

GEOFYSICAL SURVEYS: What are Seismic Surveys and How are They Done?

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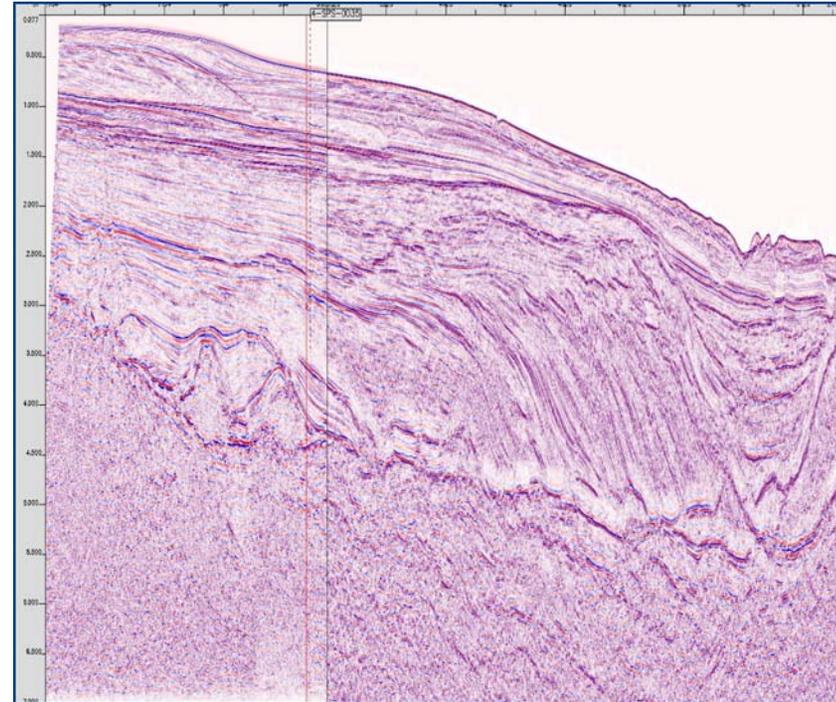
Marine Geophysical Exploration

Purpose

- Image the subsurface
- Evaluate the acreage
- Identify potential hydrocarbon accumulations

Reducing risk – fewer wells

- Condemns non-prospective areas
- Replaces drilling as an exploration tool
- Delineates reservoir boundaries



Reducing risk – drilling hazard prediction

- Ensure load-bearing ability of substrate. Seismic surveys help to avoid:
 - high pressure shallow gas/hydrates, etc.
 - Pore pressure prediction – shallow and deep

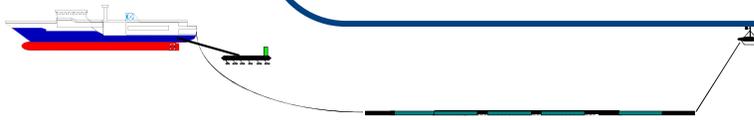
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Imaging Using Sound Waves



Ultrasound and Seismic imaging are based on the same fundamentals.

Sound energy is generated and received by specialized equipment and processed into a final image that is interpreted.

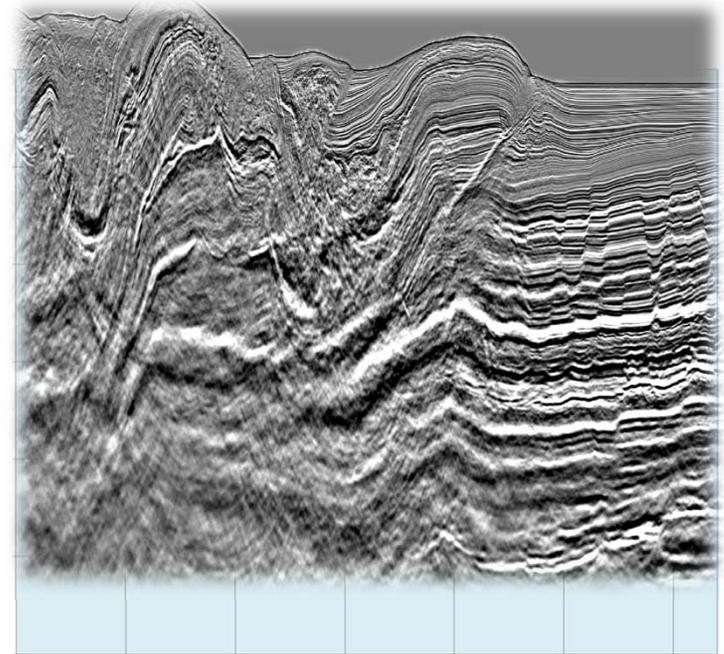


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Marine 2D Seismic Survey

- The vessel sails along a predetermined path
- Every 10 seconds the source emits an air bubble
- The energy enters the earth and is reflected back up to surface like an echo
- The recording units “listen” for the reflected “echoes”
- The “echoes” are processed into a final image



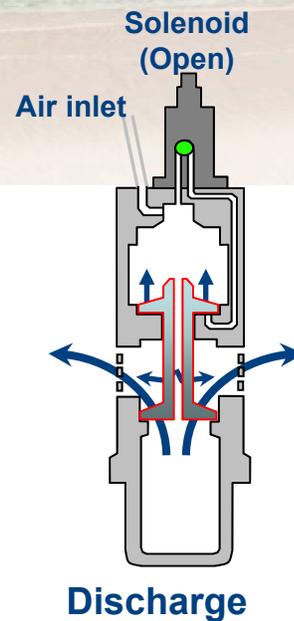
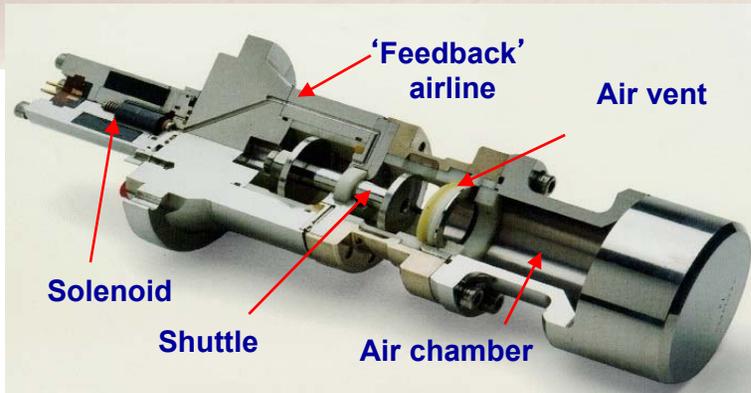
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Generalized Boat Diagram



SOURCE



Typical Volume



Each source element is about the size/volume of a large bottle of coke

Elements are combined to form larger arrays

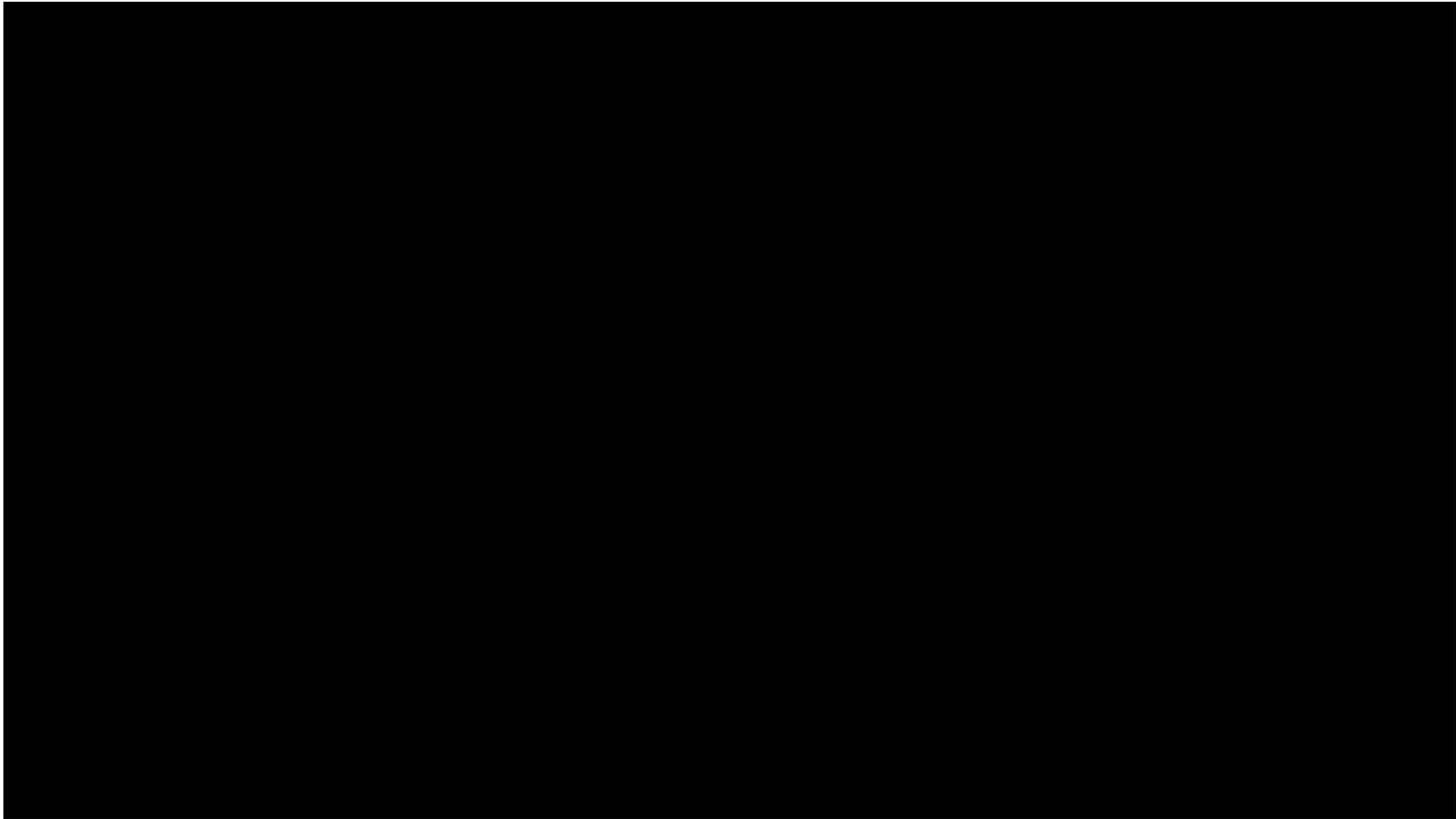
Typical Pressure



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Does a seismic source really sound like a “sonic cannon”?

See the video at <http://http://www.iagc.org/videos-and-images.html>

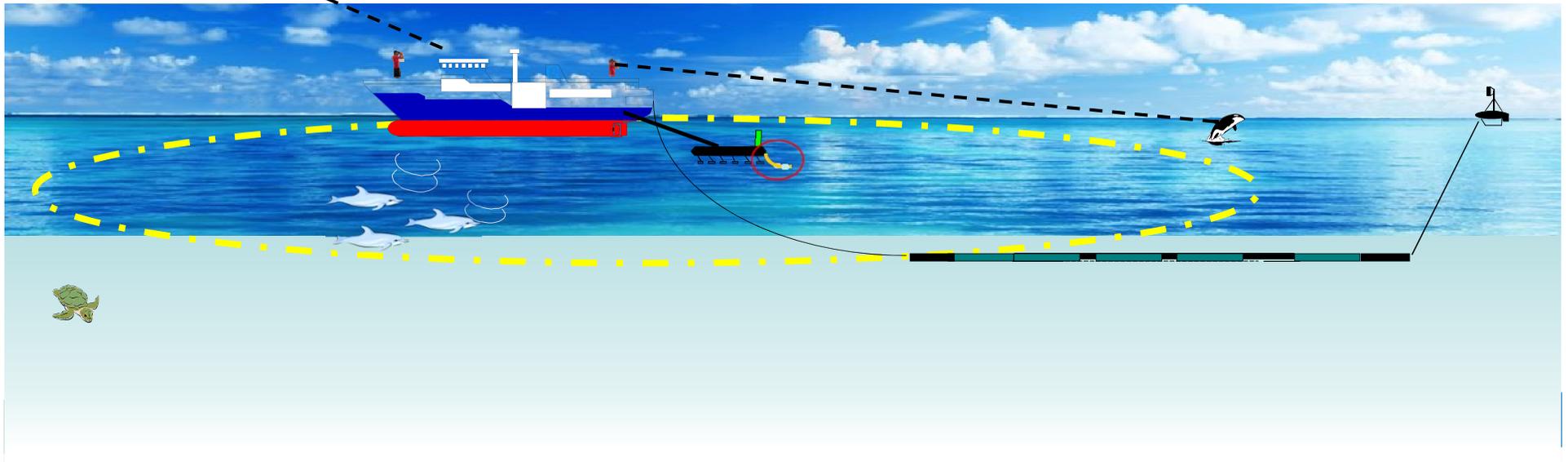


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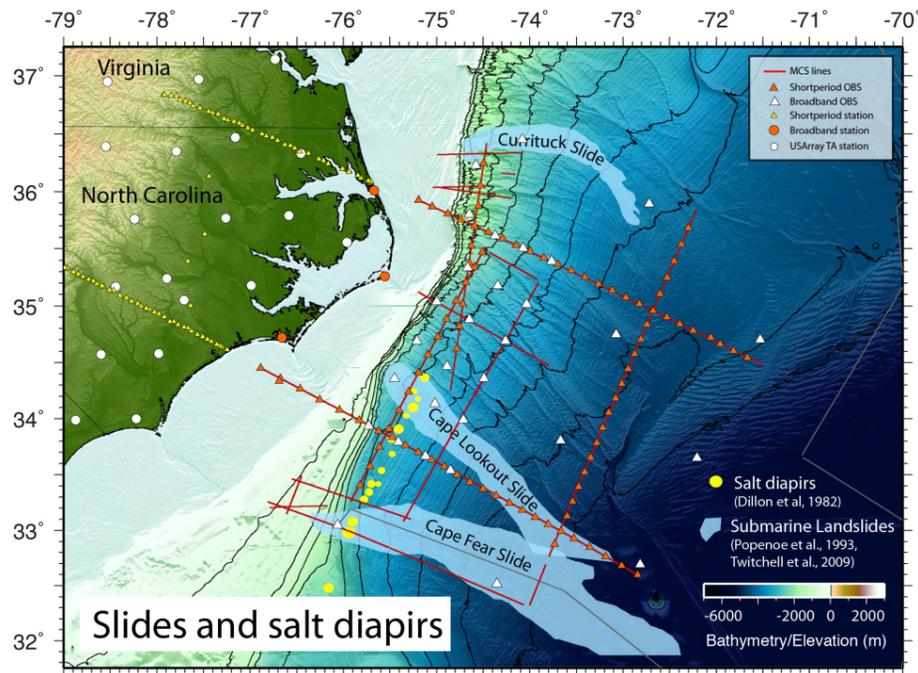
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Geophysical Industry Mitigation Measures

- Exclusion Zones - *500m from center of source array*
- At least 30 minutes all clear – *prior to activating seismic source*
- Ramp-Up or Soft-start - *over a period of at least 20 minutes*
- Shut-Down - *for marine mammals*
- Visual Monitoring - *during daylight hours, before and during surveys*
- Passive Acoustic Monitoring - *method to detect vocalizing marine mammals*



Scientific Seismic Surveys in the U.S. Atlantic OCS



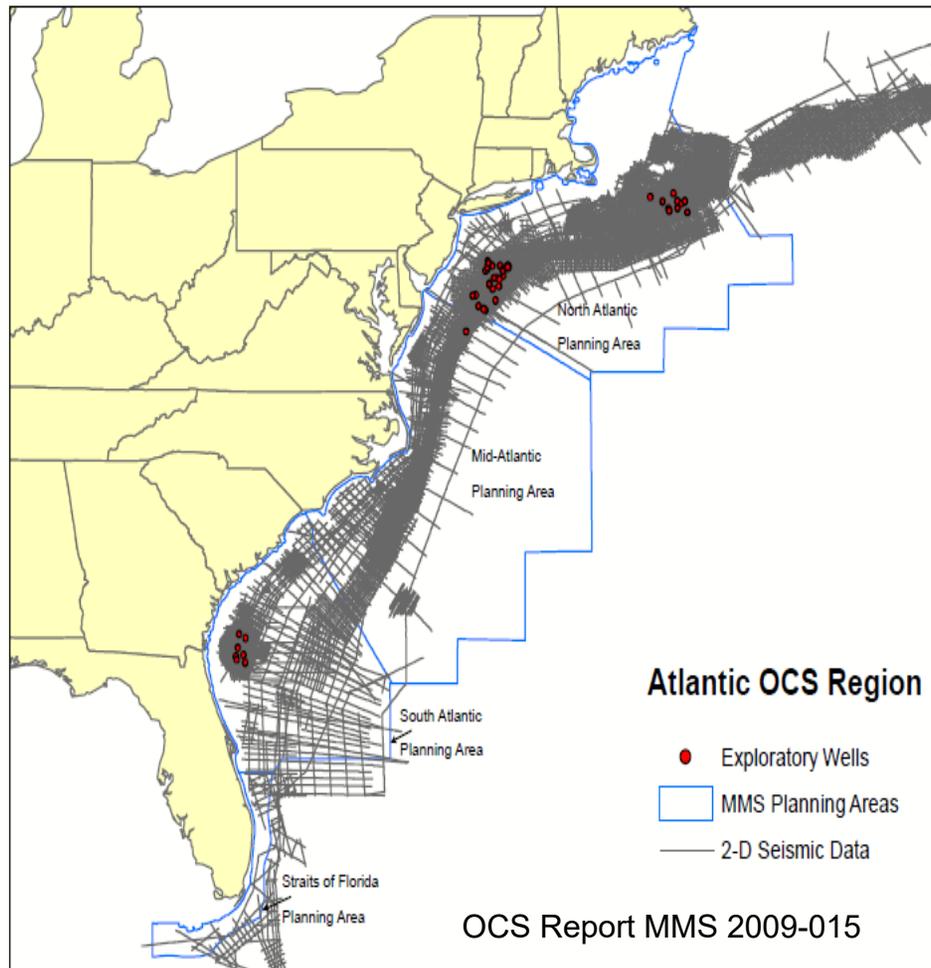
MGL1408 cruise report v2 w/ appendices

Courtesy of Dr. J.H.Knapp - USC Earth & Ocean Sciences

- Conducted periodically in Atlantic OCS over last 50 years
- Sept – Oct 2014: 3,000 miles collected offshore Outer Banks, NC
- 3D seismic survey offshore New Jersey June – August 2015
- Seismic is also used during planning and installation of offshore renewable energy facilities

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Oil & Gas Seismic Surveys in the U.S. Atlantic OCS



- Last phase exploration 1975 – 1983
- ~380,000 line km 2D seismic data
- 46 Industry Wells
- 5 Continental Offshore
- Stratigraphic Tests (COST wells)
- One small 3-D survey offshore New Jersey

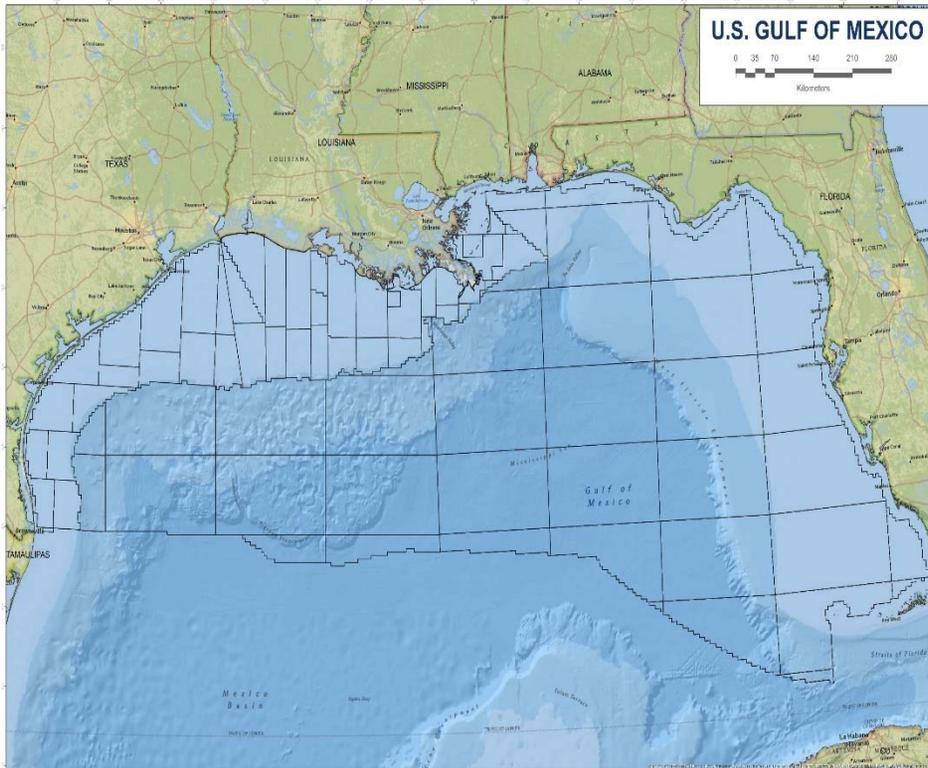
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Courtesy of Dr. J.H.Knapp - USC Earth & Ocean Sciences

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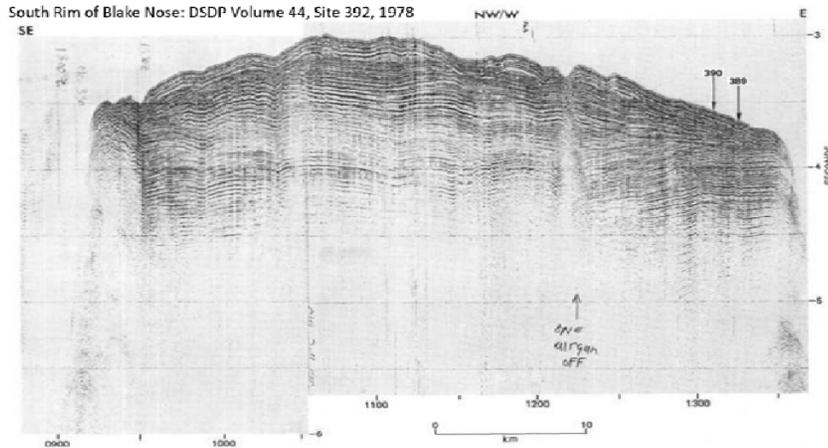
Seismic in the U.S. Gulf of Mexico



- 1937 - Western Geophysical begins marine survey operations in the Gulf
- 1944 - Extensive Marine operations began
- 1976 saw the first 3D seismic survey (Western and GSI)
- In 1981, there were 50 marine crews in the Gulf of Mexico
- 1995 first 4-Component collect in Gulf
- Seismic is also used during planning and installation of offshore renewable energy facilities

History of Seismic in the Gulf of Mexico

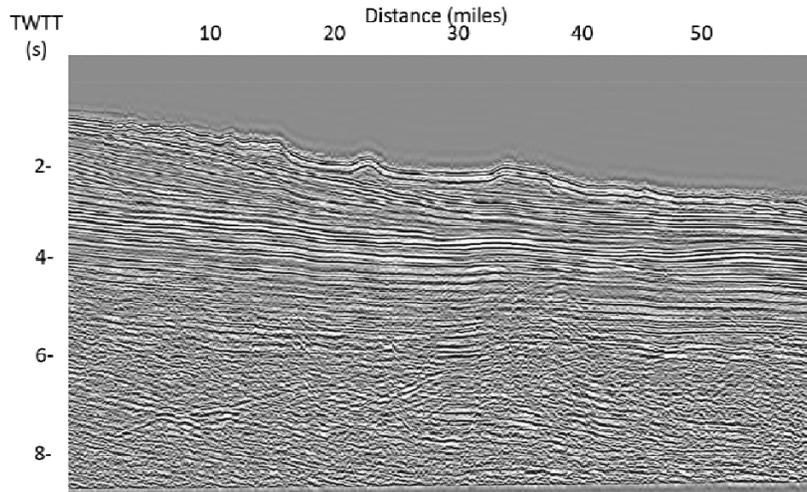
1970's 2-D Data



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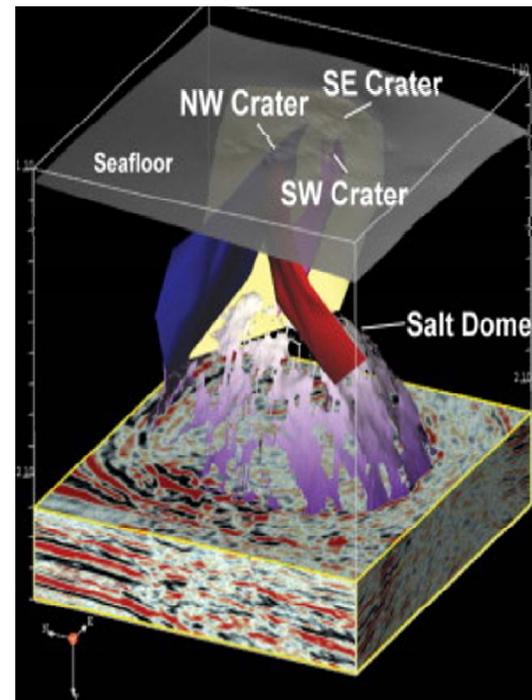
1980's 2-D Data



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Modern 3-D Seismic Data



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- Detailed analysis of geologic structures
- Prospect evaluation of formations and fluids
- Economic analysis of recoverable resource
- 70% success rate for wells

Courtesy of Dr. James Knapp

Impact on Fisheries

The Gulf of Mexico has the most active survey program in the world.



And supports a seafood industry worth nearly \$1 billion a year that directly supports more than 120,000 jobs.

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Addressing Recreational and Commercial and Tourism Activities

Consultative Process to Ensure Coordination

- Prior to operations, meetings are held with commercial and recreational fishing entities:
 - Explain seismic survey activity
 - Gain mutual knowledge of operations
 - Establish working relationship for future coordination
- During operations, communications are maintained:
 - Providing status updates on progress of seismic project
 - Informing commercial and recreational fishing entities of vessel position and safe distances



Photo: Joey Crowley

Seismic operations, tourism, and commercial and recreational fishing successfully coexist!

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The Science

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The Record: No Evidence of Potential Injury

“To date, there has been no documented scientific evidence of noise from [acoustic sources] used in G&G seismic activities adversely affecting marine animal populations or coastal communities. This technology has been used for more than 30 years around the world. It is still used in U.S. waters off the Gulf of Mexico with no known detrimental impact to marine animal populations or to commercial fishing.”

-- BOEM Chief Environmental Officer William Brown



This was reiterated by BOEM Director, Abby Hopper. She stated that there has been no known instance of sound from seismic surveys harming marine life.

--House Natural Resources, Subcommittee on Energy and Mineral Resources hearing, July 14, 2015

The Record: No Evidence of Potential Injury

NMFS:

- “[T]here is no evidence that serious injury, death, or stranding by marine mammals can occur from exposure to [acoustic source] pulses, even in the case of large [acoustic source] arrays.”

79 FR 12166 (March 4, 2014)



- “There has been no specific documentation of TTS let alone permanent hearing damage, i.e., permanent threshold shift (PTS), in free-ranging marine mammals exposed to sequences of [acoustic source] pulses during realistic field conditions.”

78 FR 33811 (June 5, 2013)

The Joint Industry Programme on Sound and Marine Life

- Where there are gaps in knowledge, we fund research for improved understanding of the effects of E&P sound on marine life.
- Effective policy and regulations will result from strong, independent science.

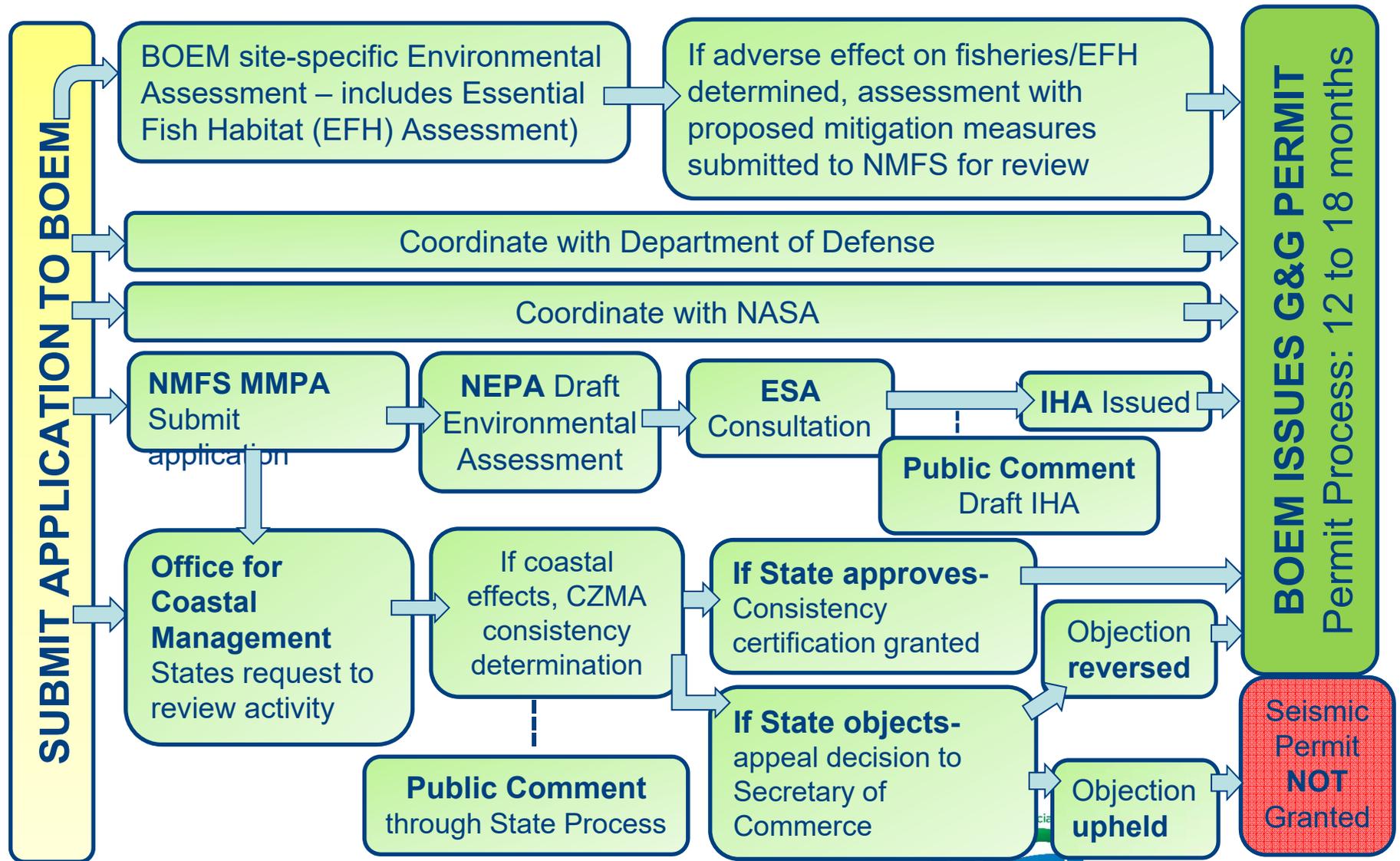


Total budget 2006-2016 ~ \$50M
Amount available 2014-2016 ~
\$18M

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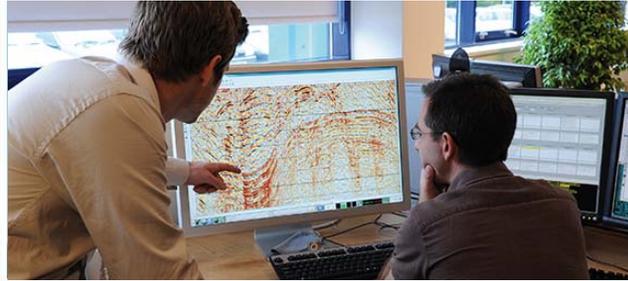
Applying for Permits and Authorizations: Atlantic OCS



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Summary

- **Geophysical exploration, specifically seismic acquisition, is a safe, proven, and efficient means to determine resource potential and eliminate potential downstream risk.**
- **Current accepted and prescribed regulatory requirements, industry practices and nearly 50 years of activity and studies have proven effective mitigations relative to seismic sources and any marine life concerns.**



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www.soundandmarinelife.org

www.crudeawakenings.com

www.iagc.org