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First Bimonthly Progress Report
Covering Period Ending December 6, 1972

A. Investigations Using Data in Alabama from ERTS-A. Proposal No. 271.

B. GSFC I. D. of P. I.: UN 604

C. Problems: Slowness of obtaining data from Goddard.

D. Accomplishments: See appendices for accomplishments in the area of

1. Investigation of Environmental Factors
2. Land Use Compilation
3. Data Processing for Land Use Compilation
4. Photo-reproduction and Unsupervised land-use classification from Digital Tape
5. Data Collection Buoys
6. Activities of the Geological Survey of Alabama.

E. See appendices.

F. See Appendix 6.

G. See Appendix 6.

H. See Appendix 7 for changes in standing order forms

I. We are still analyzing the products we have received and no image descriptor forms have been prepared at this time.

J. Data Request Form is included as Appendix 8.

Appendix I

Progress Report on ERTS Project Concerning Environmental Factors by G. P. Whittle

The major efforts in the environmental area have been directed toward the establishment of the DCP system to monitor a major river basin. In consultation with MSFC personnel, a decision was reached concerning the number and types of sensor to be placed on the data collection platforms. The sensors are: (1) dissolved oxygen; (2) pH; (3) temperature, and (4) conductivity.

Because of an anticipated reduction in the number of DCP to be made available, it was decided to place all of the platforms in one river basin. The Warrior River basin was selected, based on convenience of location and the fact that it is typical of a multiple-use water resource. Two inspection surveys of the Warrior River were made starting at the Holt Lock and Dam and progressing upstream to the confluence of the Mulberry and Locust Forks. Since no satisfactory permanent structures were found in the river for mooring the platforms, it was decided to drive pipe or other suitable piling at the desired locations. At the time of these initial surveys, only three platforms were contemplated to be available for the project. Accordingly, three locations were selected: river mile 387.4 on Locust Fork; river mile 392.3 on Mulberry Fork; and river mile 381.9 on the Warrior River in the Bankhead Lake. Measurements of depth, flow velocity, temperature and dissolved oxygen were taken at each site. Permission to drive piling at these sites was requested and obtained from the Corps of Engineers.

Recent developments indicate that a total of seven platforms would be available with two to be placed in Mobile Bay and the remaining five to be available for the river basin project. The area of the river basin to be investigated was correspondingly broadened in order to facilitate reaching the ultimate objective of demonstrating the feasibility of using the DCP concept to monitor a river basin. Efforts were then directed toward selection of DCP sites that would reflect the water quality or changes in water quality in the most effective manner. Mr. Lamar Larrimore, a graduate student and trainee on an Environmental Protection Agency grant has taken as part of his thesis topic the selection of the optimum locations for data collection platforms. Using the Warrior River as a test case, the scope of this work will be to utilize water quality data that has already been collected at various conventional monitoring and gaging stations and present this data in a form that will facilitate location of the platforms.

The basic information necessary for accomplishing this objective has already been obtained and stored in the EPA computer STORET system. In this system, a listing of all present monitoring and gaging stations in Alabama, as well as actual data on each of the parameters monitored at these stations has been assembled. This information is to be correlated with those parameters to be measured by the platforms in selecting the most advantageous locations.

Additional information has been gathered that will be of assistance in specifying locations. Since the platforms will be placed under water, maximum and minimum stage heights of the river are important factors for

those areas under consideration as possible sites for DCP locations. Data have been obtained from the U. S. Geological Survey on stage heights in Bankhead Lake as well as for stations upstream in both the Locust and Mulberry Forks of the Warrior River.

Data regarding the velocities of flow at similar points in the Warrior River have also been obtained.

The most recent projected date for the installation of the platforms is February, 1973. It is anticipated that completion of the first phase of the thesis study will be accomplished prior to this date in order to make recommendations for the optimum DCP locations.

Future work will involve expanding the scope of this project toward meeting the objective of demonstrating the utility of data collection platforms in the management of water resources. Initial contacts with governmental agencies such as the Alabama Water Improvement Commission and private industry have been made in order to alert these potential users to the system being developed. Future efforts will involve continued development of liaison with the governmental and private sectors to promote application of the ERTS data in water quality management.

Appendix II

Land Use Compilation

by R. Paul Wilms

As of August, 1972, 43 of the 67 counties in Alabama had been added for land use (using aerial photo mosaics) for a total area of 80,805 sq. km. utilizing previously determined procedures and techniques. Coding of land use for the remaining 52,695 sq. km. was completed by mid-September.

Throughout the latter stages of the land use coding phase, concern was expressed about the possibility of a cell's being coded in more than one county. To remedy this problem and to forego the possibility of a cell's being omitted entirely between two counties, a comprehensive system of checking was initiated for the purpose of assigning overlapping cells to one county or the other on the basis of the most recent air photos available. Overlapping county boundaries were made contiguous and vacant cells were appropriately identified and coded. The entire procedure was completed on November 10, 1972. The UTM coordinates and land use code for each cell added or deleted from each of the 67 counties were compiled and given to the personnel under the direction of Dr. E. T. Miller, to allow updating of their computer data and storage system.

The coding of land use data from air photo mosaics, is, admittedly, a process of interpretation and judgement. Concern for individual accuracy and consistency was exercised throughout the course of the land use phase of the investigation and prompted the initiation of a

continuing accuracy verification procedure on randomly selected cells. The results were very gratifying and provided a record of personnel accuracy while also helping to identify specific "problem" areas in the State.

Because of the many individuals coding land use during the past months, many of whom are no longer on the project, it became apparent that there was a critical need for a more systematic and comprehensive analysis of coding accuracy. A checking procedure was, therefore, activated whereby the investigator selects for each county a row or column of cells which contains the most representative (i.e., the largest number) of land use categories. Alternate other cells down the column or across the row are then scrutinized using a grided cell, the results of which are recorded and kept on file for future reference.

Seven counties have, to date, been checked for accuracy and reliability; they are: Colbert, Bibb, Autauga, Bullock, Barbour, Butler, and Coffee counties (see Figure 1). A total of 167 cells have been checked for this seven county area. Out of these, 143 cells or 85.64% of the area needed no correction in either identification or estimation of land use area. Of the 24 cells, or 14.36% area, needing some correction, the greatest part, 11.96%, needed at most only a 10% correction in any one land use category; another 1.20% required a 20% correction, and the remaining 1.20% needed a 30% correction.

These results were very encouraging, because a 10% error in any one category per cell is considered to be well within the limits of acceptibility. Hence, from this initial verification, 97.6% of the cells checked were accurately coded. It is hoped that this trend will continue or become even better as verification progresses.

The early phases of this investigation have been in the realm of preparation and adata gathering. Now that the initial "groundwork" has been all but completed and work begun on actual ERTS-I imagery, preliminary work has begun on a Master's thesis tentatively entitled, "The Feasibility of Using Remotely Sensed Data from ERTS-I for Land Use Inventory and Planning." This investigation will benefit greatly from the preparatory work already completed on the ERTS-I project, specifically the historical ground truth information which has been accumulated. The objectives of this proposed feasibility study, as they are envisioned now, are:

(a) By utilizaing photographic interpretation techniques and statistical data techniques in assessing MSS data from ERTS-I and corresponding ground truth information, produce an accurate and timely land use inventory of a predetermined target study area.

(b) By comparing historical land use data with that obtained from ERTS-I (whether manually or with the use of computers), produce maps of change for any single land use category or combination of categories, on the basis of which, certain trends and recommended courses of action (where applicable) can be determined.

(c) Determine the correlation of remotely sensed data from ERTS-I with existing ground truth information for the purpose of obtaining spectral signatures of both physical and cultural features (as well as detectable pollution features).

(d) demonstrate the usefulness of the Earth Resources Technology Satellite as a tool in land use inventory, management, and planning.

ERTS-I imagery received to date for Alabama consists of MSS positive prints for the "L" orbit of September 11, 1972 in bands 4, 5, 6, and 7 (see Figure 2). The quality of this first set of data was disapointing and ultimately led to a meeting on November 15, 1972, with personnel of the Marshall Space Flight Center, Huntsville, Alabama. It

was determined there that some of the print quality problem occurred during reproduction of the prints. It was decided that the problem could be improved photographically.

Even though poor in quality, the data yields more information than originally thought possible. Particularly prominent on band 5 are cultural features such as major industrial and commercial centers as well as strip mining areas, smoke plumes, and geologic structures. MSS band 7 is especially useful in tracing water routes, spotting cultivated fields, mapping geologic structure, and interpreting large scale geomorphic features.

An investigation of this scope involves many diverse interests and disciplines. Throughout the course of this project, potential users of ERTS-I data have been identified; and through liaison with them, a great many improvements have been made concerning our preparatory work and future applications. Continued relations with possible users is therefore being continued and expanded in the hope that the free flow of ideas will generate interest and benefits to all concerned.

As a direct result of this investigation, a course on remote sensing is being formulated and will be offered to the college community and general public beginning spring semester, 1973. This course will not only provide academic credit to interested students, but will also establish closer ties with ERTS investigators on campus and around the State

Inquirires to 46 other universities offering courses in remote sensing have been made. The responses will help in compiling a bibliography and course outline. Some of the topics to be covered will include a description of the satellite itself and the imagery, land

use inventory and compilation, pollution detection and geological applications of ERTS-I data.

After almost a year of planning and preparation, this investigation is finally entering the exciting, yet demanding phase of actual ERTS data interpretation. If data quality improves as expected and the rigorous investigative plan carried out to the fullest, many new and exciting findings are sure to result.

Appendix III

Data Processing

by Edmond T. Miller

The data storage function for base land use data has been continuing during this period. The manual process of punching data into cards has been slow and progress has been slower than anticipated, but good progress is being made at present.

Coding of a mapping program for use with the ERTS land use data has been completed. Earlier attempts to use the program named STMAP were successful, but required large amounts of computer time. The new program operates faster than STMAP by a factor of approximately 1¢.

Coding has been started on a general data summary program to facilitate generation of reports of valuable summary information from the land use files. This work has just begun, but since many of its routines for data access are identical to those used in the mapping program, rapid progress should be possible in this area.

Appendix IV

Inputs for First Bi-Monthly Progress Report (ERTS-1)

a. ERTS-A Proposal No. 271

b. U604

c. None

d. Accomplishment:

1. Photographic data received and reproduction problems detected, analyzed and solved.
2. Digital tape re-formatting for compatibility with MSFC computer programs completed, and program interfaces tested using sample ERTS data from Lake Tahoe. Final stages of these tests still underway.

Plans:

1. Perform an automatic unsupervised analysis and land use classification of the Huntsville Jetplex and surrounding area using bulk digital MSS data for channels 4, 5, 6 and 7. Evaluate results by comparison with RB-57 photographic results and ground truth information presently available at MSFC.
2. Proceed to a similar analysis of the Tuscaloosa-Birmingham area.
3. Extend to other selected state sites and repeat using data from later ERTS passages. Observe, study and analyze change for later test and evaluation of automatic change detection algorithms being developed.

e. None

f. None

g. None

h. 22 January 1972, 17 November 1972

i. None

j. 17 November 1972

Submitted 12-6-72
Robert E. Cummings

Appendix V

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

REPLY TO ATTN OF: S&E-EA-DIR

December 11, 1972

Dr. Harold R. Henry
Civil and Mineral Engineering Dept.
University of Alabama
P. O. Box 1466
Tuscaloosa, Alabama 35208

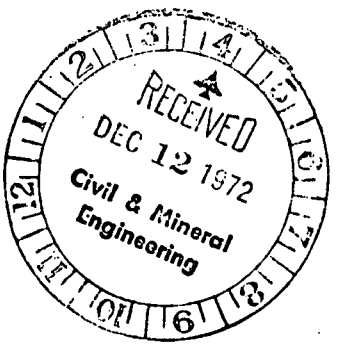
Dear Hal:

The primary MSFC activities under the Alabama ERTS-1 Project during the past month consisted primarily of initial data assessment and design activities on the data buoys. The data activities have been described adequately in Bob Cummings' report; therefore, this report will be limited to the subject of data buoys.

The preliminary design review of the basic fresh water buoy for use in the Black Warrior River system was held the week of November 20, 1972. Final design now is in progress; expected completion date is January 1, 1973. Construction will begin shortly thereafter with completion estimated in March. Based on preliminary cost estimates six buoys can be fabricated within available funding. Modification of the NASA boat to handle the buoys is in progress.

Three sites have been chosen for the fresh water buoys and permits obtained from the Corps of Engineers.

Charles T. N. Paludan
Deputy Director
Environmental Applications Office



Appendix VI

FIRST BI-MONTHLY PROGRESS REPORT

Report of the Geological Survey of Alabama
For the Project Entitled

INVESTIGATION USING DATA IN ALABAMA FROM EARTH RESOURCES TECHNOLOGY SATELLITE (ERTS-A)

Compiled By

James A. Drahovzal
Principal Investigator for the
Geological Survey of Alabama

December 7, 1972

WORK OF THE GEOLOGICAL SURVEY OF ALABAMA

This report describes the activities of the Geological Survey from August 24 through December 7, 1972. It discusses the activities prior to the receipt of ERTS-1 data as well as some preliminary analyses of the data received to date.

Pre-launch activities consisted of familiarizing the research team with the nearest analogue to ERTS-1 imagery available to us - Apollo 9 photography of Alabama. Each member of the team was encouraged to carry out library research on remote sensing methods and techniques of interpretation. Researchers were informed of the basic ERTS systems and their characteristics through meetings and memorandums. Co-investigator duties were finalized (exhibit 1), time budget worked out (exhibit 2), travel fund distribution projected (exhibit 3), the salary portion of the budget revised (exhibit 4), the schedule finalized (exhibit 5), and a reporting mechanism set up (exhibit 6).

As soon as was possible after launch, the co-investigators were supplied with an ERTS-1 schedule for Alabama along with a map showing the subsatellite track (exhibit (exhibit 7).

A few weeks before the receipt of ERTS-1 imagery, the Geological Survey created a Remote Sensing Section with its own facilities for the storing and viewing of remotely sensed data. Although this section will be the center for all Survey related research in remote sensing, it will serve as work area and library for ERTS investigators. The newly created section has initiated the development of a remote sensing data retrieval

B

system. This system will be used for all remote sensing data in the Survey files including the ERTS imagery. To keep ERTS investigators as well as other interested individuals in the Survey abreast of developments in remote sensing and the ERTS project, the Remote Sensing Section has begun a newsletter which will probably be distributed bi-weekly (exhibit 8).

The Geological Survey received the first ERTS-1 imagery through this project on November 7, 1972 (1050-15551, 15553, 15560, 15562; positive prints in all four bands). The delay was most frustrating to this investigator who saw his first ERTS imagery in Montreal in mid-August, and his first Alabama ERTS imagery at Goddard on September 28. Perhaps even more frustrating, however, has been the fact that only a single orbit for a single date has so far been provided to us. Several of us on the Survey team have had the opportunity to examine numerous data for Alabama that is available to the general public from the EROS Data Center, but which has not yet been made available to us through this project. Because we have not yet received orbit K data for Alabama, one of our team in charge of Piedmont geology will have nothing to report. We of the Geological Survey feel that the distribution of available data could be greatly improved.

We also feel that the quality of the data received to date is substantially inferior to that of other ERTS data received through other projects and sources. The following lists these points of inferiority:

1. Registration marks vague or missing. The ones in the lower right-hand corner entirely missing due to masking.
2. Gray scale only partially shown.
3. Right side lat.-long. tics entirely missing.

4. Newton rings on the green band (4) and a whitening effect on the infrared (7) caused by reproduction at Marshall, but not on originals received from Goddard.

5. General low contrast of prints.

Thirdly, the members of the Survey research group feel that a single set of the ERTS data is not adequate for our relatively large team (8 workers) and that the data in the form in which it was received (positive prints) is of limited value.

In light of the above, the Geological Survey requests that Goddard provide us directly with a set of 70 mm. negatives in addition to the 9" x 9" positive transparencies and prints already on standing order. With such data, our photography laboratory can provide our team with positive transparencies, prints, composites and enlargements to suit our needs.

In spite of the above problems, the Survey research team attempted to analyse as much of the information as possible in the short time available to us. Our studies were mainly based on the single band prints provided, but several other techniques were employed. Marshall Space Flight Center personnel formatted the ERTS imagery for viewing with a color additive viewer. In a one-day trip, two of us studied some of the various quarter-scenes on the viewer at Marshall. With the use of the machine, color-infrared and black and white composite images were produced and photographed with 35 mm. slide and print film. Marshall workers, using a camera pack made contact transparencies of three of the scenes. Results were quite satisfactory and added much to our analyses. Composites, whether they be color or black and white, are useful to us in making precise geographical locations. The drainage system shown best on the infrared and

the cultural features shown best on the red band imagery, when combined generally give us the information we need for location purposes. Color composites have been helpful in enhancing some features. We are most anxious to receive the excellent Goddard-produced color composites of certain areas in the State as soon as possible. As far as we know, no such product exists for any part of Alabama.

The following are individual investigator reports describing their activities for the period.

REPORT ON THE SIGNIFICANCE OF ERTS-1 DATA TO THE GEOLOGY OF THE VALLEY AND RIDGE AND CUMBERLAND PLATEAU PROVINCES

By James A. Drahovzal

INTRODUCTION

The ERTS-1 images were examined to determine their geologic information content in the Valley and Ridge and Cumberland Plateau Provinces of Alabama. They were further evaluated through a simple comparison with Apollo 9 photography of the same area.

GEOLOGIC OBSERVATIONS

Only the large-scale structural features in the Cumberland Plateau and Valley and Ridge Provinces are visible on the imagery provided. Most of the major folds and a few of the major faults are evident on the red band (5) imagery. Major structural elements are discernible only, however, where they are represented by large topographic features. The structural features are somewhat less evident on the infrared (6, 7) and the green (4) bands. Many of the finer structural features discernible on Apollo 9 photography are absent on the ERTS-1 imagery at any scale. This includes a narrow but important structural trend referred to as the "Coosa Deformed Belt" in the proposal (4.1.3.1.; p. 4-23).

Perhaps the most significant features displayed on the ERTS-1 images are the lineaments that were originally discovered on Apollo 9 photographs in the Piedmont and Valley and Ridge Provinces (Powell, Copeland, and Drahovzal, 1970; Drahovzal and Copeland, 1970; Drahovzal and Neathery, 1972). Many of the same lineaments described from the Apollo 9 photographic

series in eastern Alabama (AS9-26-3790) may be seen on the ERTS-1 imagery and some can be extended to the west. New lineaments to the west of Apollo 9 coverage have been discovered on the ERTS-1 imagery (exhibit 9). The newly found lineaments appear to generally coincide in orientation with those found on the Apollo 9 photographs. A northwest orientation is dominant, although some northerly and north-northwesterly oriented lineaments are also present. Very few westerly directed lineaments were defined. So far, none of the lineaments have been checked against existing maps or other information to determine whether or not they represent a naturally occurring feature. This work will be carried out in the coming months. The possible geological, hydrological, economic mineral, and environmental significance of these features will also be the subject of research in the coming months.

It is yet too early in our investigation, and data is yet too limited in quantity and quality to meaningfully discuss the significance of the lineaments to practical problems.

COMPARISON TO APOLLO 9 PHOTOGRAPHY

The SO-65 experiment carried out by the Apollo 9 crew in 1969 was designed to test the feasibility of collecting data from a system similar to the ERTS. It is therefore interesting and instructive to compare the results of these two systems over the same earth scene. Parts of two ERTS-1 images (1050-15544 and 15551) overlap the Apollo 9 photographic series coverage of eastern Alabama (AS9-26-3790). The ERTS-1 imagery was collected on September 11, 1972, at approximately 10:00 a.m. CST, while the Apollo 9 photography was taken on March 11, 1969, at 10:21 a.m. CST. Although shot in different seasons, the sun angle and conditions of illumination appear to have been comparable. Yet some striking differences can be seen.

Comparison of infrared products (Apollo 9 - AS9-26C-3798C with ERTS-1 - 1050-15551 and 15544-7) shows that definition of water/land contacts is comparable, with ERTS imagery being perhaps slightly superior to the Apollo imagery for larger bodies of water (i.e., lakes and ponds) but somewhat inferior in showing the course of small streams. Brief analysis indicates that change detection studies of water vs. land could be easily carried out using ERTS data. The topographic expressions are much fainter on ERTS infrared products than on Apollo infrared photographs. This situation was found to be true for all band comparisons, and may be the result of seasonal difference, resolution characteristics, illumination variation, and/or atmospheric conditions. It is the belief of this investigator, however, that at least part of the difference is the result of the relatively low print contrast. ERTS products received through other projects and sources are of higher contrast than those provided to this project and seem to more clearly exhibit topographic features.

Comparison of the red band products (Apollo 9 - AS9-26D-3790D with ERTS-1 1050-15551 and 15544-5) shows, as stated above, that the topographic definition is inferior on ERTS-1 products when compared to Apollo photography. As indicated above, this seems to be more than a problem of resolution because, ERTS-1 red band imagery is superior to Apollo red band photography in defining many cultural features. Road ways, in particular, are generally better defined on ERTS-1 red band imagery.

PROBLEMS

The major problems impeding the progress of the geological studies mainly revolve around the data itself and this problem has been discussed in another part of this report.

REPORTS

No reports using imagery provided through this project were completed for this report period. This investigator did, however, publish an article utilizing ERTS-1 data supplied by the EROS Data Center (Drahovzal, 1972) and recently published an abstract dealing with Apollo 9 photography (Drahovzal and Neathery, 1972). The two references are listed in the bibliography and a copy of the former is included (exhibit 10).

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REPORT ON THE SIGNIFICANCE OF ERTS-1 DATA TO THE GEOLOGY OF THE PIEDMONT PROVINCE

By Thornton L. Neathery

Because no ERTS-1 data has been received to date for the Piedmont Province, no report can be provided at this time. Survey-supported geologic mapping continued to be carried out in the area during the report period and should serve as a basis for evaluation when data is made available.

REPORT ON THE SIGNIFICANCE OF ERTS-1 DATA TO COASTAL PLAIN GEOLOGY

By Charles W. Copeland, Jr.

I made a brief examination of the Band 4, 5, 6, and 7 images to determine applications of the ERTS imagery to the delineation of structural features in the Alabama Coastal Plain.

Several large faults have been mapped at the surface in Choctaw, Clarke, Wilcox, and Washington Counties. The general lack of exposures and high degree of weathering have made it difficult to map these faults. A present objective of the current ERTS study is to see if ERTS imagery will aid in the definition of these structural features. Other unmapped faults may also occur in the region and ERTS imagery will be analyzed for these.

A series of numerous en echelon, high angle reverse faults have been mapped in Sumter and Marengo Counties. The faults are known collectively as the Livingston Fault zone and the zone can be traced on conventional air photo mosaics southeastward from southern Sumter County into northern Marengo County. The fault zone is thought to extend further to the east into central Dallas County. Another objective of the current investigation is to better define the fault zone and trace its eastward extent by the use of ERTS imagery.

The Apollo photographs of the Mobile Bay region reveal several lineaments in Mobile and Baldwin Counties. There are no faults mapped at the surface in these counties, but these lineaments may suggest a fault trace in the subsurface which has been buried by a veneer of Miocene to Holocene

clastic sediments. Minor faults are known in the subsurface in these counties, but a lack of well control prohibits an exact correlation of the known faults with the lineaments. Another objective of the present study is to examine these Baldwin and Mobile County lineaments on ERTS imagery.

Two things of interest have been noted on the ERTS imagery. The ship channel in Mobile Bay is visible on image 1050-15560-5. The water depth on the upper edge of the channel is from 10 to 20 feet deep. A pronounced circular feature was noted on image 1050-15551-5 in the vicinity of the Alabama River in Lowndes County. The feature situated in an ancient river meander or former oxbow lake has been located on the Autaugaville topographic sheet with its center being located near the section corner common to secs. 32, 33, T. 16 N. and secs. 4 and 5, T. 15 N., R. 14 E. The area is underlain by Quaternary alluvial deposits and the Mooreville Chalk of Late Cretaceous age. It will be necessary to visit the area to determine if the feature is related to geology, hydrology, or land use.

The imagery from the September 11 pass is of very poor quality and will not assist any of the objectives of the present study. However, better imagery, with excellent contrast and resolution would be very valuable. The study will also require negatives from which color composites and enlargements can be made.

REPORT ON THE SIGNIFICANCE OF ERTS-1 DATA TO THE ECONOMIC GEOLOGY OF ALABAMA

By W. Everett Smith

Evaluation of the photographs thus far furnished us has led to the conclusion that photograph quality is below our expectations. On the positive side, we are able to distinguish patterns of strip mining activity, leading to the tentative conclusion that the photos can be used for strip mine monotoring and land reclamation activities related thereto. Surface mine development for mineral production other than coal can be observed, and with improved photo resolution subtle changes in existing mine development and development of new mines should be distinguisable. Geochemical work across selected lineaments is being planned, but awaits further field checking of these features.

REPORT ON THE SIGNIFICANCE OF ERTS-1 DATA TO HYDROLOGIC STUDIES IN ALABAMA

By George F. Moravec

PROBLEMS IMPEADING PROGRESS

The scale and resolution of the initial Alabama ERTS photographs are generally marginal for the purpose of detailed hydrologic study. However, equivalent photographs of Mississippi are of significantly higher quality, and they offer encouragement that some detailed hydrologic studies are possible.

ACCOMPLISHMENTS AND PLANS

The available ERTS data for Alabama has been tentatively reviewed for possible hydrologic applications. Because of the marginal quality and small scale of the ERTS photos, only large scale features can be delineated; consequently, we are limited to analysis of large scale features affecting hydrology from which only generalized assumptions can be drawn. More data of higher quality is needed for an in depth study.

For the next reporting period, attention will be directed towards evaluation of ERTS data to the morphology of major drainage basins and the interrelationships of physiography and geology to both surface and ground water.

RESULTS

One application of band 6 and 7 photos is in the inventory of water bodies. Lakes or ponds as small as 10 acres from both band photos have been correlated to a map of recently inventoried impoundments. With better resolution, smaller water bodies may be identified.

Large scale depositional features such as bars, cut banks, slipoff-slopes, meander scars, deep channels, spits, etc., for many rivers are evident. Study of these features may add greater accuracy to the modeling of stream depositional characteristics for a given basin.

More data of higher quality must be obtained before any detailed analysis can be accomplished.

REPORT OF THE SIGNIFICANCE OF ERTS-1 DATA TO THE ENVIRONMENTAL GEOLOGY OF ALABAMA

By Paul H. Moser

INTRODUCTION

A preliminary analysis of the ERTS photography for use in environmental geology indicates that the existing scale (1:1,000,000) is too small to delineate anything but "mega features" such as rivers, large lakes, mountains and mountain ranges, large escarpments, shorelines, islands, cultivated and forested lands, etc. If these photographs were blown up two or preferably four times, the resolution of physical features would be far better, and we would benefit from the photographs far more.

The possibility of having photographs available of the same area every 18 days is a fascinating concept. However, the features I would be interested in would be those that would be noted over a longer period of time, say 12 months or more. Most of the features I would be interested in would be a "one shot affair," or else over considerable time span.

SCALE

The present scale (1:1,000,000) is so small, that the State Relief Map (1:500,000) in many cases yields more information. By far the best scale that I have seen for any type of significant work is the 1:400,000 color composites developed from the data received. A scale of 1:250,000 would be even better and would conform to the Army Map Service maps.

BEST BAND

For my type of work, the false color IR composite appears to be a good tool. The image is not clear (water-land contact) but I assume this will be cleared up though when the process is refined. I may be influenced at this time because the scale of the photos I have seen.

The band 5 (red), 1:1,000,000 scale appears to be good for our use. This appears to be particularly good to delineate cultivated land, meander scars, urban areas, drainage areas and chalk outcrop. I foresee using this band above all others if it can be obtained at a decent scale.

The band 7 (IR) also appears to be very good for delineating bodies of water and cultivated areas.

Band 4 (green) appears to have no readily apparent application.

Band 6 (IR) with its scan skips is not usable in its present state. Hopefully this can be cleared up in the future.

POTENTIAL USES

At this time, after a very cursory look, it appears that present land use maps probably can be generated from ERTS photography to outline the following features:

strip pits

urban areas

forested land

cleared-cultivated land

potential recreation areas surrounding bodies of water

There is a possibility that changes in shoreline, shore deposits and islands on the Gulf Coast can be mapped. This would involve a progression of early to recent maps, then ERTS photographs to extend over a longer period of time.

A generalized slope map probably can be generated. This may be along the lines of the following categories:

rugged relief - @ more than 15%

moderate relief - @ 8 to 15%

slight relief - @ 2 to 8%

very slight relief - @ less than 2%

This would of necessity be a highly generalized map and would entail a lot of interpretation on the worker's part. Where we have 7½-minute coverage, this breakdown and percent slope could be checked.

SUMMARY

1. It would be highly desirable to have all our coverage on at least a 1:500,000 scale. With even larger scale, the possibilities of what can be done become far greater. A 1:250,000 scale would be desirable.
2. Hopefully resolution on some subsequent deliveries will be better.
3. Stero pairs - at least on some bands might prove useful in seeing things not visible on a single photo. With 25-30 percent side lap, this would be possible, but up to the present only orbit L imagery is available.
4. Color composites or color IR will probably prove to be one of the best products available to us.

REPORT ON THE SIGNIFICANCE OF ERTS-1 DATA TO THE ENERGY RESOURCES OF ALABAMA

By Donald B. Moore

Subsurface anomalies such as anticlines, domes, and faulting are numerous in Alabama and in general are the prime mechanism for the trapping of oil and gas. Some of these structural features have already given up large quantities of oil. For instance, the Citronelle Oil field in northern Mobile County, a domal structure which has surface expressions, has produced over 100,000,000 barrels of oil. Many other subsurface structures have excellent potential for the production of hydrocarbons. The location and configuration of some are known, but undoubtedly, many others exist which have not yet been detected. Many of the subsurface anomalies, both known and unknown have surface expression to varying degrees.

In an appraisal of the initial ERTS imagery, several surface anomalies were seen which are known to reflect subsurface geologic structure. In reviewing frame 1050-15560-5 (red band), radial anomalies can be pointed out in Mobile County which coincide with known subsurface structure; the most prominent is the apparent domal structure at Big Lake Creek.

Frame 1050-15553-6 (infrared) is of poor quality but a prominent lineament can be detected which extends from southern Monroe County across northern Baldwin County. This same lineament is even more pronounced in band 7 (infrared).

The ERTS imagery can be a very excellent tool in detecting surface anomalies which may reflect subsurface structure possessing excellent oil and gas producing potential. In the coming months, this approach will be pursued.

EXHIBITS

EXHIBIT 1

ERTS-A Co-Investigator Duties

J. A. Drahovzal (P.I. for GSA effort, paleontologist-stratigrapher)

Administration of GSA's part of ERTS-A project; geology of the Paleozoic rocks in Alabama as it relates ERTS-A data with particular emphasis on the mapping and investigation of lineaments. Collection of ground truth geologic data applicable to ERTS-A data.

G. Moravec (hydrologist)

Co-ordination with Dr. Whittle and others concerned with hydrological aspects of study. Assisting in location of remote data collection platforms. Responsible for tie in of USGS's and GSA's water resource data collection network with data collection platform information. Application of ground-truth hydrologic data including water sampling, to ERTS-A data.

T. L. Neathery (metamorphic geologist)

Geology of the Piedmont province in Alabama as it relates to ERTS-A data. Collection of ground truth geologic data applicable to ERTS-A data including soil and rock sampling for chemical analyses.

W. E. Smith (economic geologist)

Economic geology and its relationship to ERTS-A imagery. Design, execution, and administration of soil, water and rock sampling program as it relates to mineral resources.

C. W. Copeland (stratigrapher-paleontologist)

Geology of the Coastal Plain province as it relates to ERTS-A data.

EXHIBIT 1 - Cont.

D. B. Moore (energy resource geologist)

Applications of ERTS-A data to exploration and management of energy resources.

P. H. Moser (environmental geologist)

Application of ERTS-A data to environmental geology.

T. J. Joiner (Assistant State Geologist)

Administration of GSA's effort in the ERTS-A project. Consultant on geology of the Coastal Plain province and structural geology

J. L. G. Emplaincourt (geographer)

Remote Sensing Section. Management of remotely sensed data, co-administrator of ERTS-1 GSA project.

ERTS-1 SCHEDULE FOR ALABAMA

August 4, 1972 - June 27, 1973

J* 10:04 A.M.**		K* 10:04 A.M.**		L* 10:04 A.M.**		M* 10:04 A.M.**	
Date	Orbit No.	Date	Orbit No.	Date	Orbit No.	Date	Orbit No.
8- 4	166	8- 5	180	8- 6	194	8- 7	208
8-22	417	8-23	431	8-24	445	8-25	459
9- 9	668	9-10	682	9-11	696	9-12	710
9-27	919	9-28	933	9-29	947	9-30	961
10-15	1170	10-16	1184	10-17	1198	10-18	1212
11- 2	1421	11- 3	1435	11- 4	1449	11- 5	1463
11-20	1672	11-21	1686	11-22	1700	11-23	1741
12- 8	1923	12- 9	1937	12-10	1951	12-11	1965
12-26	2174	12-27	2188	12-28	2202	12-29	2216
1-13	2425	1-14	2439	1-15	2453	1-16	2467
1-31	2676	2- 1	2690	2- 2	2704	2- 3	2718
2-18	2927	2-19	2941	2-20	2955	2-21	2969
3- 8	3178	3- 9	3192	3-10	3206	3-11	3220
3-26	3429	3-27	3443	3-28	3457	3-29	3471
4-13	3680	4-14	3694	4-15	3708	4-16	3722
5- 1	3931	5- 2	3945	5- 3	3959	5- 4	3973

EXHIBIT 2

ERTS-1 SCHEDULE FOR ALABAMA - CONT'D.

August 4, 1972 - June 27, 1973

J* 10:04 A.M.**		K* 10:04 A.M.**		L* 10:04 A.M.**		M* 10:04 A.M.**	
Date	Orbit No.	Date	Orbit No.	Date	Orbit No.	Date	Orbit No.
5-19	4182	5-20	4196	5-21	4210	5-22	4224
6- 6	4433	6- 7	4447	6- 8	4461	6- 9	4475
6-24	4684	6-25	4698	6-26	4712	6-27	4726

*Ground Track
**Approximate Local Time

EXHIBIT 2 - Cont.

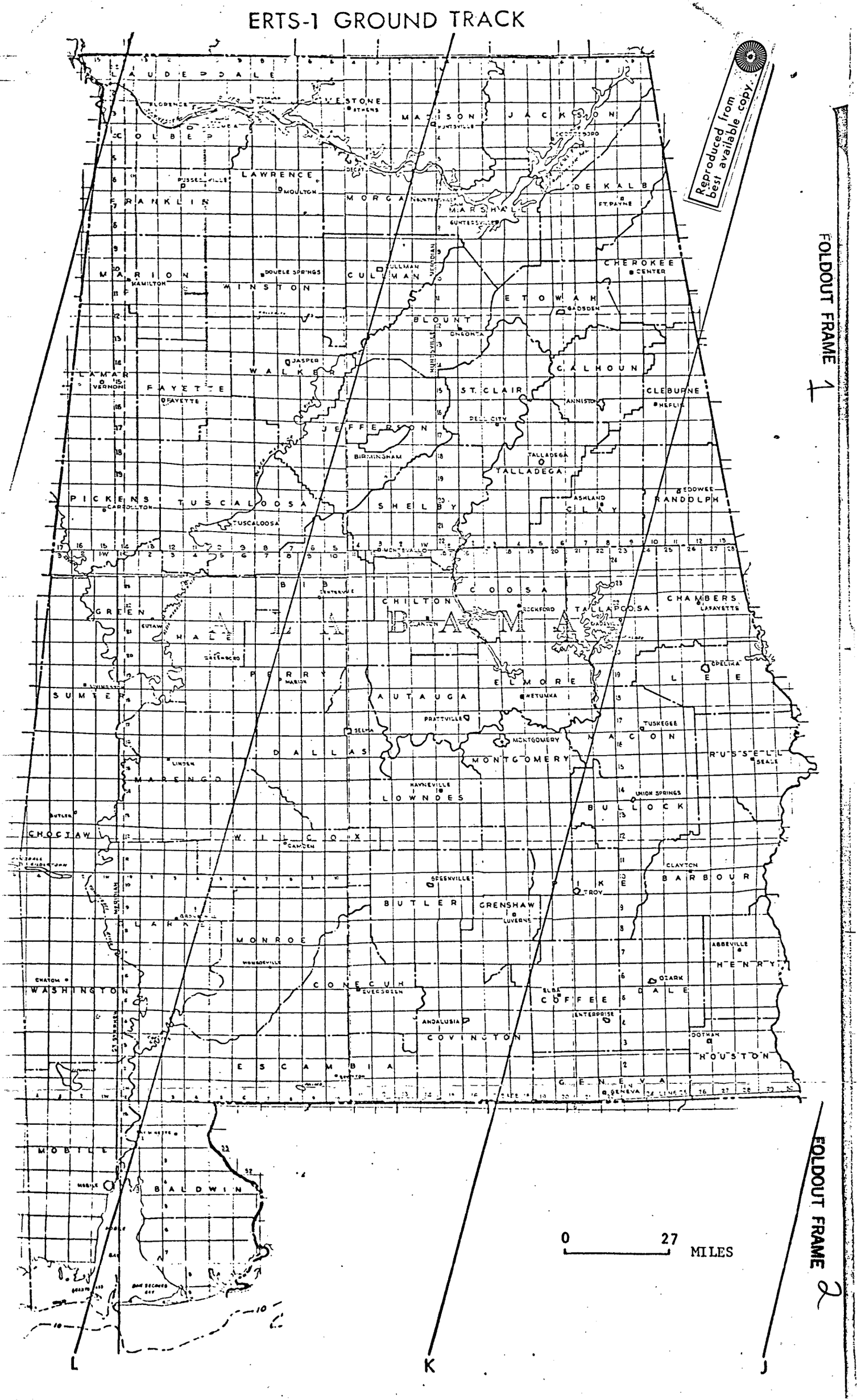
ERTS-1 GROUND TRACK
Reproduced from best available copy.
FOLDOUT FRAME 1
FOLDOUT FRAME 2
L
K
J
0
27
MILES
LAUDERDALE
COLBERT
LAWRENCE
FRANKLIN
MARION
WINSTON
LAMAR
FAYETTE
PICKENS
GREENE
SUMTER
MARENGO
CHOCTAW
WASHINGTON
MOBILE
BALDWIN
LIMESTONE
MADISON
JACKSON
MORGAN
MARSHALL
DE KALB
CULLMAN
CHEROKEE
ETOWAH
BLOUNT
WALKER
JEFFERSON
ST. CLAIR
CALHOUN
CLEBURNE
TUSCALOOSA
SHELBY
TALLADEGA
CLAY
RANDOLPH
CHILTON
COOSA
TALLAPOOSA
CHAMBERS
HALE
PERRY
AUTAUGA
ELMORE
LEE
DALLAS
MONTGOMERY
TUSKEGEE
MACON
RUSSELL
LOWNDES
BULLOCK
WILCOX
CLARKE
MONROE
BUTLER
CRENSHAW
PIKE
BARBOUR
CONECUH
COVINGTON
COFFEE
DALE
HENRY
ESCAMBIA
GENEVA
HOUSTON

EXHIBIT 3

REMOTE SENSING SECTION NEWSLETER

REMOTE SENSING SECTION NEWSLETTER

Vol. 1, No. 1 November 27, 1972

THE WHAT?

The newly created Remote Sensing Section, which is headed by Jim Drahovzal, is located within the Paleontology-Stratigraphy Division of the Geological Survey of Alabama. Jacques Emplaincourt and Chuck Wielchowsky staff the Remote Sensing Laboratory which can be found in the north basement. All available Alabama imagery is stored in this laboratory and viewing equipment either has been or will be installed. This laboratory was created for the use of all G.S.A. personnel and we encourage you to come and visit us.

One of the Remote Sensing Section's primary goals is to effectively manage the remote sensing data that has been collected within our state; therefore, we must inform the potential user in G.S.A. of the availability of these data. This is why we are "publishing" this Newsletter on a fairly regular basis.

ERTS NEWS

The Remote Sensing Section now has ERTS-1 data available for examination. These data are composed of 5 scenes taken over the state on September 11, 1972. The orbital path of the scenes runs in a northeast-southwest direction from north-central Alabama through Mobile Bay. (This orbit has been designated "orbit L".) There are 4 frames for each scene, one frame representing a particular band of the electromagnetic spectrum:

Band 4 = green band = .5μ - .6μ
Band 5 = red band = .6μ - .7μ
Band 6 = IR band = .7μ - .8μ
Band 7 = IR band = .8μ - 1.1μ

The quality of the data is fair, some of it being lost in the reproduction process at the Marshall Space Flight Center. The main flaws appearing on the imagery are: 1) Newton rings (particularly on band 4); 2) Whitening effects around water bodies, especially around Mobile Bay and the Tennessee River, appearing on band 7; and 3) in general there are shadows along the edge of the frames in all 4 bands.

All of the flaws listed above resulted from or occurred during the reproduction processs. Marshall has indicated that they will try to clear them up. Another thing that should be mentioned is that the reproduced data contain more contrast than the original data, and therefore are better suited for examination by the naked eye (i.e., landforms appear more distinctly).

Fortunately the cloud cover over the state for orbit L is 10 percent at the most (except over the Gulf).

We welcome all of you who are involved in the ERTS-1 project to come by the Remote Sensing Laboratory and examine the data at anytime.

MORE ERTS NEWS

On Tuesday, November 22, we (Chuck and Jim) visited the Environmental Applications office at Marshall Space Flight Center and worked with Jim Darington on some of the ERTS data. The main purpose of the visit was to get a look at MSFC's present set up and to provide the ERTS-1 research group with some color composites of Alabama scenes. MSFC now has 3 International Imaging Systems (I^2S) color additive viewers. This machine allows the operator to make composites of up to four separate single band products. By projecting and superimposing the green band positive transparency (ERTS's band 4) through a blue filter, the red band (ERTS's band 5) through a green filter and the infrared (ERTS's band 7) through a red filter, a composited color infrared picture is produced. In addition, the intensity for each single band may be varied as desired.

We used this viewer with the September 11 imagery that was recently supplied to the ERTS-1 research team. MSFC had made 9½ x 9½ inch transparencies from the print data that had been received from Goddard for the project. This is the same data that the Survey has received through this project. Because the viewer was not designed to use 9½-inch chips, the images had to be cut into quarters and formatted on a 9½-inch piece of film. The viewer magnifies by about 2½ times, and so the 1:1,000,000 imagery was increased to 1:400,000 on the screen. We then photographed the screen for both slide and print copy. In addition, the NASA people used a camera pack that allowed them to make contact tranparencies of the screen's image. These proved to be quite good. None of the color compositing is or will be as good as that that is being provided by the EROS Data Center. These composite products are available in the Remote Sensing Laboratory. We are still working with Tom Stone and his staff on photographic methods of producing ERTS-1 color composites.

PRG PROJECT INFORMATION

The Prescott Research Group (PRG) in cooperation with U.S.G.S. and G.S.A. personnel has begun a remote sensing study of the surface waters in the Mobile area. A single engine seaplane called the Beaver is being utilized in this research effort. Rhodamine dye was dumped into the upper reaches of the Mobile River and traced by color aerial photography. According to Bill Meyer, a hydrologist from PRG, this study is a first in that no previous remote sensing investigation of the flow characteristics of a river has ever been backed up by extensive ground truth data collection.

Meanwhile, work is progressing on the installation of a radar unit at Brookley Field, Mobile. This radar will allow accurate location of any aircraft utilized in remote sensing studies within a 125 nmi. radius of Mobile.

We would like to restate that anyone who is interested in obtaining imagery which can be utilized in a current or future project should contact this office. We will be glad to discuss the possibilities and systems with you.

EROS ERTS-1 DATA USER STUDY

The Survey is now deeply involved in the study of a group of ERTS-1 select data users. Through this research, which is being carried out for the EROS Program, G.S.A. seeks to determine practical applications of ERTS-1 data and to evaluate the general interest and response of potential ERTS data users in Alabama. To this end a meeting was held with Gary North of the Mississippi Test Facility (a regional EROS data center) to determine the most suitable data formats. A symposium is planned in the very near future for potential data users. In this symposium various spearkers will offer guidance to the potential users. This effort promises to involve the entire state in remote sensing of our earth resources.

TENNESSEE-TOMBIGBEE WATERWAY REMOTE SENSING STUDY

Last Monday, November 20, Tom Joiner, Jim Drahovzal, and Chuck Wielchowsky visited Professor Frank Miller at Mississippi State to determine if there was any additional imagery available of the Alabama portion of the waterway. Professor Miller is a forester who has done considerable work in remote sensing related to the waterway route. We obtained a list of all NASA RB-57 imagery that covered Alabama. These data consist of 1/12,000, 1/24,000 and 1/50,000 color and color IR transparencies. We may be obtaining some of this imagery from the EROS Data Center in the near future.

IRIS

In order to efficiently manage all the imagery and imagery data that G.S.A. has on hand or will receive, a computer based filing and retrieval system was designed by the Remote Sensing Section. This system has been given the acryonym IRIS (Imagery Retrieval and Information System) and is now in the implementation phase. When it becomes fully operational, the user may request imagery or imagery information based upon any criterion or group of criteria.

REMOTE SENSING COURSE TO BE OFFERED!!

Dr. Harold Henry, chairman of the Civil and Mineral Engineering Department, has announced that his department will be offering a course in Remote Sensing. This is the first time that such a course will be offered on campus. The purpose of such an innovation is not only to familiarize a greater number of students with Remote Sensing, but also to involve possible state users. According to Henry, the course is open to students from all disciplines and also to any interested members of the community who do not have to be officially enrolled in it. The course, CE-392, CE-182, or EM-192, "Application of Remote Sensing," is open to both undergraduate or graduate students, and carries 0-3 hours credit. Classes will meet 1 hour a week (probably in the evening) and will be of the seminar-discussion type. Guest speakers are scheduled on a regular weekly basis; a list of topics and speakers will soon be available (The Remote Sensing Section here will keep you informed). Some G.S.A. personnel will make presentations; others plan to audit the course. We encourage any G.S.A. member to attend.

PARTING SHOTS

The relatively new technology of remote sensing has become an important tool for many workers in a number of scientific disciplines. Indeed, geologists and hydrologists at G.S.A. have been leaders in the field of remote sensing applications; however, there remains a vast quantity of data that has been virtually untouched. We of the Remote Sensing Section would like to urge you to visit our laboratory and look at our data. Not only might you find some information that will help in a current project, but you might also see applications that no one before you has ever dreamed of. We have articles on file that explain the various types of remote sensing techniques, and we will be glad to lend them to you. Remote sensing technology can add a new dimension to many of the projects in which G.S.A. is now involved. All you have to do is come by and look. Then you can say, as did Henry David Thoreau, "I see beyond the range of sight, new earths and skies and seas around" (from "Inspiration").

EXHIBIT 4

MAP SHOWING NEWLY TRACED LINEAMENTS AND
ERTS-1 IMAGERY - APOLLO 9 PHOTOGRAPHY COVERAGE

EXHIBIT 5

ERTS-1 IMAGERY OF MOBILE BAY

By James A. Drahovzal

Reprinted From

RECENT SEDIMENTATION ALONG THE ALABAMA COAST

Leon Scarbrough, Editor

Alabama Geological Society Guidebook

10th Annual Field Trip
1972

ERTS-1 Imagery of Mobile Bay*

by James A. Drahovzal
Geological Survey of Alabama
University, Alabama

Remote sensing technology is finding increasing application in the fields of geology, hydrology and oceanography. Not only does this relatively recent technological development represent a new interpretive tool, but it also provides a means of greatly increasing the speed at which many types of data may be collected.

With the launch of the Earth Resource Technology Satellite (ERTS-1) on July 23, 1972, a most significant step was taken toward the establishment of an operational earth resource monitoring system. The satellite, a modified Nimbus, is in a 920-kilometer (570-mile) Sun-synchronous, circular, near-polar orbit which allows it to return to the same sub-orbital position every 18 days. Two imaging systems on board permits the Earth observatory to image areas 185 kilometers (115 miles) on a side. One of the systems consists of three Return Beam Videcon (RBV) television cameras. One camera images in the green part (0.475 - 0.575μ) of the spectrum, one in the red (0.560 - 680μ) and one in the near infrared (0.690 - 0.830μ). The other imaging system is the Multispectral Scanner (MSS). This devise is a four-band scanner

*Approved by the State Geologist

operating in the solar-reflected spectral region from 0.5 - 1.1μ. It scans cross-track swaths 185 kilometers (115 miles) in width, imaging six scan lines in each of the four spectral bands simutaneously. The four selected spectral bands are: green (0.5 - 0.6μ), red (0.6 - 0.7μ) and two infrared (0.7 - 0.8 and 0.8 - 1.1μ).

Coverage in Alabama began on August 6, 1972. On that day, the ERTS-1 imaged Alabama along a suborbital path running from Huntsville through Mobile Bay (orbit L as designated by NASA). The Mobile Bay scene was recorded by both the RBV and the MSS sensors; however the quality of the latter is poor. The red band product of the RBV is shown in Figure 1. The red band reduces atmospheric interference and provides the best information on the distribution of cultural features. Note that most of the roads, bridges, fields and urban areas may be distinguished on the photograph. The highly reflective beach sand and/or the surf zone probably account for the accentuated outlines of the offshore islands. The origin of some of the patterns in the Gulf of Mexico are unknown, but may represent wave groupings. Other features may be shoals or thin clouds.

Ideally, the Mobile Bay scene is imaged by the two imaging systems every 18 days at a few minutes past 10:00 a.m. Due to a malfunction on board the ERTS-1, however, RBV data

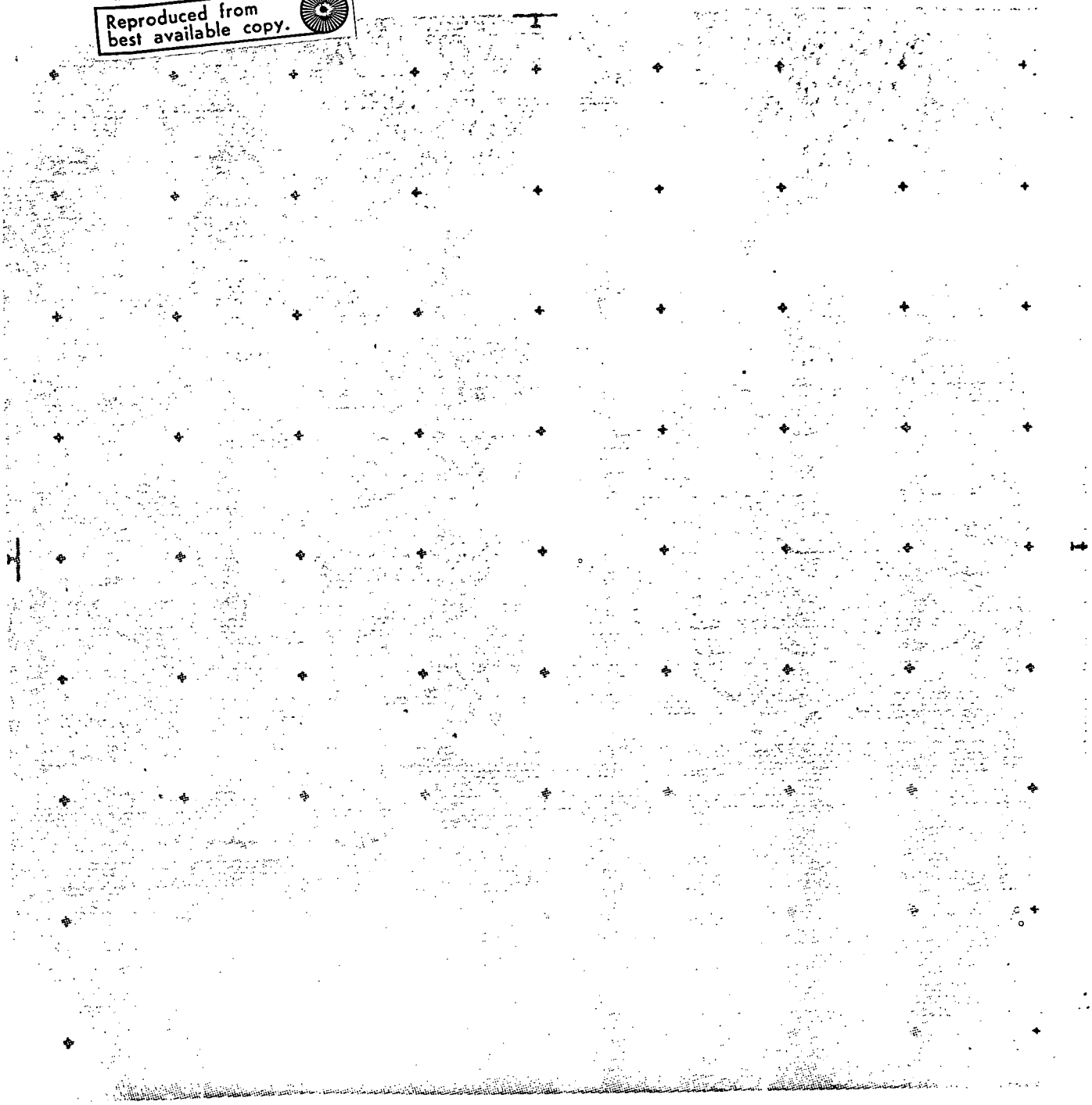

Figure 1. Redband RBV imagery of Mobile Bay taken August 6, 1972 by ERTS-1 from 913 kilometers (566 miles). Photo by NASA, courtesy of the Geological Survey of Alabama's EROS research, contract number 14-08-0001-13377.

have not been received since August 6, 1972. The MSS system, however, is continuing to provide excellent information. Cloud cover, of course, prevents the collection of useable data on an 18-day basis. The following is a tabulation of data released by NASA to date for the Mobile Bay area. This data is available to the public from the EROS Data Center, Sioux Falls, South Dakota.

Frame No.	Date	Sensor	Quality	Cloud Cover %
1014-15555-2	8/6/72	RBV	Poor	10
1014-15555-5	8/6/72	MSS	Good	10
1032-15555-5	8/24/72	MSS	Good	30
1050-15560-5	9/11/72	MSS	Good	50
1086-15562-5	10/17/72	MSS	Good	20

Such 18-day coverage is projected to last until July of 1973. NASA is slated to launch a second ERTS in November of 1973 and similar data will be available from it. Earlier next year, NASA will launch Skylab, a manned satellite, which will, as part of its duties collect imagery of the earth. Current plans call for Mobile Bay coverage on May 8 and 19, 1973, September 15, 1973 and October 20, 1973.

Evaluation of the available Alabama imagery is beginning to take place. Most of this is being done through two ERTS projects which are currently in progress in the State. One funded by the Earth Resource Observation System (EROS) Program is being conducted by the Geological Survey of Alabama. This research seeks to determine the usefulness of ERTS data to a

group of selected users in the State who represent a variety of earth resources study disciplines. The other, funded by NASA, is being carried out by the University of Alabama, the Geological Survey of Alabama, Marshall Space Flight Center and the Alabama Marine Science Institute. This program is studying the feasibility of applying remotely sensed data in the management of natural resources and the improvement of environmental quality in Alabama. The usefulness of remote sensing data to inventory and management problems in Alabama should become somewhat better defined in the next year or two as the result of these two programs.

Distribution: 1 copy each to:

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