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REPORT TITLE: New England OCS Environmental Benchmark. Vols. I through V.

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KEY WORDS: North Atlantic; Massachusetts; New Hampshire; Maine; baseline; hydrocarbons; trace metals; water column; sediment; infauna; foraminifera; seasonality; histopathology; microfauna; Georges Bank; Gulf of Maine; currents; gyre; biology; chemistry; geology; hydrography.

BACKGROUND: This report contains the findings of the first year New England Outer Continental Shelf (OCS) Environmental Benchmark Study. The program was designed as a broad area, multi-year survey program that would provide a statistically and scientifically sound characterization of key environmental aspects including physical, biological, geological, and chemical parameters. Benchmark data were to be used as the framework for comparison of measurements made on site-specific surveys to determine whether a site was representative or atypical of the geographic area and to determine which sites should be monitored or studied more closely.

OBJECTIVES: (1) To initiate seasonal studies to determine the range and variation in concentrations of high molecular weight hydrocarbons and selected trace metals in the water column, sediments, and selected benthic macrofauna species; (2) To initiate seasonal studies of benthic infaunal communities and foraminiferal populations to determine natural ranges of selected parameters; (3) To initiate histological studies to determine the health of selected benthic macrofaunal species; and (4) To enumerate all microbes and identify dominant microbes in the surface film, near surface water, and sediment.

DESCRIPTION: The study area was roughly between 40°00' and 43°00'N Lat and 65°30' and 71°00'W Long. It encompassed all of Georges Bank proper, Georges Basin, part of the Gulf of Maine southwest of Franklin Swell, the Great South Channel, Nantucket Shoals, and the area due south of Martha's Vineyard and Nantucket. Water column and sediment samples were collected from 12 stations during four seasonal cruises. Stations 1, 7, and 42 were selected as representative of water masses associated with inshore phenomena such as terrestrial runoff and anthropogenic effluents. Stations 36, 37, and 39 were selected to be representative of conditions resulting from the confluence of the Gulf of Maine counterclockwise circulating surface gyre and the Georges Bank clockwise circulating surface gyre. Several stations (Stations 13, 18, and 26) were positioned to facilitate a general investigation of the Georges Bank gyre and possible effects that the large shelf-slope vertical front might have on water column chemical and biological distributions. Effects attributable to the vortex phenomenon of a gyre and the supposed relatively static physical condition in the central portion of Georges Bank were investigated at central Stations 18, 32, and 37. Stations 1, 4, and 7 were established to investigate possible effects from relatively abundant ship traffic and for chemical and biological reasons. The broad distribution of stations on the Bank was also thought to cover areas having a high probability of becoming oil lease sites. The water column was sampled for conductivity-temperature-depth/oxygen, transmissometry, nephelometry, salinity/dissolved oxygen, micronutrients, dissolved organic carbon, particulate organic carbon, particulate trace metals, dissolved and particulate hydrocarbons, and zooplankton for trace metals, hydrocarbon, and taxonomy. Bottom sediments were sampled for microbiology, trace metals, hydrocarbons, total organic carbon, total organic nitrogen, sediment analysis, foraminifera, and infaunal taxonomy. Dredges and trawls were used to collect epibenthic macrofauna, macroinfauna, and benthos for trace metals, hydrocarbons, histopathology, and taxonomy.

SIGNIFICANT CONCLUSIONS: Common water type designations in the Gulf of Maine-Georges Bank area included Maine intermediate water, Maine bottom water, slope water, surface slope water, shelf water, and various convenient transition waters. Most of these waters were in some form of seasonal transition at any particular time. In the Gulf of Maine, the most dense, warm salty intrusions tended to collect in deep basins, mixing and diffusing slowly into surrounding waters. Intense winter overturning did not generally modify the lowest layers, Maine bottom water. Waters overlying Maine bottom water were subject to late winter deep vertical mixing; in spring, however, surface freshening and warming tended to isolate this water. From early spring through late fall, intermediate water remained distinct from surface layers and was called Maine intermediate water. The zone of water lying between the shelf edge and the Gulf Stream was a dynamic mix of Gulf Stream eddies, shelf water streamers, and slope water. During summer, surface heat exchange tended to reduce the temperature contrast between shelf water and upper slope water. The lower slope water remained distinct, however, conforming very well to North Atlantic Basin water. Waters over Georges Bank, bank transition water, tend to be a mixture of waters occurring around its boundaries.

STUDY RESULTS: In order to identify some relationships between water column parameters, average concentrations for nine constituents [particulate trace metals (PTM), particulate organic carbon (POC), and total suspended matter (TSM)] were determined for four different water types--shelf water (SW), slope water (SlW), Maine intermediate water (MIW), and bank transition water (BTW). For all parameters considered, concentrations in SW were less than any other water types. BTW, intermediate in temperature-salinity characteristics between SW and deep SlW, fell between the two in TSM level. BTW in the fall when intrusions were evident were essentially equal to SlW. TSM in BTW appeared to be higher than in SW and SlW. Near bottom processes or accumulation of suspended material over the shelf/slope front may have resulted in slight increases in TSM over SlW further removed from Bank processes. Concentrations of POC were lowest in deep SlW and MIW and highest in SW, in accordance with general levels of productivity. POC levels were correlated inversely with levels of nutrients in the water, which were low on the Bank in spring, summer, and fall but high in MIW and SlW. BTW POC levels fell between SW and SlW in accordance with the assumption that this water represented a mixture of water types. Particulate chromium, copper, and lead were also lower in SlW than in any other water types. Although iron levels were low in the SW, BTW, and SlW, MIW showed high and distinctive particulate iron levels. BTW was generally intermediate between SW and SlW. In some cases, BTW was not intermediate between these water types, perhaps as a result of the fact that other chemical and biological processes had affected the concentrations. The analysis illustrated that SW and MIW may act as sources of nutrients to the Bank but that their intrusion serves to lower concentrations of most particulate metals. A marked exception to this process was the exchange with MIW containing high levels of particulate iron and suspended matter.

A minimum of two basic geochemical regimes existed, one comprised of shallow regions of Nantucket Shoals and Georges Bank, and the second, which was chemically similar but physically separated, comprised of the Gulf of Maine region and southern slope. Basic geochemical differences were determined by distribution of fine-grained material, particularly the clay mineral component. Several areas of deposition accumulated materials introduced in that region; the southern and northern slopes, the Gulf of Maine, and the southwestern region. Chemical parameters that exhibited a large variability or pulsed input (e.g., lead and pristane) had that variability reflected in all reservoirs of the system. This indicated that they, and possibly other parameters, may have their distributions controlled by the material source. Most of the remaining chemical parameters appeared to have their distributions controlled by their geochemical sinks. There was a time lag on the order of months between the introduction of a material to the water column and its reflection in the sediments. The shelf/slope interfaces were potential regions of massive transport of materials possibly onto and off the Bank. The Gulf of Maine was potentially the material source in the sediments in the south and southwest sampling region. A hypothesis for the mechanism of this material transport was proposed. During the dynamic winter months, fine-grained sediments are removed from the Bank and deposited in deep waters. As the seasons progress into the high-runoff conditions and slightly stratified water column of spring, a large influx of freshwater and extensive mixing occur throughout the northern edges of the Bank. This water and material it contains are transported across the region and deposited in the southwest. During summer, intense stratification of the water column combined with formation of the double-gyre system between the Bank and Gulf of Maine forces material to be transported through Great South Channel and/or around the Bank in surface waters. Material deposited on the southern slopes may then be acted upon by dynamic transport processes and redistribution back onto the shelf.

STUDY PRODUCT(S): Energy Resources Company Inc. 1978. New England OCS Environmental Benchmark. Vols. I through V. A final report for the U.S. Department of the Interior, Bureau of Land Management Atlantic OCS Office, New York, NY. Vol. I - NTIS No. PB81-174906; Vol. II - NTIS No. PB81-174914; Vol. IV - NTIS No. PB81-174922; Vol. V - NTIS No. PB81-186785. Contract No. AA550-CT6-51. 1,982 pp.

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