Long Piston Coring on the Upper Slope-Outer Shelf Off New Jersey: A Millennial Opportunity

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LONG-TERM GOALS

The goal of STRATAFORM is to link short-term biological and physical processes affecting sedimentation ("event" stratigraphy" developed over hours to weeks) to the stratigraphic geometry and facies distribution of the upper ~100 m of continental margin sediments representing ~10^6 years of preserved record.

OBJECTIVES

Three groups of processes have been isolated for study by STRATAFORM investigators: 1) shelf sediment dynamics and the development of lithostratigraphy; 2) slope processes and their role in shaping geomorphology; and 3) stratigraphic sequence generation. Collecting cores from several tens to several hundreds of meters below the seafloor is an essential for comparing the geologic record observed in seismic images to samples and measurements of subsurface materials. The primary objective in this project was to answer the simple question: how deep below the seafloor and with what degree of recovery can Calypso piston coring sample sand-rich sediments of the New Jersey continental shelf? Furthermore, based on this experience, what advice can be provided to the STRATAFORM initiative for possible Calypso coring along the Eel River margin?

APPROACH

Technologies to continuously core into continental shelves and upper slopes to sub-bottom depths of interest to STRATAFORM are generally unfamiliar to the research community. These settings and these depths are a challenge to long coring because upper margin sediments are coarser-grained and hence harder to penetrate than those in the deep sea. To date, vibracores on the New Jersey shelf have been unable to penetrate past 5 mbsf; drilling and discontinuous coring from the anchored drillship *Glomar Conception* recovered only a fraction of the sediment section to 300 mbsf. More recently, continuous coring from the *JOIDES Resolution* resulted in roughly 50% recovery to 250 mbsf (at Sites 1071 and 1072); silty clay and sandy mud dominated the upper 50 mbsf, and it was suspected that more sand-rich units were present but not recovered. While the French research and polar supply vessel *Marion-Dufresne II (M-D II)* has a 'Calypso' coring system that currently holds the world's record for the longest piston core (58.5 m), none had been recovered from a sand-rich shelf setting before we tried this year. Hence during a transit north along the US east coast in June, 1999, as part of a N. Atlantic coring campaign centered around the IMAGES program, the vessel stopped and conducted two days of coring with funding provided by both ONR and JOI, Inc.

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WORK COMPLETED

Nine US participants (Clark Alexander, Skidaway Institute of Oceanography; James Broda, Woods Hole Oceanographic Institution; Alyson Craig, Skidaway Institute of Oceanography; Priscilla Desgagnes, Univ. of Laval; Cecilia McHugh, Queens College in the City of New York; Diane Minasian, US Geological Survey; Gregory Mountain, Lamont-Doherty Earth Observatory; Hilary Olsen, Univ. of Texas Institute for Geophysics; Catherine L. Schuur, Univ. of Texas Institute for Geophysics) boarded the vessel in Norfolk, Va. and participated in two days of work in the STRATAFORM study corridor offshore New Jersey. Under our guidance and site selection, the able shipboard crew aboard the M-D II attempted 1 gravity, 4 box, and 9 piston cores (see following table) between June 23 and 25 along a transect going upslope from a well-characterized part of the Hudson Apron in 640 m water depth, to 61 m of water on the outer shelf. All but one piston core was recovered with some amount of core material, though every core pipe was bent due to incomplete penetration into the seabed. The ship then departed US waters and landed in Quebec on June 29 after two additional cores related to the IMAGES program were collected in the Gulf of St. Lawrence.

Core No.	Target	water depth, m	Deg N	Min N	Deg W	Min W	core wt, lbs	free fall, m	pipe, m	core, m	recv'y %
210G	ODP 1073	609	39	13.70	72	16.76	1320	NA	6.00	1.67	0.28
210B	ODP 1073	656	39	13.44	72	16.55	1760	2	1.20	0.70	0.58
211	Holocene near 1073	636	39	13.92	72	15.58	16500	1.5	62.85	30.05	0.48
211B	Holocene near 1073	641	39	13.20	72	15.46	1760	2	1.20	0.84	0.70
212	Holocene near 1073	639	39	13.98	72	15.55	16500	1.5	43.10	37.03	0.86
213	debris flow near 1073	632	39	13.39	72	17.04	16500	1.5	38.58	29.74	0.77
114-4B	upper slope	418	39	15.38	72	17.76	1760	2	1.20	0.47	0.39
214B	upper slope	154	39	17.23	72	25.06	1760	2	1.20	0.29	0.24
214	upper slope	154	39	17.08	72	25.38	16500	1.5	35.20	1.18	0.03
215	upper slope	156	39	17.07	72	25.20	14080	4.4	13.38	1.22	0.09
216	outer shelf	143	39	15.88	72	29.68	14080	1.5	14.30	9.42	0.66
217	3 nmi S of 3D survey	70	39	16.45	72	56.27	14080	1.5	13.00	6.34	0.49
218	shelf sand ridge	60	39	18.99	72	58.08	14080	1.5	13.80	7.47	0.54
219	shelf channel fill	72	39	16.91	72	56.27	14080	1.5	14.62	0.00	0.00

core type "G" = gravity core
core type "B" = box core
"pipe" = attempted length
"core" = recovered length

All box cores were sub-sampled aboard the ship for subsequent shorebased analyses. All gravity and piston cores were measured, sectioned to 1.5 m lengths, logged in whole-round sections on an automated multisensor track (p-wave velocity, gamma-ray attenuation density, and magnetic susceptibility), and placed in refrigerated storage. Core 212 was shipped to Univ. Laval for geotechnical measurements; the rest were delivered in a refrigerated van to the East Coast Repository of the Ocean Drilling Program and placed into refrigerated storage. Thus far, 36 of 61 core sections have been split, digitally photographed and described. Geotechnical measurements and accompanying sampling were performed on core sections as they were split. The remaining cores will be split, photographed and described within the next few months.

RESULTS

Despite the heavy weight of the corer (up to 16,500 lbs.) and the long core pipe (up to 62 m), the longest penetration (into soft silty mud at 639 m on the slope) was 37 m; at 154 m on the uppermost slope we were epecially surprised to penetrate only 1.2 m into stiff silty mud. Penetration into the sands on the shelf was less than 8 m, which is only 50% better than has been accomplished previously with vibracoring.

In general, we found that shallow water is not a serious obstacle to successful Calypso coring; in fact, a team from the USGS immediately before us collected 7+ m of good core with an 11 m pipe in 14 m of water in the Chesapeake Bay; the core head was partially out of the water when it tripped. Their longest core in the Bay was 27 m, extending through the interbedded sands and muds of the Holocene section into the basal transgressive deposits. These sediments are probably most like those that will be encountered on the Eel shelf, and give an indication of core lengths that can be expected. Furthermore, it does not yet appear (though the cores have NOT been opened) that sand-rich shelf sediments we cored off New Jersey were as difficult to recover as were overconsolidated, silty clays on the uppermost slope. Although these sediments are similar to the exposed, overconsolidated material along the O-line off Eureka, in general there are many more soft, mud-rich potential coring targets off northern California than there are off New Jersey.

IMPACT / APPLICATIONS

Considering the large number of traditional piston cores already collected on the Eel River margin, we know the character of the sediments in the upper 5 m of the seabed. Based on this, there is an excellent chance that 30 m Calypso cores can be collected on the shelf, and perhaps 40-50 m cores could be recovered in muddy areas of the shelf and slope. This is made that much more certain by the fact that a 51 m core was recovered in 350 m of water in the Gulf of St. Lawrence immediately before the M-D II docked in Quebec. More encouragingly, the Calypso system collected a world record 58.5 m core in the Saguenay Fjord immediately after leaving Quebec City. The likely success of coring through buried unconformities offshore N. California to sample upturned beds along the flanks of anticlines is less certain given our experience with stiff, overconsolidated clays on the New Jersey margin. However, this type of sampling would be extremely valuable and should be attempted. It probably should begin at subcrops covered by a few 10's of m of soft sediment, as this 'cover layer' provides stability that would be absent at a bare seafloor outcrop.

TRANSITIONS

These M-D II cores from offshore New Jersey will be useful to several groups of STRATAFORM colleagues. Biostratigraphic studies for paleoenvironment are anticipated by H. Olsen (UTIG). Geochemical tracers, short-lived radioisotopic ages, and depostional histories will be determined by C.Alexander (SKIO). Physical properties will be determined by J.Locat (Univ. Laval). Mass wasting processes and provenance will be assessed by C.McHugh (CCNY Queens). Correlations of physical properties to 3.5 echocharacter and to MCS seismic character will be analyzed by G.Mountain (L-DEO). These cores are curated and maintained by the Ocean Drilling Program and when a moratorium is reached two years after the time the cores were collected, they will become a publicly available resource like other ODP cores.

RELATED PROJECTS

The New Jersey corridor has been and is likely to continue to be a region of intense study by the ODP for the history and stratigraphic expression of Neogene sea level change. JOI, Inc. provided half the funds to support the collection of these M-D II cores and is providing the curation of these cores and derivative data.

PUBLICATIONS

unpublished report of Marion Dufresne II Cruise 99 Leg 2, 1999, submitted to J.Kravitz, ONR/MG&G, G.Mountain with contributions from C. Alexander, J. Broda, and L. Schuur