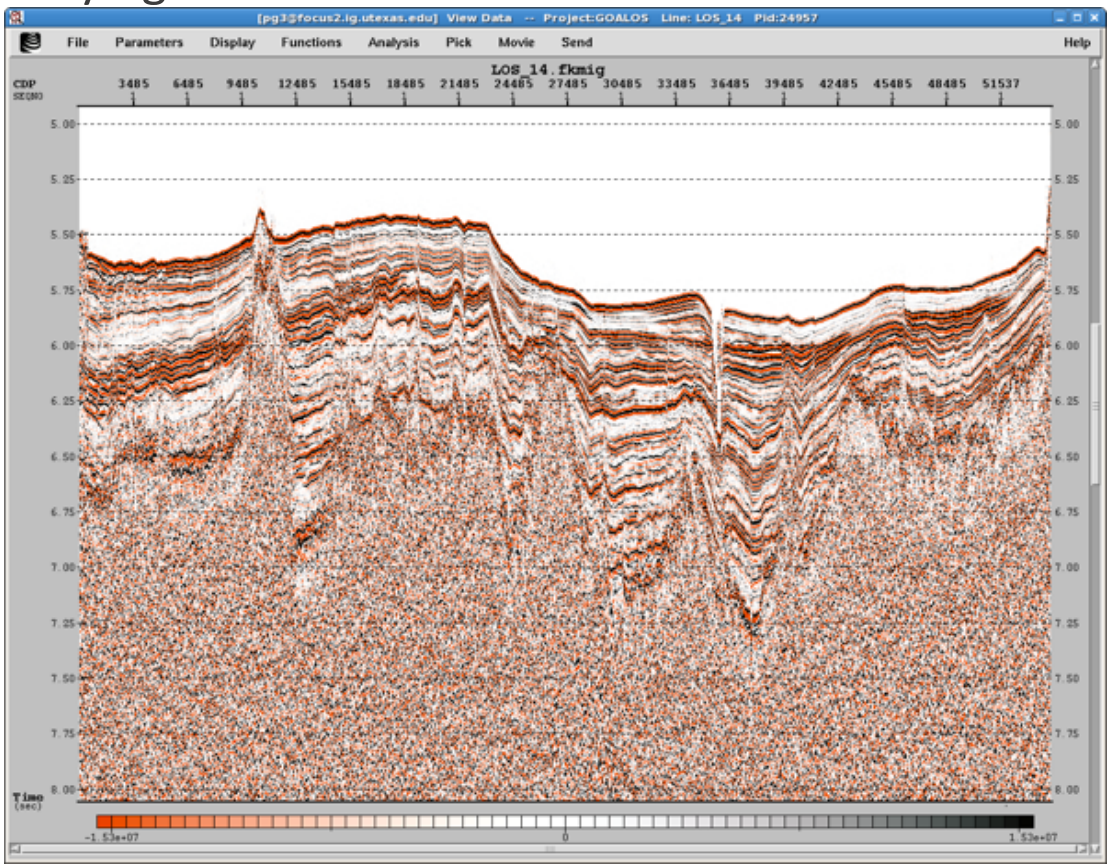
Produced new images of Pamplona Zone, Dangerous River Zone, and Transition fault
Penetrated to basement for the first time in the Gulf of Alaska
Recorded arrivals through entire thickness of Yakutat Block
See posters on Friday for science results (T53B-1941, T53B-1942)

Image from Gulick et al., Geology 2007

USGS Extended Continental Shelf

Gulf of Alaska, June 4 – 26 , 2011 (Childs, Barth, and Gulick)

Image from MGL_1109 shot across the southern end of the Baranof Fan showing an unconformity about midway down the section that predates the Fan, an older extensive channel that likely helped build the Fan, and two small modern channels overlying the older more extensive channel.

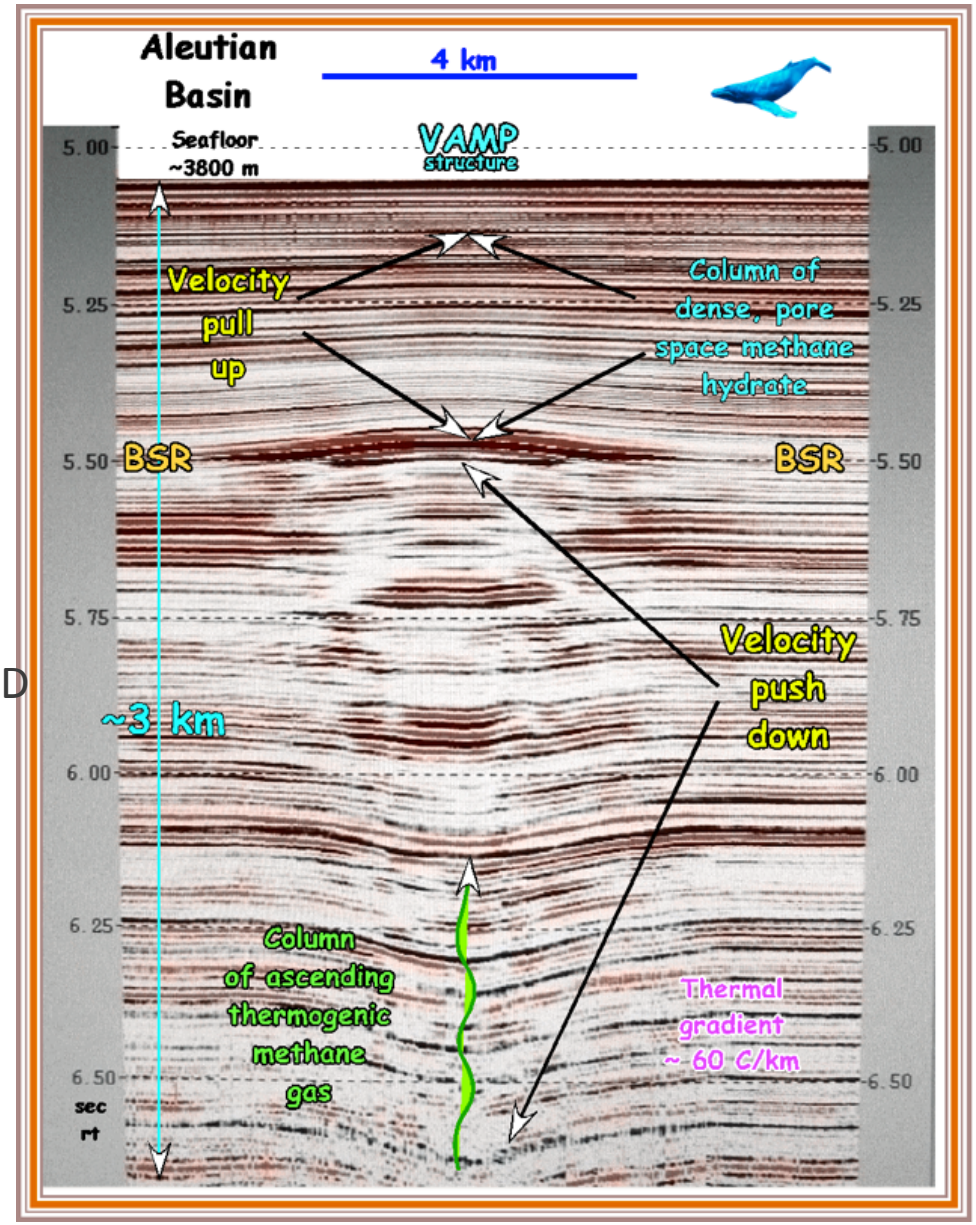


Bering Sea – 2D MCS Mapping

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

Bering Sea- Aug 2011 (Barth and Scholl)
Right, Large velocity amplitude (VAMP) anomaly structure on Line 1.
VAMP structures like to center themselves over basement knolls or maybe deeply buried seamounts.

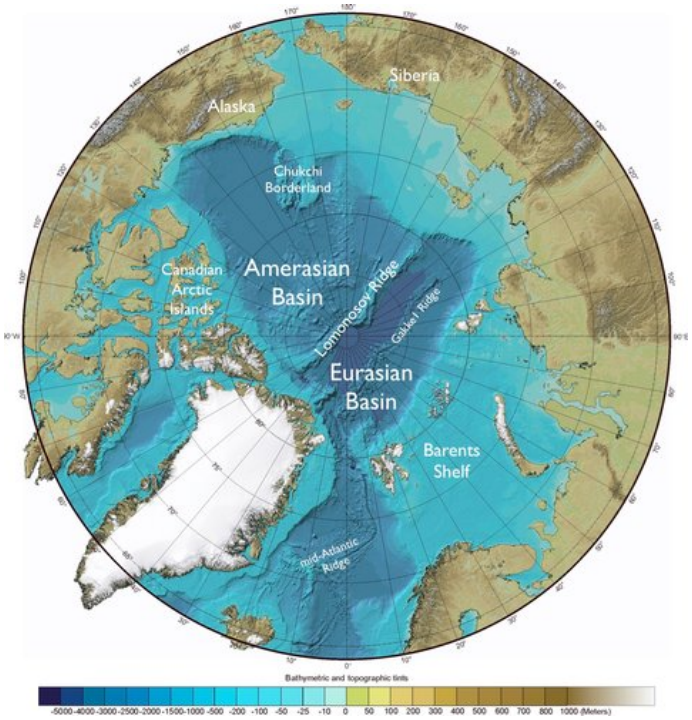
Left, Crew getting ready to launch CTD rosette to collect water sample and velocity profiles from deep part of Bering Sea

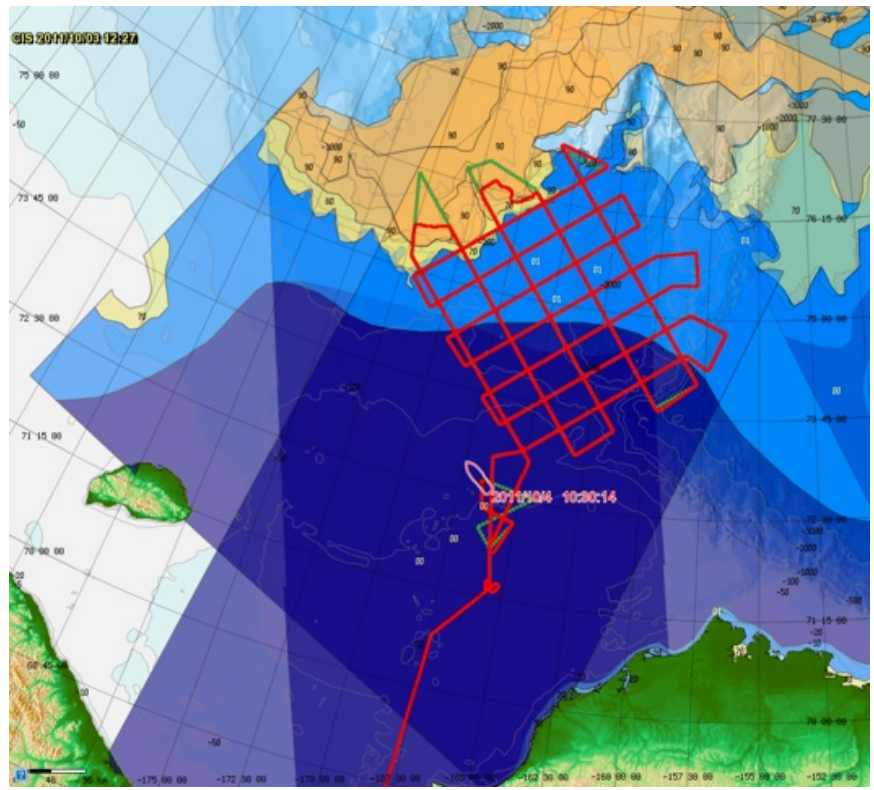


Chukchi Borderlands, Arctic Ocean–(Coakley)

Cruise Goals

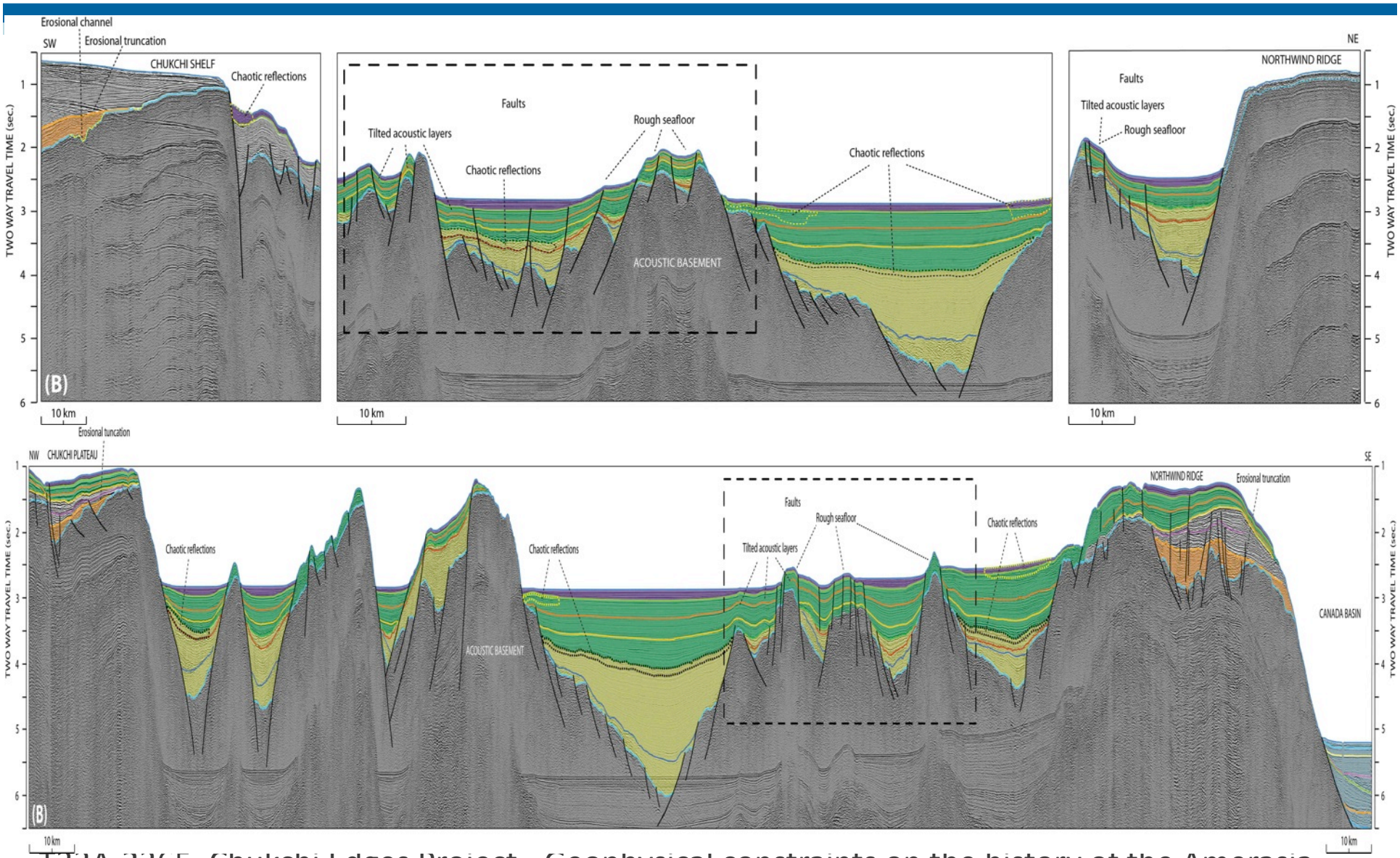
- Image Southern Edge Structure and Inter-correlate wells
- Test models for the opening of the Canada Basin
- Develop age controls on Arctic Ocean Stratigraphy





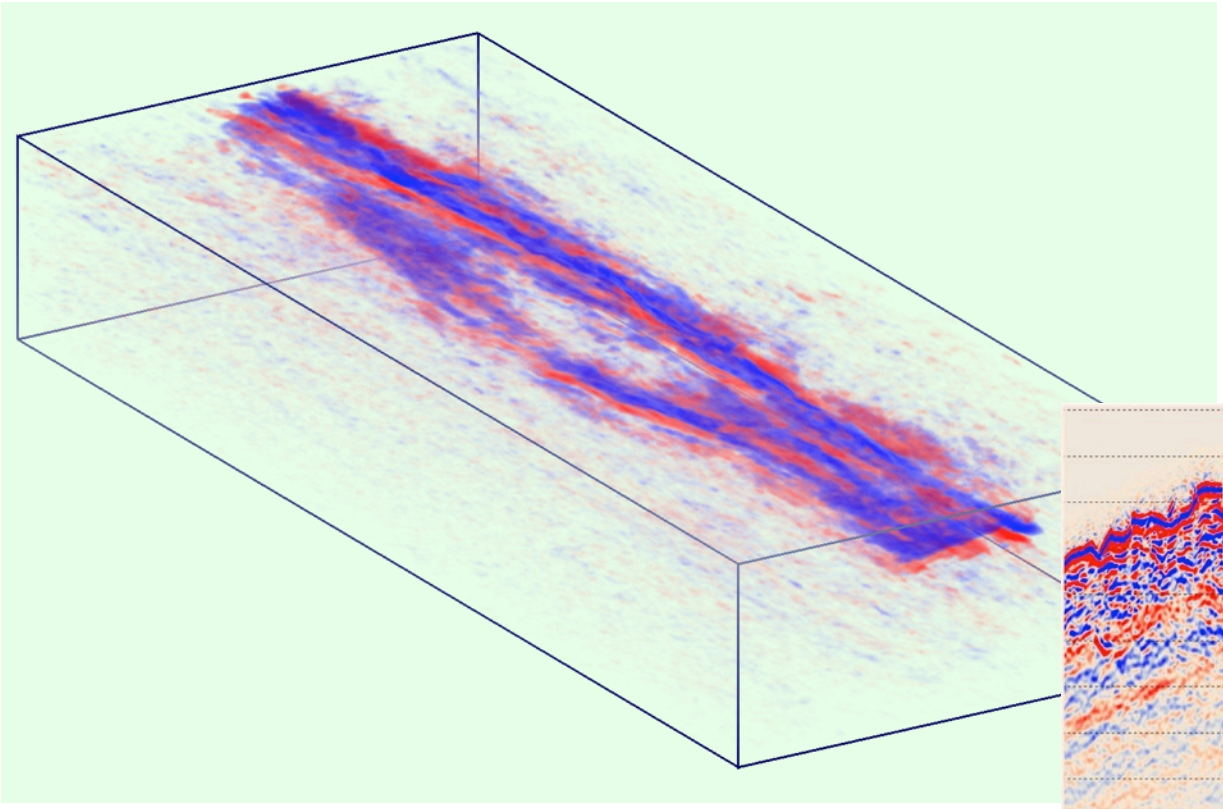
~5200 km of MCS reflection data in 5 weeks.

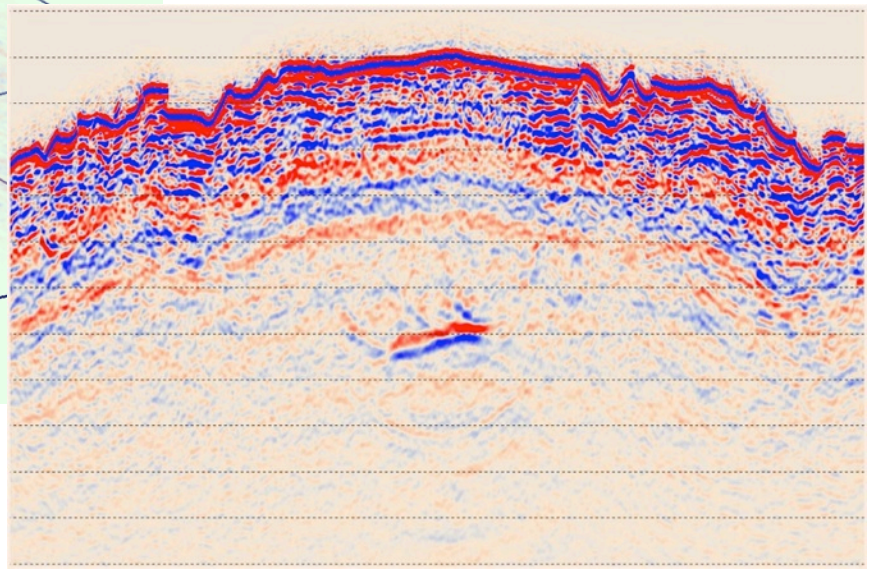
Chukchi Borderlands, Arctic Ocean–(Coakley)



T33A-2365. Chukchi Edges Project - Geophysical constraints on the history of the Amerasia Basin. *Bernard Coakley; Ibrahim Ilhan*

2008 East Pacific Rise 3D Survey





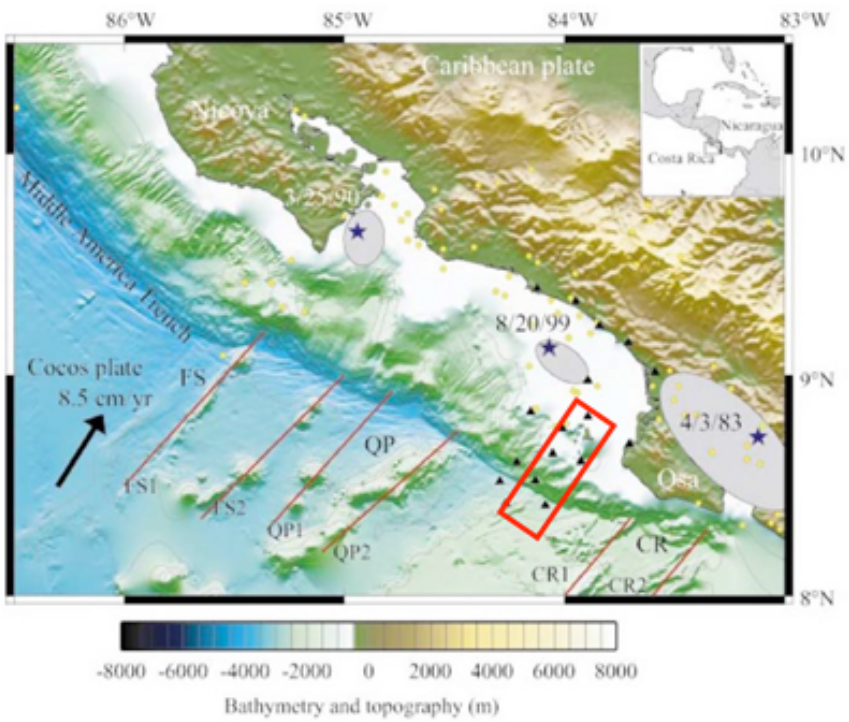
3D seismic data cube from 2008 East Pacific Rise Study on R/V *Langseth and a* Cross-section from the processed showing seafloor (top) and magma sill (center) reflections. (Carton, AGU 2009)

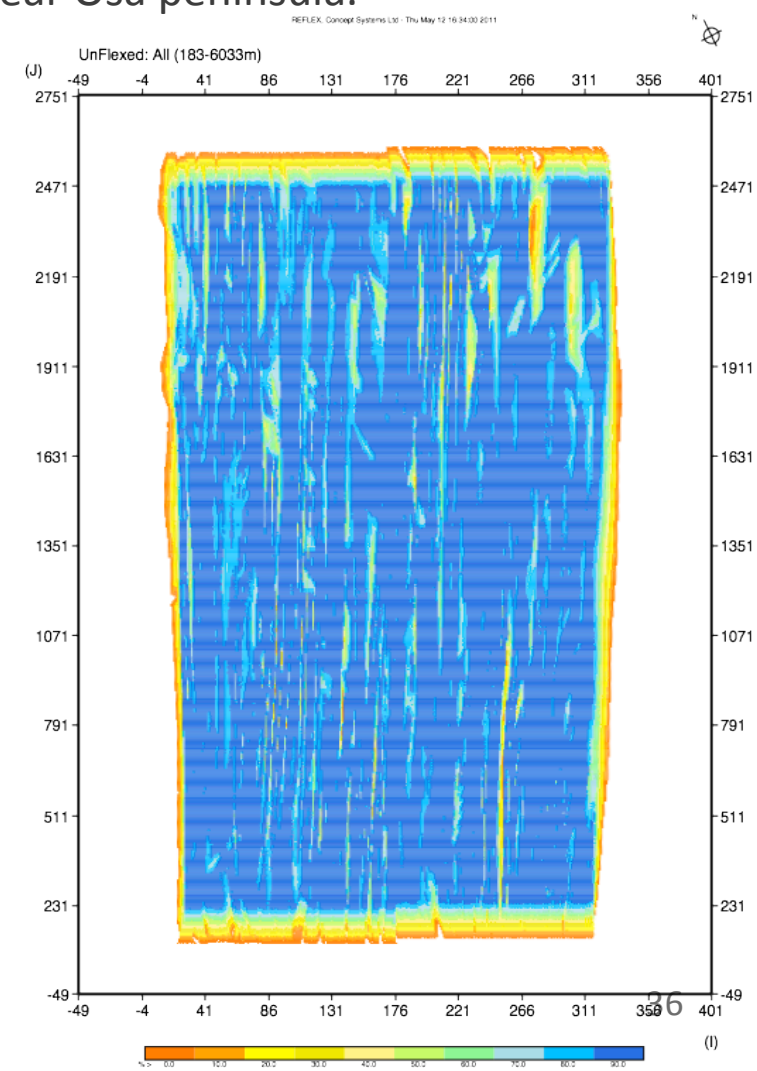
Costa Rica Seismogenesis Project (CRISP)

Offshore Costa Rica (Bangs)- April/May 2011

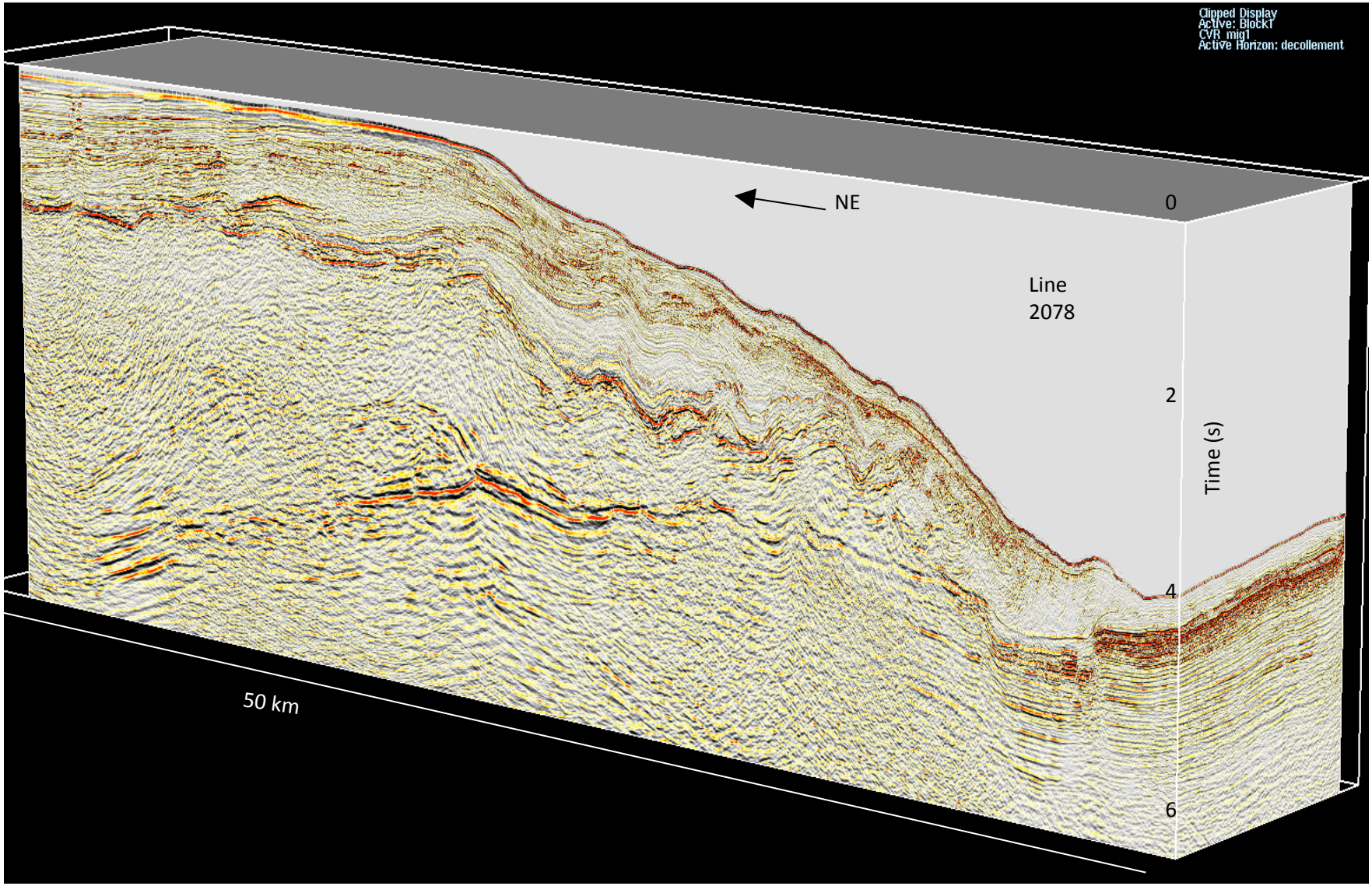
This project acquired a 11 x 55 km volume of 3D seismic reflection data to examine the 3D structure of the Costa Rica convergent margin near Osa peninsula.

Below, regional map of the Middle America subduction zone. The gray ovals are recent earthquake slip areas. The red box is the planned survey area.
Right, Final 3D coverage achieved over survey area where shades of blue =70-100% coverage.

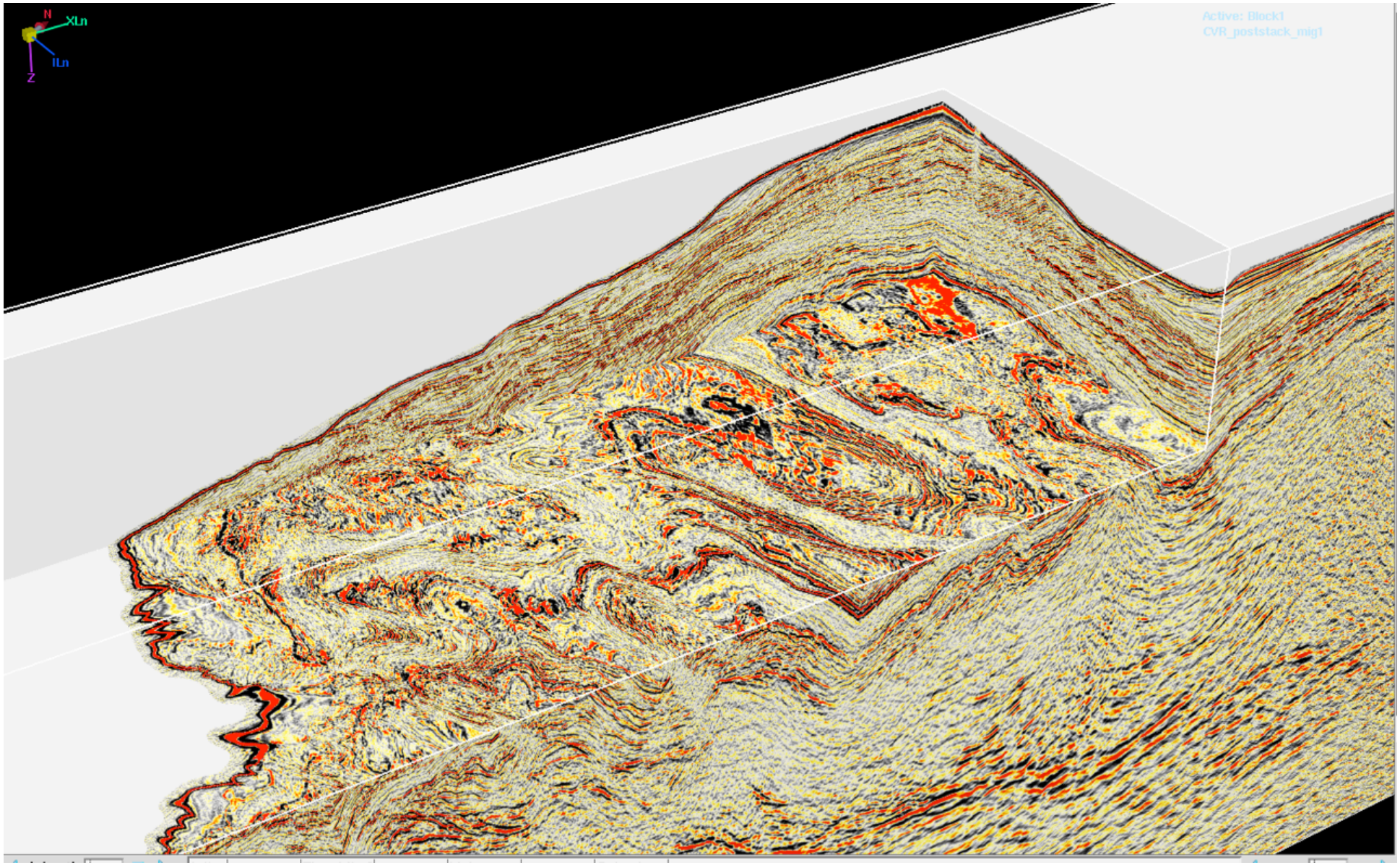




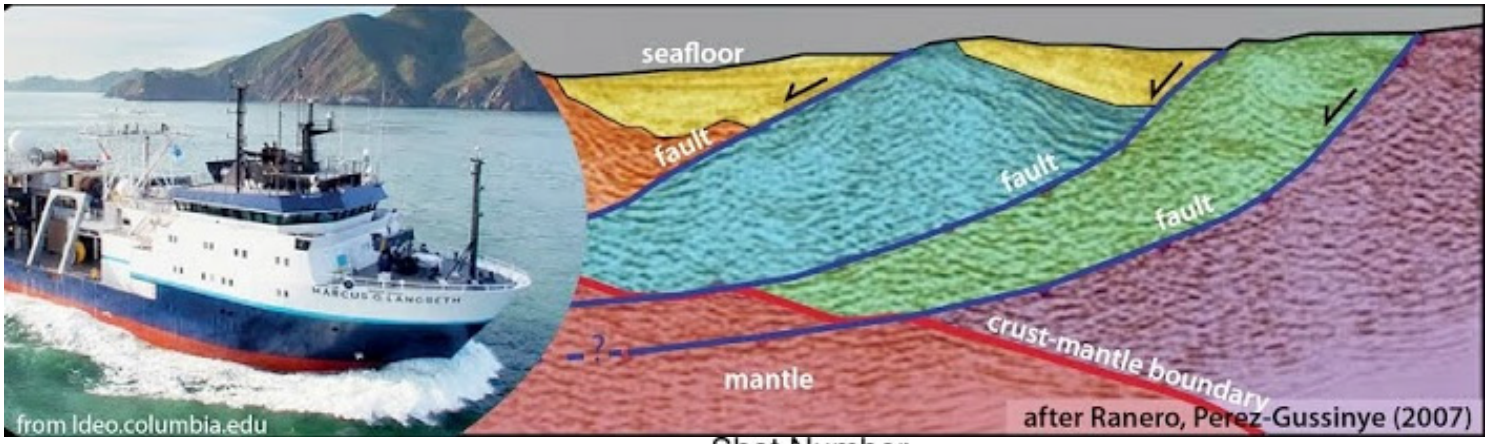
3D Seismic Imaging

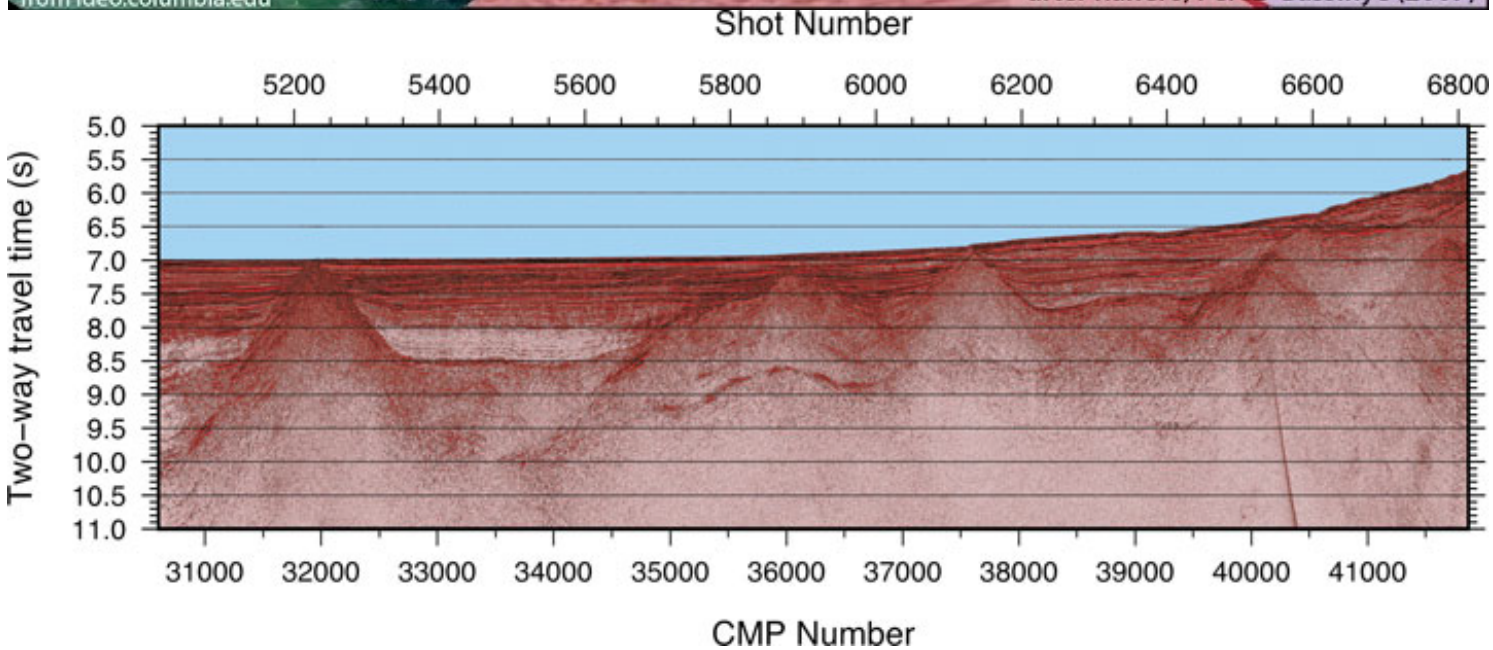


Power of 3D



3D Imaging of the Galicia Basin



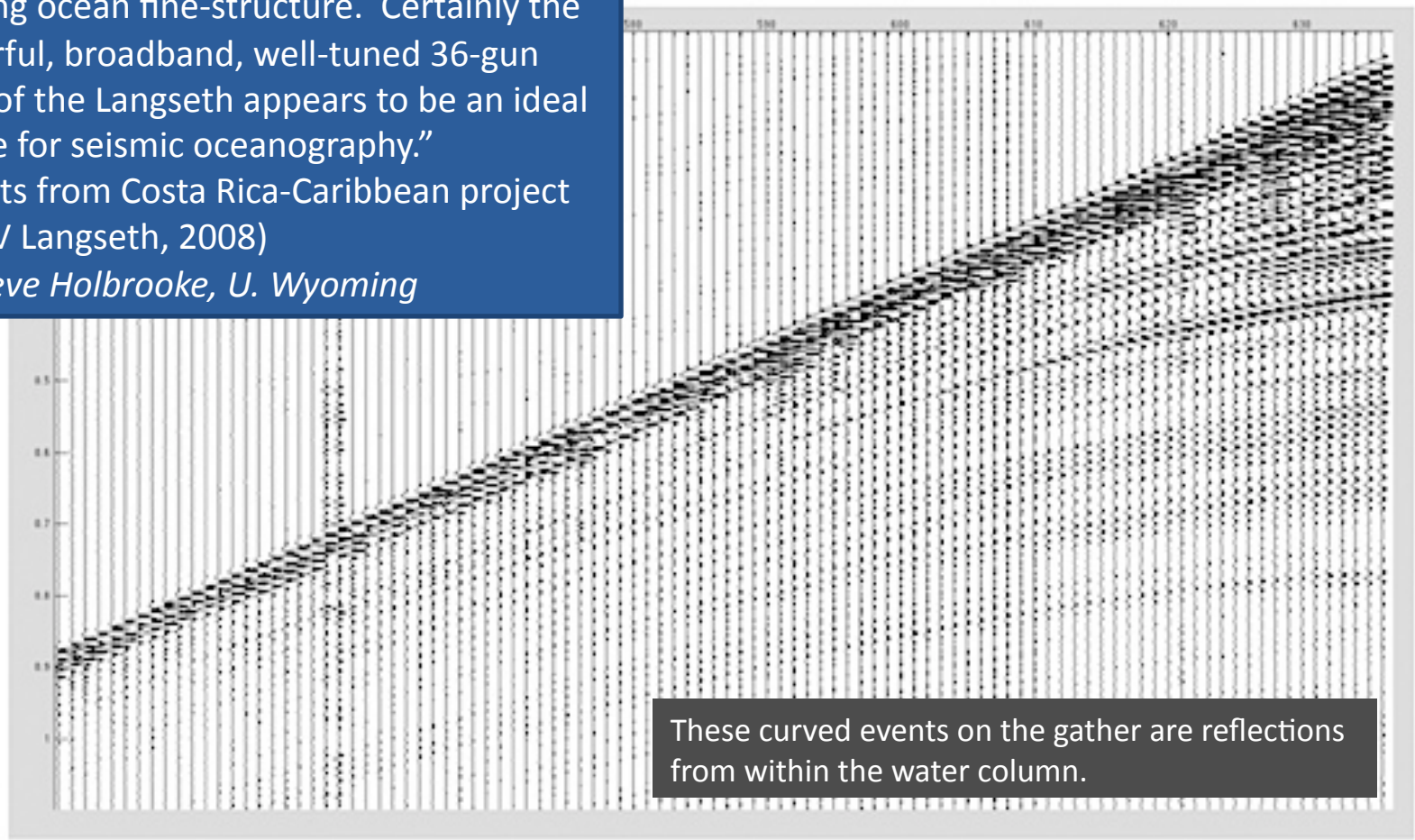


Images from Sawyer et al. MGL13-07 Cruise blog http://galicia3d.blogspot.com/

2008 - Costa Rica- (Seismic Oceanography)

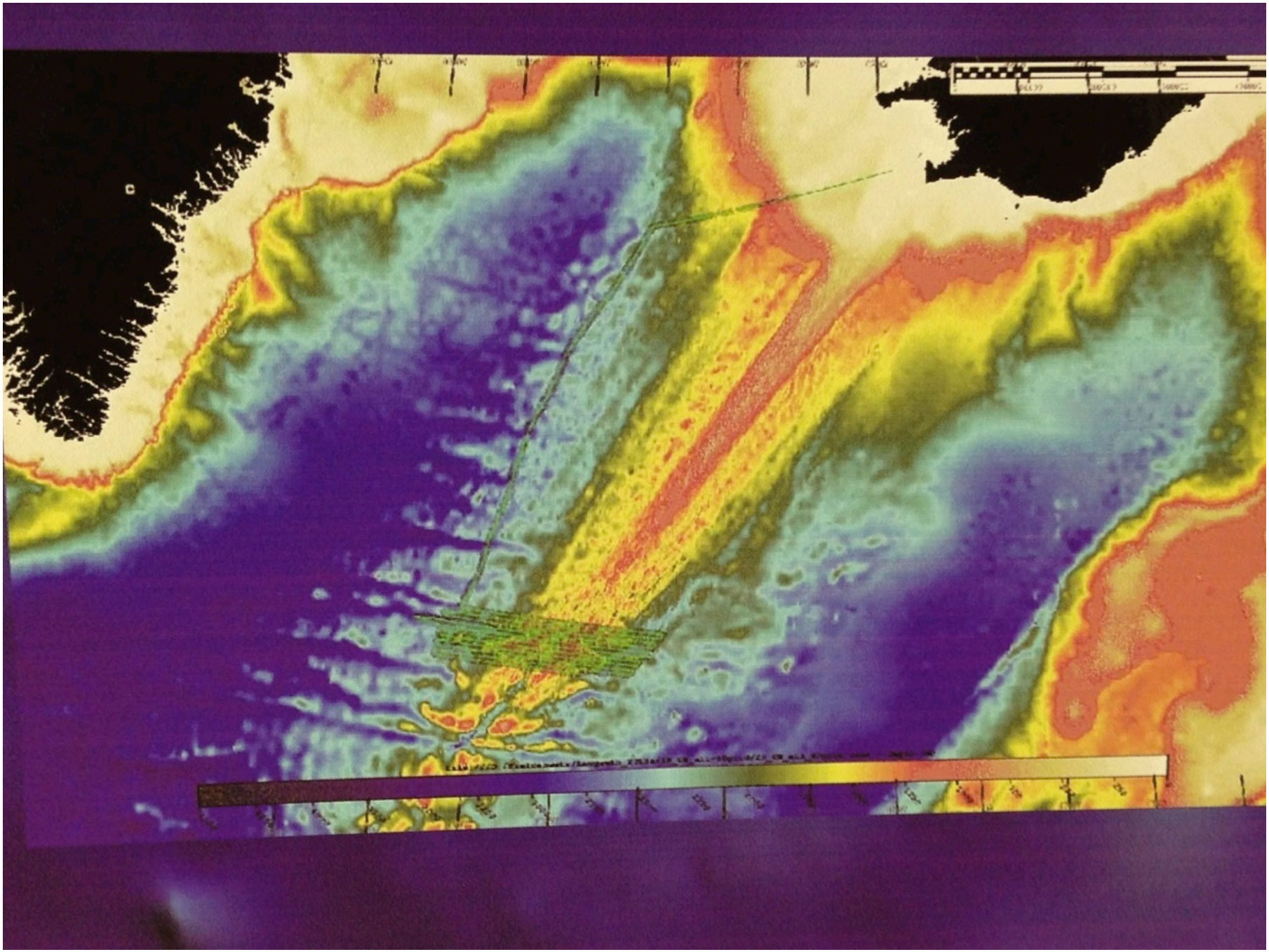
This shot gather, co-located with the XBT, shows very clear, high S/N reflections from even this subtle fine structure. This is achieved with a well-tuned 36-gun, linear array.

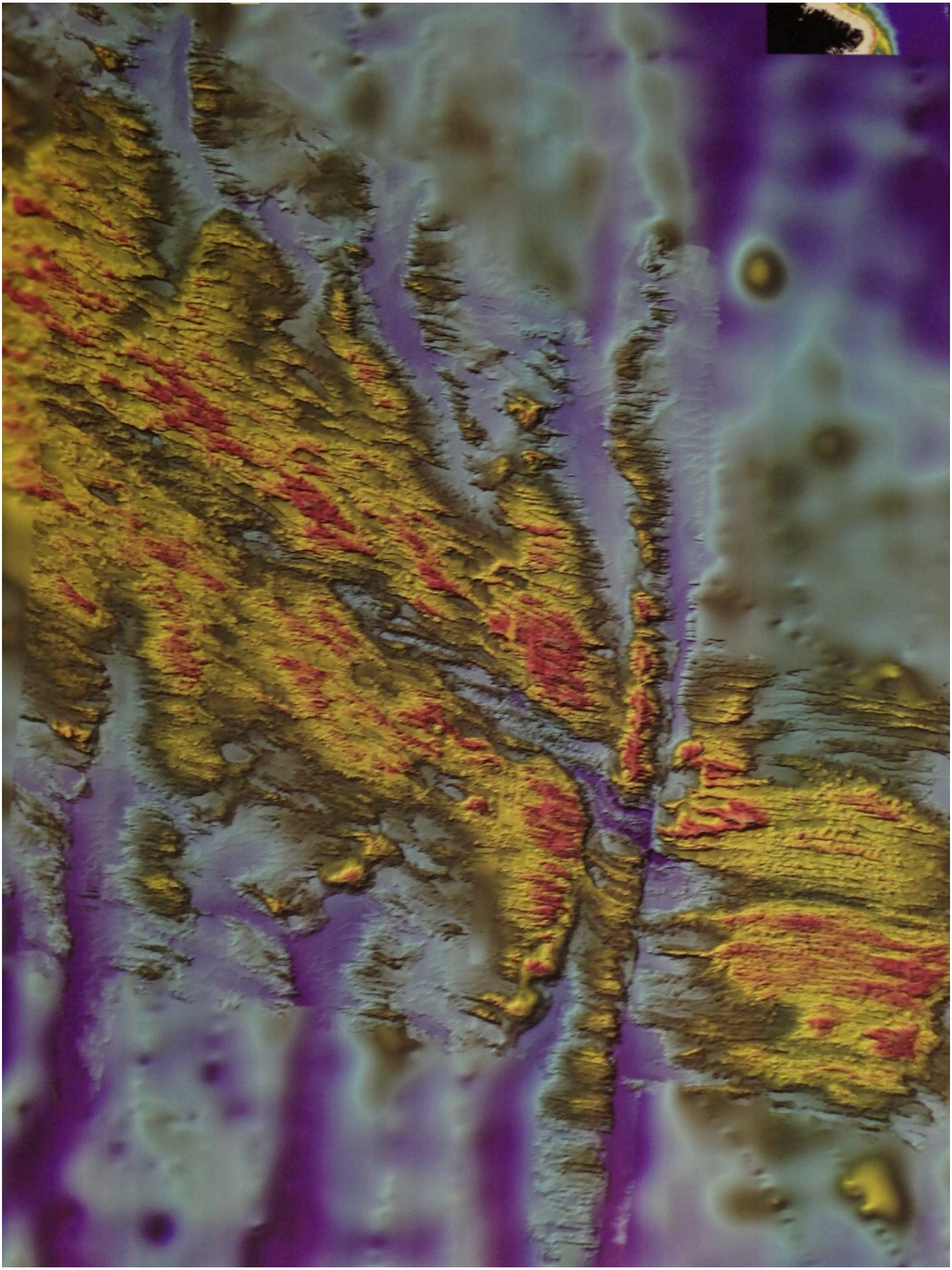
"We believe these results will redefine the sensitivity of seismic reflection data in imaging ocean fine-structure. Certainly the powerful, broadband, well-tuned 36-gun array of the Langseth appears to be an ideal source for seismic oceanography."
(Results from Costa Rica-Caribbean project on R/V Langseth, 2008)
Dr. Steve Holbrooke, U. Wyoming



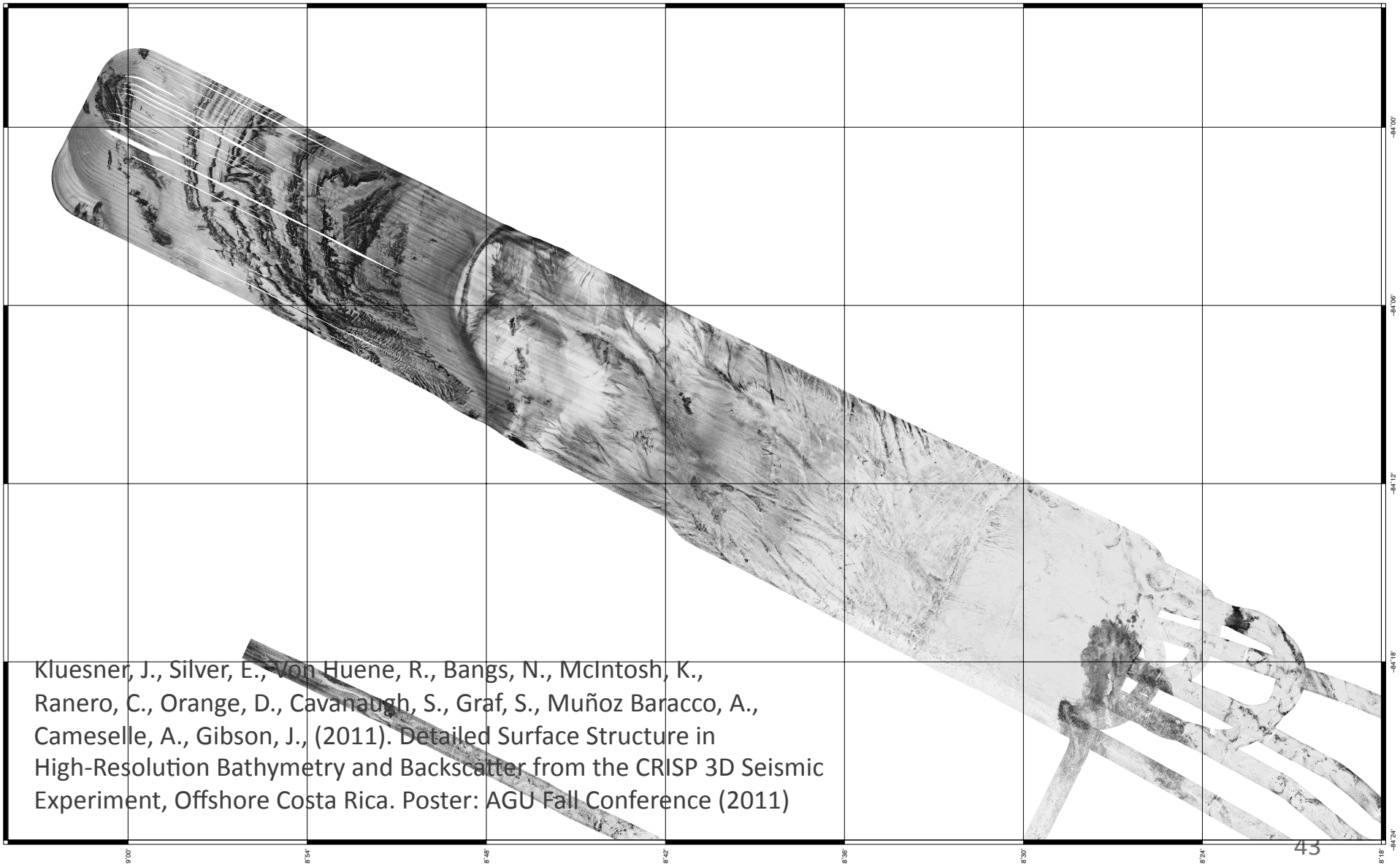
These curved events on the gather are reflections from within the water column.

Bathymetric Mapping - S. Reykjanes Ridge, 2013 (Hey, Martinez, et al)



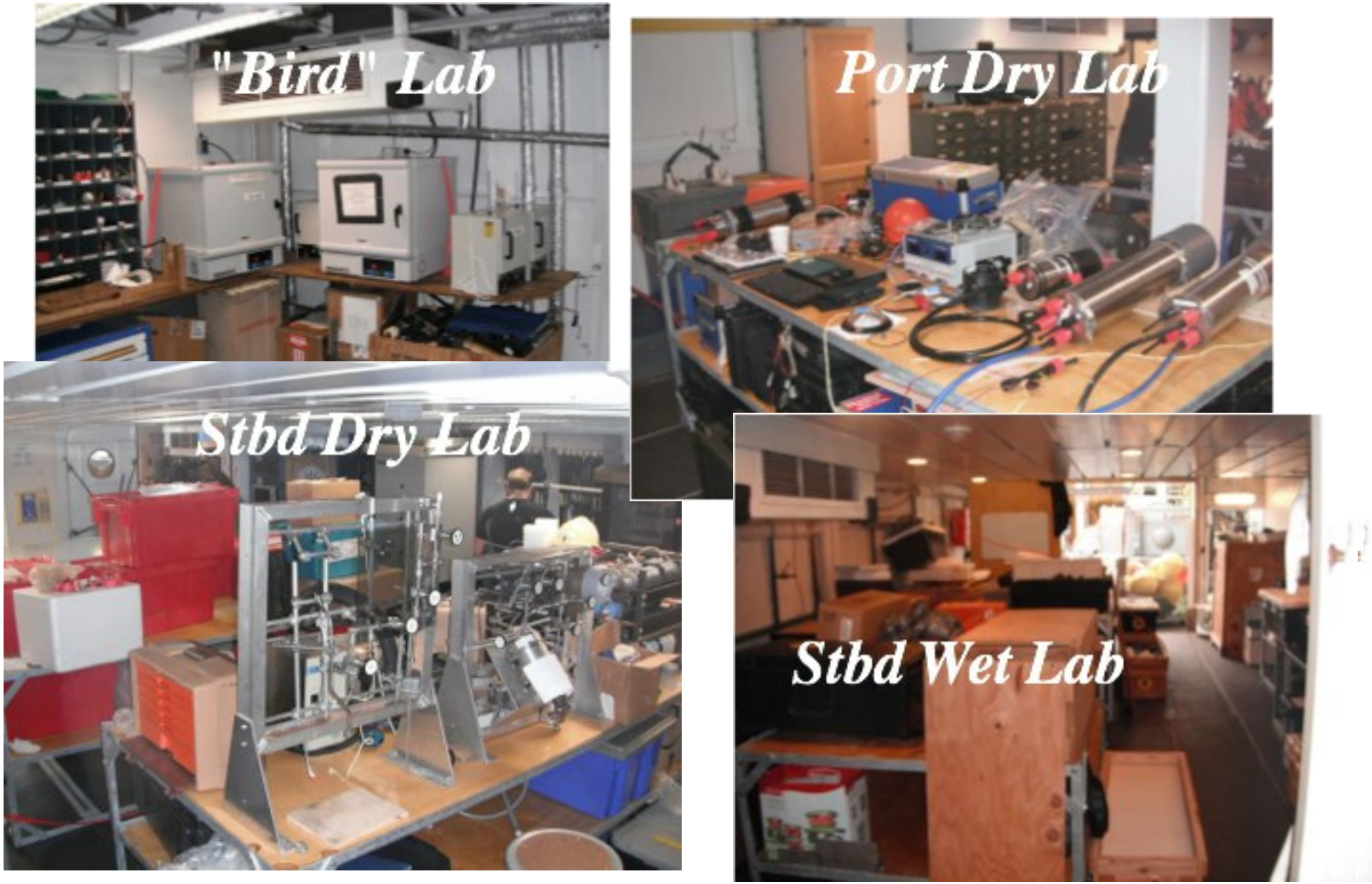


High-Resolution Reflectivity Data –(Bangs)



Kluesner, J., Silver, E., Von Huene, R., Bangs, N., McIntosh, K., Ranero, C., Orange, D., Cavanaugh, S., Graf, S., Muñoz Baracco, A., Cameselle, A., Gibson, J., (2011). Detailed Surface Structure in High-Resolution Bathymetry and Backscatter from the CRISP 3D Seismic Experiment, Offshore Costa Rica. Poster: AGU Fall Conference (2011)

MGL12-16 – JASON ROV Cruise- LABS



MGL12-16 – JASON ROV Support Vans

JASON Control and support vans on OBS deck (below). A total of 5 vans were onboard in addition to JASON/ Medea equipment.

OSU LAB van in use during MGL12-16 (above)

Tivey/Butterfield - JASON ROV Cruise

On right, photo of Main deck layout of Medea/ winch, LARS crane, JASON and HPU, and support van.

Below, JASON on main deck..

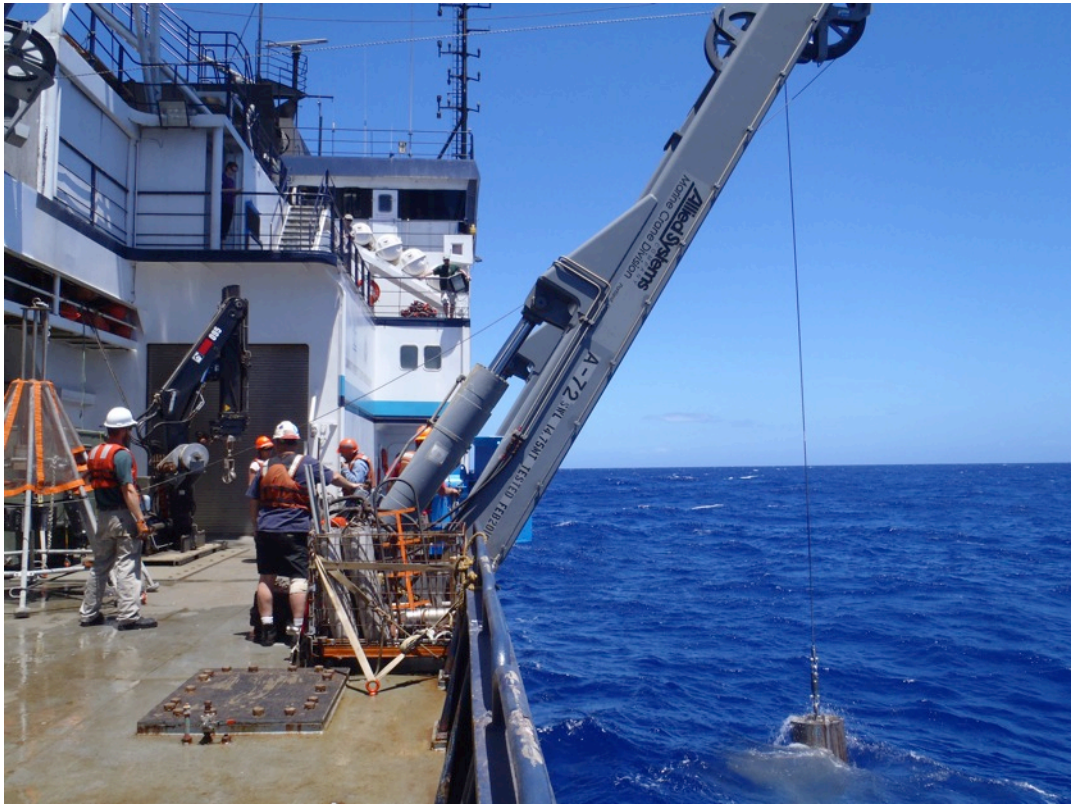
JASON Dive Photos

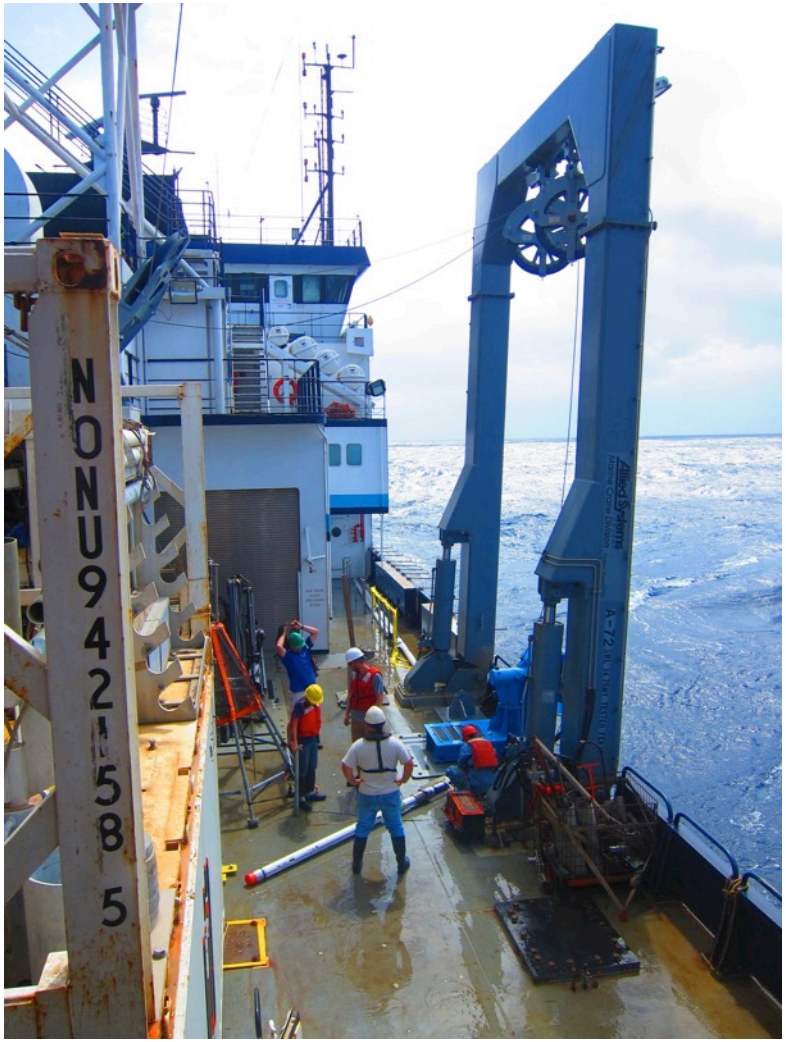
Below, photo from JASON camera during dive on Axial Seamount site. A total of 4 dives were completed along with other equipment deployments and CTD's.

Above, JASON at CORK Site 857D. Note "Octopus" staffing the site and assisting with maintenance.

Deck Space for Line Islands Coring Cruise

The main deck space on Langseth was loaded with OSU coring equipment, MST van, Hiab Crane, multi-corer, CTD rosette, and core support equipment

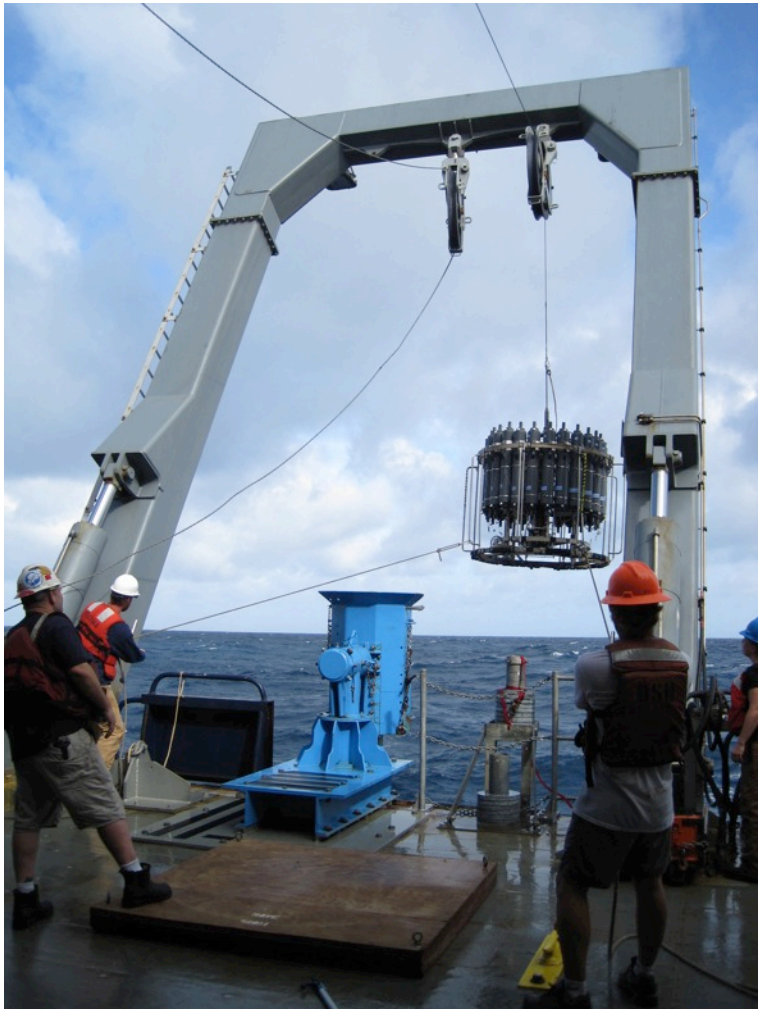




CTD Deployments for Line Islands

Lamont-Doherty Earth Observatory
Columbia University | Earth Institute

The CTD deployments for water sampling on Line Islands



MARCUS G. LANGSETH