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Distribution of DDT and other persistent organic contaminants in Canyons and on the continental shelf off the central California coast

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Abstract

Sediment samples were collected to delineate the distribution of contaminants along the central California coast. Sampling included a variety of Canyons and shelf/slope areas to evaluate contaminant transport patterns and potential delivery to Canyons and the continental slope to a depth of 1200 m. Sediments were collected and analyzed for organic contaminants using standard techniques of the NOAA National Status and Trends Program (NS&T). DDT is distributed on the shelf within a zone of fine-grained sediments between Half Moon and Monterey Bays. DDT was found at higher concentrations in Ascension, Año Nuevo, and Monterey/Soquel Canyons than in Pioneer and Carmel Canyons, the Gulf of the Farallones, or the continental slope. The Monterey Bay watershed appears to be the primary source of DDT. In contrast, PAHs and PCBs on the shelf appear to be derived primarily from San Francisco Bay. DDT appears to be delivered to the deep ocean via the Canyons more than from cross-shelf sediment transport. Sediment budget estimates for the continental shelf north of Monterey Bay need further refinement and more data to account for the movement of material from Monterey Bay onto the shelf.
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1. Introduction

A large variety of contaminants from industrial, agricultural, urban, and maritime activities are associated with marine sediments, including persistent chlorinated organic chemicals, polycyclic aromatic hydrocarbons (PAHs), and trace metals. Critical habitats and food chains supporting many fish and wildlife species involve the benthic environment. Contaminants in the sediments often pose both ecological and human-health risks through degraded habitats, loss of fauna, biomagnification of contaminants in the coastal ecosystem, and human consumption of contaminated fish and wildlife. Characterizing and delineating areas of sediment

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contamination and toxicity are therefore important goals of coastal resource management at NOAA (NOAA, 2006).

The intent of sampling cruises in 2002 and 2004 was to delineate the distribution and fate of persistent organic contaminants including chlorinated pesticides, (e.g. dichloro diphenyl trichloroethane, DDT), PAHs, and polychlorinated biphenyls (PCBs) along the central California coast, assess their potential biological impacts, and to provide data for further development of biological indicators in coastal habitats, including response to natural and anthropogenic factors.

Data from 2002 indicated sediment contaminants were not homogeneously distributed between the canyon heads between San Francisco and Monterey (Hartwell, 2004). Relative to the continental shelf and Pioneer Canyon stations, DDT was found at higher concentrations in Ascension and Monterey Canyons. Monterey Bay still receives DDT from terrestrial runoff (Routh, 1972; Mischke et al., 1985; Rice et al., 1993) and may be the source of DDT found in Ascension Canyon. It is unknown to what extent sediment contaminants are being distributed between the shelf and the canyons, or how contaminant loads moving down the canyons may be impacting benthic communities.

Additional sampling designed to investigate and document contaminant distributions and the soft bottom infaunal community in a systematic approach was initiated in 2004. Only the chemical analyses of samples collected in 2002 and 2004 are reported here. Biological data will be reported separately.

2. Methods

Fifty-six sites were selected for the 2002 cruise to target depositional areas, locations of major outfalls and river discharges, transport routes and sinks of contaminants emanating from San Francisco Bay via the Golden Gate and from the municipal Publicly Owned Treatment Works (POTW) discharge site (Southwest Ocean Outfall - SWOO). Stations were initially laid out in a grid pattern and sites were added based on known source locations, the presence of fine-grained depositional zones, the approaches to the heads of Pioneer Canyon, and in the canyon leads beyond the shelf break. Additional stations were included at a fine-grained site south-west of Half Moon Bay, at the head of Ascension Canyon, and six locations in Monterey Bay. The Monterey Bay stations were located near the mouths of the three major freshwater tributaries to Monterey Bay (San Lorenzo, Pajaro, Salinas), and in depositional zones around the canyon rim.

The 2004 sampling rationale was guided by results from 2002. Sampling was prioritized to include a variety of canyons and shelf/slope areas to allow evaluation of contaminant transport patterns along the continental shelf and potential delivery to canyons. Stations were initially stratified on the basis of depth, and were situated in specific locations that were believed to be depositional environments (as opposed to the canyon axis), based on bathymetry from detailed side-scan sonar maps and inferred sediment texture (NMFS, 2004). In addition, sites were selected to provide contrasts of benthic habitat between canyons, and between canyons and stable slope areas. Preliminary grid lines were laid out to sample sediment at up to eight locations from mid-shelf to the shelf break, and down the canyons/slope to a maximum depth of 1200 m. Target depths were established to bracket the mid-shelf mud zone (80, 110 m), the shelf break (150, 250 m), the oxygen minimum zone below the shelf break, (475, 700, 950 m), and below to 1200 m. Pioneer, Ascension, Año Nuevo, Soquel, Monterey and Carmel Canyons were sampled (Fig. 1). Two sampling transects on the continental shelf and slopes were placed between Pioneer and Ascension Canyons (slope 1 and 2). A line between Año Nuevo and Soquel Canyons to the so-called Smooth Ridge area (slope 3), and a line between Pt. Lobos and Pt. Sur were established (slope 4). A fifth series of sites approximately 20 km southeast of Pt. Sur were sampled to provide a contrast with an area where the continental shelf is typically narrow (slope 5). This was not so much a transact as a sequence of presumptively depositional locations at the target depths. A true transect was not possible as the bathymetry in this area is irregular and cut by many small gulleys.

Sampling began off San Francisco in Pioneer Canyon and proceeded south along transects roughly perpendicular to the continental slope incline. A dual Van Veen grab sampler (0.1 m^2/each) was deployed at each station, and a CTD cast. All sampling methods and analytical techniques followed standard National Status and Trends Program (NS&T) methods (Hartwell et al., 2001; Lauenstein and Cantillo, 1998; Turgeon et al., 1998). Surface sediment (top 2–3 cm) was removed with Teflon-coated titanium scoops from one sampler, homogenized, and apportioned to pre-cleaned glass containers for chemical and physical testing at