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Processing of ERTS Imagery for Dissemination Purposes

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Quarterly Progress Report 5/18/75 - 8/18/75

Prepared for
Goddard Space Flight Center
Greenbelt, Maryland 20771

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16. Abstract

Specially optically processed bands of LANDSAT scenes (ID#1390-17230 & 1353-17183) were halftoned and combined in cromalin color proofs to evaluate various combinations. The selected color images of the 48 conterminous States as prepared by EDC were critiqued and improvements agreed upon.

It was determined that over land masses bands 5 & 7 combined are in most cases equal to or superior to bands 4,5, & 7 insofar as color rendition of image data are concerned for general purpose portrayal.

A digital scene enhancement by JPL of the Florida Keys using increased band 4 contrast shows that for optimum rendition of shallow sea areas different processing is required from that accomplished over land areas.

17. Key Words (Selected by Author(s))	18. Distribution Statement
spectral band enhancement, contrast improvement, photographic processing, digital processing.	Leave Blank

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Figure 2. Technical Report Standard Title Page

Quarterly Progress Report

a. TITLE - Processing of ERTS Imagery for Dissemination Purposes

b. GSFC I.D. No. 23650

c. Statement and explanation of any problems that are impeding the progress of the investigation:

The critical problem relative to the production of LANDSAT imagery in photographic form is the determination of when and how to convert from digital to analog mode. This problem cannot be resolved until the two basic types of imaging devices (electronic vs. optical-mechanical recorder) are objectively tested and compared. Since NASA/Goddard has the only suitable electronic recorder (EBR), they must take the lead in testing this device. Most of the enhancement techniques now employed through digital manipulation by agencies such as LARS, University of Michigan, University of Illinois, and JPL can be applied as algorithms to the EBR. This agency has requested such action (see Attachment A), and with Goddard's acquisition of a second EBR it is hoped that such testing will be accomplished. The investigators are prepared to work with Goddard on the detailed implementation of such tests.

d. Accomplishments

Two LANDSAT scenes in the Powder River area of Wyoming and Montana (I.D. #1390-17230 and 1353-17183) were photographically manipulated by the Goddard LANDSAT photo lab on special request (see Attachment B).

The images were processed for (a) atmospheric removal, (b) increased contrast of selected bands, (c) normal. The USGS photo lab then converted the continuous tone imagery into halftone graphic arts film positives in order to make cromalin color proofs of various combinations. Analysis of these proofs revealed that the increase in contrast, especially band 4, provided a more attractive and informative product. It was concluded finally that for optimum image content we should (a) increase the contrast of band 4 by 0.20, (b) decrease the contrast of band 7 by 0.20, (c) not change the contrast of band 5.

Although similar effects can be obtained by lowering the contrast of band 7 by 0.25 and band 5 by 0.15, and leaving band 4 the same, the result is an overall lower-contrast version which is not as effective as the higher-contrast version.

When compared to the conventional 4-, 5-, and 7-color composite, the two-band (5 and 7) version often shows improved resolution over land masses. However, shallow-water penetration is degraded. Shallow-water areas require band 4 for optimum information content. It has even been recommended that band 4 be opened in the blue region to perhaps 0.45 μm to make it even more effective in water penetration.

A digital scene enhancement by JPL of Florida Keys image (E1584-15190) was evaluated. The resultant color composite, formed using increased contrast in band 4 and other algorithms termed ERTSFIX, revealed greater water penetration and overall better photometric response. Additional color composites were made with colors interchanged, i.e., band 4 as magenta instead of yellow, band 5 as yellow

instead of magenta. Although the color version that resulted did not look like a conventional color composite, the tonal range of magenta revealed more data in the water features.

e. Results

This work reveals that the normal color composite rendition of land areas is not suitable for the depiction of clear shallow seas where optimum depiction of the sea bottom is critical. Either in the digital or analog (photographic) domain response must be altered from that now employed for land areas.

f. Publications and reports

None during this period.

g. Recommendations concerning practical changes in operation

It is recommended that the effect of opening band 4 in the blue region be determined and that more LANDSAT imagery be acquired over shallow seas, particularly with the high-gain settings of bands 4 & 5. It is also recommended that the separate bands of MSS imagery be photometrically balanced before being composited in color form.

h. Changes to standing order forms

N/A

i. ERTS image descriptor forms

N/A

j. Listing of any changed data request forms

N/A

Attachment A

United States Department of the Interior

GEOLOGICAL SURVEY
12201 SUNRISE VALLEY DRIVE
RESTON, VIRGINIA 22092
522, National Center

October 15, 1974

Memorandum

To: Goddard Space Flight Center
Attn: 902

From: Anthony Salerno

Subject: Investigation and Research of ERTS Imagery - ERTS-B Experiment, "Processing of ERTS Imagery for Dissemination Purposes"

Background:

At the present, the EBR is used to convert computer tape information into photographic imagery. These images are positives of each of four MSS bands, namely 4, 5, 6, and 7. The scene brightness range of the imagery is recorded as the MSS sensor receives it, whereas the EBR transforms the digital information into photographic images. Although a 15-step gray scale is also portrayed along with the terrain reflectance, there is very little correlation between the scale and the image range.

Assessment of these images reveals that in most cases the given record of band 4 is very low in contrast, and even when composited with the other bands for a color IR portrayal, very little information is conveyed. In fact, color composites of bands 5 and 7 in a large majority of cases show just as much or more information as a composite with bands 4, 5 and 7.

On the other hand, band 7 exhibits a very large contrast ratio. We have seen that this band, as normally recorded and used, obliterates or masks some of the important information that bands 5, and decidedly band 4, contains or should have contained.

In addition to this contrast difference between bands, the same scene or area on the Earth varies in overall density (exposure) as a function of the season. This seasonal difference in exposure is mainly due to the difference in sun elevation, thereby causing changes in overall illumination.

USGS Proposal:

Experiments conducted to date raising the contrast level of band 4 and lowering the contrast of band 7 have shown that much information is recaptured and enhanced. However, some disciplinarians infer that manipulating third generation photo material may reduce the resolution of the imagery. We therefore propose the following investigation be conducted on the EBR at Goddard:

1. Raise the contrast or density range of band 4 to several other ranges, i.e., if the range is presently 1.0, raise it to 1.2, 1.4, 1.6, and 1.8. We prefer the contrast changes be done in the EBR.

2. Do not change the range of band 5, but do generate a first generation positive (PI) along with the adjusted ranges of band 4 so that there is a common chemical activity, thereby precluding gamma changes by chemical means.

3. Lower the range or contrast of both band 6 and 7 in the EBR. Again, as an example, if the range is 2.0 now, lower it to 1.8, 1.6, 1.4, 1.2. Process these positives at the same time and in the same chemistry as the other exposures or tests.

We also ask that the overall density be modulated according to sun elevation in order to achieve optimum response on the H&D (D-log E) curve of the positive (pl).

An outline of the work to be done is as follows:

1. A complete set of positives (pl) as normally produced shall be printed and used as control.

2. For a given range of latitudes, use as a standard exposure level, scenes produced in the months of March and September. (February, April, August, October scenes may be included. However, these months may contribute a 1/3 stop exposure change which we feel is negligible.)

3. The exposure of scenes taken in May, June, and July should be made one stop less when printed in the EBR, i.e., raise each density level an additional 0.30 units.

4. Scenes taken in November, December, and January should be increased one stop, i.e., lower each density by 0.30 units.

The particular ERTS images on which we sould like test runs are as follows:

DATE	SCENE I.D.	AREA
August 17, 1973	1390-17230	Montana
July 11, 1973	1353-17183	Wyoming
December 2, 1973	1497-15332	Ohio (winter)
July 6, 1974	1713-15275	Ohio (summer)
March 22, 1973	1242-15240	Everglades
February 27, 1974	1584-15190	Florida Keys

Followup:

We at USGS will then make several color composites with various combinations. Initially the first few composites will be made with a priori prediction. Other choice composites will be made empirically after some jury analysis.

Reports and samples will be submitted to NASA for briefing, evaluation, and basis for future experiments or specifications.

Anthony Salerno

Anthony Salerno

Attachment B

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

APR 01 1975

REPLY TO
ATTN OF: 563.1

Mr. A. Salerno
National Center
Mail Stop 522
U.S. Geological Survey
Reston, Virginia
22092

Subject: Written description of technique used to produce a comparison test of False Color Images

The enclosure is a follow up to the verbal description I gave of how the products you received were produced. If you have any questions, do not hesitate to call me.

Sincerely,

Arnold R. Shulman

Arnold R. Shulman
Image Processing Facility Operations Section
Image Processing Branch
Information Processing Division

Enclosure