High-Resolution Seismic Surveying for Miocene-Pleistocene Sequence Stratigraphy, New Jersey Continental Shelf and Slope, in Support of Strataform

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Award #:. N00014-95-1-0062 and N00014-97-1-0852
http://www.ig.utexas.edu

LONG-TERM GOAL

The collection (in 1995) and ongoing analysis of high-resolution multichannel seismic (MCS) data on the New Jersey shelf/upper slope is part of STRATAFORM, and specifically supports Ocean Drilling Program (ODP) Leg 174A (June-July, 1997). The goal is to link sedimentation processes to preserved sequence stratigraphy and facies architecture, the primary STRATAFORM objective.

OBJECTIVES

Leg 174A was designed to "ground-truth" STRATAFORM nested seismic data (Figure 1) by studying sea level history during the "Icehouse" (i.e., last ~35 Ma), in conjunction with Leg 150 on the upper slope (Mountain et al., 1994) and Coastal Plain drilling (Legs 150X/174AX; Miller et al., 1994). Analysis of Leg 174A samples and associated MCS profiles will: 1) determine the physical nature of shelf stratal surfaces, constrain their acoustic characteristics, and lead to hypotheses governing their formation and preservation; 2) help to tie well-dated Leg 150 sequences to Coastal Plain sections; and 3) link STRATAFORM program elements within the New Jersey "natural laboratory."

APPROACH

Regional MCS profiles, and "hazards" grids across proposed ODP shelf drillsites, supplemented existing data (Figure 1): 1) cores/logs collected in shelf/slope boreholes, most recently by Leg 150; 2) Coastal Plain cores/logs; 3) lower frequency, less densely spaced L-DEO MCS; 4) UTIG Huntec grids and vibra-cores (see below); and 5) commercial MCS coverage (Fulthorpe and Austin, 1998).

Austin, Mountain and Buhl collected the MCS profiles; interpretation is an ongoing joint UTIG - L-DEO effort. Austin, Fulthorpe, and Mountain participated on Leg 174A; Austin served as Co-Chief Scientist. Miller is coordinating the ongoing Coastal Plain drilling and analysis.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
1998		**00-00-1998 to 00-00-1998**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
High-Resolution Seismic Surveying for Miocene-Pleistocene Sequence Stratigraphy, New Jersey Continental Shelf and Slope, in Support of Strataform	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of Texas at Austin,Institute for Geophysics (UTIG),4412 Spicewood Springs Road Bldg. 600,Austin,TX,78759-8844**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM002252.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**5**	

WORK COMPLETED

As Leg 174A was the first shelf operation in almost 30 years of scientific ocean drilling, emphasis prior to drilling was placed on the "hazards" grids to satisfy ODP safety requirements: 1) all grids were interpreted for hydrocarbons; 2) safety review approved two locations for drilling; and 3) at both locations, a sequence stratigraphic interpretation was completed.

During summer 1997, Leg 174A drilled at the two approved shelf sites (Sites 1071 and 1072); Site 1073 was located on the upper continental slope regional MCS grid (Figure 1). The Initial Report will soon be available on-line (http://www-odp.tamu.edu/; Austin, Christie-Blick, Malone et al., 1998). Processing of the regional grid is almost completed. Interpretation of that grid is a high post-Leg 174A priority; the first manuscript detailing some of that analysis has just been accepted (Fulthorpe et al., in press).

RESULTS

Leg 174A recovered ~1 km of core, ranging in age from late Eocene-Pleistocene. The shelf succession consists of at least four late middle Miocene to Pleistocene, unconformity-bounded, progradational sequences. Offlap defines sequence boundaries. Shipboard ages (in Ma) of the four unconformities, plus one other surface, are 0.46-0.25, 1.9-1.4, 11.4-8.6, and 11.9-11.4 (Christie-Blick et al., 1998).

The unconformities may represent times/intervals of falling sea level, with seismically unresolved higher-order cyclicity probably present. Between surfaces, the shallow shelf is dominated by sandy sediments that accumulated during flooding or transgression. Seaward of "breakpoints" (positions at which sequence boundaries steepen into clinoforms), the deeper shelf is dominated by sediments that accumulated during progradation. The overall succession consists of sands, silts and clays, with most recovery from muddy intervals; the presence of sands in poorly recovered or unrecovered intervals has been inferred from downhole logs.

IMPACT/APPLICATIONS

Leg 174A, along with Legs 150 and 150X/174AX, constitutes the Mid-Atlantic Sea Level Transect. Understanding the effects of eustacy, among other forcing factors, on the deposition and preservation of stratigraphy is the goal of STRATAFORM. Unconsolidated sands were more common than expected, suggesting a dominance of transgressive facies in this shelf's sequence development. Drilling and related seismic results suggest that while clinoform breakpoints may not have been exposed during their formation, subaerial exposure probably did occur within a few km landward of those points. River systems reaching the outermost shelf were small and closely-spaced. By approximating a line source of sediment, these rivers produced the observed linearity of Miocene shelf edges (Figure 2; Fulthorpe et al., in press).

TRANSITIONS

The 1995 regional MCS profiles will be central to most post-Leg 174A investigations; these will be active for ~36 months post-cruise. Publication of most scientific results form Leg 174A is expected in ~2000.

RELATED PROJECTS

Leg 174A attempted to sample Miocene clinoforms being mapped by Fulthorpe (Fulthorpe and Austin, 1998; Fulthorpe et al., in press). Huntec very high-resolution 2-D and 3-D stratigraphic studies in the Leg 174A area continue to be conducted by Austin (e.g., Austin et al., 1996; Davies and Austin, 1997; Luhurbudi et al., 1998) and a post-orals Ph.D. student at UTIG, L. Schuur (Schuur et al., 1997).

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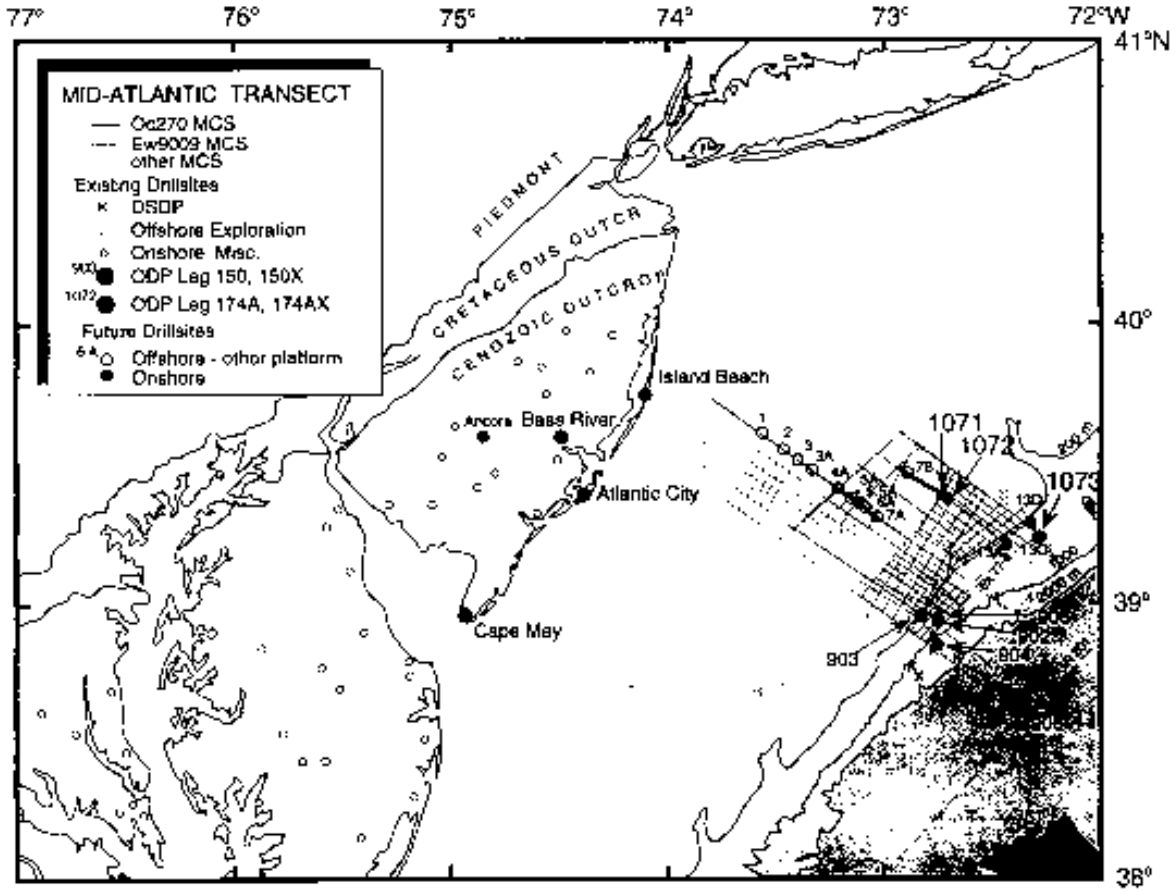

Figure 1. General location map, ongoing New Jersey shelf/slope ODP/STRATAFORM investigations.

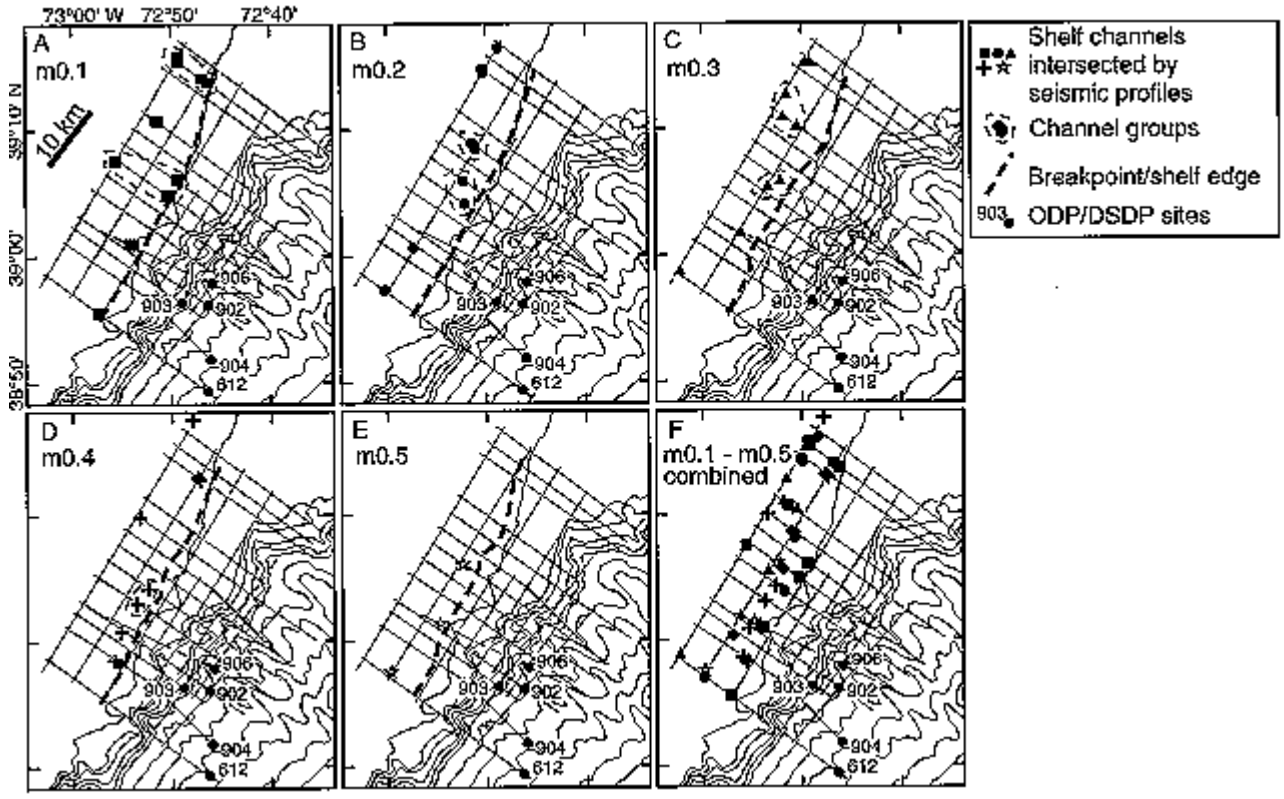

Figure 2. Seismic profile crossings of shelf channels incising upper Miocene sequence boundaries. Position of the breakpoint/shelf edge is shown for each boundary. Groups of closely-spaced channels characterize each sequence boundary, suggesting that fluvial systems occurred at ~10-15 km intervals. The uniform distribution of channels over time (panel F) suggests that rivers systems migrated rapidly as progradation occurred.