ICDP Proposal Cover Sheet

☐ **Workshop** ☐ **Preliminary** ☐ **Drilling** ◯ ***New*** ◯ ***Revised*** ◯ ***Addendum***

Please fill out information in all gray boxes

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Title:	Deep Drilling in the Central Crater of the Chesapeake Bay Impact Structure, Virginia, USA X Workshop X Preliminary X New		
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Keywords: *(5 or less)*	Impact crater Cenozoic sequence stratigraphy	**General Location:**	Virginia USA

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Permission to post abstract on ICDP Web site: ☐ ***Yes*** ☐ No

Abstract: (*400 words or less)*

We propose to drill a 1.4-km-deep corehole into the central crater of the Chesapeake Bay impact structure on the Delmarva Peninsula of southeastern Virginia, USA. The buried, late Eocene Chesapeake Bay impact structure is among the largest and best preserved of the known impact craters on Earth. It consists of a highly deformed central crater surrounded by a less deformed annular trough that is 85 km in diameter at its outer margin. The proposed drill site is at Cape Charles city, Northampton County, VA.

The proposed corehole will concurrently address three project objectives: 1) understanding the processes and products of an impact into a multi-layer, marine target, 2) understanding the consequences of the impact for groundwater resource management, and 3) understanding post-impact Cenozoic sea-level changes, stratigraphic sequences, and climate variability. Objectives 1 and 3 address geologic problems of global importance and interest. Objective 2 addresses a regional societal issue (resource management) that has transfer value to groundwater issues near impact structures in similar hydrogeologic settings. Studies of the Chesapeake Bay impact structure will complement ICDP drilling projects for the larger and older Chicxulub crater (Mexico) and the younger and smaller Bosumtwi crater (Ghana).

The U.S. Geological Survey's (USGS) Chesapeake Bay Impact Crater Project has completed the preparatory fieldwork for the proposed drilling. Commercial and USGS marine seismic-reflection surveys that cross the Chesapeake Bay crater have been analyzed in published reports. USGS onshore high-resolution reflection surveys have been completed on the Delmarva Peninsula at Cape Charles and west of Chesapeake Bay within the impact structure and across its outer margin. The USGS and affiliated agencies have drilled eight coreholes within the impact structure's outer annular trough or at its outer margin. These coreholes are relatively shallow (730 m or less) but provide excellent background information for planning a deep hole that will address the three major objectives outlined above.

This proposal requests funding for a project workshop during 2003. The workshop will bring together an international group of scientists interested in the project's three scientific objectives to create a detailed listing of research topics, research teams, and a draft Full Drilling Proposal to ICDP.

We anticipate that funding for the drilling of the Cape Charles corehole in 2004 will be a collective effort among the USGS, the New Jersey Sea Level Transect (National Science Foundation, USA), and the International Continental Drilling Program.

Scientific Objectives: (*250 words or less*)

1. To understand the processes and products of impacts into multi-layer, marine targets: Impacts into these targets produce a distinct class of impact structures. Strong contrasts in rheology at layer boundaries, and the presence of seawater and interstitial groundwater, affect such fundamental parameters as crater morphology and dimensions, volume of melt, and the character of sedimentary crater fill. Coring of the Chesapeake Bay central crater will permit direct study of the results of catastrophic impact processes at the center of a large marine impact structure.
2. To understand the consequences of the impact for groundwater resource management: The Chesapeake Bay crater coincides with a poorly understood "saltwater wedge," which is a landward extension of salty groundwater that is typically restricted to the coastal zone. Some localities have begun the costly process of treating salty groundwater pumped from the margin of the "wedge" because rapid population and commercial growth require an increasing water supply. However, it has not been possible to predict the long-term effects of this withdrawal because relationships among the "saltwater wedge," the regional groundwater flow system, and the impact structure are not well established. In particular, the geohydrology of the central crater has not been explored in coreholes. A primary objective of an associated U.S.Geological Survey study is the integration of geologic and hydrologic data in order to generate a new regional groundwater flow model that includes the impact crater.
3. To understand post-impact, middle to late Cenozoic sea-level changes, stratigraphic sequences, and climate variability: Principal tasks are to date major "icehouse" (Oligocene–Holocene) stratigraphic sequences, to compare the timing of these sequences with ages predicted from the oxygen isotope proxy for glacioeustasy, to estimate the amplitudes and rates of sea-level changes, and to evaluate sequence stratigraphic models.

Summary of Support Requested from ICDP

Requested ICDP funds: *(in US$)*	$750,000 (US$)	Estimated Total Project Budget *(ICDP funds plus other sources)*:	$1,500,000 (US$)
Planned Start:	July 2004	Estimated Duration in Months *(On-site operations only)*:	3
Requested Operational Support	Drill Engineering *(Please contact ICDPs Operational Support Group if required)*	- - -	
	Downhole Logging *(Please contact ICDPs OSG if required)*	Final corehole geophysical logging	
	Field Lab Equipm. *(Please contact ICDPs OSG if required)*	Digital core scanning and logging Data and information management (DIS)	
	Training Course *(Please contact ICDPs OSG if required))*	- - -	

Detailed Budget Plan, Management Plan, and Drilling Plan to be provided as attachment to the Proposal.
OSG contact: U. Harms (ulrich@gfz-potsdam.de), Phone: +49 331 288 1085

PRELIMINARY DRILLING PROPOSAL AND WORKSHOP PROPOSAL TO THE INTERNATIONAL CONTINENTAL DRILLING PROGRAM

Deep Drilling in the Central Crater of the Chesapeake Bay Impact Structure, Virginia, USA (January 2003)

EXECUTIVE SUMMARY

We propose to drill a 1.4-km-deep corehole into the central crater of the Chesapeake Bay impact structure on the Delmarva Peninsula of southeastern Virginia, USA. This document contains a Preliminary Drilling Proposal and a Workshop Proposal that request partial funding for this effort from the International Continental Drilling Program.

The late Eocene Chesapeake Bay impact structure is among the largest and best preserved of the known impact craters on Earth. It consists of a highly deformed central crater surrounded by a less deformed annular trough that is 85 km in diameter at its outer margin. The proposed drill site is at Cape Charles city, Northampton County, VA.

The proposed corehole will concurrently address three project objectives; they are: 1) understanding the processes and products of an impact into a multi-layer, marine target, 2) understanding the consequences of the impact for groundwater resource management, and 3) understanding post-impact sea-level changes, stratigraphic sequences, and climate variability. Objectives 1 and 3 address geologic problems of global importance and interest. Objective 2 addresses a regional societal issue (resource management) that has transfer value to groundwater issues near impact structures in similar hydrogeologic settings. Studies of the Chesapeake Bay impact structure will complement ICDP drilling projects for the larger and older Chicxulub crater (Mexico) (http://www.icdp-online.de/html/sites/chicxulub/news/news.html) and the distinctly younger and smaller Bosumtwi crater (Ghana) (http://www.icdp-online.de/html/sites/bosumtwi/index/index.html) .

The U.S. Geological Survey's (USGS) Chesapeake Bay Impact Crater Project has completed most of the preparatory fieldwork for the proposed drilling. Commercial and USGS marine seismic-reflection surveys that cross the Chesapeake Bay crater have been analyzed in reports published during the past eight years. USGS onshore high-resolution reflection surveys

have been completed on the Delmarva Peninsula at Cape Charles and west of Chesapeake Bay within the impact structure and across its outer margin. The USGS and affiliated agencies have drilled eight coreholes within the impact structure's outer annular trough or at its outer margin. These coreholes are relatively shallow but provide excellent background information for planning a deep hole that will address the three major objectives outlined above.

This proposal requests funding for a project workshop during 2003 and thereby provides the first step in internationalizing study of this world-class impact structure. We plan to invite investigators from the ICDP Chicxulub crater and Bosumtwi crater drilling projects to our workshop in addition to advertising internationally. The workshop will bring together an international group of scientists interested in the project's three scientific objectives to create a detailed listing of research topics, research teams, and a draft Full Drilling Proposal to ICDP.

We anticipate that funding for the drilling of the Cape Charles corehole will be a collective effort among the USGS, the New Jersey Sea Level Transect (National Science Foundation, USA), and the International Continental Drilling Program. A generalized timeline for the proposed drilling project is as follows:

Project Time Line

January 2003:	Submittal of Preliminary and Workshop Proposals
April 2003:	Assumed approval of Proposals by ICDP
Summer 2003:	Project workshop
January 2004:	Submittal of Full Proposal
April 2004:	Assumed approval of Full Proposal by ICDP
Summer-Fall 2004:	Drilling at Cape Charles, VA

PRELIMINARY DRILLING PROPOSAL

INTRODUCTION

The late Eocene Chesapeake Bay impact structure is among the largest and best preserved of the known impact craters on Earth. It was formed about 35 million years ago when a comet fragment or asteroid struck the U.S. Atlantic continental shelf in the area now occupied by parts of Chesapeake Bay, the Delmarva Peninsula, the tidewater Virginia area west of the Bay, and the Atlantic Ocean adjacent to the Delmarva Peninsula (fig. 1) (Poag, 1997; Poag and others, 1994; Powars and Bruce, 1999). The structure is a complex crater developed in a multi-layer, rheologically variable target and is centered near the town of Cape Charles, Virginia. It consists of a highly disturbed central crater surrounded by a less deformed annular trough; the outer margin of the annular trough is 85 km in diameter (Poag and others, 2000). The late Eocene age of the structure has led to the hypothesis that the Chesapeake Bay impact structure is the source of the chronologically similar North American tektite strewn field (Poag and others, 1994; Koeberl and others, 1996). The entire impact structure lies buried beneath a few hundred meters of post-impact Cenozoic marine-shelf sediments where it is accessible from both land and sea for test drilling and seismic surveys.

The Chesapeake Bay impact structure is the seventh largest, known impact feature on Earth (Earth Impact Database, 2003). It is the second largest of a group of well-preserved, "wet-target" (marine) impacts that includes the Mjølnir (Norway), Montagnais (Canada), Lockne (Sweden), Kamensk (Russia) and Chicxulub (Mexico) craters. In this group, the Chesapeake Bay crater occupies a broad gap in crater size between "wet-target" craters that are half its size, or smaller, and the larger Chicxulub structure (Ormö and Lindström, 2000).

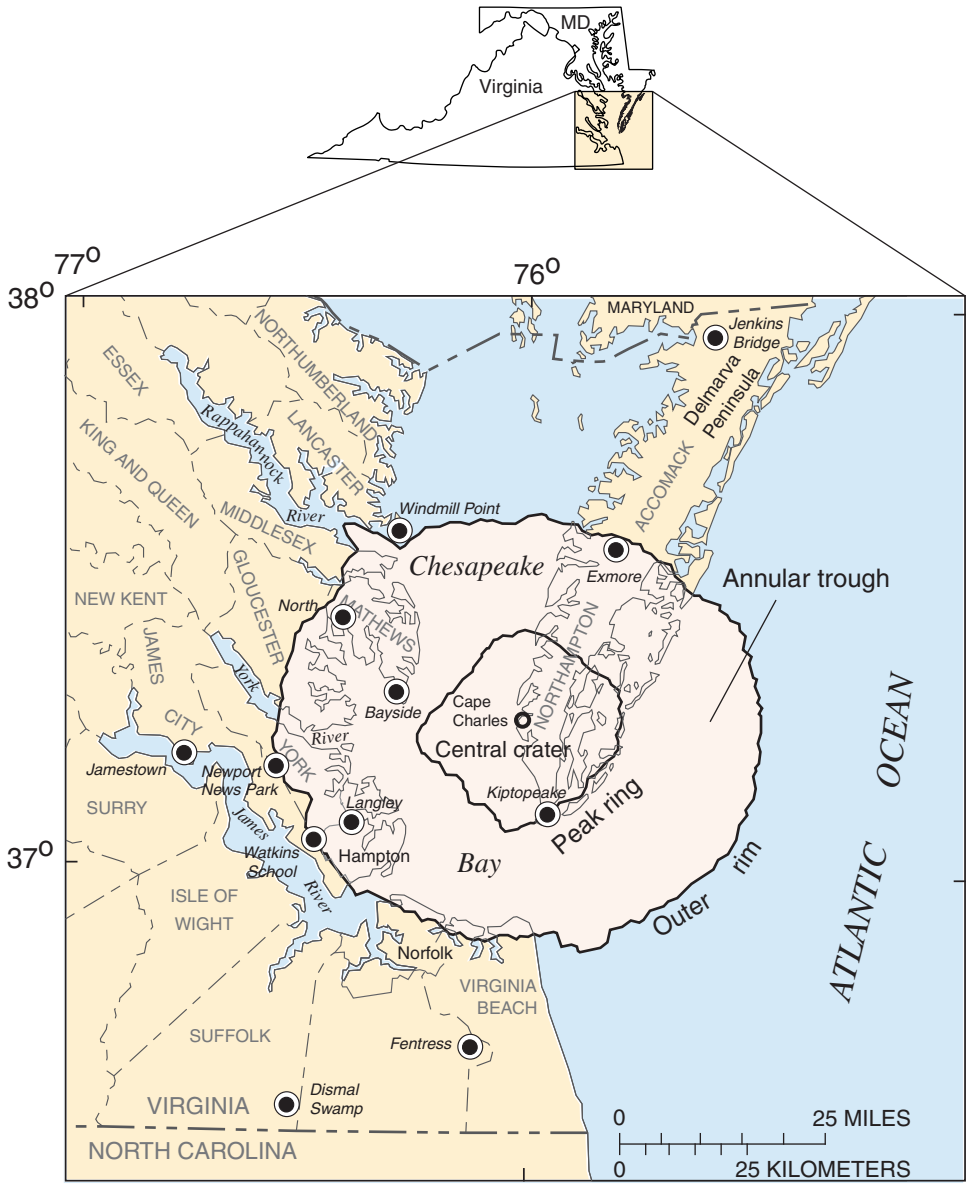

Figure 1. Map showing the location of the Chesapeake Bay impact structure and existing coreholes in southeastern Virginia, USA. The Kiptopeake corehole reached a total depth of 610 m and bottomed in 220 m of resurge deposits (sediment-clast diamicton) at the top of the crater section.

SCIENTIFIC OBJECTIVES

Overview

The excellent preservation and relative youth of the Chesapeake Bay impact structure, its geographic and stratigraphic positions, and its hydrologic characteristics make it a highly desirable deep-drilling target where three high-profile scientific issues may be addressed at a single drill site. These issues constitute the three project objectives described in the following paragraphs; they are: 1) understanding the processes and products of a marine impact, 2) understanding the consequences of the impact for groundwater resource management, and 3) understanding the post-impact, middle to late Cenozoic sea-level history, stratigraphic sequences, and climate variability of the Mid-Atlantic segment of the U.S. Atlantic continental margin.

Objective 1: Understanding the Processes and Products of a Marine Impact

Impacts into multi-layer silicate targets in marine environments produce a distinct class of impact structures that differ in many respects from dry-target or ice-target impacts on Earth and other planetary bodies. Strong contrasts in density and rheology at layer boundaries, and the presence of seawater and interstitial groundwater, affect such fundamental parameters as crater morphology and dimensions, volume of melt, and the character of syn-impact sedimentary crater fill. The Chesapeake Bay target included crystalline continental basement overlain successively by siliciclastic Cretaceous and lower Cenozoic continental-margin sediments, a neritic sea-water column, and the atmosphere.

Coring of the central crater of the Chesapeake Bay impact structure will permit direct study of the results of catastrophic impact processes at the center of a large impact structure. These processes include: crater excavation; shock deformation and metamorphism; melting and vaporization; crustal depression and rebound; and ocean resurge. This objective complements ongoing studies by the USGS and affiliated agencies that have been focused on the processes and results of crater collapse in the outer annular trough of the Chesapeake Bay impact structure (Gohn and others, 2001). One workshop objective will be to focus scientific hypotheses about processes that occur at the center of a large impact structure.

Because of its excellent preservation, drilling the Chesapeake Bay impact structure will yield a better understanding of its impact processes, which can be compared to those of other impact structures. Our drilling proposal is thus complementary to ICDP-sponsored efforts to drill the larger, more deeply buried Chicxulub (Mexico) crater (http://www.icdp-online.de/html/sites/chicxulub/news/news.html) and the smaller and younger Bosumtwi (Ghana) crater (http://www.icdp-online.de/html/sites/bosumtwi/index/index.html).

Study of the Chesapeake Bay impact structure is particularly important to studies of the Chicxulub crater, as the Chesapeake Bay structure is the only known "wet-target" (marine) impact structure that approaches the large size of Chicxulub. In addition, the Chesapeake Bay structure is twice the size, or larger, than the other known, well-preserved, "wet-target" craters listed by Ormö and Lindström (2000). Therefore, an understanding of the impact processes of the Chesapeake Bay structure is central to an understanding and linking of the processes responsible for larger peak-ring or multi-ring craters (Morgan and others, 2002) and for smaller central-peak or simple craters (Melosh, 1989).

Objective 2: Understanding the Consequences of the Impact for Groundwater Resource Management

The Chesapeake Bay impact structure coincides spatially with a long known, but poorly explained "saltwater wedge" within the Virginia Coastal Plain. This "saltwater wedge" is a landward extension of the zone of salty groundwater that typically is narrowly restricted to the coastal zone along most of the Atlantic Coastal Plain. The "saltwater wedge" has practical significance because rapid population and commercial growth in areas of Virginia underlain by the "wedge" require an increasing supply of water. This supply is heavily dependent on groundwater because the large surface-water bodies in this area are brackish estuaries. Some localities already have begun the costly process of pumping and treating salty groundwater located along the margin of the "wedge." However, it has not been possible to predict the long-term effects of this withdrawal because the relationships among the "saltwater wedge," the regional groundwater flow system, and the impact structure are not well established. In particular, the geohydrology of the central crater has not been explored in coreholes.

A primary objective of the ongoing USGS study of the Chesapeake Bay impact structure is the integration of geologic and hydrologic analyses in order to generate a new groundwater

flow model for the southeastern Virginia Coastal Plain. The current model is used by the State of Virginia to regulate groundwater withdrawal in high-use areas. However, this model was constructed without any knowledge of the crater's existence, and the creation of a new model is therefore of significant interest to state and local groundwater managers.

Objective 3: Understanding Post-impact Sea-level Changes, Stratigraphic Sequences, and Climate Variability

K.G. Miller, G.S. Mountain, and N. Christie-Blick designed the New Jersey Sea-level Transect (NJSLT) to address stratigraphic sequences and sea-level changes on a passive continental margin (Miller, 1997). The NJSLT was designed as a series of boreholes from the onshore New Jersey Coastal Plain across the continental shelf to the slope and rise. The primary goals of the NJSLT are: 1) to date major "icehouse" (Oligocene–Holocene) stratigraphic sequences, 2) to compare the timing of these sequences with ages predicted from the oxygen isotope proxy for glacioeustasy, 3) to estimate the amplitudes and rates of sea-level changes, and (4) to evaluate sequence stratigraphic models.

The NJSLT encompasses drilling on the slope by Ocean Drilling Program Leg 150, on the shelf by Ocean Drilling Program Leg 174A, and onshore by the New Jersey Coastal Plain Drilling Project (NJCPDP) (fig. 2). The latter is a joint effort of the International Continental Drilling Program, the Ocean Drilling Program (designated Legs 150X and 174X), the National Science Foundation (Earth Science Division, Continental Dynamics Program, and Ocean Sciences Division, Ocean Drilling Program), the U.S. Geological Survey, and the New Jersey Geological Survey.

The Coastal Plain Drilling Project has drilled eight continuously cored and logged boreholes in New Jersey that focused on global sea-level variations and related parameters during the past 100 m.y. In May-June 2000, the Project extended its paleogeographic scope with the drilling of a corehole at Bethany Beach, DE, in collaboration with the Delaware Geological Survey. The Bethany Beach corehole targeted the thick Miocene sequences in the main depocenter of the Salisbury embayment.

Scientific results from the Bethany Beach corehole are being published by ODP (Miller, McLaughlin, Browning, et al., 2003) and are available at http://www.rci.rutgers.edu/~kgm/bbsr.html . The Bethany beach corehole provides a

stratigraphic reference section in the mid-Atlantic region for Oligocene and younger sections unaffected by post-impact induced subsidence. Comparison of Bethany Beach and New Jersey Oligocene-Miocene sections (e.g., Miller et al., 1998) with Cape Charles will provide an understanding of the differences in stratigraphic architecture between locations affected primarily by simple thermal subsidence and loading and locations within the crater affected by fault-induced subsidence (at least during the late Eocene-early Miocene). The workshop will focus scientific objectives for post-impact sedimentation and develop a strategy for backstripping and evaluating subsidence history of the Cape Charles site.

The proposed corehole at Cape Charles further extends the paleogeographic scope of the NJSLT Project to the southern margin of the Salisbury embayment. More importantly, the thick section that will be continuously cored at Cape Charles, VA addresses three topics not addressed in previous drilling: 1) thick upper Miocene through Pleistocene marine strata will be cored, allowing for the first backstripped eustatic estimates for this time interval for this region (this section is nonmarine in New Jersey and marginal marine in Delaware); 2) the greatly expanded upper Eocene-Pleistocene section will provide unprecedented sampling of numerous global events (for example, the Eocene/Oligocene, middle Oligocene, and middle Miocene coolings, and the early Miocene warm interval; and 3) the thick upper Eocene to Oligocene section is affected by faulting which may complicate obtaining eustatic estimates but will provide an opportunity to evaluate subsidence history and the effects of cratering and subsequent faulted-influenced subsidence when compared with sections outside of the crater. In effect, we have an excellent natural experiment comparing a region dominated by simple thermal subsidence and loading (New Jersey and Delaware sections; Kominz and others, 1998) with those influenced by crater subsidence.

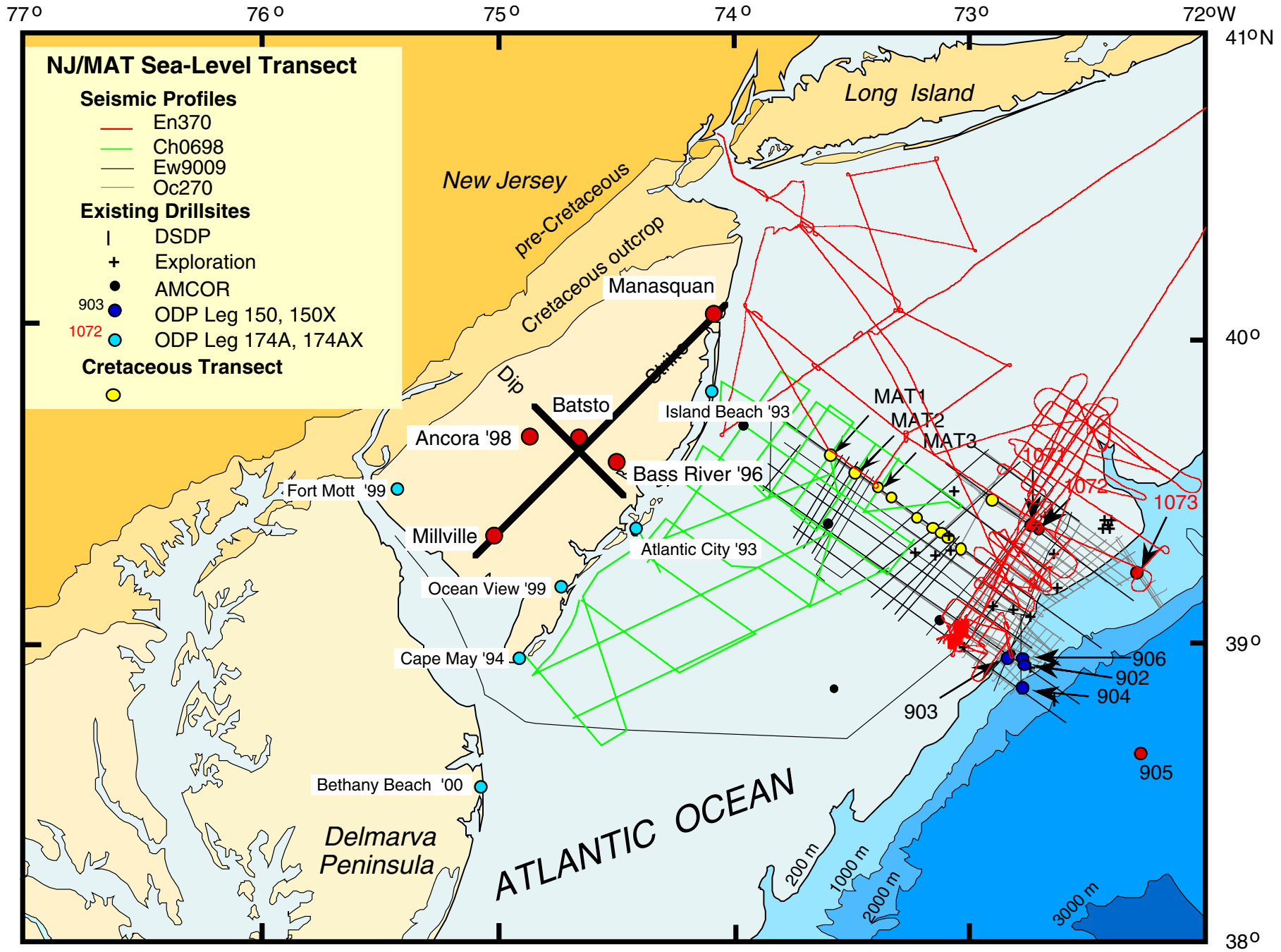

Figure 2. Map showing the location of drill holes and seismic profiles of the New Jersey Sea-Level Transect.

NEED FOR DRILLING

The central crater of the Chesapeake Bay impact structure has not been drilled previously. However, it is the central crater that records the effects of impact-generated excavation, crustal depression and rebound, shock metamorphism, and shock melting. Hence, we expect the central crater section to consist of sedimentary-clast breccias, shocked crystalline breccias, suevites, and melt-rock-dominated breccias. Multidisciplinary studies of cores from the central crater will document the primary effects of the impact and thereby facilitate the inference of crater processes, the mathematical modeling of those processes, and an increased understanding of the impact structure's hydrologic regime. To reach the impact structure, the proposed corehole must penetrate the post-impact, upper Eocene through Quaternary sediments that bury the impact structure and constitute the drilling target for objective 3.

GENERAL STRATEGY

Drilling

One purpose of the proposed workshop is to focus drilling strategy and tactics. The USGS has drilled continuously cored holes to depths as great as 730 m within the crater's annular trough. The drill rig used for this work (Longyear Hydro-44) remains available and is rated for drilling to depths approaching 1.4 km, although this capability has not been tested below 730 m. Commercial drilling companies, in conjunction with the ICDP Operational Support Group, provide the other obvious choice for drilling the proposed corehole.

Geophysical Logging

Interim geophysical logging would be conducted at breaks in the coring schedule. Interim logs will be collected using existing USGS operators and Century-brand equipment. Interim log suites will include resistivity (normal, single-point, lateral, induction), gamma-ray, spectral gamma-ray, sonic velocity, and caliper logs. Sections covered by these logs likely will consist of sedimentary-clast breccias and post-impact sediments.

Final geophysical logging will be done by the ICDP Operational Support Group or will be contracted to a commercial logging company. A full suite of electrical, physical, and perhaps nuclear properties will be recorded. This log suite likely will include induction resistivity, proximity/microresistivity, gamma-ray, spectral gamma-ray, sonic velocity, caliper, and possibly

neutron porosity and density logs. Sections covered by the final open-hole logs likely will consist of sedimentary-clast breccias, shocked crystalline-rock breccias, suevite, and melt-dominated rocks.

Sample Analysis

Research teams and team leaders will be identified as part of the workshop agenda. Sampling protocols and sample categories also will be developed in detail at the proposed workshop. Project sample categories likely would include preliminary stratigraphy, paleontology, petrology, and pore-water chemistry at the drill site and paleontology, stable isotopes, impact mineralogy and petrology, rock chemistry, radiometric ages, paleomagnetics, and fission track studies in laboratories.

Project Management

Project management will be centered within the USGS and Rutgers University. Operational planning and execution primarily will be the responsibility of the USGS. Operational planning and scheduling will be addressed in the workshop agenda. We anticipate that funding for the Cape Charles corehole will be a collective effort among the USGS, the New Jersey Sea Level Transect (National Science Foundation, USA), and the International Continental Drilling Program. We seek international cooperation and collaboration on drilling of this impact structure and intent to forge close ties with the Chicxulub and Bosumtwi drilling projects. The general schedule for the project is as follows:

Project Time Line

January 2003:	Submittal of Preliminary and Workshop Proposals
April 2003:	Assumed approval of Proposals by ICDP
Summer 2003:	Project workshop
January 2004:	Submittal of Full Proposal
April 2004:	Assumed approval of Full Proposal by ICDP
Summer-Fall 2004:	Drilling at Cape Charles, VA

PROPOSED DRILL SITE

Location

The central crater of the Chesapeake Bay impact structure underlies the southern tip of the Delmarva Peninsula and adjacent parts of southern Chesapeake Bay and the Atlantic shelf (fig. 1). The proposed drill site is on land at the center of the 28-km-wide central crater near the town of Cape Charles, Northampton County, on the Delmarva Peninsula.

Prior Drilling

A cooperative program between the USGS and the Virginia State Water Control Board (VA-SWCB, now part of the Virginia Department of Environmental Quality) took place during 1985 to 1995 (Powars and Bruce, 1999; Powars, 2000). Two coreholes were drilled within the impact crater, and two others were drilled at its outer margin (fig. 1). Four additional coreholes were drilled outside the crater within 20 to 40 km of its outer margin, thereby providing a regional stratigraphic context for comparison with crater sections.

A second drilling program is part of the ongoing USGS Chesapeake Bay Impact Crater Project. This project has drilled four coreholes within or at the outer margin of the crater's annular trough west of Chesapeake Bay (fig. 1). Two of these coreholes penetrated the full thickness of post-impact and impact-modified Coastal Plain sediments, impact-generated deposits, and underlying Precambrian crystalline rocks.

VA-SWCB and USGS drillers drilled the first set of coreholes using state and USGS drill rigs, respectively. USGS drillers and rigs from the Rocky Mountain Drilling Unit and the Eastern Earth Surface Processes Team drilled the second set of coreholes.

Seismic Surveys

Over 230 km of commercial and USGS marine seismic-reflection surveys, primarily in Chesapeake Bay, provided most of the early information about the location, morphology and structural geology of the Chesapeake Bay impact structure (Poag and others, 2000). In September 2000 and September-October 2002, the USGS collected approximately 15 km of high-resolution reflection data across the structure's outer margin and within the annular trough in Mathews and Gloucester Counties, Newport News, and Hampton (fig. 1). Approximately 3 km also were surveyed near Cape Charles city in the vicinity of the proposed core site. Data for

the high-resolution surveys were collected using 5-m spacing for geophones and shot points. Processing of the surveys near Cape Charles will be completed in the coming three to six months.

COOPERATING INSTITUTIONS (January 2003)

Hampton Roads Planning District Commission
Rutgers University
United States Geological Survey
Virginia Department of Environmental Quality

WORKSHOP PROPOSAL

WORKSHOP OBJECTIVES

We propose that the International Continental Drilling Program (ICDP) fund a workshop whose purpose is to further plan the drilling of a 1.4-km-deep corehole into the central crater of the Chesapeake Bay impact structure. This workshop is intended to bring together an international group of scientists with interests in the project's scientific objectives. The principal workshop objectives are: 1) to develop a Full Drilling Proposal to the ICDP for the drilling of the central crater of the Chesapeake Bay impact structure, 2) to establish international, discipline-based research teams, and 3) to compile secondary scientific objectives and corresponding experiments for those teams.

WORKSHOP AGENDA

The workshop agenda will include the following topics, at a minimum:

Welcome, Introduction, and Purpose
Overview of the Chesapeake Bay Impact Structure (selected speakers)
Site Characterization (selected speakers)
Technical Breakout Sessions
- Group 1: Post-impact Sequence Stratigraphy
  - Lithology, paleontology, magnetostratigraphy, stable isotopes, etc.
- Group 2: Crater Sediment-clast Breccias
  - Stratigraphy, paleontology, petrology, etc.
- Group 3: Crater Crystalline-clast, Suevite, and Melt-rock breccias:
  - Petrology, geochemistry, radiometric ages, fission-tracks, etc.
- Group 4: Geohydrology and Geophysical Logging:
  - Pore-water chemistry, borehole geophysics, etc.

Summaries of Breakout Sessions
Focus scientific hypotheses about impact processes in large craters
Preparation of draft proposal to ICDP

WORKSHOP ATTENDANCE

We anticipate accepting 25 to 30 requests from scientists to attend the workshop. Additional attendees may be accepted depending upon the available funding and space. We expect that the attendees will constitute an international group; representatives from Australia, Austria, Canada, France, Germany, Ghana, United Kingdom, Mexico, Norway, Russia, South Africa, Sweden, and the United States seem likely on the basis of our knowledge of active Earth-impact research programs. We will announce the workshop through the online and print media available from geoscience societies, for example the Geosciences Calendar in "Geotimes" (American Geological Institute).

WORKSHOP LOCATION AND SCHEDULE

The proposed workshop will be held at or near the USGS National Center in Reston, Fairfax County, Virginia. The Reston area is in the suburban corridor between Washington, D.C., and Dulles International Airport and has a large number of hotels with meeting rooms as well as overnight accommodations. In addition, the National Center has an auditorium and other meeting rooms with modern audio-video equipment that would be available at little or no cost. The proposed time for the meeting is a three-day period in mid-September 2003. The meeting would occur across 2.5 days and conclude at approximately noon on the third day.

WORKSHOP COST

We request the sum of $50,000 (US) to cover the operational costs of the workshop. We expect that the majority of these funds will be spent on travel and accommodations for workshop participants. Some incidental costs related to the workshop can be paid by the USGS.

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