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IXTOC OIL SPILL ASSESSMENT.

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Cambridge, Massachusetts

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IXTOC OIL SPILL ASSESSMENT
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16. Abstract (Limit: 200 words)

The *Ixtoc I* oil well blowout in the Bay of Campeche resulted in the largest documented spill in history. Approximately half a million metric tons of oil were released into the marine environment from June 1979 to March 1980, with an unknown quantity of oil impacting the northwest Gulf of Mexico shelf. This study was undertaken to establish the effects of residues of *Ixtoc* oil on the inner shelf. During the study the *Burmah Agate* oil tanker spilled part of its cargo of light crude oil following a collision off Galveston, Texas.

A suite of chemical analytical techniques was employed successfully to firmly establish the range of compositions of *Ixtoc* and *Burmah Agate* oils which might be encountered in sediments and animal tissue.

No petroleum residues attributable to the *Ixtoc* or the *Burmah Agate* spills were present in the sediment anywhere in the study region. *Ixtoc* oil was, however, detected in suspended sedimentary material at several sites during 1979. Polynuclear aromatic hydrocarbon compounds, products of fossil fuel combustion, were widespread in the sediments and varied with other geochemical parameters. Shrimp tissues contained low levels of hydrocarbons at many sites, but only one sample could be linked positively to *Ixtoc* residues.

Mid- and post-spill infauna collections showed precipitous declines in animal abundance and diversity area-wide, compared to pre-spill values. But because *Ixtoc* oil residues were not present in sediments, declines in the benthos could not be related definitively to hydrocarbons or any other environmental factor.

This study established a chemical and biological framework for carrying out spill assessment studies of this nature. It utilized a significant environmental data base for post- "impact" studies for the first time and identified several sampling methodologies to fine-tune such assessments in the future.

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ABSTRACT

The blowout of the *Ixtoc I* oil well in the Bay of Campeche resulted in the largest documented spill in history. Approximately half a million metric tons (140 million gallons) of oil were released from the runaway well from June 3, 1979 to March 23, 1980. Of that amount, an estimated 11 thousand metric tons (3 million gallons) impacted south Texas beaches, with an unknown quantity of oil in the waters of the northwest Gulf of Mexico over the biologically productive continental shelf.

As a result of the movement of oil from the *Ixtoc I* well blowout into the South Texas Outer Continental Shelf (STOCS) environment, a study was undertaken to establish the magnitude and areal extent of perturbation of the benthic community caused by chemical residues of *Ixtoc* oil. The study focused on the inner shelf region to the 60-metre isobath and examined both the biology and hydrocarbon geochemistry of 12 sites coincident with those of four previously studied (1975-1977) baseline transects. Additionally, 26 sites within the STOCS region sampled during 1979 (mid-spill) for chemical parameters and again in 1980 (post-spill) for chemical and biological parameters, and 39 other sites sampled in 1979 for chemical parameters, were studied. The *Burmah Agate* oil tanker collided with the freighter *Mimosa* in November, 1979 5 miles off of Galveston, Texas and spilled part of its cargo of light crude oil into offshore waters. Approximately 21 thousand metric tons (150,000 barrels) of the spilled oil burned in an ensuing fire. As the potentially complicating impact of the *Burmah Agate* tanker collision was of importance in the STOCS region, a set of six sites in the Galveston region were sampled to gain knowledge of the presence and nature of introduced chemical residues from this event. The study also focused on potential chemical impact on the commercially important penaeid shrimp population from sites within and outside of the primary study region (i.e., the STOCS region).

A blend of analytical chemical techniques was employed successfully to examine a suite of oils/tars taken from the study area beaches and water surface in order to firmly establish the range of compositions of *Ixtoc* and *Burmah Agate* oils which might be encountered in the environmental samples (sediments, tissues). High-resolution, fused silica capillary gas chromatography (FSCGC), computer-assisted gas chromatographic mass spectrometry (GC/MS), and stable isotope mass spectrometry (C,H,S) were used together successfully to define the compositional ranges and to identify highly weathered oil residues.

Once these techniques were established, a suite of sediment and shrimp tissue samples were screened for oil by ultraviolet fluorescence spectroscopy (UV/F) to aid in the selection of samples for more detailed analyses. Based on the results from a subset of sediment samples examined by FSCGC, GC/MS, and stable isotope analyses, it was concluded that petroleum residues attributable to the *Ixtoc* and/or the *Burmah Agate* spills were not present in the surface sediment anywhere in the study region. *Ixtoc* oil was, however, detected in suspended sedimentary material at several sites, thus indicating

the presence of oil in the water column system during 1979. Significant quantities of polynuclear aromatic hydrocarbon compounds, products of fossil fuel combustion rather than of direct petroleum origin, were widespread in the sedimentary environment and varied with other geochemical parameters (total organic carbon, grain size). Shrimp tissues examined by FSCGC and GC/MS were shown to be impacted by low levels of chronic petroleum pollutants at many sites, only one sample of which could be linked to Ixtoc residues.

Through biological analyses, precipitous declines in the numbers of individuals and taxa (abundance and diversity) throughout the STOCS study area were found compared with pre-spill measurements. The mid- and post-spill samples differed significantly in numbers of taxa from the fall 1976 and winter 1977 values and differed significantly in numbers of individuals from the fall 1976, winter 1977, and fall 1977 values. Detailed statistical analyses were performed, establishing the grouping of like stations and taxonomic correlations with grain size and total organic carbon parameters.

Since residues of Ixtoc oil were not present in any of the sediment samples, the temporal variations in the benthic macroinfaunal community could not be related definitively to either oil-spill-caused perturbation or to any particular human-induced or environmental factor(s), and may fall within the range of natural variability.

This study established a chemical and biological framework for carrying out spill assessment studies of this nature. It utilized a significant environmental data base for post-"impact" studies for the first time, and identified several sampling methodology deficiencies which, if corrected, may help to fine-tune such assessments in the future.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

LIST OF TABLES

LIST OF TABLES (CONT.)

LIST OF FIGURES

LIST OF FIGURES (CONT.)

LIST OF FIGURES (CONT.)

LIST OF FIGURES (CONT.)

LIST OF FIGURES (CONT.)

Page

SECTION FOUR (CONT.)

Page

SECTION FOUR (CONT.)

Page

SECTION FOUR (CONT.)

LIST OF FIGURES (CONT.)

SECTION ONE

INTRODUCTION

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SECTION ONE

INTRODUCTION

1.1 General Background

In the last two decades, man's interest in assessing the impacts of his regional and global activities on the "natural state" has led to considerable focus of his energies. Research techniques and tools have been applied, refined, and reapplied to obtain information concerning how ecological systems operate, how a multitude of anthropogenic pollutants are introduced to and transferred between these systems, how (and if) these introductions perturb the system, and how these perturbations affect man. Once they were recognized and popularized, the impacts of industrialization on the coastal marine environment became the focus of many basic and applied research programs.

Pollutant additions to the marine environment fall under one of two general classes: continuous or chronic input, and acute or episodic additions. The chronic addition of certain products of industrial development including petroleum related materials to coastal marine systems has had profound impact on indigenous marine populations and has altered the use of some localized marine environments for significant periods of time (e.g., New York Bight, as a result of ocean dumping). Other chronic inputs, such as those that result in frequent input of tar/oil to the Texas Gulf Coast (Geyer, 1981), have less of an obvious ecological impact, if any. The Brittany coast of France has been acutely affected for several years by the Amoco Cadiz oil tanker spill (CNEXO, 1981) as has the Tierra del Fuego region as a result of the Metula spill (Straughan, 1978). The existence of substantial baseline information allowed major and subtle impacts of oil spills to be detected in the cases of the West Falmouth oil spill (e.g., Burns and Teal, 1979) and the Tsesis oil spill (Linden et al., 1979). An integral part of the impact assessment process is monitoring the return to pre-spill conditions or recovery, as was undertaken for the Zoe Colocotroni (Gilfillan et al., 1981) and Amoco Cadiz (NOAA, 1981) spills.

Offshore exploration and production of petroleum on the Continental shelf was and is a logical extension of land and nearshore production of oil. The goals of the U.S. Department of Interior, Bureau of Land Management's Outer Continental Shelf (OCS) Environmental Study Program are to: (1) obtain environmental data on the impacts of petroleum exploration and production activities on the OCS, and (2) provide relevant information for the decision making (management) process, vis-a-vis offshore minerals management.

The blowout of the Ixtoc I offshore drilling rig in the Bay of Campeche, Mexico on June 3, 1979, resulted in the spillage of 0.5 million metric tons (140 million gallons; 3.5 million bbl) of oil into the Gulf of Mexico (OSIR, 1980) and transport of a significant part of this oil northward into U.S.

coastal waters (Figure 1-1). Surface oil entered U.S. waters on August 6, 1979 (OSIR, 1980) and continued to be seen in significant surface concentrations (i.e. patches of oil, sheen) until the northward-flowing western Gulf of Mexico current reversed during September 1979. The well was finally capped on March 23, 1980. During this period of time approximately 4-11 thousand metric tons (1-3 million gallons) of _Ixtoc_ oil impacted the beaches and seashore intertidal area where oil residues mixed with sand to form tar mats (OSIR, 1980; Gundlach et al., 1981; Tunnel et al., 1981) and perhaps 5 to 10 times as much passed through the Texas OCS region, largely in the form of small patches of emulsified oil (mousse) (Patton et al., 1981), without impacting shore. Approximately 180 metric tons of oil, or less than 5 percent of the total quantity of oil initially beached, was present in the tar mats. The beached oil was largely removed during a tropical storm in September 1979 and either redeposited in the nearshore bar/trough system or taken further offshore. The ultimate fate of the bulk of the oil remains unresolved, although the weathering and physical breakup process described by Patton et al. (1981) and Boehm et al. (1981) followed by distribution of small tarry particles in surface and subsurface waters in the Gulf of Mexico waters seems likely.

Early in November 1979 and still during the _Ixtoc_ I spill, the tanker _Burmah Agate_, carrying ∿36,000 metric tons (10 million gallons) of oil, collided with the freighter _Mimosa_ approximately 5 miles off of Galveston, Texas (Figure 1-2). The collision caused the _Burmah Agate_ to spill part of its cargo of light crude oil into offshore waters. Kana and Thebeau (1980) have estimated that approximately 21,000 metric tons (150,000 barrels) burned in the ensuing fire. They also estimated that ∿7,000 metric tons (48,000 barrels; 2 x 10^6 gallons) dispersed offshore during northerly winds. Approximately 10 percent of this oil was recovered offshore, leaving a large portion of the spilled oil to weather by evaporation, photochemical oxidation, etc., or to become mixed in the water column. The fate(s) of the remaining oil include (1) emulsification, dispersion and weathering, (2) mixing with sediment followed by sinking to the offshore benthos, or (3) direct sinking of partly combusted residual oil from the fire. Crude oil exposed to high temperatures, such as those produced during the fire, shows a rapid loss of volatile low-molecular-weight material which may cause an increase in density followed by rapid sinking in seawater (Kolpack et al., 1978). Sinking of large amounts of partly combusted oil and ash was the major fate of oil spilled from and burned during the _Sansinena_ oil spill in Los Angeles Harbor (Kolpack et al., 1978), a similar spill/fire event.

The spilled oil from the _Burmah Agate_ was observed to have an impact on the Texas coast considerable distances from the wreck (∿270 km).

A study of the impact of these spills on the marine environment should focus on an environmental compartment (e.g., offshore benthos) likely to be affected over a long enough time period to facilitate an accurate damage assessment. In the case of the _Ixtoc/Burmah Agate_ spills the circumstances for an accurate damage assessment were favorable because a baseline study of the South Texas Outer Continental Shelf (STOCS) area had been conducted from 1975 to 1977. This baseline information, generated as part of the BLM

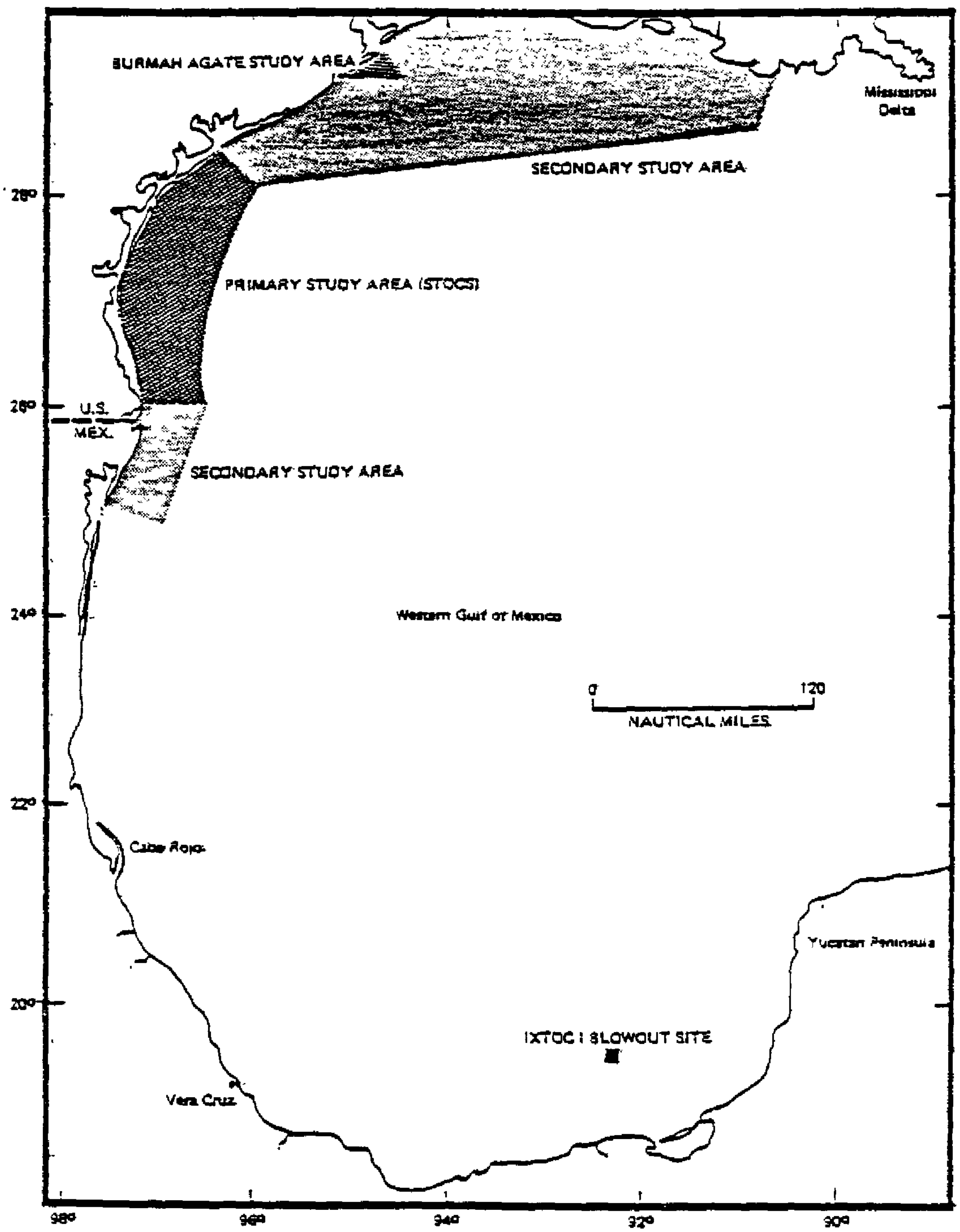


Figure 1—1. Location of Study Areas.

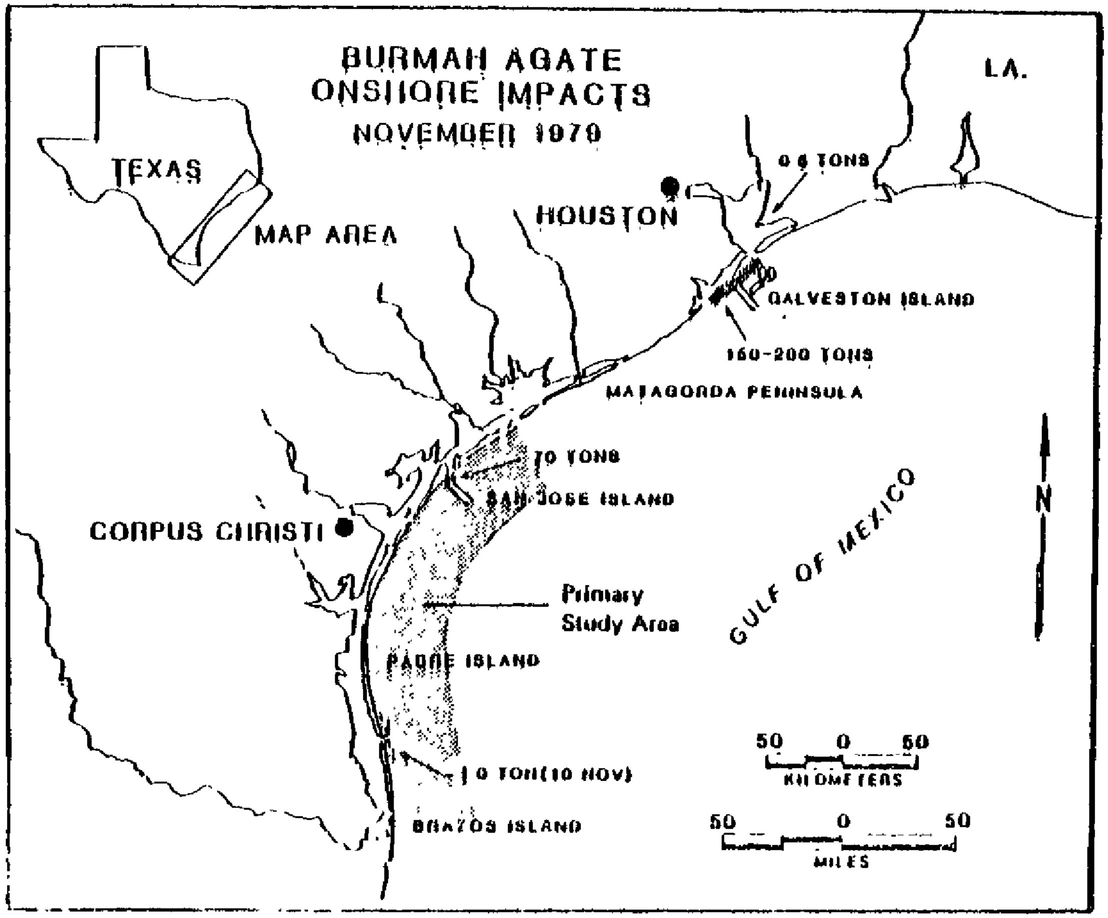


Figure 1 2. Location Map of Burmah Agate Onshore Impacts During November, 1979 (from Kana & Thebeau, 1980).

Environmental Study Program's STOCS program (conducted from 1975-1977) consists of a variety of biological, geological, and chemical oceanographic and biogeochemical data describing the pre-spill state of the OCS region.

In order to direct damage assessment sampling activities and to use this data base (the first such attempt of its kind) successfully, some knowledge of the potential behavior of spilled oil vis-a-vis benthic impact must be incorporated into a study design.

1.2 Transport of Oil to the Benthos

"Weathering" of oil at sea indicates the physical and chemical changes that alter the composition of the petroleum mixture through evaporation, dissolution, photochemical oxidation, and microbial degradation. The physical processes that both mediate these changes and also have subsequent important roles in transport of oil are mixing (dispersion), emulsification, and sorption (NAS, 1975; see Figure 1-3).

It is clear that the extent of long-term biological effects of most oil pollution events studied to date is directly dependent on the extent of oiling of the benthic substrate in and upon which organisms dwell. The existence of oil in the offshore benthos is completely dependent on one or a combination of transport mechanisms which do not come into play when shoreline impacts (marshes, mangrove swamps, intertidal regions) are being studied.

There are several postulated mechanisms by which waterborne petroleum hydrocarbons from an offshore spill event may be transported to the underlying sediment. Three of these mechanisms are presented in Figure 1-4.

There have been few studies directly pertaining to the transport of oil to the offshore continental shelf benthos via the important phenomenon of adsorption of oil on living or detrital particulate matter (or vice versa) followed by sedimentation to the benthos. An evaluation of the possible extent of this process (Figure 1-4) during a spill event is extremely important in order to predict the exposure of important benthic resources to petroleum hydrocarbons released from offshore blowouts. This process is dependent on the availability and concentration of suspended particulates and their surface area (Poirier and Thiel, 1941; Mattson and Grosa, 1979; National Academy of Sciences, 1975; Thüer and Stumm, 1977). Another possible route of transport to the benthos is by ingestion of oil by zooplankton followed by fecal pellet transport (Conover, 1971; Johansson et al., 1980). These two processes are those most likely to result in direct water column to benthos transport of petroleum hydrocarbons in continental shelf environments.

Several studies have addressed these mechanisms of transport of oil to the benthos following offshore platform blowouts and tanker spills. Kolpack (1971), and Kolpack et al. (1971) have attributed the large concentrations of oil in sediments following the Santa Barbara blowout to the interaction of petroleum hydrocarbons with sediment-rich river plumes, followed by sorption and sinking. Low but significant concentrations of oil in sediments were

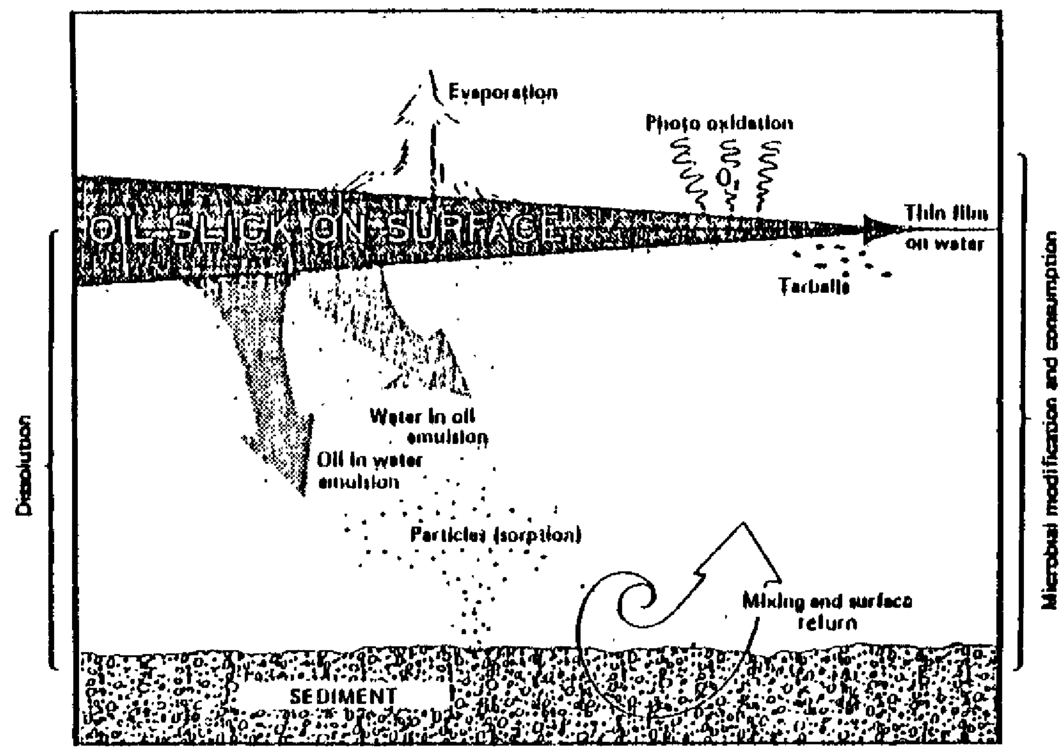


Figure 1—3. Schematic Representation of Weathering Processes and Transport Paths of Spilled Oil at Sea (adapted from, Clark and MacLeod, 1977).

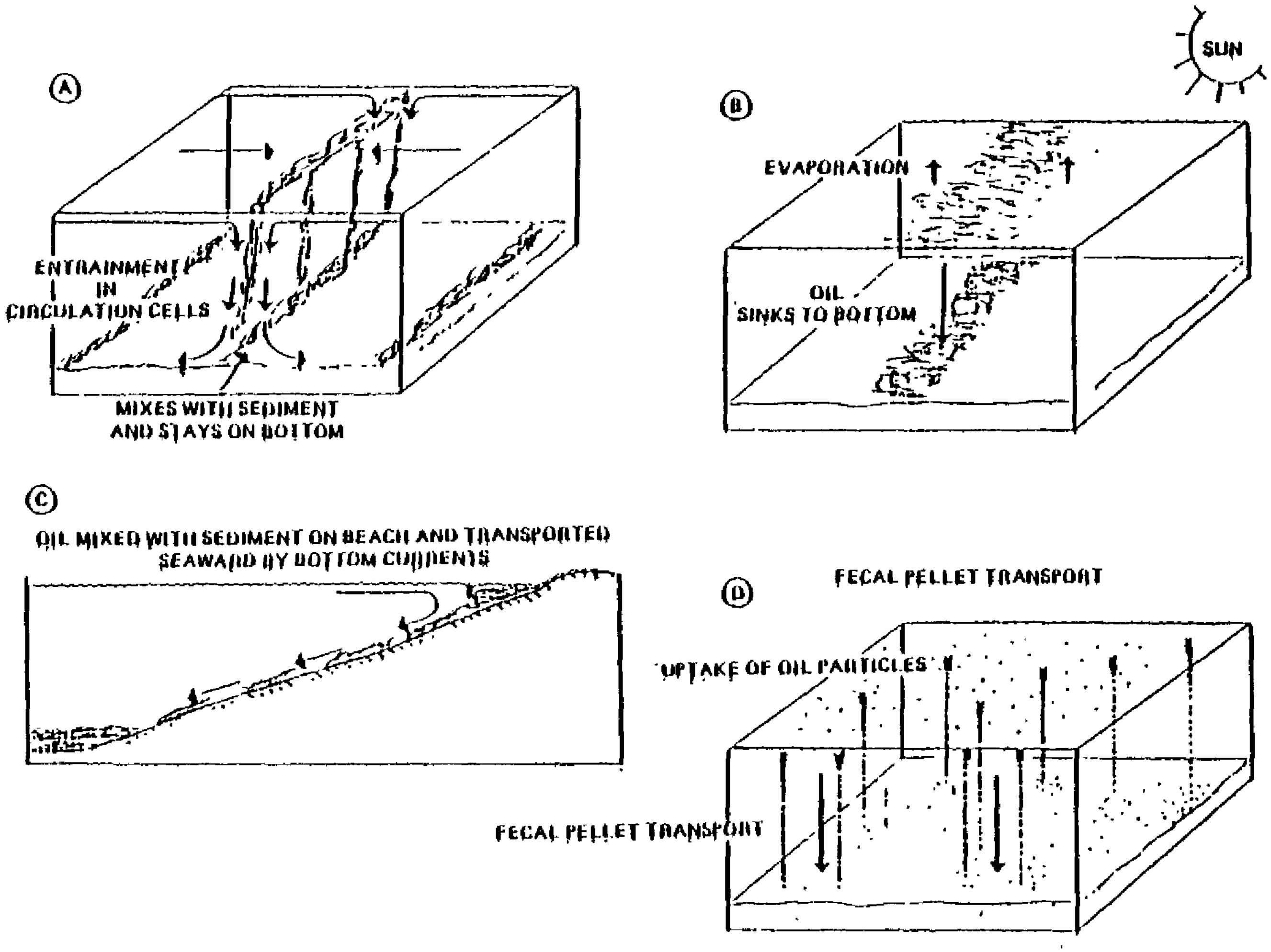
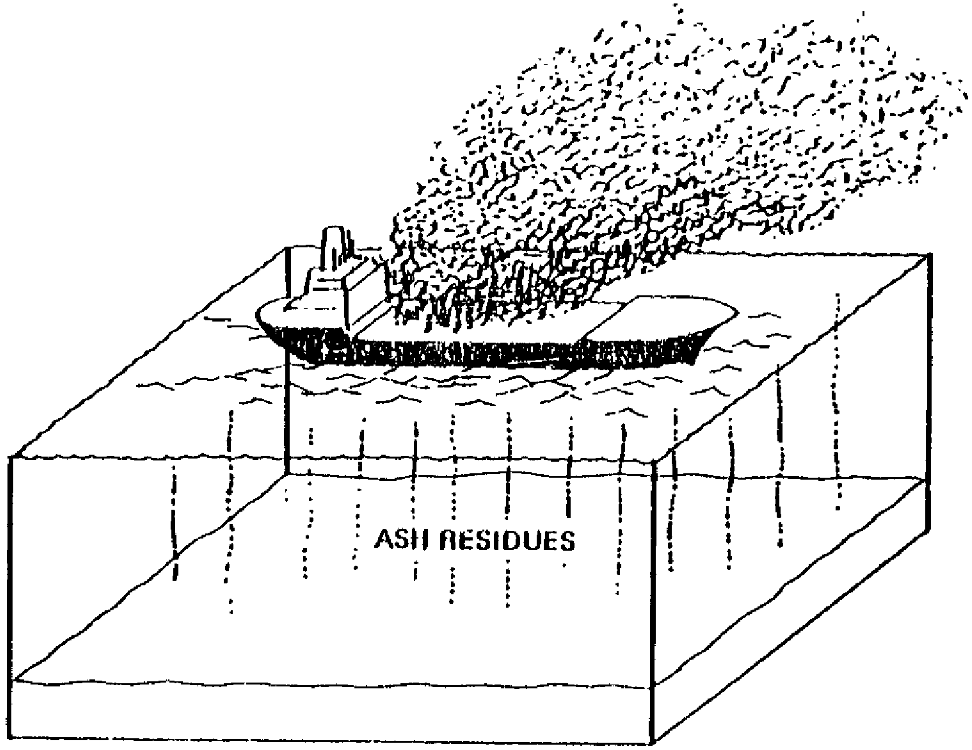


Figure 1–4. Hypothesized Methods by which Oil may be caused to Sink and Remain on the Bottom.



SURFACE OIL FIRE, SINKING OF RESIDUES & ASH

Figure 1-4. (Continued). Hypothesized Methods by which Oil may be caused to Sink and Remain on the Bottom.

observed following the Ekofisk-Bravo blowout in the North Sea (Johnson et al., 1978) although no specific mechanism was investigated. McAuliffe et al. (1975) have associated the spilled oil in sediments in the vicinity of the Chevron platform blowout at the mouth of the Mississippi River with sorption and sedimentation processes. Boehm et al. (1982) have examined the detailed chemistry of sedimenting oil captured in sediment traps deployed during the Tsesis tanker spill in Sweden. They found that microbial degradation caused rapid alteration of the chemical composition of the spilled cargo, and that the hydrocarbon composition of benthic deposit feeders (*Macoma balthica*) reflected this composition. Johansson et al. (1980) estimated that 15 to 20 percent of the oil spilled during the Tsesis event was transported to the benthos by sorption and sedimentation and/or by ingestion and zooplankton fecal pellet transport.

The rates of these processes are dependent on the rate and extent of weathering of oil at the sea surface and on mixing energy which disperses oil into the water column in fine droplets, hence increasing the probability of sorption of petroleum hydrocarbons on particulate matter. Sedimentation of oil in offshore environments is thought to be a minor sink for hydrocarbons (Mackay et al., 1979), the extent of which is dependent on suspended sediment loading and biological production (i.e., planktonic concentrations) as well as weathering changes in the oil itself.

The specific gravity of most crude and refined oils spilled at sea does not exceed that of sea water (~1.025) (Ferraro and Nichols, 1972) and hence direct sinking (Figure 1-4) of petroleum residues at sea is rare. Notable exceptions are spills associated with the Anne Mildred Brovig collision in the North Sea (Mattson and Grose, 1979) and the USNS Potomac (Grose et al., 1979) during which some sinking of oil appears to have occurred probably due to weathering and subsequent fractionation of the oil; and with the Sansinena Bunker C spill (Kolpack et al., 1978) during which the burning of the cargo resulted in the sinking of residuals (analogous to the Burmah Agate situation) (Figure 1-4). Studies of the Ixtoc I emulsified crude oil (mousse) masses off the Texas coast during August 1979 (Patton et al., 1981; Patton and Amos, unpublished data) found that photochemical and evaporative processes presumedly resulted in skinning over and subsequent flaking of mousse patches. Wind-driven dispersion (apparent sinking) drove these neutrally or positively buoyant particles into the water column (Patton et al., 1981).

Petroleum hydrocarbons have become associated with intertidal and subtidal sediments following many spills during which landfall, substrate oiling and offshore transport (Figure 1-4) of affected sediment have occurred. Long-term association of hydrocarbons with sediments has occurred during the West Falmouth (Teal et al., 1978), Chedabucto Bay-Arrow (Cretney et al., 1978; Keizer et al., 1978), and Amoco Cadiz (Beslier et al., 1980; Boehm et al., 1980) oil spills, among others. Similar landfall followed by offshore and hence subtidal transport may have occurred to a great extent during and after the Ixtoc I blowout on both the Mexican and Texas Gulf Coasts. The only documented observations were recorded off the southern Texas coast, where the formation of "tar mats" resulted (Gundlach et al., 1981).

In a study designed to quantify the extent of water-column-to-benthos transport of Ixtoc I oil through sampling and analyses of sedimentary particles (sediment traps) and surface sediment from the wellhead to the Texas coast, Boehm and Fiest (1980b) found that only minor amounts of oil reached the offshore benthos in the vicinity of the wellhead by mechanisms A and B (Figure 1-4). The extent of offshore transport of oil by mechanisms C and D remains unexplored.

Given the Ixtoc spill's history, the beaching and apparent offshore transport of petroleum, and the existence of significant amounts of suspended matter in the water column of the STOCS region, one would expect that detectable sedimentary petroleum residues would be revealed.

In this light, the BLM contracted ERCO and its subcontractors, LGL Ecological Research Associates, Global Geochemistry Corporation, and Geomet Technologies, to undertake a detailed assessment of the impact of the Ixtoc spill and the Burmah Agate "complications" on the offshore benthos of the STOCS region.

1.3 Study Objectives

The primary objectives of the Ixtoc assessment study are to examine and quantify the chemical impact of the Ixtoc and Burmah Agate spills on the offshore benthic environment and to determine if such impacts resulted in sustained perturbation of the benthic biological community. Thus while the study relies heavily on information contained in samples from the Texas beaches and from the wellhead region, the assessment study focuses on the offshore Texas OCS (Figure 1-5) from an area seaward of the offshore bars (~3 meters depth) to the 60-meter depth contour some 30-40 miles offshore. A second objective was to determine to what extent and for what duration an important commercial fisheries resource, the shrimp fishery, had been chemically affected as a result of these specific spills.

The integrated damage assessment strategy for this project involved the following elements:

1. Determination of what habitats have been affected.
2. Determination of the nature and extent of the chemical impact.
3. Determination of whether biological and ecological perturbations resulted from this impact as compared to both the pre-spill environment (baseline information) and the unaffected environment (reference stations).
4. Determination of a causal relationship between any observed biological changes and the chemical impact.
5. Determination of damage to a commercially important resource (shrimp fishery) due to the chemical impact.

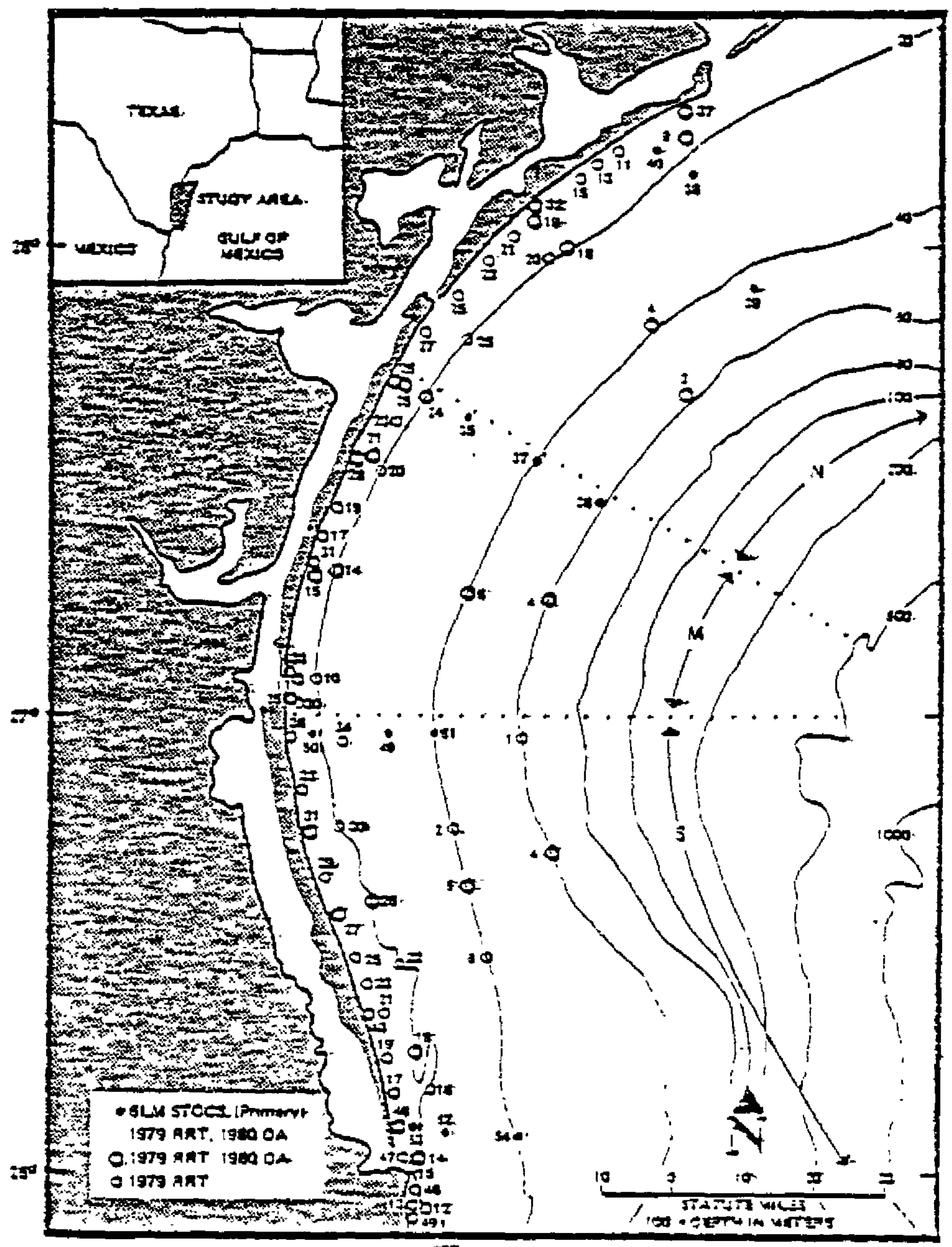


Figure 1-5. Master Locator Map (STOCS Region).

6. Determination of the pre-spill value of the ecological and/or commercial resource and the extent to which its use and/or value has been diminished.

Elements 1 and 2 are chemical questions whose answers define the exposure of an ecological system to contaminants from a particular spill. A detailed chemical-source fingerprinting has to be combined with a knowledge of possible weathering sequences to identify locations within habitats specifically affected by a spill event (Sections 2 and 3). Element 3 involves an analysis of the detailed biota, its abundance and diversity, and a comparison of pre-spill measurements with a knowledge of the range of <u>natural</u> variability (Section 4). Element 3 then draws on the results of 1 and 2 to address element 4. Impacts on commercial species, which affect marketability and human health, are separately defined through chemical analyses of tissues specifically directed to quantification of toxic aromatic hydrocarbons. The assignment of pre-spill "value" is beyond the scope of this project, but the overall goal of assigning an "extent of damage" in a quantifiable form from the biological data is central to the damage assessment strategy.

1.4 Project Strategy

As no comprehensive offshore damage assessment of this nature has previously been undertaken, we feel that the best way to accomplish the program's objectives is to address specifically the impacts of the spills under consideration and to establish and test our methodologies under the broader context of "damage assessment methodology development." Therefore in many cases, new techniques and their applications have been used singly or in combination to address the program's objectives. These will be explored in more detail in the technical chapters.

The basic elements of the project strategy were to:

1. Obtain a set of biological, chemical, and supportive data from samples obtained during Regional Response Team activities, August-December 1979 (i.e., mid-spill) (see NOAA, 1982).

2. Obtain a set of biological, chemical, and supportive data from samples obtained during the December 1980 <u>Tonya and Joe</u> cruise (i.e., post-spill).

3. Compare mid- and post-spill biological and chemical "conditions" with each other and with pre-spill "conditions" (BLM-STOCS program).

4. Examine possible cause-and-effect relationships by synthesizing biological and chemical measurements.

5. Define magnitude and areal extent of <u>Ixtoc</u> spill-related damage.

In order to achieve the program's basic objectives as previously outlined, two sets of environmental samples, one from the mid-spill time period (mid to late 1979) and one from the post-spill time period (late 1980), were obtained. From these samples biological and chemical information was extracted by a variety of methods and compared to the substantial pre-spill (1975-1977) data on similar samples. This latter set, from the STOCS/BLM-sponsored benchmark program, provided a base with which to compare the pre- and post-spill biological and chemical data. The value of the spill assessment program depends upon its ability to detect environmental changes and to assign them to proper causes. The STOCS program included a variety of environmental measurements made over a 3-year period (1975-1977) and therefore represents a potentially valuable source of information, especially with regard to temporal variations in biological and chemical parameters.

All program elements operated independently, as indicated in Figure 1-6, until causal relationships were explored during the data synthesis effort.

1.5 Sample Collections

A variety of samples were collected for the chemical analysis program. Three basic sets of samples were collected:

1. Samples designed to aid in establishing the possible range of "chemical signatures" of weathered Ixtoc and Burmah Agate oils.

    a. Floating oil/tars.

    b. Beached oil/tars.

2. Samples designed to establish the presence of oil in the offshore benthic environment.

    a. Surface sediments.

    b. Sorbent pad samples (water-column-borne oil/resuspended sediment).

3. Samples designed to establish spill impact on epifaunal populations.

    a. Penaeid shrimp.

The biology program relied on collections of benthic infaunal organisms from sediment grab samples.

The geochemical support program included determinations of sediment texture or grain size distributions for all benthic biological samples and sedimentary total organic carbon (TOC) on benthic biological and chemical samples.

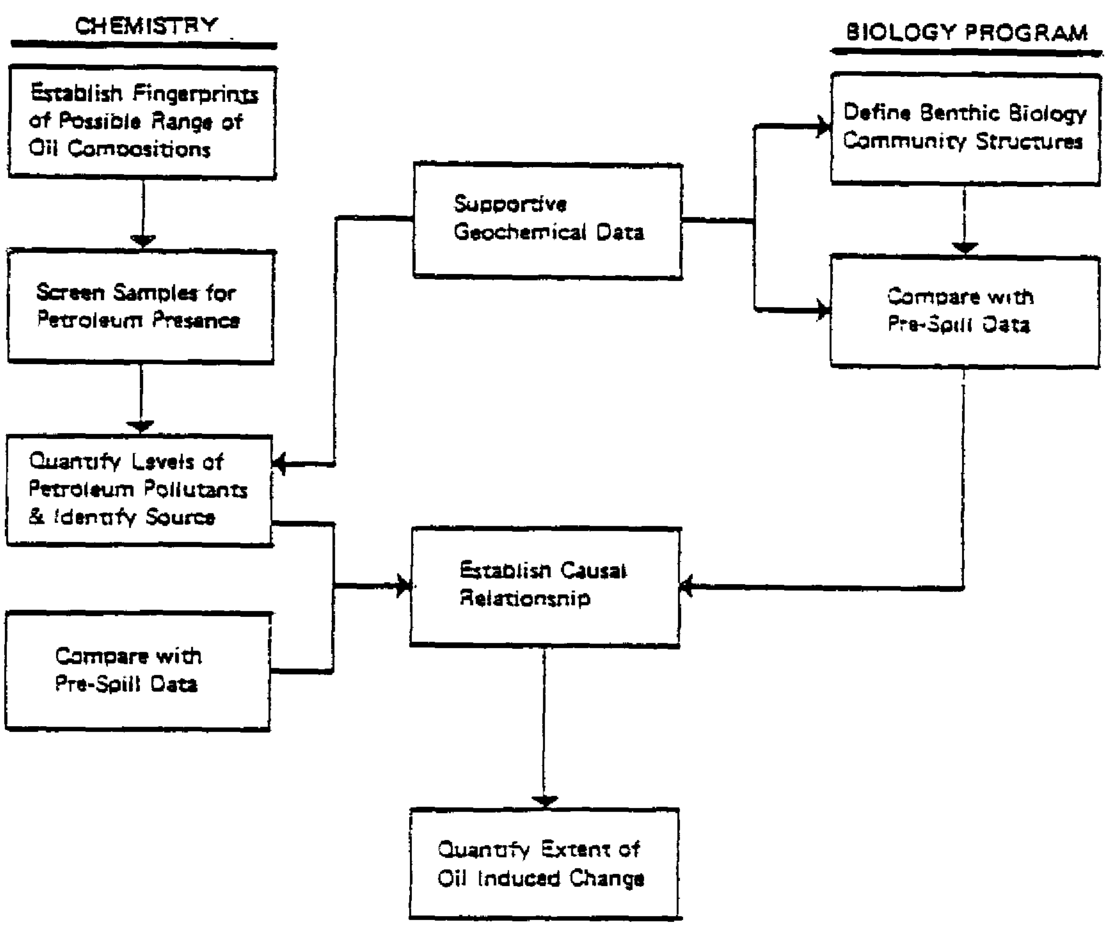


Figure 1—6. Overall Technical Approach & Flow of Information.

Details of the nature of each collection and sampling technique employed are found in Sections 2 and 4, in Appendix 9-1 and in the "Summary Cruise Report," January 15, 1981 (BLM, New Orleans OCS office).

The acquisition of samples centered on four cruises conducted in 1979 (mid-spill) and one undertaken as part of this project during late 1980 (see Table 1-1). The biology program and geochemical support program utilized samples from the Longhorn IV and Tonya and Joe cruises, while the chemical program relied not only on samples taken from these cruises, but also on some obtained during the Western Gulf cruise and on several other collection programs shown in Table 1-2.

1.6 Project Organization

Four organizations participated in the study. Their roles are indicated in Figures 1-7 and 1-8.

TABLE 1-1

SUMMARY OF CRUISES

	VESSEL & SPONSOR	DATES	OBJECTIVES
1.	Valiant (USCG)	July 16-21 (1979)	Collect surface current data on Western Gulf Continental Shelf; log oil locations; collect oil samples
2.	Point Baker (USCG)	July 27-29 (1979)	Sample oil in Mexican waters
3.	Cruise FSU-I (NSF)	July 26-31 (1979)	Emplace deep-ocean current water arrays; test on-board research equipment; log oil locations; collect oil samples
4.	Longhorn I (USCG)	Aug 4-8 (1979)	Search for oil in water column off Texas coast; collect oil, water, and biological samples; take oceanographic measurements
5.	Longhorn II (USCG)	Aug 15-22 (1979)	Survey oil concentrations along Texas/Mexico coastline; observe physical condition of oil
*6.	OSV Antelope (EPA)	Aug 25-Sep 8 (1979)	Determine surface and sub-surface oil distribution and physical form; determine composition of oil and estimate toxicity; test sediments and biological samples for microbiological analysis
*7.	Researcher/Pierce (NOAA)	Sept 11-27 (1979)	Determine effects of oil weathering on marine environment; estimate microbial effects on weathering; study effects of oil on bacteria and plankton
*8.	Western Gulf (NOAA/NMFS)		Seafood sampling

TABLE 1-1 (CONT.)

	VESSEL & SPONSOR	DATES	OBJECTIVES
9.	Cruise FSU-II (NSF)	Oct 31-Nov 6 (1979)	Recover current meter arrays deployed on FSU-I; study the thermohaline structure of the water column; log oil locations; collect samples for geochemical analysis
*10	Longhorn IV (USCG)	Nov 16-Dec 13 (1979)	Survey bottom oil distribution in the offshore, nearshore, and pass areas of South Texas
*11	Tonya & Joe (BLM)	Dec 2-Dec 13 (1980)	Damage assessment offshore benthos and shrimp sampling

*Samples obtained and used for this project.

TABLE 1-2

SUMMARY OF ADDITIONAL SAMPLE COLLECTION EFFORTS

COLLECTION NAME	COLLECTOR	TYPE OF SAMPLES	LOCATIONS	DATES
RPI	various	beached oil and beach sediment	South Texas barrier beaches	July-Sept 1979
Hooper	C. Hooper	floating tar balls	South of Corpus Christi to Mexican border	12-14 Aug 1979
URS	Sturtevant	beached oil/tar	South Texas beaches	Nov/Dec 1979
NOAA Beach Survey	Ernst, Hannah	beached oil/tar	South Texas beaches	1979/1980
Burmah Agate	Coast Guard	oil in water beached oil	Galveston area	Nov 1979
RPI-II (*Burmah Agate*)	various	beached oil	San Jose Island area	Nov 1979
Dockside Sampling	FDA	shrimp	Shrimp landings (S. Texas)	Summer/ Fall 1979

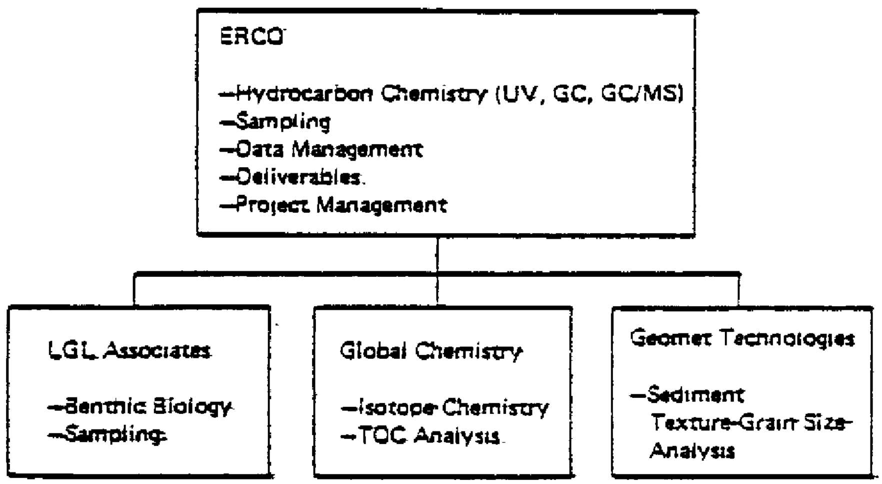


Figure 1—7. Organizational Overview Showing Major Responsibilities of Each Participating Group.

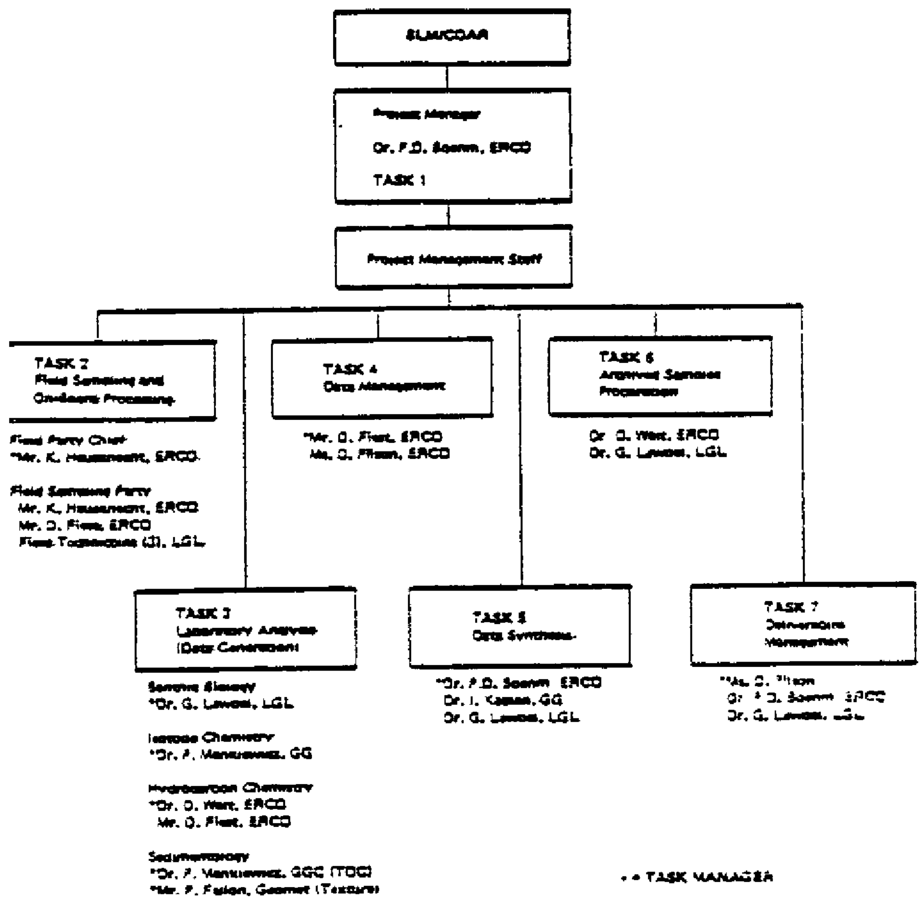


Figure 1—8. Overall Project Organization.