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PROGRESS ON THE ACQUISITION AND ANALYSIS OF COASTAL GROUND-TRUTH DATA FOR CORRELATION WITH ERTS-1 IMAGERY

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135 East Ortega Street
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1 April 1973

Type II Progress Report for Period 2 October 1972 to 2 April 1973

Prepared for:

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

TECHNICAL REPORT STANDARD TITLE PAGE

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Progress on the Acquisition Analysis of Coastal Ground Truth Data for Correlation with ERTS-1 Imagery	1 April 1973
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12. Sponsoring Agency Name and Address Mr. E. Crump (Code 430) Goddard Space Flight Center Greenbelt, Maryland 20771	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Progress in acquiring coastal ground truth and the types of data gathered is discussed. Imagery (MSS) for ground truth cruises has not been received yet. Enhancement of photographic and digital imagery is being investigated. A tentative scheme for developing a digital enhancement algorithm is described. A preliminary examination of ground truth data obtained in the first half of the field program indicates consistency between types of measurements.

17. Key Words (Selected by Author(s))	18. Distribution Statement
Ground Truth Ocean Truth Coastal Oceanography Marine Scene Enhancement	

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Figure 2. Technical Report Standard Title Page

TYPE II PROGRESS REPORT
ERTS-1
2 OCTOBER 1972 TO 2 APRIL 1973

a. Title: Acquisition and Analysis of Coastal Ground-Truth Data for Correlation with ERTS-1 Imagery.

b. Principal Investigator: Dr. William A. Anikouchine, GSFC ID PR 533

c. Difficulties and Problems: ERTS data continues to be slow to arrive. Our standing order for 70mm imagery is delayed 2 months after overflight. This adds to a 8 week lag in securing digital tapes (ordered after scanning 70mm images) and to a 6 to 8 week lag in the delivery of 9" X 9" imagery. To date, no imagery has been received for those dates on which we conducted field operations.

d. Accomplishments: Six sea truth cruises have been executed:

Location	Dates
Santa Monica Bay	1 April
Santa Barbara Channel	25 February, 15 March, 2 April
Monterey Bay	17 March, 4 April

The data taken consists of:

Location (Visual sextant angles, radar and Loran)
Date and Time
Sun Azimuth
Lateral Visibility

Vertical visibility and cloud cover %
Wave height
Wave direction
Wind speed
Wind direction
Water temperature (surface)
Secchi Disc depth
Water color (Forel-Ule scale)
Air temperature
Relative humidity
Water samples for laboratory analysis
Light extinction coefficient measured with a filter photometer

These data were obtained at stations spaced 3 to 7 miles along cruise tracks selected for each location. The cruise tracks extend beyond the limits of the contract test sites because an examination of initial ERTS imagery indicated that the dimensions of recognizable features exceeded the test site dimensions. The initial set of observations was designed to determine the optimum size and location of test site within each test location.

The laboratory analysis consisted of:

Turbidity measurement with a nephelometer

Membrane filtration for determination of color of suspended material, microscope examination and Scanning Electron Microscope identification of suspended particles.

In addition, underway measurements were made of aerosol content of the air with a continuous nephelometer. This instrument was used on the first two cruises in Santa Barbara Channel. On the 4 April cruise in Monterey Bay sea water fluorescence and turbidity were monitored continuously while underway using two flow-thru fluorometers.

Color aerial photography was obtained during the 15 March overflight of Santa Barbara Channel. Photos were taken at 27,000 feet with 90% overlap. The film specifications are Kodak Aerocolor Negative 2445 with a 4 mil Estar base. The photo coverage and interpretation is shown on the attached maps.

Attempts are being made to produce color enhancements of MSS imagery by photographic processing (contract emphasis in ocean areas) of 9 X 9 positive transparencies and diazo printing. It is too soon to comment on the effectiveness of this technique.

Digital tapes of the study areas are being processed to obtain data for use in developing digital enhancement algorithms. The techniques to be used follow from information gathered by Dr. Anikouchine during his attendance of the 2nd ERTS Symposium at New Carrollton, Md., March 5-9 1973.

The tentative scheme for the development of the digital enhancement algorithm consists of the following steps:

1. Smooth system - generated noise
2. Adjust for sensor characteristics for each MSS band
3. Adjust base level to correspond to noon-day illumination
4. Remove spectral modulations from:
   - atmospheric scattering
   - sun angle
   - cloud cover effects
5. Removal of ocean background effects:
   - white reflectance from white caps and bubbles
   - "Clean" sea water spectral reflectance
6. Target anomalies thus isolated examined for pattern recognition of oceanographic features related to turbidity and to meteorological effects

7. Establish spectral reflectance signatures of each turbidity-producing substance and extract ratios of intensity of spectral reflectance in each MSS band
8. Scan digital data for each target ratio
9. Examine residual data for indicated further study

Future cruises will be scheduled following the scheme presented in the Data Analysis Plan, weather permitting. In addition to data taken in the past, a series of solar and sea reflectance radiometer measurements and in-situ, underway nephelometer measurements will be taken. The exact cruise plans will be designed after examination of MSS imagery corresponding to the initial sea truth cruises.

e. Significant Results: No results can be reported until after the appropriate MSS imagery has arrived. Field data appears to be self-consistent; Secchi depth data seems to correlate with turbidity data, extinction coefficient values and water color data. Membrane filters show that the color and morphology of suspended material vary in time and location.

f. Abstract: An abstract of a talk presentation by Dr. Anikouchine to an ONR-sponsered workshop on "Suspended Matter in the Sea" is attached. The workshop was held in Santa Barbara, California on 20-22 March 1973.

g. Recommendations: A modification in the processing, by electron beam camera, of marine scenes seems necessary. Positive transparencies show the ocean lying within the darkest 4 tones of the gray scale step wedge. On the MSS band 7 image only 2 tones are useful and on MSS band 4, only 4 tones depict all marine features. Each tone includes 4 levels on the digital tape. It would be

useful if the camera printed each level as a separate tone on the 4, 5, and 6 band imagery of marine areas. A negative transparency of band 7 (as currently processed) could continue to be used for locating the shoreline. Expanding the tonal range in marine scene imagery will help in presenting details of marine features and aid in their interpretation.

h. Changes in Standing Order: A change in the standing order was made on 6 April 1973. Our standing order for each test site now consists of 70mm negative and positive transparencies and 9" x 9" positive transparencies (black and white, 1 in each MSS band).

i. ERTS Image Description Forms: These forms have been completed for all images received to date and are appended to this report. The forms will be up-dated as imagery is received.

j. Data Request Forms: Forms have been submitted during the period 2 February to 2 April on the following dates:

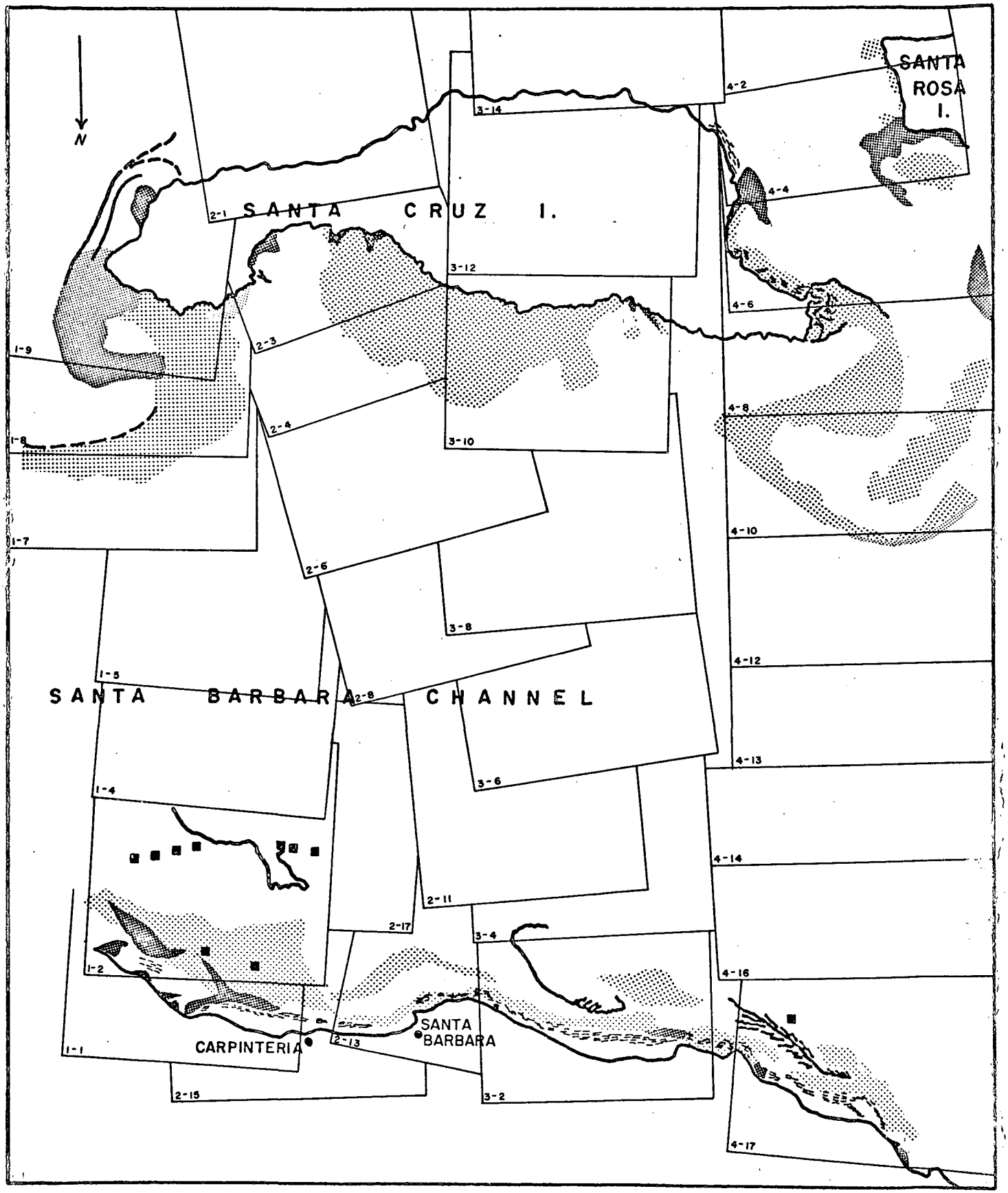
27 March	12 February
28 March	13 February
8 February	15 February

They include requests for 70mm imagery not received on standing orders, 9 X 9 imagery not on standing order, and 7 track digital tape for specific imagery of interest.

APPENDIX

6

INTERPRETATION OF AERIAL PHOTO-COVERAGE ON 15 MARCH 1973, USING COLOR FILM AT 27,000 FEET. OVERLAPPING NUMBERED SQUARES REPRESENT INDIVIDUAL PHOTOGRAPHS.



SUSPENDED SOLID MATERIAL, INTENSITY OF SHADING PROPORTIONAL TO TURBIDITY OBSERVED ON PHOTO

SURFACE DEBRIS, NORMALLY HYDROCARBON FILMS NEAR COAST LINE, FOAM LINES AT ISLANDS

FEATURES DELINIATED BY CHANGES IN SEA SURFACE SMOOTHNESS

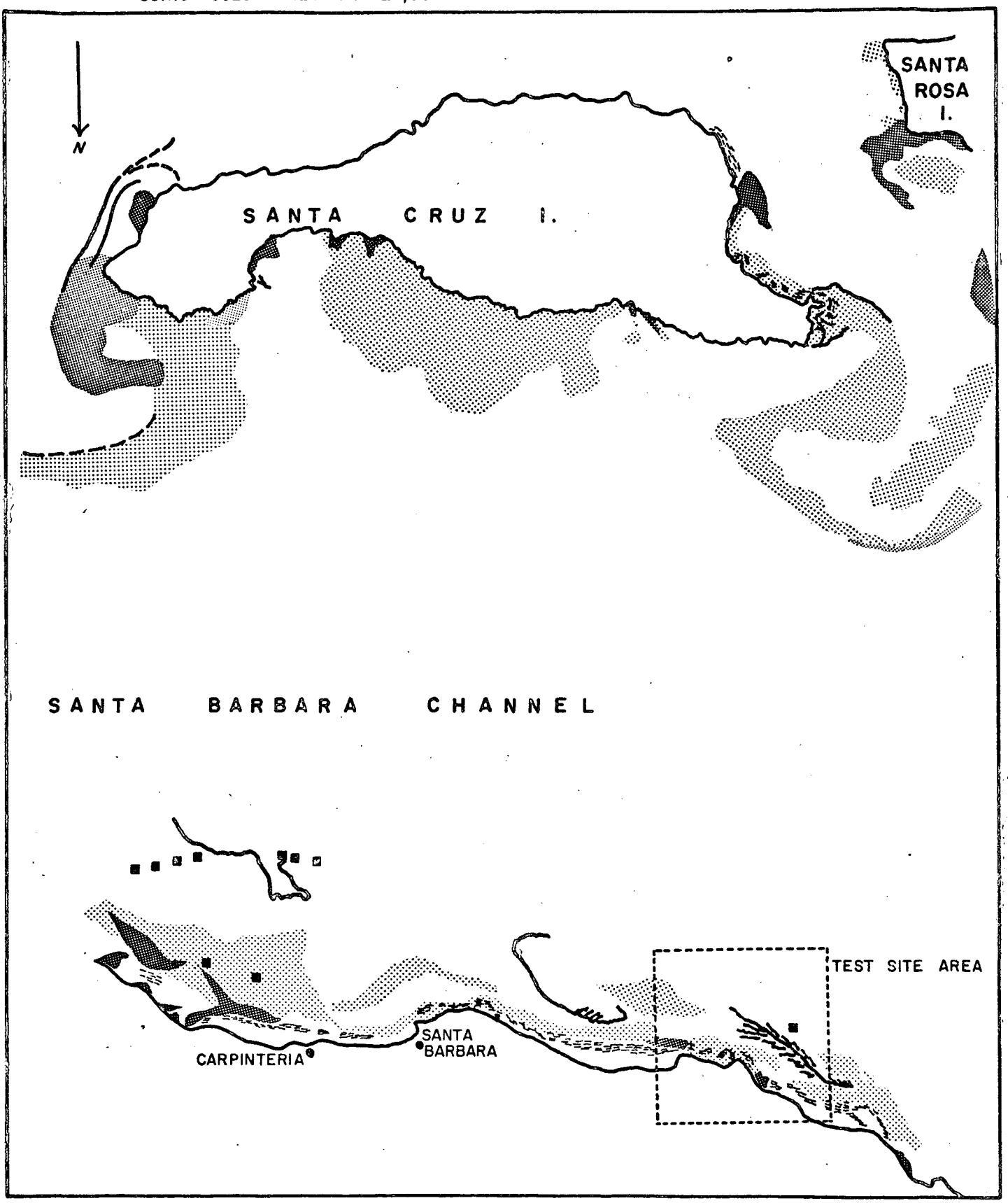
KELP

OFFSHORE OIL PLATFORM

APPROX. SCALE

0 1 2 3 4 5 N.MI.

INTERPRETATION OF AERIAL PHOTO-COVERAGE ON 15 MARCH 1973,
USING COLOR FILM AT 27,000 FEET.



SUSPENDED SOLID MATERIAL, INTENSITY OF SHADING PROPORTIONAL TO TURBIDITY OBSERVED ON PHOTO

SURFACE DEBRIS, NORMALLY HYDROCARBON FILMS NEAR COAST LINE, FOAM LINES AT ISLANDS

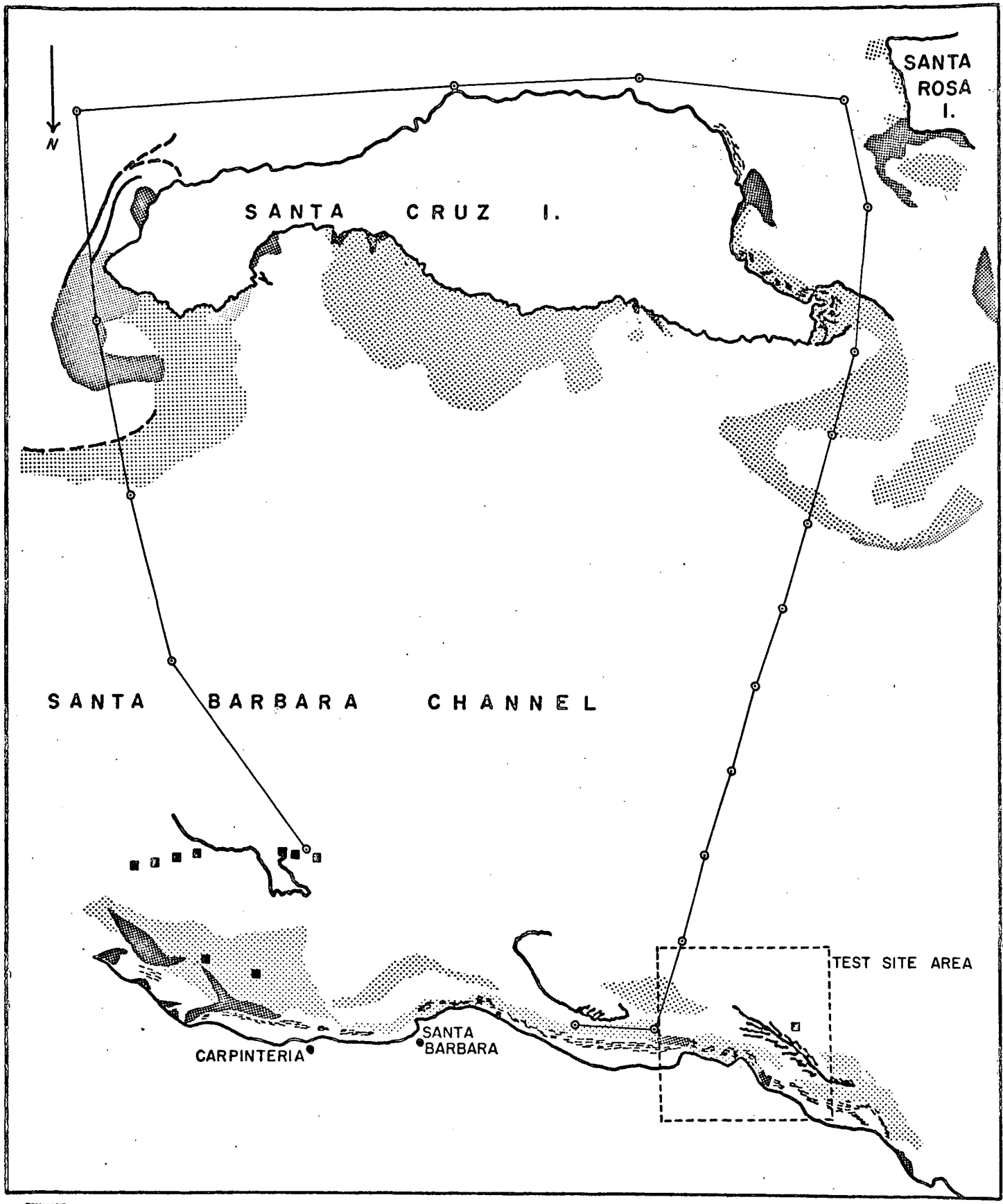
FEATURES DELINIATED BY CHANGES IN SEA SURFACE SMOOTHNESS

KELP

OFFSHORE OIL PLATFORM

APPROX. SCALE
0 1 2 3 4 5 N.MI.

INTERPRETATION OF AERIAL PHOTO-COVERAGE ON 15 MARCH 1973, USING COLOR FILM AT 27,000 FEET. TRACK OF SEA-TRUTH CRUISE IS SHOWN WITH LINE BROKEN BY CIRCLES.



SUSPENDED SOLID MATERIAL, INTENSITY OF SHADING PROPORTIONAL TO TURBIDITY OBSERVED ON PHOTO

SURFACE DEBRIS, NORMALLY HYDROCARBON FILMS NEAR COAST LINE, FOAM LINES AT ISLANDS

FEATURES DELINIATED BY CHANGES IN SEA SURFACE SMOOTHNESS

KELP

OFFSHORE OIL PLATFORM

APPROX. SCALE

0 1 2 3 4 5 N. MI.

Abstract

SUSPENDED MATERIALS AND SPACECRAFT OCEANOGRAPHY

William A. Anikouchine, PhD
Oceanographic Services, Inc.
Santa Barbara, California

Views of the ocean obtained with spacecraft and high altitude aircraft reveal that the turbidity of sea water is probably the most important property for discerning features of the ocean surface layer. Information regarding oceanic circulation, water mass boundaries, sea water properties, land-sea interaction, biological effects, and ocean fisheries must be gleaned indirectly from turbidity data. Interpretation of aerial imagery requires the knowledge of "sea truth", the actual appearance of the sea surface and the factors that create its appearance. Reflection, absorption, and scattering of light by suspended particles are extremely important as they affect the intensity and spectral composition of radiation reaching remote sensors.

Water samples gathered during "sea truth" cruises have been filtered and photographed (500x to 8000x) with a scanning electron microscope. These photographs indicate that colloids, suspended minerals, agglomerations of clay flakes, and plankton all contribute to turbidity. Plankton skeletons, cells, and protoplasm are quite important inasmuch as they alter the optical properties in several ways simultaneously. Reflection, scattering, and absorption (pigmentation effects of plankton) bear further investigation. There is a need for additional work on particle identification and for rapid quantitative assessment of suspended materials. Problems inherent in such work are discussed.

ERTS IMAGE DESCRIPTOR FORM

(See Instructions on Back)

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ID

DATE 1 April 1973

PRINCIPAL INVESTIGATOR Dr. William A. Anikouchine

GSFC ID PR 533

ORGANIZATION Oceanographic Services, Inc.

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	coast-line	kelp	jetty	
1002-18134-4	X		X	long period wave, coastal water mass structure
-5	X		X	"
-6	X	X	X	"
-7	X	X	X	
1018-18010-M	X		X	
1019-18064-M				interest cloud area obscured
1021-18172-4	X		X	Long period wave, coastal water mass structure
-5	X		X	"
-6	X	X	X	
-7	X	X	X	
1036-18010-M				Interest area cloud obscured
1037-18064-4	X		X	
-5	X	X	X	Long period area, coastal water mass structure
-6	X	X	X	
-7	X	X	X	
1054-18010-M				Interest area cloud obscured
1055-18064-4	X		X	
-5	X		X	
-6	X	X	X	
-7	X	X	X	

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

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PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	coast-line	kelp	jetty	
1057-18172-4	X		X	
-5	X		X	
-6	X	X	X	
-7	X	X	X	
1072-18010-M				Interest area cloud obscured
1073-18064-4	X		X	
-5	X		X	
-6	X	X	X	
-7	X	X	X	
1075-18173-4	X		X	Sediment plume
-5	X		X	Sediment plume
-6	X	X	X	
-7	X	X	X	
1090-18012-4	X		X	
-5	X		X	
-6	X	X	X	
-7	X	X	X	
1091-18071-4	X		X	
-5	X		X	
-6	X	X	X	
-7	X	X	X	
1092-18123-M				Interest area cloud obscured

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	coast-line	kelp	jetty	
1168-18014-4	X		X	Sediment plume
-5	X		X	Sediment plume
-6	X	X	X	
-7	X	X	X	
1109-18073-4	X		X	Sediment plume
-5	X		X	Sediment plume
-6	X	X	X	
1111-18181-M				Interest area cloud obscured
1126-18015-4	X		X	Sediment plume
-5	X		X	Sediment plume
-6	X	X	X	
-7	X	X	X	
1127-18073-4	X		X	Sediment plume
-5	X		X	Sediment plume
-6	X	X	X	
-7	X	X	X	
1129-18181-4	X		X	Sediment plume
-5	X		X	Sediment plume
-6	X		X	
-7	X		X	
1144-18015-4	X		X	Long period wave
-5	X		X	Long period wave
-6	X	X	X	Long period wave
-7	X	X	X	Long period wave

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PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	coast-line	kelp	jetty	
1145-18073-M				Interest area cloud obscured
1162-18013-4	X		X	Sediment plume
-5	X		X	Sediment plume
-6	X		X	Sediment plume
-7	X		X	
1163-18072-5	X		X	Sediment plume
-6	X	X	X	Sediment plume
-7	X	X	X	
1165-18175-4	X		X	Sediment plume
-5	X		X	Sediment plume
-6	X		X	
-7	X		X	
1180-18015-4	X		X	EEØ sediment plume
-5	X		X	EEØ sediment plume
-6	X		X	Sediment plume
-7	X		X	
1181-18071-4	X		X	Sediment plume
-5	X		X	Sediment plume
-6	X		X	Sediment plume
-7	X		X	
1183-18175-4	X		X	Sediment plume
-5	X		X	EEØ sediment plume
-6	X		X	Sediment plume
-7	X		X	Sediment plume

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PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	coast-line	kelp	jetty	
1183-18182-4	X		X	Sediment Plume
-5	X		X	EEØ sediment plume
-6	X		X	Sediment plume
-7	X		X	Sediment plume
1198-18015-M				Interest area cloud obscured
1199-18073-M				Interest area cloud obscured
1201-18181-M				Interest area cloud obscured

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