LARS Contract Report 033180

Monthly Progress Report

Training Course Entitled "Remote Sensing for Mineral Specialists"

Award No. YA-553-RFPO-2

Reporting Period: March 1-30, 1980

submitted to: Bureau of Land Management
Denver Federal Center
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April 1980

Abstract

March, 1980, was the month of greatest activity by course staff. The major accomplishments were:

1) completion of all final course arrangements that had not previously been settled, specifically for videotaping the course and for the hotel reservations for course participants and staff,

2) preparation, duplication, and packing of slides, handout materials, and other course equipment,

3) presentation of the course March 24-28 at the Denver Federal Center, and

4) development of an approach to preparing a second course concentrating on digital analysis techniques.

Arrangements

While most of the arrangements for the course had been made well ahead of this report month, a few remaining items needed to be settled.

The most critical one was to determine how the course could be videotaped, as contracted for, within the budgeted amount. The problem arose because the change in location of the course from the University of Denver to the Denver Federal Center meant that Purdue could not hire videotaping services from the University of Denver. The solution to the problem was found through using videotaping equipment available at the Denver Federal Center and hiring a camera man from within Purdue University whose services were available to us at a low hourly rate. The decision to meet the obligation in this way appears to have been good: the equipment was adequate for the job, the taping was skillfully done, and the cost was within 5% of the amount budgeted.

A problem in available facilities arose when the BLM participants were not able to get reservations in the same hotel as the course staff. The result of this was the loss of easy off-hours discussions between the two groups and, specifically, of the no-cost room the motel had agreed to provide for evening meetings. The best arrangements that could be made to compensate for this involved Purdue renting a meeting room for use one evening for minicourse viewing and informal discussions. Student attendance did not warrant renting the room for another evening.

Preparation, duplicating and packaging

Notebook binders, blank videotapes and many printed materials were shipped via UPS prior to the course. Eight boxes were sent in this way, and all arrived within a week of shipment date. All the imagery and the remainder of the course materials were carried by the instructors.

A complete list of course equipment will be included as part of the final report.

Course Presentation

A visit to the training room on Sunday evening prior to the course gave course staff the opportunity to arrange the room properly, set up A-V equipment, and begin to distribute the materials. The facilities were excellent for the group of fourteen students, but would have been crowded for more than twenty.

The only major changes in the scheduled hours for the course were the shift of lunch to an earlier hour to avoid crowds in the cafeteria and shortening lunch from 1½ hours to 1 hour on Thursday at a student's request. Numerous minor shifts in schedule were made to accommodate present situations; these will be documented in detail in the final report.

Fourteen students attended the course, and, in addition, some individual sessions were visited by other BLM employees. No attempt was made to list these other attendees.

At the conclusion of the course, a one-hour discussion was held with the contract monitor for the purpose of further course evaluation and discussion about the course as a whole.

Course on Digital Techniques

During the week of the course, Purdue staff were able to see a demonstration of BLM's IDIMS system and to talk to BLM staff about the system. As agreed in the contract, Purdue/LARS is preparing descriptive materials that outline our approach to designing a follow-on course dealing with digital techniques. A first draft of this atatement is attached herein as Appendix A. Prior to completion of the final report, it will be revised to incorporate additional information as requested by BLM and for expansion or clarification of ideas now included.

Appendix A

Design for Part II of the Course "Remote Sensing for Mineral Specialists"

Introduction

Staff geologists employed by BLM were offered an introductory remote sensing course in visual interpretation of remote sensing data. The course, which was presented at the Denver Federal Center by Purdue University, was attended by fourteen mineral specialists.

The next step in the training sequence for these participants is to introduce them to digital techniques for extracting information from remote sensing data. The present availability of such data as well as user-oriented computer configurations makes remote sensing an attractive and effective tool for geologic analyses.

While photogeology techniques may continue to be the main means of Landsat interpretation, the amount of information recorded in the data far exceeds the amount that can be represented on a photograph. To make wise resource judgments, today's geologists need to have access to computer-aided technology, both through available hardware and through a familiarity with the technology that enables them to assess realistically the value of this tool to provide the information they need.

The approach described below has been designed by LARS/Purdue staff specifically for providing this training in digital techniques to BLM staff geologists.

1. Target audience

BLM geologists who wish to continue their study of remote sensing to include digital techniques should have a firm background in visual interpretation of photographic imagery and multispectral scanner imagery. Specifically they should understand:

a) sources of electromagnetic radiation and means of detecting it;

b) the interaction of earth surface materials with impinging radiation;

c) the principles involved in the formation of standard Landsat image products;

d) principles involved in the formation of enhanced imagery, especially linear stretch, principal components, and ratioing.

No previous experience with computer processing is necessary. Because of the individualized nature of the course and the limited facilities available, a maximum 16 participants should be enrolled. Where possible two from the same state should work together as a team; an alternative approach would be to pair participants who work with similar land types.

2. Objectives and Methods

The general objectives of the course are to acquaint the participants with digital techniques for obtaining geologic information from satellite multispectral scanner data. Techniques used for this purpose include both enhancement techniques (for subsequent visual analysis) and digital analysis for classification. Because of the greater complexity of the later approach, relatively more class time will need to be set aside for work in topics related to computer classification if the students are to gain enough information and experience to be ready to use this tool in the future.

A person who wishes to start using digital enhancement and analysis techniques needs to complete a number of learning activities. Specifically, he/she needs to:

1) acquire an understanding of the fundamental concepts behind computer-aided processing,

2) learn to work comfortably in the computer environment and be familiar with basic user-oriented hardware and software,

3) practice using the hardware and key processing functions through tutorial exercises highlighting the fundamental concepts, and

4) be aware of related work that has been done in their field using these techniques.

A variety of lectures, exercises, and hands-on activities would be the best instructional media to use for meeting these objectives.

In one week's time and with the limited number of computer terminals available, it is unreasonable to expect that course participants would be able to use digital techniques with a high degree of skill at the end of the course, much less assess fully the utility of these techniques in their own work. Acquiring that amount of expertise requires extensive experience both with the data and with the software. However, it is not too much to expect participants to acquire a good foundation in understanding the theory of digital processing, feel comfortable working in the environment of a computer terminal, and be able to perform basic functions on data of their choice. Familiarity with some of the published work of other geologists will help guide their own experimentation. In addition, some advanced analysis techniques should be introduced during the course to give participants a glimpse of possibilities yet ahead. Examples include an introduction to hierarchical classifiers, use of spatial features in analysis, and building geographic information systems. This last topic may well form the basis for a third course in the sequence.

Their are many systems available today for digital enhancement and analysis of remote sensing data, and the next five years will doubtless see the arrival of others. For these reasons, it is essential that geologists who are to be trained for tomorrow as well as today have their learning focused not on specific, machine-dependent features, but on basic concepts, such concepts as ratio enhancements, minimum distance to the mean classifications, and separability measures which are basic to all fully developed digital systems. Although the way a user calls up the software will vary from one system to the next, these motor skills are quickly learned by the user who has a theoretical understanding of the operations the software is performing.

By necessity, the hands-on portion of the course will be focused on a single system, such as the IDIMS system, but instructors should strive to broaden participants' perspectives to encompass other systems and the machine-independent concepts basic to all systems.

3. Course Content

In keeping with these objectives and methods, the course content would include the following major topics, although not necessarily in this sequence. The percentages given indicate the relative class time devoted to each category.

I. Basic image manipulation (10%)

- A. Masks, grids, graphics overlay
- B. Radiometric and geometric transformations

II. Image enhancements for mineral investigations (25%)

- A. Examples of the usefulness and limitations of image enhancements, specifically contrast enhancing, edge enhancements, ratioing, principal components analysis
- B. Theory supporting the generation of enhancements with emphases on the selection of enhancement parameters
- C. How to obtain your own enhancements, from vendors and from interactive terminals
- D. Use of visual interpretation techniques for information extraction
- E. Evaluation techniques

III. Computer-aided classification of multispectral data (35%)

- A. Univariate classifications: single-band classifications, level slicing, change detection
- B. Fundamentals of computer-aided decision-making: look-up table, partitioning, pattern recognition; statistical distance measures
- C. Multivariate classifications: unsupervised, minimum-distance-to-the-mean classification, maximum-likelihood classification; selection of training samples
- D. Evaluation of results
- E. Introduction to hierarchical classifiers (layered classification, cascade classifier) and analysis using spatial features

IV. User-interface with data processing systems (15%)

- A. Characteristics of input and output devices; obtaining hard-copy output
- B. Impact of system characteristics on user's ability to do analysis: structure of data; storage methods; array processors

C. System evaluation

V. Brief introduction to geographically organized data bases (15%)

A. Data base design

B. Introduction of digital data from other sources

C. Analysis potentials

A variety of teaching approaches should be used throughout, including a minimum of four one-hour sessions for each pair of participants using an interactive image manipulation device. Activity-oriented laboratory exercises should be used to enforce theory and to give participants practical experience in working with the data. From the point of view of course relevancy and potential for future use of the techniques, it would be ideal for participants to work with multitemporal Landsat data from areas within their own districts. This would allow them to work with areas they know and to assemble existing support data prior to attending the course. The importance of current support data (e.g., topographic maps, aerial photos, ground data, etc.) in digital analysis must be stressed so participants learn to use the tool in a scientific way. By working with their own geographic areas, they would know what data would be accessible for future analysis and they would be better able to assess, at least summarily, the potential contribution of the newly learned techniques.

4. Student and instructor materials

As part of the creation of this new course, a body of tutorial materials will be assembled for use by both the students and instructors. In some instances, the materials may be identified from the open literature, for example reprints of tutorial journal articles that address aspects of the course at an appropriate level. In other cases, materials may be taken from existing teaching files of instructors, and in still others, materials may need to be newly created for the course. All should be carefully assembled and retained for future offerings of the course, whether by the initial development group or by other instructional teams.

Student materials include such items as preliminary reading sent prior to the course, printed handouts distributed during the course, and copies of photographs, imagery, maps, printouts, etc., that all students uded during the course. Instructor materials are more extensive, including, in addition to the student materials, such items as:

* outlines or abstracts of lectures,
* slides, transparencies, and display materials,
* descriptions of laboratory or hand-on exercises, including equipment needed and problems frequently encountered.
* reproducible copies of needed photography, computer data tapes, etc., or a list of the sources of these materials.
* evaluation of the course by the students and the instructors with suggestions for future presentations of this course

The full documentation of the course may include more than these items listed. The intent is that enough document exists to make it possible to offer the identical course in the future at considerably less cost or to be able to direct wisely the expenditure of funds for course improvements.