High-resolution multichannel seismic data acquired by the U.S. Geological Survey with a sparker source on the U.S. Mid-Atlantic margin in 2015 on the R/V Endeavor (EN555)

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Between April 16 and 25, 2015, the U.S. Geological Survey (USGS) collected high-resolution seismic data on the upper continental slope of the Mid-Atlantic Bight from just north of Wilmington Canyon (offshore New Jersey) to just south of Norfolk Canyon (offshore Virginia) with support from the U.S. Department of Energy's National Energy Technology Laboratory. The purpose of the field activity was imaging shallow gas distribution, the structure beneath cold seeps, and possible bottom-simulating reflections (BSRs; although the sparker source is known to be poor at detecting BSRs)

The research cruise was carried out on the R/V Endeavor (operated by the University of Rhode Island), and the ship departed from and returned to port in Narragansett, Rhode Island. The survey was designated R/V Endeavor cruise 555 (EN555) and the USGS assigned Field Activity number 2015-004 at the USGS Woods Hole Coastal and Marine Science Center. Data acquired with the native shipboard instrumentation (e.g., navigation, environmental sensors, ADCP, Knudsen subbottom profiling) were automatically deposited with the Research to Repository (R2R) portal at: https://www.rvdata.us/search/cruise/EN555.

EN555 collected seismic data to support USGS Gas Hydrates Project activities in the mid-Atlantic Bight offshore Delaware, Maryland, and Virginia. Data acquisition, processing, and interpretation were funded by U.S. Department of Energy's National Energy Technology Laboratory through interagency agreements DE-FE000291 and DE-FE0005806. C. Ruppel was Chief Scientist for the cruise, and Jared Kluesner and then-UCSC graduate student J.H. Edwards processed the seismic data, with assistance from B. Danforth. USGS staff members E. Bergeron, T. O'Brien, C. Worley, and A. Nichols participated in seismic data acquisition and managed operations.

The sparker dataset consists of 30 multichannel seismic lines oriented mostly down the continental slope (dip lines) or parallel to the continental shelf (strike lines). Data were acquired primarily between 100 and 2000 m water depth, and the locations of many of the lines were chosen to sample areas that had been identified as hosting cold seeps in Skarke et al. (2014).

Seismic data were acquired using an Applied Acoustics Delta Sparker sound source attached to a surface-towed sled and operating at 2.4 kJ and usually firing at 5 s intervals. Seismic reflections were recorded using the USGS 72-channel (nine 50-m-long active sections) Geometrics GeoEel liquid filled streamer with a group spacing of 6.25 m. Birds were used for streamer depth control. The distance from the sparker source to the middle of first channel was 61.225 m and from source to the middle of the last channel was 510.5 m. The total streamer length was ~555 m.

For navigation, the USGS used its own GPS equipment (Hemisphere antenna) mounted on the 01 deck, not the ship's navigation, and measured the distance from the USGS GPS to the stern (30.8 m). Computers recording navigation, seismic data, and other datasets was synchronized with a Brandywine NTP server every 5 minutes. Data were recorded using UTM zone 18N and the WGS84 datum.

Individual seismic shot data were recorded with Geometrics acquisition seismic software at 0.5 ms with a 4.5 s record length. J. Kluesner, J.H. Edwards, and B. Danforth processed the seismic data. They read the SEGD files into SIOSEIS seismic processing software using the type 9 geometric parameter. Data were sorted into common-depth point (CDP) gathers using the SIOSEIS gather module and then written as SEGY files for each individual seismic profile.

SEGY files sorted to CDP gathers were then imported into the Seismic Unix seismic processing software using segyread and segyclean modules. Noise spikes were removed using the module sugain. Data were then sorted into shot gathers using the susort module and a bandpass filter was applied using sufilter and a frequency range from 80 to 700 Hz. FK dip filtering was applied by flattening the outbound wave, followed by separation of the outbound wave and subtraction from the flattened input, then flattening the inbound wave, separating it and subtracting it from the flattened input. This dip filtering step used the processing modules sushw, suchw, sustatic, sufilter, sudipfilt, and suop2. Data were then sorted back into CDPs using the module susort and RMS semblance velocity analysis was carried out using CDP super gathers and the module suvelan, whereas suximage was used for visualization of the semblance plots. RMS velocity picks were made on the semblance plots and were recorded along with the corresponding TWTT. Dip move-out and normal-move correction were then applied using the picked RMS velocities and the corresponding modules sudmofk and sunmo. CDP gathers were then stacked using sustack and post-stack migration was carried out using a smoothed velocity function and sumigps, a migration module that carries out migration through phase shift with turning rays. Following migration, the water column was muted using sumute and a trace mix was applied using sumix. The results were written to new SEGY files.

To smooth the CDP coordinates onto a discrete line for each seismic profile, C. Ruppel exported the traceheaders from the SEGY files using seisee. Coordinates in arcsec were converted to longitude and latitude in the WGS84 datum. These coordinates were read into QGIS as geographic coordinates and then rewritten as UTM 18N coordinates in meters (WGS84 datum). Using Matlab, the coordinates were smoothed using a Savitsky-Golay filter over 7 points in the x-coordinate and 9 points in the y-coordinate. The smoothed coordinates were then converted from UTM to geographic coordinates. Nathan C. Miller wrote new SEGY files for each line with the smoothed geographic coordinates converted to arcsec as the CDP locations in the headers.

The CDP locations are estimated to have an uncertainty of 30 m perpendicular to the seismic lines and up to 20 m along the seismic lines. These uncertainties are not related to GPS locations, but rather to movement of the streamer, the lack of a tail buoy recording streamer position, and the mathematical smoothing done to average raw CDP locations onto a single seismic line.

A summary file (USGS_EN555_MCS_Line_summary.pdf) provides a table with information about the seismic lines. The SEGY files are named USGS_EN555_ lineXX.sgy, where XX refers to line numbers 01 through 30. The associated CSV files USGS_EN555_ lineXX.csv provide additional information about each line's geometry and CDPs, with CDPs reported in both arcseconds and geographic coordinates Seismic plots were generated by C. Ruppel in SeiSee and exported as bmp files, with CDP on the x-axis and two-way travel time in milliseconds on the y-axis. Naming convention is USGS_EN555_lineXX.bmp.

Kluesner et al. (2015) presented data from this activity, along with seismic attribute calculations and BSR calibrations. Part of the Baltimore Canyon dip line was shown in Ruppel et al. (2015) and Prouty et al. (2016). Some of the sparker data with chimney attributes calculated by J. Kluesner are part of a three-dimensional, cutaway seafloor Norfolk seep figure formulated by B. Danforth and published in an internal USGS newsletter in 2015 and later used in Ruppel et al. (2022). Several of the seismic lines are used in Ruppel et al. (2024).

References

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Files in this release

This description: USGS_EN555_datarelease.pdf

Map showing location of and numbering scheme for sparker seismic lines: USGS_EN555_map.jpg

Compiled information about seismic lines: USGS_EN555_MCS_Line_summary.pdf

SEGY files for Lines 1 through 30: USGS_EN555_lineXX.segy

CDP information for Lines 1 through 30: USGS_EN555_lineXX.csv

Images for Lines 1 through 30: USGS_EN555_lineXX.bmp