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STUDY TITLE: Biological Processes on the U.S. Atlantic Continental Slope and Rise: Part A, and Studies of the North and Mid-Atlantic Slope and Rise: Part B.

REPORT TITLE: Study of Biological Processes on the U.S. Mid-Atlantic Slope and Rise. Vol. 1, Executive Summary; Vol. 2, Final Report.

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KEY WORDS: Mid-Atlantic; Delaware; New Jersey; biology; slope; rise; chemistry; geology; benthos; trace metals; hydrocarbons; sediment; grain size; survey; infauna; epifauna; hydrography; gas chromatography; spectroscopy; abundance; diversity; drilling discharges; exploratory drilling; multivariate statistics; colonization; photographs; recovery; Atlantic Region.

BACKGROUND: Oil and gas exploration on the U.S. continental slope and rise has created a need for data on structure and composition of deep-sea communities and processes that affect them. Predictions have suggested that clay-sized particles emanating from drilling activities could be dispersed in deep water over an area measuring 4 x 80 km downstream of a discharge. A major objective of this study was to determine if drilling muds or drill casings, originating from exploratory drilling, had impacted the near-field benthic community. This report represented results of a two-year field study funded by the U.S. Department of the Interior, Minerals Management Service.

OBJECTIVES: (1) To characterize pre-drilling biological, geological, and chemical properties of the benthic environment near two deep water drilling sites (Blocks 93 and 372) on the U.S. mid-Atlantic continental slope and rise; (2) To monitor potential temporal changes in these properties and determine their origin (i.e., natural or drilling-related); (3) To determine the fate of discharged drilling-related materials; and (4) To estimate recovery rates of deep-sea benthos potentially impacted by drilling activities.

DESCRIPTION: An array of 14 benthic sampling stations, located at 1,500 and 2,100 m water depths, was placed at varying distances from two exploratory drilling sites on the continental slope and rise off the coast of New Jersey and Delaware (39°N Lat, 72°W Long to 38°N Lat, 72°W Long). Termed Blocks 93 and 372, these leases were held and being explored by Shell Offshore Inc. Stations were sampled six times over a 21-month period (i.e., March 1984 to November 1985). Temporal and spatial variations in epifaunal and infaunal communities were studied through a variety of sampling methods, including camera transects, crab traps, bottom trawls, and box corers. Data were interpreted using various statistical analyses (e.g., cluster, ordination, rarefaction curves, Shannon-Wiener diversity index, and others). Infaunal recolonization rates were measured from trays deployed for 6- or 12-month periods. Sediment textures and chemistry were examined from box core samples. Hydrocasts of Niskin bottles were employed to determine water quality at representative sites. Trace metals and hydrocarbons were

examined in two common echinoderms (i.e, the brittle star Ophiomusium lymani; sea urchin Echinus affinis).

SIGNIFICANT CONCLUSIONS: Continental slope and rise fauna of the U.S. Mid-Atlantic region were characterized by a highly diverse, but poorly known community of epifaunal and infaunal organisms. Faunal community structure was affected by water depth and topographic relief, with highest diversity observed at mid-slope depths. Temporal variability in species abundance and diversity was attributed to changes in a few dominant taxa which were altered by sediment texture differences rather than by drilling-related activities. In one downslope area, decreases in sea pen densities occurred subsequent to drilling; however, it was unclear what factors, whether natural or man made, caused the observed changes. There was no evidence of drilling-related increases in metals or hydrocarbons within the tissues of brittle stars and sea urchins analyzed.

STUDY RESULTS: The overall infaunal diversity of the U.S. mid-Atlantic continental slope and rise was high. A total of 862 species were collected from 237 box core samples, with 57% (i.e., 489 species) of the fauna being previously undescribed. Annelids, mostly polychaetes, dominated the samples and accounted for 45% (i.e., 367 species) of the total fauna collected. Important polychaete families included Dorvilleidae, Cirratulidae, Spionidae, Flabelligeridae, and Terebellidae. Arthropods represented 23% of the total fauna by abundance, with important orders being Isopoda, Amphipoda, Tanaidacea, and Cumacea. Molluscs, represented primarily by classes Bivalvia, Gastropoda, Aplacophora, and Scaphopoda, accounted for 13% (by abundance) of the total species collected.

At mid-slope depths (i.e., 1,500-1,600 m), the sipunculan Aspidosiphon zinni and the aplacophoran mollusc Prochaetoderma yongei were co-dominants. Abundance of these large burrowing species was possibly the result of higher amounts of organics in sediments. Deep stations (i.e., >2,000 m) were dominated by the polychaete Aurospio dibranchiata. Mid-slope stations were more diverse, with 176 to 184 species/1,000 individuals. Deeper (i.e., 2,100 m) stations exhibited a reduced diversity by comparison, with 144 to 171 species/1,000 individuals. Species composition was very homogeneous along the 2,100-m isobath, suggesting the presence of a single community along the 176-km long transect. Biomass varied between the two deep stations at 2,100 m, reaching nearly 0.4 g/m^2 ash-free dry weight due to the presence of polychaetes, bivalves, and ophiuroids. Recolonization experiments, completed to document changes in infaunal species composition over 6- and 12-month periods, showed that the polychaete Aurospio dibranchiata decreased in abundance over time. This trend was attributed to higher current velocities upstream from the drillsite, causing an increase in the relative amounts of sand collected in recolonization trays.

Epifaunal communities were determined by water depth and topography. Densities were greatest on the lower slope at depths of 1,800-1,900 m, reaching nearly 6 individuals/m^2. Higher densities were also noted on the shallow ridges and flat valleys of the region, as compared to steep slopes and deep valleys. Epifaunal densities on these topographic highs (where currents would be stronger and transporting more suspended food particles) were attributed to an increase in the numbers of filter feeding species. Five epifaunal species dominated the slope and rise. In water depths of 1,800-1,900 m, the brittle star Ophiomusium lymani and an unnamed cerianthid anemone were prominent; below 2,000 m, the sea pen Kophobelemnon stelliferum, the sea urchin Echinus affinis, and the octocoral Acanella arbuscula were dominant.

Sediment chemical analyses indicated that levels of both total hydrocarbons (i.e., 3 to 130 µg/g dry weight) and polycyclic aromatic hydrocarbons (i.e., 66 to 1,160 ng/g dry weight) were normal. Polycyclic aromatic hydrocarbons represent the best indicator of petroleum discharges. Hydrocarbon concentrations in brittle stars (Ophiomusium lymani) and sea urchins (Echinus affinis) were low (i.e., 27 to 163 µg/g wet weight). Trace metals were within normal levels except for aluminum, iron, and zinc which were high, possibly due to animals containing ingested sediments.

Physical impacts from drilling activities were minimal, although plastic pipe casings were seen on the seafloor. Barium levels, a good indicator of drilling muds deposition due to its high density and insolubility, only increased at one station (in Block 372) following drilling; however, values were within normal background levels. This result was surprising, since amounts of mud discharged at the other drilling site (i.e., Block 93) were ten times higher. Despite predictions that slight (i.e., 1-2 mm) accumulations of drilling muds or cutting solids may produce dramatic reductions in infaunal diversity, there was no evidence for drilling-related changes in the fauna at either site.

STUDY PRODUCT(S): Maciolek, N., J. F. Grassle, B. Hecker, P. D. Boehm, B. Brown, B. Dade, W. G. Steinhauer, E. Baptiste, R. E. Ruff, and R. Petrecca. 1987. Study of Biological Processes on the U.S. Mid-Atlantic Slope and Rise. Vol. 1, Executive Summary; Vol. 2, Final Report. A final report by Battelle Ocean Sciences, Woods Hole Oceanographic Institution, and Lamont-Doherty Geological Observatory of Columbia University for the U. S. Department of the Interior, Minerals Management Service Atlantic OCS Region, Vienna, VA. Vol. 1 - NTIS No. PB88-182845; Vol. 2 - NTIS No. PB88-183090. MMS Report 86-0050. Contract No. 14-12-0001-30064. ix + 44 pp. (Vol. 1); 310 pp. + app. (Vol. 2).

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