NATIONAL SCIENCE FOUNDATION
4201 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22230

May 29, 2014

Paul Scholz, Acting Director
Office of Ocean and Coastal Resource Management
National Ocean Service
National Oceanic and Atmospheric Administration
Silver Spring, Maryland 20910

Re: Federal Consistency Review of Federal Funding by the National Science Foundation to Rutgers University for Conducting Seismic Surveys in the Atlantic Ocean

Dear Mr. Scholz:

I am in receipt of your letter dated May 22, 2014, in which you request information related to the proposed marine geophysical survey by Rutgers, the State University of New Jersey (Rutgers) offshore of New Jersey scheduled for early this summer. Below is a summary of the proposed project, and a description of the roles of the Principal Investigators (PIs), the National Science Foundation (NSF), and the operator of the research vessel *Marcus G. Langseth (R/V Langseth)*, Columbia University's Lamont-Doherty Earth Observatory (LDEO). In addition, included are some relevant facts concerning the interactions between the State of New Jersey's Department of Environmental Protection (NJDEP), the National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource Management (OCRM), and NSF. On behalf of NSF, I sincerely hope that the information provided during our several conversations with your staff and in this letter will assist you in your review of NJDEP's request to determine whether the proposed project is subject to the review requirements for Federal Financial Assistance to State and Local Governments under 15 C.F.R. part 930, Subpart F of the Coastal Zone Management Act (CZMA) Federal Consistency regulations.

I. Description of Proposed Project

NSF received a collaborative proposal from the PIs, Drs. G. Mountain (Rutgers) and C. Fulthorpe, J. Austin, and M. Nedimovic (University of Texas at Austin's Institute for Geophysics

(UTIG)) to collect data essential to Earth processes (*see* Attachment 1). The purpose of the proposed project is to collect data across existing Integrated Ocean Drilling Program (IODP) Expedition 313 drill sites on the inner-middle shelf of the New Jersey continental margin to reveal the arrangement of sediments deposited during times of changing global sea level from roughly 60 million years ago to present. Features such as river valleys cut into coastal plain sediments, now buried under a kilometer of younger sediment and flooded by today's ocean, cannot be identified and traced with existing 2-D seismic data, despite their existence being clearly indicated in sediment cores recovered during IODP Expedition 313. These and other erosional and depositional features would be imaged using 3-D seismic data and would enable follow-on studies to identify the magnitude, time, and impact of major changes in sea level.

The PIs worked collaboratively to prepare and submit the single research proposal to NSF for funding consideration; while each institution submitted a separate proposal, the content of each proposal is the same and together they constitute one proposed project. In fact, they are connected in the NSF EJacket system and referred to as one, single proposed project.

II. The Principal Investigators

The proposal received by NSF was a collaborative effort submitted by Drs. G. Mountain C. Fulthorpe, J. Austin, and M. Nedimovic to collect data essential to Earth processes. Dr. Mountain of Rutgers is, however, the scientific lead for the proposed project, making Rutgers the lead institution for the proposed project and Dr. Mountain the lead PI. Dr. Mountain has been the key proponent of the proposed collaborative research activities and survey design. He has been involved in previous research efforts in the survey area, including previous seismic surveys in 2002, 1998, 1996, and 1990. As the lead PI, he will serve as the integrator of the research activities, coordinating various components of the efforts by other scientists involved in the project. To support the proposed project, Dr. Mountain submitted a "Ship Time Request" to use the R/V *Langseth* through the University-National Oceanographic Laboratory System (UNOLS) and is positioned to participate on the cruise as Chief Scientist.

Although Rutgers is the lead institution for the proposed project, UTIG is a collaborating institution. Drs. Fulthorpe, Austin, and Nedimovic of UTIG are collaborators on the proposed project with Dr. Mountain. While all scientists will participate collaboratively on various components of the single proposal and have important independent roles in ensuring the project's success, Dr. Mountain remains the lead PI for the entire research effort.

III. The Funding Stream

A. Research Funding

As discussed above, the proposed project is one, single, project. The monetary support provided by NSF, however, is divided into two funding streams: (1) Rutgers; and, (2) UTIG. Although the original collaborative proposal received by NSF included research funding requests for Rutgers, UTIG, and LDEO, LDEO will not receive research funding. Based on NSF science priorities and current budgetary constraints, the cognizant NSF Program Officer negotiated the proposal budget and, as a result, funding sought for an LDEO researcher will not be provided. Additionally, subsequent to the original proposal submission, but prior to the budget negotiation, Dr. Nedimovic accepted a position at UTIG; thus, he was added to the UTIG budget and, therefore, funding for his research role would be through UTIG. Consequently, funding for the proposed research activities would only go to Rutgers and UTIG. These two funding streams are reflected in the grant letters for the proposed collaborative research effort (*see* Attachments 2 and 3).

B. Funding of Ship Operations

Pursuant to a five year Cooperative Agreement (CA), originally awarded in 2012, LDEO receives funds to operate the R/V *Langseth* (*see* Attachment 4). This funding is to allow LDEO to act as the vessel operator so that a platform is available to NSF-funded researchers for conducting marine scientific research. With regard to the proposed project, the lead PI (Dr. Mountain of Rutgers) requested ship time on the R/V *Langseth* because it is the only vessel in the U.S. Academic Fleet that is capable of supporting the research. Therefore, the operation of the R/V *Langseth* should be viewed as incidental to the proposed research. Use of the R/V *Langseth* to facilitate the lead PI in carrying out the proposed project has been scheduled for approximately 30 days during the June/early July 2014 timeframe.

IV. Subpart F is the Appropriate Provision of the CZMA Regulations Applicable to the Proposed Project.

As described above, the proposed project is led by Rutgers. It is a Rutgers led project regardless of the participation by UTIG and the logistical support by LDEO. Accordingly, the proposed project is one in which there is federal assistance by NSF to a state governmental entity, Rutgers. Therefore, any consistency review appropriately falls under Subpart F of the CZMA's implementing regulations.

A threshold requirement for requesting consistency review under Subpart F of the regulations is a finding of timeliness. With regard to the proposed project, however, NJDEP's request was made approximately three and one-half months after the proposed project was released to the public for review and comment and, thus, it is untimely. Specifically, NSF posted its Draft Environmental Assessment on its website on February 3, 2014, requesting public review and comment during a 30 day public comment period, ending on March 3, 2014. NJDEP elected not to comment on NSF's Draft Environmental Assessment, which was prepared pursuant to the National Environmental Policy Act (NEPA), during this public comment period. The second public notice of the proposed project came in the form of a Federal Register notice issued by the National Marine Fisheries Service (NMFS) announcing its intent to issue an Incidental Harassment Authorization (IHA) pursuant to the Marine Mammal Protection Act (MMPA) for the proposed project. This Federal Register notice was published on March 17, 2014. In response to a request to extend the public comment period on the IHA, NMFS issued a second notice in the Federal Register extending the comment period by 30 days. This notice was published on April 9, 2014.

In addition to the formal public notices of the proposed project published on the NSF website and in the Federal Register, NSF, OCRM and NJDEP engaged in informal conversations regarding the proposed project. These informal conversations began when NSF contacted OCRM in late March to discuss CZMA implications regarding the proposed project. That conversation was held on April 1, 2014. On April 14, 2014, OCRM left a voicemail message for NSF staff notifying them that the NJDEP informally contacted OCRM on April 11, 2014 expressing an interest in the project. After receiving the news from OCRM, NSF immediately contacted OCRM and suggested holding a joint teleconference with NJDEP and OCRM to discuss NJDEP interest in the proposed project. OCRM arranged a teleconference with NJDEP and NSF on April 22, 2014, to discuss applicability of the CZMA. In preparation for the April 22nd teleconference, OCRM sent an email to both NSF and NJDEP dated April 15, 2014 (*see* Attachment 5) requesting advanced information. Specifically, OCRM asked: (1) NSF to identify which academic institutions would receive NSF funding; and, (2) NJDEP to identify any enforceable policies that may be relevant to the proposed activities. NSF provided the funding information in advance of the teleconference as requested (*see* Attachment 6); NJDEP, however, did not respond to OCRM's request to identify relevant enforceable policies that may apply to the proposed project. The teleconference went forward on April 22nd, during which the majority of the discussion was devoted to identifying which CZMA Subpart applied to the proposed project. Despite repeated requests for NJDEP to identify which enforceable policies it believed were implicated, no response was given.

Following the April 22nd teleconference with NJDEP, NSF staff held numerous discussions separately with OCRM and NJDEP staff to try to identify NJDEP's concerns with the proposed project and learn of any relevant enforceable policies NJDEP believed applied. On May 7th, another teleconference was held with OCRM, NJDEP, and NSF staff to again discuss NJDEP's concerns, however, NJDEP again failed to identify any enforceable policies it believed were implicated; only vague requests for delaying the project and employing non-specific mitigation measures were made. When NSF asked NJDEP staff to provide specifics regarding these requests, however, none were provided. NJDEP did submit comments to NMFS pursuant to the MMPA IHA public comment period on May 15, 2014. On May 20th, despite NSF's repeated and good-faith efforts to respond to NJDEP's concerns, NJDEP sent an email to NSF staff with an attachment of a letter sent by NJDEP, via U.S. Post, from Virginia KopKash, Assistant Commissioner DEP to Margaret Davidson, Acting Director OCRM requesting review of the project under Subparts C and F of the regulations implementing CZMA, with a carbon copy to NSF. The letter, however, also fails to formally identify the relevant enforceable policies of concern to NJDEP. In sum, NJDEP waited three and one-half months to bring its request to OCRM to review the proposed project under Subpart F of the CZMA's implementing regulations. Further, NJDEP waited until the very end of the lengthy environmental compliance process to make their formal request to review the proposed project; the proposed survey sail date of June 3, 2014, was clearly published in the NSF Draft Environmental Assessment available on the NSF website on February 3rd, and also in the NMFS IHA Federal Register notice on March 17th.

V. Consistency Review Under Subpart C, Likewise, Is Untimely.

In its letter to OCRM, NJDEP claims that it is seeking consistency review under Subpart C of NSF's funding of LDEO's ship operations. As previously noted, however, funding for R/V *Langseth* ship operations is provided to LDEO through a five year CA, which was originally established in 2012. Thus, the opportunity to request a consistency review of the use of the R/V *Langseth* for ship operations in support of marine scientific research closed years ago.

VI. NSF's Requirement that LDEO Obtain an IHA

As part of routine operational process, NSF has traditionally required LDEO, as the ship operator, to submit IHA requests pursuant to the MMPA when marine seismic research activities are to be carried out with the R/V *Langseth* as the research platform. As the vessel operator, LDEO is in a strong position to ensure that all necessary permits, authorizations, and clearances required for proposed research activities to go to sea (including international vessel clearances and IHAs) are obtained before the vessel leaves dock. In addition, when the vessel operator is held responsible for preparing and submitting the necessary permits and authorizations, there is consistency with document quality and content. Further, as the vessel operator, LDEO is not only responsible for obtaining the IHA, but also for obtaining any Protected Species Observers required by the IHA and providing the necessary equipment for them to carry out their role on the ship.

VII. Conclusion

I hope that the information provided above will assist your office in its review of NJDEP's request for consistency review. If you need any additional information or would like to discuss the information already provided, please do not hesitate to contact me either by email or by phone at 703-292-7713. Thank you in advance for your attention to this matter.

Sincerely,

Holly E Smith

Holly E. Smith
Environmental Compliance Officer

Attachments:
(1) Research Proposal: Collaborative Research: Community-Based 3D Imaging That Ties Clinoform Geometry to Facies Successions and Neogene Sea-Level Change
(2) Grant Letter to Rutgers for Collaborative Research: Community-Based 3D Imaging That Ties Clinoform Geometry to Facies Successions and Neogene Sea-Level Change
(3) Grant Letter to UTIG for Collaborative Research: Community-Based 3D Imaging That Ties Clinoform Geometry to Facies Successions and Neogene Sea-Level Change
(4) 2012 Cooperative Agreement to LDEO for R/V *Langseth* Ship Operations
(5) Email dated April 15, 2014 from OCRM to NJDEP and NSF
(6) Email dated April 21, 2014 from NSF to OCRM and NJDEP

Corrected : 08/22/2012

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 11-1		FOR NSF USE ONLY
PD 98-1620	08/15/12	NSF PROPOSAL NUMBER
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)		**1260237**
OCE - MARINE GEOLOGY AND GEOPHYSICS		

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
08/15/2012	2	06040000 OCE	1620	(b) (4) [redacted]	09/04/2012 4:50pm

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)
(b) (4) [redacted]	☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE
Rutgers University New Brunswick	Rutgers University New Brunswick 3 Rutgers Plaza New Brunswick, N.J. 089018559
AWARDEE ORGANIZATION CODE (IF KNOWN) 0026294000	
NAME OF PRIMARY PLACE OF PERF Department of Earth and Planetary Sciences	ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE Department of Earth and Planetary Sciences 610 Taylor Rd. Piscataway ,NJ ,088548066 ,US.

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions) ☐ SMALL BUSINESS ☐ FOR-PROFIT ORGANIZATION ☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINESS ☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Collaborative Research: Community-Based 3D Imaging That Ties Clinoform Geometry to Facies Successions and Neogene Sea-Level Change**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 789,819	24 months	05/01/13	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW
☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ EAGER* (GPG II.D.2) ☐ RAPID** (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date ______
PHS Animal Welfare Assurance Number ______
☐ HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number ______
Exemption Subsection ______ or IRB App. Date ______
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT	PI/PD POSTAL ADDRESS
Earth and Planetary Sciences	610 Taylor Rd. Wright Lab Piscataway, NJ 08854 United States
PI/PD FAX NUMBER 732-445-2044	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
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CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, lobbying activities (see below), responsible conduct of research, nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 11-1). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:
(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.
(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:
(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:
(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

Certification Regarding Responsible Conduct of Research (RCR)
(This certification is not applicable to proposals for conferences, symposia, and workshops.)

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that, in accordance with the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.B., the institution has a plan in place to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduates, graduate students and postdoctoral researchers who will be supported by NSF to conduct research.
The undersigned shall require that the language of this certification be included in any award documents for all subawards at all tiers.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME Emmeline Crowley	Electronic Signature	Aug 15 2012 10:43AM

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
848-932-4027	Emily.Crowley@Rutgers.edu	732-932-0162

* EAGER - EArly-concept Grants for Exploratory Research
** RAPID - Grants for Rapid Response Research

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 11-1

PD 98-1620 08/15/12

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

OCE - MARINE GEOLOGY AND GEOPHYSICS

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NSF PROPOSAL NUMBER

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(b) (4) [redacted]

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☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

University of Texas at Austin

AWARDEE ORGANIZATION CODE (IF KNOWN)

0036582000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

Austin, TX 787121532
US

NAME OF PRIMARY PLACE OF PERF

University of Texas at Austin Institute for Geophysics

ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE

University of Texas at Austin Institute for Geophysics
10100 Burnet Road, ROC/Bldg. 196
Austin ,TX ,787584445 ,US.

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS

☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

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☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT

Institute for Geophysics

PI/PD FAX NUMBER

512-471-0999

PI/PD POSTAL ADDRESS

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J.J. Pickle Research Campus (R2200)
Austin, TX 787584445
United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME Craig S Fulthorpe	PhD	(b) (6) [redacted]	512-471-0459	craig@ig.utexas.edu
CO-PI/PD James A Austin, Jr.	PhD		512-471-0450	jamie@ig.utexas.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

1259135

CERTIFICATION PAGE

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(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.
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The undersigned shall require that the language of this certification be included in any award documents for all subawards at all tiers.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE		SIGNATURE	DATE
NAME Barbara D Reyes		Electronic Signature	Aug 13 2012 11:15AM
TELEPHONE NUMBER 512-471-6289	ELECTRONIC MAIL ADDRESS barbarareyes@austin.utexas.edu		FAX NUMBER 512-471-6564

* EAGER - EArly-concept Grants for Exploratory Research
** RAPID - Grants for Rapid Response Research

Corrected : 08/22/2012

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 11-1 PD 98-1620 08/15/12	FOR NSF USE ONLY NSF PROPOSAL NUMBER
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) OCE - MARINE GEOLOGY AND GEOPHYSICS	1259487

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
08/14/2012	2	06040000 OCE	1620	(b) (4) [redacted]	09/04/2012 4:50pm

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)
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NAME OF PRIMARY PLACE OF PERF Columbia University Lamont-Doherty Earth Observatory	ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE Columbia University Lamont-Doherty Earth Observatory 61 Route 9W Palisades ,NY ,109641707 ,US.

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions) ☐ SMALL BUSINESS ☐ FOR-PROFIT ORGANIZATION ☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINESS ☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Collaborative Research: Community-Based 3D Imaging That Ties Clinoform Geometry to Facies Successions and Neogene Sea-Level Change**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 99,419	24 months	05/01/13	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)
☒ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ EAGER* (GPG II.D.2) ☐ RAPID** (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date ______
PHS Animal Welfare Assurance Number ______
☐ HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number ______
Exemption Subsection ______ or IRB App. Date ______
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT Seismology, Geology & Tectonophysics	PI/PD POSTAL ADDRESS Lamont-Doherty Earth Observatory P.O. Box 1000 Palisades, NY 109648000 United States
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CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, lobbying activities (see below), responsible conduct of research, nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 11-1). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.

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* EAGER - EArly-concept Grants for Exploratory Research
** RAPID - Grants for Rapid Response Research

PROJECT SUMMARY

For the general benefit of a broad user community of scientists, educators and students, the Co-Principal Investigators propose to coordinate the use of R/V *Marcus Langseth* to acquire a 3D seismic volume encompassing the three IODP Expedition 313 drillsites on the inner-middle shelf of the New Jersey (NJ) continental margin. Exp313, the latest chapter in the multi-decade Mid-Atlantic Transect, represents the community's best opportunity to link excellently sampled/logged late Paleogene-Neogene prograding clinoforms to state-of- the-art 3D images. The primary goal of this proposal is to constrain the complex forcing functions tying evolution and preservation of the margin stratigraphic record to base-level changes. These processes include eustasy, climatic and paleooceanographic variations, tectonism, compaction and rates of sediment supply. Exp313 borehole data will provide lithostratigraphy, geochronology and paleobathymetry. Geomorphology revealed by coherency in horizontal (travel-time) slices within the volume (among other 3D imaging tools) will identify diagnostic features such as river systems, shorelines, delta channels, sediment failure scars, etc., none of which can be resolved in existing 2D seismic data to the degree required to map shifting shallow-water depositional settings in the vicinity of clinoform rollovers. Embracing a community-based strategy, the co-PIs will manage planning, acquisition and data processing up to the point of an interpretable 3D volume. This will entail a pre-cruise planning workshop, hands-on training for young scientists at sea, and rapid turn-around of the data by a commercial processor. Data will be made available to the engaged scientific community to use as the foundation of follow-on, PI- driven proposals that improve understanding of factors shaping the NJ margin in particular, and that imprint the sedimentary record at continental margins in general. The scientific parties of several ocean drilling expeditions and outcrop specialists of shallow-water systems are two groups certain to want to compare their research experience with the ground-truth these data will provide.

Intellectual Merit

The NJ margin has for decades been recognized as among the best siliciclastic passive margins for elucidating the timing/amplitude of eustatic change during the "Ice House" period of Earth history, when glacioeustatic changes shaped continental margin sediment sections around the world. A transect strategy adopted by the international scientific ocean drilling community has been used to study this interval at shallow-water settings offshore NJ, New Zealand and the Bahamas that were dominated by prograding clinoforms. 3D seismic imaging is now a viable tool for the research community, ready to be applied to the NJ margin to put these sampled records in a spatially accurate, stratigraphically meaningful context. Such imagery will allow researchers to map sequences around Exp313 sites with a resolution and confidence previously unattainable, and to analyze their spatial/temporal evolution. Long-awaited objectives include: 1) establishing the impact of known Ice House base-level changes on the stratigraphic record; 2) providing greater understanding of the response of nearshore environments to changes in elevation of global sea level (with special relevance to the current relentless rise), and 3) determining the amplitudes/timing of global sea-level changes during the mid-Cenozoic, which should help humanity put anthropogenic base-level change in a proper long-term context.

Broader Impacts

The community will be engaged in 3 ways. 1) A pre-cruise workshop will review the scientific payoff that 3D seismic-core-log integration can provide, and enable attendees to help shape acquisition and data processing details that optimize this goal; 2) 12 bunks aboard *Langseth* will be reserved for student/post-doc/young scientist volunteers to acquaint each with 3D acquisition and the myriad activities that comprise a research cruise; and 3) a post-cruise workshop will identify community-based avenues for analysis/interpretation of the processed 3D volume and integration with Exp313 results. The 3D images will very likely become an integral part of IODP outreach. Lamont-Doherty Earth Observatory and the University of Texas Institute for Geophysics have collaborative NSF grants to archive marine seismic data collected with NSF support. The raw field data will be delivered to the LDEO facility immediately after acquisition, and a fully processed 3D data 'volume' will be sent to the UTIG facility ~5 months after that, with the expectation that these data will become a showcase for how such sub-seafloor imaging can inform the understanding of stratigraphic evolution at continental margins.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.B.2.

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

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PROJECT DESCRIPTION

Collaborative Research: Community-Based 3D Imaging that Ties Clinoform Geometry to Facies Successions and Neogene Sea-Level Change

PROLOGUE

This resubmission has benefited from constructive input by 8 mail reviewers, a panel summary, and NSF feedback (fall 2011). In response, we amplify three issues: 1) 3D imaging will detect nearshore features (e.g., meandering rivers, estuary complexes, lagoons/barrier islands, incised shelf valleys, etc.) that can be tied to IODP Exp313 sites M27-M29; mapping these features and associated facies, which developed during a time of known glacioeustatic variation, is a key both to understanding the evolution of siliciclastic systems and quantifying eustatic changes preserved in clinoformal architecture; 2) the proposed 3D survey area is 50% larger than in our initial submission, with no increase in survey time (34 days), as a result of revised estimates of in-fill shooting and downtime based on well-known histories of weather, currents, ship traffic and marine mammal activity in the proposed study region offshore New Jersey (NJ); and 3) a robust collaboration with the aligned GeoPRISMS community, including at-sea participation and pre- and post-data acquisition workshops; all activities are designed to help educators, young investigators and students understand the value of calibrating models of stratigraphic facies successions, as well as to engage them in theoretical and hands-on learning experiences with 3D seismic acquisition/processing. The goal throughout this project will be to optimize community use of the proposed product - a 3D data volume tied to continuously cored/logged/dated siliciclastic clinoforms that evolved at a stable passive margin during a time of independently measured glacioeustatic change.

INTRODUCTION

Shoreline movements and linked shifts in nearshore processes have important societal consequences. As discussion of global warming grows from speculation to more widespread acceptance (Intergovernmental Panel on Climate Change, 1995; 2001; 2007), impacts at the land-sea divide are gaining media attention. Nonetheless, journalists, policy makers, and even earth scientists often fail to grasp that while links exist among warming, melting ice and rising sea levels, actual effects on shoreline position locally vary widely. Shoreline positions are controlled by many factors, only one of which is global sea level. For example, in Scandinavia (rising due to glacial rebound) and Venice, Italy (subsiding due to sediment compaction), shorelines are moving in opposite directions despite the current rise in global sea-level of ~3mm/yr (projections point to an increase of ≥8 mm/yr by 2100; Rahmstorf et al., 2007). Other drivers include sediment supply and wave/storm-influenced sediment dispersal/compaction, plus regional influences: lithospheric cooling, isostatic/flexural loading, and dynamic topography within the asthenosphere. On old passive margins (e.g., NJ), regional effects are small and perhaps impossible to measure, but all contribute to the complexity of assessing eustatic change through geologic time.

Preserved shallow-water sediments are divided into facies successions bounded by regional unconformities (e.g., Sloss, 1963). The difficulty of mapping these "sequences" (Vail et al., 1977) in true 3D, and deconvolving factors that generate them, have long hindered all but broad interpretations regarding their relationships to eustatic change (e.g., Haq et al., 1987). Because of the importance of coarse-grained sand bodies as reservoirs, oil companies have sought ways to anticipate distributions of sequences based on seismic data alone, often without investing in costly geologic sampling. They focus on intervals/settings that offer the highest economic returns, most recently in structurally complex deep-water settings, leaving behind less productive, Neogene shelf clinoform settings. They also generally withhold their high-quality seismic data and predictive techniques from public disclosure. The international research community shares many of the same scientific interests, but relies less on high-quality seismic data and more on samples from scientific ocean drilling to link the preserved stratigraphic record with eustasy (COSOD II, 1987; Watkins and Mountain, 1990; JOIDES, 1992; Fulthorpe et al., 2008). Such efforts have focused on assembling a global compilation of co-registered analyses of paleo-water depths, sediment compaction/age, and thermal/isostatic/flexural subsidence in shallow-water basins along continental edges. Gathering these drilling-based data has been challenging, and accompanying industry-grade seismic data remain generally unavailable. Our goal here is to augment recently drilled and logged NJ shelf successions with superb 3D seismic images to provide the interested academic community an improved understanding of the factors shaping the global sedimentary record at passive margins, including the long-term history of eustatic change. Because continental margins contain the archive from which much of the world's oil and gas is extracted, and along which ~10% of humanity lives, knowledge of the interaction of this sediment record with ongoing base-level changes serves highly relevant societal interests.

BACKGROUND

The Transect Drilling Strategy

ODP/IODP-related workshops (refs. above) and more than two decades of community-based discussions have concluded that a global set of borehole transects across multiple passive margins is required to deconvolve eustatic signals from those of local processes (Christie-Blick et al., 1990; Kominz and Pekar, 2001). Only this strategy can confirm global synchroneity of sequence boundaries and document stratigraphic responses in diverse tectonic/depositional settings. To yield a reliable measure of eustatic change between two sequences, drilling must sample an intervening sequence boundary in at least three locations: 1) the youngest topset sediments of the older sequence, close to the seaward increase in gradient (the clinoform "rollover"/paleo-shelf edge); 2) the oldest bottomset sediments of the younger sequence at the seaward toe of that same clinoform; and 3) farther seaward along the same surface, where complications of reworking are diminished and age control optimal (Fulthorpe et al., 2008). Using this approach, lateral variations in facies, paleo-water depth and age can be traced along key surfaces. With proper accounting for total subsidence, reliable elevations/dimensions of sequences at their time of deposition can be estimated to distinguish local transgressive/regressive cycles (e.g., Scandinavia vs. Venice) from eustatic changes (e.g., Steckler et al, 1999).

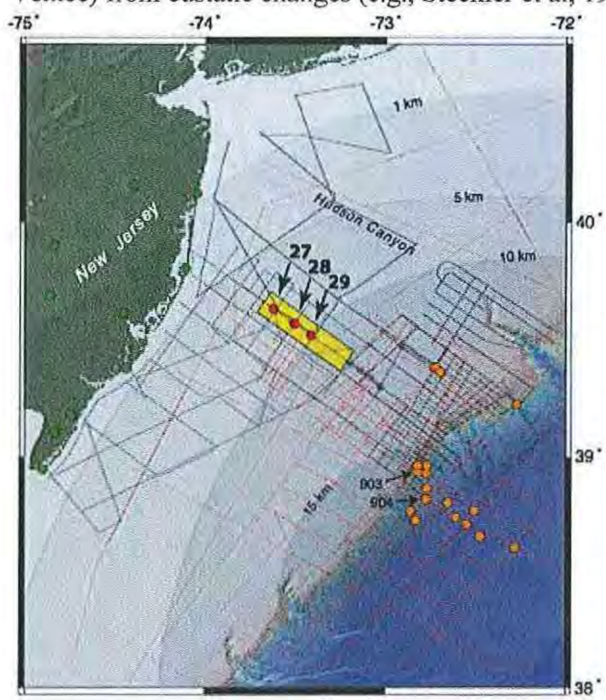

Figure 1. Proposed 12 x 50 km 3D seismic volume (yellow rectangle) encompassing Exp313 Sites 27-29 (red circles) embedded within grids of deep-penetration, reconnaissance (dashed red lines) and higher-resolution (solid gray lines) 2D MCS profiles. Previous studies have tied these grids to scientific ocean drilling wells on the outer shelf, slope and rise (orange circles). Onshore wells (green circles) provide updip equivalents to offshore stratigraphic units (see details in the text). Depths to basement are indicated (muted gray colors/contours).

IODP Expeditions 313 and 317 (NJ and offshore New Zealand, respectively) have followed this strategy, drilling dip-oriented transects imaged by grids of 2D MCS profiles (Mountain, Proust, McInroy et al., 2010; Fulthorpe, Hoyanagi, Blum et al., 2011). This proposal builds on the successful drilling of the first of these, termed the "Mid-Atlantic Transect" (MAT), by seeking to fill a critical gap in seismic correlation. Exp313 samples provide age/paleo-water depth/facies variations within and between sequences imaged by existing grids of 2D MCS data (Fig. 1). The 3D volume we propose to collect will provide accurately rendered, high-resolution "seismic geomorphology" linking depositional/erosional processes driving shoreline movements to known mid-Neogene base-level changes.

Evolution of the "Mid-Atlantic Transect" (MAT)

The NJ margin has long been recognized as a leading candidate for the study of eustatic change and its impact on the sediment record because of: 1) smooth thermal subsidence since Triassic-Early Jurassic rifting (Watts and Steckler, 1979); 2) substantial sediment supply since the mid-Oligocene (Poag, 1985), when high-latitude glaciations provide an independent measure of eustatic forcing (Miller et al., 1998;

Zachos et al., 2001; Pekar et al., 2002; Pekar and Christie-Blick, 2008); 3) optimal geochronologic control as a result of a mid-latitude setting; and 4) accessibility/wealth of supporting information (Fig. 1).

In support of the transect drilling approach, multiple 2D MCS grids have been collected since 1990 to locate potential drill sites (Fig. 1). The first was a reconnaissance grid of 120-channel, 1350 in.^{3} air-gun array profiles across shelf wells spot-cored by the U.S. Geological Survey and industry (Hathaway et al., 1976; Scholle, 1977; Libby-French, 1984). Roughly two dozen unconformity bounded, post-Eocene sequences across the shelf/upper slope were traced areally using these data. ODP Leg 150, restricted to the slope/rise, recovered sediments documenting 22 early Eocene-middle Pleistocene ("Ice House") seismic surfaces (Mountain, Miller, Blum, et al., 1994; Miller et al., 1996). In most cases, seismic sequence boundaries matched to Leg 150 boreholes showed little/no time missing across them. Coarse-grained deposits that fined upwards from the bases of many sequences were interpreted as sediments transported basinward during sea-level lowstands. The scientific community understood that Leg 150 samples were from paleo-water depths too deep to yield insight into eustatic amplitudes and their role in shaping facies successions, but shelf drilling required was not at that time deemed safe.

To attempt to remedy the need for shallow-water control, Coastal Plain drilling was begun to complement the deep-water data (Miller et al., 1994). Oligocene – mid-Miocene sequence boundaries onshore (Fig. 1) were found to correlate well with $\delta^{18}O$ increases derived from deep-ocean sampling, confirming that they formed during times of most rapid global sea-level falls (Fig. 2). Furthermore, sequence ages compared well with the Haq et al. (1987) eustatic chart (see also Miller et al., 1996, 1998).

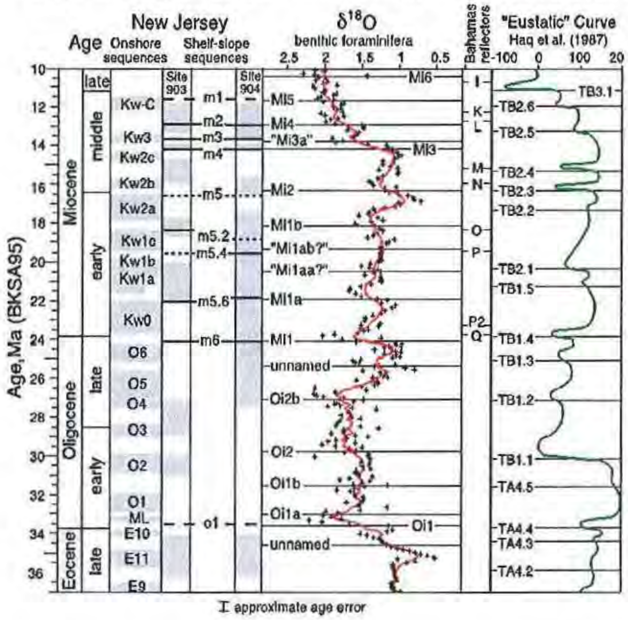

Figure 2. Correlation chart of the NJ margin, late Eocene-late middle Miocene. Onshore sequences (19 total, gray=recovered, white=hiatus) were sampled at 6 sites. Shelf sequence boundaries (10 total, o1-m1) were defined in MCS profiles (see Fig. 1) and traced to the slope. Depositional sequences at ODP slope sites 903/904 (gray=recovered, white=hiatus; Fig 1) are tied to the magnetic reversal time scale (Berggren et al, 1995) and the global $\delta^{18}O$ curve. Ice volume increases are inferred from $\delta^{18}O$-matched hiatuses in the updip/onshore record and slope sequence boundaries. A global sea level curve inferred from coastal onlap and other means (Haq et al., 1987) is at far right. While these correlations appear robust, the critical missing piece for understanding the evolution of the siliciclastic sedimentary record during a time of known eustatic change is spatial correlation of 3D seismic images (crucial for identifying/tracking shorelines and related shallow-water features) with well-sampled drillsites, such as Sites 27-29 (Fig. 1).

The Coastal Plain effort showed that: 1) sequence boundary ages could be determined to better than ±0.5 myr, thereby providing the chronologic control needed to track eustasy for the past 42 myr (Miller et al., 1996, 1998); 2) stratal surfaces are the primary cause of margin seismic reflections (Mountain, Miller, Blum, et al., 1994); 3) middle Eocene-Miocene sequence boundaries correlate with globally recognized $\delta^{18}O$ increases, linking their formation to glacioeustatic falls (Miller et al., 1996, 1998); 4) through correlation with Leg 166 (Bahamas) drilling, siliciclastic and carbonate margins yield correlatable and in some cases comparable records of inferred sea-level change (Miller et al., 1998; Eberli, Swart, and Malone, et al., 1997); and 5) several amplitude estimates of ~20-85 m for my-duration sea-level variations exist that agree with estimates based on $\delta^{18}O$ changes (Kominz et al., 1998, 2003).

Nonetheless, onshore/slope drilling on the NJ margin cannot alone constrain late Paleogene-Neogene eustasy. Onshore wells are too far updip to recover lowstand sediments and, without seismic profiles, they lack the complementary sequence architecture needed to understand facies distributions within clinoform packages. Furthermore, neither onshore nor deep-water drilling can sample paleo-shelves/clinoform rollovers that are among the most sensitive features to post-Oligocene sea-level change. The full range of known/expected "Ice House" sea-level variations cannot be addressed without drilling on the shelf.

To prepare for shelf drilling, 2D MCS profiles across the shelf/uppermost slope were collected (Fig. 1; Austin et al., 1996). These featured two aspects required for safety: high-resolution (shallowly-towed, short-offset GI gun/streamer geometry, 12.5 m shot spacing, 1 ms sampling, ~5 m vertical resolution) and dense spacing (150 m) around locations of proposed drill sites. Such data quality and density were deemed necessary to avoid drilling into pockets of shallow, pressurized gas. These data increased the resolution and number of mappable sequences (Fulthorpe et al., 1999, 2000; Fulthorpe and Austin, 2008). Unfortunately, because the *JOIDES Resolution* generally employs open-hole drilling, ODP denied all proposed sites except two that "twinned" the COST B-2 stratigraphic test well, to ensure the absence of gas (Scholle, 1977). Consequently, ODP Leg 174A drilled Sites 1071 and 1072 on the outer shelf ~.75 and 3.5 km from B-2 (Fig. 1; Austin, Christie-Blick, Malone, et al., 1998). Loose sands and drill-ship heave resulted in limited recovery to the extent that bounding surfaces could not be sampled/dated with the desired precision. Nonetheless, observed prograding clinoformal seismic sequences were confirmed as being bracketed by unconformities that formed during sea-level falls. Other contributions included: 1) water depths during late-middle Miocene-Pleistocene lowstands were close to zero ~100 km seaward of the modern shoreline; 2) inferred fluvial incisions (restricted to topsets) suggest that ambient sea-level never fell below rollovers; and 3) benthic forams indicate that maximum highstand water depths were ~50-100 m, constraining sea-level amplitudes once the effects of accumulation, compaction and loading are taken into account.

Leg 174A results also showed that a drilling platform immune to heave and a drill rig with closed-circulation were needed to provide both the flexibility in site selection and high core recovery required to meet long-standing MAT objectives. This suggested that drilling beneath the inner shelf, where ~30 m water depths permitted use of a self-propelled jack-up rig ("mission-specific platform") planted on the seafloor, was essential. To serve safety constraints, a second 2D MCS grid was completed landward of previous surveys, again with ~5 m vertical resolution and narrow line spacing (Fig. 1; Monteverde et al, 2008). Sites were selected following the transect strategy; imaging focused on early Neogene clinoforms on the inner-middle shelf.

IODP Expedition 313 – Neogene Clinoforms Continuously Cored and Logged

Exp313 drilled/logged 3 sites, (M)27-29, in 35 of water 45-65 km offshore NJ in 2009 (Figs. 1 and 3; Mountain, Proust, McInroy et al., 2010). Goals were to: 1) identify surfaces representing late Paleogene-Neogene base-level changes and compare their ages with sea-level variations implied by the $\delta^{18}O$ glacioeustatic global proxy (Fig. 2); 2) estimate corresponding amplitudes/rates/mechanisms of sea-level change during this "Icehouse" time; and 3) evaluate/improve models predicting lithofacies successions, depositional environments and seismic architecture in response to such sea-level changes and other processes that imprint the shallow-water record. Exp313 collected 1311 m of very good-excellent quality cores with 80% recovery. The deepest hole penetrated 757 mbsf to upper Eocene sediments. Slim-line logs included spectral gamma ray, resistivity, magnetic susceptibility, sonic and acoustic televiewer. Porewater chemistry profiles were generated; uncontaminated sediments were also frozen for microbiologic studies.

Downhole logs, multi-sensor track measurements of unsplit cores, and physical properties of discrete samples, aided by vertical seismic profile measurements at each site, provided core-log-seismic ties with preliminary depth uncertainties of ±5 m or less (Mountain, Proust, McInroy et al., 2010). Excellent synthetic seismograms provide support for core-log-seismic correlation within specific intervals (Mountain and Monteverde., in review). Studies by the Exp313 Scientific Party (over 2 dozen papers representing scientific results are due for submission to *Geosphere* by Aug 4, 2012) link strata to 16 seismically mapped (Figs. 1, 4) regional surfaces/unconformities. The three sites sampled topsets, foresets and toesets of multiple stacked clinoforms. Litho- and biofacies have been correlated along key seismic surfaces to yield mutually consistent depositional histories, although, as will be described, nagging

PROJECT DESCRIPTION

Expedition 313

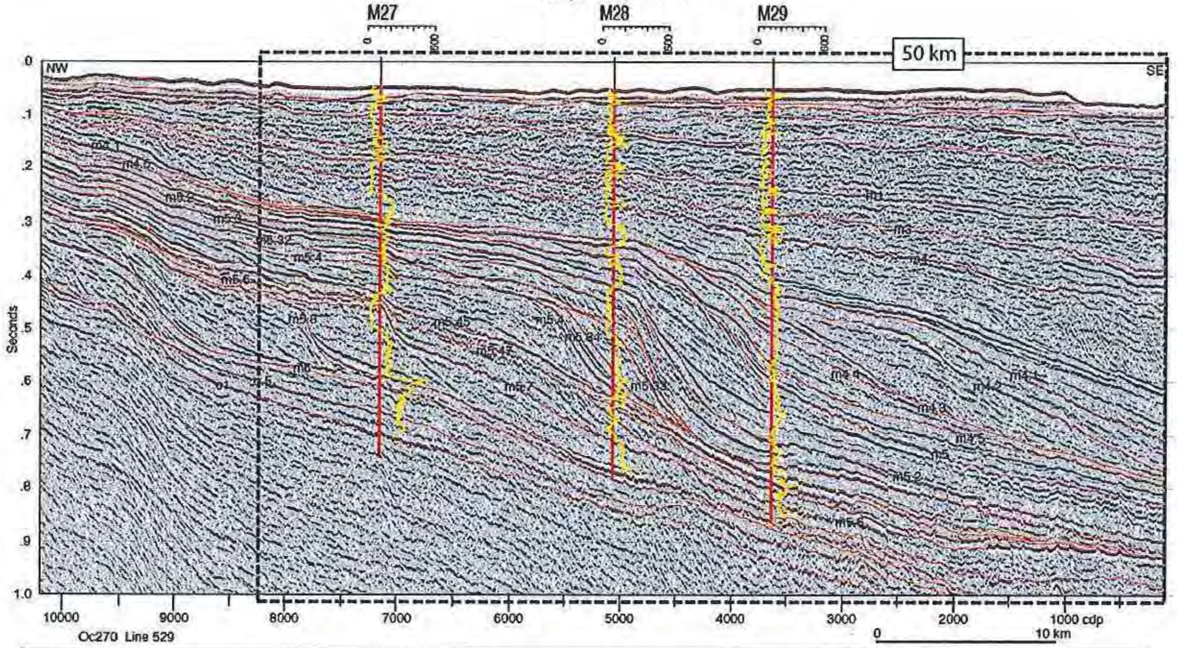

Figure 3. Oc270 line 529 through Exp313 sites M27-29 and the area we propose for a 12x50 km 3D seismic volume (dotted rectangle is the long dimension of that survey; Fig. 1). Gamma ray logs, converted to travel-time with velocities developed for Exp313, are shown in yellow. Early Oligocene - mid-Miocene sequences o1 to m4.1 have been continuously cored/logged and correlated across an existing 2D grid of seismic data on the inner shelf (Monteverde et al., 2008; Figs. 1, 4). As good as the resulting correlations appear to be, ambiguities fundamental to understanding the link between sea-level change and sequence evolution, notably the recognition of diagnostic shorelines and related shallow-water features (fluvial incisions, point bars, estuary complexes, etc.), remain and will not be fully resolved without 3D imaging encompassing these drill sites.

uncertainties remain that cannot be resolved with existing seismic coverage. Excellent paleontologic zonations (based on coccolithophores, dinocysts, diatoms and limited planktonic foraminifera), plus Sr-isotopic ages, are revealing a nearly continuous record of 0.5-2 myr sea-level cycles in the 22-12 Ma interval. Older and younger strata outside this age range have also been sampled, but were not present at all sites. Facies and benthic foram assemblages implying paleo-water depth changes of 60-80 m have been found in topset beds within transgressive-regressive cycles. Initial 2-D backstripping suggests that these paleobathymetric changes are the result of eustatic variations of ~1/2 this magnitude (Mountain and Steckler, 2011; Steckler et al, in review). Ongoing shorebased studies, involving correlation/backstripping of additional surfaces to recover original geometries, should improve eustatic amplitude estimates within the targeted time interval.

However, despite Exp313 successes, made possible by excellent core recovery with ties to logs and mapped sequences (Mountain, Proust, McInroy et al., 2010), uncertainties regarding sequence evolution and relationships with eustatic change remain: 1) If topset strata become subaerially exposed during lowstands, why are no shoreline features, and so few incised valleys, recognized on existing 2D seismic data in the Exp313 region (Fig. 4)? 2) What is the source of debris flow deposits found in Exp313 cores seaward of clinoform rollovers, during what stage(s) of the sea-level cycle are they likely to have formed, and why is there no seismic geomorphologic evidence of sediment transport from either up-dip or along-strike sources on the 2D data? 3) How are prograding Oligocene - mid-Miocene clinoforms influenced by initiation of the globally important mid-Miocene climate transition? Despite progress in sampling these clinoforms, one key element, encompassing spatial imaging, is missing. The clinoform rollover (i.e., paleo-shelf edge) is the key imaging location, because landward shoreline trajectories shift, and the growth and development of incisions in response to sea-level change can be observed seismically. Drilling calibrates those trajectories, but only spatial imaging can both recognize and document them through time.

PROJECT DESCRIPTION

We must know more about detailed processes and depositional environments at/near rollovers, especially volumes/timing of sediment bypass to clinoform slopes. Lateral variability along shorelines is also crucially important, so we must document changes in processes/depositional environments in both dip and strike directions, to the extent that resources allow.

In summary, the "MAT" has been a long-term effort, culminating in Exp313, involving repeated 2D seismics at a range of frequencies to carry out iterative drillsite targeting (using successive sampling technologies) to address the Neogene geologic history at an old passive margin. One crucial piece remains – to integrate calibrated shallow-water facies with 3D images of architecture/geomorphology.

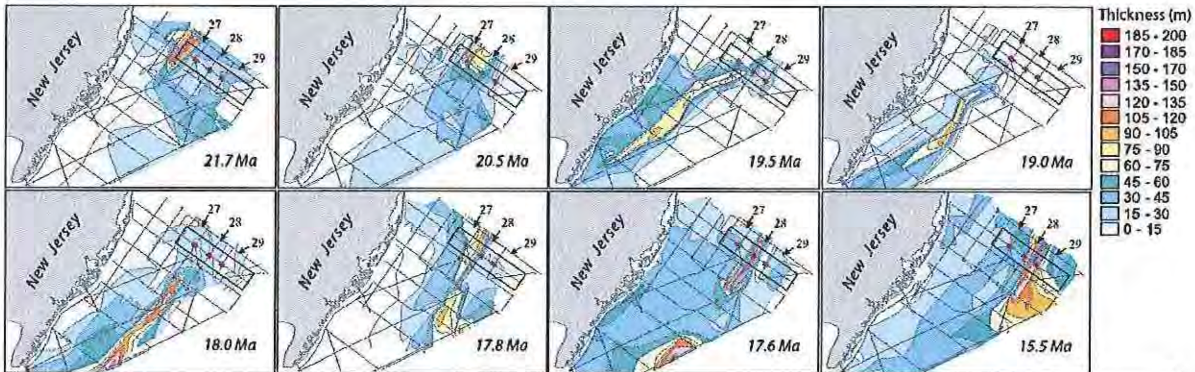

Figure 4. *Isopachs of 8 early to middle Miocene sequences offshore NJ (legend at right; after Monteverde et al., 2008; basal age of sequences from Browning et al., in review). The proposed 12 x 50 km 3D MCS volume encompassing Exp313 Sites M27-M29 (red circles) is outlined in black. Seismic sequences have been identified using 2D MCS profiles (Figs. 1, 3), tied to ODP drill sites on the outer shelf and slope (see Fig. 1), and correlated to hiatuses in ODP onshore wells (Figs. 1, 2). Note seaward progradation of Miocene sediments through time, plus progression from a northern sediment buildup (21.7 Ma), followed by a southern buildup (18.0 Ma), then returning to a northern buildup (15.5 Ma) suggesting both time-varying sources of sediment and margin-parallel redistribution. This complex evolution challenges the reliability of understanding sequence development using only sparse, primarily dip-oriented 2D profiles. The proposed 3D volume will image stratal features within both the thickest parts of some sequences and along the thinner perimeters of others.*

RESEARCH GOALS of the PROPOSED WORK

Provide Community Access to a Calibrated (by Exp 313 Drilling) 3D Seismic Volume

Integration of 3D images with Exp313 drilling results will couple the highest quality cores from this passive margin with unparalleled definition of seismic facies character and spatial geometry where they are needed, near rollovers/paleo-shelf edges most sensitive to changes in base-level during the Ice House. Such an integration will advance sea-level science, while providing unprecedented insights into impacts of migrating shorelines during rising sea level, such as we are experiencing today (see Broader Impacts). Future breakthroughs in the marine geosciences will rely on spatial imaging of the subsurface that can only be achieved with 3D technology. Since its appearance in the early 1970's (Walton, 1972), commercial 3D surveying has grown at such a rate that by 1999 it had eclipsed 2D profiling in terms of worldwide dollar value of acquisition (Liner, 1999). However, despite clear science advantages, its use by academia has followed slowly due to high costs of acquisition and processing.

NSF addressed this issue by convening the 2010 workshop *Challenges and Opportunities in Academic Marine Seismology* (http://www.steveholbrook.com/mlsoc/workshop_report.pdf) to encourage the academic research community to explore ways of increasing access to 3D data. A major recommendation comprised three parts: 1) generate "community" 3D surveys using the *Langseth*, the first academic 3D seismic vessel, 2) hire private companies to process 3D data to an initial interpretable volume within 6 months post-cruise, and 3) release 3D volumes for general use in follow-on, PI-driven interpretation projects. Our proposal follows this model, while being driven by MAT's enduring scientific goals.

Capitalize on the Fundamental Advantages of 3D Seismic Data

The power of 3D seismic volumes is their ability to elucidate both sedimentary processes and paleoenvironments, through assessments of "seismic geomorphology". Sedimentary basin fill is inherently 3D at all spatial scales. Traditional 2D surveys can document basin-scale (tens of km) three-dimensionality, but cannot differentiate km-scale (and less) morphologies, e.g., estuary complexes, shelf channels, upper slope canyons, etc., that are keys to defining shallow-water processes and paleoenvironments, which in turn can be used to determine shifting shoreline positions through time and hence constrain paleo-sea level changes. Individual profiles may image such features, but mapping them between profiles kilometers apart is possible only in a generalized fashion (see Fig. 4). Whereas commercial 3D data can meet academic research needs on some margins, such data are lacking off NJ.

A common misconception exists that 2D and 3D reflection data differ only in image presentation, i.e., that 2D surveying produces a cross section, while 3D surveying produces a volume. In truth, what can be extracted from 3D data far exceeds this conspicuous dimensional component. 2D images are also fundamentally hampered by "cylindrical ambiguity" and "viewpoint limitation". Cylindrical ambiguity means that 2D data lack information necessary to establish cross-profile positioning; there is no way to know true locations of reflections that "appear" to lie beneath the survey track, but which originate from somewhere to one (either) side of the profile plane. Viewpoint limitation means that only reflecting surfaces facing the profile plane can be imaged; all others, including those directly below with even modest cross-profile dips, remain invisible. Maximum reflector dips beneath the inner NJ shelf are small (<8°; Figs. 3, 4), so cross-profile mis-positioning of reflections is not as large as in geologic areas with more steeply dipping features. However, for the two-way travel time range of highest interest (0-0.8 s; Fig. 3), and the corresponding average velocity range (1.6-1.8 km/s), the expected maximum cross-profile mis-positioning of events on existing profiles is 35-100 m, which is as large or larger than incised valleys and related shoreline-related features we hope to observe. 3D acquisition and processing will virtually eliminate these problems.

Another challenge using 2D data for stratigraphic interpretations is caused by streamer cable side-drift/feathering (Renick, 1974; Levin, 1983). During 2D acquisition, cross-currents cause average feathering of ~10° (Yilmaz, 2001). As a result, 2D profiling becomes a limited-swath 3D survey to one side of profile track. Processing such marine survey data using standard 2D imaging procedures (as has been done to the present) creates spurious discontinuities/wipeouts in reflection events (Nedimovic et al., 2003). Currents offshore NJ vary in both strength and direction (Butman et al., 2003), so they must have caused 5-10° streamer feathering when existing 2D data were collected (Fig. 3); this is confirmed by records of visual sightings of tail buoys. Such feathering has detracted from reflection event continuity in all 2D profiles offshore NJ. Unfortunately, past feathering effects cannot be corrected because streamer navigation was not utilized during all of those 2D surveys.

Exploit the Unique Tools Associated with 3D Imaging

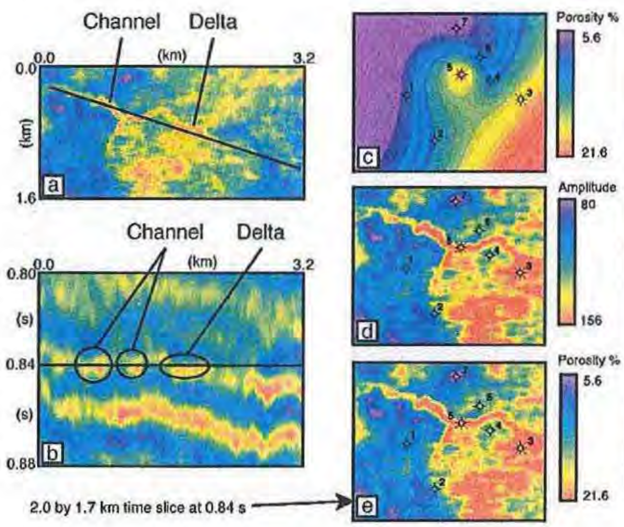

Figure 5. (a, b) Channel systems (from the Gulf of Mexico) in 2D and 3D and (c, d, e) integrating seismic and well data to extract porosity. a-b: While a map view (a) of an amplitude slice at 840 ms two-way travel-time provides a clear image of a channel and (associated) delta, little can be inferred about this system from a cross-sectional image (b) carefully chosen to cross the channel twice and the delta once. (c): Gridded porosity map at the reservoir level (840 ms, see a), based upon samples from 7 drilled holes. (d): Time slice at the same level as in (c). Note the level of detail of sratigraphic features. (e): Seismic-guided porosity map formed by integrating seismic and well data. If 3D seismic data had been collected before drilling, 5 dry holes (1, 2, 4, 6, 7) would not have been drilled. Figure adapted from Liner (1999).

PROJECT DESCRIPTION

The growing use of 3D seismic techniques has led to significant advances in stratigraphic studies. Small but important "process" features like incised channels, difficult to document using 2D data, stand out in maps derived using 3D data (Figs. 5, 6). However, stratigraphic interpretation benefits not only from a 3D view of the subsurface, but also from the ability to extract quantities called "seismic attributes" from 3D volumes. Both pre-stack and post-stack attributes will be needed from the proposed 3D volume to extract the maximum information for ongoing stratigraphic interpretations of the NJ margin.

Post-stack seismic attributes result from image manipulation (Liner, 1999; Fig. 5). For NJ, the most useful post-stack attributes are instantaneous amplitude, phase, frequency and Q (1/attenuation). When applied to 3D volumes, these attributes can be powerful indicators of lithologic variations, event continuity, fracturing and absorption. The most useful 2D attributes for delineating channels are coherency, edge detection, directional gradient (e.g., "curvature", Fig. 6) and shaded relief.

While 3D surveys provide more accurate and useful information than 2D seismic imaging (Fig. 5c-e), the most complete geologic information is extracted by combining 3D images with drilling/logging. Such a combined approach allows for detailed analysis of geometry, lithology, porosity, fluid saturation and anisotropy of buried sediments and associated depositional/erosional systems (e.g., complex fluvial channel systems; Fig. 6) and their geometric relationships with Neogene rollovers sampled by Exp313.

An excellent example of the value of 3D data is provided by ongoing research into the upper Oligocene-Recent clinoformal stratigraphy of the Northern Carnarvon Basin (NCB), Australian Northwest Shelf (NWS) (Liu et al., 2011; Sanchez et al., 2012a, b). Middle Miocene-Pliocene siliciclastic sediments represent a long-lived (~8 my) break in otherwise carbonate-dominated shelf sedimentation. Available commercial 3D volumes have enabled a profound new interpretation of these prograding siliciclastics as 27 shelf-/shelf-edge delta lobes (Fig. 7). Only through true 3D mapping has it been possible to correlate individual clinoform sets with these lobate, complex deltaic morphologies. Long-term (cumulative) progradation of this delta system and subsequent backstepping correlate with long-term sea-level fall and rise during the late middle-late Miocene. This observed siliciclastic influx correlates with other coeval increases in siliciclastic sediment supply worldwide, including offshore NJ and a prospective depocenter in the Gulf of Mexico (see text below).

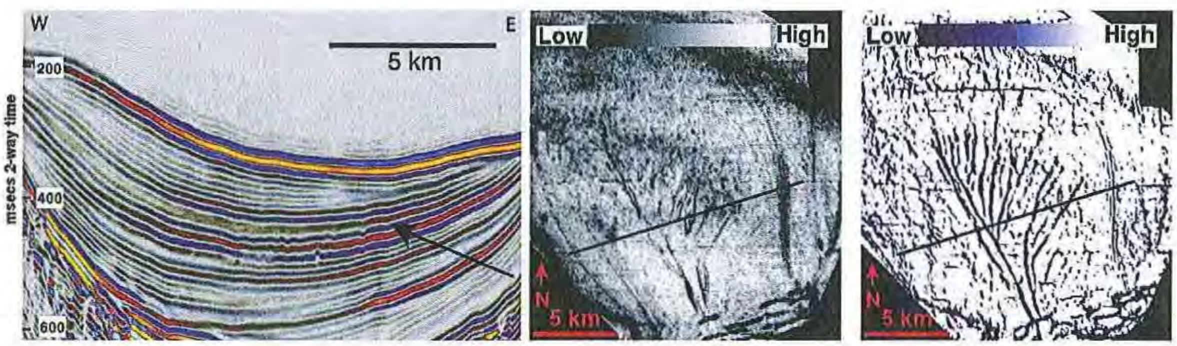

Figure 6. Visualization and interpretation of paleo-channels in 2D (left) and 3D (center, right) seismic data. Left: Strike-oriented 2D seismic reflection profile from the Gulf of Mexico showing subtle undulations in one imaged stratal horizon (indicated by the black arrow) which are produced by slope channels. However, this could not be confirmed using the 2D representation by itself. Center/right: Seismic attribute (travel-time) slices produced along the same horizon extracted from a conventional 3D volume, the center view showing "coherence" and the right view highlighting "most-negative curvature". Identifying complex channel features and tracking them spatially is straightforward using the 3D volume, but challenging if not impossible to achieve using 2D control alone, even if the 2D grid is dense, as is true for some of the grids on the NJ margin (Figs. 1, 4). From Lozano and Marfurt, 2008.

In addition, 3D mapping in the NCB has yielded important insights into the relationships between clinoformal sequence boundaries and sea-level change, particularly: 1) complex spatial acoustic evidence of karst topography (indicative of shelf exposure) along some horizons, and 2) step-like, vertical offsets up to 65 m high, downward toward the basin on the outer paleo-shelves (near rollovers) of two early-middle Miocene sequence boundaries. These have been interpreted as rarely preserved examples of wave-cut terraces or sea cliffs (Liu et al., 2011). All of these features represent direct evidence of paleo-sea level and shoreline location, which can only be interpreted with 3D data.

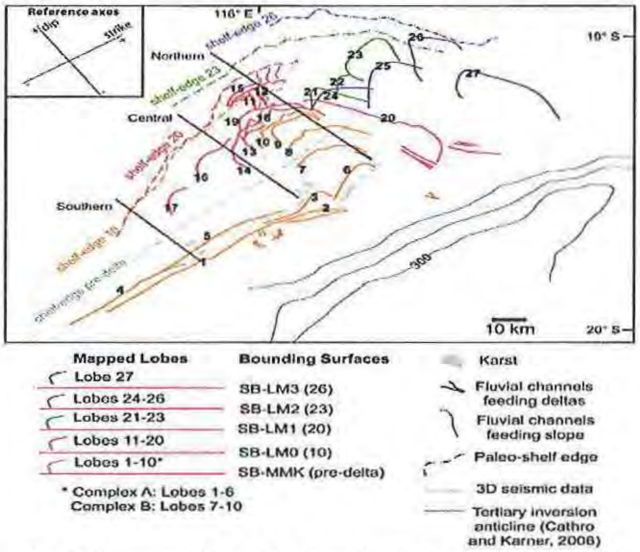

Figure 7. Delta lobes and positions of paleo-shelf edges at the ends of deltaic progradation pulses in the Northern Carnarvon Basin (NCB), Australian Northwest Shelf (NWS; Sanchez et al., 2012 a, b). The outline of each lobe corresponds to the rollover of the upper bounding unconformity of the mapped clinoform set representing that lobe. Interpreted fluvial channels within the siliciclastic interval are shown in colors correlative with their presumed associated delta lobe. Interpreted karst features, indicative of paleo-shelf exposure (i.e., sea-level low stand), also underlie lobes 1-6. This interpretation of clinoform sets as a spatially complex set of prograding delta lobes was only possible through mapping within a 3D seismic volume (outline of the volume shown in the figure, thin grey line).

Tie 3D Volume to Exp 313 Results to Resolve Ambiguities of Neogene Stratigraphic Evolution

Seismic morphologies similar to those of the NWS, containing imprints of changing sea level and other factors that control shallow-water sedimentary processes, are present on the NJ margin (Fulthorpe and Austin, 1998; Nordfjord et al., 2005). The 3D MCS volume we propose to collect will focus on resolving the origin of such features critical to understanding the relationships between sea-level change and sequence development. In particular, we will focus on shallow-water features near and at paleo-shorelines: fluvial channels, point bars and estuary complexes (Nordfjord et al., 2005). MCS line 529 (Fig. 3) runs through the center of our proposed survey area and ties the three Exp313 sites. Below, we use that image to frame three working hypotheses that can be tested by combining a 3D volume with Exp313 results. These hypotheses/related goals agree with components of the Eastern North American Margin (ENAM) component of the GeoPRISMS Draft Implementation Plan (http://www.geoprisms.org/enam.html).

1) What are the spatial/temporal relationships between sea-level low stands and areas of paleo-shelf exposure adjacent to/landward of clinoform rollovers? Linked hypothesis: low stand paleo-shelf exposure has increased since the Oligocene, probably in response to increasing eustatic amplitudes (Fig. 2), resulting in an increasing number of fluvial incisions both up-section and seaward across the NJ margin.

Seismic sequences, when first defined, were classified according to the nature of their basal boundaries (Mitchum et al., 1977). While terminology has since been refined, a fundamental observation remains valid: some sequences begin with valleys cut into the top of the underlying sequence, while others have no such incisions, and begin instead with apparently conformable deposition onto beds of the preexisting shelf/uppermost slope. The former incised, "Type 1", sequence boundaries have been inferred to indicate a larger and/or more rapid fall in base-level than the latter, "Type 2", boundaries. Judging from existing 2D MCS data off NJ (Fig. 1), incised valleys appear to be scarce in paleo-shelf strata landward of rollovers, suggesting that Type 2 boundaries dominate the early Miocene within the proposed survey area (Fig. 3). Similarly, a lack of lobate low stand fans seaward of clinoform toes (Figs. 3, 4; see below) supports the hypothesis that Type 1 systems are minor to nonexistent in this lower Miocene section. Nonetheless, there is seismic evidence (at ~cdp 4000, between m5 and m4.5, Fig. 3) of a shelf-edge delta and erosional truncation of foresets, suggesting base level at m5 time was very close to, if not below, the elevation of adjacent topsets. In addition, landward of all Exp313 sites (Fig. 1), isolated incisions ~100 m wide and 5-10 m deep are observed seismically, but none can be connected with existing data coverage (Fig. 4;

Monteverde et al., 2008). Possible explanations include: 1) incised valleys are well-preserved/present, but existing 2D profiles do not cross them (unlikely); 2) such valleys were removed by ravinement during transgressions (possible, but unlikely due to the lack of core-based evidence for accompanying hiatuses between sequences in Exp313 samples); or 3) such valleys are present, but too small/widely spaced to be resolved by existing 2D coverage (very likely). This third possibility is supported by interpretations of dense, ultra-high resolution single-channel (2D/3D CHIRP geophysical profiles) of the NJ shelf 60 km to the southeast, which confirm that complex dendritic, incised fluvial systems formed during the latest Pleistocene (Davies et al., 1992; Duncan et al., 2001; Nordfjord et al., 2005). Incised valleys are crucial paleo-water depth indicators at sequence boundaries, independent of benthic foraminiferal successions. We are confident that if incised valleys exist within lower Miocene sediments around Exp313 sites, and seaward toward correlative rollovers, they will be detected using 3D images along with related morphologic enhancement techniques (Figs. 5, 6). Mapping these incisions will constrain shoreline positions through time, improve estimates of eustatic amplitudes, and enable sequence architecture/seismic geomorphologic techniques to predict facies distributions calibrated by Exp313.

While pre-middle Miocene shelf exposure near Exp313 sites is difficult to detect with existing 2D data, this is not true of younger intervals sampled by Exp313 above reflector m4.1 (Fig. 3). Spot coring at irregular surfaces corresponding to sequence boundaries m1, m3 and m4 at sites M27 and M29 recovered shallow water sands, and in several cases ~1 m of paleosol (Mountain, Proust, McInroy, et al., 2010). These surfaces can be traced seismically to clinoforms on the mid-shelf 25 km seaward of M29, but the proposed 3D imaging will not extend seaward to those younger clinoforms. Nonetheless, several hundred meters of largely discontinuous reflectors above m4.1 (Fig. 3) are virtually certain to be resolved with 3D techniques to a degree rarely seen, providing seismic expression of nearshore and coastal plain facies tied to Exp313 cores and logs.

Using the proposed 3D volume, seismic evidence for paleo-shelf exposures and proximity of fluvial sources to paleo-shelf edges/rollovers can be mapped, along with shelf/uppermost slope delta architecture (if it exists; Fig. 7), within any of the eight sequences constrained by Exp 313 results (Fig. 3). Community-based efforts can then document any enhanced fluvial contributions to observed clinoform progradation during a known time interval of long-term eustatic fall and increasing glacioeustatic amplitudes. Seismic attribute analyses, e.g., coherence displays (Fig. 6, center), offer exciting opportunities to locate/map incised valleys/canyons at sequence boundaries, to calibrate sand distribution in shallow shelf intervals/topsets, clinoform front/toe and basinal settings, and to investigate facies-dependent bedding characteristics calibrated by Exp 313. The higher fold and improved source to be used for the proposed 3D survey (see below) will also provide enhanced multiple suppression and thereby produce sharper definition of sequence boundaries (e.g., Fig. 4), a task that is especially challenging along the mid-Atlantic shelf because of highly reflective and parallel layering of interbedded muds and sands in the Neogene section (e.g., Austin, Christie-Blick et al., 1998)

2) What are the mechanisms of sediment transport seaward of clinoform rollovers, and how do they fit into the sequence stratigraphic model? Linked hypothesis: During shelf progradation, the evolution of clinoform front morphology is a complex response to changes in gradient, sediment source geometry (point- vs. line-source), and basinward redeposition by sediment gravity flows/turbidity currents.

Despite the lack of seismic evidence for inner-shelf incisions along the tops of Oligocene-middle Miocene sequences (Fig. 4), mass-transport deposits on slopes were encountered by Exp313 (Fig. 8). The classic model of siliciclastic sequence development includes submarine fans seaward of clinoform toes (Van Wagoner et al., 1988; Posamentier and Vail, 1988), presumed to represent sediment by-pass/basinward transport of mostly coarse-grained material during times of rapid sea-level fall. However, there is little evidence of such lobate depocenters in Oligocene-Miocene sections beneath the NJ shelf (Figs. 3, 4; Greenlee et al., 1992; Poulsen et al., 1998). In their place beneath the inner shelf there are well-defined deposits less than a few km seaward of rollovers that accumulated as units 10's-100's of m thick on ~2° clinoform slope gradients (Fig. 3). All pinch out landward and thin seaward, where most become seismically indistinguishable from underlying strong reflectors at slope toes. Each extends for 10's of km along-strike. These sediments have been termed "slope apron deposits"; Exp313 results have shown that they comprise glauconitic sands and mature quartz grains up to gravel size, all presumably shed from edges of adjacent clinoform tops (Fig. 8). The Exp313 team is using both litho- and seismic stratigraphic features of several of these deposits where they occur within a single sequence. The goal is to identify criteria that divide them into separate depositional units, but because they represent rapidly deposited, reworked material, such subdivisions will be difficult or impossible to establish with the existing 2D data. We will also be able to determine how slope apron deposition relates to timing of eustatic change(s), a goal at the heart of understanding clinoform evolution. A 3D volume is required to do this work.

In addition to resolving internal structures of slope aprons, the 3D volume will also detect failure scars/transport lanes that directed mass flows basinward (Fig. 8). The volume will also document spatial/temporal connections to shelf-crossing incised valleys immediately landward of rollovers. One important objective is to determine the degree to which observed incised features served as conduits for sediment originating landward of the rollover, as opposed to more local slope redistributions, such as headward erosion, gravitational creep, slumping and/or debris flow mechanisms, all of which originated seaward of rollovers. Ties between continuously sampled cores and 3D images make this possible.

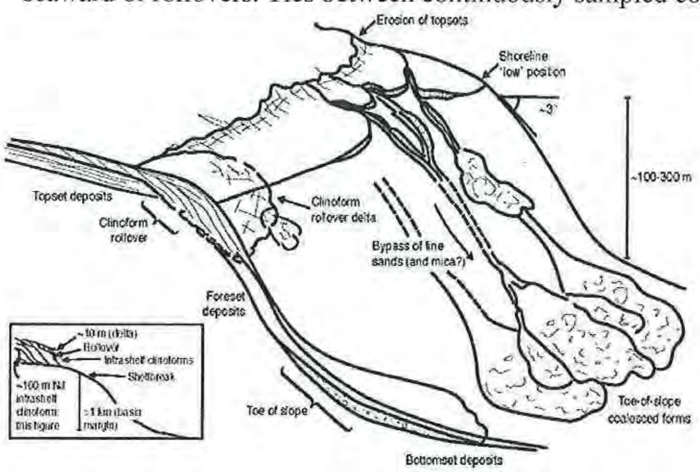

Figure 8. Conceptual model developed during Exp313 to explain regular occurrences of poorly sorted, stratified, glauconite-rich coarse sand/gravels in cores taken near the tops of clinoform slopes. Multiple channels and/or regressive shorefaces at clinoform rollovers are presumed to erode into/entrain older topset deposits. These sediments are remobilized and transported down the clinoform slope as debris flows and turbidity currents to form aprons close to the toe of slope (Mountain, Proust, McInroy et al., 2010). The 3D volume will vastly improve images of clinoform rollovers, where these sediment movements take place in response to base-level changes.

Research on sediment transport pathways using 2D data has been unable to provide definitive models of shelf/slope/basin connectivity on this or any continental margin. In the sequence stratigraphic model, fans and laterally extensive onlap depend on stable point sources of sediment (e.g., Karner and Driscoll, 1997). But even middle-late Miocene sequence boundaries that display evidence of paleo-shelf exposure are not associated with lobate lowstand accumulations basinward of clinoform toes, based on available 2D profiles (e.g., Fulthorpe et al., 2000). Perhaps such deposits were instead transported farther basinward to the continental rise and/or laterally along the margin, as probably occurred in the Miocene on Australia's NWS (Cathro et al., 2003). Lowstand fans are also absent in paleo-shelf settings of the Canterbury Basin, New Zealand, where influences of along-strike currents are unequivocal (Lu et al., 2003; Lu and Fulthorpe, 2004). Morphologic elements of paleo-slope incisions, i.e., canyons and rills, on the mid-Atlantic and other margins remain unclear with available (2D) seismic control. Pleistocene and modern canyons are large (up to 300 m deep and 2-5 km wide), closely spaced (2-10 km), and the Hudson and Delaware canyons off the east coast of the U.S. are clearly linked to river systems that have retreated westward during the Holocene sea-level rise. In contrast, middle-late Miocene canyons are both less deeply incised and less common and do not appear to be directly linked to paleo-shelf incisions, suggesting that they are not directly related to fluvial sources (Fulthorpe et al., 1999; Fulthorpe et al., 2000). Fulthorpe et al. (1999) have advanced the hypothesis that observed paleo-shelf-edge linearity results from along-strike sediment transport by waves and currents, which mutes the influence of individual fluvial point sources to form a line-source of sediment delivery to clinoform fronts (see also Fulthorpe and Austin, 2008). Individual fluvial sources apparently did not deliver sufficient sediment to overcome along-strike forcing to produce lobate depocenters (see Fig. 7), even though some fluvial incisions appear similar in width and depth to the Pleistocene Hudson and Delaware shelf channels (Fulthorpe et al., 1999). Shelf and slope incisions cannot be observed on the NCB/NWS, despite 3D imaging (Fig. 7). A lack of prominent point sources on the Miocene NJ margin (Fulthorpe et al., 1999; Pekar et al., 2003) may account for differences between NJ sequences and the standard sequence model (e.g., presence of slope aprons and absence of lobate fans). However, none of these inferences can be confirmed using only the available 2D seismic control. The only way that process-based links between sediment sources and observed/sampled NJ Oligocene-Miocene clinoforms can be established, and their relationship to sea-level cycles defined, is by 3D imaging encompassing Exp313 sites (Figs. 3-4).

Similarly, canyons cut into clinoform slopes do not appear to be linked to those incising more gently dipping surfaces basinward of clinoform toes, suggesting that different submarine erosional processes may be associated with observed changes in gradient. This may result from different "regime variables" controlling sedimentation patterns (Swift and Thorne, 1991; Fulthorpe et al., 2000). Along the modern shelf edge offshore NJ, incisions up to 140 m deep can occur even on low gradients basinward of clinoform toes, most likely due to fluid escape processes (Dugan and Flemings, 2000). 3D imaging along clinoform slopes in this project can test for this process of slope failure in the early - mid-Miocene.

3) What was the sedimentary process response to the global mid-Miocene climatic (and tectonic) transition? Linked hypothesis: Changes in the rate of sediment input to the NJ margin during the mid-Miocene, as evidenced by mapping clinoforms bracketed by sequence boundaries, are linked to globally significant changes in the relative intensity of margin erosion.

Many continental margins reveal mid-Miocene influxes of siliciclastic sediments (Molnar, 2004). In addition to NJ (Poag and Sevon, 1989; Pazzaglia and Brandon, 1996; Steckler et al., 1999), other well-constrained examples of this pattern include the Gulf of Mexico (Galloway et al., 2000; Galloway, 2008), Canterbury Basin (Lu et al., 2005), NCB (Cathro et al., 2003; Sanchez et al., 2012a, b), the Angola margin (Lavier et al., 2001), and the Maltese Islands margin (John et al., 2003). Age estimates for this influx range from 15-12 Ma. The NCB case (Fig. 7) is striking, because the observed siliciclastic increase occurred at a preexisting carbonate margin. In the Canterbury Basin, the mid-Miocene sediment increase is not linked to known tectonism in the proximal Southern Alps; the only notable increase in sedimentation rate that coincides with tectonism is much later, during a well-defined period of increasing convergence rates at the Alpine Fault (Lu et al., 2005). This global pattern of mid-Miocene sediment influxes has been linked to global cooling following the mid-Miocene $\delta^{18}O$ peak. One possible mechanism is that the post - mid-Miocene global sea-level fall may have led to increased shelf erosion everywhere. However, reconstructed paleobathymetric profiles on the NJ margin suggest that the amount of sediment required for the observed progradation, estimated as a 20-fold increase in flux, exceeds that available from paleo-shelf erosion alone (Steckler et al., 1999). Other proposed mechanisms include changes in precipitation and in the amplitude/frequency of late Cenozoic climate change (Molnar, 2001; 2004).

However, climate may not have been the only driver of mid-Miocene sediment influx. Tectonic uplift of the hinterland may also have contributed (Poag and Sevon, 1989; Pazzaglia and Brandon, 1996). Potter and Szatmari (2009) have united climatic and tectonic mechanisms for Miocene sedimentation by hypothesizing a global increase in middle-late Miocene tectonic activity driven by accelerated upwelling at two "superplumes" below the Pacific and Africa plates, which may also have produced far-field uplift of passive margins such as NJ. In their scenario, tectonic activity drove the coeval climatic transitions, through opening/closing key gateways and changing the oceanic circulation to trigger global cooling. The same Appalachian uplift that provided sediment to NJ has also been proposed as the origin of voluminous mid-Miocene sediments in the deep Gulf of Mexico (Jackson et al, 2011). These sediments were delivered by the paleo-Tennessee River, which discharged into the northeastern Gulf prior to its capture by the Mississippi (Galloway et al., 2000; Galloway, 2008). In spite of the large volumes of sandy sediment delivered to the Gulf basin, coeval updip slope canyons have not been identified, in marked contrast to the Pleistocene depositional episode (Galloway et al., 2000; Galloway, 2008). These Gulf of Mexico Miocene sediments are now targets of intensive hydrocarbon exploration, so understanding processes of middle Miocene sediment delivery from shelf to basin is economically as well as academically important.

The middle-late Miocene was a critical period in which climatic/tectonic processes combined to influence sedimentation globally. One of the long-term goals off NJ is to evaluate sedimentary response to these Miocene changes that influenced hinterland capability to provide sediment to the margin. Our proposed 3D survey will target initiation of the mid-Miocene sediment influx by imaging the transition between steep, slowly prograding Oligocene to mid-Miocene clinoforms drilled during Exp313 (Fig. 3), to more gently dipping, but more rapidly progradating features deposited later in the Miocene. Seismic geomorphology derived using the 3D volume will allow us to map temporal changes in shelf channel geometrical parameters (e.g., width, depth, sinuosity, gradient) to deduce changing sediment transport capacities from the hinterland through time, while slope morphologies, including the presence/absence of incised valley/canyons, will provide insights into processes involved in sediment bypassing to deep water (Fig. 8). In addition, correlation with the well-dated mid-Miocene sequences in the Gulf of Mexico, sourced from the same hinterland, will enable the timing of the influx in each basin to be compared.

WORK PLAN

Early-middle Miocene sequences clearly vary along-strike (Fig. 4), but a 3D volume long enough (perhaps ~100 km) to image all mapped variability is cost prohibitive. Instead, we propose to collect a 50 (dip) x 12 (strike) km volume encompassing all Exp 313 sites (Fig. 1), which has sampled ~12 sequences (Fig. 3). Some will be imaged along depocenter axes, others along peripheries, so we should image the full suite of potential shelf/slope, process-related seismic geomorphologies. Only one boundary (m5.6) will be missed. Fig. 3 shows that the volume proposed will image at least eight Miocene clinoform rollovers; these paleo-shelf edges record primary depositional processes associated with base-level change.

We have prepared a 2-year budget for acquisition/initial commercial processing of the volume (Fig.1). The data will be acquired on *Langseth*; processing will be done by a commercial company to pre-stack time-migrated (PSTM) shot gathers and 3D image volume (see quote in "Other Supplementary Documents"). The 12 km survey width optimizes turn efficiency and allows full data acquisition to be completed in two 6-km wide 'racetracks'. The 50 km dip-length enables imaging of early Miocene topsets landward of Site M27 to middle Miocene toe-of-clinoform morphologies basinward of Site M29 (Fig. 3).

We will focus on imaging the upper 1 s two-way travel time; we expect to achieve vertical resolution of 5 m or better and horizontal resolution of 15 m or better. We will record with 1 ms sampling to a travel-time depth of 4 s to image diffractions necessary for proper migration. These constraints dictate a shallow, high frequency source array and a recording design that minimizes spatial aliasing. We expect in-line dips to be <4°, and cross-line dips to be <8°, the latter along inward-facing walls of incised valleys. To reduce aliasing of diffractions that will arise from lateral discontinuities and pinchouts, we plan to collect data with a nominal bin size of 6.25 m in-line and 18.75 m cross-line. *Langseth* will tow four 3-km streamers spaced 75 m apart to provide the necessary range of source-receiver offsets required for complete imaging to a maximum estimated target depth of 5-6 km.

We estimate cruise duration based on industry acquisition standards (e.g., 30% downtime and infill) prior *Langseth* 3D projects, consultations with R. Steinhaus, Chief Sci. Officer on *Langseth*, and use of industry acquisition planning software. We anticipate leaving from/returning to Newark, NJ, a ~80 nmi transit to/from the survey area (Fig. 1). Setup/deployment/streamer ballasting should take 3 days; gear retrieval and transit at the end will be 1 day. *Langseth* will use two flip-flopping gun arrays designed for high-resolution surveying, resulting in eight CMP lines spaced at 18.75 m for each sail line. The 12 km-wide area will be covered with 80 sail lines. Total shiptime dock-to-dock is 34 days.

Data acquisition will result in 5 terabytes of field data. PGS (see quote in "Other Supplementary Documents") has responded with a detailed work plan at a competitive cost. Their approach comprises 27 processing steps leading to various 3D PSTM shot gathers and data volumes; these will provide the community with interpretable reflection results and material for follow-on data analysis proposals. The data will be processed at 2 ms sampling rate unless the records show signal above 250 Hz, in which case

PROJECT DESCRIPTION

the processing will proceed at 1 ms. Estimated data processing time is 5 mo. Two 1-week visits to the PGS facility by two co-PIs are budgeted to participate in and oversee the data preparation. Following a post-cruise workshop for the interested community of users (see UTIG Budget and Justification), we will upload delivered results to UTIG's Academic Science Portal of the Marine Geoscience Data System, and will also upload raw data/navigation to LDEO's Seismic Reflection Data Management System.

This is a collaborative effort between PIs with decades of experience collecting, processing and analyzing marine seismic data along continental margins, and in particular NJ. M. Nedimovic (MN) has recently completed a successful 2-month cruise as a Co-PI aboard *Langseth* collecting multi-streamer 2D data. His experience planning and executing that campaign (that included 6 volunteer watch-standers onboard to gain scientific experience) is valuable for the proposed project. Post-cruise, MN will provide primary oversight of the commercial processing; he will make two 5-day trips to the processing facility in Houston. He will be joined on both trips by a second Co-PI. G.Mountain (GM) has participated in every 2D MCS acquisition survey comprising the MAT. In his role as Exp313 Co-Chief, GM is in touch with Expedition-based research that will both augment and benefit from results of the proposed 3D volume. GM, MN and N. Christie-Blick (NCB) are professors at their respective institutions with years of teaching experience that can be applied to educational aspects of pre- and post-cruise workshops and the at-sea experience of volunteer watch-standers. NCB brings lengthy experience in applying sequence stratigraphic principles at the outcrop scale, which tied to the Exp313 wells is what the proposed 3D imagery will closely rival. J. Austin (JA) and C. Fulthorpe (CF) bring decades of experience in using both 2D and 3D MCS and ultra high-resolution acoustic tools (CHIRP, boomer, swath bathymetry) to the study of sediment transport on passive margins. With ONR support, they have studied the latest Pleistocene-Holocene stratigraphic succession of the NJ shelf for 25 yrs. Furthermore, both have analyzed 3D data volumes on the NW Australian continental margin, and both have been ODP/IODP Co-Chiefs in continental shelf drilling efforts (JA: Leg 174A, CF: Exp317). All co-PIs will help run shorebased workshops pre- and post-data acquisition, and 4 will sail aboard *Langseth* and participate in the instruction of volunteer watch-standers in the theory and practice of seismic acquisition, processing and interpretation. In addition to their instructional duties, GM, JA and CF will stand 8-hr watches each day at sea; MN will oversee data QC and be on-call to troubleshoot acquisition-related problems.

The 3D, pre-stack time migrated data volume will be delivered from the processing company to JA and CF, to be loaded onto a 3D visualization workstation. The co-PIs will convene a data appraisal, first-look interpretation workshop at UTIG for the interested scientific community shortly thereafter. Research themes identified will initiate sub-groups to focus on developing important research goals. Workshop products are TBD, but the intent is clear: 1) to debut the 3D data to interested researchers, 2) to task those present with developing strategies for achieving realistic goals using the 3D volume, and 3) to rapidly link a wide community of potential researchers to the 3D data by making it publically available at the close of the workshop (see the "Data Management Plan").

INTELLECTUAL MERIT

The NJ margin is among the best siliciclastic passive margins for elucidating the timing/amplitude of eustatic change over millions of years, and for examining quantitatively the link between sea-level change and the stratigraphic record. Consequently, this margin has been a key location in all long-range plans of scientific ocean drilling since it was first identified by COSOD II (1987). While Exp313 continuously cored/logged boreholes within shallow-water facies, and has recovered complete stratigraphic information, 3D seismic imaging is needed to put that sampled record in a spatially accurate, stratigraphically meaningful context. The 29 researchers of the Exp313 scientific party are an especially valuable knowledge base of the mid-Cenozoic evolution of the NJ shelf; they and other scientists involved in research of the MAT represent a large body of experts for whom the proposed seismic geomorphology will be a tremendous asset. 3D imagery will allow them to map sequences around Exp313 sites, including shoreline positions and flanking diagnostic shallow-water features (e.g., fluvial incisions, estuary complexes, point bars). The long-term objectives remain to: 1) determine the amplitude and timing of global sea-level changes during the "Ice House" 2) establish the impact of base-level changes on the preserved stratigraphic record; and 3) improve understanding of the response of shorelines/nearshore environments to changes in global sea level, a societally relevant topic today.

BROADER IMPACTS

The team of co-PIs envisions 3 phases of robust interaction with the user community before, during and after 3D acquisition aboard *Langseth*: 1) A pre-acquisition workshop to acquaint interested participants with the project (an announcement of opportunity was placed [May 2012; see 'Other Suppl. Docs.'] on the GeoPRISMS and Consortium for Ocean Leadership [COL] websites; additional announcements will follow funding) will be held at Rutgers prior to data acquisition. The scientific value of 3D data will be displayed, the history of research on the NJ margin will be highlighted, and plans for data acquisition will be laid out. Discussions will aim at reaching a consensus concerning acquisition details and processing features of the community data volume by a commercial company. 2) Community interaction during acquisition will be primarily the hands-on participation of students/young scientists aboard *Langseth* (~12 bunks are available for volunteers [see 'Mentoring Plan']). The survey area is <40 nmi from Atlantic City, so rotation of more than one group is possible by at-sea transfer, enabling a variety of education/outreach activities with perhaps occasional live satellite feeds showing the deployment/recovery of seismic gear, etc. 3) A post-acquisition workshop at UTIG will focus on avenues for community analysis/interpretation of the processed 3D volume, once that volume is available ~5 mo post-acquisition.

The Rutgers Geology Museum has previously hosted exhibits of scientific drilling in the Coastal Plain, focusing on the K/Pg boundary core obtained at Bass River, NJ (ODP Leg 174AX; Olsson et al., 1997). We will prepare similar exhibits/talks to highlight the integration of 3D seismic with drilling. We expect that 3D images will become integral to IODP outreach, along with Exp313 results. We will showcase NJ margin results for the European Union (which funded Exp313 drilling/logging costs through IODP), for ICDP (which funded some drilling costs), the COL (responsible for logging/data management) and IODP-MI (which managed Exp313). We will provide the IODP Data Bank, and, if asked, the ECORD/ESO Drilling Operator, with 3D image data. LDEO/UTIG have an ongoing collaboration through NSF to archive marine seismic data. We will make the commercially processed 3D data available to this facility, with the expectation that they will become an enduring demonstration of how 3D imaging can improve understanding of passive margin stratigraphic evolution.

A final note about societal relevance. The proposed 3D volume, tied to cored and logged drillsites, will provide a valuable opportunity to understand better the causes of an increase in mid-Neogene deposition at many passive margins around the globe (e.g., Bartek et al., 1991.). The same Appalachian hinterland that was the source of the sedimentary record offshore NJ, and concentrated on by the MAT, fed a similar pulse of sediments into the Gulf of Mexico. Consequently, increasing knowledge of the evolution of the NJ shelf may help to improve exploration strategies in the Gulf, a proven hydrocarbon province.

RESULTS FROM PRIOR NSF SUPPORT

Gregory Mountain and **Nicholas Christie-Blick** have not received NSF support in the past 5 years.
Mladen Nedimović (w/ PIs from LDEO, WHOI + SIO; only LDEO support listed): OCE-0648303, *Collab. Res.: Seismic structure + evolu-tion of oceanic crust along the Juan de Fuca Ridge + its Flanks*, 04/01/07-03/31/10, $173,519. Resulted in 3 PhD chapters, 15 AGU abstracts, 11 peer-reviewed papers (4 in G^3, 2 in *Nature*, 2 in *EPSL*, 2 in *JGR*, and 1 in *Geology*).
Craig Fulthorpe and **James Austin**, OCE 0550004 (PIs Fulthorpe, Austin, Lavier [UTIG]), *The NW Shelf, Australia: the next step in a global approach to understanding the role of eustasy in the generation and preservation of stratigraphy,* $464,278; 2/1/06-1/31/09 + 2 no-cost extensions to 1/31/11. Commercially donated 3D+2D MCS, logs and well-completion reports were used to investigate stratal architecture of a siliciclastic-rich interval of the N. Carnarvon Basin, where late mid-Miocene siliciclastics prograded across a Paleogene carbonate ramp under wave-dominated conditions during a time of base-level fall. Thus far resulted in (Liu et al., 2011; Sanchez et al., 2012a, 2012b; 1 Ph.D. (Sanchez); aid for C. Liu to visit UTIG from China to collaborate, 2008-2010.

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SUMMARY PROPOSAL BUDGET

YEAR 1

	FOR NSF USE ONLY		
ORGANIZATION: **Rutgers University New Brunswick**	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Gregory Mountain**	AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Gregory S Mountain - Professor**	(b) (4), (b) (6) [redacted]				
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)					
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS					
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (**0**) GRADUATE STUDENTS					
4. (**0**) UNDERGRADUATE STUDENTS					
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (**0**) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				(b) (4) [redacted]	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)					
2. FOREIGN					
F. PARTICIPANT SUPPORT COSTS (b) (4) [redacted]					
1. STIPENDS $					
2. TRAVEL					
3. SUBSISTENCE					
4. OTHER					
TOTAL NUMBER OF PARTICIPANT — TOTAL PARTICIPANT COSTS				(b) (4) [redacted]	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES					
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					
3. CONSULTANT SERVICES					
4. COMPUTER SERVICES					
5. SUBAWARDS					
6. OTHER					
TOTAL OTHER DIRECT COSTS					
H. TOTAL DIRECT COSTS (A THROUGH G)					
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (b) (4) [redacted]					
TOTAL INDIRECT COSTS (F&A)				(b) (4) [redacted]	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					
K. RESIDUAL FUNDS					
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**787,551**	
M. COST SHARING PROPOSED LEVEL $ **Not Shown**	AGREED LEVEL IF DIFFERENT $				

	FOR NSF USE ONLY		
PI/PD NAME: **Gregory Mountain**	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*: **Emmeline Crowley**	Date Checked	Date Of Rate Sheet	Initials - ORG

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION	FOR NSF USE ONLY		
	PROPOSAL NO.	DURATION (months)	
Rutgers University New Brunswick		Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Gregory Mountain	AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Gregory S Mountain - Professor	0.00	0.00	0.00	0	
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				0	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				0	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				(b) (4) [redacted]	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)					
2. FOREIGN					
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				(b) (4) [redacted]	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					
3. CONSULTANT SERVICES					
4. COMPUTER SERVICES					
5. SUBAWARDS					
6. OTHER					
TOTAL OTHER DIRECT COSTS					
H. TOTAL DIRECT COSTS (A THROUGH G)					
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (b) (4) [redacted]					
TOTAL INDIRECT COSTS (F&A)				(b) (4) [redacted]	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					
K. RESIDUAL FUNDS					
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				2,268	
M. COST SHARING PROPOSED LEVEL $ Not Shown	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME	FOR NSF USE ONLY		
Gregory Mountain	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Emmeline Crowley			

2 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION	FOR NSF USE ONLY		
Rutgers University New Brunswick	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: Gregory Mountain	AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Gregory S Mountain - Professor	(b) (4), (b) (6) [redacted]				
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)					
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS					
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (0) GRADUATE STUDENTS					
4. (0) UNDERGRADUATE STUDENTS					
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (0) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				(b) (4) [redacted]	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)					
2. FOREIGN					
F. PARTICIPANT SUPPORT COSTS (b) (4) [redacted]					
1. STIPENDS $					
2. TRAVEL					
3. SUBSISTENCE					
4. OTHER					
TOTAL NUMBER OF PARTICIPANT	TOTAL PARTICIPANT COSTS			(b) (4) [redacted]	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				(b) (4) [redacted]	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					
3. CONSULTANT SERVICES					
4. COMPUTER SERVICES					
5. SUBAWARDS					
6. OTHER					
TOTAL OTHER DIRECT COSTS					
H. TOTAL DIRECT COSTS (A THROUGH G)					
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				(b) (4) [redacted]	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					
K. RESIDUAL FUNDS					
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				789,819	
M. COST SHARING PROPOSED LEVEL $ Not Shown	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME	FOR NSF USE ONLY		
Gregory Mountain	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Emmeline Crowley			

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

RUTGERS BUDGET JUSTIFICATION

(b) (4), (b) (6)

[redacted]

(b) (4), (b) (6)

[redacted]

BUDGET SUMMARY

Collaborative Research: Community-Based 3D Imaging that Ties Clinoform Geometry to Facies Successions and Neogene Sea-Level Change

Rutgers University

(b) (4), (b) (6)

[redacted]

J. Total Costs	**$787,551**	**$2,268**	**$789,819**

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION **University of Texas at Austin**	FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed / Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Craig S Fulthorpe**	AWARD NO.	

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Craig S Fulthorpe - Sr. Research Scientist**	[redacted]		
2. **James A Austin, Jr. - Sr. Research Scientist**			
3.			
4.			
5.			
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)			
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)			
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)			
1. (**0**) POST DOCTORAL SCHOLARS			
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)			
3. (**0**) GRADUATE STUDENTS			
4. (**0**) UNDERGRADUATE STUDENTS			
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)			
6. (**0**) OTHER			
TOTAL SALARIES AND WAGES (A + B)			
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)			
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)			
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEED			
TOTAL EQUIPMENT		[redacted]	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)			
2. FOREIGN			
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ **0** 2. TRAVEL **0** 3. SUBSISTENCE **0** 4. OTHER **0**			
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS		**0**	
G. OTHER DIRECT COSTS			
1. MATERIALS AND SUPPLIES		[redacted]	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION			
3. CONSULTANT SERVICES			
4. COMPUTER SERVICES			
5. SUBAWARDS			
6. OTHER			
TOTAL OTHER DIRECT COSTS			
H. TOTAL DIRECT COSTS (A THROUGH G)			
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) [redacted]			
TOTAL INDIRECT COSTS (F&A)		[redacted]	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)			
K. RESIDUAL FUNDS			
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)		**79,603**	
M. COST SHARING PROPOSED LEVEL $ **Not Shown**	AGREED LEVEL IF DIFFERENT $		

PI/PD NAME **Craig S Fulthorpe**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Barbara Reyes**	Date Checked	Date Of Rate Sheet	Initials - ORG

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 2

	FOR NSF USE ONLY		
ORGANIZATION **University of Texas at Austin**	PROPOSAL NO.	DURATION (months)	
		Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Craig S Fulthorpe**	AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Craig S Fulthorpe - Sr. Research Scientist**	(b) (4) [redacted]				
2. **James A Austin, Jr. - Sr. Research Scientist**					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE					
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS					
2. (**2**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (**0**) GRADUATE STUDENTS					
4. (**0**) UNDERGRADUATE STUDENTS					
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (**0**) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				(b) (4) [redacted]	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)					
2. FOREIGN					
F. PARTICIPANT SUPPORT COSTS (b) (4) [redacted]					
1. STIPENDS $					
2. TRAVEL					
3. SUBSISTENCE					
4. OTHER					
TOTAL NUMBER OF PARTICIPANT					
TOTAL PARTICIPANT COSTS				(b) (4) [redacted]	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				(b) (4) [redacted]	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					
3. CONSULTANT SERVICES					
4. COMPUTER SERVICES					
5. SUBAWARDS					
6. OTHER					
TOTAL OTHER DIRECT COSTS					
H. TOTAL DIRECT COSTS (A THROUGH G)					
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (b) (4) [redacted]					
TOTAL INDIRECT COSTS (F&A)				(b) (4) [redacted]	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					
K. RESIDUAL FUNDS					
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**114,828**	
M. COST SHARING PROPOSED LEVEL $ **Not Shown**	AGREED LEVEL IF DIFFERENT $				

	FOR NSF USE ONLY		
PI/PD NAME **Craig S Fulthorpe**	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Barbara Reyes**	Date Checked	Date Of Rate Sheet	Initials - ORG

2 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Texas at Austin

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Craig S Fulthorpe

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Craig S Fulthorpe - Sr. Research Scientist**	(b) (4), (b) (6) [redacted]				
2. **James A Austin, Jr. - Sr. Research Scientist**					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)					
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS					
2. (**3**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (**0**) GRADUATE STUDENTS					
4. (**0**) UNDERGRADUATE STUDENTS					
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (**0**) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					

	Funds Requested By proposer	Funds granted by NSF (if different)
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)		
TOTAL EQUIPMENT	(b) (4) [redacted]	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)		
2. FOREIGN		
F. PARTICIPANT SUPPORT COSTS (b) (4) [redacted]		
1. STIPENDS $		
2. TRAVEL		
3. SUBSISTENCE		
4. OTHER		
TOTAL NUMBER OF PARTICIPANT — TOTAL PARTICIPANT COSTS	(b) (4) [redacted]	
G. OTHER DIRECT COSTS		
1. MATERIALS AND SUPPLIES	(b) (4) [redacted]	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION		
3. CONSULTANT SERVICES		
4. COMPUTER SERVICES		
5. SUBAWARDS		
6. OTHER		
TOTAL OTHER DIRECT COSTS		
H. TOTAL DIRECT COSTS (A THROUGH G)		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)		
TOTAL INDIRECT COSTS (F&A)	(b) (4) [redacted]	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)		
K. RESIDUAL FUNDS		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)	**194,431**	

M. COST SHARING PROPOSED LEVEL $ **Not Shown** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Craig S Fulthorpe

ORG. REP. NAME*
Barbara Reyes

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

BUDGET SUMMARY

Collaborative Research: Community-Based 3D Imaging that Ties Clinoform Geometry to Facies Successions and Neogene Sea-Level Change

The University of Texas at Austin

May 1, 2013 - April 30, 2015

(b) (4), (b) (6)

[redacted]

BUDGET JUSTIFICATION

Collaborative Research: Community-Based 3D Imaging that Ties Clinoform Geometry to Facies Successions and Neogene Sea-Level Change

The University of Texas at Austin Institute for Geophysics (UTIG)

May 1, 2013 - April 30, 2015

(b) (4), (b) (6)

[redacted]

(b) (4), (b) (6)

[redacted]

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION Columbia University	FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed | Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Nicholas Christie-Blick	AWARD NO.	

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Nicholas Christie-Blick - Professor	(b) (4), (b) (6) [redacted]				
2. Mladen Nedimovic - Adjunt Research Scientist					
3. Total Salaries					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE					
7. (3) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS					
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (0) GRADUATE STUDENTS					
4. (0) UNDERGRADUATE STUDENTS					
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (1) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				(b) (4), (b) (6) [redacted]	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)					
2. FOREIGN					
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				(b) (4) [redacted]	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					
3. CONSULTANT SERVICES					
4. COMPUTER SERVICES					
5. SUBAWARDS					
6. OTHER					
TOTAL OTHER DIRECT COSTS					
H. TOTAL DIRECT COSTS (A THROUGH G)					
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (b) (4) [redacted]					
TOTAL INDIRECT COSTS (F&A)				(b) (4) [redacted]	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					
K. RESIDUAL FUNDS					
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				94,508	

M. COST SHARING PROPOSED LEVEL $ Not Shown	AGREED LEVEL IF DIFFERENT $
PI/PD NAME Nicholas Christie-Blick	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION
ORG. REP. NAME* Maribel Respo	Date Checked | Date Of Rate Sheet | Initials - ORG

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
Columbia University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Nicholas Christie-Blick

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Nicholas Christie-Blick - Professor	0.00	0.00	0.00	0	
2. Mladen Nedimovic - Adjunt Research Scientist	0.00	0.00	0.00	0	
3. Total Salaries	0.00	0.00	0.00	0	
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (3) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				0	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				0	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				(b) (4) [redacted]	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)					
2. FOREIGN					
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				(b) (4) [redacted]	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					
3. CONSULTANT SERVICES					
4. COMPUTER SERVICES					
5. SUBAWARDS					
6. OTHER					
TOTAL OTHER DIRECT COSTS					
H. TOTAL DIRECT COSTS (A THROUGH G)					
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) (b) (4) [redacted]					
TOTAL INDIRECT COSTS (F&A)				(b) (4) [redacted]	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					
K. RESIDUAL FUNDS					
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				4,911	

M. COST SHARING PROPOSED LEVEL $ **Not Shown** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Nicholas Christie-Blick

ORG. REP. NAME*
Maribel Respo

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

2 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
Columbia University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Nicholas Christie-Blick

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Nicholas Christie-Blick - Professor	(b) (4) [redacted]				
2. Mladen Nedimovic - Adjunt Research Scientist					
3. Total Salaries					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE					
7. (3) TOTAL SENIOR PERSONNEL (1 - 6)					
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS					
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)					
3. (0) GRADUATE STUDENTS					
4. (0) UNDERGRADUATE STUDENTS					
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					
6. (1) OTHER					
TOTAL SALARIES AND WAGES (A + B)					
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				(b) (4) [redacted]	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)					
2. FOREIGN					
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				(b) (4) [redacted]	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					
3. CONSULTANT SERVICES					
4. COMPUTER SERVICES					
5. SUBAWARDS					
6. OTHER					
TOTAL OTHER DIRECT COSTS					
H. TOTAL DIRECT COSTS (A THROUGH G)					
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				(b) (4) [redacted]	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					
K. RESIDUAL FUNDS					
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				99,419	

M. COST SHARING PROPOSED LEVEL $ **Not Shown** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Nicholas Christie-Blick

ORG. REP. NAME*
Maribel Respo

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

BUDGET JUSTIFICATION

The following is confidential information that The Trustees of Columbia University requests not be released to persons outside the Government, except for purposes of review and evaluation

(b) (4), (b) (6)

[redacted]

TITLE: Collaborative Research: Community-Based 3D Imaging That Ties Clinoform Geometry
PRINCIPAL INVESTIGATOR(S): Nicholas Christie-Blick, PI; Mladen Nedimovic, Co-PI
PERIOD OF PERFORMANCE: May 1, 2013 - April 30, 2015

(b) (4), (b) (6)

[redacted]

1259487

CURRENT AND PENDING SUPPORT
8/7/12

Gregory Mountain

A Supporting Agency	B Project Title	C Award Amount	D Pd Covered Award	E Man-Mos. Acad. Sum. Cal.	F Location
A. Current Support					
(b) (4), (b) (6) [redacted]					
Dept. of Energy / subcontract from Battelle Corp.	Midwestern Regional Carbon Sequestration Partnership (MCRSP): Rutgers	$568,800	07/01/12 - 06/30/16	1/1/1/1 (all Sum.)	Rutgers
B. Pending Support					
(b) (4), (b) (6) [redacted]					

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Craig Fulthorpe

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

(b) (4), (b) (6)

[redacted]

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

(b) (4), (b) (6)

[redacted]

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

(b) (4), (b) (6)

[redacted]

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: James Austin, Jr.

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

(b) (4), (b) (6)

[redacted]

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

(b) (4), (b) (6)

[redacted]

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

(b) (4), (b) (6)

[redacted]

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

(b) (4), (b) (6)

[redacted]

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

(b) (4), (b) (6)

[redacted]

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

CURRENT AND PENDING SUPPORT
8/6/2012

NICHOLAS CHRISTIE-BLICK

A Supporting Agency	B Project Title	C Award Amount	D Period Covered Award	E Man-Month Acad. Sum. Cal.	F Location

A. Current Support
NONE

(b) (4), (b) (6)
[redacted]

CURRENT AND PENDING SUPPORT
8/7/2012

MLADEN NEDIMOVIC

A Supporting Agency	B Project Title	C Award Amount	D Period Covered Award	E Man-Month Acad. Sum. Cal.	F Location
A. Current Support					
NSF OCE 10-29411	COLLABORATIVE RESEARCH: EVOLUTION AND HYDRATION OF THE JUAN DE FUCA CRUST AND UPPERMOST MANTLE: A PLATE-SCALE SEISMIC INVESTIGATION FROM RIDGE TO TRENCH (CARBOTTE, S., PI; CARTON, H., NEDIMOVIC, M., CO-PI's)	223,709	3/1/12 2/28/13	NC/YR	LDEO
NSF EAR 06-07687	COLLABORATIVE RESEARCH: UPLIFT AND FAULTING AT THE TRANSITION FROM SUBDUCTION TO COLLISION- A FIELD AND MODELING STUDY OF THE CALABRIAN ARC. (STECKLER, M., PI; SEEBER, L., CO-PI; STARK, C., CO-PI; SCHAEFER, J., CO-PI; MALINVERNO, A., CO-PI; W/ NEDIMOVIC, M.; ARMBRUSTER, J.; KIM, W.Y.)	1,764,627	8/1/06 7/31/13	2/1/.5/1/NC/ NC/NC	LDEO
NSF OCE 09-26614	MEGATHRUST SEISMIC HAZARDS BY REFLECTION MAPPING (SHILLINGTON, D., PI; WEBB, S., NEDIMOVIC, M.; CO-PI'S)	713,878	1/1/10 12/31/12	NC	LDEO

(b) (4), (b) (6)

[redacted]

MLADEN NEDIMOVIC

(b) (4), (b) (6)

[redacted]

RUTGERS FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES:

Laboratory: 900 sq ft computer processing, visualization laboratory for students, researchers, faculty and visitors

Clinical:
N/A

Animal:
N/A

Computer: Instruction and pre-cruise data review for the first community workshop will be held in an 1800 sq ft instructional computer lab equipped with 16 HP 6200 Small Form Factor Computers. Each is at least a first generation i5 processor with 4GB of ram, and all are running Scientific Linux 6 as the default operating system. Fundamentals of 2D multichannel seismic processing will be demonstrated and participants will be able to complete training exercises on these machines using Seismic Unix. These same machines are connected via a Cisco 2948 switch which operates at 100 mb/s (FastEthernet), and bound to our department's LDAP and served home directories from our file server. The latter is an HP 380 G6, and utilizes a raid 5 disk array with 8TB of space that is backed up 3x daily. During the workshop we will also connect each of the client machines to our Virtual Desktop Infrastructure to enable 2D and 3D seismic visualization running SMT-Kingdom 64-bit licensed software on an HP xw6600 Windows 2008 R2 server with 4GB of ram and dual quadcore Intel Xeon E5420 processors and 1 TB of storage on a RAID 5 array. All of the existing public 2D seismic data and scientific results of IODP Exp313 are stored locally and available for instruction and participant exercises that will be prepared for this workshop.

Office:

MAJOR EQUIPMENT:

OTHER RESOURCES:

The PI will prepare lectures and instructional material for the participants in the pre-cruise workshop as well as at sea during the acquisition phase.

NSF Form 1363 (10/99)

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. Use additional pages if necessary.

Laboratory:

The University of Texas at Austin Institute for Geophysics ("UTIG") has some laboratory space at the main Institute building and a larger space in another building nearby for staging preparation for field work.

Clinical:

N/A

Animal:

N/A

Computer:

UTIG is connected to the University of Texas at Austin and the internet via a 10 gigabit Ethernet connection. Internally, a switched 10/1 gigabit LAN interconnects Solaris and Linux workstations, PCs and Macintoshes. Significant computer resources include 32 64bit Linux computers with nearly 300 cores and 1.2TB of memory. Five servers participate in a 4Gb/s fiber-channel SAN with 20TB of disk. 25TB of public fast disk with tiered demand migration to 105TB of slower disk and 220TB of tape serve Unix and Windows clients; 300TB of other network disk is online. An assortment of tape drives (3480, 4mm, 8mm, DLT, LTO3/4) allow data to be staged to disk or processed directly. Plotting devices include two 42" HP inkjet plotters, several letter-to-tabloid-size color printers and many black-and-white printers. A 42" scanner is available. Software available on all systems includes program development tools, plotting tools, and both public domain and commercial data analysis packages. All PCs and Macs have common graphics tools and office productivity applications, and share files with the Unix systems.

Office:

UTIG's main office space at the University of Texas's J.J. Pickle Research Campus, 10100 Burnet Road, Bldg. 196, Austin, Texas, is available for the proposed research.

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate, identify the location and pertinent capabilities of each.

- 2 x 32 core servers 2.7GHz/64GB/100G/4gigE
- 3 x 16 core servers 2.2+GHz/32GB/3TB/4gigE
- 7 x 12 core servers 2.9+GHz/24+GB/10TB/4gigE
- 3 x 8 core servers 2.2+GHz/16GB/1-4TB/2gigE
- 17 x 4 core servers 2.2+GHz/4-10GB/140GB/2gigE
- 1 x 4 core Sun x4200 server 2.8GHz/24G/140GB/4gigE
- 1 x 4 core Sun T2000 server 1GHz/8GB/140GB/4gigE
- 3 x 2 core Sun servers 900Mhz/4Gbyte/72G/1gigE
- 4Gb/s FC SAN; 10G network; SAM-FS data migration software
- Paradigm Focus seismic processing software
- Paradigm Geodepth pre-stack migration software
- Geoquest, Landmark interpretation software
- Arc/GIS, Caris Multi-Beam, Matlab software
- Two HP 42" color plotters; 42" scanner

OTHER RESOURCES: Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual/sub award arrangements with other organizations.

UTIG has administrative and computer support personnel.

LDEO FACILITIES, EQUIPMENT AND OTHER RESOURCES

FACILITIES

Laboratory:
N/A

Clinical:
N/A

Animal:
N/A

Computer:
Computing resources at LDEO include an extensive network of Sun and Linux workstations, fileservers and peripherals. Site-licensed software is available for interactive MCS data manipulation, 2D and 3D imaging, waveform analysis, and graphical visualization from both Landmark and Paradigm (e.g., Promax, SeisWorks, Focus, STRATA, etc.). The multichannel seismic reflection processing facility has five linux based 3.06 GHz Intel Xeon multithread dual CPU DELL workstations each with 3 GB of RAM and 750 GB internal raid arrays, and a unix based SUN enterprise 450 server with 296 MHz dual CPU, 2 GB of RAM and 510 GB of disk space. These are all 21-inch dual monitor stations. A 16 node 32 CPU linux-box cluster connected to a NAS raid array providing 100 TB useable disk space is available. There are also a number of other SUN Ultrasparc 10 stations. The MCS facility also has two 3490E cartridge drives with stack loaders, two DLT7000 cartridge drives, and two DLT2000 cartridge drives.

Office:
Office space, heating, air conditioning, administrative support, grants management and financial services, library and other academic services to support the effort are all provided under the negotiated ICR.

MAJOR EQUIPMENT:
N/A

OTHER RESOURCES:
N. Christie-Blick (PI) and M. Nedimovic (Co-PI) will participate in the planning of the cruise, the pre-cruise workshop, the post-processing data review, and the post-cruise workshop at which community-based opportunities for analysis/interpretation of the processed 3D volume and integration with Exp313 results will be developed. M. Nedimovic (Co-PI) will also take part in the cruise, and the data processing in Houston.

Data Management Plan

This project will create ~7.5 terabytes of 120-channel, 3D seismic reflection field data integrated with navigation in standard SEG-D and UKOOA formats, respectively. Metadata related to QA/QC monitoring of MCS operations, routine to all such activities aboard the *R/V Langseth*, will be recorded as well. Additional digital data gathered from other shipboard sensors, including multibeam sonar, gravity and meteorological data, will be transmitted to the Lamont Database group that will, in turn, ensure that these data are deposited in appropriate national archives for long-term preservation. The 'raw' MCS field data will be copied to the Academic Seismic Portal at Lamont-Doherty (http://www.marine-geo.org/portals/seismic/), where it will undergo additional QA/QC in preparation for archiving purposes and for its delivery to the processing center.

The MCS field shot data described above will be copied to a robust external hard drive and delivered to the commercial processing company of choice (e.g., PGS of Houston, TX; see accompanying quote), where a prearranged flow of processing steps, overseen by the PIs, will produce a 3D 'volume' of pre-stack, time-migrated data within ~5 mos. of the end of data acquisition. Processed data will be returned to Lamont-Doherty in standard SEG-Y format, with navigation embedded in trace headers.

A copy of the processed dataset will be sent to the Univ. of Texas, Austin/Institute for Geophysics where it will be served on a network of 3D-data MCS workstations. All public data from Exp313 will be installed on this network and integrated with these seismic data for access during a community workshop at UTIG, whose purpose is to examine data quality and develop strategies for maximizing the opportunities for the ensuing stage of scientific analysis.

The processed 3D data volume will be transferred to the Academic Seismic Portal at the Univ. of Texas, Austin/Institute for Geophysics (http://www.ig.utexas.edu/sdc/) which handles processed seismic data and where it will be instantly available for public distribution without restriction. The field shot data archived at the Lamont-Doherty Academic Seismic Portal will be made available at this time as well. Like any other data set released by this national facility, rules concerning derivative products and re-distribution will apply, but any qualified user who abides by these agreements will have complete access to both the processed data and the raw field data.

Postdoctoral Researcher Mentoring Plan

We seek no funds for Post-Doctoral Researchers to conduct scientific analysis of data acquired in the proposed project. While individuals selected by the PIs through an application process will be invited to participate on the cruise, they may or may not be Post-Docs. 4-6 months pre-cruise a public call will go out for 'young researchers' (grad students / post-docs / young scientists) who are looking towards a career that requires knowledge of 3D MCS acquisition, processing and/or interpretation. Following the advice of the MG&G program of NSF, we are providing this 'qualified' mentoring plan to define clearly the manner in which Post-Doctoral researchers may benefit from the proposed project.

We are acting on recommendations of the 2010 community workshop entitled *Challenges and Opportunities in Academic Marine Seismology* (http://www.steveholbrook.com/mlsoc/workshop_report.pdf) that encouraged (1) greater community access to 3D MCS data, and (2) providing bunk space on cruises that could yield hands-on learning experiences for the upcoming generation of marine scientists. Accordingly, we ask that up to 12 berths aboard the *R/V Langseth* be reserved for these young researchers. Funds are requested to subsidize their travel to and from the ship, but we seek no other financial support for them prior to, during, or following the cruise. (Of course, the daily operational costs of the *Langseth* will absorb their 'room and board' expenses at sea.) Their exact roles and contributions to the project will depend on the skills they bring with them. We hope to have the luxury of more applicants than berths and be able to select those best qualified to benefit from this opportunity.

The goals will be to: (1) provide a 'learning by doing' experience to a broad range of participants; (2) transfer experience from the 4 on-board PIs to these young researchers in such areas as planning and running a cruise, handling gear on deck, the theory and practice of seismic processing, applications of 2 and 3D MCS, etc.; and (3) stimulate members of the group to participate in the data showcase workshop (see the Project Description) and pursue a research project using the data they helped to collect. Each of the 4 PIs who will be on the *Langseth* have lecture experience, and 2 teach marine geology and geophysics at the college and graduate level. We are all prepared to conduct lessons at sea, tailored to the backgrounds and interests of the young researchers.

NATIONAL SCIENCE FOUNDATION
Grant Letter

Award:1260237 **PI Name:**Mountain, Gregory

Award Date January 15, 2014
Award No. OCE-1260237
Proposal No. OCE-1260237

Ms. D. Dee Evans
Assistant Director, Office of Sponsored Agreement Management
Rutgers, The State University
of New Jersey
3 Rutgers Plaza
ASB III, 2nd floor
New Brunswick, NJ 08901-8559

Dear Ms. Evans:

The National Science Foundation hereby awards a grant of $369,358 to Rutgers, The State University of New Jersey for support of the project described in the proposal referenced above as modified by revised budget dated December 11, 2013.

This project, entitled "Collaborative Research: Community-Based 3D Imaging That Ties Clinoform Geometry to Facies Successions and Neogene Sea-Level Change," is under the direction of
Gregory S. Mountain, in collaboration with the following proposals

Proposal No:	PI Name/Institution
1259135	Craig S. Fulthorpe, University of Texas at Austin

.

This award is effective January 15, 2014 and expires December 31, 2015.

This is a continuing grant which has been approved on scientific / technical merit. Contingent on the availability of funds and the scientific progress of the project, NSF expects to continue support at approximately the following level:

FY 2015 $312,295

The scientific / technical progress of the project is documented through submission and approval of annual and final project reports to NSF. Such reports are to be submitted electronically via NSF's Research.gov web portal [http://www.research.gov/]. Information regarding the specific due dates of such reports also is available through Research.gov.

This grant is awarded pursuant to the authority of the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-75) and is subject to Research Terms and Conditions (RTC), dated June 2011, and NSF RTC Agency Specific Requirements, dated January 14, 2013, available at http://www.nsf.gov/awards/managing/rtc.jsp and the following terms and conditions:

This award is subject to the Federal Funding Accountability and Transparency Act (FFATA) award term entitled, Reporting Subawards and Executive Compensation, which has been incorporated into the NSF Terms and Conditions referenced above.

If the awardee has any questions related to the pre-populated data associated with this award in the FFATA Subaward Reporting System, such questions should be submitted to: FFATAReporting@nsf.gov or by phone to: (800) 673-6188.

NATIONAL SCIENCE FOUNDATION
Grant Letter

Award:1260237 **PI Name:**Mountain, Gregory

The Foundation authorizes the awardee to enter into the proposed contractual arrangements and to fund such arrangements with award funds up to the amount indicated in the approved budget. Such contractual arrangements should contain appropriate provisions consistent with Articles 8.a.4. and 9 of the NSF Grant General Conditions (GC-1) (dated January 14, 2013) or Articles 5 and 40 of the Research Terms and Conditions (dated June 2011), as well as any special conditions included in this award.

The awardee agrees to administer/monitor all subcontracts/subawards it enters into and supports with NSF funds in accordance with the applicable federal cost principles and the applicable federal administrative requirements.

Please view the project reporting requirements for this award at the following web address [https://reporting.research.gov/fedAwardId/1260237].

The attached budget indicates the amounts, by categories, on which NSF has based its support.

The cognizant NSF program official for this grant is Bilal U. Haq, (703) 292-8582.
The cognizant NSF grants official contact is Irene Sattler, (703) 292-4813.

Sincerely,

Vanessa L. Richardson
Grants and Agreements Officer

CFDA No. 47.050
sponpgms@orsp.rutgers.edu

NATIONAL SCIENCE FOUNDATION
Grant Letter

Award:1259135 **PI Name:**Fulthorpe, Craig

Award Date January 15, 2014
Award No. OCE-1259135
Proposal No. OCE-1259135

Dr. Susan Wyatt Sedwick
Director of Sponsored Projects
University of Texas at Austin
101 E. 27th Street, Suite 5.300
Austin, TX 78712-1532

Dear Dr. Sedwick:

The National Science Foundation hereby awards a grant of $122,307 to University of Texas at Austin for support of the project described in the proposal referenced above as modified by revised budget dated December 3, 2013.

This project, entitled "Collaborative Research: Community-Based 3D Imaging That Ties Clinoform Geometry to Facies Successions and Neogene Sea-Level Change," is under the direction of
Craig S. Fulthorpe, Mladen Nedimovic, James A. Austin, Jr., in collaboration with the following proposals

Proposal No:	PI Name/Institution
1260237	Gregory S. Mountain, Rutgers, The State University of New Jersey

.

This award is effective January 15, 2014 and expires December 31, 2015.

This is a continuing grant which has been approved on scientific / technical merit. Contingent on the availability of funds and the scientific progress of the project, NSF expects to continue support at approximately the following level:

FY 2015 $103,848

The scientific / technical progress of the project is documented through submission and approval of annual and final project reports to NSF. Such reports are to be submitted electronically via NSF's Research.gov web portal [http://www.research.gov/]. Information regarding the specific due dates of such reports also is available through Research.gov.

This grant is awarded pursuant to the authority of the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-75) and is subject to Research Terms and Conditions (RTC, dated June 2011) and the NSF RTC Agency-Specific Requirements (dated January 14, 2013) are available at http://www.nsf.gov/awards/managing/rtc.jsp.
This institution is a signatory to the Federal Demonstration Partnership (FDP) Phase V Agreement which requires active institutional participation in new or ongoing FDP demonstrations and pilots. .

This award is subject to the Federal Funding Accountability and Transparency Act (FFATA) award term entitled, Reporting Subawards and Executive Compensation, which has been incorporated into the NSF Terms and Conditions referenced above.

If the awardee has any questions related to the pre-populated data associated with this award in the FFATA Subaward Reporting System, such questions should

NATIONAL SCIENCE FOUNDATION
Grant Letter

Award: 1259135 **PI Name:** Fulthorpe, Craig

be submitted to: FFATAReporting@nsf.gov or by phone to: (800) 673-6188.

Please view the project reporting requirements for this award at the following web address [https://reporting.research.gov/fedAwardId/1259135].

The attached budget indicates the amounts, by categories, on which NSF has based its support.

The cognizant NSF program official for this grant is Bilal U. Haq, (703) 292-8582.
The cognizant NSF grants official contact is Irene Sattler, (703) 292-4813.

Sincerely,

Vanessa L. Richardson
Grants and Agreements Officer

CFDA No. 47.050
osp@austin.utexas.edu

National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230
www.nsf.gov

COOPERATIVE AGREEMENT(CA)

AWARD: OCE-1211494

EFFECTIVE DATE: April 1, 2012

EXPIRATION DATE: March 31, 2017

PROJECTED TOTAL AWARD FUNDING:

(Subject to availability of funds)
$43,987,010

CUMULATIVE AMOUNT:

$8,847,010

SOLICITATION:

(Incorporated by reference, as amended)

NSF 04-052

Division of Ocean Sciences: Integrative Programs Section - IPS

CFDA NUMBER:
47.050

OTHER AWARDS UNDER THIS PROGRAM:

Show List of Awards

AWARDEE: THE TRUSTEES OF COLUMBIA UNIVERSITY IN T COLUMBIA UNIVERSITY

PROJECT TITLE: Ship Operations - R/V Langseth

PROJECT ABSTRACT: https://www.fastlane.nsf.gov/servlet/showaward?award=1211494

Principal Investigator(s)	Proposal No.	Institution (s)
Sean M. Higgins	OCE-1211494	THE TRUSTEES OF COLUMBIA UNIVERSITY IN T COLUMBIA UNIVERSITY

David S. Goldberg

Paul W. Ljunggren

NSF Contact Information:

Financial/Administrative questions: e-mail your NSF Grants and Agreements Official, Erica M. Stein, at estein@nsf.gov or call the Division at 703-292-8242 .

Programmatic questions: e-mail your NSF Program Officer, Rose Dufour, at rdufour@nsf.gov or call the Program Division at 703-292-8811 .

This CA is entered into between the United States of America, represented by the National Science Foundation (NSF), and the above named Awardee pursuant to the authority of the National Science Foundation Act of 1950, as amended (42 USC 1861-1875). This CA is provided electronically to the Awardee. The Awardee is responsible for full compliance with all Programmatic and Financial/Administrative Terms and Conditions as initially stated or as updated over the life of this CA. The Awardee's request to draw down funds under this CA will represent acceptance by the Awardee of all Terms and Conditions of the CA. The Authorized Organizational Representative (AOR) will be electronically notified of any changes to these Terms and Conditions and is encouraged to immediately review these changes and contact the Grants and Agreements Official or Program Officer within thirty days with any questions.

Financial/Administrative Terms and Conditions (FATC):

General FATC:
http://www.nsf.gov/publications/pub_summ.jsp?ods_key=NSF99999FATC004

Award Specific FATC:

1. Order of Precedence:

This Cooperative Agreement (CA) consists of the following terms and conditions in descending order of precedence:

A. Cooperative Agreement Specific Terms and Conditions
B. General Programmatic Terms and Conditions for Proposal Submission Guidelines for the Integrative Programs Section (IPS) (NSF 04-052) - For Ship Operations Awards, http://www.nsf.gov/pubs/policydocs/nsf04052.pdf (as amended)
C. National Science Foundation (NSF) Cooperative Agreement Supplemental Financial & Administrative Terms and Conditions for Managers of Large Facilities http://www.nsf.gov/awards/managing/co-op_conditions.jsp, Effective February 1, 2012 (as amended)
D. National Science Foundation (NSF) Cooperative Agreement Financial and Administrative Terms (CAFATC), http://www.nsf.gov/awards/managing/co-op_conditions.jsp Effective February 1, 2012 (as amended)

This CA contains certain applicable Federal administrative standards hereby incorporated by reference (as amended). The applicable requirements are contained in:

-2 CFR Part 215, "Uniform Administrative Requirements for Grants and Agreements with Institutions of Higher Education, Hospitals, and other Nonprofit Organizations" (OMB Circular A-110)
-2 CFR Part 220 (OMB Circular A-21), "Cost Principles for Educational Institutions"
-OMB Circular A-133, "Audits of States, Local Governments, and Non-Profit Organizations"

2. Funding:

A. For the total amount of NSF funding that has been obligated under this cooperative agreement, see "CUMULATIVE AMOUNT" on the cover page of this document.

B. In accordance with the CA-FATC Article entitled "Cooperative Agreement Increments", contingent on the availability of funds, satisfactory scientific/technical progress, and fulfillment of any special conditions of the award, it is the intent of the NSF to provide funds to support ship operations over a period of 5 years, unless the ship is retired or no longer needed to support NSF research.

3. Indirect Cost Rate:

The indirect cost rate to be applied by the awardee during the life of the cooperative agreement shall be [redacted] in accordance with the Awardee's negotiated indirect cost rate agreement dated February 1, 2012, incorporated by reference.

4. Ship Day Rate:

A. Definitions: For the purpose of this Cooperative Agreement the definitions of provisional and final ship day rates are as follows:

a. Provisional Ship Day Rate: A provisional ship rate will be calculated at the beginning of the calendar year, defined as the estimated yearly ship costs divided by the estimated number of operating days.

b. Final Ship Day Rate: A final day ship rate will be calculated after the end of the calendar year, defined as the actual operating costs for the year, divided by the actual number of chargeable ship use days.

B. The Provisional Ship Day Rate will be negotiated jointly by NSF and other federal agencies, as appropriate, with the Awardee once operating schedules have stabilized for the purpose of establishing a Provisional Ship Day Rate but no later than April 1, annually. The rate negotiated will be based on the proposed number of days, provisional estimated costs, and availability of program funds. If, at any time during the course of the corresponding calendar year, the Awardee expects that the Final Ship Day Rate will exceed the provisional rate by 5%, the Awardee shall provide notification to the NSF Program Officer. The Awardee will need to obtain approval from the NSF Program Officer to carry out any planned NSF funded science cruises during the remainder of the calendar year. If approval is provided, a new Provisional Ship Day Rate will be established. Any additional increases in excess of 5% of the re-baselined Provisional Ship Day Rate will require NSF Program Officer notification and approval to carry out future NSF funded science cruises.

C. The target date for annual proposals is November 15. Proposals shall provide a detailed breakdown of proposed costs for the following calendar year and historical costs in accordance with the format specified by the NSF Program Officer. Proof of insurance, including premium costs, limits of coverage, deductible, broker, date of expiration and underwriter, is also to be submitted with the annual ship operations proposal and budget. This should be a copy of the Vessel insurance "cover sheet" as long as it specifies both levels of coverage and premiums allocated to each vessel.

5. Requirements for Contractual Arrangements:

This Article hereby replaces the Article entitled "Subaward Requirements" of the Supplemental Financial and Administrative Terms and Conditions for Managers of Large Facilities. The following requirements apply under this cooperative agreement:

A. Definition: The term contractual arrangements includes contracts, cooperative agreements, purchase orders, orders issued under blanket purchase agreements or similar devices, awards made to sub-recipients regardless of form, and modifications to all the aforementioned to be issued by the Awardee under this agreement.

B. Applicablility: This article applies to initial contractual arrangements valued over $250,000. The Awardee shall not artificially segregate its contractual arrangements to lesser dollar amounts for the purpose of circumventing this requirement. For modifications to contractual arrangements previously approved, NSF Grant and Agreement Officer approval is required for increases of 20% or $100,000, whichever is less. The requirements of this article do not apply to the purchase of fuel.

C. The Foundation authorizes the awardee to enter into the proposed contractual arrangements and to fund such arrangements with award funds up to the amount indicated in the approved budget. Such contractual arrangements should contain appropriate provisions consistent with the applicable Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATCs), and any special conditions included in this Agreement.

D. Submission:

a. Upon submission of a contractual arrangement request to NSF, the awardee certifies that the contractual arrangement:

i. is appropriate, reasonable and legitimate;
ii. is issued to an organization that has the fiscal authority and responsibility to account for and handle Federal funds; and
iii. is in compliance with all Federal requirements and the Awardee's policies and procedures.

b. The Awardee will submit electronically to NSF a request for prior approval at least 30 calendar days in advance of the anticipated start date of any new contractual arrangement, unless otherwise determined by the cognizant NSF Grants and Agreements Official. Incomplete or insufficient requests will be returned without approval, for proper completion by the Awardee. Upon receipt of a complete and sufficient request, NSF will review and provide a determination within 30 calendar days. All requests shall be submitted electronically via FastLane for review by the Program Officer and the Grants and Agreements Official. The documentation shall include the proposed contractual arrangement document and a memorandum of negotiation which sets forth the principal elements of the purpose, selection procedures and price negotiation, including items, as appropriate, listed below:

i. A description of the supplies or services required.
ii. Identification of the type of contractual arrangement to be issued.
iii. Identification of the proposed subawardee or vendor, an explanation of why and how the proposed subawardee or vendor was selected, and the degree of competition obtained.
iv. For major equipment acquired under MOSA, a description of proposed Major Overhaul items and shipyard bids.
v. The proposed price of the contractual arrangement, together with the Awardees cost or price analysis thereof.
vi. Where the contractual arrangement will be made without competition, the memorandum shall include a detailed justification.

E. Award and Administration:

a. The Awardee shall insert a clause in all contractual arrangements reserving its right to assign the contractual arrangement to any third party should a successor Awardee be selected by the NSF. NSF approval is required for any contractual arrangement reassignment by the Awardee for contractual arrangements valued over $250,000.

b. After review, NSF will provide written notification to proceed to the awardee; this notification shall not be construed as a determination by NSF of the allowability of any cost under this Agreement.

c. The awardee shall make all consultant agreements, contractual arrangements, or other commitments in its own name and shall not bind the Federal Government or the National Science Foundation; and hereby agrees to administer/monitor all contractual arrangements it enters into and supports with NSF funds in accordance with the applicable federal cost principles and the applicable federal administrative requirements; remains responsible for maintaining the necessary documentation on all contractual arrangements and making it available to NSF upon request; and shall include contractual arrangement activities in the annual and final project reports that are submitted to NSF.

F. Emergency Situations:

In emergency situations, such as those that require action to protect life or property or when an immediate repair to a vessel is required to carry out planned ship operations, the Awardee is not required to obtain prior approval. In these cases, the Awardee shall submit its request for approval of the contractual arrangement within 7 calendar days, along with the rationale for not obtaining prior approval.

6. Prompt Notification of Claims:

The Awardee shall give the NSF Program Officer and Grants and Agreements Official immediate notice in writing of any legal action or suit filed, and prompt notice of any claim made against the Awardee, which in the opinion of the Awardee may result in litigation, related in any way to this CA, with respect to which the Awardee may be entitled to reimbursement from the Government.

7. Other Agency Activities:

NSF, as a Federal funding agency for the Project, must be notified prior to significant Awardee or sub-awardee activities leading to any agreements with other foreign, federal, state or local agencies or entities that relate to and substantively affect or impact the progress related to the scope of NSF's scheduled work. Significant changes are broadly defined as adjusting cruise dates outside the submitted windows of time (i.e. submitted through the UNOLS STR process or in peer-reviewed NSF proposals), changing port calls, or requiring added transit obligations. It is not NSF's intent to preclude the operator's ability to augment schedules throughout the year, nor to require notification for simple adjustments to operating schedules, rather to protect NSF's interest with regard to significant changes that affect the Awardee's ability to provide ship operation support for NSF supported cruises or may result in additional potential financial obligations to NSF.

8. Notice to the Government of Labor Disputes:

A. If a labor dispute by Awardee employees delays ship operations, the Awardee shall provide notice and details of the incident to the NSF Program Officer and the NSF Grants and Agreements Officer within 24 hours of the incident.

B. The Awardee agrees to insert the substance of this clause in any contractual arrangement to which a labor dispute may delay the timely performance of this agreement; each subcontract shall provide that in the event its timely performance is delayed or threatened by delay by any actual or potential labor dispute, the subcontractor shall immediately notify the next higher tier subcontractor or the prime Awardee, as the case may be, of all relevant information concerning the dispute.

9. Health and Safety:

A. The Awardee shall take all reasonable precautions in the performance of the work under this CA to protect the health and safety of employees and of members of the public from all hazards and to minimize danger to life and property, and shall comply with all applicable health, safety, and fire protection laws, regulations, and requirements, including those referenced in the Programmatic Terms and Conditions for Ship Operators.

B. The Awardee shall maintain an accurate record of all cases of death, occupational disease or injury arising out of, or in the course of, employment incident to performance of the work under this CA. Cases of personal injury shall be reported to NSF in accordance with Article 2.D of the award specific Programmatic Terms and Conditions within this cooperative agreement.

10. Rights in Data Necessary for the Operation and Maintenance of the Research Vessel

A. Notwithstanding CA-FATC Article 21, Copyrightable Material, or any other clause of this agreement, the Awardee grants to the National Science Foundation in perpetuity the right to use and reproduce data first produced under this award without charge or additional expense (except for whatever reasonable costs are incurred by the Awardee to reproduce the data) as necessary for the operation and management of the ship. This includes the right to make such data available to any party interested in competing for any subsequent award to operate and manage the ship, and any awardees the National Science Foundation selects as the result of any competition.

B. The types and kinds of data deemed necessary for the operation and maintenance of the ship include, but are not limited to:

i. Maintenance guides and histories
ii. Operating manuals and similar plans
iii. User manuals and similar documents
iv. Facility and instrument drawings (including design, shop and as-built drawings), designs and specifications
v. Schematics
vi. Warranty data
vii. Schedules
viii. Software
ix. Inventories
x. Document indexes
xi. Subawards, subcontracts, and vendor agreements
xii. Operations reports

These items will be assessed by NSF and the awardee for the presence of any proprietary data prior to their release to a third party. Proprietary data will not be released without the express permission of its owner.

C. Rights acquired by the National Science Foundation under this clause do not include rights to any data first produced solely for scientific research purposes.

D. Licenses to use data not first produced under this award shall provide for assignment by the Awardee to any successor awardee operating and managing the Ship or NSF.

11. Document Management:

The Awardee shall implement and maintain a secure document management system that contains critical documents related to the Research Vessel and its operations. All record-keeping functions in place for the USCG, EPA, and ABS compliance for the vessel, as well as record-keeping and tracking for ISM Safety Management Systems, if necessary. This includes but is not limited to ISM audits, vessel general permit annual reports, all inspections/drills/safety meetings conducted aboard the vessel, and safety management hazardous condition reports and corrective actions requests. The Awardee shall provide a copy of any document within its document management system upon request of the NSF Program Officer.

12. Property and Equipment:

A. For all property and equipment exceeding $5,000 to which the government holds title, and in accordance with the requirements of OMB Circular A-110, the Awardee must submit annual inventory listings of government-owned property to the NSF Property Administrator, Division of Administrative Services (DAS). The listing should include all government-owned equipment purchased under this agreement or acquired by screening excess through the General Services Administration (GSA); include the type of equipment, serial number, acquisition price, acquisition date and condition of the equipment. The inventory listings and audited financial statements should be submitted electronically to fsrpts@nsf.gov and must be received by DAS no later than September 1st each year. If financial statements are not available electronically, please submit a paper copy to: DAS, NSF Property Administration, 4201 Wilson Boulevard, Room 295, Arlington, VA 22230.

B. Title to equipment purchased with award funds shall vest in the Awardee unless NSF exercises its option to require the Awardee to transfer full title, rights, and interest to any or all equipment to either NSF or any third party named by NSF. Title will remain with the Awardee unless NSF exercises its options no later than 120 days after receipt of a Final Report.

Programmatic Terms and Conditions (PTC):

General PTC:
http://www.nsf.gov/publications/pub_summ.jsp?ods_key=NSF04052TPTC000

Award Specific PTC:

1. Research Vessel:

The purpose of this cooperative agreement is to support the operations of the Research Vessel Langseth owned by NSF and operated by Columbia University to support scientific research.

2. Reporting Requirements:

A. All reports required in this article shall be submitted via FastLane using the appropriate reporting category; for any type of report not specifically mentioned in FastLane, the Awardee will use the "Interim Reporting" function to submit reports. Emergency notifications of personal injury or property damage shall be provided by telephone (office, cell, or other available number) and/or email to NSF Program Officials within 24 hours. If NSF does not acknowledge receipt within 24 hours of the Awardee's notification, the Awardee must continue to try to make notification through other communication methods.

B. The Awardee will provide ad hoc and regular quarterly reports as designated by the NSF Cognizant Program Officer with content, format, and submission time line established by the NSF Cognizant Program Officer. The quarterly report shall provide information pertaining to safety, personnel injuries, property damage, conditions affecting ability to support scheduled oceanographic research, and technical changes that impact financial obligation, as delineated in articles 4.B Ship Day Rate and 7. Other Agency Activities of the award specific Financial and Administrative Terms and Conditions of this cooperative agreement. In addition to the technical information required, the quarterly reports shall provide updated budget information. The updated budget information shall be provided in the form of an updated Section VI from the previously submitted annual report. The Awardee shall also provide a description of any single item, valued over $10,000, purchased during the previous quarter that was not included in the originally approved annual budget, the value of that item, and a short description of the identified need for the item.

C. An Annual Project Report will be submitted following proposal guidelines in NSF 04-052, but only including sections II, III, IV, V, VI, VII and IX. These guidelines can be accessed at: http://www.nsf.gov/geo/oce/pubs/IPS_Guidelines.pdf. An inspection report with updates shall be included. The target due date is November 15. The Annual Project Report shall also include the written summary of its IT security program as described in the Article of the CA-FATC-Large Facilities entitled "Information Security."

D. In the event that a member of the crew or scientific party becomes seriously injured or ill while aboard the vessel, the Operator will notify the NSF Program Officials, with a full written report submitted within seven (7) days after the Awardee becomes aware of said injury or incapacity. A "serious injury" or "serious illness" means an injury or illness which renders the individual unfit for service for at least 48 hours, or which results in the payment of medical and/or other benefits in excess of $10,000.

E. In the event that the Vessel or any of its systems suffers damage in excess of $10,000, or causes damages to another vessel, the marine environment, shore facility in excess of $10,000, and/or safety of the crew and science party is affected, emergency notifications must be provided to the NSF Program Officials. The Awardee shall also notify the UNOLS office; however, the Awardee is not required to obtain confirmation of receipt of the UNOLS notification. If warranted, a full report of incident should be submitted to the NSF Program Officer no later than seven days from determining an inability to provide support as originally scheduled.

F. The Awardee shall furnish the NSF Program Officials information regarding any condition affecting the Awardee's ability to conduct NSF-supported scheduled oceanographic research as soon as possible and followed by written notification no later than seven (7) calendar days from determining an inability to provide support as originally scheduled. In cases where NSF cruises are moved into the following operating year, the Awardee shall ensure that the chief scientist obtained NSF Science Program Manager concurrence.

G. At the completion of any MOSA activities, the Awardee shall provide a detailed report of completed MOSA items and the associated costs.

3. Ship Operation Data:

The Awardee shall furnish the UNOLS Office with Ship Utilization Data cruise reports, Ship Captain post-cruise assessments, and annual Final Ship Schedules. This data shall be provided as frequently as practicable but at least once per year.

4. Data Sharing:

The Awardee shall comply with the NSF Division of Ocean Sciences Sample and Data Policy (as amended).

5. Quality of Service Objectives:

The Awardee's performance under this cooperative agreement shall be evaluated, considering the following factors:

1) Ability to support research programs, in the ability to address scheduling, equipment, and safety issues to provide the best available platform to carry out science goals;

2) Responsiveness of the operator to post cruise assessments and the ability to use criticism constructively to improve operations.

Change History

Prior Awarded Funding Amount:
Per Original Award on
05/14/2012: $8,847,010

From: Kerry Kehoe - NOAA Federal [mailto:kerry.kehoe@noaa.gov]
Sent: Tuesday, April 15, 2014 3:34 PM
To: Blanco, Caroline M; Hassell, Kevin
Cc: David Kaiser - NOAA Federal; Jackie Rolleri - NOAA Federal; Jeff Dillen - NOAA Federal; Randall Schneider - NOAA Federal; Glynnis Roberts - NOAA Affiliate
Subject: Proposed meeting time: Tuesday 4/22 at 3:00

Caroline and Kevin:

Please check with your principals in regards to their availability to meet on Tuesday, April 22 at 3:00 to discuss NSF funding for seismic surveys off the coast of New Jersey. I will ask David and Jeff Dillen to place a hold on their calendars for that time.

Between now and the call, it would be helpful if we could resolve the question as to who is considered to be the award recipient for the purposes of determining the applicability of Subpart F of the CZMA Federal Consistency regulations.

Going into the call, it would also be helpful if the State can identify the effects it is concerned about and the enforceable policies that apply to those effects.

Apart from the present question of the applicability of federal consistency to the proposed seismic survey, let's use this call to look forward as to how the NSF and State can coordinate in the future.

Please confirm as to your availability for this call and I will send out a conference line to use.

Kerry

--
R. Kerry Kehoe
Office of Ocean and Coastal Resource Management
National Oceanic and Atmospheric Administration
301-563-1151

From: Smith, Holly E.
Sent: Monday, April 21, 2014 3:45 PM
To: Kerry Kehoe - NOAA Federal; Hassell, Kevin; Blanco, Caroline M
Cc: David Kaiser - NOAA Federal; Jackie Rolleri - NOAA Federal; Jeff Dillen - NOAA Federal; Randall Schneider - NOAA Federal; Glynnis Roberts - NOAA Affiliate; Bauke (Bob) Houtman (bhoutman@nsf.gov)
Subject: RE: Proposed meeting time: Tuesday 4/22 at 3:00

All – Thank you all for agreeing to meet tomorrow to discuss the proposed marine seismic survey off the coast of New Jersey. Per Kerry's message below, we've done a little further research into the entities that would be considered to be the award recipients.
For the proposed research activities, research funds would go directly to "Rutgers, the State University of New Jersey" (RU) and "University of Texas at Austin" (UTIG). Although the original collaborative proposal received by NSF included research funding requests for RU, UTIG, and Columbia University's Lamont-Doherty Earth Observatory (LDEO), LDEO will not receive research funding. Based on NSF science priorities and current budgetary constraints, the cognizant NSF Program Officer re-negotiated the proposal budget. Funding sought for an LDEO researcher will not be provided. Additionally, subsequent to the original proposal submission but prior to the budget re-negotiation, another LDEO researcher who sought funding accepted a position at UTIG. During budget re-negotiations, that researcher was added to the UTIG budget and therefore would receive funding via UTIG. Therefore, funding for the proposed research activities would only go to RU and UTIG. Through a separate Cooperative Agreement, LDEO would receive funds for vessel operations.

We apologize for the confusion associated with which academic institutions might be involved with the proposed research. The Draft EA was prepared and submitted to NMFS to initiate the Endangered Species Act (ESA) Section 7 consultation process and the Incidental Harassment Authorization (IHA) Application for compliance purposes before it was known that the proposal had been re-negotiated by the NSF Program Officer.

We look forward to discussing our proposed research project with you further tomorrow.
Regards,
Holly Smith

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