Morphology of Hudson Canyon And Hudson Apron

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LONG-TERM GOALS

Numerous studies along continental margins have documented a vast array of geological, biological, and oceanographic processes that shape the continental shelf, slope and rise. Because of their increased seafloor gradients, the slope and rise are in many ways more complex than the continental shelf. They are affected extensively by differential sediment accumulation, biological erosion, current scour, ground-water expulsion and sapping, gas-hydrate disassociation, slumping, sliding, debris flows, and turbidity currents. Environmental assessment of these areas, and particularly understanding operative processes and evaluating their effects in material transfer between the shelf and slope/rise, is of fundamental scientific interest and has important practical implications. Long-terms goals of our research are to assess the geomorphology and stratigraphy of the continental slope and rise off the eastern U.S., to understand the nature and efficacy of processes that have shaped these provinces, and to evaluate the potential that these processes have for further modification of the seabed.

OBJECTIVES

All of the processes noted above have some level of impact on slope stability and control of channel and canyon development on the continental slope and rise, but their relative importance, spatial distribution, and changes with time are poorly known. Many existing studies are deficient because they used instrumentation with very limited coverage (e.g., submersible) and they had no larger-scale detailed 3-D data other than crude bathymetry within which to interpret observations. Consequently, we still do not know which processes are primarily responsible for initiation and maintenance of features such as slope channels and canyons, nor do we know why some slope areas are unusually stable.

To begin analyzing the structure and processes operative on the continental slope and rise, we selected Hudson Canyon and part of the adjacent Hudson Apron for study. These areas are unique along the U.S. East Coast in that they combine, within a small region, two end members in the spectrum of slope stability. At one end of the spectrum, Hudson Canyon is the largest on the eastern U.S. margin, it has had a long history of development (Late(?) Cretaceous-Recent), it evolved by means of a wide variety of sedimentation and erosion processes, and it is associated with a major, long-lived subaerial drainage system (Hudson River, and Hudson Valley on the shelf). The canyon incises widely variable lithofacies (e.g., chalks, sandstones, shales) over a large age range (Upper Cretaceous to Quaternary). Because of the variable composition, consolidation, porosity, and permeability of these facies, very different styles of failure (and very different resultant morphologies) are present throughout the canyon.

The virtually undeformed Hudson Apron is at the other end of the spectrum. This sedimentary blanket covers the outer shelf and upper slope immediately south of Hudson canyon, and it appears to have been deposited during the most recent (and perhaps also the penultimate) sea-level cycle. There are no canyons or channels in this apron and there are only minor indications of incipient slope failure. The apron is a rare example of undeformed continental slope along the U.S. East Coast margin. By studying and understanding why it has not experienced significant failure, we can better constrain the necessary conditions for slope failure in other areas. Furthermore, the stratal and morphological simplicity of the apron can a) facilitate acquisition of accurate, high-resolution sediment-velocity information, b) aid correlation of seismic reflections across the shelf-slope break, and c) allow us to examine the origin of stratigraphic sequences and their bounding unconformities along the outer shelf and slope in terms of glacial-eustatic fluctuations, sediment supply, and physiography.

The Hudson canyon/apron area has a wealth of existing data available for study. Analysis of these data is a necessary first step to constrain the sedimentary environment and to define what field work will eventually be needed to understand the 4-D characteristics (space and time) and relative importance of sedimentary processes that have controlled development of the contrasting canyon and stable-slope environments. Our present research constitutes an initial part of this analysis, and it is devoted to processing and interpreting existing SeaBeam 2112 multibeam bathymetric and sidescan-sonar data over Hudson Canyon and Hudson Apron. These data will provide a fundamental morphological foundation for all future studies that may occur in the region.

APPROACH

We are conducting a 6-month study of the morphological framework of Hudson Canyon and apron using SeaBeam 2112 multibeam bathymetric data and its associated 'sidescan' (backscatter) data. We acquired these data during a survey aboard R/V Atlantis in April 1997. The survey obtained 100 percent sonar coverage of Hudson Canyon and the bordering, uneroded seafloor of Hudson Apron. The survey extends from the westernmost canyon incision in the shelf near 80 m water depth out to ~3500 m depth on the central continental rise. The bathymetric data are being processed to remove beam-point errors, and they will be gridded and analyzed in map form and with computer 3D visualization software. The associated sidescan-sonar data are also being processed to remove spurious values, and these data also will be gridded and analyzed. Both data sets will be used to interpret sedimentary processes, slope stability patterns, and history of canyon development.

Our data covers a region adjacent to EM1000 bathymetry and sidescan sonar surveys that the U.S. Geological Survey has obtained across the continental shelf, extending from Hudson estuary through Hudson Valley to the edge of our SeaBeam survey. To the extent that time and funds allow, we will integrate our data with the USGS coverage, as well as with auxiliary data (e.g., 12- and 3.5-kHz profiles, seismic profiles, seafloor sample data, GLORIA long-range sidescan-sonar data) in the area, to interpret the Hudson channel and canyon system across the shelf, slope and rise.

WORK COMPLETED

Our grant commenced on 1 July 2001, and at this writing we are editing and processing the SeaBeam 2112 multibeam bathymetric data. This will be followed by processing of the associated sidescan-sonar data and by analysis and write-up of results.

RESULTS

Because our data processing began only recently, there are no current results. We expect that the final product of our effort will be excellent digital gridded data sets that define the morphology and backscatter characteristics of seafloor across Hudson Canyon and Hudson Apron. With the support available from this grant and from other WHOI resources we plan to publish our results in the scientific literature.

IMPACT/APPLICATIONS

Understanding the structure and formative processes of continental slope and rise morphology and stratigraphy has practical applications for assessing such diverse factors as geohazards, hydrocarbon resources, dispersal of contaminants from marine dump sites, relation of seafloor environment and environmental alteration to fisheries, stability and effects of emplacement of manmade cables and structures, and civilian and military navigation and security. In addition, the digital database of multibeam bathymetry and backscatter patterns being developed here will provide a firm foundation for any future fieldwork and data analysis in the Hudson Canyon and Hudson Apron region.