OCS Study
MMS 97-0028

DeSoto Canyon Eddy Intrusion Study

Annual Report: Year 1

MMS U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

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I. INTRODUCTION

This document describes progress by the Science Applications International Corporation (SAIC) team in accomplishing the principal objectives of the DeSoto Canyon Eddy Intrusion Study (Minerals Management Service (MMS) Contract 1435-01-96-CT-30825) during the first program year, September 30, 1996 through June 30, 1997. Briefly stated, the study objectives are to:

- document and analyze by means of *in-situ* current measurements, hydrographic data, and satellite images the Loop Current intrusions and interactions with the northeastern Gulf of Mexico (NEGM) slope. This study shall examine at a minimum the frequency and horizontal and vertical extent of these interactions and intrusions. Through the use of dynamical principles, a conceptual model shall be developed to explain how the Loop Current-slope interactions observed in the course of this study evolved;

- document and examine the dynamical processes of momentum, mass, and vertical vorticity exchanges that occur during Loop Current-slope interactions and other driving forces;

- estimate the frequency of Loop Current and secondary eddy interactions with the NEGM slope, and conduct and assessment of the vertical and horizontal current shears, exchanges of vorticity, momentum, and mass fields associated with these eddy-slope interactions; and

- elucidate the role of the DeSoto Canyon in Loop Current and eddy interactions and as a route of mass and momentum exchange between the shelf and deep water of the NEGM.

Three tasks are required to accomplish the listed objectives:

(1) Field Work and Data Collection,
(2) Data Reduction /Analysis and Synthesis, and
(3) Program and Data Management.

Task 1 is being accomplished by SAIC scientists, principally Mr. James Singer, with assistance from Specialty Devices, Inc. of Plano, Texas. Task 2 will be accomplished by a team consisting of Drs. Peter Hamilton (SAIC), Tony Sturges (Florida State

University (FSU)), Robert Leben (University of Colorado (CU)), Tom Lee (University of Miami (UM)), and Mr. James Churchill (Woods Hole Oceanographic Institution (WHOI)). Task 3 is the responsibility of Dr. Thomas Berger (SAIC - Program Manager) and Dr. Evans Waddell (SAIC - Data Manager).

The Louisiana Universities Marine Consortium (LUMCON) research vessel (R/V) Pelican is being used for all regularly scheduled cruises to deploy or rotate instruments and acquire hydrographic data. LUMCON is also providing logistics support and storage space to the program. Additional logistics support and storage of anchors is being provided by the Port of Pensacola.

The study area and locations of the proposed moorings is shown in Figure 1.

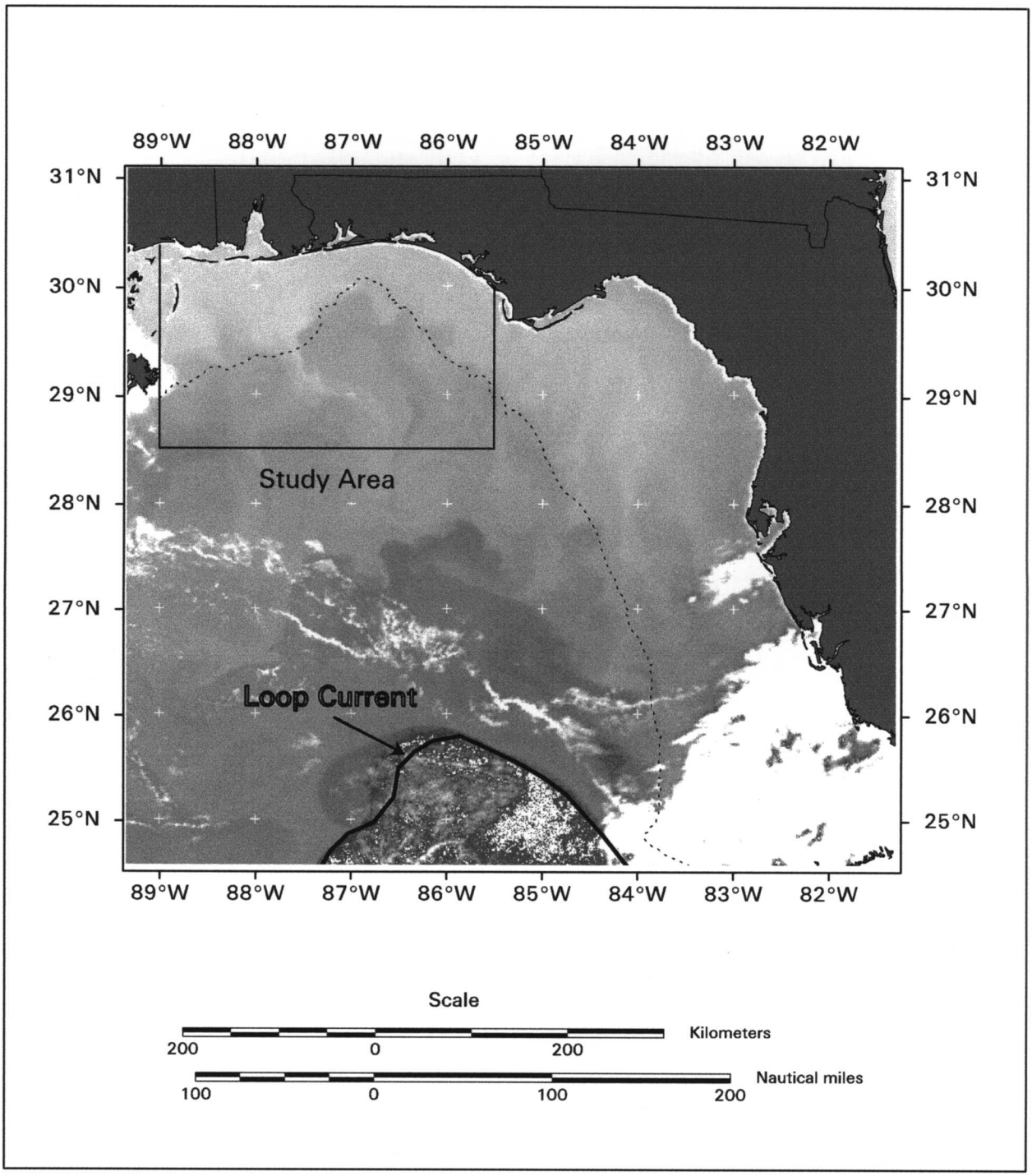

Figure 1. DeSoto Canyon Study Area. Map shows study area and the Loop Current (heavy line), which is in a southerly location. Map is overlain on an AVHRR image on March 24, 1997. Dotted line indicates the 100 m isobath. White areas are clouds.

II. OVERVIEW AND CHRONOLOGY OF EVENTS

This section briefly describes the activities completed from October 1, 1996 through June 30, 1997.

2.1 Pre-Cruise 1 Mobilization

The contract for this study was awarded September 30, 1996 and work commenced immediately on honing the details of equipment to be used and beginning the purchase of RD Instruments (RDI) Workhorse self-contained acoustic doppler current profilers (ADCP), Hugrun SEAMON thermistors and Sea-Bird Electronics SBE 37 MicroCAT moored conductivity-temperature-depth (CTD) instruments. Later purchases involved mooring components and a trawl resistant bottom mount from Flotation Technologies for use at mooring site D1 on the 100 m isobath at the head of DeSoto Canyon.

Other similar activities included finalizing the design of the moorings (see comments below); identification of government furnished equipment (GFE) to be used in the program; negotiation of ship charters with LUMCON; calibration, repair and/or modification of current meters and acoustic releases; general refurbishment of flotation elements; and a variety of other tasks associated with mobilization for Cruise 1.

2.2 Administration

SAIC completed and submitted revisions to the original schedule to reflect actual cruise dates, based on negotiations with LUMCON; negotiated a data archiving agreement with National Oceanographic Data Center (NODC), which calls for data delivery via the Internet; and received U.S. Coast Guard Eighth District approval for moorings B1, C1, and E1, all on the 100 m isobath, which require surface marker buoys because these moorings extend above a depth of 26 m (85 ft). Suitable marker buoys for these moorings, plus one spare, have been provided as GFE. Other mooring designs (A2, B2, C2, and D2) were modified slightly such that no element of the mooring was above a depth of 61 m (200 ft), thus obviating requirements for surface marker buoys at these locations.

Program participants attended the MMS Information Transfer Meeting (ITM) in December and participated in joint meetings with

participants in related programs being conducted in the northeastern Gulf of Mexico. Other travel, prior to Cruise 1, included a trip by to LUMCON and Pensacola in February by Jim Singer to verify receipt of mooring components and review logistics arrangements at both locations.

2.3 Cruise 1

Cruise 1 proceeded as scheduled in March 1997. All moorings were deployed and 74 hydrographic stations were occupied as shown in Figure 2. Details of the moorings such as location, water depth, and instrument type and depth are shown in Table 1. The Program Manager met the R/V Pelican during its first call in Pensacola to deliver minor supplies and to verify availability and placement of anchors and other mooring components for efficient loading.

2.4 Mooring E1 Marker Buoy Replacement

On May 8, SAIC was notified by a fishing vessel in the Gulf of Mexico by phone that marker buoy E1 had drifted up to the vessel and had been taken aboard. Initial indications were that the marker buoy tether had been severed and the remainder of the buoy was in good condition. The buoy was taken to the vessel's company facility in Panama City.

Subsequently we notified MMS and the Coast Guard (Private Aids to Navigation, Eighth District) that the marker was missing. Our initial assessment was that the mooring was probably intact since the design called for the marker buoy tether to be the weak link in the mooring. After some discussion between SAIC and MMS, it was decided to leave the mooring in place and replace the marker buoy during the scheduled July cruise.

After required written notification to the Coast Guard on May 20, the Coast Guard decided that the marker buoy had to be replaced within 15 days of receipt of written notification by the Coast Guard. The notification was actually received by Certified Mail on June 2. Arrangements had already been made to replace the marker using a spare marker buoy stored at LUMCON. On May 27 Jim Singer and Scott Sharpe (SDI) went to Biloxi (via LUMCON to pick up the spare marker buoy, tools, mooring parts and spare instruments) and boarded R/V TOMMY MUNRO for a brief cruise (2230 CDT May 27 to 1210 CDT May 29) to replace the missing marker buoy. On arrival in the area, the mooring was found to be intact

with the marker buoy tether hanging loose. The tether had been cut part way through at the thimble at the bottom of the marker buoy. Data were recovered from the ADCP and Aanderaa RCM-7 but have not yet been examined in detail.

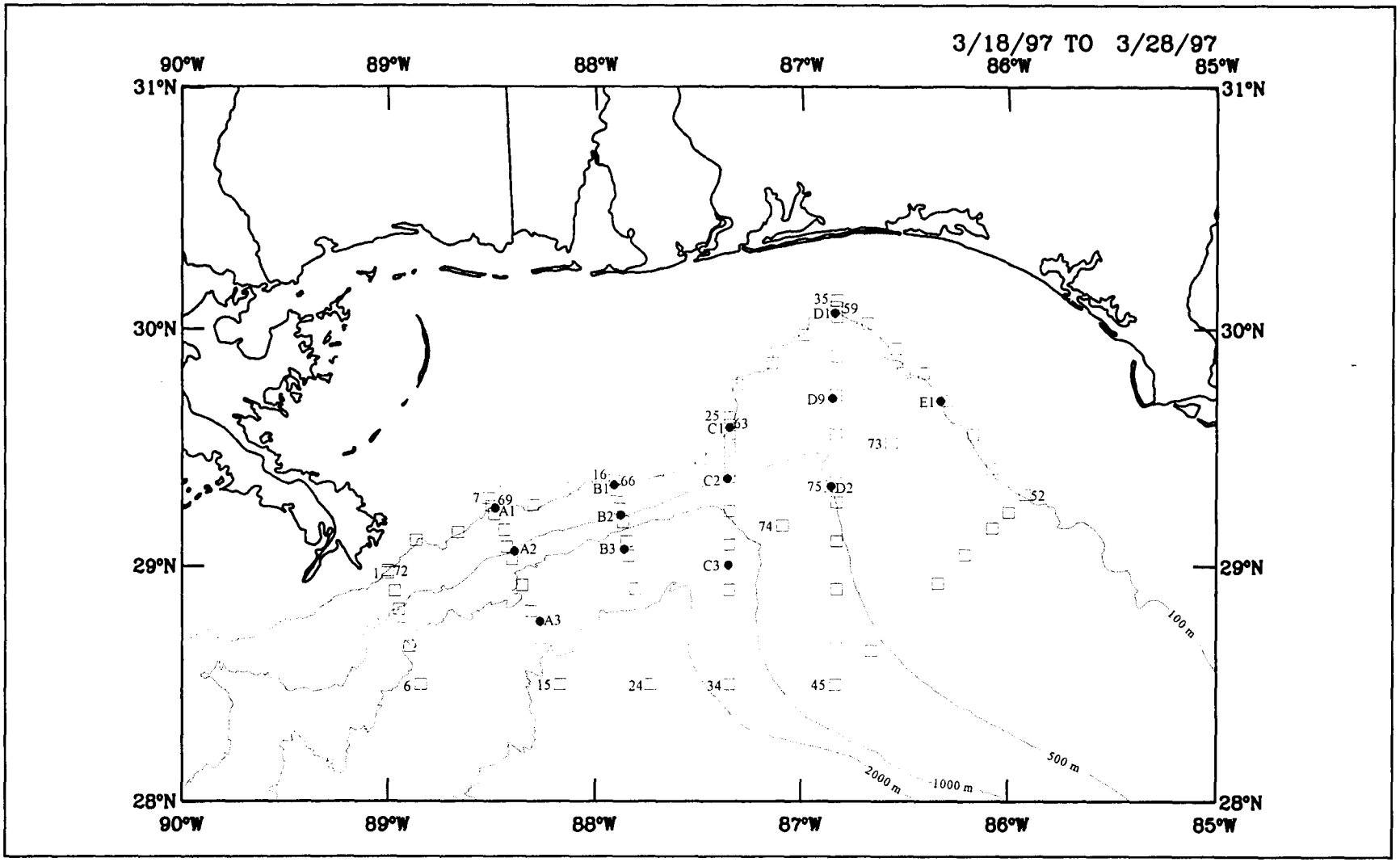

Figure 2. Cruise 1 Map. Mooring locations are shown as solid dots (•) Hydrographic stations are shown by an an open box (□).

Table 1. DeSoto Canyon Eddy Intrusion Study Moorings

Mooring	Location	Water Depth (m)	Instrument Depth (m)	Instrument Type
A1	29°14.502'N 88°29.101'W	100	80 95	ADCP S4
A2	29°03.558'N 88°23.406'W	500	62 90 150 200 250 300 490	Thermistor ADCP Thermistor RCM-7 Thermistor RCM-7 MK2
A3	28°45.974'N 88°15.903'W	1300	80 500 1290	ADCP MK2 RCM-8
B1	29°20.570'N 87°54.535'W	100	20 80 82 95	C/T/D ADCP C/T RCM-7
B2	29°12.722'N 87°52.334'W	500	62 90 150 200 250 300 490	Thermistor ADCP Thermistor RCM-7 Thermistor RCM-8 MK2
B3	29°04.239'N 87°51.414'W	1300	80 500 1290	ADCP MK2 RCM-8
C1	29°35.210'N 87°20.972'W	100	20 80 82 95	C/T/D ADCP C/T RCM-7

Table 1. DeSoto Canyon Eddy Intrusion Study Moorings (cont.)

Mooring	Location	Water Depth (m)	Instrument Depth (m)	Instrument Type
C2	29°22.271'N 87°21.387'W	500	62 90 150 200 250 300 490	Thermistor ADCP Thermistor RCM-7 Thermistor RCM-7 MK2
C3	29°00.191'N 87°21.198'W	1300	80 500 1290	ADCP MK2 RCM-8
D1	30°04.133'N 86°50.371'W	100	99	ADCP - TRBM
D2	29°20.095'N 86°51.126'W	500	62 90 150 200 250 300 490	Thermistor ADCP Thermistor RCM-7 Thermistor MK2 MK2
D9	29°42.456'N 86°50.794'W	200	180	ADCP (NB)
E1	29°42.037'N 86°19.779'W	100	20 80 82 95	C/T/D ADCP C/T RCM-7

Acronyms:

ADCP Acoustic doppler current profiler 300kHz Workhorse, except Mooring D9, which has 150 kHz narrowband (NB) unit;

C/T/D Sea-Bird Electronics recording conductivity temperature depth instrument (SBE-16 on loan from Sea-Bird);

C/T same as above but owned by MMS and without depth (pressure) sensor;

MK2 General Oceanics Niskin winged current meter MK2;

RCM-7 Aanderaa recording current meter version 7 with solid state memory,

RCM-8 same as above but with increased depth capability; and

TRBM trawl resistant bottom mount from Flotation Technologies.

III. DETAILS OF DATA COLLECTION AND ANALYSIS

3.1 Time Series Data

This data set includes current meter data, CTD data from six moored SEACAT/MicroCAT instruments, and thermistor data. The only time series data acquired thus far is a limited set from mooring E1 ADCP and near-bottom Aanderaa RCM-7, which was downloaded in late May when the surface marker buoy was replaced. None of these data has been analysed to date. The first full set of time series data will be available after Cruise 2 (July 8-18, 1997).

3.2 Hydrographic Data

This data set consists of the hydrographic station data acquired during each cruise. Cruise 1 yielded 74 stations along with bottle samples at the stations. Station data have been downloaded to the SAIC Physical Oceanographic Data System (PODBMS) and have been plotted to check for systematic errors. Review of these plots suggested that the lowering rate for the Sea-Bird CTD system on R/V Pelican be reduced in the upper portion of the water column to reduce the possibility of data spikes. This will be done during subsequent cruises. Effects will be reviewed following Cruise 2.

Bottle samples from Cruise 1 were analysed at Texas A&M University (TAMU) and the results provided to SAIC. Cursory examination of these data and the CTD data did not suggest any systematic errors in the CTD data. More rigorous comparisons of these data will be made.

3.3 Ancillary Data

The principal ancillary data types include satellite imagery provided by US Geological Survey, satellite altimetry data being processed by University of Colorado, and appropriate meteorological data. In future, data from the Pinnacles Trend Study and GulfCet II will also be available.

Satellite images of the northeastern Gulf of Mexico (area from 22.0°N to 31.6°N and 79.0°W to 92.7°W) are available from the USGS web page at

http://stimpy.er.usgs.gov/HTML/Imagery/East_Gulf/.

Thumbnail images are reviewed online and the images with cloud free coverage of the study area (and vicinity) are then downloaded and converted from TIFF to ERDAS Imagine image format. Navigation data are then applied to each image. Ninety-eight images have been selected covering the period from January 29, 1997 through June 4, 1997. It is anticipated that no further imagery will be downloaded until early fall when the surface waters of the Gulf of Mexico cool sufficiently to show some contrast between different water types. Images have been archived for the dates shown in Table 2.

Table 2. Monthly Distribution of Satellite Images

Month	Image Dates (parens indicate multiple images)
January	29, 31
February	24, 25, 26, 27, 28
March	1-6, 9, 11, 15, 16, 18, 19, 22, 24(2), 25(2), 26(2), 27(2), 31(3)
April	2(2), 3, 10, 17, 18(2), 22(2), 23(2), 24(2), 25, 30(2)
May	1(2), 2(2), 4(2), 6(3), 13(2), 14(2)
June	2(2), 3, 4

Satellite altimetry data are archived at the University of Colorado and will be used in data analysis and synthesis. These data may be seen at the Colorado Center for Astrodynamics Research (CCAR) web site at

http://shaman.colorado.edu/~leben/gom_rgdr.html.

Appropriate meteorological data will be acquired as needed during the project. None, other than weather forecasts related to each cruise, have been acquired to date.

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.